National Aeronautics and Space Administration

Part 3: Creating GEE Apps and Example Usage

Abigail Barenblitt & Temilola Fatoyinbo

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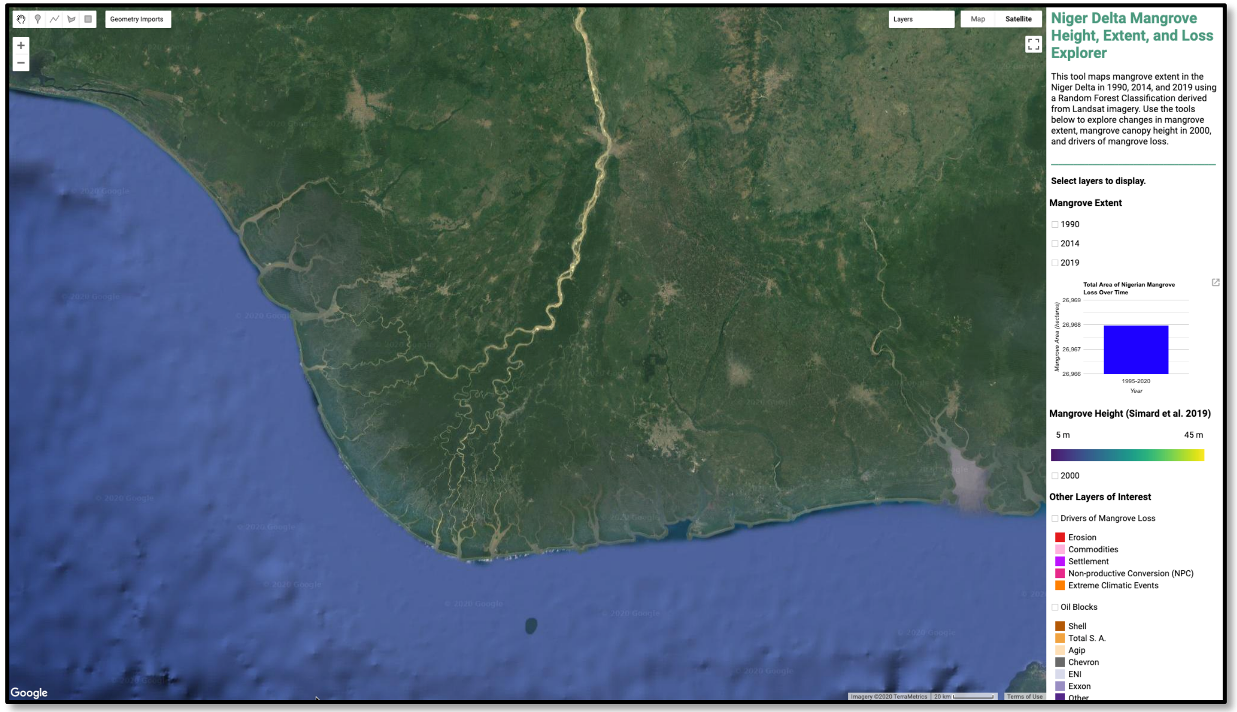
Learning Objectives

By the end of this presentation, you will be able to:

- Use previously created mangrove maps to create a GEE app
- Understand how to add functionality to various app widgets

Using Apps for Communication

- GEE apps help us communicate technical analyses to a non-technical audience.
- They eliminate the need for your audience to understand code.



Niger Delta Mangrove Height, Extent, and Loss Explorer

This tool maps mangrove extent in the Niger Delta in 1990, 2014, and 2019 using a Random Forest Classification derived from Landsat imagery. Use the tools below to explore changes in mangrove extent, mangrove canopy height in 2000, and drivers of mangrove loss.

Select layers to display.

Mangrove Extent

□ 1990

□ 2014

□ 2019

Mangrove Height (Simard et al. 2019)

□ 2000

Other Layers of Interest

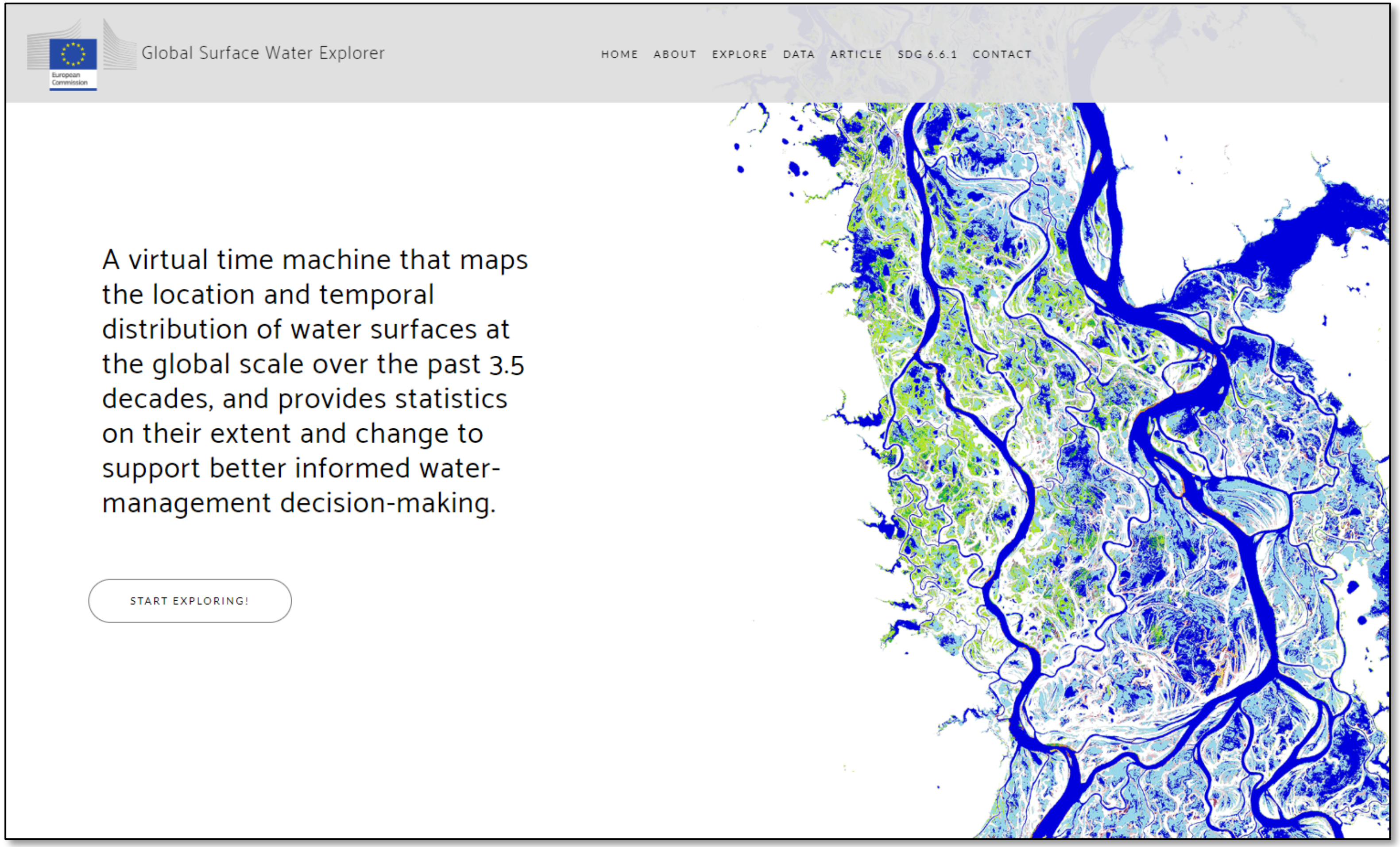
□ Drivers of Mangrove Loss

- 🟥 Erosion
- 🟪 Commodities
- 🟪 Settlement
- 🟪 Non-productive Conversion (NPC)
- 🟧 Extreme Climatic Events

□ Oil Blocks

- 🟫 Shell
- 🟧 Total S. A.
- 🟨 Agip
- ⬛ Chevron
- ⬜ ENI
- 🟪 Exxon
- 🟪 Other

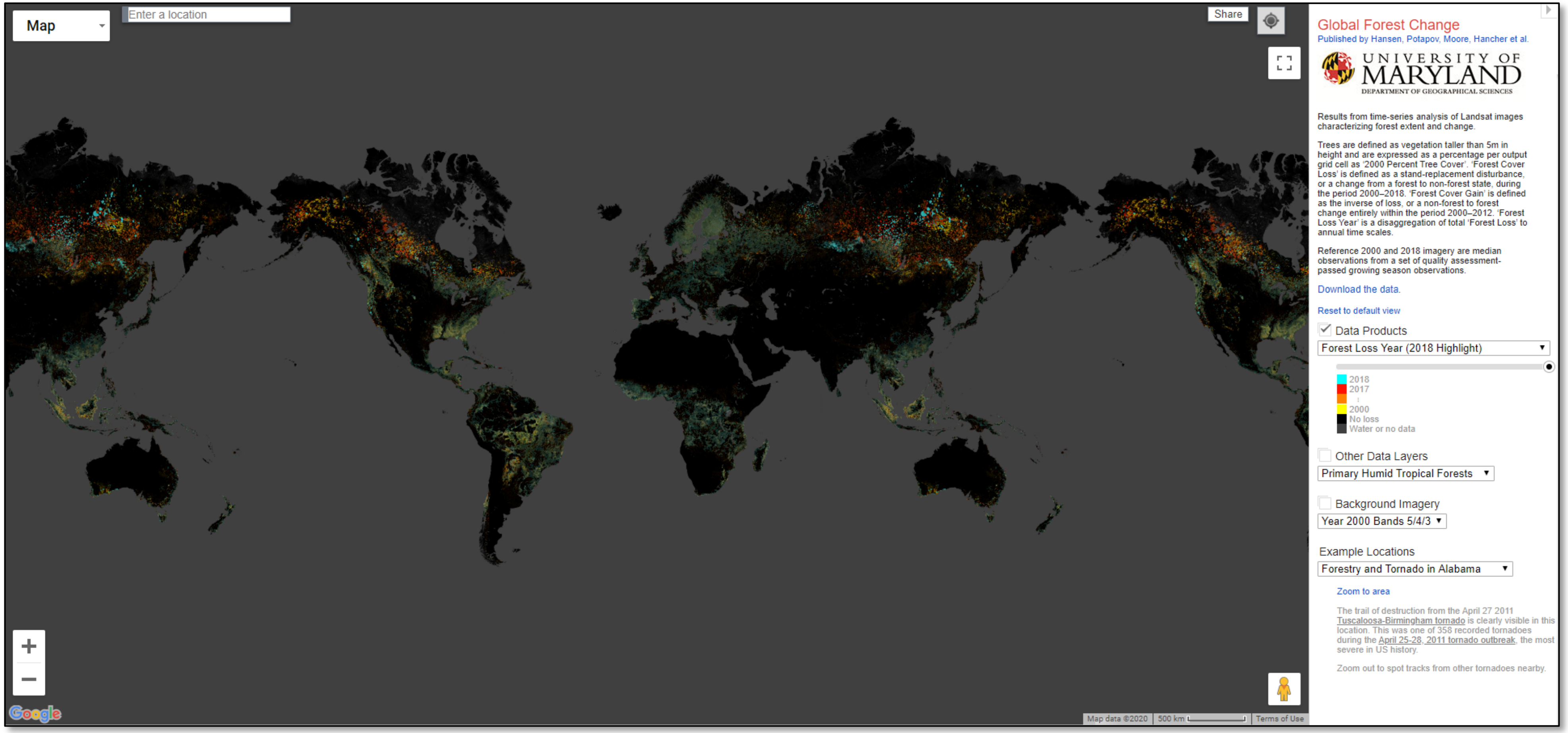
Example Apps



A virtual time machine that maps the location and temporal distribution of water surfaces at the global scale over the past 3.5 decades, and provides statistics on their extent and change to support better informed water-management decision-making.

[Global Surface Water Explorer]

Example Apps



Global Forest Change

Published by Hansen, Potapov, Moore, Hancher et al.

UNIVERSITY OF MARYLAND
DEPARTMENT OF GEOGRAPHICAL SCIENCES

Results from time-series analysis of Landsat images characterizing forest extent and change.

Trees are defined as vegetation taller than 5m in height and are expressed as a percentage per output grid cell as '2000 Percent Tree Cover'. 'Forest Cover Loss' is defined as a stand-replacement disturbance, or a change from a forest to non-forest state, during the period 2000–2018. 'Forest Cover Gain' is defined as the inverse of loss, or a non-forest to forest change entirely within the period 2000–2012. 'Forest Loss Year' is a disaggregation of total 'Forest Loss' to annual time scales.

Reference 2000 and 2018 imagery are median observations from a set of quality assessment-passed growing season observations.

Download the data.

Reset to default view

☑ Data Products

Forest Loss Year (2018 Highlight) ▾

🟦 2018
🟥 2017
🟧 ⋮
🟨 2000
⬛ No loss
⬛ Water or no data

□ Other Data Layers

Primary Humid Tropical Forests ▾

□ Background Imagery

Year 2000 Bands 5/4/3 ▾

Example Locations

Forestry and Tornado in Alabama ▾

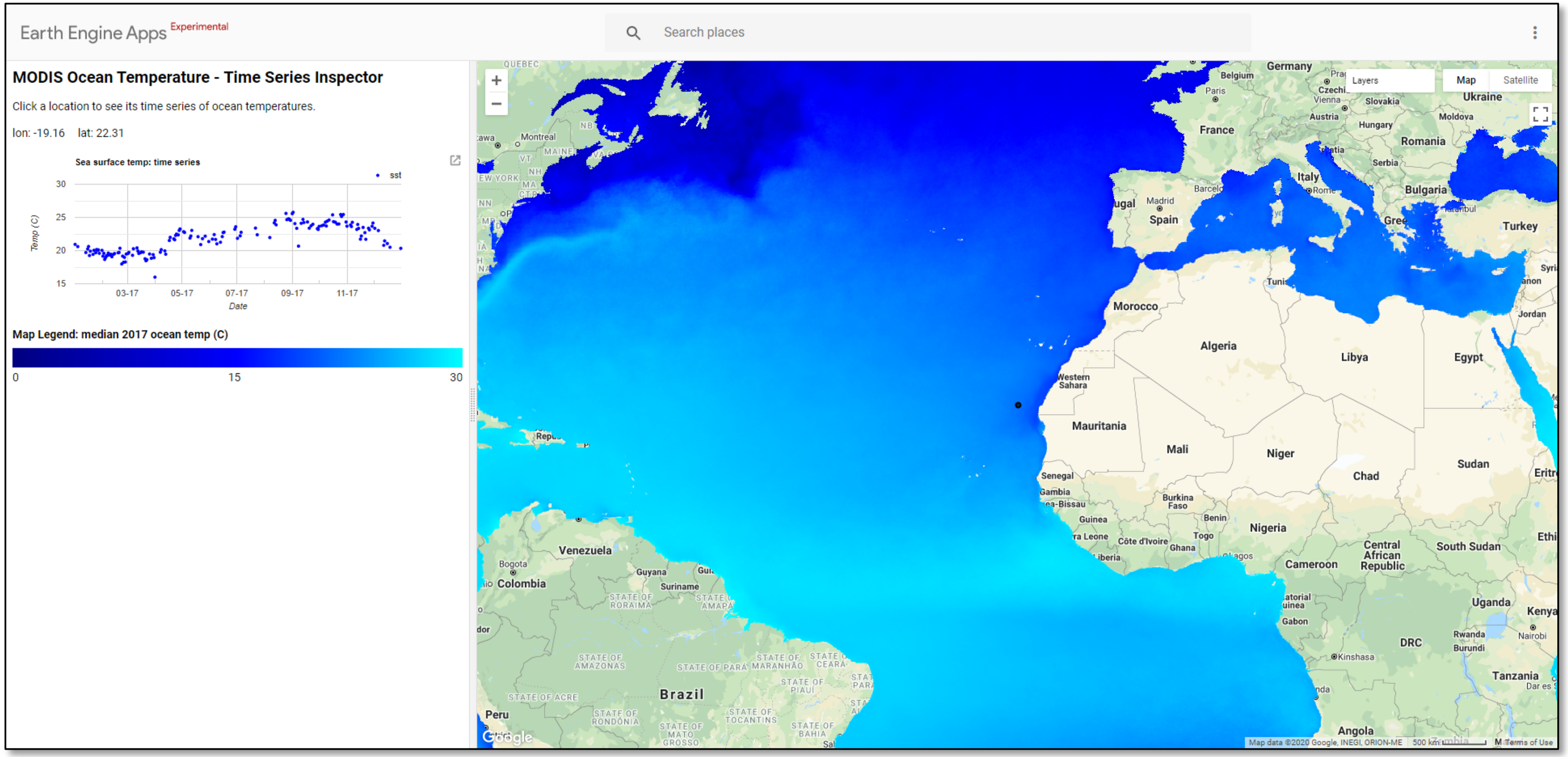
Zoom to area

The trail of destruction from the April 27 2011 Tuscaloosa-Birmingham tornado is clearly visible in this location. This was one of 358 recorded tornadoes during the April 25-28, 2011 tornado outbreak, the most severe in US history.

Zoom out to spot tracks from other tornadoes nearby.

Global Forest Watch Hansen, et al 2013

Example Apps



Earth Engine Apps Experimental

Search places

MODIS Ocean Temperature - Time Series Inspector

Click a location to see its time series of ocean temperatures.

lon: -19.16 lat: 22.31

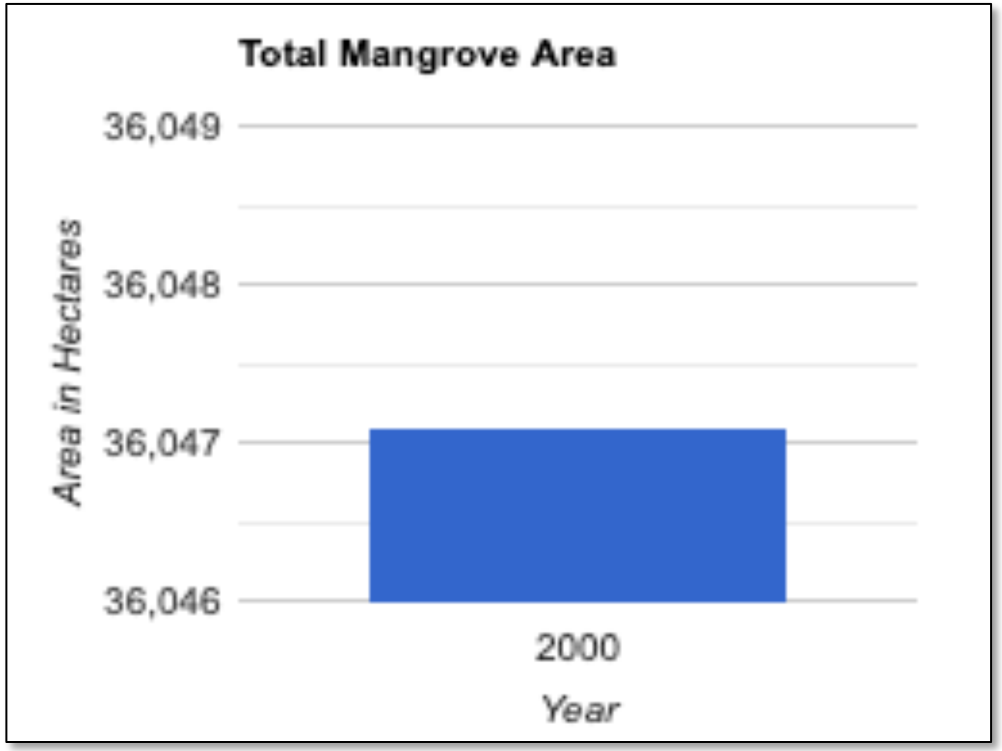
Map Legend: median 2017 ocean temp (C)

0 15 30

MODIS Ocean Temperature Inspector

App Widgets

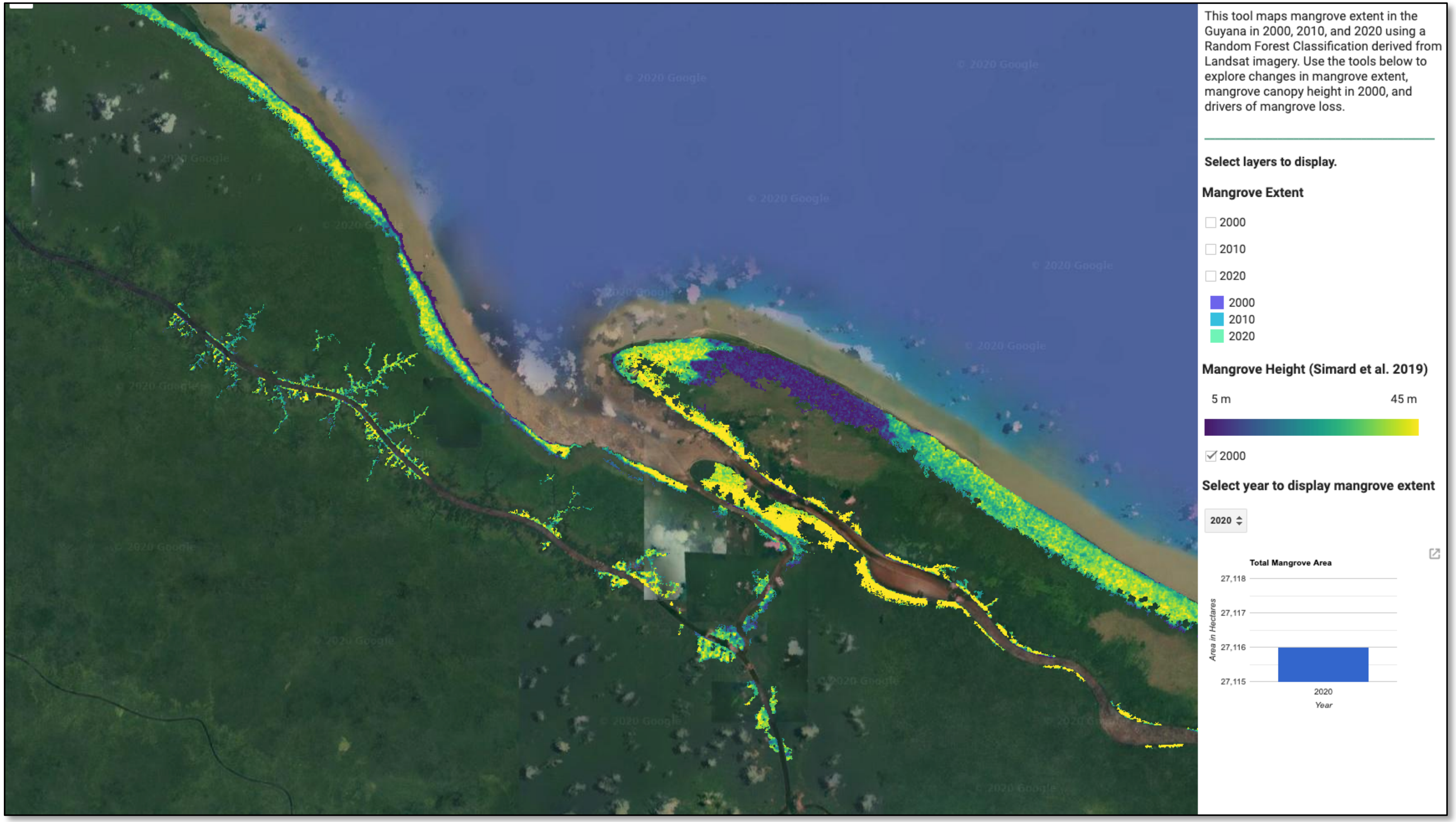
- Any component of a Graphical User Interface (GUI)
- Graphical elements designed to allow a user to manipulate components using their mouse



GEE Widget Examples

- Panels
- Buttons
- Checkboxes
- Graphs
- Sliders
- Thumbnails

Guyana Mangrove Explorer



This tool maps mangrove extent in the Guyana in 2000, 2010, and 2020 using a Random Forest Classification derived from Landsat imagery. Use the tools below to explore changes in mangrove extent, mangrove canopy height in 2000, and drivers of mangrove loss.

Select layers to display.

Mangrove Extent

☐ 2000

☐ 2010

☐ 2020

🟪 2000
🟦 2010
🟩 2020

Mangrove Height (Simard et al. 2019)

5 m 45 m

☑ 2000

Select year to display mangrove extent

2020

TO FOLLOW ALONG WITH THE FULL SCRIPT:

https://code.earthengine.google.com/705e6c7974f42373f1b9535e2bd40243

1) Import Layers

For ease of use, import the following layers from the Mangrove Science lab.

```
var extent2000 = ee.Image('projects/mangrovescience/Guyana2000Extent')
var extent2010 = ee.Image('projects/mangrovescience/Guyana2010Extent')
var extent2020 = ee.Image('projects/mangrovescience/Guyana2020Extent')
var simard =
ee.ImageCollection('projects/mangrovescience/DAAC_Hba_Simard')
var Guyana =
ee.FeatureCollection('projects/mangrovescience/GuyanaMangroveBorder')
```

Mosaic Simard Layer

The Simard Height layer is an image collection. To clip it, we need to mosaic it to an image.

```
var hba = simard.mosaic()
```

2) Set Up Map Appearance

```
// Set up a satellite background
Map.setOptions('Satellite')

// Center the map to Guyana
Map.centerObject(Guyana,9)

// Change style of cursor to 'crosshair'
Map.style().set('cursor', 'crosshair');
```

Set Up Viridis Color Palette

We want to display the Simard Height data using the Viridis color palette, so we need to make a variable for this.

```
var viridis = {min: 0 , max : 25,palette :
        ['#481567FF','#482677FF','#453781FF','#404788FF','#39568CFF',
        '#33638DFF','#2D708EFF','#287D8EFF','#238A8DFF','#1F968BFF',
        '#20A387FF','#29AF7FFF','#3CBB75FF','#55C667FF',
        '#73D055FF','#95D840FF','#B8DE29FF','#DCE319FF','#FDE725FF’
        ]};
```

Create Variables for GUI Map Layers

We set each layer to "false" so the user can turn them on later.

```
var simHBA = ui.Map.Layer(hba,viridis,'Simard Canopy Hba',false)
var ext2000 = ui.Map.Layer(extent2000, {palette:['6D63EB'], min:1, max:1},
'Extent 2000',false)
var ext2010 = ui.Map.Layer(extent2010, {palette:['34BFDE'], min:1, max:1},
'Extent 2010',false)
var ext2020 = ui.Map.Layer(extent2020, {palette:['71F4B7'], min:1, max:1},
        'Extent 2020',false)
```

Add Layers to Map

These layers won’t display until the user turns them on.

```
Map.add(ext2000)
Map.add(ext2010)
Map.add(ext2020)
Map.add(simHBA)
```

3) Begin Setting Up Panels With Text

Let’s start with the title and summary widgets.

```
// App Title
var header = ui.Label('Guyana Mangrove Height, Extent, and Loss Explorer',
{fontSize: '25px', fontWeight: 'bold', color: '4A997E'});

// App Summary
var text = ui.Label(
        'This tool maps mangrove extent in the Guyana in 2000, 2010, and 2020
        using a Random Forest Classification derived from Landsat imagery. ' +
        'Use the tools below to explore changes in mangrove extent,
        mangrove canopy height in 2000, and drivers of mangrove loss.',
        {fontSize: '15px'});
```

Create a UI Panel

```
var panel = ui.Panel({
            widgets:[header, text], // Adds header and text
            style:{width: '300px',position:'middle-right'}});
```

Create Variables for More Text

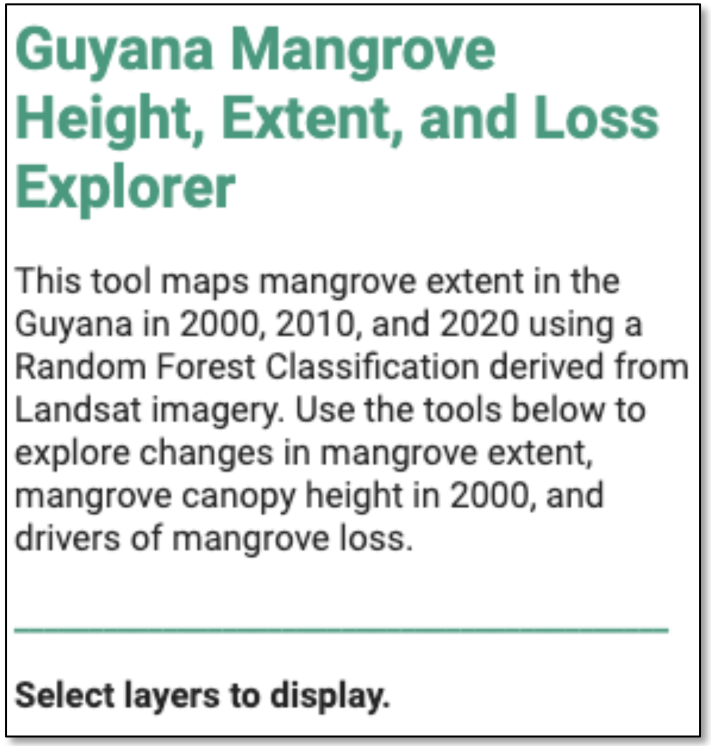
We want to create another panel to house a line separator and instructions.

```
var intro = ui.Panel([
          ui.Label({
            value: '____________________________________________',
            style: {fontWeight: 'bold',  color: '4A997E'},
          }),
           ui.Label({
           value:'Select layers to display.',
          style: {fontSize: '15px', fontWeight: 'bold’}
           })]);
```

Add Panels to Map

First, add the ”intro” panel to the main panel.
Next, add the main panel to the root of our GUI.

```
panel.add(intro)

ui.root.insert(1,panel)
```



Guyana Mangrove Height, Extent, and Loss Explorer

This tool maps mangrove extent in the Guyana in 2000, 2010, and 2020 using a Random Forest Classification derived from Landsat imagery. Use the tools below to explore changes in mangrove extent, mangrove canopy height in 2000, and drivers of mangrove loss.

Select layers to display.

4) Construct Checkboxes

Create a new label for this series of checkboxes.

```
var extLabel = ui.Label({value:'Mangrove Extent’,
        style: {fontWeight: 'bold', fontSize: '16px', margin: '10px 5px’}
        });
```

Extent Checkbox Widgets

Create checkboxes that will allow the user to view the extent map for different years.

Creating the checkbox will not do anything yet, we add functionality further in the code.

```
var extCheck = ui.Checkbox('2000').setValue(false); // false = unchecked

var extCheck2 = ui.Checkbox('2010').setValue(false);

var extCheck3 = ui.Checkbox('2020').setValue(false);
```

HBA Checkbox

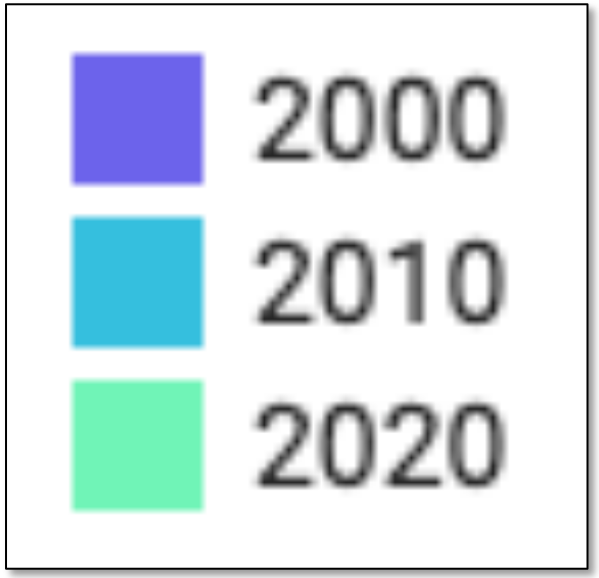
Now do the same for the Simard Height map.

```
var heightLab = ui.Label({value:'Mangrove Height (Simard et   al. 2019)’,
          style: {fontWeight: 'bold', fontSize: '16px', margin: '10px 5px’}
          });

var heightCheck = ui.Checkbox('2000').setValue(false);
```

Adding Legends

Start with the Mangrove Extent legend.

```
// Set position of panel
var extentLegend = ui.Panel({
        style: {
        position: 'bottom-left',
        padding: '8px 15px’
        }
        });
```



🟪 2000

🟦 2010

🟩 2020

Extent Legend

The following creates and styles 1 row of the legend.

```
var makeRowa = function(color, name) {
    // Create the label that is actually the colored box.
    var colorBox = ui.Label({
          style: {backgroundColor: '#' + color,
     // Use padding to give the box height and width.
         padding: '8px',
         margin: '0 0 4px 0' }});
    // Create a label with the description text.
    var description = ui.Label({
         value: name,
         style: {margin: '0 0 4px 6px'} });
         // Return the panel.
         return ui.Panel({
          widgets: [colorBox, description],
         layout: ui.Panel.Layout.Flow('horizontal’) });};
```

Extent Legend

Create a palette using the same colors we used to map the extent layers.

```
var paletteMAPa = [
        '6D63EB',//2000
        '34BFDE',//2010
        '71F4B7',//2020
        ];
```

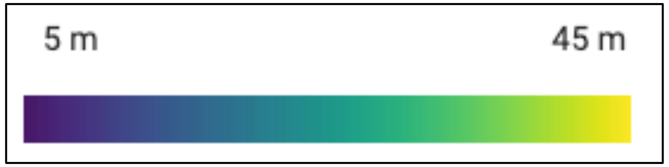
Extent Legend

```
// Name of each legend value.
var namesa = ['2000','2010','2020'];


// Add color and names to legend.
for (var i = 0; i < 3; i++) {
          extentLegend.add(makeRowa(paletteMAPa[i], namesa[i]));
         }
```

Height Legend

For the height legend, we want a gradient color bar.

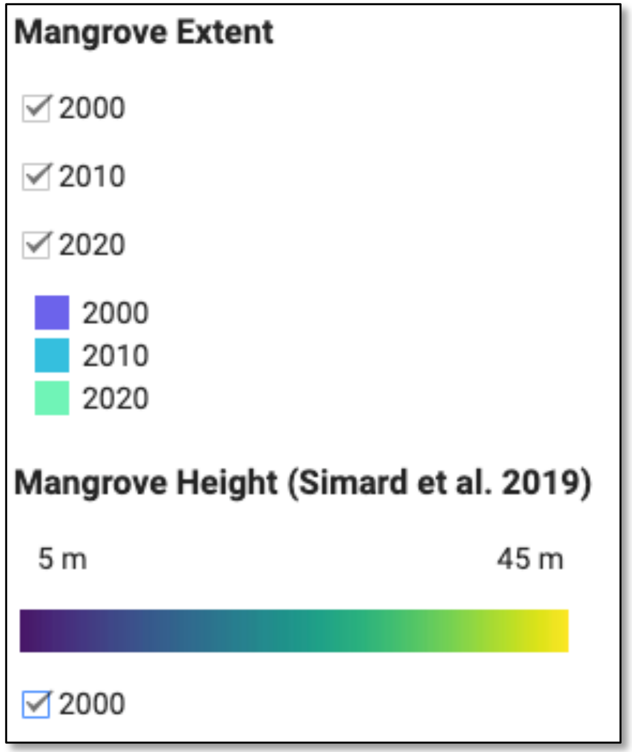
```
function makeLegend2 (viridis) {
        var lon = ee.Image.pixelLonLat().select('longitude');
        var gradient = lon.multiply((viridis.max-viridis.min)/100.0).add(viridis.min);
        var legendImage = gradient.visualize(viridis);
        var thumb = ui.Thumbnail({
                image: legendImage,
                params: {bbox:'0,0,100,8', dimensions:'256x20'},
                style: {position: 'bottom-center’} });
        var panel2 = ui.Panel({
                 widgets: [
                 ui.Label('5 m'),
                 ui.Label({style: {stretch: 'horizontal'}}),
                ui.Label('45 m') ],
         layout: ui.Panel.Layout.flow('horizontal'),
         style: {stretch: 'horizontal', maxWidth: '270px', padding: '0px 0px 0px 8px'}});
        return ui.Panel().add(panel2).add(thumb);}
```



Add Widgets to App

Now add all of the widgets we created to our main panel.

```
panel.add(extLabel)
          .add(extCheck)
          .add(extCheck2)
          .add(extCheck3)
          .add(extentLegend)
          .add(heightLab)
          .add(makeLegend2(viridis))
          .add(heightCheck)
```



Mangrove Extent

☑ 2000

☑ 2010

☑ 2020

🟪 2000
🟦 2010
🟩 2020

Mangrove Height (Simard et al. 2019)

5 m 45 m

☑ 2000

5) Add Functionality to Checkboxes

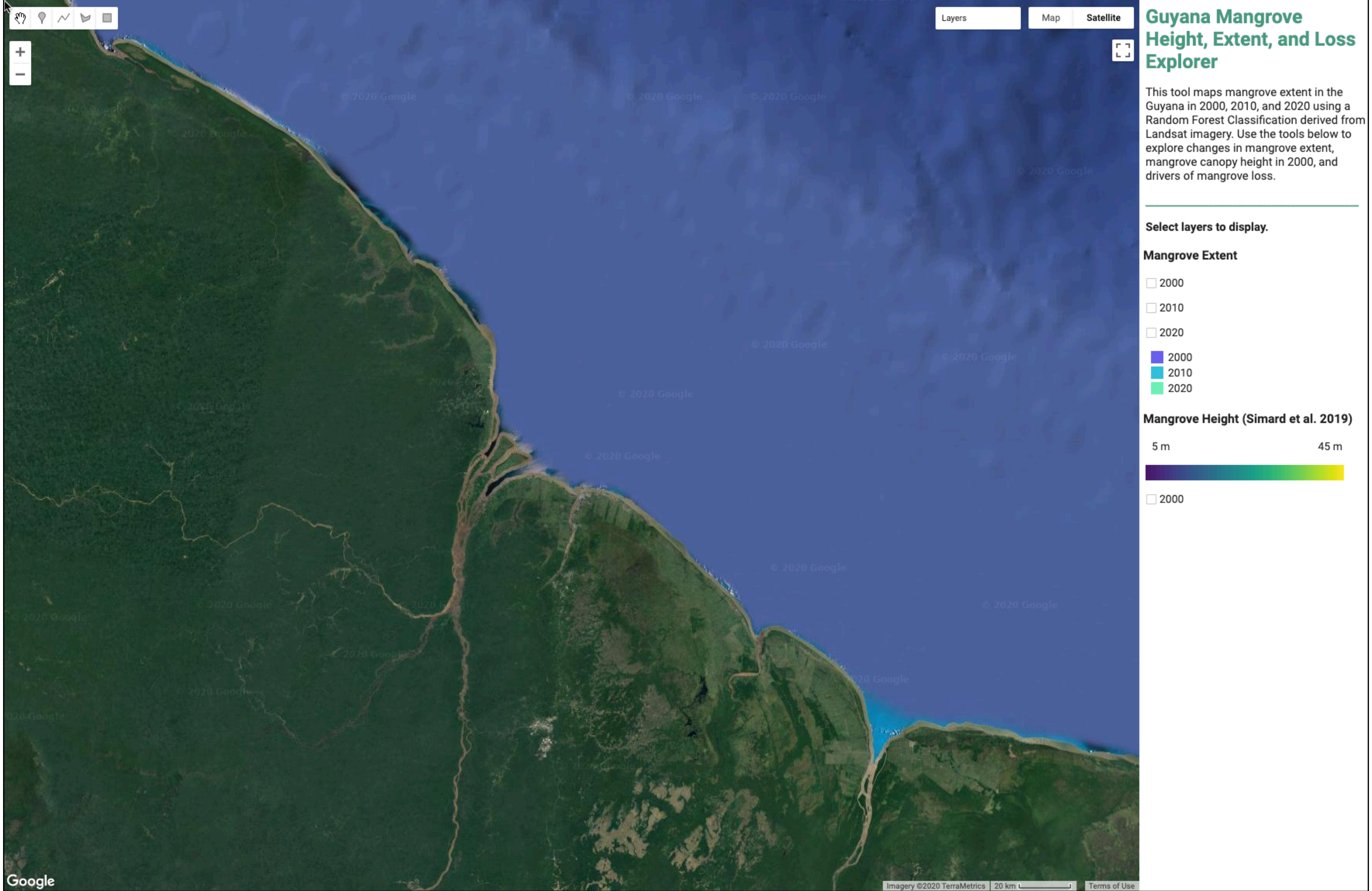
The following creates and styles 1 row of the legend.

```
// Extent 2000
var doCheckbox = function() {
        extCheck.onChange(function(checked){
        ext2000.setShown(checked) })}
        doCheckbox();

// Extent 2010
var doCheckbox2 = function() {
        extCheck2.onChange(function(checked){
        ext2010.setShown(checked) })}
        doCheckbox2();
```

Add Functionality to Checkboxes

The following creates and styles 1 row of the legend.

```
// Extent 2020
var doCheckbox3 = function() {
        extCheck3.onChange(function(checked){
        ext2020.setShown(checked)})}
        doCheckbox3();

// Simard Height Data
var doCheckbox4 = function() {
        heightCheck.onChange(function(checked){
        simHBA.setShown(checked)})}
        doCheckbox4();
```



Guyana Mangrove Height, Extent, and Loss Explorer

This tool maps mangrove extent in the Guyana in 2000, 2010, and 2020 using a Random Forest Classification derived from Landsat imagery. Use the tools below to explore changes in mangrove extent, mangrove canopy height in 2000, and drivers of mangrove loss.

Select layers to display.

Mangrove Extent

□ 2000

□ 2010

□ 2020

🟪 2000
🟦 2010
🟩 2020

Mangrove Height (Simard et al. 2019)

5 m 45 m

□ 2000

Following Slides if Time Allows

Add an Inspector Tool

Create an inspector panel with a horizontal layout.

```
var inspector = ui.Panel({
 layout: ui.Panel.Layout.flow('horizontal')
});

// Add a label to the panel.
inspector.add(ui.Label('Click to get HBA'));

// Add the panel to the default map.
Map.add(inspector);
```

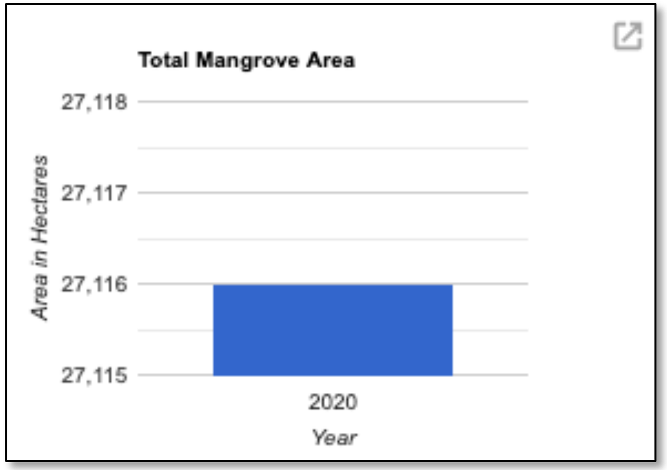
Create Functionality for Inspector

```
Map.onClick(function(coords){
inspector.clear(); // Clear the panel and show a loading message.
inspector.style().set('shown', true);
inspector.add(ui.Label('Loading...', {color: 'gray'}));
var point = ee.Geometry.Point(coords.lon, coords.lat); // Compute the HBA value.
var reduce = hba.reduce(ee.Reducer.first());
var sampledPoint = reduce.reduceRegion(ee.Reducer.first(), point, 30);
var computedValue = sampledPoint.get('first');
computedValue.evaluate(function(result) {. // Request the value from the server and use the results in a function.
inspector.clear();
inspector.add(ui.Label({. // Add a label with the results from the server.
    value: 'HBA: ' + result.toFixed(2),
    style: {stretch: 'vertical’}  }));
inspector.add(ui.Button({ // Add a button to hide the Panel.
    label: 'Close',
    onClick: function() {
      inspector.style().set('shown', false);   } }));});});
```

Construct Graphs for Extent

Let’s start with extent for 2000.

```
// Calculate area in Hectares.
var get2000 =
extent2000.multiply(ee.Image.pixelArea()).divide(10000).reduceRegion({
    reducer:ee.Reducer.sum(),
    geometry:Guyana,
    scale: 1000,
    maxPixels:1e13,
    tileScale: 16
    }).get('classification');
```



Get Area for Guyana

```
var feature = ee.Feature(Guyana)
var feature2000 = feature.set('2000', ee.Number(get2000))
```

Construct Bar Chart

```
var chart2000 = ui.Chart.feature.byProperty(feature2000, ['2000'], ['Total'])

// Set up title and labels for chart.
chart2000.setOptions({
  title: 'Total Mangrove Area',
  vAxis: {title: 'Area in Hectares'},
  legend: {position: 'none'},
  hAxis: {
    title: 'Year',
    logScale: false
  }});
```

Repeat for 2010 and 2020

```
var get2010 =
extent2010.multiply(ee.Image.pixelArea()).divide(10000).reduceRegion({
    reducer:ee.Reducer.sum(),
    geometry:Guyana,
    scale: 1000,
    maxPixels:1e13,
    tileScale: 16
    }).get('classification');

// Get area for the Guyana region
var feature2010 = feature.set('2010', ee.Number(get2010))
```

Repeat for 2010 and 2020

```
// Construct Bar Chart
var chart2010 = ui.Chart.feature.byProperty(feature2010, ['2010'], ['Total'])

// Set up title and labels for chart
chart2010.setOptions({
  title: 'Total Mangrove Area',
  vAxis: {title: 'Area in Hectares'},
  legend: {position: 'none'},
  hAxis: {
    title: 'Year',
    logScale: false
  }});
```

Repeat for 2010 and 2020

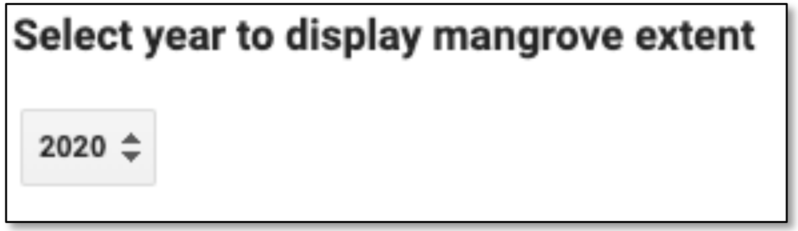
```
// Calculate area in Hectares
var get2020 =
extent2020.multiply(ee.Image.pixelArea()).divide(10000).reduceRegion({
    reducer:ee.Reducer.sum(),
    geometry:Guyana,
    scale: 1000,
    maxPixels:1e13,
    tileScale: 16
    }).get('classification');

// Get area for the Guyana region
var feature2020 = feature.set('2020', ee.Number(get2020))
```

Repeat for 2010 and 2020

```
// Construct Bar Chart
var chart2020 = ui.Chart.feature.byProperty(feature2020, ['2020'], ['Total'])

// Set up title and labels for chart
chart2020.setOptions({
  title: 'Total Mangrove Area',
  vAxis: {title: 'Area in Hectares'},
  legend: {position: 'none'},
  hAxis: {
    title: 'Year',
    logScale: false
  }});
```

Create Dropdown for Graph Display

```
// Add panel to hold graphs within main panel
var panelGraph = ui.Panel({
  style:{width: '300px',position:'middle-right'}})

// Create key of items for dropdown
var y2000 = '2000'
var y2010 = '2010'
var y2020 = '2020'
```


Select year to display mangrove extent

2020

Construct Dropdown

ui.Select() is used to create a dropdown menu.

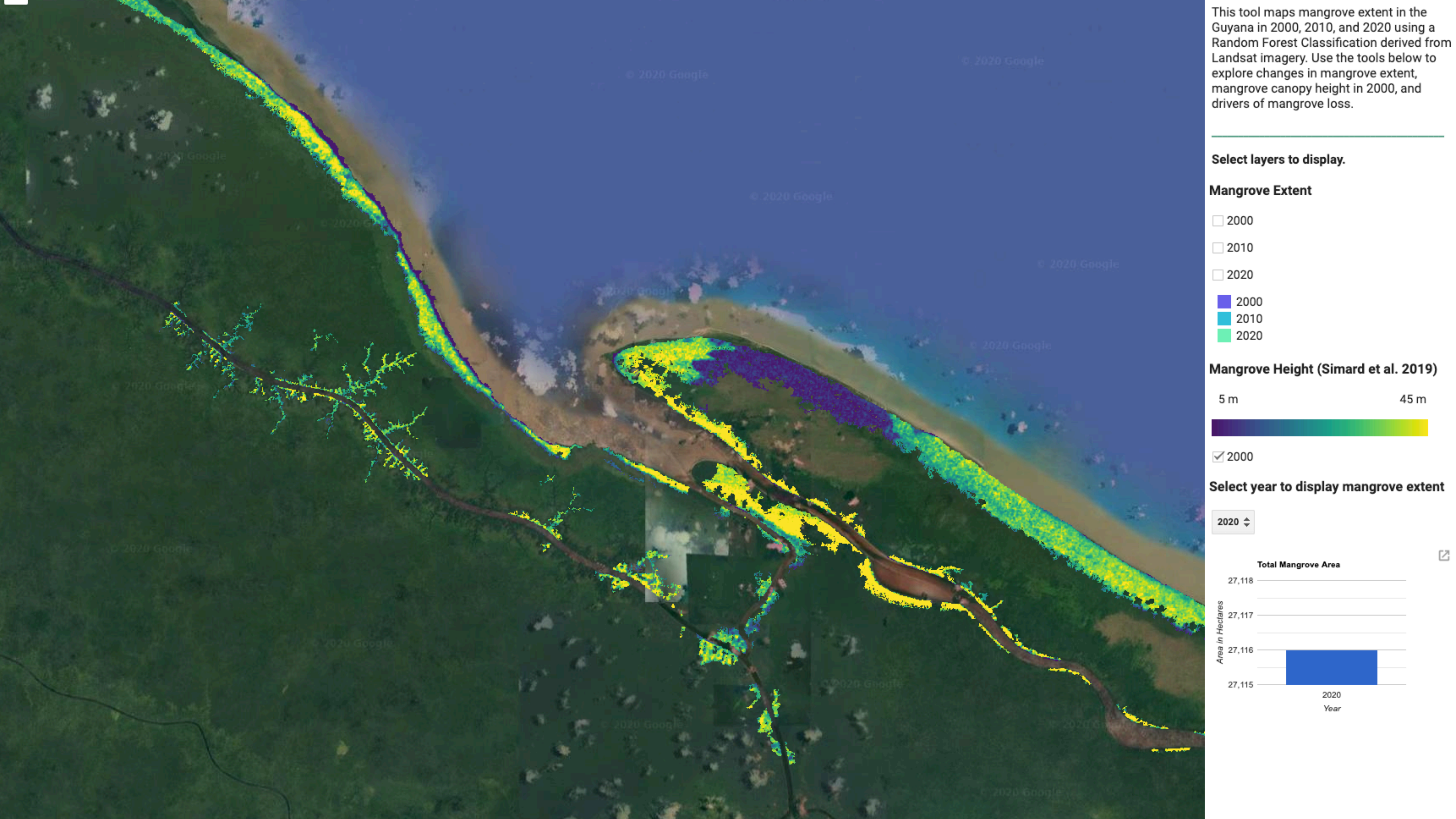
```
var graphSelect = ui.Select({
  items:[y2000,y2010,y2020],
  placeholder:'Choose year',
  onChange: selectLayer,
  style: {position:'top-right'}})
var constraints = []
```

Write Functionality for Dropdown

```
function selectLayer(){
  var graph = graphSelect.getValue()      // Get value from dropdown selection
  panelGraph.clear()         // Clear graph panel between selections so only one graph displays
  if (graph == y2000){        // We use "if else" statements to write instructions for drawing graphs
    panelGraph.add(chart2000) }
  else if (graph == y2010){
    panelGraph.add(chart2010)  }
  else if (graph == y2020){
    panelGraph.add(chart2020) }
  for (var i = 0; i < constraints.length; ++i) {
    var constraint = select[i];
    var mode = constraint.mode.getValue();
    var value = parseFloat(constraint.value.getValue());
    if (mode == GREATER_THAN) {
      image = image.updateMask(constraint.image.gt(value));
    } else { image = image.updateMask(constraint.image.lt(value)); }}}
```

Add Selector to Panel

```
// Create new label
var graphLabel = ui.Label({value:'Select year to display mangrove extent',
style: {fontWeight: 'bold', fontSize: '16px', margin: '10px 5px'}
});

// Add selector and graph panel to main panel
panel.add(graphLabel)
     .add(graphSelect)
     .add(panelGraph)
```



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Select layers to display.

Mangrove Extent

□ 2000

□ 2010

□ 2020

🟪 2000
🟦 2010
🟩 2020

Mangrove Height (Simard et al. 2019)

5 m 45 m

☑ 2000

Select year to display mangrove extent

2020 ⇕

Questions

- Please enter your questions into the Q&A box.
- We will post the questions and answers to the training website following the conclusion of the course.

Contacts

- ARSET Contacts
  - Amber McCullum: AmberJean.Mccullum@nasa.gov
  - Juan Torres-Perez: juan.l.torresperez@nasa.gov

- General ARSET Inquiries
  - Ana Prados: aprados@umbc.edu

- ARSET Website:
  - http://arset.gsfc.nasa.gov

APPLIED REMOTE SENSING TRAINING PROGRAM

TRAIN - EMPOWER - ADVANCE

Thank You!