Google Earth Engine

Hands on Experience

Project 4 Mangrove habitats and Blue Carbon

Introduction

Mangrove Wetlands

Mangroves

Mangroves are salt-tolerant evergreen forests found in intertidal environments, at the interface between land and sea. Mostly found at tropical and sub-tropical latitudes, they grow in areas along sheltered coastlines, shallow-water lagoons, estuaries, rivers and deltas, where they experience and adapt to drastic changes in their environment. These lead to the development of adaptation mechanisms to survive in conditions of changing salinity, extreme tides, strong winds, temperature, and soils.

Mangroves as nature-based solutions / Blue Carbon

Blue carbon is the term for the carbon captured by the oceans and coastal ecosystems. Our oceans and coasts provide a natural way of reducing the impact of greenhouse gases on our atmosphere through sequestration of this carbon.

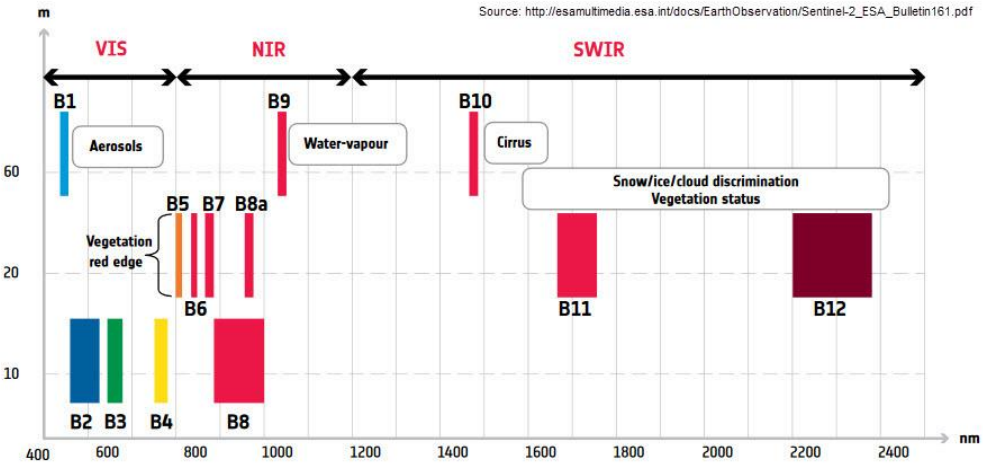
Wetlands including sea grass beds, mangroves, and salt marshes along our coast "capture and hold" carbon, acting as a carbon sink. Despite being a smaller area than terrestrial forests, these coastal ecosystems sequester carbon at a much faster rate and can continue to do so for millions of years.

When these systems are damaged, an enormous amount of carbon can be emitted back into the atmosphere, where it can further contribute to climate change. Efficiently mapping these habitats is key to understanding further changes in these environments, its subsequent effects on the ecosystem, and help us to plan out coastal habitat conservation and restoration efforts.

Sentinel-2 and MVI

Sentinel-2

Sentinel-2 is a high-resolution, multi-spectral imaging twin satellite mission designed to give a high revisit frequency of **every 5 days** at the equator. The platforms carry an optical instrument payload that samples 13 spectral bands: four bands at **10 m**, six bands at **20 m** and three bands at **60 m** spatial resolution. Data acquired from the mission are utilized mostly for land monitoring, emergency management, security, climate change, and marine applications.



↑ Spatial resolution versus wavelength: Sentinel-2's span of 13 spectral bands, from the visible and the near-infrared to the shortwave infrared at different spatial resolutions ranging from 10 to 60 m on the ground, takes land monitoring to an unprecedented level

Mangrove Vegetation Index

$$MVI = (NIR - Green) / (SWIR - Green)$$

The MVI is a rapid yet accurate mangrove vegetation index developed to separate Mangroves to other vegetation covers. It was specifically developed for use with Sentinel-2 imagery bands, but has shown good application for other satellite systems with Green, NIR, and SWIR bands as well.

Guided Lab

1. Import Sentinel-2 Dataset

```
//Importing Harmonized Sentinel-2 MSI: MultiSpectral Instrument
data set

var S2Dataset =
ee.ImageCollection("COPERNICUS/S2_SR_HARMONIZED");

//Import color palettes
var palettes = require('users/gena/packages:palettes');
var color = palettes.cmocean.Speed[7];
```

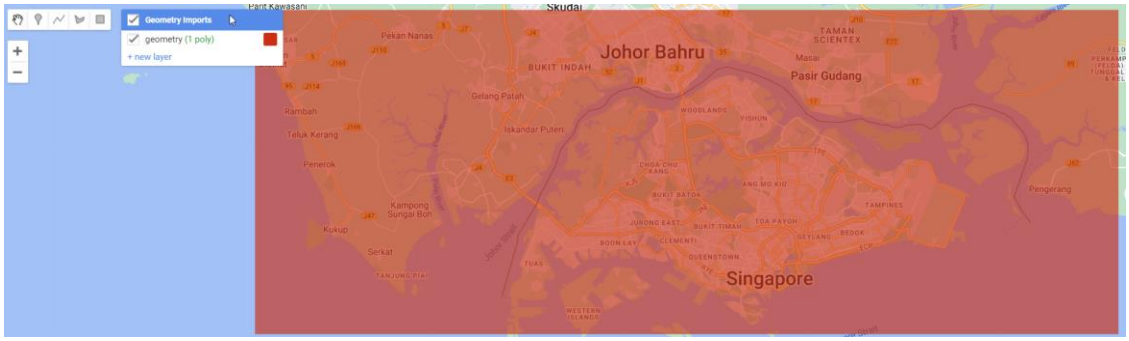
2. Set area of interest (AOI)

```
//Draws a rectangular polygon over Singapore and Johor area

var geometry =
ee.Geometry.Polygon(
        [[[103.371, 1.532],
          [103.371, 1.229],
          [104.175, 1.229],
          [104.175, 1.532]]],null, false);

//Declare geometry as aoi
var aoi = geometry;
```

Alternatively, you can draw a rectangle or polygon over the area of interest. In the imports tab, an object for geometry will show up.



Guided Lab

3. Cloud mask function

```
// Masking out using the SCL class, 3 (Cloud shadow), 7-10
(Clouds)

function cloudMask(image){
  var scl = image.select('SCL');
  var mask = scl.eq(3).or(scl.gte(7).and(scl.lte(10)));
return image.updateMask(mask.eq(0));
}
```

4. Set parameters for composite image

```
//Setting the start and end date of image collection

var startDate = '2022-01-01';
var endDate = '2022-12-31';


//Selecting the images based on the date, cloud mask, and
area of interest
var image = S2Dataset.filterBounds(aoi)
  .filterDate(startDate,endDate)
  .map(cloudMask)
  .median()
  .clip(aoi);

//Display false color composite using RGB 8-11-4
Map.addLayer(image, {bands:['B8', 'B11', 'B4'], min:0,
max:[5000,3000,2000]}, 'False color');
```

Guided Lab

5. Calculate and display MVI

```
// Masking out using the SCL class, 3 (Cloud shadow), 7-10
(Clouds)

var MVI = image.expression('(NIR-Green)/(SWIR-Green)',{
    'NIR':image.select('B8'),
    'Green':image.select('B3'),
    'SWIR':image.select('B11')}).rename('MVI');

//Display MVI
Map.addLayer(MVI, {min:0, max:12, palette: color}, 'MVI
Stretch');

//Display mangrove extent map based on threshold
var MVI_extent = MVI.gte(4.5).selfMask();
Map.addLayer(MVI_extent, { palette: 'green' }, 'Mangrove
Extent');
```

6. Calculate total area of mangrove cover

```
// Area pixel in hectares
var area_ha = ee.Image.pixelArea().divide(10000);


var area_mangrove =
ee.Number(MVI_extent.multiply(area_ha).rename('area').reduc
eRegion({
  reducer: ee.Reducer.sum(),
  geometry: aoi,
  scale: 10,
  bestEffort: true
  }).get('area'));

print(ee.String('Mangroves area (ha) inside AOI:
').cat(area_mangrove));
```

Guided Lab

7. Add other supporting datasets

```
// Add vector data from Global Mangrove Watch for 2020

var extent_2020 = ee.FeatureCollection("projects/earthengine-
legacy/assets/projects/sat-io/open-
datasets/GMW/extent/gmw_v3_2020_vec");

Map.addLayer(extent_2020, {palette:'black'},'GMW Extent');
```

Guided Lab

8. Additional resources to explore

- Global Mangrove Watch Datasets
- Time series modeling
- Biomass/Carbon Density Datasets in GEE

9. Questions to think about

- Sentinel-2 has 13 spectral bands. Why do you think only 3 (Green, SWIR, and NIR) are commonly used for analyses on vegetation like mangroves?

- Areas with MWI values greater than 4.5 are considered mangroves. Is this a reasonable assumption?
- If given more time and resources, what are some ways you can find out that 4.5 is an appropriate cut-off for mangroves?

- What are the differences between the map generated versus the map from the Global Mangrove Watch?
- Which do you think is more useful for detecting changes over time?