Questions & Answers Part 2

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: High burn severity has low infrared range, but it's supposed to have water absorption- how is that possible?
Answer 1: High burn severity regions have higher values in the mid-infrared because there is low water absorption. Healthy vegetation has lower mid-infrared values because it has more water absorption. Take a close look at slides 19 and 20 from the lecture.

Question 2: Does the NBR hold true for grasslands or arid areas?
Answer 2: Yes the NBR can be used for grasslands and potentially arid regions, depending on the vegetation cover. It is most useful because we are able to observe differences in the vegetation properties, so if you are investigating an arid region that does not have much vegetation cover in the first place, you may not see much change in the NBR across multiple years.

Question 3: Is there a common reference for thresholds based on ecosystem type?
Answer 3: A common threshold reference is proposed by the USGS, and you can see that on the UN SPIDER website here:
https://un-spider.org/advisory-support/recommended-practices/recommended-practice-burn-severity/in-detail/normalized-burn-ratio

In the case of altering your threshold values, this really relies on analyst interpretation. These categories can be modified based on your understanding of the particular ecosystem of interest, and most importantly ground-based information such as the Composite Burn Index (CBI). Here is a paper with more information on this topic:
https://fireecology.springeropen.com/articles/10.4996/fireecology.0301003

Question 4: How can we interpret dnbr value? There is any table for that?
Answer 4: Please see the answer for Q3

Question 5: If wildfires affect human settlements/infrastructure, it seems vegetation-based indexes would not be appropriate. Do we have alternatives that can measure that impact?
Answer 5: Great point. I am not aware of a standard index that can be used to examine urban impacts. Assessment of the urban impacts may be best done by ground assessments. Another dataset that may be of interest if the urban area is large enough is the VIIRS nighttime lights. This could be used to examine urban areas that are highly lit prior to a fire and if they have lost power you could see some significant differences. Here is more information about the VIIRS nighttime lights: https://earthdata.nasa.gov/learn/backgrounders/nighttime-lights

Question 6: In Bolivian fires that involved many fires, why is the pre-fire situation not affected by the burns? I mean pre and post are happening at the same time affecting the landscape, temperature etc.
Answer 6: Yes, that is a good point. In regions that have many burns over multiple years it can be difficult to distinguish between regions that have been affected by previous fires, and where there is vegetation regrowth. So it is a good idea to be specific with your image dates, and get as much information as possible about previous burns.

Question 7: What is the difference then between Earth Engine and Climate Engine which we tried out last session? The actual sat-data or what is the difference?
Answer 7: Google Earth Engine is a computing platform that allows users to access satellite data, run geospatial analysis, and develop software that conducts this analysis. Climate Engine is one of those pieces of software that was developed (and is powered by) Earth Engine. There is no difference in the data that is being used, but there's no coding involved. Earth Engine is also more flexible as well.

Question 8: I was wondering if GEE can evaluate the soil burn severity and the post-fire effect on the watershed?
Answer 8: The soil burn severity estimates are ground-based measurements that examine the changes in the physical, chemical,and biological soil properties, so for that you will need to conduct some ground-based assessments. In terms of impacts of fire to the watershed, remote sensing could be used to monitor things like landslides. Here is an ARSET training that focuses on the use of SAR data for landslides for example: https://appliedsciences.nasa.gov/join-mission/training/english/arset-sar-disasters-and-hydrological-applications. There are also other trainings that focus on water resources and watershed analysis.

Question 9: What is the easiest way to figure out whether the fire is fully out and no smoke in your location? Especially when part of the fire might be out and part of the fire is still burning...
Answer 9: In terms of a remote sensing perspective you can take a look at MODIS and VIIRS daily surface reflectance data using a tool like Worldview: https://worldview.earthdata.nasa.gov/. You can also look at the active fire hot spots to see if the satellites have detected heat anomalies if the fires are still burning. We covered this in our previous training in the “during” fire presentations: https://appliedsciences.nasa.gov/join-mission/training/english/arset-satellite-observations-and-tools-fire-risk-detection-and

Question 10: In the Bolivia case it seems that the classification has some unnatural edges (does not smoothly blend across Bolivia). Why did this happen and how do I tackle it?
Answer 10: Great point. This is likely due to the fact that Bolivia is a region with a lot of cloud cover, necessitating the removal of many pixels that are covered by clouds during this time period. You can test out a few different options like changing the date range or the dataset (Sentinel-2) to see if there are less pixels removed from the cloud masks. However, this highlights an important limitation of the use of optical data in tropic regions. SAR data might be more useful in this region, as it is not impacted by cloud cover.

Question 11: Can this analysis be done using sentinel?
Answer 11: Yes! Please see the Bolivia example code where you can modify it to use Landsat 8 imagery or Sentinel-2.

Question 12: Can the calculation of RdNBR be incorporated into the code?
Answer 12: Yes! This is not something I have done myself, but check out this paper, where I think they have a GEE code linked at the end: https://www.mdpi.com/2072-4292/10/6/879

Question 13: Are the dNBR thresholds (used to determine classes) standardized or do the thresholds need to change based on the fire type and region?
Answer 13: See Q3

Question 14: Does nbr give any idea of how old the occurrence of fire may be through time series data?

Answer 14: Not necessarily, however, if there is some vegetation regrowth that has occurred in the region, the NBR values will be lower. If you had, say, monthly or yearly imagery and wanted to do a time series analysis you could likely pinpoint when the fire occurred. A great resource for this is the Landtrendr algorithm that you can implement on GEE. You can do time series analysis easily with multiple different vegetation indices, such as NBR. https://emapr.github.io/LT-GEE/

Question 15: Can you load a shapefile loaded locally rather than a bounding box?
Answer 15: Yes! You can upload shapefiles (and more) through the “Assets” tab near the top left of the page. GEE Developers created a guide for uploading data here: https://developers.google.com/earth-engine/guides/table_upload
Just keep in mind that when you use a shapefile, you might have to change the privacy settings of the shapefile if you’re trying to share your code with colleagues or the public.

Question 16: What informed the class values for the classes? (the numbers in the array starting with -1000...)
Answer 16: The dNBR is a ratio, so the values will be from -1 to 1, and in this example they have been multiplied by 1000 to get whole numbers. You can see more information about the class designations which have been set by the USGS from the UN SPIDER website here: https://un-spider.org/advisory-support/recommended-practices/recommended-practice-burn-severity/in-detail/normalized-burn-ratio

Question 17: Could you please explain again what the reducer does?
Answer 17: The reducer takes the values of all the pixels that fall within the parameter you define and applies whatever summarizing function you specify to those pixels. In this example, we used the reducer **ee.Reducer.count()** to count the number of pixels in the bounding box we drew called ‘**geometry**.’ In line 135, we used **.reduce(‘sum’)** to add all the pixels within the image we applied the function to. There are lots of different reducers you can use and different ways to apply them. You can learn more here: https://developers.google.com/earth-engine/guides/reducers_intro

Question 18: Can you use a shapefile of the actual fire perimeter so the percentages would be related just to the fire and not the surrounding unburnt area?
Answer 18: Yes, if you had a shapefile of the fire perimeter you could load that as an asset and use that as the geometry to run the analysis. You can upload shapefiles (and more) through the “Assets” tab near the top left of the page. GEE Developers created a

guide for uploading data here:
https://developers.google.com/earth-engine/guides/table_upload

Question 19: Can you share the range of nbr values ...depending on severity .. say high severity.. moderate severity...and so on
Answer 19: You can find the different thresholds of burn severity at this link: https://un-spider.org/advisory-support/recommended-practices/recommended-practice-burn-severity/in-detail/normalized-burn-ratio

Question 20: When we try to get data as quickly as possible to respond to a disaster for example & mobilize resources, from your experience, is GEE the best source or would we need to access other resources as well to verify & clarify?
Answer 20: Yes I would say it is a great resource for a quick analysis. You can also use things like Worldview: https://worldview.earthdata.nasa.gov/ or NASA's Disaster Portal: https://disasters-nasa.hub.arcgis.com/. GEE is used for quite a few early warning systems for other natural disasters, like flooding, and is helpful because they update their data catalogs in near real time. Once new imagery is available, you can access it in GEE.

Question 21: If we ran these indices on the archive of images through time, and search areas of high severity burn, we could build long-term statistics for an area / country. But this would also include deforestation in the category of wildfire. Any idea how we could eliminate such false positives?
Answer 21: Yes! There are a few other resources for that type of analysis too, such as Global Forest Watch, which calculates summary statics on a variety of variables: https://www.globalforestwatch.org/map

Question 22: Would you please touch a little bit about post-fire vegetation recovery assessment using spectral signatures timeseries? Is it better to do the analysis for each burn severity classes or just for the general fire affected AOI?
Answer 22: Good question, and I guess it depends on the questions you are trying to ask with your analysis. For example, if you are interested in how regrowth differs in high vs low burn severity you might want to run you analysis on those categories individually. You might see regrowth occurring more rapidly in the lower burn severity regions for example. If you are just interested in generally how long it takes for vegetation to come back you could create a fire perimeter shapefile and run the analysis over the entire region. It is a good idea either way to look at changes over multiple years to examine the regrowth.

Question 23: By replacing L8 with S2, it isn't able to execute as pixels increase from 5000. How do we decrease that?
Answer 23: Oh that is a good point, and highlights the limitation of GEE processing. You max out at a number of pixels for certain functions, and since the spatial resolution is higher, you can only do the analysis over a smaller region. I would recommend making your geometry smaller (via a rectangle or via a shapefile as an asset), then running the analysis again. I had to modify my geometry several times for the Landsat example to address that issue.

Question 24: For the Boliva example: setting the image selection dates: For the Post-Fire imagery, wouldn't a year window for an image selection result in some errors related to severity? Specifically, after a year following the fire, given potential vegetation recovery, wouldn't a year old image result in a different picture of burn severity compared to a few days after the end of large fire growth?
Answer 24: Yes, that highlights the pros/cons of doing this type of analysis. As mentioned in a previous question you have to strike a balance between finding an image with limited cloud coverage and an image close enough prior and after the fire to ensure you are primarily examining the effects of the fire(s) of interest. In tropical regions, it can be quite difficult to find an image with limited clouds, therefore we often set the time window to be longer, but then you run into issues of including fires or regrowth that you did not intend to analyze.

Question 25: What sort of existing characteristics in forest cover would be most appropriate for using the Relativized dNBR?
Answer 25: The RdNBR can be useful in regions where the vegetation cover is lower prior to the fire, but it also has its limitations. Here is a publication from the US Forest Service that outlines this and some of the pros/cons to both the dNBR and the RdNBR: https://www.mdpi.com/2072-4292/6/3/1827/htm

Question 26: How does one know which system is more accurate to run against; for example Copernicus or Landsat8; are they about the same?
Answer 26: That choice depends on the problem you are researching. Different satellites have different spatial and temporal resolutions, longevity of data availability, and spectral bands, among other things. For instance, Sentinel-2 has a spatial resolution of 10m while Landsat 8 has a spatial resolution of 30m. Different satellites may also give more accurate results than others depending on the process you are running. Here is more information from USGS on the difference between Landsat and

Sentinel-2:
https://www.usgs.gov/centers/eros/science/usgs-eros-archive-sentinel-2-comparison-sentinel-2-and-landsat

Question 27: Are there good datasets that would allow you to measure the emissions of large fires in Earth Engine? e.g. how much CO2 was emitted?
Answer 27: Yes you can take a look at aerosol data in GEE as well, such as satellite Sentinel-5P). Here is a list of atmospheric data available on GEE:
https://developers.google.com/earth-engine/datasets/tags/atmosphere

Question 28: What RGB combination with SAR SENTINEL 1 images can be used to determine the burn or fire scar?
Answer 28: There is quite a bit of recent research into using Sentinel-1 C-band SAR imagery in combination with optical imagery to determine/monitor burned area. Here are a couple articles:
https://www.sciencedirect.com/science/article/pii/S0034425719303645
https://www.nature.com/articles/s41598-019-56967-x

Question 29: NBR and other indices depend on some specific spectral bands, would there be an advantage to using hyperspectral data over the multispectral data available in Landsat or Sentinel?
Answer 29: Yes hyperspectral data may be useful in particular to improving the identification of vegetation types, fuel conditions, fire temperatures, emissions, and vegetation recovery. You are however limited by the availability of hyperspectral data and the additional processing knowledge (or computer space) for dealing with these images.

Question 30: Do you have any recommendations for indices besides dNBR if using UAV imagery for pre and post fire monitoring and only having access to red, green, blue, red edge, and near- infrared bands?
Answer 30: You could take a look at the NDVI (red and near infrared). If you see a dramatic and abrupt decline in the NDVI values this could also indicate fire activity.

Question 31: Why do you prefer to use Landsat and Sentinel data for post-fire monitoring, while there's another options like MODIS products?
Answer 31: The Landsat and Sentinel data have a higher spatial resolution, so you can identify things like the fire perimeter with more confidence. There are freely-available MODIS products that provide fire perimeters as well, but they often have a latency of a

few months to a year, so you might need to wait for longer to obtain those products as well. But they are still a good option if you are not interested in doing the analysis yourself.

Question 32: Would thresholds for these indices vary depending upon the geographical location(tropics or temperate), and also upon the seasonality(summer, post-monsoon/winters)?
Answer 32: Sure, you can modify the thresholds based on what you deem is most appropriate for your study area. As mentioned, ground-based information can help with that as well. You might also want to consider phenological changes to the vegetation in non-tropical regions where the vegetation health will decline in the winter months. It is best to use imagery as close to the yearly anniversary of the fires, to eliminate as much of this as possible.

Question 33: Hi! Thank you very much for the training, super useful! I am running the Bolivia example for another country, could you please explain again the criteria to select the pre-fire start and end dates? Should this interval cover a period with no fires?
Answer 33: Yes, ideally you would select pre-fire dates that fall well outside of the time of the fires. Depending on your region, you might also want to consider phenological changes to the vegetation in non-tropical regions where the vegetation health will decline in the winter months. It is best to use imagery as close to the yearly anniversary of the fires, to eliminate as much of this as possible.

Question 34: In the Bolivia case task in the high severity burning region, some places are completely unburned. I think those are the Landsat/Sentinel image tile edges. How is it possible? I think there is an error. Because when I usually process remote sensing data in ArcMap(ex: Toa or Lst calculation)the same happens. In that edgy region of the image tile, the values usually get either very high or very low. Any suggestions?
Answer 34: Yes, that could be an issue with how the data are being used to generate the composite images for the entire country of Bolivia. You could select a smaller geographic area that does not include the image edges, and you might be able to specify within GEE which image to use.

Question 35: Seems like with the S2 images we have a bottleneck of 5000 images for the composite. I've already created a smaller study area. Would it make sense to limit the cloudy pixel percentage for the image collection as well, so it does not try to process the super cloudy images?

Answer 35: Yes, that is a good idea, you can modify the cloud cover threshold in the code. I generally use 20% as a threshold value so that any images covered with more than 20% of clouds are eliminated.

Question 36: What is the best Sentinel 2 dataset available in GEE which has coverage of Kenya and Tanzania (for a study I am doing)? Could you link the specific dataset from the catalog, because there are so many to choose from its very overwhelming! What is the difference between Level 1C and Level 2A? When I try and visualize Sentinel 2 on the map there are always gaps over Kenya and Tanzania - why would this be?
Answer 36: I would use the Sentinel-2 surface reflectance products because those have already been preprocessed to deal with atmospheric effects (Level-2A orthorectified atmospherically corrected surface reflectance). The gaps are likely due to the revisit time of the satellite and the length of time you have set for your analysis. If you have a longer period of time, you will likely have full coverage of Kenya or Tanzania with the imagery. Here is a link to the Sentinel-2 imagery on GEE: https://developers.google.com/earth-engine/datasets/catalog/sentinel-2

Question 37: Does GEE use a 'default' coordinate system we should be aware of?
Answer 37: All data in the Earth Engine public data catalog is stored in its original map projection. However, you can easily *resample* the data into other map projections for analysis or visualization. Here is a link with more information about that: https://medium.com/google-earth/introduction-to-map-projections-with-google-earth-engine-part-1-7840e4ca6264

Question 38: In a case that the study area is covered by more than one scene, how would you deal with the mosaic process in GEE and the index calculations?
Answer 38: As you will notice with the Bolivia example, GEE will automatically generate a mosaic of images within your set time period using the best pixels available. Therefore, the composite might consist of pixels from different dates. You can ensure you have pixels all from the same date by limiting the time or by specifying the image (like we did in the Canada example). But there is a tradeoff between this and finding images that are not covered by clouds.