



**Google Earth Engine: MODIS
Normalized Difference Vegetation
Index (NDVI) Training**
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Google Earth Engine: MODIS Normalized Difference Vegetation Index (NDVI) Training

MODIS Normalized Difference Vegetation Index (NDVI)

The Moderate Resolution Imaging Spectroradiometer (MODIS) is an instrument carried by NASA's Aqua and Terra satellites. It captures images of Earth's surface in 1-2 day intervals in 36 spectral bands. The spatial resolution is 1000m, and the data extends from March 5, 2000 to the present. MODIS images can be used to analyze land surface changes over time, including vegetation changes as calculated through the normalized difference vegetation index (NDVI). The MODIS Combined 16-day NDVI computes this index from the near-infrared (NIR) and red bands of each scene as $\frac{NIR-Red}{NIR+Red}$, ranging in value from -1.0 to 1.0 and using the MCD43A4 MODIS surface reflectance composites as inputs.

Why was it developed?

This Google Earth Engine map displays global NDVI over a user-input 1-year period. The tool also provides NDVI long-term and short-term time series for a user-specified region over user-specified time periods.

What is the tool used for?

The tool is used for analysis of global vegetation trends, with possible applications to climate change, agriculture, vector-borne diseases, water resources, etc.

What can the current tool not be used for?

The Terra and Aqua satellites were launched in 1999 and 2002, respectively. Therefore, the tool can only be used for analyzing NDVI data from March 5, 2000 to the present, with about a month delay between satellite imaging and availability of data. It cannot be used for future NDVI projections.

1.1 Definition

The Google Earth Engine – MODIS NDVI tool can be modified to output a time-series of NDVI values for a user-defined region. This region can be defined through use of the geometry tool shown in the image below.



The region is imported into the map through the following code:

```
// Import region
var region = geometry;
```

Alternatively, a region can be selected using Google Fusion Tables. Specific countries can be accessed from the 'Countries.csv' Google Fusion Table available publicly at:

<https://www.google.com/fusiontables/data?docid=1tdSwUL7MVpOauSgRzqVTOWdfy17KDbw-1d9omPw#rows:id=1>. The code below selects Brazil from this file. Other data layers can be uploaded to Google Fusion Tables and accessed similarly, or public tables can be searched at: <https://research.google.com/tables>.

```
//Choose country using GEE Feature Collection
var region = ee.FeatureCollection('ft:1tdSwUL7MVpOauSgRzqVTOWdfy17KDbw-1d9omPw').filterMetadata('Country', 'equals', 'Brazil');
```

This layer is then added to the map, showing the outline of the country.

```
//Add region outline to layer - for selected countries
Map.addLayer(region, {}, 'Brazil')
```



Following this region selection, the MODIS NDVI image collections are uploaded into Google Earth Engine (GEE), as follows:

```
// Collect data and filter by total dates
var modisNDVI = ee.ImageCollection('MODIS/MCD43A4_NDVI');
```

The imported MODIS NDVI data

```
// Collect data and filter by total dates
```

The Google Earth Engine – MODIS NDVI tool provides a map of very short-term (1 month) average NDVI, a time series of long-term (16-year) average NDVI, and a time series of short-term (1-year) average NDVI. These long and two short-term periods can be input by the user for a desired analysis period by manipulating the code below, where collection05 is the long-term period, collection01 is the short-term period, and collection00 is mapped.

```
// Select dates
var collection05 = ee.ImageCollection(modNDVI.filterDate('2002-01-01', '2004-12-31'));
var collection01 = ee.ImageCollection(modNDVI.filterDate('2008-01-01', '2008-12-31'));
```

Finally, the MODIS NDVI data sets are “clipped” to the user-specified region.

```
//Clip to Specified Region
var clipped05 = collection05.mean().clip(region)
var clipped01 = collection01.mean().clip(region)
```

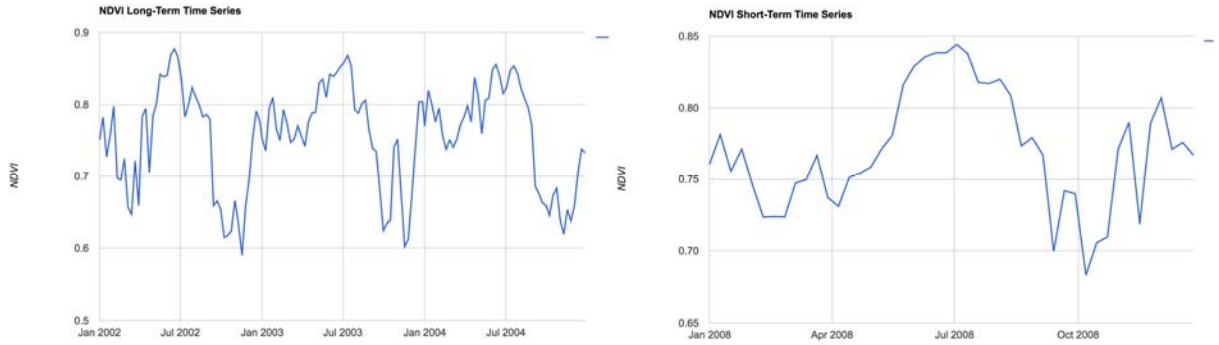
The NDVI time series are then charted and display in the GEE Console. In this case, all of Brazil is too large a region for Google Earth Engine to create a time series. Therefore, a smaller region must be chosen through use of the geometry tool (or a uploading a district shapefile through Google Fusion Tables), here called ‘small_region’ and shown in purple: (NOTE – Rename ‘geometry’ import to ‘small_region’)



The NDVI time series are then charted and display in the GEE Console.

```
// Charts //
//Long-Term Time Series
var TS5 = Chart.image.seriesByRegion(collection05, small_region, ee.Reducer.mean(), 'NDVI',
500, 'system:time_start').setOptions({
  title: 'NDVI Long-Term Time Series',
  vAxis: {title: 'NDVI'},
});
print(TS5);

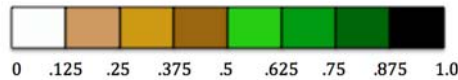
//Short-Term Time Series
var TS1 = Chart.image.seriesByRegion(collection01, small_region, ee.Reducer.mean(), 'NDVI',
500, 'system:time_start').setOptions({
  title: 'NDVI Short-Term Time Series',
  vAxis: {title: 'NDVI'},
});
print(TS1);
```



The map is then centered to the desired latitude, longitude, and zoom. The short-term NDVI data is added to the map for both the clipped MODIS NDVI region and global NDVI, on a scale of 0 to 1. The color-scale is shown below. Other color codes can be found at:

<http://www.nthelp.com/colorcodes.htm>.

```
//Set Center of Map and Add Clipped Image Layer
Map.setCenter(-50, -10, 3); //lat, long, zoom
Map.addLayer (clipped00, {min: 0.0, max: 1, palette: ['FFFFFF', 'CC9966', 'CC9900',
'996600', '33CC00', '009900', '006600', '000000']}, 'NDVI');
Map.addLayer(collection00,{min: 0.0, max: 1, palette:
['FFFFFF', 'CC9966', 'CC9900', '996600', '33CC00',
'009900', '006600', '000000']}, 'NDVIglobal', false);
```



1.2 Interpretation

The MODIS Normalized Difference Vegetation Index map runs on a scale of 0 to 1, where white and brown indicate no to low vegetation, and green to black indicate medium to high vegetation. It is important to note that depending on the region or range of dates selected, some information may be missing (cloud cover) and thus show up as transparent, showing the gray country layer below.

The NDVI values displayed on the map are average NDVI over a short-term period ('collection01day'). The NDVI time series charts display average NDVI over time for the user-specified geometrical "small region".

1.3 Access

The Google Earth Engine – MODIS NDVI Code can be accessed at <https://code.earthengine.google.com/4a1a814f882c98134e7e666527bc5275>. Google Earth Engine access can be requested through the form at <https://signup.earthengine.google.com>.

1.4 Analyses

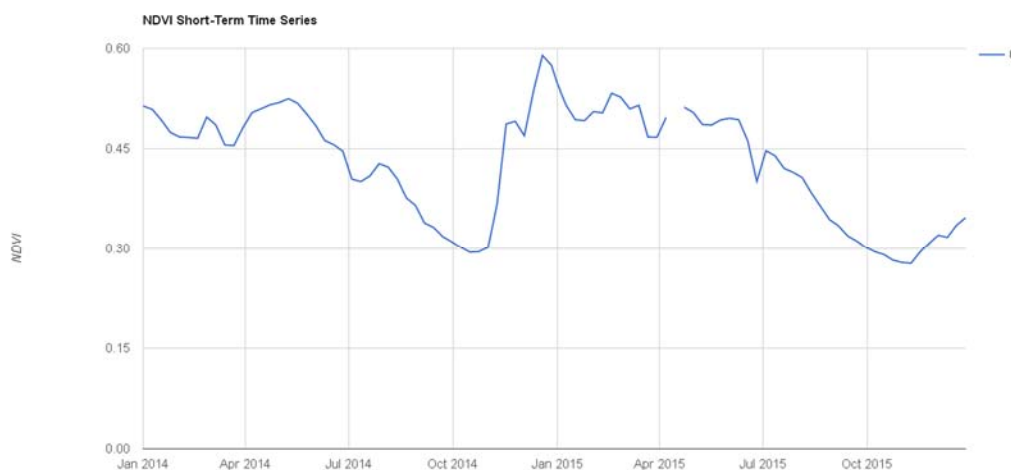
Users can choose to map average NDVI over a short-term or long-term period, as desired. The user can also choose to chart long-term and short-term time series for average NDVI over any specified time periods.

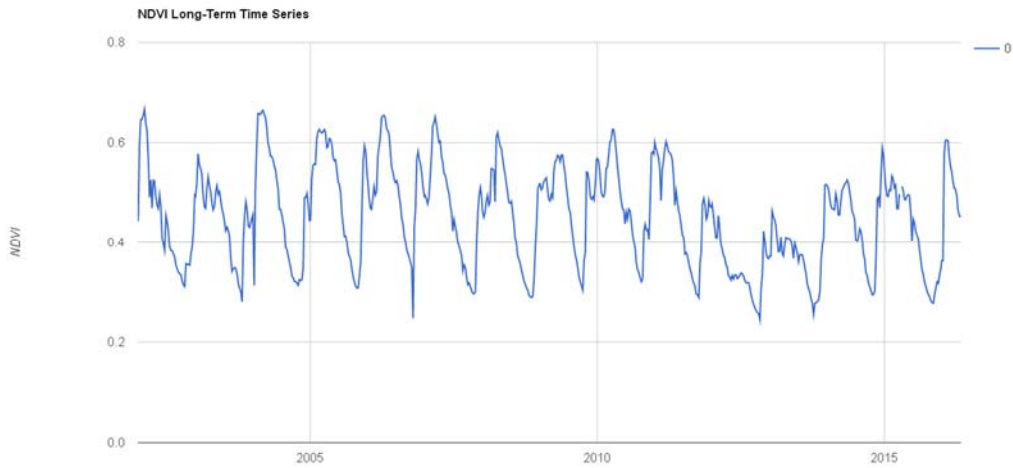
1.5 Case Study – Brazil

The Fundação Oswaldo Cruz (FIOCRUZ) in Brazil wants to assess the length and timing of the most recent severe drought event in North-East Brazil, in order to understand a possible link with mosquito population.

The answer can be obtained by selecting Brazil as the target country from the Google Fusion Table 'Country.csv' feature collection and selecting a new polygon over the North East region called "north_east". The most recent drought in Brazil occurred in January 2015, so the user could input January 2014 to December 2015 as the short-term time series and the 2002-2015 period as the long-term time series:

<https://code.earthengine.google.com/5dd583e914860cb88a63e979aea33aba>





1.6 Summary

The Google Earth Engine – MODIS Normalized Difference Vegetation Index (NDVI) code is to be used in assessment of historical vegetation. It enables the user to access information on any time scales between March 2000 and the present, at any location either input by country or by geometrical selection of a region.

1.7 References

"MODIS: Moderate Resolution Imaging Spectroradiometer." NASA Goddard Space Flight Center. N.p., n.d. Web. 20 Apr. 2016.