Spatial Informatics
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Lecture – 31
Remote Sensing and GIS – I

Hello, today we will discuss about another important topic in Spatial Informatics which is remote sensing or rather we should talk about Remote Sensing and GIS, right. So, over several lectures previous several lectures we have seen that spatial data modelling, spatial database, a spatial networks, several type of spatial analysis and so and so forth and definitely spatial queries etcetera, right.

Now, we see that two major aspects which are primarily thought of a mostly a quote unquote under the purview of geography. Now, it has multidisciplinary aspects and became an important source for acquisition, maintenance, analysis of spatial data. Nevertheless our concept of modelling spatial database squaring remains same and as much as important as these aspects, right. We will see that how to relate those things, right.

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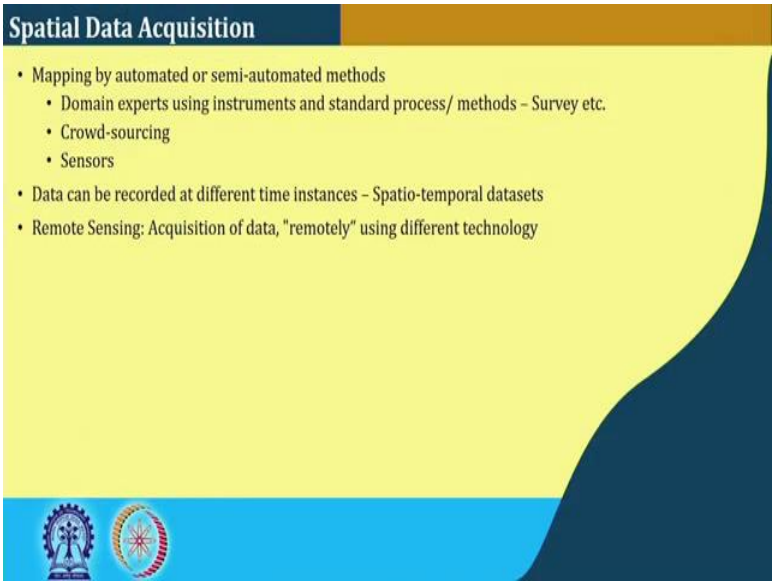

So, one of the major challenge in spatial data is the data acquisition. These data are pretty large has a space time relationship; you need to acquire both space and time. So, mapping by automated or setting automated method is one of the things right; how do I

map or capture we are using the word mapping because there is a spatial phenomena, right. So, usually this spatial data or geospatial data we represent by a maps, right. So, I can have a mechanism of automating capturing the information or there are some of the things were semi automated; in that sense there are human intervention is required I mean we want to capture some of the data etcetera.

Like capturing image by a above that surface by a flying over or aircraft or satellite maybe in an automated way doing the things. But, I can do some sort of a human driven sourcing of the things like identification of the point of interest, finding a particular doing some sensors type of things and mapping it to the backend maps that things are there. That where it is not all that automated, there is a interventions there. Nevertheless, even if I capture something automated I may require some pre-processing etcetera which may be automated or sometimes semi-automated never.

So, whenever usually this data etcetera what we capture is something domain specific, right. It is related to something like you are capture we are capturing vegetation related data or say soil related data or say build up or building related data for all those things I require some sort of expertise to do that. And, if you recollect during the spatial modelling we have seen that while modelling also I need to have some sort some sort of a domain expertise; who can talk, who can basically have that semantic meaning and have the appropriate association between different entities.

So, domain expert some using some instruments and standard process or methods can do this mapping, right. I can say I want to do some sort of a soil sample, I want to do some sort of a atmospheric pollution type of things and stuff like that, right. So, I can even have a crowd sourcing. So, different things we want to do through a crowd source mechanisms. So, that can be a way of handling data, it can be sensor based; like I want to capture using different type of different category of sensors. So, that can be one way of handling data right. I can have say temperature sensor, pollution sensor, onboard sensor for image capturing etcetera.

Data can be recorded at different time instances spatio temporal data sets right, data can be recorded at different time instants instances right. I can the say I want to do say for example, say as we are talking about the pollution data. So, it is over the day over in a single day over different time start at 6 pm, 7 pm, 6 am, 7 am and so on; hourly basis or

3 hourly basis I am capturing. So, it is a not only which location which time of the location right space time type of data. So, that can be space time data.

Even if I capture images by aircraft or drone or satellite images; why I may we may do on a repetitive basis I capture and going on doing it captures. It may have different applications like say flood monitoring and types type things like that; so, and type of things.

Data can be recorded at a data remember; so, for that one of the major way of capturing data is remote sensing right; remotely sensed data, acquisition of data remotely using different technology, right. So, I data acquisition which I remotely sensing like one good example is capturing by satellite, drone and type of things right; even not we are capturing on the remotely sense. So, this is this has become extremely popular; we will see why. First of all they are somewhat quote unquote accurate, timely and somewhat precise; precise in that the amount of data in the precision you want to capture.

So, accuracy also as there is a standard system is capturing so, accuracy is guaranteed. If there is a deviation you know that what are the system error and type of things you always you can cover up the things.

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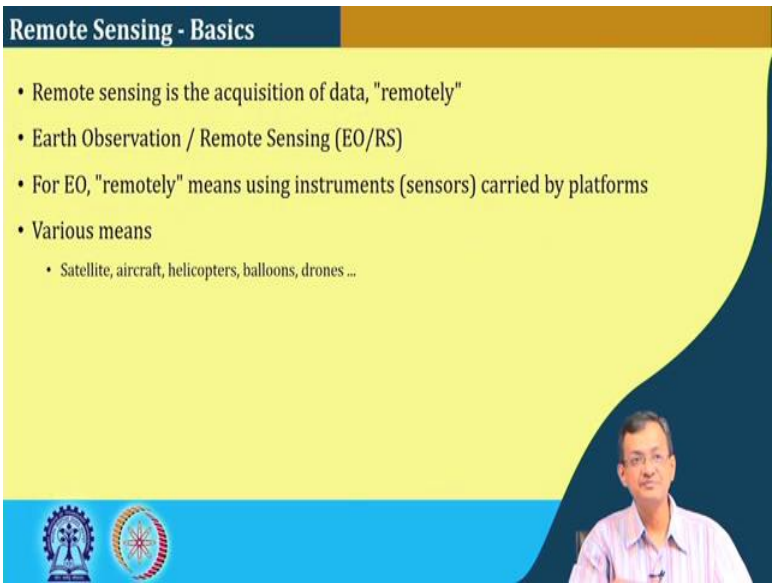

So, remote sensing; if we see that remotely sensing the acquisition of the data; so, the word remote come into remotely come into a. So, popularly also known as earth

observation or remote sensing data or information; for earth observation remotely means using instruments, sensors carried on over the platform, right. So, like satellite say remote sensing satellite when we talk about or satellite remote sensing when you talk about. The satellite is carrying some of the sensors who is able to capture. What it captures? It captures different aspects of the earths.

Some satellite may be doing things like land use type of things more specialized for vegetation and type of things like how things some of the, some sensor payloads may be more to our oceanography, some may be atmospheric data and type like that. So, I have different type of sensors on board or on the platforms which capture the things, right.

And, there can be various time means of doing that like one is satellite remote sensing is pretty popular, in our own country ISRO launch satellite. What are the IRS category of side right, you know Indian Remote Sensing satellites; they are aircraft, helicopters, balloon, drones and these are different way we can capture the data. Like even I can capture the data going on a high rise building or through using a high end what we say crane or type of things right where at a elevated things I can capture the data, right. So, but we as it is remotely sense it is remotely sensing.

So, how it what things matters? One of the things we will see later on is the resolutions, spatial resolution plays a important part. What is it? Like a pixel in the say image, what does it remain means what does it area power on the ground. Like say commonly remote sensing satellite for our IRS or say land sat type of satellite, what we are having?

We are having that data as 1 pixel is around between 20 to 23 meters so; that means, if I have 23 meters. So, 23 meters 23 meters on the ground is 1 point or 1 pixel in the image. So, in other sense any object less than 23 cross 23 will be not distinctly recognizable right because, it becomes a pixel; more than that I can basically try to look at it. Now, this resolution matters because if you go on higher resolution like submitter accuracy like say 0.5 meter by 0.5 meter is on the earth surface then your data load increases pretty much.

Now, where you require that make say things right like the precision require, the sensor capacity will be costly; sensors will be costly greater will be huge like even instead of say 20 meters, if I come down to 10 meters the data low it will be 4 times, right. So, for that I require that which other things. So, as such high resolution imaging thing things

are there, there are different standard for that it is a agreed upon standard. So, image captured by somebody or the data accuracy by somebody, somebody else can use right. So, we have a different mechanism to do that.

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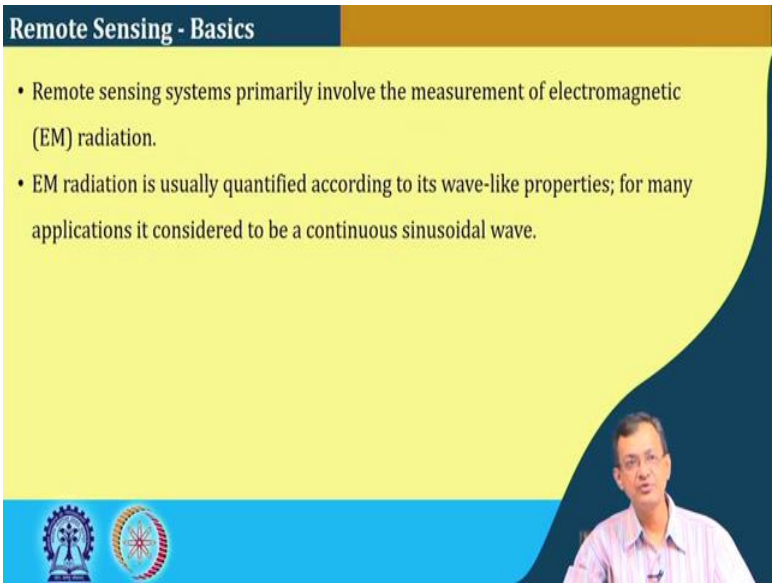

So, remote sensing system primarily involve measurement of electromagnetic radiations. So, that we need to think that what it sense is a electromagnetic radiation. Like for that matter what we see also is in the, is within the range of the electromagnetic radiation which is in the visual range or which is visible, but it can have different type of ranges, right. And, EM radiation is usually quantified according to this wave like properties for many application, it considered to be a continuous sinusoidal wave, right.

So, in other sense how it thinks any wave like properties. So, any wave as we know is identified by this frequency, wavelength, amplitude and of course, at times the phases of the things, right. So, or in the electromagnetic spectrum what is the frequency range dictates that what sort of data need to be captured.

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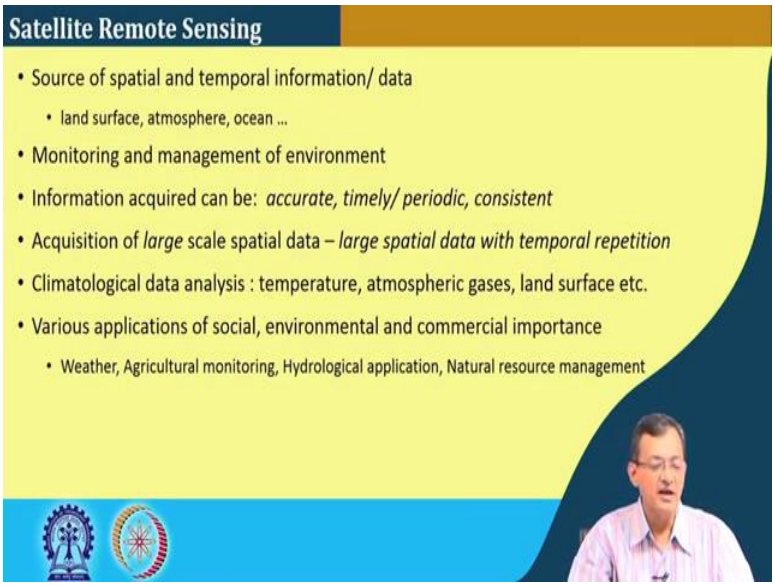

Like if I have satellite remote sensing, source of spatial data and temporal information and data land surface, atmospheric ocean, right. These are the different data which can be captured, monitoring and management of environment is one of the major things what we do with the remote sensing data, natural resource management like you I want to find out this say crop productions estimation or the forest coverage estimation. Or, even say in case of water body estimation of what are the water bodies etcetera and also I have a good amount of implication in disasters management like disasters like flood etcetera.

So, how much inundation is there, if I have this village map of the road map which are the villages or the areas, it may not be not only villages in the city area also is likely to be inundated or already inundated. And, over that I can if I have that a some sort of a flood model with elevation model which has again expertise from the civil engineering or hydrological department.

So, now I can predict that down the rain if so, much rain is there and this area this is likely to be flooded. So, this gives sample or this gives say inputs to these government bodies or different federal agencies to take corrective actions or type of things, right.

So, this becomes; so, the data is some data is remotely sense, some analytics is run over this, can be mixed up with already can be need to be analyzed with already existing data. Like we may have a road network, you may have a road network or the settlement network which are not so volatile, it is not changing day in day out.

So, acquisition of large scale spatial data, large spatial data with temporal limitation like climatological data analysis: temperature, atmospheric gas, land surface etcetera, right. Various application of social, environmental, commercial importance right whether agriculture, hydrological, natural resource management, disasters management I think right. So, one important that it is accurate, it can be timely and periodic and consistent, right.

So, say a every 3 day if our own IRS satellite is taking picture of this is IIT, Kharagpur, it is taking in a temporal scale and it is consistent of that particular resolution. And, accuracy in that terms in the sense that it is as a automated and a modeled instrument or standardized instrument is used so, those are things. If there is error that is also usually systematic error, in a for a systematic error we can have a corrective function to recover from that error right; so, those type of things are there.

So, climatological so, lot of application in climatological data analysis and there can be various applications of social, environmental and commercial importance, right. Like as we are talking weather, agriculture monitoring, hydrological application, overall natural resource management, disasters management and type of things right. So, these are different type of things which you can have.

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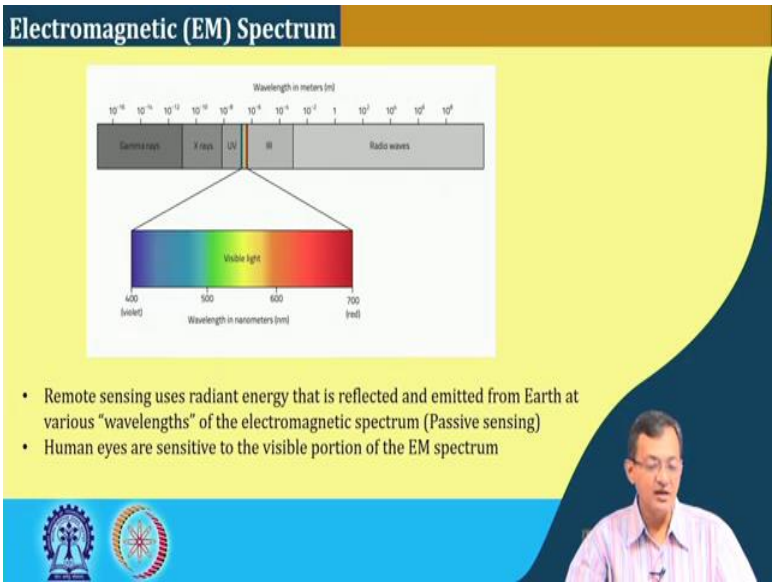

So, as we are talking about the spectral band a image taken from the internet, but it is a very popular EM band image. So, this is our visible range visual visible range light

nitrate violet and this range is there, other than we have different other range. Say radio waves, gamma rays, X-rays, UVs, some range is a microwave range and type of things, right. So, when we design a sensor which can be at different range of the things, right.

So, remote sensing uses radiant energy that is reflected and immediate from the earth at various wavelengths from the electromagnetic spectrum. So, sometimes called a passive sensing; that means, as we are doing in using our camera, a mobile camera or your handled camera. So, what you are doing? There is a in the daytime, there is a light source which gets reflected and it is captured by the thing. So, my camera sensors senses the thing which is some sort of a electromagnetic in some range it is getting reflected, right.

Now, these are passive because you require a light source to do that, you can have some of the active things like you carry a flash, right. So, you put the light and then the take that take the capture. So, in case of a satellite remote sensing or a real photography or taking photographs or images using different mechanisms like air aircrafts or drone or balloons and etcetera those are mostly passive sensors, right. So, they take earth as a source of light, but there can be active sensor sources like microwave sensors, right.

So, specifications if the earth is the or optical sensors how to say, if earth is the source of light a sorry sun is the source of light a source of light. So, sunrise falls and then I take the images, right. So, during night there is no sun; so, you cannot take the images, not only that if there is a cloud cover then also the things will not come and not get reflected to the sensors at the satellite or even high altitude aircrafts. So, then also image cannot be there.

So, there are challenges with this type of sensor things right which are passive things, but nevertheless these are easily what we say quote unquote understandable and or processable or interpretable right for the things and widely used, right. There is another category of sensor mostly what we say microwave sensors, which has a active sensor; that means, it says sense microwave things and captures the things or I can set the signal and then capture the signal. And, they are also known as day night sensors because it can work in night also, because they are active, they are not waiting for the sun to give the source of energy or light or thing.

And, also many of these can penetrate the cloud cover; that means, specially during disasters management like flood and when heavy rains are there then you have a lot of

cloud canopy. So, this energy penetrating it becomes a serious problem. So, human eyes are sensitive to visual visible portion of the electromagnetic spectrum. So, our eyes or our sensors in our eyes can are sensitive or can capture from the visible light right or visible portion of the electromagnetic spectrum, but I can have different sensors. Why I require different sensor? Based on my requirement, suppose I acquire something to be there which is to be in a particular microwave ranges, then I do the things with the sensors.

Another interesting phenomena we will discuss later on also is that see this type of satellites which are based on the sun. So the, my area of interest should be well lit when my sensor board is there, say Indian remote sensing satellite, right. So, their major interest is capturing the data of India, right. So, if should over above the earth above during the when the sun is there over the over India right. So, if it is circling and coming at during night time then it is it will miss the chance of doing the things, right. So, these are these are sort of satellites are unlike our geostationary satellite which has at the fixed on over a particular locations in India; these are mostly what we say polar orbiting satellites.

So, it orbits around the pole, right. So, the earth is moving like that and it was bits like this and whenever the, it is tuned or configured such a way that whenever it is on India side; it comes into the on the basically the sunrise there. Like, it crosses India around say around 10 to 11 on the earth's surface. So, that becomes a things like that ok. So, human eyes so, these are polar orbiting satellite, right. So, it is pole orbiting and they basically orbit the earth more of a more times rather say 13-14 times a day or type of things, right.

Not only that they are mostly low flight, typically I may not be very exact, but somewhere 700 to 900 kilometer above the earth surface, where if you see the geo stresses attack there are far away from the around 36,000 kilometer and so.

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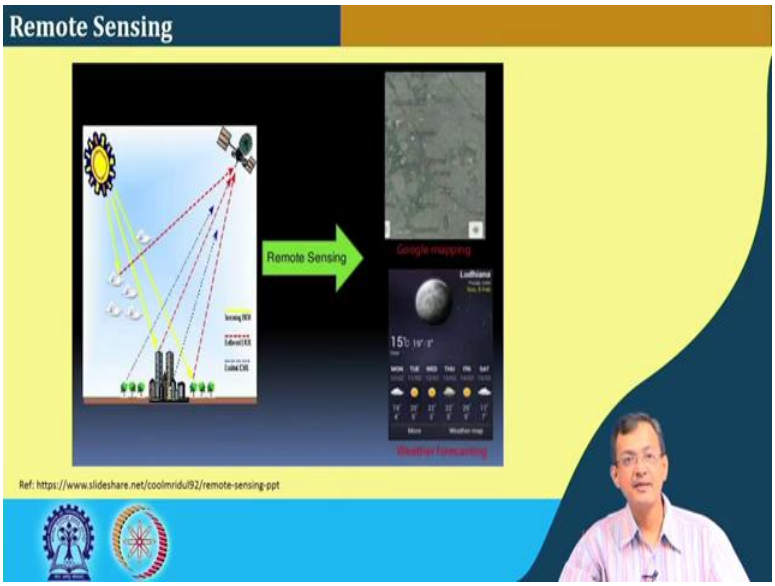

So, this is what we are talking about the sun is there reflected and captured by the things right, if there are cloud cover etcetera it is stuck. So, that things are not coming up, we capture something like a map like right data like this right. This is a Google earth map, but something that we will come up like this right; I can have different other whether focusing or temperature scale maps etcetera. So, you see the phenomenon is that some source of light mostly is the sun is there and it gets reflected and type of things.

This different material we will have different absorbent, different deflection capacity based on that my data recorded in the thing will be different like same as our photography, right. Like, if you take the photography so, the face, the hair, the cloth and everything have a different type of reflectance value. And, those are recorded in my photographic film or that photographic sensor thing's is; similarly here also recorded and those are being transmitted to the earth station which are later on processed, right.

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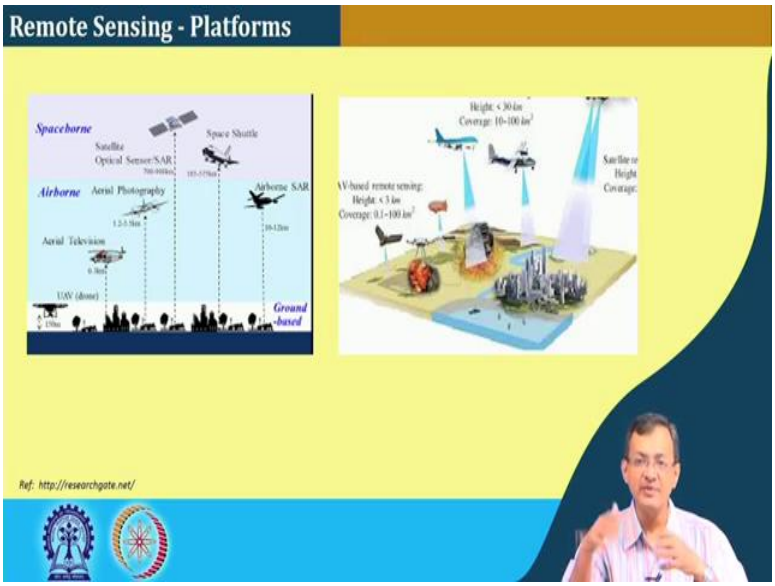

These are some of the other things; like we it can be the platforms can be ground based, these are all ground based platform. It can be airborne, it can be space shuttle which may be carrying; these are space born things some of the airborne and I can have even ground based sensors right to sense the data, but all are remotely sense. Similarly, here also we can have different type of sensory boats. So, there are different mechanisms of the things.

We are mostly concentrating that the data what whatever will be showing it said they are mostly satellite remote sensing data which are captured by the things. The several such data are openly available like land sat data, USGS given several data, but for academic purpose and research purpose those are available on the things. And, some of the data need to be purchased or you need to have a means need to registered with an organization right; like if you want to have Indian remote sensing satellite data in several cases you need to have a contract with them that that is or you need to apply for the data.

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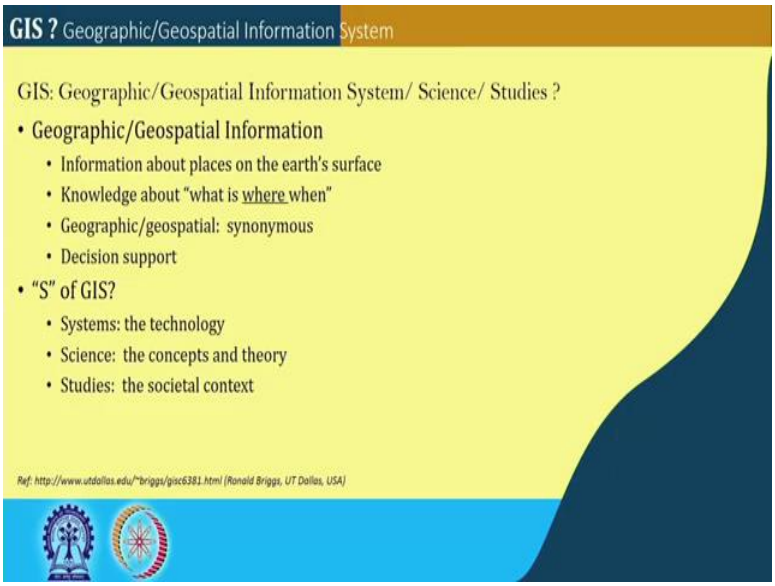

So, now this is on the remote sensing part. So, what it is giving? So, it is giving a large scale data sources right, it is used data sources. Like if you have I can give you an idea like even with our own remote sensing data IRS type of data, if the Kharagpur is mapped the whole matrix is to the tune of somewhere between 4000 cross 5000, if not more, all right. And, and it is a huge volume of data alright and in several cases it may not fit into your region appear. So, you can a couple of things you can need to match.

So, there are several volume order; on the things if I can pre-process these data and then use this data for other mappings etcetera will be a advantage to do that. So, it becomes a big source of data, it is repetitive, accurate and systematic way collected, right. So, it becomes a great like say I continuous monitoring of flood, continuous monitoring of vegetation, continuous monitoring of say ocean studies or even study of say forest deforestation and type of things; so, I can have a mechanism to that. So, it becomes a source of data, right for our any type of things rather this data in some sense of red thing we can put for my, our region interest in the in a spatial database, right.

And, then I can query on the things right or I can mix with the other data set, like I can have a road network that overall land use, road and your build up data along with that flood inundation data helps me to find out that how much things are covered in the flood. So, these things are important to do that. So, GIS geographic the other aspects; so, what we think the remote sensing and then we see another aspects which is geographic

information system; though there are different several definitions we will see that, but somewhat they converge to the same thing.

So, it is a geographic sometimes called geospatial information system which takes the which primarily meant for something more of a decent support sort of things right, it is a information system. So, it allows you to store, capture and finally, analyze the data. So, source of data can be this one of a remote sensing data also. So, and can be other source of data. It works with usually a spatial back end spatial database right, which helps in querying on the spatial data and type of things. It also have a visualization tools to see that what is the end result and type of things, right.

So, a geographic or geospatial information system sometimes it has or graduated more of a say geographic information science or there can be different geographic information study. So, S stands for different manifestation systems, science and studies right. So, geographic or geospatial information, information about the space about places on the earth surface, but more on a based on a basic region of interest or basic geo spatial framework, like I can point out this is this type of things. And, it harvest the data from different or different layers of data for the same region and allows to analyze with the things, right. Knowledge about what is and where and wind. So where; what it is and where it is right in the terms of location and time as well as in spatio temporal data set.

And geospatial, geographic geospatial are interchangeably used, we also will be using interchangeably and also one of the things it is a spatial decision support system. So, decision support system imposing spatial temporal data sets. Now, as we are discussing S has different manifestation in GIS systems, science, studies and technology concepts and theory and social context. So, these are the different aspects of the term S, right.

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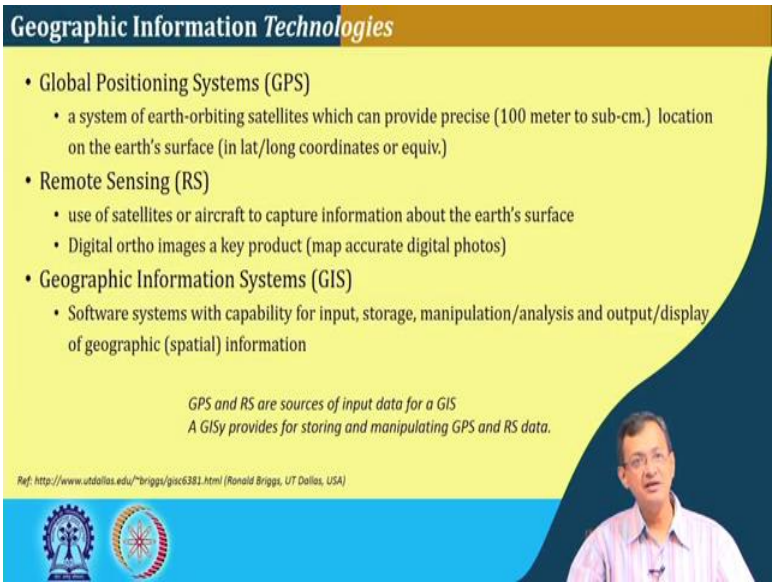

So, there are several cooperative technologies which helps GIS to bloom. One is the Global Positioning System GPS: a system on the earth orbiting satellites which can provides precise even from 100 meter to sub centimeter location on the earth surface in lat long coordinates or there are several coordinate or different coordinate systems also. GPS we are used to it with the mobile right, we are using with finding the shortest path or the finding a path between these two etcetera and finding where the location is. So, this GPS is the important aspects and which is one of the major component.

Of course, remote sensing use of satellite and aircraft to capture information about the earth surface it is of course, it gives a. Digital ortho images is a key product map accurate to the digital photos; like once we take the images, it needs to be probably mapped with earth surface, right. Like I take by sensor say photography of say forest land mostly concentrating on the things, you take mostly on the say build up area or road network which is concentrating on those type of things, then I match. This would sit on one another and this would refer to the same place on the earth, right. For that I require appropriate correction and transformation of the datasets which creates a accurate digital data which can be used for analysis, otherwise things will may not see it.

You put different layers and then you can analyze very things with them or in other sense if I think about I have a set of transparent papers, right. I fit into a particular graph paper, graph is my reference and I draw somewhere road, somewhere that road of the IIT,

Kharagpur, buildings of the IIT, Kharagpur in another paper say water bodies. And, then if I club they one put one to another say road with the building, they actually sit; actually what is there it is mapping on the things. And, they can be refer referred by a coordinate or systems or crucial reference system. The may be the most popular things what we see it get long, there can be a other reference systems also, right.

So, that is important otherwise you cannot work with that, you cannot do any decent support with that, right. So, that is pretty important for that we require this ortho images, digital ortho images. Geographic information system per se is a software systems with capabilities of input, storage, manipulation analysis, output display of the spatial data. So, if I look at that as a system what is geographic information? So, it can capability of input, storage, manipulation analysis, output display of the geography informantion. GPS and RS are the source of input data for a GIS; a GIS system provides a storing and manipulating of the this different location data and remote sensing data and other sources of data sets.

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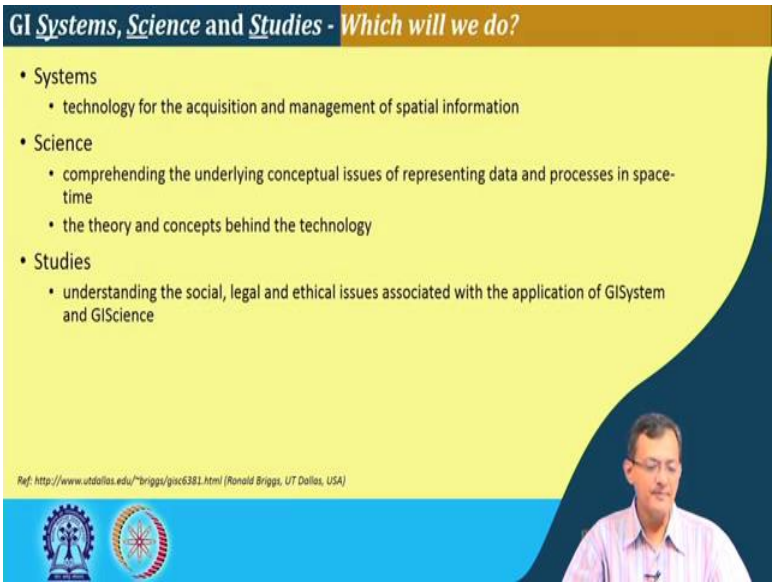

So, GI systems science and studies what are the things, like systems the technology for acquisition and management of the spatial information. So, that is important right, unless that system is in place the framework is in place you cannot do anything. Science comprehending the underlining conceptual issues of representing data and process in

space time, right so, that is the scientific study space your temporal analysis, forecasting or predicting something or doing some inference drawing.

If this depends there so, that is what we say finding that correlation or how that mapping them together and those things are important. The theory and concept behind the technology, and studies and understanding of the social, legal and different type of things which can be studies on the geo. So, I can we can this; mostly we will be consulting on the systems and science definitely looking some aspects of the studies, but mostly on the systems and science aspect for this particular course.

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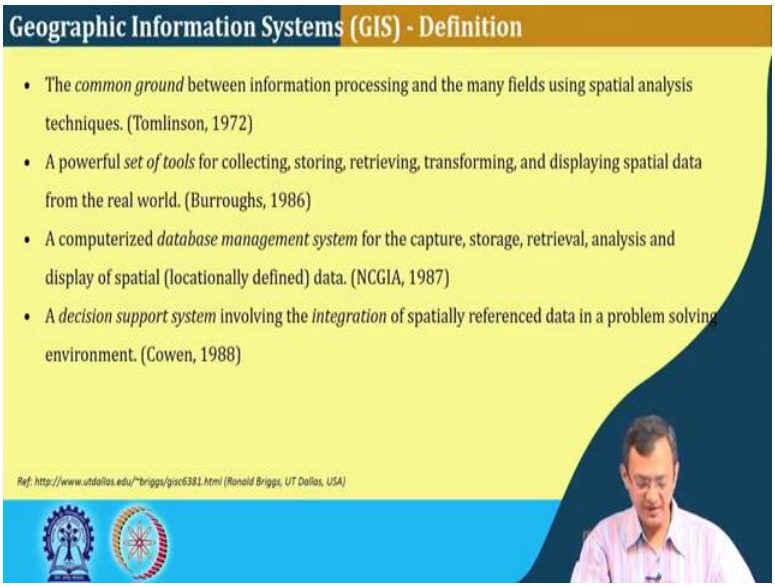

So, now definition. Now, come back to the definition. So, there are different type of things people different what we say look or how I look at the things right; a common ground between the information processing and many fields using spatial data analysis techniques; a powerful set of tools for collecting, storing, retrieving, transforming, displaying, spatial data from the real world. A computerized database management system for capture, storage, retrieval, analysis, display of spatial data which is locationally defined or location enabled things like if the coordinate systems are there.

A decent support system involving integration and a spatial reference data in a problem solving environment. So, I more of a decent support or analysis of this different layers of data. So, what we try to look at this today's class or today's lecture is more of a how this remote sensing and GIS plays a role in spatial informatics. So, remote sensing we will

see in subsequent couple of more classes that or also the GIS that how the remote sensing has allows us to capture and what are the different aspect of things. It is a source of main source of data which is as we have seen photon code accurate and timely and systematic way of capturing.

And, GIS enables us to harvest this data in appropriate things; one may be input from the remote sensing, there can be crowd sourcing, there can be other sources of data already historical data. GIS allows us to build up the layer with a spatial reference systems, otherwise things we will not sit together right. Underlining things are definitely the spatial database, what we have learned things, right; so, spatial database and querying or the spatial database by the systems, which are manifestation of the things, right. We will continue our discussion in the subsequent lectures and on remote sensing and GIS in our subsequent lectures.

Thank you.