Supplementary materials

Section A: Data sources description

1. Observed Meteorological records of daily precipitation, maximum and minimum temperature obtained from Ethiopian Meteorological Agency by request (http://www.ethiomet.gov.et/) and the data access is restricted by law to transfer the observed data to third party.

2. Beside the observed data we used data from Climate Research Unit (CRU) version TS4.01 CRUTS4.01 to analyze the seasonal rainfall performance by using Empirical orthogonal function (EOF). The CRU TS4.01 data of precipitation and temperature is available https://data.ceda.ac.uk//badc/cru/data/cru_ts/cru_ts_4.01/data/http://pcmdi3.llnl.gov/esgcet

3. To project the future extremes of we used model datasets of both precipitation and temperature for the periods of 2011 to 2099 from Climate Model Inter-comparison Project of Phase 5 (CMIP5) datasets obtained from PCMDI; http://pcmdi3.llnl.gov/esgcet

Section B: Software and climate extreme indices

1. The software which we used to calculate climate extremes based on World Meteorological Organization (WMO) recommendation available from http://etccdi.pacificclimate.org/software.shtml. The software's are free and used both in windows, Unix/Linux operating systems. For window operating system RCLIMDEX works by using a statistical package of R programming language software.

2. The Expert Team on Climate Change Detection and Indices and World Meteorological Organization recommended a total of 27 core extreme obtained and available from http://etccdi.pacificclimate.org/list_27_indices.shtml.

Section C: Statistical and probability density function (PDFs) analysis

The Mann-Kendall S Statistic is computed as follows:

$$S = \sum_{i=1}^{n-1} \sum_{j=i+1}^{n} sign(\mathrm{Xj} - \mathrm{Xi}) \qquad (1)$$

Where xj are the sequential data values, n is the data length of time-series, and

$$\text{sign (Xj-Xi)} \begin{cases} 1 & Xj > Xi \\ 0 & Xj = Xi \\ -1 & Xj < Xi \end{cases}$$

Where Xj and Xi are the annual values in years j and i, j > i, respectively

In detecting the trend, a hypothesis was set as follows; null hypothesis (H_0), signified no trend and the alternative hypothesis (H_1), indicated the presence of trend, either increasing or decreasing monotonic trend. The variance of S is calculated using Eq.2;

$$\text{Var (S)} = \frac{n(n-1)(2n+5)}{18} \qquad (2)$$

$$Z = \frac{S-1}{\sqrt{Var(S)}} \quad if\ S > 0$$

$$= 0\ if\ S = 0$$

$$= \frac{S+1}{\sqrt{Var\,(S)}}\ if\ S < 0 \qquad (3)$$

The trend is considered decreasing if Z is negative and computed probability is greater than the level of significance.