Crop and Climate Related Modeling Datasets That Were Used or Generated by Models During the Project, "Improved Modeling of Household Food Security Decision Making and Investments Given Climate Change Uncertainty"

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Climate Data

GCM data:
Data from four Global Climate Models (HadCM3, ECHAM, CCSM and CSIRO, all SRES A1B, IPCC AR4) were obtained from an open access website of CCAFS (http://ccafs.cgiar.org/). It was downloaded in 2012 to use for the Zambia domain, and in 2011 to use for the Kenya (East Africa) domain.

The original GCM data with variable resolutions ranging from 1.4 to 2.5 degrees were downscaled to a 6 km resolution. The downscaling was conducting using thin plate smoothing splines via the ANUSPLIN V4.3 software (Hutchinson 1998), purchased from Australia National University. The GCM data were splined using latitude and longitude as independent variables for rainfall, and latitude, longitude, and elevation for temperature. Data were downscaled from their original grid spacings to the 6km surface using a second-order spline. Data for 60 years were downloaded for each GCM. We splined 30-year averages for each month for each GCM. Two datasets were prepared per model, one centering on 2000 and one on 2050. The size of the data is approximately 1 TB in ascii. The data used by the crop model (monthly means of minimum and maximum temperature, precipitation and solar radiation for each year) were provided in an ascii format used for MarkSim.

Hutchinson, Michael F. 1998. Interpolation of rainfall data with thin plate smoothing splines. Part I: Two dimensional smoothing of data with short range correlation. Journal of Geographic Information and Decision Analysis 2.2: 139-151.

WorldClim: a 1 km spatial resolution monthly precipitation climatology dataset (www.worldclim.org/) that represents a mean year of "current" (1960s to 1990s) climate. It is open access. It is at 1 km grid spacing, and we aggregated it to 6 km for the simulations. Since it's a climatology, it only has one value for each month that represents the mean for the 2nd half of the 20th century.

Meteorological station data: we obtained observed weather data originating from the Zambia Meteorological Department and from the Kenya Meteorological

Department. The Zambia data we obtained from IAPRI and from the USAID-Zambia office. The Kenya data we obtained from WMO and from a collaborator. We are unable to openly share this data because it belongs to those governments (typically, meteorological departments grant permission to analyze the data and disseminate the summary results, but not to share the data itself). Some of the meteorological station data was obtained from the World Meteorological Organization (https://www.wmo.int/datastat/wmodata_en.html) which openly shares that data under agreement with governments.

CHIRPS: a time series, historical spatial precipitation dataset prepared by the Climate Hazards Group of the University of California Santa Barbara. It is global and covers 1982 to 2014. It is open access available from http://chg.geog.ucsb.edu/data/chirps/ .

Funk, C.C., Peterson, P.J., Landsfeld, M.F., Pedreros, D.H., Verdin, J.P., Rowland, J.D., Romero, B.E., Husak, G.J., Michaelsen, J.C., and Verdin, A.P., 2014, A quasi-global precipitation time series for drought monitoring: U.S. Geological Survey Data Series 832, 4 p., http://dx.doi.org/10.3133/ds832.

NASA Power: minimum and maximum temperatures and solar radiation data were obtained from National Aeronautics and Space Administration -Prediction Of Worldwide Energy Resource (NASA-POWER) data base (open access): http://power.larc.nasa.gov/cgi-bin/cgiwrap/solar/agro.cgi?email=agroclim@larc.nasa.gov .

Soils data

We used soil class/unit data from digital global soils map (FAO 1995). For all agriculturally suitable soil types in the study area we selected representative soil profiles from International Soils Reference and Information Center (ISRIC) data base entitled World Inventory of Soils Emission Potentials (WISE) (Batjes, 2008, 2009). Gijsman et al. (2007) converted 836 soil profiles from WISE data base to be used directly as input to crop simulation models. As these soil profiles are geo-referenced, they can be readily linked to digital version of FAO_UNESCO soil map of world. This data is open access. Recent versions can be obtained from:

1.FAO (Food and Agriculture Organization of the United Nations), 1995. Digital Soil Map of the World and Derived Soil Properties, Version 3.5. Land and Water Digital Media Series 1, FAO, Rome. Recent version: http://www.fao.org/soils-portal/soil-survey/soil-maps-and-databases/harmonized-world-soil-database-v12/en/ .

2. Gijsman, A.J., Thornton, P.K., Hoogenboom, G., 2007. Using the WISE database to parameterize soil inputs for crop simulation models. Computers and Electronics in Agriculture 56, 85–100. Recent version: http://www.isric.org/data/isric-wise-global-soil-profile-data-ver-31 .

Crop Modeling Data

Models used:

1. DSSAT (http://dssat.net/) . This model was developed and is maintained by the University of Florida. It is available for free after registering on their website. For this project, version 4.0 was used. Decision Support System for Agrotechnology Transfer (DSSAT) is a software application program that comprises process-based crop simulation models. The set-up of the DSSAT model we use permits it to link to spatially explicit input data (e.g., climate model data) and the subsequent crop modeling results to be mapped in GIS.
2. MarkSim (http://ccafs.cgiar.org/marksimgcm#.VUum-Wa25cw) is a stochastic weather generating tool created by the CGIAR system and is open access. Our project used it to generate daily weather data from the availably monthly GCM and WorldClim data to use in DSSAT.
   Jones, P.G., Thornton, P.K., 2000. MarkSim: Software to generate daily weather data for Latin America and Africa. Agronomy Journal 92, 445–453.

Crop model simulations:

The input data for the crop model consists of the climate datasets and the soils datasets described above. The crop cultivars were calibrated as possible with available information and local expert advice.

Crop simulations were conducted for each pixel (location) in the East African and Zambian domains at six Km resolution. There are 68,672 pixels in the Zambian, and 86,421 pixels in the East African domain. Each pixel could contain between one and five different soil types, and the plant's growth for each soil type in each pixel was simulated; the results were given a weighted average by area of the pixel to produce one result (e.g., yield) per pixel per year. To identify the impact of climate change, 30 years were simulated for each pixel for 5 climate situations in East African and Zambia (one current climate represented by WorldClim, and the 4 GCMs representing future climates).

In other words, the growing and environmental conditions at each pixel were simulated daily, and over numerous times: 60(30 years x 2domains) multiplied by 5 (the number of climates) multiplied by a number bettween1 and 5 (the number of soils in the pixel).

The crop model creates two basic files for each simulation: the summary file and the overview file. We also save all weather files and about 11 other important output files for each run.

The summary file contains 55 variables for each season's growth for each soil profile and each pixel. It is approximately 99GB of data for each East African 30 year simulation set. The overview files give summary of simulation details such as treatment description, simulated results for the five different growth stages, biomass produced at selected growth stages, maximum leaf area index at flowering stage and an environmental variable table summarizing environments such as Max and Min temperature, precipitation and evapotranspiration and water and nitrogen stress factors during each growth stage.

The following crop simulations were conducted:

Zambia spatial 6 km (all rainfed)

1. Groundnuts: 5 simulations all with 5 N kg/ha. Simulations were with 5 climates (current and 4 projected future).
2. Maize variety "500 series" short duration.
   a. 5 simulations with 85 N kg/ha (5 climates)
   b. 5 simulations with 5 N kg/ha (5 climates)
3. Maize variety "700 series" long duration
   a. 5 simulations with 85 N kg/ha (5 climates)
   b. 5 simulations with 5 N kg/ha (5 climates)

Each 30 year simulation set produces 2.93 million files in 66885 folders and amounts to 77 GB of data.

Zambia point (all rainfed)

Ten point locations modeled of 700 and 500 series maize using observed weather data (for various years, e.g., from 1984 to 2009), with 6 nitrogen levels (so 12 simulations for each point for several years).

East Africa spatial 6 km

1. Dry beans: 5 simulations all with 5 N kg/ha, rainfed. Simulations were with 5 climates (current and 4 projected future).
2. Maize variety Katumani Composite
   a. 5 simulations with 85 N kg/ha rainfed (5 climates)
   b. 5 simulations with 35 N kg/ha rainfed (5 climates)
   c. 5 simulations with 5 N kg/ha rainfed (5 climates)
3. Maize variety H614
   a. 5 simulations with 85 N kg/ha rainfed (5 climates)
   b. 5 simulations with 35 N kg/ha rainfed (5 climates)
   c. 5 simulations with 5 N kg/ha rainfed (5 climates)
   d. 5 simulations with 85 N kg/ha irrigated (5 climates)

Each 30 year simulation set produces 99GB (3.86 million files in 86972 folders).

Kenya point (all rainfed)

Four point locations modeled of H614 maize variety using observed and/or CHIRPS weather data (for various years, e.g., from 1984 to 2009), with 6 nitrogen levels (so 6 simulations per weather for each point for several years).