Tutorial for SEPAL workshop

Nigeria, 17-20 July 2018

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INTRODUCTION AND OBJECTIVES

The Forest Carbon Partnership Facility (FCPF) of the World Bank is supporting the Federal Government of Nigeria to develop her REDD+ readiness, and part of the Readiness funds have been allocated to develop a national forest reference emissions level (FREL). Nigeria has already developed a sub-national Forest Reference Emission and submitted this FREL in January 2018; and feedback has been received from the LULUCF experts as part of the Technical Assessment.

FAO will be supporting Nigeria with the implementation of this activity through a Technical Assistance (TA) Agreement (UTF/NIR/066/NIR) signed with the Federal Government. Output 1 of the TA Agreement includes a historical forest cover change assessment and the strengthening of government capacities to monitor periodically REDD+ activities.

The production of activity data in Nigeria at national level will follow the below steps:

- define the nomenclature, providing detailed composition for each of the 14 land cover classes

- produce a mosaic of imagery for the beginning of the reference period (2000)

- produce training data for the same year (environment tbd) and run the classification over the mosaic

- correct and edit the base map where necessary

- run an independent change detection

The independent change detection analysis can be produced with different approaches:

Option 1: a direct classification of change between two dates can be conducted using change training data, derived by expert knowledge.

Option 2: dense time series analysis using break detection (BFAST type of approach, or LandTrendR) is performed on one index of vegetation taking all acquisitions for the period of interest. This is heavy in terms of computing but usually produces more consistent results than only-2-dates analysis.

Option 3: use global dataset of tree cover change as a proxy for the base change map

Regardless of the option taken for change detection, the change class output will then be intersected with the land cover map created for the year 2000 to further stratify the change per forest cover class. . The areas will be assessed through a stratified sampling design, based on the obtained change map and as recommended by GFOI (2016) and Olofsson et al (2014).

Through a partnership agreement with Norway, FAO has developed a System for Earth Observation Data Access, Processing and Analysis for Land Monitoring (SEPAL), which helps countries access and process satellite data, for use in forest resources monitoring.

SEPAL is 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. SEPAL overcomes barriers of poor internet connections and low computing power or storage space on local computers and can also connect to and use data and outputs from FAO's free and open-source software tools Open FORIS.

The Breaks for Additive Seasonal and Trend (BFAST) method enables to analyze the dynamics of satellite dense time series and overcome the major challenge to distinguish land-cover change from seasonal phenological variations. Verbesselt et al. (2010), Dutrieux et al. (2015) and DeVries et al. (2015) used this 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 gridded data, such as the Landsat satellite imagery that cover our period of interest. 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.

A training was developed for the benefit of the Nigerian stakeholders and aimed at:

- giving an overview of SEPAL functionalities

- introducing the BFAST algorithm and the underlying concepts of dense time series analysis

- training the staff to the use of the bfastSpatial package within SEPAL

- training the staff to the use of R modules to process global data (ESA CCI, GFC) as proxies for activity data

- training the staff to the production of time series snippets for accuracy assessment and change area estimation

REQUIREMENTS

All necessary data for the completion of this tutorial is available at https://github.com/lecrabe/ws_nga_20180717

Background information on the OpenForis initiative www.openforis.org

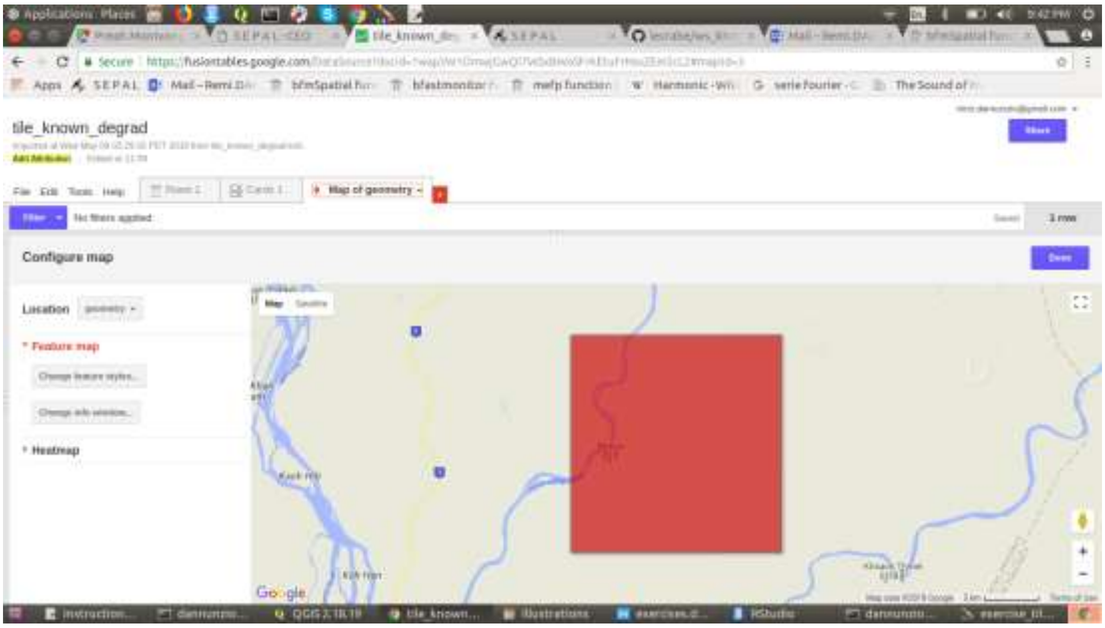
You can request Access to SEPAL with the following
1/ have-open a GMAIL account (in order to access Google Earth Engine functionality)
2/ get the account registered and white listed in Google Earth Engine
https://earthengine.google.com/signup/
3/ open an account in SEPAL https://tinyurl.com/sepal-access

CONTENT OF THE TUTORIAL

1. Create an AOI

Find a fusion table corresponding to a tile in the country

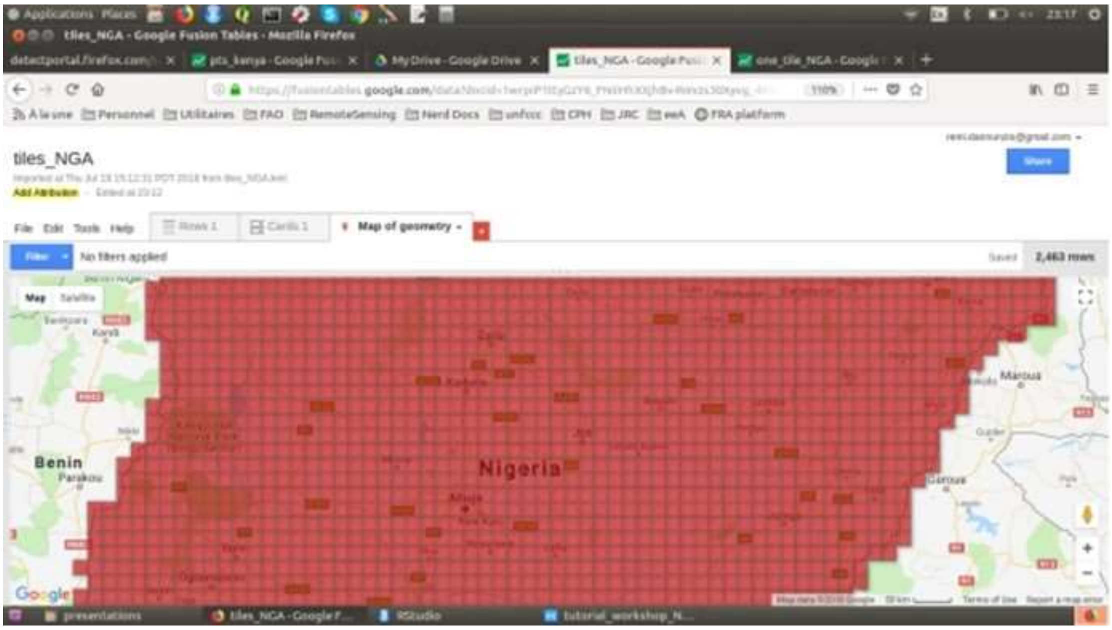
For example: 1Jaxchf3Pi8oWKn43499daXa1PydTyj5V_ehbKP-n



Alternatively, you can draw by hand an AOI and run the time series creation.

All 2463 tiles of 20km by 20km are available here:

1wrpiP1ttyGzY6_FNiiHhXXjhBv4Wvzs30Xyvg_4X

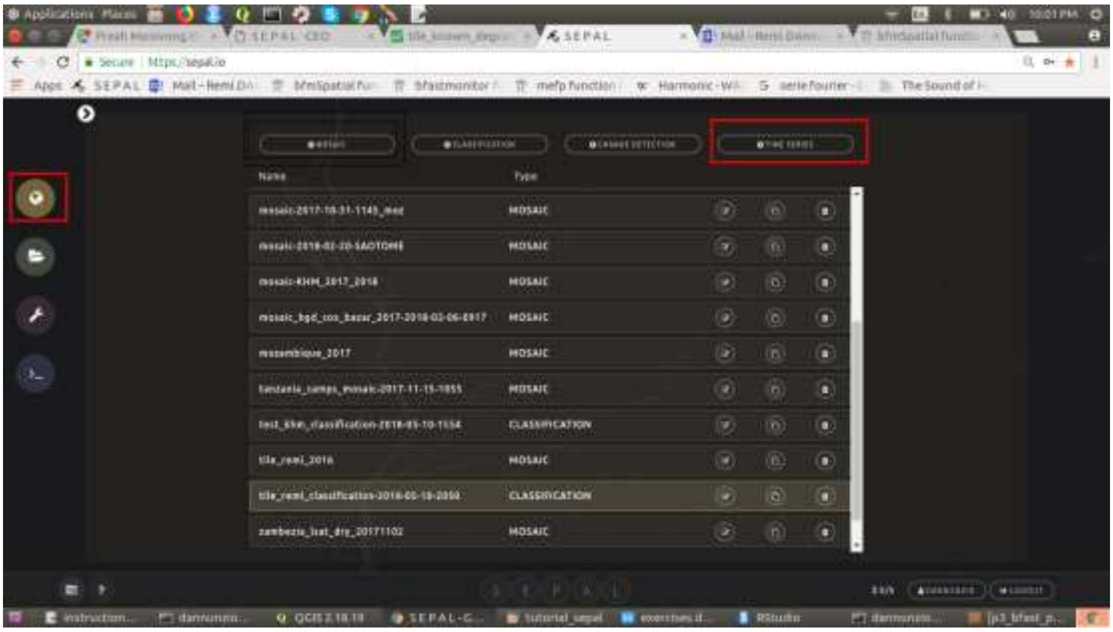


2. Generate Data

Open https://sepal.io

2.1 Generate satellite imagery Time Series for an index

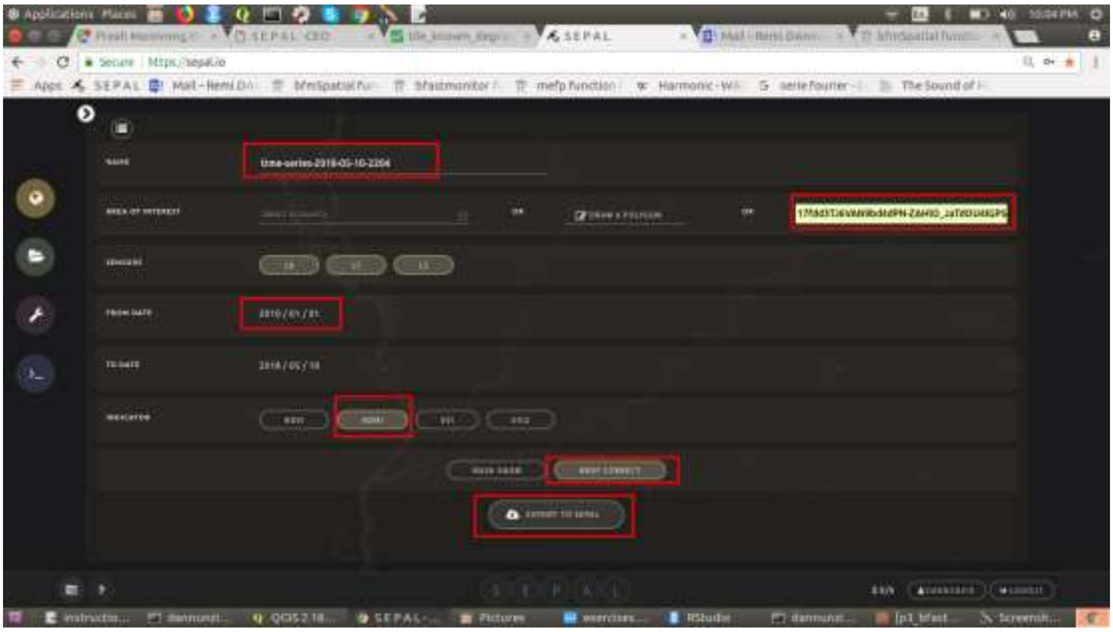
Start Search / Time Series



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

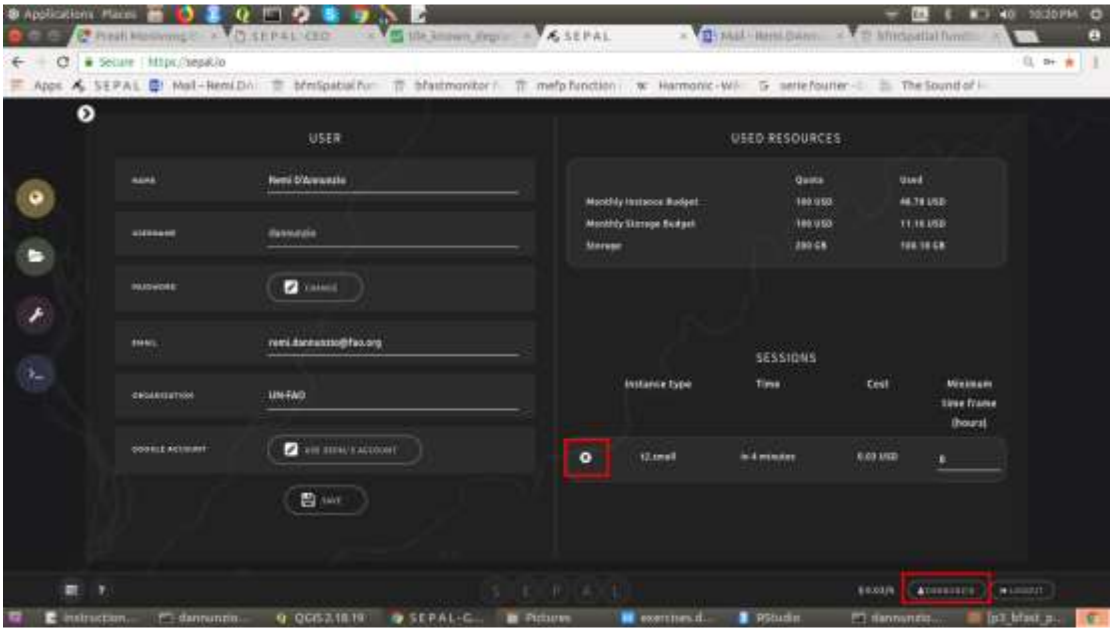
Select dates 2010-01-01 to Current date, Select NDMI, BRDF correct

Export your Time Series to SEPAL

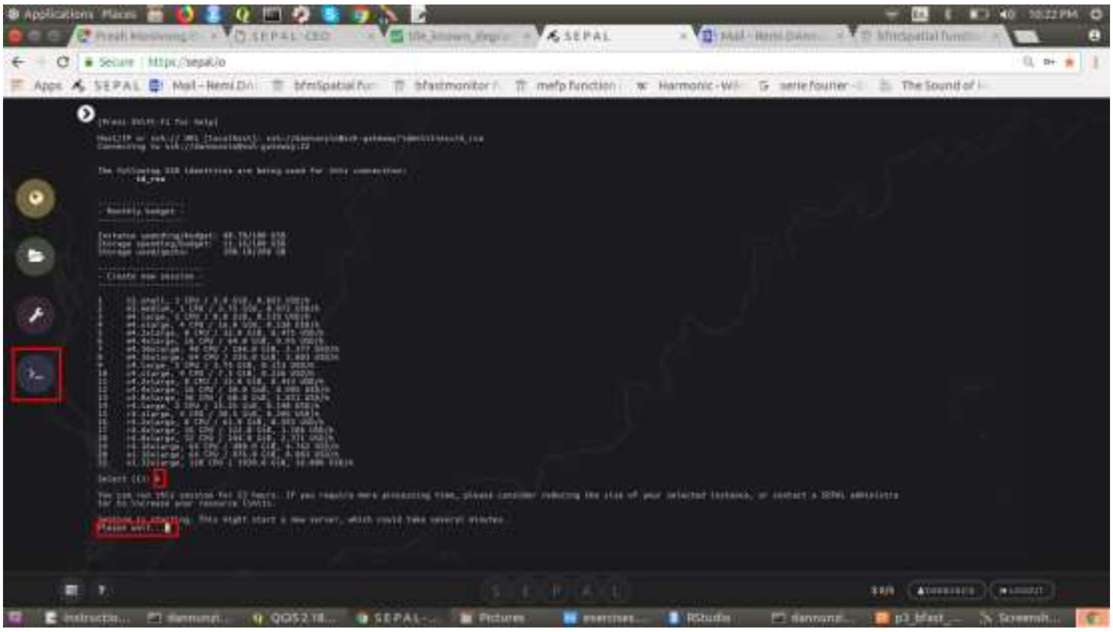


2.2 Run BFAST

Check your budget, kill any t2 instance



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

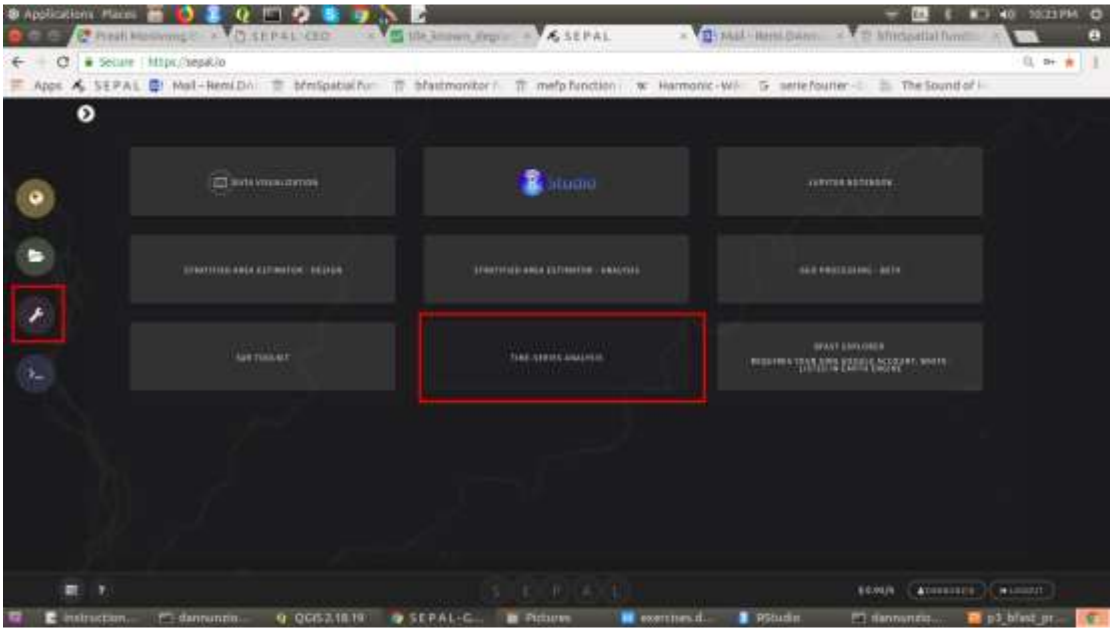


Update your repository by typing the following in the terminal:

`cd ws_nga_20180717`

`git pull`

Go to Process / Time Series Analysis

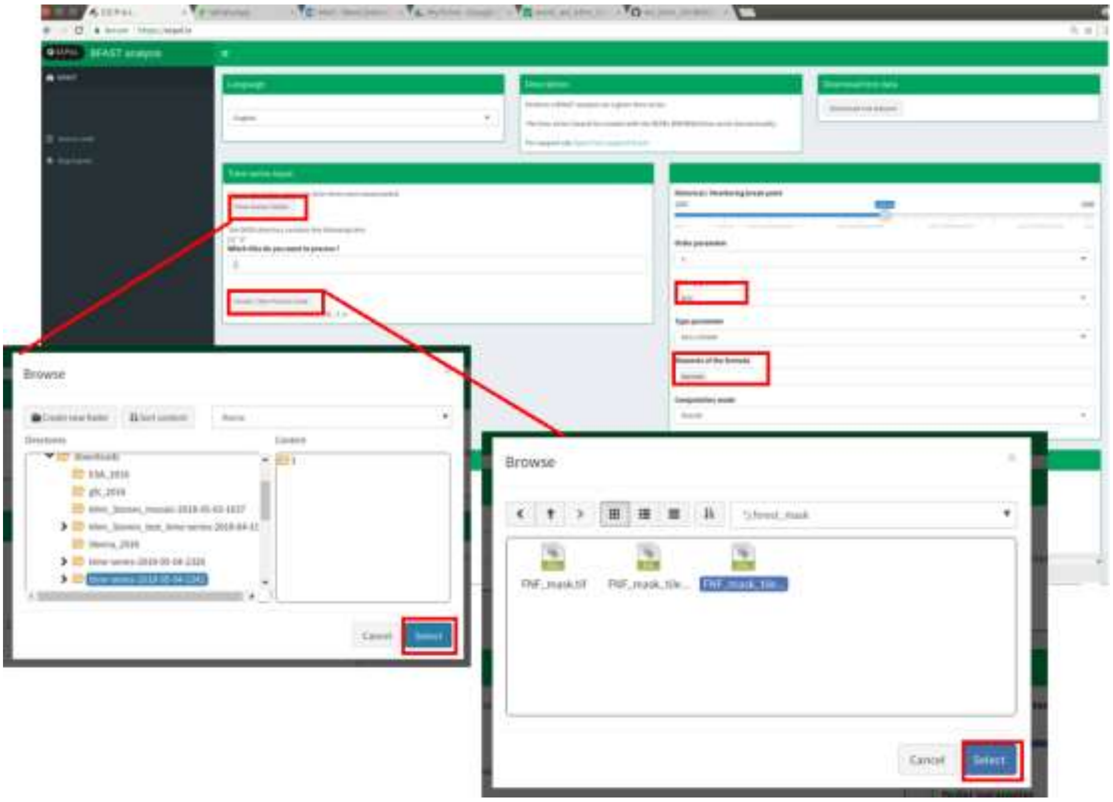


Select the tile you exported

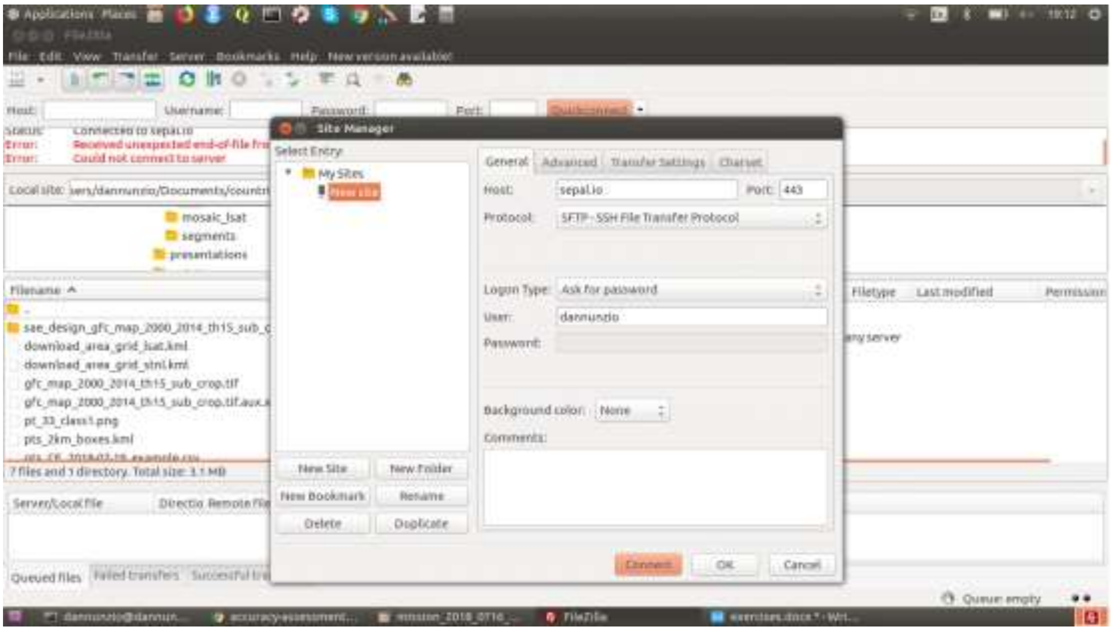
Load the forest mask and select "FNF mask"

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 (go to Files/Site Manager and connect)

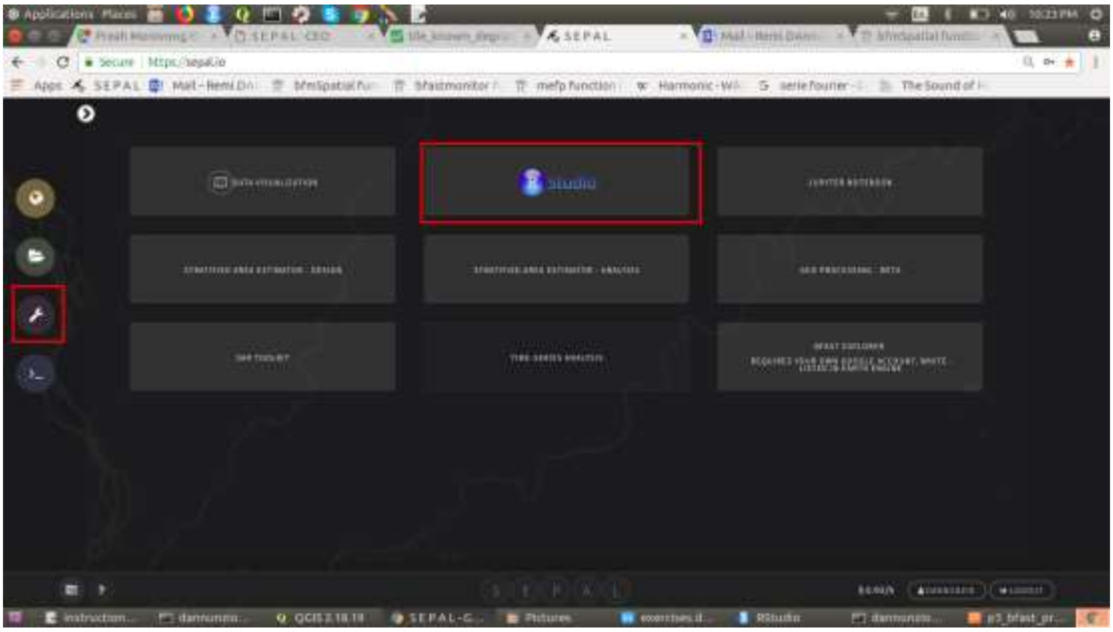


3. GFC clip exercise

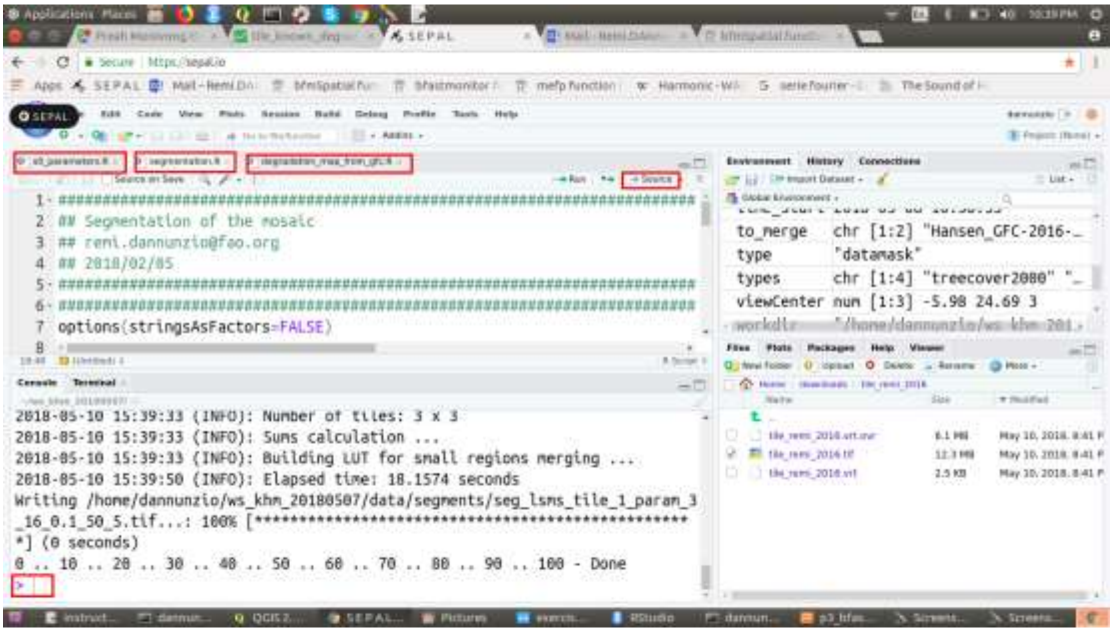
Check your budget, kill any “t2 instance”

Open the terminal and start a #4 instance

Go to Process / RStudio



Load the scripts (“/home/xxxx/ws_nga_201807017/scripts/”) from the workshop folder and source() them, in the below order.



1. s0_parameters.R

Provide local parameters for your account, load packages and setup the environment variables. This script should always be run first when you start a new R session.

2. get_gadm_data.R

Get administrative layers from www.gadm.org and extract one state of interest.

3. download_ESA.R

Download the ESA CCI map for Africa (based on Sentinel 2 data for the year 2016) from http://2016africalandcover20m.esrin.esa.int and unzip the file.

4. download_gfc_2016.R

Download the GFC layers (Treecover, LossYear, Gain and Datamask) for the tiles covering the country. Merge the tiles together and produce a composite covering the country, for each layer. Data can be found here :
https://earthenginepartners.appspot.com/science-2013-global-forest

5. clip_LC_products.R

Generate Forest mask in 2000 and 2016, generate a map of forest loss and gain for 2000-2014. Clip the products to the country boundaries and to one state boundaries (CRS in the workshop example). Clip the ESA map to country and state boundaries

Each 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

4. Generate visual snippets of imagery to support change validation

Check your budget, kill any “t2 instance”

Open the terminal and start a #4 instance

4.1 Go to Process / Stratified Area Estimator - Design application

Load your map of interest and follow the steps described here https://github.com/openforis/accuracy-assessment/blob/master/presentations/p_sae_design.pdf to generate a stratified random sampling over the map

The main output of the process is a CSV file containing the points coordinates with the class they belong to.

In the workshop example, it can be found there:
“/home/xxxxx/ws_nga_20180717/data/gfc/sae_design_gfc_map_2000_2014_th15_sub_crop/pts_CE_20180719_example.csv”

4.2 Open and source() *script1_generate_ft_for_gee.R*

This script takes the point CSV file as an input, generates 2km boxes around each point, produces a grid for easy download of Landsat and Sentinel data inside GEE and exports them as KML.

4.3 Open Google Drive (www.drive.google.com), create three Fusion Tables using the 3 KML produced earlier:

/home/xxxx/ws_nga_20180717/data/gfc/sae_design_gfc_map_2000_2014_th15_sub_crop/

- download_area_grid_lsat.kml

- download_area_grid_stnl.kml

- pts_2km_boxes.kml

Once they are created, make the Fusion Tables public (Tools/Publish/Change visibility)

4.4 Open the GEE script, replace the fusion table IDs in the script and run. In “Tasks”, activate all the “Run” buttons

The process of getting the imagery will take some time, depending on the resources of the network. It can run even if you shutdown your computer.

Once all the imagery is downloaded to your Drive, proceed to next step.

4.5 In SEPAL, open the *auth_key.R* script, follow the link and get a authorization key. Replace the value in the script, source().

Open and source() the *script2_google_drive_to_desktop.R*

This will automatically transfer the files from Google Drive to your sepal environment.

4.6 Open and source() the *scriptxx_clip_time_series.R*

This will generate snippets of the downloaded imagery for each sample.

You can tweak the display of snippets, size of the boxes, band combination.