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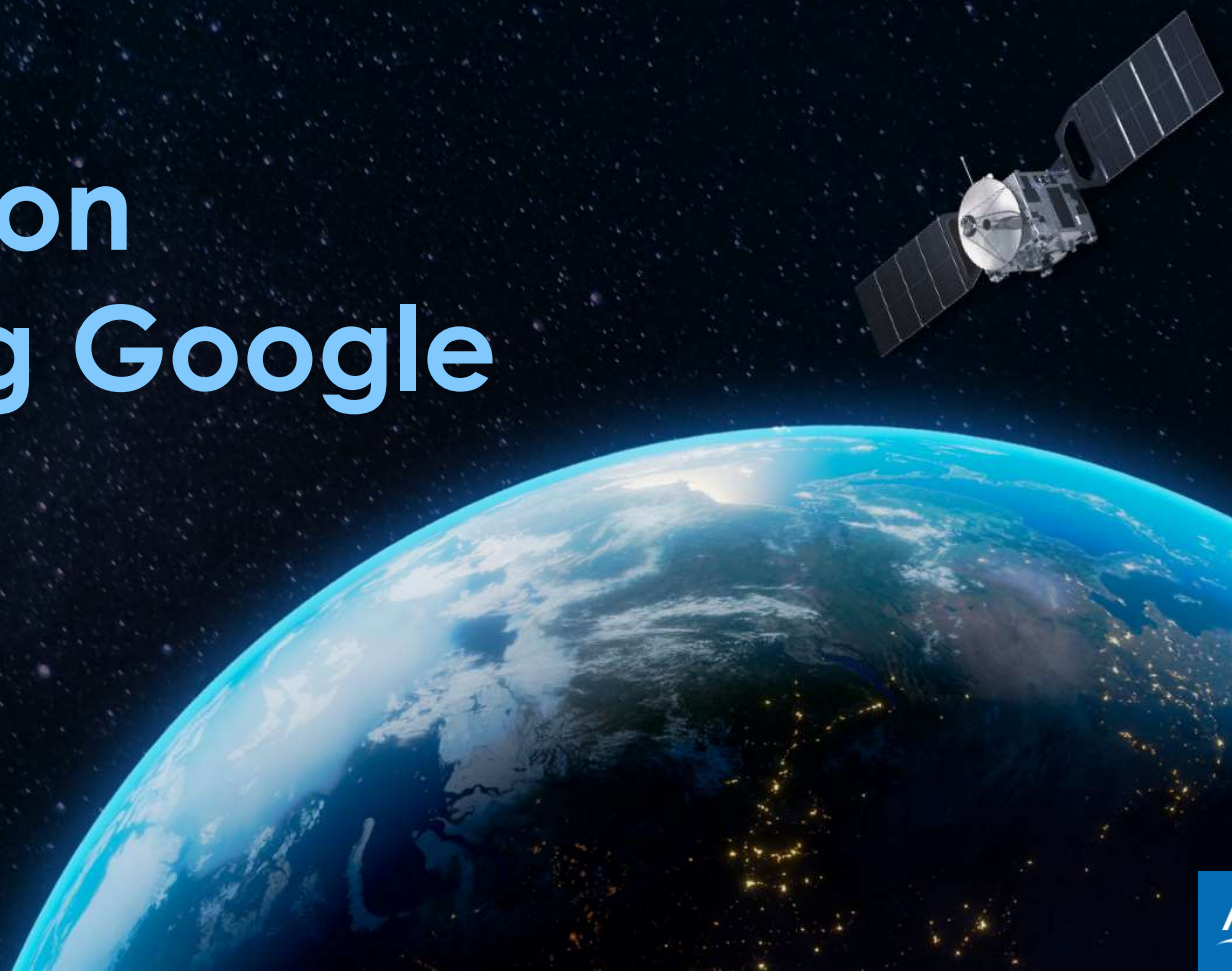
Flood inundation mapping using Google Earth Engine



Kabir Uddin

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BBC NEWS


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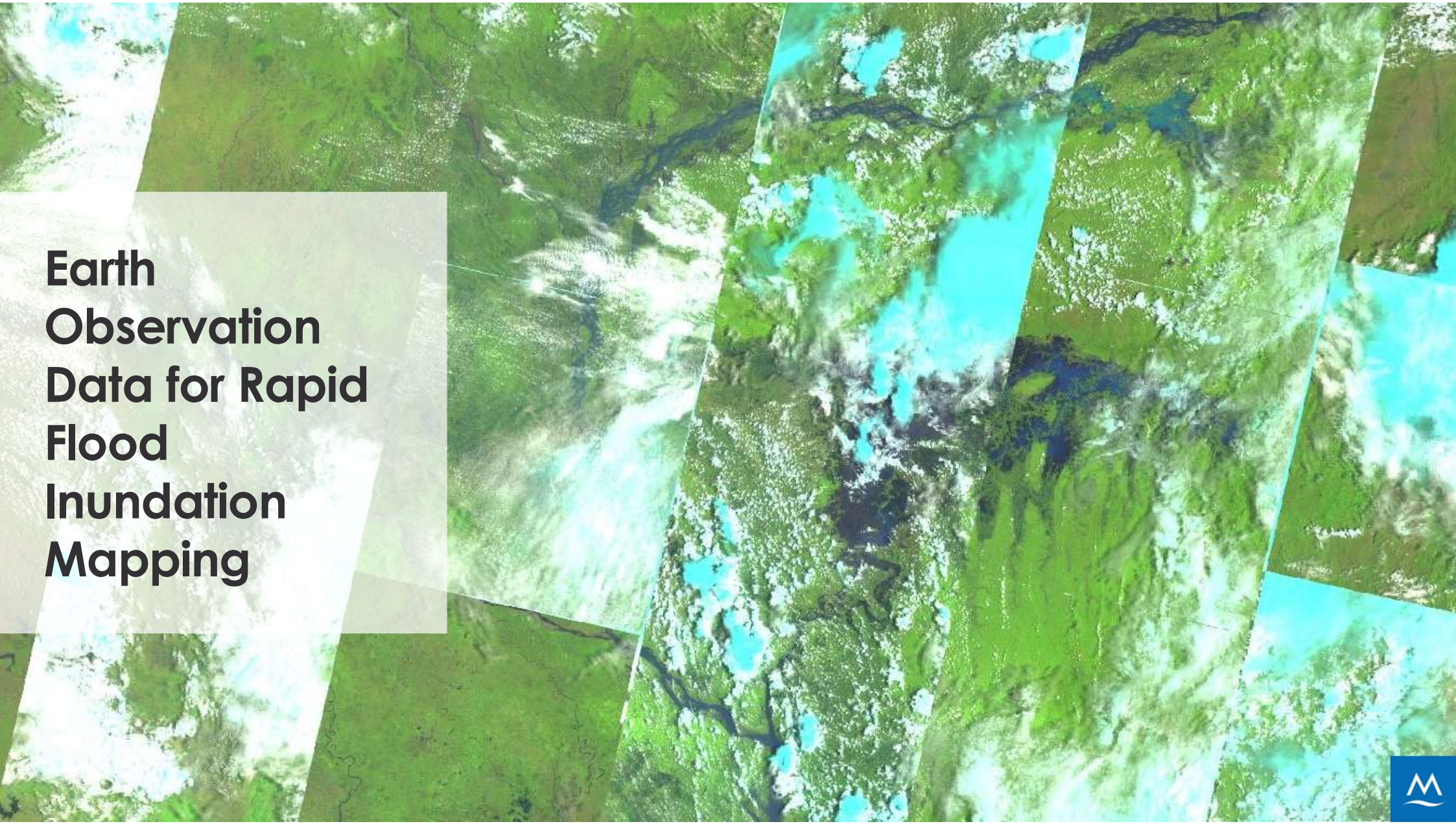
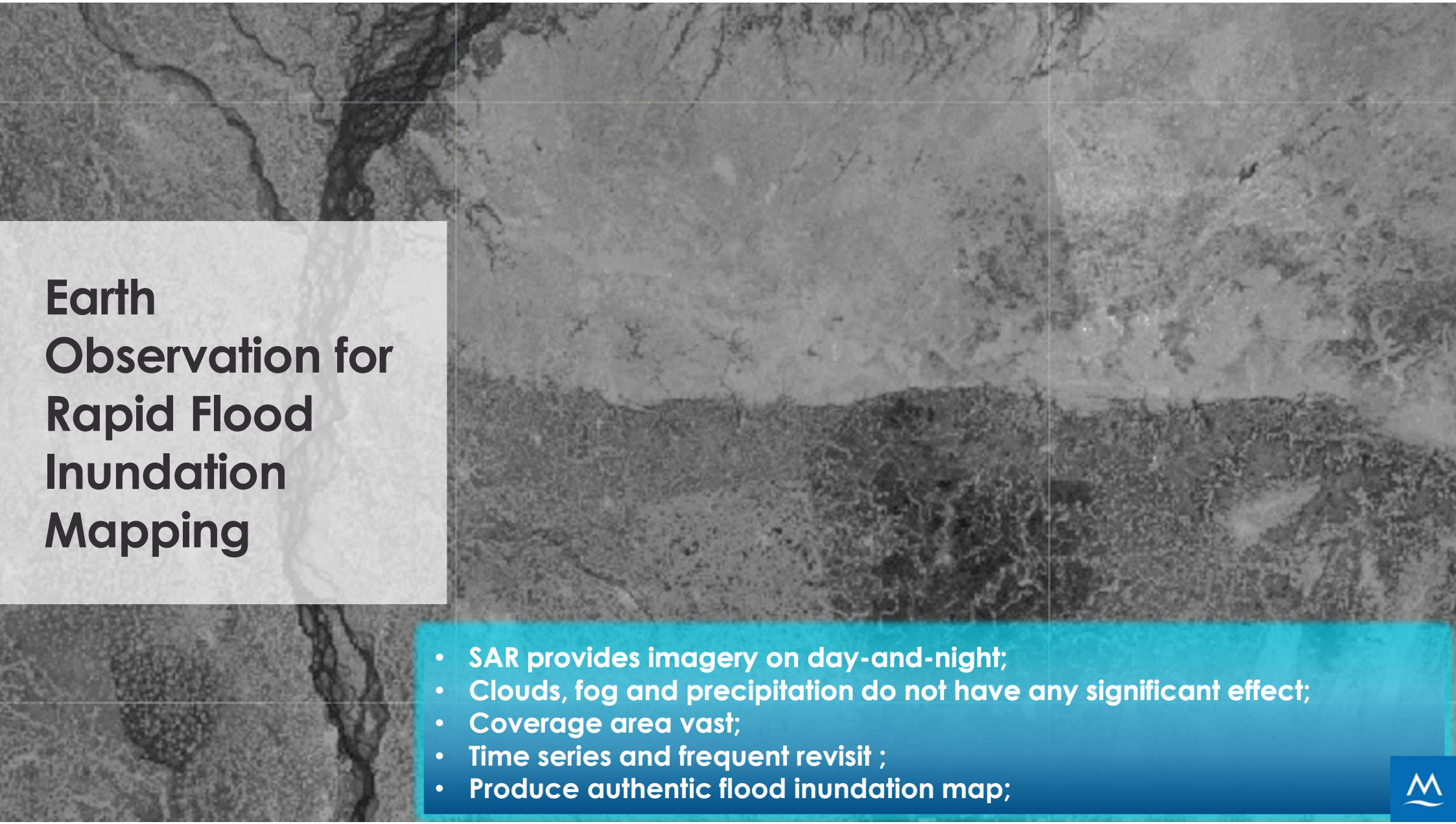
Flood hazard, vulnerability and risk mapping
Flood early warning system
Flood inundation area
Flood damage assessment
Flood shelter suitability area



Earth Observation Data for Rapid Flood Inundation Mapping



Earth Observation for Rapid Flood Inundation Mapping

- SAR provides imagery on day-and-night;
- Clouds, fog and precipitation do not have any significant effect;
- Coverage area vast;
- Time series and frequent revisit ;
- Produce authentic flood inundation map;

Tools and Methods

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Tools and Methods

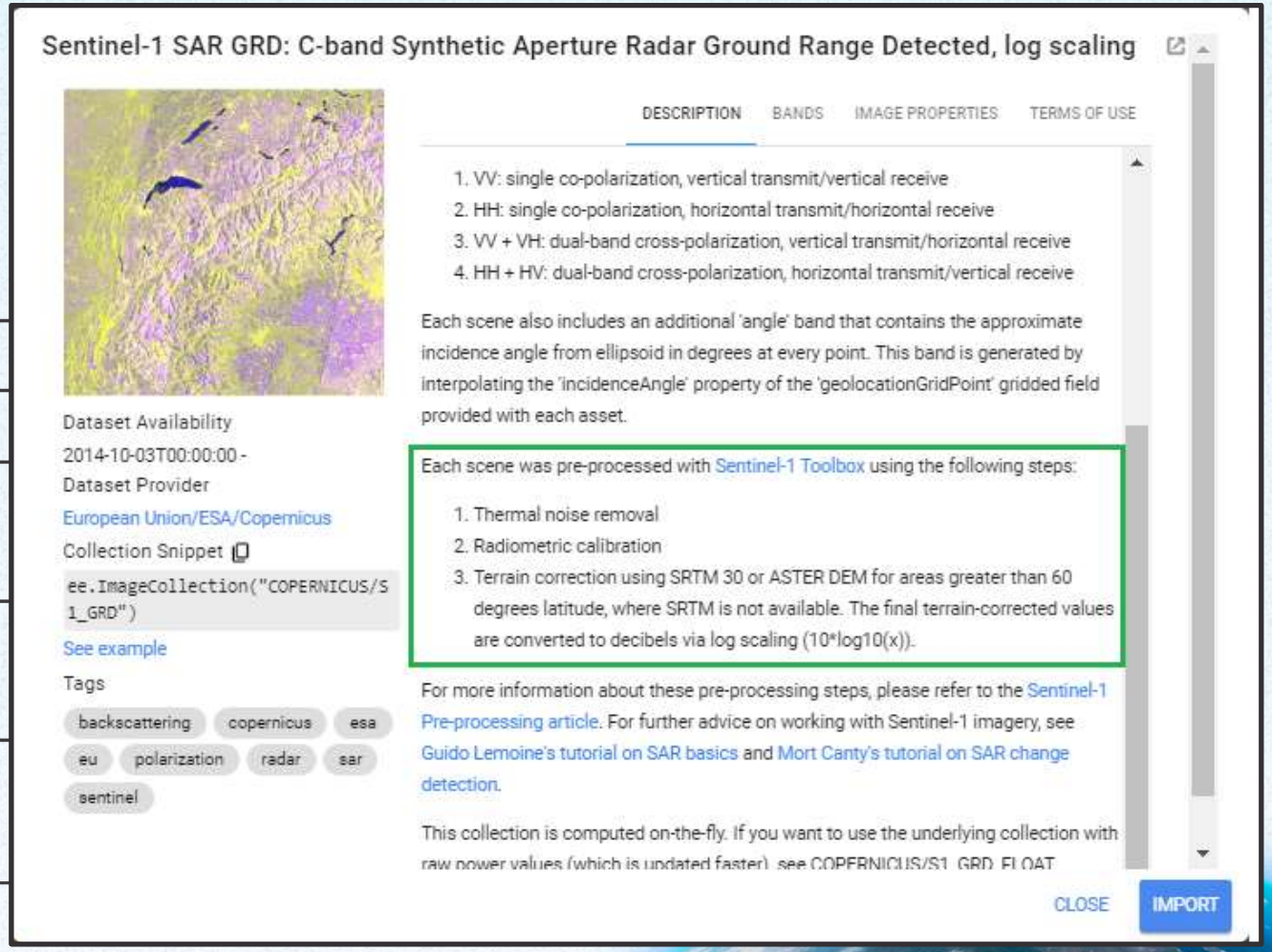
Sentinel-1 images

Calibration

Terrain correction

Landsat image

Flood map validation



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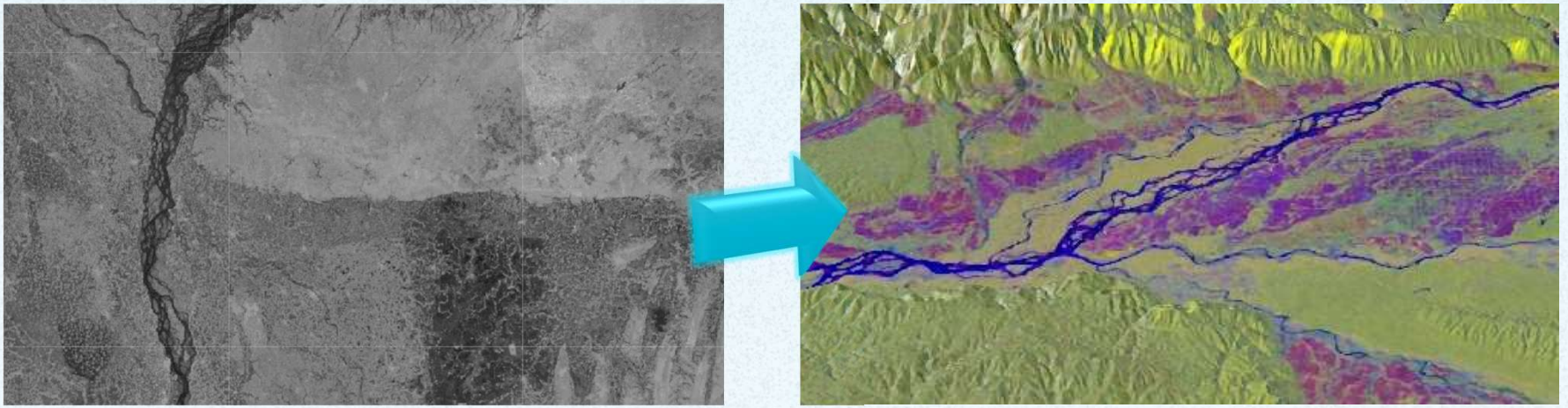
Exercise - 1

Creating a composite image for flood inundation mapping using Sentinel-1 data



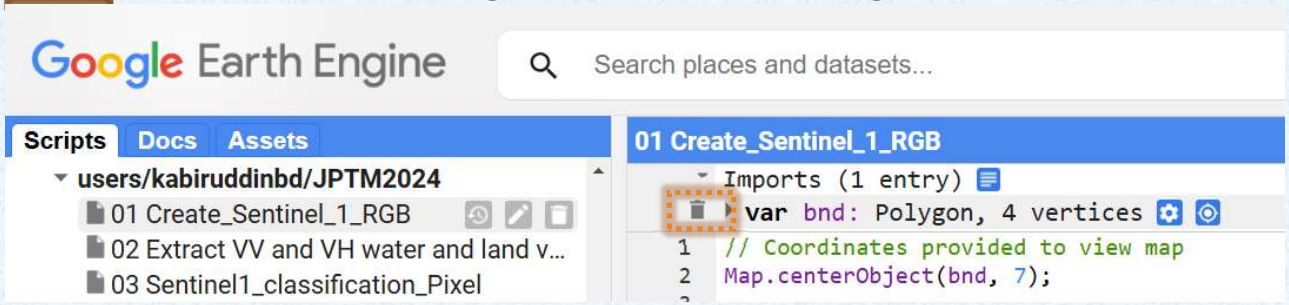
Open the link: https://tinyurl.com/24zbmzv4

https://code.earthengine.google.com/a9926a94a5264dca7c8c65eb754264c0

Exercise - 1

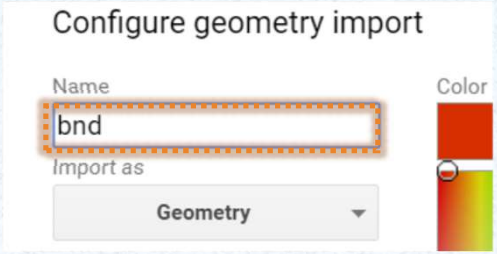
Creating a composite image for flood inundation mapping using Sentinel-1 data

Task Delete the existing boundary and digitized a new study boundary



Task Digitized a new study boundary

Task Rename default name "geometry" to "**bnd**"



Task Run the code with new boundary

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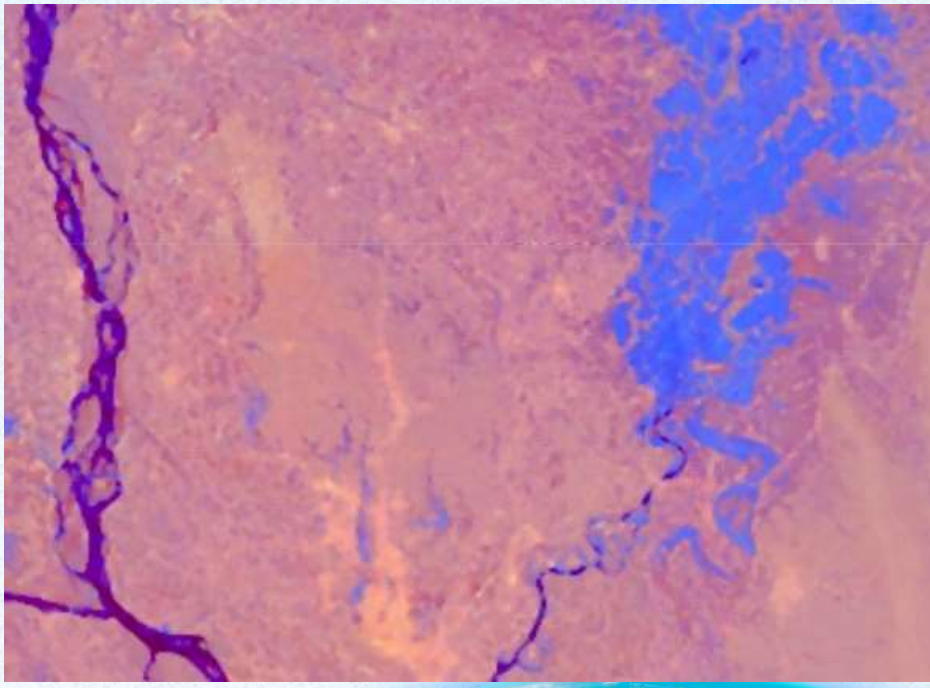
Exercise - 1

Creating a composite image for flood inundation mapping using Sentinel-1 data

01 Create_Sentinel_1_RGB — Get Link | Save | Run

```
77
78
79  // Create a Flood Image Composite using various bands
80  var FloodImgComposite = ee.Image.cat([
81    vvFloodSmoothed.rename('VVFlood_Filtered'),
82    vhPreSmoothed.rename('VHPre_Filtered'),
83    vvDifference.rename('VVDifference_Filtered'),
84    vvvhFloodRatio.rename('VVVH_Flood_Ratio'),
85    vhFloodSmoothed.rename('VHFlood_Filtered'),
86    vvvhFloodSmoothed.rename('VVVH_Flood_Filtered')
87  ]);
88
89  // // Create Flood Image Composite to the map
90
91  // Map.addLayer(FloodImgComposite.clip(bnd), {
92  //   bands: ['VVFlood_Filtered', 'VHPre_Filtered', 'VVDifference_Filtered'],
93  //   min: [-25, -25, -10],
94  //   max: [0, 0, 10],
95  //   gamma: 1.5
96  // }, 'FLood Image Composite');
97
```



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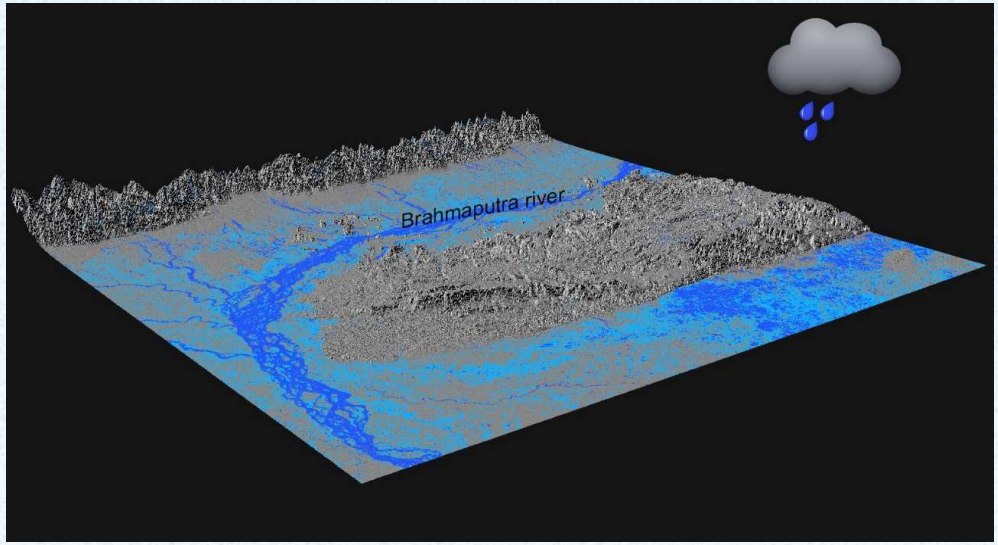
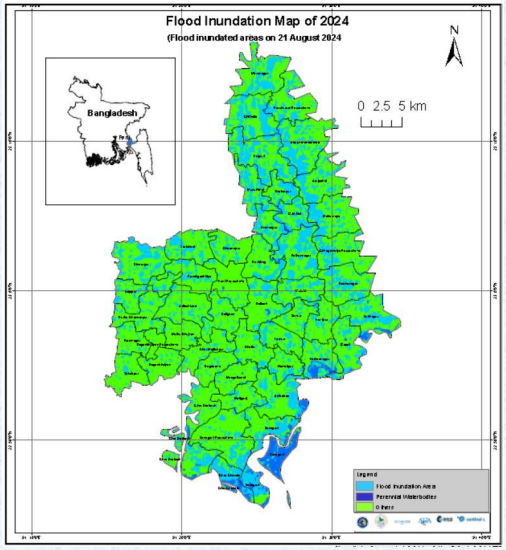
Exercise - 2

Flood inundation mapping using sentinel-1 for any chosen site/**boundary** and date





Open the link: https://tinyurl.com/r789zje7

https://code.earthengine.google.com/00812066ce87f14bd7ea5038694ddf0e

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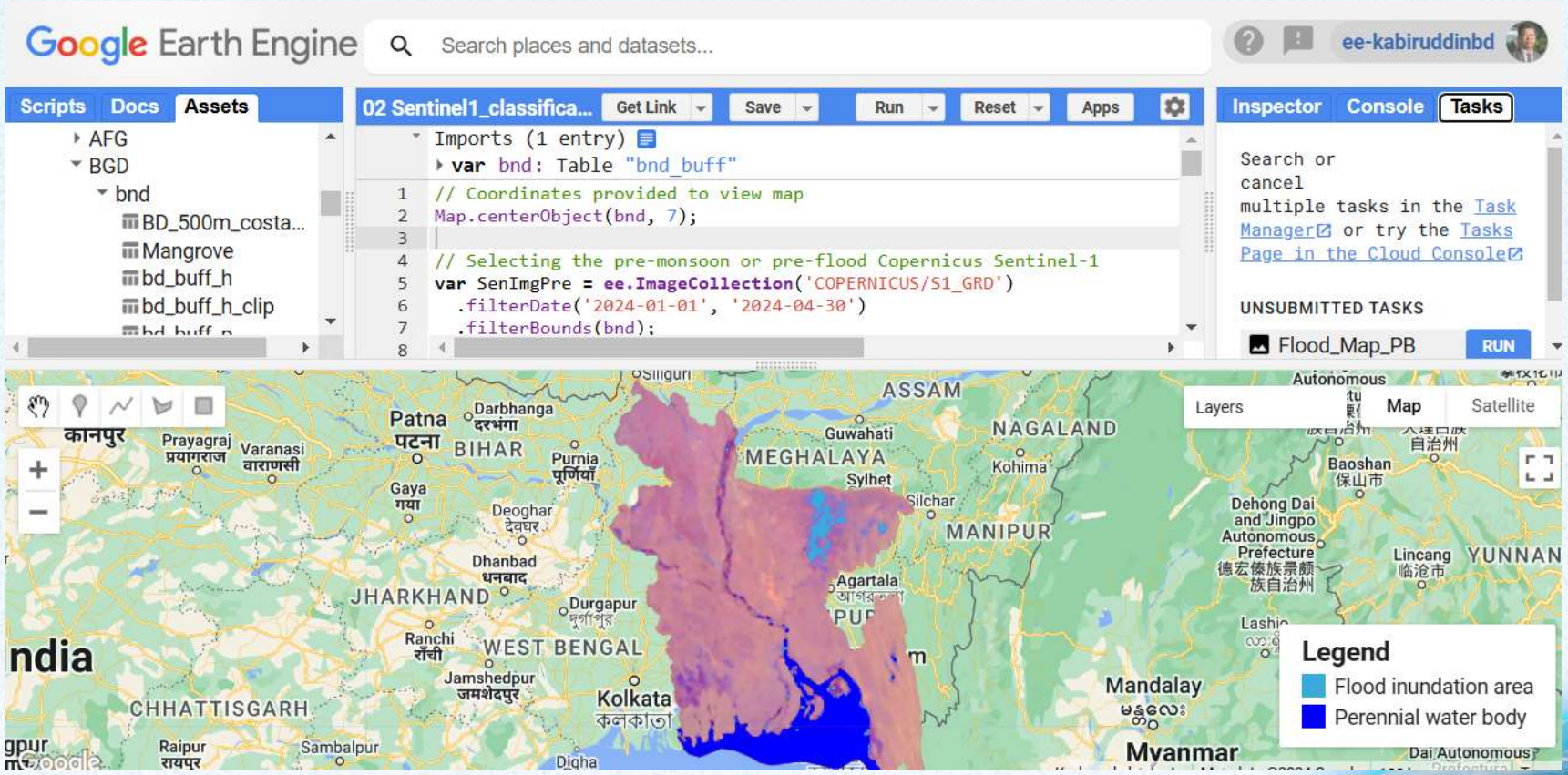
Exercise - 2



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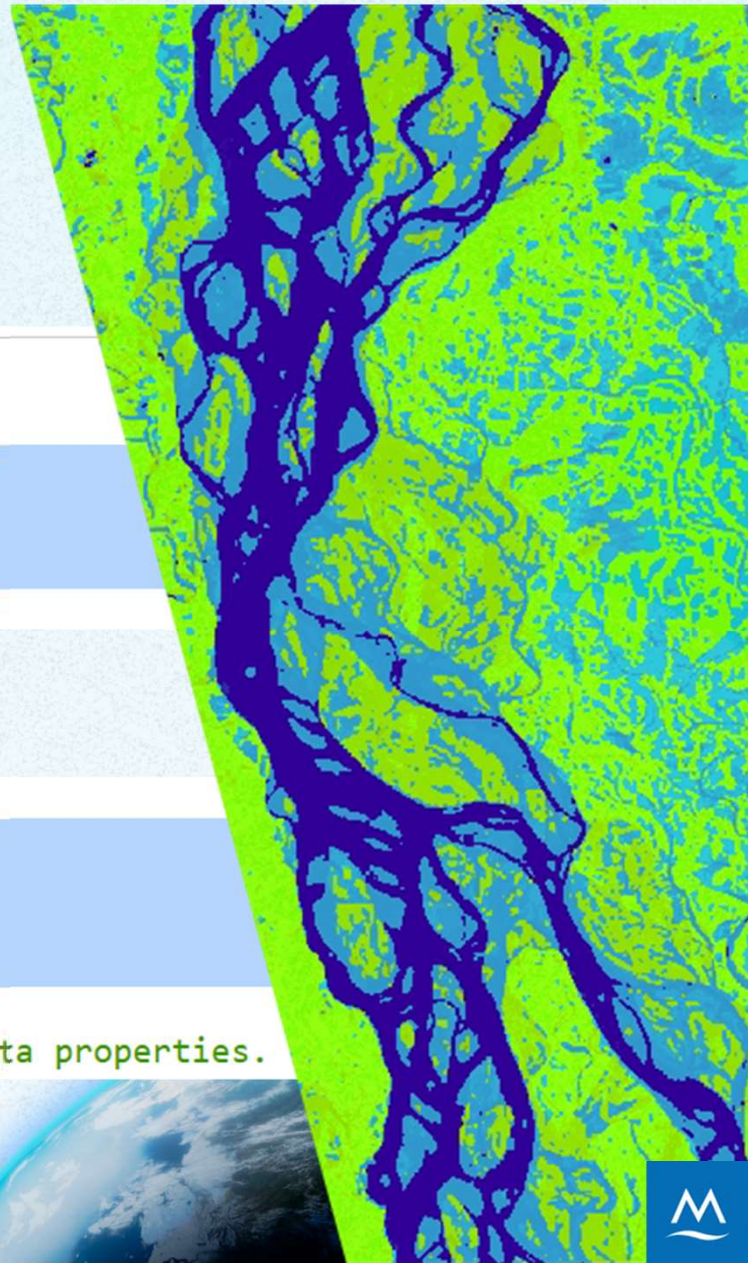
Exercise - 2

Task //Select the pre-flood Copernicus Sentinel-1 imagery

```
1  // Coordinates provided to view map
2  Map.centerObject(bnd, 7);
3
4  // Selecting the pre-monsoon or pre-flood Copernicus Sentinel-1
5  var SenImgPre = ee.ImageCollection('COPERNICUS/S1_GRD')
6    .filterDate('2024-01-01', '2024-04-30')
7    .filterBounds(bnd);
8
```

Task //Select the flooding time Copernicus Sentinel-1 imagery

```
30
31 // Selecting the flood Copernicus Sentinel-1
32 var SenImgFlood = ee.ImageCollection('COPERNICUS/S1_GRD')
33   .filterDate('2024-09-02', '2024-10-07')
34   .filterBounds(bnd);
35 print('Flood Image Collection:', SenImgFlood);
36 // Filtering flood time Copernicus Sentinel-1 image by metadata properties.
```



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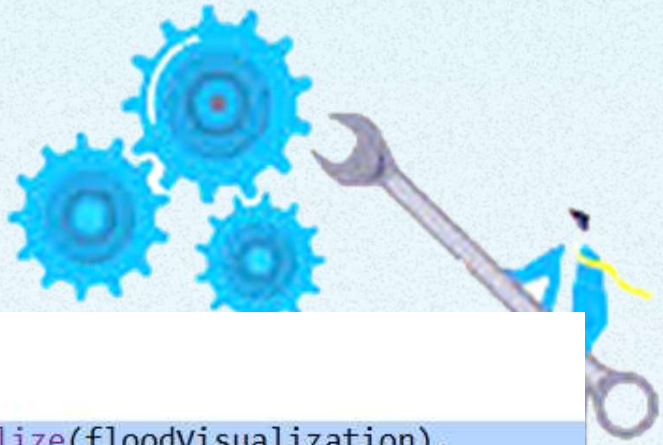
Exercise - 2



Task //If needed adjust the sentinel-1 backscatter threshold

```
104
105  // Flood masking and mosaicking the Sentinel-1 image
106  var classifiedFloodPB = ee.ImageCollection([
107    vvFloodSmoothed.updateMask(vvFloodSmoothed.lt(-15.94)).visualize(floodVisualization),
108    vhPreSmoothed.updateMask(vhPreSmoothed.lt(-24.06)).visualize(floodVisualization),
109    vvvhFloodRatio.updateMask(vvvhFloodRatio.lt(-28)).visualize(floodVisualization),
110
111    waterMask_PreFlood.visualize({palette: ['BLUE']})
112  ]).mosaic();
```

Note: Exercise – 3 will show how we can determine the appropriate backscatter value

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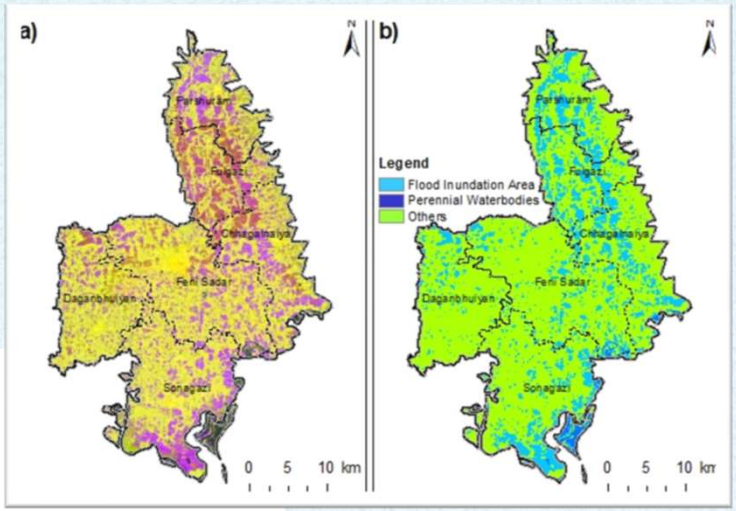
Exercise - 2



Task Export the generated flood map

```
118
119  // ** Export the Pixel-Based Flood Map (Flood Map Pixel-Based PB)) **
120  Export.image.toDrive({
121    image: classifiedFloodPB,  // Clipped Pixel-Based Flood Map
122    description: 'Flood_Map_PB',
123    folder: 'a',  // a is the folder name, please specify the Google Drive folder name
124    fileNamePrefix: 'Flood_Map_PB',  // File name for the exported image
125    scale: 10, // Sentinel-1 resolution scale, recomanded to export 30 meter scale
126    region: bnd,  // Study ara boundary
127    fileFormat: 'GeoTIFF',
128    maxPixels: 3e9  // Adjust this if necessary for larger regions
129  });
```

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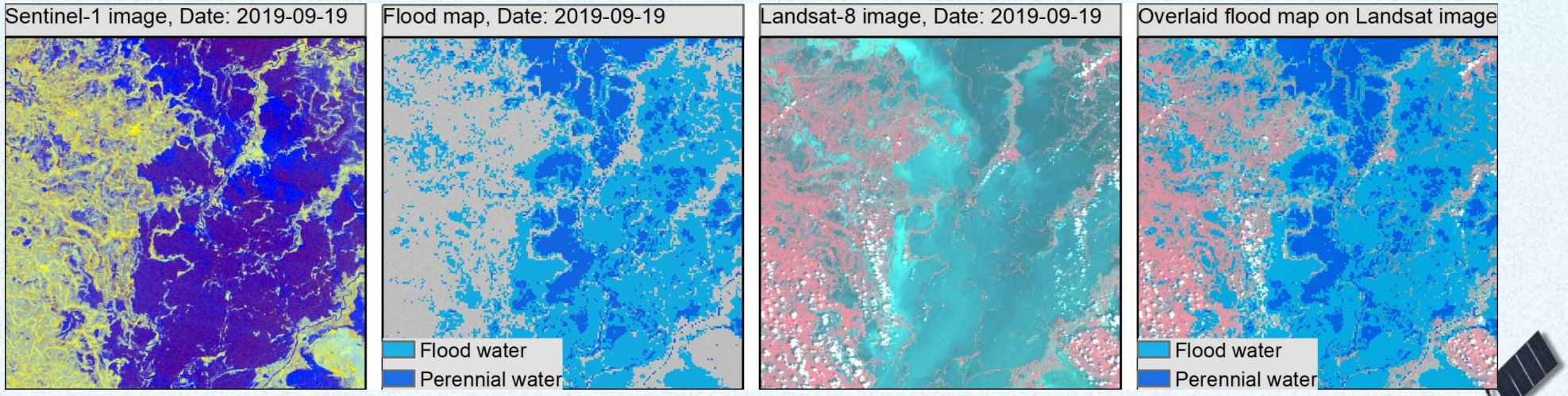
Exercise - 3

Determination of Copernicus sentinel-1 backscatter threshold to automatically flood inundation mapping in GEE and comparison of sentinel-1 based flood inundation map with Landsat-8 image



Open the link: https://tinyurl.com/2djwe9tn

https://code.earthengine.google.com/7fb06c3f197db41aeff5d54127ca3d46

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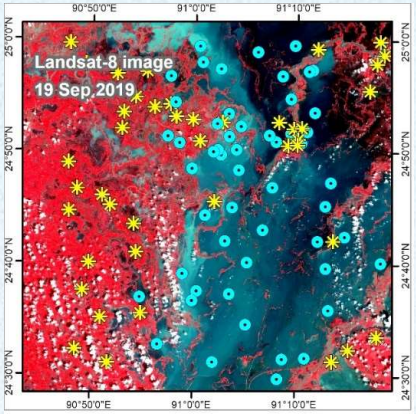
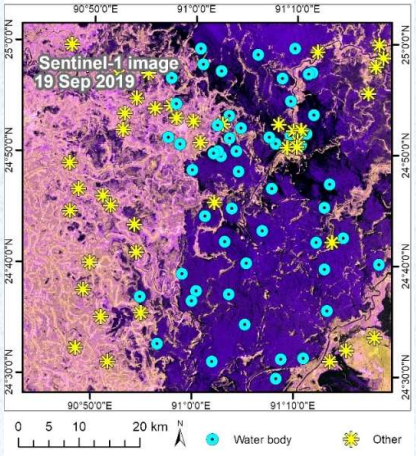
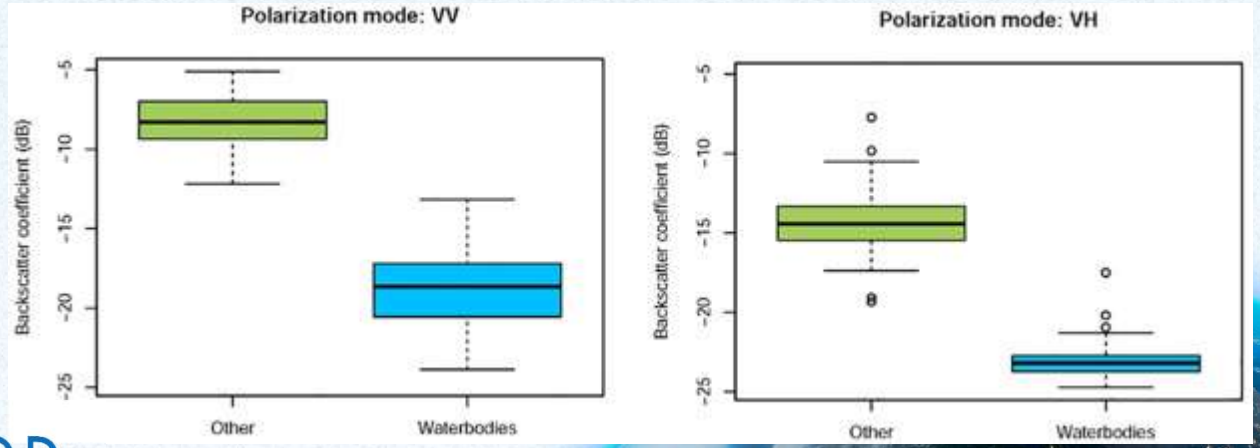
Exercise - 3





- Insert water and land samples on the Landsat image/Sentinel 1 image.
- Extract VH and VV-band backscatter (dB) statistics for water body and other samples.
- Find the interquartile range, mean and median value of waterbodies on the VH and VV-band backscatter (dB)
- Use the VH and VV-band backscatter (dB) for mapping



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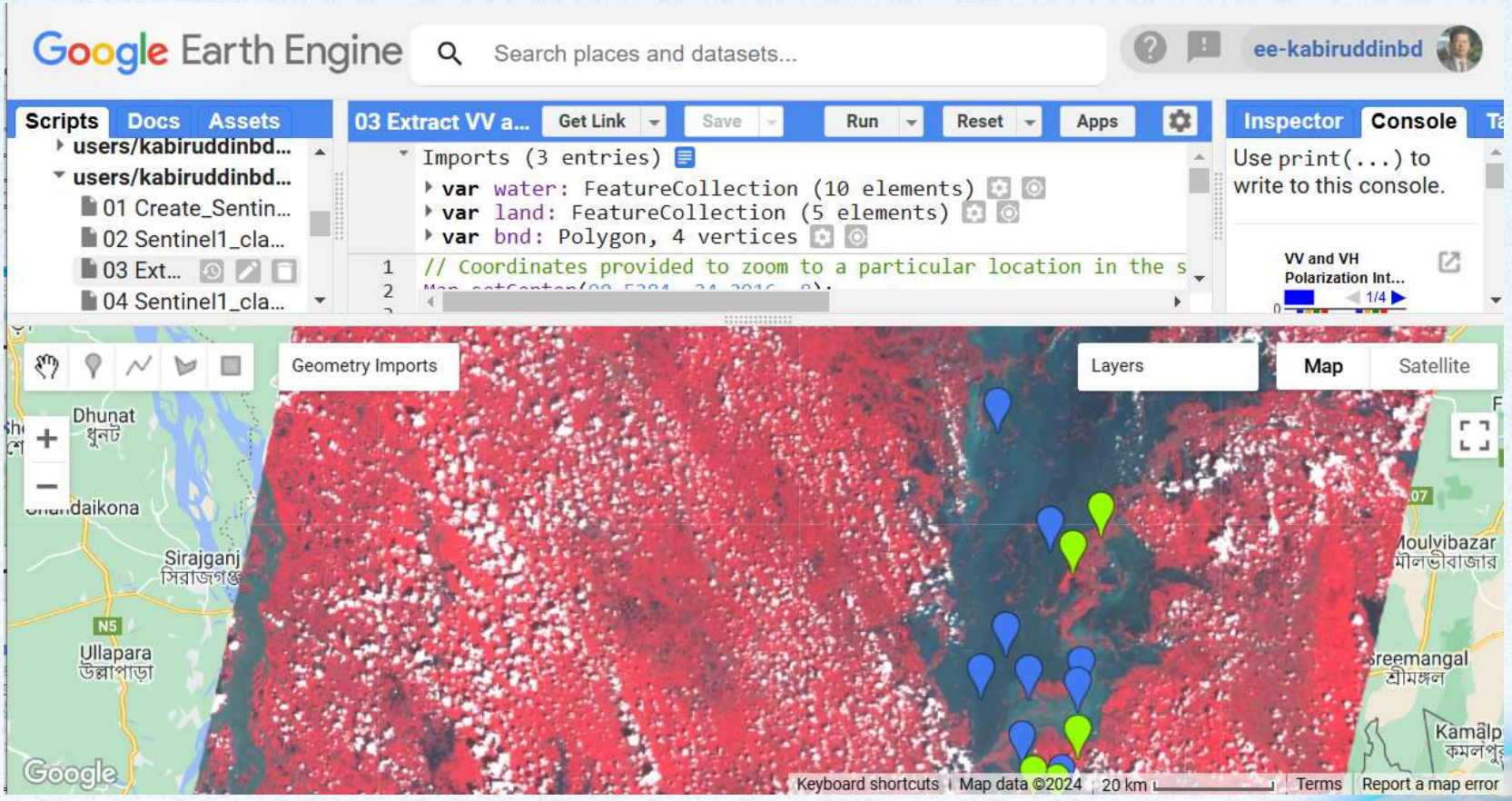
Exercise - 3



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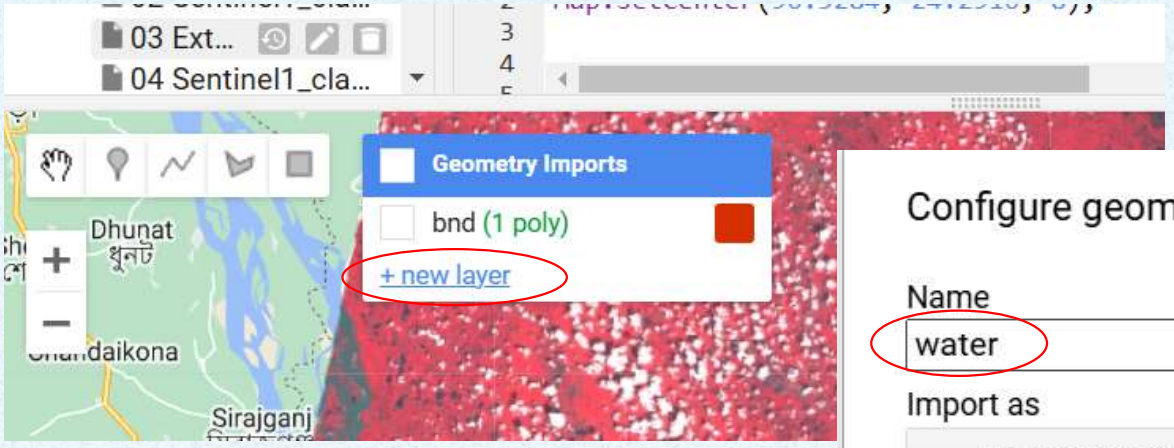
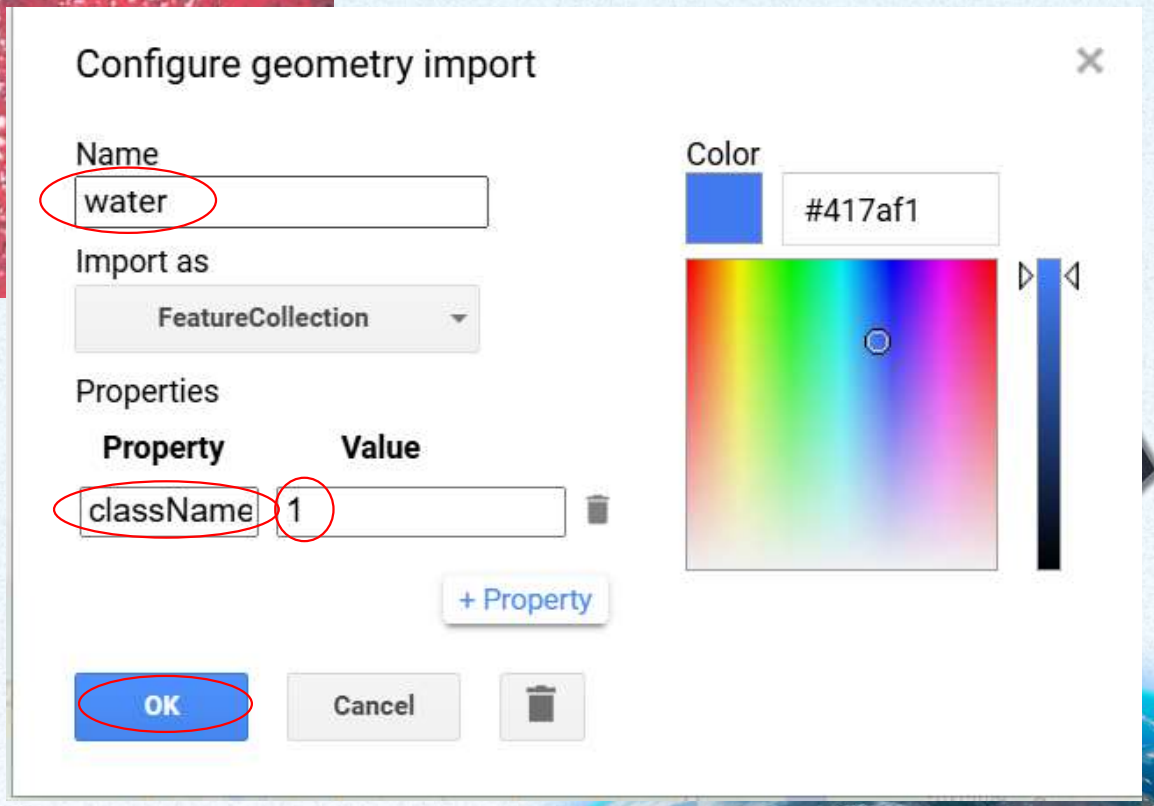
Exercise - 3





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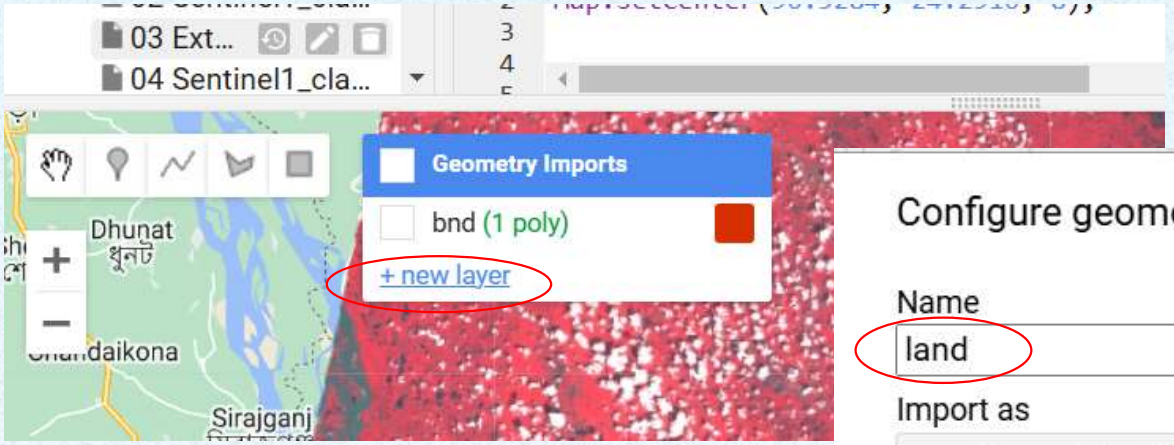
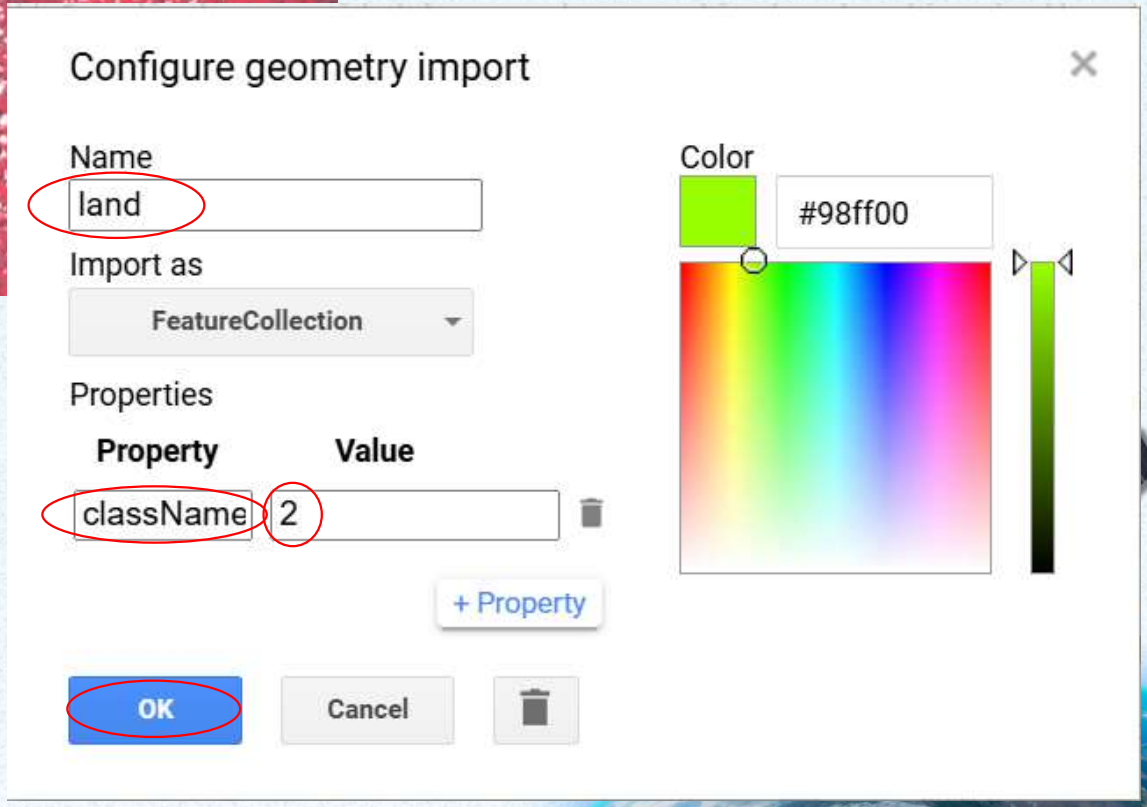
Exercise - 3





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Exercise - 3

03 Extract VV and VH water and land value *

Get Link | Save | Run | Reset

```
Imports (3 entries)
  var water: FeatureCollection (10 elements)
  var land: FeatureCollection (5 elements)
  var bnd: Polygon, 4 vertices
1  // Coordinates provided to zoom to a particular location in the study area
2  Map.setCenter(90.5284, 24.2916, 8);
3
4  // Pre-monsoon or pre-flood Copernicus Sentinel-1 Date: 2019-05-20
5  var SenImgPre = ee.Image('COPERNICUS/S1_GRD/S1A_IW_GRDH_1SDV_20190520T120441_20190520T120506_027311_031480_43CA');
6
7  // Flood inundation periods Copernicus Sentinel-1 Date: 2019-09-19
8  var SenImgFlood = ee.Image('COPERNICUS/S1_GRD/S1A_IW_GRDH_1SDV_20190919T235547_20190919T235612_029097_034D72_B042');
48 // Landsat image for comparison
49 var landsat = ee.Image('LANDSAT/LC08/C02/T1_RT/LC08_137043_20190920');
50 Map.addLayer(landsat, {bands: ['B5', 'B4', 'B3'], min: 2164, max: 20205}, 'Landsat 20 Sep 2019', false);
68
69 // Flood masking and mosaicking the Sentinel 1 image.
70 var FloodMap = ee.ImageCollection([
71   vvFloodSmoothed.updateMask(vvFloodSmoothed.lt(-17)).visualize(floodViz),
72   vhFloodSmoothed.updateMask(vhFloodSmoothed.lt(-21)).visualize(floodViz),
73   Sprevv_smoothedmask.visualize({palette: ['BLUE']}),
74 ]).mosaic();
75 Map.addLayer(FloodMap.clip(bnd), {}, 'Flood Map');
```

Task

Please change the backscatter value from line 71 and 72, and run code.
Visually compare the results with Landsat image.

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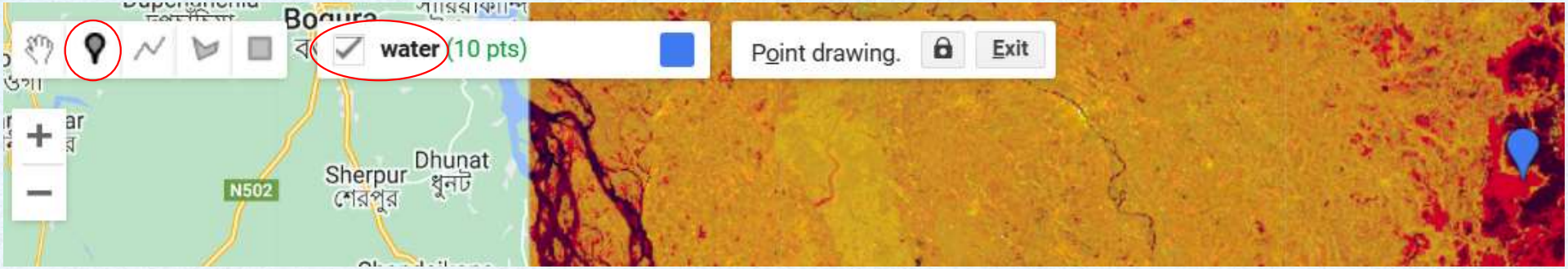
Exercise - 3

Insert point for water and land



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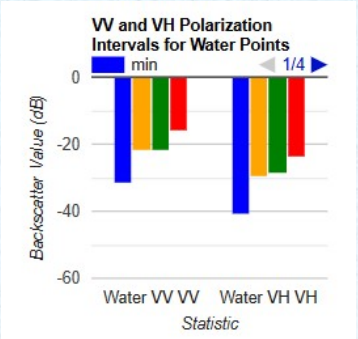
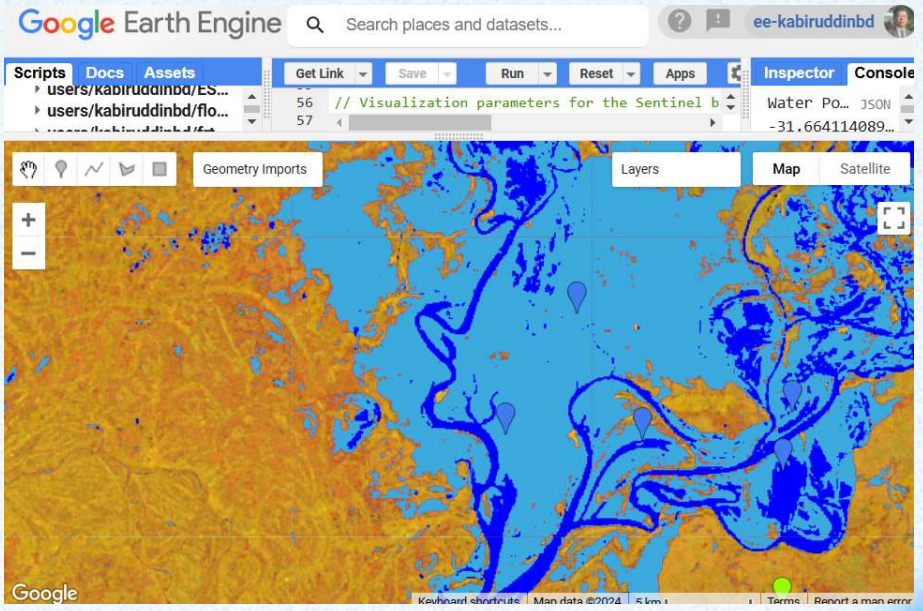
Exercise - 3

Please change the backscatter value from line 72 and 73 and run code. Visually compare the results with Landsat image.




```
Water Points VV Min:
-31.664114089543798

Water Points VV Max:
-15.942186064300024

Water Points VV Mean:
-22.086264130646097

Water Points VV Median:
-21.98514182857053

Water Points VH Min:
```

```
69
70  // Flood masking and mosaicking the Sentinel 1 image.
71  var FloodMap = ee.ImageCollection([
72    vvFloodSmoothed.updateMask(vvFloodSmoothed.lt(-17)).visualize(floodViz),
73    vhFloodSmoothed.updateMask(vhFloodSmoothed.lt(-21)).visualize(floodViz),
74    Sprevv_smoothedmask.visualize({palette: ['BLUE']}),
75  ]).mosaic();
76  Map.addLayer(FloodMap.clip(bnd), {}, 'Flood Map');
```



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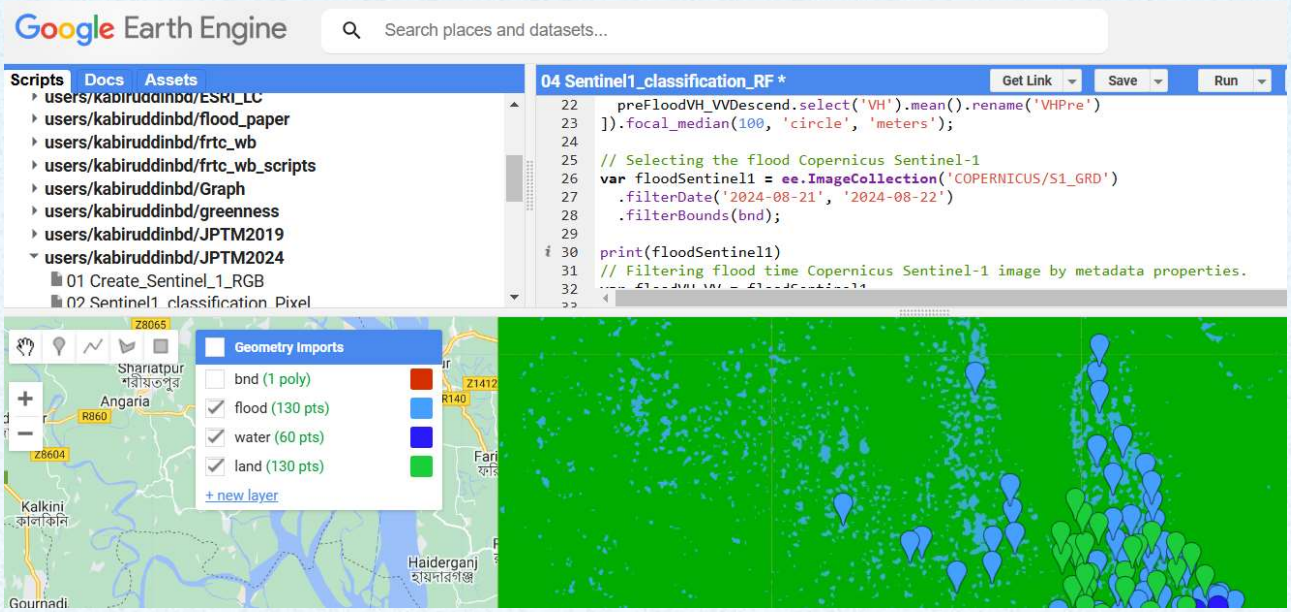
Exercise - 4

Using the Random Forest classification technique for flood inundation mapping



Open the link: https://tinyurl.com/2djwe9tn

https://code.earthengine.google.com/ac3aa9fd4c2f6e53aada0c6d4b0b7214

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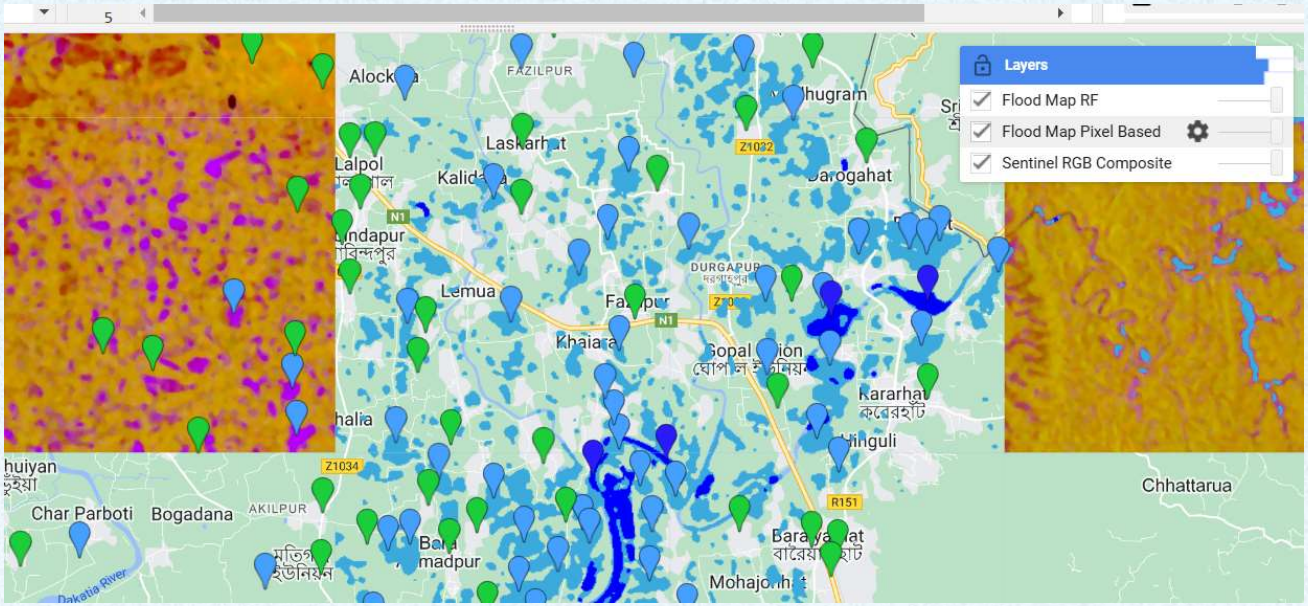
Exercise - 5

Using the Random Forest classification technique for flood inundation mapping



Open the link: https://tinyurl.com/4e352w82

https://code.earthengine.google.com/cbee2a9d18c5f94c3c2066b24050a8b5

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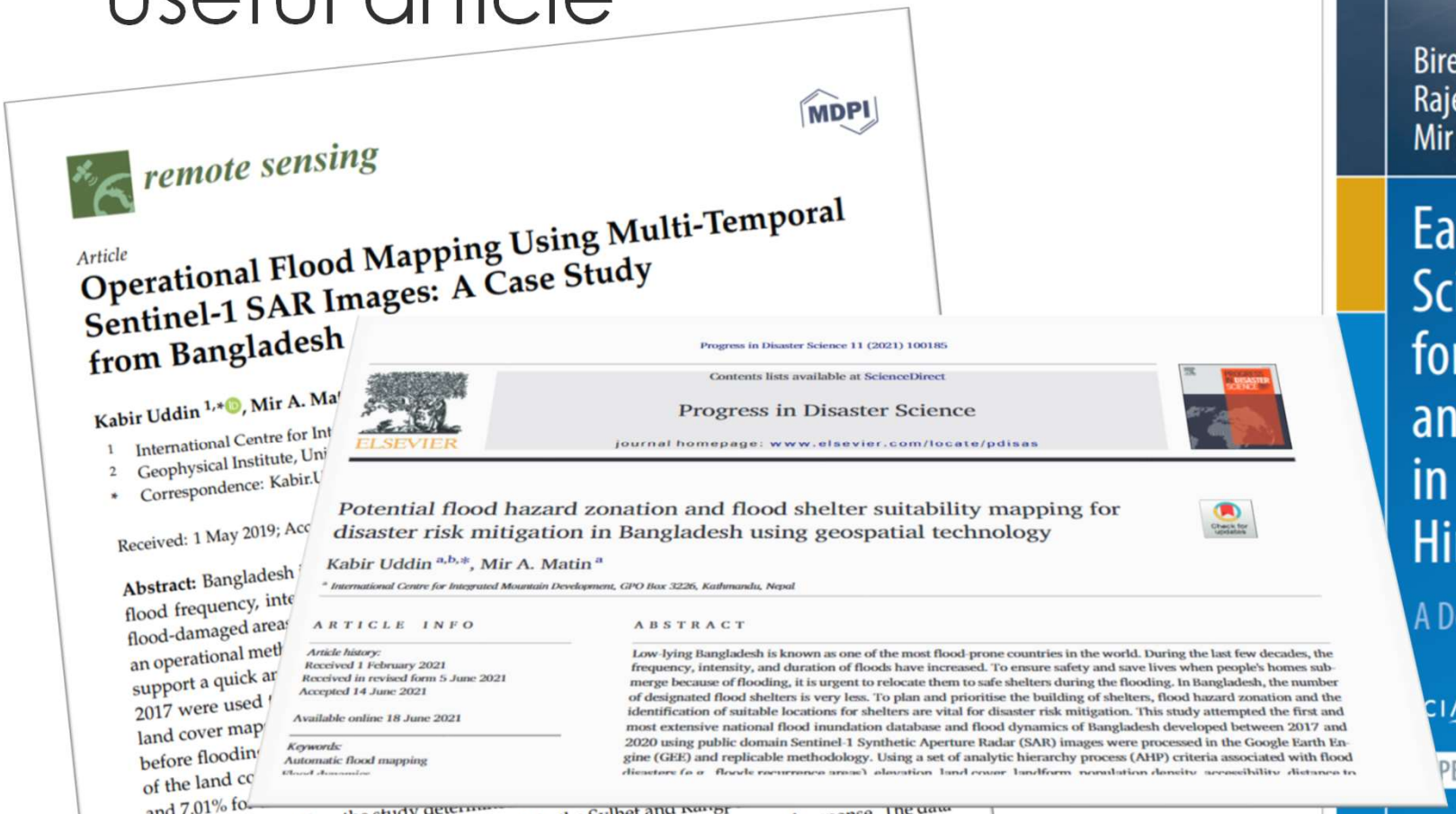
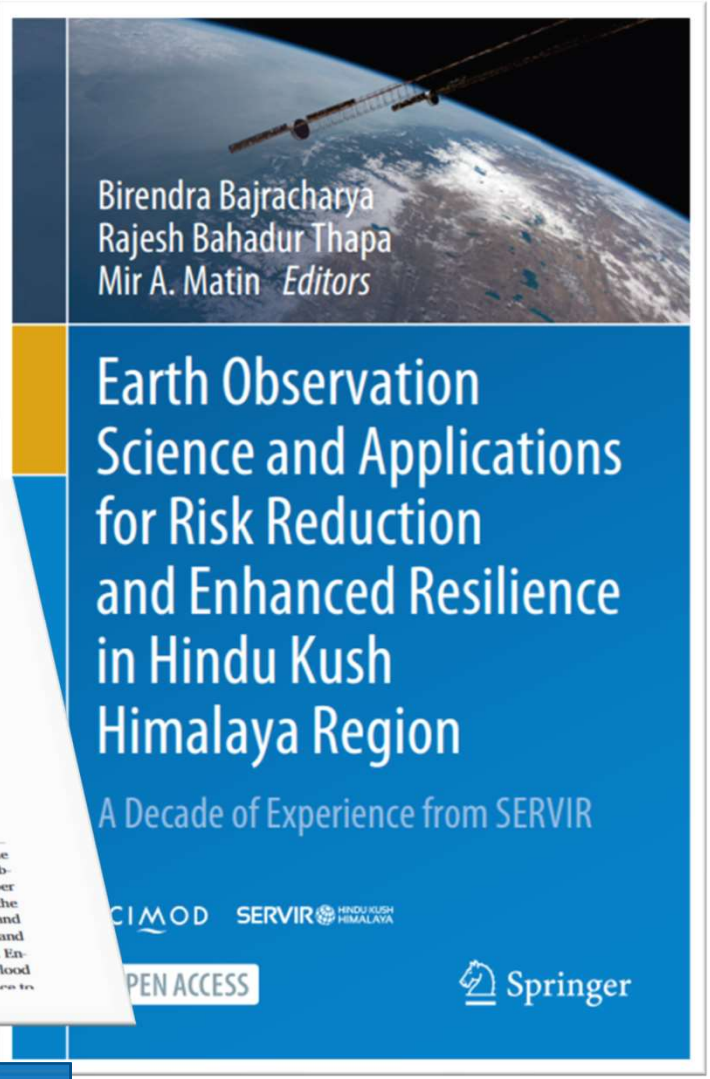
Useful article





www.mdpi.com/2072-4292/11/13/1581
https://link.springer.com/chapter/10.1007/978-3-030-73569-2_10
www.sciencedirect.com/science/article/pii/S2590061721000454

Thank you

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