Remote Sensing and GIS for Rural Development
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Week – 7
Lecture – 34
Digital Elevation Models and Sources

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Hello everyone. Welcome to NPTEL course on Remote Sensing and GIS for Rural Development. This is Week 7 Lecture 4. In this week, we have been looking at certain aspects of extracting data from images and other resources like QGIS plugins, data repositories that can aid us in creating a database for rural development.

This is important because unlike urban development and urban scenarios, data for rural development may not be easily accessible. In such a case, we do need to provide data and or mind or proxy data that can support our argument. Saying no data for over the periods has been okay but now with remote sensing and GIS tools, one should not always say there is no data.

There is always some data that we could manage to procure and apply it for rural development. So, in the past three lectures in week 7, we have looked at exploring with Google Earth Pro and other resources and softwares that can aid us to collect data. QGIS plugin is one such data set that gives you a lot of data that is procured and provided by volunteers. So, let us continue that aspect and in today's lecture we will touch upon something very very important for land management in rural areas.

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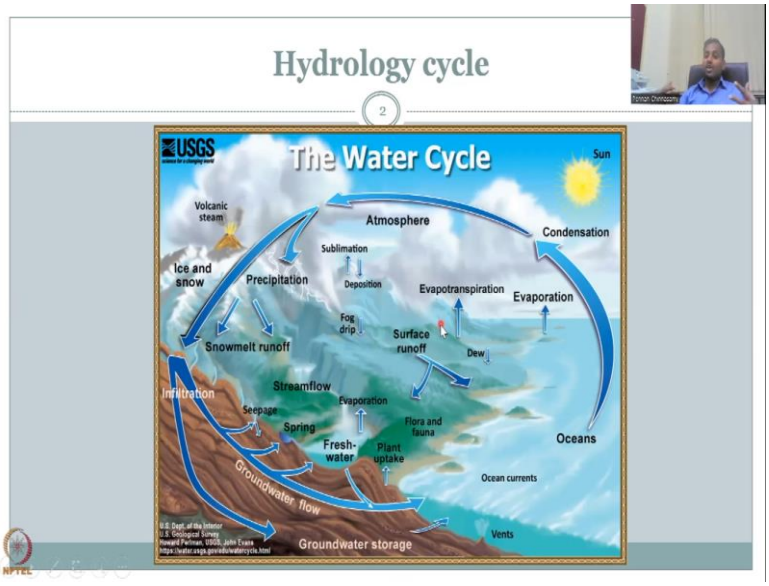

This is the basic hydrology diagram by USGS which is widely used. Hydrology is a study of movement of water. So, once you have rainfall, how it moves and distributes itself across the land is called hydrology. There is multiple components in hydrology like rainwater, surface water, soil water, ground water, oceans, seas, plant water, evaporation, water vapor, etcetera.

Of this, water goes through a cycle. You could see that how water starts in one part. Let us say take any any part for starting, let us say we start in the oceans. Due to sunlight and heat, water evaporates and then condenses into clouds, further condenses into precipitation. We have types of precipitation rainfall and snow and then you have sublimation deposition always a small small water hydrological components.

Most of it comes down as runoff, as a snow melt runoff or precipitation runoff. And then you have stream flow, stream revers networks, etcetera. All these happen when water hits the ground and the ground elevation, elevation as in the height differences between the ground, leads to water movement. If the land was like this and water falls, it wo not move anywhere because there is a gradient because there is a difference in height water moves. Water moves through gravity and water moves from high energy to low energy.

In other words from high potential to low potential or high elevation to low elevation. You do not see water moving from ground to tank without a pump. Naturally through gravity, tanks to tap and ground it flows. So, that is what this is about. If you have the brown part accurately assist, you can know how the water moves and then you can take a lot of management

practices into action. For that, we are in need of an elevation model, how is the land distributed in elevation.

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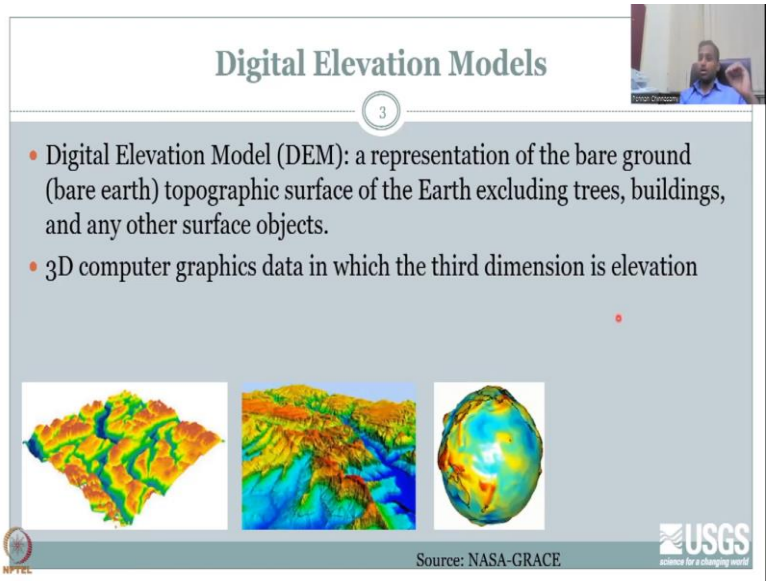

So, these are called digital elevation models. It is a model because like a globe is a model of the Earth, a 3D map is a model of the Earth, the elevation model, digital elevation model is the model of the elevation changes. In simple terms it is described as a representation of the bare ground which is the bare Earth, the solid part of the Earth, topographic surface of the Earth excluding trees, buildings and any other surface objects.

So, it is basically a ground, you do not add the trees, buildings and then say elevation is high. The land elevation from the sea level, the sea is zero and how is the land elevated. Because, if you say land is below sea level, sea is here, below the sea level, then water accumulates during floods and stuff. If you build stills, if you build pillars and then you put your house up that does not mean your land is elevated, your land is still low, only in some places engineeringly they elevate the land.

For example, Chicago they have elevated the stream bed, so that the water flows in opposite directions. So, they have a stream bed which is engineered in Chicago where in some parts of the monsoon, the water goes down and some parts of the mountain the water goes the other way because they can shift this elevation. It is very expensive and cannot be done everywhere.

So, normally you allow nature to take full control and the force of nature is very very powerful. So, the digital elevation model gives how the water moves because of elevation changes and it is the elevation or representation of the bare ground with nothing built on it. It is a 3D computer graphics data in which third dimension is the elevation. So, there are three dimensions X, Y is the location, X and Y two plane.

So, you have this is a two plane and then you have X and Y and Z. Z is your elevation, it can be up or down based on the relevance to sea level. So, in a raster data set, if you have a pixel, so, what would be in the pixel? It is the elevation, just one value for the entire raster. So, these are some examples taken from NASA.

The first example is you could say that the land is flat but then suddenly there are valleys, sudden jumps in the elevation like dips in the elevation, elevation so water would be going and moving down. Soil would erode down. And then the same thing you can see from a point of a ridge.

So, how you have small small hills and mountains taking shape and around it there is no elevation. The third image is very interesting. This is a satellite called Grace which I use a lot in my research work and you could see this is how the mass is distributed. It is not a smooth surface, the land is not smoothly elevated like we assume.

It is having ups and downs dips and highs and it is because of this it is squished from some angles. It is not a perfectly sphere. You do not get an orange perfectly without engineering it like it is like. So, some part little bit bulged out and then in a very very irregular shape. However, the closest shape that we can assume for this is a spheroid.

So, this spheroid is having mass at different different locations, like differences of masses are there and that mass is because a lot of mass is built on top of a layer which is the elevation and from there water can flow. Water or whatever you want to model, we will see some models. So, digital elevation model is a representation of the bare ground of the earth which gives you the elevation from as with respect to the zero level which is the sea level.

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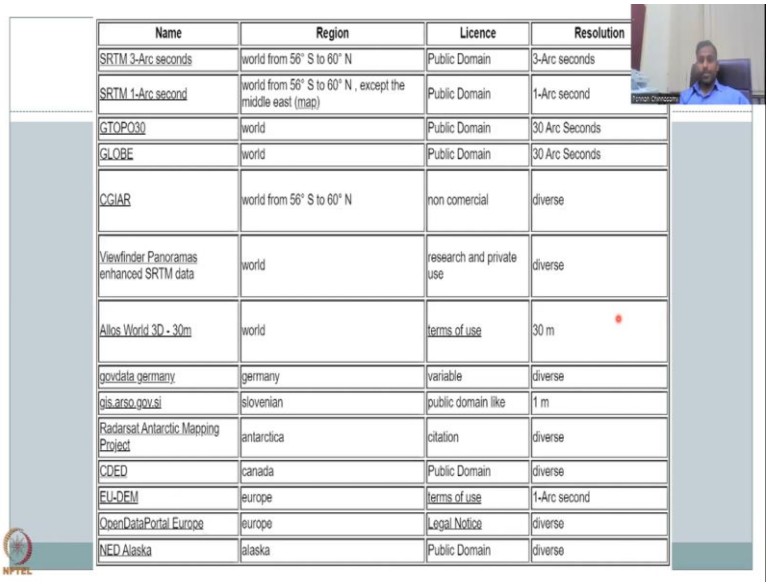

Name	Region	Licence	Resolution
SRTM 3-Arc seconds	world from 56° S to 60° N	Public Domain	3-Arc seconds
SRTM 1-Arc second	world from 56° S to 60° N , except the middle east (map)	Public Domain	1-Arc second
GTOPO30	world	Public Domain	30 Arc Seconds
GLOBE	world	Public Domain	30 Arc Seconds
CGIAR	world from 56° S to 60° N	non comercial	diverse
Viewfinder Panoramas enhanced SRTM data	world	research and private use	diverse
Allos World 3D - 30m	world	terms of use	30 m
govdata germany	germany	variable	diverse
gis.arso.gov.si	slovenian	public domain like	1 m
Radarsat Antarctic Mapping Project	antarctica	citation	diverse
CDED	canada	Public Domain	diverse
EU-DEM	europe	terms of use	1-Arc second
OpenDataPortal Europe	europe	Legal Notice	diverse
NED Alaska	alaska	Public Domain	diverse

There are multiple multiple sources of data and a lot of this has been still updated. It is keep on updating. Some database is given here for your reference. Just look at the names, the regions that have been expanded now, the resolutions have been increased. You have SRTMs, 3 Arc seconds, 1 Arc second and then 1 Arc is approximately 30 meters to along the equator.

It differs where you are. And then you have a GTOPO 30, 30 meter resolution, 30 Arc second resolution, the globe is a 30 Arc second resolution, CGIAR gives you diverse resolutions which means in some areas like for example, the Indian regions, you get around 30 meter by 30 meter resolution and then you have SRTM, Viewfinder Panoramas, Allos, Germany and then Radar CDED European Union, 1 Arc second, 1 meter resolution in the Slovenian countries, Canada, Europe, Alaska, all have different different resolutions.

Some of these are national missions where they understand the importance of a DEM and so they have high cost instrumentations or data collecting pathways and then they keep collecting data, so that they can have a high resolution DEM. These DEM are very expensive or very low cost depending on the resolution. So, if you are using some methodologies like satellites, it is less costly whereas some others are very very costly.

One thing you should understand is the land surface does not change abruptly. So, you would not take, you do not need to take this at a high spatial resolution like monthly, annually, etcetera, once in five years, once in six years, ten years. that is what the normal is. If there is

an earthquake or an actual calamity then people would, the scientists would quickly take the elevation changes, otherwise the elevation does not change.

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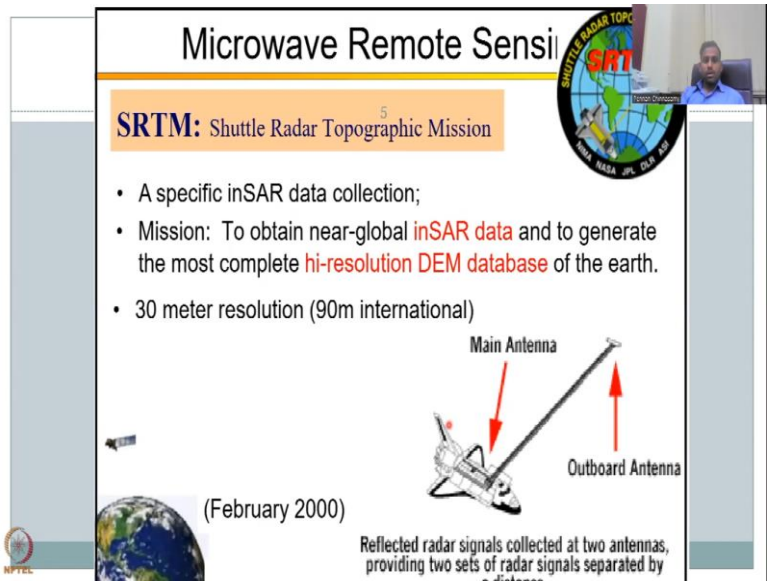

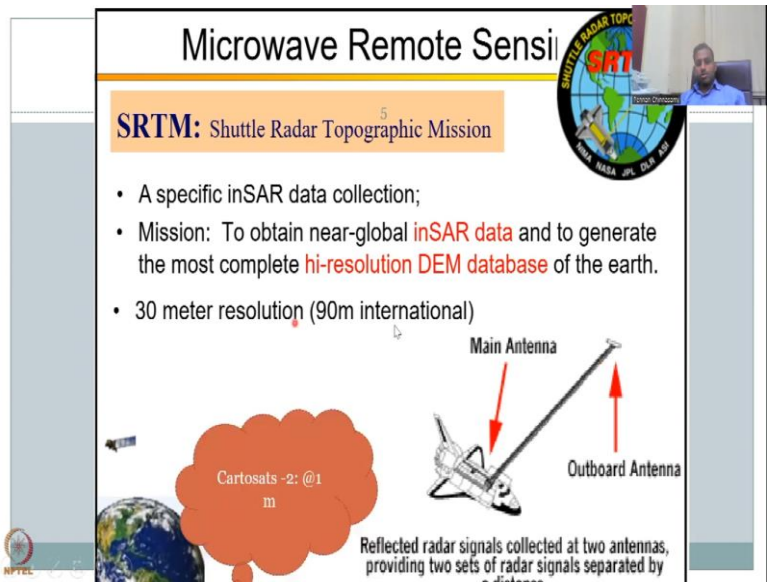

So, let us look at some of the data types. So, one is microwave remote sensing. They are using the SRTM mission which is the shuttler radar topographic mission from the NASA. You could see that it has a main antenna on board and then there is non-board antenna where it sends data and picks up data from NASA.

So, these are kind of active sensors where micro radio waves are sent, bounce back from the earth and comes back. So, once the velocity with which the waves are being sent and then it bounces back at a particular level then what is the elevation. So, 30 meter resolution and 90

meters international, so most of the reservations are very high. The Carter set 2 which is an Indian mission, similar mission has 1-meter resolution. These are the updated resolutions. And you would see that the resolutions are getting better and better every two three years once because a lot of investments have been done on this.

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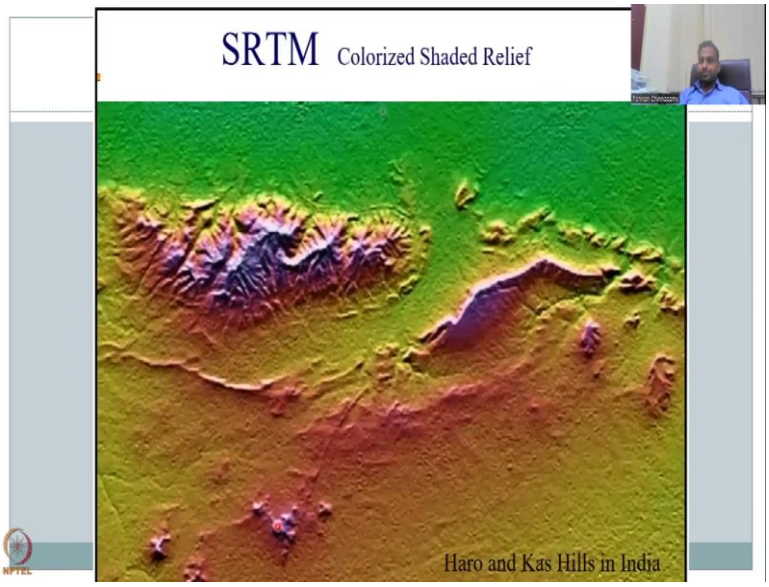

This gives an example the SRTM and the U.S. NASA product for Haro and Kas Hills in India and you could see that the high elevations are given as pink and violet color and then the lower elevations are green. So, you see how a hill is looking at not a smooth surface but a high gradient and then the there is a slope.

There is a slope and a low height. This is very very important because now we know where soil erosion can happen where people should not be building houses, rural evacuation areas, naturally high risk prone areas, we should know we should not be building houses or indulge in farming where it can disrupt the sustainability of the system.

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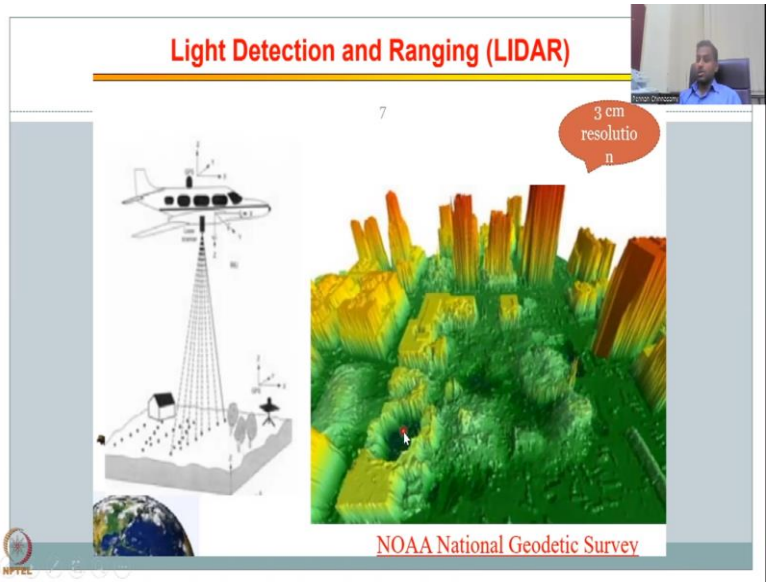

Then we have, so, the satellites are pretty expensive but then when you come to LIDAR, LIDAR resolution methods, you know that you have really really high resolution imagery. So, this is three-centimeter resolution where you could see that a plane is carrying a light detection and ranging called LIDAR.

It is an instrument which sends light pulses and the same as radar. It knows how fast the light particles move and when it hits and comes back you know the distance, the distance between the plane and the bare surface and that is the elevation. Because the plane's height is known with respect to sea level and when it bounces and backs, comes back, we know the time taken by the pulse to come down and up and that gives you the resolution in elevation.

So, three-centimeter resolution is taken by LIDAR and these are done by NOAA which is in a U.S. agency and you can see that how they have invested in taking these LIDAR images. These are not bare Earth. So, this is not a DEM but a full picture of the elevation with trees and canopies and buildings.

So, this is also important because when you have this data and take off the ground data, now you know the height of the trees and the associated particles. These are very important to use in terms of finding new developments or forest station or a forest station, how the plants, trees, etcetera grow and where pockets of low elevation develop which could be leading to flood prone regions or using a spawn city concept where you can divert the floods and store it here.

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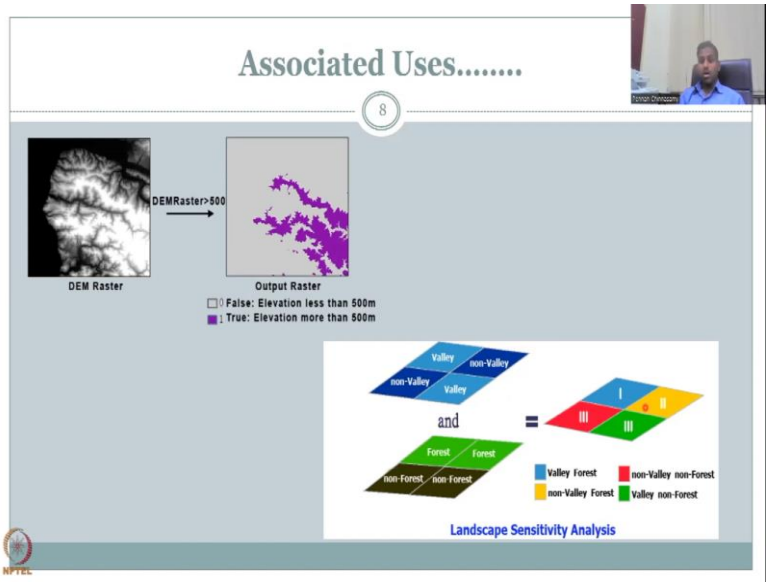

Let us look at some associated uses before we jump into one example of a DEM. Let us take a DEM. DEMs are always rasters. Why? Because it is not a point data, it is a continuous data and as I said it is grided, each pixel has a value and the value is a elevation. The elevation could be in feet, meters depending on the satellites specification.

So, now you have a DEM and then you say that let me take each pixel and then put a filter saying that only elevation above 500 meters should be allowed or it says to pass through the filter. So, now a DEM which has all elevations is passed through and then you can have only the high elevations, above 500 meters. And now you have valley and non-valley.

Valleys are low elevations gradients with non-valleys of the high. And then you have forest and non-forest which is the land use land cover. So, if you club these two, if you club the valley at the high elevation, low elevation and then the land cover then you have landscape sensitivity analysis. Which is a different coloring of the landscape which gives you a valley forest, non-valley forest, non-valley non-forest, valley and non-forest.

So, you have multiple permutation combinations which are very important for biodiversity, plants, insects, animal, livelihood, etcetera. So, especially these are very important in rural regions where agroforestries is practiced. Because agroforestry means you have to merge with the forest and conduct agricultural practices, not erasing the forest. So, this type of activities are highly appreciated there.

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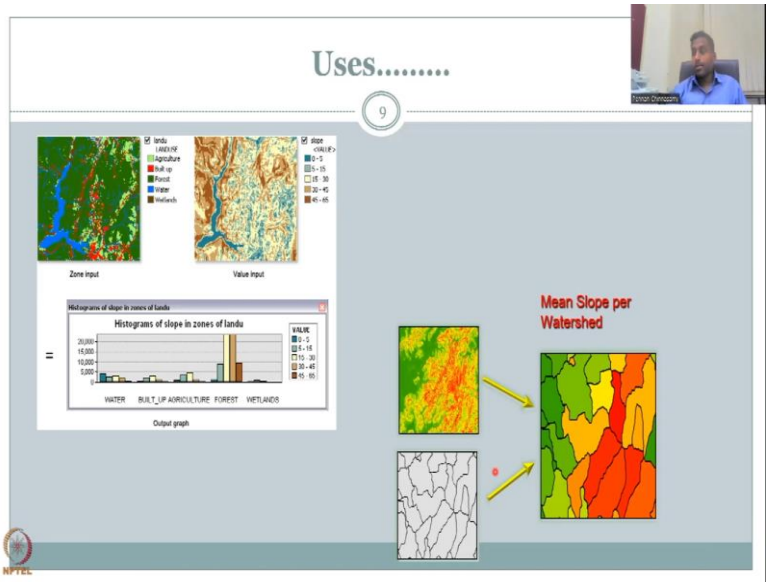

One more use we will see before we go into the Bhuvan data set. So, you can actually take a land use land cover, let us say land use land cover is taken from a landsat and then DEM is taken from SRTM and then what you can do is if you know the elevation and the gradients, you can estimate the slope.

So, through GIS, you can say, okay, this is the raster, this is the elevation, give me the slopes. So, the elevations are converted to slope. So, two elevations are there and if there is a gradient, if there is a fall or a high climbing radiant, rising radiant then you have a slope, the slope can be negative or positive.

So, these slope values are merged with the land use land cover to estimate mean slope per watershed area and where water accumulates or where land and soil can be protected. Because when water moves, it erodes soil, it erodes plant life, etcetera. And when it comes in stagnates or slowly flows, not fast flow, flow of waterfalls when it is flows slowly that is where life form thrives, fish, insects thrive and that contributes to agricultural productivity.

If it flows fast then the top soil is removed and you have erosion and the plants are disturbed, the agricultural productivity is disturbed. So, the best idea is to slow down the water, capture most of the water and use it for agriculture, rather than letting it pass through as a flood water.

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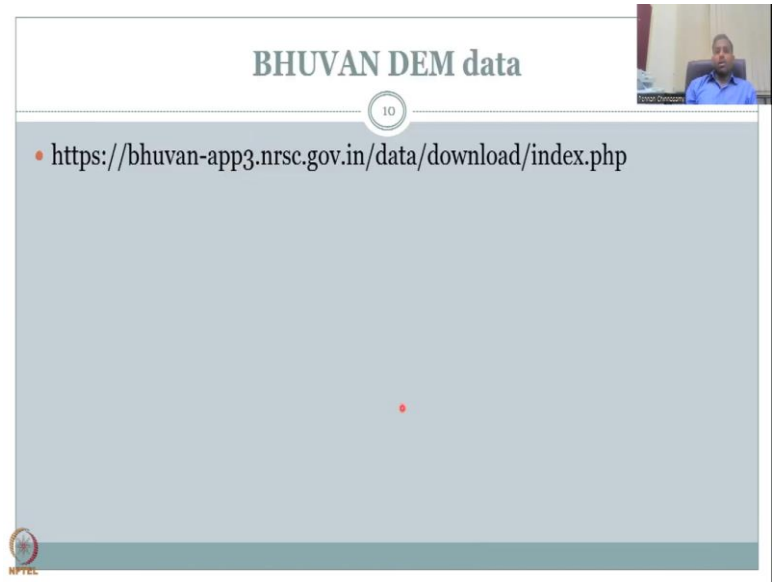

So, there are multiple data sets but let us first promote our own ISRO data set and we have this link which I have taken from Bhuvan. I will show you now how to access it and then read through the materials available for creating a DEM data set or understanding where the data is and how it looks like. So, let me share the screen for the Bhuvan link that I have shared.

Let us, I will open the Bhuvan main page, so that you understand that we are going to anyway sometimes the links might change but the main page looks like this. The Bhuvan main page. So, in the Bhuvan main page you will go to open data archive and then when you come to open data archive.

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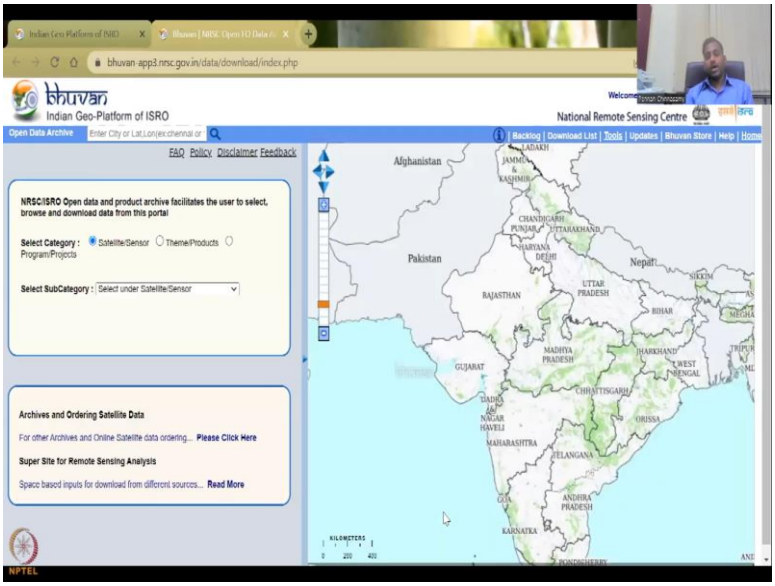

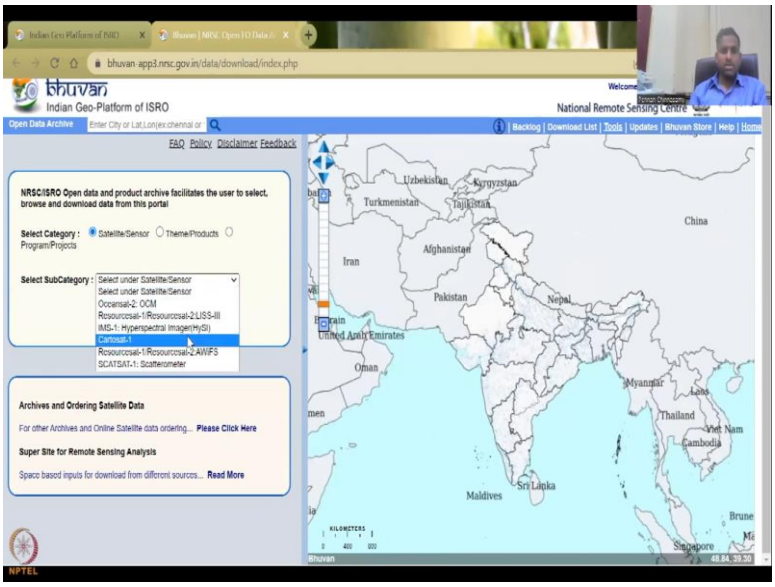

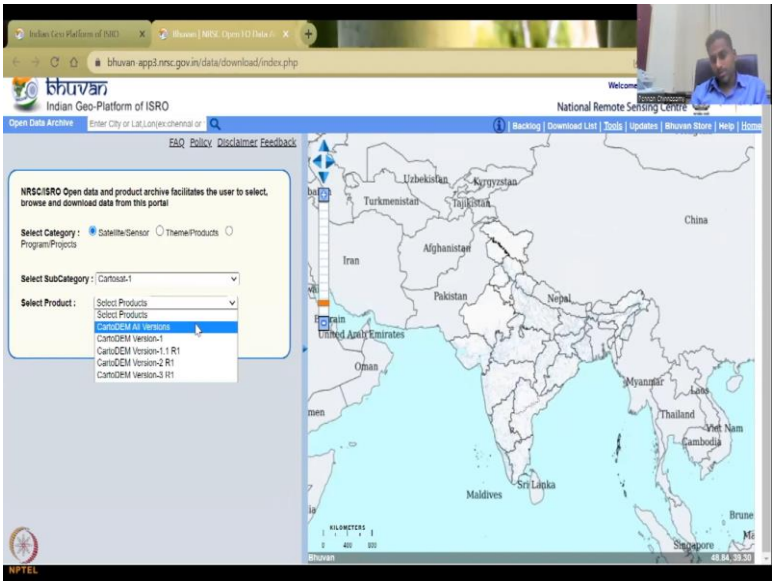

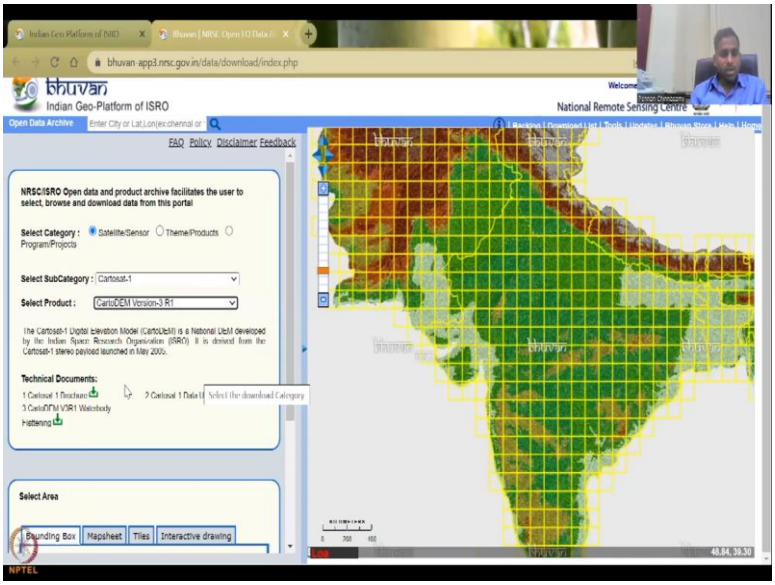

You will have this India picture that we have looked at in previous examples. And you have satellite, sensor, theme, products or programs and projects. In the satellite sensors, as I mentioned earlier, you can go to Cartosat-1 and you can see all the DEM versions. The highest versions 3 R but let us read through it and then let us read through.

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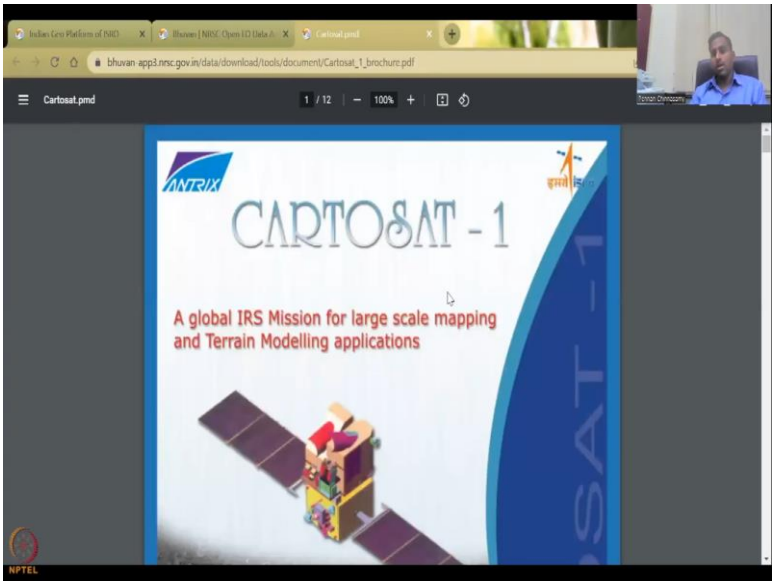


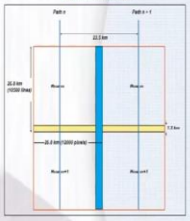
Cartosat-1 is a global mission. The nominal life of the mission is planned to be five years. The satellite was launched by the indigenously built Polar Satellite Launch Vehicle (PSLV - C5). The satellite covers the entire globe in 1867 orbits with a repetivity of 126 days. Adjacent paths are covered with a separation of eleven days.

The Cartosat-1 satellite has two panchromatic cameras with 2.5 m spatial resolution, to acquire two images simultaneously, one forward looking (FORE) at +26 degrees and one aft of the satellite at -5 degrees for near instantaneous stereo data.The time difference between the acquisitions of the same scene by the two

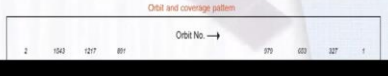
Orbit Specifications

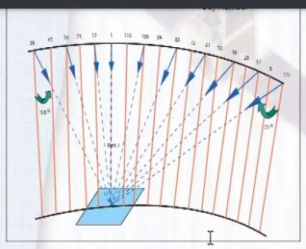
S.No	Parameter	Specifications
01	Orbit	Polar Sun Synchronous
02	Orbital Altitude	618 km
03	Orbits / cycle	1867
04	Semi Major Axis	6996.14 km
05	Eccentricity	0.001
06	Inclination	97.87 °
07	Local Time	10:30 AM
08	Revisit	5 days
09	Repetition	126 days
10	Orbits / day	14
11	Orbital Period	97 minutes

Stereo Scene Layout



Orbit and coverage pattern





swath images of 55 km are obtained by the cameras. The spacecraft also has a facility to provide various pitch-biases to vary the look angle conditions of the stereo pair.

The satellite covers the same area in a specified interval of 126 days.Cartosat-1's roll tilt capability can be used to increase this viewing frequency, which varies with latitude. The revisit capability at equator is 5 days.

Data Handling system

The data rate requirement for 2.5 m resolution system is about 336 Mbps for a 10 bit quantization. This high bit data is compressed by 3.2:1 by JPEG compression technique. A spherical Phased Array Antenna with steerable beam is used to transmit the data to the required ground station. A solid state recorder with 120 Gb capacity to store about 9 minutes of Payload data is available for global operation of the payloads.

produce high precision products by using control points / external DEM in the commercially available off-the-shelf (COTS) software. It is recommended to use software packages, certified by Department of Space, for better results.

Stereo Products

Scene based stereo products are supplied with only radiometric corrections. Stereo data are supplied as digital products only. These products can be supplied in LGSOWG format and in GeoTIFF format with RPCs.

In the case of stereo data in LGSOWG format, radiometrically corrected data from both Fore and Aft cameras are provided. Stereo data in GeoTIFF format comprise of radiometrically corrected data from both Fore and Aft cameras and an RPC file.

products. These products can be supplied with different area coverages – 7 ½' x 7 ½' (both Survey of India (SOI) mapsheet based and floating), 5' x 5', 3.75' x 3.75' and 2.25' x 2.25'. All these products are supplied as a single product. Best efforts are made to provide the data with seamless radiometry in case the area is covered on two different dates.The location accuracy of these products will be better than 25m. For global users, these products can be supplied with the help of GCPs provided by the user.

So, this is the metadata if you click the metadata, it will open in another tab. So, this is the satellite, a global IRS mission for large-scale mapping and terrain modeling applications. So, it models a terrain for you and terrain modeling includes the land elevation, digital elevation model.

When you say digital surface model then it will also include all the buildings and trees and stuff. So, you can have some terrain which is capturing both the built and trees and areas and stuff as some only take the surface. So, here you could see that the resolutions orbit days 97 minutes what time it, this is 126 days. So, you have the repetition of your scenes and then how the image is being taken on day 1 and day 126. All these products are given and where to access it etcetera, etcetera.

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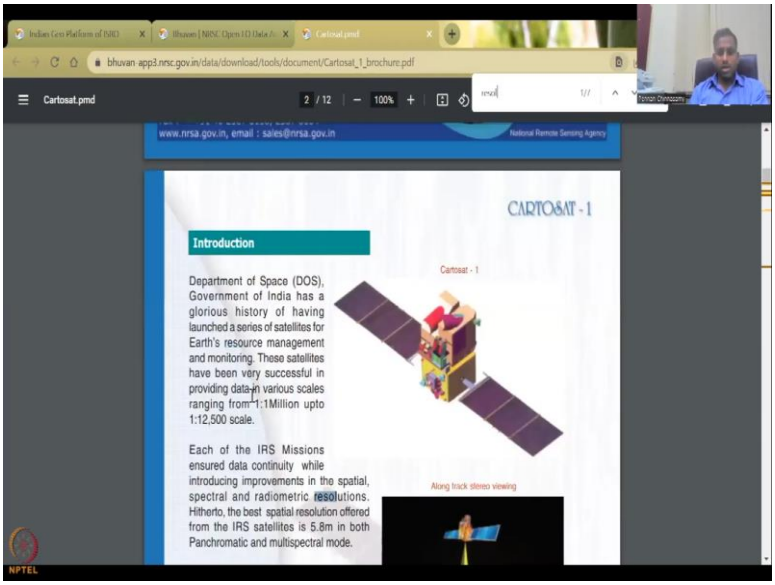

You can click on the resolution and it says that the radiometric resolutions Hitherto, the best spatial resolution offer from the IRS satellite is that 5.8 meters in both Panchromatic and multi-spectral mode. This is the cartosat-1. So, but not all areas you can get it for free for that resolution. Let us see how the resolution stays when it is being post processed.

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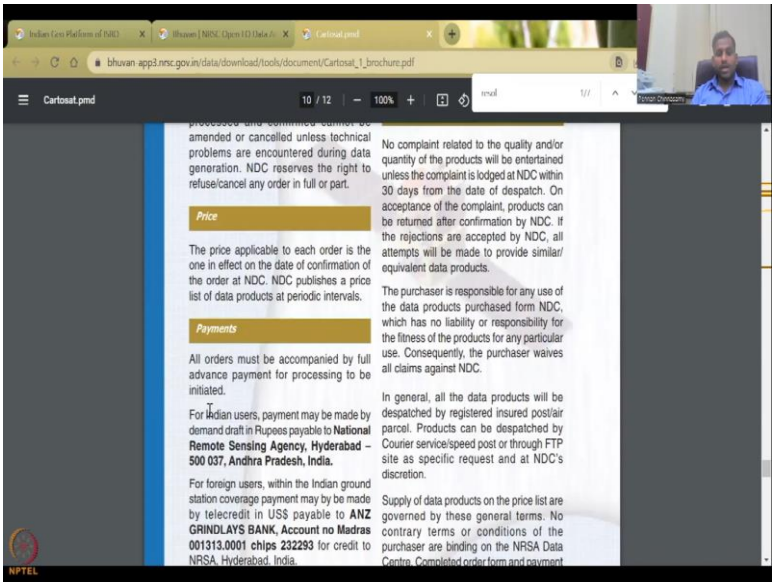

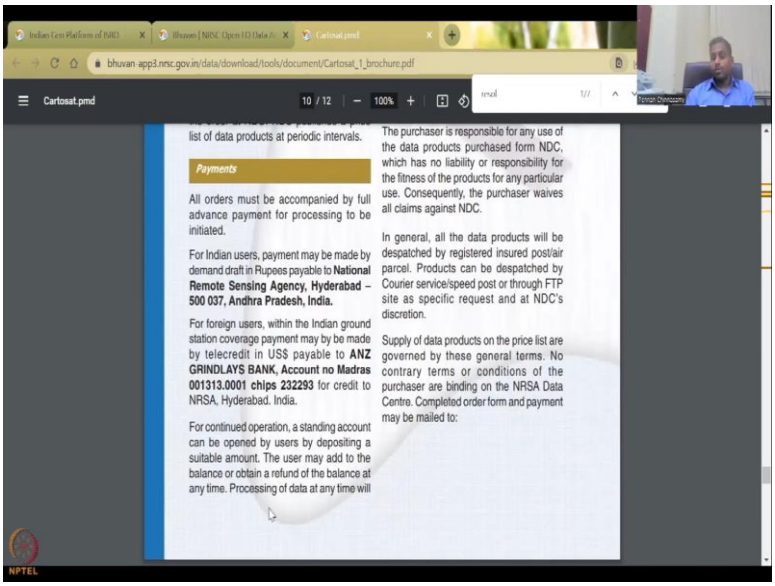

Sometimes you will have to pay money also. For Indian users payment may be made demand draft etcetera. But there are other ways where through research and education use, you can request Bhuvan ISRO team and through some agreements they may be considering some data which is for studies and academics. Because a lot of people do a business with this.

So, there are a lot of spatial data companies which are making a lot of money and using free open source data. So, to make sure that they can make money but the cost will be incurred by the user, to make sure that everyone uses it similarly, there is a price.

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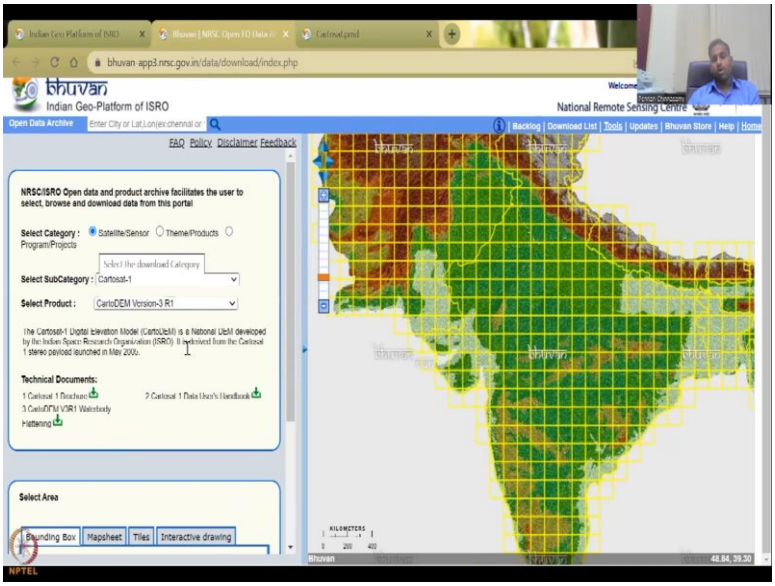

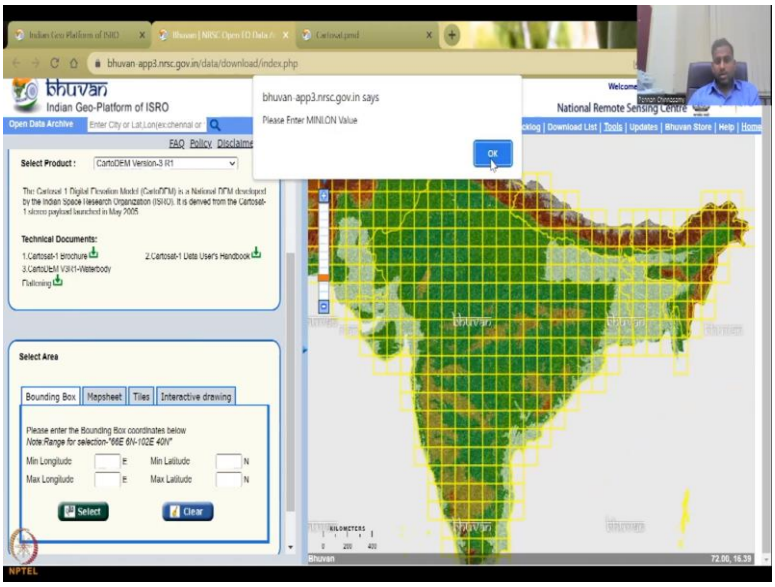

So, this is by satellite and sensor. So, we went to cartosat DEM version 3 1. Let us see what is the difference. So, you can put a bounding box. Let us say I am looking at Maharashtra and I click a bounding box. So, I select select. Please, enter Mn Ln value. If you do not have an Mn Ln value you can put the coordinates. We have seen this east, north, latitude, longitude coordinates, if you do not have it, you can draw. So, let us say I am going to draw.

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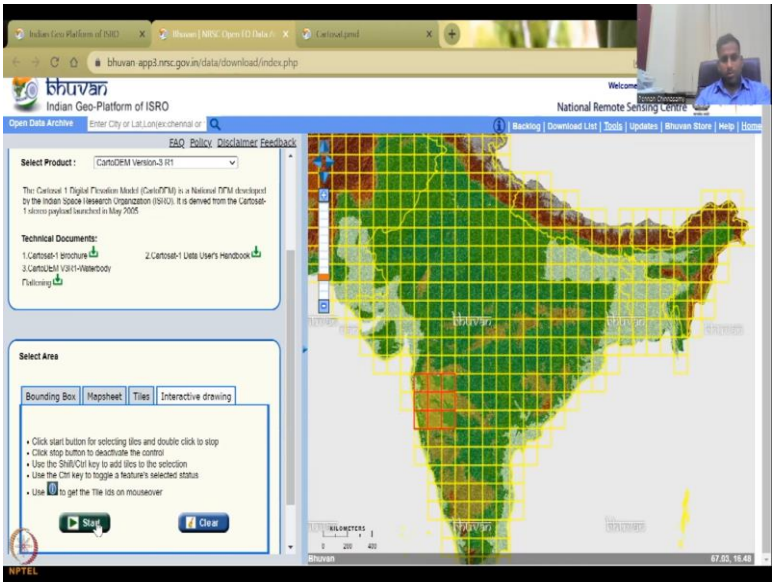

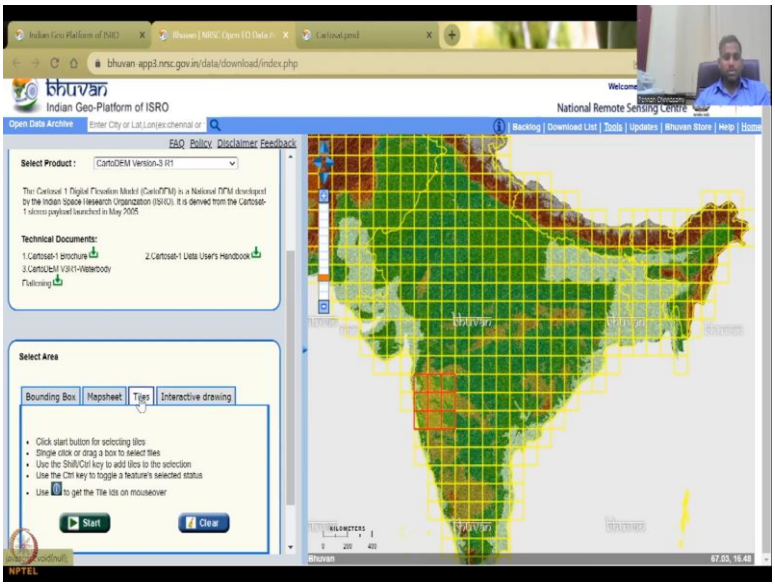

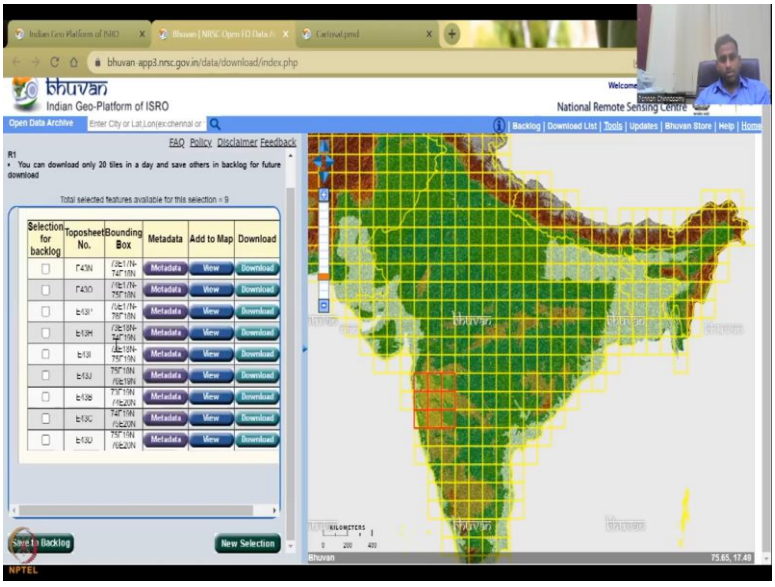

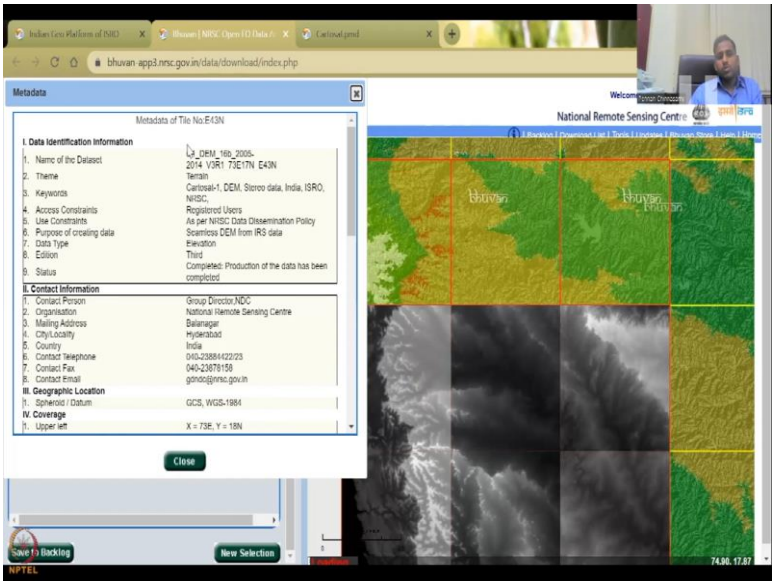
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Metadata
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I. Data Identification Information
1. Name of the Dataset: cartosat-1_DEM_16b_2005-2014_V3R1_73E17N_E43N
2. Theme: Terrain
3. Keywords: Cartosat-1, DEM, Stereo data, India, ISRO, NRSC,
4. Access Constraints: Registered Users
5. Use Constraints: As per NRSC Data Dissemination Policy
6. Purpose of creating data: Seamless DEM from IRS data
7. Data Type: Elevation
8. Edition: Third
9. Status: Completed: Production of the data has been completed
II. Contact Information
1. Contact Person: Group Director,NDC
2. Organisation: National Remote Sensing Centre
3. Mailing Address: Balanagar
4. City/Locality: Hyderabad
5. Country: India
6. Contact Telephone: 040-23884422/23
7. Contact Fax: 040-23878158
8. Contact Email: gdndc@nrsc.gov.in
III. Geographic Location
1. Spheroid / Datum: GCS, WGS-1984
IV. Coverage
1. Upper left: X = 73E, Y = 18N
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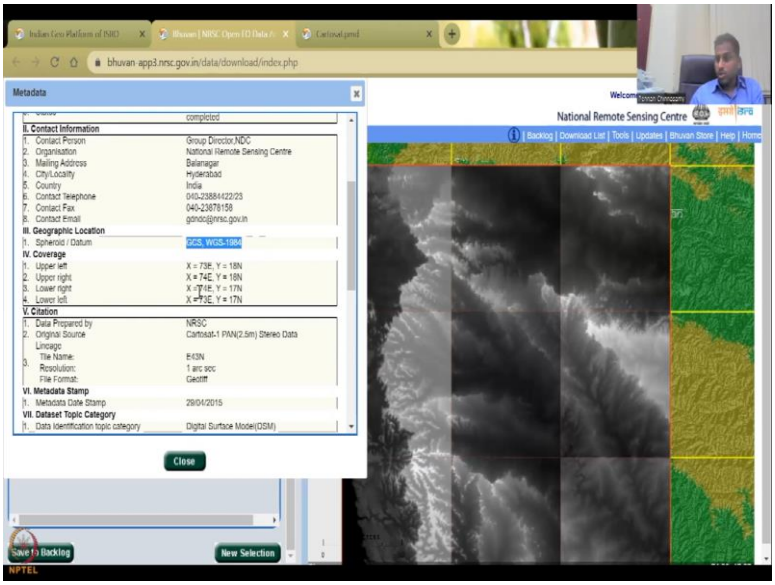
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Metadata
completed
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8. Contact Email: gdndc@nrsc.gov.in
III. Geographic Location
1. Spheroid / Datum: GCS, WGS-1984
IV. Coverage
1. Upper left: X = 73E, Y = 18N
2. Upper right: X = 74E, Y = 18N
3. Lower right: X = 74E, Y = 17N
4. Lower left: X = 73E, Y = 17N
V. Citation
1. Data Prepared by: NRSC
2. Original Source: Cartosat-1 PAN(2.5m) Stereo Data
3. Lineage: Tile Name: E43N, Resolution: 1 arc sec, File Format: Geotiff
VI. Metadata Stamp
1. Metadata Date Stamp: 29/04/2015
VII. Dataset Topic Category
1. Data Identification topic category: Digital Surface Model(DSM)
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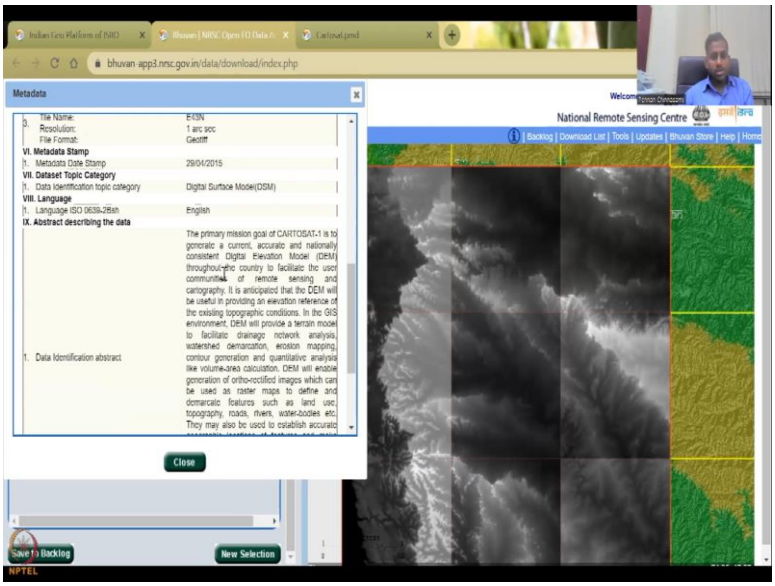
bhuvan-app3.nrsc.gov.in/data/download/index.php
Metadata
Tile Name: E43N
Resolution: 1 arc sec
File Format: Geotiff
VI. Metadata Stamp
1. Metadata Date Stamp: 29/04/2015
VII. Dataset Topic Category
1. Data Identification topic category: Digital Surface Model(DSM)
VIII. Language
1. Language ISO 0639-2Bsh: English
IX. Abstract describing the data
1. Data Identification abstract: The primary mission goal of CARTOSAT-1 is to generate a current, accurate and nationally consistent Digital Elevation Model (DEM) throughout the country to facilitate the user communities of remote sensing and cartography. It is anticipated that the DEM will be useful in providing an elevation reference of the existing topographic conditions. In the GIS environment, DEM will provide a terrain model to facilitate drainage network analysis, watershed demarcation, erosion mapping, contour generation and quantitative analysis like volume-area calculation. DEM will enable generation of ortho-rectified images which can be used as raster maps to define and demarcate features such as land use, topography, roads, rivers, water-bodies etc. They may also be used to establish accurate
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I am going to start the drawing by saying these, these boxes I want. That is it. And then I say stop, then you go to tiles, go to next. So, all these data sets are here. So, if you want the bounding box, you can take the data from here. But anyway, you already have the topo sheet numbers and the bounding box details, you can just click view and the data will be populated.

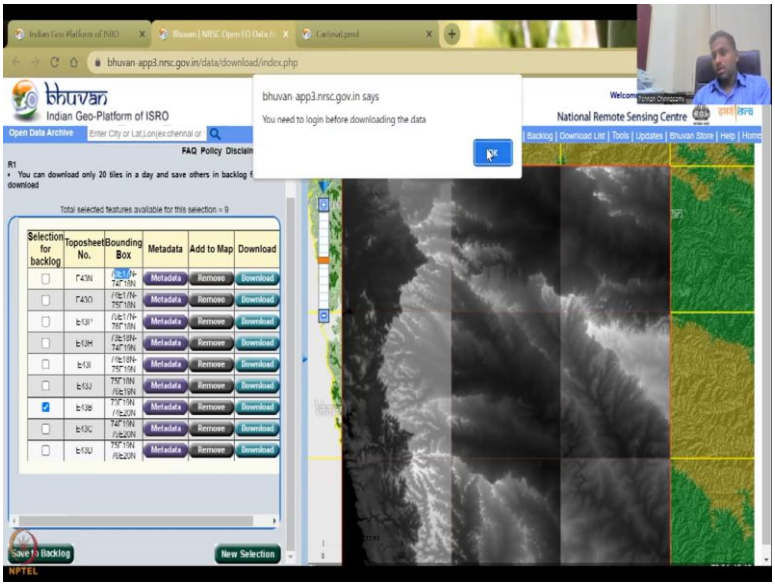
So, I am going to click all the views before I download just to see if they are good, if they are good and the data exists. So, you can see slowly it is getting populated. It went too much into, so let me just zoom out a bit and then we wait. So, you see here it says loading. So, let it load and then while it is loading also we can look at the metadata.

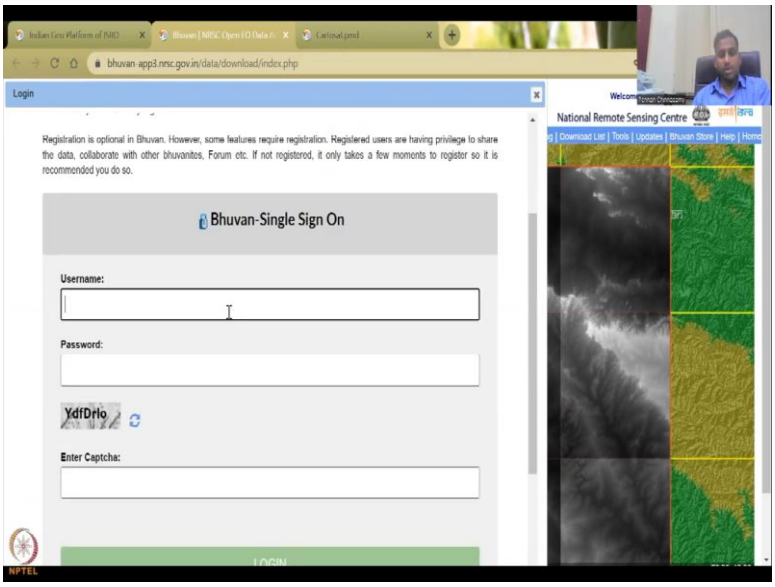
So, the metadata clearly tells you what is the resolution of the post-processed image. So, this is the version 3. It is a terrain model, cartosat DEM stereotype number 1, NRSC, National Remote Sensing Center and all the data is for as per NRSC data distribution policy again it is the elevation, third edition, etcetera, etcetera.

The datum and the coordinate system which we had looked at in the previous lectures. So, it is a WGS 1984 and the resolution is 1 Arc second, approximately 30 meters. Whereas this original source, the source with which the data has taken is 2.5 meters but then they have to do some calculations together this image.

And then you see what is the primary mission, about the mission, 1 Arc second is the spatial resolution and the unit in which the elevation is taken is meters, not feet, not inches, kilometers, etcetera, it is meters. So, now what you could do is if you like the data, you could download it. So, just look at it, it is 1 Arc second and then this is the third resolution, third mission.

(Refer Slide Time: 25:33)

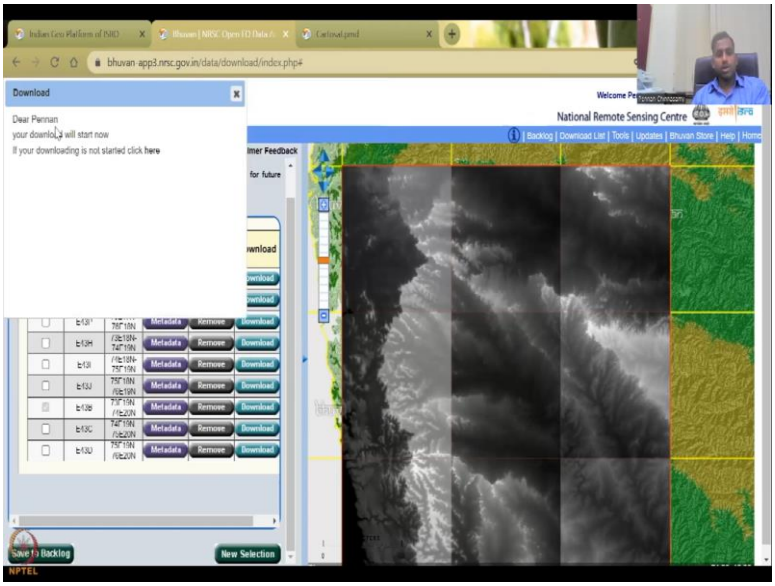


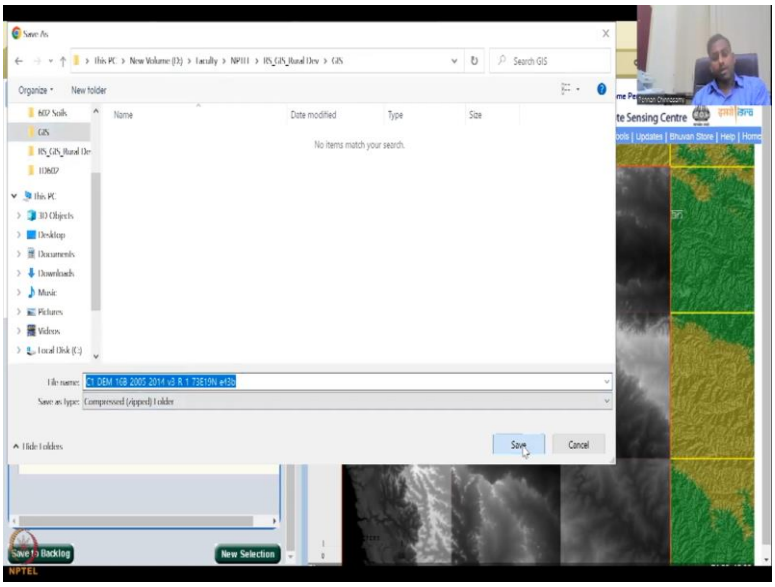


So, for example, you need the data, you can click on which data you need and you say download. You need to log in and then I have shown you how to log in and then you can download the data. So, basically, you can log in, once you click that it will come here and then some password, just to check the DR, you are not a robot.

It asks you all these things and then download happens. I have already have an account. So, my download will start now. So, the download list you can see here. So, it shows what are the tiles that are being downloaded and you can again click it and then it starts downloading.

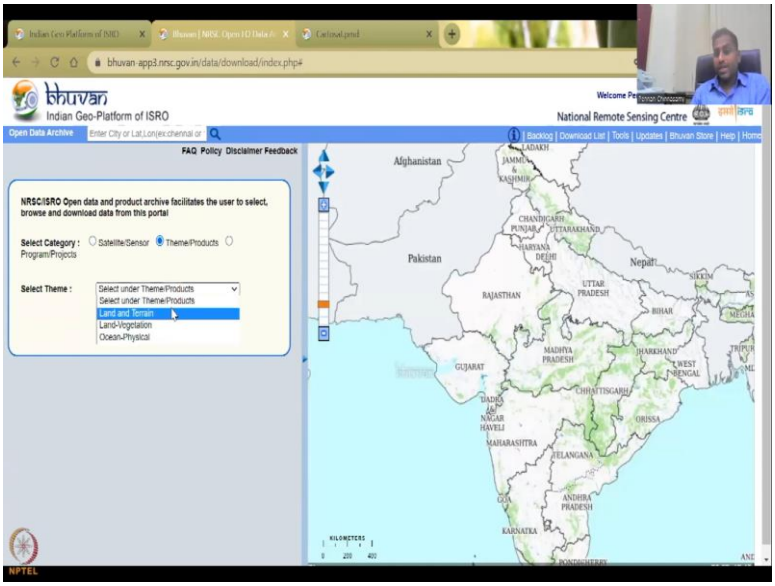
(Refer Slide Time: 26:15)

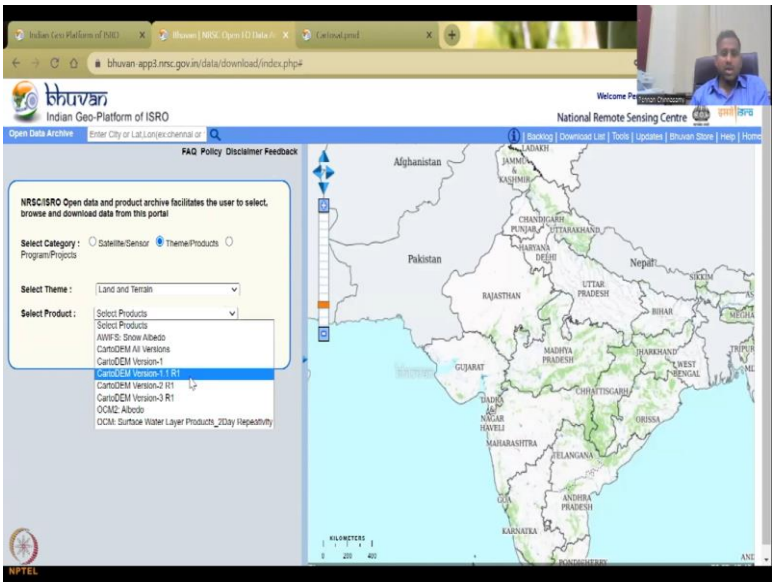


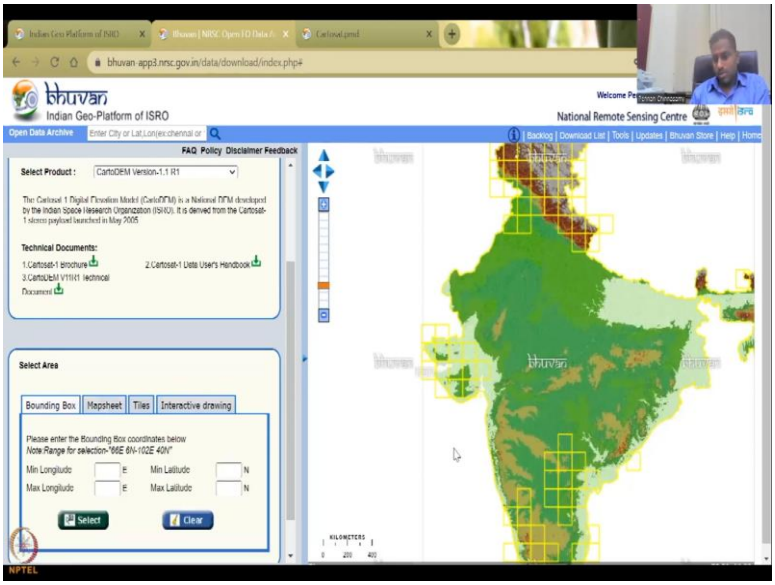


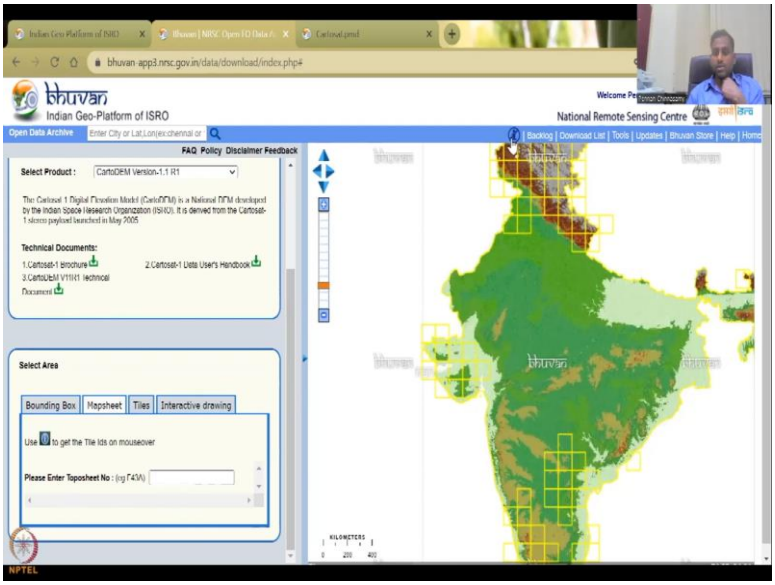
Dear Pennan your download will start now, it is done. So, when we download it, we can put it in our RS GIS, GIS and hopefully we will use it in the lecture class where we show the hands-on session. So, this is one data. So, now I am going to close, this I am going to go back to the new selection and then here. So, this is one thing.

(Refer Slide Time: 26:41)





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2.Cartosat-1 Data User's Handbook
3.CartoDEM V1R1 Technical Document
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Use to get the Tile Ids on mouseover
Please Enter Toposheet No : (eg:f43A)
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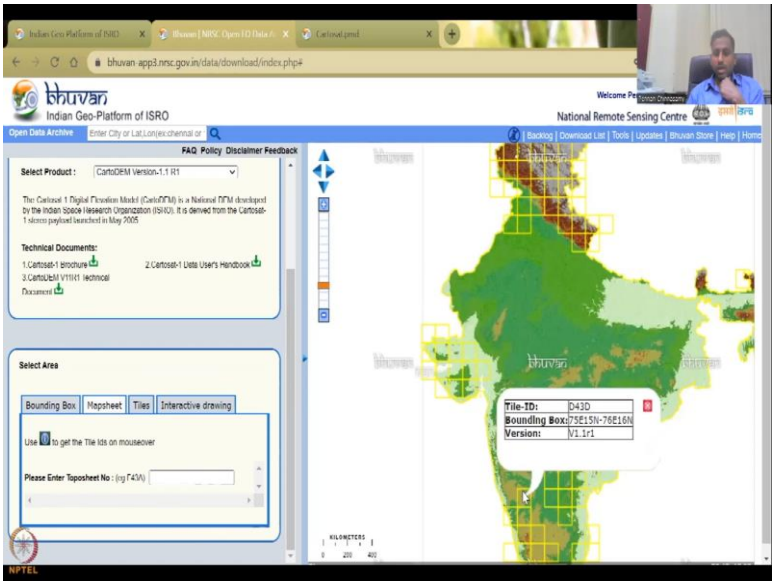
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Please Enter Toposheet No : (eg:f43A)
Tile-ID: D43D
Bounding Box: 75E15N-76E16N
Version: V1.1r1
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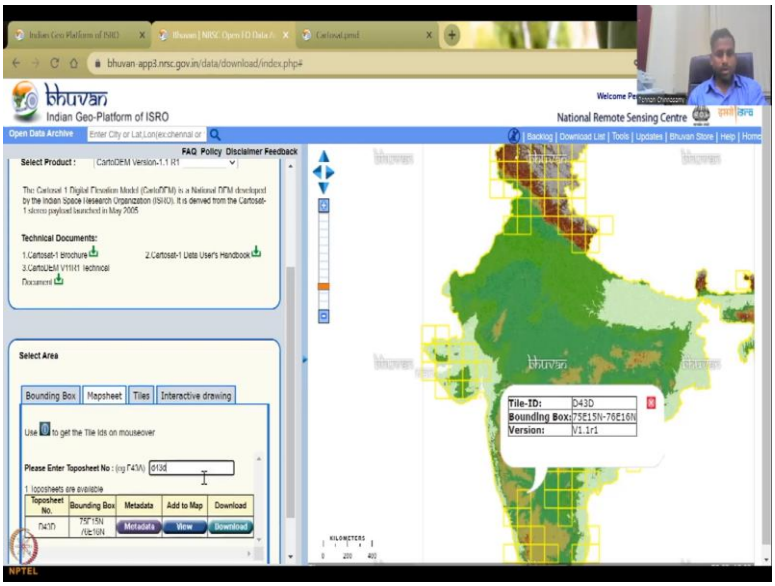
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2.Cartosat-1 Data User's Handbook
3.CartoDEM V1R1 Technical Document
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1 toposheets are available
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d43D
75E15N
76E16N
Metadata
View
Download
Tile-ID: D43D
Bounding Box: 75E15N-76E16N
Version: V1.1r1
KILOMETERS
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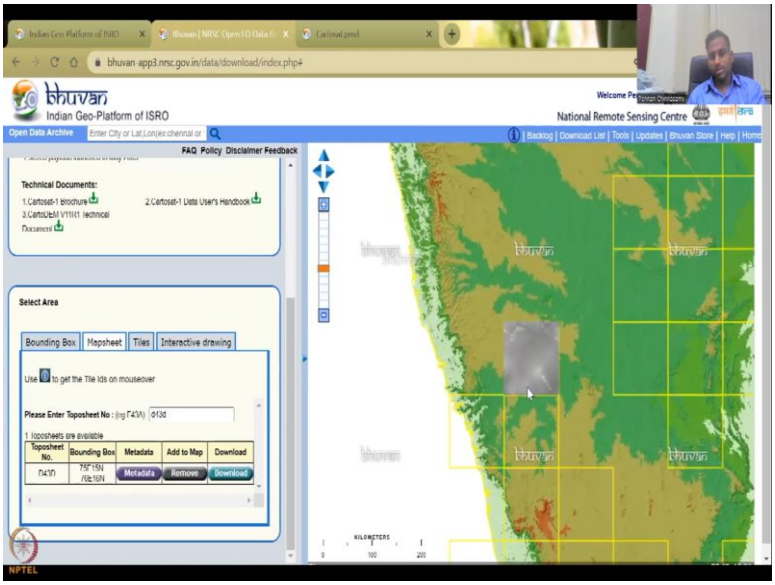
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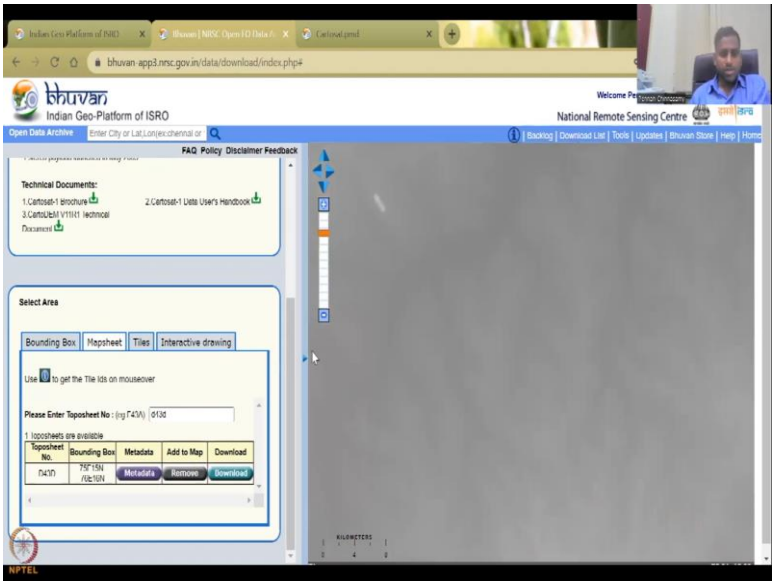
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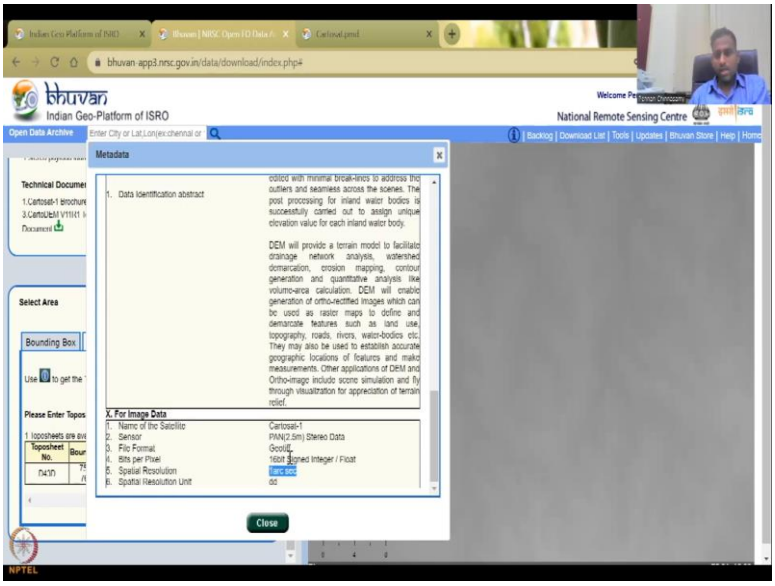
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Metadata
1. Data Identification abstract
X. For Image Data
1. Name of the Satellite
Cartosat-1
2. Sensor
PAN(2.5m) Stereo Data
3. File Format
GeoTIFF
4. Bits per Pixel
16bit Signed Integer / Float
5. Spatial Resolution
zero pix
6. Spatial Resolution Unit
dd
Close
NPTEL

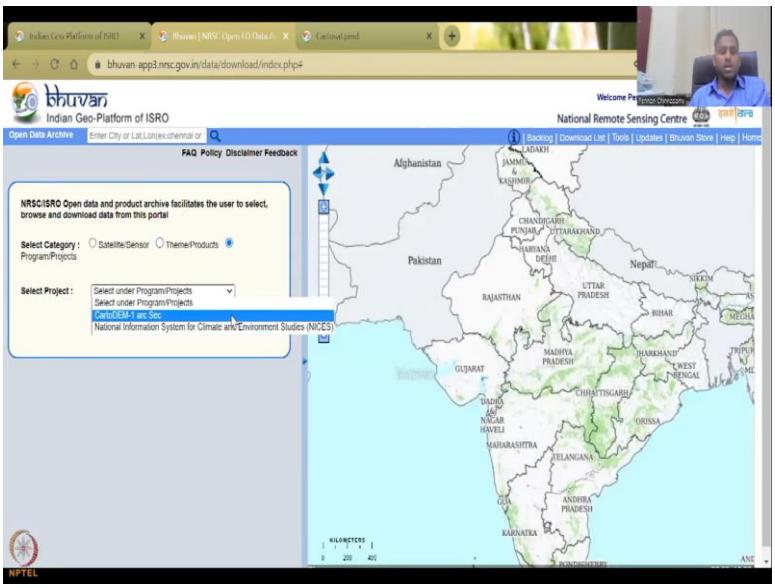
The other is by theme and products. So, I am going to go land and terrain. So, I am going to have the land elevation. So, it is land and terrain, no biophysical, no ocean. I do not want vegetation. I want terrain. So, in this all DEM versions, you can select. So, now let us select a one version and see what is the difference between the versions.

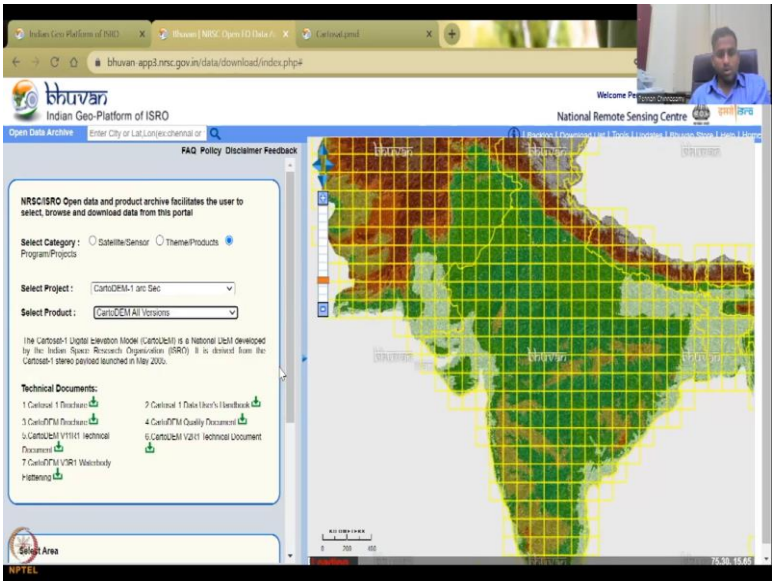
We will select the same sheets or if I will also show you the bounding box which I have already shown that you can take interactive drawing and then the bounding box you can put. But this is very neat that if you do not know the topo sheet, you can go here, press the I button and then press on a catalog data set.

So, basically this version does not have the entire database or maybe it is not loading yet. But let us see let us click on this one and it gives you a bounding box number. So, it is tile ID is a 24 3D and what it says is the topo sheet or the bounding box is there. So, let us do D4 3D, D4 3D. So, there it is. It automatically populates. I click view and the data comes up.

So, there it is, the data has come up. We can zoom in to see how the data looks like and the resolution is very coarse. You see that in the metadata version. You will come down and see that it is still 1 Arc second but it is not clear. So, that is where the third update, the third version is much much better. This is the first version. So, if you look at the version differences, all the other details are same but the version and the data stamp is much much different in the third upgraded version. So, algorithms would change.

(Refer Slide Time: 28:32)

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4.CartoDEM Quality Document
5.CartoDEM V1R1 Technical Document
6.CartoDEM V2R1 Technical Document
7.CartoDEM V3R1 Waterbody Flattening
Select Area
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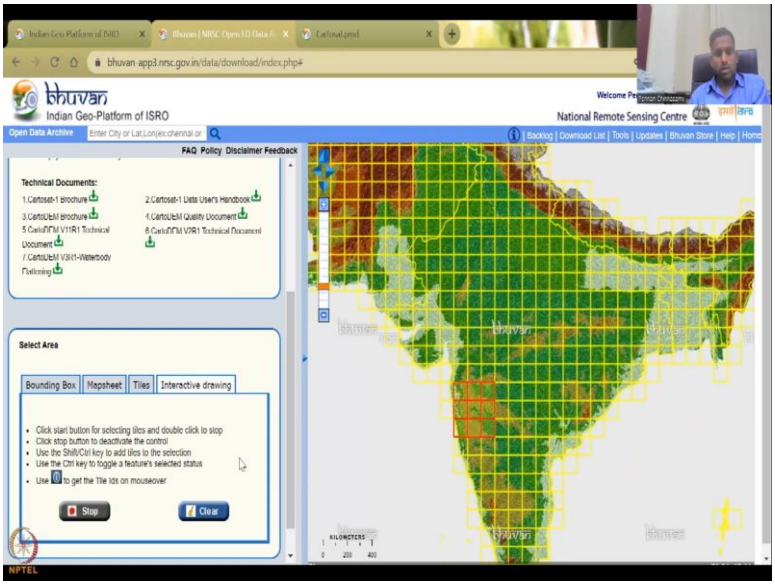
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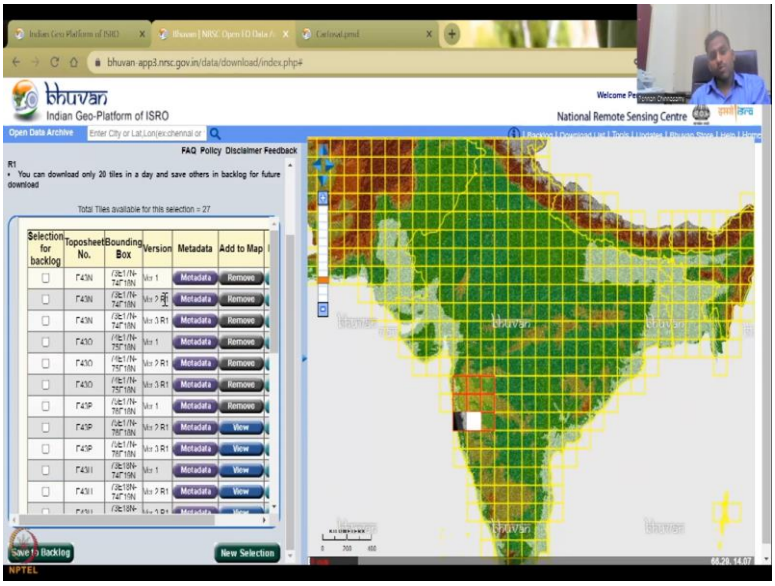
4.CartoDEM Quality Document
5.CartoDEM V1R1 Technical Document
6.CartoDEM V2R1 Technical Document
7.CartoDEM V3R1-Waterbody Flattening
Select Area
Bounding Box
Mapsheet
Tiles
Interactive drawing
Click start button for selecting tiles and double click to stop
Click stop button to deactivate the control
Use the Shift/Ctrl key to add tiles to the selection
Use the Ctrl key to toggle a feature's selected status
Use to get the Tile ids on mouseover
Stop
Clear
NPTEL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View
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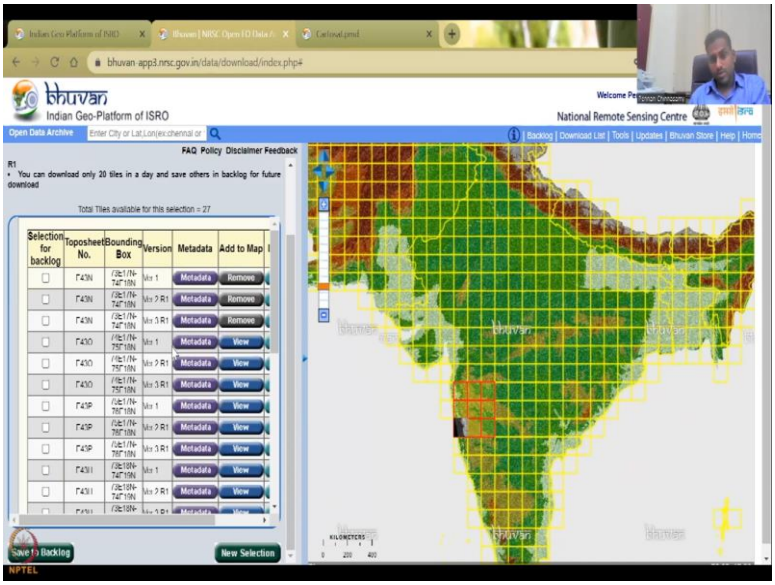
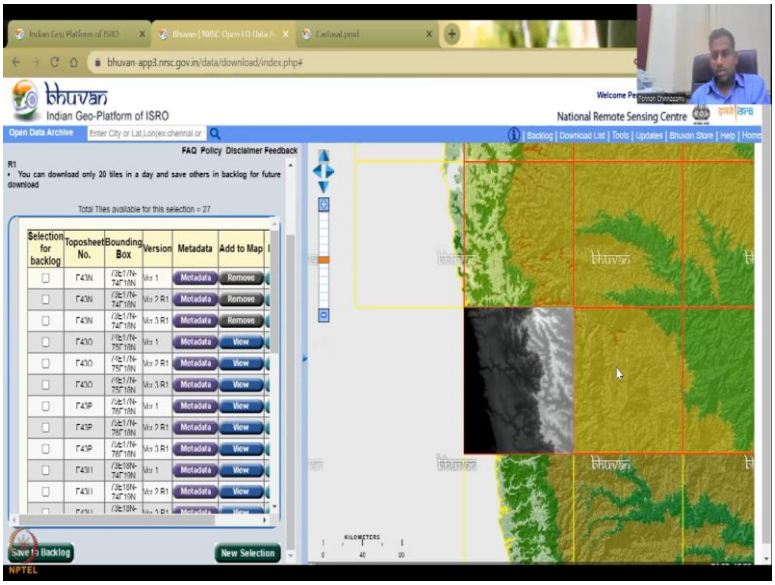
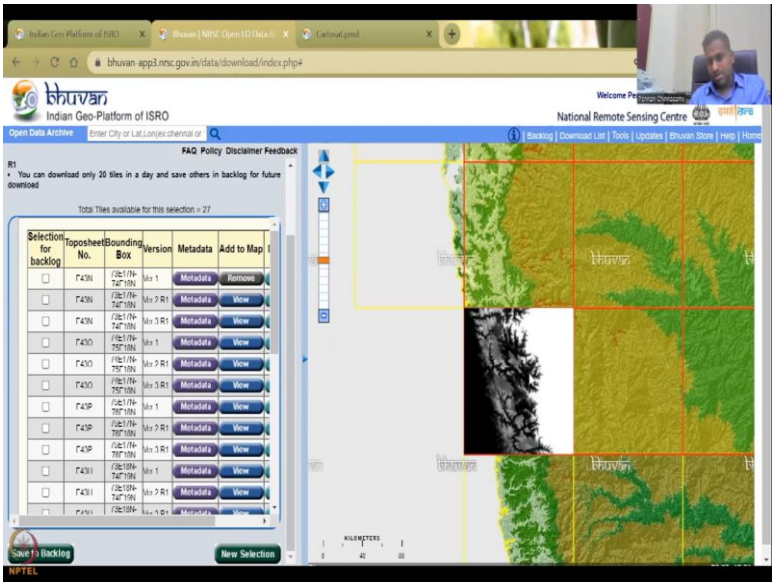


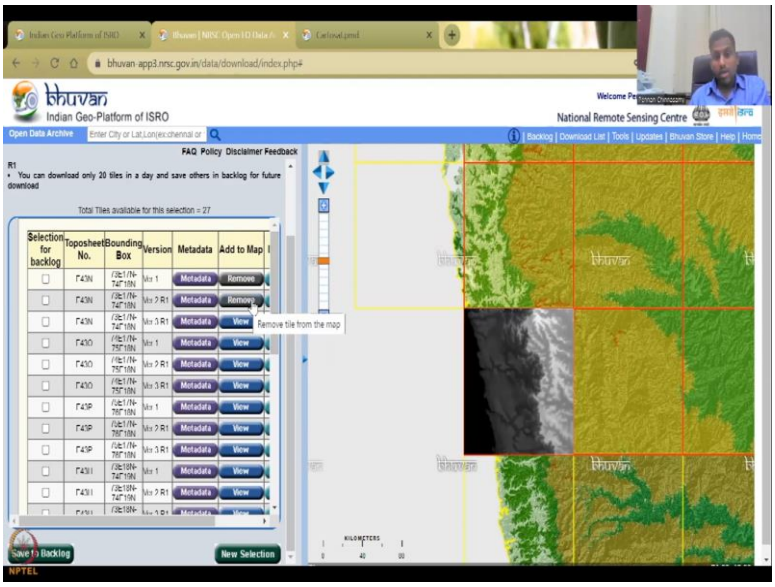


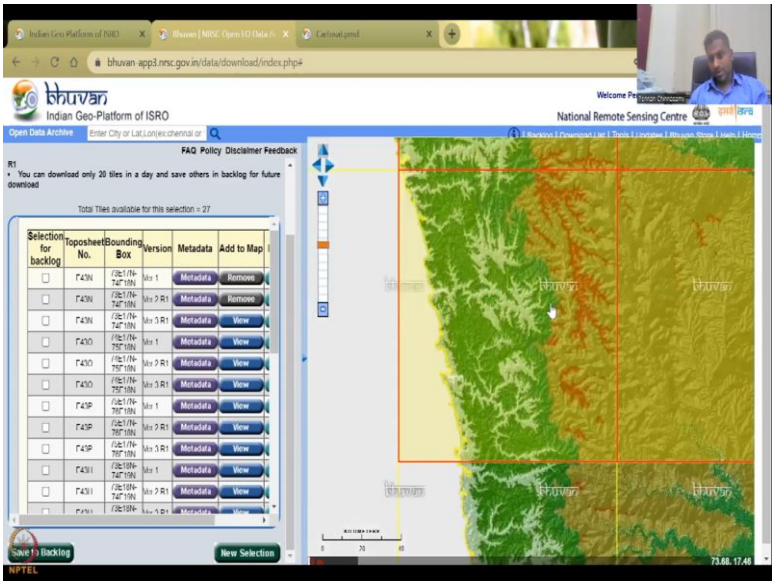
Then you have programs and projects. You can have 1 Arc second and then you can have all the products and then just click what versions you want and then let us say the same versions when we select here, start and then I said stop, next, view, view, view, this is all. So, you will see all the versions, version 1, version 2, version 3, version 1, version 2, version 3.

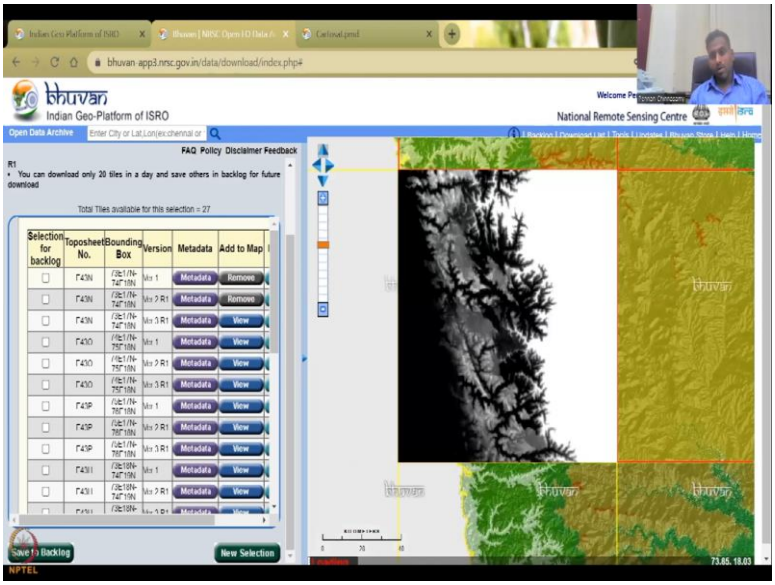
So, you can actually let us remove all these and just see the version 1, version 2, version 3 for this specific data. I am just going to zoom in for this and then you will know the difference between version 1, version 2 or version 3, Also I can do one thing. So, maybe the nearest scale and let us do this first and then we will see.

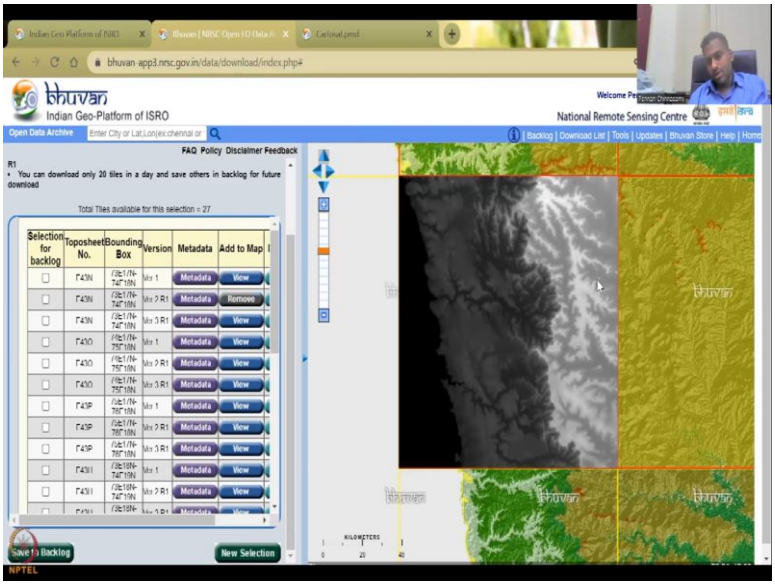
(Refer Slide Time: 29:39)











So, this is version 1. You can see that the resolution is there but this white space does not look good because it shows that maybe there is no data. Now you see more and more fingering of the streams and revers. So, what you see as this breaking up of the land mass is the elevation gradient and the lows and highs.

So, the lows and highs are normally taken up here. So, I am going to remove the behind one, so that you can see it properly. So, coming back again, this is the version 1. You would only see these streams but the smaller streams are not there, the ones you see like trees are streams.

So, from you look from the top, there is no trees or buildings, it is only land. And suddenly the black means it is going down. So, going down means it is revers or streams that are

bifurcating. Then I am going to add the second version. If you add the second version, you will see in some more streams coming up and it is little bit sharper than the first image.

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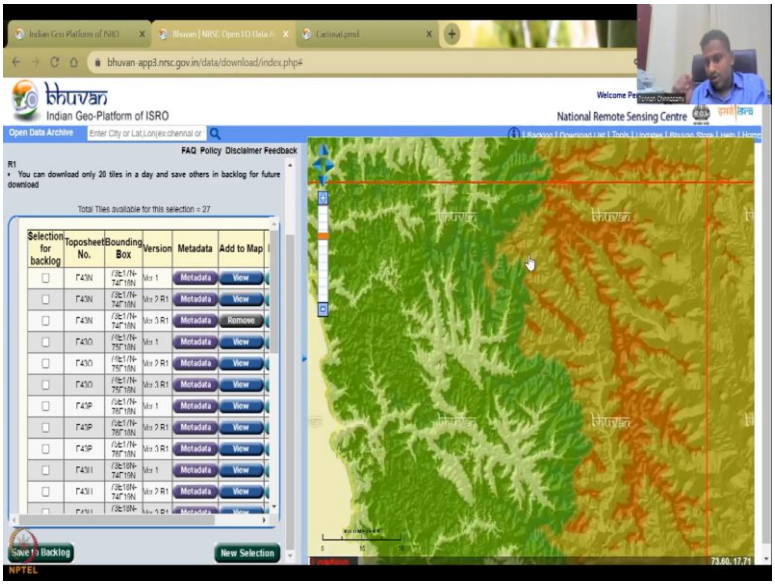

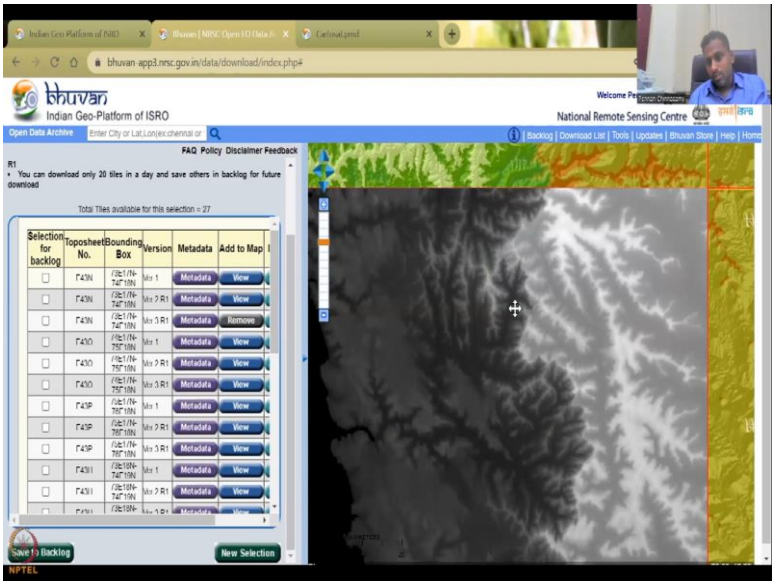

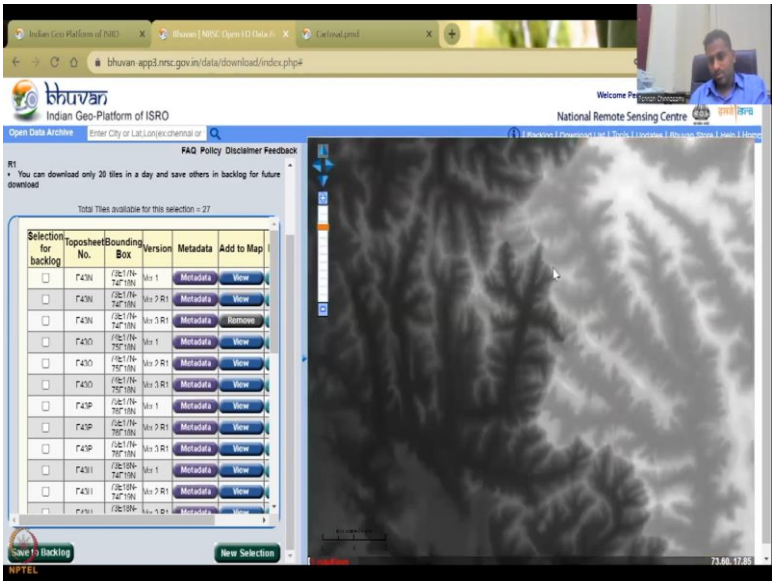

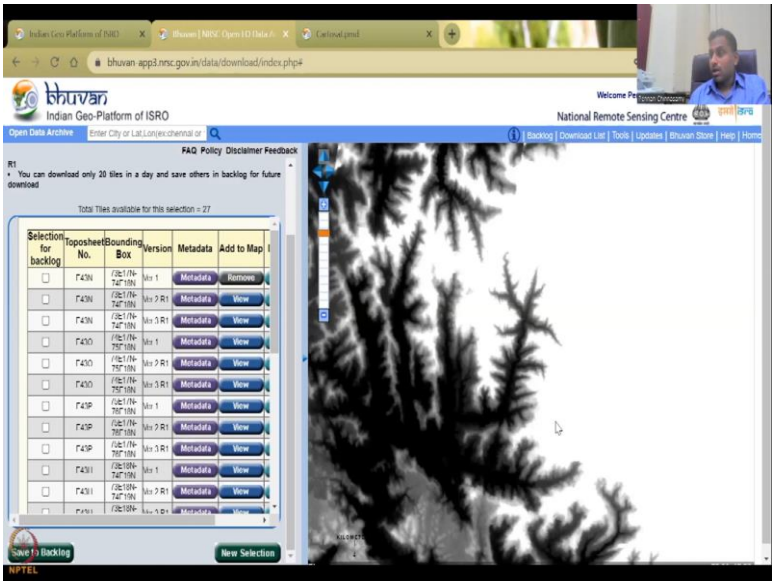

Now, I am going to add the third version and remove the second version. You could see some more slightly the fingerings of the minute minute details getting more noticed. So, you can see this more noticed. So, I am going to put again. So, let us do from start. So, only some part of the elevations are captured.

Whereas you can see this part is also captured but not sharp and when you put this some other parts are getting sharper. So, this. So, people would normally use the version 3. All have the same spatial resolution as 1 Arc second, approximately 30 meters. But if you have higher higher versions then the clarity of the data is better.

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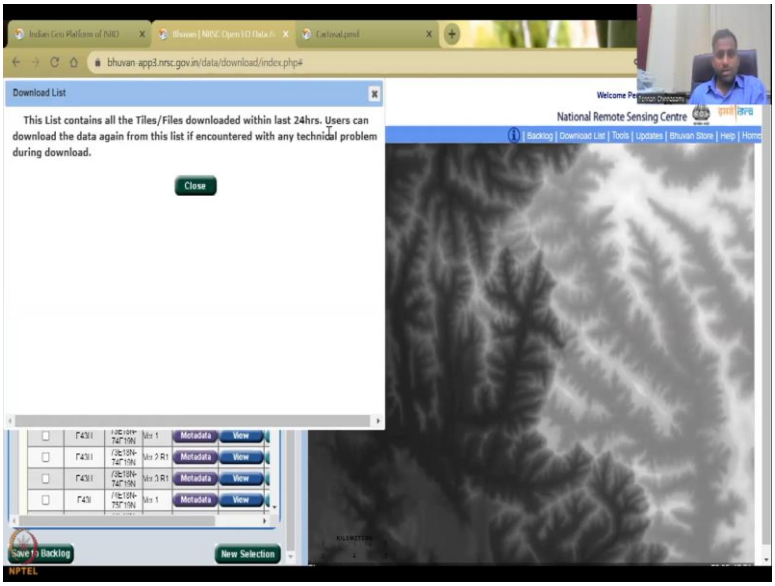

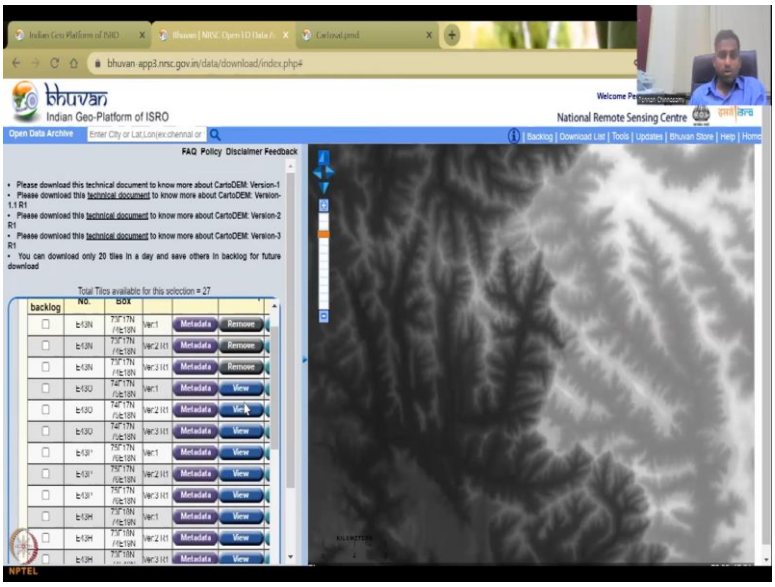

So, now you could go back to download list and download the data if you want. This list contains all the files that you have downloaded 24 hours. You can download already we downloaded our file. So, we do not need to download again. So, this is how you would access the DEMs from Bhuvan. There are multiple other sources.

In the next class, we will go through the download putting it in QGIS and mapping it into a map with different colors, so that you can represent the rural area in elevations, how the elevation is. Suppose, the elevation is very solid and straight, it is easy to land manage it. You plough it and then you put crops, supply water, etcetera.

But if it is like this, high sloping then even if you plough too much here, all the soil will come down here. If you apply water then water will definitely move down. So, there is land management that you need to do. Leveling is different and losing the top soil is different. So, if you say, okay, I will take all the soil and then make it straight when you are taking the soil which is the fertile part that the farm needs, the plant needs.

So, that is not correct in rural development scenarios. You need to manage it with the elevations. So, if you come to some elevated countries like Malaysia and even Mumbai, you will see some regions, they preserve the elevations, they do not cut it and then make it straight. Why?

Because of the elevations, there are multiple hot spots in biodiversity, water and living creatures. So, they want to preserve it. These are very very important for rural development. If you make it all straight, it is not easy to manage. It is easy to cut it straight and then put a tractor on top of it. But then there should be soil and water. So, the land mass should not be altered too much. With this, I will stop today's lecture and then we will see in the next lecture where we can have a hands-on experience on using this data for rural development. I will see you in the next class, thank you.