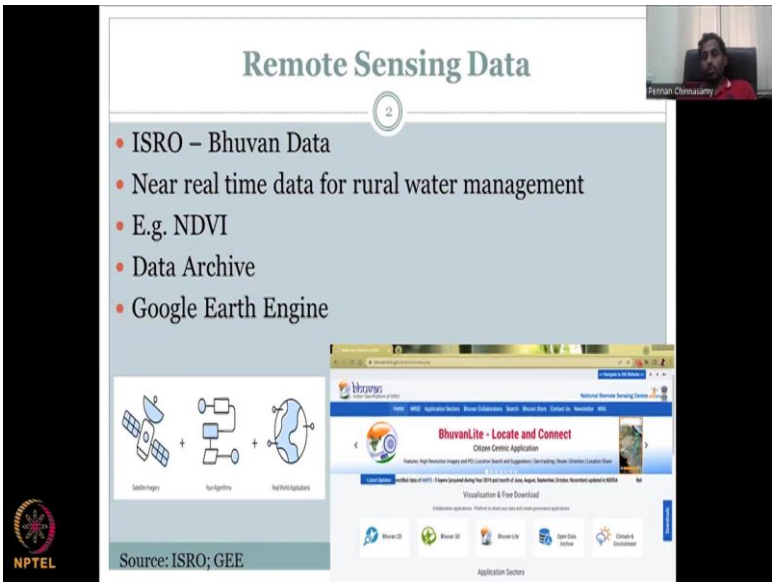
Rural Water Resources Management
Professor Pennan Chinnasamy
Centre for Technology Alternatives for Rural Areas
Indian Institute of Technology, Bombay
Week 12 - Lecture 04
Rural water database - Remote Sensing

Hello everyone, welcome to NPTEL course on Rural Water Resource Management. This is week 12 lecture 4. This week, we have been looking at multiple databases that can aid our understanding on rural water resource management, and also get us data for future assessments of rural water resources. On this note, we will be looking at some more data from the water balance. In the past lectures we looked at soil moisture, rainfall storage, and other aspects of the water balance, in today's lecture, I will be showcasing the remote sensing power in collecting data for rural water management.

(Refer Slide Time: 1:08)



So, in the past, like lectures, we have seen that there are a lot of government data. However, the time and space in which it is available is limited. For example, your groundwater is taken in once in every four 4 and it is not spread across the country, but also has some concentrations in some regions. So, this may not be applicable to a rural entity where they may not have any groundwater wells monitoring system and or a river flowing towards or does discharge value.

So, in that kind of cases, it is best to augment which means join observation data and remote sensing data. That is what IMD has done very clearly, the Indian metrological department where they take observation, rainfall, and then satellite rainfall data and then they covered

into one rainfall data. So, now it is a mixture of observation and satellite data. Before that it was only a observation data or only a satellite data and there were some issues on both sides. But now, when they are emerged the data product becomes more robust and also has better spatial and temporal resolution.

Now, since this is attested, we now know that remote sensing use is pretty good for our system, what do we do? We need to have more access to this data, so, for that ISRO has made a data website called Bhuvan, and this requires GIS and remote sensing which you could learn from other resources, but I am just going to focus on the rural water databases available in Bhuvan.

So, if you look at the progression of this two-lecture series, you would have seen that I refer to papers, NGO reports, manuals, world bank reports etc, and then I also refer to the databases available in these systems. Then moving on, I also showed you how you could collect data from government and private entities. And now we have come to the remote sensing case.

So, the Bhuvan database has a lot of applications and it is made by the ISRO team, Indian Space Research Organization under multiple umbrellas and NRSC, ICC, where they give near real time data for rural water management, for are multiple data that come in the next lecture, which is the lecture 5 will be going through to show you how a model can be created for which you need multiple data and that data is not readily available. And so, in that occasions, remote sensing data helps, some data are very expensive to get you have to buy it, and some data, the temporal or spatial resolution is limited.

So, how do you balance between these two? You add some open source satellite data, which can capture all the dynamics but it needs hand holding of observation data. So, the observation data you get from your local resources, IMD, CWC, etc, and then you merge it with the remote sensing data to get a good data product form. And they have done like this for near real time data for what management.

What do you mean by near real time? Is almost from the date of access, it is very close. So, in the soil moisture, I would say it is near real time because they are giving you data within four days, whereas ET they are giving you data in one week. So, somewhere, we could say that it is near real time, all these data bases.

One example of the data, they give us NDVI, which is a normalized difference vegetation index. It is kind of an indicator about is vegetation there or not. So, you could use land use land cover, but the land use land cover does not also talk about water and stress, etc., whereas, this indicator can talk about it.

So, how they estimate these indicators, why it is beyond the scope? But what I am trying to say is, there are data for rural water management in the remote sensing platform, for example, rainfall slope. How sloppy the land is, land use, land cover, barren land versus soil data, all these you can take from Bhuvan. And then you have your NDVI like indicators, which can be guiding you towards proper rural water management. They are big data archives. So, you do not have to always download data and keep it on your system, make it heavy, you can always download whatever you need from these databases and then update, keep updating your database with the data they have.

One more private agency is Google Earth Engine, which I will also showcase in this lecture, because there are some data which you can get it from Bhuvan, but there are other data, which are available from Google Earth Engine. So, Google Earth Engine is similar to Bhuvan, but it brings in data from various satellite platforms, not only ISRO, but it takes from NASA, from US, ESA, from the European Space Agency, Europe, Japan, etc. So, all these data come together in a single platform, and that is called Google Earth Engine.

So, let us look at this Bhuvan, I will first look at it so one as good light and normal connect. First, I will try to do local normal one website because it has more GUI interface, if it does not work, because of the internet, we will show you the light and this is how the Google Earth Engine works.

So, you have satellite data on one side, it is mixed with algorithms the algorithms can be from Google Earth Engine or your algorithm. For example, you want to mix data observation plus remote sensing data, all these you can give algorithms, you can type it as an algorithm in the Google Earth Engine and it will run for you and give you output, output could be a merged product, output could be the scaled product or a zoomed in product of a particular region. You can also have multiple layers together to give one value which talks about stress indicators for rural water management.

Let us take an example. So, rural water management stress can be indicated by your water levels in the dam, so, water level could indicate stress. Another indicator could be your

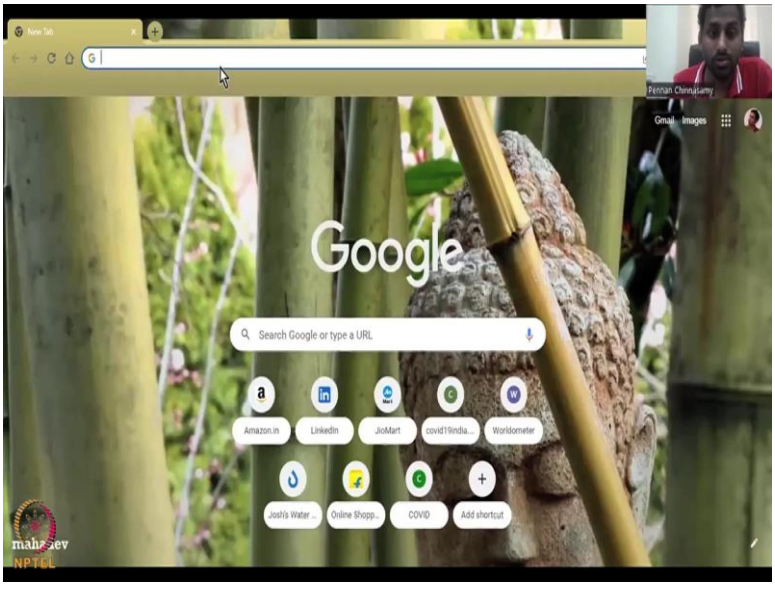
rainfall, if rainfall is not there, you can say it is a stress the other indicators you will have a lot of water, but if the plants are taking more water because of a prop type, people like eucalyptus, then you will say it is another stress.

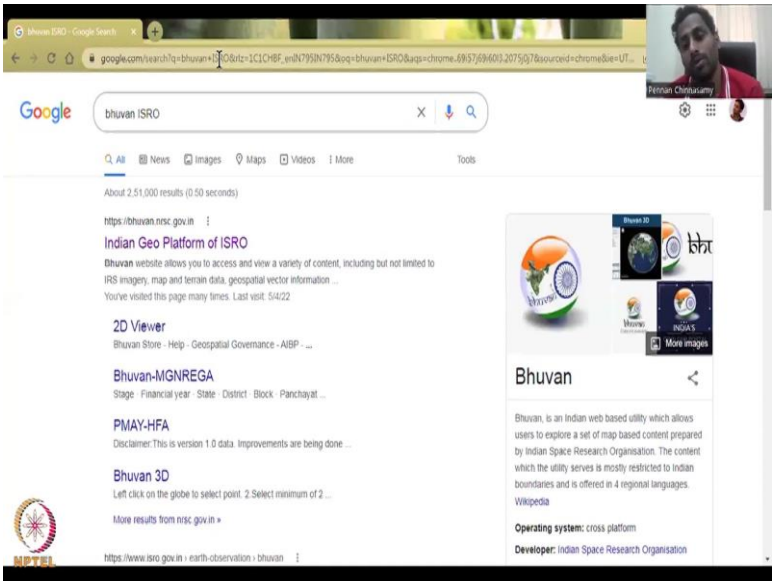
So, these stresses may not be just associated with one data like for example rainfall, it can be associated with multiple data, so, we have to be open to capture these multiple data to assess what is the role of water in this and that helps us to be different than just looking at rainfall. For example, if we just looked at rainfall and say, the water is there so, they should be okay, but then when we go to the ground we notice that rainfall happens but everything washes away because the slope is so high, runoff happens, or the plants are taking too much water then needed, eucalyptus, so you do not have water in the land, lakes and ponds.

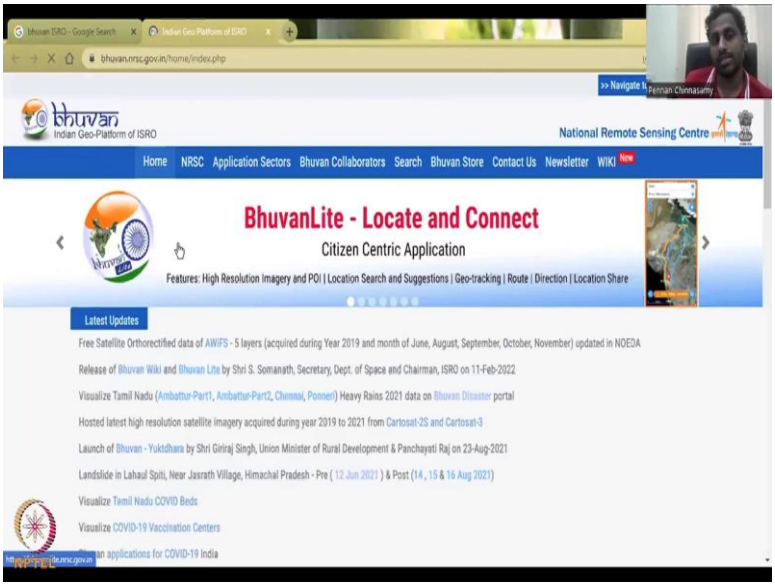
So, these kinds of things can be put in a model after you understand for which you need multiple databases, just not having rainfall or soil moisture can help for this exercise, because the problems are complex and multidisciplinary. So, you also need a multidisciplinary approach to capture the data and use the data in your rural water resource assessment work.

It could be simple or very complex, either way, you have to include multiple data, just not one data is enough. For example, you will have rainfall, but not discharge, maybe there is a dam, which is actually closing the water for which you need the location of the dams, and then the slope of the land where the water is taken from rainfall into the dams.

(Refer Slide Time: 10:53)

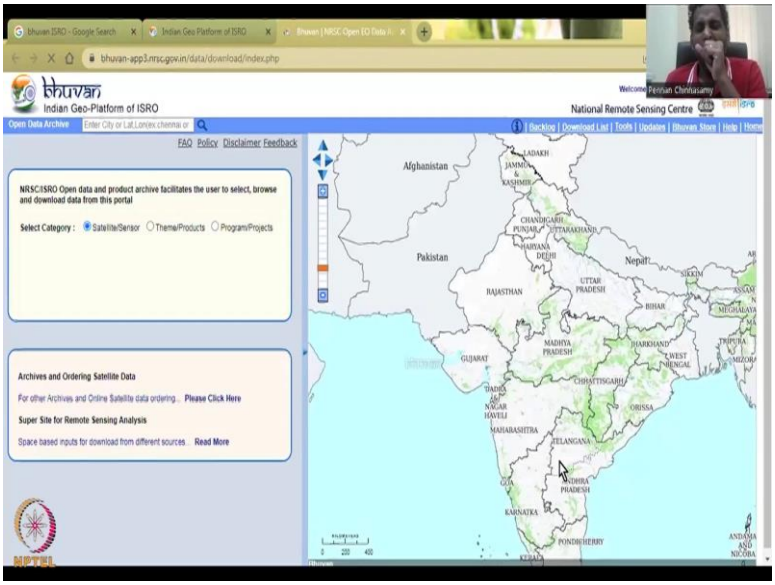






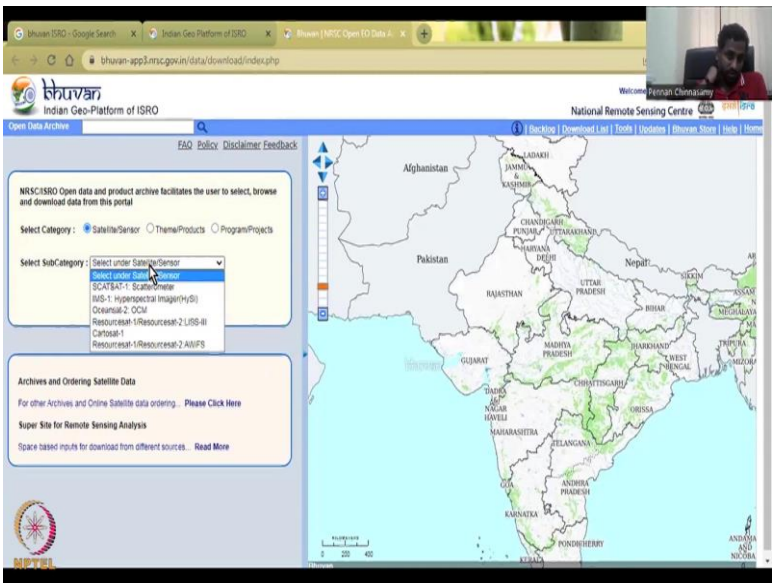
So, now, we are going to look at this Bhuvan website. So, I am going to share the website of Bhuvan. So, I just first start with the Google search, you can just type Bhuvan ISRO, and then the first one is India geo platform of ISRO or Indian Geo Platform of ISRO. ISRO dot NRC, which is the National Remote Sensing Center. So, as I said, they take the data, and then they put it in these kinds of platforms so that anyone can access, lot of people access this data, multi multiple people from India and abroad. So, it is a very useful website for data collection. Let us do the open archive data.

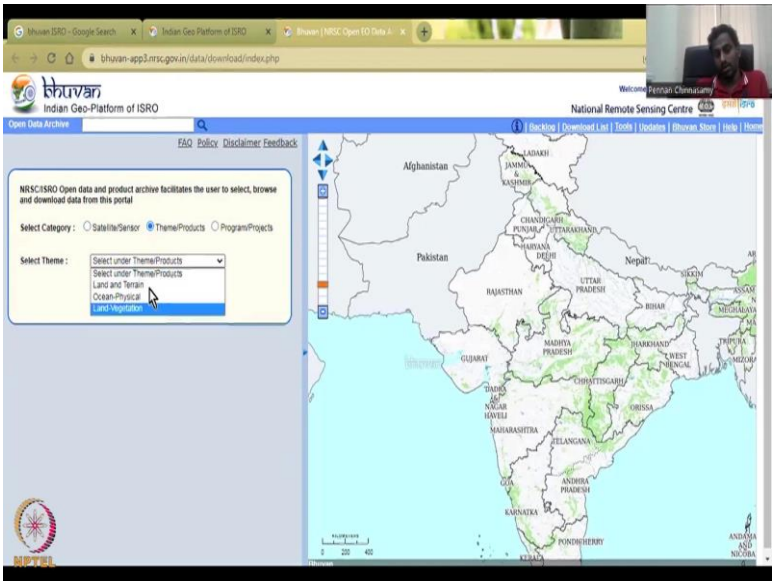
(Refer Slide Time: 11:33)

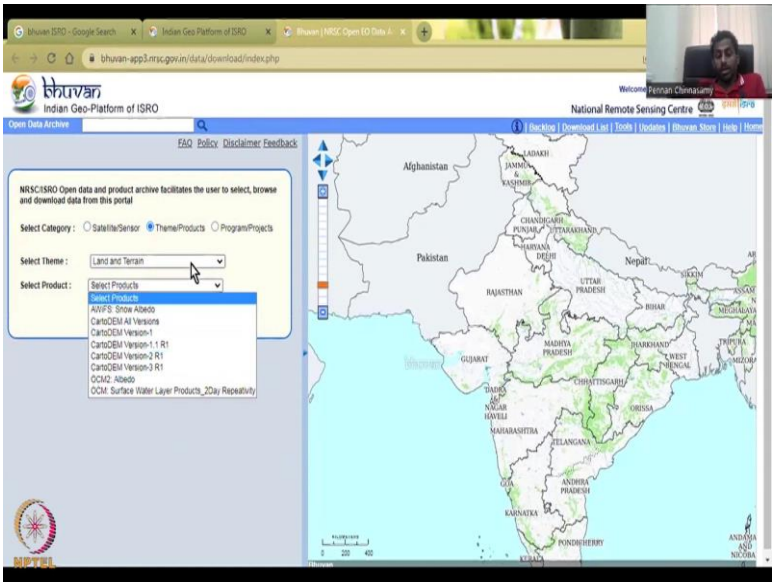


This is much faster than the WRIS website. Data is more but still, I think, because it is so they have some really good hardware and computers, they will have better access tools. So, you could see that you can actually type in a location to zoom in to a particular location and see the data then you can collect the data and process. Once you visualize the data processing and collecting the data as a different source like GIS and the Remote Sensing Platforms, which is not part of this course, I just want to show you the data availability, how you use it in your work is different class. So right now, I will just want to show you what data is available, so that you could have idea that data is available, I would need to just learn the techniques.

(Refer Slide Time: 12:32)



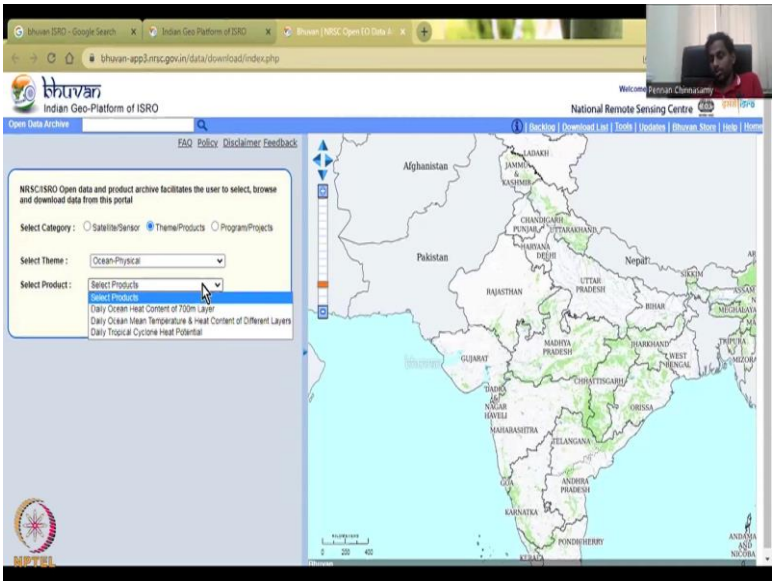


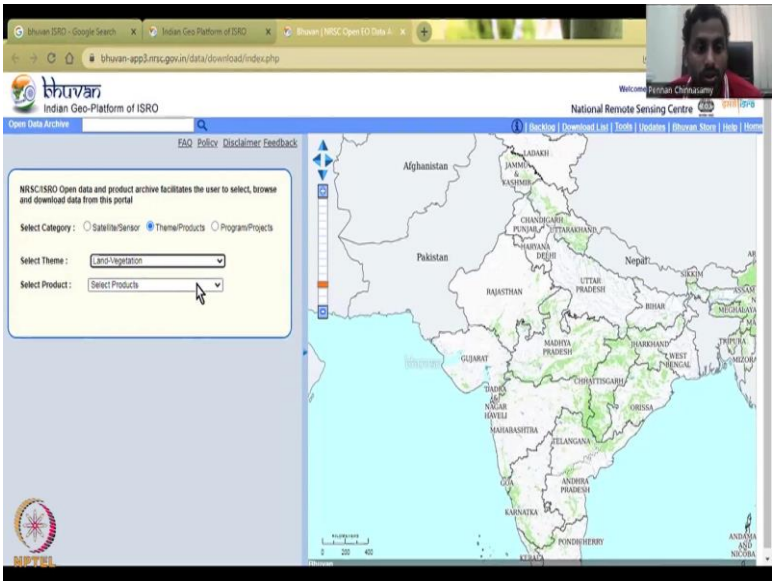


But so, I would first you can go to satellite, the first tab on Open Data Archive, it will give you per satellite what data is available. Since, we are starting fresh, I will join with you guys to start afresh, but we do not know what satellite use what products. So, let us not use that term, let us go to theme and products. So, in theme and products you can pull the drop-down menu, you can have land and terrain.

So, I will just click land and terrain, what is land and during terrain here? It gives you the elevation gradient, how elevated the land is, where are the depressions, etc., for storage structures, form ponds? Those kinds of things we can look at. So, that is all given here with some snow, albedo values which we are not using at this stage.

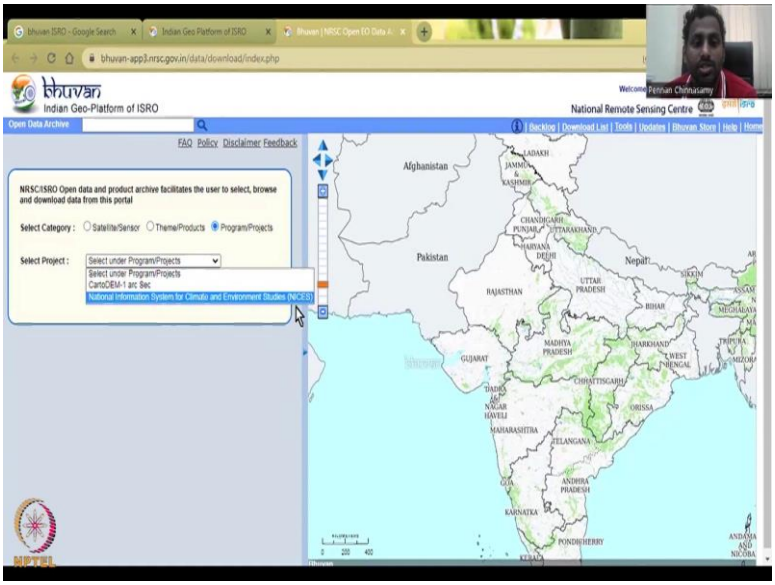
(Refer Slide Time: 13:19)





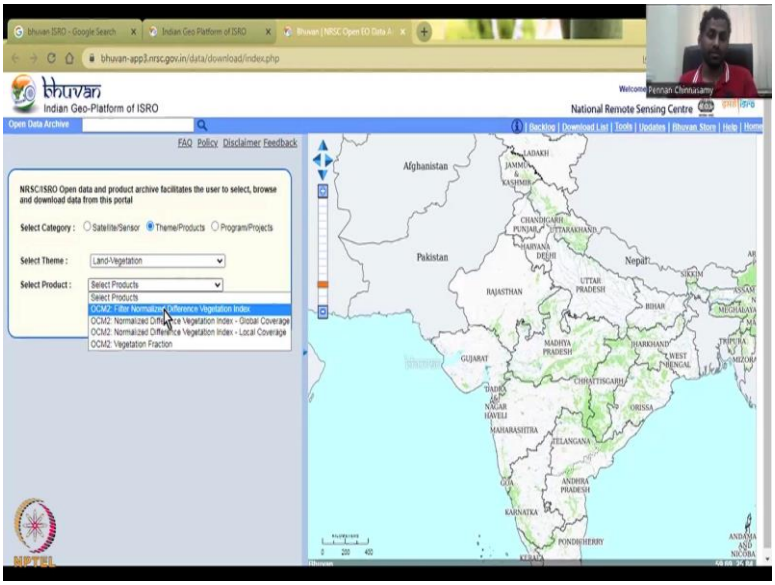
Then the ocean and physical products, you can click ocean and physical and then you can see heat wave temperature, cyclones, those kinds of things. Because, if you are in the coastal region, these data would help or is needed very much for understanding the water coming in, like in terms of rainfall, temperature, currents, all these things we can look at. Most important one we will be looking for this class is the land and vegetation theme and products. So, before we go then I will just finish this off also.

(Refer Slide Time: 13:56)



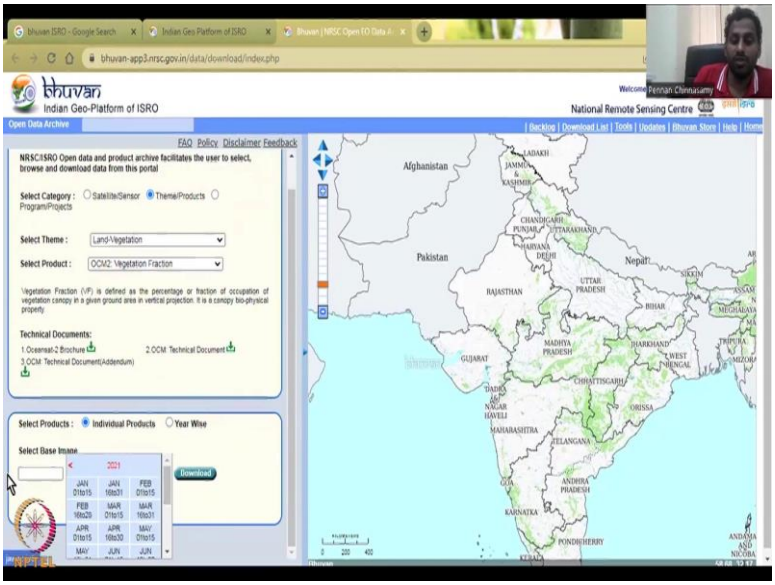
So, in program and projects you will see like there is a national climate change study which has been done and high-resolution elevation math which has been done, we are still updated. So, you could use it if you need but I will go back to Theme and products and then land and vegetation.

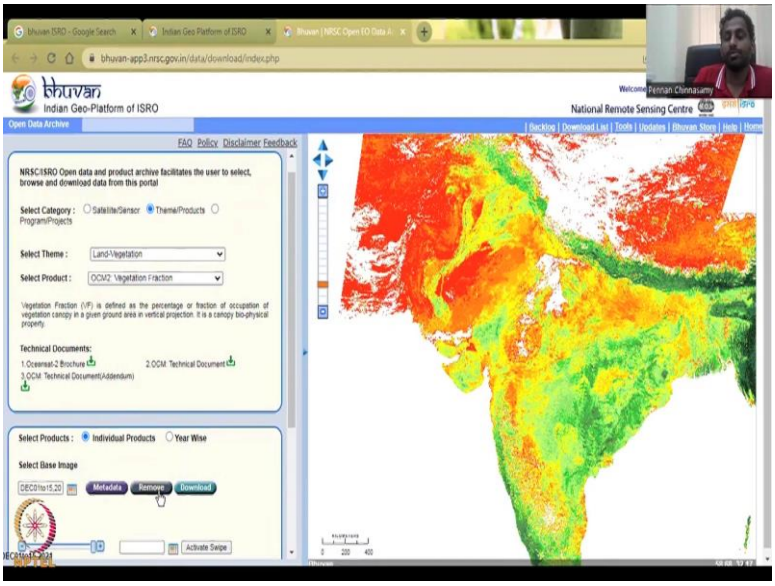
(Refer Slide Time: 14:15)



In the land and vegetation you have products such as Normalized Difference Vegetation Index, the NDVI which I talked about, or you have the global coverage and local coverage, and the vegetation fraction.

(Refer Slide Time: 14:40)



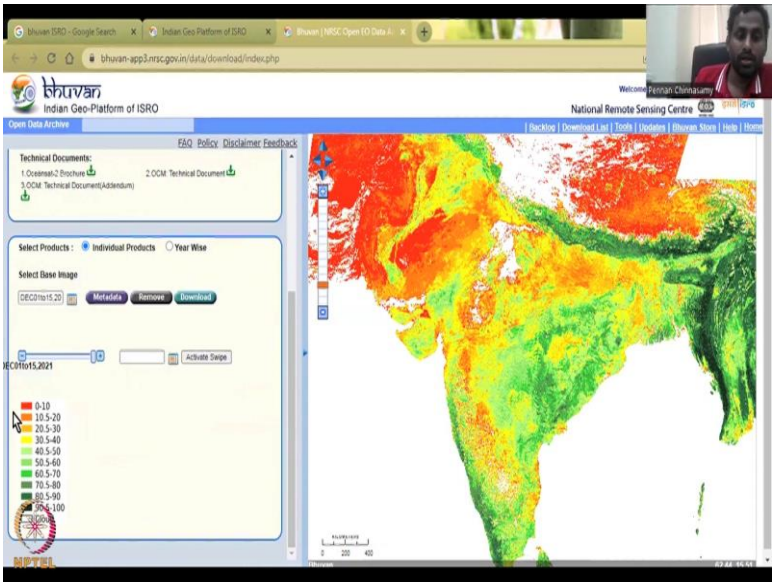


Let us first look at the vegetation fraction. When I click vegetation fraction when the definition of the vegetation fraction comes up, which actually says, what is the percentage or fraction of occupation of vegetation canopy, trees, crops etc. to the area? So, if you have 100 acres and 50 acres with the crops, then it is 50 percent as the vegetation fraction, and this fraction is given as a color and the color is painted on this map, when you look at it.

So, you can look at individual products, the date in which you want, you can click it and then it says that every 15 days, there is a map, the last one we have is this December, so I will just click this December and then view beautiful. So, you have the India colored with anywhere from red to green, and red implies that there is less vegetation crop, etc. Whereas, your green

would indicate a lot of forest cover along the area. So, you see here and same like your WRS you can zoom in and zoom out those kinds of things.

(Refer Slide Time: 15:53)



The color is given here, December 1 to 15, if you use a slider in jump the dates and go to a different date. What it tells you is, there is some cloud cover here the white is not like empty spaces, it is not no data, it is covered with Cloud, so, it is cloudy even in December. And what you will see is, these areas are 90 to 100 percent having vegetation, which means that full 100 by 100 percent is given taken up by the vegetation.

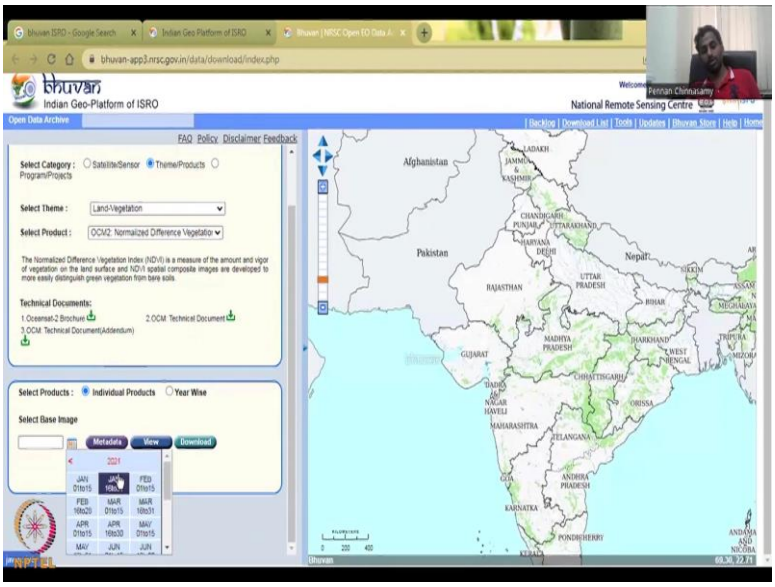
Whereas, in the red areas, as I said, these are the desert regions etc, you will see only 20 to 30 percent of the land being converted. Actually, that is in the most parts of India, you have in because the Kaveri the southern part is also having less water and high-water stress. Vegetation fraction can be converted to an ET value, because now you know the area, and in the previous class we discussed about evapo-transpiration.

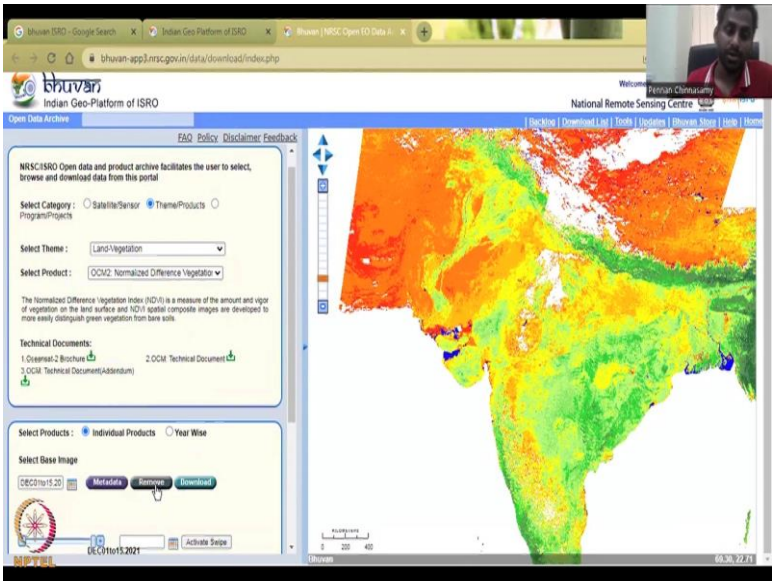
So, for a particular area, you know that evaporation rate, you can simply multiply the area which is unit of meters square, along with your evapo-transpiration, which is units of meters to get cubic meters of volume of water, which is lost. These help widely in understanding the groundwater potential, the surface water potential and remaining water resources in rural India.

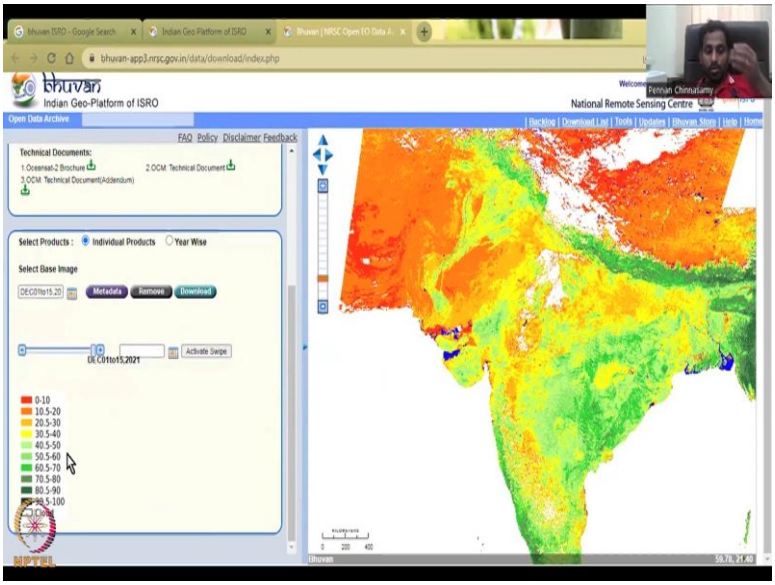
Because, as I said, there would not be any data collected in some of these regions, look at it, like whole of India is painted and colored with different values, which means that the highest spatial and temporal resolution data is helping. This data is actually merged with the previous

central groundwater board SWID data, where they can have better indicators of why this groundwater is depleting or rural water is depleting? Because now, we have the maps, which show how much fraction of the land is vegetated and what type you have to go down to the ground.

(Refer Slide Time: 18:17)







This is one data product that we saw, the next data product is normalized difference vegetation coverage for India, just for India. It does not populate yet because you have not taken the date. And as I said, it is near real time, when you click the data you can have until December of 2021 which is kind of near real time.

When you do it in your in your summer time, you will see that during the growing period, you will see that you will have higher data like, just a week before, two weeks before data you will have. Right now, because in March and February there is not much crops growing it is the winter season and the post monsoon season, so you would not see much vegetation index showing in these maps.

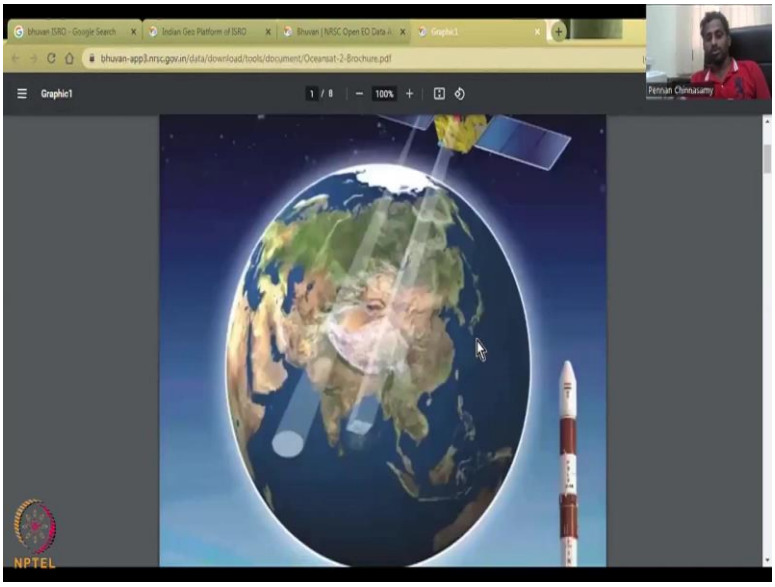
Then we have the normalized vegetation index NDVI, which is a measure of the amount of vegetation on the land surface. And NDVI special composite which is a develop to more easily distinguish between greenish green vegetation from the bare soils, bare soil is this brown soil which does not have that much of crops.

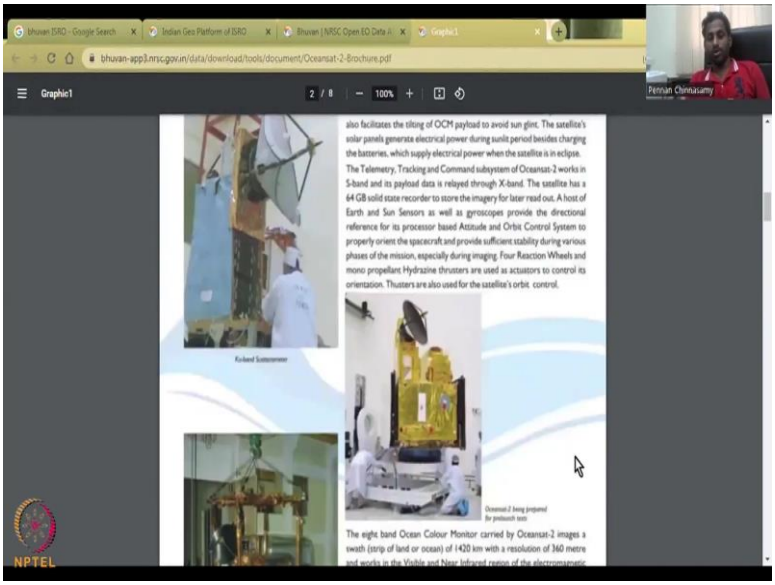
Right now, the data is coming up you could see that 0 to 10 NDVI means almost barren. In this part is where you have the deserts and other regions, whereas most of this part, the alluvial aquifers, etc. is around 22 to 5.30 the 20.5 to 30 the NDVI range, still it is less vegetation, anything about 50 which is the green color, would show healthy vegetation. So, 50's are okay vegetation, whereas 80's and 90's are high healthy vegetation.

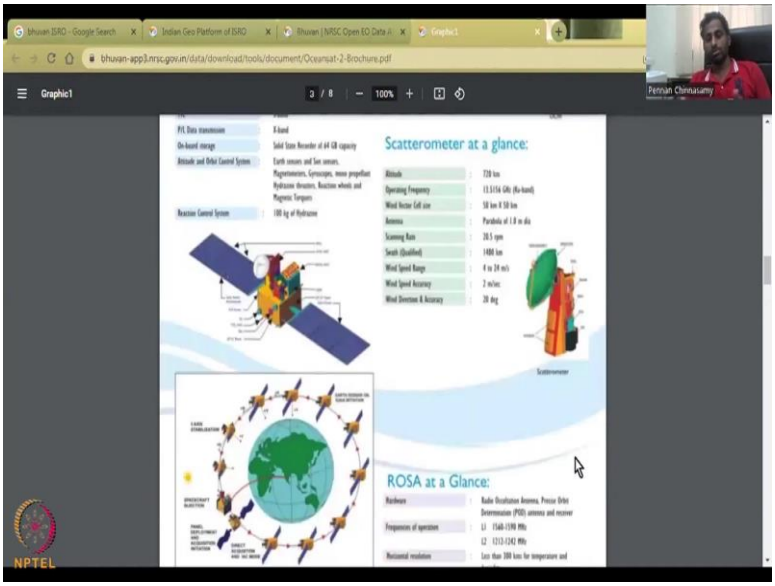
90 to 100 is mostly the forest, and that is why you can see forest here in the Western Ghats, some in the Eastern Ghats, and also in Assam regions, the northeastern India, lot of beautiful forests are there. So, all of this can be analyzed from the NDVI data from the one website.

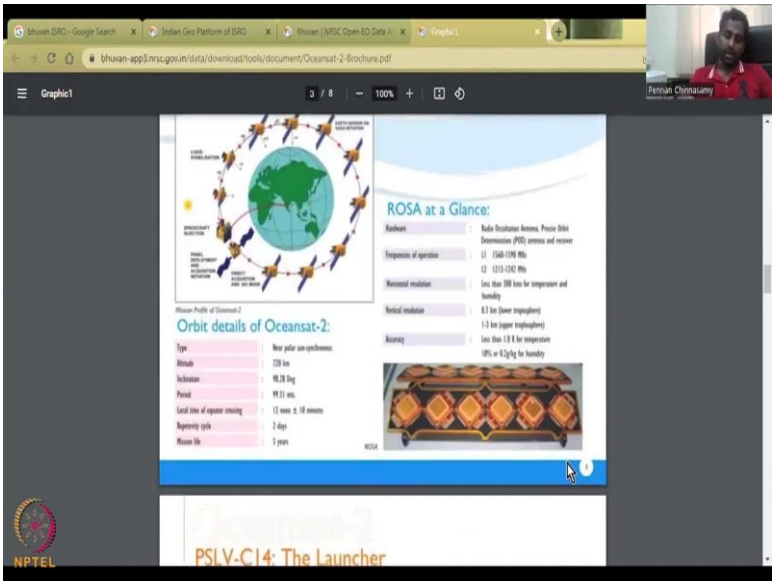
So, if you are working on government projects, they will love to see these kinds of images more than the Google Earth engines which are going to show.

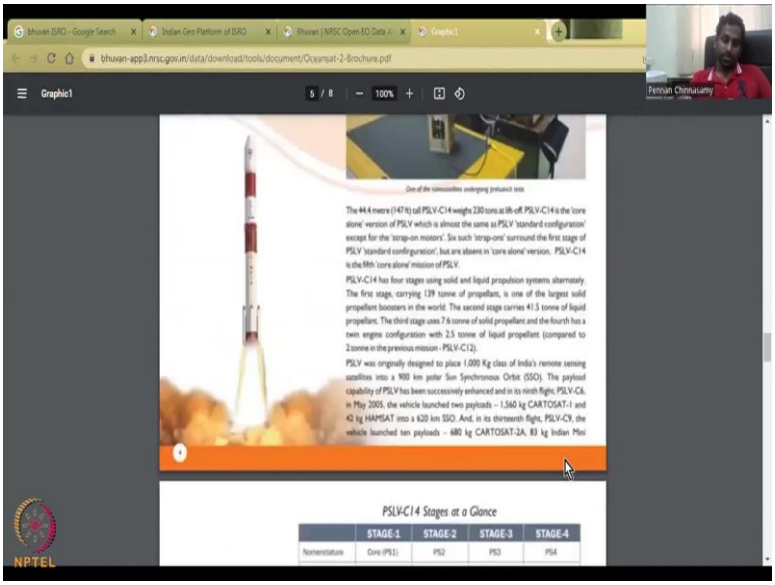
(Refer Slide Time: 20:46)

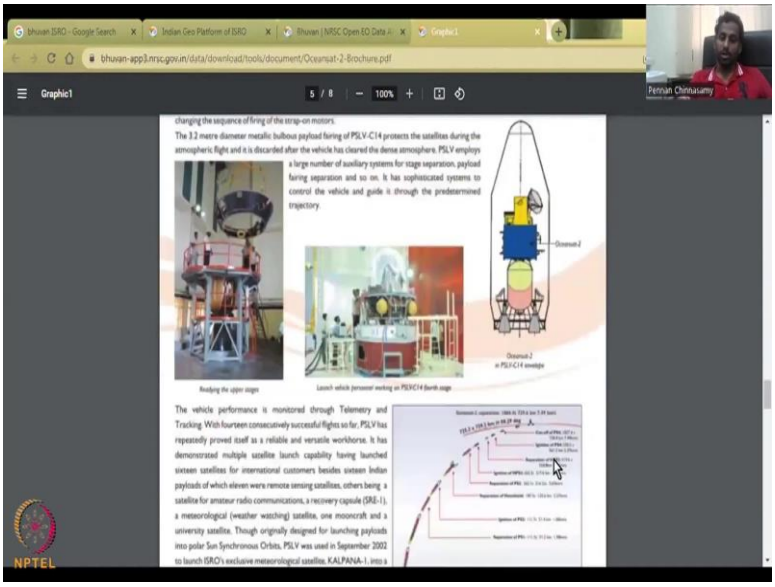


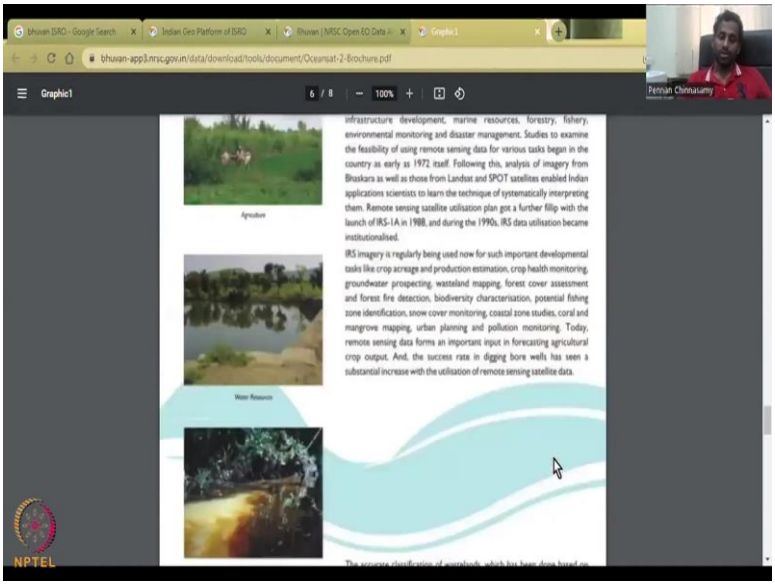

Graphic1
2 / 8
100%
also facilitates the tilting of OCM payload to avoid sun glint. The satellite's solar panels generate electrical power during sunlit period besides charging the batteries, which supply electrical power when the satellite is in eclipse.
The Telemetry, Tracking and Command subsystem of Oceansat-2 works in S-band and its payload data is relayed through X-band. The satellite has a 64 GB solid state recorder to store the imagery for later read out. A host of Earth and Sun Sensors as well as gyroscopes provide the directional reference for its processor based Attitude and Orbit Control System to properly orient the spacecraft and provide sufficient stability during various phases of the mission, especially during imaging. Four Reaction Wheels and mono propellant Hydrazine thrusters are used as actuators to control its orientation. Thusters are also used for the satellite's orbit control.
The eight band Ocean Colour Monitor carried by Oceansat-2 images a swath (strip of land or ocean) of 1420 km with a resolution of 360 metre
Pennan Chinnasamy
NPTEL

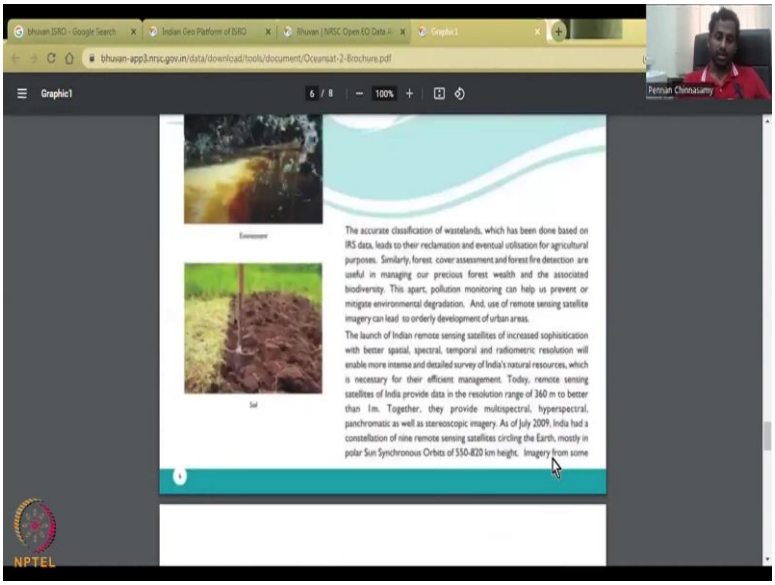

Graphic1
3 / 8
100%
Scatterometer at a glance:
ROSA at a Glance:
Pennan Chinnasamy
NPTEL

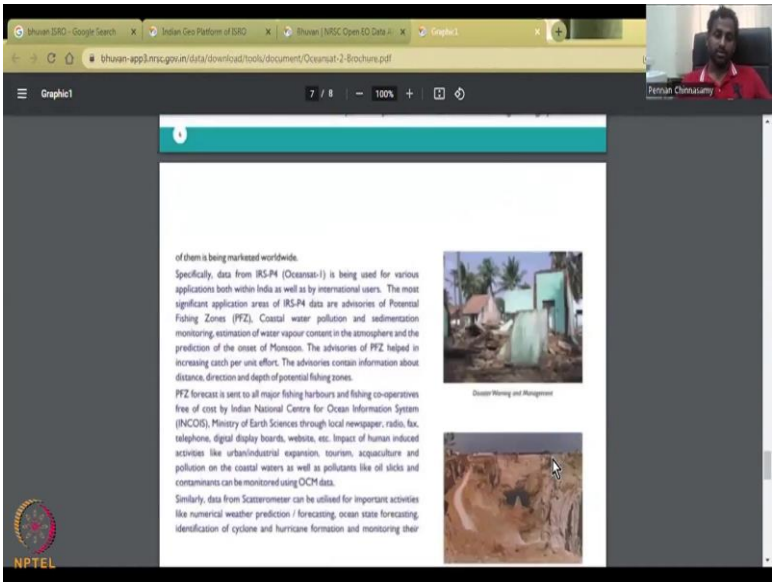

Graphic1
3 / 8
100%
ROSA at a Glance:
Orbit details of Oceansat-2:
PSLV-C14: The Launcher
Pennan Chinnasamy
NPTEL

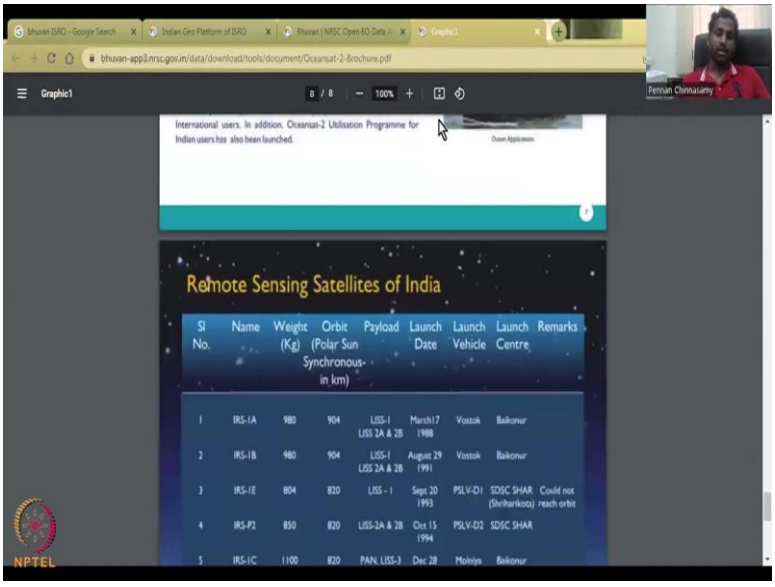

bhuvan-app3.nrsc.gov.in/data/download/tools/document/Oceansat-2-Brochure.pdf
Graphic1
5 / 8
100%
Pennan Chinnasamy
One of the subassemblies undergoing prelaunch tests
The 44.4 metre (147 ft) tall PSLV-C14 weighs 230 tons at lift-off. PSLV-C14 is the 'core alone' version of PSLV which is almost the same as PSLV 'standard configuration' except for the 'strap-on motors'. Six such 'strap-ons' surround the first stage of PSLV 'standard configuration', but are absent in 'core alone' version. PSLV-C14 is the fifth 'core alone' mission of PSLV.
PSLV-C14 has four stages using solid and liquid propulsion systems alternately. The first stage, carrying 139 tonne of propellant, is one of the largest solid propellant boosters in the world. The second stage carries 41.5 tonne of liquid propellant. The third stage uses 7.6 tonne of solid propellant and the fourth has a twin engines configuration with 2.5 tonne of liquid propellant (compared to 2 tonne in the previous mission - PSLV-C12).
PSLV was originally designed to place 1,000 Kg class of India's remote sensing satellites into a 900 km polar Sun Synchronous Orbit (SSO). The payload capability of PSLV has been successively enhanced and in its ninth flight, PSLV-C6, in May 2005, the vehicle launched two payloads – 1,560 kg CARTOSAT-1 and 42 kg HAMSAT into a 620 km SSO. And, in its thirteenth flight, PSLV-C9, the vehicle launched ten payloads - 680 kg CARTOSAT-2A, 83 kg Indian Mini
PSLV-C14 Stages at a Glance
STAGE-1 STAGE-2 STAGE-3 STAGE-4
Nomenclature Core (PS1) PS2 PS3 PS4
NPTEL


bhuvan-app3.nrsc.gov.in/data/download/tools/document/Oceansat-2-Brochure.pdf
Graphic1
5 / 8
100%
Pennan Chinnasamy
changing the sequence of firing of the strap-on motors.
The 3.2 metre diameter metallic bulbous payload fairing of PSLV-C14 protects the satellites during the atmospheric flight and it is discarded after the vehicle has cleared the dense atmosphere. PSLV employs a large number of auxiliary systems for stage separation, payload fairing separation and so on. It has sophisticated systems to control the vehicle and guide it through the predetermined trajectory.
Oceansat-2
Oceansat-2 in PSLV-C14 envelope
Readying the upper stages
Launch vehicle Jurrasseer working on PSLV-C14 fourth stage
The vehicle performance is monitored through Telemetry and Tracking. With fourteen consecutively successful flights so far, PSLV has repeatedly proved itself as a reliable and versatile workhorse. It has demonstrated multiple satellite launch capability having launched sixteen satellites for international customers besides sixteen Indian payloads of which eleven were remote sensing satellites, others being a satellite for amateur radio communications, a recovery capsule (SRE-1), a meteorological (weather watching) satellite, one mooncraft and a university satellite. Though originally designed for launching payloads into polar Sun Synchronous Orbits, PSLV was used in September 2002 to launch ISRO's exclusive meteorological satellite, KALPANA-1, into a
NPTEL


bhuvan-app3.nrsc.gov.in/data/download/tools/document/Oceansat-2-Brochure.pdf
Graphic1
6 / 8
100%
Pennan Chinnasamy
Agriculture
Water Resources
infrastructure development, marine resources, forestry, fishery, environmental monitoring and disaster management. Studies to examine the feasibility of using remote sensing data for various tasks began in the country as early as 1972 itself. Following this, analysis of imagery from Bhaskara as well as those from Landsat and SPOT satellites enabled Indian applications scientists to learn the technique of systematically interpreting them. Remote sensing satellite utilisation plan got a further fillip with the launch of IRS-1A in 1988, and during the 1990s, IRS data utilisation became institutionalised.
IRS imagery is regularly being used now for such important developmental tasks like crop acreage and production estimation, crop health monitoring, groundwater prospecting, wasteland mapping, forest cover assessment and forest fire detection, biodiversity characterisation, potential fishing zone identification, snow cover monitoring, coastal zone studies, coral and mangrove mapping, urban planning and pollution monitoring. Today, remote sensing data forms an important input in forecasting agricultural crop output. And, the success rate in digging bore wells has seen a substantial increase with the utilisation of remote sensing satellite data.
NPTEL

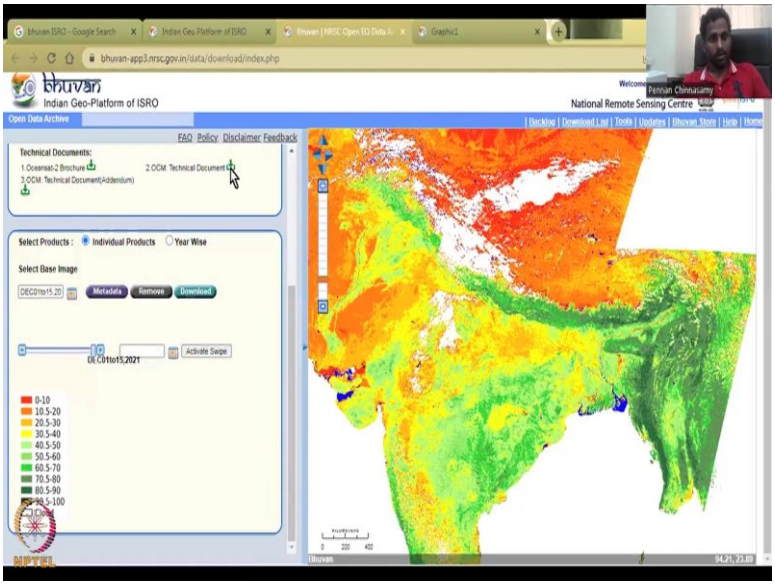

bhuvan-app3.nrsc.gov.in/data/download/tools/document/Oceansat-2-Brochure.pdf
Graphic1
6 / 8
100%
Environment
Soil
The accurate classification of wastelands, which has been done based on IRS data, leads to their reclamation and eventual utilisation for agricultural purposes. Similarly, forest cover assessment and forest fire detection are useful in managing our precious forest wealth and the associated biodiversity. This apart, pollution monitoring can help us prevent or mitigate environmental degradation. And, use of remote sensing satellite imagery can lead to orderly development of urban areas.
The launch of Indian remote sensing satellites of increased sophistication with better spatial, spectral, temporal and radiometric resolution will enable more intense and detailed survey of India's natural resources, which is necessary for their efficient management. Today, remote sensing satellites of India provide data in the resolution range of 360 m to better than 1m. Together, they provide multispectral, hyperspectral, panchromatic as well as stereoscopic imagery. As of July 2009, India had a constellation of nine remote sensing satellites circling the Earth, mostly in polar Sun Synchronous Orbits of 550-820 km height. Imagery from some
Pennan Chinnasamy
NPTEL

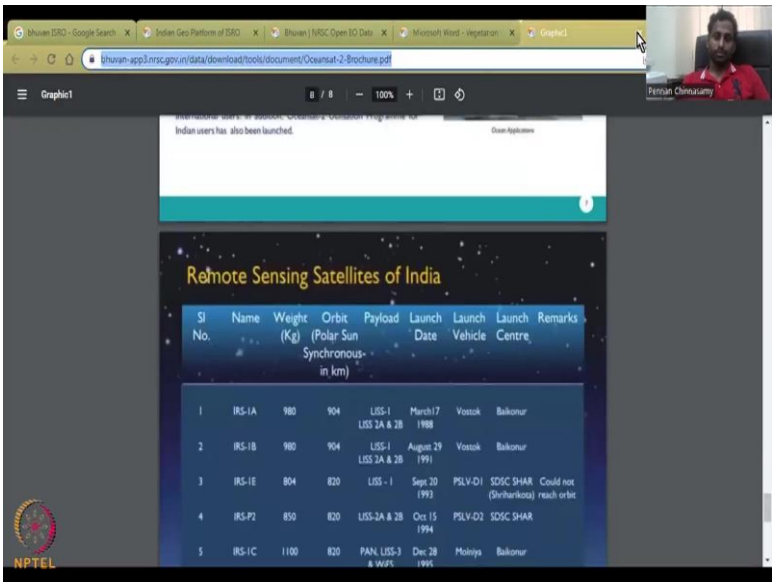

bhuvan-app3.nrsc.gov.in/data/download/tools/document/Oceansat-2-Brochure.pdf
Graphic1
7 / 8
100%
of them is being marketed worldwide.
Specifically, data from IRS-P4 (Oceansat-1) is being used for various applications both within India as well as by international users. The most significant application areas of IRS-P4 data are advisories of Potential Fishing Zones (PFZ), Coastal water pollution and sedimentation monitoring, estimation of water vapour content in the atmosphere and the prediction of the onset of Monsoon. The advisories of PFZ helped in increasing catch per unit effort. The advisories contain information about distance, direction and depth of potential fishing zones.
PFZ forecast is sent to all major fishing harbours and fishing co-operatives free of cost by Indian National Centre for Ocean Information System (INCOIS), Ministry of Earth Sciences through local newspaper, radio, fax, telephone, digital display boards, website, etc. Impact of human induced activities like urban/industrial expansion, tourism, acquaculture and pollution on the coastal waters as well as pollutants like oil slicks and contaminants can be monitored using OCM data.
Similarly, data from Scatterometer can be utilised for important activities like numerical weather prediction / forecasting, ocean state forecasting, identification of cyclone and hurricane formation and monitoring their
Disaster Warning and Management
Pennan Chinnasamy
NPTEL

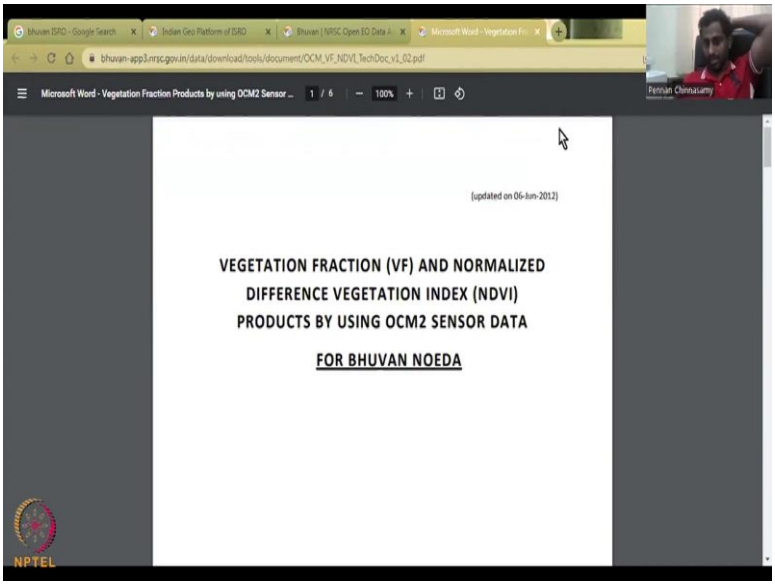

bhuvan-app3.nrsc.gov.in/data/download/tools/document/Oceansat-2-Brochure.pdf
Graphic1
8 / 8
100%
International users. In addition, Oceansat-2 Utilisation Programme for Indian users has also been launched.
Ocean Applications
Remote Sensing Satellites of India
Sl No.
Name
Weight (Kg)
Orbit (Polar Sun Synchronous- in km)
Payload
Launch Date
Launch Vehicle
Launch Centre
Remarks
1 IRS-1A 980 904 LISS-I LISS 2A & 2B March17 1988 Vostok Baikonur
2 IRS-1B 980 904 LISS-I LISS 2A & 2B August 29 1991 Vostok Baikonur
3 IRS-1E 804 820 LISS - I Sept 20 1993 PSLV-D1 SDSC SHAR (Shriharikota) Could not reach orbit
4 IRS-P2 850 820 LISS-2A & 2B Oct 15 1994 PSLV-D2 SDSC SHAR
5 IRS-1C 1100 820 PAN, LISS-3 Dec 28 Molniya Baikonur
Pennan Chinnasamy
NPTEL

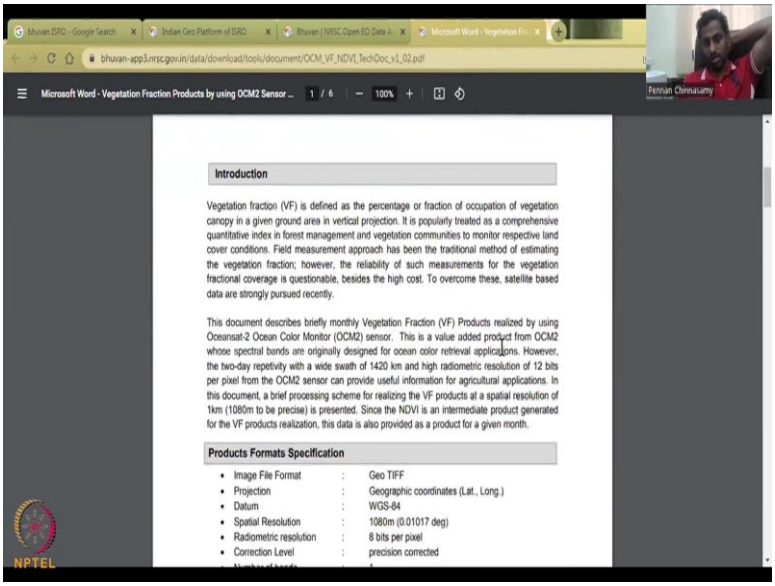
So, how do we know what data, what method they use? For that they have a brochure, you can click the brochure and it will open as a PDF file, it will tell you what satellite was used, which permission, which payload, etc, was used to collect the data, well talk a lot of all the technical parts of the data in the brochure, it is like buying this satellite data product, but you know, it is just free.

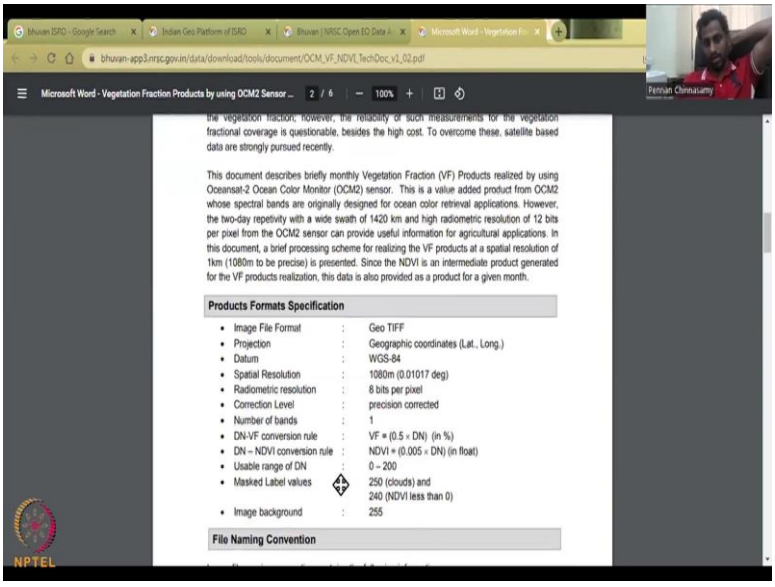
(Refer Slide Time: 21:11)

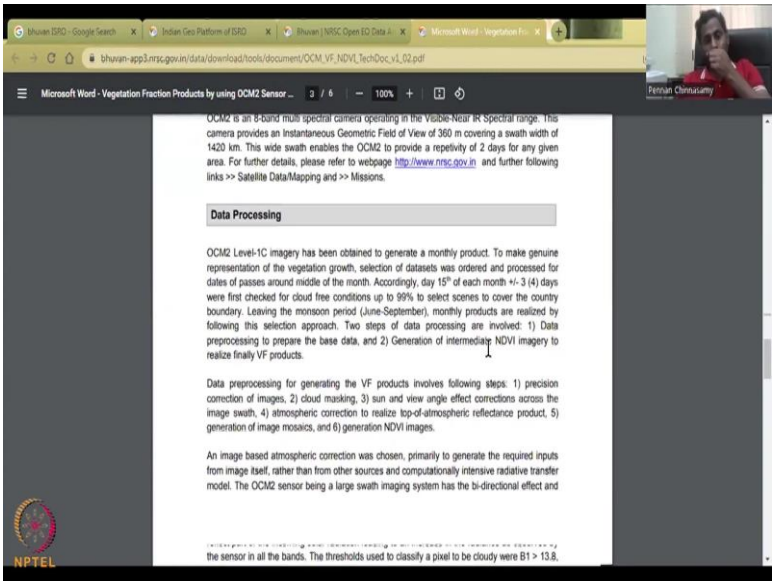


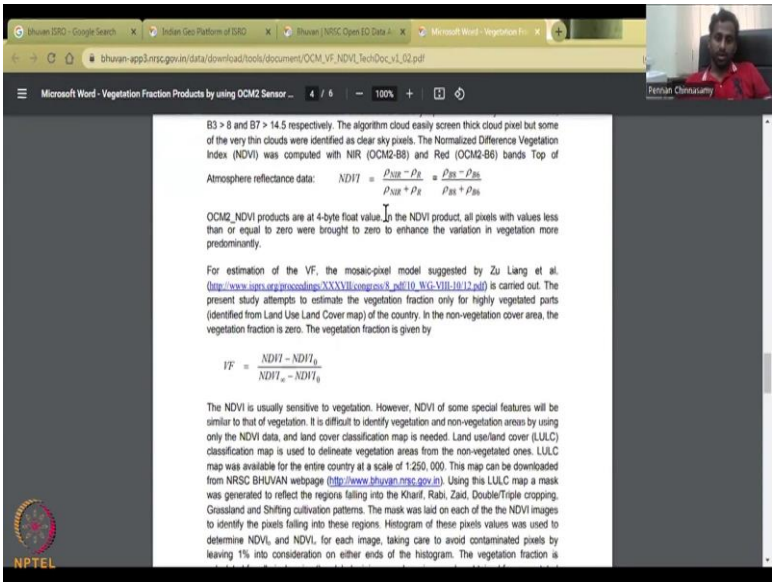


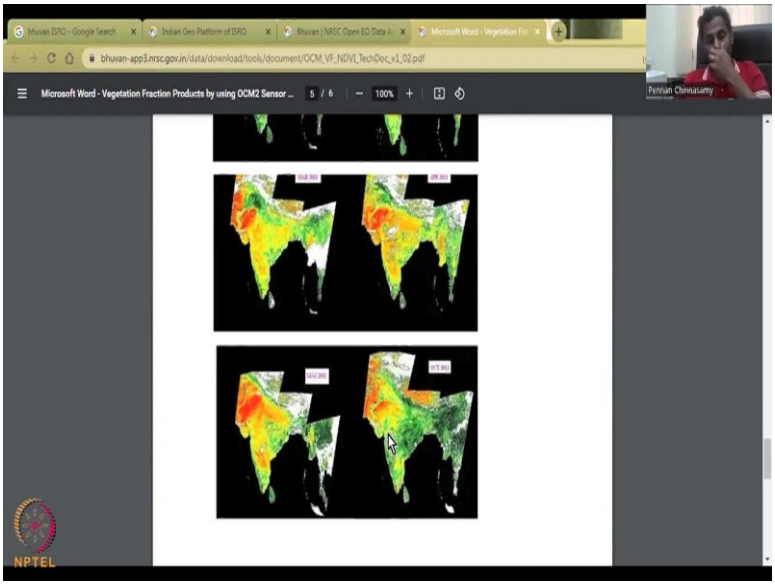

bhuvan-app3.nrsc.gov.in/data/download/tools/document/OCM_VF_NDVI_TechDoc_v1_02.pdf
Microsoft Word - Vegetation Fraction Products by using OCM2 Sensor ... 1 / 6 100%
Pennan Chinnasamy
(updated on 06-Jun-2012)
VEGETATION FRACTION (VF) AND NORMALIZED DIFFERENCE VEGETATION INDEX (NDVI) PRODUCTS BY USING OCM2 SENSOR DATA
FOR BHUVAN NOEDA
NPTEL

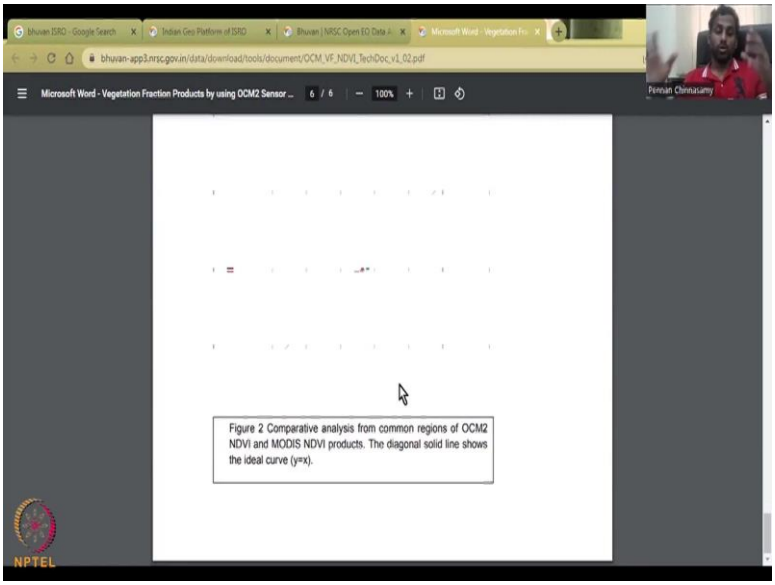

bhuvan-app3.nrsc.gov.in/data/download/tools/document/OCM_VF_NDVI_TechDoc_v1_02.pdf
Microsoft Word - Vegetation Fraction Products by using OCM2 Sensor ... 1 / 6 100%
Pennan Chinnasamy
Introduction
Vegetation fraction (VF) is defined as the percentage or fraction of occupation of vegetation canopy in a given ground area in vertical projection. It is popularly treated as a comprehensive quantitative index in forest management and vegetation communities to monitor respective land cover conditions. Field measurement approach has been the traditional method of estimating the vegetation fraction; however, the reliability of such measurements for the vegetation fractional coverage is questionable, besides the high cost. To overcome these, satellite based data are strongly pursued recently.
This document describes briefly monthly Vegetation Fraction (VF) Products realized by using Oceansat-2 Ocean Color Monitor (OCM2) sensor. This is a value added product from OCM2 whose spectral bands are originally designed for ocean color retrieval applications. However, the two-day repetivity with a wide swath of 1420 km and high radiometric resolution of 12 bits per pixel from the OCM2 sensor can provide useful information for agricultural applications. In this document, a brief processing scheme for realizing the VF products at a spatial resolution of 1km (1080m to be precise) is presented. Since the NDVI is an intermediate product generated for the VF products realization, this data is also provided as a product for a given month.
Products Formats Specification
Image File Format : Geo TIFF
Projection : Geographic coordinates (Lat., Long.)
Datum : WGS-84
Spatial Resolution : 1080m (0.01017 deg)
Radiometric resolution : 8 bits per pixel
Correction Level : precision corrected
NPTEL


bhuvan-app3.nrsc.gov.in/data/download/tools/document/OCM_VF_NDVI_TechDoc_v1_02.pdf
Microsoft Word - Vegetation Fraction Products by using OCM2 Sensor ... 2 / 6 100%
Pennan Chinnasamy
fractional coverage is questionable, besides the high cost. To overcome these, satellite based data are strongly pursued recently.
This document describes briefly monthly Vegetation Fraction (VF) Products realized by using Oceansat-2 Ocean Color Monitor (OCM2) sensor. This is a value added product from OCM2 whose spectral bands are originally designed for ocean color retrieval applications. However, the two-day repetivity with a wide swath of 1420 km and high radiometric resolution of 12 bits per pixel from the OCM2 sensor can provide useful information for agricultural applications. In this document, a brief processing scheme for realizing the VF products at a spatial resolution of 1km (1080m to be precise) is presented. Since the NDVI is an intermediate product generated for the VF products realization, this data is also provided as a product for a given month.
Products Formats Specification
Image File Format : Geo TIFF
Projection : Geographic coordinates (Lat., Long.)
Datum : WGS-84
Spatial Resolution : 1080m (0.01017 deg)
Radiometric resolution : 8 bits per pixel
Correction Level : precision corrected
Number of bands : 1
DN-VF conversion rule : VF = (0.5 × DN) (in %)
DN – NDVI conversion rule : NDVI = (0.005 × DN) (in float)
Usable range of DN : 0 – 200
Masked Label values : 250 (clouds) and 240 (NDVI less than 0)
Image background : 255
File Naming Convention
NPTEL


bhuvan-app3.nrsc.gov.in/data/download/tools/document/OCM_VF_NDVI_TechDoc_v1_02.pdf
Microsoft Word - Vegetation Fraction Products by using OCM2 Sensor ... 3 / 6 100%
Pennan Chinnasamy
OCM2 is an 8-band multi spectral camera operating in the Visible-Near IR Spectral range. This camera provides an Instantaneous Geometric Field of View of 360 m covering a swath width of 1420 km. This wide swath enables the OCM2 to provide a repetivity of 2 days for any given area. For further details, please refer to webpage http://www.nrsc.gov.in and further following links >> Satellite Data/Mapping and >> Missions.
Data Processing
OCM2 Level-1C imagery has been obtained to generate a monthly product. To make genuine representation of the vegetation growth, selection of datasets was ordered and processed for dates of passes around middle of the month. Accordingly, day 15th of each month +/- 3 (4) days were first checked for cloud free conditions up to 99% to select scenes to cover the country boundary. Leaving the monsoon period (June-September), monthly products are realized by following this selection approach. Two steps of data processing are involved: 1) Data preprocessing to prepare the base data, and 2) Generation of intermediate NDVI imagery to realize finally VF products.
Data preprocessing for generating the VF products involves following steps: 1) precision correction of images, 2) cloud masking, 3) sun and view angle effect corrections across the image swath, 4) atmospheric correction to realize top-of-atmospheric reflectance product, 5) generation of image mosaics, and 6) generation NDVI images.
An image based atmospheric correction was chosen, primarily to generate the required inputs from image itself, rather than from other sources and computationally intensive radiative transfer model. The OCM2 sensor being a large swath imaging system has the bi-directional effect and
the sensor in all the bands. The thresholds used to classify a pixel to be cloudy were B1 > 13.8,
NPTEL

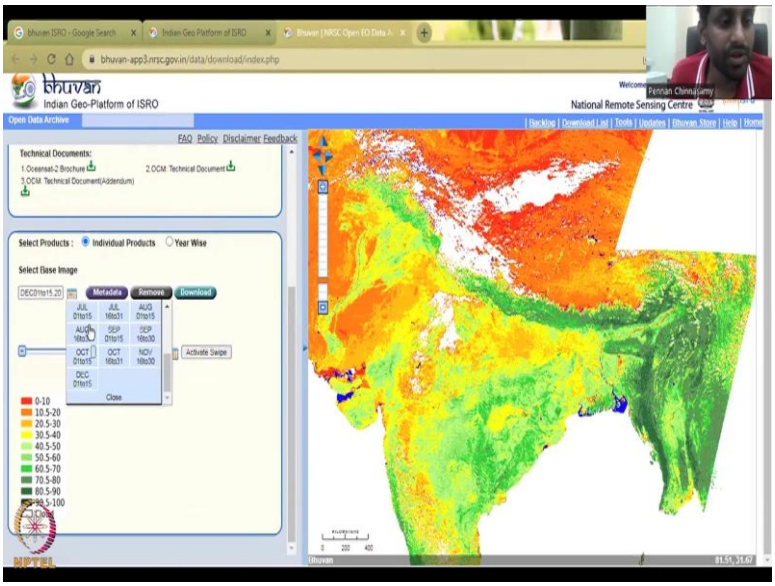

bhuvan-app3.nrsc.gov.in/data/download/tools/document/OCM_VF_NDVI_TechDoc_v1_02.pdf
Microsoft Word - Vegetation Fraction Products by using OCM2 Sensor ... 4 / 6 100%
Pennan Chinnasamy
B3 > 8 and B7 > 14.5 respectively. The algorithm cloud easily screen thick cloud pixel but some of the very thin clouds were identified as clear sky pixels. The Normalized Difference Vegetation Index (NDVI) was computed with NIR (OCM2-B8) and Red (OCM2-B6) bands Top of Atmosphere reflectance data: $NDVI = \frac{\rho_{NIR} - \rho_R}{\rho_{NIR} + \rho_R} = \frac{\rho_{B8} - \rho_{B6}}{\rho_{B8} + \rho_{B6}}$
OCM2_NDVI products are at 4-byte float value. In the NDVI product, all pixels with values less than or equal to zero were brought to zero to enhance the variation in vegetation more predominantly.
For estimation of the VF, the mosaic-pixel model suggested by Zu Liang et al. (http://www.isprs.org/proceedings/XXXVII/congress/8_pdf/10_WG-VIII-10/12.pdf) is carried out. The present study attempts to estimate the vegetation fraction only for highly vegetated parts (identified from Land Use Land Cover map) of the country. In the non-vegetation cover area, the vegetation fraction is zero. The vegetation fraction is given by
$VF = \frac{NDVI - NDVI_0}{NDVI_\infty - NDVI_0}$
The NDVI is usually sensitive to vegetation. However, NDVI of some special features will be similar to that of vegetation. It is difficult to identify vegetation and non-vegetation areas by using only the NDVI data, and land cover classification map is needed. Land use/land cover (LULC) classification map is used to delineate vegetation areas from the non-vegetated ones. LULC map was available for the entire country at a scale of 1:250, 000. This map can be downloaded from NRSC BHUVAN webpage (http://www.bhuvan.nrsc.gov.in). Using this LULC map a mask was generated to reflect the regions falling into the Kharif, Rabi, Zaid, Double/Triple cropping, Grassland and Shifting cultivation patterns. The mask was laid on each of the the NDVI images to identify the pixels falling into these regions. Histogram of these pixels values was used to determine $NDVI_\infty$ and $NDVI_0$ for each image, taking care to avoid contaminated pixels by leaving 1% into consideration on either ends of the histogram. The vegetation fraction is
NPTEL


bhuvan-app3.nrsc.gov.in/data/download/tools/document/OCM_VF_NDVI_TechDoc_v1_02.pdf
Microsoft Word - Vegetation Fraction Products by using OCM2 Sensor ... 5 / 6 100%
Pennan Chinnasamy
NPTEL



The next part is your technical document which basically gives you the methodology on how they collected the data, what is the resolution the image so, this is how they calculated the NDVI, and then there is a volume fraction, vegetation fraction. So, all these have been given specifically for this and the data that they use will also be told, what data they use to estimate these values properly. Then we have the entire world data, but again, as I said, it takes a lot of cumbersome images to take from the world data to your location. So, we will not be doing that. We will just show you what is India data.

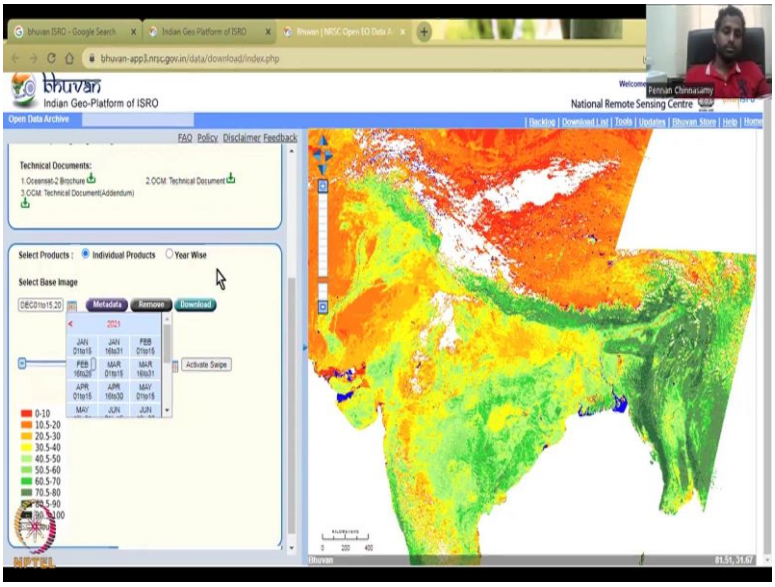
(Refer Slide Time: 22:09)

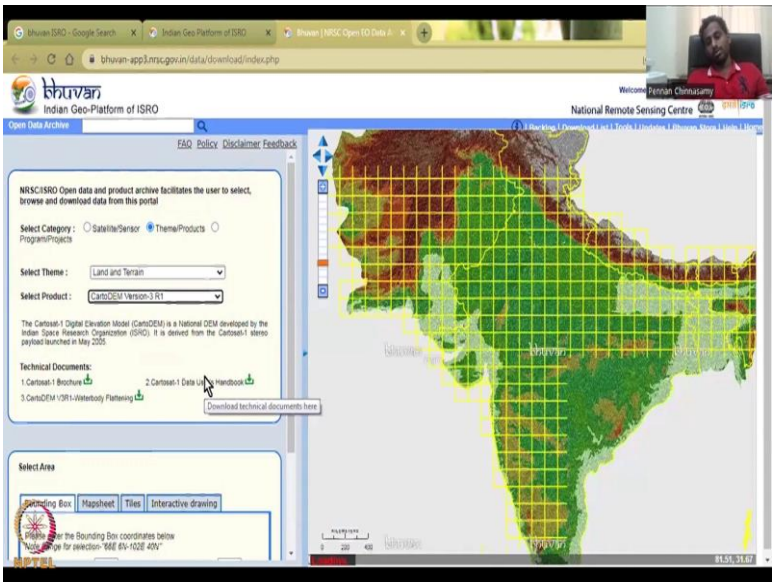


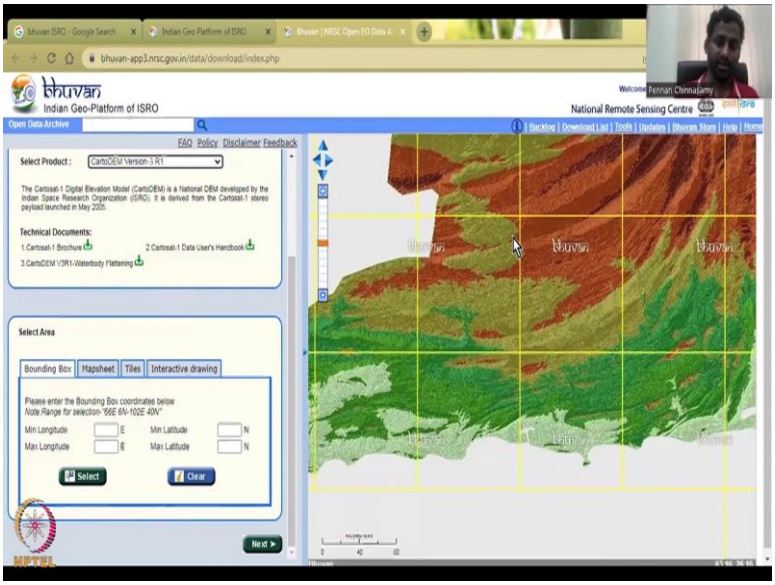
So, we have seen the data range from almost 15 days, you can look at it 15 days, December 1 to 15, and then the Jan part is not there because they have not updated it, but normally during the growing period you will see this data available. So, now you know the land use, land

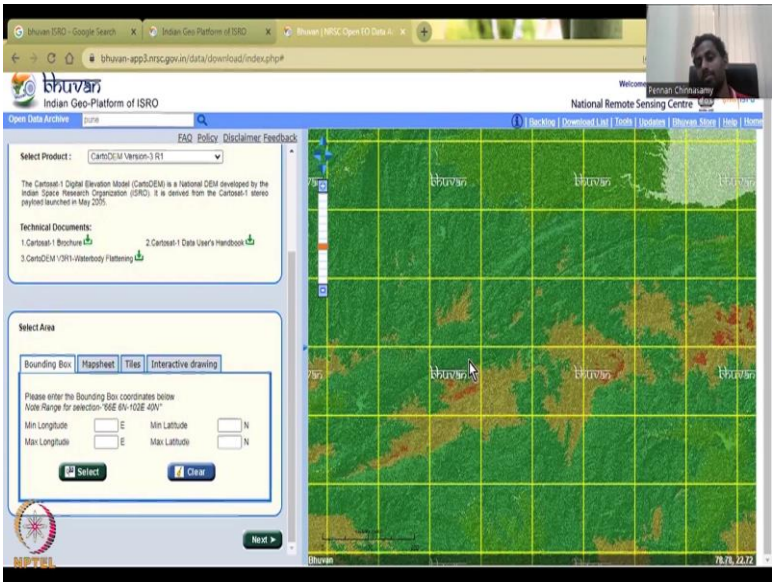
cover type, you have the evapo-transpiration, you can multiply the area to get the volume that is lost from the water balance equation.

(Refer Slide Time: 22:33)







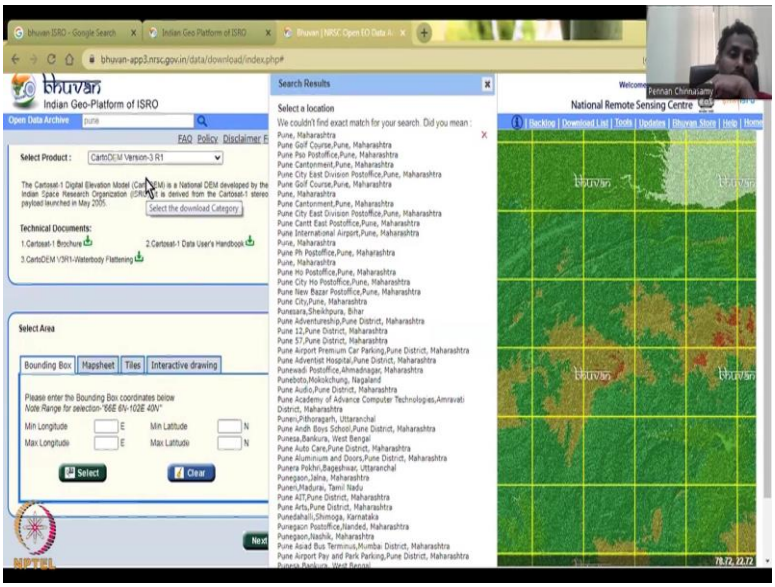


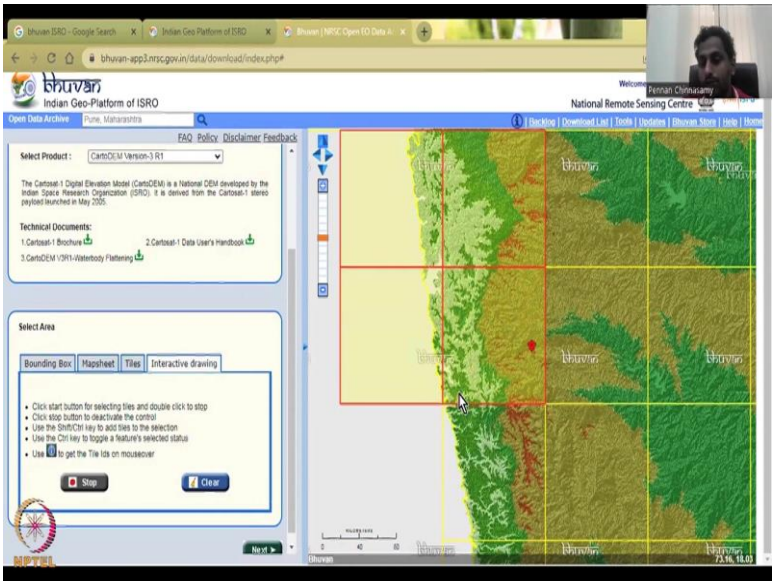
There are other products also that we could show, one product I would like to show is the DEM project. So, DEM are digital elevation models, how the elevation is occurring in the land and again you do not need to put a date here because elevation of the land is a stationary property it may change because of land subsidence, earthquakes, movement, plate movements, tectonic movements, but it does not change everyday like your soil moisture, ET or your NVDI.

So, all these are non-stationary products, whereas here the location and the elevation for that location is a stationary product. You can see this, you can download exact range and the technical document will give you what these colors mean. For example, if I if you want to see Pune, the map can go to Pune and locate your elevation radiant, but you cannot directly access the values from here, it is just colored, but the coloring is based on a particular value.

So, what you have to do is, you will have to learn GIS to work on these data maps or MATLAB, SCILAB, those kinds of programs where they can take these GIS maps and then convert it into an Excel database. So, we have seen the NDVI and other ranges.

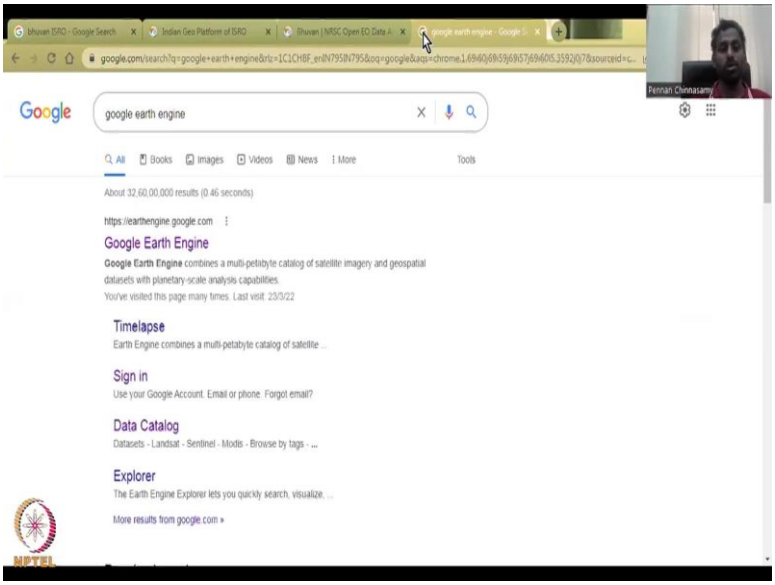
(Refer Slide Time: 24:16)

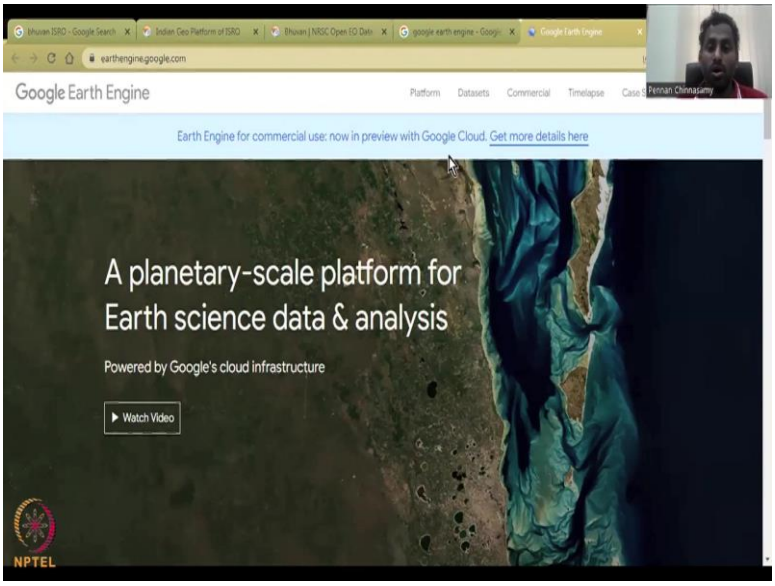




In case asking which Pune, there is so many Pune, there you go. So, Pune has been located with dot, and that dot means okay then I will just take this box of data to come. For example, I am going to start I am just going to click this box data only I want. So, you can take these two data. So, you have selected all these blocks of tiles of data, you can download now or then to desktop, you can download them for your Pune work, because Pune that is the center the part of it also the district boundary also lies in the other region. So, this is all with Bhuvan.

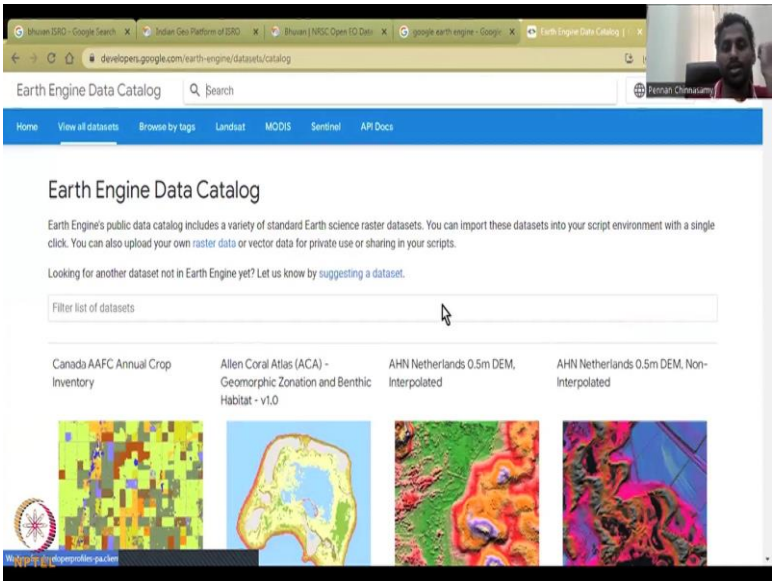
(Refer Slide Time: 25:22)





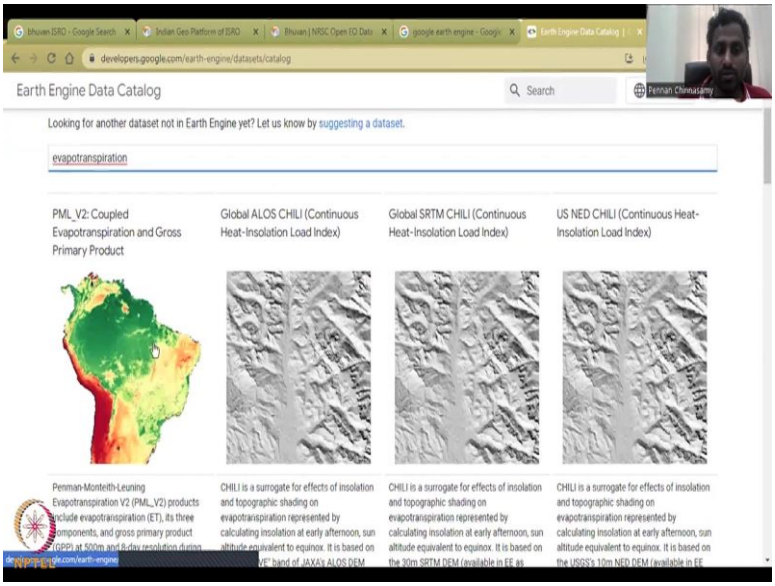
Now, let me move on to Google Earth Engine. So, I all have to say is Google Earth Engine, you can type it in Google, GEE is the short form and you can you will be pulled up to this. If you have a Gmail account, you will automatically be having an account on Google Earth Engine.

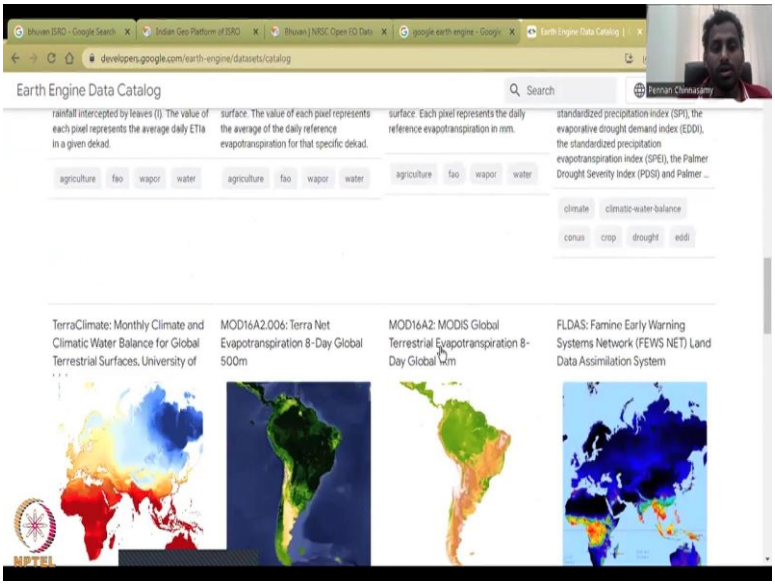
(Refer Slide Time: 25:42)



Now, we will just look at datasets I am just clicking data set which is on the top and then waiting for the datasets to upload. What it says is, there is all a lot of datasets you can go to view all datasets and then there is a search box which helps you to select the data. So, it is running but you can also type it here and then click search. So, here is all the data set in the find all data sets as I said, this is a big-big data set because, it has a lot of satellite data from different parts of the country and the world, so you will have lots of data on this.

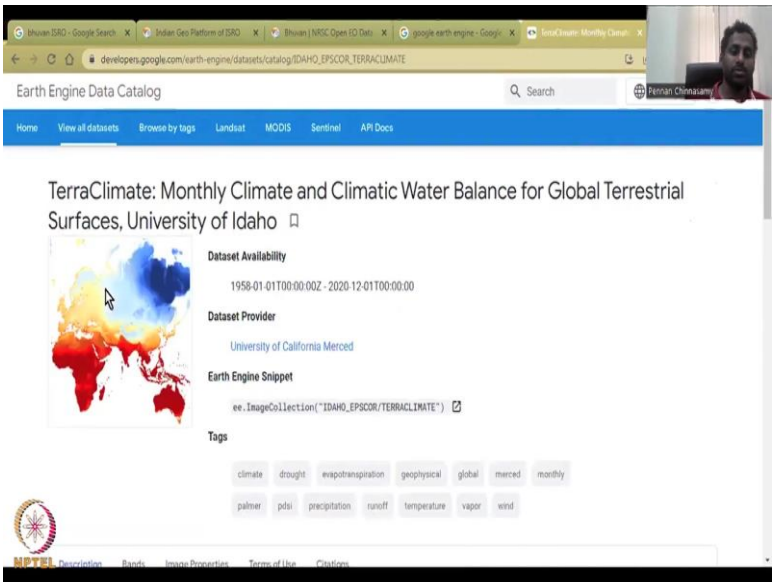
(Refer Slide Time: 26:21)

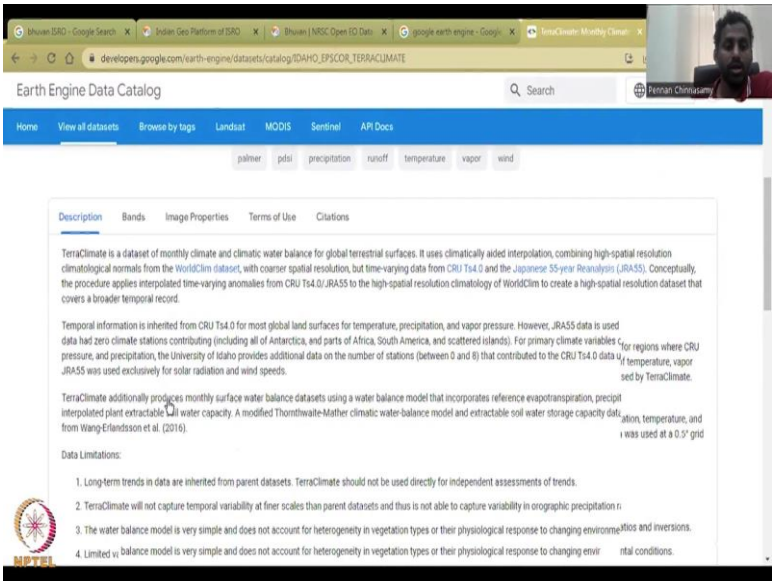


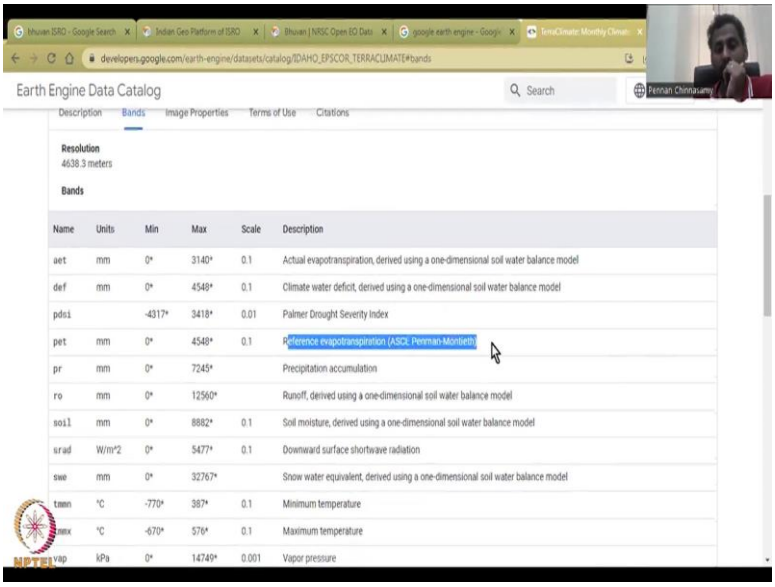


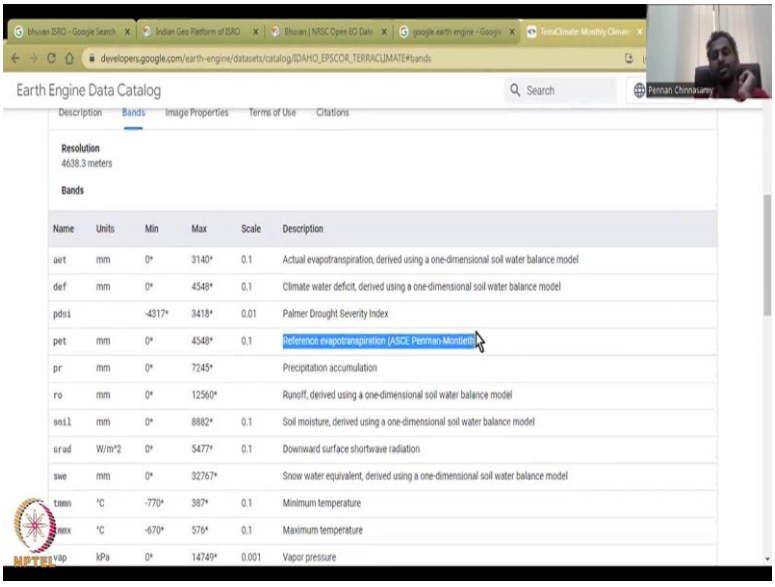
Let us say evapo transpiration. So, there are a lot of products, this is different couple products ALOS CHILI product, isolation heat, actual evapo-transpiration, decadal daily evapo-transpiration, Terrra data, so there is a lot of data which does this ET estimate different satellites. So, the NRSC maybe a different satellite this can be a different satellite, famine early warning system.

(Refer Slide Time: 27:08)



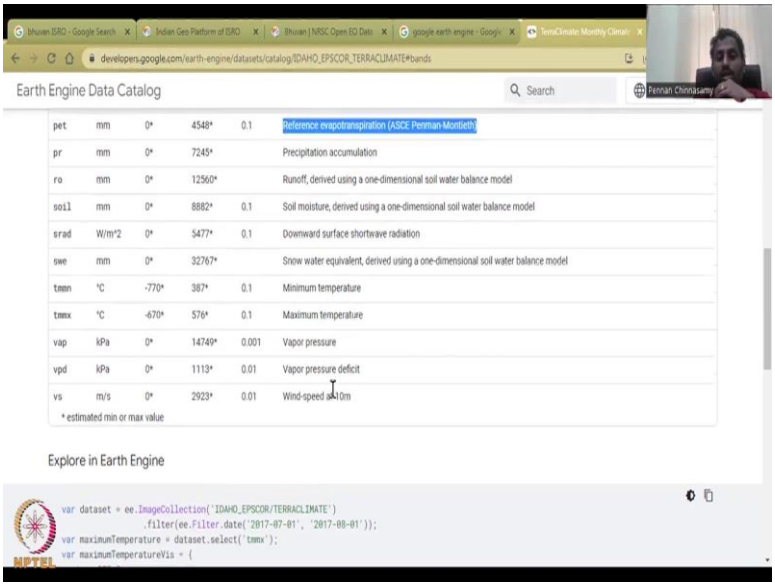

Earth Engine Data Catalog
Search
Home
View all datasets
Browse by tags
Landsat
MODIS
Sentinel
API Docs
palmer
pdsi
precipitation
runoff
temperature
vapor
wind
Description
Bands
Image Properties
Terms of Use
Citations
TerraClimate is a dataset of monthly climate and climatic water balance for global terrestrial surfaces. It uses climatically aided interpolation, combining high-spatial resolution climatological normals from the WorldClim dataset, with coarser spatial resolution, but time-varying data from CRU Ts4.0 and the Japanese 55-year Reanalysis (JRA55). Conceptually, the procedure applies interpolated time-varying anomalies from CRU Ts4.0/JRA55 to the high-spatial resolution climatology of WorldClim to create a high-spatial resolution dataset that covers a broader temporal record.
Temporal information is inherited from CRU Ts4.0 for most global land surfaces for temperature, precipitation, and vapor pressure. However, JRA55 data is used
data had zero climate stations contributing (including all of Antarctica, and parts of Africa, South America, and scattered islands). For primary climate variables c
pressure, and precipitation, the University of Idaho provides additional data on the number of stations (between 0 and 8) that contributed to the CRU Ts4.0 data u
JRA55 was used exclusively for solar radiation and wind speeds.
for regions where CRU
l temperature, vapor
sed by TerraClimate.
TerraClimate additionally produces monthly surface water balance datasets using a water balance model that incorporates reference evapotranspiration, precipit
interpolated plant extractable soil water capacity. A modified Thornthwaite-Mather climatic water-balance model and extractable soil water storage capacity data
from Wang-Erlandsson et al. (2016).
ation, temperature, and
was used at a 0.5° grid
Data Limitations:
1. Long-term trends in data are inherited from parent datasets. TerraClimate should not be used directly for independent assessments of trends.
2. TerraClimate will not capture temporal variability at finer scales than parent datasets and thus is not able to capture variability in orographic precipitation r
3. The water balance model is very simple and does not account for heterogeneity in vegetation types or their physiological response to changing environme
ntios and inversions.
4. Limited w balance model is very simple and does not account for heterogeneity in vegetation types or their physiological response to changing envir
ntal conditions.


Earth Engine Data Catalog
Search
Description
Bands
Image Properties
Terms of Use
Citations
Resolution
4638.3 meters
Bands
Name Units Min Max Scale Description
aet mm 0* 3140* 0.1 Actual evapotranspiration, derived using a one-dimensional soil water balance model
def mm 0* 4548* 0.1 Climate water deficit, derived using a one-dimensional soil water balance model
pdsi -4317* 3418* 0.01 Palmer Drought Severity Index
pet mm 0* 4548* 0.1 Reference evapotranspiration (ASCE Penman-Monteith)
pr mm 0* 7245* Precipitation accumulation
ro mm 0* 12560* Runoff, derived using a one-dimensional soil water balance model
soil mm 0* 8882* 0.1 Soil moisture, derived using a one-dimensional soil water balance model
srad W/m^2 0* 5477* 0.1 Downward surface shortwave radiation
swe mm 0* 32767* Snow water equivalent, derived using a one-dimensional soil water balance model
tmmn °C -770* 387* 0.1 Minimum temperature
tmmx °C -670* 576* 0.1 Maximum temperature
vap kPa 0* 14749* 0.001 Vapor pressure


Earth Engine Data Catalog
Search
Description
Bands
Image Properties
Terms of Use
Citations
Resolution
4638.3 meters
Bands
Name Units Min Max Scale Description
aet mm 0* 3140* 0.1 Actual evapotranspiration, derived using a one-dimensional soil water balance model
def mm 0* 4548* 0.1 Climate water deficit, derived using a one-dimensional soil water balance model
pdsi -4317* 3418* 0.01 Palmer Drought Severity Index
pet mm 0* 4548* 0.1 Reference evapotranspiration (ASCE Penman-Monteith)
pr mm 0* 7245* Precipitation accumulation
ro mm 0* 12560* Runoff, derived using a one-dimensional soil water balance model
soil mm 0* 8882* 0.1 Soil moisture, derived using a one-dimensional soil water balance model
srad W/m^2 0* 5477* 0.1 Downward surface shortwave radiation
swe mm 0* 32767* Snow water equivalent, derived using a one-dimensional soil water balance model
tmmn °C -770* 387* 0.1 Minimum temperature
tmmx °C -670* 576* 0.1 Maximum temperature
vap kPa 0* 14749* 0.001 Vapor pressure

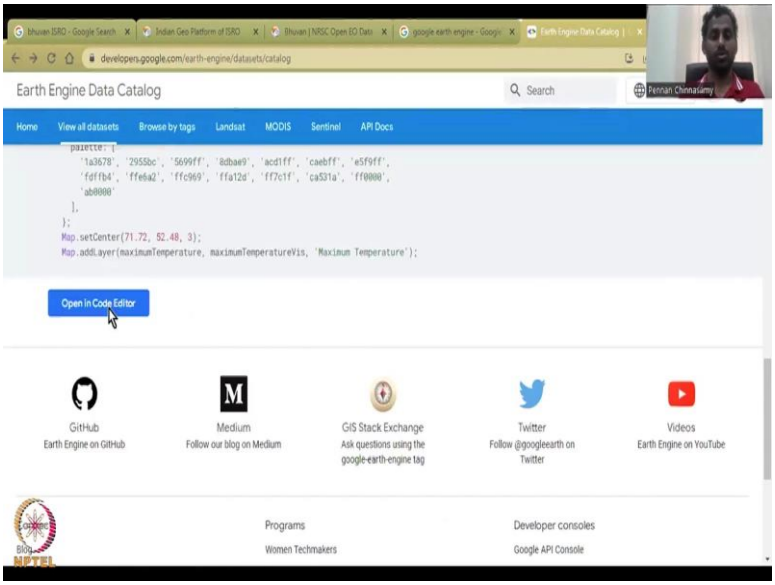
I am going to click the Terra climate. So, I will show you how to read the data out. Once you click the Terra climate, the meta data or the data about the data comes in, and then you can see the description and read how to get the data look at the data. In the bands you can click and see what is each band let it to, what is the data available. So, as I said, we want the reference evapo-transpiration and accumulation or precipitation. So, you have ET, the reference evapo-transpiration has given as millimeters same unit, the minimum is 0 maximum is 4548 millimeters.

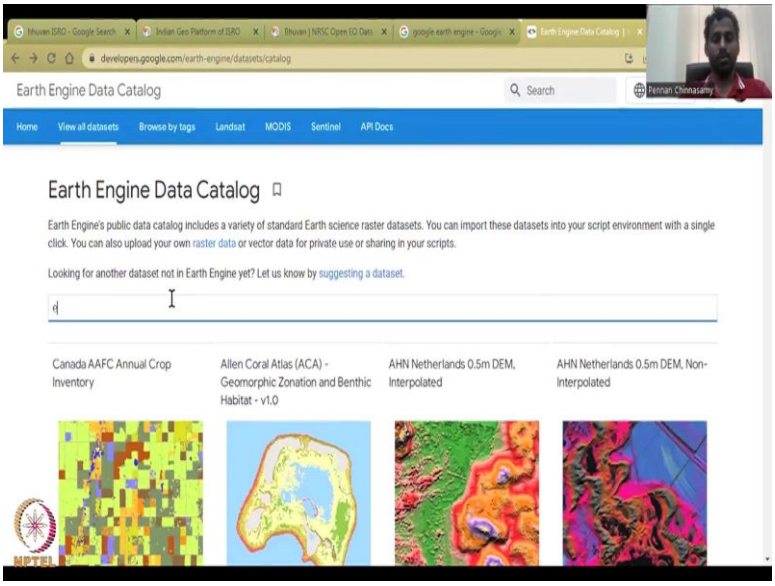
(Refer Slide Time: 27:47)

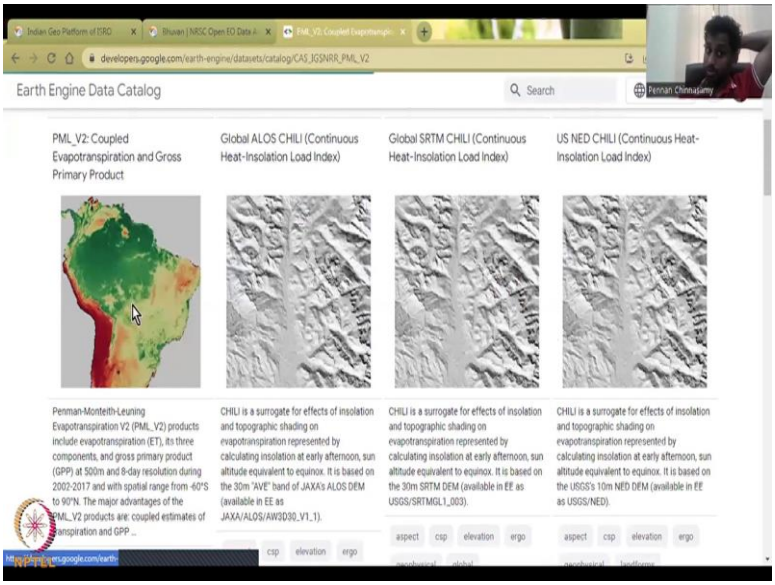


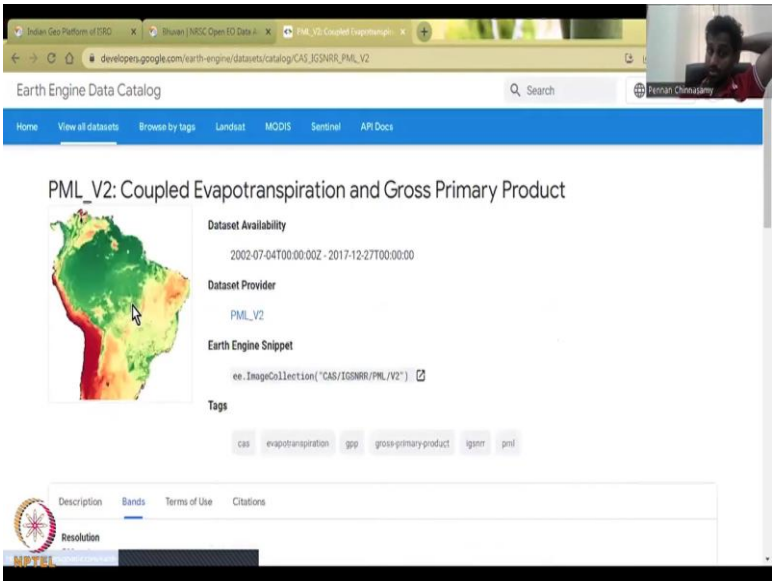
Then you have max and min temperatures. The good thing about this is when you download this data, you can readily apply it to your GIS platforms, so that you can download the data and work on the water budget equation. So, here you will see one satellite can give you well speed, vapor pressure, maximum-minimum temperatures, surface short radiation, how much radiation comes in, and then, soil radiation, soil moisture, data, runoff, precipitation, reference ET, all these things.

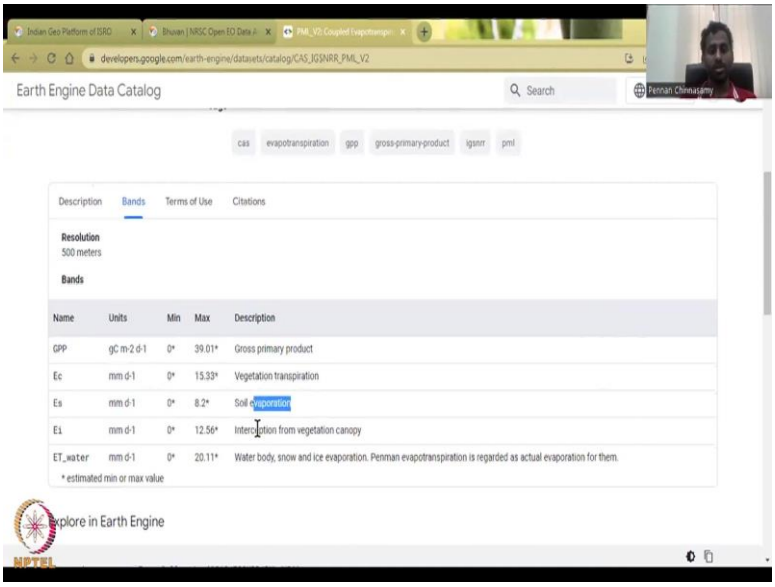
(Refer Slide Time: 28:29)

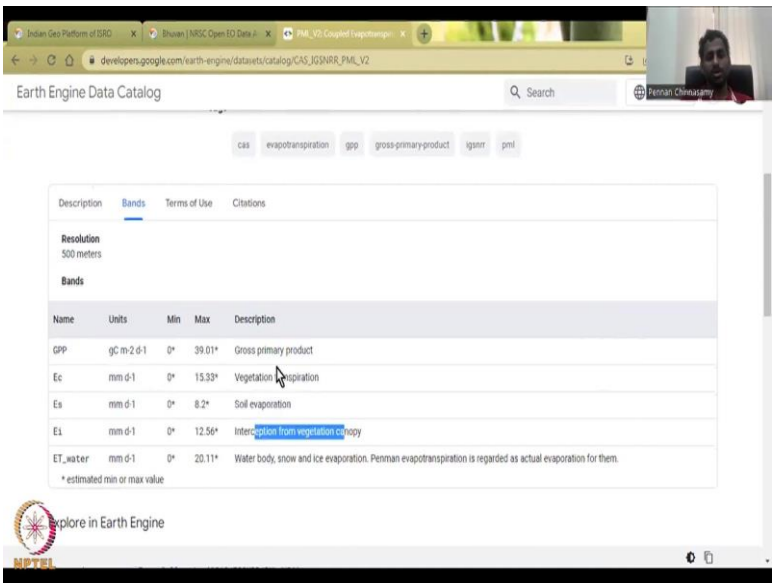


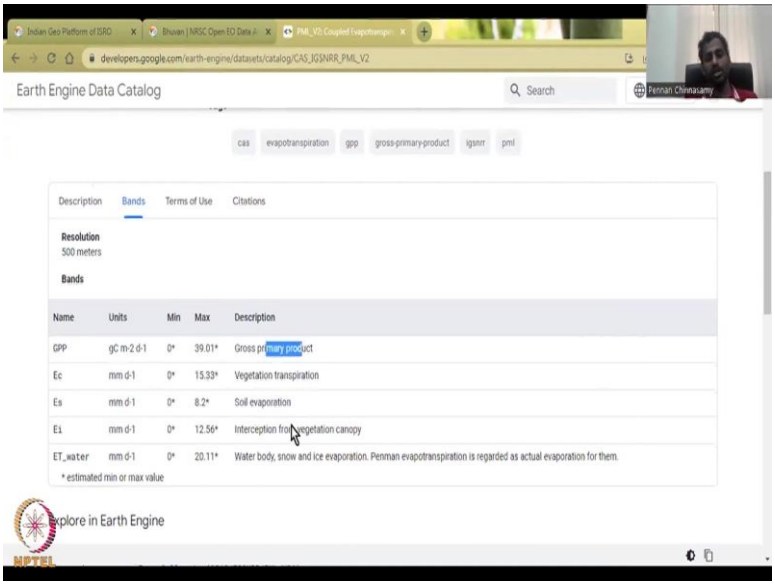


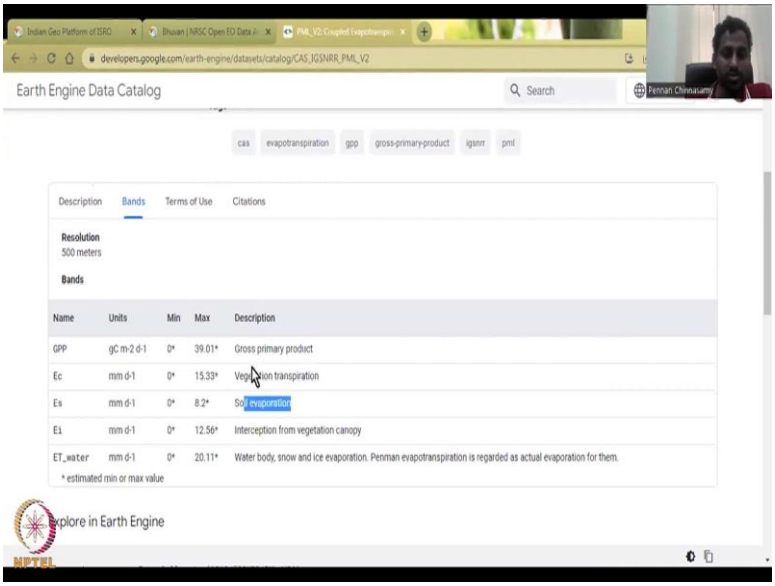


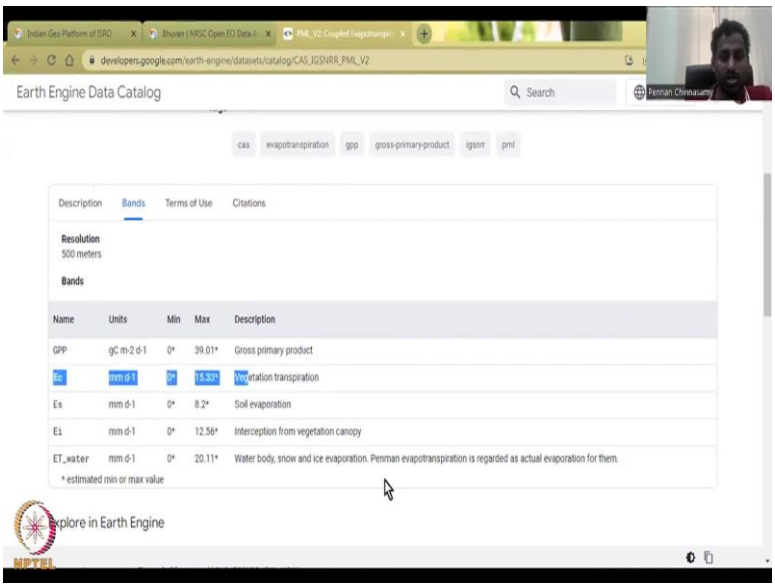

Earth Engine Data Catalog
Search
Pennan Chinnasamy
Home
View all datasets
Browse by tags
Landsat
MODIS
Sentinel
API Docs
PML_V2: Coupled Evapotranspiration and Gross Primary Product
Dataset Availability
2002-07-04T00:00:00Z - 2017-12-27T00:00:00
Dataset Provider
PML_V2
Earth Engine Snippet
ee.ImageCollection("CAS/IGSNRR/PML/V2")
Tags
cas
evapotranspiration
gpp
gross-primary-product
igsnrr
pml
Description
Bands
Terms of Use
Citations
Resolution
NPTEL


Earth Engine Data Catalog
Search
Pennan Chinnasamy
cas
evapotranspiration
gpp
gross-primary-product
igsnrr
pml
Description
Bands
Terms of Use
Citations
Resolution
500 meters
Bands
Name
Units
Min
Max
Description
GPP
gC m-2 d-1
0*
39.01*
Gross primary product
Ec
mm d-1
0*
15.33*
Vegetation transpiration
Es
mm d-1
0*
8.2*
Soil evaporation
Ei
mm d-1
0*
12.56*
Interception from vegetation canopy
ET_water
mm d-1
0*
20.11*
Water body, snow and ice evaporation. Penman evapotranspiration is regarded as actual evaporation for them.
* estimated min or max value
Explore in Earth Engine
NPTEL


Earth Engine Data Catalog
Search
Pennan Chinnasamy
cas
evapotranspiration
gpp
gross-primary-product
igsnrr
pml
Description
Bands
Terms of Use
Citations
Resolution
500 meters
Bands
Name
Units
Min
Max
Description
GPP
gC m-2 d-1
0*
39.01*
Gross primary product
Ec
mm d-1
0*
15.33*
Vegetation transpiration
Es
mm d-1
0*
8.2*
Soil evaporation
Ei
mm d-1
0*
12.56*
Interception from vegetation canopy
ET_water
mm d-1
0*
20.11*
Water body, snow and ice evaporation. Penman evapotranspiration is regarded as actual evaporation for them.
* estimated min or max value
Explore in Earth Engine
NPTEL

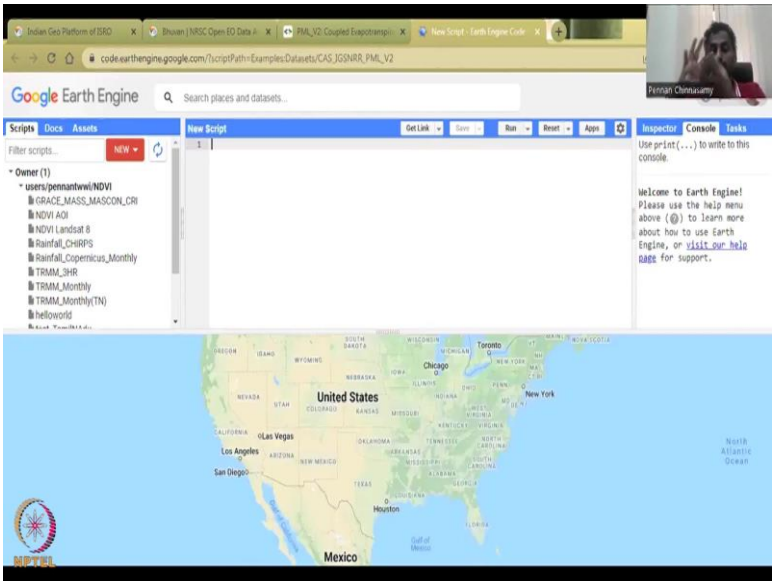

Earth Engine Data Catalog
Search
Description
Bands
Terms of Use
Citations
Resolution
500 meters
Bands
Name Units Min Max Description
GPP gC m-2 d-1 0* 39.01* Gross primary product
Ec mm d-1 0* 15.33* Vegetation transpiration
Es mm d-1 0* 8.2* Soil evaporation
Ei mm d-1 0* 12.56* Interception from vegetation canopy
ET_water mm d-1 0* 20.11* Water body, snow and ice evaporation. Penman evapotranspiration is regarded as actual evaporation for them.
* estimated min or max value
Explore in Earth Engine


Earth Engine Data Catalog
Search
Description
Bands
Terms of Use
Citations
Resolution
500 meters
Bands
Name Units Min Max Description
GPP gC m-2 d-1 0* 39.01* Gross primary product
Ec mm d-1 0* 15.33* Vegetation transpiration
Es mm d-1 0* 8.2* Soil evaporation
Ei mm d-1 0* 12.56* Interception from vegetation canopy
ET_water mm d-1 0* 20.11* Water body, snow and ice evaporation. Penman evapotranspiration is regarded as actual evaporation for them.
* estimated min or max value
Explore in Earth Engine


Earth Engine Data Catalog
Search
Description
Bands
Terms of Use
Citations
Resolution
500 meters
Bands
Name Units Min Max Description
GPP gC m-2 d-1 0* 39.01* Gross primary product
Ec mm d-1 0* 15.33* Vegetation transpiration
Es mm d-1 0* 8.2* Soil evaporation
Ei mm d-1 0* 12.56* Interception from vegetation canopy
ET_water mm d-1 0* 20.11* Water body, snow and ice evaporation. Penman evapotranspiration is regarded as actual evaporation for them.
* estimated min or max value
Explore in Earth Engine

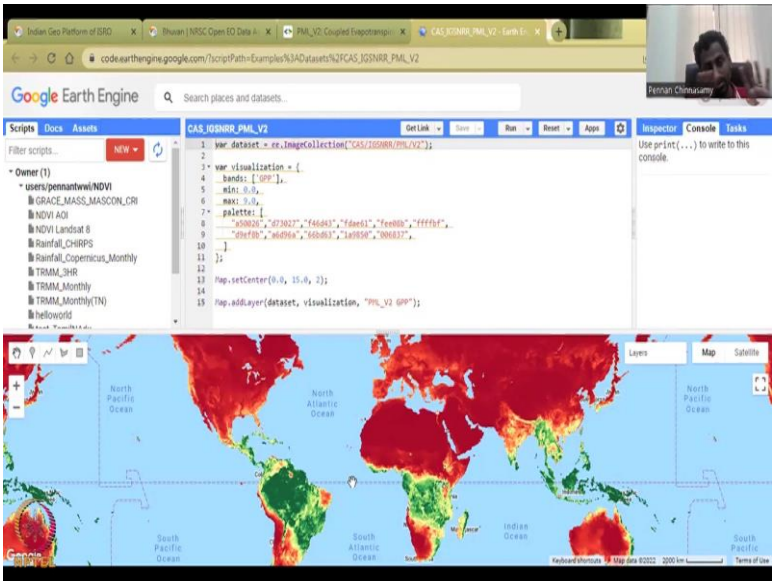
So, all this data is shown, I will also quickly give an example of the data. So, I am just going to come down and say open code editor. So, before that, it just went back to the search, let us say evapo-transportation, maybe for the band which I close all the. I am just using the first to see and then here you have the bands as a soil evaporation, interception, vegetation transpiration, say evaporation and transportation are kept separately.

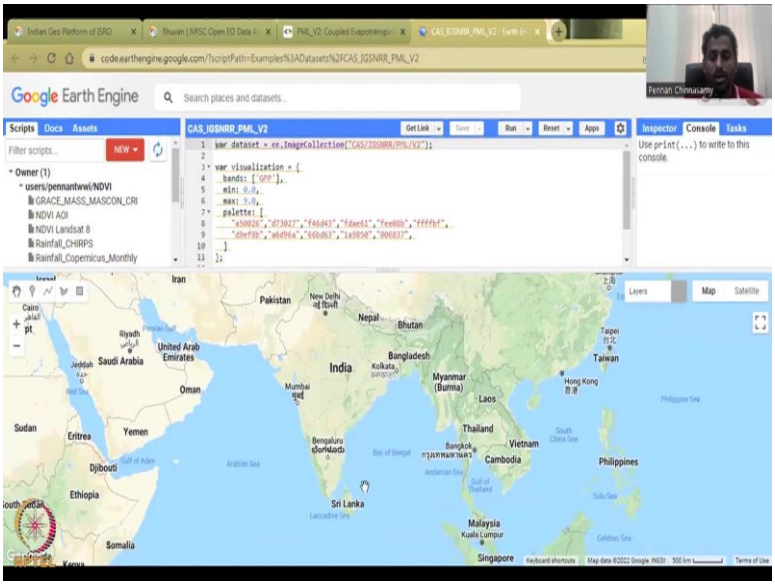
(Refer Slide Time: 29:18)

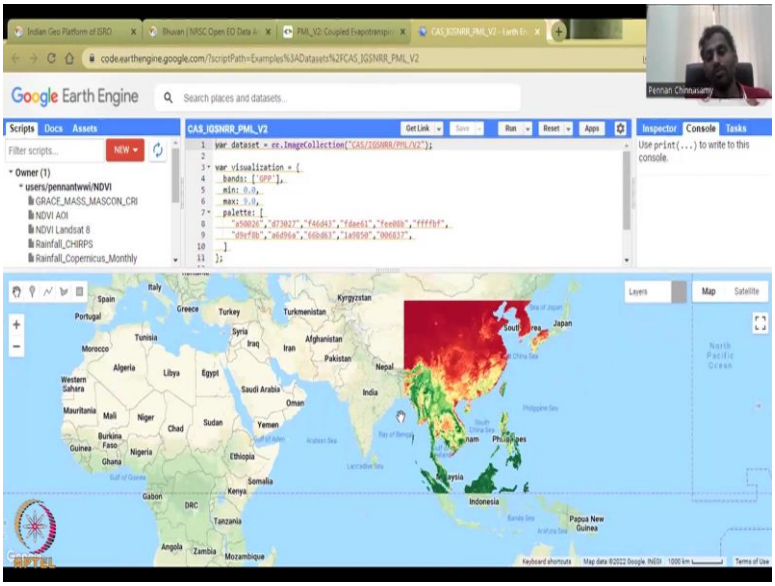


And then I can open it in code editor. So, in editor, the map will open. And this one does not pull down your system. If, for example, there is a lot of data, but it does not actually work on the data on your computer. It works silently behind, and this is a Google Earth Engine, the gearbox, which turns and collects data for you.

(Refer Slide Time: 29:42)







So, I am going to run this. Again, the code just gives you running of the layers and then the layers are plotted, what this code does, how it runs, etc. I would request you to read about these Google Earth Engines. My point here is show that there are multiple data available and different platforms available for rural water management. The whole world is now populated, you can see that it just runs back and forth because it is a complete picture of all the countries, but for us let us go to India.

India platform is shown and you can download the data it is just for India or other countries depending on what you want to work on. Here it is, we have data for India for soil moisture, open body transpiration, all these things, which are very-very useful for farmers, but you need to localize the solution given, giving an India size image may not get that much traction

from farmers, you need to give localize advisories and localize data. With this I am closing today’s session, thank you.