



# Climate Variability Adaptation Strategies: Challenges to Livestock Mobility in South-Eastern Burkina Faso

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**How to cite this paper:** Sanou, C.L., Tsado, D.N., Kiema, A., Eichie, J.O. and Okhimamhe, A.A. (2018) Climate Variability Adaptation Strategies: Challenges to Livestock Mobility in South-Eastern Burkina Faso. *Open Access Library Journal*, 5: e4372. <https://doi.org/10.4236/oalib.1104372>

**Received:** January 24, 2018

**Accepted:** February 25, 2018

**Published:** February 28, 2018

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## Abstract

This research work aims to study the perceptions of pastoralists and agro-pastoralists on climate change impacts on mobile herding and the effectiveness of herders' adaptive strategies within Kompienga Province, south-eastern region of Burkina Faso. In order to achieve this aim, survey data were retrieved from 271 respondents and analysed. From respondents' perceptions, climate change is real and is negatively affecting forage availability (in quality and quantity); livestock production and reproduction performances; herders' practices, their livelihoods and the cohabitation of herding and crop farming. To overcome the increasing constraints the pastoral herding is facing, sound and urgent actions need to be undertaken by Burkina Faso government. These actions include: 1) providing the grazing reserves with necessary facilities such as perennial reservoirs; 2) conducting research to improve breeds that would adapt to current climatic conditions; 3) encouraging and supporting gradual shift of herders from mobile herding to the sedentary breeding; 4) supporting and organizing forage production by farmers. At short term an effective cross-border framework could be created to seek for sound solutions to secure the mobility of herds within ECOWAS territory.

## Subject Areas

Agricultural Engineering, Agricultural Science, Animal Behavior, Atmospheric Sciences, Environmental Sciences, Environmental Sciences

## Keywords

Adaptation, Climate Variability, Pastoralism, Perception

## 1. Introduction

Climate change constitutes one of the biggest challenges of the development process over the last century. This phenomenon is increasingly threatening communities' livelihoods in West Africa and particularly in Burkina Faso. Indeed, recent climate deterioration makes its economy gradually vulnerable mainly through the decline in rainfall that negatively affects pasture biomass and crop yield. The future climate of Burkina Faso will experience a decrease in rainfall (−3.4% by 2025 and −7.3% by 2050) coupled with a very strong seasonal and inter-annual variability of climatic factors [1]. This situation is likely to further affect rangelands productivity [2] [3] and jeopardize the development of livestock production in Burkina Faso. Yet livestock occupies a prominent place within national economy of Burkina Faso after gold and cotton. The livestock sector contributes about 18% to Gross National Product (GNP) and accounts for 26% of exports and constitutes a source of incomes for nearly 80% of the population [4]. Livestock farming relies largely on pastoral herding in the country. It is an extensive animal rearing characterized by herds mobilities and the exploitation of natural forage whose productivity is underpinned by climatic conditions and soil quality. Mobility consists in a flexible solution enabling a sound exploitation of variable resources [5] by mobile herds. Accordingly, over the past 10 years, this mobility has been perceived as increasing the resilience of rural households in semi-arid Africa to climate change and variability [6]. Similarly, many authors argued that mobile herding, a long-term adaptation way to climate variability, should continually play a paramount role among livelihood strategies in rural area [7] [8] [9] [10] [11]. However, how long will this mobility contribute to reinforce the resilience of pastoralists in South-Eastern Burkina Faso? This interrogation is raised because of the increased challenges to which mobile herding is gradually confronted in West Africa. Among challenges there are the reduction of grazing land size [12]-[20], the obstruction of livestock routes [21], the reduction of watering points, the qualitative and quantitative decline in forage biomass [21] [22] [23] [24] and the recrudescence of conflicts between land users. These challenges affect livestock production and reproduction performance and finally the livelihoods of pastoral communities. Given these challenges one might wonder about the relevance of the adaptation strategies against climate variability and related hazards. A focus will be done on livestock mobility strategy (internal mobility and cross border transhumance). Understanding geographical patterns of this mobility as well as its opportunities and constraints, is critical in the definition of support actions to pastoralists adaptation to increasing climatic variability [6]. The current study highlights recent changes in livestock mobility due to climate change and variability. The results will provide information on emergent constraints and give room for good management policies. The research hypothesis is that: “recent changes in climate conditions is gradually compromising the effectiveness of livestock mobility as adaptation strategy to climate change and variability”.

## 2. Materials and Methods

### 2.1. Study Area

Kompienga province located in south-eastern region of Burkina Faso at the border with Togo and Benin Republic, constitutes the study area of the current research (Figure 1). It lies between longitude  $0^{\circ}30'4.96''\text{E}$  and  $1^{\circ}22'22.25''\text{E}$  and  $10^{\circ}56'16.85''\text{N}$  and  $11^{\circ}27'21.09''\text{N}$ . About 2/3 of the total land area of the province (6998 km<sup>2</sup>) is occupied by forest and wildlife reserves [25]. The climate of Kompienga is Sudanian, characterized by a longer dry season (October to April). The annual rainfall fluctuates between 700 and 1000 mm on average [26] while the mean temperature over the province is 26°C [27]. The whole of the eastern region, is characterized by a peneplain with some hills around Pama [26]. The leached tropical ferruginous soils predominate, sometimes with hydromorphic soils found along rivers [28]. The flora is dominated by shrub and woody savannahs. These savannahs are dotted with islands of clear forest formations and furrowed by woody savannahs, clear forests and gallery forests, especially in the vicinity of rivers [29] [30] [28]. The population dynamic in the study area is important and the population tripled in two decades after the construction of the Kompienga dam representing annual growth rates of 5.7% between 1985 and 2006. The projected population based on estimated growth rate of 4.41% was

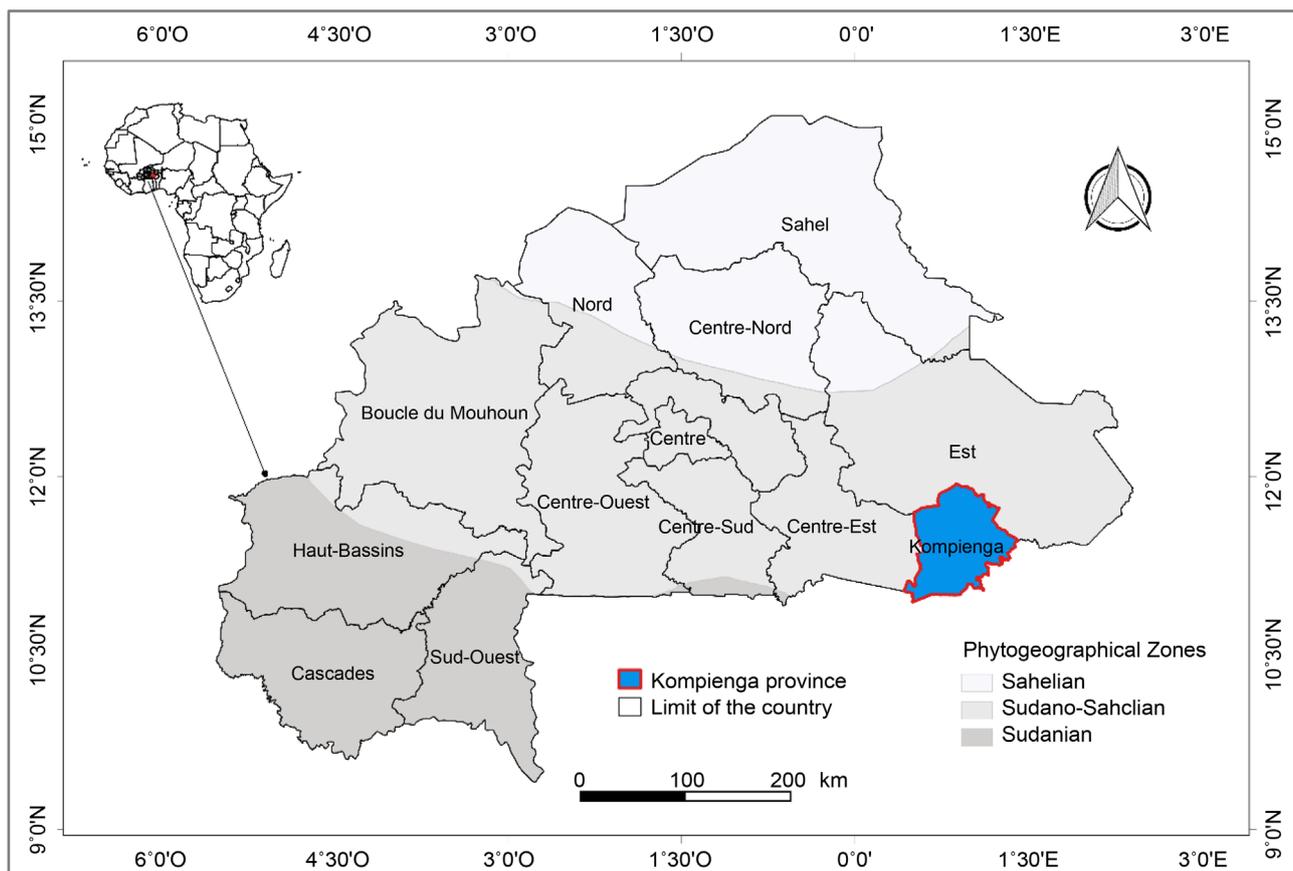


Figure 1. Burkina Faso showing Kompienga province (source: Institut Geographique du Burkina Faso).

102,645 peoples in 2013 which was four times more than 1985 figure (23,818) [31] [32].

## 2.2. Data Collection

The research used household survey data collected in twelve out of thirty-eight (38) villages in Kompienga province. The selection of these villages was based on anyone of the following criteria: 1) recurrence of conflicts among land users; 2) constraints in range lands and other pastoral resources conditions. The targeted respondents of the study were pastoralists and agro-pastoralists household heads and respectively classified as owner of 10 - 25 cattle and more than 25 cattle. A total of 271 respondents (**Table 1**) were involved in the study representing, according to RGPH<sup>1</sup> of 2006 [31], 5.3% of the total household number (5103 households) of the villages in the study area. Data collection was conducted through individual survey following these steps:

1) a questionnaire was first designed on farmers' perception on climate change and the impacts of this latter phenomenon on mobile herding. This questionnaire first written in English was then translated into French to ensure a better translation of the questions in local languages by the translator; 2) the survey was carried out through an individual interview of household' heads in each village.

**Table 1.** Respondents involved in the study.

Villages	Main activities		
	Pastoralism*	Agro-pastoralism**	Total
Nadiagou	16	11	27
Oumpougoudeni	7	20	27
Mamanga	13	4	17
Kaboanga	11	17	28
Kalmama	6	12	18
Bombantangou	2	7	9
Folpodi	14	7	21
Madjoari	3	2	5
Bounou	14	4	18
Diabiga	3	17	20
Kpankpaga	41	19	60
Kompienga	18	3	21
Total	148	123	271

In this study, <sup>2</sup>pastoralism\* is referred as a socio-economic system and way of life based on a mobile or extensive livestock herding. On the other hand, <sup>3</sup>agro-pastoralism\*\* is a form of farming that combines cropping and mobile livestock farming.

<sup>1</sup>Recensement Général de la Population et de l'Habitation.

<sup>2</sup>Pastoralism definition from <https://en.wiktionary.org/wiki/pastoralism>.

<sup>3</sup>Agro-pastoralism definition from <https://en.wiktionary.org/wiki/agropastoralism>.

### 2.3. Data Analysis

Statistical analysis was carried out on data collected from respondents. The Statistical Package for Social Science (SPSS version 23) software was used to code and analyse these data exported from Sphinx 4.5. Results obtained were presented as charts and tables. Frequency analyses and Pearson’s chi-square ( $\chi^2$ ) test were used to analyse respondents’ statements related to climate change impacts on pastoral herding. Statistical test significance was set at 5% ( $p < 0.05$ ). The computational formula of the chi-square ( $\chi^2$ ) is:

$$\chi^2 = \sum \frac{(f_o - f_e)^2}{f_e}$$

where  $\chi^2$  is the Chi-square;  $f_o$  denotes the frequency of the observed data and  $f_e$  is the frequency of the expected values.

## 3. Results and Discussion

### 3.1. Pastoralists and Agro-Pastoralists’ Perceptions on Climate Change or Variability

From respondents’ perspective climate is undoubtedly changing for worse in Kompienga province over the last decades (Figure 2). While 93.4% of respondents asserted that temperature is increasing, the rainfall amount, intensity and the length of rainy season were said to be decreasing by respectively 97.8%, 97.4% and 94.5% of respondents. 90%, 58.3% and 92.6% of respondents reported an increase in the occurrence of strong winds, floods and animals’ diseases;

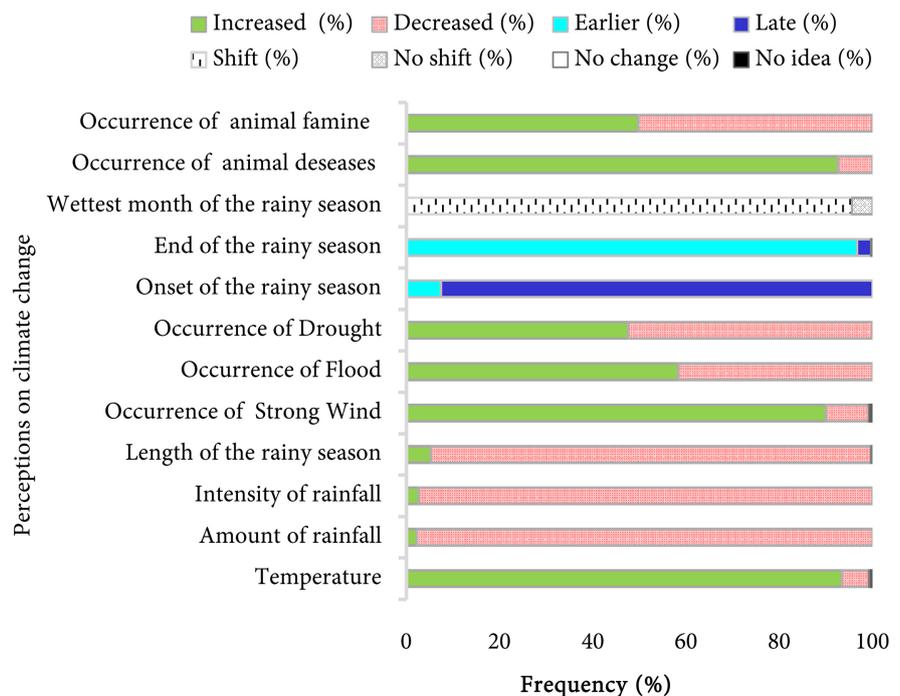


Figure 2. Perception of pastoralists and agro-pastoralists (n = 271) on climate change and climatic hazards in Kompienga province.

92.6% stipulated a late onset of the rainy season, while its cessation is early (96.7% of respondents). Similar results were obtained in the eastern regions of Burkina Faso [24] [33], where the authors found out from respondents' perceptions a decrease in rainfall, an increase in temperature associated with strong winds, a shift in rainfall onset and cessation. Similarly, [34] found from 98% of respondents, change in the overall climate pattern within Sub-Saharan West-Africa. Furthermore, [35] indicated from respondents' perceptions a pejo-ration in rainfall conditions. However, changes perceived by respondents were not always in agreement with the observed climate data as indicated by [35] [36] and [20]. The pejo-ration of climate conditions is not without consequences in South-eastern Burkina Faso where the economy is underpinned by rain related activities.

### 3.2. Respondents Perceptions on the Impacts of Climate Change and Variabilities on Livestock and Herders' Livelihoods

Although, there are many climate change impacts on livestock [20] [24] [33], the respondents mentioned the following as the most important (Table 2). These are affecting mobile herding during the last decades within Kompienga province. The impacts are visible on livestock (Table 2), herders (Table 3) and their practices (Figure 3). Indeed, 98.9%, 99.6% and 49.4% of respondents respectively reported a drop-in milk production, an excessive loss of body weight by livestock and a decline in yearly parturition of calves per cow. On the other hand, 98.2% reported an increase of infectious and parasitic diseases and emergence of new animal diseases. These results corroborate the findings of [20] [22] [37] [38]. These authors asserted that climate changes affect livestock production performance (offspring numbers, milk and meat yields) and also causes the emergence of new Livestock diseases associated with high mortality. In addition, the combined effects of high temperatures, low rainfall, high evapotranspiration and

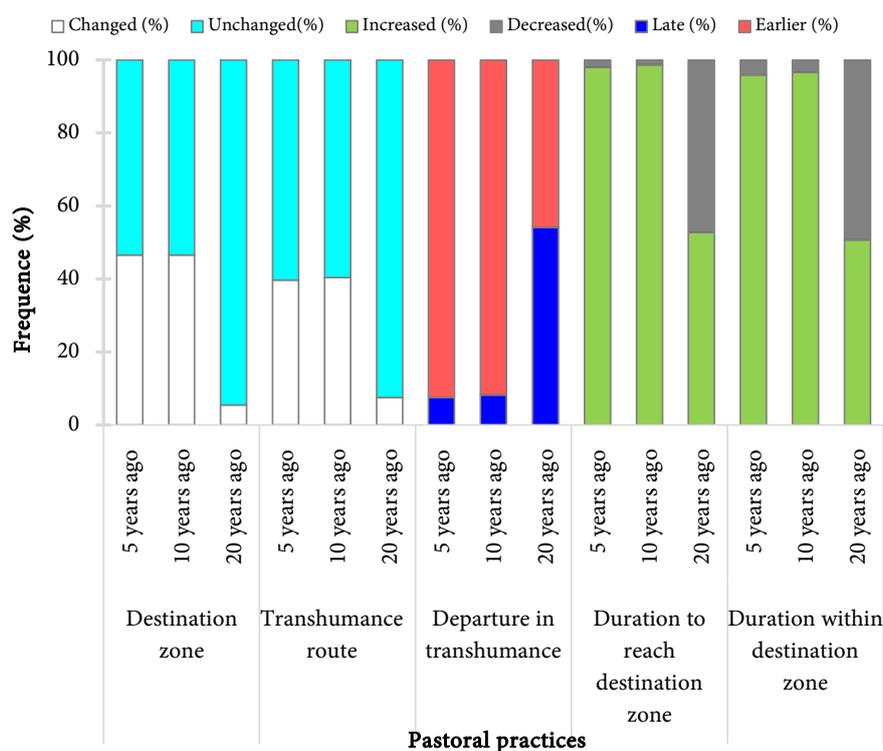
**Table 2.** Respondent's perceptions on climate change impacts on mobile herds over last 10 years (n = 271).

Climate change impacts	Agree (%)			$\chi^2$ (df*)	p-value
	Total	Pastoralist	Agro-pastoralists		
Animals travel longer distances to feed and drink	97.8	53.9	43.9	1.66 (2)	0.44
Decrease in the number of births per year	49.4	26.9	22.5	0.002 (1)	0.97
Drop in Milk production	98.9	54.6	44.3	3.65 (1)	0.06
Excessive loss of weight	99.6	54.6	45.0	1.21 (1)	0.27
Increase of infectious and parasitic diseases	98.2	54.6	43.5	6.13 (1)	0.01*
Appearance of new animals' diseases	98.2	53.5	44.6	0.06 (1)	0.80

\*df: degrees of freedom.

**Table 3.** Respondent's perceptions on climate change impacts on pastoral herder's livelihoods over last 10 years (n = 271).

Climate change impacts	Agree (%)			$\chi^2$ (df)	p-value
	Total	Pastoralist	Agro-pastoralists		
Decrease in incomes	95.9	52.8	43.2	1.30 (2)	0.51
Regression of animal heritage	98.5	53.9	44.6	0.04 (1)	0.85
Food insecurity	78.2	42.4	35.8	0.05 (1)	0.82
Increase in physical effort in herding	100.0	54.6	45.4	-	-
Loss of prestige	87.5	49.4	38.0	2.90 (2)	0.24

**Figure 3.** Perception of pastoralists and agro-pastoralists (n = 271) on climate change impacts on pastoral practices.

high incidence of drought will have a negative impact on livestock production performances [39]. Apart from the occurrence of infectious and parasitic diseases, no significant ( $p < 0.05$ ) differences were noticed between pastoralists and agro-pastoralists' perceptions on the impacts of climate change and variabilities (CCV) on mobile herds.

Moreover, from respondents' perspective, climate change is negatively affecting herders' livelihoods (Table 3). A decrease in incomes, a regression of animal heritage, food insecurity, increase in physical effort in herding and loss of prestige were noticed respectively by 95.9%, 98.5%, 78.2%, 100% and 87.5% of respondents. This is consistent with the results of [40]. Indeed, [40] attest that cli-

mate change impacts could affect severely pastoralists' livelihoods. Dependent on rangelands conditions, this could happen through the numbers of animals that they can keep, livestock productivity, potential loss of animals during the dry season, and higher amplitudes of cross-border transhumance in search of pasture and water. No significant difference ( $p < 0.05$ ), was found between the perceptions of pastoralists and agro-pastoralists on the impacts of CCV on herders' livelihoods.

Furthermore, climate deterioration is negatively affecting herds' transhumance over the last decades (**Figure 3**). About 46.6% of respondents reported changes in destination zone respectively over last 5 and 10 years while 39.7% and 40.4% reported changes in paths followed by transhumant herds respectively over 5 years and 10 years ago. For the departure period in transhumance, respondents reported that it has been earlier over the last decades. Indeed, almost 92.5% and 91.8% of the respondents indicated earlier departure respectively over the last 5 to 10 years. However, at least half of the respondents reported an increased duration within and to reach destination zones. Thus, 5, 10 and 20 years ago durations to reach reception zones have increased respectively for 97.9%, 98.6% and 52.7% of respondents while 95.9%, 95.6% and 50.7% reported an increased duration within these zones. In such conditions the effectiveness of livestock mobility (which have been for long time an adaptation strategy to climate variability) and the related practices appears to be gradually challenged in Burkina Faso. The reference [41] similarly found changes in mobility patterns in Mongolia, but contrary to the current study it was noticed a reduction in the distance travelled by herds during the seasonal movements. Early departure in transhumance and the increased duration of livestock within destination zones could have reinforced transhumant resilience as new alternatives to adapt to climate change. Unfortunately, these alternatives are gradually compromised. Indeed, recently, the main host countries (Benin Republic and Togo) have established official dates of entry and release of transhumant herds from their countries. In respondents' perspectives, the authorized periods set (3 to 4 months) [42] [43] are far shorter than the current necessary duration (about 6 months). This situation will negatively affect pastoral herding in Burkina Faso if sound and comprehensive solutions are not found by countries leaders involved in regional mobility of livestock.

### **3.3. Challenges of Pastoral Herders' Adaptations Strategies and Their Effectiveness**

Respondents adopt some practices to cope with the negative effects induced by climate hazards and their impacts (**Table 4**). The most important strategies to adapt to drought are: Feed supplement (99.3%), which is the utilisation of feed concentrates of high nutritional value (cottonseed cake, cereals) and multi-nutritional blocks in support of forages. The second most important adaptation strategy to drought identified by the respondents was transhumance (96.3%). This consists sound and sustainable exploitation of sparse resources

**Table 4.** Respondents' adaptations measures to main climate hazard and their impacts on mobile herding activities (n = 271).

Adaptation measures	Drought	Inadequate grazing land	Inadequate water	Livestock diseases
Use of crop residues	93.7	93.4	0.0	1.8
Use of fodder trees	76.8	77.1	0.0	1.5
Rainwater harvesting	1.8	0.0	17.3	0.0
Use of ground water	65.3	3.0	65.3	0.0
Forage cropping	4.4	19.6	0.0	0.0
Fattening/Destocking	88.2	87.1	46.9	3.3
Transhumance	96.3	97.0	90.8	37.3
Abandonment of pastoral herding	3.7	12.5	8.9	6.3
Prayers and other rites	94.5	32.8	92.3	39.5
Food supplement	99.3	98.2	2.6	32.8

between a zone of deficit and destination zone of suitable environment (rich pasture, abundance of water, free from animals' diseases). Abandonment of pastoral herding (3.7%) and Prayers or other rites (94.5%), are practices of last resort where herders are desperate seeing their livestock die as a result of lack of resources (feed, water). Prayers and performance of other rites may not be seen as an effective form of adaptation to drought, however, for the respondents it is a major practice. Crop residue utilisation that involves feeding of livestock on stems of crops (corn, millet or other crops) after harvest is another form of adaptation strategy widely practiced by the respondents (93.7%). The use of fodder trees consists of grazing livestock on leaves, fruits or flowers of some trees qualified as fodder trees. About 76.8% of the respondents adopted this strategy to cope with drought. Access to water is a major constraint to livestock and aggravated by drought occurrence. Very few respondents (1.8%) practice rain water harvesting, however, watering livestock from wells and boreholes (65.3%) was more practiced. While water harvesting refers to the collection of rainwater falling on the roofs of houses that are channelled through pipes into reservoirs for domestic use and watering of livestock, ground water is the utilisation of water from wells and or boreholes. To cope with extreme drought conditions, many of the respondents (88.2%) also resorted to culling and selling some of the animals to maintain sizable herds. In certain case few animals are fattening before sale. The high dependence on natural vegetation makes it extremely difficult to access feed during drought period. This is demonstrated by the fact that few respondents (4.4%) practiced forage cropping. This is a technic that involves pasture cultivation to increase forage availability for livestock. To adapt to the inadequacy of grazing land, the major adaptation strategies are: feed supplement (98.2%), transhumance (97.0% respondents), use of crop residues (93.4%), fattening/destocking (87.1%), use of fodder trees (77.1%). Against the inadequate

water supply, prayers and other rites (92.3%), transhumance (90.8%) and the use of ground water (65.3%) are the principal strategies adapted by respondents. These adaptation strategies were quite similar to those highlighted by [24] [20]. However, the results were quite different from findings of [44] [45]. The author reported similar adaptation strategies consisting in the use of crop residue (98.4%), the use of fodder trees (42.3%), herd destocking (44.8%). Furthermore, the author indicated more adaptation strategies beyond that mentioned by respondents such as: the adoption of agro-pastoralism (89.5%), the use of concentrated feed (80.6%) and vaccination (91.9%). To cope with high diseases incidence, respondents identified prayers and others rites (39.5%), transhumance (37.3%) and feed supplement (32.8%) as the major adaptation strategies. Other less practiced strategies were, abandonment of pastoral herding (6.3%) destocking/fattening (3.3%) use of crop residues (1.8%) and use of fodder trees (1.5%). Rainwater harvesting, use of ground water and forage cropping were not regarded as adaptation strategies for livestock diseases.

From respondents' point of view (Figure 4), the use of crop residues (78.2%), fodder trees (68.3%) and ground water (60.1%), the destocking/fattening (75.3%), the transhumance (72.7%), prayers and other rites (63.5%) and food

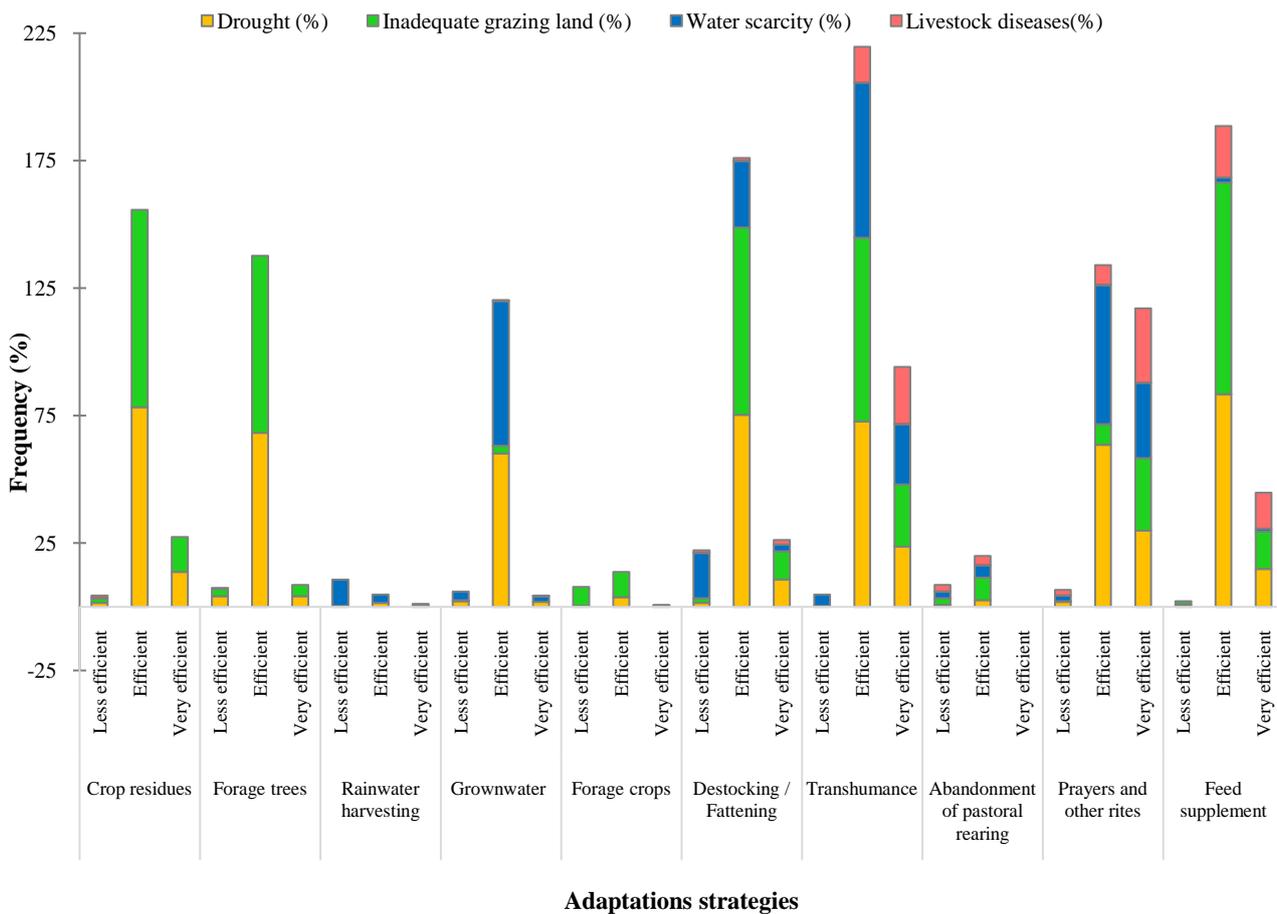


Figure 4. Effectiveness of respondents' (n = 271) adaptive strategies to climate change impacts on their activities.

supplement (83.4%) are efficient adaptations actions to drought. Efficient adaptations measures to the lack of grazing are: crop residues (77.5%), forage trees (69.4%), destocking/fattening (73.4%), transhumance (72.0%), food supplement (83.0%). To the lack of water, the efficient adaptation measure is the use of ground water (56.8%), transhumance (60.8%), prayers and other rites (54.6%). Finally, against the occurrence of livestock diseases, none adopted measure appeared to be effective to the recrudescence of animal diseases. The effectiveness of ground water to adapt to climate changes is confirmed by [46]. Moreover, the effectiveness of livestock mobility, forage cropping, supplemental feeding and the use of groundwater were found to be an efficient adaptation practices to climate change and the extreme events [41].

Among all the practices the mobility (transhumance) is declared by farmers as the most effective strategy after feed supplement. Taking into account the socio-economic implications, mobility ahead of feed supplementation is more accessible to herders. However, for how long will herd mobility remain effective to climate change and variabilities? Facing the increasing challenges such as reduction of grazing lands and livestock routes, livestock mobility to adapt to climate change is likely to be compromised in the coming decades. From respondents' perspectives, current challenges faced by mobile herding is fuelling the recrudescence of violent conflicts between herders and crop farmers which in the long run is likely to stop transhumance. Indeed, on one hand violent conflicts were reported in Kompienga province within the villages of Nadiagou in 2013, Pama in 2014 and recently in 2015 within villages of Mamanga, Diapienga, Tibadi, Folpodi, Nimoutingou. The last conflict affected 106 Fulani camps, 343 houses burnt, 3.9 tons of by-product destroyed and about 80 tons of hay burnt 35 goats and sheep killed [47]. On the other hand, herders have experienced inside Togo, violent conflicts within villages of Kante, Namon and Kouka in 2017, within the village of Borgou in 2014, in the village of Bassar 2016 and 2017 and within the village of Djarakpana over the last five years. Finally, recent conflicts were also reported in Benin Republic (village of Datori) and in Ghana (village of Guschiegu) respectively in 2013 and 2016. These conflicts were characterized by loss of both human and livestock life orchestrated by crop farmers along transhumance routes. Pastoralists are facing more conflicts and taxes payment within Togo and nevertheless, they prefer moving into this country contrary to Ghana and Benin Republic. According to respondents, Togo offers more suitable environment for a best production and reproduction conditions of livestock. In this perspective, they asserted that rainfall and forage availability are earlier in Togo. Adequate availability of water and high forage quality in Togo appear to be the major factors that attract herders more than the other destinations. Indeed, transhumant pastoralists stipulated that forage in Benin Republic is highly contaminated with diseases. Each herd once back from Benin Republic, must be seriously treated to avoid mortalities due to diseases contracted during grazing. Less transhumance is noticed toward Ghana probably due to the distance. Furthermore, over last

years, herders seem to move far and far southward within host countries (namely in Togo). Therefore, according to respondents, transhumant herds start visiting the village of Djarakpana only this last five (5) years (Figure 5). Given all the recent challenges, livestock mobility, a long-term adaptation strategy to harsh environment conditions, is no more playing this role unless sound and comprehensive solutions are found. Which solutions must settle a good and frank collaboration between herders and crops farmers within zones crossed by transhumant herds. Facing the future challenges such as deterioration of pastoral resources, respondents' strategies will be mainly the abandonment of pastoral rearing (67.2%), the reduction of herds size (65.3%) and activities diversifications (4.8%). The abandonment of pastoral herding without adequate support to ensure availability of pasture might increase cattle mortality and consequently leading to food insecurity.

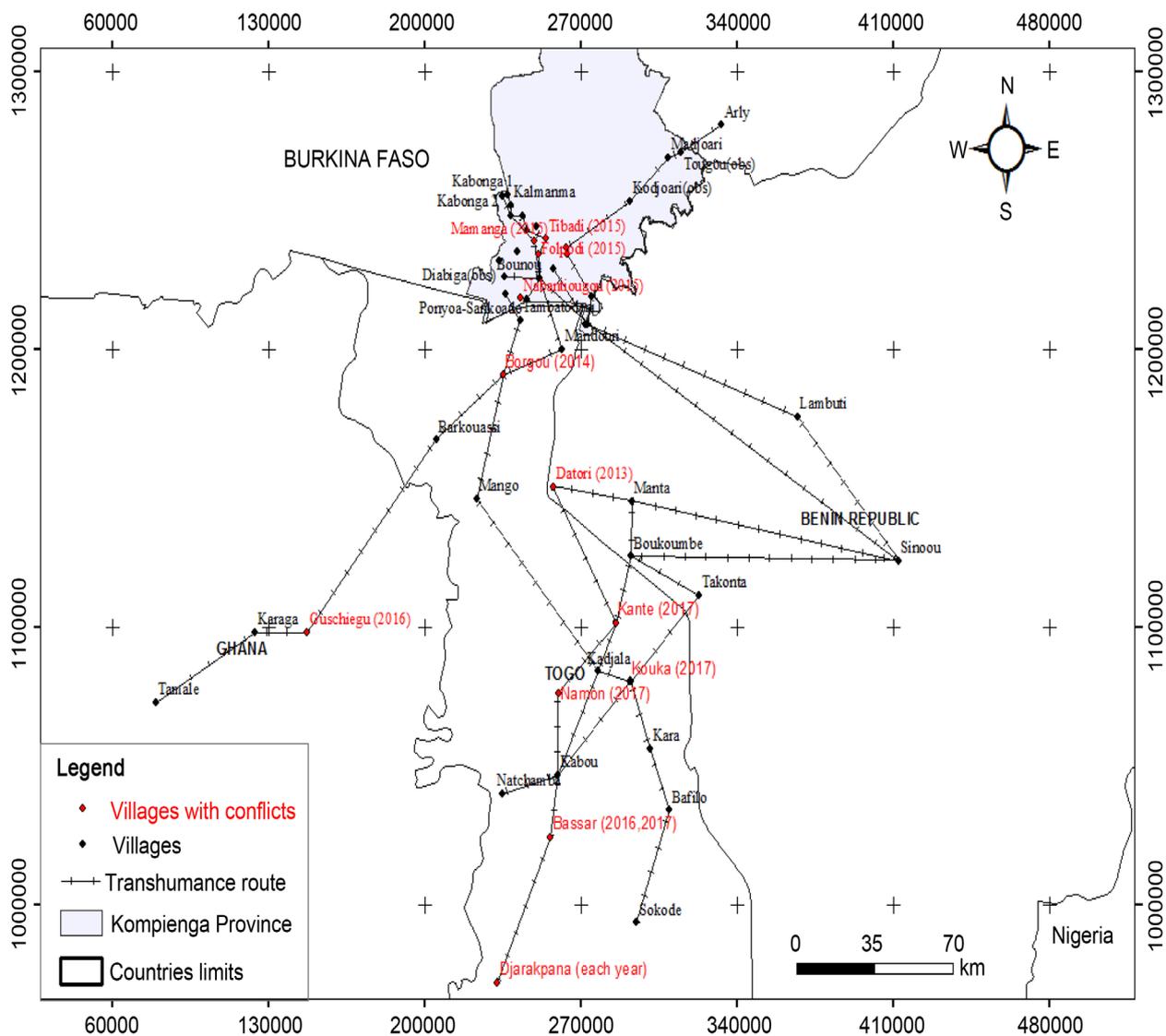


Figure 5. Transhumant herders mobilities from Kompienga province facing increasing challenges.

## 4. Conclusion

From respondents' perspectives, changes in climate conditions as well as their impacts on mobile herding, are indisputable within Kompienga province. Globally, respondents noticed decrease in rainfall amount, a decrease in the number of rainy days and shift in rain onset (found later) and cessation (found earlier) while temperature, occurrences of strong winds, floods and animal's diseases were all regarded to be increasing. Deterioration in climate conditions affects livestock production and reproduction performance and herders' livelihoods. It results an increasing pressure/competition for natural resources with its corollary of conflicts within Kompienga province and host countries as well. Given all the recent challenges livestock mobility, a long-term adaptation strategy to harsh environment conditions, is no more playing this role unless sound and comprehensive solutions are found. In order to overcome the exacerbation of constraints related to mobile breeding, the Government of Burkina Faso urgently needs to undertake actions to reduce the number of transhumant herds and to increase the availability/accessibility of resources (feed, water) for livestock. This might be ensured by: 1) Providing all the grazing reserves with necessary facilities including adequate and continuous water supply and regenerate the pastures; 2) conducting research for the selection of improved breeds resistant to new climatic conditions; 3) encouraging and supporting gradual shift of herders from transhumance to the sedentary breeding; 4) supporting and organizing forage production by farmers. At short term an effective cross-border must be created to seek for sound solutions to secure the mobility of herds within ECOWAS<sup>4</sup> territory.

## Acknowledgements

We are grateful to the German Federal Ministry of Education and Research (BMBF) who funded this research work through West Africa Science Centre of Climate change and Adapted Land use (WASCAL). We are also grateful to all the respondents the workers of livestock and fishery extension services of Kompienga Province who facilitated the good achievement of my field work.

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