Yemen Shelter Cluster Winter Temperature Severity Analysis Methodology Note

Purpose

This document aims at,

- ✓ Listing all data sources used in assessing the winter weather severity in Yemen.
- ✓ Defining the indicator(s) used in calculating final weather severity per admin feature.
- ✓ Detailing the calculation and aggregation methods utilized in deriving severity level per admin feature.

Data Sources

This method relies on 3 key data sources,

- **MOD11A2 V6.1[1]:** The Terra Moderate Resolution Imaging Spectroradiometer (MODIS) Land Surface Temperature/Emissivity 8-Day (MOD11A2) Version 6.1 product provides an average 8-day per-pixel Land Surface Temperature and Emissivity (LST&E) with a 1 kilometer (km) spatial resolution in a 1,200 by 1,200 km grid. Each pixel value in the MOD11A2 is a simple average of all the corresponding MOD11A1 LST pixels collected within that 8-day period. This dataset was used in lieu of the daily temperature raster layer to accommodate for the extreme temperature variations within a given day and 8-day periods.
- **WorldPop Global Project Population Data, Estimated Residential Population per 100x100m Grid Square:** This is mainly used to map "populated areas" and exclude areas with insignificant population densities from the final analysis and severity results.
- **Admin Boundaries:** Sourced from HDX and widely used by humanitarian organizations in Yemen as the recognized administrative boundaries. The layer used is at admin-2 (district level) with 333 features with simplified islets boundaries.

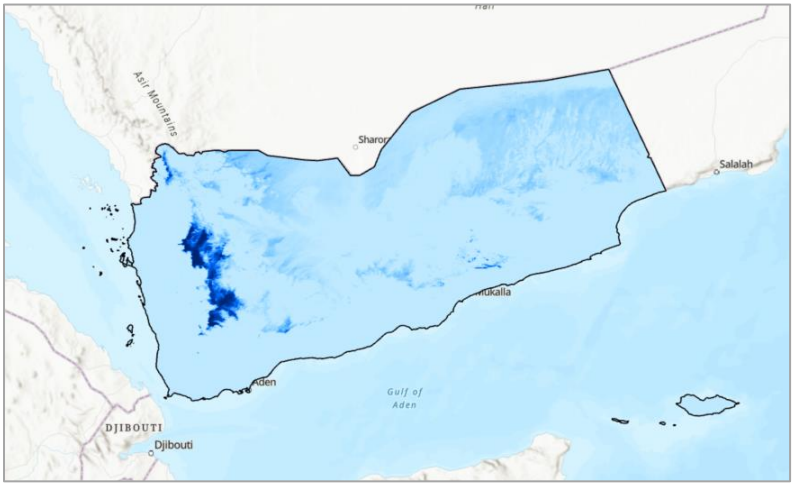
Calculation Method

Number and Percent of Cold Days

The analysis period included all night falling within winter season in Yemen (October, November, December, January, and February) of each year between the period of 1/1/2000 until 31/12/2022. The nights layer is filtered by the source between sunset and sunrise as perceived by the satellite for the different time zones (for Yemen, this is approximately sometime between 17h30 and 6h00 with slight differences based on the longitude and month of the Year). The large sample is to ensure that the larger sample size will produce results that are more statistically representative. The raster used is

[1] Wan, Z., Hook, S., Hulley, G. (2021). MODIS/Terra Land Surface Temperature/Emissivity 8-Day L3 Global 1km SIN Grid V061 [Data set]. NASA EOSDIS Land Processes Distributed Active Archive Center. Accessed 2023-09-26 from https://doi.org/10.5067/MODIS/MOD11A2.061

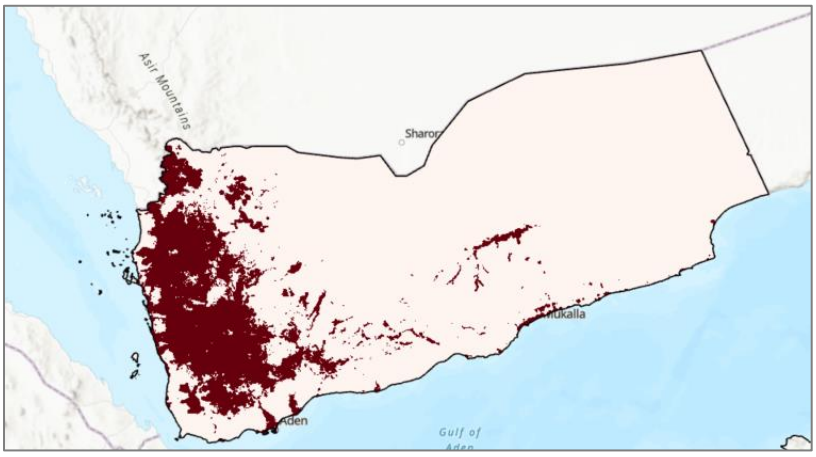
an 8-day average, to ensure that temperature variations are considered when calculating the percentage of cold winter days. The temperature threshold is set at 10 Degrees Celsius and each pixel with any temperature below this threshold is added to the result and multiplied by 8 (to represent the whole period.) The result is then divided by the number of all data points to get the *Percent of Winter Nights with Temperature below 10C*.



Raster of #Days with Temperature below 10C for the Analysis Period

Populated Areas

Populated areas are identified through the WorldPop Population Density raster with a threshold of 0.5 per 100m grid (+50 person Per Square Kilometer) all other areas are excluded from the final analysis results.



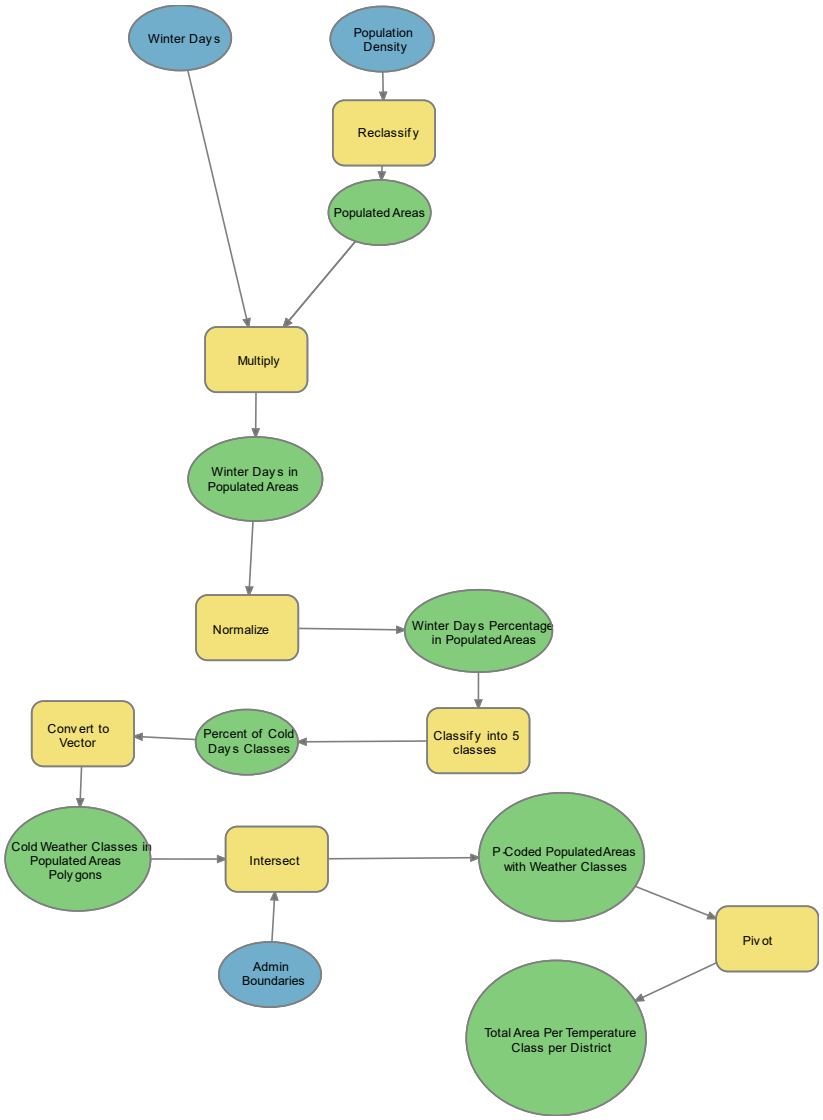
Yemen Populated Areas Raster Based on the Chosen0020Threshold

Final Winter Weather Severity

The results of the first two indicators are layered to get final severity per admin boundary, going through the following steps,

- ✓ Calculate percentage of winter nights with temperature below 10C (no admin boundary applied).

- ✓ Divide the resulting raster into 5 temperature categories, based on the percent of winter days below 10C,
  - CAT1: 0 - 1%,
  - CAT2: 1.1 - 10%,
  - CAT3: 10.1 - 25%,
  - CAT 4: 25.1 - 50%,
  - CAT 5: 50.1- 75%,
  - CAT 6: 75.1 - 85%,
  - CAT 7: +85.1%.
- ✓ Calculate Populated areas based on the threshold value.
- ✓ Break populated areas into the 5 identified temperature categories.
- ✓ Join populated areas with administrative boundaries (admin-2)
- ✓ Aggregate for each district (total area under each category per district)
- ✓ Identify areas under each category as a percentage of the total populated area.
- ✓ Summarize as the sum of (0.5 of the third category, 0.75 of the 4th category and the full last 3 categories percentages) of the populated areas per district.



The final resulting matrix should be represented as follows,

District Information			% of Populated Areas Under Each Weather Category							Severity Calculations	
			0 - 1% Winter Nights Below 10C	1.1 - 10% Winter Nights Below 10C	10.1 - 25% Winter Nights Below 10C	25.1 - 50% Winter Nights Below 10C	50.1 - 75% Winter Nights Below 10C	75.1 - 85% Winter Nights Below 10C	85.1 - 99% Winter Nights Below 10C		
Gov	District	HRPcod	CAT 1	CAT 2	CAT 3	CAT 4	CAT 5	CAT 6	CAT 7	CAT 3+	Final Weather Se
Ibb	Al Qafr	YE1101	98%	1%	1%	1%	0%	0%	0%	1%	1
Ibb	Yarim	YE1102	34%	1%	1%	5%	31%	10%	19%	64%	4

The final weather severity is identified through the classification of the ***Percent of Populated Areas under Temperature CAT 3 and Higher*** into the following categories[2],

- **Severity 1:** 0 – 10 %.
- **Severity 2:** 10.1 – 25 %.
- **Severity 3:** 25.1 – 50 %.
- **Severity 4:** 50.1 – 75 %.
- **Severity 5:** +75%.

[2] This classification is based on pervious years to ensure consistency. For this year, the final weather severity classification does not account for elevation, as both factors directly and positively correlate.