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Research Article

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in processes, practices, and structures to moderate potential damages and/or to bene t from opportunities associated with climate change [16]. Adaptations are of longer-term in nature [32]. Coping strategies, on the other hand, consist of household practices used as short term measures when confronted with unexpected events such as droughts [32,33]. A pre-test of the questionnaire was made before the actual data collection, and appropriate modi cations and corrections were made. Interviewers were recruited and trained in an attempt to improve the accuracy of answers to questions. Out of ve pastoral and agro-pastoral districts of the zone, three districts (e.g. Wadera, Gorodola and LIn ea ba

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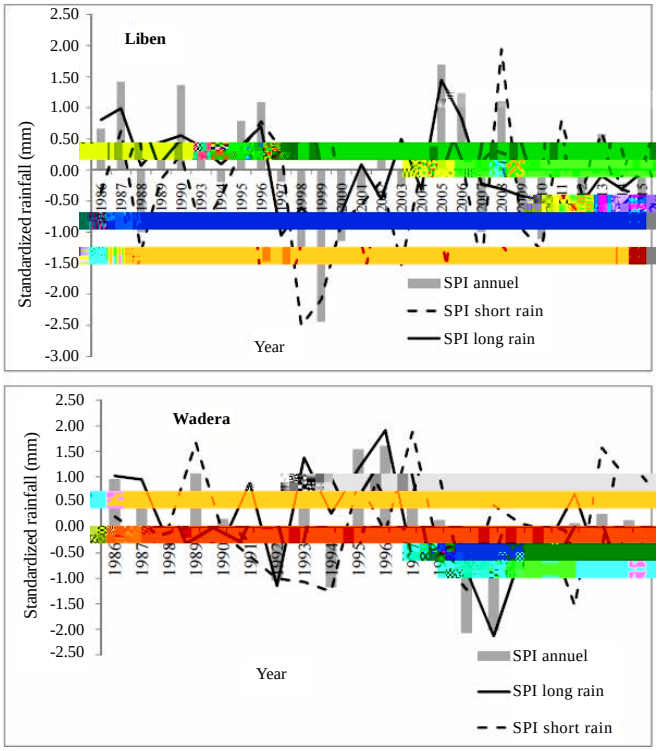

Figure 2: Standardized precipitation index for annual, long and short rainy season in Liben and Wadera districts of south Ethiopia.

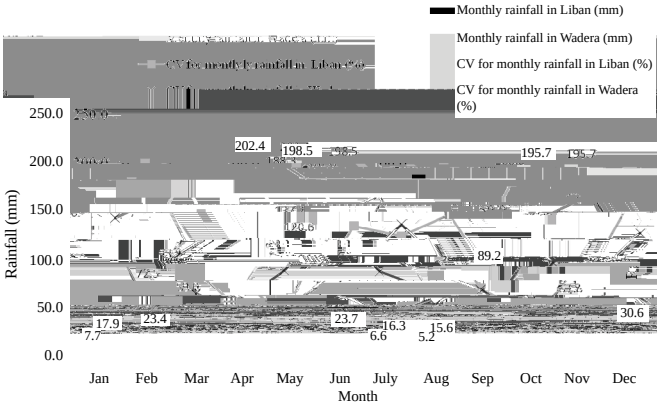

Figure 3: Monthly rainfall and coeffcient of variation in Liben and Wadera districts of south Ethiopia.

rainy season (Figure 3). Furthermore, rain onset months for instance March for long and September for short season as well as rainfall cessation time (May for long and November for short rainy season) had extreme rainfall variability (Figure 3). is shows that rain onset and cessation time has variable.

Annual and seasonal Precipitation Concentration Index (PCI) values are presented in Figure 4. In general, mean annual PCI values was high at both districts and higher at Liben (23.3%) than Wadera district (19.77%), which shows there was inter annual precipitation variability (Figure 4). About 64.3% of annual PCI value at Liben had shows above 20 and the remaining 35.7% PCI values were between 16-20, which indicates the distribution of precipitation were an irregular and seasonal pattern. Regarding to seasonality, in study districts large proportion of PCI values in both seasons as well as annual rainy season had not show uniform precipitations distribution. At Liben only 39.2% in long rainy and 7.9% in short rainy season had PCI values under 11, which shows distribution of precipitations was uniform (Figure 4).

As depicted in Figure 5, the mean, maximum and minimum daily temperature of study area were 20.90°C, 26.32°C and 15.09°C, respectively. e highest mean monthly temperature was recorded in March while the lowest was in July. e standardized temperature anomalies indicated that among the studied periods (1985-2014) at Liben in about 66.67% of mean annual temperature had shown above the long-term average while the remaining 33.33% studied periods reveled below the normal average (Figure 6). Similarly, for about 21 years (77.78%) mean annual minimum and maximum temperature had above the long term average (Figure 6). Furthermore, the Mann-Kendall trend revealed that mean annual, minimum and maximum temperature showed signi cantly (P<0.001) an increasing trend (Table 4).

Aadaption and coping mechanisms of communities to climate change risks

Local communities' used a range of climate adaption strategies and their response is presented in Table 5 and Figure 7. Most respondents involved in adjustment in crop production practices. ese practices include use of diversi ed crop varieties and expansion of farmland (72.8%), use early maturing and drought tolerance crop varieties and adjust agronomic practices (78.76%) include choices of crop varieties, altering planting date, use of minimum tillage, inter cropping, and use of input such as fertilizer. Local communities' diversify di erent crops use of small scale irrigation for producing of vegetables (mainly common at Wadera and Genale district of Liben), Today's, local communities shi

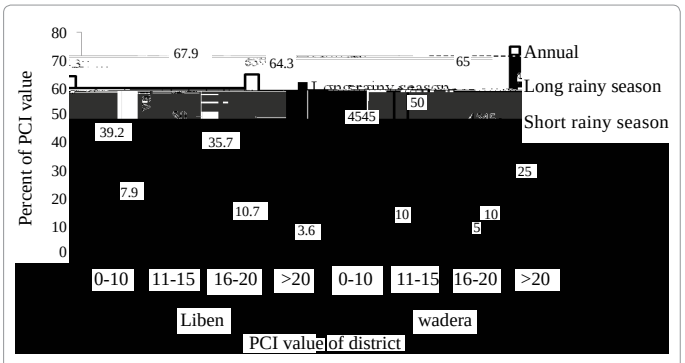

Figure 4: PCI for annual, long and short rain season in Wadera and Liben districts of South Ethiopia.

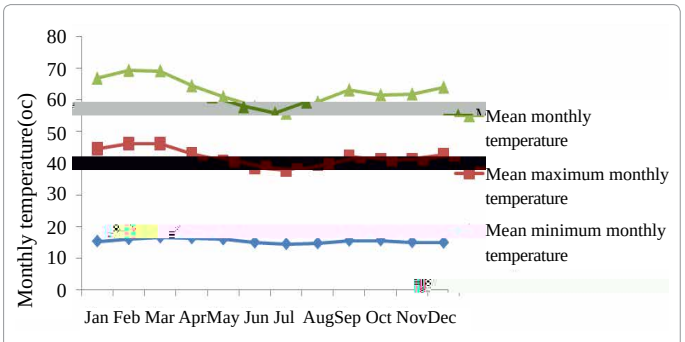

Figure 5: Monthly mean maximum and minimum temperature in Liben district (1985-2014) of South Ethiopia.

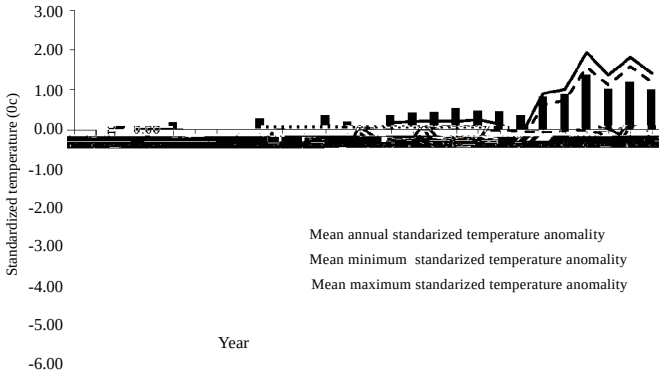

Figure 6: Standardized mean minimum, maximum and annual temperature anomalies of Liben district of South Ethiopia.

Parameters	Wadera %	Gorodola %	Liben %	Mean %
Accumulate livestock or other assets	64.8	43.3	60	56
Traditional mutual social supporting system	56	30	70	52
Divide livestock and family into separate places	62.6	53.3	66.2	60.7
Keep some animals with relatives as insurance	57.1	53.3	91.7	67.4
Expansion and diversi fcation of crop production	68.3	78.3	71.7	72.8
Use drought resistant and early maturing crop varieties and adjusting agronomic practices	82.4	86.7	65	78
Seek alternative income sources	82.4	81.7	65	76.4
Avoid use of expensive agricultural inputs	53.8	40	63.3	52.4
Land management for soil and moisture conservation practices	54.9	75	35	55
Praying	48.4	45	73.3	55.6
Pay attention to climate forecasts/early warning systems	59.3	75	36.7	57

Table 5: Communities climate change response adaptation strategies in Guji zone of South Ethiopia (n=211).

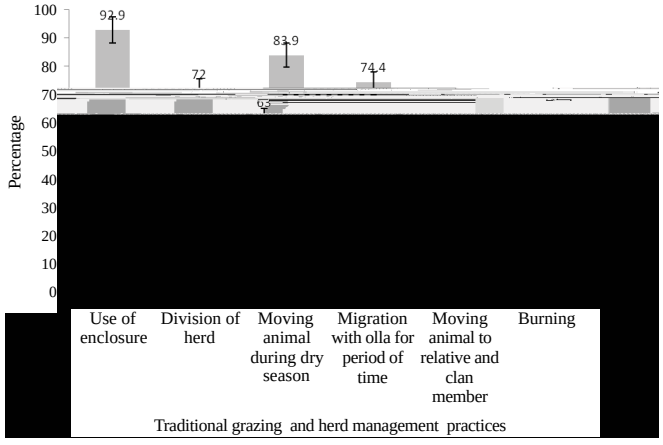

Figure 7: Traditional range land utilization and management practices in Guji zone of South Ethiopia (n=211).

to produce cash crops (e.g. haricot bean, khat, co ee, enset) and tree (eucalyptus tree) as well as practicing agro-forestry practices. Growing of haricot bean has been intensi ed and considered as emerging crops, before 10-15 years ago; haricot bean production is very low interims of yield and area cover. At present, it becomes among the dominant crop. e intensi cation of haricot bean could relate with high market demand, early maturing, and drought tolerance could grow under moisture stress condition. e intensi cation of this leguminous pulse crop would contribute to household food security, household income as well as enhance soil fertility and this might encourage communities' to integrate a crop with other food and forage crops.

e majority of respondents have been implimenting various grazing and herd management strategies in response of feed scarcity and droughts condition. ese practices include use of enclosure (92.9%) and establish of drought reserve grazing lands way of responding to the scarcity of feed for vulnerable herd classes, seasonal herd mobility (74.4%), herd splitting (72%), moving animal during dry season (83.9%), partitioning of grazing lands into wet and dry season, adoption and diversi cation of herd composition (73%) mainly drought tolerance species (e.g. camel and goat), moving animal to relative and clan member (63%) to exploit areas remote from their permanent settlement sites and use of re (25.3%) (Figure 7). Communities local keep more female dominated herd to facilitate rapid animal recovery a er drought. Furthermore, some households use browse plant species, crop resides, and hay as copping strategies in response to drought and declined pasture were traditional grazing land practices which contribute to adaption of local climate change.

e majority of respondents accumulates livestock (57.3%), relying on savings (64.9%), involved in non-pastoral income generating activities (53.6%) (e.g. promotion of crop cultivation, petty trade, sale of charcoal, and re wood), traditional mutual social supporting system (32.6%) were among main adaption strategies. ese social systems are meant to support poor households or those who have lost many assets due to hazards such as droughts, con icts or diseases. Additionally, communities used many coping mechanisms for short term strategies and the practices that have been used are presented in Table 6. Most respondents (81%) used frequent sale of livestock as the primary copping strategies to obtained grains to supplement their families followed by minimised daily food intake and eat less preferred food items (74.4%), use of traditional mutual social supporting system (66.8%) were among the copping strategies (Table 6).

Discussion

Local indictors of climate change

is study has provided a wealth of information on contribution of indigenous knowledge on climate change, its impacts, coping and adaption strategies of pastoral and agro-pastoral communities in Guji zone of south Ethiopia, which will be valuable for many stakeholders that focus on climate changes related issues. As observed in this study and in many pastoral areas e.g. Kenya [45], Uganda [21] and southern Ethiopia [46] have reported that local communities' perceive the existence of climate change and explain use of multiple indictors mainly declining precipitation amount, erratic on onset and cessation time of rainfall, and increasing frequency of drought as well as temperature. e change in amount of rainfall, rainy days, onset and cessation time rainfall, standardized precipitation index, rainfall trend, PCI and temperature could indicate climate change. is view is in agreement with the empirical climate data analysis for the study area. Other studies

have also shown a considerable decline in precipitation and increased drought recurrences in the East of African, and associated such trends to climate change [2,46].

Impact of climate change

Recurrent drought and rainfall variability has been a major cause of food insecurity and challenge in east Africa pastoral group (46). e perceived e ects of drought on forage production, availability of water, livestock production and pastoral communities' in present study have been documented by many studies [47-49]. e decline of precipitation, increased drought and raising of temperature in Guji and Borana communities caused a declining of forage, water availability, and seriously a ect the productivity (e.g. milk yield, body weight, growth and reproductive performance of livestock), and health [26]. Additionally, the periodic drought induces loss of crop yield, and local food insecurity [50], this view was supported in the present study. e increases drought and the rise in temperature adversely a ect pastoral livestock production through pose thermal stresses on animals; impair feed intake, and thereby hindering their production and reproductive performances [13] and disease distributions [12]. Drought in Guji and Borana pastoral communities has resulted in a substantial change in livestock holding at the household level, while communities in general have lost their livestock asset and become destitute. Another consequence of drought is linked to food insecurity, poverty to the extent of food aid, expansion of aridity and the need for alternative livelihood income and diversi cation. e children dropout from school, incidence of human and livestock disease, land dispute, and more pressure on females described by local communities in this study is similar with other study documented in other pastoral area of Ethiopia [20].

As described in this study by local communities, the increased in drought directly pose on tree seedling germination and recruitments and indirect impacts on forest resources through putting enormous pressure on a resources, for example, during drought and pasture decline times forest serve as key refuge and communities' use sale of rewood, charcoal, timber and Gesho as alternative income generating activities. However, these households' strategies might be e ective for short term, yet become unsustainable as droughts prolonged and sever which, leads to deforestation. Consequently, the deforestation can leads to loss of other ecosystem services, including local climate regulation, and biodiversity. In the past, in Guji communities had no individuals involved in charcoal making as a livelihood strategy and it has recent phenomena and poverty driven.

Adaptation and coping response of local communities

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intensi ed climate related risks. Hence, use of these kinds of strategies to long term plan might be unsustainable and destructive for pastoral production system. Additionally, use of continuous food aiding, reduce the quantity, quality and frequency of daily food consumption lead to malnutrition, and poor disease resistance. Withdrawal of children from school could in uence further adaptive capacities of local communities.

Conclusion

e study shows local communities perceived existence of climate variability and explained use of multiple indictors mainly declining of precipitation amount, and change in pattern (rainy days; onset and cessation time of rainfall) and increasing frequency of drought. e long term empirical climatic analysis supports the communities' views and the existence of climate variability interims of Standardized Precipitation Index, Precipitation Concentration Index, trend analysis and coe cient of variability. Communities' in uenced by numerous challenges that emanating from climate change include drought, scarcity of forage, livestock disease, crop failure, food insecurity and deforestation were among the e ects. However, the communities' had many adaptation response the main were categorized as adjusting of crop production strategies, grazing and herd managements, look for alternative income and diversi cation options, and use of traditional mutual supporting system. e study shows communities' had a set of coping strategies frequent sale of livestock found be the main copping responses. Yet, some of the coping strategies are become less e ective and cannot be scaled up easily to other areas. To adapt and limit the negative e ect of climate change in the region, e orts should base on clear understanding of local context, practices and knowledge. Finally, it is vital to integrate local knowledge and scienti c approaches should have a potential to develop and look an alternative adaptation strategies.

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