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Research Article

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Incidence of Climate Variability on Maize Production in Buea, Southwest Region, Cameroon

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ABSTRACT
The irregular distribution of climatic parameters has impacted global food security. This issue is particularly relevant in Cameroon, specifically in the Buea Municipality. This study aimed to examine the implications of climate variability on maize production in the Buea Municipality. It used qualitative and quantitative techniques, such as questionnaires, interview guides, focused group discussions, interrogations, and climatic data extracted from NASA. Secondary data from existing literature. The results showed fluctuating rainfall with decreasing trends and increasing temperature trends. The temperature ranged from 24°C (June and July) to 27°C (February and March), while rainfall varied from 410mm and 441mm (July and August) to 41 mm and 29 mm (December and January). These fluctuations affected maize production by creating favourable conditions for pests and diseases, moisture deficiency, and fast soil degradation. A Pearson correlation analysis confirmed a positive relationship between maize yield and rainfall amount. While farmers have adapted by practising irrigation, buying improved seeds, and cultivating wetlands, challenges such as poverty, institutional voids, and knowledge gaps have offset their efforts. In conclusion, maize production remains crucial for the population in Buea, and the study recommends holistic measures such as agricultural training and the distribution of improved seeds by stakeholders.

Keywords: Adaptation, Agriculture, Vulnerability, Rainfall, Temperature

Introduction

Global warming has a growing impact on Earth's ecosystems, representing a serious threat to agricultural sustainability [1]. An increase in agricultural productivity in an environmentally sustainable way, in the context of climate variability, is a huge challenge [2]. The FAO stated that the burgeoning population increase in the human population must be accompanied by stable and secured food production [3]. Agriculture has always been the interface between natural resources and human activity and is nowadays crucial to solving some of the greatest mankind challenges, associated with the eradication of hunger and poverty while maintaining stable climate conditions [3]. On a global scale, the increase in the number of small-scale farmers has been severely affected by climate change and variability scenarios, typically linked to fluctuations in rainfall and temperatures [4]. In most arid and semi-arid areas of the world, the severity of climate variability has seriously been felt by many farmers. For example, in Northern Nigeria, the changes in the quantity and length of rainfall have been a source of grave concern to most farmers as the concentration of greenhouse gases continues to increase. The fluctuations in rainfall and temperature conditions threaten the sustainability of millions of people whose livelihoods rely on agriculture in Sub-Saharan Africa, especially those with low adaptive capacities [5-7].

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Climate variability and the increasing frequency and intensity of weather extremes pose multiple challenges to agriculture and related dimensions: they aggravate risk and impacts affecting all dimensions of food security and nutrition (availability, access, utilization, and stability), disproportionally impact the social groups in the most vulnerable situations and add pressure on land and water resources and fragile agri-food systems and ecosystems [8]. Climate extreme events such as heat and cold waves, severe droughts, and heavy rainfall, underline the high vulnerability of agricultural systems. Global warming impacts can already be observed, namely, reduced snow and ice areas and rising sea levels. Moreover, estimated future climate changes are believed to additionally amplify the existing climate-related risks and create new ones [2].

Agriculture incorporates about 70% of the total population in Cameroon and contributes to about 35% of the country's GDP [9]. Thus, it is considered the mainstay and main sustainer of the Cameroonian economy and a greater proportion of her livelihoods. The majority of the population in the country is agriculturally dependent and often described as "the wretched of the earth". Cameroon's rainfall in recent years has largely become inconsistent. It is characterized by a decreasing trend in the number of rainy days and the total amount of rainfall at a rate of 43 mm per decade for the country. This has already been foretold in about 80% of the country, with a reported increasing trend in mean temperature of about 0.91°C [10]. The changing weather conditions over the years have been a setback to the perennial benefits often derived from these activities. Food production areas in Cameroon such as Foumbot, Ndop, Ndu, and Moyuka amongst others that were bellwethers of adequate food supply nationwide are today faced with food bankruptcy and the same situation applies to the Buea Municipality. This study investigates the relationship between climate variability and maize production in the Buea Municipality.

Agricultural production has remained the major livelihood activity of the inflated population in the Buea Municipality over time with maize production being the dominant and sustainable crop species cultivated by the population [11]. Local farmers have converted most of the wetlands in this municipality into maize production zones. With regards to the fact that Buea is characterized by extended fields of volcanic soil that has been favourite for the cultivation of staple maize, a majority of farmers are currently grappling with numerous issues suspected to be instigated by the wavering climatic conditions that farmers earlier concluded to be mild. Most of the benefits derived from maize cultivation by farmers have been upset by the momentary swing in climatic conditions. Maize is cultivated in the Buea Municipality throughout the year and the sporadic nature of rainfall in November, December, January, and February creates unfavourable conditions for sustainable maize production. Increasing diurnal temperature conditions in these months are well-defined recipes for the occurrence of army warms and stem borers that are harmful to maize yields. Also, June, July, and August months are characterized by heavy downpours which enhances soil erosion within farming zones that lie on the flanks of the mountain leading to crop failure. The perpetual atmospheric transitions observed within the production cycles that is, from farm preparation, planting, and harvesting periods full of variations in moisture amount, temperature conditions, and wind speed, creating conditions that favour the survival and rapid spread of pests and diseases that affect the quality and quantity of maize yields. Increasing evidence of climate variability is becoming apparent through the recurrent incidents of dry spells, especially a few days after maize planting, as well as the frequent late onset and early cessation of rainfall.

Study Area and Methods

The Buea Municipality is found in the Fako Division, Southwest Region of Cameroon. It is situated between latitudes 4°3" and 4°12"N of the Equator and longitudes 9°2" and 9°9"E of the Greenwich Meridian. It is situated precisely on the eastern slope of Mount Cameroon. Buea Sub-Division is bounded in the Southwest by a portion of the Atlantic Ocean and Limbe, South by Douala, Muyuka in the East, and the North-Eastern part by Mount Fako (Figure 1).

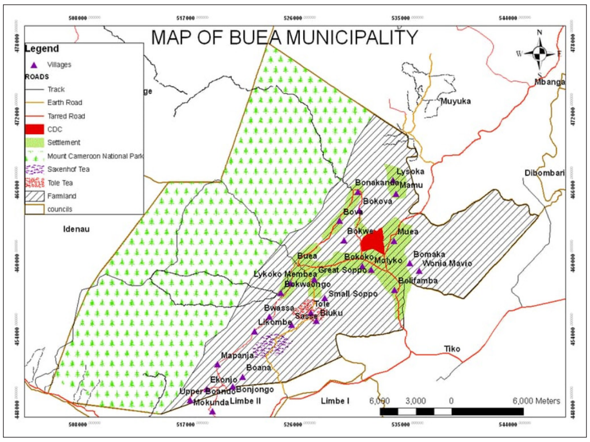

Figure 1: Layout of the Buea Municipality
Source: Buea Council Archives

Given its mountainous location, the Buea Sub-Division enjoys a cool climate conducive to human habitation and the performance of human and economic activities such as agriculture and commerce. There exists a sub-tropical highland climate condition in the Buea Municipality. Because of its location on the slope, high-elevated areas are characterized by intense coolness, while those at the lower elevation experience somewhat higher temperatures. The area consists of steep sloping terrain with table lands at some point which have given rise to the development of human settlements. It is found within the tropical rainforest with vegetation evergreen. There exists volcanic soil with few portions of sedimentary soil due to the influence of weathering and climate elements. The population is growing at an alarming rate with developing nucleated settlements and linear settlement patterns. Approximately 70% of the population is into primary and secondary activities.

Research Methodology

The study was investigatory and interrogatory, adopting the mixed research design involving the use of qualitative and quantitative techniques. The quantitative technique addressed the quantitative aspects of the study (climate variability trends and trends of maize production) and the qualitative technique gave way to the investigation period of massive maize harvest, climatic-related challenges, and adaptation measures. The benefits enshrined in these were exploited and their inherent biases were prevented. The target populations of the study were the various farming communities in Buea, agricultural institutions, households, and the local council. Through a clustered random sampling technique, 250 maize farmers were randomly for inquiries while selected agricultural extension workers, Non-Governmental Organization (NGO) workers, and council were the key informants.

Primary data were obtained through questionnaires, interviews, direct field observations, interrogations, and focused group discussions. Climatic data were downloaded online using the NASA platform and were supplemented with farmers' perceptions. Secondary data for the study were obtained from published related articles, magazines, online and offline libraries, and databases. Data on maize production was collected from the Regional Delegation of Agriculture and Rural Development for the Southwest (2011-2021).

Both qualitative and quantitative techniques were employed in data analysis. Two climatic elements (rainfall, and temperature) influence the climate of Buea. To make sense of these and to determine interannual trends to show their relationship with maize production. Inferential and descriptive statistical techniques were used to analyze quantitative and qualitative data, respectively. The inferential technique brought out correlation and multiple regression results on climate variability trends and maize production while the descriptive produces frequencies, percentiles, and standard deviations.

Results

The Buea Municipality is characterized by diverse environmental factors such as soil type, vegetation, hydrology, and climate that affect maize production in different ways. This explains why farmers cultivate different varieties of maize, why cultivation varies seasonally as well as the outputs. In this study, most of the findings are geared toward maize production, and each proposal or measure established centres around maize production and climate variability. Related information is therefore analyzed subsequently:

Dominant Maize Species and Maize Seasons in Buea

During the field survey, investigations were done on the varieties of maize cultivated by farmers in the Buea Municipality. This was done because each variety of maize has its optimal climatic condition at which it survives as well as its resilience capacity to the swinging climatic conditions (Figure 2). Close to half (48%) of maize farmers pointed out that they do cultivate mostly white maize, 32% said that they cultivate mostly yellow variety of maize while 20% they cultivate both species of maize.

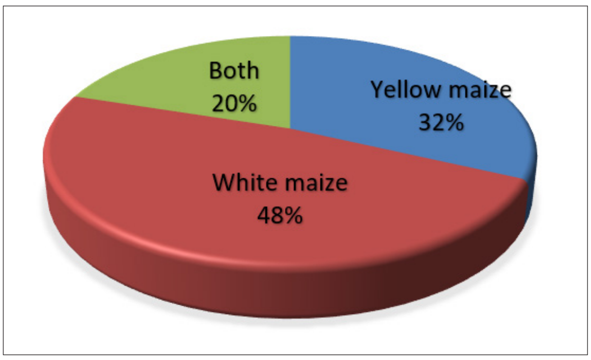

Figure 2: Farmers' choices of maize species grown in Buea

Those involved in white maize cultivation explained that it is the highest consumed species of maize while those for yellow maize said that it is the most resilient species to the current fluctuating climatic conditions. This investigation was succinct by further inquiries on the main season with peak maize production in the Buea Municipality (Figure 3).

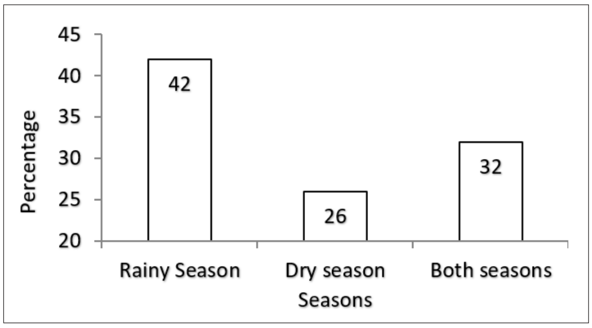

Figure 3: Seasons with dominant maize production in Buea

Results revealed that the rainy season is dominated by intensive maize production which is due to stable rainfall that provides sufficient soil moisture. That is why 32% of the maize farmers said they grow maize in the rainy and dry seasons and these were said by those who have farmlands around marshland environments while 26% of the farmers said that they do grow maize in the dry season. Detail investigations were also done concerning areas where maize is commonly grown within the Buea Municipality (Figure 4).

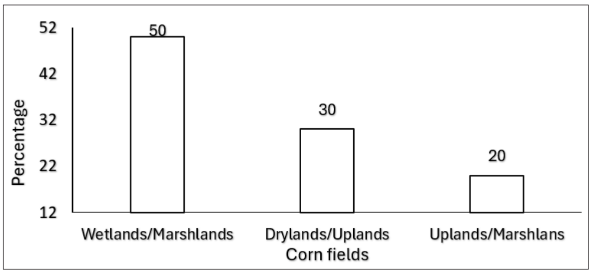

Figure 4: Areas of maize production in the Buea Municipality

Half (50%) of maize farmers concentrate in wet/marshland areas to cultivate maize because of their fertility nature and water moisture contents, 30% cultivate in dry and uplands while 20% cultivate in all these areas. This is done concerning farmers who have access to these areas.

Trend of Maize Production in Buea

Empirical data shows that there have been fluctuating trends in the quantity of maize production in the Buea Municipality from the year 2011-2022. There has been an irreversible decline of tons of maize within some years while others have witnessed massive increases. These fluctuations are provoked by the wavering nature of climate parameters (Figure 5).

Rainfall has a pronounced relationship with maize production as much is needed for the kernels, tassel, and silk that determine the quality and healthiness of maize. Fluctuations in climate conditions such as the false and late onset of rains and the deepened breaks during the rainy seasons modify the production chain thereby negatively affecting the growth conditions of maize.

Maize Farmers' Perceptions on the Trends of Climate Variability

During the field survey, approximately 100% of maize farmers admitted that climate is the most influencing environmental factor that influences maize production in the Buea Municipality and additionally that over time there have been unprecedented changes in most principal climatic parameters. As to their perceptions the most fluctuating of the climatic parameters (Figure 6).

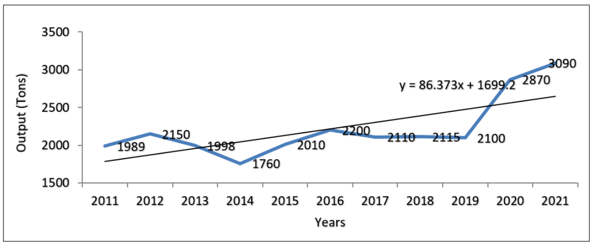

Figure 5: Trends of maize production in the Buea (2011-2021)
Data source: Regional Delegation of Agriculture and Rural Development for the Southwest (2023)

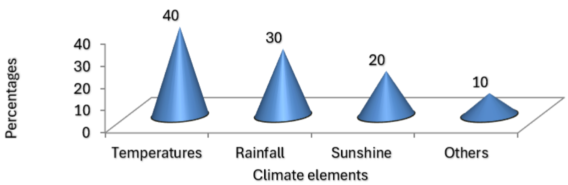

Figure 6: Maize farmers' perceptions of the most fluctuating climate parameters

In the opinions of maize farmers, temperatures and rainfall are the most fluctuating climatic parameters in the Buea Municipality as pointed to by 40% and 30% of the farmers, respectively, while 20% said that sunshine. Furthermore, 10% of the farmers complained about fluctuations in other parameters such as relative humidity and wind speed. Testimonies indicated that temperature conditions have changed significantly, showing an increasing trend. Additionally, the majority of the farmers reported a late onset and termination of the rainy season. Also, farmers testified that during some months especially in the dry season, sunshine becomes unbearable and this trend is gradually affecting the rainy season. The information established from farmers' perceptions of climate variability trends was complemented by results obtained from analyses of climate data collected from the NASA Archives in online sources to determine the present situation. Details on these climatic trends were presented in the subsequent paragraphs.

Mean Monthly Maximum and Minimum Temperature Conditions in Buea

The maximum and minimum monthly temperature conditions vary significantly in the Buea Municipality. The Former goes approximately 30°C in January and March while declining in June-October, 26.91°C and 25.99°C, respectively (Figure 7).

The latter does the same in the aforementioned months reaching 24.6°C and 24.°C in March and May and dropping to 22.6°C and 22.4°C in July and August. Such irregular distribution of temperature conditions creates changes for the spread of agricultural pests and diseases and moisture deficiency within farmlands. Average monthly temperature conditions (Figure 8) also show great disparity within agricultural months in the Buea Municipality.

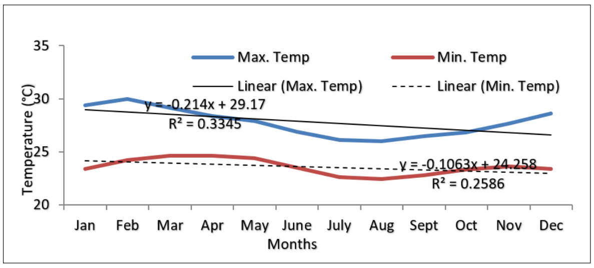

Figure 7: Average Maximum and minimum monthly temperature conditions in Buea (1990-2022)
Source: NASA Data (2023)

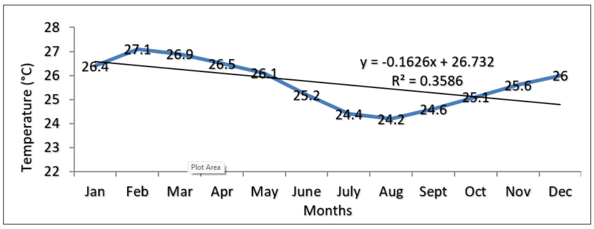

Figure 8: Mean Monthly temperature conditions in Buea (1990-2022)
Source: NASA Data (2023)

Decreasing trends of temperature conditions are experienced during the rainy season (June-October) considered as the cultivation season while they gradually increase in the months of November-January. Differences in the mean monthly temperature conditions also explain why there is variation in the quantity of maize production, cultivation patterns, and seasonal intensities. Temperature conditions have also been varying annually within the Buea Municipality (Figure 9). The trends of temperature conditions show fluctuating and increasing trends, especially in the last 10 years or so.

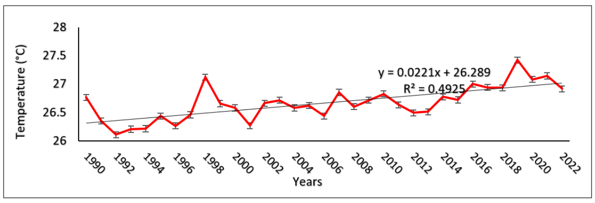

Figure 9: Mean Annual Trends of Temperature Variability in Buea Municipality
Source: NASA Data (2023)

The mean annual temperature conditions were relatively low in 1990, 1992, 1994, 1996, and 1998, with, however, an unexpected increase in 1999 and 2000. From the year 2021-2018, temperatures have declined with fluctuating trends from year to year, and have been increasing from 2020 up till date. The decline in temperature conditions in some months is attributed to La Nina events that have cooling effects on temperatures and also the solar minimum that occurred around 2000-2009. The decline in temperature conditions negatively affects maize production, especially during the ripening stage when intensive sunlight is needed to enhance maize readiness for harvest. Years of increasing temperature conditions like 1999 and 2000 have been instigated by El Nino events and the rapid environmental degradation practices by the local population such as poor farming, deforestation, and rapid urban sprawl. Such increases in temperature conditions bring about seasonality and dry up of water sources that affect the amount of moisture available for plants.

Rainfall Trend in Buea

Rainfall which is the actual determinant factor of agricultural activities has also been fluctuating across the agricultural landscape of the Buea Municipality. The fluctuations are evident on a monthly and annual basis. Mean monthly rainfall conditions show conditions of excessive decline in November-March with mean values below 150 mm (Figure 10). The drastic fall in the amount and intensity of rainfall between these months explains why maize production varies in terms of scale, intensity, and methods from season to season.

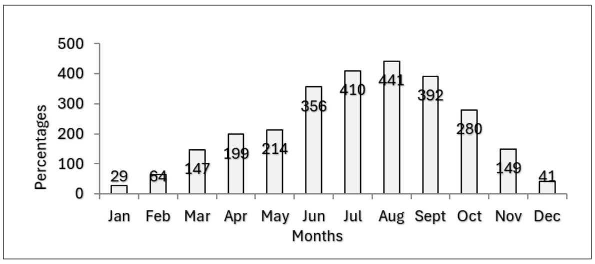

Figure 10: Average monthly rainfall conditions in the Buea Municipality
Source: NASA Data (2023)

There is increasing and high-intensity rainfall in the months of April-October. These are typical rainy season months in this area and provide sufficient moisture for staple maize production but there are adverse situations where this torrential rainfall results in abject soil erosion and crop destruction. The mean annual rainfall conditions in the Buea Municipality also depict year-to-year discrepancies with some years characterized by sufficient rainfall that sustains agricultural production (Figure 11).

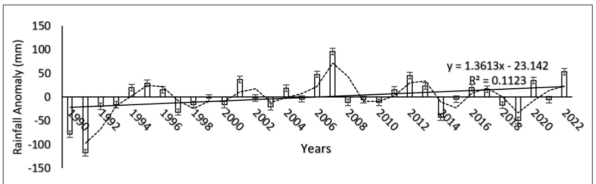

Figure 11: Mean annual rainfall of Buea
Source: NASA Data (2023)

Farmers' Perceptions on the Implications of Climate Variability on Maize Production

From farmers' perspectives, the changing patterns and trends of climate variability have severe implications for maize production (Figure 12).

Results indicate that 32% of the farmers lodge complaints that climate variability has enhanced the fast degradation of soil fertility, 28% said there has been abject soil deficiency while 18% attributed it to the occurrence of massive agricultural pests and diseases. Furthermore, 14% of the farmers also pointed out that climate variability has instigated poor crop yields and 8% said because of this phenomenon, there is always late crop harvesting which threatens food security (Figure 13 a & b).

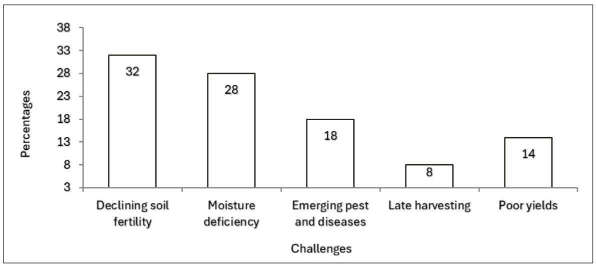

Figure 12: Farmers' Perceptions on the Implications of Climate Variability on Maize Production

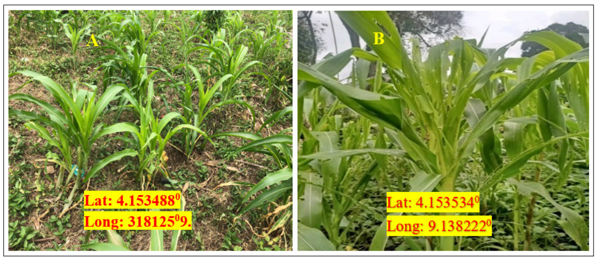

Figure 13: Climate-related challenges on maize production in Buea

Figure 13A shows the wilting of maize caused by climate variability especially during periods of dry spells while 13B shows the manifestation of agricultural pests and diseases which is caused by limited moisture availability.

Relationship between Maize Production and Rainfall in Buea

A Pearson's Product Moment Correlation analysis was run between rainfall amount and maize yields (tons) to determine if maize production has any relationship with rainfall (Figure 14).

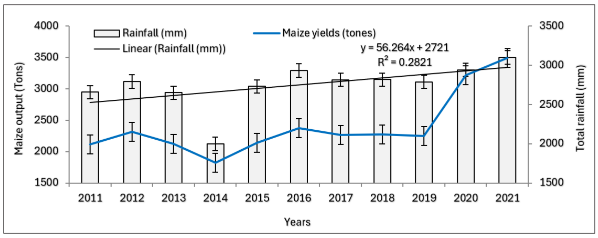

Figure 14: Correlation between Annual Rainfall and Maize Yields

From the results, it can be seen that an increase or decrease in rainfall has the same impact on maize yields. In Figure 8, the years with the highest amount of rainfall recorded the highest amount of maize yields. This is seen for the years 2021 and 2020 with yields of 3090 and 287 tons respectively. As narrated by workers at MINADER, early and sufficient rainfall eases the flowering of the corn plant thereby guaranteeing better output. Other years recorded small amounts of rainfall and so did the maize yields drop. This is seen in the years 2014 and 2013 with yields of just 1760 and 2010 tons respectively. The actual correlation values are shown in the subsequent tables (Table 1a & 1b).

Table 1a: Descriptive Statistics of rainfall and maize yields

Variables	Mean	Std. Deviation	N
Average Rainfall	3058.5455	351.35263	11
Maize Yields	2217.4545	397.55487	11

Table 1b: Correlation results between rainfall and maize yields

Correlation	Average Rainfall	Maize Yields
Pearson Correlation	1	0.714*
Sig. (2-tailed)		0.014
Sum of Squares and Cross-products	1234486.727	996785.273
Covariance	123448.673	99678.527
N	11	11
*Correlation is significant at the 0.05 level (2-tailed)		

As regards the information in Table 1 (b), the result was statistically significant with a value of 0.014, and a correlation value of 0.714 at a significant level of 0.05%. The positive correlation value of 0.714 revealed that rainfall has a direct relationship with maize yields as depicted by the trending line (Figure 8). As rainfall increases, so thus maize yields increase and vice versa. Measures must be put in place to control or limit the declining trends of rainfall manifested in some years. If this is not put into practice and most especially, timely; then maize production will be affected and there will be general food security.

Adaptation Measures of Farmers to Climate Variability

Maize farmers always implement local measures to cope with climate-related issues. Some of the measures were identified (Figure 15).

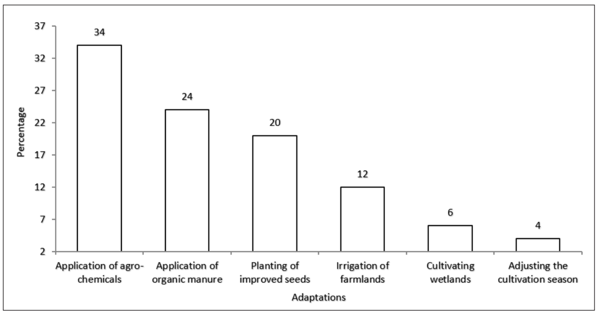

Figure 15: Maize farmer's adaptation measures to climate variability in Buea

As regards the information, 34% of the farmers said that they often apply chemical fertilizer in areas with rapid soil degradation characterized by declining yields, 24% pointed at organic manure while 20% said that they have replaced alien species with adapted or improved species of maize seeds. Furthermore, 12% claimed to have been irrigating their farmlands during periods of seasonality, followed by 6% who lodged complaints they mostly cultivate wetlands to benefit soil moisture and fertility and 4% who said they have adjusted their cultivation season by doing more wet season maize production (Figure 16 a & b).

There is the application of wood ash (Figure 16a) and 16b shows the application of chemical fertilizer. This is done to enhance the growth and quality of the yields.

Challenges Faced in Adapting to Climate Variability

In the course of implementing measures against climate variability by farmers, many challenges emerged that make these adaptation measures not to be sustainable (Figure 17).

Figure 16: Adaptation measures of farmers to climate variability in Buea

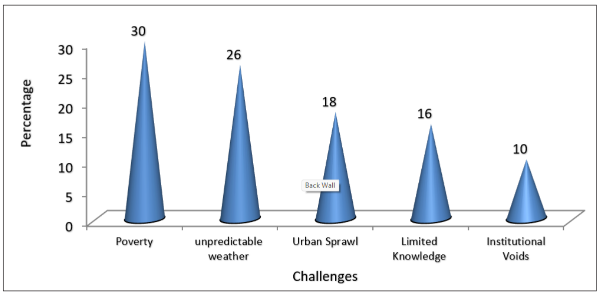

Figure 17: Adaptation challenges faced by maize farmers to climate variability

Results indicate that 30% of the farmers attribute low implementation of sustainable adaptation measures to poverty, while 26% point to unpredictable and rapidly changing weather patterns pose threats to adaptation measures. Again, 18% indicated that urban sprawl is another major problem. Most wetlands and forest areas have been cleared for settlement function, thereby increasing seasonality episodes. Also, 16% of farmers said that they have insufficient knowledge on how to deal with climate-related issues and 10% said that there exist limited institutions to support agricultural initiatives.

Discussion

The study aimed to analyze the implications of climate variability on maize production in the Buea Municipality. It examined the different maize species cultivated by farmers, identified the season with peak maize production, and assessed the trends of climate variability in the area. The Pearson Correlation technique was used to establish the relationship between rainfall and maize yields. The results indicated that farmers in the Buea Municipality predominantly engage in the mass production of maize, particularly the white and red varieties. Most maize production occurs during the rainy season, while cultivation during the dry season is relatively low. This is primarily due to the sufficient soil moisture present in the rainy season, which promotes rapid maize ripening. Additionally, the environmental conditions during this period are favourable for growth. In contrast, the dry season presents unfavourable conditions that hinder maize cultivation. As a result, farmers mainly grow white maize because it is resilient and can thrive in these conditions with minimal disruption from environmental factors. This finding aligns with Semedo, who noted that maize is commonly cultivated alongside other principal cereals in Northern Nigeria [2]. Similarly, Tume and Nyuyfoni; Tume et al.; Zetem and Kometa examined rainfall variability and crop vulnerability, highlighting that significant environmental changes have led farmers to focus more on wetland cultivation, with production activities being more dominant during the rainy season [12-16].

Maize production yields in the Buea Municipality from 2011 to 2021 exhibited a fluctuating trend each year. Some years saw high maize yields, while in other years, yields drastically declined. These variations were attributed to several factors, including climate variability, declining soil fertility, aging seeds, and changes in environmental conditions. Similar findings on fluctuating trends in crop yields were reported by Balgah et al. and Zetem and Kometa, who noted that maize outputs fluctuate both seasonally and annually [11,16]. An analysis of maize and bean outputs from 2000 to 2015 indicated that these crops have also experienced fluctuations, particularly under climatic stress. Furthermore, Amawa et al. examined the implications of climate variability on market gardening crop production in Santa (Cameroon) and found that market garden produce was unstable over the years, with both declining and increasing outputs [17].

Significant variations in climate parameters, particularly rainfall and temperature, have been observed. Rainfall is inconsistent throughout the year, with noticeable fluctuations, especially during the dry season. Months such as November, December, January, and February typically see reduced rainfall, dropping below 100 mm, which affects both pattern and intensity. In contrast, rainfall is sufficient from June to September, reaching over 250 mm with minimal discrepancies. Temperature conditions vary inversely with rainfall; during months with adequate rainfall (June to September), average temperatures drop below 21°C, while they rise to approximately 27°C from November to February. Information regarding climate variability was also captured by Nkemasong and Yinkfu, who assessed the implications of seasonal variations in moisture and heat budget components on livestock production [18]. They noted discrepancies in rainfall, where high levels occurred during the rainy season and significant drops were seen in the dry season. A similar pattern was reported for temperature, which tended to be very high in the dry season and much lower in the rainy season. Ngwani et al., in their assessment of climate challenges faced by indigenous Mbororo communities in the Mbum Plateau (Cameroon), also highlighted substantial variations in temperature and rainfall monthly and annually [19].

Wavering climatic conditions have numerous negative impacts on maize production. For instance, from November to February, rainfall often drops below 100 mm, leading to dry season characteristics that hinder maize cultivation [20,21]. Common issues during this period include soil moisture deficiency, rapid soil erosion, the prevalence of agricultural pests and diseases, and harsh weather conditions that impact both maize crops and farmers. Conversely, although adequate rainfall from June to September enhances maize productivity, continuous heavy downpours during the harvesting months (June to August) can adversely affect ripening conditions, leading to mould development and rapid decay of the maize. Additionally, farmers face climate-related challenges such as soil erosion, stunted maize growth, poor harvests, and invasive weeds. High temperatures occurring from March to early April impede seed germination, resulting in the need for costly re-sowing. These temperature conditions also lead to the development of hard soil layers, making tillage difficult. Increased temperature means maize production increasingly relies on stable rainfall. The WMO report highlights that rising trends in temperature, relative humidity, and precipitation are expected to shift production seasons, pest and disease patterns, and alter feasible crop options, thus affecting production, prices, incomes, and ultimately, livelihoods [22]. Furthermore, Semedo noted that the decreasing trend and frequency of rainfall in Northern Nigeria present significant barriers to staple agricultural production [2]. Inadequate rainfall exacerbates the prevalence of diseases and pests, negatively impacting both the quality and quantity of crop yields.

To cope with climate-related challenges, farmers have implemented various measures. Some practices include cultivating wetlands during the dry season and applying agrochemicals, such as fertilizers and organic manure. However, these efforts have been largely ineffective, as many farmers are impoverished and lack sufficient knowledge about effective measures. Additionally, institutional gaps hinder farmers' access to essential inputs, like chemical fertilizers and tools such as watering cans, hoes, and machetes. The rapid urban expansion is also encroaching on farmlands and complicating adaptation measures due to the uncontrolled disposal of urban waste on agricultural land. The intensity and frequency of extreme weather events are increasing, making it increasingly difficult for farmers to cope. These findings align with those of Ndung'u and Bhardwaj, who noted that agricultural adaptation may include strategies such as crop diversification, the use of resilient crop varieties, mixed crop and livestock farming practices, adjusting planting dates, and irrigation [23]. However, Perez et al., emphasized that many African states lack the institutional capacity to address climate variability and change, leaving individuals and groups within societies without the necessary means to adapt effectively [24-26].

Conclusion

The study analyzes the implications of climate variability on maize production in the Buea Municipality using the Pearson Product Moment Correlation method. Climate trends from 1990 to 2022 and maize yields from 2011 to 2021 have been examined. Temperature conditions show fluctuating and increasing trends, whereas rainfall exhibits fluctuating but decreasing patterns. Maize production yields over the years are directly proportional to rainfall trends but contrast with the rising temperatures. Years with declining rainfall have corresponded with reduced maize yields, primarily due to insufficient moisture and increased incidences of agricultural pests and diseases that thrive in such conditions. The dry-season cultivation of maize is becoming increasingly challenging as moisture deficiency escalates. Farmers have attempted various adaptation measures, but these approaches have proven unsustainable, resulting in only temporary successes. The study predicts that climate variability will continue to intensify, largely due to uncontrolled human activities around the Buea Municipality. Consequently, the study concludes that Buea remains a critical town for socio-economic activities, particularly for the growing human population that relies on agricultural produce. It recommends a comprehensive approach that includes training farmers in modern farming techniques, providing necessary inputs, and disseminating information on climate change. To foster a sustainable environment conducive to maize production and food security in Buea Municipality, the local council should initiate environmentally friendly programs, such as tree planting and wetland restoration. Proper land-use planning is essential to manage urban sprawl. The local community should shift from traditional farming methods that involve deforestation to more lucrative practices like agroforestry. Additionally, promoting agricultural diversity, where maize is grown alongside other cereals or tubers, can help mitigate the risks of crop failure. Non-governmental organizations (NGOs) should facilitate workshops to educate the community on the importance of environmental conservation and sustainable practices. Moreover, timely climate information should be provided to farmers, who should also seek advice from agricultural extension workers and experts regarding climate variability. Farmers are encouraged to adopt improved seed varieties and apply organic manure to their fields, as well as implement ecologically friendly practices such as zero-tillage and Nature-based Solutions. Finally, the government should offer incentives and farming inputs to enhance production techniques.

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