Migration in the Face of Climate Change: Assessing the Potential of UPG Programs: Variable Dictionary for Household Datasets

Till Meissner, t.a.meissner@lse.ac.uk

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Contents

1 Introduction

This document provides a comprehensive listing of all variables in the household-level climate datasets, organised by category. Sections 3-8 report variables available in the household-level climate dataset (stored as `hh_data_final.dta` and `hh_data_final.Rds`) in the project Dropbox folder. Section 9 reports variables available in the household-level climate vulnerability indices dataset (stored as `hh_indices.dta` and `hh_indices.Rds`) in the project Dropbox folder. Both datasets have 2,793 observations.

1.1 Temporal Periods

Climate variables are constructed for the following temporal periods:

- **pre (pretreatment)**: 2000–2019
- **20152019**: 2015–2019 (pre-intervention)
- **20202024**: 2020–2024 (post-intervention)
- **20152024**: 2015–2024 (full treatment window)

1.2 Seasonal Definitions

- **Summer**: May–October (months 5–10)
- **Winter**: November–April (months 11, 12, 1–4)

2 Household Identifiers

Variable	Description	Source
`hhid`	Household ID	Household survey
`agglom_id`	Agglomeration ID	Household survey

3 Geographic and Topographic Variables

Data Source: SRTM Digital Elevation Model, OpenStreetMap & Google Distance Matrix API

Variable	Description	Unit	Source
`slope`	Elevation above sea level	metres	SRTM DEM
`elevation_dem`	Terrain slope	degrees	SRTM DEM
`distance_nile_metres`	Distance to Nile River	metres	OpenStreetMap
`distance_waterway_metres`	Distance to nearest waterway	metres	OpenStreetMap
`distance_suhag_km`	Travel distance to Suhag (by road)	kilometres	Google API
`distance_suhag_min`	Travel time to Suhag (by road)	minutes	Google API
`distance_asyut_km`	Travel distance to Asyut (by road)	kilometres	Google API
`distance_asyut_min`	Travel time to Asyut (by road)	minutes	Google API

Variable	Description	Unit	Source
distance_markettown_km	Travel distance to nearest market town (above 50k) (by road)	kilometres	Google API
distance_markettown_min	Travel time to nearest market town (above 50k (by road)	minutes	Google API

4 Temperature Variables

Data Source: ERA5 Reanalysis (Copernicus Climate Data Store)
Spatial Resolution: ∼11km
Temporal Coverage: 1960–2024 (daily)
Historical Baseline: 2000–2015 for shock calculations

4.1 Temperature Shock Days

Number of days where temperature exceeds 2 standard deviations from historical (2000–2015) monthly mean.

- temp_shockdays_summer_{period}: Number of summer days with temperature shocks
- temp_shockdays_winter_{period}: Number of winter days with temperature shocks

Periods: pre, 20152019, 20202024, 20152024

4.2 Average Daily Mean Temperature

- temp_avgmean_summer_{period}: Average daily mean temperature in summer (°C)
- temp_avgmean_winter_{period}: Average daily mean temperature in winter (°C)
- temp_mean_growth_summer: Growth rate in summer mean temperature (2015-2019 to 2020-2024)
- temp_mean_growth_winter: Growth rate in winter mean temperature (2015-2019 to 2020-2024)

4.3 Heatwave Metrics

Definition: Heatwave day = day where mean temperature exceeds 85th percentile of historical (2000-2015) July-August temperatures

- temp_heatwave_days_avg_{period}: Average number of heatwave days per year
- temp_heatwave_days_n_{period}: Total number of heatwave days
- temp_heatwave_length_{period}: Average length of heatwave season (days)

4.4 Winter Days Above 30°C

Number of winter days with maximum temperature exceeding 30°C (agronomically stressful).

- `temp_wdays30_mean_{period}`: Average number of winter days above 30°C per year
- `temp_wdays30_n_{period}`: Total number of winter days above 30°C

4.5 Temperature Variability

Standard deviation of daily temperatures within seasons.

- `temp_sd_max_summer_{period}`: SD of max daily temp in summer (°C)
- `temp_sd_max_winter_{period}`: SD of max daily temp in winter (°C)
- `temp_sd_min_summer_{period}`: SD of min daily temp in summer (°C)
- `temp_sd_min_winter_{period}`: SD of min daily temp in winter (°C)
- `temp_sd_mean_summer_{period}`: SD of mean daily temp in summer (°C)
- `temp_sd_mean_winter_{period}`: SD of mean daily temp in winter (°C)

5 Universal Thermal Climate Index (UTCI) Variables

Data Source: ERA5-HEAT UTCI (Copernicus Climate Data Store)
Spatial Resolution: ∼27km
Temporal Coverage: 2000–2024 (daily)
Historical Baseline: 2000–2015 for shock calculations

UTCI is a bioclimatic index incorporating temperature, humidity, wind speed, and radiation to assess physiological thermal stress.

5.1 UTCI Shock Days

Number of days where UTCI exceeds 2 standard deviations from historical (2000–2015) monthly mean.

- `utci_shockdays_summer_{period}`: Number of summer days with UTCI shocks
- `utci_shockdays_winter_{period}`: Number of winter days with UTCI shocks

5.2 Extreme Heat Stress Days

Definition: Days with UTCI above 46°C (extreme heat stress threshold)

- `utci_heatstress_mean_{period}`: Average number of extreme UTCI days per year
- `utci_heatstress_n_{period}`: Total number of extreme UTCI days

6 Evaporative Stress Index (ESI) Variables

Data Source: NOAA ESI (via Google Earth Engine)
Spatial Resolution: 4km
Temporal Coverage: 2001–2024 (weekly, 12-week composite)
Historical Baseline: 2000–2015 for shock calculations
Coverage Note: ESI only defined for cropland pixels; 177 households excluded

ESI measures actual evapotranspiration relative to potential evapotranspiration, indicating agricultural drought.

6.1 Mean ESI Values

- `esi_mean_summer_{period}`: Mean ESI value in summer (standardized)
- `esi_mean_winter_{period}`: Mean ESI value in winter (standardized)
- `esi_mean_growth_summer`: Growth in mean ESI summer (2015-2019 to 2020-2024)
- `esi_mean_growth_winter`: Growth in mean ESI winter (2015-2019 to 2020-2024)

6.2 ESI Variability

- `esi_sd_summer_{period}`: Standard deviation of ESI in summer
- `esi_sd_winter_{period}`: Standard deviation of ESI in winter

6.3 Moderate Drought Days (ESI < -1)

- `esi_mdrought_summer_{period}`: Total moderate drought days in summer
- `esi_mdrought_winter_{period}`: Total moderate drought days in winter

6.4 Severe Drought Days (ESI < -2)

- `esi_sdrought_summer_{period}`: Total severe drought days in summer
- `esi_sdrought_winter_{period}`: Total severe drought days in winter

7 Normalized Difference Vegetation Index (NDVI) Variables

Data Source: MODIS MOD13Q1 v061 (via Google Earth Engine)
Spatial Resolution: 250m
Temporal Coverage: 2000–2024 (16-day composite, aggregated to monthly)
Historical Baseline: 2000–2015 for shock calculations
Extraction: Cropland pixels only (Copernicus 2019 Land Cover) within 1km buffer

NDVI measures vegetation greenness and health from red and near-infrared reflectance.

7.1 Mean NDVI Values

- `ndvi_mean_summer_{period}`: Mean NDVI value in summer (index 0-1)
- `ndvi_mean_winter_{period}`: Mean NDVI value in winter (index 0-1)
- `ndvi_mean_growth_summer`: Growth in mean NDVI summer (2015-2019 to 2020-2024)
- `ndvi_mean_growth_winter`: Growth in mean NDVI winter (2015-2019 to 2020-2024)

7.2 NDVI Shock Months

Definition: Months where NDVI is 2 standard deviations below historical monthly mean

- `ndvi_shockmonths_summer_{period}`: Number of NDVI shock months in summer
- `ndvi_shockmonths_winter_{period}`: Number of NDVI shock months in winter

8 Enhanced Vegetation Index (EVI) Variables

Data Source: MODIS MOD13Q1 v061 (via Google Earth Engine)
Spatial Resolution: 250m
Temporal Coverage: 2000–2024 (16-day composite, aggregated to monthly)
Historical Baseline: 2000–2015 for shock calculations
Extraction: Cropland pixels only (Copernicus 2019 Land Cover) within 1km buffer

EVI is similar to NDVI but with improved sensitivity in high biomass regions and reduced atmospheric interference.

8.1 Mean EVI Values

- `evi_mean_summer_{period}`: Mean EVI value in summer (index 0-1)
- `evi_mean_winter_{period}`: Mean EVI value in winter (index 0-1)
- `evi_mean_growth_summer`: Growth in mean EVI summer (2015-2019 to 2020-2024)
- `evi_mean_growth_winter`: Growth in mean EVI winter (2015-2019 to 2020-2024)

8.2 EVI Shock Months

Definition: Months where EVI is 2 standard deviations below historical monthly mean

- `evi_shockmonths_summer_{period}`: Number of EVI shock months in summer
- `evi_shockmonths_winter_{period}`: Number of EVI shock months in winter

9 Climate Vulnerability Indices

Based on the geographic distance variables (see Section 3) and climate shock variables (see Sections 4-8), inverse distance weighting is used to construct various climate vulnerability indices at the household level. These are stored in the `hh_indices` dataset. The climate vulnerability indices are calculated for the following periods:

- **pre (pre-treatment)**: 2000–2019
- **15–24**: 2015–2024 (full treatment window)
- **20–24**: 2020–2024 (post-intervention)

The following indices are calculated for each period:

- `heat_stress_index_{period}`: Based on air temperature shock variables (Section 4).
- `heat_stress_index_comb_{period}`: Based on air temperature and UTCI (Section 5) shock variables.
- `drought_stress_index_esi_{period}`: Based on ESI shock variables (Section 6).
- `drought_stress_index_comb_{period}`: Based on ESI and NDVI (Section 7) shock variables.
- `heatdrought_stress_index_{period}`: Based on air temperature and ESI shock variables.
- `c_heatdrought_stress_index_{period}`: Based on air temperature, UTCI and ESI shock variables.
- `heatdroughtdist_index_{period}`: Based on air temperature, ESI and distance from nearest waterway (Section 3).
- `c_heatdroughtdist_index_{period}`: Based on air temperature, UTCI, ESI and distance from nearest waterway.
- `unpredictability_index_{period}`: Based on standard deviations of air temperature and ESI.

10 Data Sources Summary

Data Type	Source	Provider	Resolution	Coverage
Temperature	ERA5 Reanalysis	Copernicus/ECMWF	∼9km, hourly	1960–2024
UTCI	ERA5-HEAT	Copernicus	∼27km, daily	2000–2024
ESI	Evaporative Stress Index	NOAA	4km, weekly	2001–2024
NDVI/EVI	MOD13Q1 v061	NASA MODIS/GEE	250m, 16-day	2000–2024
Elevation	SRTM DEM	NASA SRTM	30m	Static

Data Type	Source	Provider	Resolution	Coverage
Waterways	OpenStreetMap	OSM Contributors	Vector	2024
Boundaries	HDX Egypt Admin	HDX	Vector	2017
Travel times	Distance Matrix API	Google	n/a	2026

11 References and Documentation

- **Work Documentation**: See Work Documentation document for conceptual overview, background and references.
- **Scripts**: All processing scripts are in Github repository with numbered workflow (available upon request).