Supplementary Information (SI)

for

Linking Climate Change information with Crop Growing Seasons in the Northwest Ethiopian Highlands

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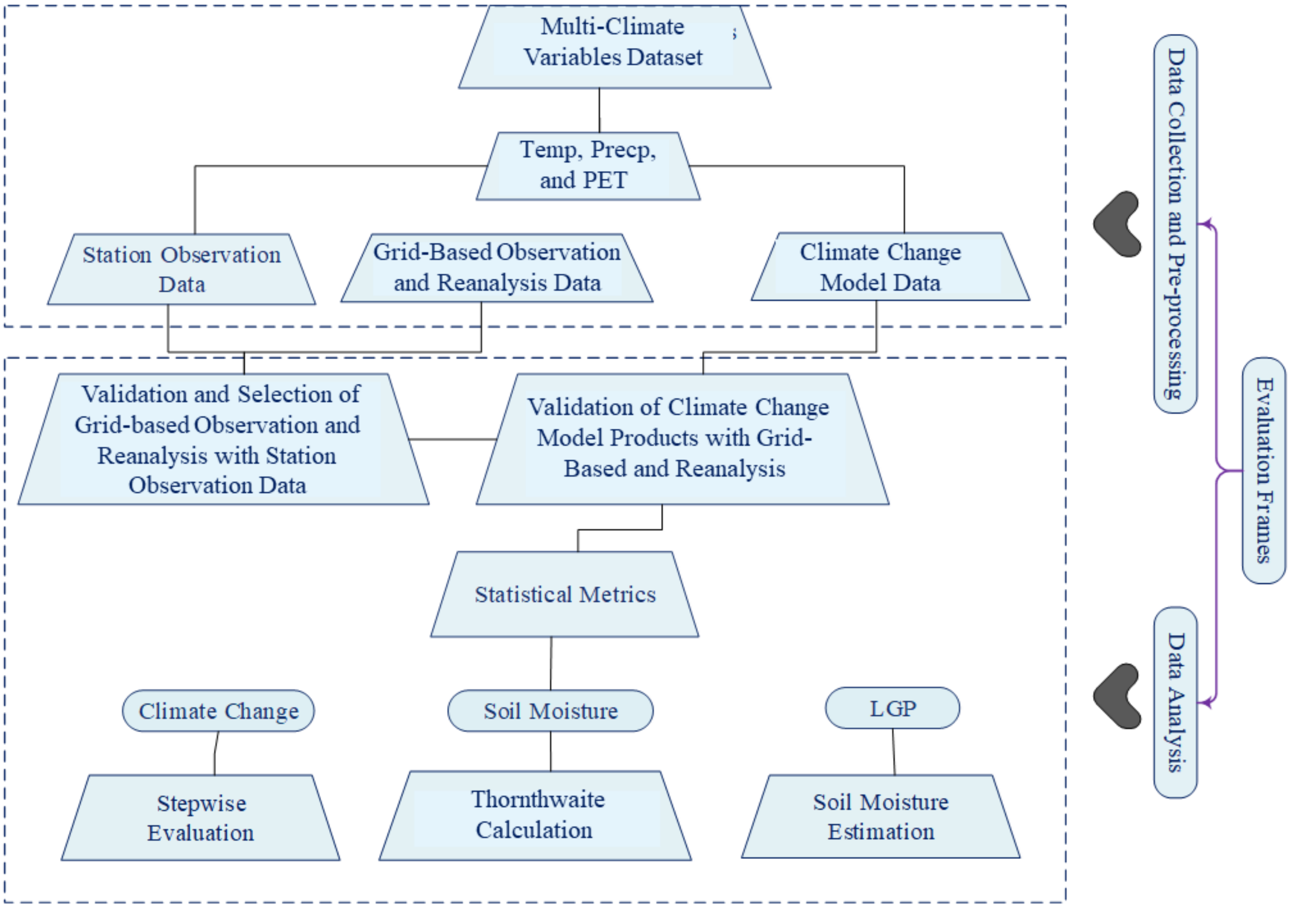

Figure S1. Flow chart illustrating how the research steps are interlinked.

Table S1. Runoff coefficient: empirical coefficient representing fraction of rainfall that runs off (adapted from McBean et al., 1995).

Runoff coefficients for landfill	
Surface Conditions: Grass cover (slope)	Runoff Coefficient

Sandy soil, flat, 2%	0.05 - 0.10
Sandy soil, steep, 7%	0.10 - 0.15
Heavy soil, flat, 2%	0.15 - 0.20
Heavy soil, average, 2-7%	0.13 - 0.17
Heavy soil, steep, 7%	0.18 - 0.22
Sandy soil, average, 2-7%	0.25 - 0.35

Table S2. Summary of research methods used in this study.

No	Activity	Methods applied	Climate variab required/ acquired
1	Data collection Station data Gridded observation and reanaly data Model-simulated data	Station area average P, Tasmax a PET in NW Ethiopian highlands GPCC V6 (P) and CRU TS v3 (Tasmax) gridded observation d and reanalysis shf data from ER interim and MERRA from Clim Explorer website (climexp.knmi. CMIP5 web page: http://cm cmdi.llnl.gov/cmip5 or via Clim Explorer website (climexp.knmi.	Maximum, minimu and mean temperature (Tasm Tasmin, ta Precipitation (I sensible and latent h flux, soil water conte and PET
2	Filling missing station data	Arithmetic mean	Rainfall a temperature
3	Clustering in homogenous zones	EOF analysis	GPCC V6-precipitatio
4	Model development and validation	Linear regression and stepw evaluation	P, Tasmax, shf, lhf, I and soil moisture
5	Analysis of climate change,	Statistical descriptors (me median, standard de percentiles), linear trend	Tasmax, Tasmin, tas, onset, offset date a LGP, PET, and s moisture
6	Trend test	Regression slope and significa test	Tasmax, Tasmin, tas, LGP and PET
7	Computing soil water balance (P-Es)	Subtraction PET of each mon from the respective rainfall (P) each month	P and PET
8	Calculating accumulated potent water loss (Acc. Pot. WL)	Progressively adding (P-Es) valu starting from the first negat value that occurs usually after t rainy season	P-Es
9	Converting Acc. Pot. WL to soil wa storage or reserve (ST)	Soil water retention tables prepar by Thornthwaite and Mather	Acc. Pot. WL a 200mm field capac and silty loam at on meter depth
10	Computing soil water change (ΔST)	Reduce soil water content stora (ST) from the next month ST start by taking December initial stora or reserve	soil water conte storage (ST) of annu cycle
11	Interpolating monthly data to da data	Instat +v 3.36 software	Monthly annual cy soil water change

12	Onset date, cessation, and LGP of past (1981-2010) and the future (20 2070)	Instat + v3.36 software a Microsoft office Excel 2007	ΔST, Tasmax a Tasmin
14	Assessing impact of climate change length of growing season	CV, percentiles, correlati standard dev.	ΔST, onset da cessation date, and LC

Stepwise evaluation

The stepwise criteria used for the evaluation of the CMIP5 rcp6 model simulations compared with monthly observations in the NW Ethiopian highlands are described as follows (Jury, 2015):

- Firstly, the CRU3 TS v3.22 (tasmax) and GPCC V6 (P) interpolated observations were compared with local stations' tasmax, and rainfall averaged over the NW Ethiopian highland area respectively, and revealed good results (as described in sections 4.1.1 and 4.1.2 above). This step is critical for further evaluation (Schwalm et al., as cited by Jury, 2015).
- Next, the mean annual cycle of highland area-averaged tasmax and rainfall in CMIP5 rcp6 outputs was evaluated for intensity and distribution. Models that simulated bi-modal rainfall or had dry/wet bias were screened out; the remaining models had a uni-modal peak ≈7mm/day in July-August.
- The spatial distribution of annual rain difference was compared with GPCC V6 precipitation (P) and CRU TSv3.22 (tasmax) for the period 1981-2010.
- To model the simulated annual cycle, correlations with GPCC V6 (P) and CRU TS3.22 (tasmax) were calculated, and $r < 0.9$ was deemed unfit.
- In addition, seasonal JJAS (P) and MAM (tasmax) differences were calculated, and values (> ±1 mm/day or > ±1^{o}C) were screened out.