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Trend analysis of seasonal rainfall and annual temperature in semi-arid Central lowland of Oromia state, Ethiopia

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Ethiopia is located in a tropical region where differences of temperature are strongly modulated by elevation where it comprises of 61% of lowland mass The past climate of the three study areas found in the Central lowland of Oromia of Ethiopia was used for ground observation data for the trend detections that were recorded at Melkassa (1977-2013), Adam Tulu (1973-2012), and Mieso (1973-2012) meteorological stations. The seasonal rainfall and annual minimum and maximum temperature data of the study areas were assessed using the Mann–Kendall trend test and Sen's slope estimator trend. The result of Sen.'s slope estimation also indicates that, the trend of the seasonal rainfall and annual maximum and minimum temperature under Mieso, Melkassa and Ademi Tulu condition increasing trend whereas Man-Kendall trend estimation indicates that the seasonal rainfall and annual maximum and minimum temperature shows a positive trend at the study areas expect negative trend of minimum temperature for Melkassa and Ademi Tulu. The high variability of climate aspects in the semi-arid central lowland of Oromia, which signals the likely impact of this variability on crop production risk study areas.

Keywords; Trends, seasonal rainfall, annual maximum and minimum temperature

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INTRODUCTION

Ethiopia is located in a tropical region where differences of temperature are strongly modulated by elevation (Kreyling et al,.2010) According the reports of McSweeney et al 2010 Ethiopia comprise of about 61% of the total land mass of the country is lowland where its elevation is below 1500m and are commonly known by warmer and drier than the highlands .In similar way as like of other Africa countries and the rest of the world, studies climate have shown changes in temperature and precipitation trends and variability's during recent decades in Ethiopia (Selish and Zanke ,2004:Cheung et al 2008:Doherry et al 2009 and Wong et al 2010).The change in magnitude and trend vary with locations, time series analysis of mean national maximum and minimum have shown positive trends(NMA,2001:Beliethathan et al 2009:Gebere et al 2009). The observed warming is escorted by a steady decline in precipitation in many parts of the country (Abebe et al 2006: Genet and Alem 2006: Tadessa and Dagnchew 2006 and Williiam and Funk,2011) although increases have been reported in some areas(Meza2004 and NMA,2001) and no changes detected in others (Selish and Zank,2004).

The analysis of past climate data in Ethiopia showed that an increase of annual minimum temperature by 0.37 °C per decade since 1951 (NMA,2007) and annual mean temperature by 1.3 °C between 1960 and 2006,[9] whereas as rainfall decline in different parts of the country(Selish and Zank,2004).The human induced climatic change would bring further warming in Ethiopia over the next century as like of the other parts of Africa (Selish and Zank,2004). Therefore, the main purpose of this article is to assess the seasonal rainfall and annual temperature trends in central lowland of Oromia state

METHODOLOGY

Description of the study areas

The areas under the study were found in central rift valley of Ethiopia in state of Oromia The first study site was Melkassa near to Adama about 115km from Addis Ababa. .The second study site Adami Tulu located at 160 km to south east of Addis Ababa The third study site Mieso located to the east of Addis Ababa at about of 300 km. The soil type at the study site is a well-drained silty clay loam soil largely developed from volcanic parent material. Crops grown in the area include maize (*Zea mays* L.), sorghum (*Sorghum bicolor*), teff (*Eragrostis teff*), and other cereals, pulses, and oil crops. (Table 1 & Figure 1)

Meteorological data source and Quality control

The past climate of the three study areas found in the Central Rift valley (CRV) of Ethiopia was used ground observation data for the trend detections that were recorded at MARC (1977-2013), ATARC (1973-2012), and Mieso (1973-2012) meteorological stations The whole dataset did not have more than 10% missing values. The data series was also examined for homogeneity using the cumulative deviation method and no heterogeneity was detected. Some missing and the outlier data were estimated using INSTAT+ v3.37 first order Markov-chain simulation model Stern and Knock, 2006). The main reason for choosing this model to fill the missing daily rainfall, minimum and maximum temperature data is that it does not overstate the result and gives a more accurate model to each of the study areas as has been explained by NMSA (1996b).

Seasonal rainfall and annual temperature trend analysis

Trends of seasonal rainfall and annual minimum and maximum temperature for the study areas were assessed using the Mann–Kendall trend test and Sen's slope estimator. The Mann– Kendall test is a non-parametric approach, widely applied in various trend detection studies [2]). Statistical analyses and other computations were performed with INSTATv3.37 statistical software (Stern *et al.*, 2006).Accordingly, the test of the null hypothesis H0 (no trend) states that the data (x1, x2,........,xn) is a sample of n independent and identically distributed random variables. The alternative hypothesis H1 (there is trend) of a two sided test, on the other hand, states that the distribution of Xk and Xj is not identical for all k, j ≤ n with k ≠ j. The test statistic S is computed from equations 1 and 2:

$$\left(S = \sum_{k=1}^{n-1} \sum_{j=k+1}^{n} \operatorname{sgn}(Xj - Xk \right) \text{-------------------------------------}$$

Equ;1

Where Xj and Xk are the annual values in years j and k, j> k, respectively, and

$$\operatorname{sgn}(x = \operatorname{sgn}(Xj - xk) = \begin{cases} +1, if\,(Xj - Xf > 1) \\ 0, if\,(Xj - Xk) = 0 \\ -1, if\,(Xj - Xk) < 1 \end{cases} \text{-------------}$$

----Equ;2

For n larger than 10, the standard normal Z test statistic was used and computed from equation 3 as:

$$\begin{aligned} &S = s - 1/\sqrt{\operatorname{var}(s)} --- s > 1 \\ &0 ------------- s = 0 \text{------------------------Equ;3} \\ &S = {}^{s-1}\!\Big/\sqrt{\operatorname{var}(s)} ---- s < 1 \end{aligned}$$

The level of significance α= 0.05 (95% confidence interval) was applied for each analyzed seasonal rainfall, and annual maximum and minimum temperature trend analysis for the three study areas.

The magnitude of trend was predicted by the Sen's estimator. As National Non-point Source Monitoring Program stated (2011) on monotonic trend analysis, the null hypothesis of no trend is rejected when S and τ are significantly different from zero. If a significant trend is found, the rate of change can be calculated using the Sen's Slope estimator

$$Ti = \frac{Xj - Xk}{j - k} -- forj = 1,2,3 -- N \qquad \text{--------------}$$

Equ;4

Where xj and xk are considered as data value at time j and k (j>k) correspondingly. The median of these N

Table 1. Description of the selected study areas

Site	Geographical coordinate		Altitude(m)	Periods(years)	missing
	Latitude(N)	Longitude(E)			
Melkassa	$8^{0}24$	$39^{0}12$	1550	1977-2013	
Mieso	$8^{0}48$	$40^{0}9$	1470	1973-2012	
Adami Tulu	$7^{0}52$	$38^{0}43$	1640	1973-2012	

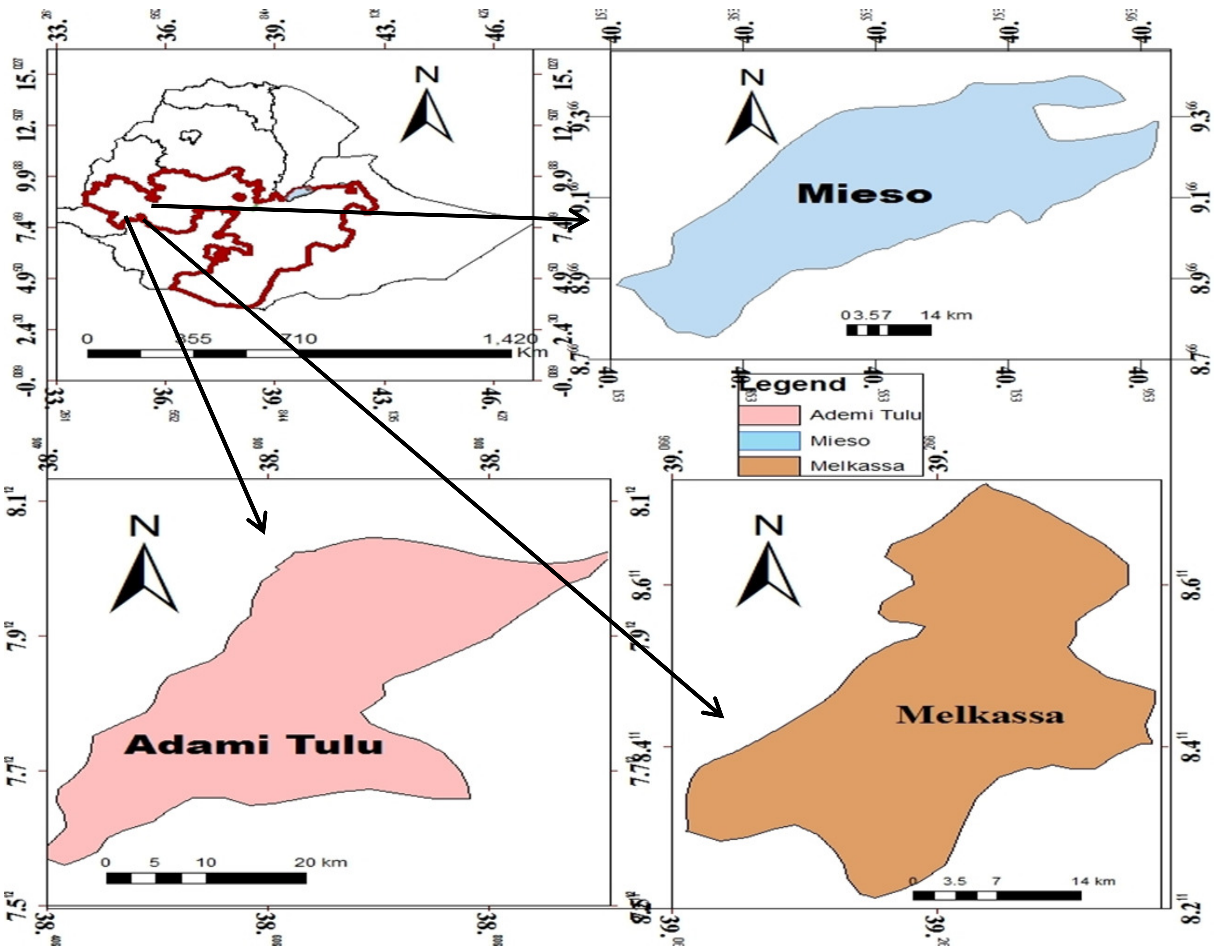

Figure 1. Location of the study areas

values of (Ti) is represented as Sen's estimator of slope given by

$$Qi = \int T \frac{N+1}{2} ------N- = odd$$

$$Qi = \left\{ 1/2 \left| T\frac{N}{2} + T\frac{N+1}{2} \right| --- N - even \right.$$

Equ;5

Sen.'s estimator is computed as Q med=T (N+1)/2 if N appears odd, and it is considered as Qmed=[TN/2+T(N+2)/2]/2 if N appears even. At the end, Q med is computed by a two sided test at100 (1-α)% confidence interval and then a true slope was obtained by the non-parametric test. Positive value of Qi indicates an upward or increasing trend and a negative value of Qi gives a downward or decreasing trend in the time series.

Table 2. Trend of rainfall (mm) at Mieso Melkassa and Adami Tulu weather station

Station name	Sen's slop mm/yer	Man-Kendall tau	Risk (%)	p-value	Confidence interval
Mieso	2.69	0.85	34	0.34	-2.44 -6.9
Melkassa	2.52	1.41	20	0.2	-1.17-5.41
Adami Tulu	0.37	0.373	52	0.52	-2.75-5.22

Table 3. Trend of Minimum and maximum temperature at Mieso Melkassa and Adami Tulu weather station

Station name	Sen's slop ^{0}C/yer	Man-Kendall tau	Risk (%)	p-value	Confidence interval
Maximum temperature					
Mieso	0.035	5.11	0.0%	0.00	0.26-12.40
Melkassa	0.018	1.63	61.56%	0.6156	-0.04 - 0.025
Adami Tulu	0.095	3.25	16.4%	0.1641	-0.117-0.66
Minimum temperature					
Mieso	0.009	1.25	55.09%	0.055	-0.0100-
Melkassa	0.014	-1.6	7.9%	0.079	-0.072 - 0.004
Adami Tulu	0.018	-0.9	58.8%	0.58	-0.058-0.032

RESULT AND DISSECTIONS

Analysis of seasonal rainfalltrend

The trend of rainfall during growing seasons at Mieso, Melkassa and Ademi Tulu areas are non-significant in the past years. As indicated in Table 2, the result of Man-Kendall trend estimation indicates that the growing season rainfall shows a positive trend at Mieso, Melkassa and Ademi Tulu, respectively. In which statistically non-significant, at Mieso, Melkassa and Ademi Tulu. Simultaneously, the Sen.'s slope estimation also indicates that, the trend of the rainfall of the growing season under Mieso, Melkassa and Ademi Tulu condition increases by 2.69, 2.52 and 0.13, respectively (Table 2).
Generally, the trend analysis result reveals that the growing season rainfall exhibited a slightbut statistically insignificant increase in the Central lowland of Oromia of Ethiopia country.[9] reported that the *Kiremt(June,July,August and September)*season rainfall, even if not statically significant, in the Central lowland of Oromia experienced in the past year decreasing trend but for the case of Melkassa and Adami Tulu areas increasing trend.

Analysis of Maximum and minimum annual temperature trend

As shown in Table 3 the result of Mann-Kendall trend estimation indicates that there are positive trend in maximum temperature at their study sites, while statically significant at Mieso but non-significant for Melkassa and Adami Tulu .In addition, the Sen.'s slope estimator result shows that the maximum temperature over the areas has increased by 0.035, 0.018 and 0.095 0C/year at Mieso, Melkassa, and Adami Tulu, respectively.In the same manner, the result of Mann-Kendall trend estimation shows that positive trend at

Mieso but negative trend at Melkassa and Ademi Tulu of the annual minimum temperature and also non-significant. The Sen.'s slope estimation method proved that there was increasing trend in annual minimum temperature by 0.009, 0.014 and 0.018 0C/year at Mieso, Melkassa and Adami Tulu, respectively (Table 3).

From the foregoing, it can be inferred that the different trend analysis methods gave different results regarding the trends of maximum and minimum temperature. The methods also gave different results at the three stations for the same parameter. Therefore, this shows that there is high variability of climate aspects in the semi-arid central rift valley of the country, which signals the likely impact of this variability on crop production by increasing the probability of occurrence of thermal drought particularly in the study areas. When this happens, the length of the rain fed growing season will decrease and, thus, increase the risk of decreasing crop yield

SUMMERY AND CONCLUSION

The Sen.'s slope estimator indicates that the total seasonal rainfall during the growing season of the studies areas increases by 2.69,2.52 and 0.37 mm/yearat Mieso, Melkassa and Adami Tulu respectively and also Mann-Kendall shows positive trend at the study areas.

The result of the Man-Kendall trend estimation shows that there is positive trend of the annual maximum temperature and also the annual minimum temperature shows positive trend for Mieso but negative trend for Melkassa and Ademi Tulu areas .Whereas, the result of Sen's slop estimations also indicates an increase of annual maximum temperature by 0.035, 0.018 and 0.095^{0}Cfor Mieso, Melkassa and Ademi Tulu, respectively and Sen.'s slope shows that there was increasing trend of annual minimum temperature by 0.009, 0.014 and 0.018 ^{o}C/year for Mieso, Melkassa and Ademi Tulu respectively.

Generally, the trend analysis result reveals that the growing season rainfall and annual maximum and minim temperature exhibited a slight but statistically insignificant increase in the Central low land of state of Oromia Therefore, this shows that there is high variability of climate aspects in the semi-arid central lowland of Oromia, which signals the likely impact of this variability on crop production by increasing the probability of occurrence of thermal drought particularly in the study areas.

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REFERENCES

Abebe T, Gebru T, Genet W, Tadesse Y. 2006. Causes, consequences and management aspects of the 2006 flooding hazards in Awash River basin. In Ethiopia between the sharp scissors of climate change and environmental degradation. Report o the 2006 flood disaster in Ethiopia, Addis Ababa, Ethiopia

Alexander, L.V. and Arblaster, J. M. (2009). Assessing trends in observed and modelle climate extremes over Australia in relation to future projections. *International Journal of Climatology* 29, 417–435

Belliethathan S, Tibebe Y, Woldegiorgis G. 2009. The impact of climate change on Millennium Development Goals (MDGs) and Plan for Accelerated and Sustained Development to End Poverty (PASDEP) implementation in Ethiopia. Poverty Action Network of civil society organizations in Ethiopia (PANE), Addis Ababa, Ethiopia.

Cheung WH, Senay GB, Singh A. 2008. Trends and spatial distribution of annual and seasonal rainfall in Ethiopia. *Int. J. Climatol.,* DOI: 10.1002/joc.1623

Doherty RM, Stich S, Smith B, Lewis SL, Thornton PK. 2009. A green future for East Africa: implications of future climate and atmospheric CO2 content on regional carbon cycling and biogeography. *Glob. Chang. Biol.* **16**(2): 617–640

Gebre Michael Y, Kifle M. 2009. Local innovation in climatechange adaptation by Ethiopian pastoralists. Final report PROLINNOVA–Ethiopia and Pastoralist Forum Ethiopia (PFE), Addis Ababa, Ethiopia

Genet W, Alem S. 2006. The 2006 flood hazard in Fogera plain: Causes, effects and issues for effective management. In Ethiopia between the sharp scissors of climate change and environmental degradation. Report on the 2006 flood disaster in Ethiopia, Addis Ababa.

Kreyling J, Wana D, Beierkuhnlein C. 2010. Potential consequencesof climate warming for tropical plant species in high mountains of southern Ethiopia. *Divers. Distrib.* **16**: 593–605.

McSweeney C, New M, Lizcano G. 2010. UNDP climate change profile for Ethiopia. Retrieved on June 03, 2011. http://countryprofiles. geog.ox.ac.uk

Meze-Hausken E. 2004. Contrasting climate variability and meteorological drought with perceived drought and climate change in northern Ethiopia. *Clim. Res.* **27**: 19–31.

National Meteorological Services (2007) Climate change national adaptation program of action (NAPA) of Ethiopia. NMS, Addis Ababa

NMA (National Meteorological Agency of Ethiopia). 2001. *Initial national communication of Ethiopia to the United Nations Framework Convention on Climate Change (UNFCCC)*. Addis Ababa:Ethiopia.

Rosell S, Holmer B. 2007. Rainfall change and its implications for Belg harvest in South Wollo, Ethiopia. *Geografiska Annaler A* **89**(4): 287–299.

Seleshi Y, Zanke U. 2004. Recent changes in rainfall and rainy days in Ethiopia. *Int. J. Climatol.* 24: 973–983.

Tadesse Y, Dagnachew S. 2006. Flooding in Dire-Dawa: a case study of the 2006 flash flood. In: Ethiopia between the sharp scissors of climate change and environmental degradation. Report on the 2006 flood disaster in Ethiopia, Addis Ababa.

Williams AP, Funk C. 2011. A west ward extension of the warm pool leads to a westward extension of the Walker circulation, drying eastern Africa. *Clim. Dyn.* **37**: 2417–2435.

Wong MC, Mok HY, Lee TC. 2010. Observed changes in extreme weather indices in Hong Kong. *Int. J. Clim.,* DOI: 10:1002/joc.2238