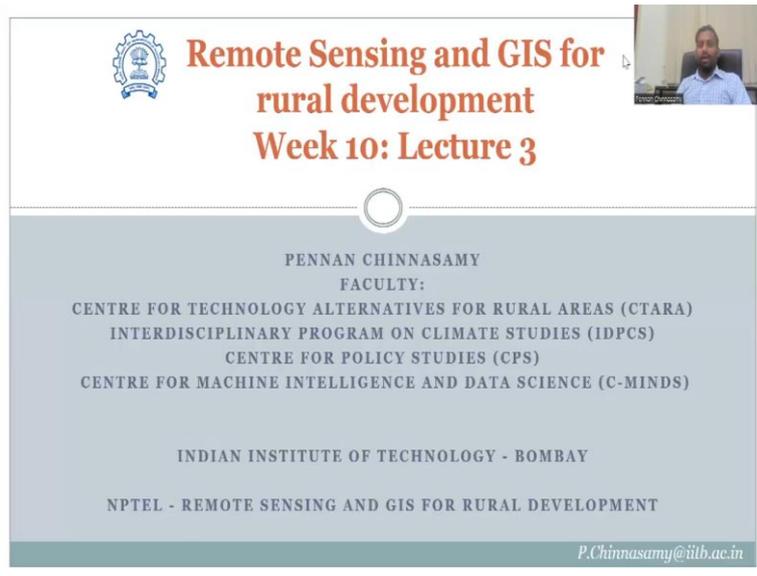


Remote Sensing and GIS for Rural Development
Professor Pennan Chinnasamy
Centre for Technology Alternatives for Rural Areas (CTARA)
Indian Institute of Technology, Bombay
Week – 10
Lecture – 3
NDVI Data Access

(Refer Slide Time: 00:15)



**Remote Sensing and GIS for
rural development**
Week 10: Lecture 3

PENNAN CHINNASAMY
FACULTY:
CENTRE FOR TECHNOLOGY ALTERNATIVES FOR RURAL AREAS (CTARA)
INTERDISCIPLINARY PROGRAM ON CLIMATE STUDIES (IDPCS)
CENTRE FOR POLICY STUDIES (CPS)
CENTRE FOR MACHINE INTELLIGENCE AND DATA SCIENCE (C-MINDS)

INDIAN INSTITUTE OF TECHNOLOGY - BOMBAY

NPTEL - REMOTE SENSING AND GIS FOR RURAL DEVELOPMENT

P.Chinnasamy@iitb.ac.in

Hello everyone. Welcome to the NPTEL course on Remote Sensing and GIS for Rural Development. This is Week 10, Lecture 3. In this week, we have been looking at NDVI, in particular, and using multi-source multi-theme data of the indicators that can be used for rural development in agriculture.

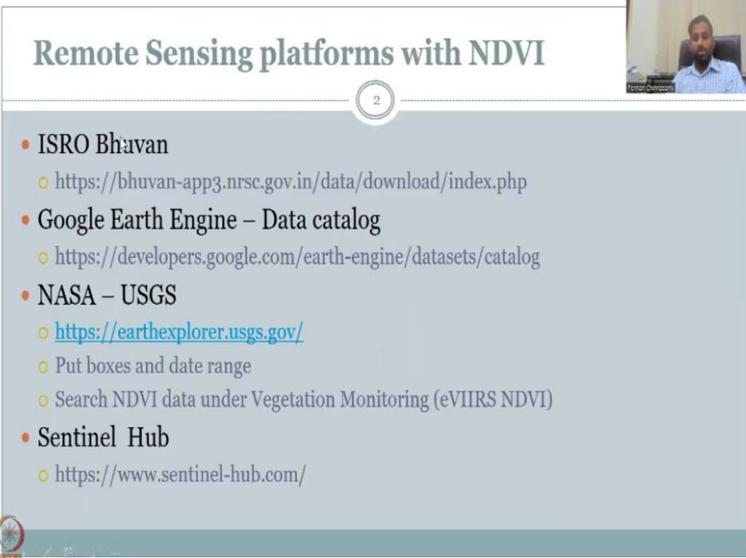
NDVI has been widely used because it gives you the healthiness of the plant and also can be used as a proxy for area acre coverage for vegetation. And these can be trickled down to other stakeholders that we discussed in the previous lectures like government agencies, insurance agencies, farmers for storage, business professionals for buying and creating the demand for the product.

All are linked to this healthy growing of agricultural crops. These have to be monitored regularly. And since observation data can be expensive, satellite-based data can be used. And in the previous exercise, we saw the 15-day window from Bhuvan, ISRO's website. So, now, if a particular pixel is moving from light green to dark green that means the plant is growing healthy.

Similarly, if every 15 days I am saying, if in a time frame it converts to gray from green to brown red then it means that the plant has attained the peak growth and now it is dying down or ready to be harvested. If you see wheat rice, etcetera when it is growing it is very green and beautiful. But when you are going to harvest it, it turns the right color and the right color has a different signature on satellites and remote sensing data and that is where we have found that this NDVI as an indicator can help immensely on understanding the plant health, plant growth.

Then based on that what are the resources that are needed, both financially and natural resources or subsidies in fertilizers, water, pumping, etcetera. And we have seen one resource of it which is the Bhuvan ISROs database. Now, today we will go to the other resources as promised.

(Refer Slide Time: 03:11)



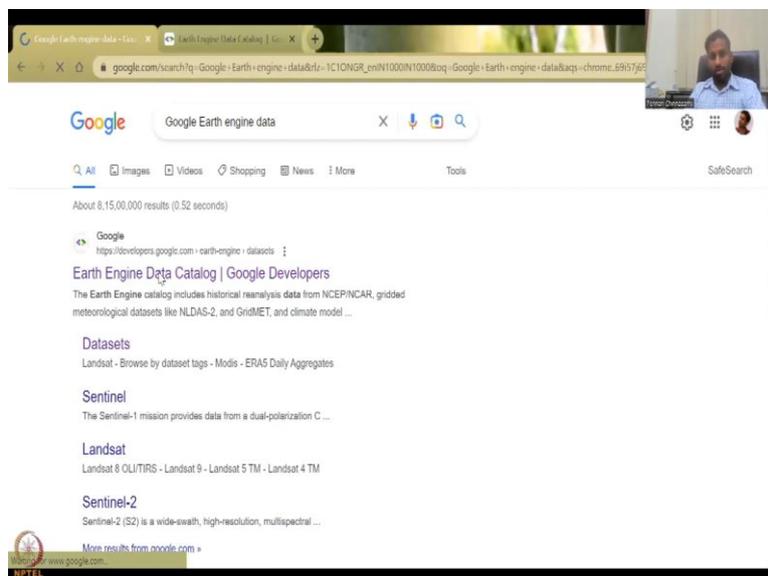
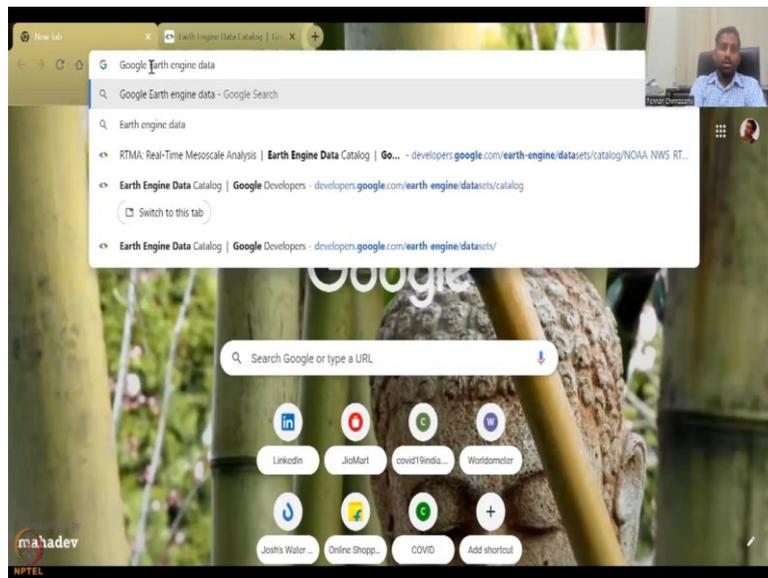
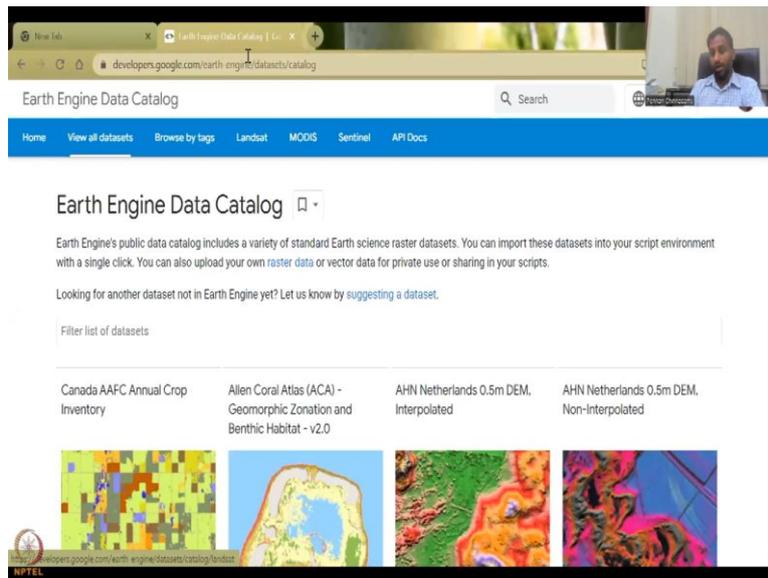
The slide is titled "Remote Sensing platforms with NDVI" and features a small video inset of the presenter in the top right corner. The slide content is as follows:

- ISRO Bhuvan
 - <https://bhuvan-app3.nrsc.gov.in/data/download/index.php>
- Google Earth Engine – Data catalog
 - <https://developers.google.com/earth-engine/datasets/catalog>
- NASA – USGS
 - <https://earthexplorer.usgs.gov/>
 - Put boxes and date range
 - Search NDVI data under Vegetation Monitoring (eVIIRS NDVI)
- Sentinel Hub
 - <https://www.sentinel-hub.com/>

The slide also includes the NPTEL logo in the bottom left corner.

So, in the previous lecture, we looked at Bhuvan and if time permits, we can also look at how a pixel converts from one to the other in a particular time frame. But I would like to show the Google Earth engine which is really really impressive. So, let me share my Google Earth screen. So, the link is given but as usual I will share an empty window and start from scratch on how to search for it.

(Refer Slide Time: 03:44)



Google Earth Engine Data Catalog

Home View all datasets Browse by tags **LandUse** MODIS Sentinel API Docs

A planetary-scale platform for Earth science data & analysis

Earth Engine's public data archive includes more than forty years of historical imagery and scientific datasets, updated and expanded daily.

[View all datasets](#)

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Google Earth Engine Data Catalog

Home View all datasets Browse by tags **LandUse** MODIS Sentinel API Docs

Browse by dataset tags

Filter dataset tags

16-day 8 datasets	3-hourly 4 datasets	3dep 3 datasets	8-day 15 datasets	aai 2 datasets
abi 15 datasets	aboveground 2 datasets	accessibility 2 datasets	accumulation 2 datasets	aerosol 8 datasets
africa 27 datasets	agriculture 14 datasets	ahn 3 datasets	air-quality 15 datasets	albedo 8 datasets
alh 2 datasets	alos 6 datasets	alos2 5 datasets	aluminium 4 datasets	annual 3 datasets
antarctica 1 dataset	aqua 1 dataset	arctic 6 datasets	area 3 datasets	aspect 15 datasets

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Google Earth Engine Data Catalog

Home View all datasets Browse by tags **LandUse** MODIS Sentinel API Docs

Browse by dataset tags

4 datasets	2 datasets	5 datasets	4 datasets	2 datasets
hcho 2 datasets	heat 5 datasets	highres 3 datasets	history 3 datasets	hotspot 7 datasets
hourly 6 datasets	human-modification 2 datasets	humidity 10 datasets	hurricane 7 datasets	hycom 3 datasets
hydrography 25 datasets	hydrology 31 datasets	hydrosheds 35 datasets	ice 9 datasets	idaho 2 datasets
imagery 6 datasets	imerg 3 datasets	infrared 2 datasets	intertidal 4 datasets	isda 21 datasets
lucn 2 datasets	jaxa 25 datasets	jpl 7 datasets	jrc 13 datasets	knmi 9 datasets
l1 2 datasets	l2 2 datasets	l3 2 datasets	l4 4 datasets	l5 5 datasets
l7	l8	l8sr	l9	l9sr

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Earth Engine Data Catalog

Search

marine 4 datasets	mascon 2 datasets	mass 6 datasets	mcd44a1 3 datasets	mcmip 9 datasets
merced 3 datasets	merit 3 datasets	merra 5 datasets	metdata 2 datasets	mod09q1 3 datasets
mod11a2 4 datasets	mod16a2 2 datasets	mod17 4 datasets	mod44w 2 datasets	modis 61 datasets
modis-derived 3 datasets	monitoring 5 datasets	monthly 26 datasets	mosaic 2 datasets	mpa 2 datasets
mrhc 2 datasets	msi 5 datasets	mss 10 datasets	mtbs 2 datasets	multispectral 3 datasets
murray 4 datasets	nasa 136 datasets	nature-conservancy 15 datasets	ncep 7 datasets	ndvi 11 datasets
neighborhood 5 datasets	nesdis 15 datasets	netherlands 5 datasets	nex 8 datasets	nhc 2 datasets

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Earth Engine Data Catalog

Search

neighborhood 5 datasets	nesdis 15 datasets	netherlands 5 datasets	nex 8 datasets	nhc 2 datasets
nicfi 3 datasets	night 2 datasets	nighttime 5 datasets	nir 3 datasets	nitrogen-dioxide 2 datasets
nlcd 4 datasets	nlcd-derived 4 datasets	no2 2 datasets	noaa 51 datasets	nopp 3 datasets
npp 8 datasets	nrg 2 datasets	nrt 3 datasets	nsidc 4 datasets	nws 3 datasets
o3 3 datasets	ocean 23 datasets	ocean-color 3 datasets	oceandata 3 datasets	oisst 2 datasets
oli-tirs 5 datasets	ols 3 datasets	onset-greenness 2 datasets	openehub 15 datasets	openlandmap 15 datasets
optical 2 datasets	oregonstate 3 datasets	organic-soils 2 datasets	orml 2 datasets	orthophoto 7 datasets

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Earth Engine Data Catalog

Search

Home View all datasets Browse by tags Landsat MODIS Sentinel API Docs

Filter dataset tags

16-day 8 datasets	3-hourly 4 datasets	3dep 3 datasets	8-day 15 datasets	aai 2 datasets
abi 15 datasets	aboveground 2 datasets	accessibility 2 datasets	accumulation 2 datasets	aerosol 8 datasets
africa 22 datasets	agriculture 14 datasets	ahn 3 datasets	air-quality 15 datasets	albedo 8 datasets
ah 2 datasets	alos 6 datasets	alos2 5 datasets	aluminium 4 datasets	annual 3 datasets
antarctica 3 datasets	aqua 23 datasets	arctic 6 datasets	area 2 datasets	aspect 15 datasets
aster 2 datasets	atmosphere 8 datasets	atmospheric 5 datasets	australia 5 datasets	avhrr 8 datasets

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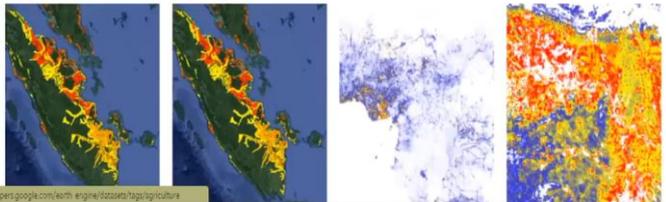
Earth Engine Data Catalog

Home View all datasets Browse by tags Landsat MODIS Sentinel API Docs

Datasets tagged agriculture in Earth Engine

Filter list of datasets

UN FAO Drained Organic Soils Area (Annual)	Drained Organic Soils Emissions (Annual)	Forest proximate people (FPP)	Tree proximate people (TPP)
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Earth Engine Data Catalog

WAPOR Actual Evapotranspiration and Interception

WAPOR Dekadal Evaporation

WAPOR Dekadal Interception

WAPOR Dekadal Net Primary Production



The actual evapotranspiration and interception (E_{Ta}) (dekadal, in mm/day) is the sum of the soil evaporation (E), canopy transpiration (T), and evaporation from rainfall intercepted by leaves (I).

The evaporation (E) data component (dekadal, in mm/day) is the actual evaporation of the soil surface. The value of each pixel represents the average daily actual evaporation for that specific

The interception (I) data component (dekadal, in mm/day) represents the evaporation of intercepted rainfall from the vegetation canopy. Interception is the process where rainfall is captured by the leaves. Part of this captured rainfall will

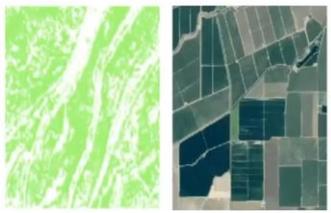
Net primary production (NPP) is a fundamental characteristic of an ecosystem, expressing the conversion of carbon dioxide into biomass driven by photosynthesis. The pixel value represents the mean daily NPP for that

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Earth Engine Data Catalog

DESS China Terrace Map v1

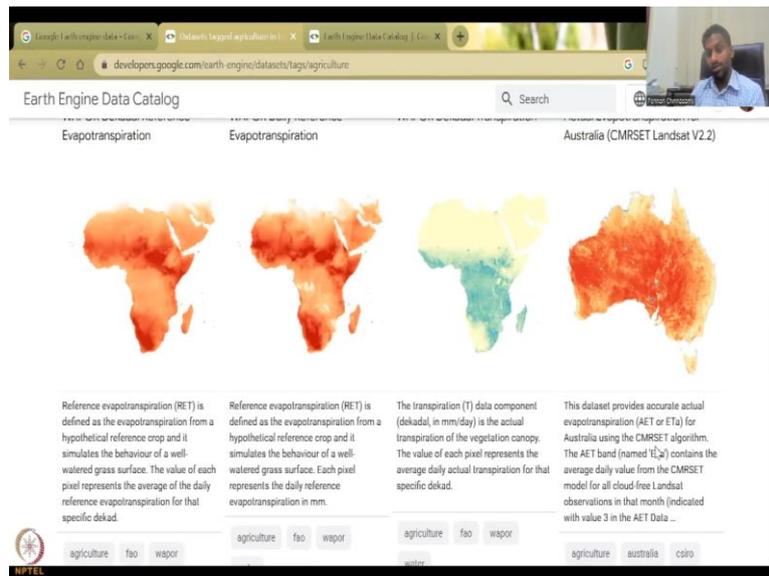
NAIP: National Agriculture Imagery Program



This dataset is a China terrace map at 30 m resolution in 2018. It was developed through supervised pixel-based classification using multisource and multi temporal data based on the Google Earth Engine platform. The overall accuracy and kappa coefficient achieved 94% and 0.77, respectively. This first ...

The National Agriculture Imagery Program (NAIP) acquires aerial imagery during the agricultural growing seasons in the continental U.S. NAIP projects are contracted each year based upon available funding and the imagery acquisition cycle. Beginning in 2003, NAIP was acquired on a 5 year cycle.

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So, this is the link which I have shared already. But suppose the link is not working, let us see. So, Google Earth engine. You can type NDVI directly or you can actually just type data and then just click on. So, you have the data sets, data catalog. So, go to here, the first one will come up, and under that there is multiple tabs.

So, you can say by satellites, landsat has been used for NDVI models has been used by NDVI Sentinel has been used for an NDVI but we will just look at tags. So, if you just click tags and type vegetation then you can see a multiple vegetation. But before that I want to explain what these tags are. The tags are like Twitter and Instagram that you put tags of a picture.

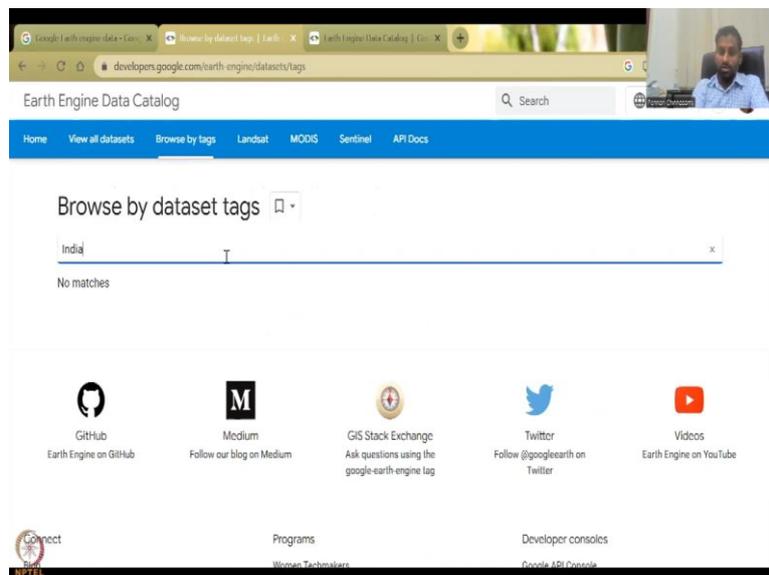
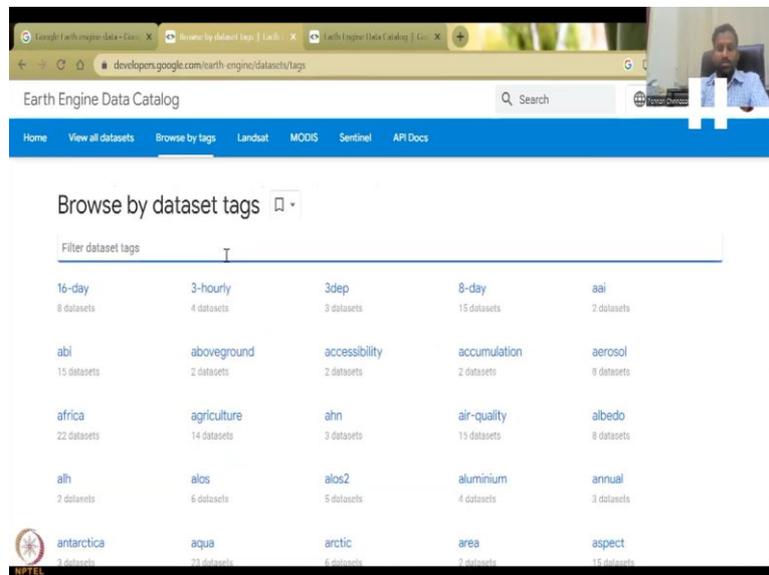
So, when a data set is created for quick access and search, these are like a keyword. So, the tags are given so that people can just type and then find. So, for example, for agriculture there is one. If you come down this arranged in alphabetical order. So, if you come down for crops, hydrology, you have hydrology and then you have landsat for the satellite itself or land fire as a product.

So, modis as a satellite and M N, so, we are coming at N now. So, n has NSD, NIR, nitrogen, et cetera. So, we do not have it as NDVI but we do have agriculture. So, let us quickly look at what do we have in agriculture. We also have deforestation which is also very important. So, let us say, agriculture and how many data sets are there.

You have the UN FAO drained soils, or the soils that are drained, organic soil emissions, decadal evaporation, net productivity, all these are related to agricultural productivity, etcetera. And then the national agricultural imagery program and there is something for just

the Chinese region. So, you have African regions also, very very focusedly done in Australia. These could be their own satellites that they map only their regions and we can also go by tags.

(Refer Slide Time: 06:01)



Earth Engine Data Catalog

Browse by dataset tags

ISRO

No matches

 GitHub
Earth Engine on GitHub
  Medium
Follow our blog on Medium
  GIS Stack Exchange
Ask questions using the google-earth-engine tag
  Twitter
Follow @googleearth on Twitter
  Videos
Earth Engine on YouTube

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  Developer consoles

Earth Engine Data Catalog

Browse by dataset tags

NDVI

ndvi
11 datasets

 GitHub
Earth Engine on GitHub
  Medium
Follow our blog on Medium
  GIS Stack Exchange
Ask questions using the google-earth-engine tag
  Twitter
Follow @googleearth on Twitter
  Videos
Earth Engine on YouTube

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Earth Engine Data Catalog

Datasets tagged ndvi in Earth Engine

Filter list of datasets

<p>MOD13A1.061 Terra Vegetation Indices 16-Day Global 500m</p> 	<p>MOD13A2.061 Terra Vegetation Indices 16-Day Global 1km</p> 	<p>MOD13Q1.061 Terra Vegetation Indices 16-Day Global 250m</p> 	<p>MYD13A1.061 Aqua Vegetation Indices 16-Day Global 500m</p> 
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 NPTEL
  Developer consoles

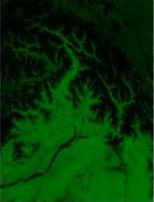
Earth Engine Data Catalog

NOAA CDR AVHRR NDVI: Normalized Difference Vegetation Index, Version 5



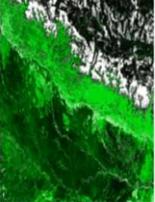
The NOAA Climate Data Record (CDR) of AVHRR Normalized Difference Vegetation Index (NDVI) contains

VNP13A1: VIIRS Vegetation Indices 16-Day 500m



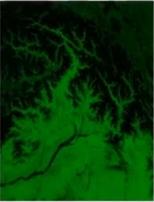
The Suomi National Polar-Orbiting Partnership (SNPP) NASA Visible Infrared Imaging Radiometer Suite (VIIRS) Vegetation Indices (VNP13A1)

VNP22Q2: Land Surface Phenology Yearly L3 Global 500m SIN Grid



The Suomi National Polar-Orbiting Partnership (Suomi NPP) NASA Visible Infrared Imaging Radiometer Suite (VIIRS) Land Cover Dynamics data

Earth Engine Data Catalog


The NOAA Climate Data Record (CDR) of AVHRR Normalized Difference Vegetation Index (NDVI) contains gridded daily NDVI derived from the NOAA AVHRR Surface Reflectance product. It provides a measurement of surface vegetation coverage activity, gridded at a resolution of 0.05° and computed globally over land ...

The Suomi National Polar-Orbiting Partnership (SNPP) NASA Visible Infrared Imaging Radiometer Suite (VIIRS) Vegetation Indices (VNP13A1) data product provides vegetation indices by a process of selecting the best available pixel over a 16-day acquisition period at 500 meter resolution. The VNP13 data products are designed ...

The Suomi National Polar-Orbiting Partnership (Suomi NPP) NASA Visible Infrared Imaging Radiometer Suite (VIIRS) Land Cover Dynamics data product provides global land surface phenology (GLSP) metrics at yearly intervals. The VNP22Q2 data product is derived from time series of the two-band Enhanced Vegetation Index (EVI2) ...

avhrr cdr daily land 16-day evi nasa ndvi land nasa ndvi noaa ndvi noaa noaa npp npp onset-greenness

Earth Engine Data Catalog

Home View all datasets Browse by tags Landsat MODIS Sentinel API Docs

MYD13A2.061 Aqua Vegetation Indices 16-Day Global 1km



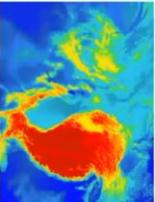
The MYD13A2 V6.1 product provides two Vegetation Indices (VI): the Normalized Difference Vegetation Index (NDVI) and the Enhanced Vegetation Index (EVI). The NDVI is referred to as the continuity index to the existing National Oceanic and Atmospheric Administration

MYD13Q1.061 Aqua Vegetation Indices 16-Day Global 250m



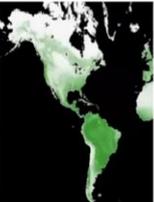
The MYD13Q1 V6.1 product provides a Vegetation Index (VI) value at a per pixel basis. There are two primary vegetation layers. The first is the Normalized Difference Vegetation Index (NDVI) which is referred to as the continuity index to the existing National Oceanic and Atmospheric Administration

AG100: ASTER Global Emissivity Dataset 100-meter V003



The Advanced Spaceborne Thermal Emission and Reflection Radiometer Global Emissivity Database (ASTER GED) was developed by the National Aeronautics and Space Administration's (NASA) Jet Propulsion Laboratory (JPL), California Institute of Technology, The

GIMMS NDVI From AVHRR Sensors (3rd Generation)

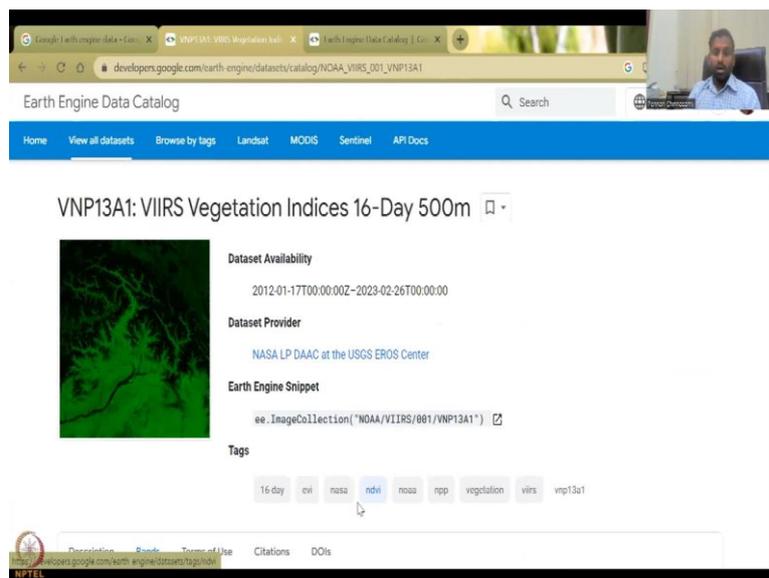


GIMMS NDVI is generated from several NOAA's AVHRR sensors for a global 1/12 degree lat/lon grid. The latest version of the GIMMS NDVI dataset is named NDVI3g (third generation GIMMS NDVI from AVHRR sensors).

So, you can click browse by tags and if it is very specific, you can also click India, there is no match, not updated yet. ISRO is also no match yet they do not have it as a tag and as we saw in NDVI, we have 11 data sets and these are the 11 data sets. So, 11 data sets are available and this is. So, if you look at the Bhuvan, what was the resolution? It was one kilometer, 15 days.

Here, it is 16 days almost 15 days and then 500 meters. So, higher spatial resolution from this particular payload V I I R S. We will be seeing this in when we download the NASA data days from the earth Explorer. But for now, we can see that what are the different NDVI's that are there, land surface phenology, Aster Global emissivity NDVI can be created, GIMMS NDVI etcetera, etcetera. So, we have a global 16-day, 1 kilometer coverage which is as similar as our the one we have from Bhuvan and this is very very recent also.

(Refer Slide Time: 07:09)

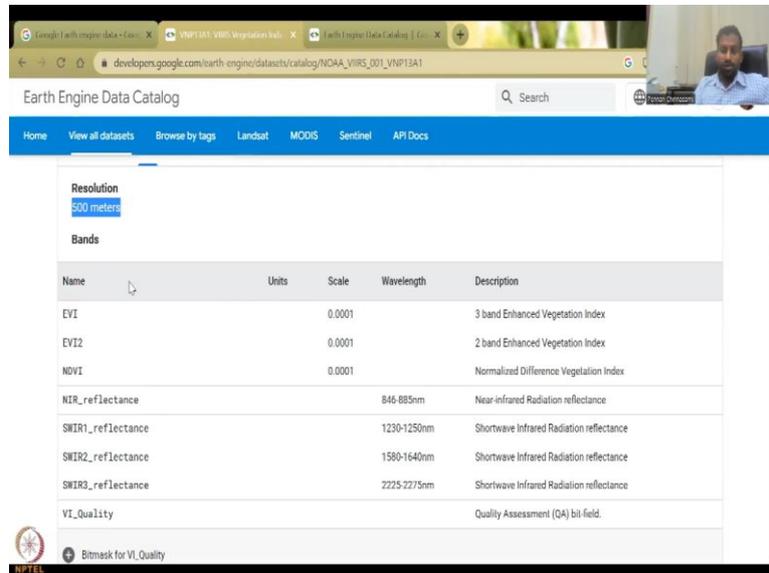


So, the one in Bhuvan we had stopped it. So, I am doing this on the same day. Why? Because I want to show what is the difference between the data sets, the recordings I am saying. I am doing it on the same day so that you can witness that which data set is best for your analysis. Suppose, you have a region and you are working for an Indian region and you need to see that if the data is available from a particular date. So, in the Bhuvan region it was 2011, 2011 to 2021.

So, I said around 11 years whereas here it is 2012 till date. So, this is just. So, now, today is around the March. So, yeah. So, the last date, we have the 16th date which is February end. So, this is very very recent data. And it takes a year for this to appear in the Bhuvan. If you

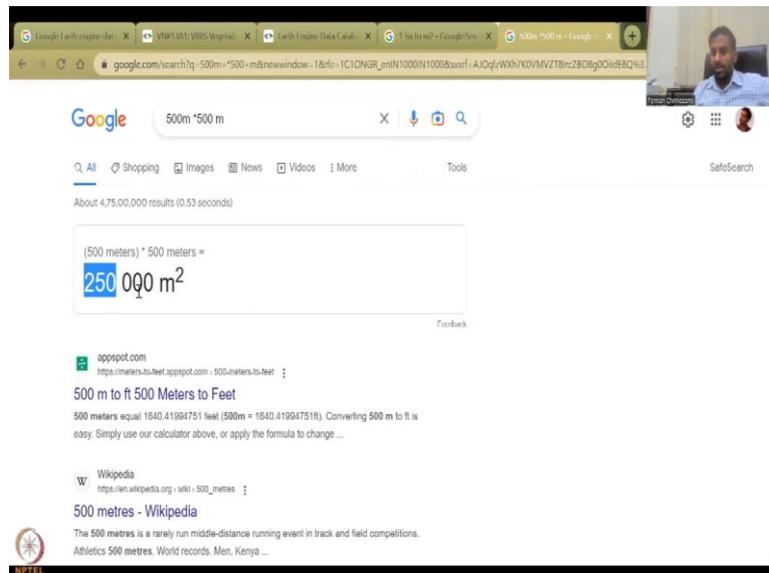
go to Bhuvan you can get good data until 2021 but then you will have to wait for a year to get 2022 and 2023. So, only in 2024 you get 2022. So, there is approximately 2 years of, about one year, one and a half years of delay.

(Refer Slide Time: 08:25)



The screenshot shows the Earth Engine Data Catalog interface. The resolution is set to 500 meters. The bands table is as follows:

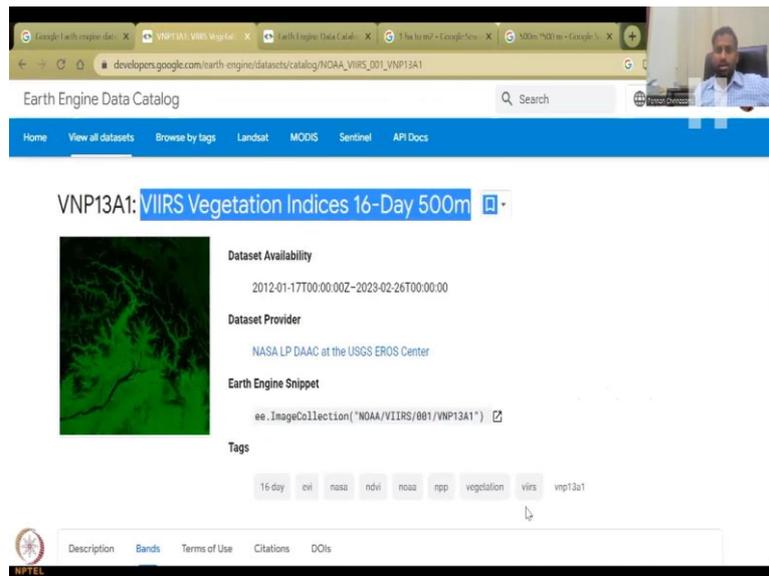
Name	Units	Scale	Wavelength	Description
EVI		0.0001		3 band Enhanced Vegetation Index
EVI2		0.0001		2 band Enhanced Vegetation Index
NDVI		0.0001		Normalized Difference Vegetation Index
NIR_reflectance			846-885nm	Near infrared Radiation reflectance
SWIR1_reflectance			1230-1250nm	Shortwave Infrared Radiation reflectance
SWIR2_reflectance			1580-1640nm	Shortwave Infrared Radiation reflectance
SWIR3_reflectance			2225-2275nm	Shortwave Infrared Radiation reflectance
VI_Quality				Quality Assessment (QA) bit field.



The screenshot shows a Google search for "500m * 500m". The search results include a calculator showing the calculation: (500 meters) * 500 meters = 250,000 m². Below the calculator, there are search results from appspot.com and Wikipedia.

appspot.com
https://meters-to-feet.appspot.com/500-meters-to-feet
500 m to ft 500 Meters to Feet
500 meters equal 1640.41994751 feet (500m = 1640.41994751ft). Converting 500 m to ft is easy. Simply use our calculator above, or apply the formula to change ...

Wikipedia
https://en.wikipedia.org/wiki/500_metres
500 metres - Wikipedia
The 500 metres is a rarely run middle-distance running event in track and field competitions. Athletics 500 metres. World records. Men, Kenya ...



Whereas here you have it all. And it is not only one particular area, it is for the globe. And the resolution is much much better than Bhuvan. It is 500 meters because the average land holding size is one hectare. So, one hectare is pretty small. So, just let us say, one hectare to meters square.

So, we get around 10,000 square meters. And this pixel is 500 times 500 meters. So, this pixel is around a 250 meters. So, we have 250,000 meters square, this one. But think about one kilometer that is double of this. So, somewhere these are still not as small as we want it but for free source we can do it.

And if we know that in a particular belt we have almost the same things across 500 by 500 meters and this is pretty good. So, I will show you how to use it one by one. So, we looked into this VIIRS vegetation index 16 day and it is a composite of indexes, not only NDVI that is what Google Earth gives, engine gives.

So, Google the engine collects the data sets that are available and couples it for the payload. So, this is the payload or the satellite and we have these other bands. So, these are not the bands like. So, this is the bands which are the NIR, SWIR, etcetera, etcetera and then they use this for creating these indicators.

(Refer Slide Time: 10:06)

Earth Engine Data Catalog

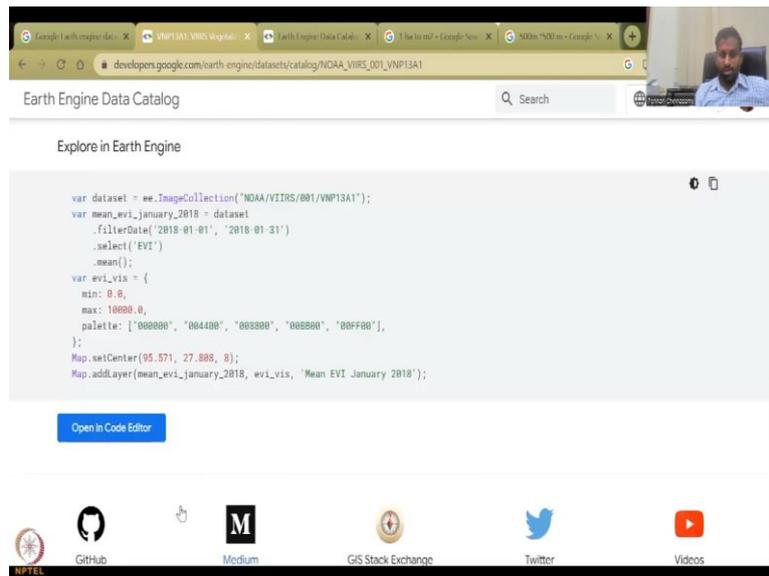
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EVI		0.0001		3 band Enhanced Vegetation Index
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NDVI		0.0001		Normalized Difference Vegetation Index
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SWIR2_reflectance			1580-1640nm	Shortwave Infrared Radiation reflectance
SWIR3_reflectance			2225-2275nm	Shortwave Infrared Radiation reflectance
VI_Quality				Quality Assessment (QA) bit field.
+ Bitmask for VI Quality				
red_reflectance			600-680nm	Red band reflectance
green_reflectance			545-656nm	Green band reflectance
blue_reflectance			478-498nm	Blue band reflectance

Earth Engine Data Catalog

Name	Units	Scale	Wavelength	Description
EVI		0.0001		3 band Enhanced Vegetation Index
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SWIR2_reflectance			1580-1640nm	Shortwave Infrared Radiation reflectance
SWIR3_reflectance			2225-2275nm	Shortwave Infrared Radiation reflectance
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green_reflectance			545-656nm	Green band reflectance
blue_reflectance			478-498nm	Blue band reflectance

Earth Engine Data Catalog

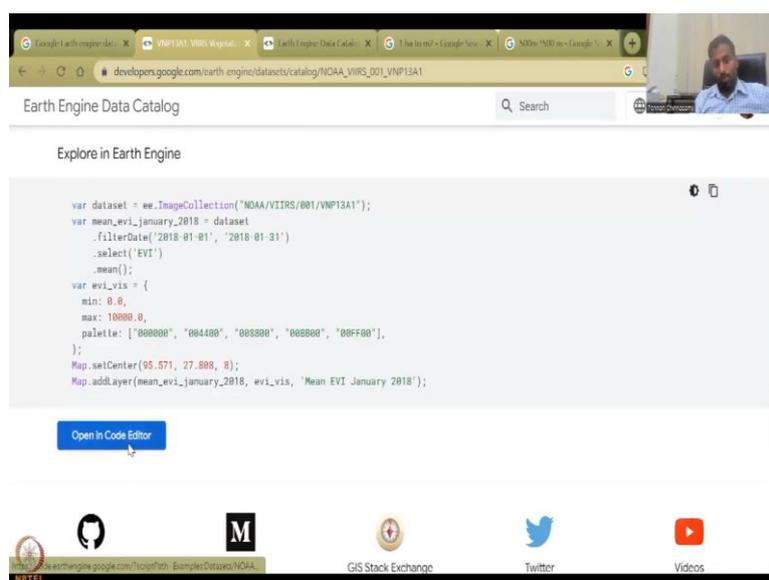
Name	Units	Scale	Wavelength	Description
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VI_Quality				Quality Assessment (QA) bit field.
+ Bitmask for VI Quality				
red_reflectance			600-680nm	Red band reflectance
green_reflectance			545-656nm	Green band reflectance
blue_reflectance			478-498nm	Blue band reflectance
composite_day_of_the_year	Day			Julian day of year
pixel_reliability				Pixel usefulness using a simple rank class
relative_azimuth_angle	degrees			Relative azimuth angle for each pixel
sun_zenith_angle	degrees			Sun zenith angle for each pixel
view_zenith_angle	degrees			View zenith angle for each pixel



So, the indicators will not have a wavelength, you can see, whereas these are available. And there are rescale. So, if you see that they are rescaled to particular values which are double checked by them. So, normalized vegetation index is what we want. This is the enhanced vegetation index.

Let us not get into that because every time they create new new indexes, indices but we will keep the NDVI which is very well known. And then we have the qualities, the band reflectance, green, blue, red. So, as we said the red near infrared. So, NIR minus red by, divided by NIR plus red is NDVI which has been done already by the Google Earth engine.

(Refer Slide Time: 10:47)



Google Accounts

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- p.chinnasamy@iitb.ac.in
- pennan.iwmi@gmail.com
- pennan.ntu@gmail.com
- pennan.atree@gmail.com
- pchinnasamy@wesleyan.edu

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Google Earth Engine

```
1 var dataset = ee.ImageCollection("NOAA/VIIRS/001/VNP13A1");
2 var mean_evi_january_2018 = dataset
3   .filterDate('2018-01-01', '2018-01-31')
4   .select('EVI')
5   .mean();
6 var evi_vis = {
7   min: 0.0,
8   max: 10000.0,
9   palette: ["000000", "004400", "008800", "00CC00", "00FF00"],
10 };
11 Map.setCenter(95.571, 27.888, 8);
12 Map.addLayer(mean_evi_january_2018, evi_vis, 'Mean EVI January 2018');
```

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

Google Earth Engine

```
1 var dataset = ee.ImageCollection("NOAA/VIIRS/001/VNP13A1");
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7   min: 0.0,
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10 };
11 Map.setCenter(95.571, 27.888, 8);
12 Map.addLayer(mean_evi_january_2018, evi_vis, 'Mean EVI January 2018');
```

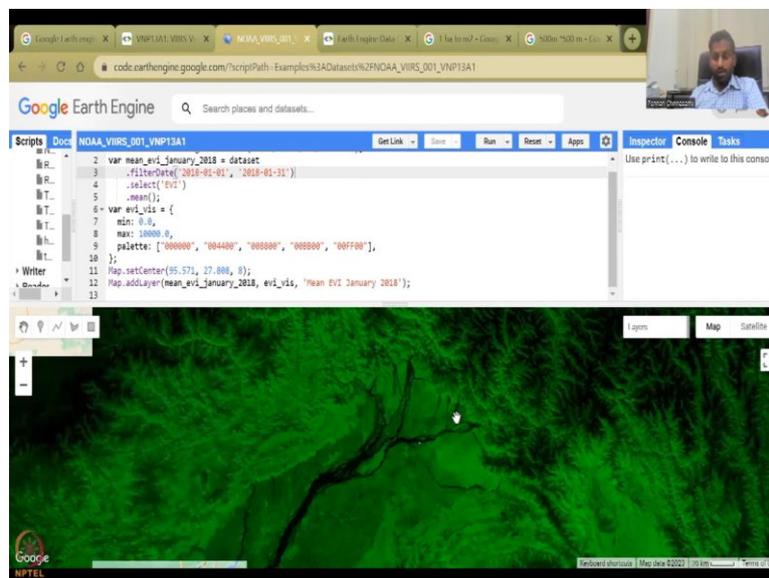
Welcome to Earth Engine! Please use the help menu above (H) to learn more about how to use Earth Engine, or visit our [help page](#) for support.

So, if you open the code, it will ask for which email you would like to use. So, you have multiple emails in Gmail. So, you can take which Gmail you would like to use and then you can look at where and how you would like to put the dates. So, this is for the globe and it can be changed as per need.

As I said this learning into the coding world does take time but will not get into that for now, in the basic remote sensing class. When we go to advanced level, yes, we will do some coding on this. I can share some codes that we have written through my students, one of my students shivanand has written good quotes. I will show you how the result is. This is mostly to showcase the remote sensing tools and how they are powerful compared to the other tools so that you can widely use them for NDVI analysis.

So, here is the data set, the data set is taken as VIRS, the versions are given here and then what it means is January 2018 data set. So, all these are mean they have taken. This is where you can pick and choose. So, here you could see that the mean date, mean January evi is being taken and given here. So, we have 2018 into 2018 01 and this this is the evi, not the NDVI, but if you run it, we can see how the code runs.

(Refer Slide Time: 12:39)



Google Earth Engine

```

2 var mean_evi_january_2018 = dataset
3   .filterDate(2018-01-01, 2018-01-31)
4   .select('evi')
5   .mean();
6 var evi_vis = {
7   min: 0.0,
8   max: 10000.0,
9   palette: ['000000', '004400', '008000', '00C000', '00FF00'],
10  };
11 Map.setCenter(95.571, 27.888, 8);
12 Map.addLayer(mean_evi_january_2018, evi_vis, 'Mean EVI January 2018');
13

```

Google Earth Engine

```

2 var mean_evi_january_2018 = dataset
3   .filterDate(2018-01-01, 2018-01-31)
4   .select('evi')
5   .mean();
6 var evi_vis = {
7   min: 0.0,
8   max: 10000.0,
9   palette: ['000000', '004400', '008000', '00C000', '00FF00'],
10  };
11 Map.setCenter(95.571, 27.888, 8);
12 Map.addLayer(mean_evi_january_2018, evi_vis, 'Mean EVI January 2018');
13

```

Earth Engine Data Catalog

Earth Engine's public data catalog includes a variety of standard Earth science raster datasets. You can import these datasets into your script environment with a single click. You can also upload your own raster data or vector data for private use or sharing in your scripts.

Looking for another dataset not in Earth Engine yet? Let us know by [suggesting a dataset](#).

Filter list of datasets

Canada AAFC Annual Crop Inventory	Allen Coral Atlas (ACA) - Geomorphic Zonation and Benthic Habitat - v2.0	AHN Netherlands 0.5m DEM, Interpolated	AHN Netherlands 0.5m DEM, Non-Interpolated
-----------------------------------	--	--	--

Remote Sensing platforms with NDVI

2

- ISRO Bhuvan
 - <https://bhuvan-app3.nrsc.gov.in/data/download/index.php>
- Google Earth Engine – Data catalog
 - <https://developers.google.com/earth-engine/datasets/catalog>
- NASA – USGS
 - <https://earthexplorer.usgs.gov/>
 - Put boxes and date range
 - Search NDVI data under Vegetation Monitoring (eVIIRS NDVI)
- Sentinel Hub
 - <https://www.sentinel-hub.com/>



Earth Engine Data Catalog

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A planetary-scale platform for Earth science data & analysis

Earth Engine's public data archive includes more than forty years of historical imagery and scientific datasets, updated and expanded daily.

[View all datasets](#)

NPTEL

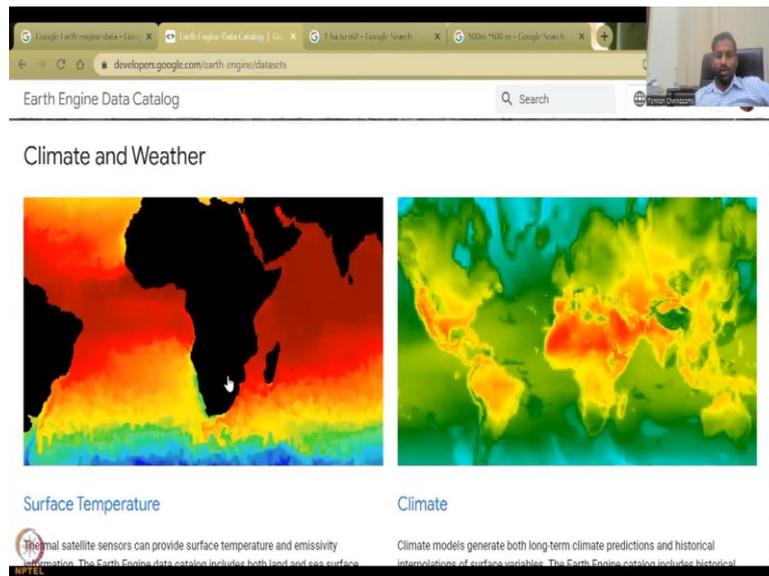
Earth Engine Data Catalog

platform for Earth science data & analysis

Earth Engine's public data archive includes more than forty years of historical imagery and scientific datasets, updated and expanded daily.

[View all datasets](#)

Climate and Weather



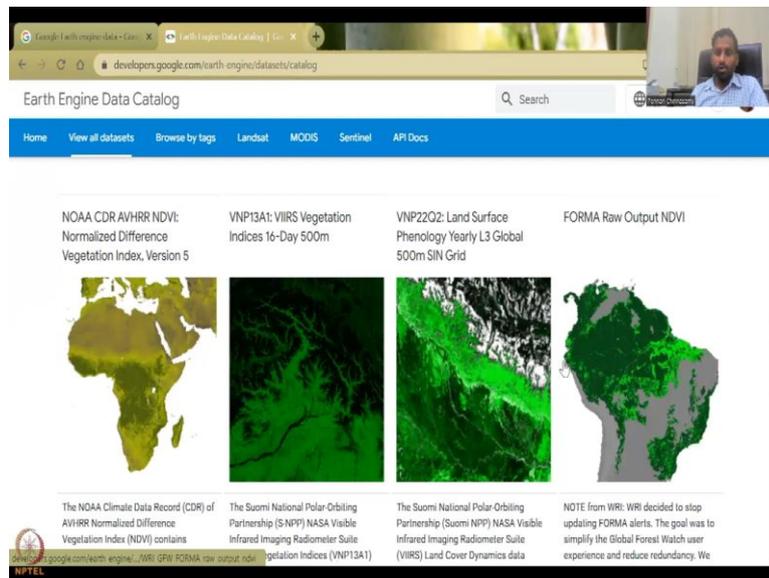
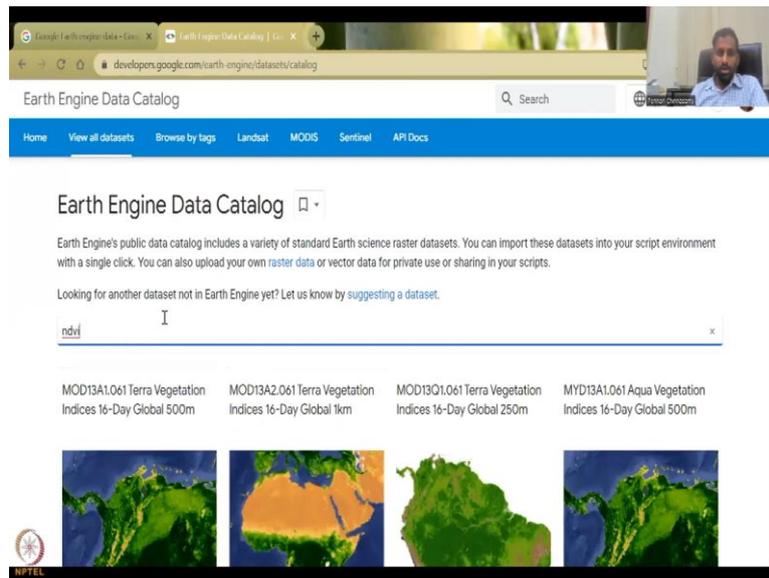
So, basically it just quickly takes up the data set and then plots the vegetation index, really beautiful and very quick and the resolution is very very good. So, there it is. It is actually plotted in our own Indian region which is good but if you can zoom out you can actually see India being the layer.

So, the layers here is get get populated in Google Earth engine. So, this is a vegetation fraction for January, you can see January 1 to January 18, the composite vegetation has been taken. Here, the legends are not clear. So, you will have to download it put it in GIS and do it. But what this does for you is it gets the data for you quickly and all you have to do is download the data and use it on your QGIS platform as a raster and then does the other calculations.

So, as I promised, I will show the other NDVIs that I have. So, before that let us close this so that I can show you the other tab that we opened. So, these are the Earth engine catalog. So, the link I have given on the presentation is the link for the data sets, the data catalogs. You can see here the data catalogs and if you click that you will get into this website which is this Earth data catalogs. How do you go there?

You go to data catalog, it will come here and then here you can say home or view all data sets. The home comes like this for Earth engine and you can see view all data sets, climate weather, climate agriculture, etcetera, etcetera. High imagery you can take. You can say just view all data sets or browse by tags. The browse by tags we already have done. So, let us not get into that part now, we only look into view all data sets. It does take some time depending on the internet. So, here we are.

(Refer Slide Time: 14:44)



So, here we can just type NDVI and there you are. We do not have to type enter, you can type enter but then you can also see all the NDVI data here. Here you would see 1 2 3 4, 4, 8, 12, in the other one, well, we in the other one we saw 11. So, here somewhere else it searches for the word NDVI not the tag. So, here somewhere it could have said that this data can be used for NDVI. So, then you can use it for NDVI and then do it.

(Refer Slide Time: 15:16)

Earth Engine Data Catalog

Indices 16-Day Global 1km Indices 16-Day Global 250m Dataset 100-meter V003 Sensors (3rd Generation)

The MYD13A2 V6.1 product provides two Vegetation Indices (VI): the Normalized Difference Vegetation Index (NDVI) and the Enhanced Vegetation Index (EVI). The NDVI is referred to as the continuity index to the existing National Oceanic and Atmospheric Administration-Advanced Very High Resolution Radiometer (NOAA-AVHRR) derived NDVI...

The MYD13Q1 V6.1 product provides a Vegetation Index (VI) value at a per pixel basis. There are two primary vegetation layers. The first is the Normalized Difference Vegetation Index (NDVI) which is referred to as the continuity index to the existing National Oceanic and Atmospheric...

The Advanced Spaceborne Thermal Emission and Reflection Radiometer Global Emissivity Database (ASTER-GED) was developed by the National Aeronautics and Space Administration's (NASA) Jet Propulsion Laboratory (JPL), California Institute of Technology. This product includes the mean emissivity and standard deviation for all 5 ASTER Thermal Infrared...

GIMMS NDVI is generated from several NOAA's AVHRR sensors for a global 1/12-degree lat/lon grid. The latest version of the GIMMS NDVI dataset is named NDVI3g (third generation GIMMS NDVI from AVHRR sensors).

16-day aqua evi global vegetation

Earth Engine Data Catalog

Home View all datasets Browse by tags Landsat MODIS Sentinel API Docs

MYD13A2.061 Aqua Vegetation Indices 16-Day Global 1km

Dataset Availability: 2002-07-04T00:00:00Z–2023-02-10T00:00:00Z

Dataset Provider: NASA LP DAAC at the USGS EROS Center

Earth Engine Snippet: ee.ImageCollection("MODIS/061/MYD13A2")

Tags: 16-day aqua evi global modis nasa ndvi usgs vegetation myd13a2

Description Bands Terms of Use Citations DOIs

Earth Engine Data Catalog

Home View all datasets Browse by tags Landsat MODIS Sentinel API Docs

Bands

Name	Units	Min	Max	Scale	Wavelength	Description
NDVI		2000	10000	0.0001		16-day NDVI average
EVI		-2000	10000	0.0001		16-day EVI average
DetailedQA						VI Quality indicators
Bitmask for DetailedQA						
sur_ref1_b01		0	10000	0.0001	620-670nm	Surface reflectance band 1 (red)
sur_ref1_b02		0	10000	0.0001	841-876nm	Surface reflectance band 2 (near-infrared)
sur_ref1_b03		0	10000	0.0001	459-479nm	Surface reflectance band 3 (blue)
sur_ref1_b07		0	10000	0.0001	2105-2155nm	Surface reflectance band 7 (mid-infrared)
ViewZenith	Degrees	0	18000	0.01		View zenith angle of VI Pixel
SolarZenith	Degrees	0	18000	0.01		Sun zenith angle of VI pixel
RelativeAzimuth	Degrees	-18000	18000	0.01		Relative azimuth angle of VI pixel

Earth Engine Data Catalog

DetailedQA

VI Quality indicators

Bitmask for DetailedQA

Band	Min	Max	Resolution	Wavelength	Description
sur_ref1_b01	0	10000	0.0001	620-670nm	Surface reflectance band 1 (red)
sur_ref1_b02	0	10000	0.0001	841-876nm	Surface reflectance band 2 (near-infrared)
sur_ref1_b03	0	10000	0.0001	459-479nm	Surface reflectance band 3 (blue)
sur_ref1_b07	0	10000	0.0001	2105-2155nm	Surface reflectance band 7 (mid-infrared)
ViewZenith	Degrees	0	18000	0.01	View zenith angle of VI Pixel
SolarZenith	Degrees	0	18000	0.01	Sun zenith angle of VI pixel
RelativeAzimuth	Degrees	-18000	18000	0.01	Relative azimuth angle of VI pixel
DayOfYear	Julian Day	1	366		Day of year VI pixel
SummaryQA					Quality reliability of VI pixel

SummaryQA Class Table

Value	Color	Description
0		Good Data: use with confidence

Earth Engine Data Catalog

SummaryQA Class Table

Value	Color	Description
0		Good Data: use with confidence
1		Marginal Data: useful, but look at other QA information
2		Snow/ice: target covered with snow/ice
3		Cloudy: target not visible, covered with cloud

Explore in Earth Engine

```

var dataset = ee.ImageCollection('MODIS/B61/MYD13A2')
  .filter(ee.Filter.date('2018-01-01', '2018-05-01'));
var ndvi = dataset.select('NDVI');
var ndviVis = {
  min: 0.0,
  max: 9888.0,
  palette: [
    'FFFFFF', 'CE7E45', 'DF923D', 'F18555', 'FC0163', '998718', '74A981',
    '66A88B', '52948B', '3E8681', '2B7481', '056281', '084C8B', '823881',
    '012E81', '011D81', '011381'
  ]
};

```

So, as we can look at this one, for the global, it is from 2002 till date. So, this is much much older than the Bhuvan data which is available, readily available. Again the Bhuvan data was from 2011. This is 20 years or more than 20 years of data, 21 years accounting I would say or like 2022 7. So, yeah, approximately 20 years plus data you have.

And you can see that what are the bands they have? They have NDVI with a range of minus 2000 to 10000. Again, this range you have to normalize it back to minus 1 to 1, which lot of papers will give you the details. And then as I said you can also have these values which are getting populated, cloud cover, do not use this data, good data use with confidence is zero. Summary of class tables. And then you have the NDVI that has been calculated.

(Refer Slide Time: 16:17)

Earth Engine Data Catalog

DetailedQA VI Quality indicators

Bitmask for DetailedQA

- Bits 0-1: VI quality (MODLAND QA Bits)
 - 0: VI produced with good quality
 - 1: VI produced, but check other QA
 - 2: Pixel produced, but most probably cloudy
 - 3: Pixel not produced due to other reasons than clouds
- Bits 2-5: VI usefulness
 - 0: Highest quality
 - 1: Lower quality
 - 2: Decreasing quality
 - 4: Decreasing quality
 - 8: Decreasing quality
 - 9: Decreasing quality
 - 10: Decreasing quality
 - 12: Lowest quality
 - 13: Quality so low that it is not useful

Earth Engine Data Catalog

DetailedQA VI Quality indicators

Bitmask for DetailedQA

Band Name	Min	Max	Scale	Wavelength	Description
sur_refl_b01	0	10000	0.0001	620-670nm	Surface reflectance band 1 (red)
sur_refl_b02	0	10000	0.0001	841-875nm	Surface reflectance band 2 (near-infrared)
sur_refl_b03	0	10000	0.0001	430-470nm	Surface reflectance band 3 (blue)
sur_refl_b07	0	10000	0.0001	2105-2155nm	Surface reflectance band 7 (mid-infrared)
ViewZenith	Degrees	0	18000	0.01	View zenith angle of VI Pixel
SolarZenith	Degrees	0	18000	0.01	Sun zenith angle of VI pixel
RelativeAzimuth	Degrees	-18000	18000	0.01	Relative azimuth angle of VI pixel
DayOfYear	Julian Day	1	366		Day of year VI pixel
SummaryQA					Quality reliability of VI pixel

SummaryQA Class Table

Value	Color	Description
0		Good Data: use with confidence

Earth Engine Data Catalog

2002-07-04T00:00:00Z-2023-02-10T00:00:00Z

Dataset Provider
NASA LP DAAC at the USGS EROS Center

Earth Engine Snippet
`ee.ImageCollection("MODIS/061/MYD13A2")`

Tags
16-day aqua evi global mods nasa ndvi usgs vegetation myd13a2

Description Bands Terms of Use Citations DOIs

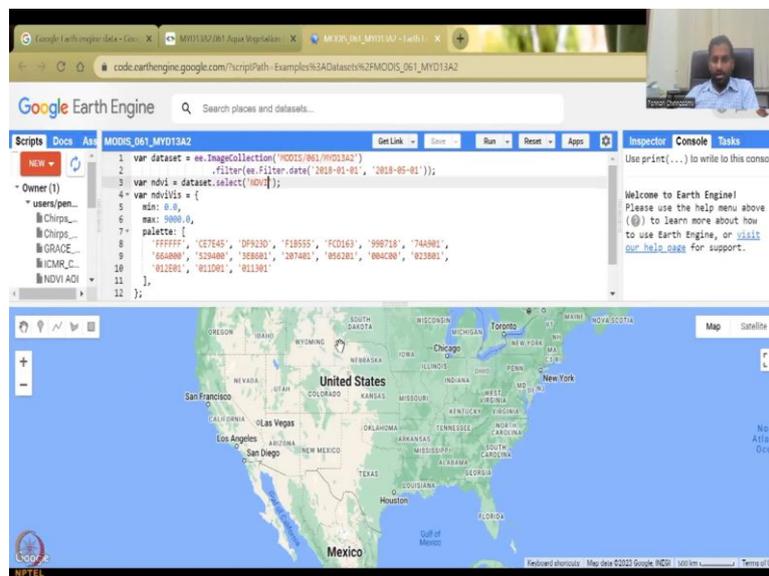
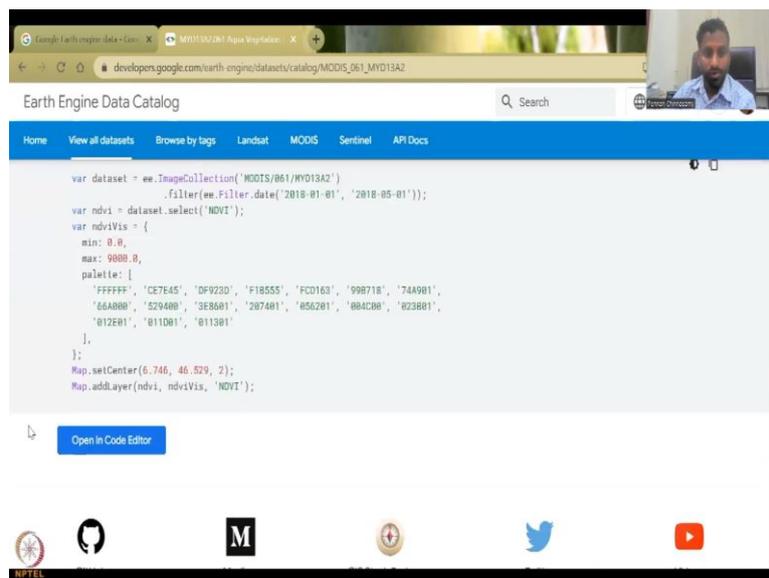
Resolution
1000 meters

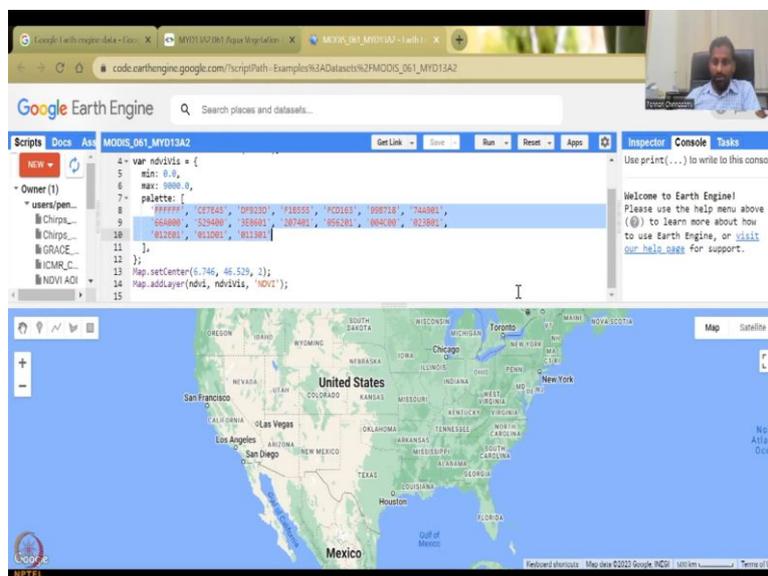
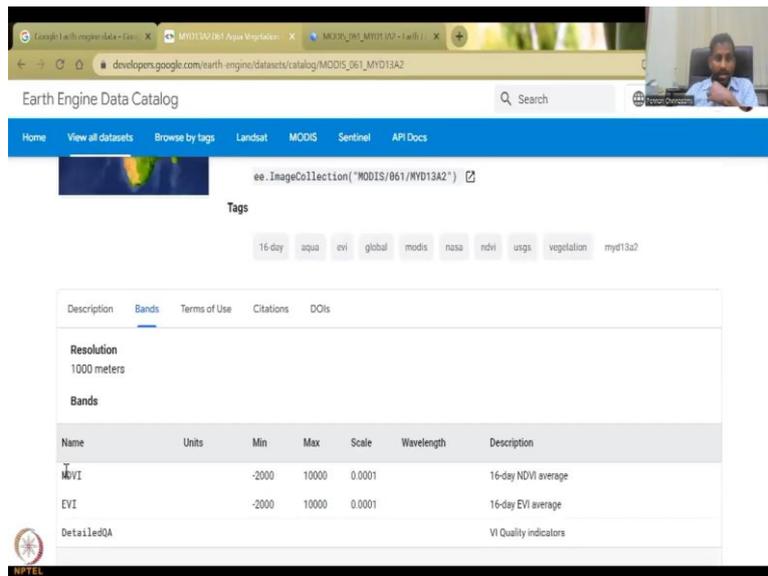
Bands

Name	Units	Min	Max	Scale	Wavelength	Description
NDVI		-2000	10000	0.0001		16-day NDVI average

And then some more data about what are the visual, the data wavelengths etcetera are given here. So, here it is, the scale is also 500 meters approximately and rescaled back. So, here they give you a thousand meters one kilometer. So, one kilometer is the same as the Bhuvan data. So, what is different here? The difference here is that it is having better spatial resolution in terms of time series. 1000 meters is the same but you have here from 2002 whereas the Bhuvan was from 2011.

(Refer Slide Time: 16:56)

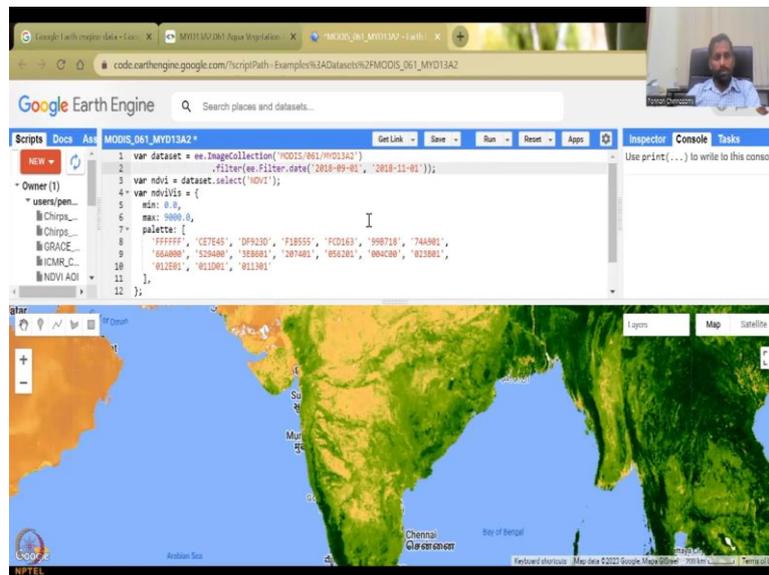
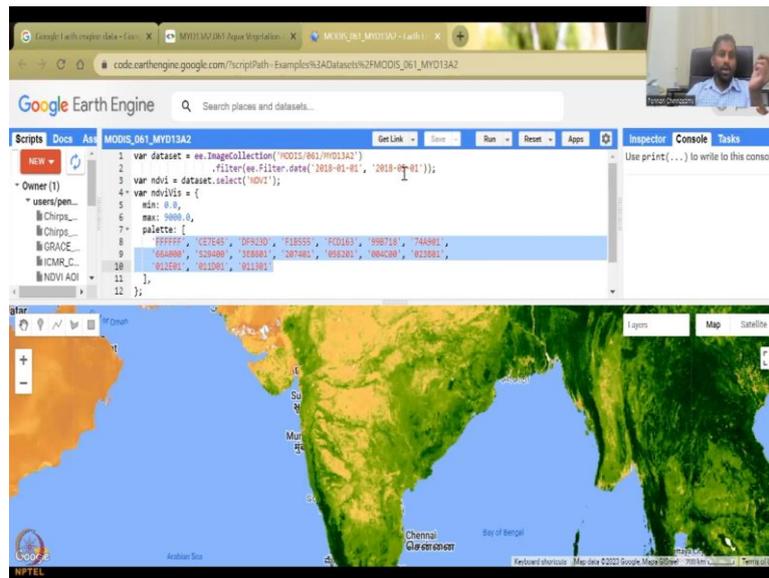




So, if you open the code editor, let us say if they have NDVI always will have to plot in NDVI. So we have minimum max. And then what data is it taking? NDVI. So, in a selecting NDVI. So, select NDVI is the band. So, if I select evi, I have to type evi here. So, it is basically the VAR data set, is a variable data set, we are defining the data set as the image, and within the image, there are multiple bands which are given here and the band name.

So, this is not a band name, only these 2 are the band names. So, you can type whatever band you want, either evi or NDVI. We have typed NDVI and it will do the mean, the mean from 2018 to 2008. 1 1 2 5 1. So, it is just year, month and date. So, you have the month which is 4 4 5 months of data 4 months of data and then we have the palette which is the coloring. Again, I will not get into the details of codings and it goes to the map center lat longs that have been given and the map add layer is NDVI.

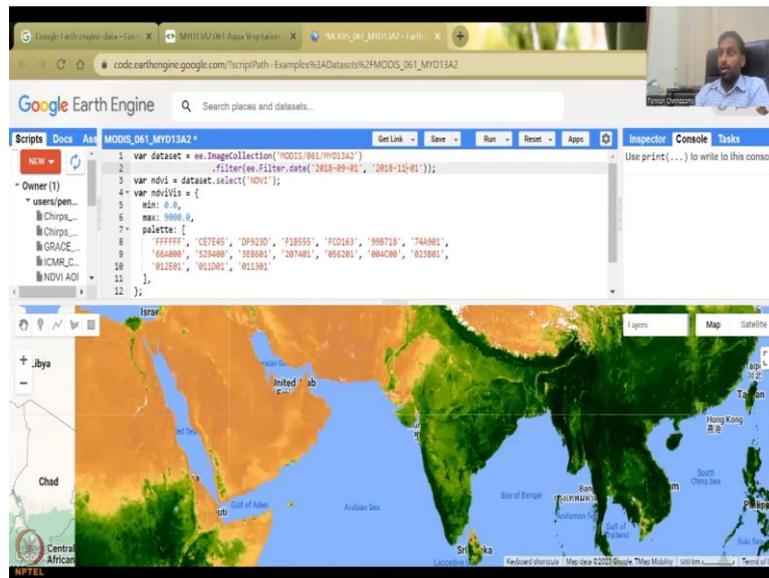
(Refer Slide Time: 18:14)



So, if I just quickly run it, you will see that the entire globe NDVI is being created and there you are. Within a couple of seconds, based on my internal speed. There is no computing here. It just goes through the super computer and Google Earth engine and then they give you the NDVI.

So, here if you see, this is the month of 1 to 5 and maybe it is an average they have done but let us do. So, you see Maharashtra, May month is pretty pretty in the summer but now, I am going to run the post monsoon season or during the monsoon and the post monsoon season. Let us say September. So, let us say 9 to 11 and then I am just going to run. So, now, I am changing the date and then running it.

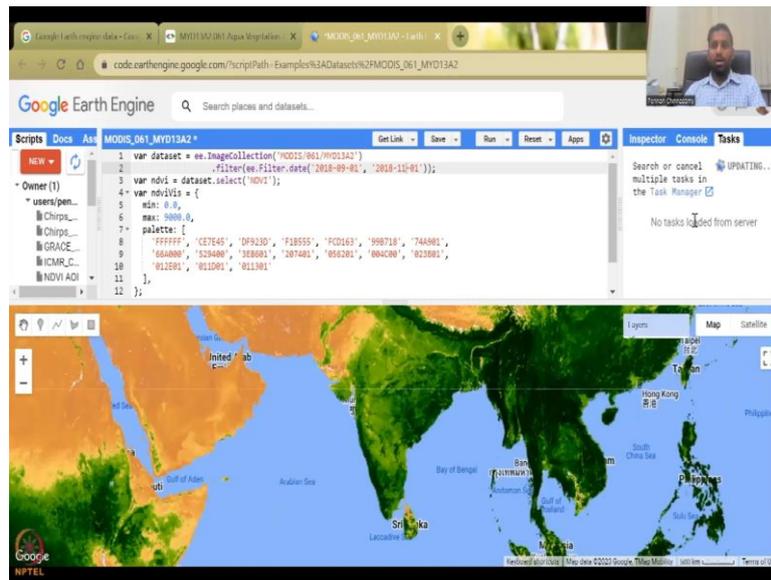
(Refer Slide Time: 19:10)



So, you could see how, see the indeed the initial version had all brown but now, all is green. So, how quickly we could do this without monitoring is the beauty. So, what we see here is a full layer of NDVI during the post monsoon season and beautifully it covers the entire globe. And how we can extract it for the Indian region is by using a mask which has already been taught in this lecture series.

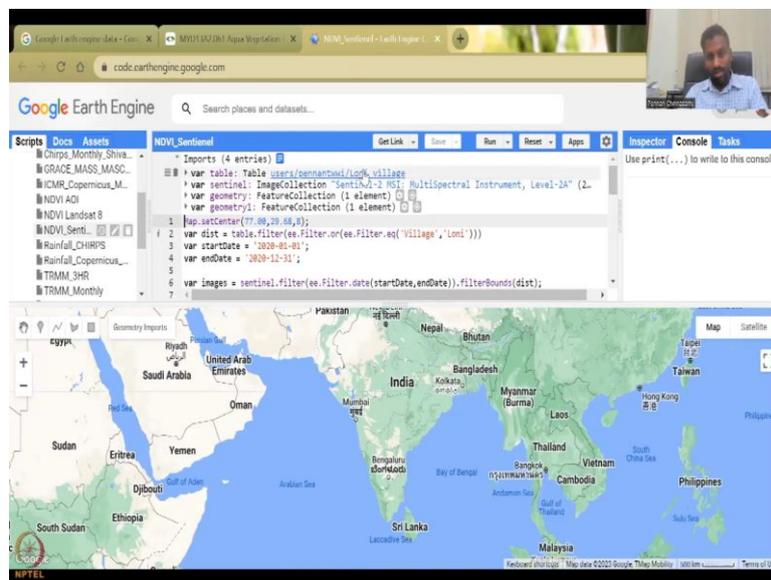
There is a lot of Google Earth engine tutorials done by Google and other resources. Please, go through it, it is very very useful for understanding the practical use of this data and you would also get a lot of benefits of using the supercomputer, the computing facilities that can be accessed online. So, here I am also going to show you some other feature.

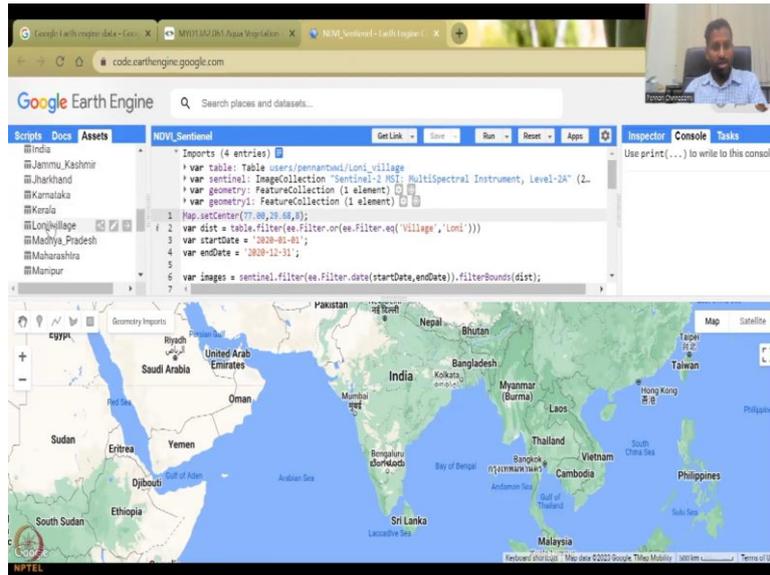
(Refer Slide Time: 20:22)



So, in the tasks you could see like what has been run and it is been updating, you can open your task manager, all these you can learn from different resources. But as I promised, let us I am going to show you what advanced, how just a small snippet of advanced computing in Google Earth engine.

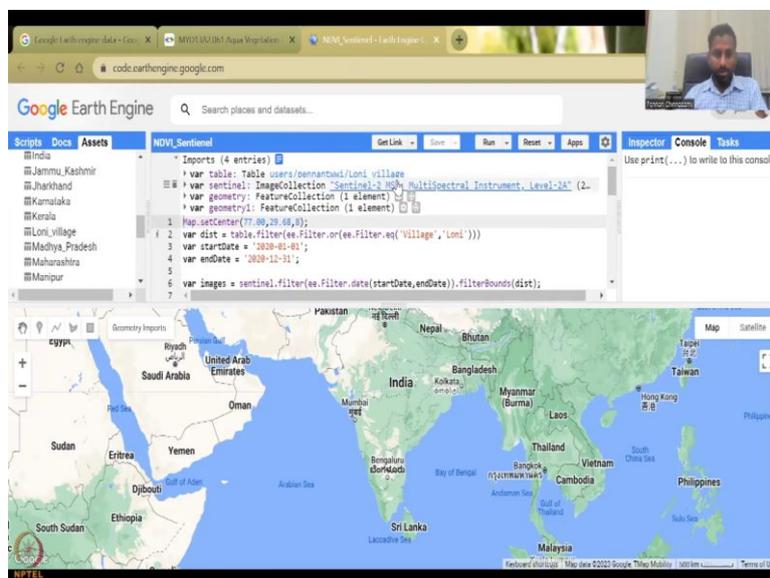
(Refer Slide Time: 20:42)

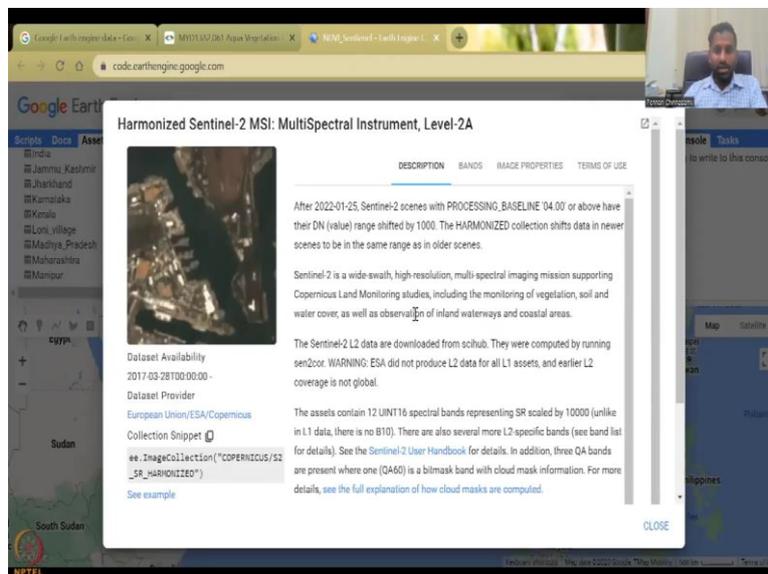
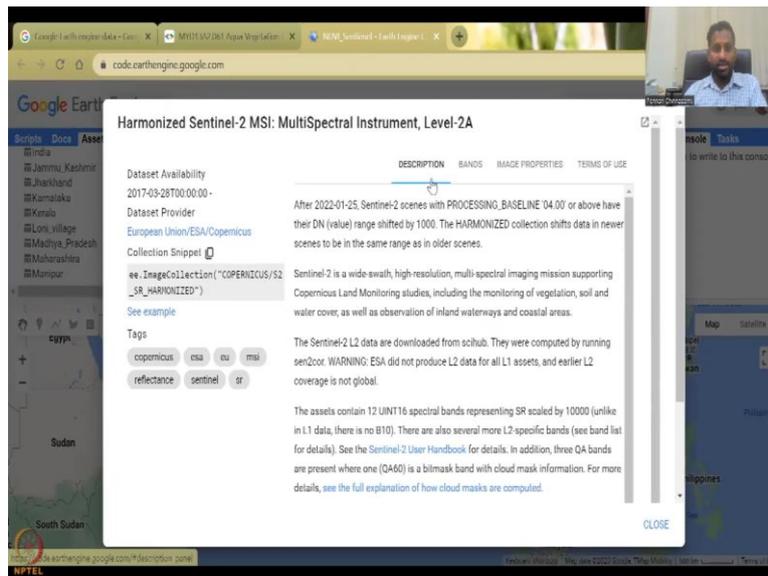




So, here I am taking the sentinel data set. I am taking one village which is Loni village. I have the boundary of Loni village in my assets. If you come down, you see I have Loni village. I have imported the Loni village into this Google Earth engine in my account that is why you have to go and choose your Google account. I have that as a table. So, Loni village variable is being done.

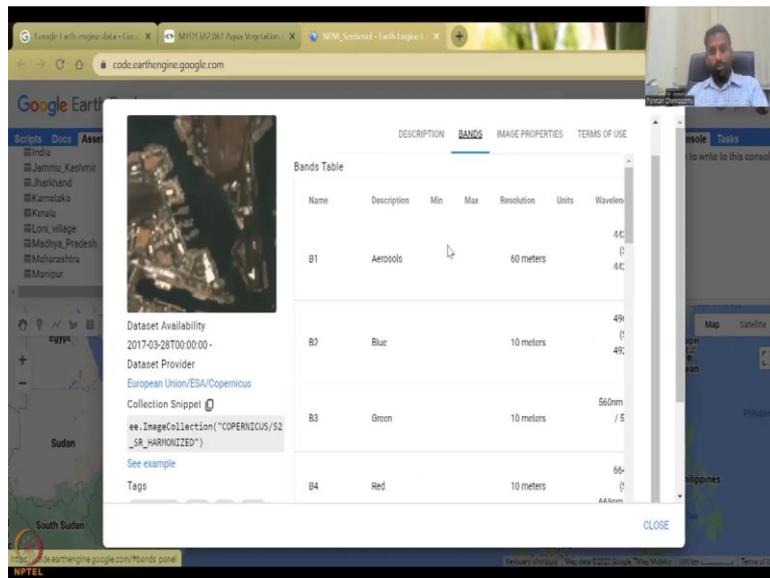
(Refer Slide Time: 21:09)





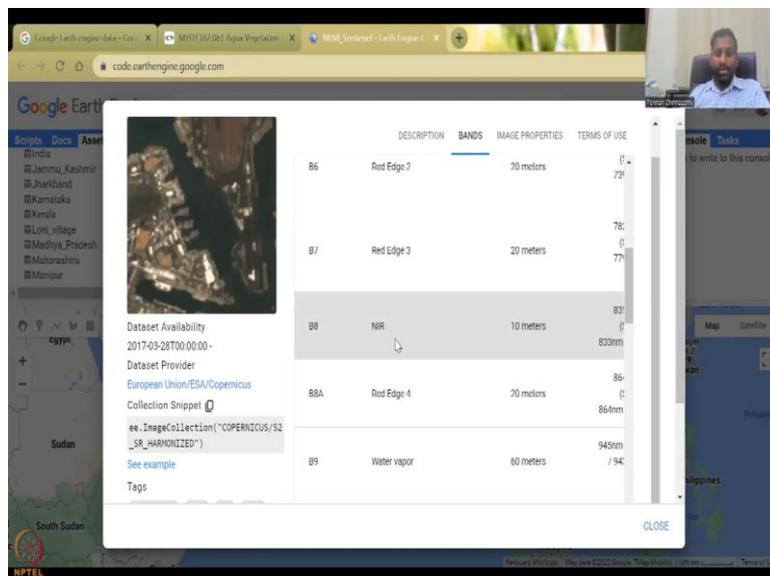
I have taken the sentinel data set. I am just going to click on the data set to show what is sentinel. So, what is the sentinel 2 data set? It has a lot of bands. Let us open this data set in the whole full form. Let me open it. Yeah.

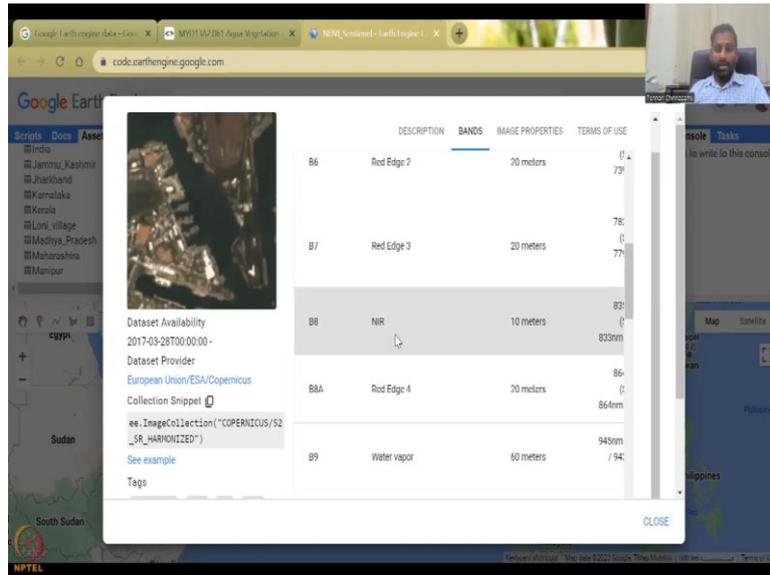
(Refer Slide Time: 21:30)



So, what are the bands available? We have aerosols, blue, green, red, red edge, red edge and NIR. So, now, what is the equation in this particular Sentinel? What would be the equation for NDVI?

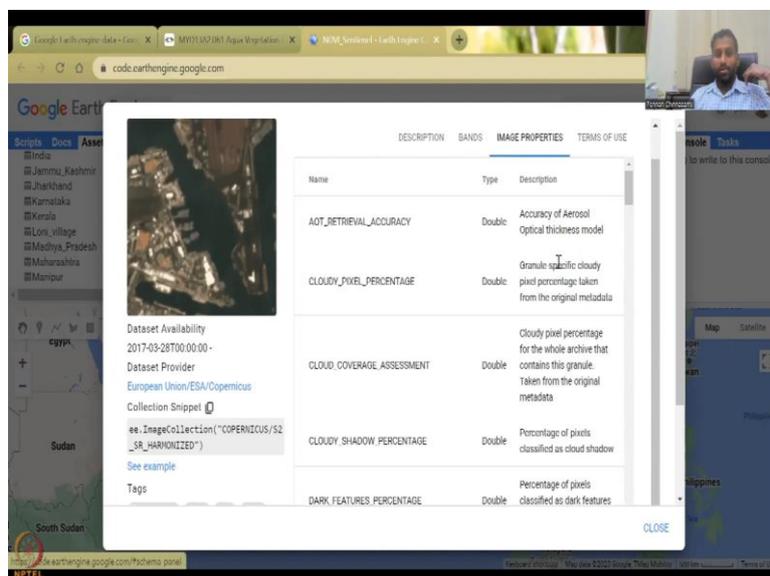
(Refer Slide Time: 21:43)





It is B8 minus red, red is B4. So, $B8 - B4$ divided by $B8 + 4$. So, and the resolution is 10 meters, just look at how good the resolution is 10 meters and then this is also 10 meter. So, this is the highest free open source image available for us to do these calculations, that is why we use these calculations. But this is the raw, they have not done NDVI. We will do NDVI based on this. So, because here you could see that there is all these multi bands are available.

(Refer Slide Time: 22:22)



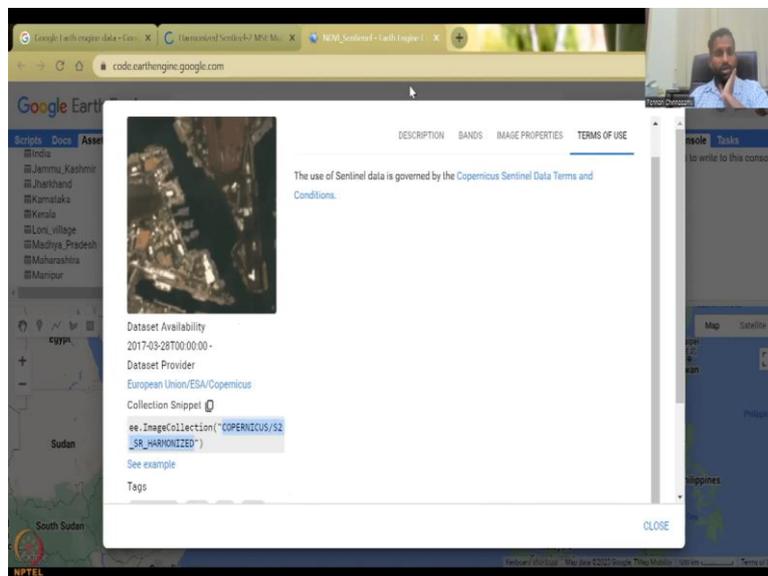
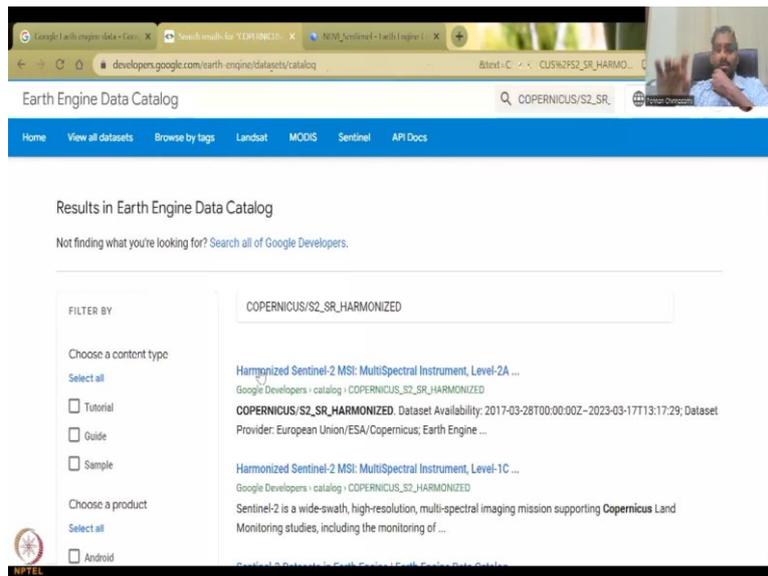
And then the image properties, what they are.

(Refer Slide Time: 22:26)

The screenshot shows the Google Earth Engine interface. A panel is open displaying details for a dataset. The panel includes a satellite image thumbnail, a 'DESCRIPTION' tab, and a 'TERMS OF USE' section. The 'TERMS OF USE' section states: "The use of Sentinel data is governed by the Copernicus Sentinel Data Terms and Conditions." Below this, the 'Dataset Availability' is listed as '2017-03-28T00:00:00 -', the 'Dataset Provider' is 'European Union/ESA/Copernicus', and the 'Collection Snippet' is `ee.ImageCollection("COPERNICUS/S2_SR_HARMONIZED")`. There is a 'See example' link and a 'Tags' section. A 'CLOSE' button is at the bottom right of the panel.

The screenshot shows the Earth Engine Data Catalog homepage. The header includes 'Earth Engine Data Catalog' and a search bar. Below the header, there are navigation links: 'Home', 'View all datasets', 'Browse by tags', 'Landsat', 'MODIS', 'Sentinel', and 'API Docs'. The main content area features a large satellite image background with the text: "A planetary-scale platform for Earth science data & analysis". Below this, it says: "Earth Engine's public data archive includes more than forty years of historical imagery and scientific datasets, updated and expanded daily." There is a 'View all datasets' button.

The screenshot shows the Earth Engine Data Catalog search results. The search bar contains the text 'COPERNICUS/S2_SR_HARMONIZED'. Below the search bar, there is a 'SUGGESTED SEARCHES | EARTH ENGINE DATA CATALOG' section. The suggested searches are: 'copernicus s2 sr harmonized' and 'copernicus s2 sr harmonized copernicus'. There are also links for 'All results in Earth Engine Data Catalog' and 'All results across Google Developers'. The background of the page is the same satellite image as in the previous screenshot.



And then in terms of use, it is open source. So, you can use it. So, let us just see the COPERNICUS. This is the link to the data set. I am just copying this, going back to my Google Earth engine data home and you can click on view all that datasets or you can search it here, just click okay and then it comes here. Harmonize Sentinel multispectral image. So, let us click it which is already imported here in my other resource. So, I am just going to close this. Because I have already these are my scripts.

(Refer Slide Time: 23:04)

The screenshot shows the Google Earth Engine code editor. The script is as follows:

```

Imports (4 entries)
var table = Table users/pennantawi/Loni_village
var sentinel = ImageCollection("Sentinel-2 MSI: MultiSpectral Instrument, Level-2A") (2)
var geometry = FeatureCollection (1 element)
var geometry1 = FeatureCollection (1 element)
Map.setCenter(77.88,29.88,8);
var dist = table.filter(ee.Filter.or(ee.Filter.eq('Village','Loni')));
var startDate = '2020-01-01';
var endDate = '2020-12-31';
var images = sentinel.filter(ee.Filter.date(startDate,endDate)).filterBounds(dist);
  
```

The map below the code shows a region in South Asia, specifically focusing on India and surrounding countries like Pakistan, Nepal, and Bangladesh. The map is centered on the coordinates 77.88, 29.88.

The screenshot shows the Earth Engine Data Catalog page for the dataset 'COPERNICUS/S2_SR_HARMONIZED'. The 'Bands' tab is selected, displaying the following table:

Name	Units	Min	Max	Scale	Pixel Size	Wavelength	Description
B1				0.0001 60	443.9nm (S2A) / 442.3nm (S2B)	443.9nm (S2A) / 442.3nm (S2B)	Aerosols
B2				0.0001 10	496.6nm (S2A) / 492.1nm (S2B)	496.6nm (S2A) / 492.1nm (S2B)	Blue
B3				0.0001 10	560nm (S2A) / 559nm (S2B)	560nm (S2A) / 559nm (S2B)	Green
B4				0.0001 10	664.5nm (S2A) / 665nm (S2B)	664.5nm (S2A) / 665nm (S2B)	Red
B5				0.0001 20	703.9nm (S2A) / 703.8nm (S2B)	703.9nm (S2A) / 703.8nm (S2B)	Red Edge 1

The screenshot shows the Earth Engine Data Catalog page for the dataset 'COPERNICUS/S2_SR_HARMONIZED'. The 'Dataset Provider' section is highlighted, showing the provider 'European Union/ESA/Copernicus' and an 'Earth Engine Snippet' for the dataset. The snippet is:

```
ee.ImageCollection("COPERNICUS/S2_SR_HARMONIZED")
```

The 'Bands' tab is also visible, showing the same table as in the previous screenshot.

We have written codes, as I said one of my student has written these codes, and then we are here. So, the same thing is is populated here. All you could see is the image, just check this name if it is the same S2 SR harmonized, we have the image collection from S2 multispectral level 2, yes. So, that is the image collection we have. And then you can also search for the band.

(Refer Slide Time: 23:39)

Earth Engine Data Catalog

Search

Description Bands Image Properties Terms of Use

Bands

Name	Units	Min	Max	Scale	Pixel Size	Wavelength	Description
B1				0.0001	60 meters	443.9nm (S2A) / 442.3nm (S2B)	Aerosols
B2				0.0001	10 meters	496.6nm (S2A) / 492.1nm (S2B)	Blue
B3				0.0001	10 meters	560nm (S2A) / 559nm (S2B)	Green
B4				0.0001	10 meters	664.5nm (S2A) / 665nm (S2B)	Red
B5				0.0001	20 meters	703.9nm (S2A) / 703.8nm (S2B)	Red Edge 1
B6				0.0001	20 meters	740.2nm (S2A) / 739.1nm (S2B)	Red Edge 2
B7				0.0001	20 meters	782.5nm (S2A) / 779.7nm (S2B)	Red Edge 3
B8				0.0001	10 meters	835.1nm (S2A) / 833nm	NIR

Earth Engine Data Catalog

Search

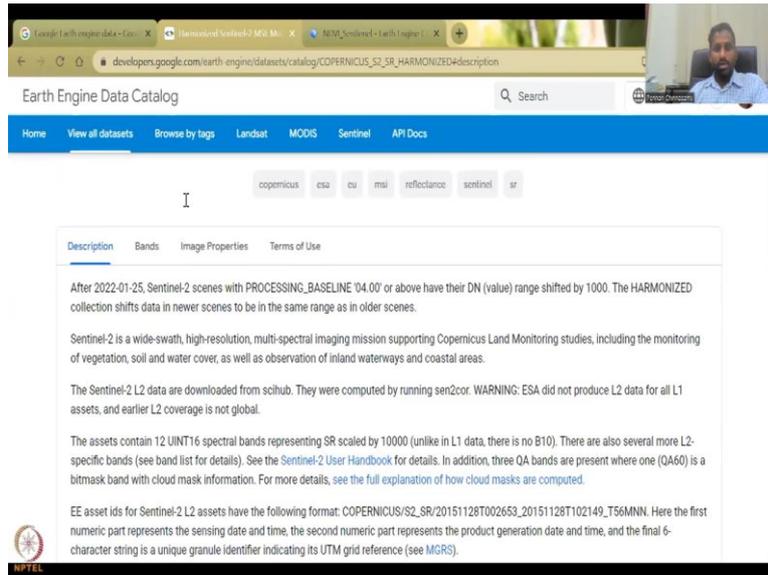
Home View all datasets Browse by tags Landsat MODIS Sentinel API Docs

Tags: copernicus esa eu msi reflectance sentinel sr

Description Bands Image Properties Terms of Use

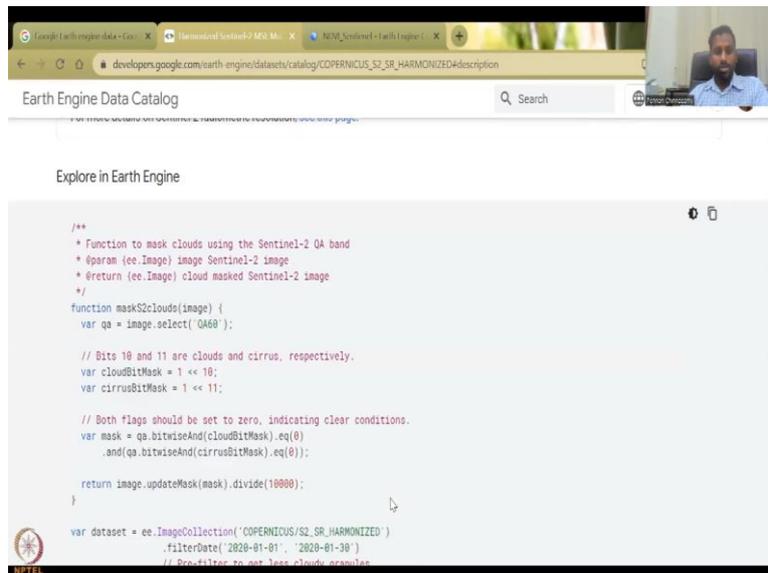
Image Properties

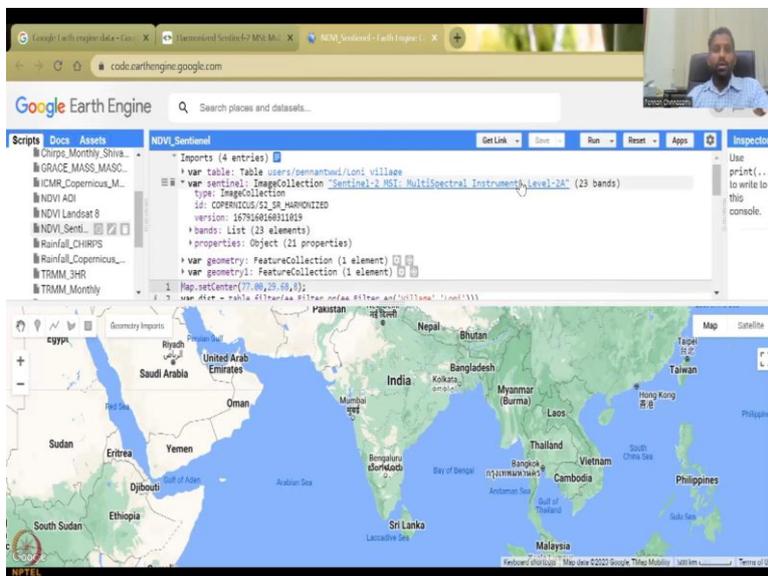
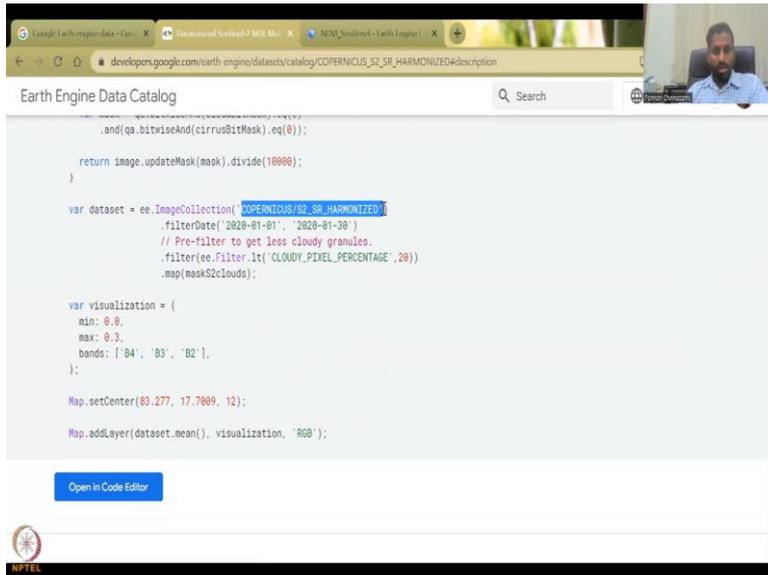
Name	Type	Description
AOT_RETRIEVAL_ACCURACY	DOUBLE	Accuracy of Aerosol Optical thickness model
CLOUDY_PIXEL_PERCENTAGE	DOUBLE	Granule-specific cloudy pixel percentage taken from the original metadata
CLOUD_COVERAGE_ASSESSMENT	DOUBLE	Cloudy pixel percentage for the whole archive that contains this granule. Taken from the original metadata
CLOUD_SHADOW_PERCENTAGE	DOUBLE	Percentage of pixels classified as cloud shadow
DARK_FEATURES_PERCENTAGE	DOUBLE	Percentage of pixels classified as dark features or shadows
DATASTRIP_ID	STRING	Unique identifier of the datastrip Product Data Item (PDI)
DATATAKE_IDENTIFIER	STRING	Uniquely identifies a given Datatake. The ID contains the Sentinel-2 satellite, start date and time, absolute orbit



So, the bands, the names of the bands are here, B8 is 10 meters and then B4 I said is also 10 meters. These are given in this property. So, image copy is also the same, description it is the same that we used in the previous image.

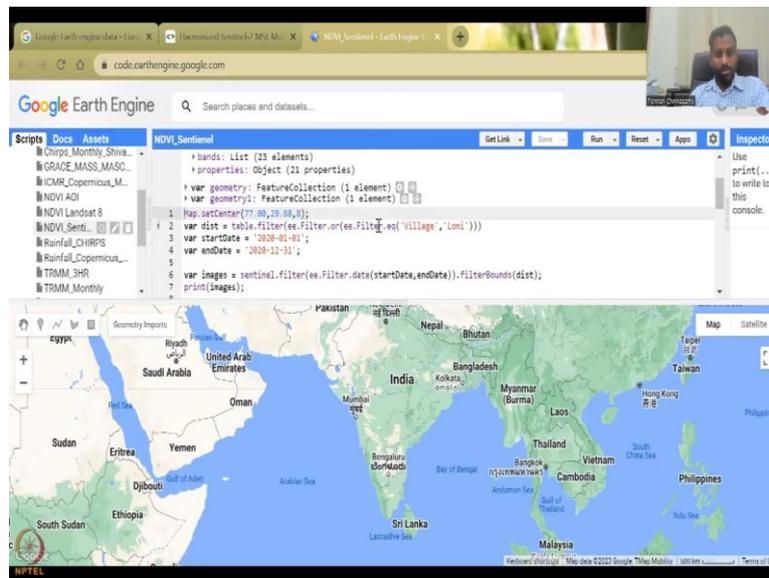
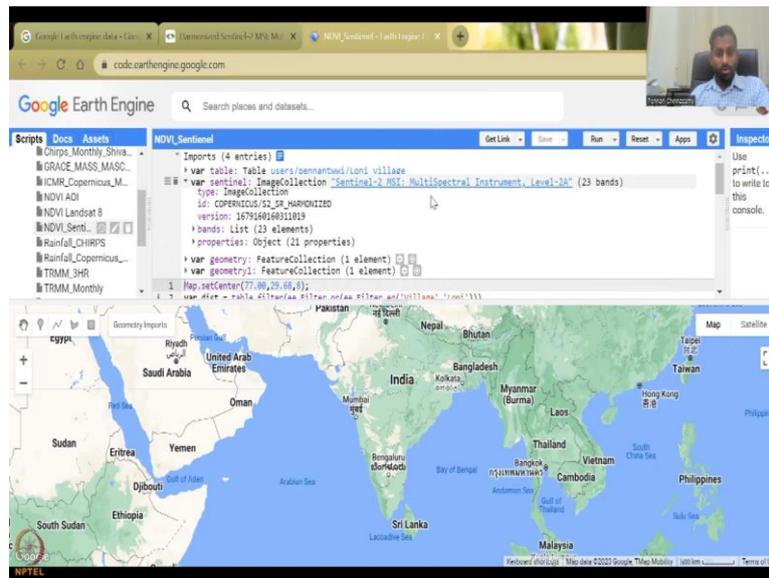
(Refer Slide Time: 23:57)





So, it says that this is the code that we can download and use COPENICUS S2 SR harmonize is the image classification and it is given here as 2A. Let me see if I can just 23 bands are there.

(Refer Slide Time: 24:15)



And you could also bring it down into this element. So, this is kind of advanced, but let me show you what this can do. So, this can actually, this code can actually take Loni village and only make Loni village which is in Maharashtra region, populate with the NDVI data. I do not want the entire Globe which will take some time of my internet.

So, I do not want that. So, the processing is not done on your computer, but then when it comes to your computer, your internet and computing speed is needed to put it onto the screen. So, we do not want to delay that. So, I am just using the village which I want to use and then.

(Refer Slide Time: 24:54)

The screenshot shows the Google Earth Engine interface. The top navigation bar includes 'code.earthengine.google.com'. The main area is divided into a 'Scripts' panel on the left, a 'Code Editor' in the center, and a 'Map' on the right. The 'Code Editor' contains the following JavaScript code:

```
var table = Table({users:pennantawi/Loni_village});
var sentinel = ImageCollection('Sentinel-2 MSI: MultiSpectral Instrument, Level-2A' (23 bands));
var geometry = FeatureCollection({
  id: 'COPERNICUS/S2_SR_HARMONIZED',
  version: 167916916811019,
  bands: List(23 elements),
  properties: Object(21 properties)
});
var geometry1 = FeatureCollection(1 element);
var geometry2 = FeatureCollection(1 element);
Map.setCenter(77.89, 29.69, 8);
use dist = table.filter(geo.Filter.and('Village', 'Loni'));
```

The map displays a satellite view of South Asia, with a red circle highlighting the region around Loni, India. The 'Inspector' panel on the right shows the 'Use print(...) to write to this console.' option.

The screenshot shows the Earth Engine Data Catalog interface. The search bar contains 'COPERNICUS/S2_SR_HARMONIZED'. The main area displays a script for filtering and visualizing Sentinel-2 data:

```
.and(qa.bitwiseAnd(cirrusBitMask), eq(0));
return image.updateMask(mask).divide(10000);
}

var dataset = ee.ImageCollection('COPERNICUS/S2_SR_HARMONIZED')
  .filterDate('2020-01-01', '2020-01-30')
  // Pre-filter to get less cloudy granules:
  .filter(ee.Filter.lt('CLOUDY_PIXEL_PERCENTAGE', 20))
  .map(maskS2Clouds);

var visualization = {
  min: 0.0,
  max: 0.3,
  bands: ['B4', 'B3', 'B2'],
};

Map.setCenter(83.277, 17.7869, 12);

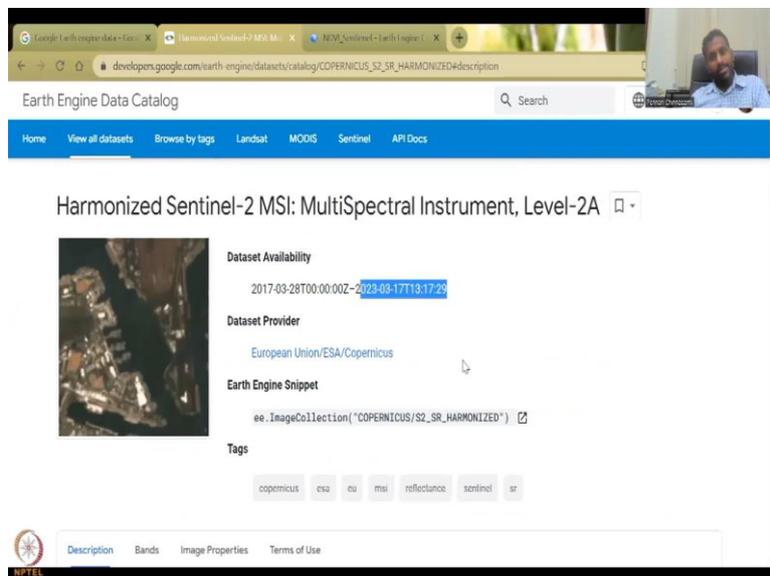
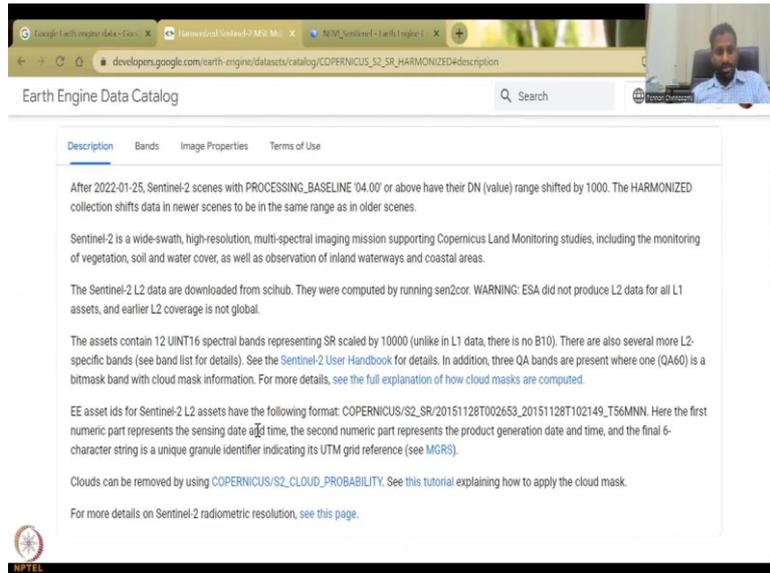
Map.addLayer(dataset.mean(), visualization, 'RGB');
```

An 'Open in Code Editor' button is visible at the bottom of the script area.

The screenshot shows the Google Earth Engine interface. The 'Code Editor' contains the following JavaScript code:

```
1 Map.setCenter(77.89, 29.69, 8);
2 var dist = table.filter(geo.Filter.or('Village', 'Loni'));
3 var startDate = '2020-01-01';
4 var endDate = '2020-12-31';
5
6 var images = sentinel.filter(ee.Filter.date(startDate, endDate)).filter(bounds(dist));
7 print(images);
```

The map displays a satellite view of South Asia, with a red circle highlighting the region around Loni, India. The 'Inspector' panel on the right shows the 'Use print(...) to write to this console.' option.



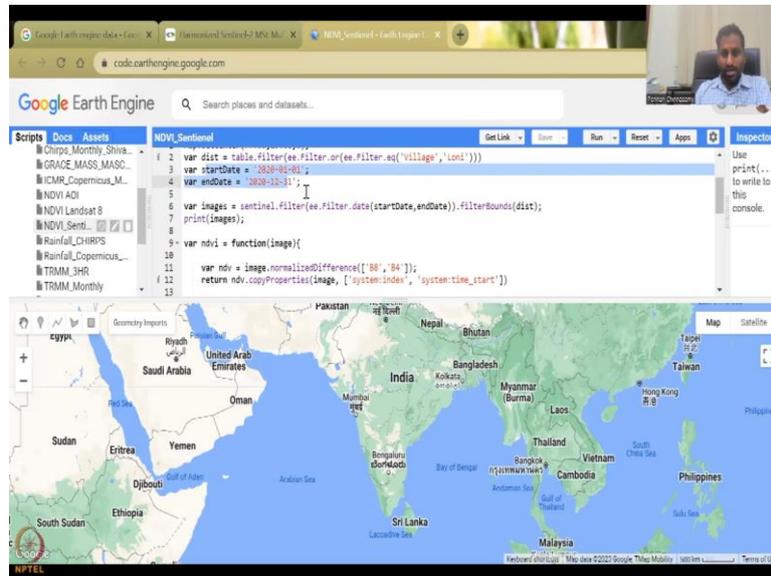
So, this is the ID here COPERNICUS SR2 harmonized which is this the same COPERNICUS SR2 SR harmonized and then the version is there, number of bands are there which is fine. I am just going to click this up. So, then the feature, feature 1 element these are just created for our geometry.

The map centers going to go to Loni village and then the filters only for that and the date service. So, they the dates are 1 1 to 12 31. So, one whole year I am going to take the data every 16 days. So, that is what this data set tells, every 16 days the data has been collected. You can see the. So, to run 2017 to 2023.

So, this is not as new as the Bhuvan ocm data, however, this is very very high resolution. That is one kilometer, this is 10 meters. So, I would recommend using this one at least for

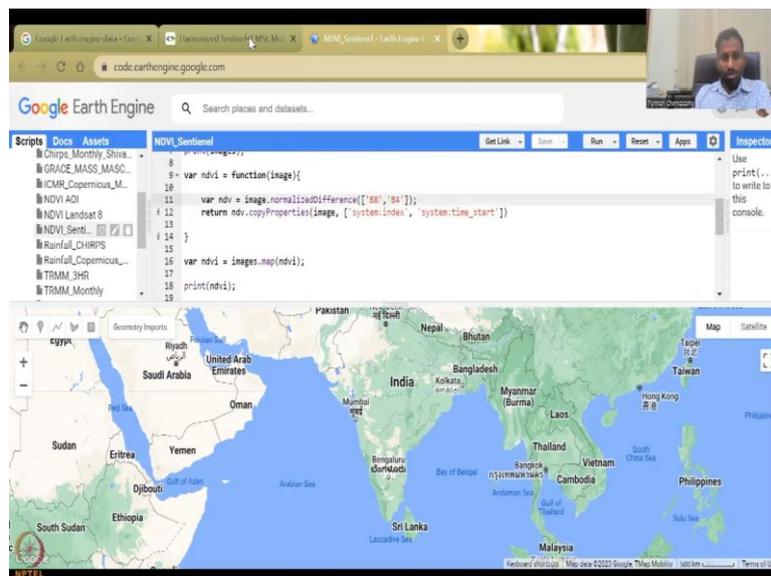
now. 10 meters with some close processing but at least good for 30 meters resolution, 90 meters resolution. So, you could see here that this data set has been done. It is also bi-weekly as as done here.

(Refer Slide Time: 26:09)



So, we have the files start and end date which is given here. So, as the start and end date is done, the data is being filtered. That is what this code says.

(Refer Slide Time: 26:18)



Google Earth Engine Data Catalog

Search

	0.0001	10 meters (S2B)			
B2	0.0001	10 meters (S2B)	496.6nm (S2A) / 492.1nm (S2B)	Blue	
B3	0.0001	10 meters (S2B)	560nm (S2A) / 559nm (S2B)	Green	
B4	0.0001	10 meters (S2B)	664.5nm (S2A) / 665nm (S2B)	Red	
B5	0.0001	20 meters (S2B)	703.9nm (S2A) / 703.8nm (S2B)	Red Edge 1	
B6	0.0001	20 meters (S2B)	740.2nm (S2A) / 739.1nm (S2B)	Red Edge 2	
B7	0.0001	20 meters (S2B)	782.5nm (S2A) / 779.7nm (S2B)	Red Edge 3	
B8	0.0001	10 meters (S2B)	835.1nm (S2A) / 833nm (S2B)	NIR	
B8A	0.0001	20 meters (S2B)	864.8nm (S2A) / 864nm (S2B)	Red Edge 4	
B9	0.0001	60 meters (S2B)	945nm (S2A) / 943.2nm (S2B)	Water vapor	
B11	0.0001	20 meters (S2A) /	1613.7nm (S2A) /	SWIR 1	

NPTEL

Google Earth Engine Data Catalog

Search

	0.0001	10 meters (S2B)			
B2	0.0001	10 meters (S2B)	496.6nm (S2A) / 492.1nm (S2B)	Blue	
B3	0.0001	10 meters (S2B)	560nm (S2A) / 559nm (S2B)	Green	
B4	0.0001	10 meters (S2B)	664.5nm (S2A) / 665nm (S2B)	Red	
B5	0.0001	20 meters (S2B)	703.9nm (S2A) / 703.8nm (S2B)	Red Edge 1	
B6	0.0001	20 meters (S2B)	740.2nm (S2A) / 739.1nm (S2B)	Red Edge 2	
B7	0.0001	20 meters (S2B)	782.5nm (S2A) / 779.7nm (S2B)	Red Edge 3	
B8	0.0001	10 meters (S2B)	835.1nm (S2A) / 833nm (S2B)	NIR	
B8A	0.0001	20 meters (S2B)	864.8nm (S2A) / 864nm (S2B)	Red Edge 4	
B9	0.0001	60 meters (S2B)	945nm (S2A) / 943.2nm (S2B)	Water vapor	
B11	0.0001	20 meters (S2A) /	1613.7nm (S2A) /	SWIR 1	

NPTEL

Google Earth Engine

Search places and datasets...

Scripts Data Assets

NDVI_Sentinel

```

Imports (4 entries)
+ var table: Table users/penmardul/loni_village
+ var sentinel: ImageCollection "Sentinel-2 MSI: MultiSpectral Instrument, Level-2A" (23 bands)
+ var geometry: FeatureCollection (1 element)
+ var geometry: FeatureCollection (1 element)
1 Map.setCenter(77.89, 20.48, 8);
2 var dist = table.filter(ee.Filter.or(ee.Filter.eq('Villages', 'loni')));
3 var startDate = '2018-01-01';
4 var endDate = '2018-12-31';
5
6 var images = sentinel.filter(ee.Filter.date(startDate, endDate)).filterBounds(dist);
7 print(images);
  
```

Inspector

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

NPTEL

Google Earth Engine interface showing a table of satellite bands. The table lists various bands with their descriptions, resolutions, and center wavelengths.

ID	Description	Resolution	Center Wavelength
B6	Red Edge 2	20 meters	725nm
B7	Red Edge 3	20 meters	785nm
B8	NIR	10 meters	833nm
B8A	Red Edge 4	20 meters	854nm
B9	Water vapor	60 meters	945nm

Google Earth Engine interface showing the 'Harmonized Sentinel-2 MSI: MultiSpectral Instrument, Level-2A' dataset information. It includes a thumbnail image and a table of bands.

Harmonized Sentinel-2 MSI: MultiSpectral Instrument, Level-2A

ID	Description	Resolution	Center Wavelength
B4	Red	10 meters	665nm
B5	Red Edge 1	20 meters	705nm
B6	Red Edge 2	20 meters	725nm
B7	Red Edge 3	20 meters	785nm

Dataset Availability: 2017-03-28T00:00:00-
 Dataset Provider: European Union/ESA/Copernicus
 Collection Snippet: ee.ImageCollection("COPERNICUS/S2_SR_HARMONIZED")
 See example

Google Earth Engine interface showing a script in the console and a map of the region. The script filters Sentinel-2 images for a specific location and displays the result on the map.

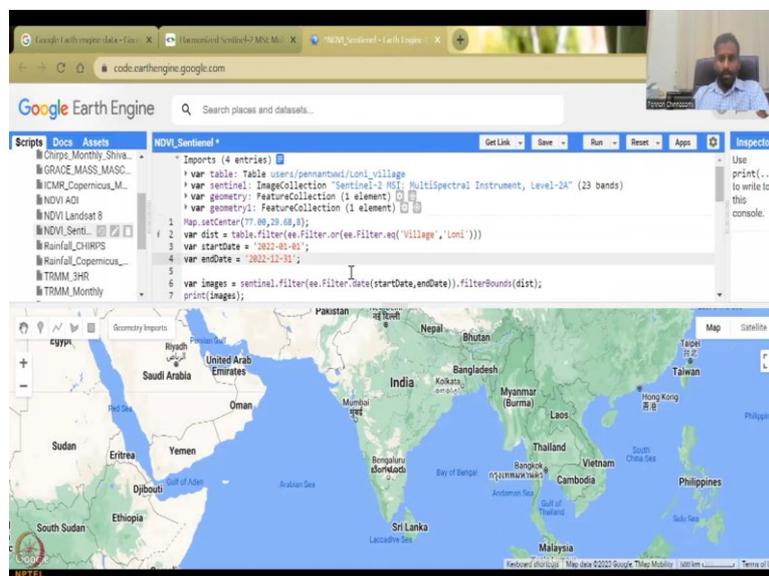
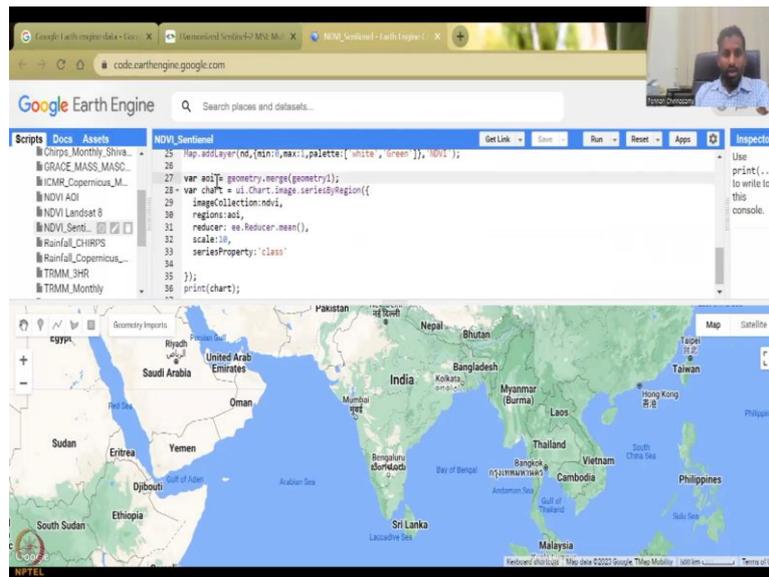
```

var ndvi = images.ndvi();
print(ndvi);
var loc = ndvi.first().clip(dist);
var sen_image = images.Filter(ee.Filter.eq('system:index', '202004147052651_20200414705352_743R0N')).First();
Map.addLayer(sen_image, {bands: ['B8', 'B4', 'B3'], min: 0, max: 0.85}, 'PCC');
  
```

The map shows the region of the Indian subcontinent and Southeast Asia, with the location of the filtered image highlighted.

And then it says normalized difference is B8 and B4. So, you can come here and see which is the bands B8 is NIR and B4 is the red which is also given in this link. If you click this link, the bands are here. It says B8. B8 is NIR minus B4 which is red. So, this is the NDVI formula which we discussed earlier. And then it gives the dates, filter bound system. So, it is just going to say NDVI is equal to map NDVI, print NDVI, etcetera, etcetera.

(Refer Slide Time: 26:54)



Google Earth Engine interface showing a script for NDVI Landsat 8. The script is as follows:

```

1 //OLI: 11 bands and 30 m resolution
2 var landsat8e_imagecollection = ImageCollection('LANDSAT/OLI_T1_RT')
3   .filter(ee.Filter.lessThan('CLOUD_COVER', 10))
4   .filter(ee.Filter.equals('WRS_PATH', 14))
5   .filter(ee.Filter.equals('WRS_ROW', 51))
6   .filterDate('2013-01-01', '2019-12-31')
7
8 //Map.addLayer(landsat8, {bands: ['B4', 'B3', 'B2'], 'landsat8'})
9 print(landsat8, 'landsat8')
10
11 var landsat_size = landsat8.size()
12 print(landsat_size, 'landsat_size')

```

The console output shows:

```

Use print(...) to write to this console.
ImageCollection LANDSAT_8
landsat8
27
landsat_size
3508

```

Google Earth Engine interface showing an updated script for NDVI Landsat 8. The script is as follows:

```

7 //Map.addLayer(landsat8, {bands: ['B4', 'B3', 'B2'], 'landsat8'})
8 print(landsat8, 'landsat8')
9
10 var landsat_size = landsat8.size()
11 print(landsat_size, 'landsat_size')
12
13 var landsat_list = landsat8.toList(landsat_size)
14 print(landsat_list, 'landsat_list')
15
16 for (var a=0; a < landsat_size; a++) {
17   //36 is size of landsat8
18 }

```

The console output shows:

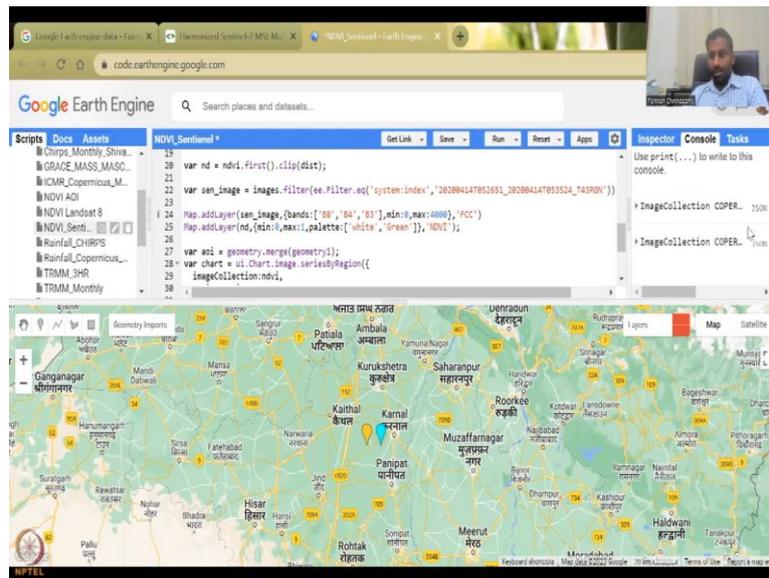
```

Use print(...) to write to this console.
ImageCollection LANDSAT_8
landsat8
27
landsat_size
3508

```

So, for this particular area, it is going to chart. So, why this code was written is not to visualize but to create a chart for a particular area. So, let us do the updated time frame for this. 2022 to 2022 December. I have not done it because this is the first time I am changing the date. I am running it. So, let us go here. So, first what it does?

(Refer Slide Time: 27:17)



It goes to Loni village and then you can see here it is populating the village and all the images are being. So, always you have to keep, making sure that the code is running as per the particular area of interest. So, here also I have given the location as the tables that you have seen here.

And you can close this also. So, basically, Google Earth engine is there. I would refrain from teaching the editing codes and stuff right now, but at least where the data has been stored and can be used for your purposes. So, in the next class I will teach about Earth Explorer and Sentinel Hub. Thank you.