Due date for submitting the assessment: 11 August 2023 17:00 EST

Submission requirements: Submit all scripts, output, applicable screenshots and share repository that you have created while completing this assessment.

You may be asked to do a presentation based on the outcome of your assessment. Save all your original work.

1. **You have been given a list of projects (excel sheet), each with a location point (latitude, longitude) and an associated boundary file in KML format. You need to identify if the location points are inside the corresponding project’s KML boundary or not.**

**To do this, you can write a script or procedure that checks if the given latitude and longitude are within the boundary of the project. If the latitude and longitude are not within the boundary, you can create a centroid of the project and use that as the location point and update the excel file. The .kml files names begin with the project id.**

The output can also be found in the excel file named “output to append”.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Project ID | Latitude | Longitude | Inside the boundary (Y/N) | If Not, Latitude | If Not, Longitude |
| 2262 | -73.574749 | 1.761024 | NO | 1.757593204 | -73.57228171 |
| 2587 | -60.962586 | -6.522687 | NO | -6.563893531 | -60.94464611 |
| 2586 | -60.760809 | -5.963038 | NO | -6.039228335 | -60.81272852 |
| 2538 | 11.92694 | -33.656109 | NO | 11.50355263 | 2.159482421 |
| 2842 | 0 | 0 | NO | 22.27537325 | -105.5148292 |
| 2556 | 27.096944 | -57.981664 | NO | -27.09032635 | -56.36835165 |
| 3227 | 47.28689 | -48.131012 | NO | 47.41788909 | 132.0181622 |
| 3237 | 47.312702 | -48.385529 | NO | 47.35787177 | 131.6509616 |
| 3236 | 47.451523 | -48.259506 | NO | 47.43546312 | 131.8624146 |
| 3235 | 47.58 | -48.33 | NO | 47.56422376 | 131.8316825 |

1. **You have been given a project boundary of a REDD project in Canada (Question 2). You can use Google Earth Engine to classify the land cover of that project by selecting two cloud-free images that are at least two years apart from the Google Earth Engine image catalogue. You can use existing ground truth dataset for image classification and accuracy assessments.**

I did not understand the purpose of using images that are at least 2 years apart. If it is for change detection, we will need to use two different sets of training and testing features. Here, I used the same features. When I tried to filter out one particular cloud free image, a lot of Landsat scenes were missing from the project area. Therefore, instead of single image from each year, I used an average image filtered by < 10% cloud cover.

The link to Google Earth Engine code can be found here:

<https://code.earthengine.google.com/25d2bcd62425c45d26a5b2b3076bb9a4>

A map of canada with red and blue colors

Description automatically generated

Figure 1: 2017 Landsat image classification

A map of canada with different colored areas

Description automatically generated

Figure 2: 2020 Landsat image classification

1. **Using data acquired from remote sensing in estimating biomass and hence carbon has a huge potential in digital monitoring, reporting, and verification (DMRV) for forestry related projects. However, its usage is not very widespread at present. There are several challenges that need to be overcome to make remote sensing a more widely used tool for DMRV. Please describe some of the challenges and the ways which we can use to overcome them and make remote sensing a more widely used tool for DRMV.**

Carbon monitoring research has rapidly expanded over the last two decades due to international agreements targeted at reducing carbon emissions and establishing the need for accurate MRV of carbon. Presently, MRV can be done using available satellite and forest inventory data. At a project scale, carbon MRV can be conducted exclusively with in situ data. However, monitoring forest carbon change at regional and global scales using field based methods is constrained by time and labor costs. Currently, remote sensing monitoring of forest carbon change can be done using optical, SAR and LiDAR data. A number systems launched during the past decade greatly enhanced the monitoring capability, including Landsat, Sentinel-1, Sentinel-2, ICESAT-2, and GEDI mission. One major challenges for DMRV is the reliability and accuracy of estimates of emissions reductions on which payments are based. Traditional forest inventories are statistical sampling of a population and typically collect measurements over large number of plots selected using design-based sampling schemes thus, can provide comprehensive regional estimates of above ground (ABG) carbon with relatively small errors. Generally, the uncertainty reported in the remote sensing model is plot level uncertainty which does not tell us how good the map is doing over an area. Remote sensing models are trained over large populations and may result in higher uncertainty if we use it to estimate on an area. The possible solution to deal with this problem is using vast amounts of data with actual projects that have traditional inventories inside them where we can compare the estimates made by our model in those areas to the estimate made by the actual forest inventory. But, in reality, nobody has that kind of data. Although SAR is more sensitive to vegetation structure than optical systems, both of the systems saturate in mid- to high-biomass levels. Obtaining accurate ground truth data for calibration and validation of remote sensing models can be logistically challenging and expensive. Of the three remote sensing instrument types, LiDAR can provide metrics that are directly related to forest structure and height and hence has potential for accurate biomass estimation. ICESAT-2 and GEDI have collected large quantities of LiDAR samples which will allow for more robust calibration and validation of mapping algorithms at regional to global scales. However, these current spaceborne LiDAR systems can only collect samples along their tracks. Therefore, data fusion technique can be applied to use these samples with optical sensor like Landsat to create spatially contiguous biomass map. An integrated approach that combines remote sensing data, in situ data, and machine learning models could form part of systematic framework for monitoring changes in forest cover and carbon stock. With sophisticated machine learning models, we can process vast streams of remote sensing data and these machine learning models can be trained with manual inventories data to get sound carbon estimates. Instead of requiring an inventory for every project, we can build models that are validated for a particular region and apply those models to the data acquired by satellites.