



Climate change and vulnerability of climatic migrants in the transboundary zones of Ako, Misaje, Dumbo and Sabongari, North West Region, Cameroon.

Changement climatique et vulnérabilité des migrants climatiques dans les zones transfrontalières d'Ako, Misaje, Dumbo et Sabongari, Région du Nord-Ouest, Cameroun.

Julius Tata NFOR¹, Desire NDOKI¹, Umaru Hassan BUBA¹, Gideon SAMBA²

Abstract: It was rare to talk of droughts in the humid tropics as it is the case today in the transboundary areas of Ako, Misaje, Dumbo and Sabongari between Cameroon and Nigeria. The present study attempts an analysis of the socio-spatial recomposition of the pastoral landscape of the study area in the context of climate variability. To attain this objective, the method adopted for data collection was random sampling. GPS points permitted us to produce maps on the evolution of land use, water availability and conflict hotspots. From our data analysis, it was established that mediocre pastoral hydraulic equipment is crucial likewise the reduction of the available quantity of water. In this context where the combination of natural factors and human activities sustainably affects the principal economic activity of the region, the measures adopted by pastoralists to cope with water shortages and disputed pastures are not cost-effective.

Keywords: climate change, vulnerability, climatic migrants, transboundary areas, humanitarian services, Nkambe Plateau.

Résumé : Il était rare de pouvoir parler de la sécheresse dans les tropiques humides comme c'est le cas aujourd'hui dans les zones transfrontalières d'Ako, Misaje, Dumbo et Sabongari entre le Cameroun et le Nigeria. La présente étude s'interroge sur la recomposition socio-spatiale du paysage pastoral dans les zones d'étude dans un contexte de variabilité climatique. Pour atteindre cet objectif, la méthode adoptée pour la collecte des données a été l'échantillonnage aléatoire. Les points GPS ont permis la confection de cartes d'évolution de l'utilisation des terres, de la disponibilité en eau et des foyers de tensions. Il découle de l'analyse des données que la désaffectation des équipements d'hydraulique pastorale a donné la première alerte quant à la diminution des quantités d'eau disponible. Dans ce contexte où la combinaison des facteurs naturels et des activités humaines affecte durablement la principale activité économique de la région, les mesures adoptées par les éleveurs et les migrants climatiques pour faire face aux pénuries en eau et à la dispute des pâturages n'arrivent pas à compenser le déficit.

Mots clés : changement climatique, vulnérabilité, migrants climatiques, zones transfrontalières, services humanitaires, Plateau de Nkambe.

INTRODUCTION

Climate variability and changes at different scales have had significant impacts on natural systems that constitute the resource base for the survival of mankind on the planet earth (IPCC, 2014). One such system relates to freshwater ecosystems that have been used by man for various development purposes. Given this complex climatic problem, the United Nations Environment Program and the International Union for the Conservation of Nature highlight, in Agenda 2030 on the Sustainable Development Agenda state that, over 40% of the people around the world are affected by water scarcity, with more than 41 countries experiencing water stress (UNEP/IUCN, 2015). Within the context of Cameroon, 70% of the country's population is largely agrarian, with their activities dictated by the prevailing climatic conditions (TSALEFAC, 1999; MOLUA & LAMBI, 2007). This is typical of the pastoralists whose reliance on water resources for their pastoral activities is significantly based on oscillations in the climatic conditions characterized by increasing seasonality (TSALEFAC *et al.*, 2013; FEUGUE KENFACK *et al.*, 2020). In the Nkambe Plateau, situated between latitudes 6° 00' and 6° 01.13' N and longitudes 10° 01.03' and 10° 01.45' E, apart from climate variability and change, a combination of human-related factors act together to influence water shortages affecting greatly pastoralists livelihood (TSALEFAC, 1999). In the wake of such a dramatic scenario, our research preoccupation was to investigate the manifestations of climate change and the vulnerability of climatic migrants. It was equally imperative to assess the factors limiting the capacity of

¹ Department of Geography-Planning-Environment; Research Unit of Climatology and Environmental Studies (URCLIREN), The University of Dschang, Cameroon. * corresponding author : jnfor2007@gmail.com

² Department of Geography and Planning, The University of Bamenda, Cameroon.

climatic migrants, State and humanitarian services to cope with climate change in order to propose sustainable resilience strategies.

STUDY AREA

The Ako, Misaje, Dumbo and Sabongari transboundary zones are found in the Donga Mantung fault plain which covers a vast boundary of about 1500 km² with Nigeria in its northern, southern and eastern borders respectively. It is drained particularly by the Rivers Donga at Ako, Kimbi at Misaje/Dumbo and Mantung at Sabongari (Fig. 1). The topography is relatively low with an average elevation of 700 m above sea level, with a mild climate, ever-green vegetation, well-drained hydrographic network and rich forage which favours pastoralism, especially during transhumance periods.

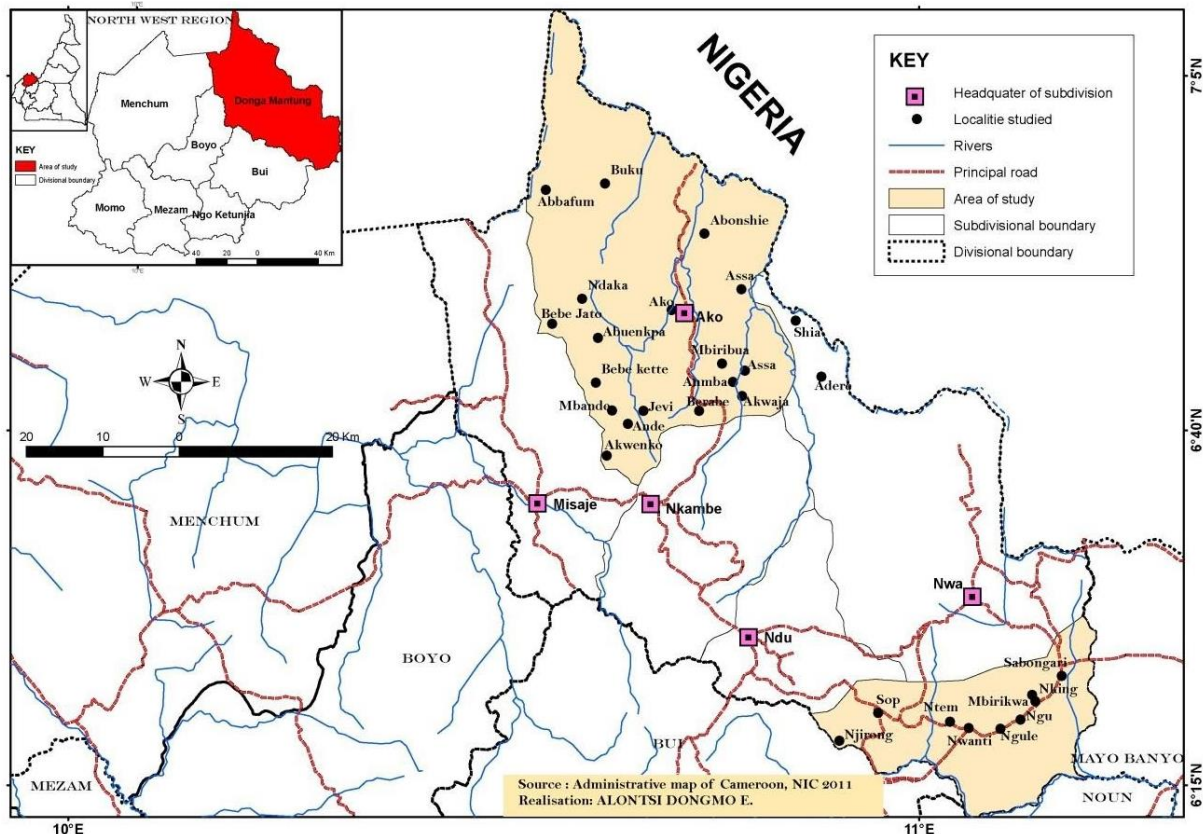


Figure 1.- Location of the study area
(Source: adapted from Administrative of Cameroon NIC, 2011; Alontsi Dongmo, 2016).

METHODOLOGY

In order to bring out the spatial pattern in the analysis of the data and appreciate the degree of vulnerability of climatic migrants in different transhumance zones, the study area was divided into main transhumance zones constituting, Sabongari, Ako, Misaje and Dumbo. The size of the sample of each sub-grazing zone is determined by the size of the population, cattle capacity and the importance of the degree of implication of climate variability on water resources, watershed degradation and inappropriate land use. As for the hypothesis that, water resources management strategies adopted by climatic migrants and stakeholders to adapt to climate variability are not cost-effective, opinions from pastoralists, the general public, and other stakeholders in environmental issues, as well as data from MINEPDED, MINFOF, Councils, NGOs and voluntary associations, are taken into consideration and analyzed. Direct observations of practical realities in the field were equally included in our data collection methods.

Rainfall variability trends (1957-2014) were analyzed by adopting the method used by AMOUGOU and BATHA (2014) (see Eq. 1-3). In order to study the evolution and rainfall variability in the study area, the Nicholson rainfall variability index was used to represents the relationship between the annual rainfall and the mean annual rainfall (NICHOLSON, 1993). The index is >1 when rainfall is largely above average and <1 when there is a strong rainfall shortage. It helps to declare with precision when the periods are humid and dry during the period under study.

$$p = \sum_{1957}^{1/2014} px / 1957 \dots \text{Eq. 1}$$

Where p represents average rainfall height (1957-2014)

$$pi = \sum_i^k = pk/10) \dots \text{Eq. 2}$$

NB: Px = Annual rainfall

Pm = Monthly rainfall

With pi representing the period (more or less ten years) mean of annual rainfall;

$$P1 = \sum_{57}^{66} px ; P2 = \sum_{67}^{76} px ; P3 = \sum_{77}^{89} px ; P4 = \sum_{90}^{99} px ; P5 = \sum_{2000}^{2009} px ; P6 = \sum_{2010}^{2014} px \dots \text{Eq. 3}$$

With P1= mean decade rainfall (1957-1966), P2 (1967-1976), P3 (1977-1989), P4 (1990-1999), P5 (2000-2009) and P6 (2010-2014)

The coefficient of variation (CV) has also been used to determine the percentage of deviation from the mean or better still rainfall variability over time (1957-2014). If CV>40%, the rainfall distribution is negative and highly deviated from the mean/normal, CV<40% the rainfall distribution is positive and the deviation from the mean/normal is insignificant.

Deviation index from the mean temperature (Em) which is obtained by subtracting the annual temperature (Ta) from the mean temperature (T) during the period 1957-2014 (Em = Ta-T).

The deviation index from the mean is positive for the years with high temperatures and negative for the years with low temperatures.

As regard the hypothesis, to verify how climatic migrants and stakeholders have integrated droughts-prone adapted innovations, indigenous knowledge, modern science, research and holistic approaches to adapt to water stress, findings from pastoralists and stakeholders' strategies and indirect observation on the field by photographs, maps or practical realities were analyzed.

RESULTS AND DISCUSSION

1. Climate change manifestations in the Ako, Misaje, Dumbo and Sabongari transboundary zones

The inter-annual and annual rainfall variability indices from 1982 to 2014 have not been very significant to appreciate the problem of water shortages in the study area. This is because the coefficient of rainfall variation (CV) of 11.13% for 1982-2014 is far below the 40% standard to be considered as rainfall deficient on the Nkambe Plateau. However, some years and periods (e.g. 1977-1999) were quite dry in major grazing zones (Table 1). The situation in the study site is therefore in conformity with the global paradigm of increasing trends of rainfall variability in Central, Western and Southern Africa in recent years (TSALEFAC *et al.*, 2007; IPCC, 2014). Mean annual temperatures varied between 21 °C and 24 °C with years 1996, 1998, 2005, 2010, 2011, 2013 and 2014 well above average. Over the last three decades, temperature has increased of 0.5 °C in the area of interest.

Table 1.- Index of period rainfall variation, coefficient of variation and classification.

Time period	Rainfall indices	Coefficient of variation	Classification
1957-1966	1.26	11.88	Humid period
1967-1976	1.04	11.28	Humid period
1977-1989	-0.18	12.43	Dry period
1990-1999	-0.82	11.48	Dry period
2000-2009	0.51	8.49	Humid period
2010-2014	1.36	7.99	Humid period

2. Vulnerability of climatic migrants in the transboundary zones of Ako, Misaje, Dumbo and Sabongari

It should be noted that in the pastoral highlands of Nkambe, inaccessibility to land and water resources and social amenities to the dominant cattle-rearing communities for a better living standard is becoming recurrent. Recently, these vulnerable communities are subjected to misery and poverty, always in constant conflicts with farmers and other developmental actors (AMINOU, 2017). They feel disfavored by the State's land tenure system and customary land laws. Their vulnerability is exacerbated by climate variability and changes, land degradation, drought, cattle theft and the recent socio-political crises observed in the Anglophone regions of Cameroon, public insecurity and the influx of migrants from the war, infectious diseases prone Mambila and Jos Plateau in Nigeria (Fig. 2).

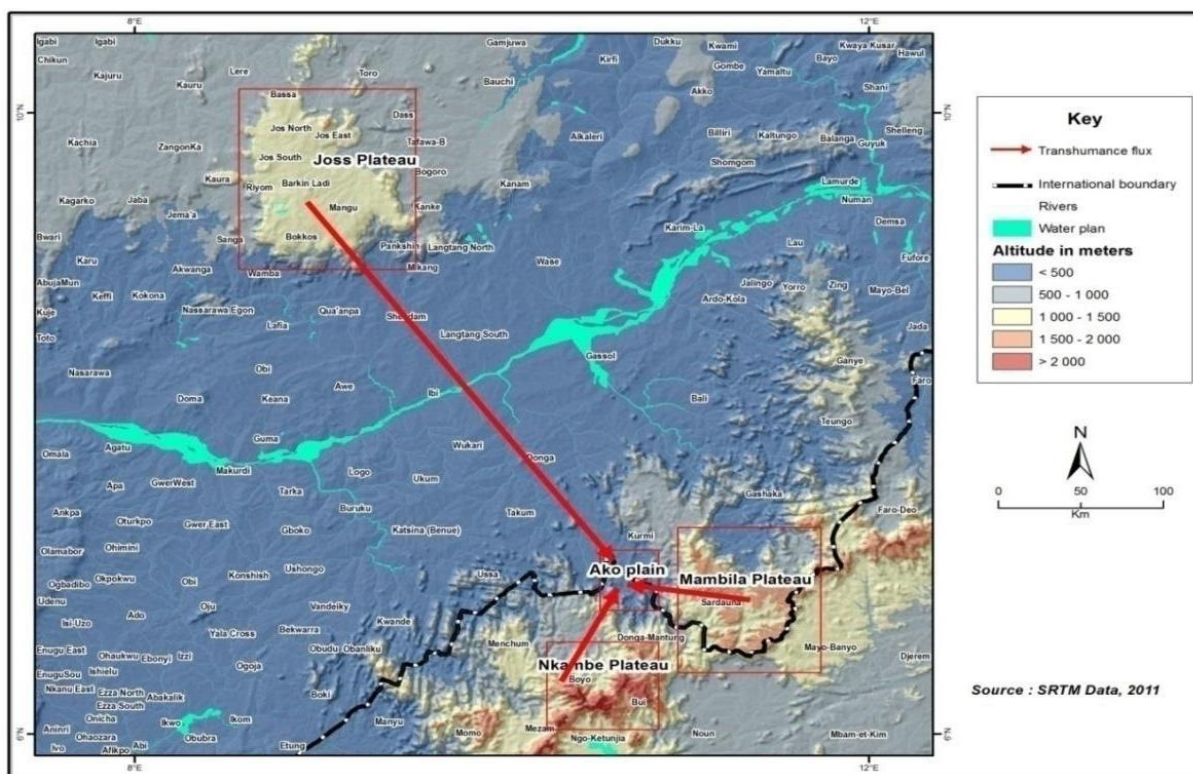


Figure 2.- The Ako Plain: a strategic transboundary transhumance zone with constant influx of pastoralists from Nkambe Plateau in Cameroon, Mambila and Jos Plateau in Nigeria (Source: TATA, 2016 ; SRTM data, 2011).

Considering the financial, cultural and social implications of pastoralists' mobility and their cattle, the supervision of transhumance season has become an expensive and risky adventure. Most often, the unprecedented movement of pastoralists' dominantly household heads has led to marital crises and deprived Mbororo pastoralists' children of effective family training and formal education. Transhumance zones are generally void of education facilities favoring school dropout, and high literacy rates. The Mbororo pastoralists are progressively adopting new lifestyles which are opposed to their culture and customs. Their habitats are temporal as they are always in constant mobility in search of water and pasture exacerbated by climatic uncertainty. The high national flux of climatic migrants into the Ako, Sabongari, Misaje and Dumbo transhumance zones are from the Adamawa Plateau, Bamileke Plateau, Boyo, Bui and Wum pastoral rangeland (Fig. 3). These spatiotemporal mobility dynamics have been a catalyst of farmer-grazer and pastoralist-pastoralist conflicts.

3. Climatic migrants, State and humanitarian services constraints to cope with climate change

In Cameroon, since the severe droughts episodes of the 1970s, recent agro-pastoral mutations, the influx of socio-political and environmental pastoral migrants from neighbouring countries, and internal socio-political crises prompted the intervention of the State, humanitarian non-governmental organizations to address the plight of pastoralists and agro-pastoralists climatic migrants. It is true that the actions of both the national and international non-governmental organizations have been proactive on the field but the question of self-reliance or autonomy of local nongovernmental organizations and the target population like the Mbororo Development and Cultural Organization (MBOSCUA), Strategic Humanitarian Services (SHUMAS), para-public institutions; Société de Développement Pastorale (SODEPA), Cameroon Red Cross, remains unsatisfactory despite the huge humanitarian assistance from multinational institutions; PLAN International, Heifer International, Netherlands Development Organization (SNV), World Bank, Islamic Development Bank, High Commission for Refugee in Cameroon, United Nations Systems in Cameroon, International Agricultural Development Agency (FIDA), and the World Food Program (WPF).

It is under this backdrop that it is imperative to investigate what could explain the inability of climatic migrants, and the national humanitarian non-governmental organizations to effectively cope with climate change in the Ako, Misaje and Sabongari. What conditions are necessary for the growth of institutional and operational innovations in the domain of humanitarian services by Cameroon in order to boost the self-reliance of Humanitarian institutions, effective engagement and the autonomy of climatic migrants?

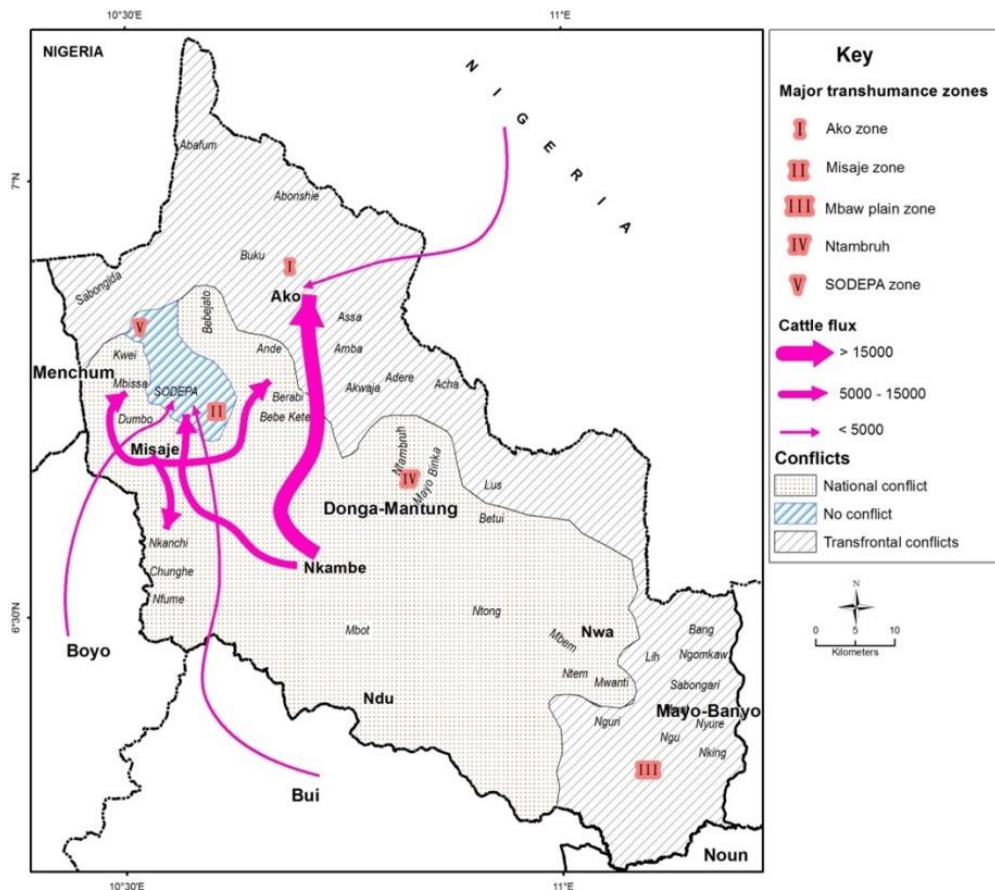


Figure 3.- Mobility of pastoralists and typology of conflicts in major transhumance zones (Source: TATA fieldwork, MINEPIA Report Donga Mantung, 2016).

Governance and bureaucracy

Government policy in the livestock sector has demonstrated serious limitations to boost cattle production on the Nkambe Plateau. Pastoral code is a problem as the grazing system is communal, discouraging wealthy pastoralists to invest in macro, even micro water points and pasture development projects. Conflictual approach by the many stakeholders involved in land use management like the Ministries of Livestock, Fisheries and Animal Husbandry (MINEPIA), Environment, Nature Protection and Sustainable Development (MINEDEP) and Housing and Urban Development (MINDUH) always put personal interest above the pastoralists' interest. The unscrupulous intervention of some technical services, council authorities, Divisional Officers, Senior Divisional Officers, and Judiciary have taken advantage of poor governance and lack of State political will to violate the 1974 and 1978 land ordinance and pastoral code respectively. It is very common to see land allocation to grazers without a grazing permit, major projects for agriculture, urban development allocated to influential Administrators, and Elites on dry and wet season grazing lands at the detriment of cattle breeding. According to our field survey, out of 250 pastoralists interrogated on the challenges of effective adaptation to climate variability, 74 (29.6%) attribute land grabbing as a major constraint, 52 (20.8%) conflictual institutional approach, 46 (18.4%) harassment by the Judiciary, Administrators and Native population, 29 (11.6%) pasture and hydraulic projects abandoned, 18 (7.2%) grants or subsidies given with strings attached, 17 (6.8%) grants or subsidies misdirected, and 14 (5.6%) animal inspection by veterinary technicians based on special mission allowance respectively.

The lack of collaboration from some Elites in this region with diverse political ideologist has greatly retard progress in the conservation strategies adopted so far by environmental stakeholders. Equally, most council staff has not been trained on environmental management issues and they are more interested in infrastructural development of short-term benefits, since most of them are appointed on the political bases and answerable to their electorates and not on intellectual bases. Most often elected officials had to play the role of politicians to safeguard their political position.

Institutional difficulties

There exist several technical services and nongovernmental organizations in Nkambe Plateau working within the framework of water resource management or related activities such as the Ministries of Forestry and Wildlife (MINFOF), Environment, Nature Protection and Sustainable Development (MINEDEP), Energy and

Water Resources (MINEE), Economy, Planning and Regional Development (MINEPAT), Land Tenure and State Properties (MINDAF), Housing and Urban Development (MINDUH), Youth Development, Training and Protection Association (YDETPA), Nkambe Highlands Youths for Environmental Sustainability (NHYES), Safe Your Future Association (SYFA), Cameroon Water Cooperation (SNEC), Councils, and Public Security. These institutions are always at loggerheads (conflicts) on who does what, when and how? Most often some of these institutions do not want to assume their responsibilities in terms of water management and its development. This is an impediment to a harmonized strategy of water resources and rangeland management.

Economic and financial constraints

A majority of the technical services in the region have the inadequate technical staff to adequately patrol the water catchment sites and booked all defaulters to the law. The technical services and environmental stakeholders operating within this region equally have insufficient material and financial motivation to multiply the organization of seminars, educational talks, round table conferences and green concerts to thoroughly sensitize the population on the techniques and importance of water resource management. Since the 1980s general economic crisis in Cameroon, the State suspended most of its investment in the production sectors such as agriculture and livestock, liberalizing these sectors to private actors. The pastoralists since then were exposed to extreme poverty characterized by a drop in grazer's household financial capacity and purchasing power. This unprecedented situation is exacerbated by the changing climatic condition which has exposed pastoralists to financial constraints. Our field statistics have proven that out of 250 grazers investigated, 71 (28.4%) consider the high cost of Jangali taxes as a burden to family income and impediments to effective management of harsh prolonged dry seasons, 46 (18.4%) high cost of technology and research innovation, 39 (15.6%) SODEPA suffered from budgetary constraints, 34 (13.6%) high cost of animal inputs, 32 (12.8%) low household revenue, and 28 (11.2%) inadequate subvention respectively.

Since the liberalization of the production sectors in Cameroon, the budget allocation to the livestock and animal husbandry sector has been mediocre from the financial year 2005 to 2013 (Table 2). The World Bank-Cameroon loan project FONADER which use to boost cattle production during the 1970s was also liquidated due to the economic crises of the early 1980s and the Structural Adjustment Program. According to FONADER/SODEPA Regional Office, Bamenda, and Quarterly Report for April-June, 1979 cattle breeders have access to FONADER loan of about 437.114.940 million FCFA to 322 beneficiaries. This encouraged investment in cattle rearing by public civil servants, Mbororo, Haussa, teachers, traders and farmers but today most of them have abandoned the activity due to inadequate financing of the livestock by the State of Cameroon (Table 2).

Table 2.- Index of period rainfall variation, coefficient of variation and classification.

Years	2005	2007	2008	2009	2010	2011	2012	2013
Ministries of Rural Sectors	Allocated budgetary resources (Billion FCFA)							
MINADER	29,795	40,129	39,776	48	54	61,4	69,7	79
MINEPIA	7,746	10,041	9,481	10,7	12	14,6	16,7	19,1
MINFOF	6,851	13,155	15,051	16,3	19	20,8	23,1	25,4
MINEDEP	3,68	2,995	3,583	4,8	5,7	6,4	7,4	8,5
Total budgetary resources of rural sector	44,8	66,3	67,9	90,8	103,3	117	132	150
State budget (Financial law)	1,76	2,25	2,28	2,35	2,52	2,74	2,90	3,16
% rural sector in relation to national budget	2,5	2,9	3	3,9	4,1	4,3	4,6	4,7
% of livestock national budget in relation to other rural sectors	17,3	15,1	14	11,8	11,6	12,5	12,7	12,7

Inadequate human resource

Cattle production is highly based on traditional subsistence systems since most pastoralists have not been trained in animal production techniques, and attended refresher courses to develop competencies in hydraulics, diseases and pasture management. The grazer and veterinary technician or engineer ratio is very low (one hundred grazers per four veterinary technicians). Animal husbandry infrastructures are inadequate and the State parastatal institution, the National Animal Production Cooperation (SODEPA) since its creation in 1974 has not fully attained its assigned mission of training the pastoralists on modern cattle breeding, diseases, hydraulics and pasture management. The services offered by SODEPA veterinary Training School in Jakiri do not have a component that deals directly with peasant grazers while the Dumbo cattle ranch the past years suffered from the early 1990s Structural Adjustment Program motivated by the 1980s economic crises. It was recently in 2010 that the institution is undergoing a significant transformation to regain its role of modernizing the cattle production sector in the

context of uncertainty in the climatic conditions. The MINEPIA services most especially the zootechnical centres created to accompany the pastoralists are inadequate and understaffed. Generally, the Nkambe Plateau according to our field appreciation is divided into six grazing zones considering the region's geographical and agroecological specificity. Unfortunately, the grazing zones have only two zootechnical centres; Binka and Nkambe with ten staff members to take care of more than six hundred grazers and about fifty thousand cattle. According to pastoralists interrogated, out of 250 grazers, 134 (53.6%) attributed their inability to effectively manage water shortages, pastures, and animal diseases are due to the low ratio of hydraulic engineers and veterinary technicians, 85 (34%) not trained in animal production techniques, 31 (12.4%) not attended a refresher course respectively.

Inadequate knowledge and information tools

Information and communication are indispensable in the management of climate variability impacts on the agricultural and livestock sectors. Unfortunately, in the 21st-century pastoralists still depend on indigenous knowledge to determine weather and climatic conditions. This is a serious handicap to effective prevision and speculation of the recent recurrent fluctuation of rainfall patterns, and temperatures by pastoralists. Today, with the exception of SODEPA which has a meteorological station, there is no state or private meteo service to update the grazers on the climatic and weather conditions. The existing meteorological stations owned by Cameroon Tea Estate at Ndu (CTE), Cameroon Development Cooperation (CDC) at Mbawrong, Ministry of Agriculture and Rural Development at Nkambe (MINADER) do not communicate their weather observation for the benefit of the grazers and the entire population. From our field survey, out of 250 pastoralists interrogated, 135 (54%) acknowledge that inadequacy in information diffusion tools especially meteorological stations retards their efforts to adapt to climate variability, 81 (32.4%) nonexistence of demonstration animal production farms, 34 (13.6%) inadequate best farm practice respectively. The Nkambe council in collaboration with technical services; MINEPIA and MINADER has been organizing annual agro pastoral shows to motivate materially, and financially best agro-pastoralists and encourage best cattle breeding practices adapted to recurrent harsh climatic conditions. However, the motivation for agro-pastoralists is highly symbolic as it cannot permit grazers to engage in semi-intensive or intensive pastoralism.

Complexity and ignorance of the population

The dominant Native population's ignorance of the 1974 land tenure laws and 1978 pastoral code considers the Mbororo pastoralists as invaders of their ancestral land. This perception has triggered conflicts in pastoral land management and most attempts to construct water points for cattle are often contested by villages found within the fringe of the major grazing land and transhumance corridors. A majority of the pastoralists have not had formal education and are very resistant to innovations in the domain of pasture improvement, cattle breeding and pastoral hydraulics management.

Socio-cultural and the adapted land tenure system

The hereditary pastoral system based essentially on nomadism and transhumance by the Mbororo pastoralists remains a setback to the modernization of cattle production adapted to the changing climatic conditions. Most Mbororo pastoralists, especially the Akou nomads, are resistant to scientific and technological innovations due to their high attachment to customs and traditions. The land tenure system does not give pastoralists the possibility to acquire land certificates on their grazing land. This discourages some wealthy pastoralists from carrying out meaningful projects like the construction of water points, paddocks, cattle dips, vaccination crutches, construction of meteorological stations and modern ranches. The grazing systems are communal and hardly encourage private investment in hydraulic infrastructures and rangeland development. According to our fieldwork, out of 250 grazers interrogated, 148 (59.2%) attribute their inability to effectively adapt or cope with climate variability most especially because of water shortages, and pasture degradation to the anarchy of rangeland occupation, 68 (27.2%) prefer the indigenous cattle breeds to improved breeds resistance to water and heat stress, and 34 (13.6%) still prefer transhumance to sedentarization.

CONCLUSION

The paper has assessed the state of vulnerability of climatic migrants particularly pastoralists to climate change in the transboundary zones of Ako, Misaje, Dumbo, and Sabongari and factors limiting the capacity of the State and humanitarian services to effectively mitigate and/or adapt to environmental stress. From the data analysis, it was established that climatic migrants are highly vulnerable to extreme events such as droughts due to erratic rainfall, relatively increased temperature and evaporation trends, dry spells which have favoured water shortages, pasture degradation and the emergence of zoonotic diseases and agro-pastoral conflicts. This is in accordance with previous studies focusing in Africa or more precisely in Cameroon (GEMENNE *et al.*, 2017; TCHOKOUAGUEU

et al., 2019; DE LONGUEVILLE *et al.*, 2020; ABOSSOLO NDONGO & NKANS BIOUELE, 2022; DJOUKANG NGUIMFACK & BRUCKMANN, 2022; SOHBE DJIDIM, 2022). Despite the effort of Humanitarian services and the State to address the problem of climatic migrants, they are confronted with socio-cultural and adapted land tenure systems, complexity and ignorance of the population, lack of knowledge and non-existence of Weather observation stations, economic, and financial, human resource, institutional and political constraints. To effectively cope with climate change in the study area, it is imperative for pastoralists and stakeholders to manage the risk of zoonotic animal diseases associated with water stress and pastoral conflict. In line with the post-2015 Sustainable Development Goals and 2020-2030 National Development Strategic Document of Cameroon, pastoralism and humanitarian policies must be proactive to cope with the recent challenges of climate variability and water shortages in the livestock and animal husbandry subsector. Policy reforms should be reoriented to contribute to poverty reduction among pastoralists by implementing policies and programs and projects on pastoral hydraulics, rangeland management, cattle hybridization, pasture improvement and weather forecast which improve pastoralists' livelihood, mitigate their vulnerability and /or facilitate income diversification access and adoption of alternative livelihood.

REFERENCES

- ABOSSOLO NDONGO, J., & NKANS BIOUELE, C., 2022. Contraintes environnementales et migrations des populations du grand Nord Cameroun vers les berges du barrage de Lom-Pangar. Essai de compréhension des mobilités intérieures. *Geo-Eco-Trop*, 46(4): 477-487.
- AMINOUE, B., 2017. *Water, planning and management of agro-pastoral spaces in the region of Mayo-Kebbi West (Tchad)*. PhD Thesis, University of Dschang: Dschang, Cameroon.
- AMOUGOU, J.A., & BATHA, R.A.S., 2014. Dynamique spatio-temporelle des précipitations de 1960 à 2010 et essai d'élaboration d'un calendrier agricole dans la zone des hauts plateaux du Cameroun. *Revue Ivoirienne des Sciences et Technologie*, 23: 153-177.
- DE LONGUEVILLE, F., OZER, P., GEMENNE, F., HENRY, S., MERTZ, O., & NIELSEN, J.Ø., 2020. Comparing climate change perceptions and meteorological data in rural West Africa to improve the understanding of household decisions to migrate. *Climatic Change*, 160: 123-141.
- DJOUKANG NGUIMFACK, V., & BRUCKMANN, L., 2022. Perception des changements climatiques dans l'Ouest du Cameroun : exemple de Santchou. *Geo-Eco-Trop*, 46(4): 509-518.
- FEUGUE KENFACK, J., TSALEFAC, M., & KONGNSO, M.E., 2020. Perception de la variabilité climatique sur les versants sud des monts Bamboutos (Ouest Cameroun). *International Journal of Social, Political and Economic Research*, 7(3), 687-707.
- GEMENNE, F., BLOCHER, J.M.D., DE LONGUEVILLE, F., VIGIL DIAZ TELENTI, S., ZICKGRAF, C., GHARBAOUI, D., & OZER, P., 2017. Changement climatique, catastrophes naturelles et déplacements de populations en Afrique de l'Ouest. *Geo-Eco-Trop*, 41(3): 317-337.
- IPCC, 2014. *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [FIELD, C.B., BARROS, V.R., DOKKEN, D.J., MACH, K.J., MASTRANDREA, M.D., BILIR, T.E., CHATTERJEE, M., EBI, K.L., ESTRADA, Y.O., GENOVA, R.C., GIRMA, B., KISSEL, E.S., LEVY, A.N., MACCRACKEN, S., MASTRANDREA, P.R., & WHITE, L.L. (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1132 pp.
- MOLUA, E.L., & LAMBI, C.M., 2007. The economic impact of climate change on agriculture in Cameroon. *Policy Research working paper N°4364*. World Bank: Washington DC, USA.
- NICHOLSON, S., 1993. An overview of African rainfall fluctuations of the last decade. *Journal of Climate*, 6(7): 1463-1466.
- SOHBE DJIDIM, N., 2022. Migrations agricoles et dynamiques socio-spatiales dans la plaine de Poli (Nord Cameroun). *Geo-Eco-Trop*, 46(4): 459-466.
- TCHOKOUAGUEU, F.A., BRUCKMANN, L., & OZER, P., 2019. Interactions entre changements environnementaux et migrations dans l'Ouest du Cameroun : exemple de la commune rurale de Kékem. *Geo-Eco-Trop*, 43(2): 299-308.
- TSALEFAC, M., 1988. *Climat et élevage sur les Hautes Terres de l'Ouest Cameroun*. In CABAUSSEL, G. (Ed.), *L'Homme et la montagne tropicale* (pp 151-158). Sepanrit: Bordeaux, France.
- TSALEFAC, M., 1999. *Variabilité climatique, crise économique et dynamique des milieux agraires sur les Hautes Terres de l'Ouest*. Thèse de doctorat, Université de Yaoundé I: Yaoundé, Cameroun.

TSALEFAC, M., BRING, C., SUCHEL, J.-B., & TCHIADEU, G., 2013. *Plus d'un siècle de climatologie camerounaise : bilan, enjeux et perspectives*. In SONWA, D.J., & NDI NKEM, J. (Eds). Les forêts du Bassin du Congo et l'adaptation aux changements climatiques (pp 41-50). Karthala: Paris, France.

TSALEFAC, M., ZANINETTI, J.-M., GIROIR, G., & NGOUFO, R. (Eds), 2007. *Afrique Centrale, le Cameroun et les changements globaux*. Université de Yaoundé I: Yaoundé, Cameroun.

UNEP/IUCN, 2015. *Sustainable pastoralism and the post 2015 Agenda: Opportunities and barriers to pastoralism for global food production and environmental stewardship*. <https://sustainabledevelopment.un.org/content/documents/3777unep.pdf>