B−27 GLOBAL CLIMATE CHANGE IMPACT ON RAINFALL AND TEMPERATURES OF ETHIOPIA; RELATIONSHIP WITH ENSO

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1.ABSTRACT

Global climate change has significantly affected distribution, intensity and frequency of rainfall in Ethiopia. Observed precipitation data from 7 different stations in the country from 1955-2004 show decrease during the main rainy season; June, July and August (JJA) with different rates from 2-24 % comparing mean of the period 1955-1964 with 1995-2004. In areas receiving bimodal rainfall in March, April and May (MAM), in the south and eastern parts of Ethiopia, precipitation has increased by 1-19%. Future precipitation projection by Hadley Centre Atmospheric Model (HadAM3) and CSIRO Mk2 shows considerable decrease of JJA in most part of Ethiopia while it will increase in southern part. Global warming exacerbated drought in Ethiopia: the recurrent drought happened in Ethiopia have a remarkable association with El Nino periods. Researches indicate that global temperature increase (decrease) will tend to trigger an El Niño (La Nina), which influences precipitation. Haile (1988) indicated that ENSO events and sea surface temperature (SST) anomalies affected rainfall distribution in Ethiopia by displacing and weakening the rain producing air mass. Temperature change in Ethiopia also shows increase by 0.818 ^{O}C ± 0.078°C comparing the period 1955-1964 with 1995-2004.

2. INTRODUCTION

Climate of Ethiopia

Ethiopia has a tropical monsoon climate with a wide climatic variation according to wide varying topography. The central plateau has a moderate climate with minimal seasonal temperature variation with temperature ranges from 6 °C to 26°C. Temperature variations in the lowlands are much greater, with occasional highs of more than 40 °C. Annual rainfall varies from less than 250 mm along the borders with Somalia and Djibouti to more than 2,000 mm in the highlands of the southwest (Fig. 1). The national average rainfall is 744 mm per year (FAO, 1995). Like precipitation and temperature, potential evapotranspiration

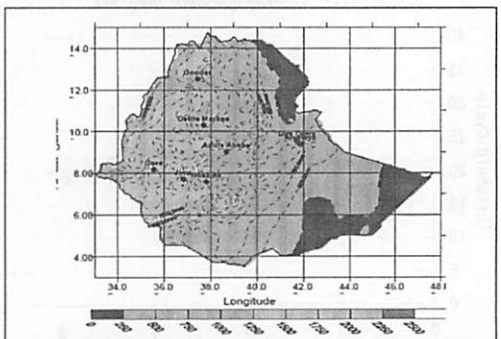

Fig 1.Cumulative Mean Annual Rainfall (mm), source; National Meteorological Services agency

varies with altitude and location. The high potential evapotranspiraion values known in the lowlands exceed 1,500mm/year (up to 2,100mm/year) while the low values in the highlands are below 1,150mm/year (up to 900mm/year).

3. CLIMATE CHANGE IN ETHIOPIA

(1) Observed precipitation change

Rainfall data from different parts of the country indicate variable change of rainfall in Ethiopia. Table.1shows the result of change in precipitation comparing the period 1955-1964 with 1995-2004: June, July and August (JJA main rainy season) precipitation has decreased at all stations considered in this study by different rate 2-24 %. In areas receiving bimodal rainfall in March, April and May (MAM), in the South and Eastern parts of Ethiopia, precipitation has increased between 1-19%.

Table .1 changes in precipitation at different stations comparing the period 1955-1964 with1995-2004.

Rainfall of 1955-1964 compared with1995-2004 at different locations			
Place/Location	Annual	JJA	MAM
	Change in %		
Addis Ababa	-4.92	-5.53	+8.59
Alemaya	-11.49	-2.62	+0.77
Debre-Markos	-8.82	-7.98	-14.92
Dire-dawa	+7.03	-19.43	+24.4
Gore	-24.59	-22.15	-22.22
Hosana	-2.31	-7.08	-2.54
Jimma	-2.91	-7.29	-5.99

(a) Addis Ababa observed precipitation change

Addis Ababa is located at the central high lands of Ethiopia. The change in rainfall at observatory station in the city for the compared periods indicates decrease by 4.92%. The JJA precipitation shows decrease by 5.53% while in contrary MAM rainfall shows increase by 8.59. (See fig.1 and table .1)

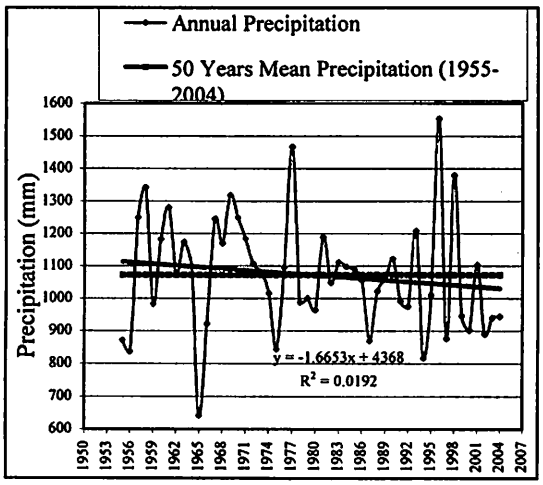

Fig.2 Trend of 50 Years Annual Precipitation of Addis Ababa (1955-2004)

(b) Gore Observed precipitation change

Gore is located south west of Ethiopia, known for its highest annual rainfall in Ethiopia greater than 2000mm; significant change has been observed in case of Gore where the change for the compared periods shows decrease by 24.58%. The JJA and MAM rainfall decreased by 22.14 and 22.21 respectively. (See fig.1 and table .1)

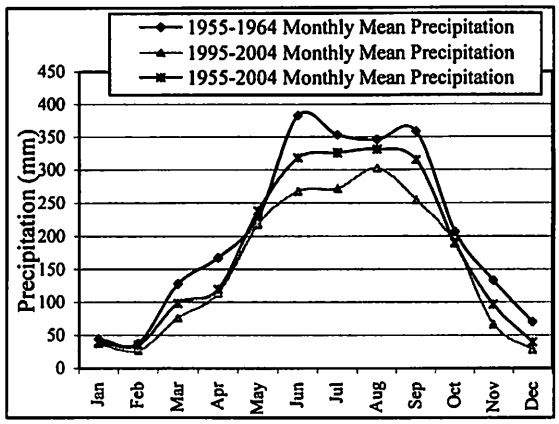

Fig.3. Gore Mean Monthly Precipitation for the period 1955-1964, 1995-2004 and 1955-2004

(c) Dire-Dawa observed precipitation change

Dire-Dawa is located at the eastern part of Ethiopia where annual rainfall is relatively low; rainfall at this station shows annual increase by 7.03 %: JJA rainfall decreased by 19.43% but MAM rainfall increased by 24 %. (See fig.1 and table .1)

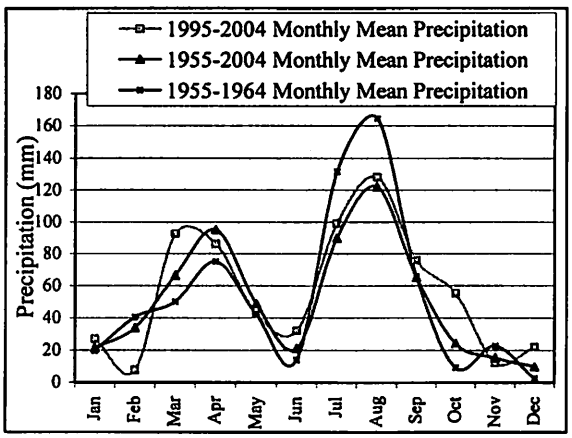

Fig.4 Dire-Dawa Monthly Mean Precipitation for the period of 1955-1964, 1995-2004 and 1955-2004

(2) Observed temperatures change

In Ethiopian temperature has significantly risen over the last 50 years from 1955-2004 as observed from mean temperatures of 8 stations. The mean temperatures of 1995-2004 of 8 stations relative to 1955-1964 has risen by 0.818 ^{O} C ± 0.078°C and 0.663 ^{O}C ± 0.043°C relative to 1955-2004. The 4th IPCC assessment report indicates that Global mean surface temperatures have risen by 0.74°C ±

0.18°C when estimated by a linear trend over the last 100 years (1906–2005). Fig 5 shows mean precipitations of 8 stations from 1955-2004.

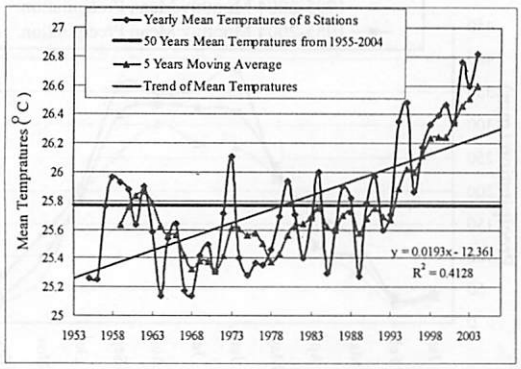

Fig.5 Mean temperatures of 8 stations (Addis Ababa, Dire-Dawa, Jimma, Negele, Gore, Combolcha, Debre Markos , and Gonder) in Ethiopia from 1955-2004

4. ENSO AND DROUGHT IN ETHIOPIA

Droughts in Ethiopia and the past ENSO events have a remarkable association. Table .2 shows El Niño and Ethiopian drought association from 1911-1993. ENSO events and Sea surface temperature (SST) anomalies affected rainfall distribution in Ethiopia by displacing and weakening the rain producing air mass (Hail 1988). Eltahir (1996) concluded that ENSO events affect flows of the Nile

Table .2 El Niño and Drought in Ethiopia

El Niño Years	Drought/Famine in Ethiopia	Regions affected
1911-1912	1913-1914	Northern Ethiopia
1918-1919	1920-1922	Ethiopia
1930-32	1932-1934	Ethiopia
1953	1953	Tigray and Wollo
1957-1958	1957-1958	Tigray and Wollo
1965	1964-1966	Tigray and Wollo
1972-1973	1973-1974	Tigray and Wollo
1982-1983	1983-1984	Ethiopia
1986-87	1987-1988	Ethiopia
1991-92	1990-92	Ethiopia
1993	1993-94	Tigray, Wollo, Addis

Sources: Quinn and Neal (1987, 14451); Degefu (1987, 30-31); Nicholls 1993; Webb and Braun; Ayalew 1996

River (indicating drought in highland Ethiopia, which is a source of 85 percent of Nile water). Researches indicate that drought occurrence in Africa especially in South Africa and horn of Africa (including Ethiopia) caused by physical processes related to the occurrence of ENSO events thousands of miles away. Tsonis, 2005 suggested deeper connection between global temperature and ENSO. Empirical data indicates also an association of ENSO event and drought in Ethiopia. It is believed that ENSO is not an independent phenomena; global temperature, increase or decrease will tend to trigger an El Nino or La Nina respectively.

5. FUTURE PRECIPITATION TREND IN ETHIOPIA BY GCMs

According to Global circulation model (GCMs) of Hadley Centre Atmospheric Model (HadAM3) and CSIRO Mk2 (Fig.6) JJA precipitation in central, north, northwest and eastern part of Ethiopia will be decreased while in southern part will increase considerably.

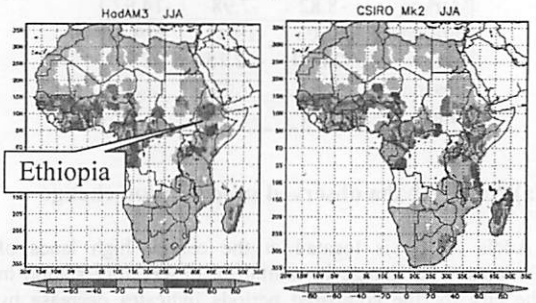

Fig .6 Anomaly of mean monthly precipitation (mm) using daily data empirically downscaled; forced by the SRES A2 scenario. Anomalies are for the future period (2070 to 2099) minus a control 30-year period (from Hewitson and Crane, 2006). Source IPPC report

6. CONCLUSION

Global climate change significantly affected climate of Ethiopia. Considerable change in rainfall distribution, intensity and frequency have been observed which impacted water resources, agricultures economy, and others related fields. Global climate models show that future trend of climate change will substantially increase. Therefore, in addition to mitigating the increase of green gas accumulation, developing mechanism of adaptation would minimize the impact on nature, life economy and related other.

7. REFERENCE

- IPCC Fourth Assessment Report (AR4). "Climate Change 2007", http://www.ipcc.ch/
- Impacts on East Africa A Review of the Scientific Literature Climate Change. Published in November 2006,Gland, Switzerland. michael.case@wwfus.org
- African climate change: 1900–2100 Mike Hulme1, Published August 15.