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Analysis of rainfall and temperature data to determine climate change in Dilla Zuria District, Southern Ethiopia

Tesfahun Fentahun[1*] and Temesgen Gashaw[2]

[1] Department of Natural Resource Management, Debre Tabor University, Ethiopia
[2] Department of Natural Resource Management, Adigrat University, Ethiopia
*Corresponding Author: tesfa9562@gmail.com

Abstract
The objective this study was to determine climate change in Dilla Zuria District, Southern Ethiopia using rainfall and temperature data. To do so, rain fall data from 1955-2010 and temperature data from 1997-2010 was employed. Focus group discussions and key informant interview were also conducted. The collected data was analyzed using SPSS v.16 soft ware. The result showed that there was a reduction of rain fall with the variability on the onset and off set of rainy seasons and increase of temperature. The conversion of large indigenous trees is responsible for the observed changes in rainfall and temperature.
Key words: Temperature, rainfall, variability, climate change

1. Introduction

Global climate change is not new phenomena, but the warming that is occurring today is unprecedented with respect to the rate of change. Future annual warming of the world is projected to increase in the coming decades. In Ethiopia, mean annual temperature has increased by 1.3°C between 1960 and 2006, an average rate of 0.28°C per decade. The mean annual temperature is projected to increase by 1.1 to 3.1°C by the 2060s, and 1.5 to 5.1°C by the 2090s (McSweeney *et al*., 2007). However, rainfall is highly variable across the country, from season to season, and from year to year. Climate projections suggested that an increase of rainfall variability with a rising frequency of both severe flooding and droughts due to global warming (World Bank, 2010). During drought years, the country suffered significant production deficit of about 20% in the agricultural sector, resulting in a significant decrease of total annual production, mainly involving cereals and pulses (UNDP, 2008). The Intergovernmental Panel on Climate Change's (IPCC, 2007) findings suggests that developing countries like Ethiopia will be more vulnerable to climate change due to their economic, climatic and geographic settings. In parallel, Zenebe *et al*. (2012) reported that its low adaptive capacity, geographical location and topography make the country highly vulnerable to the adverse impacts of climate change. Thus, this study aims to determine climate change using rainfall and temperature data, and to look into the associated socio-economic and environmental effects.

2. Materials and methods

2.1 Study area

The study was conducted in Dilla Zuria District, Southern Ethiopia. It is bordered by Wenago district in southwest, Oromia region in west, Sidama zone in north, and Bule in southeast. Topographically, the area revealed undulated plateau at the upper limit to valley and plain in the lower limit. Its altitude ranges between 1750-2200m above sea level, and covers about 75,000km^2. The average annual rainfall and temperature is 1300 mm and 21^{0}C respectively. The area has two major rainy seasons (spring and summer). The old age indigenous agroforestry system of agriculture is the major economic activity which is characterized by ever green coffee, fruit and shed trees. Indigenous multipurpose trees such as *Cordial Africana*, *Fiscus sur*, *Millettia ferruginea*, *Prunus africanus* and *Vernonia amygdalina* with cash crops such as coffee, enset, banana, avocado, mango, pineapple and kacht are predominate in the area**.**

2.2 Data sources

The study was conducted using rain fall and temperature data. Rain fall data from 1955-2010 and temperature data from 1997-2010 were employed. The data were employed from Dilla station which is found in Dilla Zuria District. Two focus group discussions with farming households having a group member of nine and key informant interview (elders) were also conducted. Men and women youngsters and elders were involved in the group discussions for the purpose of getting varied information.

2.3 Data analysis

The study has used mixed research approach i.e. quantitative and qualitative approach. Thus, the collected data was analyzed using both quantitative and qualitative methods. Quantitative data collected from rain fall and temperature data was analyzed using SPSS v.16 software. While, qualitative data collected through focus group discussions and interview were discussed in line with the quantitative data. The study will give much emphasis to quantitative data analysis which was supported by qualitative data analysis. For this, sequential explanatory strategy has been implemented. This is to mean, first quantitative data collection followed by quantitative data analysis then qualitative data collection followed by qualitative data analysis, then interpretation of the entire analysis.

3. Results and discussion

3.1 Rainfall data analysis

For the last 55 years, there was a variability of annual rain fall (Figure 1). Again, during focus group discussions and key informant interview the participant reported that the monthly rainfall pattern has been fluctuated for the last 20 years. Similar to this result, rain fall variability was also observed in Gonder, Debre Markos, Combolecha, Gore, Jigijiga during the study periods (Ademe and Kinfe, 2000). In addition to this variability, reduction of rain fall amount is also observed in both spring and summer rainy seasons. The result of focus group discussion and key informant interview showed that the conversion of larger indigenous trees is responsible for the observed changes/variability in rainfall. Similarly, studies revealed the reduction of rain fall amount in different parts of the country. For example, there is a reduction of spring and summer rainfall by 15–20% across parts of southern, southwestern, and southeastern Ethiopia between the mid-1970s and late 2000s. The combined spring and summer rainfall reductions were a loss of more than 150 mm of rainfall per year in the most densely populated long cycle crop growing area of the country (Funk *et al*., 2012). Similarly, Seleshi and Zanke (2004) also reported the decline of rainfall in eastern, south and southwestern Ethiopia from 1986 to 2002 which is caused by the corresponding persistent warming of the South Atlantic Ocean over the period. In the same way, there is a negative rainfall anomaly in north central highland of Ethiopia with frequently reduction of the main rainy season (June–September) than the long-term average in the second half of 20th century (Osman and Sauerborn, 2002).

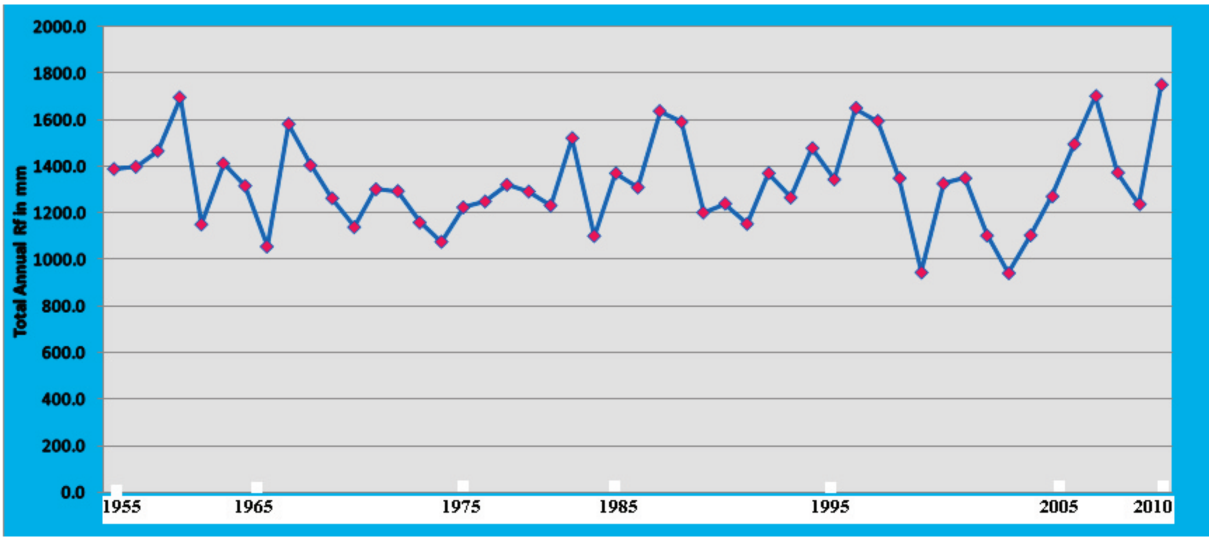

Figure 1: Annual rainfall pattern of Dilla Zuria District (1955-2010)

3.2 Temperature data analysis

The annual maximmum, average and minimmum pattern of temperatures shows a silight flactuation from 1997-2010 (Figure 2). This may be attributed to the use of short term temeprature data. However, participants in focus group discussions replied the changeable behavior of local climate which is characterized by an increase in temperature, decline in rainfall and increase in evaporation. In general, the result of this study showed that there was a detriroratution of local climate change. Similarly, Funk *et al*. (2012) argue that if recent warming trends continue, most of Ethiopia will experience more than a 1.0°C increase in air temperature, with the warming tendency projected to be greatest in the south-central part of the country. This warming will intensify the impacts of droughts, and could particularly reduce the amount of productive crop land for coffee.

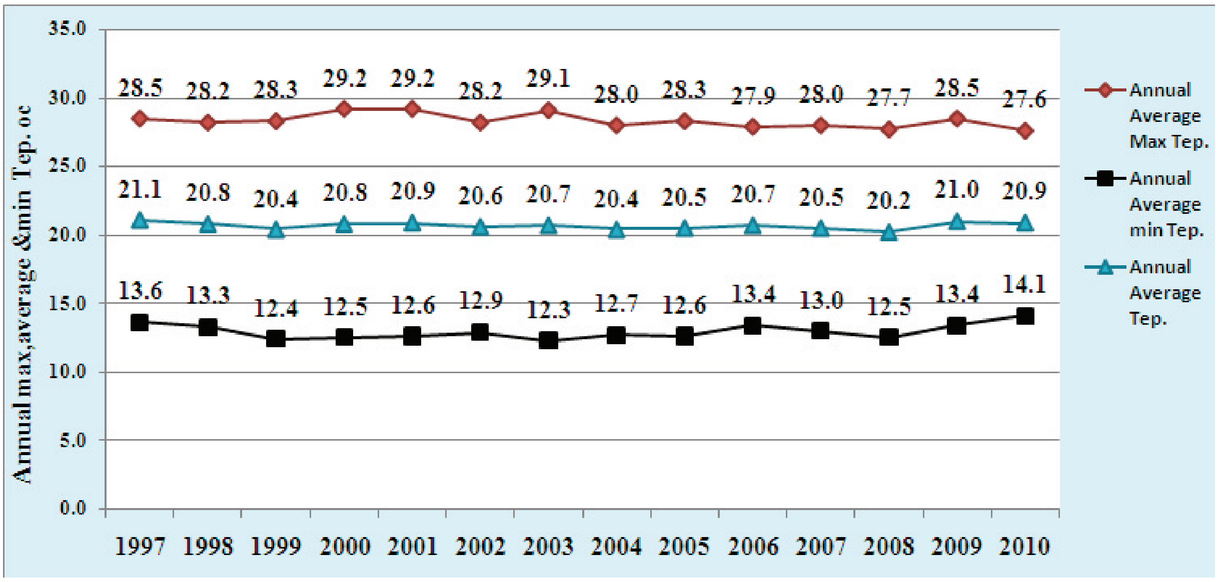

Figure 2: Annual temperature pattern of Dilla Zuria District (1997-2010)

3.3 Conceptual linkage of climate change/variability and related effects

All of the residential of the District has highly dependent on agricultural economic activities. As a result, the fluctuation of rainfall and increase of temperature has adverse impacts on the livelihoods of the society as well as biophysical environment. The frequency and severity of seasonal drought problems increase from the higher to the lower altitudes. The periodicity of coffee in yielding good produce further complicates the hardship. The worst situation happens when poor coffee production coincides with poor rainfall conditions (SLUF, 2006). In general, climate change and variability in the study area resulted decline of soil moisture and fertility, decrease the amount of agricultural output, deterioration of livelihood (prevalence of poverty), further degradation of natural resources to full fill basic needs, which again contributes for climate change and variability (Figure 3). In parallel, UNFCCC (2007) reported that developing countries are the most vulnerable to climate change impacts because they have fewer resources to adapt: socially, technologically and financially. A study by Temsegen and Rashid (2009) trying to quantify to what extent climate change will reduce crop yields in Ethiopia. By using three different climate models under different scenarios income per hectare will decrease by 9.71%–303.27% by 2050 and 103.39%–418.01% by 2100. Rising temperatures in particular will affect crop yield.

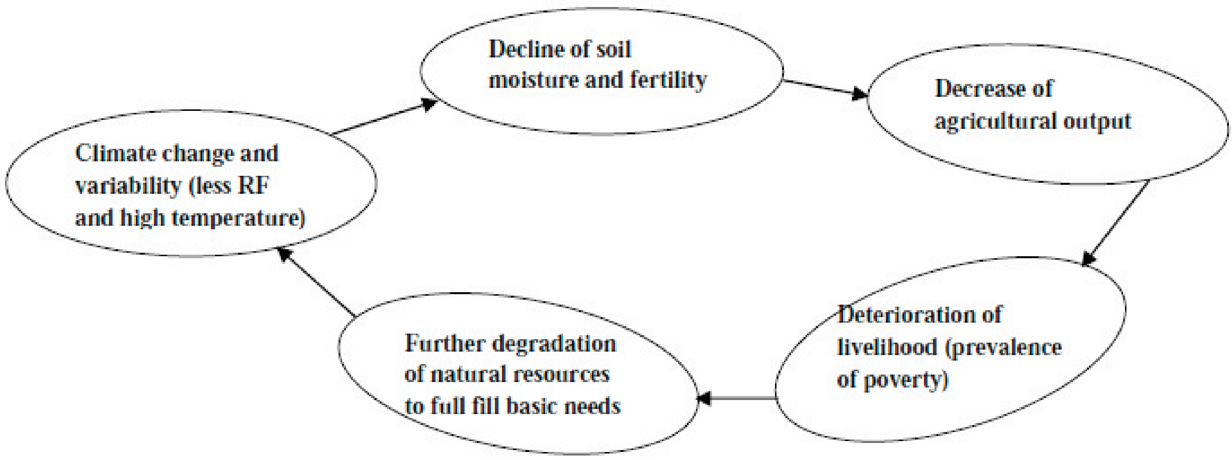

Figure 3: Climate variability, soil fertility and moisture, agricultural output, livelihood and natural resources

4. Conclusion

Analysis of rain fall data of 55 years and temperature data of 13 years revealed that there was a reduction of rain fall with the variability on the onset and off set of rainy seasons and increase of temperature. This change is associated with the conversion of indigenous trees. These local climatic changes has resulted the deterioration of livelihood (prevalence of poverty) and further degradation of natural resources. Thus, proper care of available indigenous trees will maintain the local climate change and associated effects.

Acknowledgment
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