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Tutorial for degradation monitoring in SEPAL

Cambodia, Phnom Penh Hotel

7-11 May 2018

INTRODUCTION AND OBJECTIVES

In the context of the REDD+, Cambodia has a national program that benefits from support of FAO for the establishment of its National Forest Monitoring System. As noted in Cambodia 2016 FREL submission, degradation of forests represent a significant source of emissions that couldn't be accounted for at the time because the information to support was not robust and reliable enough.

The use of dense time series to analyze trends in forest cover change is one of the different approaches to monitor degradation through remote sensing¹. This approach is computationally intensive and requires to process large volumes of data.

Verbesselt et al. (2010, 2012), Dutrieux et al. (2015) and DeVries et al. (2015) used the Breaks for Additive Seasonal and Trend (BFAST) approach to demonstrate that time series can be decomposed into trend, seasonal, and remainder components and that the time and number of changes can be detected at high temporal resolution (i.e., 16 days), enabling detection of tree cover change and separation from phenology signal.

The same authors developed the [bfastSpatial package](#) (R language) which provides utilities to perform change detection analysis on time-series of spatial grid data, such as the Landsat satellite imagery.

FAO has developed the System for Earth Observation Data Access, Processing and Analysis for Land Monitoring (<https://sepal.io>), a big-data processing platform that combines super-computing power, open-source geospatial data processing software and modern geospatial data infrastructures like Google's Earth Engine.

In collaboration with the University of Wageningen, FAO has adapted the bfastSpatial package into a functional processing chain (<https://github.com/yfinegold/runBFAST/>) that uses both Google Earth Engine (GEE) for the preparation of the time series and SEPAL for the processing of the algorithm itself.

This tutorial is developed for the GDANCP/MOE team and aims at:

- providing an introduction to cloud computing
- training the staff to the use of the bfastSpatial package within SEPAL
- training the staff to the use of Object-Based processing chain on the server

¹ Assessing Forest Degradation. FAO Lessons Learned. In: Proceedings of the Joint GFOI/GOFC-GOLD Expert Workshop #2 on "Approaches to monitoring forest degradation for REDD+". GFOI. 2014. <http://www.gfoi.org/rd/second-rd-workshop/>.

REQUIREMENTS

All necessary data for the completion of this tutorial is available at https://github.com/lecrabe/ws_khm_20180507

Background information on the OpenForis initiative
www.openforis.org

You can request Access to SEPAL with the following

- 1/ have-open a GMAIL account (in order to access Google Earth Engine functionality)
- 2/ get the account registered and white listed in Google Earth Engine
<https://earthengine.google.com/signup/>
- 3/ open an account in SEPAL <https://tinyurl.com/sepal-access>

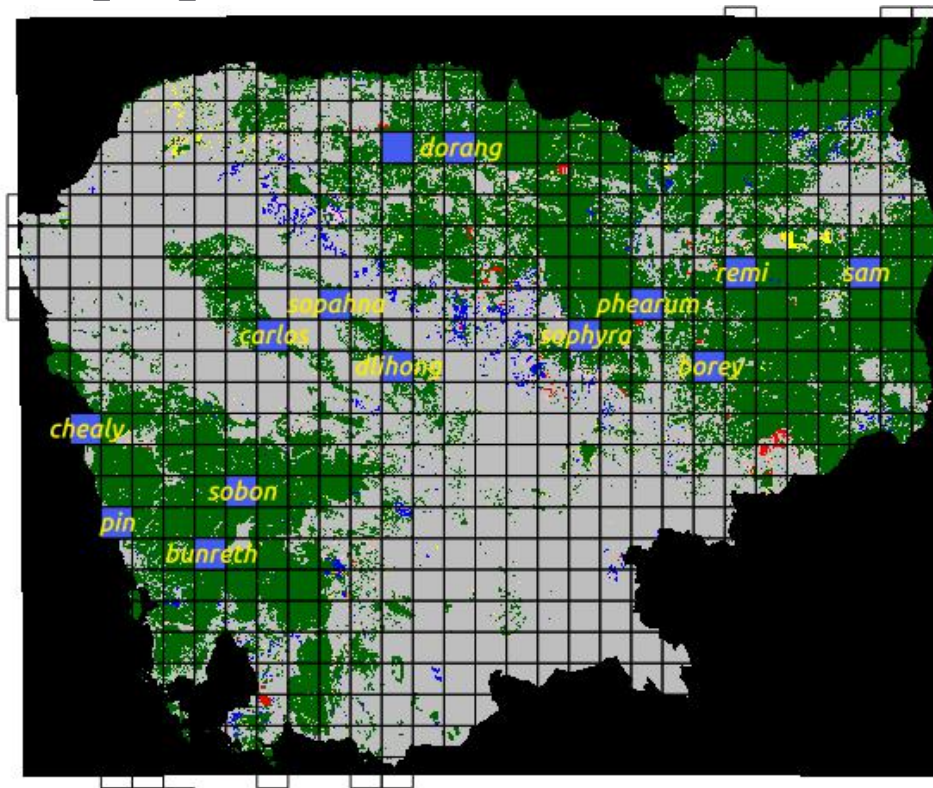
If not completed, please fill in the quick intro survey:
<https://goo.gl/forms/Jv2mCTLhMGYHjiQh2>

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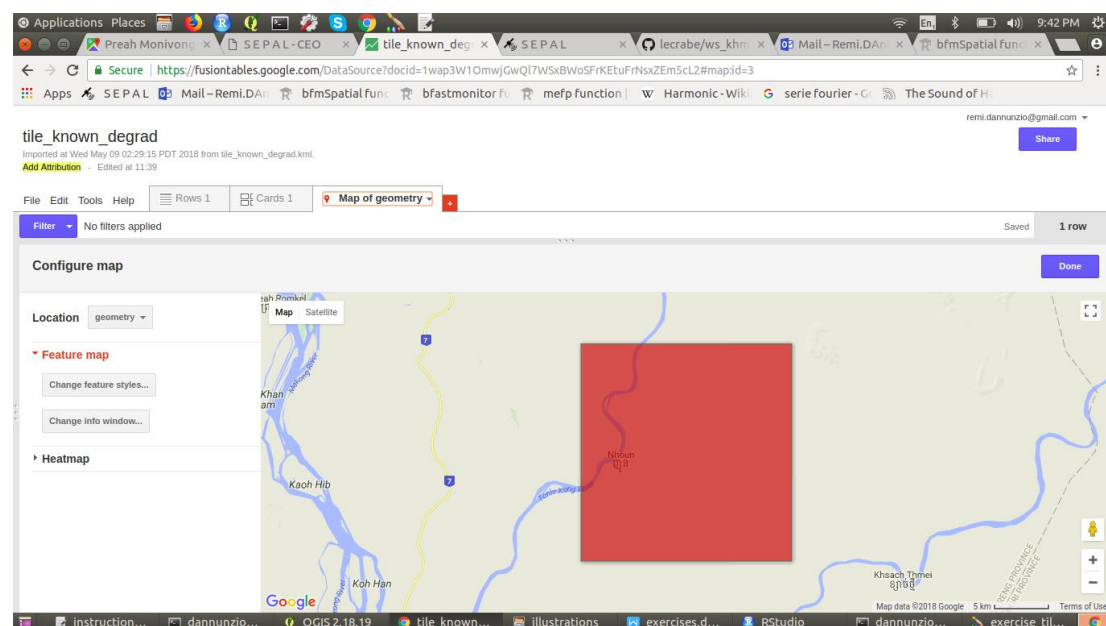
1. Create an AOI

Load the exercise shapefile of 20x20 tiles in a GIS
“~/ws_khm_20180507/data/tiling/exercise.shp”



Select the tile corresponding to your name, Save the tile as KML
Load the tile as a Fusion Table, make it public, copy the FT ID

For example: 1wap3W10mwjGwQl7WSxBWoSFrKEtuFrNsxZEm5cL2

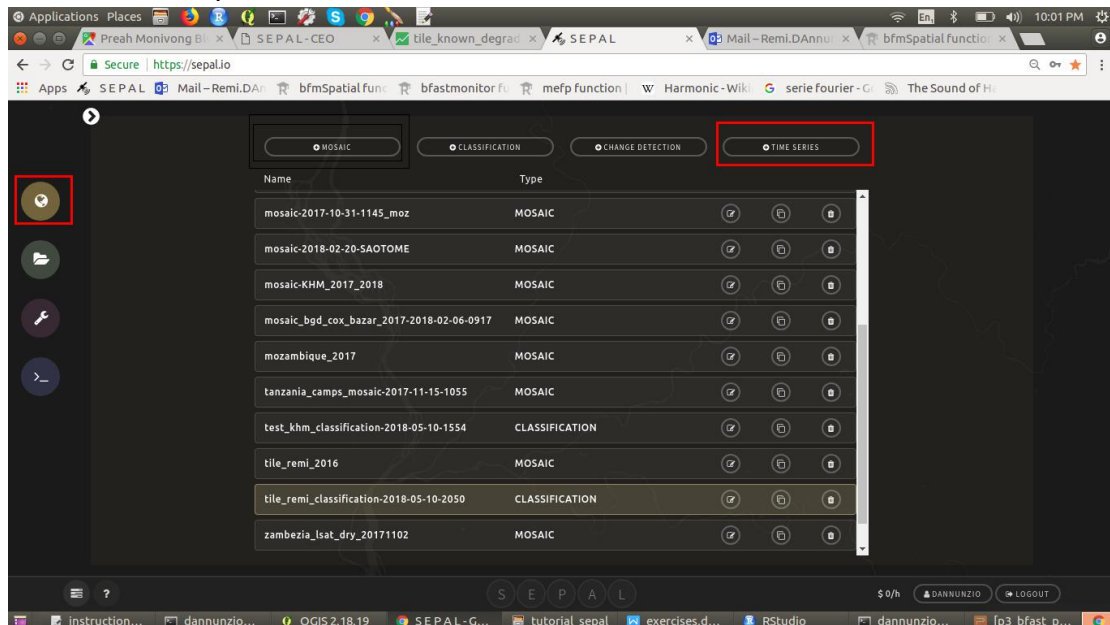


2. Generate Data

Open <https://sepal.io>

2.1 Generate satellite imagery Time Series for an index

Start Search / Time Series

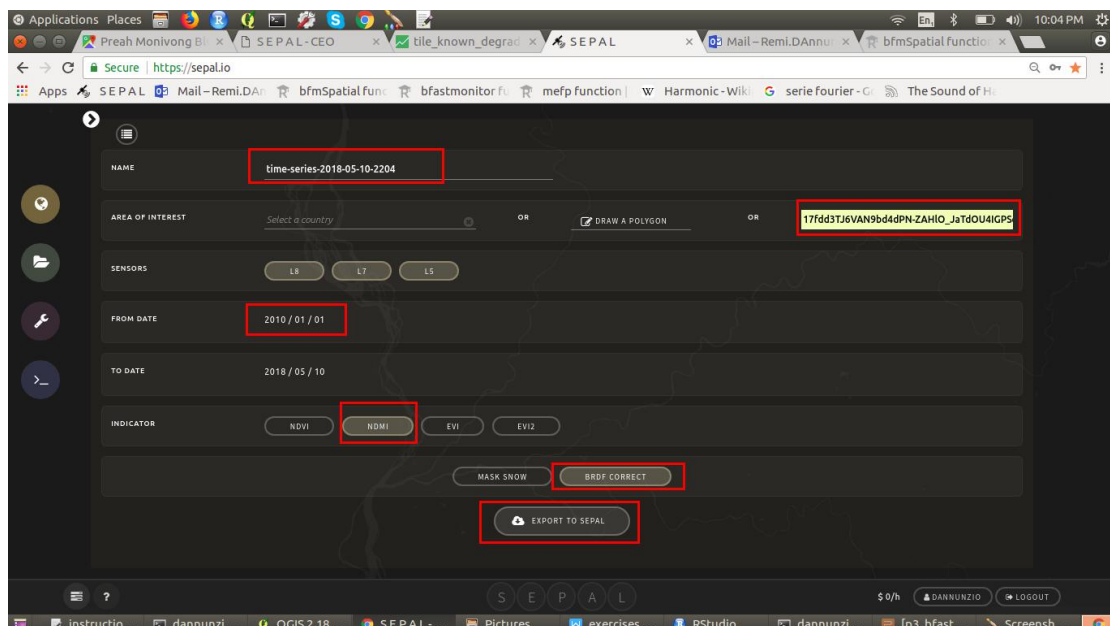


Change the name, Use the FT ID as Area of Interest

Select dates 2010-01-01 to Current date

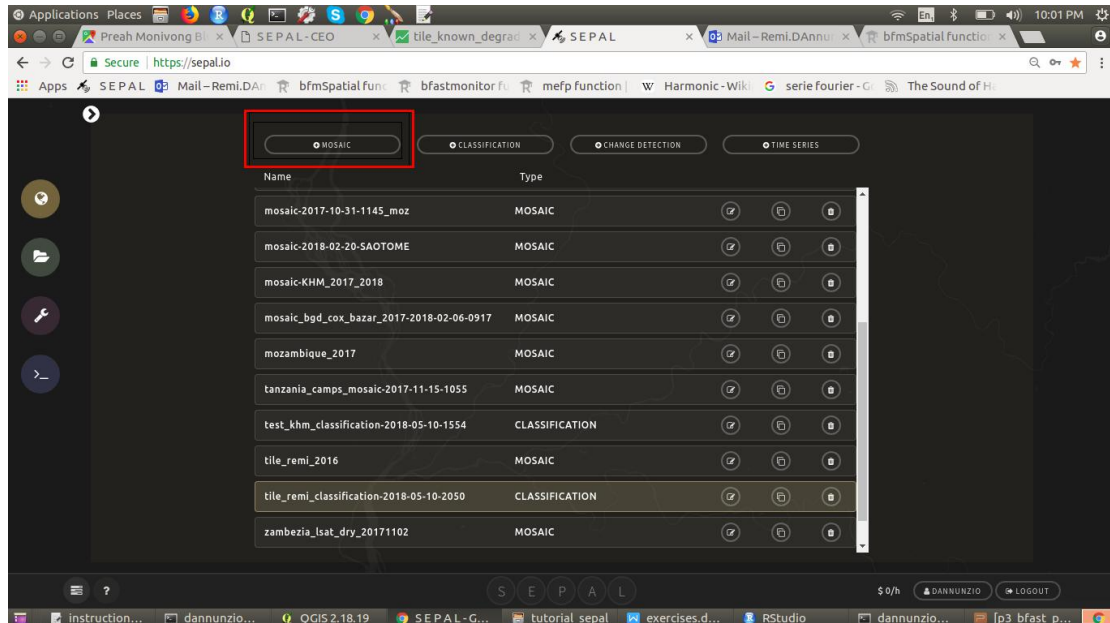
Select NDMI, BRDF correct

Export your Time Series to SEPAL



2.2 Generate a satellite imagery Mosaic

Start Search / Mosaic



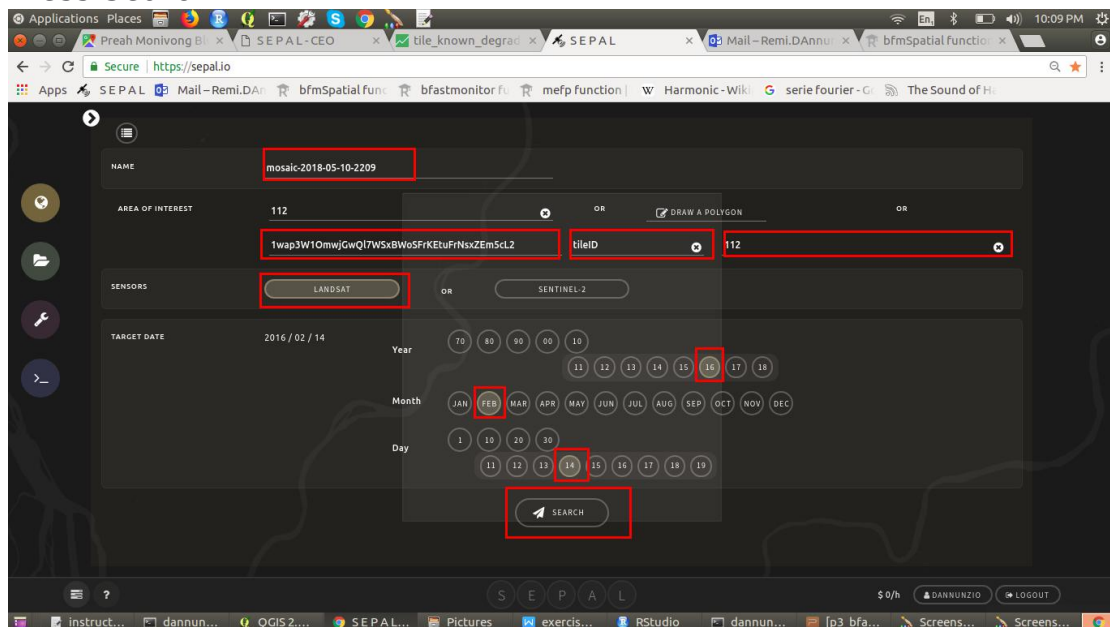
Change the name

Use the FT ID as Area of Interest

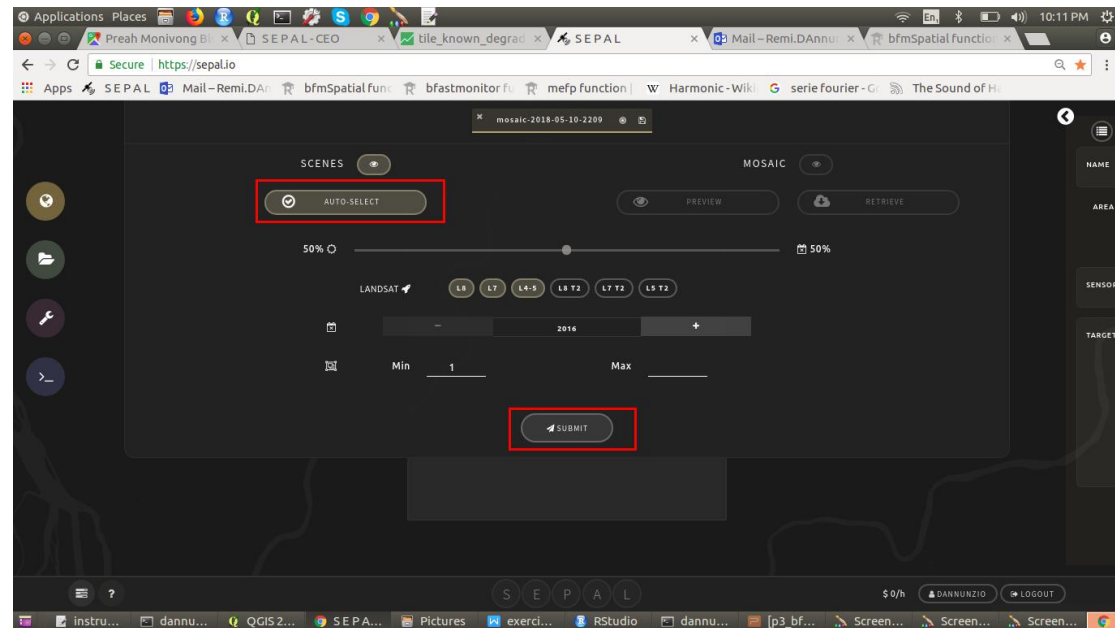
Select LANDSAT

Select date 2016-02-14

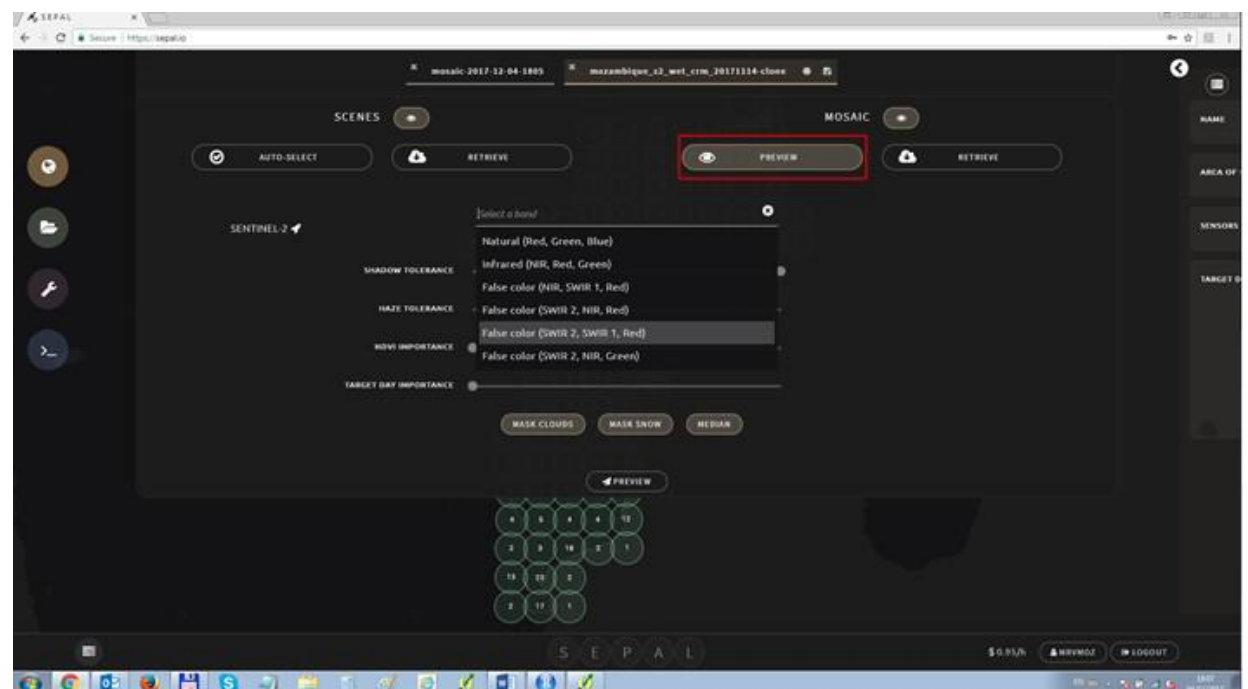
Press Search



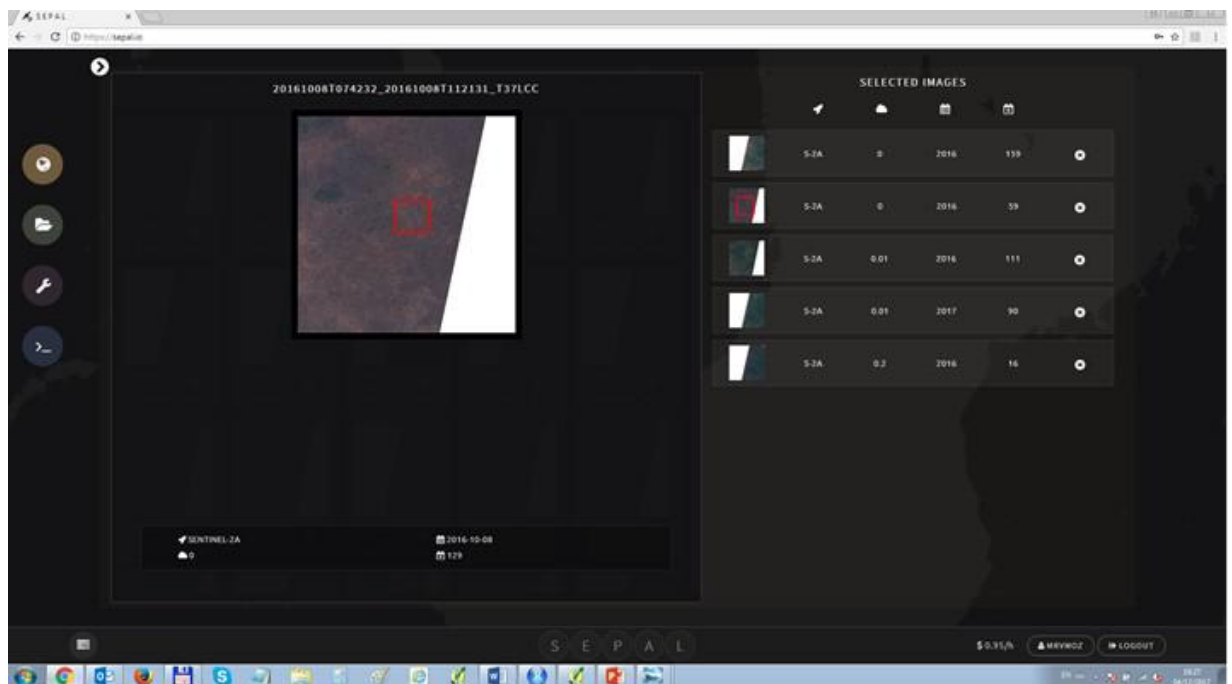
Press Auto-Select and Submit



Press Preview and Select a band combination

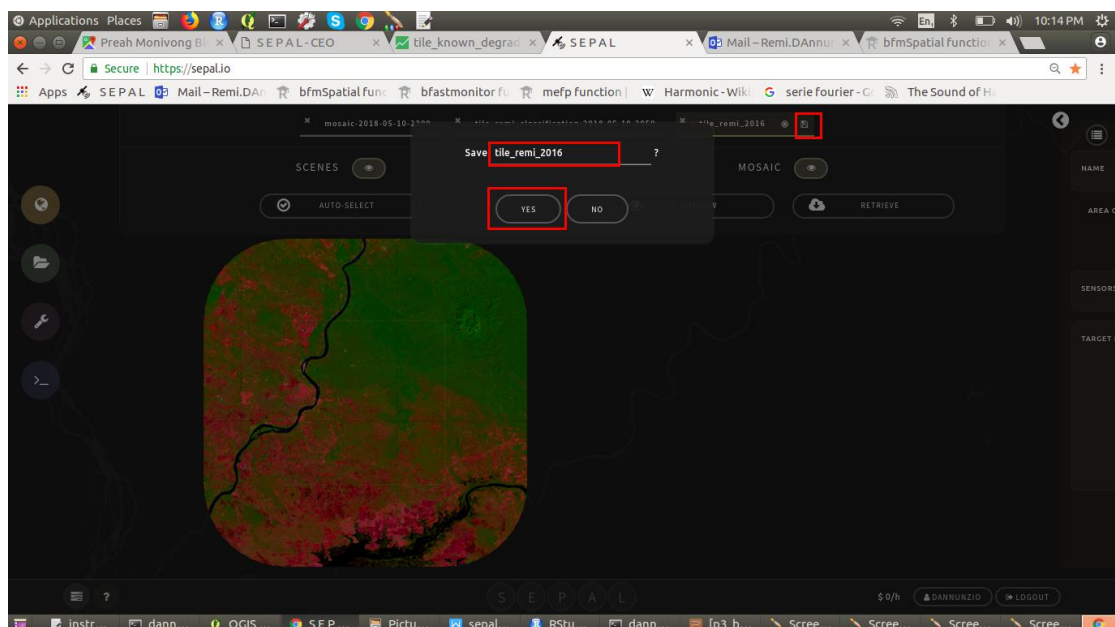


Change the scenes if needed by clicking on them

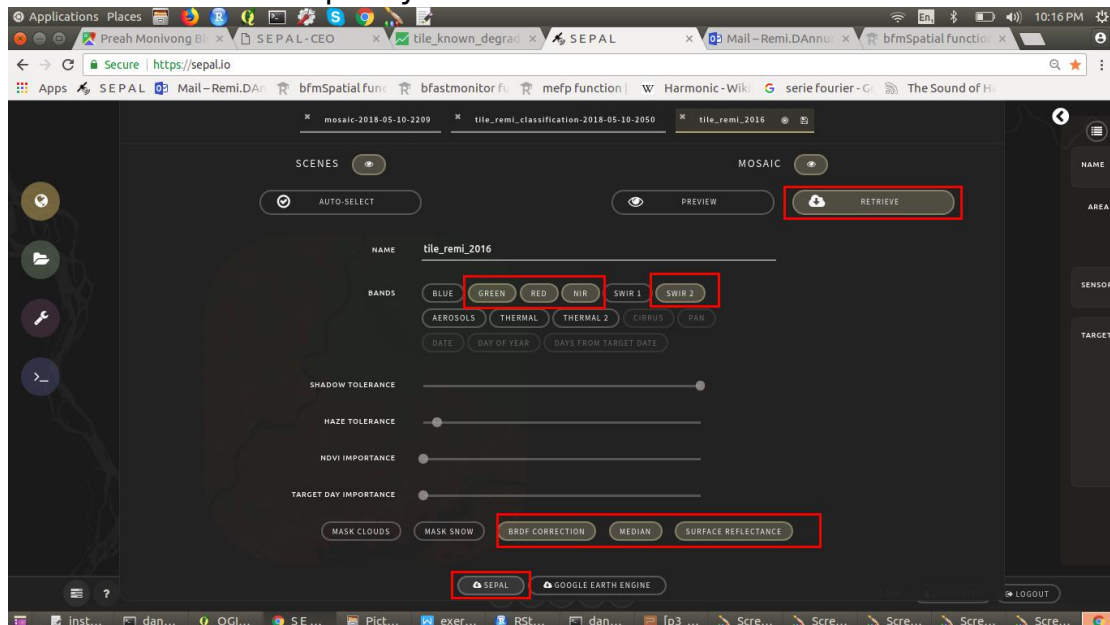


Once you are satisfied with your mosaic, you can save as a recipe in the top right button. You will be able to access again your mosaic with the saved parameters.

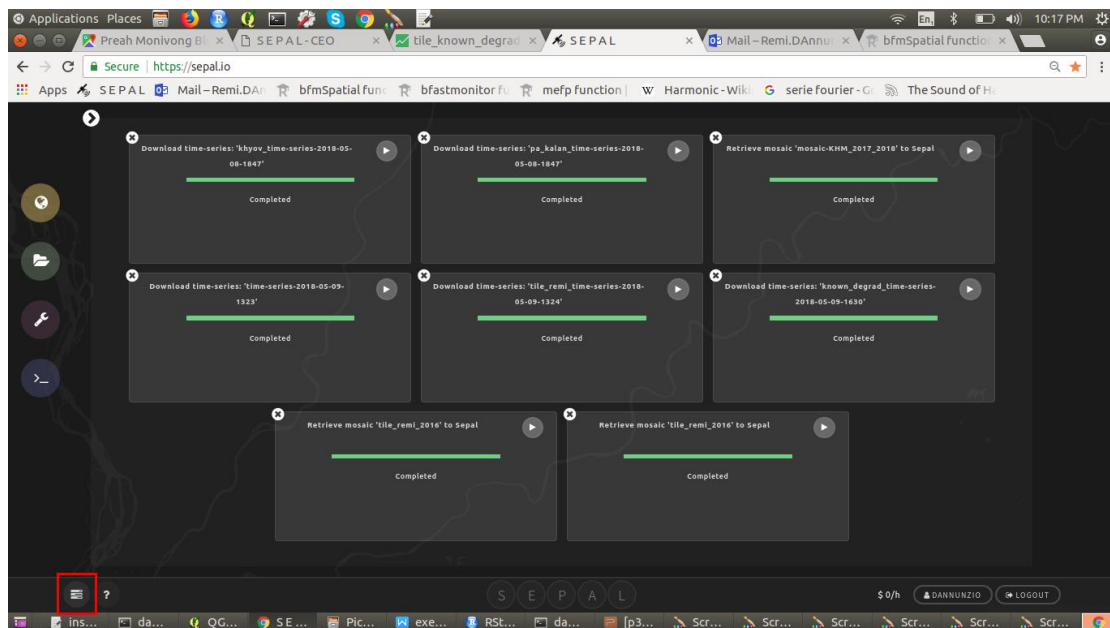
Edit the Name if needed



Press Retrieve with bands Green, Red, NIR, SWIR2, BRDF correct, median, surface reflectance.
Choose SEPAL to export your mosaic.



You can monitor the download progress in the bottom left icon



3. Run BFAST

Check your budget, kill any t2 instance

The screenshot shows the SEPAL web interface. On the left, the 'USER' profile for Remi D'Annunzio is displayed with fields for NAME, USERNAME, PASSWORD, EMAIL, ORGANIZATION, and GOOGLE ACCOUNT. On the right, the 'USED RESOURCES' section shows a table with Quota and Used values for Monthly Instance Budget, Monthly Storage Budget, and Storage. Below this, the 'SESSIONS' table lists active instances, with the 't2.small' instance highlighted by a red box. At the bottom right, the user's name 'DANNUNZIO' is highlighted with a red box.

NAME	Remi D'Annunzio
USERNAME	dannunzio
PASSWORD	[CHANGE]
EMAIL	remi.dannunzio@fao.org
ORGANIZATION	UN-FAO
GOOGLE ACCOUNT	[USE SEPAL'S ACCOUNT]

	Quota	Used
Monthly Instance Budget	100 USD	48.78 USD
Monthly Storage Budget	100 USD	11.16 USD
Storage	200 GB	100.18 GB

Instance type	Time	Cost	Minimum time frame (hours)
t2.small	in 4 minutes	0.03 USD	0

Open the terminal and start a #6 instance (type 6 and ENTER)

The screenshot shows the SEPAL terminal interface. It displays the SSH connection details and a list of available instance types. The user has selected instance #6 (t2.small) and is prompted to create a new session. The terminal shows the session is starting and the user is prompted to wait.

```
[Press Shift-F1 for help]
Host/ID or ssh:// URL [localhost]: ssh://dannunzio@ssh-gateway?identities=id_rsa
Connecting to ssh://dannunzio@ssh-gateway:22

The following SSH identities are being used for this connection:
id_rsa

----- Monthly budget -----
Instance spending/budget: 48.78/100 USD
Storage spending/budget: 11.16/100 USD
Storage used/quota: 100.18/200 GB

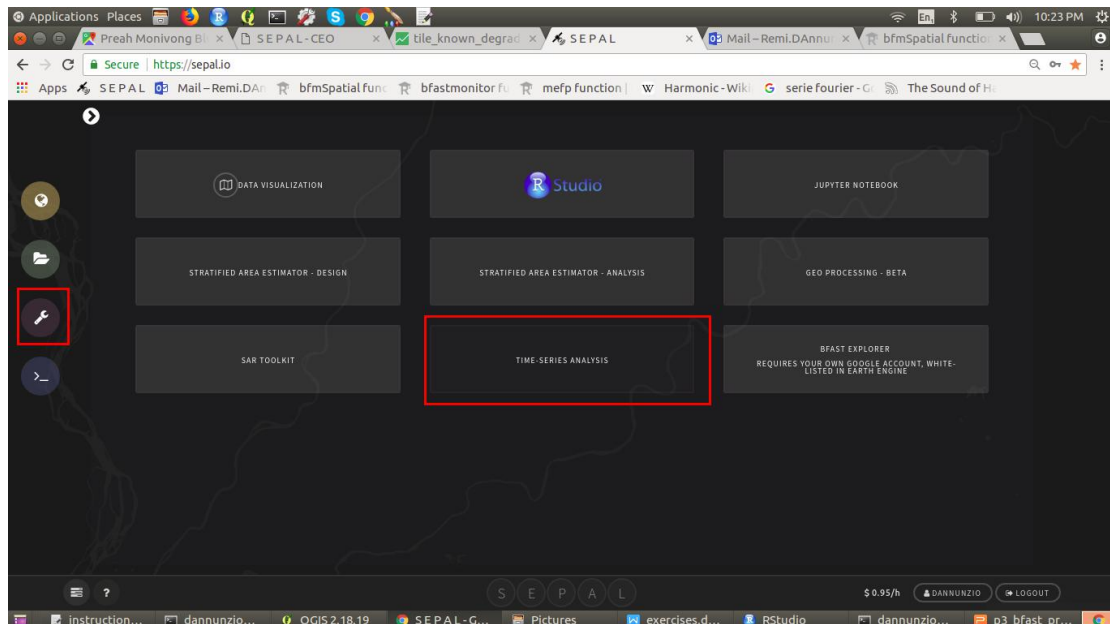
----- Create new session -----
1 t2.small, 1 CPU / 2.0 GiB, 0.025 USD/h
2 m3.medium, 1 CPU / 3.75 GiB, 0.073 USD/h
3 m4.large, 2 CPU / 8.0 GiB, 0.139 USD/h
4 m4.xlarge, 4 CPU / 16.0 GiB, 0.238 USD/h
5 m4.2xlarge, 8 CPU / 32.0 GiB, 0.453 USD/h
6 m4.xlarge, 16 CPU / 64.0 GiB, 0.95 USD/h
7 m4.2xlarge, 32 CPU / 128.0 GiB, 1.917 USD/h
8 m4.4xlarge, 64 CPU / 256.0 GiB, 3.883 USD/h
9 c4.large, 2 CPU / 3.75 GiB, 0.113 USD/h
10 c4.xlarge, 4 CPU / 7.5 GiB, 0.226 USD/h
11 c4.2xlarge, 8 CPU / 15.0 GiB, 0.453 USD/h
12 c4.4xlarge, 16 CPU / 30.0 GiB, 0.905 USD/h
13 c4.8xlarge, 32 CPU / 60.0 GiB, 1.811 USD/h
14 r4.large, 2 CPU / 15.25 GiB, 0.148 USD/h
15 r4.xlarge, 4 CPU / 30.5 GiB, 0.296 USD/h
16 r4.2xlarge, 8 CPU / 61.0 GiB, 0.593 USD/h
17 r4.4xlarge, 16 CPU / 122.0 GiB, 1.186 USD/h
18 r4.8xlarge, 32 CPU / 244.0 GiB, 2.371 USD/h
19 r4.16xlarge, 64 CPU / 488.0 GiB, 4.742 USD/h
20 x1.16xlarge, 64 CPU / 976.0 GiB, 8.883 USD/h
21 x1.24xlarge, 128 CPU / 1952.0 GiB, 15.666 USD/h

Select (1): 6

You can run this session for 53 hours. If you require more processing time, please consider reducing the size of your selected instance, or contact a SEPAL administrator to increase your resource limits.

Session is starting. This might start a new server, which could take several minutes.
Please wait...
```

Go to Process / Time Series Analysis

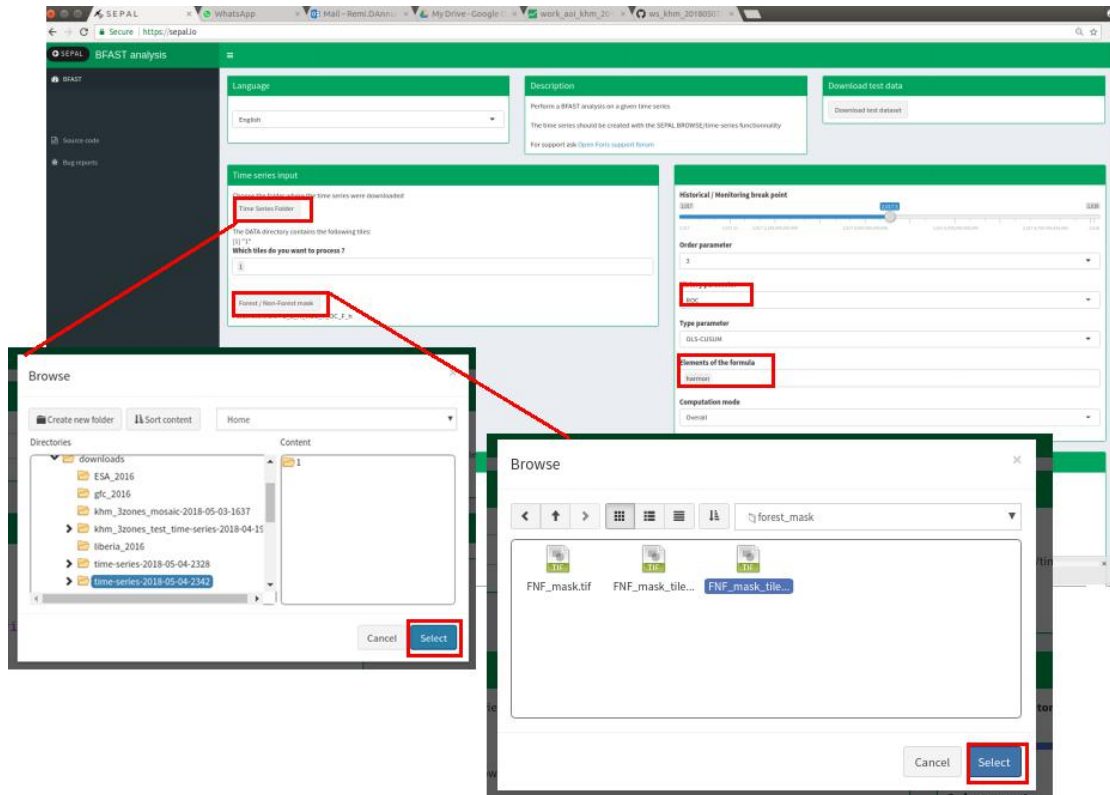


Select the tile you exported

Load the forest mask and select "FNF mask"

Change your options for History (All) and Formula (h+t)

Launch the process



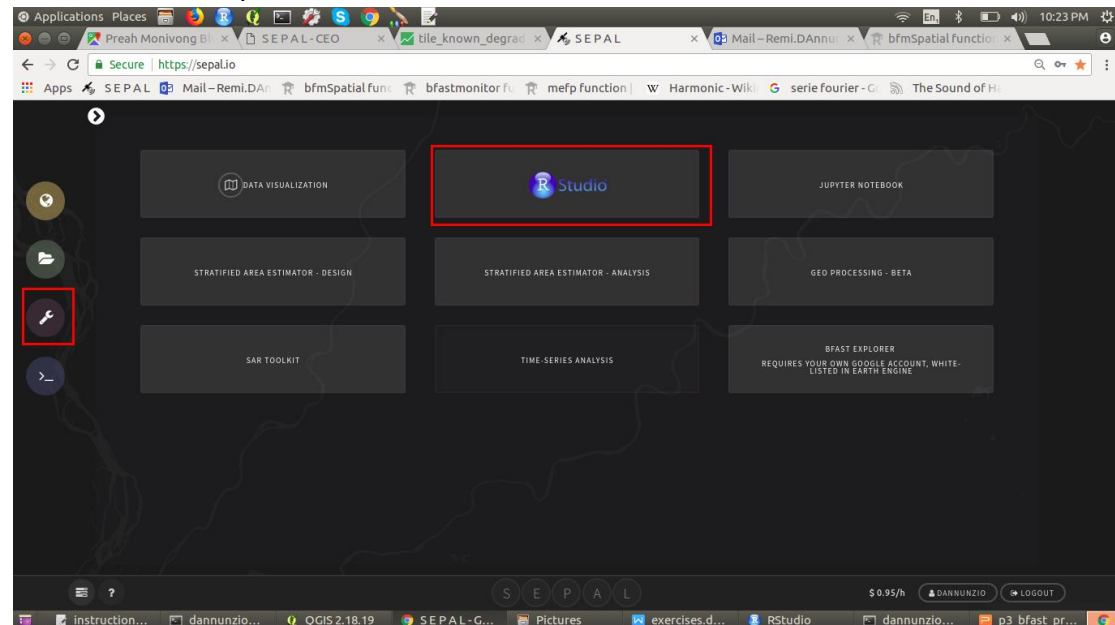
Download the product to your computer using either Browse or a SSH/FTP solution like FileZilla

4. GFC spatial integration exercise

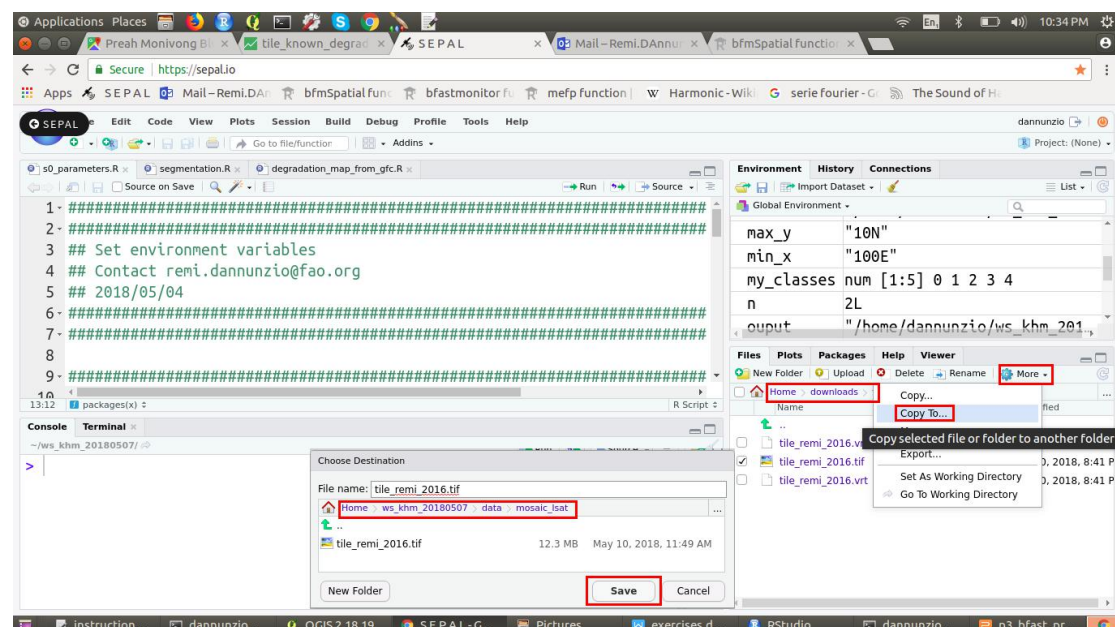
Check your budget, kill any instance

Open the terminal and start a #4 instance

Go to Process / RStudio

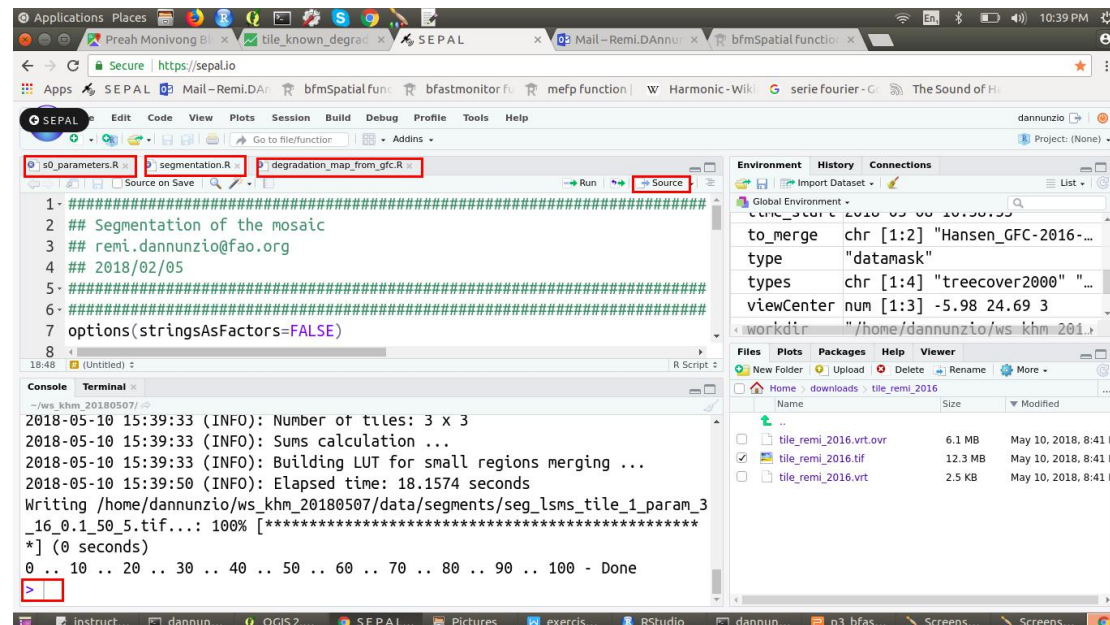


Copy your mosaic from the “~/Downloads/tile_xxx_mosaic” folder into the “ws_khm_20180507/data/mosaic_lsat” folder



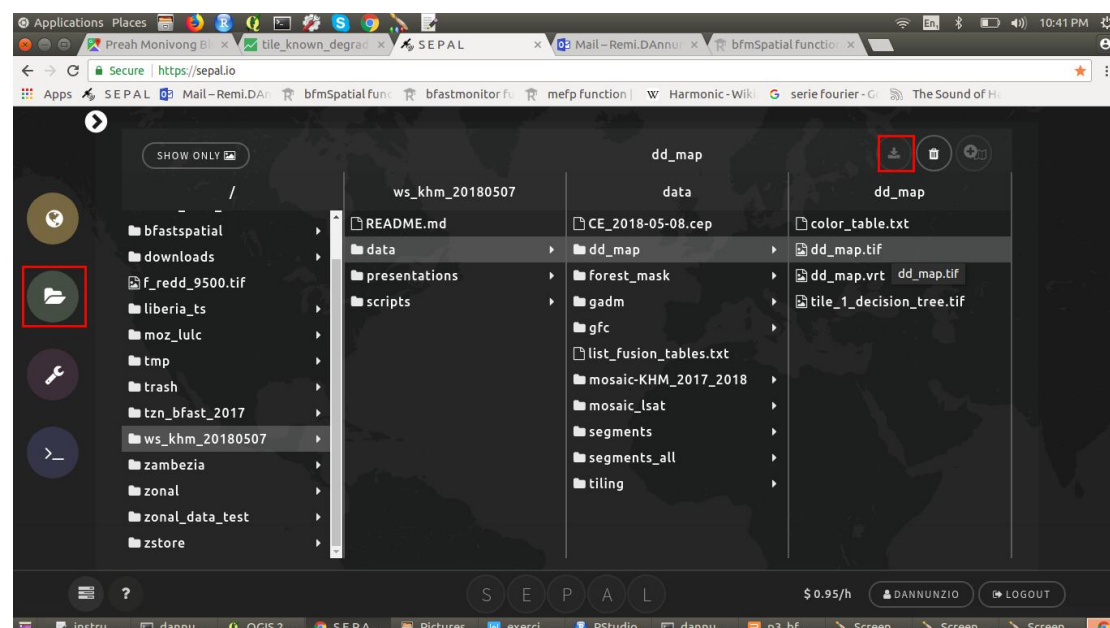
Load the different scripts from the workshop folder and source them, in that order

1. s0_parameters.R
2. segmentation.R
3. degradation_map_from_GFC.R



Every script has finished running when you have a blue prompt on the last line of the console.

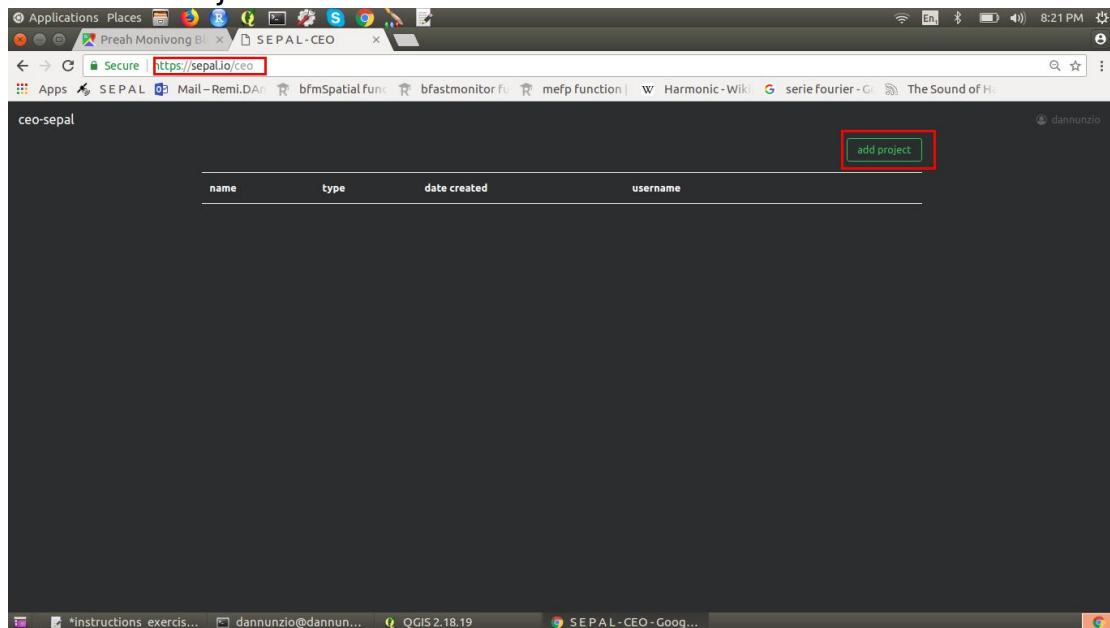
Download the product to your computer using either Browse or a SSH/FTP solution like FileZilla



5. Classification exercise in CEO

Open <https://sepal.io/ceo>

Click Add Project



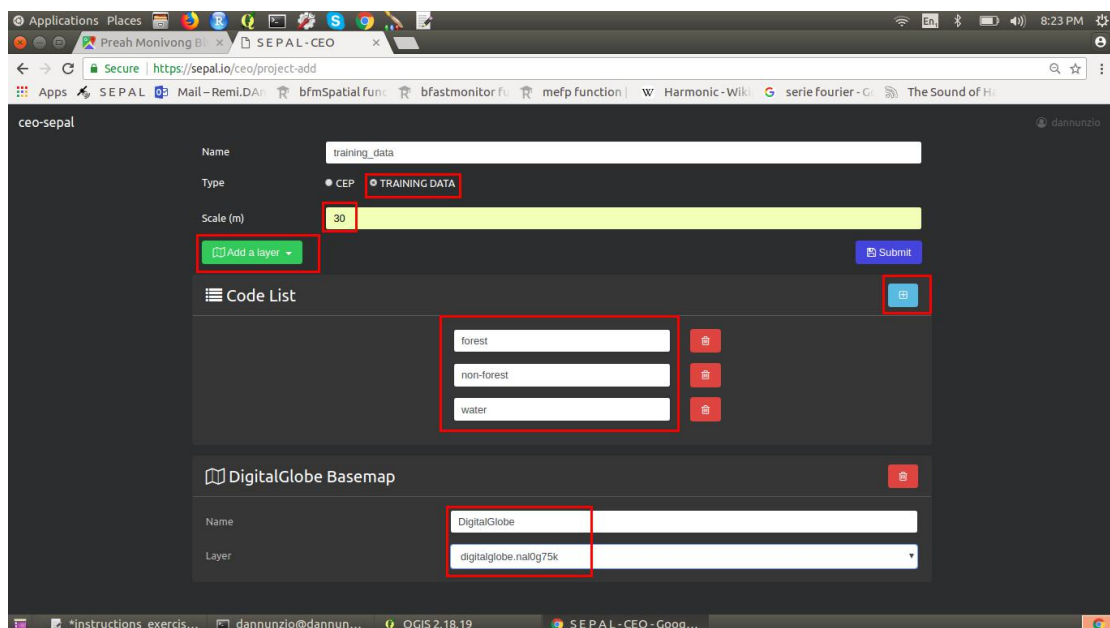
Select Training Data

Choose a Name (e.g "Exercise - training data")

Select 30m for the scale

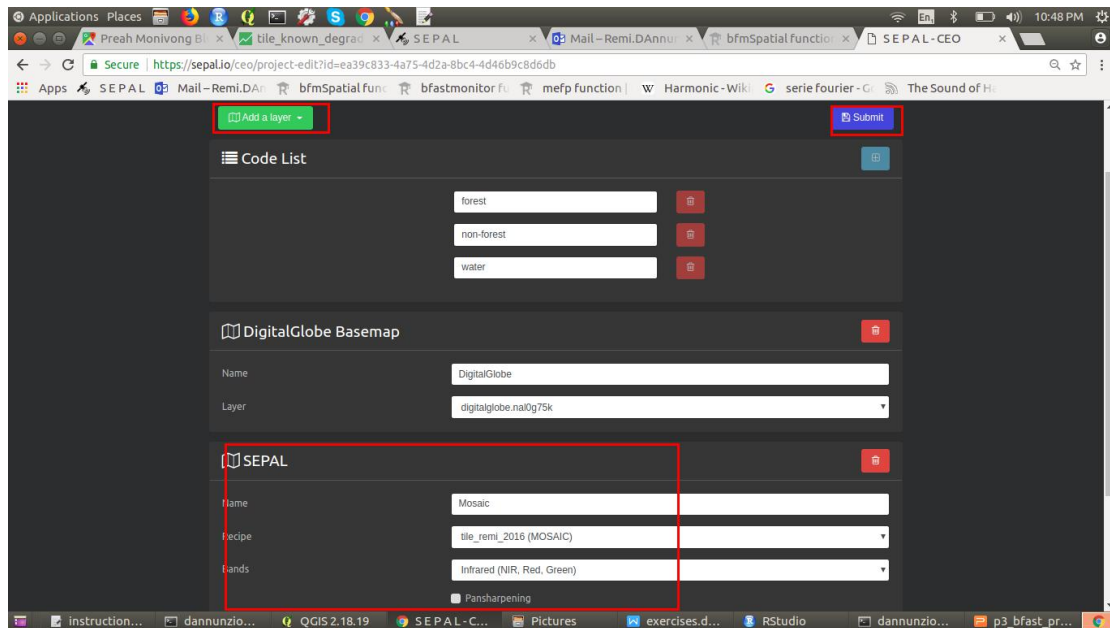
Add several Land Cover codes in the Code list (e.g Forest, Non-Forest, Water)

Add Layer with Digital Globe (call it Digital Globe)

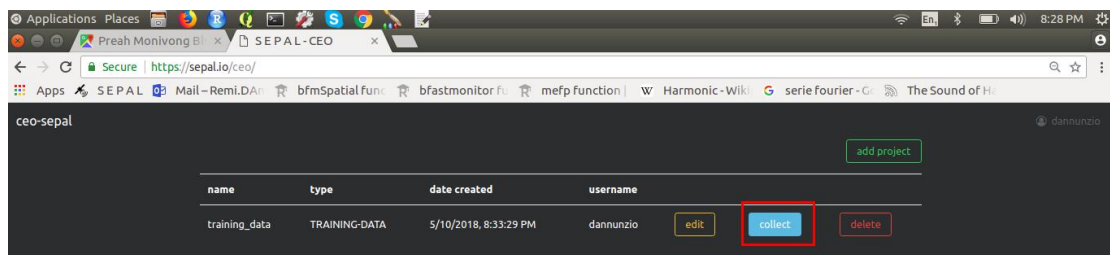


Add Layer with SEPAL and choose the mosaic you saved in exercise 2.2

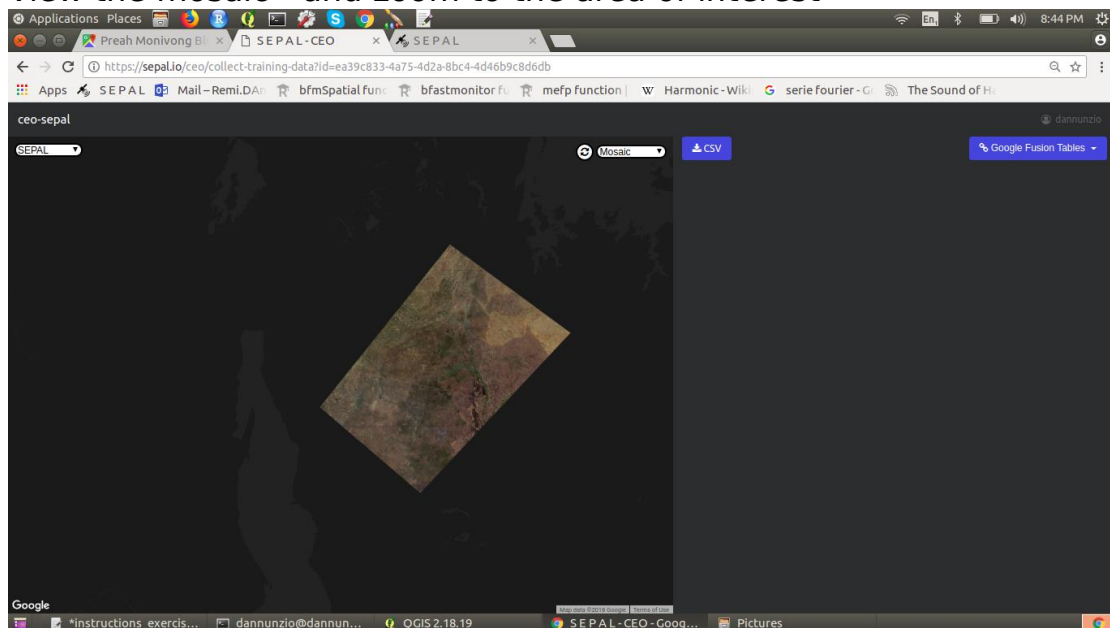
Click Submit



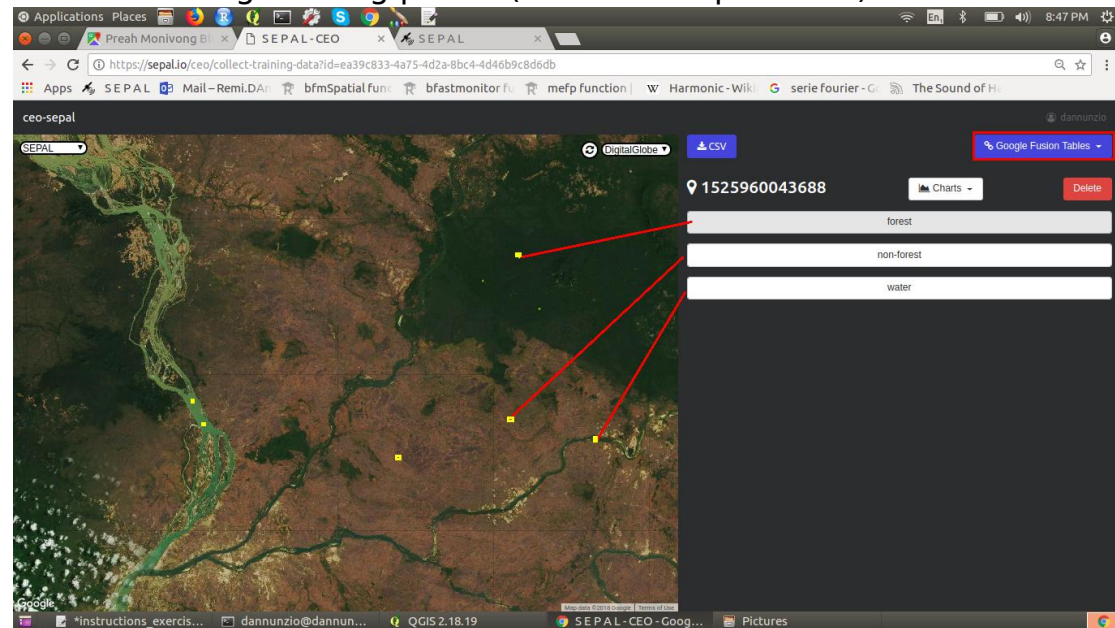
Click Collect



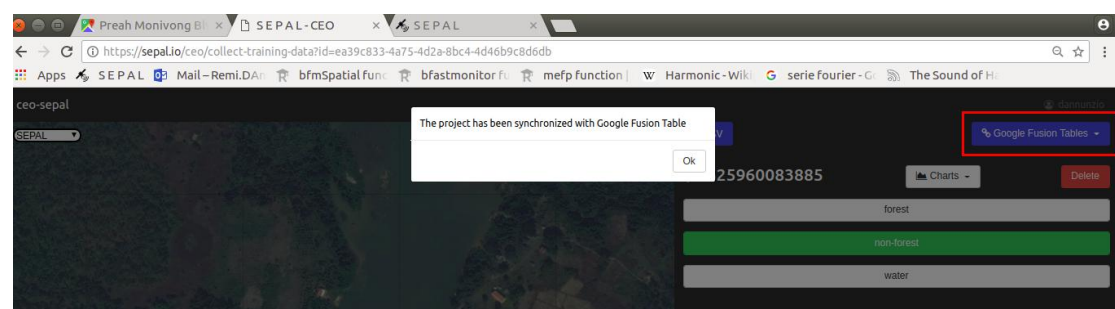
View the mosaic and zoom to the area of interest



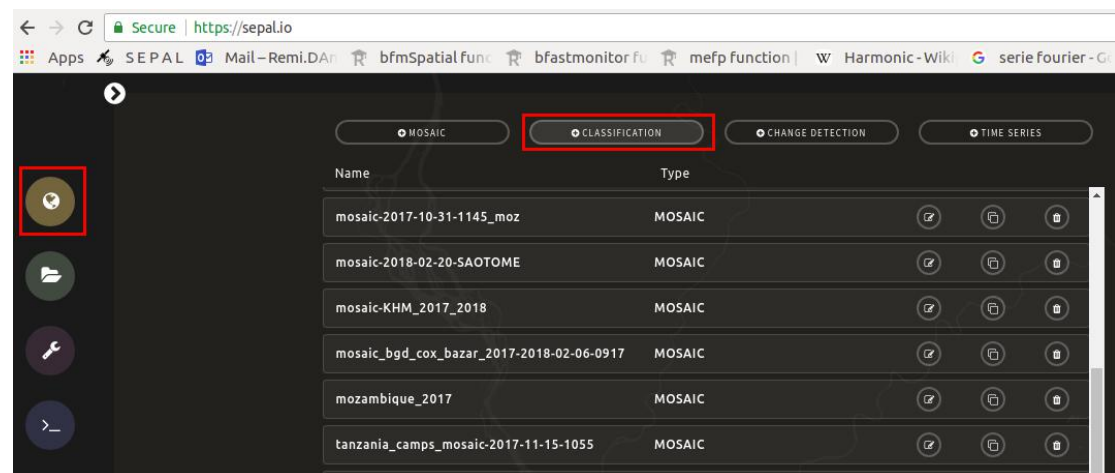
Start collecting training points (start with 3 per class)



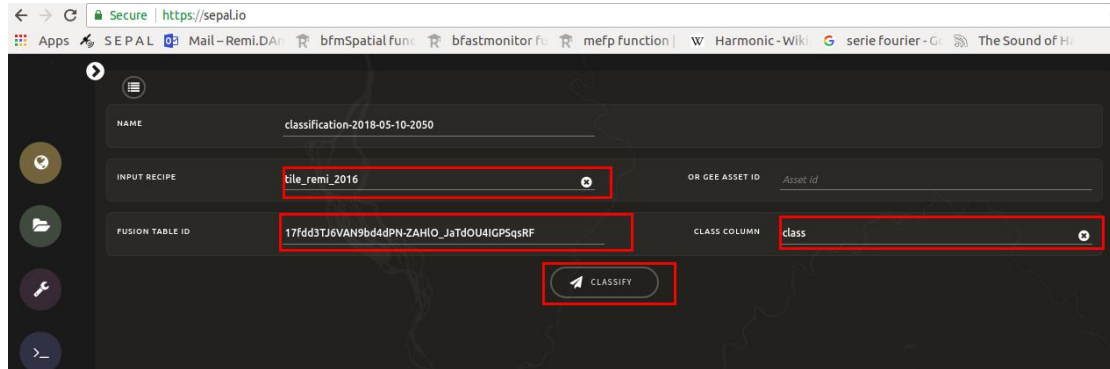
Click on Google Fusion Tables and Export
When it is Synchronized, click on Clipboard



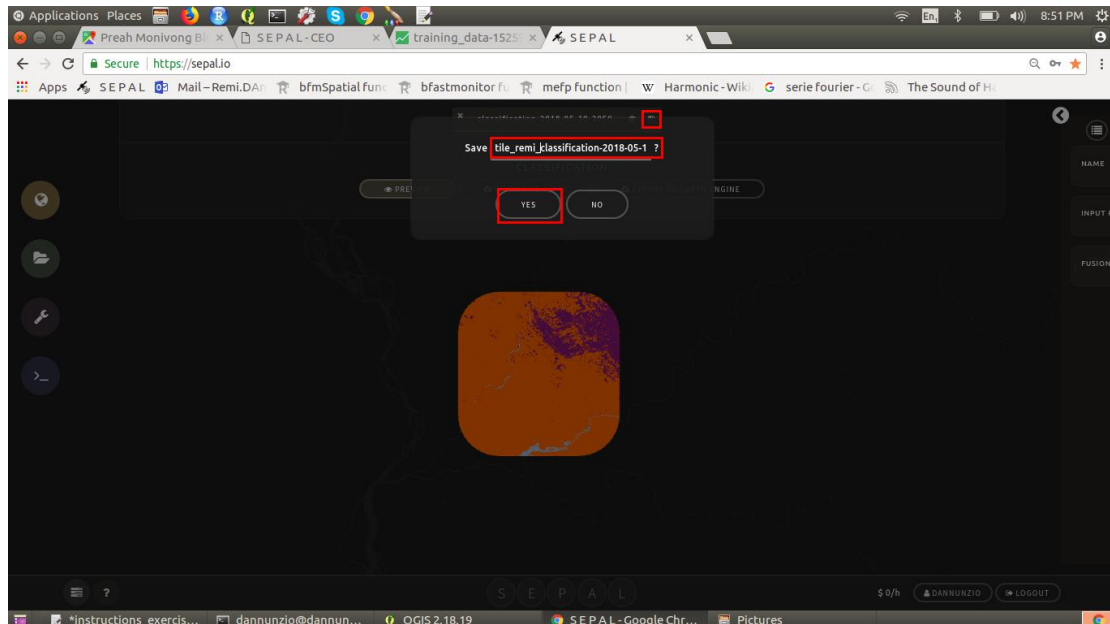
Go to <https://sepal.io> and open Search / Classification



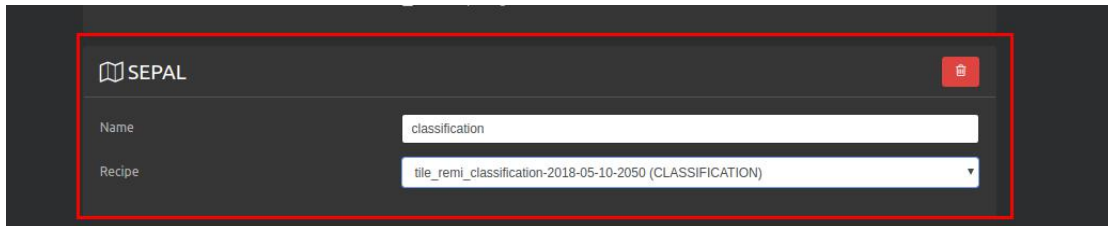
Using the mosaic recipe and paste the FT ID you just created (copied to clipboard already). Use the "class" attribute.



Save the classification

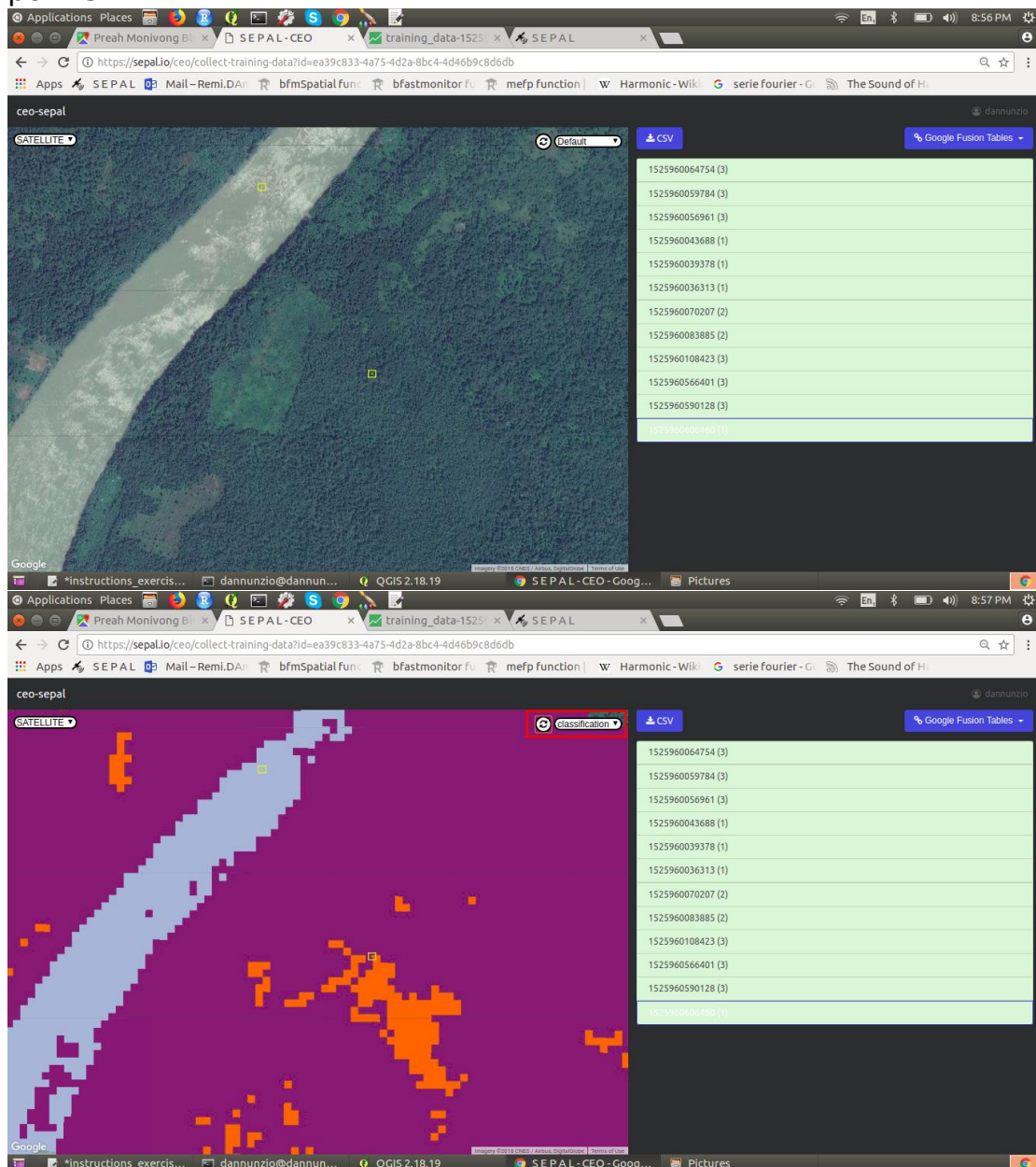


Go to sepal.io/ceo, edit the project and add a new SEPAL layer
Choose the classification you just saved
Click submit and Collect



The screenshot shows the SEPAL web interface. A red rectangle highlights the 'Name' and 'Recipe' fields. The 'Name' field contains the text 'classification'. The 'Recipe' dropdown menu is open, showing the selected option 'tile_remi_classification-2018-05-10-2050 (CLASSIFICATION)'.

Load the classification
Assess where you have classification errors and collect more training points



Update to see the classification being iterated on the fly

Finally go to sepal.io and retrieve your land cover map

