Part 2 Questions & Answers Session A

Please type your questions in the Question Box. We will try our best to get to all your questions. If we don't, feel free to email Jamon Van Den Hoek (jamon.vandenhoek@oregonstate.edu) or Andrew Zimmer (andrew.zimmer1@montana.edu).

Question 1: What would be an acceptable data product to understand temperature variation at 30 meters or below? Is land surface temperature reliable for a small case study? What are the other alternatives?
Answer 1: Land surface temperature from Landsat could be used (100m), but it depends on what type of temperature variations you're interested in studying. The temporal record might not be as strong to track the variability using Landsat. Some studies have used LST from Landsat for urban heat mapping (https://doi.org/10.1016/j.uclim.2023.101615).
There's a previous ARSET training on this too:
https://appliedsciences.nasa.gov/get-involved/training/english/arset-satellite-remote-sensing-measuring-urban-heat-islands-and

Question 2: In order to access the trial data in Google Drive, it has to be shared first. The code cell number 4 in the Colab, only indicates changing it to the personal drive, but no data is shared, currently. However, I checked the data repo in the file, and all the data are from GEE datasets.
Answer 2: Personal drive is used to load extra packages to process gridded temperature data using Xarray. These packages aren't available directly so are stored in my personal google drive folder and then read into the workshop. Setting up a path to your personal drive is helpful for storing datasets when you've finished an analysis, too.

Question 3: How was the threshold of 41 degrees Celcius chosen? I am guessing it is likely a physiological extreme but does it account for acclimation? Would a more flexible percentile-based threshold of heat stress (i.e. # of days above the 99th percentile of temperature values in any region) be a more relevant measure for heat stress measurement in general?

Answer 3: As we mention in the training, defining a heat stress metric can be difficult, and there are lots of ways to do it. Percentile based approaches are useful because they really focus on deviations from normal and allow us to pinpoint extra-hot days. In refugee settings however, people have often moved from other locations and so their acclimatization is less relevant than their exposure to temperature thresholds. You make a good point though, picking thresholds is difficult, and many humid-heat thresholds are used as they have physiological limits/impacts.

Question 4: Does heat stress also consider the land temperature?
Answer 4: We would typically use air temperature, or other composite metrics that incorporate humidity to have a stronger coupling with health outcomes.

Question 5: Is it possible to apply the human comfort equation?
Answer 5: In theory, yes, but I think some of these metrics require information about clothing and activity level. We lack such detailed information for a lot of refugee settings. Universal Thermal Climate Index (UTCI) can also be used, which is another metric that combines temperature and humidity.

Question 6: Is there any specific work that looks at heat impacts and survivability limits for pregnant women?
Answer 6: Here's a few that are related: https://doi.org/10.1136/bmj.m3811 and https://doi.org/10.1002/ijgo.14381

Question 7: Kindly discuss the challenges and limitations of using geospatial datasets to assess heat stress in refugee settings, and how might these be overcome?
Answer 7: This is an important question. Geospatial data (such as from OpenStreetMap) can offer a lot of insight around cooling features or infrastructure but these data are often unavailable, incomplete, or out of date in refugee settings. Satellite data can tell us about heat dynamics on the ground and over time, but the full picture of indoor conditions (influenced by building materials, air circulation, cooling devices, etc.) vs. outdoor conditions (influenced by wind, shading, ground materials, etc) requires a much more involved analysis.

Question 8: Are there any recommended relatively accurate global climate datasets, including precipitation and temperature, from at least the year 2000 to present?
Answer 8: There are a few different datasets one can use. Here, we use the ERA5 dataset, but there are others at varying temporal and spatial resolutions (TerraClimate, CHIRTS/CHIRPS etc.)

Question 9: How important is spatial resolution here? E.g. The CHIRTS Africa dataset goes down to 5 km. Would we expect a substantially different risk assessment due to variability on fine scales here?
Answer 9: This is a good point - fine resolution is helpful, particularly if comparing between urban and rural temperature exposure as we might expect the urban heat island effect to impact temperatures. As far as a different risk assessment, finer scale would likely give more detail, but the general consensus in many of these locations is that they are experiencing increasing exposure to extreme heat.

Question 10: How about using the ERA5-Land data product, which provides access to much finer resolution data?
Answer 10: We use ERA5-Land in the training portion, since it is available on GEE and provides data at an hourly time-step.

Question 11: What's the resolution of the ERA-5 data? Additionally what's the major difference between the ERA-4 and the newly developed ERA-5 data.
Answer 11: ERA5 is at a resolution 0.25 degrees, but there is another product that we use in this training (available on GEE), which is ERA5-Land, which is available at 9km. For more information about the ERA5 product, see: https://climate.copernicus.eu/climate-reanalysis

Question 12: Many people talk about climate resilient infrastructures to tackle the rising temperatures but how cost effective is it? Can this idea really be mainstream? Any comment on this will be insightful.
Answer 12: Whilst climate resilient infrastructure can be helpful in reducing exposure to extreme heat, it is a little outside the context of this training. In many refugee settlements there is little time or funding to prepare communities with climate resilient infrastructure to avoid the worst impacts of extreme heat. Some strategies could

include air conditioning, increasing shade and making sure cooling provisions are available for vulnerable populations.

Question 13: What role can Nature-Based Solutions (NBS) play in mitigating heat risk? And how can the integration of green and gray infrastructure enhance their effectiveness? Please provide specific examples of their implementation and outcomes in regards policy perspective too.
Answer 13: Whilst NBS infrastructure can be helpful in reducing exposure to extreme heat, it is a little outside the context of this training. In many refugee settlements there is little time or funding to prepare communities with climate resilient infrastructure to avoid the worst impacts of extreme heat. Some strategies could include air conditioning, increasing shade and making sure cooling provisions are available for vulnerable populations.

Question 14: How do I input study area shapefile in Google Colab?
Answer 14: In this example, we read in a geojson file, but if you were applying to a different area of interest you could load a shapefile from your google drive directory using the geopandas package.

Question 15: Can we use this code in small areas?
Answer 15: Yes, the code can be used for different sized areas. Making them smaller will actually speed things up and make the data processing more manageable

Question 16: Could you provide a list of the packages that need to be installed prior to running the commands in the Colab notebook? Some packages like atmos are not working as intended.
Answer 16: To calculate wet-bulb temperature we have to use packages that are in development and are not currently accessible directly in python. In this example, we are using the atmos package, which is in development and can be seen here: https://github.com/robwarrenwx/atmos If you want to set this up to run the code book, you'll have to download the package and set it up in your google drive folder system, setting up your working directory to access it.

Question 17: Is it possible to use SAR data or optical imagery to make the same heat analysis?

Answer 17: Unfortunately, SAR - synthetic aperture radar - like that collected by Sentinel-1 is not sensitive to heat-relevant signals. Optical imagery (like from MODIS or Sentinel-2) that are sensitive to thermal conditions are helpful for heat assessments.

Question 18: How does the type of settlement and shelter type affect the risk related to long term heat stress? For example, metal roofs vs tents?
Answer 18: This likely would have an effect. Metal roofs will likely heat up and retain more heat than tents and so would exacerbate extreme heat risk. In an ideal world, information about camp structures could be added to extreme heat assessment to really pinpoint vulnerable locations

Question 19: Can you reflect on where you see the largest need right now - gauging the current exposure of IDPs and refugees or trying to assess future exposure?
Answer 19: Gauging and addressing current exposure of IDPs and refugees is arguably of greater need. Learning about what works and what doesn't in terms of local and remote assessments, building strategies for refugee and IDP leadership and inclusion as much as possible in the decision-making processes, and mitigation and adaptation approaches are essential to get ahead of the challenges that we will likely see more of in future decades.

Question 20: Where could I find more information about the refugee data? Where would I be able to download it and see the metadata for example?
Answer 20: Please see UNHCR's Geoservices portal for many relevant datasets https://data.unhcr.org/en/geoservices/

Question 21: I thought research suggested that a WBT of 35° or 31° were suggested as dangerous - why are we using 25° WBT here?
Answer 21: The literature referenced in the slide deck suggested that a WBT of 35°C is fatal within 6 hours of exposure, although this could be lower. Since we're interested in extreme heat stress rather than fatalities, we use a much lower threshold. 25°C WBT is still a very warm temperature.

Question 22: I'm wondering why the historical air temperature used in this analysis is based on a numerical model rather than the satellite data such as NASA AIRS mission?

Answer 22: We combine historical air temperature with historical data on refugees - this allows us to join them at appropriate spatial and temporal periods.

Question 23: Which climate models are more suitable to project future heat stress scenarios, particularly for camp settings?
Answer 23: Global models from CMIP5 and CMIP6 and regional models from CORDEX can be used. There are also new products in development from the Climate Hazard Center at UCSB which project extreme heat. See: https://doi.org/10.1038/s41597-024-03074-w for more

Question 24: Followed by the global climate dataset question… Is the data being validated for countries with fewer weather stations? Or are most of them purely modeled data?
Answer 24: You can see the documentation from ERA5 here, which includes an web page which allows you to identify a variable and reward all about their production, assessment and validation:
https://cds.climate.copernicus.eu/cdsapp#!/dataset/reanalysis-era5-single-levels?tab=eqc

Question 25: How was the future climate scenario selected?
Answer 25: We only focus on historical climate scenarios in this example. We use historical ERA5 data, although these methods and approaches could be combined with climate projection data to look at future extreme heat exposure in refugee settings

Introductory ARSET Training: Selecting Climate Change Projection Sets for Mitigation, Adaptation, and Risk Management Applications

Question 26: Will future training include a demonstration of how to download additional necessary packages like ATMOS?
Answer 26: This is an intermediate training, with a demonstration rather than a code walk-through. The package is publicly accessible and users will have to set up their code and file system to access and utilize it. Previous trainings have covered how to load packages in more detail.

Question 27: How can we measure the differences in wet bulb and dry surface temperature that might occur in the future and those due to weather events like El Nino?
Answer 27: To measure future changes we can use climate models - CMIP6 and CORDEX are examples of these. These provide us with an estimate of what future heat risk might look like.

Part 2 Questions & Answers Session B

Please type your questions in the Question Box. We will try our best to get to all your questions. If we don't, feel free to email Jamon Van Den Hoek (jamon.vandenhoek@oregonstate.edu) or Andrew Zimmer (andrew.zimmer1@montana.edu).

Question 1: Is there a good resolution disease vector map (i.e. mosquitoes) for overlay?
Answer 1: This is outside my area a little so I'm not sure about disease mapping. A quick google search seems to indicate there might be some out there. If they are raster or vector data, it would be possible to integrate with analysis in google earth engine - you might just have to load the data yourself instead of calling from the GEE catalog.

Question 2: I am having trouble importing the atmos package, what do I need to download and add to my drive directory, and from where? I did not find anything on the atmos github page.
Answer 2: To calculate wet-bulb temperature we have to use packages that are in development and are not currently accessible directly in python. In this example, we are using the atmos package, which is in development and can be seen here: https://github.com/robwarrenwx/atmos If you want to set this up to run the code book,

you'll have to download the package and set it up in your google drive folder system, setting up your working directory to access it.

Question 3: I am more used to using Jupyter Notebook; is the coding workflow in Google Colab necessary or does it also work in other IDEs?
Answer 3: Most of the code will work on a Jupyter Notebook - however some of the initial setup will be a little different since you won't be mounting google drive, but instead pointing to your local directories. As long as the Python versions between Jupyter and Colab are compatible, the core code functionality should carry over fine.

Question 4: Could you please give some guidance as to where the following data lives? "wrl_prp_p_unhcr_refugees_noLBN_onlySettlements-2024_02.geojson" It seems it is in your drive but you suggested the data would be open source so I'm wondering where one could find that information?
Answer 4: Please see UNHCR's Geoservices portal for many relevant datasets https://data.unhcr.org/en/geoservices/

Question 5: Is max air temperature the average of the year, i.e. 2018 ?
Answer 5: When we calculate max air temperature initially, yes. We calculate the maximum air temperature across the whole year and plot that on the map. When we use air temperature later on, we use hourly air temperature for a better understanding of the temporal variability of extreme heat

Question 6: Kindly discuss the challenges and limitations of using geospatial datasets to assess heat stress in refugee settings, and how might these be overcome?
Answer 6: This is an important question. Geospatial data (such as from OpenStreetMap) can offer a lot of insight around cooling features or infrastructure but these data are often unavailable, incomplete, or out of date in refugee settings. Satellite data can tell us about heat dynamics on the ground and over time, but the full picture of indoor conditions (influenced by building materials, air circulation, cooling devices, etc.) vs. outdoor conditions (influenced by wind, shading, ground materials, etc) requires a much more involved analysis.

Question 7: How do microclimatic variations within refugee camps influence long-term heat stress and associated health outcomes, and what adaptive strategies can be effectively implemented to mitigate these impacts?
Answer 7: Great, complicated question. I don't think we have a good sense of microclimates within refugee settings, unfortunately. We have a sense of the kind of building materials that are used in certain refugee camps – if the camp is "planned" by the UNHCR and the host country, dwellings and other buildings are constructed following a handbook of best practices. But to understand microclimates, we would need information on greenspace, shade, ground materials… all the factors that contribute to "urban heat island" phenomena.

Question 8: Which climate models are more suitable to project future heat stress scenarios, particularly for camp settings?
Answer 8: Global models from CMIP5 and CMIP6 and regional models from CORDEX can be used. There are also new products in development from the Climate Hazard Center at UCSB which project extreme heat. See: https://doi.org/10.1038/s41597-024-03074-w for more

Question 9: I wanted to know what innovative modeling approaches can be developed to assess the long-term impacts of heat stress and evaluate the effectiveness of different intervention strategies?
Answer 9: A lot of this relies on information within the camps and is currently lacking. We are limited in knowing the exposure of the households.