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THE EFFECTS OF CLIMATE VARIABILITY ON COFFEE PRODUCTION IN MOSHI RURAL DISTRICT, TANZANIA

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KeyWords

Challenges, Climate Variability, Perceptions, Response, Vulnerability, Water Access

ABSTRACT

This paper aimed at exploring the effects of climate variability on coffee production in Moshi rural district. Socio-economic survey design was used and both qualitative and quantitative research approaches was employed. Data were collected using questionnaires survey, key informant interviews, focus group discussions as well as field observation. A total of 96 farmers were involved in the study. The Statistical Package for Social Sciences (SPSS) was used to analyse the data. The data were presented in condensed form in terms of tables, and figures.The findings revealed that communities were knowledgeable about the effects of climate variability. Their knowledge was based on the effects already felt and attributed to climate variability, including unpredictable patterns of rainy seasons. Climate variability was associated with decrease in cash crop production and increase in household food supply, unpredictable farming calendar including drying of water sources used for irrigation and domestic uses. The findings revealed a decreasing trend of Coffee yields during the year 1990 to 2016. The decreasing trend of coffee production in the area was not only contributed by climate change variability but also fall of coffee price in the world market. The communities in the study area developed different adaptation strategies in responding to effects of climate variability. The developed strategies include among others; crop substitution, intercropping, planting early maturing crops and drought resistant crops and the use of traditional canal irrigation system. The projected climate change effects show that; the future is unreriable for rain-fed dependancy farming practices. Therefore, this paper recommended farmers options to include among others irrigation of crops and conservation farming with a potential to increasing coffee production in order to ensure food security as well as socio economic development of farming communities.

Introduction

Climate variability is a global phenomenon, whose impacts is locally based and differs across locations where by it is widely projected that as the planet warms, climate and weather variability increase and threatens food availability in the world (IPCC, 2014). Changes in frequency and severity of extreme climate variability events alter weather patterns and have significant consequences for human as well as natural systems (IPCC, 2014a). Climate variability already has substantial impacts on biological systems, smallholder communities and countries which depend on them in both developing and developed countries. Global food shortage has been experienced in USA where 14.7% of household s approximated to have low or very low food security. In Africa the situation is more worse since 27.4% of its population is reported to have severe food insecurity (WFP, 2015).

Africa is one among the continents affected by climate variability which results into frequency of climatic extremes of droughts and floods with far reaching impacts (IPCC, 2001; Niang *et al.,* 2014). In SADC countries the problem of food insecurity is severe and is estimated that about 41.2 million people was food ensecure in the 2019 consumption year. The major cause of this severe food insecurity in the region is climate change and variability related events (SADC, 2019)

Tanzania is one of the country experiencing climatic extreme events over time causing impacts in her economic sectors, such as crop production, livestock, hunting, fisheries and forestry. The government reports show that among the most vulnerable sectors to climate variability is the agricultural sector, especially crop production system (Mbilinyi, 2020). Also climate variability has serious impacts on farmers in producing coffee, bananas, beans and maize in Tanzania, depending much on rain-fed whereby dates of planting and harvesting have changed (Regassa *et al.,* 2010).

Effects of climate change is locational based and vary across regions.Kilimanjaro, like other regions in Tanzania, is vulnerable to climate variability through its impacts on crop production, water resources and human health (Mwakalila, 2013). It has been observed that temperatures in Kilimanjaro have increased and rainfall variability is becoming highly common whereby there was warming rate of 0.275 degrees Celsius (°C) per decade between 1976 and 2000, significantly higher than global average warming (Agrawala *et al.,* 2003). Incidences of floods and droughts have also been reported in Moshi rural district together with declining trend in precipitation on slopes of Mount Kilimanjaro (URT, 2005).

The Fifth Assessment Report of the Intergovernmental Panel on Climate Change indicated that pests and diseas-

es adversely affect crop production, which is the main livelihood activity in Moshi rural district, thereby posing more challenges to agriculture sector (IPCC, 2014a). Therefore this papar explored the effects of climate variability on water access for coffee production in moshi rural district, Tanzania.

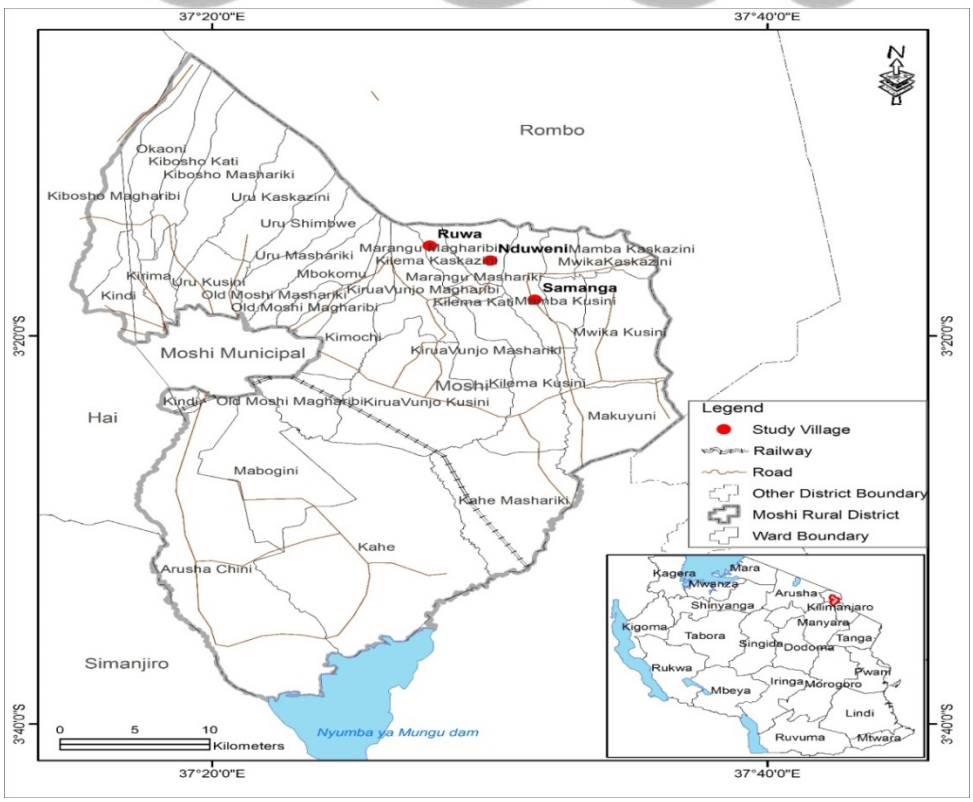
Objective

The objective of this paper was to find the effects of climate variability on coffee production in Moshi Rural district and was guided by two questions;

i. What is the extent to which climate variability affects coffee production in Moshi rural?
ii. What were the strategies used by coffee producers in Moshi rural to reduce effects of climate variability?

Location of the Study Area

The study was carried out in Moshi Rural District, Kilimanjaro Region. The district is one of the seven districts of Kilimanjaro region. The other districts include Hai, Siha, Rombo, Mwanga, Same and Moshi Urban. The district is located between latitude $3^{o}10'S$ and $3^{o}48'S$; and longitude $37^{o}15'E$ and $37^{o}36'E$. To the west, the district is bordered by Siha and Hai districts, while Mwanga district lies to the Southeast. To the north east, the district is bordered by Rombo district. To the south, it is bordered by Simanjiro district, which is in Manyara region (Figure 3.1). The district covers an area of 1529 kilometre squares (km2) and administratively the district is divided into four divisions, 31 wards and 165 villages (URT, 2013). This study involved 3 wards and 3 villages from each ward selected randomly.



Figire 1: Location of the Study Area

Source: Cartographic Unit, University of Dar es Salaam (2017)

Methodology

This part explains the research design used and the sources of data;

Research Design

This study used social economical survey design with quantitative and qualitative methods for data analysis. Three villages from the district were purposefully selected due to their characteristics. Quantitative research approach was used to analyse coffee production records, rainfall records and temperature records in the study area. Qualitative research approach was used to establish community members' responses to climate variability as well as examine the effects of climate variability on coffee farming in the study area. Both simple random sampling and purposive sampling were employed in this study. Purposive sampling were used to select study villages as well as key informants involved in the study while simple random sampling were used to select households involved in the study.

Sources of Data

Different research instrument were used to collect data under social economic survey design. The Household survey was conducted using questionnaires to collect data on the effects of climate variability in the area as well as the adaptation strategies used by the people in the study area to reduce those effects. The meteorological data was used to indicate the historical timeline for incidences of climatically variability and the Moshi district social economic profile information was used to indicate and analyse trends of coffee productivity in the area. Data collected using questionnaires were analysed using SPSS. Descriptive and inferential statistics were used to determine course effects relationship and occurrences of variables. Direct observation was also employed to depict ground actions such as crop substitution.

Results and Discussion

This section presents and discusses the findings from the field on the effects of climate variability on coffee production as well as the strategies used by coffee producers in Moshi rural to reduce effects of climate variability in coffee production.

The extent to which Climate Variability Affects Coffee Production

Findings indicated that majority (91.7%) of respondents reported that there was low yield of crops, which made them to shift from indigenous crops that required constant water to higher yielding crop varieties and shorter cycle crop varieties, for example hybrid seeds. Few respondents (8.3%) noted that no changes of crops yielding because in shortage of rainfall they use irrigation. Also majority (92.7%) of respondents reported that some crops, which required adequate water were no longer being planted, while few (7.3%) pointed out that they still plant them because they use mulching and irrigation (Table 1). Moreover, findings revealed that majority (90.6%) of respondents noted that there was drying up of water sources such as rivers and streams (Table1). Besides, 86.5 percent of the respondents noted that there was reduction of pastures for animals, while the rest (13.5%) noted that there was no reduction of pastures (Table 1).

Table 1. Responses on Impact of Climate Variability on Farming

Questions	Response	Frequency	Percent
Low yield is Indicator of climate variability	Yes	88	91.7
	No	8	8.3
	Total	96	100.0
Decrease of crops is indicator for climate variability	Yes	89	92.7
	No	7	7.3
	Total	96	100.0
Drying up of sources of water is indicator for climate variability	Yes	87	90.6
	No	9	9.4
	Total	96	100.0
Reduction of pastures is indicator of climate variability	Yes	83	86.5
	No	13	13.5
	Total	96	100.0

Source: Source: Field Survey (2018)

The findings in table 1 noted that, climate variation trends have significant impacts on crop production. The majority of the responses show that community in the study area are aware of the variations in the amount crop yields and are associating this change with climate variability. Also climate variability in the area is related with incidencies of Reduction of pastures as well as drying of water sources which create big problem in agricultural production which depends on irrigation. Among the crop that indicated decrease in its productivity due shortage

of water was coffee (Figure 2). Coffee production records obtained from Moshi rural district office indicates that coffee production in the area has been decreasing at the rate of 0.2337 from 1990-2007. During this period the optimum mean temperature ranged between 28 °C and 30°C in the stdudy area. Studies affirm that Temperatures above 23ºC accelerate the development and ripening of fruits and can provoke loss of physical and beverage quality. High temperatures above 30°C with a prolonged dry season may cause abortion of flowers (Hermann et al, 2010). In the same period between 1990 and 2007 rainfall in the study area ranged between 600mm and 1800mm. It is considered that for Arabica coffee to grow in the highlands the range between 800mm and 4200mm is acceptable. In the study area rainfall went as down as 600mm which might be one of the reasons for the decreasing trend of coffee production in the area.

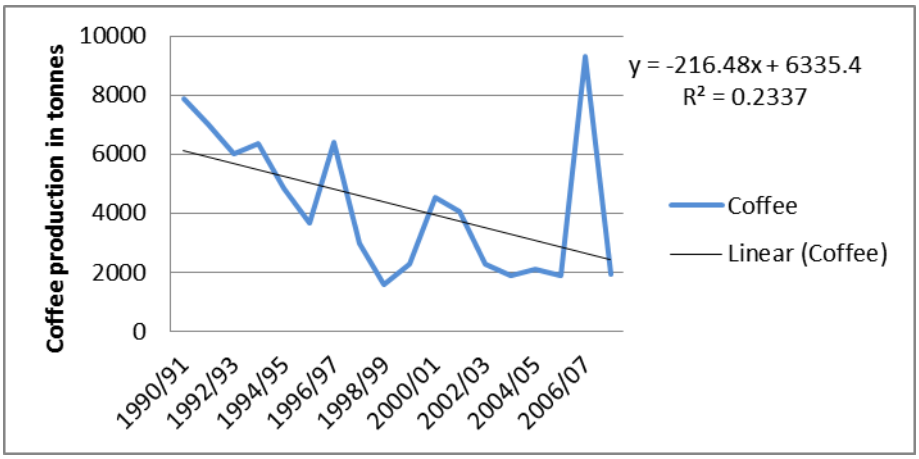


Figure 2. Variations of Coffee production from 1990-2007
Source: MDC(2016)

Also coffee production records in the study area show that coffee production in the area has been decreasing at the rate of 0.4024 from 2008-2017(figure 3). As compared with 1990-2007 decreasing rate which was 0.2337, this rate is bigger than the previous. During this period the optimum mean temperature ranged between 18 °C and 30°C in the stdudy area. The records show that the minimum temperature continued to be lower in the area. Since many monthes recorded Temperatures above 23ºC, this accelerated the development and ripening of fruits and provoked loss of physical and beverage quality (Hermann et al, 2010). In this period between 2007 and 2017 rainfall in the study area ranged between 317mm and 1800mm. The suitable rainfall ranges for growing

Arabica coffee in the highlands is between 800mm and 4200mm. The minimum rainfall record of 317mm in the study area is the reason for increasing decreasing rate from 0.2337 in 1990-2007 to 0.4024 in 2008-2017 (Figure 3). Generally the variations of rainfall and temperature in the study area have affected the production of coffee in the area.

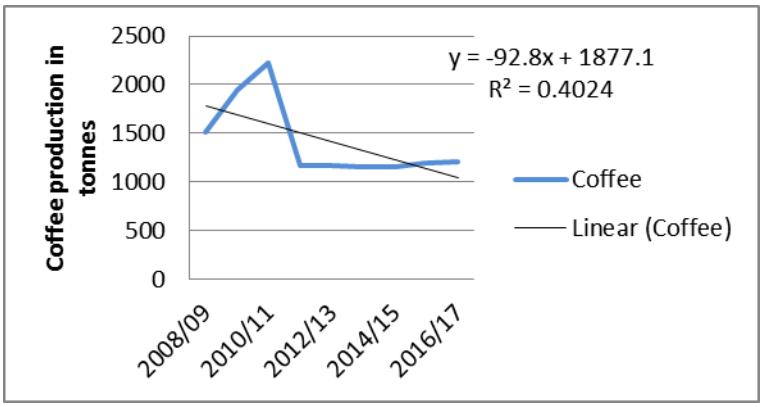


Figure 3. Variations of Coffee production from 2007-2017
Source: MDC (2016)

In the interview with key informants in the study area it was revealed that climate variability was not the only factor that caused the decrease in coffee production in Moshi Rural. It was pointed out that the decreasing trend was also caused by fall of coffee price in the world market between 1997-2001 (TCB,2010). The price of coffee fall from 2.37 dollars per pounds in 1997 to 0.47 dollars per pounds in 2001 in the world market(Figure 4). Green coffee prices fluctuating continue over decade and show no signs of improvement in the short and medium terms. The causes for this fluctuation include an oversupply of coffee on the world market sustained by the global movement of coffee market deregulation since the 1990s (Hermann et al, 2010). This situation has caused small scale coffee producers in the study area to shift from producing coffee to other types of crops which are more profitable.

Figure 4. World benchmark Prices for Arabica coffee in $ per pound
Source: Macrotrends data (2020)

Strategies Used by Coffee Producers in Moshi Rural to Reduce Effects of Climate Variability

Findings from this study revealed that primary response measures to climate variability included use of drought resistant crops (54%), planting early maturing crop varieties (60%), intercropping (52%), irrigation (83%) and 85 percent said use of manure (85%) Table 2.

Table 2 Methods Used to Adapt to the Impact of Climate Variability

Mitigation method used		Frequency	Percent
Planting drought tolerant varieties is the method to improve production.	Yes	52	54.0
	No	44	46.0
	Total	96	100.0
Planting early maturing varieties is the method to improve production.	Yes	58	60.0
	No	38	40.0
	Total	96	100.0
Intercropping is the method to improve production.	Yes	50	52.0
	No	46	48.0
	Total	96	100.0
Irrigation is the method to improve production.	Yes	80	83.0
	No	16	17.0
	Total	96	100.0
Manure as the method to improve production.	Yes	82	85.0
	No	14	14.0

Total	96	100.0

Source: Field Survey (2018)

Moreover, farmers have started to diversify cash crops, for example, they are shifting from depending on coffee as a sole cash crop in the area to production of avocado as the source of food and sold extra yields so as to improve their living standards. During discussions with key stakeholders, it was disclosed that people started to grow grafted avocado in year 2000 when the price of coffee was very low. The grafted avocado grows fast and has higher yields than native type (Plate 1).

Plate 1: Grafted Avocado Farm in the Study Area replacing Coffee Farm

Source: Field Survey (2018)

Conclusion

The findings and discussions revealed that most interviewed farmers in the study area had experienced climate variability conditions such as temperature and rainfall. The data revealed that rainfall amount has been decreasing over time while temperatures have increased over time which has impact on coffee production. Based on the findings it is revealed that decrease of production of coffee in the Moshi Rural District is caused by climate variability in the area as well as falling of coffee price in the world market. In response to fall of price of coffee in the world market communities in the study area decided to practice crop substitution of which many of the coffee farms were replaced by avocado farms. In response to effects of climate variability, such as shortage of wa-

ter due to drought, unpredicted rainfall on crop production and food insecurity, communities in the study area have developed adaptation strategies such as irrigation farming using traditional gravity canal irrigation systems, use of indigenous knowledge system for forecast weather conditions and planting drought resistant crops.

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References

Hermann A. Jürgen P, Marc J., (2010). GROWTH AND PRODUCTION OF COFFEE, in Soils, Plant Growth and Crop Production, [Ed. Willy H. Verheye], in Encyclopedia of Life Support Systems (EOLSS), Deve oped under the Auspices of the UNESCO, Eolss Publishers, Oxford, UK, [http://www.eolss.net] [Retrieved January 22, 2020].

Intergovernmental Panel on Climate Change (IPCC). (2001), 'Synthesis Report' A Contribution of Working Groups I, II, and III to the Third Assessment Report of the IPCC [Watson, RT, and the Core Writing Team (eds.)], Cambridge University Press, United Kingdom, and New York, USA, pp. 398.

IPCC. (2014a). 'Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects' Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1132.

Mbilinyi, D. (2020). The Role of Indigenous Weather Forecasting Knowledge Systems for Adaptation to the Effects of Climate Variability on Agriculture in Kondoa District- Tanzania, Global scientific journal 8 (1), 855-856.

MDC. (2016). Socio-Economic Profile Briefs. District Executive Director, Moshi.

Macrotrends data,(2020). World benchmark Prices for Arabica coffee. Retrieved from http://www.macrotrends.net on 21st January, 2020

Mwakalila, S. (2013). Climate change impacts and adaptation strategies in Kilimanjaro transect in Tanzania. *Journal of Environmental Science and Water Resources*, *3*(1), 007-014.

Regassa, S., Givey, C., and Castillo, G. (2010). The Rain Doesn't Come On Time Anymore: Poverty, vulnerability, and climate variability in Ethiopia. *Oxfam Policy and Practice: Climate Change and Resilience*, *6*(1), 90-134.

SADC,(2019). Southern African Development Community Synthesis Report on the State of Food and Nutrition Security and Vulnerability in Southern Africa.

Tanzanian Coffee Board (TCB). (2010). *Tanzanian Coffee Industry Development Strategy*, Kilimanjaro, New Cooperative Initiative. Strategy 2011-16. TCB/TACRI, 35 p

URT. (2005). Singida Region Socio-economic Profile. Second, Printed with Cooperation of National Bureau of Statistics and Singida Regional Commissioner's office.

URT. (2013). *National Population Census Report: Population Distribution by Age and Sex*. National Bureau of Statistics, Dar es Salaam.

WFP,(2015). Annual Performance Report.