

## Purpose

This script identifies and summarizes trends in selected bands of RAP fractional cover products using the Mann-Kendall test to determine significance, and both Sen's slope and a simple linear regression to ascertain the annual rate of change and the estimated cumulative change over the entire time period of the analysis.

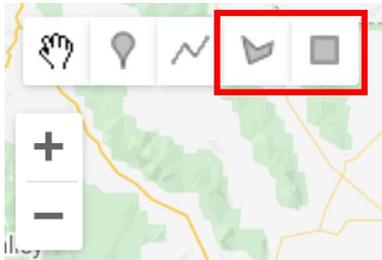
Follow this link to the script!

<https://code.earthengine.google.com/73cd3ee463a8363afcc4b870549ccc05>

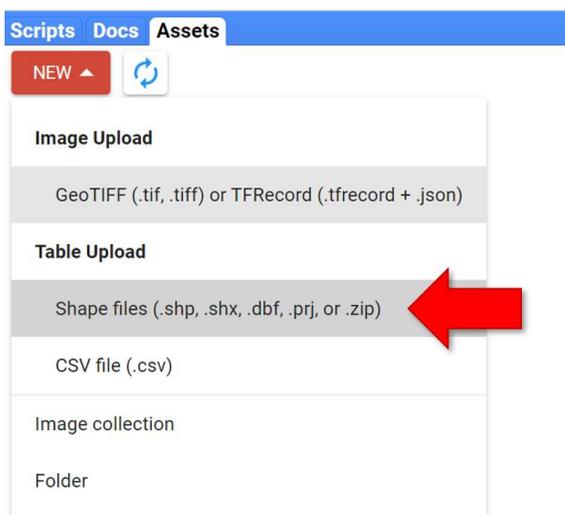
## Step-by-step Instructions

1. Define or upload your shapefile with multiple regions of interest

You can draw your region of interest using the GEE interactive map. You can do so by zooming to your general region of interest and then either drawing a free-hand polygon or a rectangle.



To upload, click on the Assets tab in the left-side window and then click the New button and select Shape files.



A pop-up window will open. Follow these steps: 1) Click the SELECT button and upload either a zipped shapefile or each of the file extensions separately (a zipped shapefile is usually easiest), 2) name your new Earth Engine Asset, and 3) leave the remaining items as default, and click UPLOAD.

**Upload a new shapefile asset**

**Source files**

**1** SELECT

Please drag and drop or select files for this asset.  
Allowed extensions: shp, zip, dbf, prj, shx, cpq, fix, qix, sbn or shp.xml.

**Asset ID**

users/ericjensen41\_default/ Asset Name **2**

**Properties**

Metadata properties about the asset which can be edited during asset upload and after ingestion. The "system:time\_start" property is used as the primary date of the asset.

[Add start time](#) [Add end time](#) [Add property](#)

**Advanced options**

Character encoding  
UTF-8

Maximum error  
1.0

Split large geometries

[Learn more](#) about how uploaded files are processed.

CANCEL **3** UPLOAD

Upon initiating the upload, the Tasks tab in the right-side window will light up yellow, indicating that the upload has started.

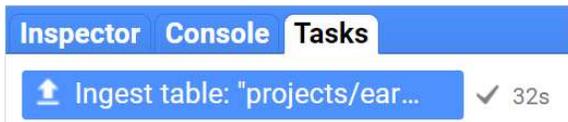
**Inspector** **Console** **Tasks**

Use `print(...)` to write to this console.

---

**Welcome to Earth Engine!**  
Please use the help menu above ( ? ) to learn more about how to use Earth Engine, or [visit our help page](#) for support.

Depending on the complexity of the shapefile geometry and the number of features, it may take several minutes or longer to complete.



You can refresh the web page to see if it has finished. Once it lights up blue, the upload has completed.

Click on the Assets tab in the left-side window again. This time, find your new asset and click the arrow to import it.



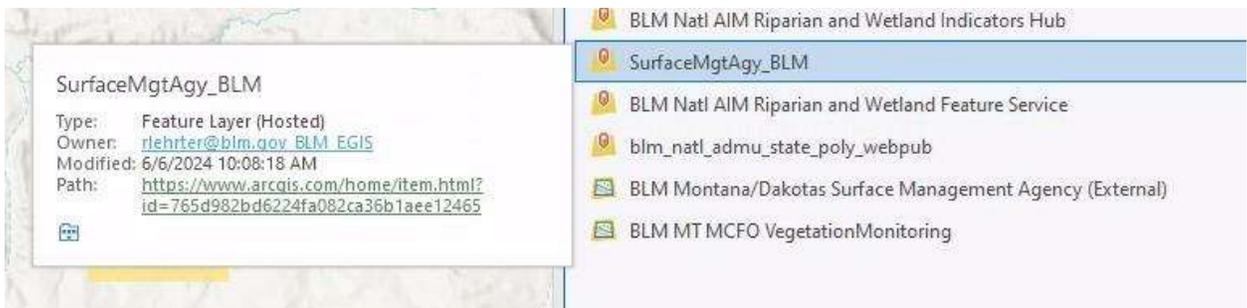
You will now see a new import table at the top of your script.

Note: If your region is too large, you will receive an error!

Once you have created or uploaded and added your region, you will see a new import called “table” that you should rename to “geometry” at the top of the script by clicking its name.

Optionally, you can draw or upload an additional shapefile to filter the rasters within your geometry. In this example, we will use a shapefile of BLM land ownership so our output only retains information for the BLM land within the geometry polygon. Specifically, we imported these BLM admin polygons:

<https://www.arcgis.com/home/item.html?id=765d982bd6224fa082ca36b1aee12465>.



In order to run the script with the additional filter geometry, you will need to rename the polygons imported for filtering “blmLand”, uncomment lines 36-38, and comment out line 41 to resemble the screenshot below.

```

33 // -----
34 // ----- OPTIONAL: select only specific areas within the region of interest for inclusion in analyses -----
35 // ----- this example filters out lands that are not managed by BLM -----
36 var outputGeometry = blmLand.map(function(feature) {
37   return feature.geometry().intersection(geometry); // Clip each feature to the intersection with your geometry
38 });
39
40 // DEFAULT: use this line to rename your polygon if you are not filtering
41 // var outputGeometry = geometry;
42

```

The imported assets at the top of your script should look like the screenshot below with the omission of blmLand if you are not using that step.

The screenshot shows an 'Imports (2 entries)' panel in a code editor. It lists two imports: 'var blmLand: Table projects/blm-gee-mtso/assets/BLM\_MT' and 'var geometry: Table projects/blm-gee-mtso/assets/Moon\_'. Below the imports, there is a line of code: '// return feature.geometry().intersection(geometry); // Clip each feature to the intersection with your geometry'.

## 2. Define the years that you want to export

The yearStart and yearEnd variables on lines 46 and 47 of the script define the first and last years of data that will be exported. The example below exports data for every year between 2010 and 2019.

To export multiple non-sequential years, simply run the script multiple times.

```

43 // ----- Define the years that you want to analyze -----
44 // ----- End year is inclusive in this case -----
45 // years available for RAP: 1986 to 2024 as of March 2025
46 var yearStart = 2010;
47 var yearEnd = 2019;
48

```

## 3. Define the plant functional types you want to export

The PFTs variable on line 54 of the script is a list of the plant functional types (PFTs) that you want to export. You can either keep the entire list if you want to export all of them or remove any PFTs that you are not interested in.

'AFG' is annual forb and grass cover, 'BGR' is bare ground cover, 'LTR' is litter cover, 'PFG' is perennial forb and grass cover, 'SHR' is shrub cover, and 'TRE' is tree cover.

```

49 // ----- Define the plant functional types (PFTs) that you want to export -----
50 // PFTs are "AFG" (Annual forb and grass cover), "BGR" (bare ground), "LTR" (litter),
51 // "PFG" (perennial forb and grass cover), "SHR" (shrub cover), and "TRE" (tree cover)
52
53 // this is the full list of options: ['AFG', 'BGR', 'LTR', 'PFG', 'SHR', 'TRE']
54 var PFTs = ee.List(['AFG', 'BGR', 'LTR', 'PFG', 'SHR', 'TRE'])

```

## 4. Select confidence interval

Change the critical z value based on the desired confidence interval for masking out insignificant pixels. For example, the current default of 1.28 corresponds to a confidence interval of 80%, meaning we can be 80% confident that the true trend differs from zero when a pixel is considered significant (i.e., not masked in the output). Another common, more stringent critical z value is 1.96, which corresponds to a 95% confidence interval.

```
56 // Define significance level for masking pixels- 1.96 for 95%, 1.285 for 80%
57 var criticalZValue = 1.285; // default 80% confidence
```

#### 5. Choose your variables and output names

This script offers several different output rasters that represent trends of fractional cover over time. Sen's slope is a nonparametric analysis that is robust to outliers and non-normal data commonly found in ecological studies. It calculates the annual trend between each pair of subsequent years and selects the median of these slopes. Linear regression is a statistical method that fits a straight trend line to the data by minimizing the differences between observed and predicted values, assuming normality and being sensitive to outliers. The outputs from both analyses can be interpreted as follows: A positive value indicates an annual or cumulative increase in the % fractional cover of the selected vegetation bands, while a negative value signifies an annual or cumulative % decline. For example, an AFG\_Annual\_Sens\_Slope or AFG\_Annual\_Trend of -2 would indicate that pixel is experiencing a decline of 2% fractional cover of annual vegetation per year on average over the selected years of analysis. In contrast, an AFG\_Overall\_Sens\_Slope or AFG\_Overall\_Trend of -2 would indicate that pixel is estimated to have experienced a total decline of 2% fractional cover of annual vegetation over the entire period of analysis. Keep in mind there is nothing constraining the average and overall trend in this analysis, so you might get a trend estimate that is unrealistic (e.g., an increase of over 100% even though RAP cover cannot exceed 100%).

Comment lines on or off using a double forward slash “//” to select which variables you want to receive as output. By default, the sens slope per year and overall masked and unmasked are the only output.

```

58
59 // User-defined variable for output layer names
60 var outputVars = [
61   'yearSens',      // Annual Sens Slope
62   'yearSensMask', // Masked Annual Sens Slope
63   'totalSens',    // Overall Sens Slope
64   'totalSensMask' // Masked Overall Sens Slope
65   // Add any additional layers as needed, using their
66   // 'yearTrend',    // Annual Trend
67   // 'yearTrendMask', // Masked Annual Trend
68   // 'totalTrend',   // Overall Trend
69   // 'totalTrendMask' // Masked Overall Trend
70 ];
71
72

```

Be sure to comment the corresponding names on or off if you change the default layers output. You can also change the name of the layer here if you desire.

For example, if I wanted to include the annual trend as an output, I would add a comma after line 64 ('totalSensMask',), remove the // and comma from line 66 ('yearTrend'). I would also perform a similar action to the niceLayerNames variable by adding a comma to line 77, then removing the // and comma from the corresponding name from that layer (line 79).

```

72 // Define nice or descriptive names for the outputs
73 var niceLayerNames = [
74   'Annual Sens Slope',
75   'Masked Annual Sens Slope',
76   'Overall Sens Slope',
77   'Masked Overall Sens Slope'
78   // Add corresponding nice names for any additional
79   // 'Annual Trend',
80   // 'Masked Annual Trend',
81   // 'Overall Trend',
82   // 'Masked Overall Trend'
83 ];
84

```

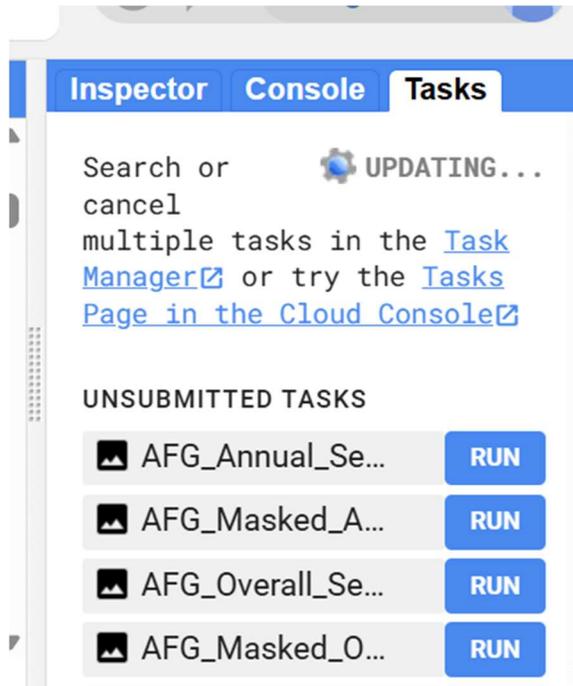
## 6. Run the script

Simply click "Run" at the top of the script to export your data, which will initiate the export process for each year of data.



Almost immediately, the "Tasks" tab in the right-side panel will turn yellow indicating that

you are ready to export. When you click "Tasks" you will see a list with items for each layer that you exported. Click "Run" on each of them to begin processing. You can click Run on the export popup to keep the default settings, which will export the raster as a geotiff to the Google Drive linked to your Google Earth Engine account.



#### 7. Retrieve your output

The export process may take several minutes to complete. However, once you have started the export you can close the Earth Engine tab and it will continue to run. You can always return to the Tasks tab at [code.earthengine.google.com](https://code.earthengine.google.com) to check on the progress of your export. Once your table has finished exporting you will find them in your Google Drive. It is now available for you to download to your local computer.

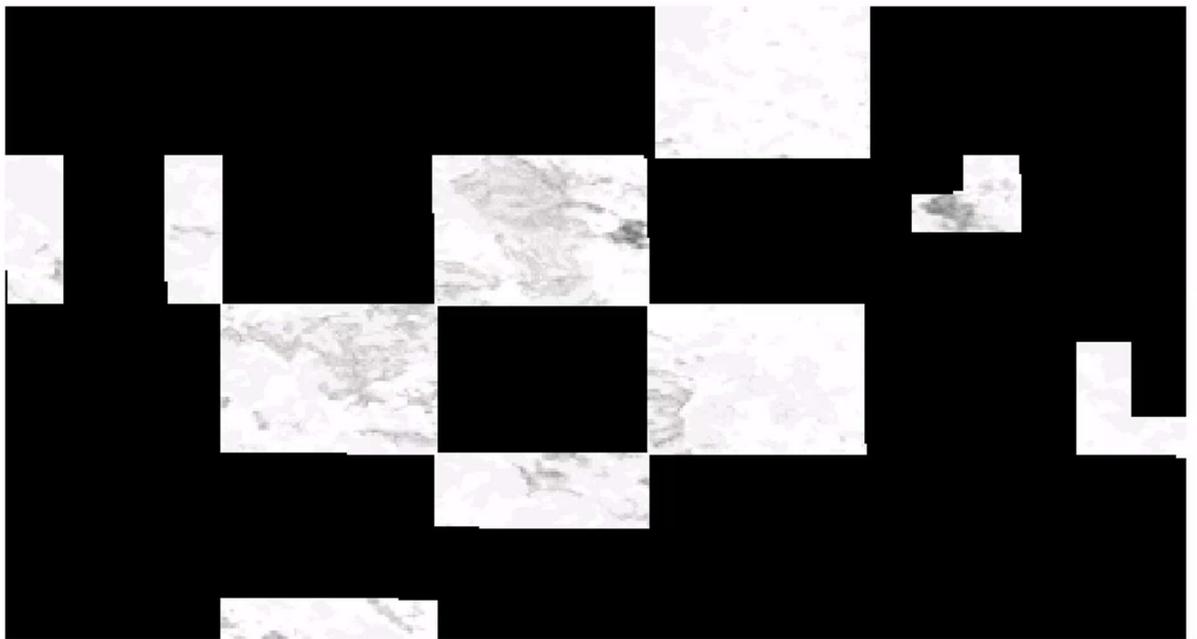
#### 8. OPTIONAL: Retrieve summary statistics about your geometry of interest

The end of this script offers summary statistics about RAP over the time period of interest for your masked geometry (i.e., quartiles, mean, median). To run this portion of the code, you need to uncomment lines 262-376. Highlight those lines and use a keyboard shortcut (ctrl + /) to easily uncomment that section of code. Then you can run the code as usual and there will be a new output available for export- Chart\_Data\_Export.csv. That export contains annual summary statistics for your geometry over the years of interest. Scroll down in the console to see graphs made from those data. You may take a screenshot of that graph, but it cannot be exported directly at this time.

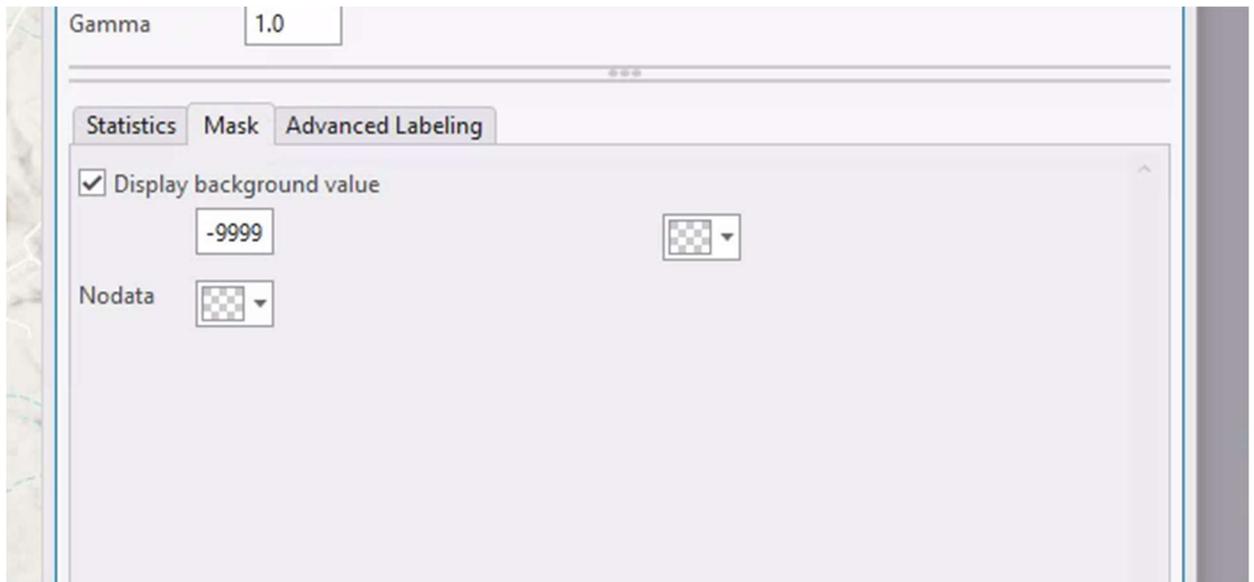
Note: This portion will not run if your area of interest is too large- it runs into memory issues!

9. OPTIONAL: Visualize your output raster(s) in ArcGIS Pro

Download your output raster(s) from Google Drive. Add the raster(s) to your ArcGIS Pro project by dragging and dropping into the Contents window or Add Data -> navigate to file(s) location. Allow it to calculate statistics if that pop-up window appears. You might notice your raster no longer appears to be clipped to your geometry of interest or masked by significance. For example:



Right click the newly added raster layer -> Symbology -> Mask -> Check Display background value -> add -9999 to the box below that check.



This step is necessary because GEE and ArcGIS Pro do not currently correctly communicate which values of the raster do not contain any data. Without completing this step, the clipped or masked areas of your raster will erroneously appear to be data in ArcGIS Pro. Your raster(s) output should appear as expected now:

