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Understanding the Nexus Between Climate Change, Dwindling Agro-Pastoral Resources, and Conflicts in Kouoptamo, Cameroon

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ABSTRACT

Climate variability and change are a major threat to rain-fed agro-pastoral systems in Africa and a potential source of conflict. This work sets out to examine the relationship between climate variability, resource degradation, and agro-pastoral conflicts. Using mixed research methods, secondary data was collected from archives and reports in institutions while primary data was collected through the administration of 120 questionnaires to purposively selected farmers and grazers while 09 in-depth interviews were conducted with key stakeholders. Quantitative and qualitative analysis of data revealed that climatic elements of rainfall and temperature have been varying in space and time with negative impacts on water and pasture. The regression model considered climate variability as a predictor of resource degradation and the independent variable explained the outcome variable at $R=0.711$; $R^2=0.633$; $\Delta R^2=0.622$; $p<0.01$. Also, climate variability was able to predict agro-pastoral conflicts at, $R=0.736$; $R^2=0.542$; $\Delta R^2=0.540$; $p<0.01$. Climate-exacerbated conflicts have been recorded in Mbankouop (40.9%), Njougoumbe (31.8%) and Njitapon (27.25). Conflicts occur between crop farmers and pastoralists and between pastoralists themselves as they compete over diminishing resources. Hence, understanding the nexus between climate change, resource scarcity and conflicts paves the way for proper adaptation and limits conflicts.

INTRODUCTION

Climate variability and change are some of the greatest challenges affecting the human and natural systems in Sub-Saharan Africa. Among the sectors severely impacted, agriculture tops the list as it solely depends on the natural factors of rainfall and temperatures. The cultivation of crops and the rearing of animals take a seasonal pattern marked by the onset and termination of rains. This subsistence type of agriculture occupies more than 70% of the population and forms the backbone of most economies. In Cameroon, about 35% of the Gross Domestic Product comes from agriculture and related sectors (Molua, 2010). However, climate variability and change are characterized by increasing frequency and intensity of prolonged dryness, a reduction in rainfall amounts, a decline in the length of the rainy season and rising temperatures (Amani *et al.*, 2010; Nicholson, 2017). The climatic parameters of rainfall and temperature are the main drivers of crop growth and given that agriculture in Sub-Saharan Africa is predominantly rainfed, small changes in climatic conditions lead to falls in productivity (Malua, 2010).

Cameroon has a diverse and rich ecological setting that permits the cultivation of a wide range of crops and the rearing of animals. Each ecological zone has specific agricultural activities but in most cases, crop cultivation and animal rearing are carried together in what is called the mixed-agricultural zones. The Western Highlands of Cameroon is one of the agro-ecological zones where crop farmers and animal herders cohabitate. Crop farming is mostly done by the native population while a cattle rearing is predominantly done by Mbororo Fulanis who migrated into the region from neighbouring Nigeria (Jabiru, 2010).

Studies by Nyuymenka (2016), revealed that more than 95% of the Mbororos of Cameroon practice extensive grazing with little inputs. Two prominent methods of rearing used are pastoral nomadism and transhumance though recent mobility has been considered a traditional strategy to cope with the dwindling pastoral resources caused by climate variability in traditional grazing zones (Manu *et al.*, 2014; Moye *et al.*, 2021). According to Pelican (2012), the Mbororos in the grass fields of Cameroon are agro-pastoralists but most Mbororo families complement cattle husbandry with subsistence agriculture. This diversification to non-pastoral activities permits them to reduce shocks from climate anomalies. The use of indigenous knowledge systems in enhances adaptation is taking the central stage (Kinyili, 2023). Pastoralists due to their inextricable link with nature have permitted to accumulate a huge knowledge base that needs to be mains tream to adaptation policies.

Climate change has negatively affected the natural resource base and livelihoods of the population. The shrinking of water sources and degradation of pasture has resulted in conflicts in pastoralist communities. Conflicts result from competition over resources that have been made increasingly scarce due to an increase in human population and the increasing number of animals in grazing zones. Animals in search of diminishing resources tend to encroach into farmlands and destroy crops leading to conflicts (Quentin *et al.*, 2005; Moritz, 2008; Higazi, 2022). The impacts of these conflicts have had negative consequences on the livelihoods of pastoralists and as such addressing the root causes has been a concern both on the part of pastoralists themselves, crop farmers and the government. Though these conflicts have existed over

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the past decades, this work shows that they have been exacerbated by the vagaries of weather. It equally seeks to establish the link existing between climate change, resource degradation and conflicts, an approach that has not been sufficiently explored in the Western highlands of Cameroon.

MATERIALS AND METHODS

The study area

Kouoptamo in the Noun division was use as case study. It is located between longitudes 100291011 and 1004513011E of the Greenwich Meridian and latitudes 50311011 and 504713011N of the equator (Bidias *et al.*, (2023) (Figure 1). It falls within the Western Highlands agro-ecological zone, covering a surface area of 312 km² with a population of 48772 inhabitants. This gives an average population density of 156 persons/km² (BUCREP 2005). It has a tropical climate of the savanna type, characterized by two seasons: a longer rainy season that lasts for about 8 months and a shorter dry season. The average annual rainfall is 1760.88mm and the average annual temperature of 25.31°C. (Bidias *et al.*, 2023). This seasonal pattern has permitted the cultivation of food crops and the growth of pasture for animals.

The systems of crop cultivation are intensive and extensive. Intensive farming involves the cultivation of vegetables on well-drained slopes during the rainy season and along valleys, swamps and lowlands during the dry season. The Noun Valley and banks of the Bamendjim reservoir are suitable areas for dry season farming. Extensive farming involves the cultivation of cereals such as maize and beans with farm sizes ranging between 1 to 4 hectares. These crops are mainly cultivated in the dry season but farms also contain perennial crops such as plantains, cassava, cocoyam and banana. Due to an increase in population, pastoralists have adopted a sedentary pastoral nomadism system of rearing whereby herdsmen have permanent residences but lead their animals to fresh pasture and water points daily, covering several kilometres. They allow their animals to graze continuously with little or no restriction once they are within their prescribed area. These animals consist of mainly cattle, but in some cases accompanied by sheep. Cattle herding is practised mainly by Mbororo pastoralists who migrated into the area from the Adamawa plateau while crop farmers are in the majority, the Bamoun people. The use of the same space by pastoralists and crop farmers increases the possibility of farmer-herder conflicts.

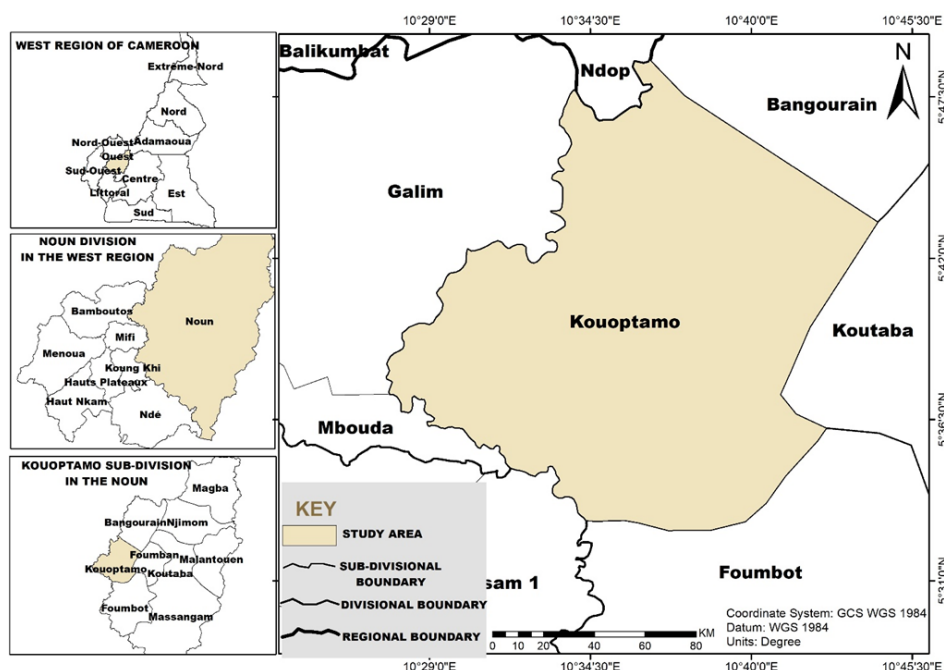


Figure 1: Kouoptamo in the West Region of Cameroon.

Data collection and Treatment

This study adopted a mixed methods approach to collect data from both primary and secondary sources. Secondary data was collected from archives at the Divisional Delegation of Livestock and Animal Husbandry, Agricultural and Rural Development and from the Mbororo Development and Cultural Association, MBOSCUA. Primary data on the other hand was collected from the administration of 120 household questionnaires to purposively selected cattle herders and crop farmers and from 9 in-depth interviews with key stakeholders. Households involved

are those that are either involved in cattle rearing, crop farming or both. In-depth interviews were conducted with the MBOSCUA representative, the Mbororo traditional ruler called Ardos, native traditional rulers of the three main grazing areas (Mbamkouop, Njitapon and Njigoumbe), Divisional delegations of livestock and animal husbandry and that of Agriculture and Rural Development and with the Divisional Delegate of the Kouoptamo Sub Division. To ascertain the level of climate variability, temperature and rainfall data were collected for the period from 1981 to 2021. Given the scarcity of in-situ

data, data was downloaded from www.nasa.power.org and used in the analysis.

Data collected was treated using quantitative and qualitative methods. Questionnaires were coded and treated in SPSS version 20 while voice notes recorded during interviews were treated using content and thematic analysis. To test the validity and reliability of the instrument, the cronbach's alphas (α) coefficient for all the sub variables were calculated. The hypotheses were tested at 0.05 levels of significant correlation, including hierarchical regression and T-test. H1 looks at the relationship between climate variability and resource degradation while H2 studies the link between climate variability and conflicts. At 5% level of sig, we reject the null hypothesis for the test with a probability estimate lower than 5 % (.05) and conclude that there are statistically significant. Otherwise, we accept 0.05 when probability estimates are above and conclude that there is no statistically significant. Excerpts captured from some key informants have been used to express perceptions of the population on the link between climate change and conflicts. Rainfall and temperature data were smoothened using 5-year running means and coefficients of variations were computed to establish the rate of climate variability. To establish anomalies, deviations from the normal were computed for the main climatic parameters and the growing period

RESULTS AND DISCUSSIONS

Indicators and manifestations of Rainfall and temperature Variability in Kouoptamo

Rainfall and temperature are the main drivers of crop and pasture growth in the area and slight changes in its spatial and temporal dimensions are likely to affect livelihoods negatively. Computing the rainfall data set from 1981-2021, it was revealed that the annual average rainfall amount is 1957.213mm, standard Deviation of 479.546mm, with a coefficient of Variation of 24.5%. This is above the reliability threshold of 10% and therefore indicates high fluctuations in the inter-annual amounts of rainfall. This high inter-annual rainfall variability demonstrates the unreliable nature of rainfall in Kouoptamo. This unreliability in rainfall is higher in the rainy season with a CV of about 60%. Temperatures on the other hand have been rising steadily over the past decades despite the observed fluctuations. With a mean of 20.69°C for the study period and a standard deviation of 0.3879°C, temperature variability is shown by a CV of 1.87%. These slight temperature changes have negative outcomes for agricultural activities.

Climate variability and change manifest in the frequency and intensity of anomalous scenarios. Climatic anomalies are deviations from the climatic normal, which are either positive or negative (Figures 2 and 3).

Using the growing period data, the data set has shown fluctuations between positive and negative anomalies. Positive anomalies are period of excess rainfall and the probability of flood occurrence is a higher while negative

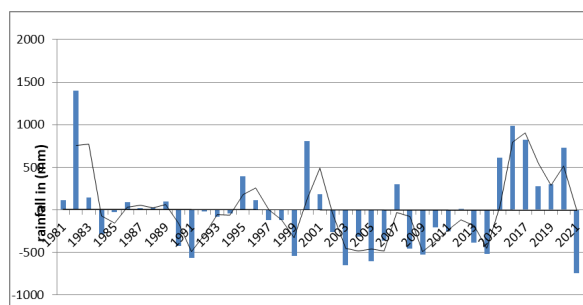


Figure 2: Growing period rainfall anomalies

anomaly are associated with rainfall shortages and dry spells. The data set shows that more than 50% of the growing periods registered water shortages with an overall falling rainfall trend. In the main time, temperatures are equally fluctuation (Figure 3).

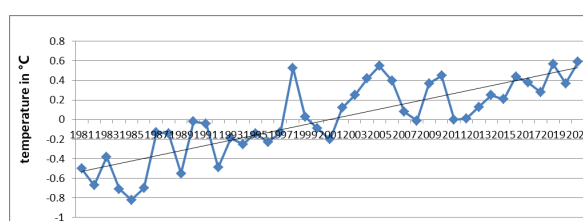


Figure 3: Temperature anomalies in Kouptamo

Figure 3 shows fluctuations between periods of positive and negative anomalies. However, the trend shows an increase in temperatures which is associated with dry spells and water scarcity. The questionnaire survey equally revealed that agro-pastoralists in Kouptamo have witnessed changes in the weather patterns, notably in rainfall and temperatures (Figure 4).

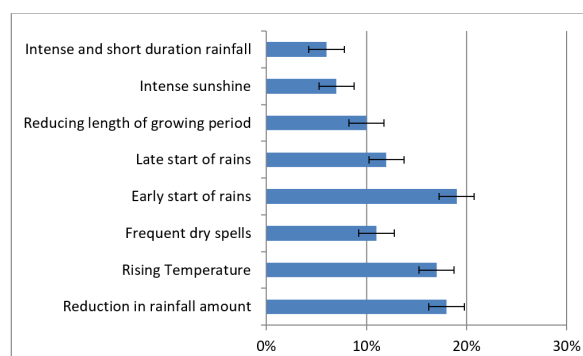


Figure 4: Perceptions of agro-pastoralists on the indicators of climate change

Figure 4 shows that agro-pastoralist have witnessed changes in the main climatic parameters of rainfall and temperature. Climate variability manifest through a fall in rainfall amounts (18%), rising temperatures and heat waves (17%), frequent dry spells(11%), fluctuations in the dates of onset and cessation of rains (19%) and the reducing length of the growing period(10%). These perceptions act as a pre-requisite for adaptation.

Impacts of Climate variability on agro-pastoral resources

The questionnaire survey has revealed that climate variability has negative impacts on crop farmers and cattle

herders in Kouptamo (Table 1).

Table 1: Effects of climate variability on agro-pastoral activities

Perceived Impacts of climate change	Frequency	%Frequency
Shrinking water courses	16	13.33
Pasture Degradation	18	15.00
Crop submergence during floods	11	9.17
Wilting of crops during dry spells	16	13.33
Cattle losing weight	15	12.50
Competition over resources	9	7.50
Emerging pests and diseases	11	9.17
Fall in output	13	10.83
Cattle encroaching into farm lands	11	9.17
Total	120	100.00

The impacts of climate variability and change include pasture degradation (15.0%), wilting of crops during dry

spells and water shortages (13.3%), cattle losing weight (12.5%), emergence of pest and diseases (9.17%), fall in agricultural output (10.17%), crop damages during floods (9.17%), cattle encroachment into grazing land (9.17%) and competition over the diminishing resources(7.50%). These impacts were further explained with excerpts captured during an interview with a cattle herder;

“...High altitude areas and slopes such as Kounden are exposed to stronger winds, dry spells and scorching rays of the sun. This accelerates evapotranspiration which causes pasture and water to dry off faster and become deficient. This is common during seasonal transitions when the effects of the harmattan wind are felt in this area....” (Interview, 2023).

These periods of pasture and water shortage usually coincide with periods of seasonal fluctuations. A prolonged dry season causes pasture shortages with impacts on the cattle.

HR1: Climate variability has significantly influenced the reduction of agro-pastoral resources

The first hypothesis was designed to find out if changes in climatic factors can significantly determine the reduction in agro-pastoral resources (water and pasture). This bivariate correlation was computed in SPSS and the model summary has been presented on Table 2.

The variability of climatic elements of temperature

Table 2 : Predicting the influence of climate variability on pasture degradation

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					RSquare Change	F Change	df1	df2	Sig.F Change	
1	.711a	.633	.622	5.41092	.633	359.05	1	217	.000	1.720

a. Predictors: (Constant), Climatic factors

b. Dependent Variable: Resource degradation

and rainfall were considered as a predictor of resource degradation and the independent variable explained the outcome variable at $R=0.711$; $R^2=0.633$; $\Delta R^2=0.622$; $p<0.01$. From the analysis, it is evident that fluctuations in climatic parameters of rainfall and temperature were able to predict 63.3% of the variation in the independent variable and consequently, the hypothesis was accepted. This implies that the changing climatic conditions characterized by frequent dry spells, fluctuations in date of onset and cessation of rains, reduction in rainfall amounts and rising temperatures have led to the pasture degradation and shrinking of water sources. To test whether the overall regression model is a good fit for the data set, the f-ratio in the ANOVA statistics was used.

Table 3 shows that climate variability statistically predict the degradation of pastoral resources $f(1,52)=77.764$, $p<0.0005$. That is the regression model is a good fit of the data. The general form of the equation to predict resource degradation due to climate variability is gotten from the equation $\text{climate variability}=31.302-(.504*\text{resource degradation})$. The unstandardized coefficients indicate how much the degradation of agro-pastoral resources vary with climatic anomalies when all other variable are held

Table 3: ANOVA Statistical significance

ANOVA ^a						
Model		Sum of Squares	df	Mean Square	F	Sig
1	Regression	2635.987	1	2635.987	77.764	.000 ^b
	Residual	17931.768	529	33.897		
	Total	20567.755	530			

a. Dependent Variable: Resource degradation

b. Predictors: (Constant): Climate variability

constant (Table 4) Table 3 shows that climate variability statistically predict the degradation of pastoral resources $f(1,52)=77.764$, $p<0.0005$. That is the regression model is a good fit of the data. The general form of the equation to predict resource degradation due to climate variability is gotten from the equation $\text{climate variability}=31.302-(.504*\text{resource degradation})$. The unstandardized coefficients indicate how much the degradation of agro-pastoral resources vary with climatic anomalies when all other variable are held constant (Table 4).

As shown in table 4 above, the unstandardized coefficient,

Table 4: Estimated model coefficients

Coefficients ^a								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	31.302	1.306		23.976	.000	28.737	33.866
	Resource degradation	.504	.057	.358	8.818	.000	.392	.616

a. Dependent Variable: Climate variability

B, for resource degradation is equal to 0.504. This means that for each given change in climatic conditions above or below the normal, there is an increase in the rate of agro-pastoral degradation of 0.504. This shows climate variability is an important factor that plays a central role in resource degradation. Given this situation, attempts by cattle herders to feed their animals on farmlands and get other sources of water have led to competition between crop farmers and cattle herders leading to conflicts.

Climate driven resource based conflicts and manifestations

Findings revealed that conflicts have become frequent, occurring between crop farmers and pastoralists and

between pastoralists themselves. Severe conflicts have been frequent in the pastoral zones where animals are permanently present as is the case in the localities of Mbankouop Kounden, Njigoumbe and Njitapon. However, the cause may vary but climate remains the indirect cause of conflicts.

HR 2: Climate variability has a significant influence on agro-pastoral conflicts

The second hypothesis was designed to examine if climate variability can determine the occurrence of agro-pastoral or resource-based conflicts and a summary of results has been presented on Table 5.

In SPSS, climate variability was entered to determine

Table 5: Predicting conflict outbreak

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.736a	.542	.540	8.30461	.542	257.66	1	218	.000	2.001

a. Predictors: (Constant), climate variability

b. Dependent Variable: conflict outbreak

agro-pastoral conflicts and the independent variable was able to predict the dependent variable at, $R=0.736$; $R^2=0.542$; $\Delta R^2=0.540$; $p<0.01$. It was observed that climatic aberrations are capable of predicting conflicts up to 54.2%. It is evident that the fluctuation in climatic parameters leads to resource degradation and therefore has a significant influence on the outbreak of conflicts. Hence, the alternative hypothesis accepted. This further confirms the high relation, $r=0.73$ and confirming that the model is good fit in predicting conflict outbreak. These conflicts occur at different levels and have different manifestations.

Conflicts that result from the destruction of crops by animals

This is the principal cause of climate-driven conflicts that occur between crop farmers and pastoralists. Crop farmers argue that a plant has never travelled to meet the animals but rather, the animals are mobile and stray to crop farms where they cause enormous damage. This is the most frequent type of conflict and presents the highest magnitude in the pastoral zones of Mbankouop, Njigoumbe and Njitapon. As revealed during interviews, 22 conflicts were recorded in 2023. Out of this

number, 40.9% were recorded in Mbankouop, 31.8% in Njigoumbe and 27.25 in Njitapon. The principal cause is the shortage of pastoral resources generated by climate variability. This explains why they occur mainly during periods of acute pasture shortage. Temporally, although they occur throughout the year, the peak periods are the later part of the dry season from late December to early March and the early part of the rainy season from late March to the end of April when pasture is insufficient for the animals. For instance, on the 20th of March 2022, the destruction of crops by cattle led to the burning of residences of the Mbororo Pastoralists in Kounden. According to some interviewees, crop farmers usually have the impression that the Mbororos are the ones who direct the animals to their farms and that is why their response is often violent. This has led to several court cases in the area despite measures to ensure a peaceful resolution of conflicts.

Conflicts over water points

Water is an important agro-pastoral resource as it is used to irrigate crops and for drinking by cattle. Conflicts over water points occur between grazers and herders and between pastoralists themselves. It was revealed

that when the dry season becomes prolonged, the volume of water becomes reduced and some rivers dry up completely. During such periods, crop farmers need water to irrigate their vegetable farms while pastoralists need to secure the water for their animals. Some crop farmers dredge portions of streams and canalize them to their farms. Each time animals pass around these facilities, they destroy them and conflicts arise. On the other side, pastoralists also dredge some spots of streams for their animals. When the crop farmers use water from these points to water their crop farms, conflict arises. Such conflicts equally occur between pastoralists who compete over a water point.

Conflicts during Transhumance

Transhumance is an adaptation strategy adopted by pastoralists to cope with pasture and water shortages in the highlands. This strategy consists of the movement of herdsmen with their animals from the uplands around Kounden and the slopes of hills such as Nkeugham to lowland pastoral zones of Njigoumbe, Njitapon, Machoutnoun and into river Noun valley. According to the agro-pastoral calendar, herdsmen leave from the Kounden area on the 23rd of December when the harsh conditions of the dry season cause the pasture to dry off and they move to the lowlands and valleys where pasture is still available. The transhumance zones of Njitapon and Njigoumbe are found along the Bamenjim reservoir. The waters of this reservoir moderate the effect of the dry season such that these areas can maintain much pasture throughout the year. Upon arrival, Herdsmen guide their animals to farms where maize has just been harvested so that they can eat the corn stalks. They equally deposit their droppings in the farm which adds to the fertility of the soil. The herdsmen construct temporal huts while some have permanent huts where they stay till the 15th of March which marks the end of their transhumance period.

In February, the pasture lands are burnt in the area of origin so that with the coming of rains in March, the pasture regenerates. This strategy is repeated every year and remains one of the oldest strategies which have become the tradition of the Mbororo pastoralists. However, conflicts occur along transhumance corridors and at destinations.

Conflicts along transhumance corridors

The journey from uplands and mountain slopes to lowlands and river valleys in the middle of December and back to the hills in the middle of March has also been marked by conflicts. This movement called transhumance is a response to pasture scarcity up the slopes. The paths taken during this movement are called transhumance corridor. Interviews revealed that as animals move along transhumance corridors, they trample on farms and destroy perennial crops such as cassava, bitter leaves and plantain. In some cases, they push down fences and give the impression that animals are left uncared for.

This generates conflicts with the crop farmers. Their main transhumance corridors include; Mbankouop to Njigoumbe, Mbankouop to Njitapon. Mbankouop to Machoutnoun and from Mbankouop to the Noun valley. These transhumance corridors lack basic facilities such as campsites, veterinary posts and water points. In some cases, pastoralists compensate for damages on the way before they finally get to their destination.

Conflicts in transhumance destinations

The transhumance destinations are in the pastoral zones of Njigoumbe, Njitapon, Machoutnoun and parts of Kouoptamo, especially along the Noun Valley and the Galim along the slope of Mount Bamboutos. Climate variability is responsible for some of these conflicts because it disrupts the agro-pastoral calendar. The agro-pastoral code fixes the periods for transhumance, a period during which crops must have been harvested. However, it has been revealed that crops tend to mature late due to delays in rainfall as indicated in the following excerpt

".....In some years, yields of corn were not very good due to rainfall variability. Rains started late and corn took a longer time to mature. Consequences were enormous; pests and diseases attacked corn and animals arrived at transhumance destinations when parts of the corn were not yet ready for harvest. This led to conflicts as crop farmers resisted the arrival of pastoralists and their herds..." (Interview, 2023)

Apart from seasonal crops, perennial crops remain at risk due to their permanent presence in the farms. These include; cassava, bitter leaf, plantains and sugarcane. Sugarcane is mostly dotted in most farms of all the transhumance pastoral zones. In the dry season, sugarcane is the principal source of income for many crop farmers. Dry-season vegetables such as huckleberry, garden eggs, tomatoes and other green spices are cultivated during the dry season in irrigated portions along the Noun Valley and adjacent to the Bamenjim reservoir in the Njigoumbe and the Njitapon area. Given that dry season farming is an important source of income for the population, they generally resist the herding of cattle in such areas.

Generally, these conflicts are not evenly distributed both spatially and temporally. They are concentrated in mixed farming zones, transhumance corridors and transhumance destinations. Findings show that Kounden, Njigoumbe and Njitapon where animals are present throughout the year are the high conflict zones. These conflicts have different intensities, depending on the extent of the damage and the actors involved. Some conflicts pass unnoticed while some are very violent and even lead to damages which attract the attention of the entire subdivision and the administration. Most conflicts within the Mbororo pastoralists are mild and in most cases do not go beyond the Mbororo community since they are settled by the Ardos and the Djoros. Conflicts between the Mbororo pastoralists and crop farmers are generally violent. These conflicts have had some consequences, especially on the Mbororo pastoralists.

The survey revealed that crop farmers tend to poison

animals (12%), attack cattle (32%), attack herdsmen (10%), destruction of Mbororo huts (17%) and court cases (29%). Interviews revealed that these violent reactions towards Mbororo pastoralists lie in their inability to cooperate with crop farmers when damages occur. Most crop farmers are not able to face the Mbororo pastoralists in court cases due to corrupt officials who collect bribes from pastoralists. They also believe that serving a summons letter to the Mbororo pastoralists will entail time and cost and might not yield any positive feedback due to administrative bottlenecks. These consequences prompted the Ministry of Livestock and Animal Husbandry to put in place an Agro-pastoral Commission in charge of settling conflicts. It is headed by the Divisional officer, with members being the representative(s) from The Ministry of Land Tenure, Agriculture, Livestock, the traditional chiefs and two notables, and the Ardo to represent the Mbororo pastoralists.

Despite the creation of this commission, Mbororo pastoralists still suffer most from the effects of these conflicts. Findings revealed that due to conflicts, they lose animals; pay heavy fines, and lose property and life at times. As such, MBOSCUA (Mbororo Social and Cultural Development Association) came up with a peaceful conflict resolution platform. This platform plays a mediation role during conflicts within the Mbororo themselves and between the pastoralists and crop farmers. Many climate-driven conflicts have been settled peacefully through this platform as MBOSCUA has equally tackled the root cause of these conflicts. In response to climate change, they have put in place an alliance system of farming that permits crop farmers and pastoralists to use the same resources and gain mutual benefits. Pastoralists and crop farmers have equally been sensitized and trained on smart agricultural practices such as planting of artificial pasture, water supply schemes in grazing land and the diversification of livelihoods. These options have significantly reduced vulnerabilities to climate change and conflicts.

Discussions: Understanding the Nexus

This work has revealed that the link between climate variability, resource degradation and farmer-herder conflicts is an inextricable one. Firstly climate variability has been ascertained to be one of the greatest challenges affecting the livelihoods of the population in Sub-Saharan Africa but its manifestations may vary from one agro-ecological zone to the other. The Western Highlands of Cameroon in general and Noun division in particular have witnessed climatic variations for the last 4 decades indicated by coefficients of variations above 10%, which is the threshold of variability. Climate variability and change are characterized by increasing temperatures, falling rainfall trends, fluctuations in the dates of onset and cessation of rains and a rise in the frequency of extreme weather events such as dry spells and floods. These findings corroborate the works of Amani *et al.*

(2010) indicating that since 1970, the length of the rainy season in the tropics has been experiencing a decline, with the number of rainy days of more than 10mm reducing and by frequent high temperatures. According to Molua (2010), seasonal fluctuations have been acute because the meeting of southwest monsoon Winds and the northeast trade winds creates a zone of instability called the Inter-tropical Convergence Zone. It shifts northwards in the rainy season and southwards in the dry season depending on the intensity of the respective air masses and this has led to fluctuations in dates of onset and termination of rains.

These climatic aberrations have affected the livelihoods of pastoralists and crop farmers negatively. The rate of pasture degradation along slopes and highlands has increased while water scarcity is registered. In relation to this, Tikhatri and Bhattarai (2023) examined the impacts of climate change on water scarcity and its consequences on the livelihoods of peasants. Water is a very important resource for agro-pastoral activities but our findings have revealed that during the seasonal transitional periods, some water sources dry up completely while some shrink drastically. During this same period, food crops are wilting due to water shortages and irrigation becomes practically impossible. Inter-seasonal variations and fluctuations in the date of onset and cessation of rains have disrupted the agro-pastoral calendar and the planning of agro-pastoral activities. On the other hand, lowlands and valleys become zones of attraction as they still contain water and fresh pasture. Herders tend to embark on transhumance while crop farmers concentrate on the cultivation of vegetables and other market gardening crops. This is so because climate is the principal regulator of plant productivity and therefore leads to livestock and crop production dynamics within the tropics (Ogutu *et al.*, 2007). The influence of climate variability and change on agro-pastoral resources in Sub-Saharan Africa has been examined and critiqued by many authors (Mwakaje, 2013; Koske, 2014; Abugu & Anoba, 2015; Ntangti *et al.*, 2019; Moye *et al.*, 2022) but establishing the nexus between these and agro-pastoral conflicts has been the pivot of this work.

Conflicts resulting from encroachments of cattle into crop farms and destruction of crops by cattle, competition over water sources, narrowing of transhumance corridors by crop farmers and challenges resulting from the sharing of a common space have led to conflicts. The effects of such conflicts in Kouoptamo have gone by court cases, physical attacks to loss of property and life. Although these conflicts have been occurring over the past years, their intensity and frequency have increased in recent times (Ntangti *et al.*, 2019; Mbih, 2020; Ehiane & Moyo, 2021; Moye *et al.*, 2021). Most works tackle the immediate conflicts but climate variability and change are the main cause of resource-based agro-pastoral conflicts in the Western Highlands of Cameroon and conflict resolution strategies should integrate climate change adaptation and range governance.

CONCLUSION

The objective of this work was to establish the nexus between climate change, resource degradation and conflicts. Using rainfall and temperature data from 1981-2021, variability was computed and analyzed using the coefficient of variations and the anomaly index. The indicators of climate change include rising temperatures, frequent dry spells, fluctuations in dates of onset and cessation of rains and falling rainfall amounts. Their impacts on agro-pastoral resources in Kouoptamo include but are not limited to; pasture degradation (15.0%), wilting of crops, water shortages (13.3%), cattle losing weight (12.5%), emergence of pests and diseases (9.17%), cattle encroachment into grazing land (9.17%) and competition over the diminishing resources (7.50%). These have negative consequences on the livelihoods of the population. Their coping strategies are not appropriate and have led to the outbreak of conflicts. Recent conflicts between crop farmers and pastoralists are said to be climate-driven conflict resolution strategies should be area-specific and climate-responsive.

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