Remote Sensing and GIS for Rural Development
Professor Pennan Chinnasamy
Centre for Technology Alternatives for Rural Areas
Indian Institute of Technology, Bombay
Week 02
Lecture No - 2
Introduction to Remote Sensing and Need

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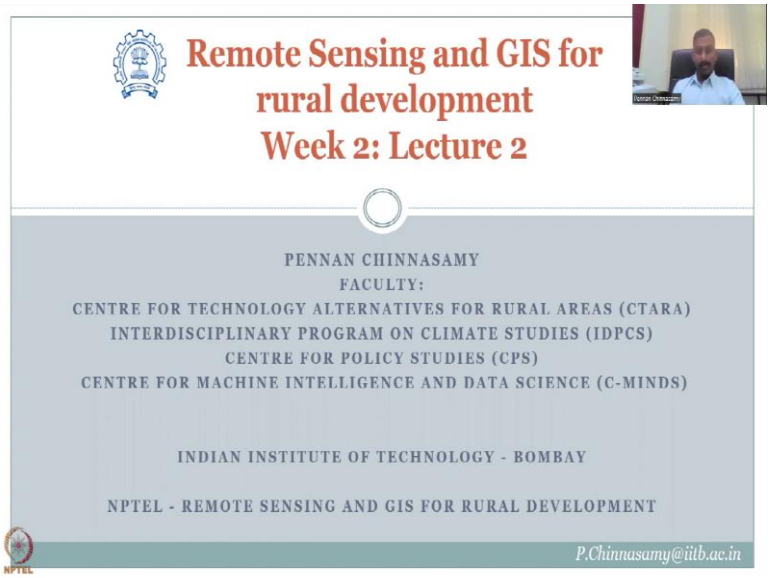

Hello everyone, welcome to the NPTEL course on Remote Sensing and GIS for Rural Development. This is week 2, lecture 2.

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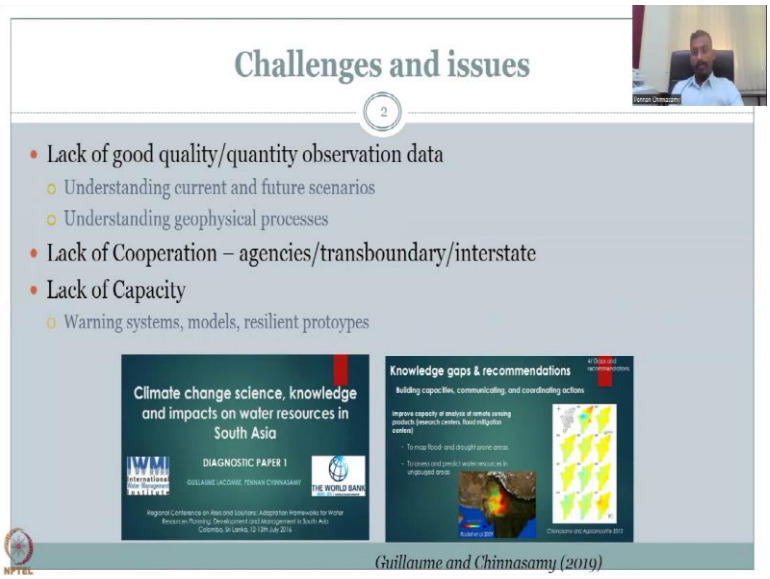

In this week, we are continuing our discussion with the challenges and issues of data for rural development. The first week we have already defined rural development and how data can

aid in the different government schemes and more importantly, provide a better outlook of the issues. We looked at lack of good quality data and quantity observation data which impacts the understanding of current and future scenarios, which is called the baseline and the future scenarios which are built from the baseline.

And also, we looked at understanding geophysical processes, there is also lack of cooperation between agencies trans boundary states, districts, countries and interstate, it is important to understand that everyone cannot collect the full scale of data. For example, the Ganges basin as their I said poor countries are sharing the Ganges basin, India cannot be monitoring Nepal's Ganges basin part, but the Nepal's Ganges basin part is also contributing to the Ganges flow in India. So, it is very important for us to understand how much water is incoming and outgoing, which is leading for agricultural productivity and then rural development. So, this cooperation has to exist, if observation data is the key and lack of capacity is there as air condition for warning systems, models and building resilient prototypes.

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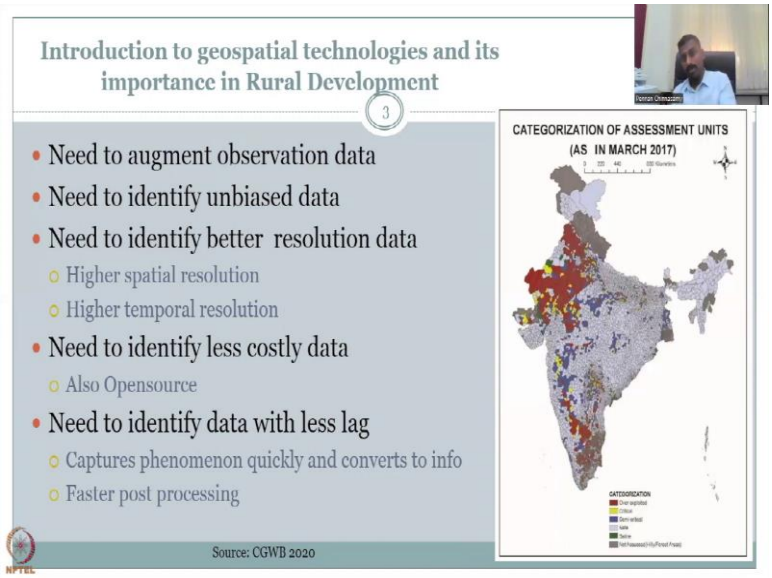

So, moving on in this week, we have been trying to introduce geospatial technologies and how it is important in rural development. The need comes in from the last slide, we understood that there is a need to augment observation data. For example, you have observation data, you need to add more data to make it full scale both in spatial or resolution.

For example, if you have monthly data, can you downscale it to weekly by using satellite data? Or can you upscale it by to annual using remote sensing data or other data we will get into how remote sensing can be that in this coming slide. Then, there is a need to identify

unbiased data, what do you mean by unbiased here? So, there should be not any bias for a particular activity.

For example, a country which is involved in tourism will always claim that it is a safe country to visit, it is a safe country to visit whatever the issues are. Or it will say it is a very clean ecosystem. The diseases are very less in this country, please visit. But when you go there and see it is different. So, that is the bias nature, I am saying.

To understand Rural Development and the resources that contribute to rural development, there has to be an unbiased data. And that comes from installation of instruments and the data procurement type which has to be unbiased. We will come to examples of this. And for sure, from the last slide we say that there is less spatial and temporal data. So, we need to identify better resolution data, higher spatial resolution.

So, it is not only India scale, but also it could go down to district and also states and stand some districts, villages scale and higher temporal. So, instead of annual, and monthly, can you do daily, weekly, those kind of things. So, there is a big need for higher spatial resolution data and temporal. I will also define officially what is spatial and temporal.

We also need to identify less costly data, which means cost effective also, an open source, open source means everyone can use it. So, it need not be only low-cost data, but also open source where everyone can use it. These are also part of the new data that we are going to use for this course. And we need to identify data with less lag. What do you mean by lag is? There is a time lag.

For example, if I go and collect a groundwater data in a village, I have to record it in an Excel sheet or paper, bring it back to my office, work on it and then upload it to the farmers. So, this is what a government agency normally does, and how long does it take for data collection to the report generation is normally 1 year or 2 years.

However, within the 1 or 2 years, the impact of the groundwater is felt. So, what is the use of such a delayed response is a question. So, we need instantaneous reports we need instantaneous data coming in. And that helps you to plan for rural development. So, there is a big need to identify data with less lag, captures phenomena quickly and converts it to info.

So, the data itself is collecting time takes time you go to the field, you have to travel from the say Mumbai to Pune take the groundwater come back from Pune to Mumbai and then work on the data and then publish it, then it takes a lot of time. Rather than that, can you have data

collection as less time-consuming activity and faster post processing? Not taking it in paper, not just typing it in a dashboard and then downloading it, can you make it augmented very fast.

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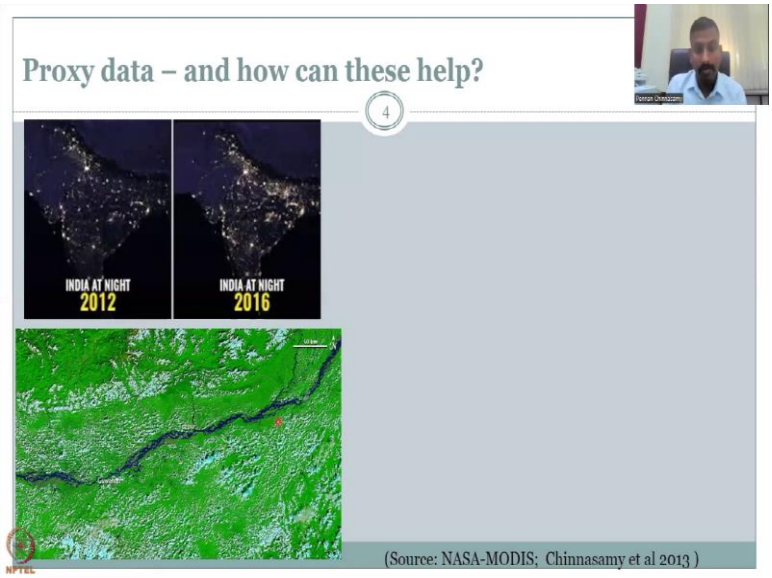

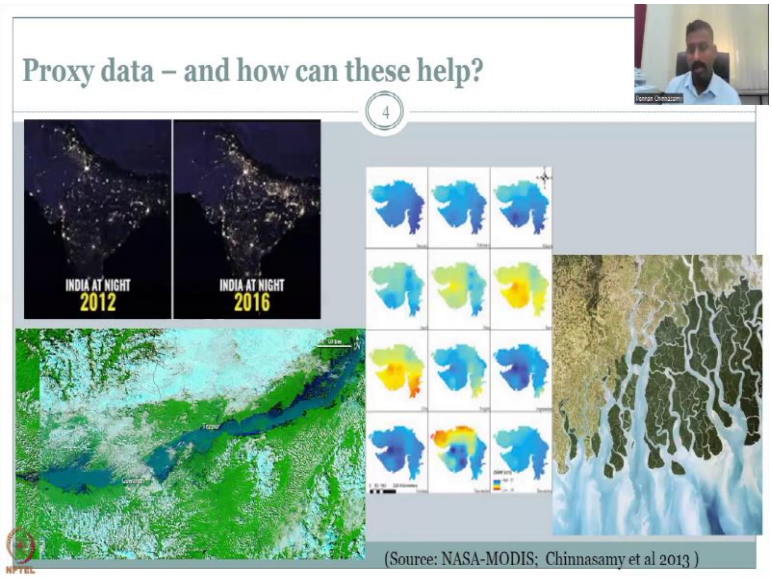

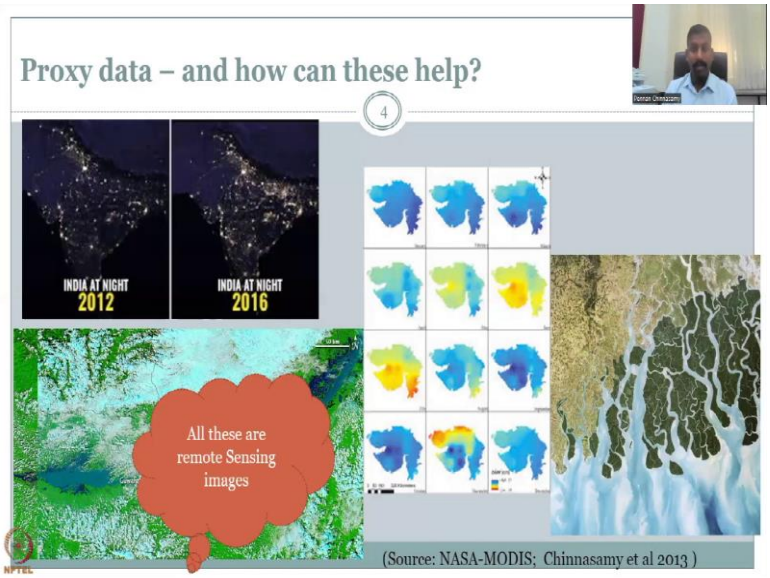

And some of the times you do not have data observation data. Like for example, for COVID. We did not have specific data for rural population that is migrant. We did not have density data, population density data. We did not have the water need data, on those circumstances. You cannot go and put an observation system at once.

You would need to have proxy data, which is something that tells about it but not directly is involved. Normally proxy is the attendance you see in class where I am teaching as a faculty and I am taking attendance one person gives attendance instead of an other person that is proxy duplicates, but here the word proxy is kind of similar, that it is not a data collected for a particular phenomena, but it can explain the phenomenon. Let us look at some examples.

So, the first example is India at night. In this image, what you see is lights that is being lit up in the night it could be your house light, street light, the highway light anything. So, this is kind of a illuminant picture and the luminescence is taken from satellite as an image and that is two different pictures India at night 2012 and 2016 taken by the NASA US agency.

However, if we look at it for long and think what can this be used for that becomes a proxy. So, for example, I could say before between 2012 and 2016, the cluster size of the cities have become big. If you see Delhi it has become bigger. You can see this dot put my pointer on, so you can see Delhi is becoming bigger.

You could see all the major cities becoming more and bigger on by his life is becoming bigger and in more some cities have been created. More importantly, the connectivity is more or less see, you cannot see that here there is one dot dot, dot dot, but the connectivity is not as less, but here you could see some connectivity tying up to the cities.

So, this could be a well-documented evidence that power supply from the Indian schemes, especially to rural India has increased, the availability of power, only when there is power, you can light up your light, house in terms of using electricity. So, that could be a proxy data for the efficiency of a government scheme, that focuses on bringing electricity to rural India.

It can also say where the housings are, because there is a house there you form a cluster, all these cannot be industries and then water coming and like coming from the industries, it could be a group of houses and those are community houses. So now, we can also see that in regions where there is more light, maybe more inhabitants have come more houses are come.

And it also shows economic viability, because you have enough money to pay for the electricity and you have good quality electricity that is coming throughout the night. The timing of this image is also important, we should note that is it all taken along the same night time. Let us look at another example. So, this is a flood. So, this first you can see the blue line is a river. And what you see is the Ganges River, and another image, different days between a week.

So, you could see that the river is flowing peacefully, small lines are being seen, which are the sub tributaries of the major river. So, this is the major river and India have tributaries coming on the other sides, here, here, etc. And the river also flows in multiple channels. However, during a flood, there is only one channel, you could see it, it is huge, and the thickness is much bigger than the initial channel.

So, what does this tell about? This tells about the regions where the flooding could have happened? Because normally people would have had houses and agriculture fields along the riverbanks now all the riverbank is being taken up by the rivers floods. Is this sustainable? It is not. So, those kinds of analysis you could do, you could do an analysis of the flood inundation areas, which areas along the river have been flooded. Let us look at another example of proxy data. This was taken by Grace satellite from NASA.

And you could see different water storage levels in the ground. So normally, the government records groundwater once every 4 months or 3 months depends on the agency. So, let us say CGWP they collected quarterly, so every 3 months they collect data and you plot it. So, every monsoon pre-monsoon post-monsoon etc, you have the data, however, monthly estimates are not available. Whereas in this picture, you could see that the grace satellite can take groundwater at monthly intervals and plot it. So, this is very important to understand the water storage under the ground.

So, it becomes a proxy of observation data. The final image I would like to show is the Bangladesh coastal region. And you could see both the Ganges and Brahmaputra coming into Bangladesh and existing out, while its existing out you could also see that, a sea level rise is happening. So, these are rural entities, these are agricultural lands. What is happening is water level is rising and it gets into the land.

So, sea level incursion is there. Sea level rise has taken up a lot of land. And intrusion not only happens on the surface but also underground. So, this would not have been bad earlier because they would not have data along the coastal regions, they may have four levels, but not on the ground to see if the if the land is getting inundated.

Now, you could see that the sea is actually swallowing part of the land, because the sea is rising and those are becoming vulnerable for rural entities, because those are mostly the agricultural land and the rural occupied land. So, what does they been doing on a side note, they have been investing in hybrid rice crops that are flood resistance or they can stand in sea water.

It may not be the same rice that we consume every day, but what else can they do? The land is limited, the land has been taken away by the sea and so, they have to eat rice that is grown on stagnant water. So, these are examples of proxy data or images that serve for a particular purpose, the images would have been taken for just as an imagery, you can take a picture and that can serve as a data.

So, for the picture itself, but using it for another total angle is called proxy. So, this has been used for rural water, inundation, land inundation by sea level rise. The first one is rural electrification, infrastructure and rural connectivity, connectivity can be related to both road connectivity, electrical connectivity and also nowadays a communication connectivity, like your cell networks, your mobile networks, and the central part is the groundwater storage anomalies that can be taken by proxy data.

So, I want you to think more on how you can use such data for rural development, where it may not be taken for a particular Rural Development Initiative. But under the proxy class, we can use it, all these are remote sensing images, satellite taken data, so all of them are remote sensing.

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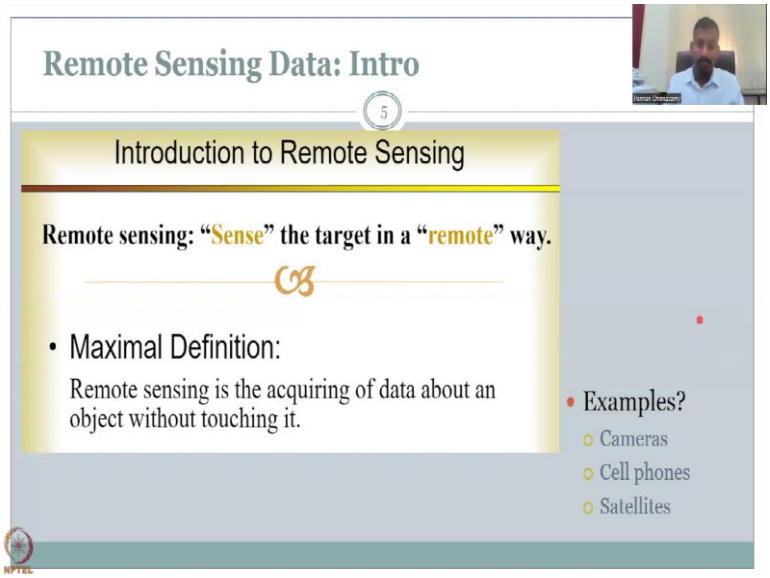

Let us first define remote sensing, because now we are getting into the introduction part. What does it mean? The maximal definition is given us remote sensing is the acquiring of a data about an object without touching it. So, if as I said, the temperature experience, if I am the human and I am having a temperature rise, I need to check the temperature.

So, there is two ways the normal way you put a thermometer in the mouth or under the armpit, you take measurement, that is touching the object and the object it is being touched. Whereas in during the COVID, you would have noticed the gun type, those are remote sensing, because you are not touching the body from a distance you are shooting and then taking the temperature, you sensing the infrared actually, so heat.

So, this is remote sensing. So, remote sensing, again is collecting data from an object without touching it. Very, very simple definition. A lot of examples exist. So, your cameras are all taking pictures without touching the object, your cell phones, because they are also used to take images, satellites, because they take images from atmosphere down to the earth, or from the space to the earth. They are not touching.

Now, I gave the thermometer example, by have a temperature gun that can take temperature, there are multiple such instruments along the list, and some are around the visible spectrum. So, that is what imagery is. So, if you take an image and the image taken by remote sensing satellites and other products, there are wavelengths. I will give you the link to the introductory part of remote sensing. You will learn more about what are the different wavelengths and how light gets reflected from a body and then captured by satellites. But

here we want to know that, is just a tool that collects data and then converts it into information that can be used for rural development.

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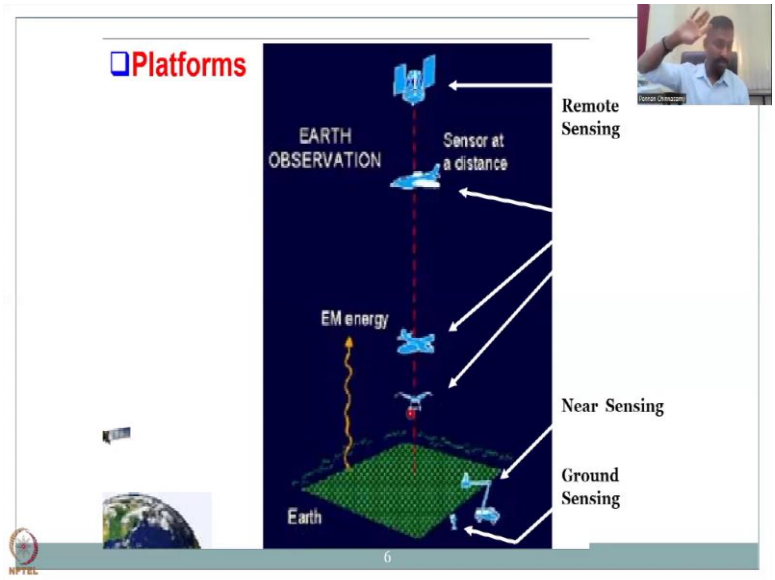

So now, we have defined it, what are the different platforms or remote sensing. So, there is grounds sensing These are mostly for local government initiatives. It could be used for other initiatives also. So, there is ground sensing, where a person is on the ground and takes data, for example, your cell phone, you can go in and map a crop type, or take a crop image and then use it in your database.

So, that is ground sensing using a mobile phone or another camera that you take, you can also go on a Jeep, elevated Jeep and take data from convoy, from our pedestal, that is also ground sensing, because you are on the ground. Now, slowly you are going to take flight, we are going to detach from the ground.

So, the first thing that you see a lot nowadays is near sensing platforms. And the near sensing platforms include drones, Unmanned Air Vehicles UAVs, that are flying in a low altitude and taking data, then you have some aeroplanes, some flights that take data and they also fly in a low elevation, mostly the agricultural flights are smaller in size and they take data.

Then you have bigger planes, which collect data like for example, there are weather data that are collected by commercial planes, what I mean by commercial is what we carry the passengers from one place to another. So, for example, if I am going to Denmark, I would take a flight, commercial flight, so that flight can also collect data about rainfall, humidity, air

temperature along the way, all these are near sensing, they are nearer to the ground compared to ground sensing, but they are on the ground.

Then you have the remote sensing distance and that is your satellites. So, by definition, all our remote sensing, but by definition of distance, we call satellites mostly remote sensing, the drones are called remote sensing under the near sensing category, and also there is ground sensing where remote sensing is possible.

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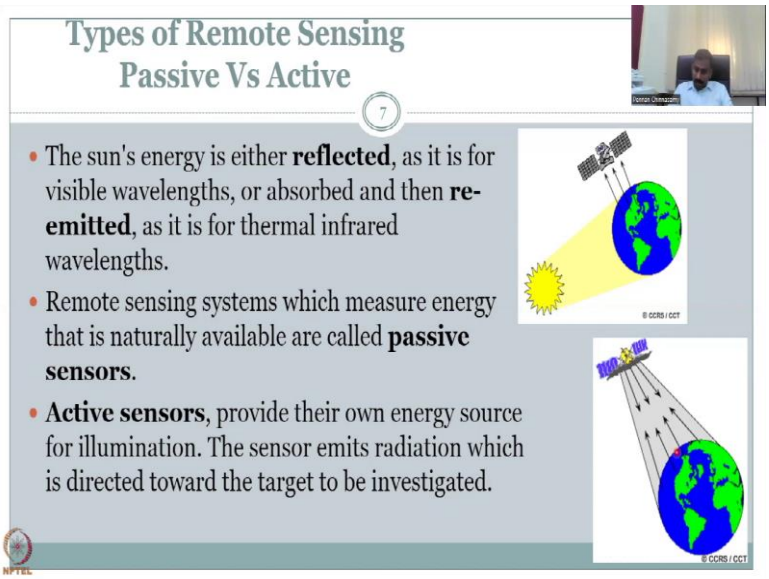

There are two types of remote sensing, major two types, which are called passive and active. We are going to talk about mostly the satellite base but it can be used for cameras and our data was… Why satellites is because that is the data that will be using throughout this course. We all know that, the sun energy falls on the planet and that falls through a spectrum of wavelengths, there are some wavelengths we can see and those are called visible wavelengths, there are multiple others below and above the wavelength that we are not able to see or record it.

So, however, the earth as a whole can absorb most of it and then either absorb it and get heated up or re-emit or reflect, so observe, get heated up and then re emit or just reflect bounce back. So, most of his energy comes in and then some interaction happens. So, all the two remote sensing if there is a satellite, if you see on the top, the sun's energy comes, gets reflected or re emitted to a satellite, then it is called passive sensor.

The sensor on the satellite is called passive, remote sensing tool is called passive remote sensing. Why? Because it is taking an energy from a different source, which has been

reflected, refracted, absorbed and re-emitted whatever it is, what are the processes fine, your energy comes in, hits an object and then you take the data that is reflected, refracted, observe what other projects you want to call Bandon etc.

Those are passive sensors, because they are not supplying energy and taking the data. On the other hand, active sensors provide their own energy. For example, this satellite has an antenna and the antenna is both a transmitter and a receiver. In this example, the antenna was just a transmitter receiver, it was receiving the race not transmitting, whereas here it is both transmitting and receiving.

So, it transmits energy and it takes back... So, this is a very important satellite because many of you would have known that during night how we collect data, when the sun is not there. So, those are the times you use active sensors. It is very important for many, many aspects. However, it becomes more expensive, because a satellite has to generate energy to send energy particles. And then it gets bounced back and reads. Whereas in the previous passive sensor, it does not need that much energy. Because it is just collecting whatever is hitting on the surface. Active needs more energy, which means more cost because new sensors new payloads, etc and the size is also…

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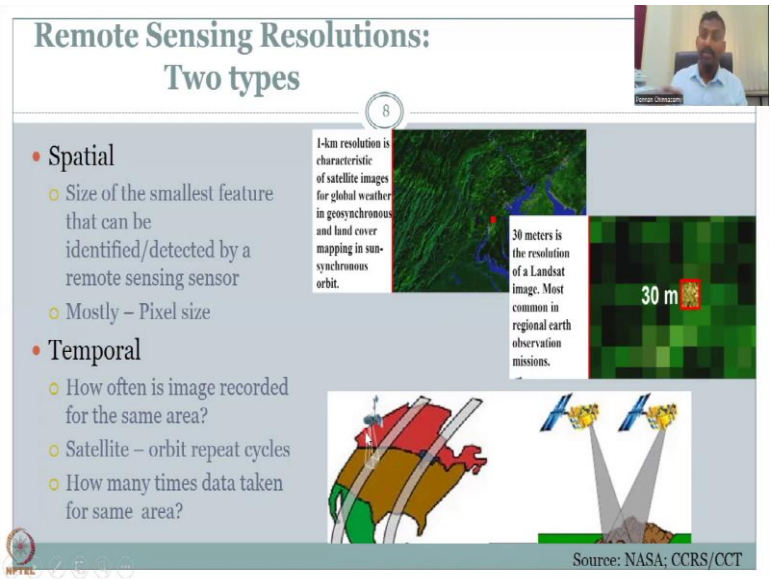

Continuing on the remote sensing topic, there are two types of resolutions we need to talk about as I mentioned, there is a spatial resolution and temporal resolution, spatial defined as the size of the smallest feature that can be identified detected by the sensor. What is the smallest we can see? That becomes your spatial resolution. What is the smallest for our eye, it

is not constant, because for my eye maybe I could see a small ant, very, very tiny ant, but others cannot see an ant they have to put glasses. They can only see a coin.

So, our eyes are different. However, for satellites, it sees as a grid because all our digital, the sensors from a satellite sees an image and then converts to grids. The smallest grid size that you could see by the sensor of the satellite or remote sensing object is called spatial resolution. It is mostly the pixel size. So, everyone knows camera phones. So, these camera phones are now bought as pixels, or is it a 10 million pixel? How big is the pixel, the call is not the entire screen, but the entire screen is divided into grids.

And the smallest grid, it is a uniform grid. But the smallest grid size that your cell phone can look at through the camera is called the spatial resolution. So, as an example, I will show you the Landsat data, you can see there is a ground data. And that ground, if you zoom in, it becomes gridded.

So, all these are pixels. It is pixelated, if you draw and along the perimeter, the side, the side of the perimeter of the pixel, which is a square. So, if it is a square all sides are equal. So, the side length is given us 30 meters. So, people would say normally it is a 30-meter resolution for this example Landsat or 30 by 30 grid resolution, because 30 by 30, you can say is the size resolution.

Temporal is how often images occurred for the same area. So now, I will talk about a resolution of a particular image that I take using a camera. But if every week I come and take that becomes my temporal resolution, so I am monitoring a plant, let us say I am growing a plant in this bottle, I take an image today, I take an image next month and then every month the first I take, so then the temporal resolution is 1 month, whereas writing daily and image and analyse it becomes daily temporal resolution.

So, how often the image is recorded is called the temporal resolution, the satellite orbit repeat cycles. So, normally your satellite comes to a particular location and then goes to the same location through the repeat cycle and those are defines the temporal resolution, how many times data is taken for the same area. So, as an example, you can see here, the satellite goes in this orbit takes an image goes to the next orbit, next orbit and then comes back to the same orbit. So, the time taken for the satellite to come back to the same orbit is the temporal resolution.

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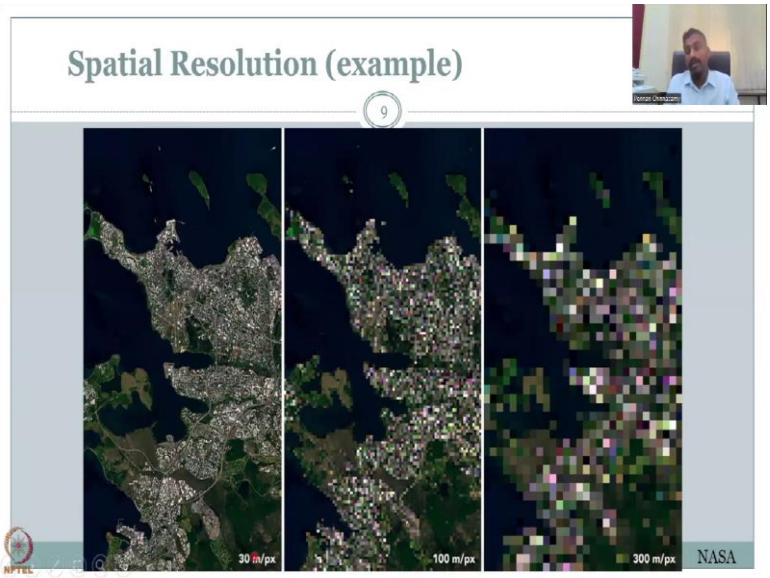

Some examples of spatial resolution, you could see it depends on the sensor it depends on the satellite payload. So, you have 300 size 130, So as the size goes smaller, the pixel size you could see more detail can be seen. So, 300 is too big, and within that just one colour is there, so you do not see much difference between houses and stuff. Then 100 meters per pixel. You can see some features coming up. But when you bring it down to 30 meters per pixel, you see a lot of more features.

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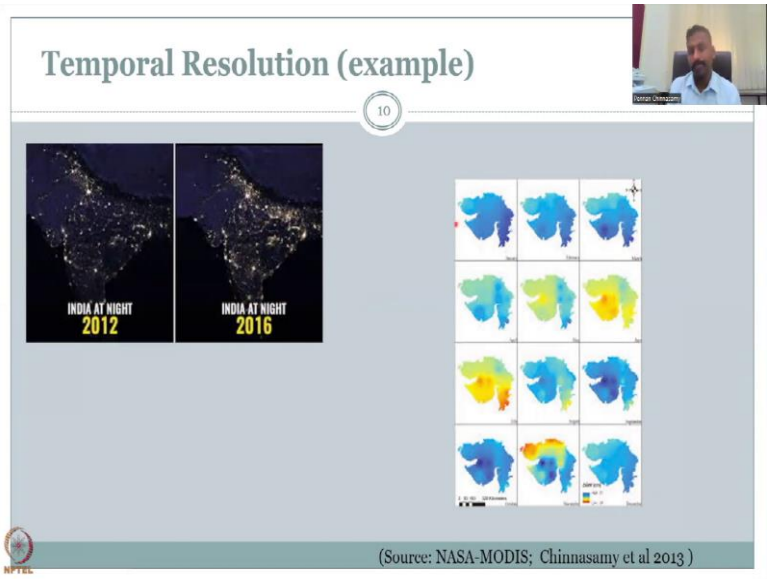

Temporal resolution, we already saw this example of a night image and a day image I am sorry, night image into two different years. So, the so now 2012 and 2016. For this dataset, the temporal resolution was 4 years maybe the day the satellite was taking every day, then

you say that for the satellite that it was used, it is daily or monthly, depending on the satellite. For this image, which I already explained in the proxy data, what is the temporal resolution? It should be monthly, because every month, I am taking a data.

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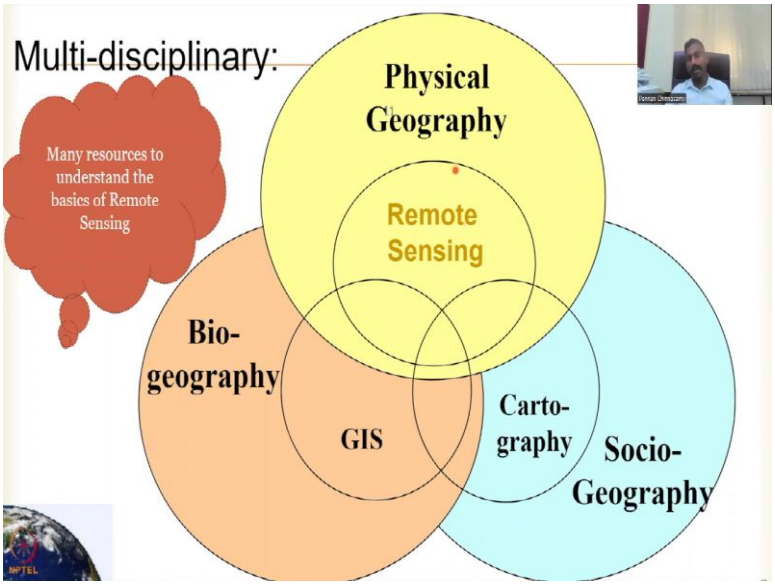

So, remote sensing as a whole is a multidisciplinary, you could see remote sensing used in physical geography, where you talk a lot of physics and geo locations, images, but it is also used in social geography and cartography, you map people and the biogeography where you map the living things humans, trees, plants, animals, etc. So, it is a multidisciplinary by default.

There are many resources to understand the basics or most sensing and as I promised, there are some NPTEL courses. You feel that you need to update before you take my class, please go through this notes and class lecture videos which are already available online by two eminent professors two different courses, but similar I would say about remote sensing and GIS.

This course cannot now you could understand that because rural development is the core, we need to spend more time on rural development. But since we using remote sensing and GIS as a tool, you can still go ahead and look at this tool for updating or understanding the basics remote sensing and GIS.

With this, I would conclude today's lecture. Even though you do not know remote sensing and GIS you can understand where and how you can use remote sensing and GIS, in this course for development. And that understanding will lead you to these materials that I said

that can let you know where and how you can learn remote sensing and GIS. Please do not keep that if you do not know remote sensing and GIS you should not take this course no not at all. The basic that I want to teach should be enough also. With this, I will see you in the next class. Thank you.