Google Earth Engine

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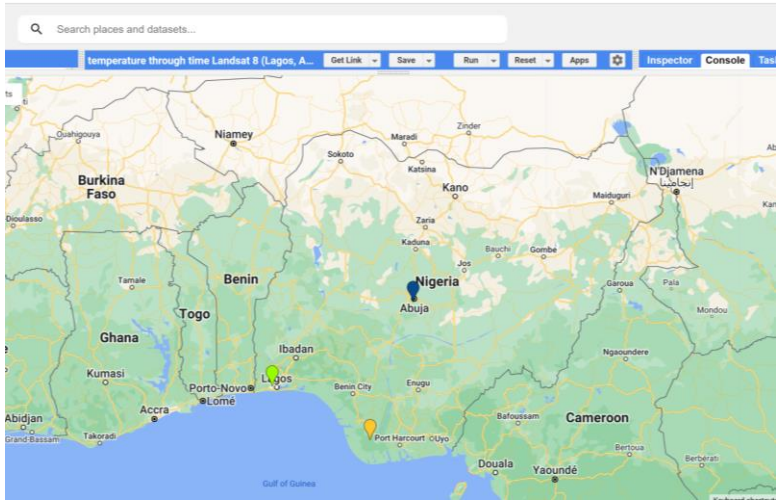
Comparing Temperature Values from 3 Urban areas in different regions in Nigeria

- For this exercise, I decided to select typical urban settlements from the 3 different weather regions of Nigeria. Below is a brief introduction to the areas to give a bit of context.

- **Ikotun, Lagos State:** My home town in the heart of Lagos mainland, which is in the south western Nigeria, with one of the highest population densities in Nigeria.
- **Lugbe, Abuja:** In North Central Nigeria is one of the major residential areas in the Federal Capital Territory. Abuja's annual weather pattern is characterized by extremes (Cold and Hot).
- **Amassoma, Bayelsa:** Within the beautify Niger Delta, there exists one of the few mangrove rainforests in Nigeria. It is characterized by high temperature and humidity, and filled with settlements called creeks. Ammasoma is one such creek.



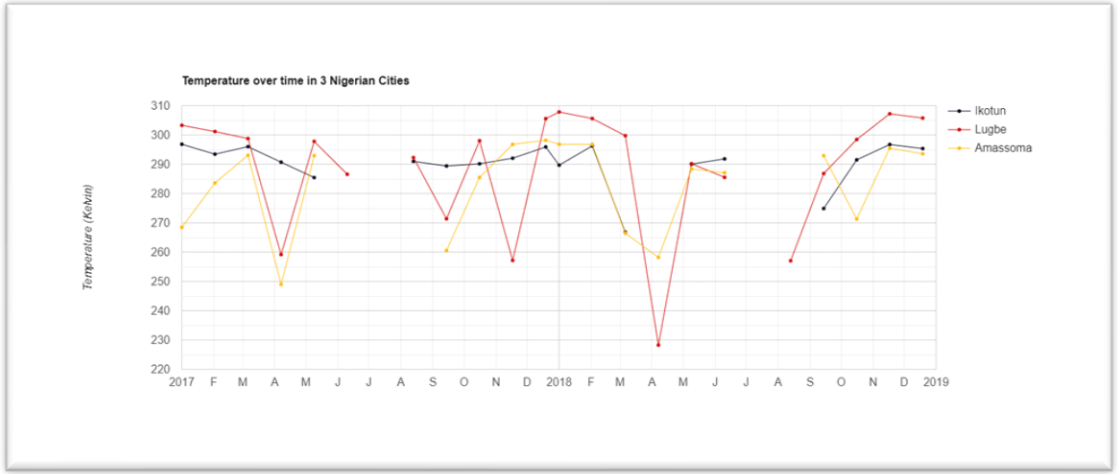
Ikotun, Lagos
Lugbe, Abuja
Amassoma, Bayelsa

Google Earth Engine Search places and datasets...

emperature through time Landsat 8 (Lagos, Abuja, Bayelsa) Get Link Save Run Reset Apps

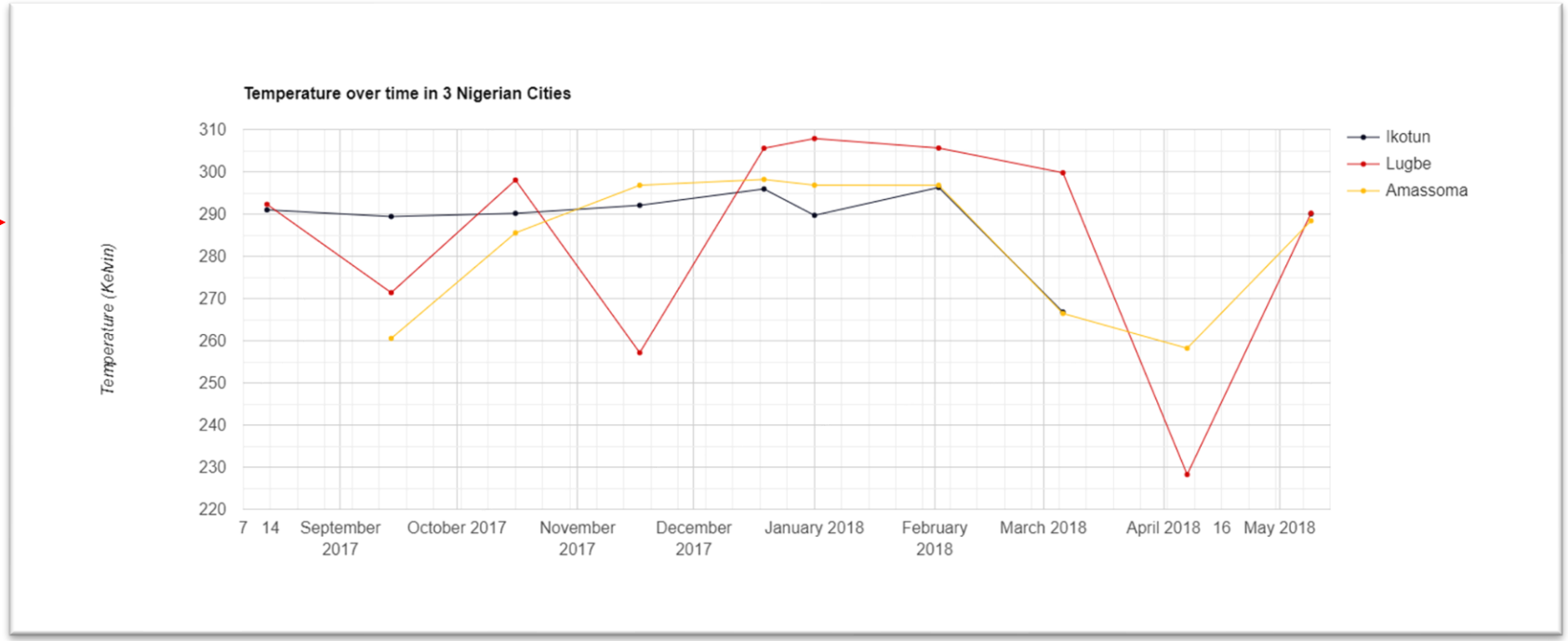
```
Imports (3 entries)
  var geometry: Feature 0 (Point, 1 property)
  var geometry2: Feature 0 (Point, 1 property)
  var geometry3: Feature 0 (Point, 1 property)
// Define a FeatureCollection: Ikotun, Lugbe, Amassoma
var regions = ee.FeatureCollection([
  geometry,
  geometry2,
  geometry3
]);

// Load available Landsat 8 brightness temperature data for 1 year.
var temps2017 = ee.ImageCollection('LANDSAT/LC08/C01/T1_32DAY_TOA')
    .filterDate('2017-08-13', '2018-06-10')
    .select('B11');

// Create a time series chart.
var tempTimeSeries = ui.Chart.image.seriesByRegion(
    temps2017, regions, ee.Reducer.mean(), 'B11', 200, 'system:time_start', 'label')
        .setChartType('LineChart')
        .setOptions({
          title: 'Temperature over time in 3 Nigerian Cities',
          vAxis: {title: 'Temperature (Kelvin)'},
          lineWidth: 1,
          pointSize: 3,
          series: {
            0: {color: '03071E'}, // red
            1: {color: 'D00000'}, // green
            2: {color: 'FFBA08'}  // blue
}});

// Display.
print(tempTimeSeries);
```

Code



An earlier selection over a larger time span (Jan 2017 to Dec 2019) revealed a gap in image availability between June and August of both years.

Resulting Chart



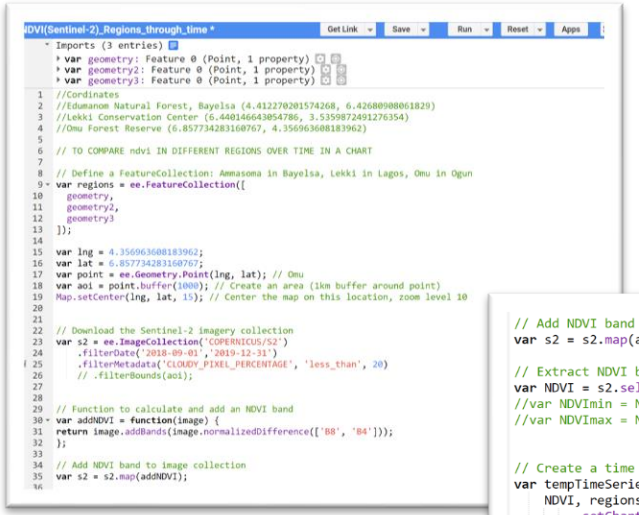
NDVI Over 3 of Nigeria's Forrest Ecosystems

I decided to compare NDVI values over time for 3 of Nigeria's Forest Ecosystems.

Omu Forest Reserve: Located in South Western state of Ogun. Omu is one of Nigeria's most enduring forest conservation efforts.

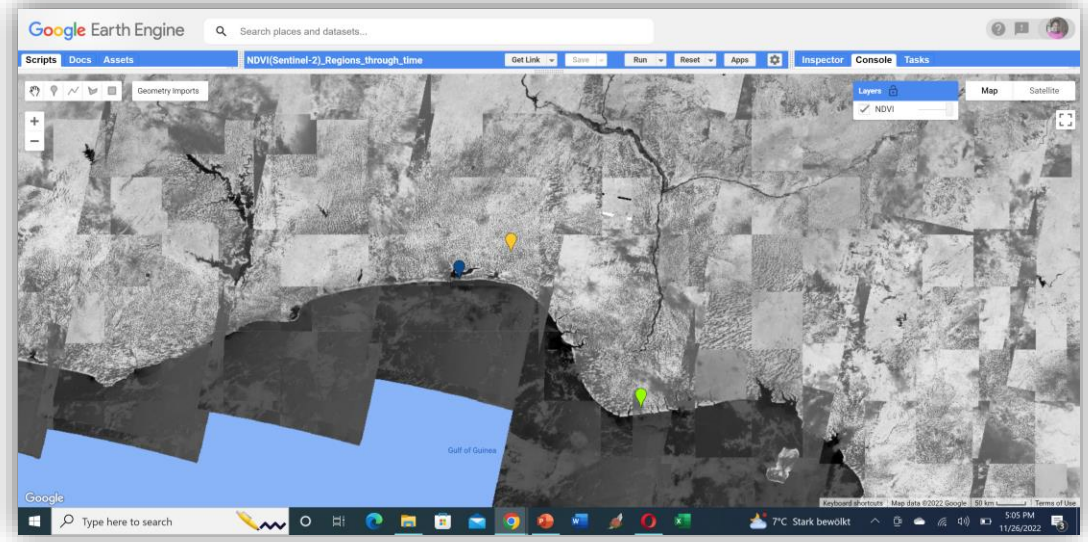
Edumanom Natural Forest: Is a mangrove forest conservation effort within the Niger Delta.

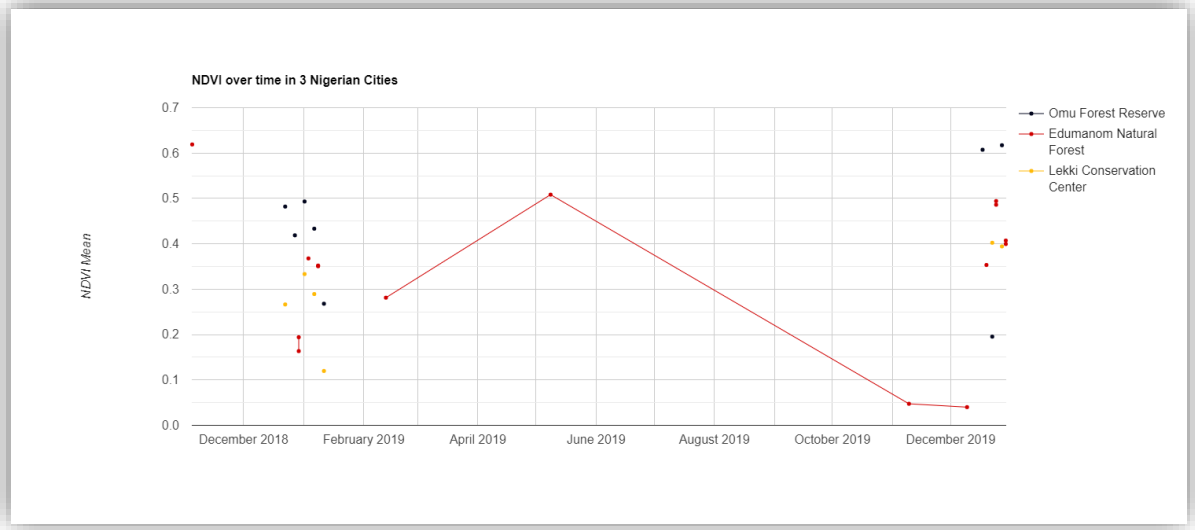
Lekki Conservation Center: is a relatively new effort to conserve a 78 hectare nature preserve at the heart of a very urbanized Lagos.



Code

```
// Add NDVI band to image collection
var s2 = s2.map(addNDVI);

// Extract NDVI band and create NDVI median composite image
var NDVI = s2.select(['nd']);//the newly added NDVI Band
//var NDVImin = NDVI.min();
//var NDVImax = NDVI.max();


// Create a time series chart, uisng Mean reducer
var tempTimeSeries = ui.Chart.image.seriesByRegion(
    NDVI, regions, ee.Reducer.mean(), 'nd', 200, 'system:time_start', 'label')
        .setChartType('LineChart')
        .setOptions({
          title: 'NDVI over time in 3 of Nigerias forests',
          vAxis: {title: 'NDVI Mean'},
          lineWidth: 1,
          pointSize: 3,
          series: {
            0: {color: '03071E'}, // ~ Xiketic
            1: {color: 'D00000'}, // ~ Rosso Corsa
            2: {color: 'FFBA08'}  // ~ Selective Yellow
}});

// Display the chart
print(tempTimeSeries);


//Adding the NDVI from the most recent image to the Map
var s2_sorted = NDVI.sort('system:time_start', false);
var NDVI_recent = s2_sorted.select('nd')

//define visParams for layer2
var visParams = {bands: ['nd'], min: -0.5, max: 0.9 };

//Add to map
Map.addLayer(NDVI_recent, visParams, 'NDVI')
```

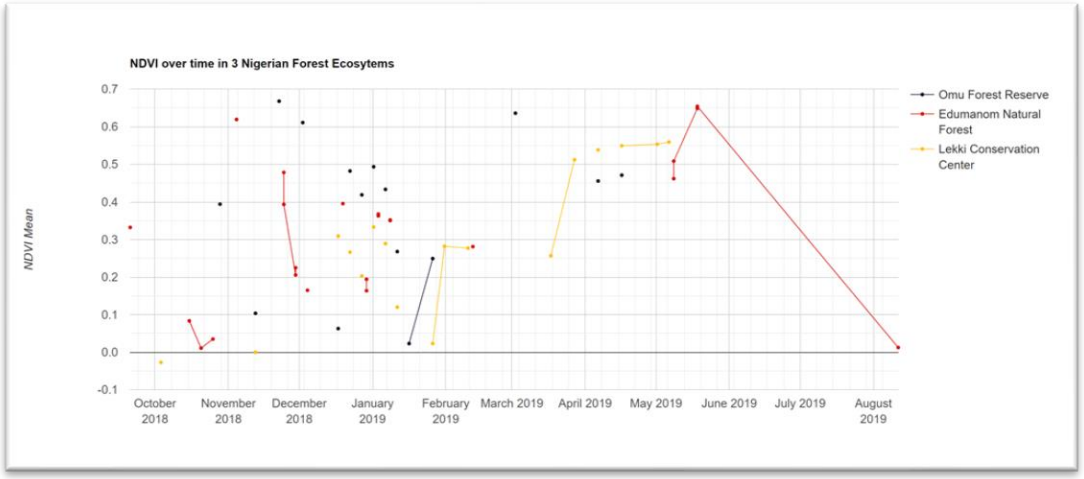




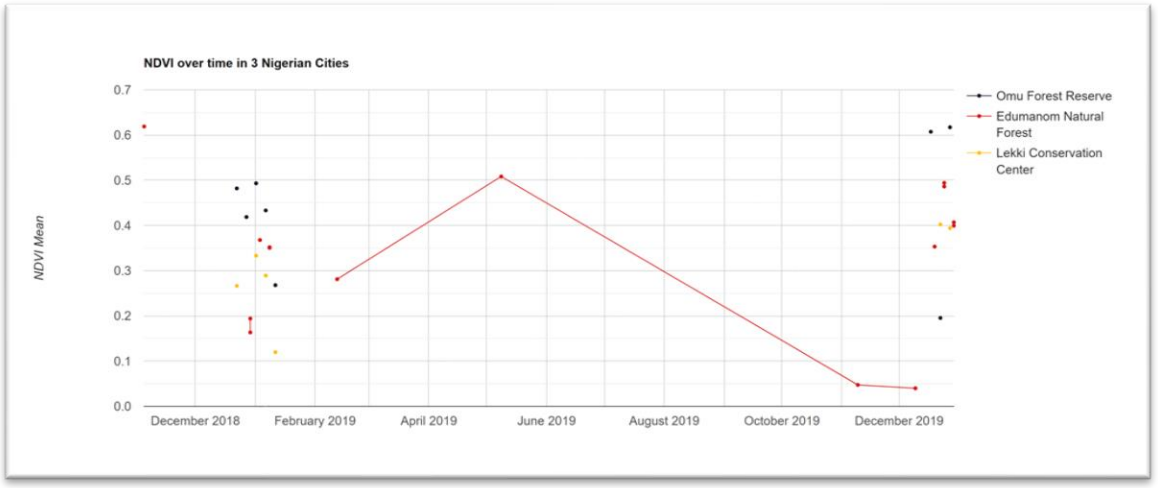
Noting that this created a somewhat messy chat, I went ahead to create individual charts for each forest NDVI over time, next 2 slides.

What I did differently!

From the previous chart, I noticed that I was getting significantly lower values for my NDVI for a forest. On closer inspection of the NDVI (after adding to map), I discovered significant clod cover which impeded a proper estimation of NDVI. I therefore reduced the cloud cover specification to **20.**



Before (30% Cloud Cover)



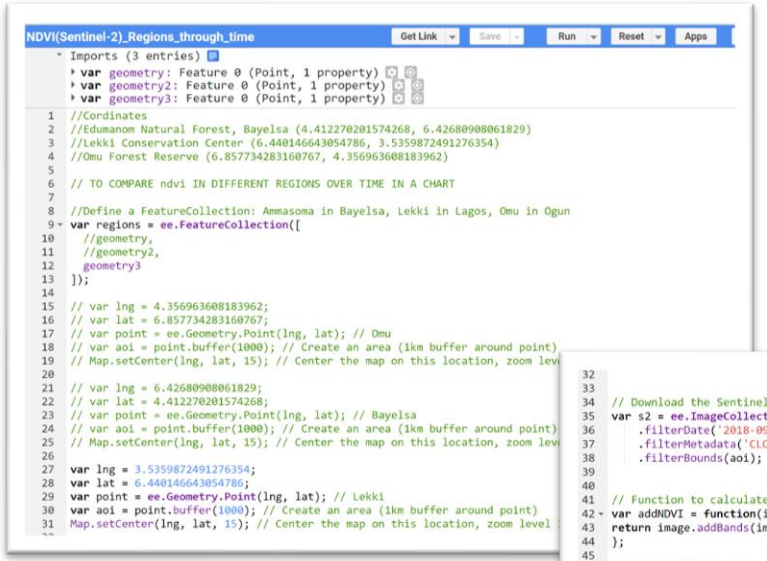
After (20% Cloud Cover). Notice there are fewer images available to process

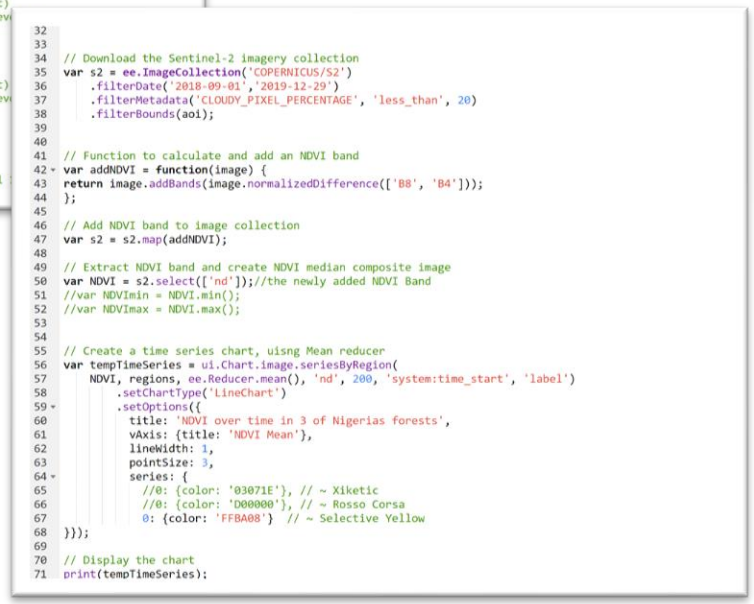
Focusing on one forest at a time

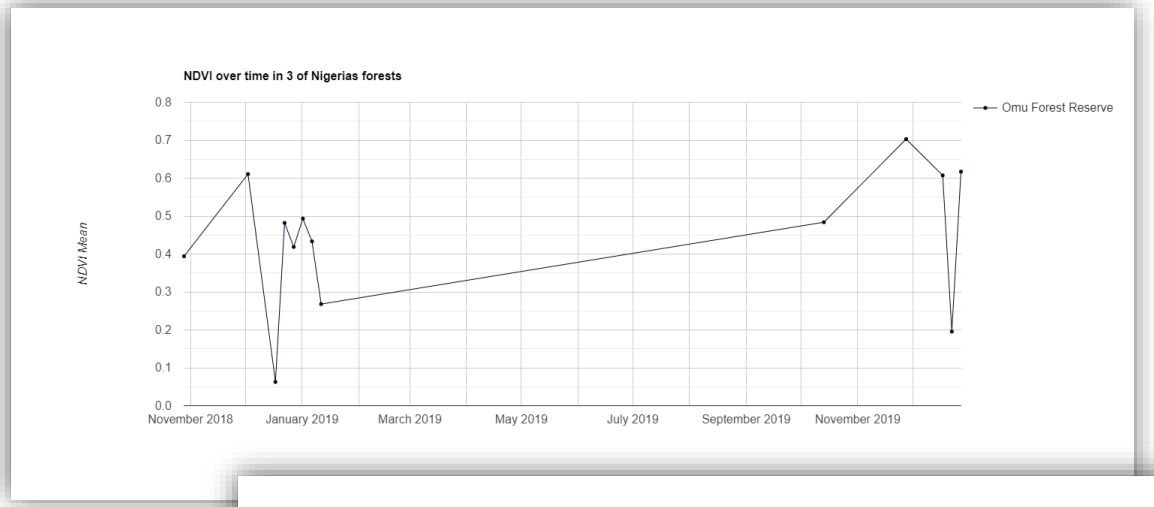
By setting an aoi (for each forest coordinates) and filtering the image collection by that, I focus the chart on each of the forests, so that I have a dedicated chart to each forest NDVI over time. This results in a less messy chart.

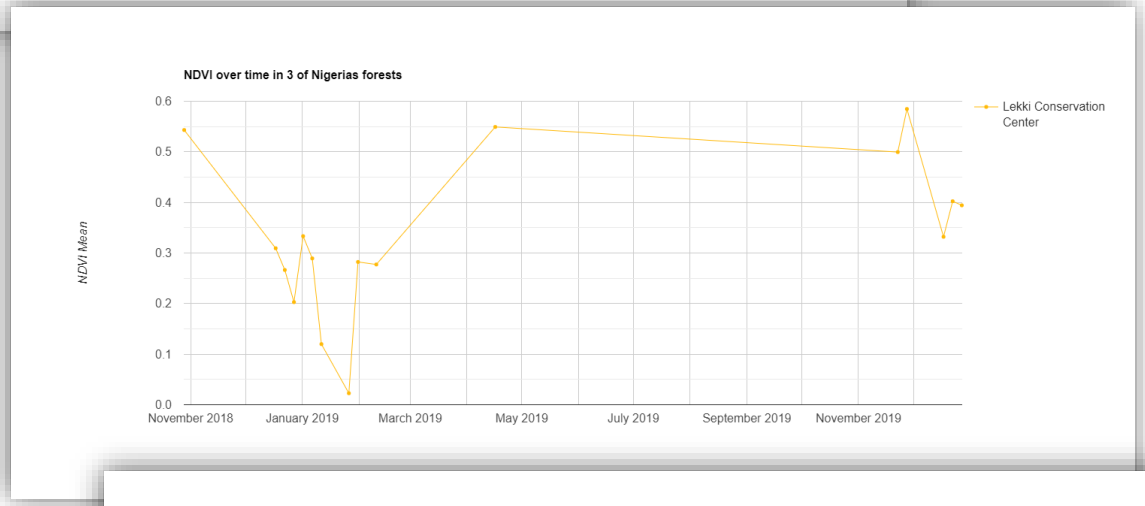
For each chart, the aoi coordinates correspond with the region.

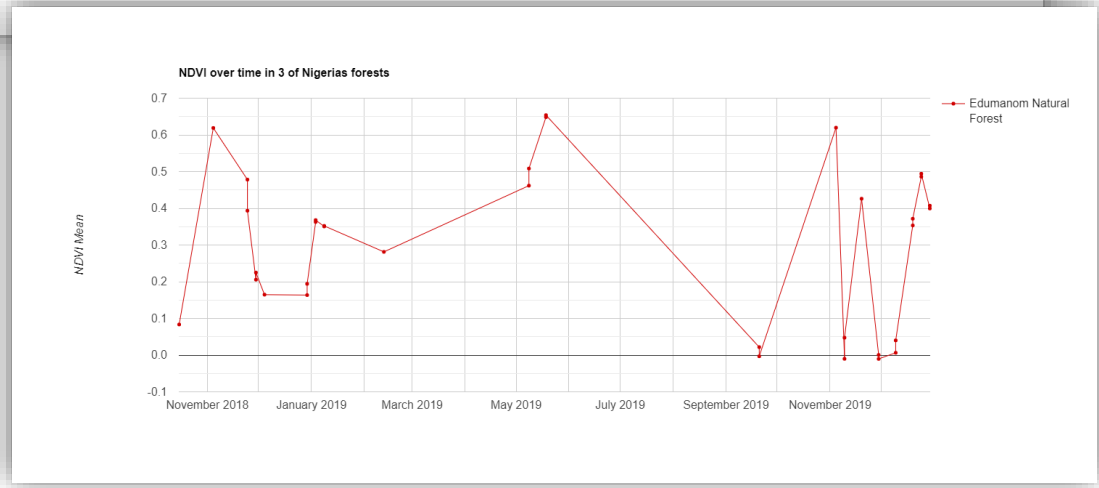
The remaining code is the same for all, except the line color specification











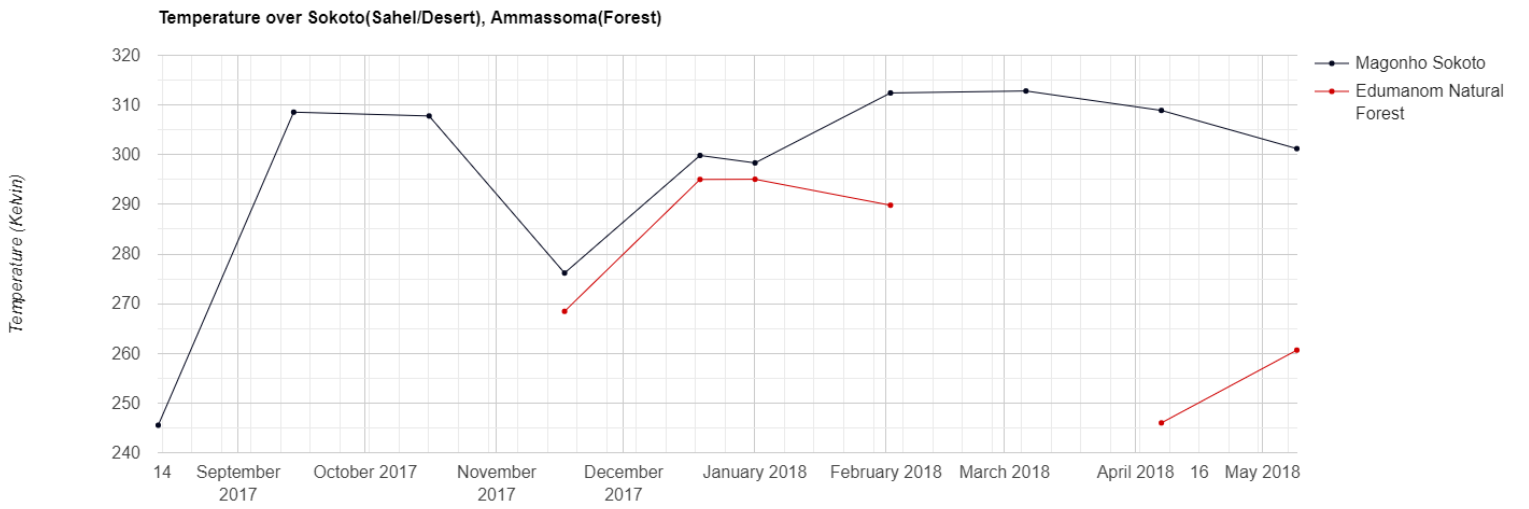
Surface Temp (Desert, Rainforest)

Lastly, I compared surface temperature between 2 different land use types (Savanna/Desert type) and (Mangrove Rainforest).

It is important to note that although there is significant temperature variation between the two, with the Desert type temperature being higher (characterized by sharp contrasts), temperatures in mangrove is high as well, compounded by the unusually high humidity.

temperature through time Landsat 8 (Desert, Rainforest) — Get Link | Save | Run | Reset | Apps

```
Imports (2 entries)
  var geometry: Feature 0 (Point, 1 property)
  var geometry2: Feature 0 (Point, 1 property)

// Define a FeatureCollection: Amassoma, Sokoto
var regions = ee.FeatureCollection([
  geometry,
  geometry2,
]);


// Load available Landsat 8 brightness temperature data for 1 year.
var temps2017 = ee.ImageCollection('LANDSAT/LC08/C01/T1_32DAY_TOA')
    .filterDate('2017-08-13', '2018-06-10')
    .select('B11');

// Create a time series chart.
var tempTimeSeries = ui.Chart.image.seriesByRegion(
    temps2017, regions, ee.Reducer.mean(), 'B11', 200, 'system:time_start', 'label')
        .setChartType('LineChart')
        .setOptions({
          title: 'Temperature over Sokoto(Sahel/Desert), Ammassoma(Forest)',
          vAxis: {title: 'Temperature (Kelvin)'},
          lineWidth: 1,
          pointSize: 3,
          series: {
            0: {color: '03071E'}, // ~ Xiketic
            1: {color: 'D00000'}, // ~ Rosso Corsa
}});

// Display.
print(tempTimeSeries);
```



There are many missing values for Edumanom Natural Forest . This may be due to there being significantly fewer TOA cloud-free composites for the area than for Sokoto.


EO Browser
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Script Used : Historic NDVI Changes with Landsat 4-5TM and Landsat 8

- This script was developed by Monja B. Šebela @ Sinergise, to show how NDVI values have changes over a span of years. It does not refer to change in cropping cycles (hence it is important to compare images within the same time of year for the different years you analyse), rather the potential long term de-vegetation and revegetation of land.

- The script uses **data-fusion** technique, by analytically comparing historic Landsat 4-5 Level 2 imagery with contemporary Landsat 8-9 Level 2 imagery.

- Vegetation reduction (pink) could be indicative of on urban growth, or deforestation, and an increase (green) may imply agricultural land expansion, or reforestation.

- In my example, I applied this script to the city of **Salzburg, Austria** and **Ikorodu, Nigeria** with significantly different results.
  - While I found less significant changes in the vegetative cover of Salzburg, which could be indicative of little to no changes in the land use over the years (Salzburg being an ancient city has seen most of its urban growth even before remote sensing became a thing), the situation is significantly different for Ikorodu, which over the past 30 years (1984 - 2021), has seen significant de-vegetation, and surprisingly revegetation in some parts.

Script Used : Historic NDVI Changes with Landsat 4-5TM and Landsat 8

How it works:

NDVI is calculated for both collections, and returned in RGB to display changes. In the output, the recent Landsat 8 NDVI is displayed in the green channel, and the historic Landsat 4-5 TM NDVI in both red and blue channels.

The resulting RGB image shows green, where vegetation cover was high on a more recent image and low on an older one, thus indicating vegetation cover increase. Pink color indicates high vegetation cover on the older date and low on a newer one, thus indicating reduction in vegetation cover.

The script

The first part of the script sets up the samples list for both datasets (Landsat 4-5 and Landsat 8).

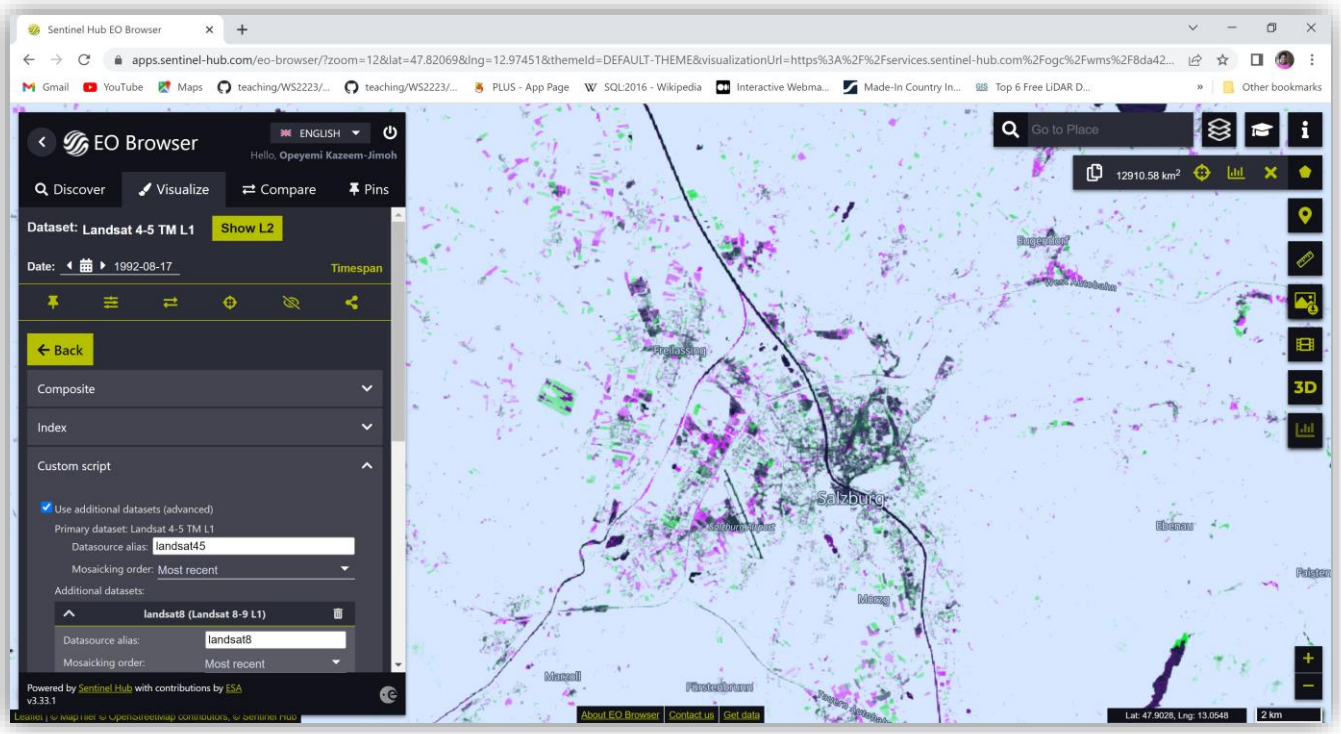
```
function setup() {
  return {
                input: [
                 {datasource: "landsat45", bands:["B04", "B03","dataMask"], mosaicking: "ORBIT"},
                 {datasource: "landsat8", bands:["B05", "B04","B03","dataMask"], mosaicking: "ORBIT"}
                ],
                output: [
                 { id: "default", bands: 3, sampleType: SampleType.AUTO }
                ]
  };
```

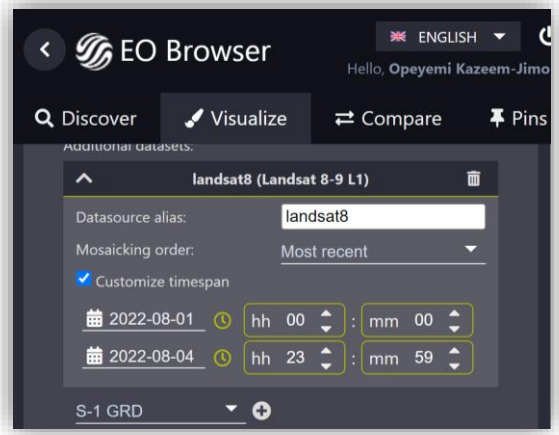
The second part calculates the NDVI for both current and historic datasets individually, the outputs RGB values with the historic NDVI in R and the newer one in Green and Blue.

```
function evaluatePixel(samples, inputData, inputMetadata, customData, outputMetadata) {
 var L8 = samples.landsat8[0]
 var L45 = samples.landsat45[0]
 let oldNDVI = (L45.B04 - L45.B03) / (L45.B04 + L45.B03)
 let newNDVI = (L8.B05 - L8.B04) / (L8.B05 + L8.B04)

 let val = [2*oldNDVI, 2*newNDVI, 2*oldNDVI];
 return {
   default: val
 }
}
```

Salzburg



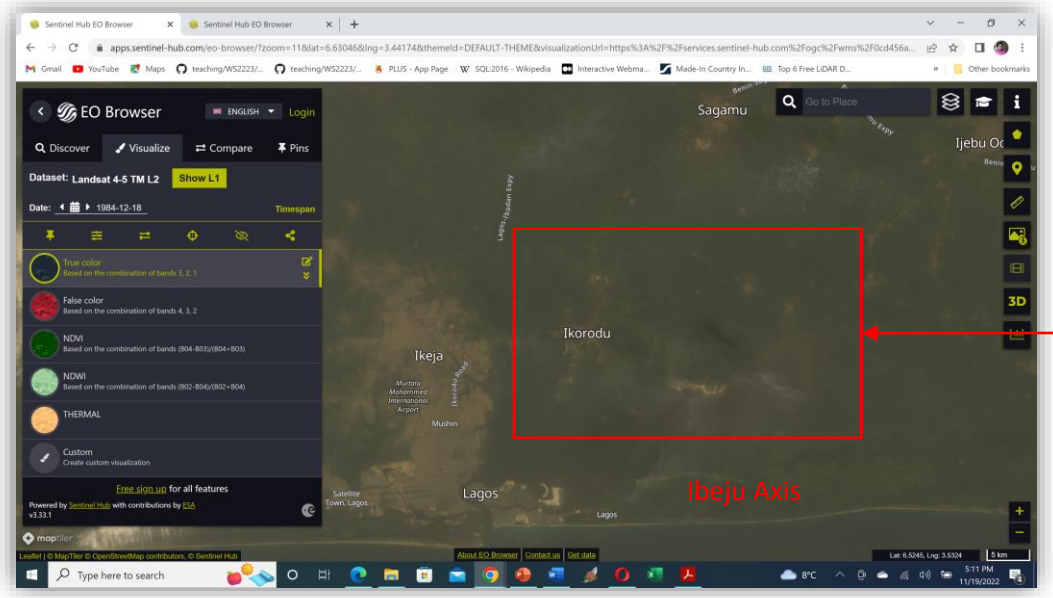


Salzburg from 1992-08-17 to 2022-08-04 shows areas where the vegetative cover has reduced. Although this does not happen on as large a scale as Ikorodu for example, mainly because the city structure has been established long before remote sensing became a thing, it indicates that many vegetative parcels of land have since become repurposed.

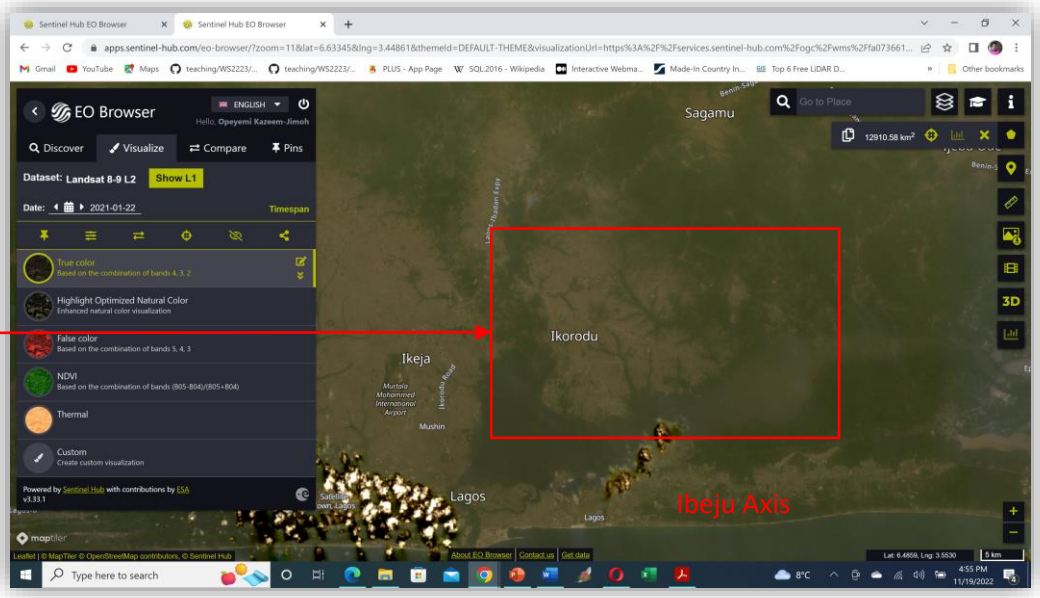
Overall, there is a higher degree of de-vegetation than re-vegetation.

Ikorodu, Lagos

- Ikorodu is a metropolitan city in the heart of Lagos Mainland, and has seen significant growth and urbanization in the past 30 years. This coupled with the fact that I grew up here prompted me to run this analysis, mainly to see how the urban center has grown over time.
- Ibeju's growth happened in the past 10 years mainly, but this is also captured here.

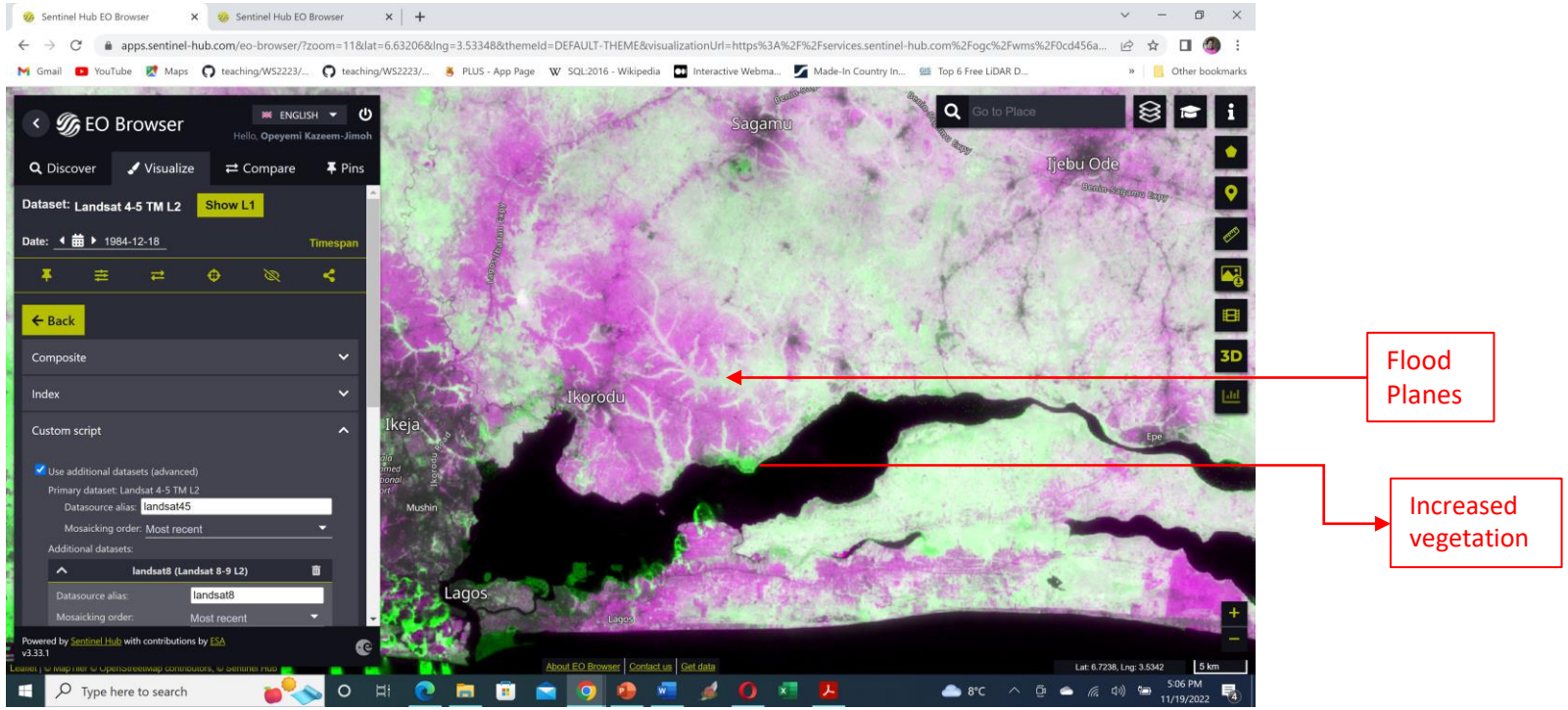


Landsat 4-5 Level 2
Imagery of Ikorodu
(date: 1984-12-18)



Landsat 8-9 Level 2
Imagery of Ikorodu
(date: 2021-01-22)

Ikorodu Result



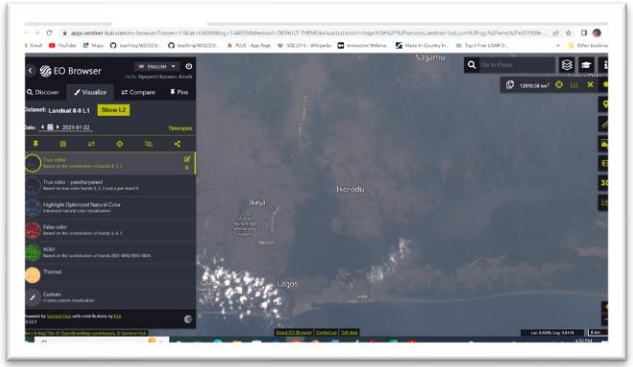
Ikorodu and Ibeju clearly show significant reduction in vegetation over time. Like I said in the previous slide, this can be alluded to widespread human settlement and growth in the urban area. The places that remain relatively unchanged are the lowland flood planes.

Something I find particularly curious is the increased vegetation in the south eastern tip of Ikorodu. On closer inspection it looks like reforestation from baren/sandy land and not agricultural land expansion, which I find peculiar, because this would mean that the are was abandoned and reclaimed by nature, something that is not common in that part of the world, for its lack of conservation prowess. Unfortunately I could not find any historical records to explain this, as at the time of submission.

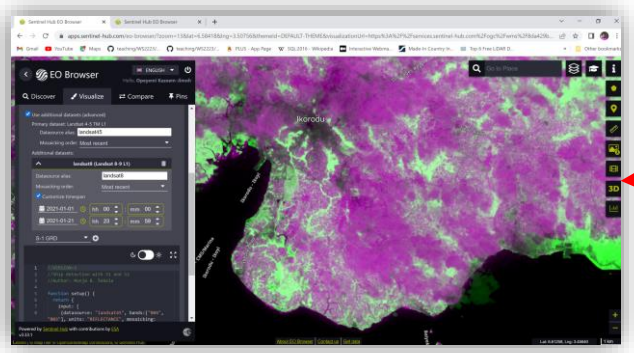
Overall, there is a higher degree of de-vegetation than re-vegetation.

What I did differently;

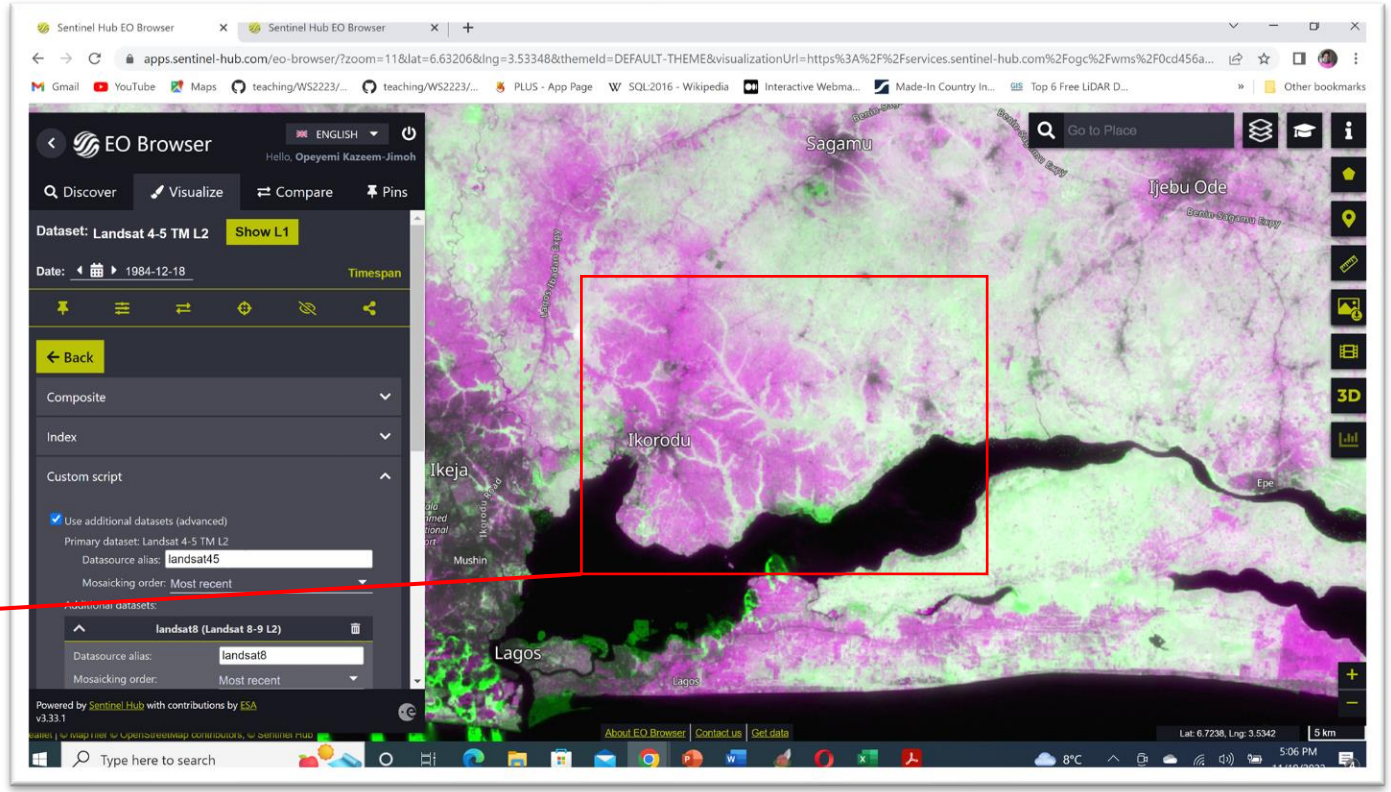
- Although the example uses Landsat 4-5 and Landsat 8 TM Level 1 imagery, I used Leve 2 of both because I realize that it give more accurate values and is less affected by shadows as the imagery is much sharper.
- Also, I have noticed that clouds cause false estimates, therefore, it is pertinent that cloud free imagery is use.



Level 1 True color



Level 1 Output



Level 2 Output