Climate Change Impact on Growing Seasons in the Ethiopian Highlands and the Surrounding Lowlands

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Introduction

1.1 Background

Climate change is a major development challenge in Ethiopia unless adaptation measures are implemented. Ethiopia has seen droughts in the recent half century (Alebachew and Bewoket, 2011) caused by late onset and early cessation of seasonal rains and associated failure of the crop growing season. Hence, to optimally utilize the seasonal rainfall for agricultural production, additional knowledge is needed on how shifts may affect yields and the ability to predict the start, length and end of growing season is vital. Moreover, improved forecasts of seasonal precipitation with high spatial resolution could potentially increase agricultural production and reduce production risks (Robertson et al. 2007). Therefore, to predict spatial and temporal precipitation, temperature and the connected growing seasons are crucial for livelihoods dependant on rain-fed agriculture.

2. Research design and Methodology

Location of the study area

1) The Ethiopian highlands with lat. 7–14° and long. 36–40°
2) Eastern Ethiopia lowlands with lat. 3–14° and long. 40–48°
3) Western Ethiopia lowlands with lat. 3–14° and long. 33–36°
4) Southern Ethiopia with lat. 3–7° and long. 36–40°

DATA TYPE, SOURCE AND COLLECTION MECHANISMS

Meteorological station in the Ethiopian highland are plentiful (>150), but some stations lack long and continuous records >30 yr. Stations data archived by NMA need to be interpolated using satellite and model to cover the gaps, so for this reason historical data on rainfall and temperature were extracted from gridded GPCP and CRU, respectively. http://ipdas.uesg.gov/502/2012/303/)

The GPCP v6 global precipitation re-analyses were used to describe rainfall variability and trends in the Ethiopian highlands and the surrounding lowlands. After annual cycle validation studies from 1981–2010 showed agreement with reference rain-gauge data from 42 stations in Eastern Amhara (n=39).

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The GPCC T5v3.22 dataset (n=90)

GLDAS NOAH1 L.0.20d-stf (n=90)

GLDAS NOAH1 L.0.20d (sensible heat flux) difference (P-E+1)

climate change models applied for this study are based on the output of model group of CMIPs data accessed on (http://cmip
cpc.ncep.noaa.gov/CMIP5/) or via Royals Netherlands Meteorological Institute (KNMI)

Step-wise criteria used to evaluate CMIPs model outputs

To project the future PET of the Ethiopian we employed GLDAS-NOAH1 M020 sensible heat flux as a reference to compare with CMIPs MPI models output for sensible heat flux for the Ethiopian highlands.

Following step-wise evaluation the models most likely appropriate to project the future sensible heat flux of Ethiopian highlands is HadGEM2-ES (n=0.94).

Methods used in the data analysis

1) Climate change comparison

Comparing Temperature

Comparing Rainfall

Models performance evaluation

Comparing growing seasons

Conclusion

This study presents an analysis on the comparison of climate change and climate variability and their impact on growing seasons of the past and the future between the Ethiopian highlands and the surrounding lowlands.

Historical observations data from CRU TS 3.22 (temperature) and GPCC v6 rainfall; and from CMIPs model output to predict the past, intermediate and projection 2011–2040 (ES, RF, SRI, PC, SCDI) for Ethiopian highlands, Eastern Ethiopia lowlands with lat. 3–14° and long. 40–48°; Western Ethiopia lowlands with lat. 3–14° and long. 33–36°; Southern Ethiopia low lands with lat. 3–7° and long. 36–40°, for the period 1981–2010.

The Ethiopia South cluster revealed maximum PET seasonal rainfall and short period 50% season rainfall and the variance to model temperature extreme maximum rainfall and temperature anomalies from 1981 to 2010.

The regression trend analysis shows decreasing trend in the two potential rainfall regions: the Ethiopian highlands and the Eastern lowlands, and increasing trend in the Eastern East and South low land of Ethiopia during the same period. The Ethiopian South cluster revealed maximum PET seasonal rainfall and short period 50% season rainfall and the variance to model temperature extreme maximum rainfall and temperature anomalies from 1981 to 2010.

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