

unsupervised

October 20, 2023

```
[ ]: import geemap, ee
```

```
[ ]: Map = geemap.Map()
Map.add_basemap("SATELLITE")
# Map
```

0.1 Change to Sentinel 2 TOA and check cloud covers; change ROI and clustering ROI for better accuracy!

```
[ ]: # point = ee.Geometry.Point([-122.4439, 37.7538])
# point = ee.Geometry.Point([-87.7719, 41.8799]) # Michigan
# point = ee.Geometry.Point([18.08, 59.32]) # Stockholm
# region = ee.Geometry.BBox(17.82, 59.22, 18.34, 59.42) # Stockholm
region = ee.Geometry.BBox(17.70, 59.20, 18.70, 59.60) # Stockholm

image = (
    ee.ImageCollection('COPERNICUS/S2_SR_HARMONIZED')
    .filterBounds(region)
    .filterDate('2023-06-01', '2023-08-31')
    .sort('CLOUDY_PIXEL_PERCENTAGE', False)
    .mosaic()
    .unitScale(0, 10000)
    .clip(region)
    # .select('B[1-7]')
)

# True Color Display:
vis_params = {'min': 0, 'max': 0.3, 'bands': ['B4', 'B3', 'B2']}

Map.centerObject(region, 10)
Map.addLayer(image, vis_params, "Sentinel-2")
```

```
props = geemap.image_props(image) props.getInfo() # props.get('IMAGE_DATE').getInfo()
# For LandSat-8; Sentinel-2 does not have these image properties #
props.get('CLOUD_COVER').getInfo() # For LandSat-8; Sentinel-2 does not have these
image properties
```

1 Construct Training Data Set:

```
[ ]: ndvi = image.normalizedDifference(['B8', 'B4']).rename('ndvi')
      ndwi = image.normalizedDifference(['B3', 'B8']).rename('ndwi')
      input = image.addBands([ndvi, ndwi])

      # Define the input features for the classifier
      # inputBands = ['B2', 'B3', 'B4', 'B8', 'B8A', 'B11', 'ndvi', 'ndwi']
      inputBands = ['B2', 'B3', 'B4', 'B8', 'B11', 'ndvi', 'ndwi']

[ ]: # Make the training dataset.
      training = input.select(inputBands).sample(
          **{
              'region': region,
              'scale': 30,
              'numPixels': 5000, # Default, given
              # 'numPixels': 10000,
              # 'seed': 0,
              # 'geometries': True, # Set this to False to ignore geometries
          }
      )

      # Plot the training sample data (not really necessary)
      # Map.addLayer(training, {}, 'training', False)
      # Map
```

```
[ ]: # Instantiate the clusterer and train it.
      n_clusters = 15
      clusterer = ee.Clusterer.wekaKMeans(n_clusters).train(training)
```

```
[ ]: # Cluster the input using the trained clusterer.
      result_unclassified = input.select(inputBands).cluster(clusterer)
      # geemap.image_props(result)

      # # Display the clusters with random colors.
      # Map.addLayer(result.randomVisualizer(), {}, 'clusters')
      # Map.addLayer(result, {}, 'clusters')
      # Map
```

2 Unlabelled cluster:

```
[ ]: # Define 15 colors to distinguish the clusters and look at what they are!
      # legend_keys = ['One', 'Two', 'Three', 'Four', 'ect']
      # legend_colors = ['#8DD3C7', '#FFFB3', '#BEBADA', '#FB8072', '#80B1D3']
      legend_keys = ['0', '1', '2', '3', '4', '5', '6', '7', '8', '9', '10', '11', '12', '13', '14']
      legend_colors = [
          '#e6194B', '#3cb44b', '#ffe119', '#4363d8', '#f58231', '#911eb4', '#42d4f4', '#f032e6', '#bfe145',

```

```

Map.addLayer(
    result_unclassified, {'min': 0, 'max': 14, 'palette': legend_colors},
    ↪ 'Unclassified clusters'
)
Map.add_legend(
    keys=legend_keys, colors=legend_colors, position='bottomright'
)
Map

```

```

[ ]: Map(center=[59.399925146053874, 18.199999999999986],
    controls=(WidgetControl(options=['position', 'transparent_...

```

3 Cluster-Class Remapping:

3.1 0 - Urban: 7 (darker/road), 9 (metallic rooftop or cloud)

3.2 1 - Water: 2 (deep), 13 (shallow), 14 (?, close to outer seas)

3.3 2 - Vegetation: 0 (larger), 1 (wet?), 3, 4 (slight veg) , 5 (tall), 8 (very wet), 11 (more disperse veg)

3.4 3 - Bare Field: 6 (a bit more veg), 10 (barer), 12 (even more barer)

```

[ ]: # 0 - Urban
      # 1 - Water
      # 2 - Forest/Veg
      # 3 - Bare Fields

      # Define Classification Correspondance Scheme: ['Urban', 'Water', 'Vegetation',
      ↪ 'Bare Field'] = [0,1,2,3]
      legend_keys_classified = ['Urban', 'Water', 'Vegetation', 'Bare Field']
      legend_colors_classified = ['#a9a9a9', '#4363d8', '#3cb44b', '#ffe119']

      # Remap the spectral classes from clusters:
      fromClusters = [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14]
      toClasses = [2, 2, 1, 2, 2, 2, 3, 0, 2, 0, 3, 2, 3, 1, 1]

      # Reclassify the map
      result_classified = result_unclassified.remap(fromClusters, toClasses)

      Map.addLayer(
          result_classified, {'min': 0, 'max': 3, 'palette':
          ↪ legend_colors_classified}, 'Labelled clusters'
      )
      Map.add_legend(
          keys=legend_keys_classified, colors=legend_colors_classified,
          ↪ position='bottomleft'
      )

```

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)
```

4 Split bar (problematic, to remove)

5 import geemap.foliummap as gf

```
import geemap as gf
Map2 = gf.Map()
Map2.centerObject(region, 8)
Map2.add_basemap("SATELLITE")

tile_img = gf.ee_tile_layer(image, vis_params, 'Sentinel-2 True Colour')
tile_cluster = gf.ee_tile_layer(result, {'min': 0, 'max': 14, 'palette': legend_colors}, 'Sentinel-2 Clustered Unclassified')

Map2.split_map(left_layer=tile_img, right_layer=tile_cluster)
Map2.addLayerControl()

Map2.add_legend(labels=legend_keys, colors=legend_colors, position='bottomright') #
Map2.add_legend(keys=legend_keys, colors=legend_colors, position='bottomright') #

Map2
```

6 Unsupervised Classification - Accuracy Assessment:

```
[ ]: # Import User Labelled Polygons from Supervised Classification for Accuracy Assessment:
# 0 - Urban
urban = ee.FeatureCollection(
    [ee.Feature(
        ee.Geometry.Polygon(
            [[18.052726907332364, 59.33283313087029],
             [18.052726907332364, 59.33097251700143],
             [18.056632203658047, 59.33097251700143],
             [18.056632203658047, 59.33283313087029]]], None, False),
        {
            "landcover": 0,
            "system:index": "0"
        }
    ),
    ee.Feature(
        ee.Geometry.Polygon(
            [[18.123178256624882, 59.34183084125545],
             [18.123178256624882, 59.33977376018854],
             [18.1297013889491, 59.33977376018854],
             [18.1297013889491, 59.34183084125545]]], None, False),
        {
            "landcover": 0,
            "system:index": "1"
        }
    ),
    ee.Feature(
        ee.Geometry.Polygon(
```

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        [[[18.08752600541425, 59.302238496085714],
          [18.08752600541425, 59.30166886554873],
          [18.088727635052923, 59.30166886554873],
          [18.088727635052923, 59.302238496085714]]], None, False),
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      "system:index": "2"
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        [18.091452759412054, 59.304681226570594],
        [18.091903370526556, 59.304681226570594],
        [18.091903370526556, 59.30506459883667]]], None, False),
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        [18.09853379121137, 59.301011587691676],
        [18.099864166882757, 59.301011587691676],
        [18.099864166882757, 59.30164695649144]]], None, False),
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        [18.112695854810003, 59.30852570710506]]], None, False),
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    })

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    }),
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          [18.054513376858953, 59.3000256470941],
          [18.055232208874944, 59.3000256470941],
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          [18.08209721436811, 59.29859050471372],
          [18.08209721436811, 59.29939024801239]]], None, False),
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      [18.066907389429442, 59.329803438513316],
      [18.066907389429442, 59.33083229652714]]], None, False),
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            "system:index": "41"
        }
    ),
    ee.Feature(
        ee.Geometry.Polygon(
            [[[18.076102861290718, 59.330665802264626],
              [18.076102861290718, 59.32895831035639],
              [18.077883848076606, 59.32895831035639],
              [18.077883848076606, 59.330665802264626]]], None, False),
        {
            "landcover": 0,
            "system:index": "42"
        }
    ),
    ee.Feature(
        ee.Geometry.Polygon(
            [[[18.06681168926313, 59.33242793150725],
              [18.06681168926313, 59.33050162407892],
              [18.070995935326362, 59.33050162407892],
              [18.070995935326362, 59.33242793150725]]], None, False),
        {
            "landcover": 0,
            "system:index": "43"
        }
    ),
    ee.Feature(
        ee.Geometry.Polygon(
            [[[18.057627805596137, 59.33543756823588],
              [18.057627805596137, 59.332734379438314],
              [18.063142427330757, 59.332734379438314],

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        [18.063142427330757, 59.33543756823588]]], None, False),
    {
        "landcover": 0,
        "system:index": "44"
    }
  ),
  ee.Feature(
    ee.Geometry.Polygon(
      [[[18.066918977623725, 59.336367765649314],
        [18.066918977623725, 59.333325378356406],
        [18.07202590358808, 59.333325378356406],
        [18.07202590358808, 59.336367765649314]]], None, False),
    {
        "landcover": 0,
        "system:index": "45"
    }
  ),
  ee.Feature(
    ee.Geometry.Polygon(
      [[[18.074965604668403, 59.33634587894395],
        [18.074965604668403, 59.334748111364725],
        [18.07655347240522, 59.334748111364725],
        [18.07655347240522, 59.33634587894395]]], None, False),
    {
        "landcover": 0,
        "system:index": "46"
    }
  ),
  ee.Feature(
    ee.Geometry.Polygon(
      [[[18.061940797692085, 59.32557590961766],
        [18.061940797692085, 59.324327948601535],
        [18.06427968395307, 59.324327948601535],
        [18.06427968395307, 59.32557590961766]]], None, False),
    {
        "landcover": 0,
        "system:index": "47"
    }
  ),
  ee.Feature(
    ee.Geometry.Polygon(
      [[[18.070116170769477, 59.327053698925624],
        [18.070116170769477, 59.32536791929732],
        [18.072605260735298, 59.32536791929732],
        [18.072605260735298, 59.327053698925624]]], None, False),
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        "landcover": 0,
        "system:index": "48"
    }
  ),
  ee.Feature(
    ee.Geometry.Polygon(

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        [[[18.073688873177314, 59.32490814670384],
          [18.073688873177314, 59.32308541557434],
          [18.07600630176618, 59.32308541557434],
          [18.07600630176618, 59.32490814670384]]], None, False),
    {
      "landcover": 0,
      "system:index": "49"
    }),
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    ee.Geometry.Polygon(
      [[[18.014933906145004, 59.298658811950276],
        [18.014933906145004, 59.291843811956106],
        [18.02853807026854, 59.291843811956106],
        [18.02853807026854, 59.298658811950276]]], None, False),
    {
      "landcover": 0,
      "system:index": "50"
    }),
  ee.Feature(
    ee.Geometry.Polygon(
      [[[18.02896722371092, 59.29605130436041],
        [18.02896722371092, 59.29322445274832],
        [18.032615027971175, 59.29322445274832],
        [18.032615027971175, 59.29605130436041]]], None, False),
    {
      "landcover": 0,
      "system:index": "51"
    }),
  ee.Feature(
    ee.Geometry.Polygon(
      [[[18.007123313493636, 59.2935969970161],
        [18.007123313493636, 59.29050694765425],
        [18.01304563099852, 59.29050694765425],
        [18.01304563099852, 59.2935969970161]]], None, False),
    {
      "landcover": 0,
      "system:index": "52"
    }),
  ee.Feature(
    ee.Geometry.Polygon(
      [[[18.050762952358074, 59.287753021604054],
        [18.050762952358074, 59.28615296911046],
        [18.054153264552898, 59.28615296911046],
        [18.054153264552898, 59.287753021604054]]], None, False),
    {
      "landcover": 0,
      "system:index": "53"
    })

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    }),
    ee.Feature(
      ee.Geometry.Polygon(
        [[[18.04408961632902, 59.292004850361536],
          [18.04408961632902, 59.290043376807],
          [18.047994912654705, 59.290043376807],
          [18.047994912654705, 59.292004850361536]]], None, False),
      {
        "landcover": 0,
        "system:index": "54"
      }
    ),
    ee.Feature(
      ee.Geometry.Polygon(
        [[[18.054196179897136, 59.28957216799478],
          [18.054196179897136, 59.287621513277216],
          [18.057264627010174, 59.287621513277216],
          [18.057264627010174, 59.28957216799478]]], None, False),
      {
        "landcover": 0,
        "system:index": "55"
      }
    ),
    ee.Feature(
      ee.Geometry.Polygon(
        [[[18.0106585631674, 59.28036585000463],
          [18.0106585631674, 59.27793233568166],
          [18.019499124080486, 59.27793233568166],
          [18.019499124080486, 59.28036585000463]]], None, False),
      {
        "landcover": 0,
        "system:index": "56"
      }
    ),
    ee.Feature(
      ee.Geometry.Polygon(
        [[[18.001753629237957, 59.272626232999606],
          [18.001753629237957, 59.2706088200282],
          [18.008319676906414, 59.2706088200282],
          [18.008319676906414, 59.272626232999606]]], None, False),
      {
        "landcover": 0,
        "system:index": "57"
      }
    )
  ]))

# 1 - Water
water = ee.FeatureCollection(
  [ee.Feature(
    ee.Geometry.Polygon(
      [[[18.1287605285643, 59.420668377041466],
        [18.1287605285643, 59.41855057178141],

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        [18.132880401611175, 59.41855057178141],
        [18.132880401611175, 59.420668377041466]]], None, False),
    {
        "landcover": 1,
        "system:index": "0"
    }),
ee.Feature(
    ee.Geometry.Polygon(
        [[[18.155077293266338, 59.390922117625365],
          [18.155077293266338, 59.388518363011805],
          [18.160570457328838, 59.388518363011805],
          [18.160570457328838, 59.390922117625365]]], None, False),
    {
        "landcover": 1,
        "system:index": "1"
    }),
ee.Feature(
    ee.Geometry.Polygon(
        [[[18.101690605033916, 59.36862621806919],
          [18.101690605033916, 59.36512749188252],
          [18.107784583915752, 59.36512749188252],
          [18.107784583915752, 59.36862621806919]]], None, False),
    {
        "landcover": 1,
        "system:index": "2"
    }),
ee.Feature(
    ee.Geometry.Polygon(
        [[[18.078485317078293, 59.322705646967805],
          [18.078485317078293, 59.32136999522701],
          [18.0823047827155, 59.32136999522701],
          [18.0823047827155, 59.322705646967805]]], None, False),
    {
        "landcover": 1,
        "system:index": "3"
    }),
ee.Feature(
    ee.Geometry.Polygon(
        [[[18.056233263540545, 59.32401824428743],
          [18.056233263540545, 59.322047668267054],
          [18.059752321768084, 59.322047668267054],
          [18.059752321768084, 59.32401824428743]]], None, False),
    {
        "landcover": 1,
        "system:index": "4"
    }),
ee.Feature(

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ee.Geometry.Polygon(
    [[[17.990464791118104, 59.330316839397135],
      [17.990464791118104, 59.32834662857648],
      [17.994155510722596, 59.32834662857648],
      [17.994155510722596, 59.330316839397135]]], None, False),
{
    "landcover": 1,
    "system:index": "5"
}),
ee.Feature(
    ee.Geometry.Polygon(
        [[[17.98780403977533, 59.34467403662359],
          [17.98780403977533, 59.34252959696393],
          [17.991494759379822, 59.34252959696393],
          [17.991494759379822, 59.34467403662359]]], None, False),
        {
            "landcover": 1,
            "system:index": "6"
        }
    ),
ee.Feature(
    ee.Geometry.Polygon(
        [[[18.25405792757162, 59.37983915870227],
          [18.25405792757162, 59.37826529692743],
          [18.25731949373373, 59.37826529692743],
          [18.25731949373373, 59.37983915870227]]], None, False),
        {
            "landcover": 1,
            "system:index": "7"
        }
    ),
ee.Feature(
    ee.Geometry.Polygon(
        [[[17.789414237013364, 59.3573267225729],
          [17.789414237013364, 59.35277679343631],
          [17.797653983107114, 59.35277679343631],
          [17.797653983107114, 59.3573267225729]]], None, False),
        {
            "landcover": 1,
            "system:index": "8"
        }
    ),
ee.Feature(
    ee.Geometry.Polygon(
        [[[17.732422659864927, 59.4209617222526],
          [17.732422659864927, 59.41711904193939],
          [17.736542532911802, 59.41711904193939],
          [17.736542532911802, 59.4209617222526]]], None, False),
        {
            "landcover": 1,

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        "system:index": "9"
    }),
    ee.Feature(
        ee.Geometry.Polygon(
            [[[17.76881487177899, 59.44645209758956],
              [17.76881487177899, 59.4440086473052],
              [17.779114554396177, 59.4440086473052],
              [17.779114554396177, 59.44645209758956]]], None, False),
        {
            "landcover": 1,
            "system:index": "10"
        }
    ),
    ee.Feature(
        ee.Geometry.Polygon(
            [[[18.316071341505552, 59.30794491711008],
              [18.316071341505552, 59.30373889551123],
              [18.324311087599302, 59.30373889551123],
              [18.324311087599302, 59.30794491711008]]], None, False),
        {
            "landcover": 1,
            "system:index": "11"
        }
    ),
    ee.Feature(
        ee.Geometry.Polygon(
            [[[18.161232779493833, 59.32695314970951],
              [18.161232779493833, 59.32485137940307],
              [18.166382620802427, 59.32485137940307],
              [18.166382620802427, 59.32695314970951]]], None, False),
        {
            "landcover": 1,
            "system:index": "12"
        }
    ),
    ee.Feature(
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              [18.280552863119695, 59.37980028875377],
              [18.289565085409734, 59.37980028875377],
              [18.289565085409734, 59.38369091578032]]], None, False),
        {
            "landcover": 1,
            "system:index": "13"
        }
    ),
    ee.Feature(
        ee.Geometry.Polygon(
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              [18.0418225207434, 59.50482454456448],

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        [18.0418225207434, 59.50996377764133]]], None, False),
    {
        "landcover": 1,
        "system:index": "14"
    }),
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        [[[18.09538833818113, 59.31835313775008],
          [18.09538833818113, 59.31728010393107],
          [18.098478242966287, 59.31728010393107],
          [18.098478242966287, 59.31835313775008]]], None, False),
    {
        "landcover": 1,
        "system:index": "15"
    }),
ee.Feature(
    ee.Geometry.Polygon(
        [[[18.09163324556028, 59.32151729537798],
          [18.09163324556028, 59.31990788176361],
          [18.09493772706663, 59.31990788176361],
          [18.09493772706663, 59.32151729537798]]], None, False),
    {
        "landcover": 1,
        "system:index": "16"
    }),
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    ee.Geometry.Polygon(
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          [18.04970794169684, 59.30451837520289],
          [18.05350594966193, 59.30451837520289],
          [18.05350594966193, 59.30631471939471]]], None, False),
    {
        "landcover": 1,
        "system:index": "17"
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ee.Feature(
    ee.Geometry.Polygon(
        [[[18.033850722000796, 59.30993997876862],
          [18.033850722000796, 59.30795763406247],
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          [18.037112288162906, 59.30993997876862]]], None, False),
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ee.Feature(
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        [[[18.01400237529059, 59.312108378207],
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          [18.01655583827277, 59.31138559375791],
          [18.01655583827277, 59.312108378207]]], None, False),
    {
      "landcover": 1,
      "system:index": "19"
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        [18.00598936987815, 59.39735680230275],
        [18.009744462499, 59.39735680230275],
        [18.009744462499, 59.399749007250186]]], None, False),
    {
      "landcover": 1,
      "system:index": "20"
    }),
  ee.Feature(
    ee.Geometry.Polygon(
      [[[17.991934594640114, 59.415146831337566],
        [17.991934594640114, 59.41191496074184],
        [17.99704152060447, 59.41191496074184],
        [17.99704152060447, 59.415146831337566]]], None, False),
    {
      "landcover": 1,
      "system:index": "21"
    }),
  ee.Feature(
    ee.Geometry.Polygon(
      [[[18.05465537024436, 59.40777640587995],
        [18.05465537024436, 59.40706111625854],
        [18.05623250914512, 59.40706111625854],
        [18.05623250914512, 59.40777640587995]]], None, False),
    {
      "landcover": 1,
      "system:index": "22"
    }),
  ee.Feature(
    ee.Geometry.Polygon(
      [[[18.060865223528232, 59.37764527486218],
        [18.060865223528232, 59.374934514359545],
        [18.067259609819736, 59.374934514359545],
        [18.067259609819736, 59.37764527486218]]], None, False),
    {
      "landcover": 1,
      "system:index": "23"
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    })),
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          [18.025545895220127, 59.37438796382078],
          [18.025545895220127, 59.37646480901623]]], None, False),
      {
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      })
  ]))
# 2 - Forest/Veg
vegetation = ee.FeatureCollection(
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        [18.01369561111225, 59.344594188824566],
        [18.01425351058735, 59.344594188824566],
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        "landcover": 2,
        "system:index": "0"
      }
    ),
    ee.Feature(
      ee.Geometry.Polygon(
        [[[18.014038933866157, 59.341924553350076],
          [18.014038933866157, 59.341661954918315],
          [18.0149830714394, 59.341661954918315],
          [18.0149830714394, 59.341924553350076]]], None, False),
      {
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        "system:index": "1"
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    ),
    ee.Feature(
      ee.Geometry.Polygon(
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          [18.02884909415171, 59.36028026804388],
          [18.032239406346534, 59.36028026804388],
          [18.032239406346534, 59.36211740667467]]], None, False),
      {
        "landcover": 2,
        "system:index": "2"
      }
    ),
    ee.Feature(
      ee.Geometry.Polygon(
        [[[18.060434787511085, 59.36064661017352],
          [18.060434787511085, 59.35982096784676],
          [18.060434787511085, 59.35982096784676],
          [18.060434787511085, 59.36064661017352]]], None, False),
      {
        "landcover": 2,
        "system:index": "3"
      }
    )
  ]))

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```

        [18.061969011067603, 59.35982096784676],
        [18.061969011067603, 59.36064661017352]]], None, False),
    {
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        "system:index": "3"
    }
  ),
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    ee.Geometry.Polygon(
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        [18.066153257130836, 59.36341865303429]]], None, False),
    {
        "landcover": 2,
        "system:index": "4"
    }
  ),
  ee.Feature(
    ee.Geometry.Polygon(
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        [18.049169509648536, 59.36255480597621],
        [18.051122157811378, 59.36255480597621],
        [18.051122157811378, 59.36349519538389]]], None, False),
    {
        "landcover": 2,
        "system:index": "5"
    }
  ),
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    ee.Geometry.Polygon(
      [[[18.071378200291846, 59.35682442829472],
        [18.071378200291846, 59.3545713812703],
        [18.07674261832163, 59.3545713812703],
        [18.07674261832163, 59.35682442829472]]], None, False),
    {
        "landcover": 2,
        "system:index": "6"
    }
  ),
  ee.Feature(
    ee.Geometry.Polygon(
      [[[18.039706676243995, 59.35710878282482],
        [18.039706676243995, 59.355818231598626],
        [18.04232451224253, 59.355818231598626],
        [18.04232451224253, 59.35710878282482]]], None, False),
    {
        "landcover": 2,
        "system:index": "7"
    }
  ),
  ee.Feature(

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ee.Geometry.Polygon(
  [[[18.078321700064755, 59.364546150150915],
    [18.078321700064755, 59.363693266342196],
    [18.081046824423886, 59.363693266342196],
    [18.081046824423886, 59.364546150150915]]], None, False),
{
  "landcover": 2,
  "system:index": "8"
}),
ee.Feature(
  ee.Geometry.Polygon(
    [[[18.082505946127988, 59.36660173071935],
      [18.082505946127988, 59.36565049348929],
      [18.08473754402838, 59.36565049348929],
      [18.08473754402838, 59.36660173071935]]], None, False),
    {
      "landcover": 2,
      "system:index": "9"
    }
  ),
ee.Feature(
  ee.Geometry.Polygon(
    [[[18.090574030844785, 59.36484137416718],
      [18.090574030844785, 59.36314653467683],
      [18.093513731925107, 59.36314653467683],
      [18.093513731925107, 59.36484137416718]]], None, False),
    {
      "landcover": 2,
      "system:index": "10"
    }
  ),
ee.Feature(
  ee.Geometry.Polygon(
    [[[18.121429990560365, 59.328055748769714],
      [18.121429990560365, 59.32693923570562],
      [18.123361181051088, 59.32693923570562],
      [18.123361181051088, 59.328055748769714]]], None, False),
    {
      "landcover": 2,
      "system:index": "11"
    }
  ),
ee.Feature(
  ee.Geometry.Polygon(
    [[[18.13576371553595, 59.32540670706443],
      [18.13576371553595, 59.32398358287265],
      [18.13825280550177, 59.32398358287265],
      [18.13825280550177, 59.32540670706443]]], None, False),
    {
      "landcover": 2,

```



```

        "system:index": "12"
    }),
    ee.Feature(
        ee.Geometry.Polygon(
            [[[18.048286438822153, 59.31351383988241],
              [18.048286438822153, 59.31245160437228],
              [18.050754071115854, 59.31245160437228],
              [18.050754071115854, 59.31351383988241]]], None, False),
        {
            "landcover": 2,
            "system:index": "13"
        }
    ),
    ee.Feature(
        ee.Geometry.Polygon(
            [[[18.12301317314356, 59.338600584300885],
              [18.12301317314356, 59.33581009907216],
              [18.128549252550297, 59.33581009907216],
              [18.128549252550297, 59.338600584300885]]], None, False),
        {
            "landcover": 2,
            "system:index": "14"
        }
    ),
    ee.Feature(
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```

```

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```

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            "system:index": "46"
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        "system:index": "51"
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        "system:index": "57"
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```

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        "system:index": "59"
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        "system:index": "66"
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```

```

        [[[17.799312617896028, 59.25490277865673],
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        [17.75826381433025, 59.25468939007088],
        [17.75826381433025, 59.25762912949226]]], None, False),
    {
      "landcover": 3,
      "system:index": "73"
    })

```

```
}}))
```

```
Map.addLayer(water, {}, "water")
Map.addLayer(vegetation, {}, "vegetation")
Map.addLayer(urban, {}, "urban")
Map.addLayer(bare, {}, "bare")
```

```
[ ]: # Combine labelled polygons to one training feature:
trainingFeatures = water.merge(vegetation).merge(urban).merge(bare)
classifierTraining = input.select(inputBands).sampleRegions(
  **{
    'collection': trainingFeatures,
    'properties': ['landcover'],
    'scale': 30,
    'geometries': True
  }
)

# Separate into training & testing sets, but only the testing set is used for
↳Unsupervised Learning Accuracy Assessment:
trainingTesting = classifierTraining.randomColumn()
trainingSet = trainingTesting.filter(ee.Filter.lessThan('random',0.6)) # Not
↳used
testingSet = trainingTesting.filter(ee.Filter.greaterThanOrEquals('random',0.6))

[ ]: result_classified.bandNames().get(0) # Verify the property inherited from the
↳remap function
```

```
[ ]: <ee.computedobject.ComputedObject at 0x1dc5b8ada20>
```

```
[ ]: # Construct Confusion Matrix:
testVec = result_classified.sampleRegions(
  **{
    'collection': testingSet,
    'scale': 30,
    'geometries': True
  }
)

confusionMatrix = testVec.errorMatrix('landcover',result_classified.bandNames().
↳get(0))
```

7 Print Confusion Matrix and relevant accuracies:

```
[ ]: confusionMatrix
```

```
[ ]: <ee.ConfusionMatrix at 0x1dc5b8dc940>
```

```
[ ]: confusionMatrix.accuracy()

[ ]: <ee.ee_number.Number at 0x1dc5b8fae60>

[ ]: confusionMatrix.producersAccuracy()

[ ]: <ee.Array at 0x1dc5b8f7970>

[ ]: confusionMatrix.consumersAccuracy()

[ ]: <ee.Array at 0x1dc5b8fb550>

[ ]: testingSet.size() # Check size of testing set

[ ]: <ee.ee_number.Number at 0x1dc5b818f70>
```

8 Unsupervised Classification - Final Plot Map:

```
[ ]: # Replotting the unsupervised classification result:
Map2 = geemap.Map()
Map2.centerObject(region, 10)
Map2.addLayer(image, vis_params, "Sentinel-2")

Map2.addLayer(
    result_classified, {'min': 0, 'max': 3, 'palette':_
    ↪legend_colors_classified}, 'Unsupervised Classification'
)
Map2.add_legend(
    keys=legend_keys_classified, colors=legend_colors_classified,_
    ↪position='bottomleft'
)
Map2.addLayer(water, {}, "water")
Map2.addLayer(vegetation, {}, "vegetation")
Map2.addLayer(urban, {}, "urban")
Map2.addLayer(bare, {}, "bare")

Map2

[ ]: Map(center=[59.399925146053874, 18.199999999999986],
    controls=(WidgetControl(options=['position', 'transparent_...

[ ]: # Memory cleaning to improve performance:
import gc
gc.collect()

[ ]: 1501
```