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Analysis of Trend in Extreme Temperature and Rainfall over Addis Ababa City, the Case of Bole Meteorological Station

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Abstracts

Changes in frequency and intensity of extreme weather events are likely to have more impact on Environment and human activities than changes in the mean climate. During the last decade, climatic events with strong impacts on environmental and economic activities have been experienced in Ethiopia. For example the major floods such as in Dire-dawa and Omo basin of June 2006 illustrates the risks to ecosystems, human health and welfare, and infrastructure from short duration weather extremes.

This study employed trends in indices of climate extremes on the basis of daily series of rainfall and temperature observation data of Addis Ababa city covering period 1985-2014. Climpact2 software is recommended by World Meteorological Organization-Commission for Climatology (WMO-CCI) to calculate the climate change indices.

The analyzed results showed that increasing trends of hot extremes have been observed. On the other hand, increasing of trends in cold extremes was detected and Precipitation extremes indicate decreasing trends. In general, the trend suggest that the city exhibited warming trends.

Keywords: Extremes; Climate Change; Trends; Temperature and Precipitation

1. Introduction

Climate change is one of the main long term drivers of economic, social and environmental change. Its impact is global with very different regional expressions (Kelemen et al 2009). Rising air temperature and changes in precipitation patterns are undeniable facts, which may have different impacts on various aspects of human life, especially on human settlements, agricultural products, energy consumption, etc. (Piticar & Ristoiu 2014). The future climate change may add to the complexity of climate over East Africa by increasing the frequency and intensity of extreme events (IPCC AR5 2014). This region is home to hundreds of thousands of farmers, pastoralists, and others who structure their life in structure with the environment; which is greatly influenced by climate. The climate change thus has social, economic, and demographic implications.The impacts of climate change are felt most strongly through changes in extremes. There are many regional and national studies of trends and variability in temperature and rainfall over Africa. On study (NAPA, 2004) indicated that annual mean minimum temperature in Ethiopia reported increasing. Whereas, the annual rainfall has been increasing over the same period with high seasonal variability. Addis Ababa is vulnerable to riverine as well as flash floods due to extreme climatic events and upper catchment activities and the vulnerability to flooding is more aggravated due to a poor drainage system, rapid house in development along river banks and using inappropriate construction materials (world bank, 2015).Other studies on changes in extremes over Addis Ababa are simple indices that describe various characteristics of extremes, including frequency, amplitude and persistence. The indices are easy to understand but only represent a limited number of all possible characteristics of extremes. This study is the first of its kind conducted using the climpact2 software that utilize statistically extreme value theory to analyze the temporal changes in extremes indices over the city using the time series of temperature and rainfall data covering a period 1985-2014. The document has five sections. The first section deal with introduction, significance and objective of the study, the study area as well as its climate. Data and methods are described in section two. The third section focussed on result and discussion. Conclusion is covered on section four. Finally, the last section of the study is the reference

2-Materials and Methods

2.1 Data Source

Daily time series of minimum and maximum temperature and rainfall covering a period of 30 years from 1985 to 2014 were obtained from National Meteorological Agency of Ethiopia. The period of record for this study begins in 1985 because from this year onward there are data with relatively less missing values and quality controlled

2.2. Methods

The analyses were conducted using the climpact2 software. The Climapct 2 softwre used for; Quality Control: automated checking for erroneous data (e.g. maximum temperature less than or equal to Minimum temperature, negative precipitation), automated search for outliers and automated generation of data plots enabling visual inspection of the data. The next steps after quality control were the indices calculation using the software. Nine temperature and rainfall indices have been selected from the list of indices for surface data recommended by World Meteorological organization commission for climatology Expert Team for climate Change Monitoring and Indices (ETCCDMI). The selected indices are relevant to the climate of the city.

Table 1: Temperature and rainfall indices calculated using climpact2 software

No.	**Index**	**Descriptive name**	**Definition**	**units**
1	PRCPTOT mm	Wet day precipitation	Annual total precipitation from wet days(>1mm)	mm
2	R20mm	Very heavy precipitation	Annual count of days when PR ≥20mm	days
3	RX1day	Very heavy precipitation	Annual maximum 1 day precipitation	days
4	SU	Hot days	Annual count when TX>25℃	days
5	TR20	Warm nights	Annual count when TN>20℃	days
6	TXx	Hottest day	Monthly highest TX	℃
7	TNx	Hottest night	Monthly highest TN	℃
8	TXn	Coolest day	Monthly lowest TX	℃
9	TNn	Coolest night	Monthly lowest TN	℃

3. Results and Discussion

3.1. Temperature

3.1.1. Cold extremes (TXn, TNn)

The trends for annual coolest days and coolest nights are shown in the following figure . Monthly lowest Maximum Temperature (TXn) and Monthly Lowest Minimum Temperature (TNn) have been increased at a rate of 0.039 and 0.082 ℃ per decade respectively.

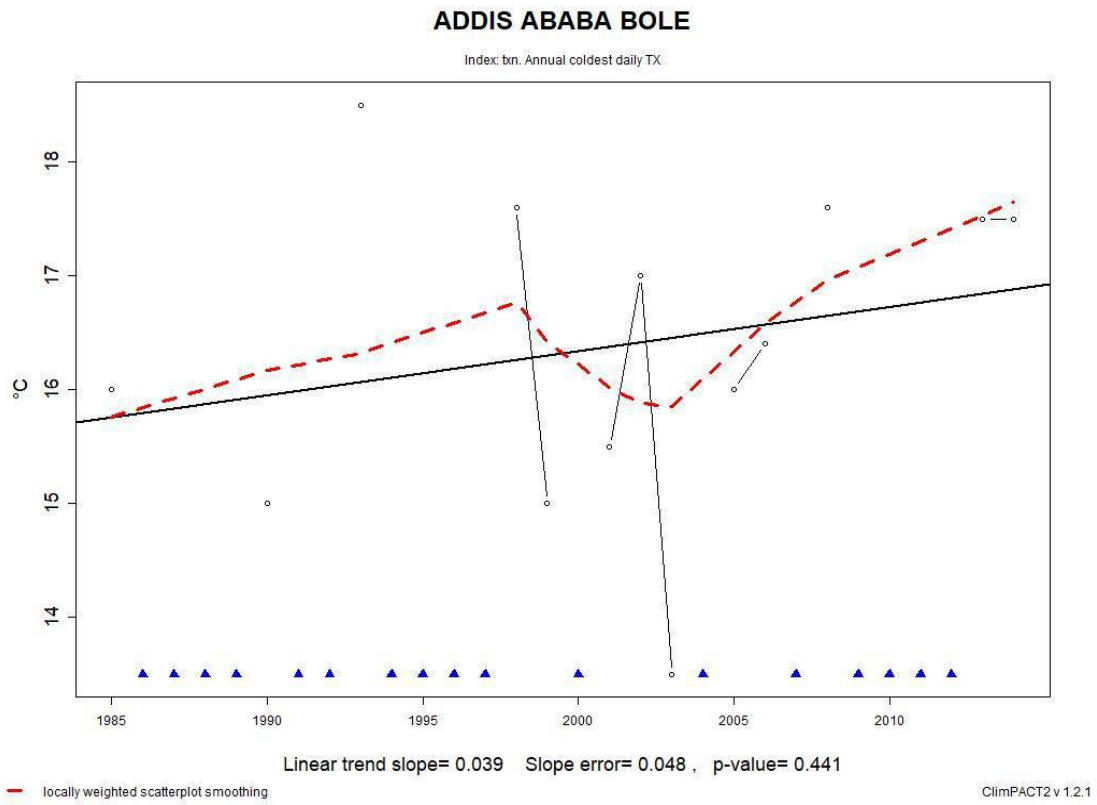

Figure1A : index TXn Annual coldest daily Tx

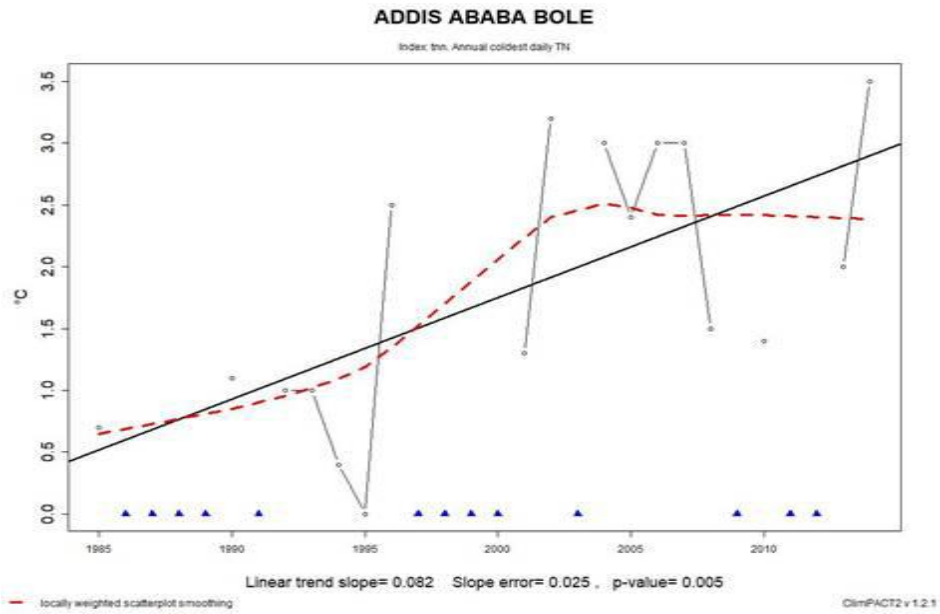

Figure 2B : Index TNn Annual coldest daily TN

3.1.2. Hot extremes (TR20, TXx, TNx and SU)

Figure 3 depicted that hottest days Monthly highest Maximum Temperature (TXx), hottest nights Monthly highest Minimum Temperature (TNx) and hot days Annual Maximum Temperature greater than or equal 25℃ (SU) have been increasing at magnitudes of 0.033, 0.141 and 1.911℃ per decade Respectively indicating warming trend over the city. Whereas warm nights Annual Minimum Temperature greater than 20℃(TR20) showed no trend.

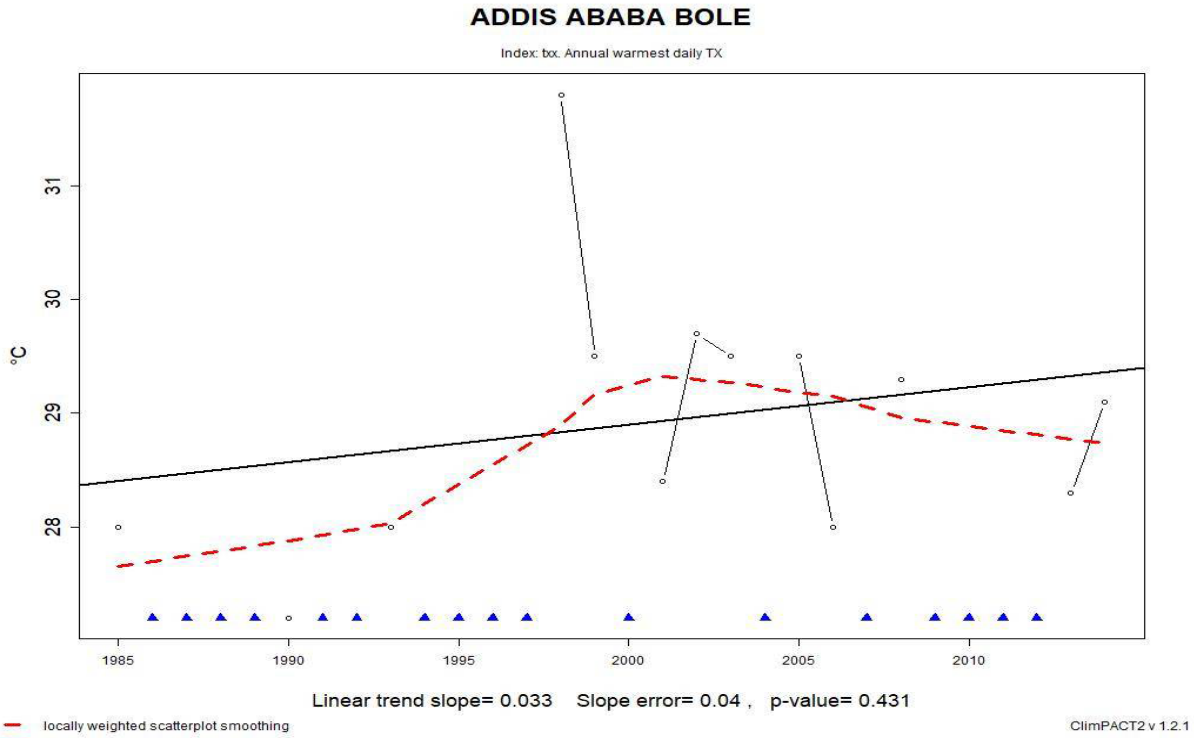

Figure 3 A: Index TXx Annual Warmest daily TX

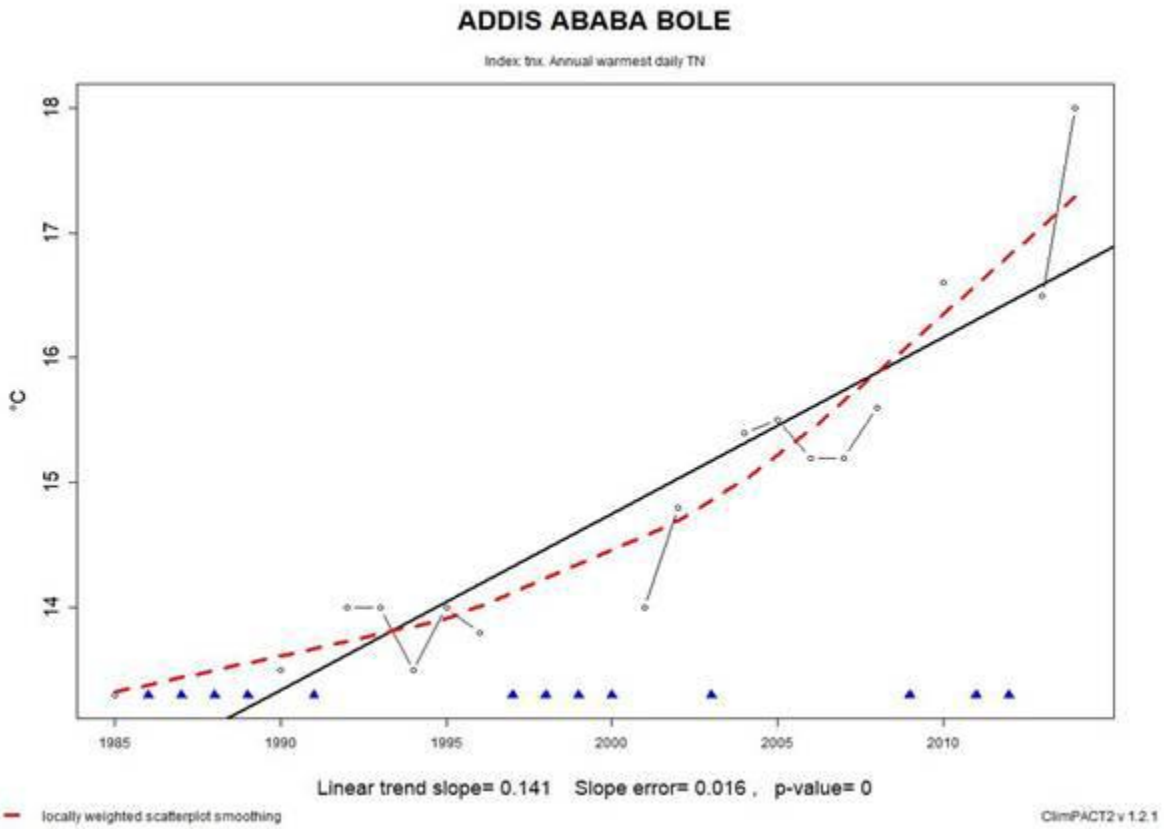

Figure 3 B : Index TNx Annual Warmest daily TN

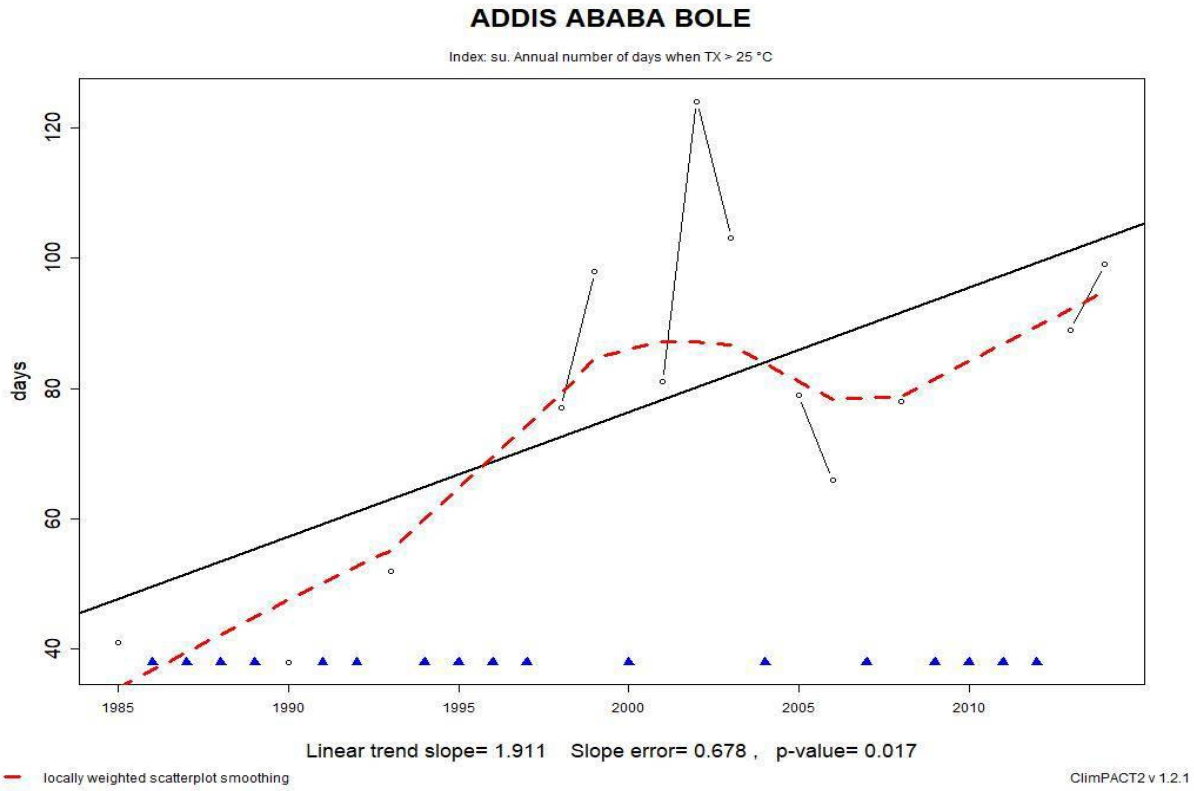

Figure 5 C: Index Annual Number of daysWhen TX > = 25°C

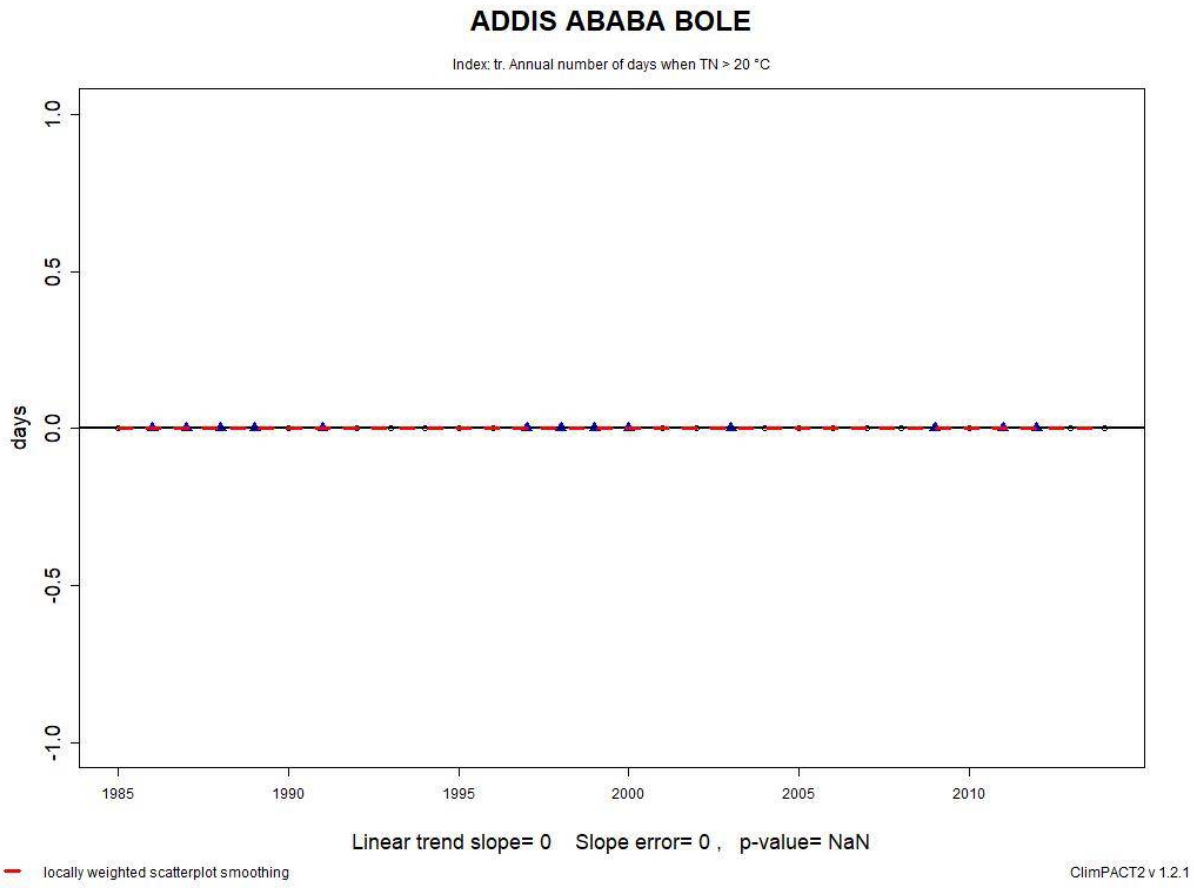

Figure 3D : Index TR20 Annual Number of daysWhen TN >20°C

3.2. Precipitation extremes (PRCPTOT, R20mm, RX 1day)

The trends in precipitation indices shown in the figure 6 below. In general the signs of the trends of precipitation indices indicate decreasing trend at a rate of -1.183, -0.112 and -0.563 mm per decade respectively.

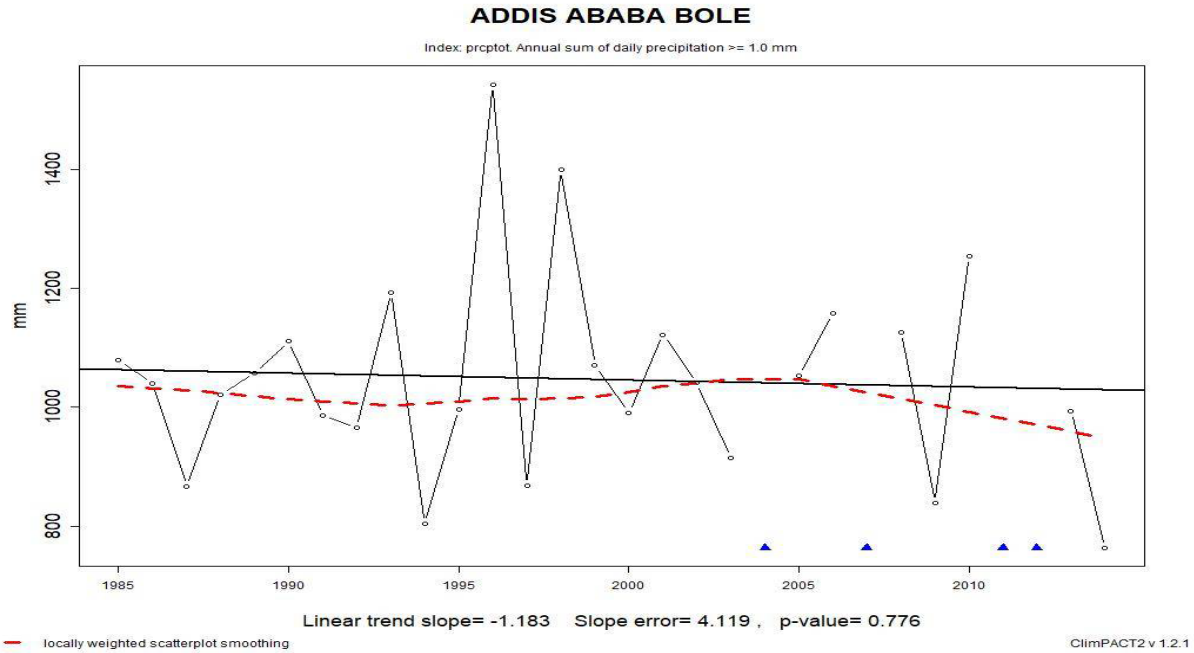

Figure 4A: Index PRCPOT Annual sum of daily precipitation > 1mm

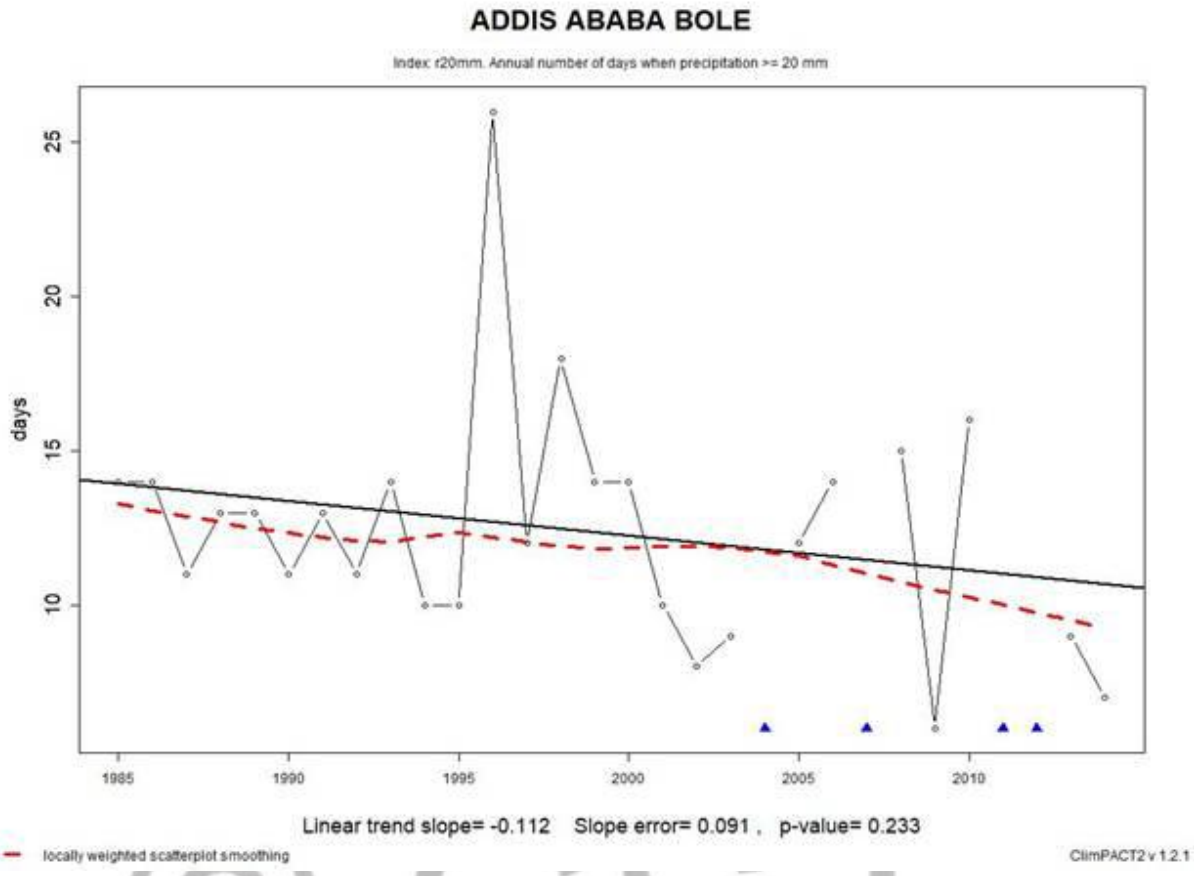

Figure 4 B: Index R20 mm Annual Number of days When precipitation > = 20 mm

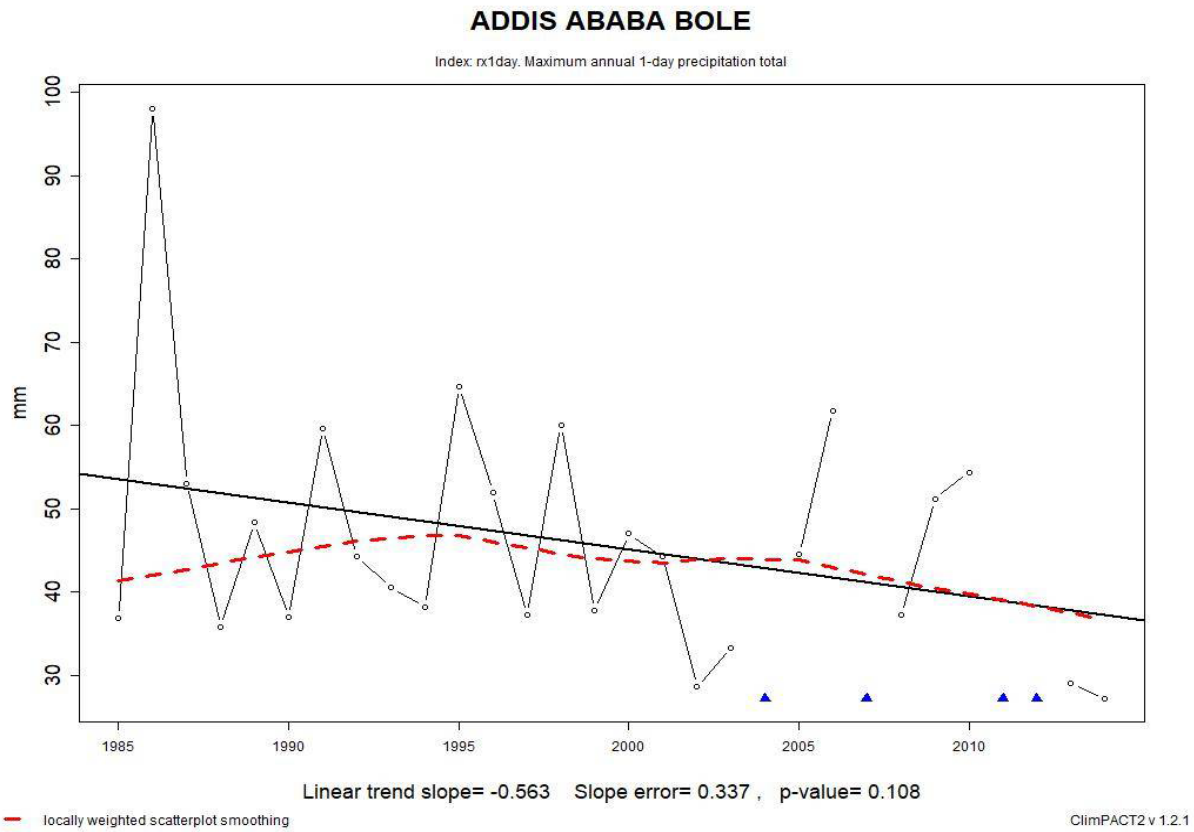

Figure 4C: Index RX1day maximum Annual 1- day precipitation

4. Conclusion

This study presents an evaluation of extreme weather events as a result of climate change in study area by focusing on the analysis of daily precipitation, minimum and maximum temperatures. This study analyzed the temporal trends in time series of six temperature and three precipitation extreme indices over Addis Ababa city using observation data covering a period 1985-2014. There is a consistence pattern of trends in temperature except TR20 which exhibited no trend. While the trends in rainfall indices indicate that decreasing trend. In general, the trend suggests that the city exhibited warming trends.

5. Reference

- ✓ **Beyene AN (2016)** Precipitation and Temperature Trend Analysis in Mekelle city, Northern Ethiopia, the Case of Illala Meteorological Station.
- ✓ **De Melo, T.M., Louzada, J.A.S. and Pedrollo, O.C. (2015)** Trends in Extreme Indices and Seasonal Analysis of Precipitation and Temperature in the Northwest Region of Rio Grande do Sul, Brazil. American Journal of Climate Change, **4**, 187-202
- ✓ **Ethiopia: National adaptation programme of action** - NAPA (2007)
- ✓ **Marigi, S.N., Njogu, A.K. and Githungo**, W.N. (2016) Trends of Extreme Temperature and Rainfall Indices for Arid and Semi-Arid Lands of South Eastern Kenya. Journal of Geoscience and Environment Protection, 4, 158-171.
- ✓ **National meteorological services agency of Ethiopia**, Climate and agro climatic resources of Ethiopia, Vol.1, Agues 1985.
- ✓ **Tesfaye, H., 1986.** Climatic variability and support feedback mechanism in relation to the Sahelo-Ethiopian droughts. M.Sc. Thesis, Department of Meteorology, University of Reading, U.K. pp.119
- ✓ WIREs Climate Change 2011. doi: 10.1002/wcc.147
- ✓ **2007 population and housing**. Census of. Ethiopia. Administrative. Report. Central statistical. Authority. April 2012. Addis Ababa .
- ✓ https://www.ipcc.ch/pdf/assessment-report/ar5/wg2/WGIIAR5-Chap22_FINAL.pdf
- ✓ http://dx.doi.org/10.4236/gep.2016.412012
- ✓ **World bank, Addis Ababa** – Enhancing Urban Resilience: city strength resilient cities program, working paper 100980, Washington D.C, 2015.
- ✓ **S. Eriksen, K. O'Brien, L. Rosentrater**, Climate Change in Eastern and Southern Africa Impacts, Vulnerability and Adaptation, GECHS Report, ISSN 1504-6338, Oslo, 2 (2008) 1-27.18
- ✓ **Kelemen A., Munch W., Poelman H., Gakova Z., Dijkstra L., Torighelli** B., 2009 Regions 2020 - the climate change challenge for European Regions, European Commission, Directorate General for Regional Policy, Background document to Commission Staff Working Document, An assessment of future challenges for EU Regions, 27 pp.
- ✓ **Piticar A., Ristoiu D., 2012** Analysis of air temperature evolution in Northeastern Romania and evidence of warming trend. Carpathian Journal of Earth and Environmental Sciences 7(4):97-106.
- ✓ **Piticar A., Ristoiu D., 2014** [The influence of changes in teleconnection pattern trends on temperature and precipitation trends in Northeastern Romania]. Risks and DİSASTERS XIII, 14(1):109-122 [in Romanian].
- ✓ **Zhang, X., Alexander, L., Hegerl, G.C., Jones, P., Tank, A.K., Peterson, T.C., Trewin,B. and Zwier**s, F.W., 2011. Indices for monitoring changes in extremes based on daily temperature and precipitation data. *Wiley Interdisciplinary Reviews: Climate Change*, *2*(6), pp.851-870.