Questions & Answers Part 1

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 Amber McCullum (amberjean.mccullum@nasa.gov) or Juan Torres-Pérez (juan.l.torres-perez@nasa.gov).

Question 1: What about anthropogenic factors? Where does this factor in?
Answer 1: Anthropogenic factors can be considered within these variables at many points. For example, increased temperatures or changes in precipitation variability due to climate change. You could also assess changes to land cover and/or forest structure that have been caused by human activities. We mentioned land cover classification in the lecture, you could also assess a time series of land cover classifications over multiple years to see how the landscape has changed as a result of agricultural expansion or urban growth for example. We will not cover forest structure topics in this training, but you can use SAR data for this. Check out a past training on SAR data for more information on forest density/structure: https://appliedsciences.nasa.gov/join-mission/training/english/arset-forest-mapping-and-monitoring-sar-data

Question 2: Why always after a wildfire event, the same vegetation types and density that were burnt, come back and colonise the same area?
Answer 2: Vegetation regrowth patterns may vary depending on the area of interest. But often times, due to multiple factors, the same types of vegetation will grow back in the areas where the wildfire occurred. In many forest systems wildfire is a natural part of the ecosystem and actually benefit the regrowth of and health of the forest. Some conifers also release their seeds through fire. Additionally, if the same climate and land surface conditions remain, we are likely to see the same types of vegetation return. There is evidence, however of increased diversity of plant species after fires as well. Check out this paper: https://www.frontiersin.org/articles/10.3389/fevo.2019.00252/full

Question 3: How can wildfire effects be linked to groundwater changes?
Answer 3: Depending on the severity of the fire, soil conditions can be modified, which can in turn affect things like recharge rates. If much of the soil structure has been damaged, this could decrease infiltration rates through the soil (with fewer gaps in the

soil particles). Severe fires can also lead to an increase in runoff in a watershed due to the lack of vegetation, which can lead to things like landslides. Check out part 5 **"Satellites, Sensors, and Earth System Models for Climate and Hydrology-Based Applications (Post-Fire)"** of our Fires training from last summer for more information: https://appliedsciences.nasa.gov/join-mission/training/english/arset-satellite-observations-and-tools-fire-risk-detection-and

Question 4: What are some examples of heavy fuels?
Answer 4: Heavy fuels can be: large tree branches, downed logs, and buildings, require more heat energy to ignite, but they burn longer and produce more heat once ignited. Light fuels include grasses, shrubs, and tree leaves or needles. They are referred to as light and flashy fuels, and ladder fuels are shrubs or small trees of intermediate height that act as ladders carrying the flames from the forest surface up into the tops of trees. Here is a great resource for this: https://www.srs.fs.usda.gov/factsheet/pdf/fire-understanding.pdf

Question 5: To account for multi-year drought events, instead of starting/ending "fire season" on FIXED DATES, could RS be used to assess landscape conditions (soil moisture, Et, various indices), to determine a temporally "dynamic fire season?"
Answer 5: Yes, you could assess the soil moisture, ET, vegetation indices, etc. on any timescale of interest. You will see a few examples of this in the exercise. You can also look at anomalies during specific time periods that show the difference from average, when considering a 30-year climatological average. For Climate Engine in particular, you can create time series on any scale in real time.

Question 6: How can individual height of trees be calculated through SAR without LiDAR data or any 3D data? Is it possible from a Sentinel-1 image to achieve this?
Answer 6: No, you cannot calculate individual tree height with something like Sentinel-1, but you can estimate forest stand height (FSH) more generally. I am not an expert on SAR data, so I am not sure exactly to what spatial resolution you can estimate FSH, but please check out a recent ARSET SAR training for more information: https://appliedsciences.nasa.gov/join-mission/training/english/arset-forest-mapping-and-monitoring-sar-data. In part 4 there is a lecture specifically on FSH mapping.

Question 7: What resolution does the Fire Weather Index (FWI) have ?

Answer 7: The resolution of the Fire Weather Index (FWI) depends on the data that you're using to calculate it. FWI consists of six different measurements, so your spatial and temporal resolution depends on the resolution of the data you're using. You can find out more about the FWI here: https://cwfis.cfs.nrcan.gc.ca/background/summary/fwi, and more information about the resolution of data that the Canadian Wildland Fire Information System uses here: https://cwfis.cfs.nrcan.gc.ca/background/dsm/fwi

NASA ResourceWatch also has a global Fire Weather Index on their site at a 0.1 degree resolution. Here is the link: https://resourcewatch.org/. Here is the description about the FWI data from Resource Watch: The data inputs for these calculations are measurements of 12:00 local time temperature at 2 m, relative humidity at 2 m and wind speed at 10 m. Daily snow-depth and precipitation were totaled over the previous 24 hours. GFWED includes several different versions of these calculations, each of which uses a different input weather and precipitation data. The version of these calculations shown on Resource Watch uses input data from GEOS-5 for temperature, relative humidity, wind-speed and snow depth; input precipitation comes from the 'Late' version of GPM IMERG Daily Precipitation. **Global daily calculations of the FWI System indices using these data inputs are available from 2015 to present with 0.1° resolution**.

Question 8: Is there a relationship between fires and el niño and la niña?
Answer 8: Yes, the effect of El Niño Southern Oscillation (ENSO) depends on the phase (el niño and la niña) and your region of interest. ENSO affects patterns of precipitation and temperature, and in California for example, we tend to see less precipitation with a La Nina, and therefore increased drought conditions that may lead to wildfire outbreaks. In the Bolivia example, it has been suggested that another climate oscillation, the AMO, has driven drier conditions in the region, leading to fire outbreaks. Here is a paper on the global effects of ENSO on wildfires: https://www.frontiersin.org/articles/10.3389/feart.2020.00199/full

Question 9: Is there any agency-led effort to develop new fire-weather indices?
Answer 9: I do know for example that the US forest service and the USGS work together to produce data on Fire danger. I am sure there have been efforts with other agencies to share data and to estimate fire danger that I may not be aware of. Here is

some information on the USGS/USFS Fire Danger Forecasting Project: https://www.usgs.gov/fire-danger-forecast

Question 10: Are you able to customize your search preferences (in Climate Engine) within the variable? For example, say I am interested in the percentage of time over 28C for JJA for an area
Answer 10: Depending on the variable of interest, there are statistics you can calculate, such as the total, the difference from average, the percent of average, etc. You can play around with these options under the Processing—Calculation option on the left panel.

Question 11: Can we use all of these analysis results as server service or download to use them further in a GIS software?
Answer 11: Yes, in the Make Map option you can create a rectangular region and download the data as a GeoTiff or a png. In the Make Graph option, you have the option to download the data as a csv as well.

Question 12: Have you had any luck loading or analyzing the Hazard layers in Climate Engine? Do we need to process or treat them differently given that they are usually somewhat static?
Answer 12: Given that it's a newer feature in Climate Engine, we have not looked into it extensively. But yes many of the data layers for the Wildfire Risk to Communities option come from LANDFIRE and are specific to one year and include more static data. If you go to the yellow question mark in the make map panel, you can get information about the dataset. Depending on your analysis, make the appropriate choice about what to use.

Question 13: Who provides the data for each of the search engine groups/organization - weather bureaus? forestry divisions? NASA, NOAA, ESA, CSA? etc. How is it verified?
Answer 13: It varies depending on what data you are looking at as well as your variable of interest. Climate Engine uses Google Earth Engine as its backend for computing. GEE uses data from DAACs, which the data has been tested and checked for quality control before being released to the public. One example of agency collaborations is Landsat, being a joint venture between NASA and the US Geological Survey (USGS). Many regional and local agencies also incorporate data from DAACs as well.

Question 14: I was wondering if the Bolivia data graph -with increasing fire counts over time- discriminates between "wildfire" and "intentional fires for clearing"? If not, would that be possible?
Answer 14: I don't believe that the graph in the presentation discriminates between wildfire and intentional fire. Clearing land using fire is a common practice in this region for agricultural purposes. The SERVIR Amazonia dashboard does discriminate fires based on the type of burn of the fire (i.e. understory). Regional/local agencies may have more specific information about the type of fire.

Question 15: Lack of precipitation can increase stress in conifers. This can make them more vulnerable to fatal attacks by insects like the western pine beetles. Does this increase fire risk outside of just heat/ lack of precipitation that the area is already experiencing?
Answer 15: Yes. The mountain pine beetle outbreak has been extensive, especially in the Western United States. The pine beetles can be fatal to the trees and can lead to increased spread of fires, dryer fuel and hotter burns. We had a training based on LandTrendr in Google Earth Engine to look at the vegetation health using time series analysis: https://appliedsciences.nasa.gov/join-mission/training/advanced-webinar-investigating-time-series-satellite-imagery

Question 16: Is it possible to produce Normalized Burn Ratio from pre- and Post fire data?
Answer 16: Yes, we will be focusing on this in Part 2 of this training series using the GEE Code Editor.

Question 17: Can we briefly review the graphing function?
Answer 17: In the Bolivia example, we do a quick run through of the Make Graph interface. Check out pages 7-10 on that example.

Question 18: Besides human induced fire, what are common causes of forest fires?
Answer 18: Lightning strikes are the most common cause of forest fires. Other things like volcanic activity can also cause wildfires.

Question 19: What about tropical peat fires? Since the fuel source is different can we use one of these indexes?

Answer 19: While I am not an expert in peatland fires, I do know that often times they are the result of drained peatland or drying of the region. In the case of drying or degradation to the region some of the same indices (like decreased precipitation and increased temperatures) could be used.

Question 20: Are data available in near real time in the climate engine, or is this app only for historic analysis?
Answer 20: It depends on the variable and the data source. For much of the data, as soon as they become available or served through the DAACS or universities they are available on CE. So the latency for a variable is generally driven by the data producer itself, not CE. For example, the GridMET data are generally available within a few days. CE also has climate forecasts, so this is something you can use for up to a month in advance.

Question 21: How accurate is the GWIS fire danger forecast for Africa (and other geographic regions)?
Answer 21: The Fire Weather Index rating system is specifically calibrated to describe the fire behaviour in a standard jack pine stand (*Pinus banksiana*) typical of Canadian forests, and can therefore have accuracy issues in other regions. There are other fire danger rating systems that may or may not be as useful in your region of interest. Here is a great resource that describes some of these different rating systems and how to assess the accuracy: https://www.ecmwf.int/en/newsletter/147/meteorology/nwp-driven-fire-danger-forecasting-copernicus

Question 22: In Climate Engine, in the variable section under the type Remote sensing, how do you account for cloud cover in your image (data) or is the image already pre-processed for analysis?
Answer 22: ClimateEngine applies a cloud mask to the Landsat TOA/SR data. The cloud masking attempts to remove medium and high confidence snow, shadow and cirrus clouds using the BQA quality band provided in the Landsat GEE collection. You can get more information by clicking on the yellow question mark on the left panel next to Dataset.

Question 23: Do any of the systems shown use smart data processing in the back like using machine learning or simulations, then send an alert when the system identifies a scenario with weather etc. which might be dangerous?

Answer 23: I am not aware of any of the systems that send alerts related to fire weather, but there are sites that send alerts related to actively burning fires, such as FIRMS. Here is where you can sign up for fire alerts with FIRMS: https://firms.modaps.eosdis.nasa.gov/alerts/

Question 24: Please review how the Amazon fire dashboard categorizes fire drivers (i.e. deforestation, agriculture, etc.)?
Answer 24: For each fire event they combine information about land cover (tree cover, biomass, historic deforestation rates) within the fire perimeter and fire characteristics (e.g., fire radiative power, persistence, progression, day-time detection fraction, and size) based on all satellite fire detections within the larger perimeter. The combination of these data provides a unique signature of each fire type that allows for classification using three confidence intervals (low, moderate, and high). You can take a look at their methods here for more information: https://globalfiredata.org/pages/amazon-dashboard/#faq_methods

Question 25: Does deciduous vegetation have a specific impact on wildfire scenarios? If yes, how so?
Answer 25: Deciduous trees can be extremely flammable in the early spring just before their new leaves emerge. During this period of time the moisture levels in the trees are low, increasing their flammability until their leaves emerge.

Question 26: Can one use this system to detect fires that are less in intensity but large in number, for example, stubble burning in India?
Answer 26: Yes, I believe so, I would encourage you to take a look at some of the active fire mapping tools we did not highlight in this training, but that we talked about in our previous training. https://appliedsciences.nasa.gov/join-mission/training/english/arset-satellite-observations-and-tools-fire-risk-detection-and. These include FIRMS and Worldview, among others.

- https://firms.modaps.eosdis.nasa.gov/
- https://worldview.earthdata.nasa.gov/