Google

#GeoForGood19

Learn EE basics through applied examples

Night-time light, Agriculture

Yasushi Onda / September 19, 2019

This deck:
bit.ly/G4G19-EEB

This session's goal

- Provide a starting point for beginners.

  "I created an GEE account but haven't used GEE that much.... Not really sure where to start."

- Understand the basics of Google Earth Engine through specific examples such as night time lights and agriculture.

- We will touch many parts of GEE in an hour. No need to understand the details in an hour!

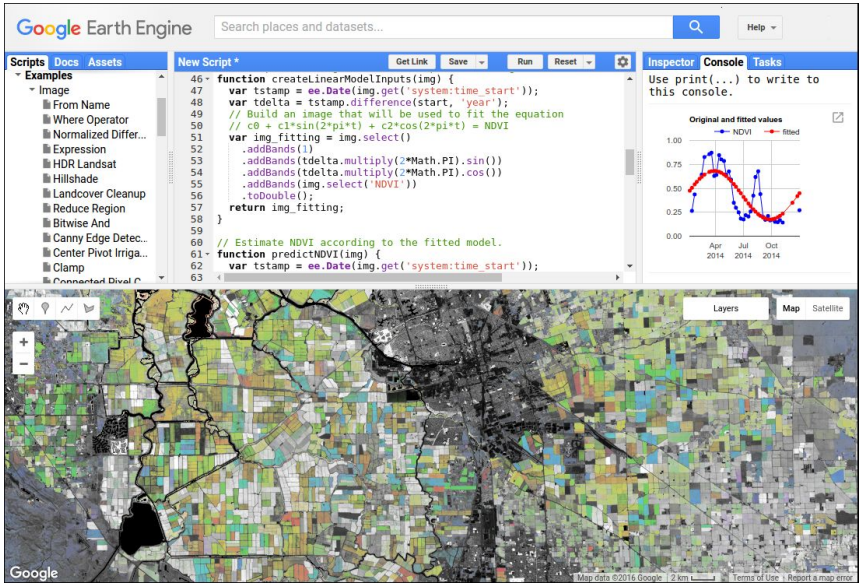
Agenda

- **Earth Engine Overview**
- **Basic code labs**
- **Applied examples**
  - Night time light
  - Agriculture
- **How to expand your knowledge**

Earth Engine Overview

How Do I Use It?

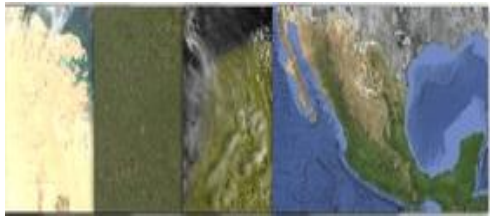
- **Timelapse**
  - View changes on land through a certain time period
- **Code Editor**
  - Interactive interface to use full function of GEE
  - Javascript API
- **Python API**
  - API to create Web apps
  - Python module
  - Web Apps with AppEngine



Requests

Results

Geospatial Datasets



add

mosaic

distance

filter

join

convolve

focal_min

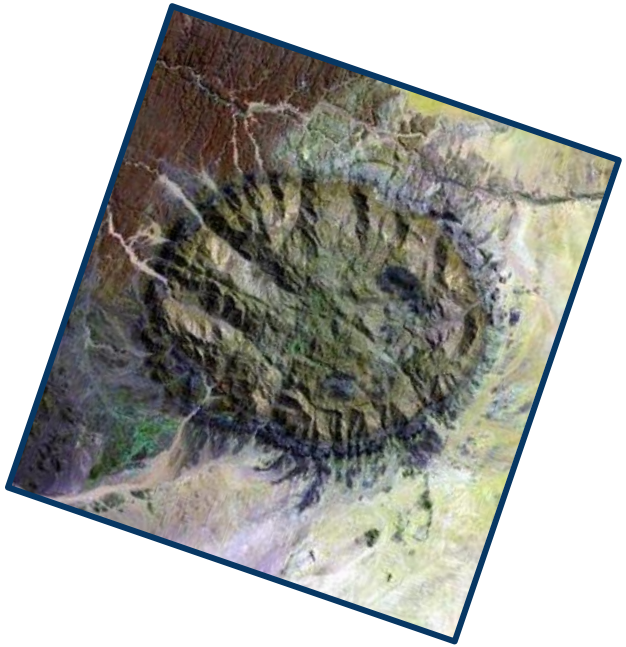
reduce

Algorithmic Primitives

Storage and Compute

What can you do with Earth Engine?

Get an Image

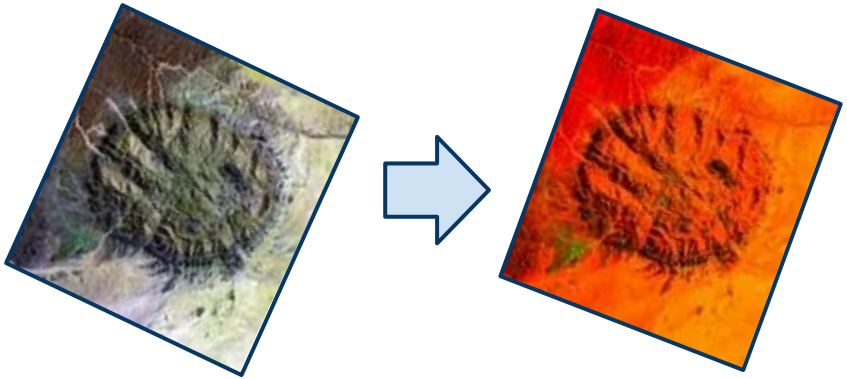


Pick your: Projection, resolution, bands, bounding-box, visualization

What can you do with Earth Engine?

Get an Image

Apply an algorithm to an image



Library functions or script your own.

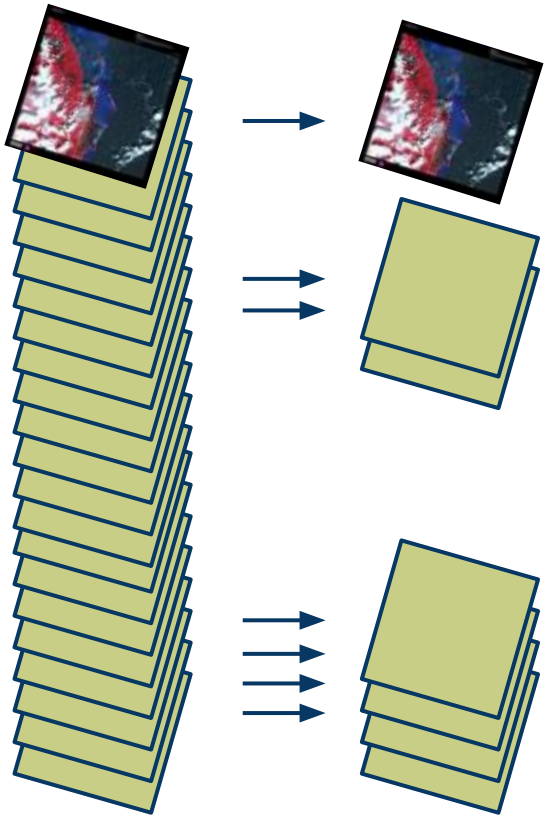
What can you do with Earth Engine?

Get an Image

Apply an algorithm to an image

Filter a collection

Time, Space & Metadata search



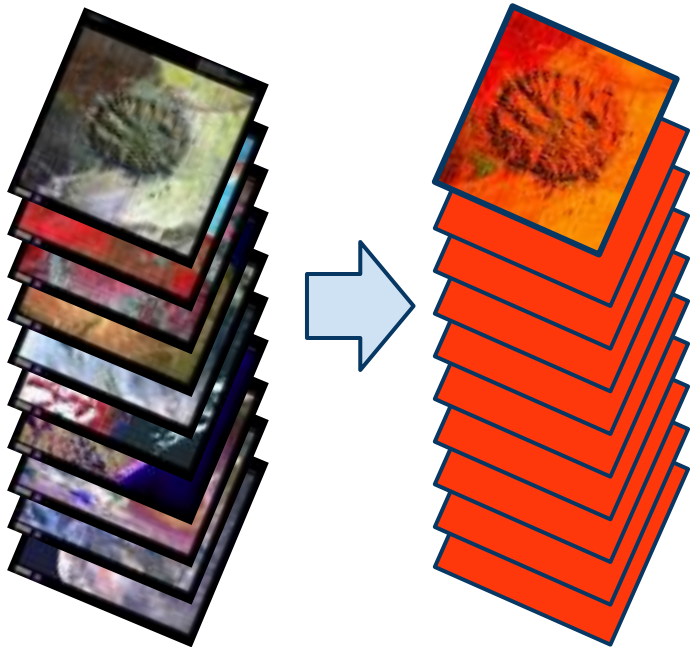
What can you do with Earth Engine?

Get an Image

Apply an algorithm to an image

Filter a collection

Map an algorithm over a collection



N → N

What can you do with Earth Engine?

Get an Image

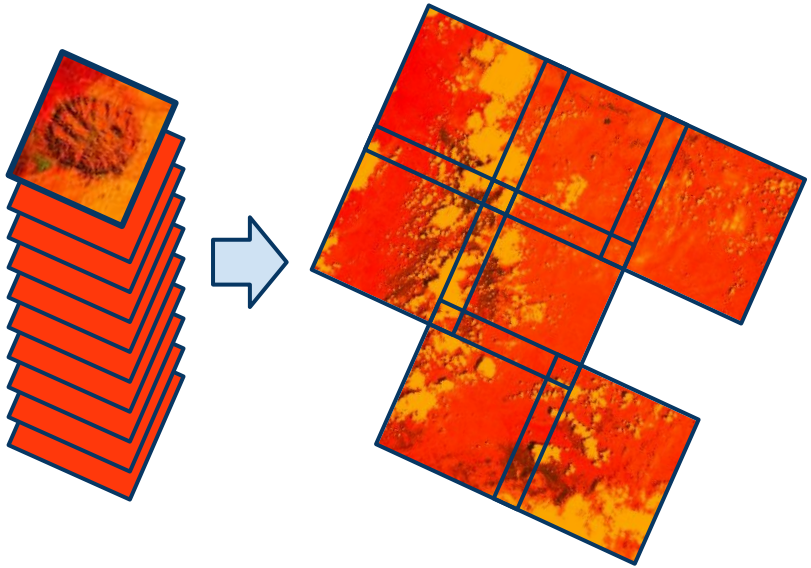
Apply an algorithm to an image

Filter a collection

Map an algorithm over a collection

Reduce a collection

$N \rightarrow 1$ or $N \rightarrow M$



What can you do with Earth Engine?

Get an Image

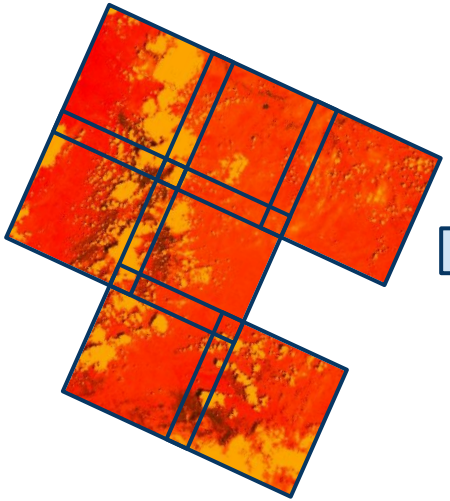
Apply an algorithm to an image

Filter a collection

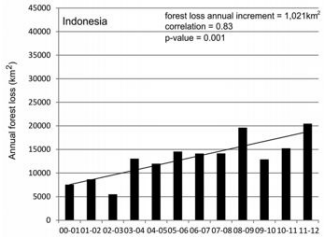
Map an algorithm over a collection

Reduce a collection

Compute aggregate statistics



Gabon	1891	391	11898
Lithuania	1845	1226	40296
Cuba	1725	2271	68008
Mali	1694	0	1247103
Costa Rica	1653	382	11327
Czech Republic	1646	1331	46934
South Sudan	1635	38	460581
North Korea	1605	137	67695
Italy	1603	898	201331



Basic Code labs

Let’s prepare for the basic code lab!

This presentation: http://bit.ly/G4G19-EEB

Hello Images, bands, and Layers

- Goal:
  - Understand how to pull out data and show it on the map

- Important points:
  - You can search for data by using keywords such as “elevation”, no need to know the exact name of data set
  - Consider the bands in the data
  - Layers are used to show data on the map
  - Use Inspector to get an idea of your image
    - Check if Bands are correct
    - Choose Range for viewing

Load and filter a collection

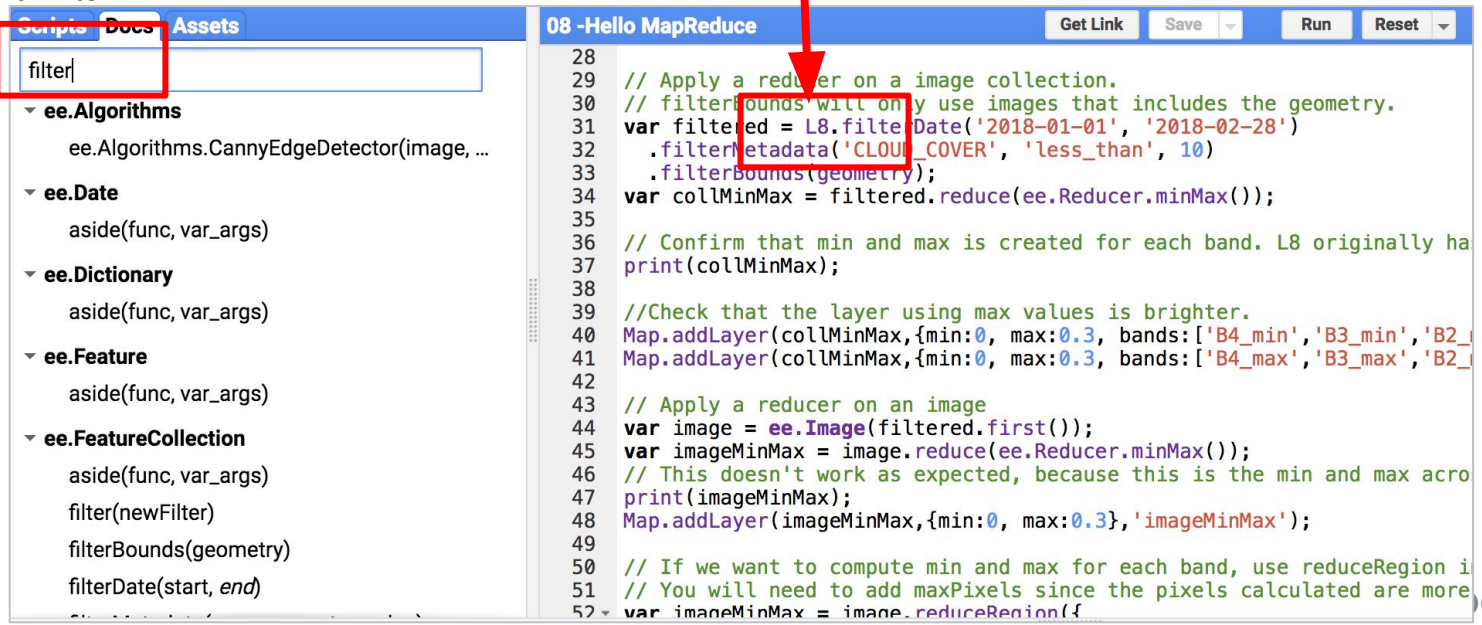
- Goal:
  - Understand how to filter image collections
- Important points:
  - Search Doc tab for “filter” to understand types of filters

Using the docs tab (1)

- There are many ways to filter... How should I know? -> Search the Docs tab!

Search “filter” -> You will see all the built-in functions related with filter

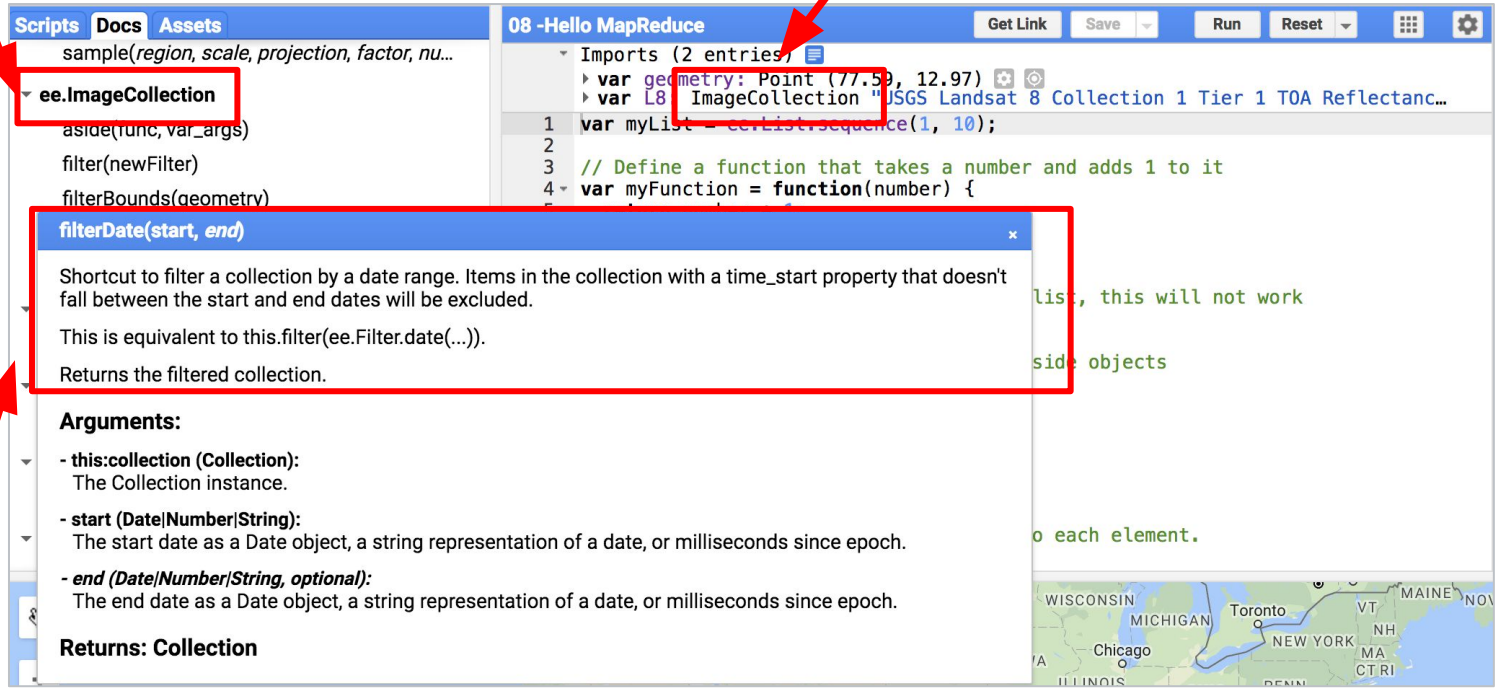
Make sure what type of object you want to filter. What is “L8”?



Using the docs tab (2)

Look for section about “ImageCollection”

“L8” is an “ImageCollection”



-Check the details about “filterDate” function. Basic concept is to chain commands. “L8.filterDate()”

-Arguments in *Italic* are optional

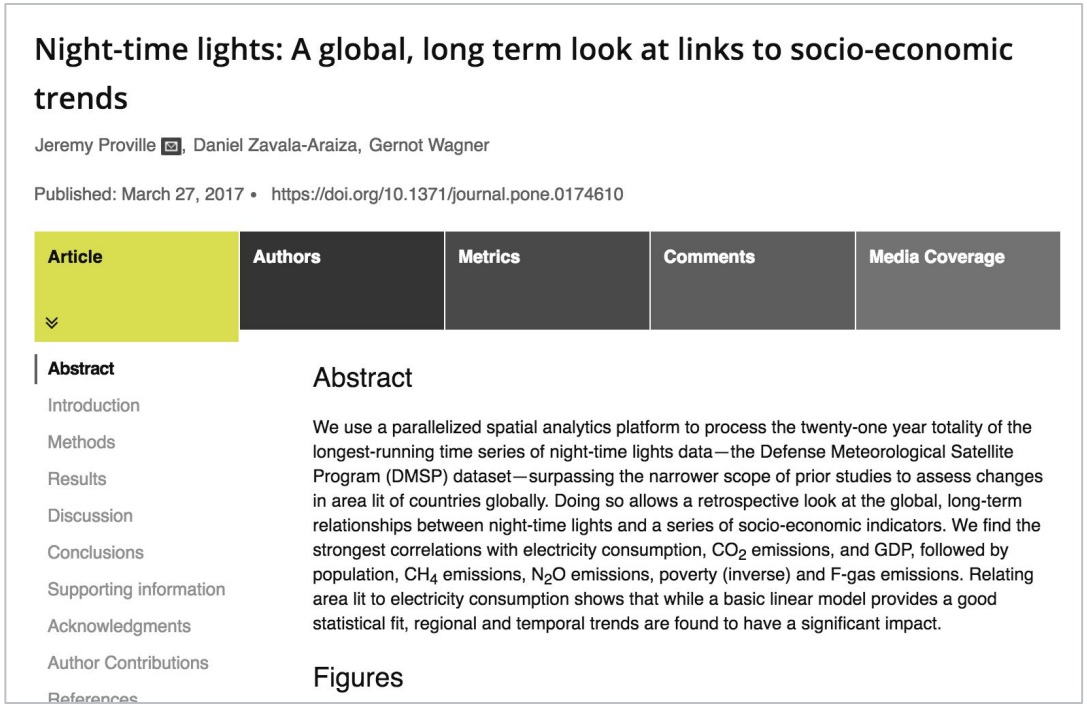
Display different band combinations with Landsat data

- Goal:
  - Understand how to use bands, tips of visualization including false composites
- Important points:
  - Check band details by looking at details of data sets

Applied examples

Night-time light

- Night lights can be used for estimating economy. -- Seems interesting!



Night-time lights: A global, long term look at links to socio-economic trends

Jeremy Proville, Daniel Zavala-Araiza, Gernot Wagner

Published: March 27, 2017 • https://doi.org/10.1371/journal.pone.0174610

Article | Authors | Metrics | Comments | Media Coverage

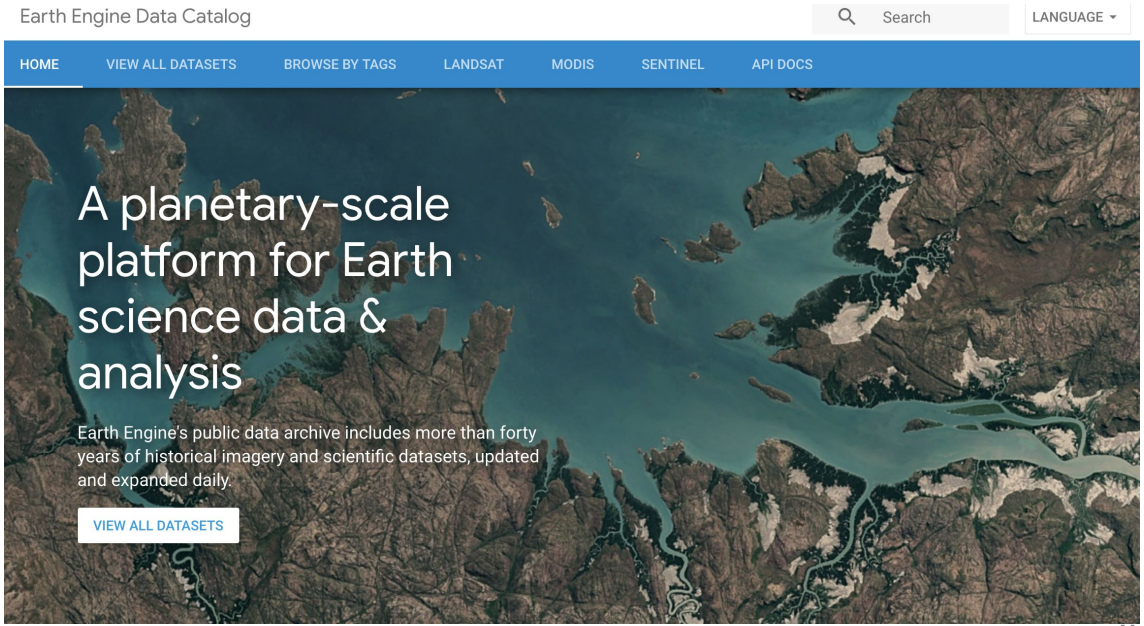
Abstract

We use a parallelized spatial analytics platform to process the twenty-one year totality of the longest-running time series of night-time lights data—the Defense Meteorological Satellite Program (DMSP) dataset—surpassing the narrower scope of prior studies to assess changes in area lit of countries globally. Doing so allows a retrospective look at the global, long-term relationships between night-time lights and a series of socio-economic indicators. We find the strongest correlations with electricity consumption, CO_2 emissions, and GDP, followed by population, CH_4 emissions, N_2O emissions, poverty (inverse) and F-gas emissions. Relating area lit to electricity consumption shows that while a basic linear model provides a good statistical fit, regional and temporal trends are found to have a significant impact.

Figures

Look for available data -- Earth Engine Data Catalog

https://developers.google.com/earth-engine/datasets/catalog/



Night light data sets

HOME | VIEW ALL DATASETS | BROWSE BY TAGS | LANDSAT | MODIS | SENTINEL | API DOCS | SEND FEEDBACK

DMSP OLS: Global Radiance-Calibrated Nighttime Lights Version 4, Defense

The Defense Meteorological Program (DMSP) Operational Line-Scan System (OLS) has a unique capability to detect visible and near-infrared (VNIR) emission sources at night. This collection contains global nighttime lights images with no sensor saturation. The sensor is typically operated at a high-gain setting to enable

DMSP OLS: Nighttime Lights Time Series Version 4, Defense Meteorological Program

The Defense Meteorological Program (DMSP) Operational Line-Scan System (OLS) has a unique capability to detect visible and near-infrared (VNIR) emission sources at night. Version 4 of the DMSP-OLS Nighttime Lights Time Series consists of cloud-free composites made using all the available archived DMSP-

VIIRS Nighttime Day/Night Band Composites Version 1

Monthly average radiance composite images using nighttime data from the Visible Infrared Imaging Radiometer Suite (VIIRS) Day/Night Band (DNB). As these data are composited monthly, there are many areas of the globe where it is impossible to get good quality data coverage for that month. ...

VIIRS Stray Light Corrected Nighttime Day/Night Band Composites Version 1

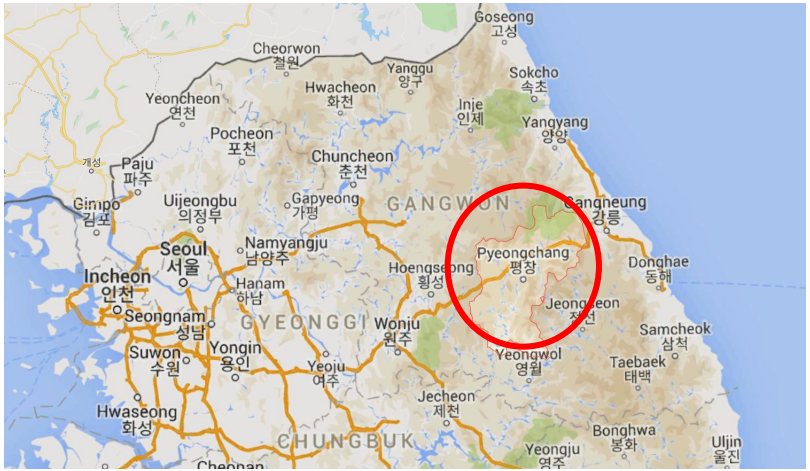
Monthly average radiance composite images using nighttime data from the Visible Infrared Imaging Radiometer Suite (VIIRS) Day/Night Band (DNB). As these data are composited monthly, there are many areas of the globe where it is impossible to get good quality data coverage for that month. ...

GEE function: Charts over time

- Chart nightlight over time
  - Goal:
    - Understand how to use charts over time for visualization.
  - Important points:
    - Use geometry to select area of interest.
    - Use “ui.Chart.image.series()” to output chart into console.

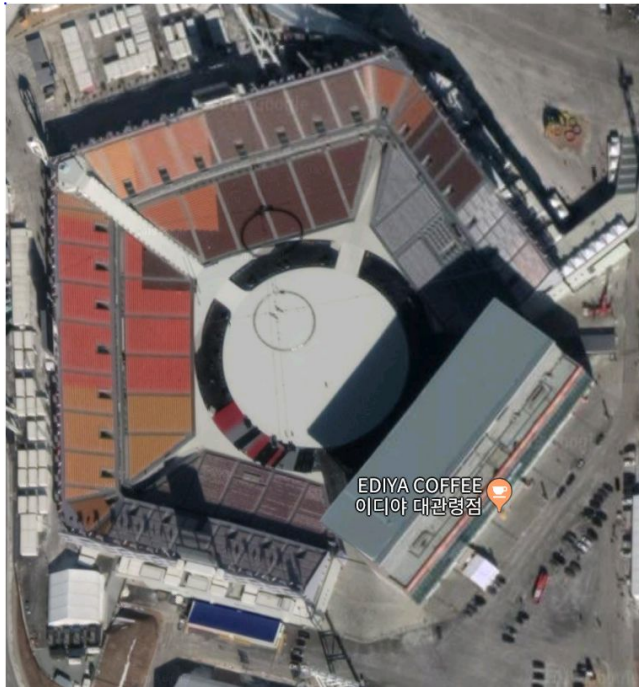
Can we observe effects of the Olympics?

- The 2018 Winter Olympics was held in Pyeongchang.
- Population is 40,000

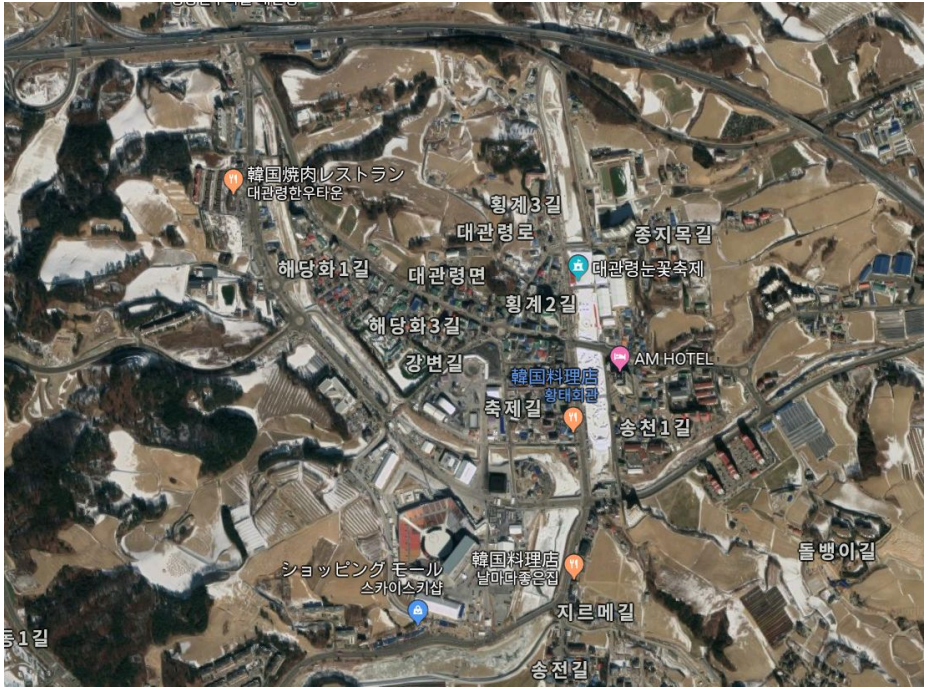


Areas of interest

main stadium



city area



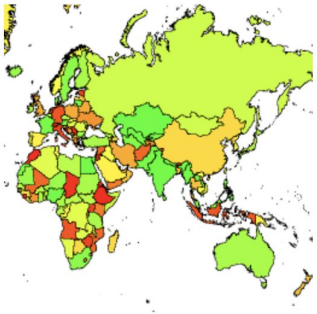
Can we observe effects of the Olympics?

- Chart nightlight over time in Pyeongchang
  - Idea:
    - The 2018 Winter Olympics was held in Pyeongchang.
    - Let’s see if we can detect something interesting.

Using country boundary data sets

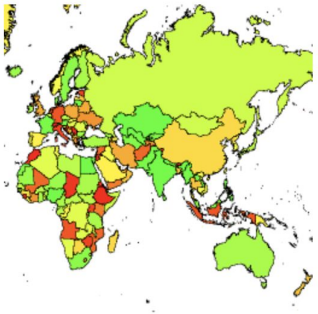
- [Chart nightlight over time for entire Japan]

LSIB: Large Scale International Boundary Polygons, Detailed



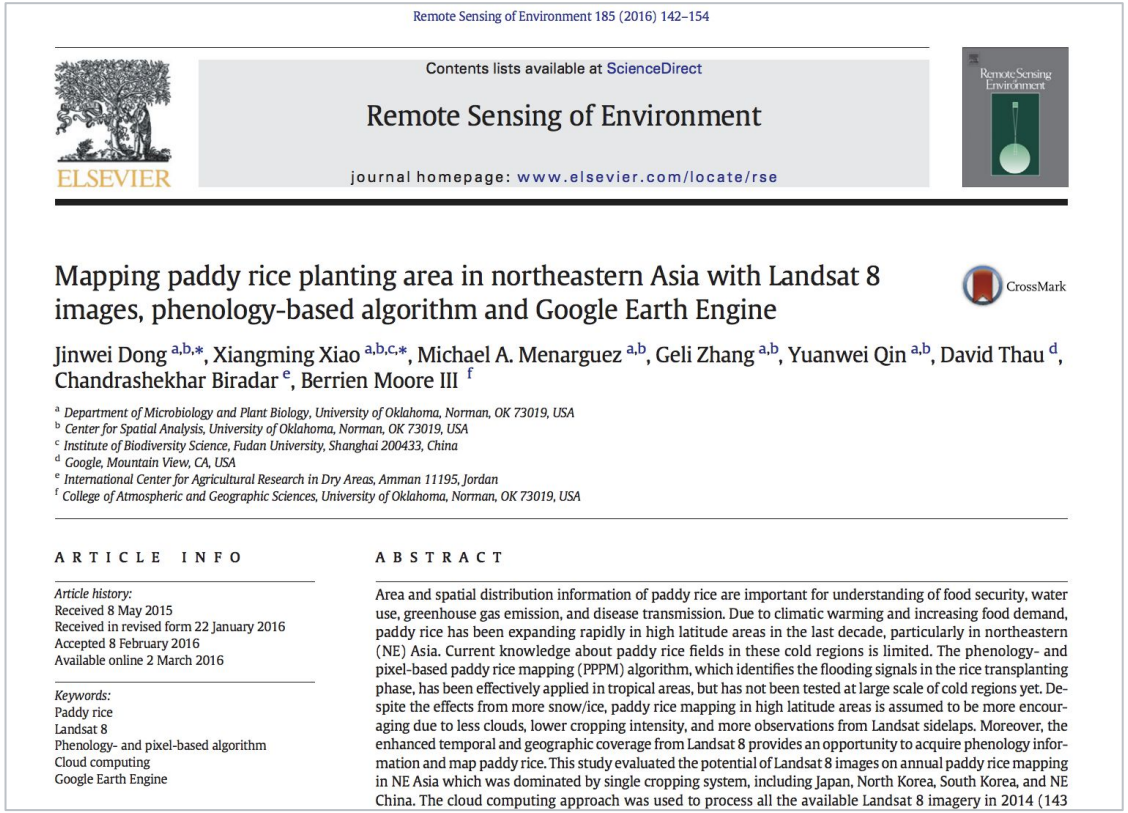
The United States Office of the Geographer provides the Large Scale International Boundary (LSIB) dataset. It is derived from two other datasets: a LSIB line vector file and the World Vector Shorelines (WVS) from the National Geospatial-Intelligence Agency (NGA). The interior boundaries reflect U.S. government ...

LSIB: Large Scale International Boundary Polygons, Simplified



The United States Office of the Geographer provides the Large Scale International Boundary (LSIB) dataset. The detailed version (2013) is derived from two other datasets: a LSIB line vector file and the World Vector Shorelines (WVS) from the National Geospatial-Intelligence Agency (NGA). The interior boundaries ...

Agriculture -- Paddy rice detection concepts



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journal homepage: www.elsevier.com/locate/rse

Mapping paddy rice planting area in northeastern Asia with Landsat 8 images, phenology-based algorithm and Google Earth Engine

Jinwei Dong [a,b,*], Xiangming Xiao [a,b,c,*], Michael A. Menarguez [a,b], Geli Zhang [a,b], Yuanwei Qin [a,b], David Thau [d], Chandrashekhar Biradar [e], Berrien Moore III [f]

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Cloud computing
Google Earth Engine

ABSTRACT

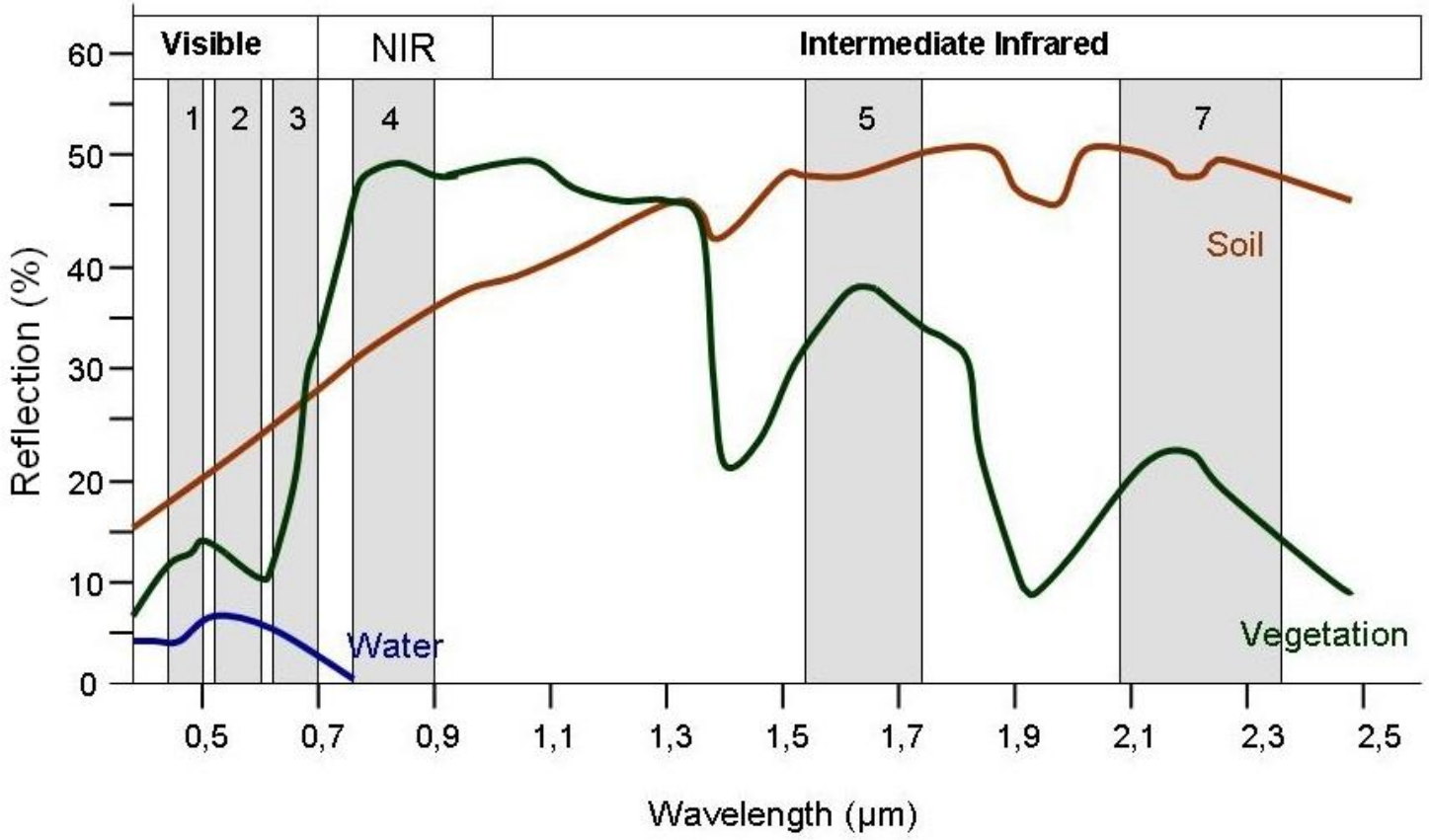
Area and spatial distribution information of paddy rice are important for understanding of food security, water use, greenhouse gas emission, and disease transmission. Due to climatic warming and increasing food demand, paddy rice has been expanding rapidly in high latitude areas in the last decade, particularly in northeastern (NE) Asia. Current knowledge about paddy rice fields in these cold regions is limited. The phenology- and pixel-based paddy rice mapping (PPPM) algorithm, which identifies the flooding signals in the rice transplanting phase, has been effectively applied in tropical areas, but has not been tested at large scale of cold regions yet. Despite the effects from more snow/ice, paddy rice mapping in high latitude areas is assumed to be more encouraging due to less clouds, lower cropping intensity, and more observations from Landsat sidelaps. Moreover, the enhanced temporal and geographic coverage from Landsat 8 provides an opportunity to acquire phenology information and map paddy rice. This study evaluated the potential of Landsat 8 images on annual paddy rice mapping in NE Asia which was dominated by single cropping system, including Japan, North Korea, South Korea, and NE China. The cloud computing approach was used to process all the available Landsat 8 imagery in 2014 (143

Difficulties of paddy rice detection

- Spectral similarities of paddy rice and other land covers
- Frequent clouds and cloud shadows in the rice planting regions

Approaches

- Use images of certain stages of paddy rice
- Use time series data for cropland classification
- Identify paddy rice based on the flooding signatures


Visible
NIR
Intermediate Infrared
1
2
3
4
5
7
Soil
Water
Vegetation
Reflection (%)
60
50
40
30
20
10
0
0,5
0,7
0,9
1,1
1,3
1,5
1,7
1,9
2,1
2,3
2,5
Wavelength (µm)

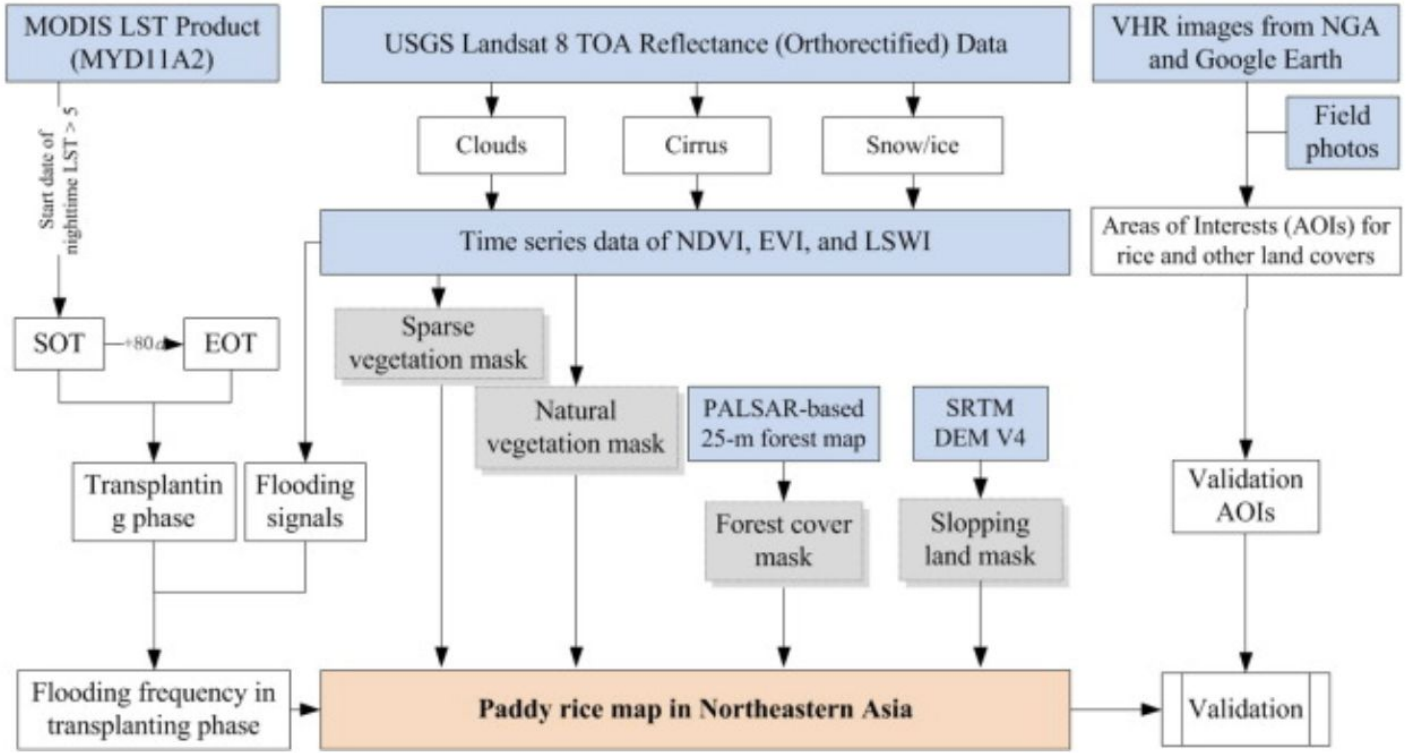
Normalized Difference Vegetation Index

NDVI = Normalized Difference Vegetation Index

- NIR channel: Cell walls **reflect NIR**
  - high NIR reflectance values = high quantity of photosynthetically active biomass
- Red channel: Chlorophyll **absorbs Red** (photosynthesis)
  - lower Red reflectance values = high photosynthetically active vegetation

Normalize the difference (NIR - Red) between them to determine NDVI

Workflow


MODIS LST Product (MYD11A2)
USGS Landsat 8 TOA Reflectance (Orthorectified) Data
VHR images from NGA and Google Earth
Start date of nighttime LST > 5
Clouds
Cirrus
Snow/ice
Field photos
Time series data of NDVI, EVI, and LSWI
Areas of Interests (AOIs) for rice and other land covers
SOT
+80d
EOT
Sparse vegetation mask
Natural vegetation mask
PALSAR-based 25-m forest map
SRTM DEM V4
Transplantin g phase
Flooding signals
Forest cover mask
Slopping land mask
Validation AOIs
Flooding frequency in transplanting phase
Paddy rice map in Northeastern Asia
Validation

Reducing image collections (Cloud free images)

- Goal:
  - Understand reducing via generating cloud free images

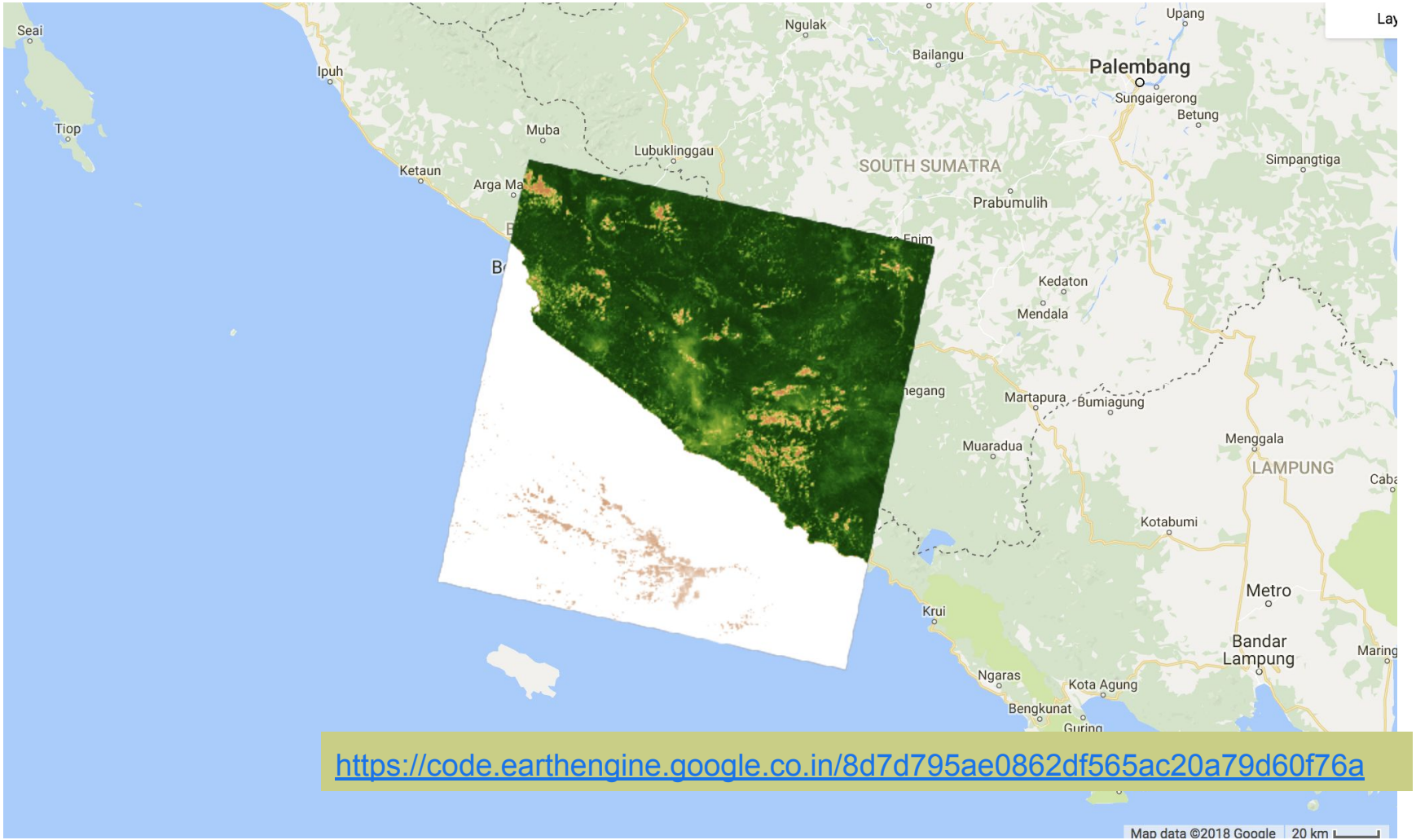
- Important points:
  - Use metadata to filter images
  - There are different ways to generate cloud free images, by using functions prepared in Earth Engine.
  - Search the web for information about metadata
    - Check “CLOUD_COVER” in the document below
    - https://landsat.usgs.gov/sites/default/files/documents/LSDS-809-Landsat8-Level1DFCB.pdf

GEE functions - Calculating metrics

$$NDVI = \frac{\rho_{NIR} - \rho_{Red}}{\rho_{NIR} + \rho_{Red}}$$

$$LSWI = \frac{\rho_{NIR} - \rho_{SWIR}}{\rho_{NIR} + \rho_{SWIR}}$$

- Calculate NDVI
  - Goal:
    - Understand how to calculate NDVI.
  - Important points:
    - Built-in function “normalizedDifference(bandNames)” can only handle Image, not ImageCollections.
    - Make sure to use “ee.Image()” to create an Earth Engine Image object.
- Map a function over a collection
  - Goal:
    - Understand how to scale a function over a collection.
  - Important points:
    - Use “ee.ImageCollection.map()” to apply a function to an ImageCollection.



https://code.earthengine.google.co.in/8d7d795ae0862df565ac20a79d60f76a

How to expand your knowledge

Resources - help documents, etc

- Check the help documents
  -  (Upper right button in Code Editor) -> User Guide
- Search the User Guide, look into the docs tab.
- Take a look at the debugging guide
- Search the discussions in the Earth Engine developers' list
  - Post your question in the developers' list
  - Don't forget to get the link of your code when asking questions.

Resources

- Data Catalog -Easy to search data sets
- Medium posts - Interesting cases, news from GEE team
- Case Studies - Details of cases
- GIS Specialists training deck - sample codes
- Scholar search - Search for papers
- Google Fusion Tables Turndown - Some guides of alternatives

Let’s enjoy Earth Engine!

Google

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