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Trend Analysis and Challenges of Adaptations to Climate Change in Hararghe, Ethiopia

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Abstract

In Ethiopia, climate change is a key emerging threat to the livelihoods of rural poor and marginalized groups. Hence, an adaptation measures to the changing climate is critical, which in turn require the perception that the climate is under a changing. The study was conductan and randomizing the samples, SPSS version 16.0 was employed to analyze t revealed that the annual mean temperature over Chiro district was 20.3ºC, showing an increasing trend by 1.8ºC/ year and average annual rainfall was 927 mm/year, showing a decreasing trends by 19.2 mm/year in the last three decades. The mean annual maximum and minimum temperature in the study area was 27.87 and 12.72°C, respectively. Moreover, the study shows that all seasons had a positive temperature trend. Results of survey

elements were the major challenges in addition to the scarcity of lands

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Moreover, Ethiopia is one of the African countries whose

e expectation that climate is changing in the upcoming centuries

requires the need to capture the perceptions of farmers towards the climate change to guide the mechanisms for adaptation so as to ensure resilience [11,12]. Two steps have to be recognized whenever we need to develop any adaptation strategies. First, initially requires the perception that climate is changing, second, responding to any new changes [13].

In Ethiopia, the challenge of climate change is very serious, given the degraded lands combined with highly variable rainfall and high temperature increment. e current climate change and variability is characterized by shorter rainfall season, erratic distribution (in time and space) with a decreasing amount from year to year. During the last four decades, a number of severe droughts exert expensive loss of human and property in the country, o en covering the greater Horn of Africa. In general, in 1965, 1973, 1984, 1987 and 2011, the spatial occurrence of drought indicated that most of the drought events were happened in two broader zones of Ethiopia [14,15]. e rst covers the central and north-eastern highlands while the second area is comprised of the crescent of low-lying agro-pastoral lands. Scienti c investigations on climate issues and its economic impact on agricultural productivity are critical to develop e ective and locally adaptive production systems in the face of the increasing climate change and variability [16]. erefore,

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the aim of this study was to characterize the trends of climate, to study the perception of farmers' towards the climate change, and to explore challenges of farmers in regards with adaptation mechanisms in order to intervene policy makers on ways to promote adaptation mechanisms so as to ensure food security of the poor farmers.

Materials and Methods

Description of the study area

e study was carried in Chiro district, Hararghe zone, Ethiopia. It is situated at 8 degree latitude and 38 degree longitude with an altitude ranging from 1826-1950 meters above sea level. e major crops grown are Sorghum (*S gh bic* L) and maize (*Zea a a L*). Whereas, the annual cash crops are known to be co ee (*C ee a abica*) and *Kha* (*Ca ha ed i*). e 2007 national census reported a total population for this town of 33,670, of whom 18,118 were men and 15,552 were women. On the basis of the religion classi cation, of the populations, 49.88% were Muslims. However, 43.34% practiced Ethiopian Orthodox Christianity and 5.33% of the populations were Protestant [17] (Figure 1).

Research approach

e study employed both qualitative and quantitative methodologies. In line with this, signi cance of climate change trends was done using thirty years of weighted spatial average temperature and rainfall data for the entire region collected from National Meteorological Agency of Ethiopia. INSTAT version 3.37 was used to analyze these climate data [18]. However, climate trend analysis were done using Mann-Kendall trend test. Moreover, the socio-economic data were collected from three *ebe e* (sub-divisions of the district) selected deliberately on the basis of their landscape settings and proximity. ese selected *ebe e* were found approximately about 15 to 20 km from *Chi* town, Ethiopia. From the selected *ebe e* , households (considering both male-headed and female-headed households) and extension workers were randomly selected. en questionnaires, focus group discussion (FGDs) and interview were employed to collect primary data important for this study. us, a total of 75 households, 25 from each *ebe e*, were involved a er clustering of villages and randomizing the samples in the socio-economic investigation of the study area. SPSS version 16.0 was employed to analyze the survey data. en, the results were expressed in gures, tables and other descriptive statistics.

Trend analysis test

In a trend of time series climate data, Mann-kendall trend test was used to see whether there is a decreasing or increasing trend or not. ere are many tests available for the detection and estimation of trends. Di erent so ware such as SPSS and Microso excel can be used for trend analysis test. However, they are very sensitive to outliers. However, in this study, Mann-Kendall trend test was used to detect the trend of climate pattern in the study area. Mann-Kendall's test is a non-parametric method, which is less sensitive to outliers and test for a trend in a time series without specifying whether the trend is linear or nonlinear [19,20]. Furthermore, Mann-Kendall trend test was used to detect the trend and normalized p-value for signi cant test. e total score for the time-series data is the Mann-Kendall statistic, which is then compared to a critical value, to test whether the trend in rainfall is increasing, decreasing or if no trend. In doing this, data for analysis should be in time sequential order [21]. e Mann-Kendall's test statistic is given as:

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more signi cant than the mean maximum temperature change. e mean of annual temperature change indicates signi cant variations of temperature observations increased by approximately 1.8ºC for the last three decades, and it is statistically signi cant at p value of 0.05. e same result has been reported by the IPCC [23] where each of the last three decades has been successively warmer at the Earth's surface than any decade since 1850. Intergovernmental Panel on Climate Change (IPCC) Fi h Assessment Report (AR5) also presents strong evidence of warming over the lands of Africa in the last 50-100 years [5]. African surface temperatures have already increased by 0.5-2°C over the past hundred years [5]. e slope of the trend line in all the graphs of (T_{max}, T_{min} and T_{mean}) is positive value showing the addition of signi cant value across the three decades time series analysis. In line with this, Taddesse

respective CV value. Moreover, the peak amount of rain during *i e* season was found to be 860.7 mm over the last three decades. Belay et al. [27] reported that the *Ki e* season rainfall, even if not statically signi cant, central part of Ethiopia experienced a decreasing trend in the past years. Simultaneously, the Sen's slope estimation also indicates that, the trend of the rainfall of the main growing season (JJAS) at Chiro district has increased by 140 mm/year (Table 3).

Whereas, for small rainy season (FMAM), trend test showed a decreasing pattern by -276 mm/year and it is statistically signi cant at p 0.1 level. IPCC [5] AR5 justi ed that this is due to rapid warming of the Indian Ocean, causing less rainfall over eastern Africa between March and May-June in the last 30 years. Overall, the magnitude and direction of small rainy season was not uniform due its high inter-annual variability (CV ≥ 45%) (Table 3). It has been also noted that there was high seasonal and annual rainfall variability in the study area over the period of 1980-2010. Much contribution of annual rainfall in the study area was from the main rainy season (JJAS) accounting about 51%, 35% from Belg *(*FMAM*)* season, and the rest was contributed from Bega season rainfall.

Annual precipitation change

e change in the annual average precipitation of the study area has been analyzed and interpreted as follows. e annual precipitation change from the mean average has to be 930.37 mm as per the trend line. However, this value has been changed by the factor of -0.1869 (Figure 5). Negative sign of the slope of the trend line indicates that precipitation declining from 1980-2010 over Chiro district.

Farmers' perceptions on climate change

Results of survey data indicated that 83% of the sampled households have well perceived an increasing trend in annual average temperature (Table 4). ough they did not recognized to what extent the temperature was rises up. is result goes in line with the outcomes achieved via meteorology data analysis of same area, showing the trend is positive and statistically signi cant at p level 0.01. Whereas, about
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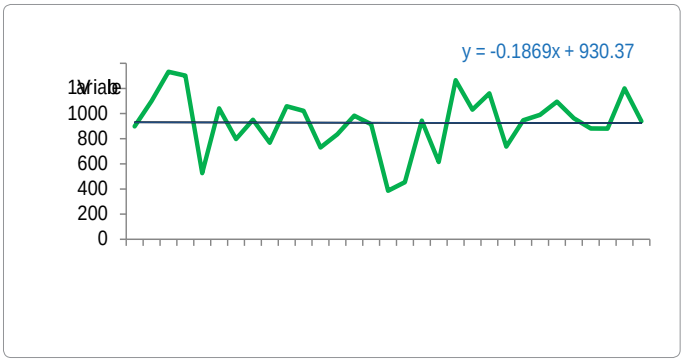
amount of rainfall in the area over the last three decades, leading to the di culty in growing crops (Table 4). Additionally, there are a number of respondents who replied that there was no climate change at all. ey believe that temperature increases and rainfall decreases due to the ''anger of the Lord''. e reason for this might be mainly due to lack of information on climate issues and its serious consequences, indirect reliance on agriculture whose product is measured by climate change and others could be the reasons for their perception they had towards climate change.

Furthermore, the study revealed that of the sampled households, 89% respondents reported that onset and cessation of rainfall in the study area was variable (Table 4). Overall, it could be generalized that majority of the farmers in Chiro district was well perceived about the climate change and its e ects due to their live was depend on agriculture which is sensitive to the e ects of climate change. is particularly, retards the lives of poor farmers, female-headed households and other marginalized social groups. Because, relatively these groups have low capacity to withstand the challenges of climate change, once they faced.

Adaptation mechanisms and challenges faced

Farmers are practicing many options to overcome the problem coming with the changing climate. However, e ective adaptation responses with targeted actions from the local to national levels are critical, given the di erentiated social impacts based on gender, age, disability, ethnicity, geographical location, livelihood, and migrant status IPCC [23]. Animal fattening, planting cash crops, changing planting date, saving and borrowing, migration and resettlements are the major means of adaptation in most of the cases. However, of the households considered for this study, about 87 and 89% replied that animal fattening and planting cash crops respectively are the major



adaptation options in Chiro district (Table 5). Additionally, there are also small-scale irrigation practices around Chiro district, not following the scienti c procedures of e cient water utilization. Many soil and water conservation practices were constructed in last few years as per the national consensus on environmental rehabilitation program. More or less, all the adaptation mechanisms that farmers reported are pro t driven than climate change driven. In African countries, there are strategies to o set the impacts of natural hazards on individual households: these include early warning systems, emerging risk transfer schemes, social safety nets, and disaster risk contingency funds and budgeting, livelihood diversi cation, and migration [28,29]. However, the action is not yet implemented e ectively to restore victimized farmers from the consequences of climate change. e study depicted that lack of information specially critical to agriculture such as: onset, cessation, length of growing period, number of rainy days, and dry spells are not given su ciently at site speci c level in time. is leads many farmers in the study area more vulnerable to the impacts of climate change. About 73% of the respondents con rmed this challenge though scarcity of land was highly noti ed in the area (Table 5).

In general, in the study area, the farmer's capacity to adapt to the changing climate is very limited due to lack of scienti c knowledge about adaptation measures, lack of or late technology adoption, economic capacity and their dependency on agriculture which is highly sensitive to climate change. Given numerous challenges they faced, the overall capacity to overcome the problem coming with climate change is less. e fact that climate is changing, with less attention given at national levels. ere are no organized national action plans which consider the short or long term climate changes e ects. e prolonged and increasing temperature, combined with declining rainfall and frequency of extreme weather events like: drought, ooding and extreme temperatures results in declining of crop products. A study conducted by Deressa et al. [30] indicated crop yield would decline by about 32.8% due to the e ects of extreme weather events. at is why farmers are struggling to have their own adaptation mechanisms to tackle the problems of climate change.

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