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The impacts of climate change on food security: the case of maize in Chókwè District, Mozambique

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Abstract: *Food security and climate change are two issues that are highly correlated, especially when talking about developing countries, because they are highly dependent on agriculture and they are vulnerable to climate change. This paper focus on Chokwé district in Mozambique and analyzes how climate change has impacted maize production, because maize is the most produced crop in Chokwé and it is very important to ensure food security. The paper also analyzes the government plans to cope with climate change and if they meet the needs of the population. A classic regression model was carried out to identify the relation between climate change and maize production in Chokwé. The time horizon was from 1992 to 2015. The results showed that there is a positive relationship between cultivated area, precipitation, maximum temperature and maize production. The district does not have an adaptation plan. A contingency plan is used to respond to climatic extreme events, however it is not sufficient and neither efficient. It is important to have a long-term plan that deals with adaptation measures and transformation, for people to be more resilient to climate change.*

Keywords – *Chokwé, climate change, food security, maize production, Mozambique.*

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I. Introduction

Food security is a complex issue, which has gained increasing relevance within internal debates, as well as in international organizations. Currently, 24% of households are chronic food insecure (which means approximately 5 750 000 people) and 3.5% are acute food insecure (840 000 people) [1].

Food insecurity is higher in rural areas, where poverty is predominant and about 70% of the population is located, having agriculture as their main source of income and subsistence. People depending on occasional labour, food assistance and charity, as well as households involved in production and commercialization of agricultural production and livestock are most vulnerable to chronic food insecurity. In May 2015, about 137 thousand people were in acute food insecure in Gaza and Inhambane provinces and about 900 thousand people were at risk of being food insecure [2].

There are some aspects that contribute to the current situation of food security in Mozambique: 1) low productivity in agricultural production; 2) limited access to food production areas and food at a national level; 3) lack of diversification of food production; and, 4) climate related hazards.

"Rural hunger is allayed when small farmers produce more crops that they may consume directly or, more importantly, when their higher incomes (achieved through the sale of cash crops) allow them to purchase adequate food" [3].

Developing countries are considered the most susceptible and vulnerable to the impacts of climate change, due to their high dependence of livelihoods on natural resources (land, water, forestry, etc.) and limited adaptive capacity to cope with external shocks [4]. Mozambique ranks third amongst the African countries most exposed to risks from weather-related hazards [5].

Climate related hazards has a significant impact on food security in Mozambique, because about 98% of farms practice rainfed agriculture. In the last decade it represented a loss of thousands of human lives, crops and livestock production, ecosystems and the destruction of public and private infrastructure (including schools, hospitals, access roads, homes and tourist resorts, among others) and suitable areas[1] [7]. Considering the latest manifestations of climate change, the situation of food insecurity in the country can be worse.

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[1] The zones that are probably the most affected by loss of suitable area will generally be those that already struggle from the impacts of irregular and extreme climate events. These include the mixed arid-semiarid systems in Gaza and semiarid systems in parts of northern Inhambane and south of Tete, the coastal regions of Southern and Central southern zones, and many of the drier zones of major river systems like Limpopo, Save and Zambeze [6].

Considering that Mozambique is among the poorest countries in Africa and even though it does not emit a significate amount of greenhouse gases (GHGs), it will be considerable affected and, projections indicate that its impact will increase both in frequency and intensity, so it becomes relevant to analyze the impact of climate change on the availability of food (maize), as well as analyze the adaptation measures that the government has defined and if they meet the needs of the population, more specifically, the farmers.

The assignment will focus on maize production (since it is the main crop produced by the majority of the farmers and, also is very important to ensure food security) and it will be concentrated in the Gaza province (Chokwé district), which has experienced droughts and also floods leading to complete or partial loss of production, therefore affecting the availability of food, which in turn has a negative impact on food security. This district also have research centers which would facilitate the collection of information.

Food security has four main dimensions: availability, access, utilization and stability. However, this assignment will only focus on availability.

The main objectives of this research are the following:

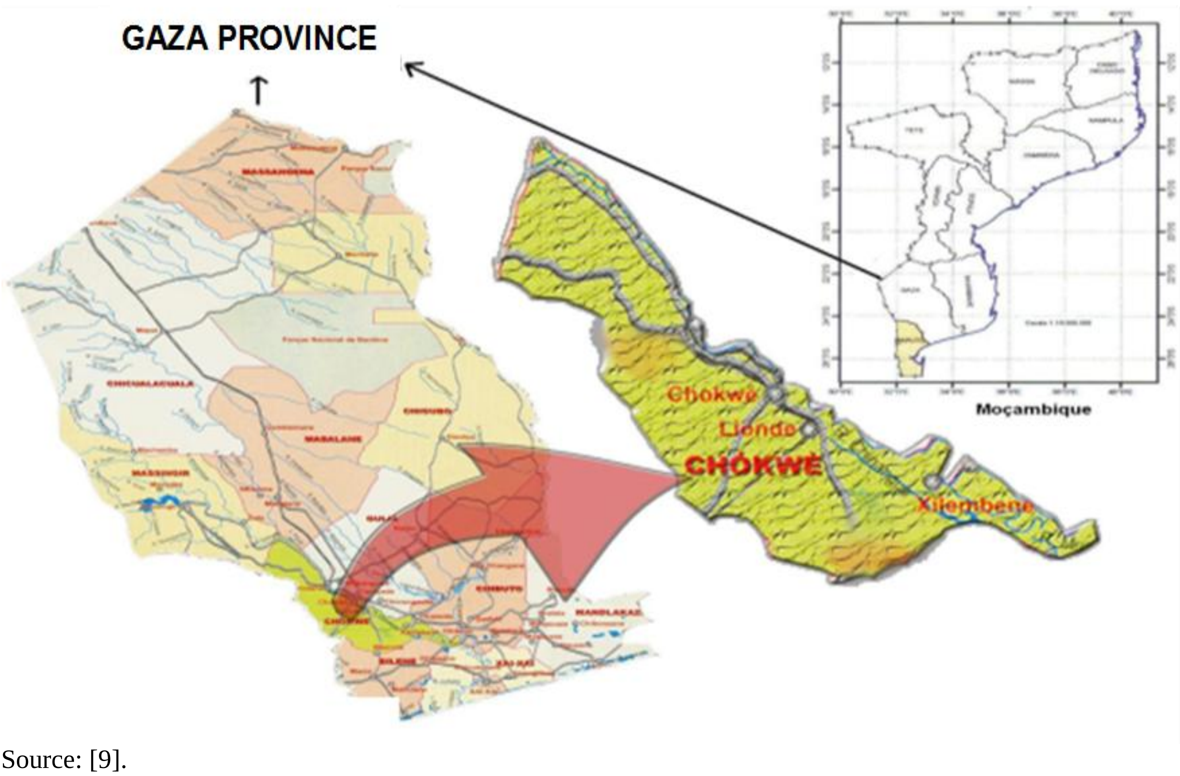
- Analyze climate and maize production in Chokwé District.
- Establish a relation between climate and maize production in Chokwé.
- Verify the gap between the government plans and the farmer's needs.

This paper is part of a research project on food security that is being developed at Observatório do Meio Rural (OMR). The project is a follow-up of a study developed by OMR in collaboration with the World Food Programme (WFP) "Food Security and Nutrition Challenges in Mozambique".

The paper was elaborated within the International Training Programme on Climate Change – Mitigation and Adaptation, organized by the Swedish Meteorological and Hydrological Institute (SMHI) and financed by the Swedish International Development Cooperation Agency (Sida). The paper was also supported by Observatório do Meio Rural (OMR).

II. The climate change perspective

Chokwé district is located in the South of Mozambique, in Gaza province, standing in the middle reaches of the Limpopo River. The current situation of the district is characterized by high level of relative poverty in some locations susceptible to natural disasters such as droughts and floods, which aggravate the food insecure population. The current rate of food insecurity in the district stands at about 12% [8].



Source: [9].

Figure 1. Chokwé District

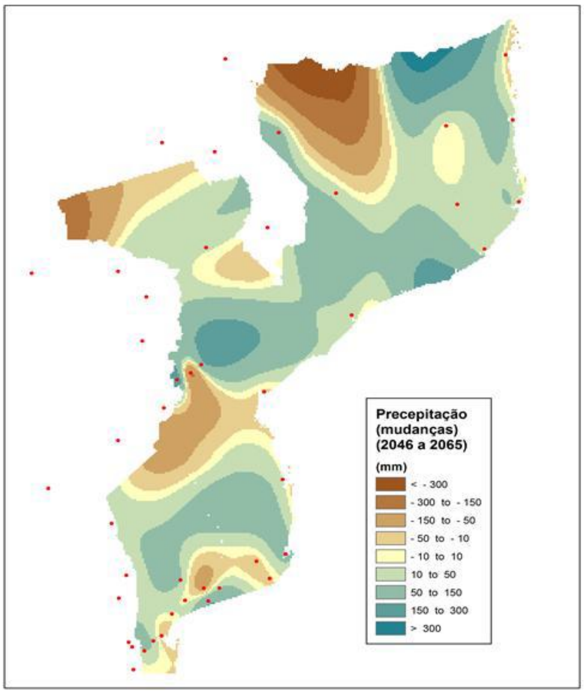
The district has a semi-arid climate (dry-savanna), with an average annual temperature of 24ºC, the average annual rainfall is between 500mm and 800mm. The district is prone to cyclical natural disasters, prolonged droughts, strong winds, cyclone, specifically in the Malau locality (Administrative station of Lionde), Machinho and Matuba (Administrative station of Macarretane) and floods of large magnitude [8].

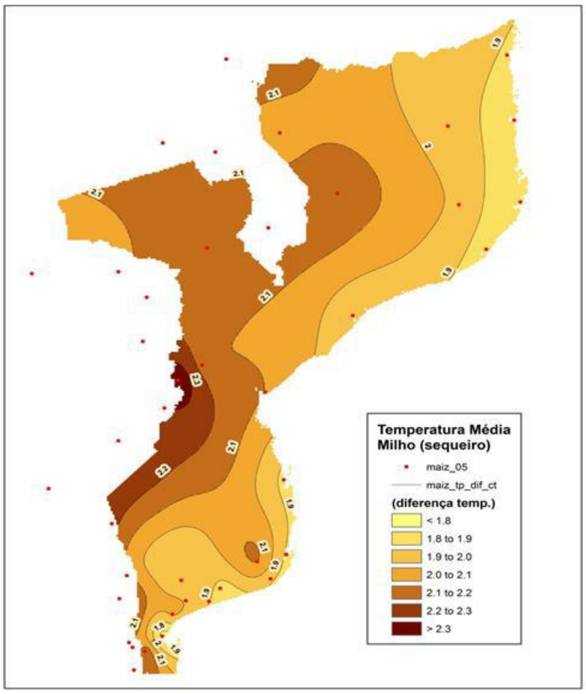
Agriculture is considered the main activity in Chokwé district, because it is practiced by the majority of households, and constitutes the main source of subsistence, employment and income, among other factors. Women are responsible for agriculture and household activities, while men are responsible for grazing (especially young people). Farmers and stockbreeders represent about 75% of households, and are the most disadvantaged and vulnerable. Most of the land is exploited in intercropping system of food crops (maize, cassava, cowpeas, groundnuts, sweet-potatoes and rice). Maize is one of the most produced crops and it is produced by many farmers. Rainfed agriculture is dominated by maize, and therefore it is considerably affected by climate change [8].

The district has an irrigation system. However, it does not benefit all the farmers. The most vulnerable regions are the ones that do not benefit from the irrigation system (in the uplands). Droughts (in areas not covered by irrigation) has been the main disaster that weakens the productive capacity of the population culminating with the lack of food (mainly between May and September). The drought period have been more prolonged, and in 2016 it was more severe, because even the irrigation system was not working, due to the breakdown in the bottom sluices, which is aggravated by the lack of rainfall.

"It is expected in the future a decrease of effective rainfall for agricultural, resulting from the combination of an increase in rainfall intensity (heavier rains), and a decrease in the number of rainy days" [10](see Fig. 2).

In relation to the temperature, it is expect an increase in temperature during the maize growing period [10] (see Fig. 3). According to the Fig. below the temperature is expected to increase in the Chokwé District region.





Source: [10].

Figure 2. Expected changes in the future (2046-2065) in the median of 7 GCMs for rainfall during maize growing period, expressed in rainfall mm.

Figure 3. Expected changes in the future (2046-2065) in the median of 7 GCMs for the average daily temperatures during maize growing period, expressed in ºC.

III. Methodology

In an initial phase, a literature review was carried out. The government plans (contingency plan, the national adaptation plan for climate change, etc.) were analyzed. This assignment was based in a quantitative analysis in order to analyze climate change in Chokwé district, through precipitation and temperature data and, maize production, in order to establish a relation between climate change and maize production in Chokwé district. Climate variables (temperature and precipitation) were obtained at the National Institute of Meteorology (INAM) and maize production was obtained at the Chokwé District Service of Economic Activities (SDAE). The collected data were introduced and worked on a statistical programme, SPSS 20.

The variables considered in this study were the following: annual precipitation, maximum temperature annual average, minimum temperature annual average, maize cultivated area and maize production. It was used annual data, because the data provided for maize production is annual. It corresponds to the total amount of the campaign, which is made in two seasons, the first season starts in September/October and the second in March/April.

In order to determine whether and in which extent changes in precipitation and temperature affects maize production in Chokwé, the classical regression model was used, where the endogenous variable was maize production. The time horizon was between 1992 and 2015. The regression can be represented as follows:

(1) $$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \mu_i$$

Where:
Y – maize production
β_0 – intercept
β_1, β_2, β_3, β_4 – Coefficient of the independent variable
X_1 – cultivated area
X_2 – annual precipitation
X_3 – average maximum temperature
X_4 – average minimum temperature
μ_i – error term, assumed to be normal distributed

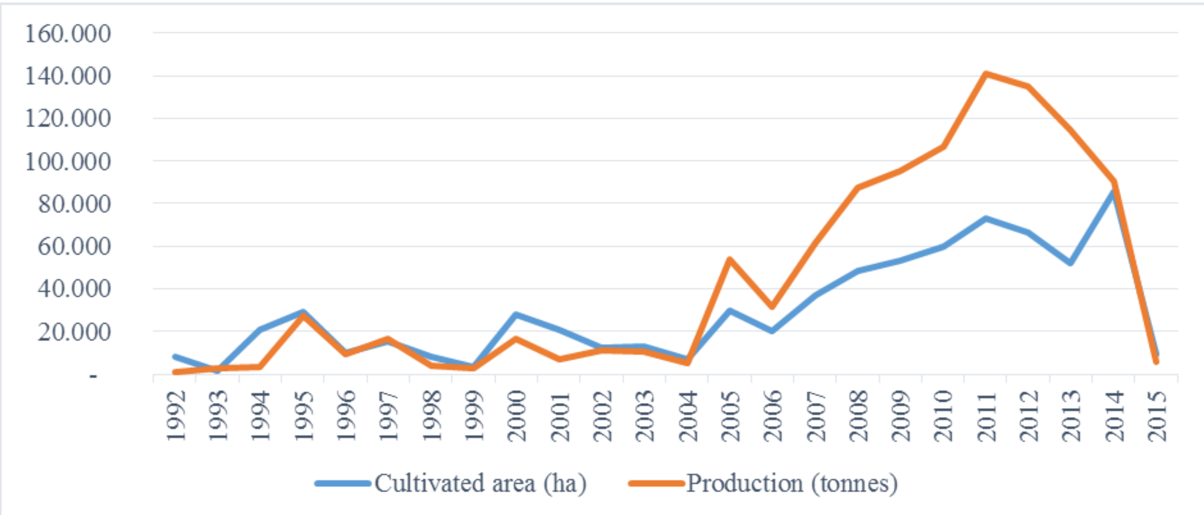
On the other hand, a qualitative method was used, through interviews and discussions with the main stakeholders (farmers, government and IIAM researchers) to collect their perceptions in relation to the government plans to cope with climate change and its implementation, as well as their needs and strategies adopted.

Since Chokwé district does not have an adaptation plan, to achieve the third objective of the study, the contingency plan of the district was analyzed, in order to verify whether there is a gap between the government plans and the farmer's needs. Interviews were carried out with the main stakeholders, in order to support this analysis and to understand whether the contingency plan is enough, it is being implemented and, whether it is efficient in meeting the farmer's needs.

IV. Results

4.1. Variables analysis

In order to understand the evolution of the variables used in this study a set of figures will be analyzed.



Source: [11].

Figure 4. Maize production and cultivated area in Chokwé

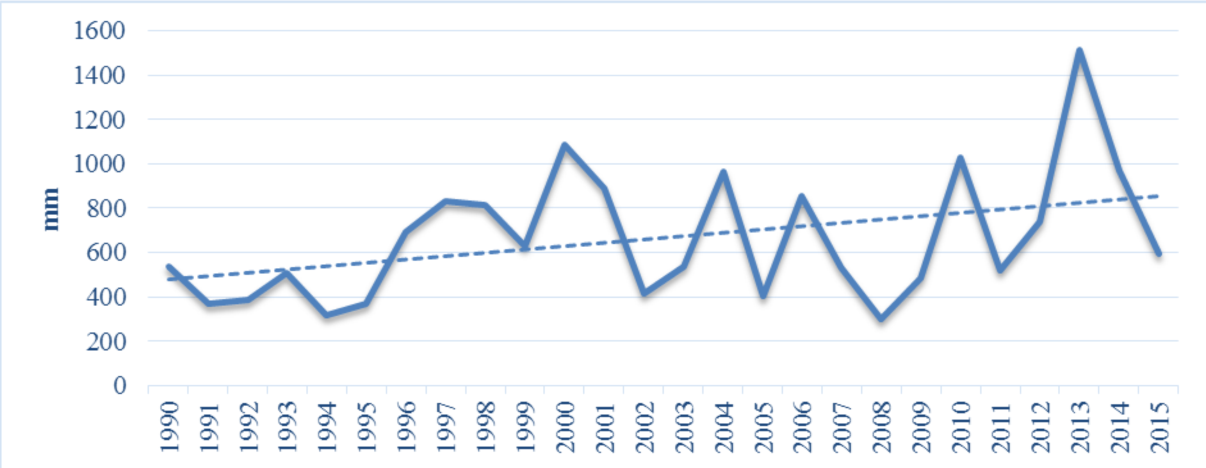
In Mozambique, increases in production are directly related with increases in cultivated areas, which can be confirmed in Fig. 4. There is a strong positive relation between cultivated areas and production in Mozambique [12] [13] [14].

As can be seen in the Fig. 4, between 1992 and 2004, maize production remained low, after 2005 it began to increase and achieved the best production in 2011 with 141 158 tons of maize, due mainly to the introduction of new varieties of maize, distribution of inputs and improved seeds. On the other hand, in the same year precipitation reduced from 1030 mm in 2010 to 519.5 mm. This increased production can be explained by the fact that maize is produced within 4 to 5 months and the critical period is in the sowing (mostly in October), flowering (30 to 45 days after sowing) and grain filling period (60 to 80 days after sowing), in that period there was a significant amount of precipitation.

After 2012 there was a significant decrease in maize production in Chokwé. Among other reasons, according to the IIAM researcher, a possible explanation for that might be the political tension that started in 2012. Most of the seeds come from the Center and North regions, where the political tension is intense. After 2012 the government started to reduce the distribution of seeds.

According to [15] the highest rainfall was recorded during the second decade of January, during which accumulated rainfall were higher than 240 mm in less than two days, causing flooding in both rainfed area and irrigated areas, leading to loss of crops. Besides, cereal crops were seriously affected by a pest (*lagarta invasora* – caterpillar invasive). In the following years, the incidence of pests was higher and affected mostly cereals.

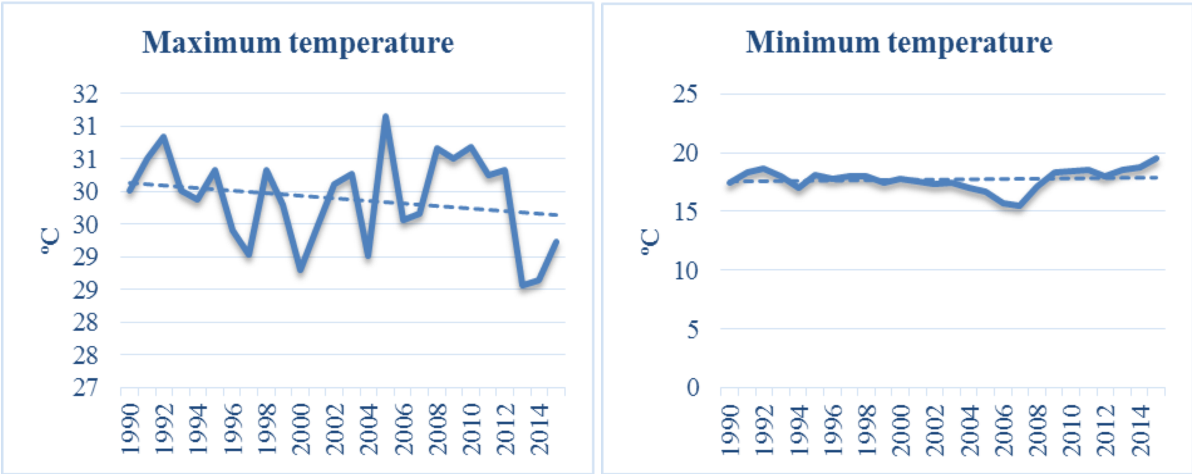
According to [16] the climatic forecast for the campaign 2014/15 predicted a sufficient rainfall index to meet the water needs of crops. So it was expected a good campaign for 2014/15, which could be a good explanation for the increase in cultivated areas in 2014. However, the Chokwé District experienced rainfall below normal in October and November, increasing in December. From January to March the tendency of rainfall was also below normal. There was a reduction in overall production due to the droughts experienced in the rainfed area, which affected mostly the maize cultivated area in about 70%, therefore reducing maize production [16].



Source: [17].

Figure 5. Total annual precipitation

Annual precipitation in Mozambique is very unstable over the years. And it shows a tendency to increase. The years with higher precipitation, such as 2000, 2010 and 2013 are the years in which there were floods in Chokwé. This Fig. does not show a pattern for a changing climate, and also it is not consistent with the predictions. This can be explained by the fact that even though the amount of annual precipitation is increasing the rainfall has been heavy and more concentrated (reduction on the number of days). Unfortunately, it was not possible to show that climate change is happening, but as a recommendation for future work, cordex data might be used in order to confirm that climate change is happening and it is affecting the livelihoods of the population.



Source: [17].

Figure 6. Maximum and minimum temperature (annual average).

The minimum average temperature has not shown great variability in the last two decades. Differently, the maximum average temperature has shown great variability.

4.2. Regression analysis

In order to analyze the influence of climate variables such as precipitation and temperature on maize production, the classical regression model was used, and the results are presented on the Tables below. To interpret the results the following tests were considered: the R-square (coefficient of determination), the t-test, the multicollinearity test – VIF test (Variance Inflation Factor), the F-test, the Durbin- Watson test and the Kolmogorov-Smirnov test, in order to meet the assumptions of the model.

The Table below provides a descriptive statistics about the variables considered for this study, namely, the number of observations (N), the maximum and minimum values verified in the time series, as well as the standard deviation.

Table 1. Descriptive Statistics

	N	Minimum	Maximum	Std. Deviation
Maize production	24	1081	141158	47537.095
Cultivated area	24	1418	85865	24224.576
Annual precipitation	24	299	1511	295.671
Annual average maximum temperature	24	28.56	31.16	.72571
Annual average minimum temperature	24	15.52	19.51	.91370
Valid N (listwise)	24			

Table 2. Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.944[a]	.891	.869	17231.014	2.319

a. Predictors: (Constant), Minimum average temperature, Maximum average temperature, Cultivated area, Annual precipitation

b. Dependent Variable: Maize production

Table 3. ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	46333585706.109	4	11583396426.527	39.013	.000[b]
	Residual	5641249111.891	19	296907847.994		
	Total	51974834818.000	23			

a. Dependent Variable: Maize production

b. Predictors: (Constant), Minimum average temperature, Maximum average temperature, Cultivated area, Annual precipitation

According to Table 2, the variables considered in the model (climate variables and cultivated area) account for almost 90% of changes in maize production in Chokwé District (R-square = 89.1%).

The Durbin-Watson test measures the autocorrelation between the variables. The hypothesis to be tested is that there is no autocorrelation between the variables. The Durbin-Watson test is 2.319 which means that there is no autocorrelation between the variables.

The F-test is a test for the overall model. The results in Table 3 show that the test is significant, which means that not all coefficients are null, that is, there is at least one coefficient that is different from zero, which means that it is possible to estimate a model.

Table 4. Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	-499113.620	225957.711		-2.209	.040					
	Cultivated area	1.737	.159	.885	10.948	.000	.926	.929	.827	.874	1.145
	Annual precipitation	32.081	17.577	.200	1.825	.084	.212	.386	.138	.478	2.092
	Maximum average temperature	16748.443	6942.311	.256	2.413	.026	.138	.484	.182	.509	1.966
	Minimum average temperature	-1752.752	4081.785	-.034	-.429	.672	.171	-.098	-.032	.928	1.077

a. Dependent Variable: Maize production

The model's assumptions consider absence of multicollinearity between the variables. The VIF test indicate that there is an acceptable multicollinearity, since the VIF value is between 1 and 10 . This means that there is an acceptable relation between the independent variables.

The t-test aim to test the significance of each of the independent variables in explaining the variations on the dependent variable. The coefficient is statistically significant if its p-value or t-sig is lower than the level of significance. According to the results, cultivated area, annual precipitation and maximum temperature are statistically significant at 1%, 10% and 5%, respectively, which means that it is possible to interpret the coefficients and know how these variables influence maize production. On the other hand, there is no evidence of the influence of minimum temperature on maize production in Chokwé.

There is a positive relation between cultivated area, precipitation and maximum temperature and maize production in Chokwé. Analyzing the standardized coefficients it is possible to verify that the cultivated area is the variable which most influence maize production. The explanations behind this results will be explained later.

Another assumption of the model is that the residuals are normally distributed. To test this assumption the Kolmogorov-Smirnov test was used.

Table 5. One-Sample Kolmogorov-Smirnov Test

		Unstandardized Residual
N		24
Normal Parameters[a,b]	Mean	0E-7
	Std. Deviation	15661.15259223
Most Extreme Differences	Absolute	.140
	Positive	.084
	Negative	-.140
Kolmogorov-Smirnov Z		.686
Asymp. Sig. (2-tailed)		.735

a. Test distribution is Normal.
b. Calculated from data.

The hypothesis of this test are the following:

H0: The residuals are normally distributed.
H1: The residuals are not normally distributed.

The significance is 0.735 which is greater than the level of significance, which means that H0 is not rejected, that is, the residuals are normally distributed.

V. Discussion

Objective 1: Analyze climate and maize production in Chokwé District.

Maize production and maize cultivated area are decreasing in the last years (see Fig. 4). The decrease on maize production is mainly due to reduced cultivated areas. According to the field work and the interviews, one of the reasons for the reduced production is related to droughts.

The Director of Chokwé District Service of Economic Activities (SDAE) in 2016, said that Chokwé is prone to droughts as well as floods. He considers that even though floods cause more damages, it is considerably easy to recover, while droughts are more frequent and prolonged and, are more difficult to cope with. [6] confirm "…the south has high frequency of droughts with extensive drought periods during the early 80's and late 90's. It is important to note that whilst droughts are more common in the south, the magnitude of floods in this region can be very high and cause high damages".

Even though there are no data available for 2016, the interviewee argued that Chokwé experienced the worst drought in 2016 (which can only be compared with the drought of 1983). Even though Chokwé has an irrigation system which benefit some of the farmers (mostly private farmers), the lack of rainfall and the breakdown in the bottom sluices do not allow the discharge of water. So, if there was normal rainfall, this would not be a problem because the water could be discharged by the surface floodgates.

According to the Director of SDAE the amount of rainfall has reduced: "by analyzing the history of the past 30 years, it is possible to see that in the last 5 years the trend is decreasing. Before the rainfall was 600mm / 700mm now tends to reduce. And there are days with very high temperatures, we have experienced temperatures of 39°C to 40°C in Chokwé which is not normal. And it seriously affects the maize production, because maize is strategic to food security for the entire population of Gaza, and Chokwé, in particular. It is a crop that is practiced in rainfed conditions, which is very dependent on rain. If there is not enough rain the production fails and there are food security problems".

Some farmers are moving to areas close to the Limpopo River, in order to produce and try to survive. But it is also not sufficient, because even the Limpopo River flow is low. Some farmers in Malau village (Administrative station of Lionde) said that they are not producing because of lack of water, instead they are working in the roads and they are also doing some work at the dams in order to allow greater accumulation of water when it rains, and in return the government gives them food (maize and beans).

In the last two decades the temperatures has slightly increased. Regarding the average minimum temperature, it can be verified that it has not showed great variability from 1990 to 2004. It has reduced afterwards, and since 2008 it started to increase slowly. This evidence, alone, cannot prove that climate change is happening.

Objective 2: Establish a relation between climate and maize production in Chokwé.

According to the results, there is a positive relation between cultivated area, precipitation and maximum temperature and maize production. There was no evidence about the influence of minimum temperature on maize production in Chokwé.

As explained previously, in Mozambique, increases in production is highly related to increases in labor force and cultivated area [12] [13] [14] The regression result confirms by showing that cultivated areas are the variable with most impact on maize production. This happens mainly for food crops which are produced by smallholders because almost all of them do not use technology, fertilizers, etc. [12] [18]. And therefore, productivity is very low.

Annual precipitation also has a positive impact on maize production. That is an increase in precipitation in a unit will lead to an increase in maize production in 32 tons. However, it is necessary to take into account the period of sowing, flowering and grain filling, because these are the period in which rainfall is most important. This result is consistent with the literature. In Chokwé, in particular, maize production is made in a rainfed system by smallholders. So, the lack of rainfall affects negatively maize production.

[10] studied the impact of climate change in rainfed agriculture and, concluded, for the particular case of maize under rainfed production, that potential maize yields are expected to decrease by 11.1% as a result of climate change (temperature in relation to evapotranspiration and rainfall).

According to the results higher maximum temperatures leads to higher production. According to the interview with the IIAM maize breeder researcher the ideal temperature for maize production is between 24ºC to 27ºC, lower temperatures are not recommended. If the temperature reaches 30ºC is not bad. Since the temperatures in Chokwé were around 30ºC, it is reasonable that it leads to higher production.

According to [6], the period with lower temperatures (winter) is between May and September and, October and April is the period with high temperatures (summer). The period with high temperatures is coincident with the rainy season. Which might be an explanation for the positive relation between maximum temperature and maize production, because the first maize campaign begins in September/October.

In general, extreme climate events have a negative impact on food production, and affects food security. According to the Director of SDAE in 2016, the number of people food insecure increased in the district in about 10 000 people from March 2016 to August 2016, and it will continue to increase.

Objective 3: Verify the gap between the government plans and the farmer's needs.

Chokwé District does not have an adaptation plan for climate change. Instead they have a contingency plan which provides information on what to do in case of an extreme event, focusing in alerting people to the climate events that will occur in the short term, identifies host places (in case of floods), advises people to stay in the lower areas with water availability and humidity (in case of droughts), advice the farmers to produce crops more resistant to droughts (such as cassava, sweet-potatoes, pigeon pea, etc.) which are also good to ensure food security and also includes a budget for means of survival for the most disadvantaged and vulnerable.

The vulnerable households are identified by the community leaders. However, there is always problems associated with the selection of the most vulnerable, because the community leaders are accused of choosing their families and friends. The ones that are already receiving food assistance from INGC do not receive food assistance in an emergency situation (for example, in cases that occur severe droughts or floods).

Those households who receive food assistance from the government, do not obtained it for free. They have to work and in exchange they receive food, the so called "*comida pelo trabalho*" (work for food).

On the other side, the communities have a tendency to resist to those measures proposed by the government. But, as the event is happening, with more frequency and intensity they start adopting the measures.

Although the contingency plan is important for different emergency cases, it is not sufficient. It is necessary another plans which focuses on improving the infrastructure in order to cope with extreme climatic events such as floods and on techniques which increases productivity.

The government agrees that a contingency plan is not sufficient, because it only respond to the climate extreme events that are already happening. They said that there is a national adaptation plan, but they recognize the need to develop a specific adaptation plan for the Chokwé District. It is necessary to elaborate and implement a broader plan which includes some adaptation measures such as improve the construction of houses and schools to make them more resistant, improve access roads and communication, etc.

Chokwé has two production systems, the irrigation and the rainfed system, in drought years, different from 2016, when there is water in the irrigation system the government advice farmers in the rainfed system to produce together with and in the lands of the farmers in the irrigation system. The government sensitizes the farmers in the irrigation system to produce with the other farmers. However, the situation was worst, because there is no water even in the irrigation system, so the government is distributing food (maize and beans) and also water which is provided by INGC.

According to the government there are regions that are considerably affected by droughts in all administrative stations. On the contrary when there are floods, those regions are not affected, but they are isolated. The population who lives in the uplands of Chokwé is most food insecure, mainly in the drought period.

There were made interviews with some households that are not in the irrigation system in Malau and Xangulene villages, in order to know what is happening, what are they producing, how are they adapting to climate change, and what are the government doing for them and what are their needs.

In both villages, when there is rainfall, the households produce maize, different types of beans, sweet-potatoes, potatoes, cassava, etc. In that moment they were producing only vegetables, because of lack of rainfall. The farmers were producing using a watering system. In Malau the farmers fetch water in the river and in Xangulene in the wells, which is difficult because they have to walk great distances to find water. However, they only produce these crops for present consumption, because it is not possible to conserve. The farmers choose not to produce maize to save water, because they use the water to produce and also to consume, even though they consider the maize the basis for their subsistence.

In Malau, the farmers argue that in the past (20 years ago) they used to have good campaigns, and they were able to achieve about 3 to 4 carts (which is equivalent to 600 kg). Then it started to decrease, and in the last years they are producing only 100kg to 150kg per campaign, mostly because of lack of rain.

They are not able to guarantee food throughout the all year, so there are some months that they starve, so they have to reduce the number of meals per day, and find another ways to feed themselves. In both villages they used to cut firewood and sell in order to buy maize and rice. In Xangulene they also sell charcoal. The elderly and disabled are not able to do that, so they have more difficulties. Even though it is a men's job, considering the current events, even women are used to cut firewood to obtain money to buy food.

The farmers argued that only recently they received support from the government, by working for food. They are working at the dams (to accumulate water after the rainfall) and at the roads. They receive approximately 40kg of maize per person (only one person per household) for 8 days of work, which they consider to be insufficient.

In relation to water, in Malau they affirmed that the support has stopped, and now they are making water wells, but even the wells are dry now. They ask for the support of the government in providing food and water so they could produce.

In general, the government need an adaptation plan and even the contingency plan has to be improved, because it is not benefiting everyone and it is not satisfying the needs of the farmers. It is necessary to improve and construct wells and open water holes, to help the population having water for consumption and also for production.

VI. Conclusions

The results of this paper showed that cultivated area is the most important factor that influences maize production in Chokwé. It is also important to consider climate variables such as precipitation and temperature.
There is a positive relation between the climate variables considered and maize production in Chokwé, which shows that the lack of precipitation and the high temperatures, has led to droughts, which in turn has a negative impact on maize production. Therefore, affecting food availability and worsening food insecurity in the district.

Farmers are facing difficulties because of lack of water. They are not able to produce important crops to ensure food security. Due to lack of water, they are only able to produce vegetables. And they have to work at firewood cutting, in order to sell it, to buy food. They also work at the dams and roads, in order to receive the "food assistance" from the government, which is not sufficient. They claim for the support of the government in providing water for production. Their main concern is water.

Since the government does not have an adaptation plan, those situations will continue to exist, because the contingency plan only provides measures to respond to the extreme events. The allocated resources for the contingency plan are not sufficient, and the farmers needs still need to be fulfilled. They are asking for water, to produce, to survive.

The government should start by elaborate an adaptation plan which includes long-term actions that will benefit the population and will make them more resilient to climate change. The irrigation system is an advantage for the district, so it should be enhanced so as to bring more benefits for the population, mainly in the drought period, to support the farmers that are not in the irrigation system. Water wells and holes should be provided in the villages so the population has access to water. The selection criteria of the vulnerable households should be revised and the community leaders should be monitored in the selection process to prevent the benefit of some and the exclusion of those who really need.

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