Questions & Answers Part 1

Please type your questions in the Question Box. We will try our best to answer all of your questions. If we don't, feel free to email Erika Podest (erika.podest@jpl.nasa.gov).

Question 1: Why use descending pass for flood mapping? Can we use an ascending pass?
Answer 1: You can absolutely use an ascending pass. To do that - go to the part of the code that specifies DESCENDING and replace it with ASCENDING and rerun your search. I used descending because in this case there were more images available than with ascending.

Question 2: Can someone please explain how the RGB was created? I don't see any code for it.
Answer 2: Lines 40 and 41 of the code create the RGB image. Min and max are how you want to stretch your values to visualize your image. Setting the min. and max values is purely through trial and error until you find the best stretch to visualize your image.

Question 3: Which polarization is best for mapping partially inundated croplands? What about shallow running water?
Answer 3: The cross-pol is better at detecting open water because it's a specular scatterer and it does not depolarize the signal. For partially inundated croplands, VV if using Sentinel-1. The reason for this is because there is a higher probability of penetration through the canopy and hence detection of inundation with VV. With cross-pol such as VH, the signal tends to depolarize when there are many scatterers within the illuminated area. The signal will scatter from many different components of the vegetation. This increases the likelihood of depolarization and reduces penetration. With VV, there will not be as many bounces since the signal is only interacting with the vertical components of the surface. If using PALSAR, then it would be HH.
The best polarization for detecting shallow running water is the cross pol, VH in the case of Sentinel-1.

Question 4: Can you please explain the color and the extent of flooding in greater detail? Higher intensity of color, means more reflection makes sense but does that translate to more flooding on that particular date?

Answer 4: The colors correspond to dates of flooding. They are not associated with intensity. Everything that was flooded for the 21st of August is in green, for example. The difference map, however, is interpreted such that the brighter pixels are areas of change - in this case that change is associated with inundation. Therefore in the case of the difference between Aug. 9 and Aug. 21, areas that are bright indicate that the backscatter was high on Aug. 9 and low on Aug. 21.

Question 5: Initially, how am I going to decide a threshold (like 1.25 in the script) without knowing? Depending on what parameters will the threshold be decided or is that like applying and checking and updating?
Answer 5: It is indeed applying and checking and updating through trial and error. Validation data can be useful when doing this. You can also click on a pixel on the difference image and look at its value. One thing you can also do is draw a polygon over your bright areas and calculate the average value in those bright areas and define your threshold based on that. You can also create a histogram based on the values of your image to help visually define your threshold.

Question 6: When doing a large-scale flood analysis, for example an entire country, is connectedPixel able to perform that fast enough during such analysis? Or does the region of study need to be subdivided to match the maximum number of pixels allowed by GEE?
Answer 6: Good question. Some of these things do time out if the domain is too large. You will have to see what works for you. If it's too large of a region it just won't compute that calculation and you will have to subdivide your area. However, I do not know what that size limit is.

Question 7: How would you differentiate between inundation in urban areas and inundation in forest/vegetation areas?
Answer 7: The dominant backscattering mechanism in urban areas and in inundated vegetation is the same - double bounce. Since these areas are equally bright, the best way to differentiate them is to use an external map delineating urban areas and mask those areas out.

Question 8: Is there a way to set the upper threshold automatically so that the flood extent can be produced easily for any area of interest?
Answer 8: You can create polygons for the bright areas and look at the median, mean, and standard deviation and define different cutoffs based on those statistics. You can then apply the threshold and validate it using different values. Then you can identify

which threshold yields the highest accuracy (based on validation pixels). All of that can be automated.

Question 9: Can SAR be used to identify different types of water based on dissolved substances, say a muddy water, clear water...
Answer 9: No it can't, not directly. Optical is sensitive to the chemical properties of your surface. SAR is sensitive to structure, roughness, and dielectric. You might be able to identify that your water has different characteristics based on its surface roughness (i.e., surface roughness in the area of an oil spill is different than that of an oil-free area) but you cannot identify whether those differences are due to dissolved substances.

Question 10: How can we generate layover and shadow masks using GEE?
Answer 10: Take a DEM and mask out areas of complex topography. Then look at the values within that area of complex topography and mask out the areas that are very low, which are likely shadows. You can also use an aspect map and mask out the areas that have low backscatter that are facing away from the radar. Use DEM and incidence angle to identify layover as well.

Question 11: What is the min, max value here and what is the last value in the array (0)?
Map.addLayer(sep_02.select('VH'), {min:-25,max:-5}, 'S1 Sep. 02, 2018 VH', 0);
Answer 11: Min and Max is how you stretch your pixel values in order to visualize your image. It has nothing to do with changing the values within the image. A 0 at the end means that your image is going to be added to the layers bar but it will not automatically display unless you click on it in the layers bar. A 1 means that the image will automatically display when you run your code.

Question 12: What does the .multiply function do?
Answer 12: It is used to calculate the area of flooded pixels. I counted the number of pixels that were inundated and multiplied it by the pixel resolution (10 meters) and then converted meters to hectares to get the total inundated area in hectares.

Question 13: Can we quantify uncertainties associated with the final flood extent map by using any statistical means?
Answer 13: If you have validation data you can compare the areas that were classified as inundated with ones that were actually inundated. You can generate an accuracy percentage based on your results.

Question 14: Can we upload our own created land cover map created using Sentinel-2?
Answer 14: Yes, of course you can. Go to assets > new and from there you can upload a GEOTIFF, shapefile or .csv file.

Question 15: Is it possible to derive flood depth from this flood extent map?
Answer 15: No, it's not. What we're looking at here is just inundation - whether it is 1cm or 10m of water above the soil - the signal response is the same. Flood depth is more complicated and you would have to use phase. There is a NASA satellite in development called SWOT, which will be launched within the next 2 years and will measure water change differences in inland water bodies.

Question 16: Is this code like an automation of the manual work that can be done in SNAP software?
Answer 16: If you were to download these images for use in SNAP, you would have to do the preprocessing. The software used to preprocess the images on GEE is the SNAP software, therefore, if you decide to preprocess the images yourself on SNAP, they should look exactly the same as the ones on GEE. You can apply thresholds and derive the same results on SNAP. The only downside is that you would need to download the four images to your desktop, which can be large (about 1.2 GB each).

Question 17: Can we go lower than 10 meters in Sentinel-1?
Answer 17: Not with the GRD. These are ground range projected datasets. In fact, 10 meters is the maximum resolution. Since we're applying a speckle filter, it reduces the spatial resolution. Therefore, even though the derived product is gridded to 10 meters, it is actually not 10 meters.

Question 18: Sentinel-1 band on Google Earth Engine has not been really helpful in detecting floods in the forest. Is there a way to process the SAR band C data to improve on detection of flooded forest? Or some post processing methods?
Answer 18: Unfortunately, it's not a matter of processing the data, it's the physics of the signal interaction with the land surface. C-band has a wavelength of 5-6cm and it will therefore not penetrate through dense forests in order to detect flooded conditions. You would need L-band data to penetrate dense forests.

Question 19: Do you have any suggestion to access a validated criteria for selecting thresholds?

Answer 19: Take a look at the polygons and histograms to give you a sense of the values. That is the best way to guide your selection of a threshold.

Question 20: Which constraints do you see on applying SAR products in detecting flood areas in urban regions?
Answer 20: You already have double bounce in urban areas. Flooding causes more double bounce. You might also have specular scattering. You will have to create difference images using a before and after event image and set an upper threshold (to detect areas where there is open water such as open areas, baseball fields, golf courses, etc) and a lower threshold (to detect areas where there is double bounce (such as inundated streets in dense urban areas or inundated vegetation in urban parks).

Question 21: What is the impact of de-polarisation on scattering from objects?
Answer 21: The radar signal tends to depolarize when there is volume scattering, such as in a vegetation canopy. That is why cross polarizations are very good at detecting the presence of vegetation.

Question 22: Can we use higher resolution land cover maps such as ESA WorldCover 10m v100 to remove misclassified pixels in areas where there is permanent open water?
Answer 22: Yes, of course. The ESA WorldCover map is on Google Earth Engine.

Question 23: Thank you for your presentation, For line 16 of the script, why did you include the "999" when you had to put it on the list: collection_list=ee.ImageCollection(collection).toList(999);
Answer 23: It wasn't actually needed here. But if you expect many images from your search, you will want to specify that the list will be long and make space for it since the list function has a default number of rows.

Question 24: In question 3, you explained why using VV instead of VH to detect inundated crops. But shouldn't HH be equally good as VV for that?
Answer 24: Yes, I explained VV because that is what Sentinel-1 has. HH is actually even better to detect inundation vegetation because it has an even higher likelihood of penetration through the canopy.

Question 25: I have questions for Sentinel-2 on GEE. Is it possible to use the Sentinel-2 to map the flooded area? Is the image in db or dn? What calibration has been done for the Sentinel-2 datasets?
Answer 25: Sentinel-2 images are optical, which you can also use to map flooded areas. Radar is particularly useful because inundated areas are typically cloud-covered. The Sentinel-1 images on GEE are in db. You will have to take a look at the Sentinel-2 database on GEE to see how that specific dataset has been calibrated.

Question 26: Will the values of extent of flooding vary in open waters in different bands like C and L?
Answer 26: I suspect that the extent of detection of open water will not vary significantly between L and C band since specular scattering is always going to be very low.

Question 27: Can I determine present and past surface melt on an ice-sheet? Which polarization will be better - HH or HV?
Answer 27: Yes, you can. There is a large change in dielectric between frozen and liquid water on ice sheets.

Question 28: Does the signal response differ if the flood consists of a lot of soil/sand debris? e.g., flood in mountainous/volcanic areas?
Answer 28: As long as the open water surface is a specular scatterer, the signal response is not going to differ.

Question 29: Can trees and canopy lead to underestimation of flooded area?
Answer 29: When you have inundated vegetation the radar signal is dominated by double bounce and appears as very bright. In areas of open water it's very dark. You can account for inundated vegetation by setting a threshold to classify pixels above a certain value.

Question 30: How can we use full polarimetric data for flood inundation mapping?
Answer 30: It might be easier to detect different types of inundated vegetation with fully polarimetric data. You can do a polarimetric decomposition and identify the areas where double bounce dominates and classify those as inundated. The challenge is obtaining the fully polarimetric data.