Geographic Information Systems
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Module No. #04
Lecture No. #18
Coordinate Systems

Hello namaste, I am back with next set of lectures on geographic systems specifically as I said in my previous lecture, I would be speaking on the coordinate systems. So I understanding this coordinate system is extremely important and it is a extremely essential when you have to work on a map ok.

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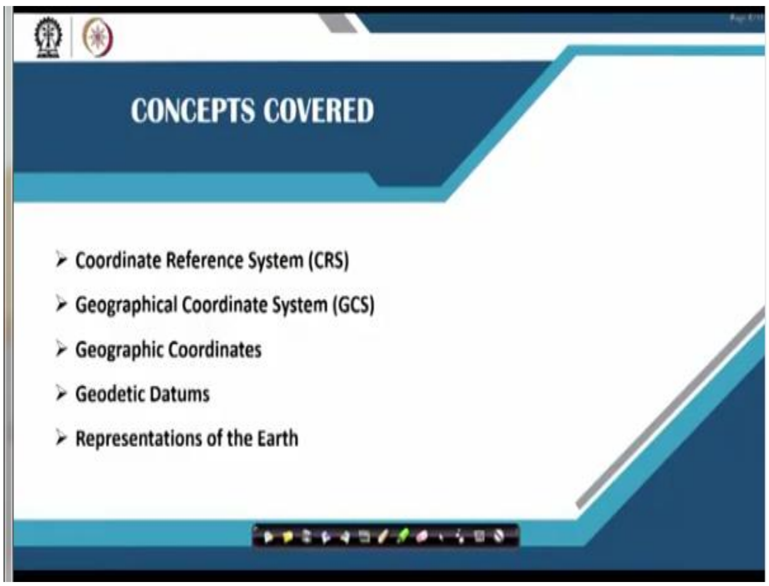

So when we look at this entire lecture, lecture is being divided into some concepts like coordinate reference system, which is also called as CRS. Then we look at geographical coordinate system are called as GCS in simpler terms than a geographic coordinates, what you mean by geographic coordinates, geodetic datum ok than representation of the earth. So we will cover all of these topics in this particular lecture.

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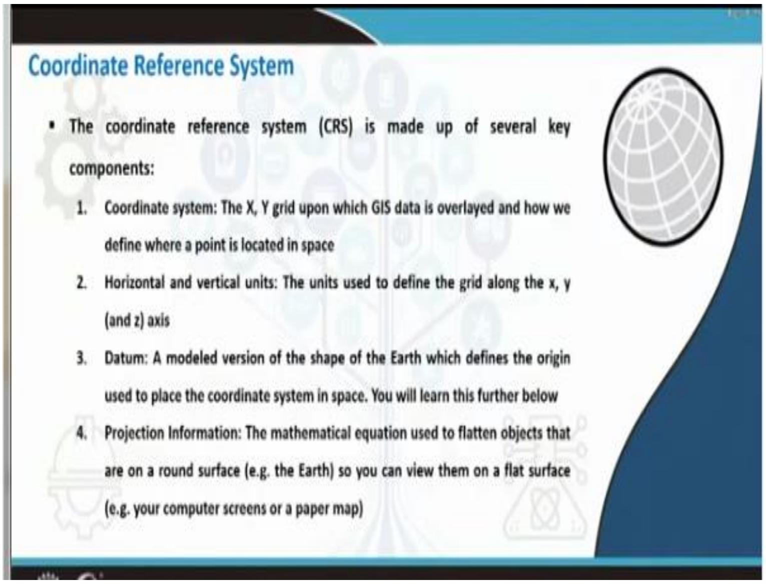

The first thing when we look at the coordinate reference system whenever I refer CRS it is nothing but a coordinate reference system. So when I say coordinate system. it is an x, y grid upon which, so it is always an x and y, so it is x, y grid ok, upon which a GIS data is overlead and how we define a point that is located on the earth surface or in a space ok. So now horizontal and vertical units, these are the units that are use to define the grid along the x, y and if in case it is necessary z axis or z axis.

So when you look at this a modeled version of the shape of the earth which actually defines the origin use to place the coordinate system in space, so it is origin use to place a coordinate system in space ok, that is nothing but a datum ok. So when we look at datum in more pictorial form, so you will understand what is a datum then is the projection information, projection information we look at it the mathematical equation that is use to flatten a 3D object into a 2D object ok.

A 3D round earth shape into a 2D flat map then it is called a projections information I spoke to you spoke about this in my first lecture of this particular module. So whenever we look at coordinate referencing system we have to look at coordinate system then look at the vertical units, horizontal and vertical units at x and y and in some and many cases as z axis ok. Then look at datums and finally look at the projection information, without which you are CRS would not stand ok.

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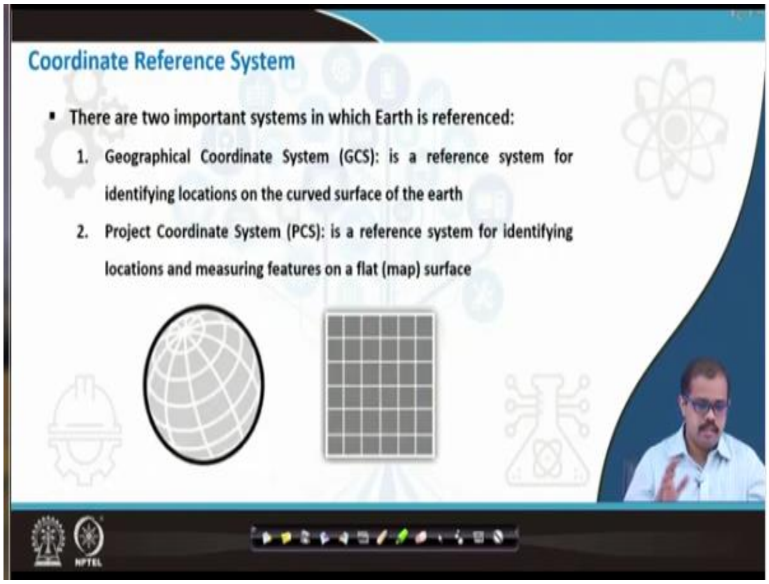

So keep this in mind, so whenever you are looking at CRS look at all of these 4 quantities then only you will be able to understand the CRS. There are 2 important systems in the earth referencing system, so coordinate referencing system, so be very careful. So these are the 4 different quantities that we have to see that I explained in my previous slide but in order to reference you have 2 types of system one is called as a geographical coordinate system is a reference system for identifying locations of a curved surface of the earth.

But there is something called as a projected coordinate system is a reference system to identify location measuring on a flat map. So when you see GCS it is more of identifying location on the curved earth surface and when you are looking at a PCS that is the project coordinate system or a projected coordinate system it is on a flat map it is on a 2D map. So keep this in mind these are reference systems ok.

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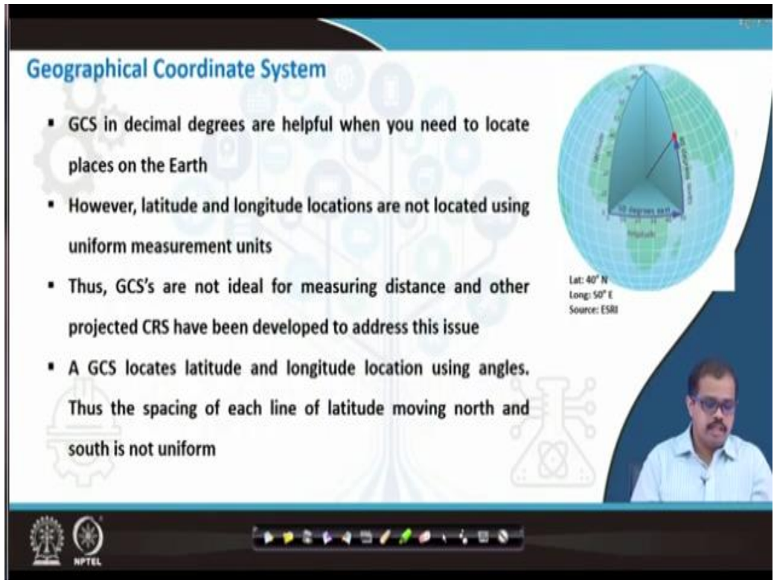

So when we look at geographical coordinate system, it is normally is in decimal degrees and are helpful when you need to locate a place on the earth. For example the very good example that probably many of you have looked at is the Google maps ok, sometimes when you are actually hovering I would suggest something like this. If you are looking at this particular lecture open up your Google maps ok and open up a particular place, where you may have to travel maybe tomorrow day after tomorrow etc.

Look at the distance from that to that particular place fine now you are comfortable at looking at that distance. Now just take out that red pointer and put it somewhere else which the map does not have any, so what does it show, it actually tells you the x and y of that particular place that is in terms of maybe in degree decimals or in degree minutes and seconds yes, that is what I am speaking about a the GCS system.

So latitude and longitude locations are not located using uniform measurement units please keep this in mind that is what is one of the major disadvantage of the system. So GCS are not ideal for measuring distances and other projected CRS have been developed to address this particular issue. If you have to measure distance than latitude, longitude, the way the GCS works is not the way you use it but if you have to use the measurement system then use a projected coordinate system.

The GCS locates latitude longitude location using angles thus the spacing of each line of a latitude moving north and south is not quite uniform which you can look at it here ok. So a GCS when you look at a GCS coordinate system the north the lines that are moving it is the north or the south is not very uniform and you can never measure anything as a distance measure in a GCS system, whereas in your projected coordinate system it is much easier to understand.

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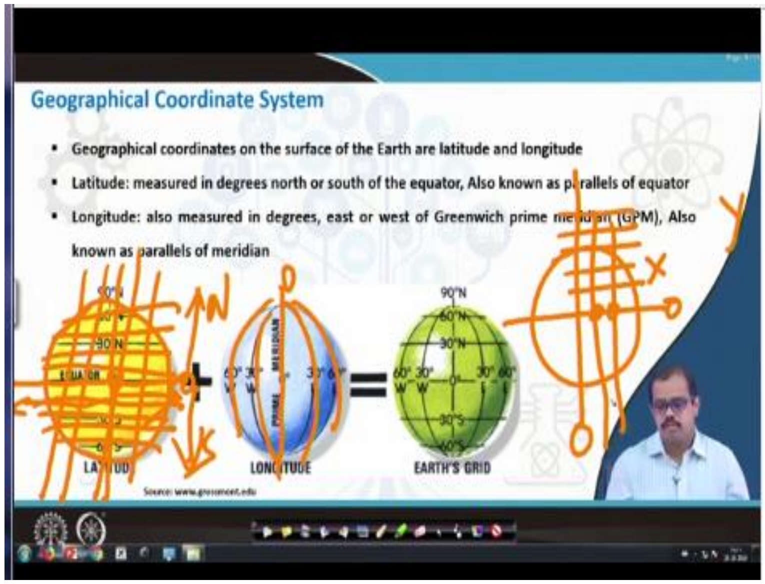

When you look at geographical coordinates on the earth surface mainly you would have seen it in the form of a latitude and a longitude when I say latitude this are measured in degree north or south of the equator also known as parallels of the equator ok. Longitude measured in degrees east or west, of the Greenwich prime meridian also known as parallels of meridian. So when we look at this particular example here that I have mention if this is your earth surface that you have considered ok.

Now we know equator, equator is central part of the line that is passing through the centre of the earth's surface, which is 0 ok 0 degree. Now if you start drawing lines at this something like this, these are latitudes and in as northing when you are writing this, is towards the south these are latitudes. So when you draw latitudes all or in north and south latitudes and when if the same thing if you start drawing like this, these are longitudes ok.

This is if this is 0, this is the line that is easting and westing from here you have easting and from here you have westing something like this is the prime meridian which is 0, you have 30 degree east 60 degree east whereas you have 30 degree west and 60 degree west. Now my prime question to many of the students would be something like this I happen earth surface something like this now this is your 0 equator and this is your 0 prime meridian ok.

Now if someone wants to locate a latitude on which axis you would measure to actually locate a latitude and which axis you would measure to locate a longitude. So the answer here is if you are locating a longitude, for example if you write longitude here, so now it is actually intersecting on the x-axis. So longitude measurements are on the x-axis but it is represented as y ok because you have x-axis representing these are longitudinal.

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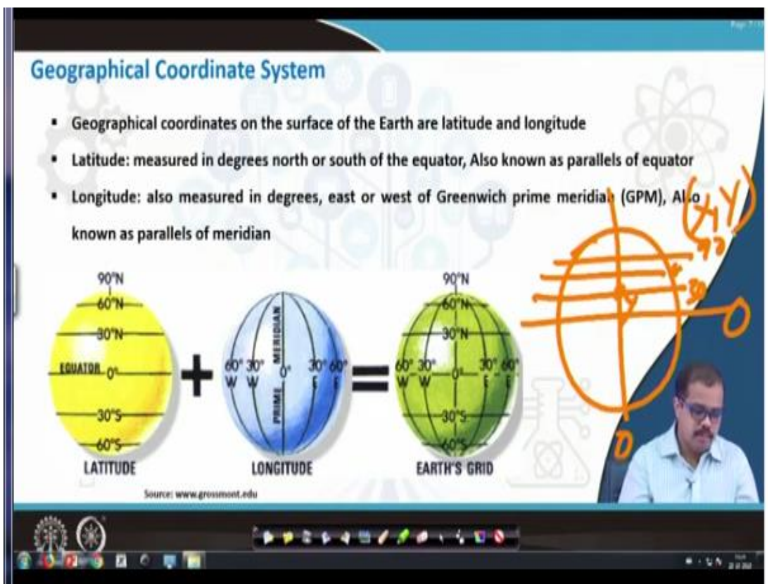

Now if you want to do a latitude measurements, so what you do let us say this is a earth surface. Now this is your equator right, so you want to do an latitude measurements which means if this is your prime meridian if you starts having the northing here is 30 north, 60 north, 90 north. So now you are intersecting on the y-axis right, so your measurement is on x values ok, so x, y so, latitude, longitude this how you arrive at it.

So please remember longitude will have it marking on the x-axis latitudes will have marking on the y-axis, so this is where most of the students make a mistake.

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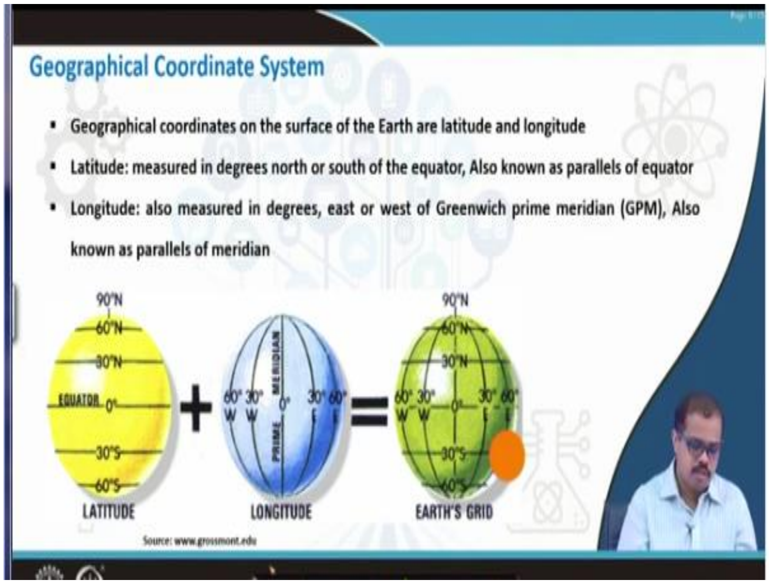

So please understand, how the latitudes are marked and longitudes are marked, so plubbing this will give the entire earth's grid ok.

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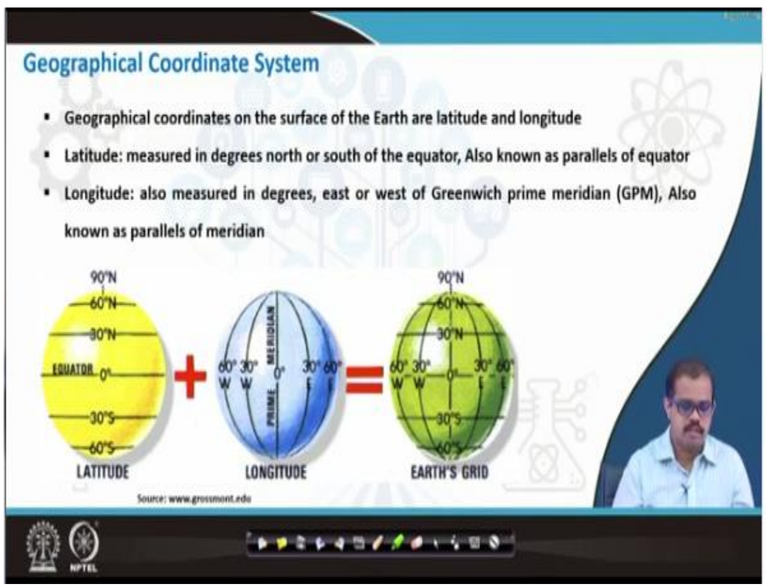

So once we have understood this we will move on to the next of understanding.

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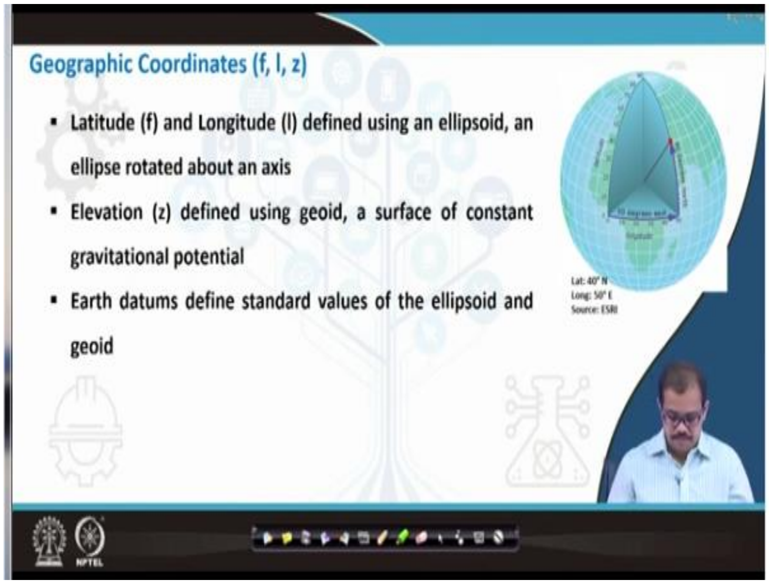

Latitudes and longitude or defined using an ellipsoid or a spheroid and ellipse rotated about an axis ok, elevation is defined using a geoid ok a surface of constant gravitational pull. We have already looked at it an earth datums defined the standard values of the ellipsoid and geoid ok.

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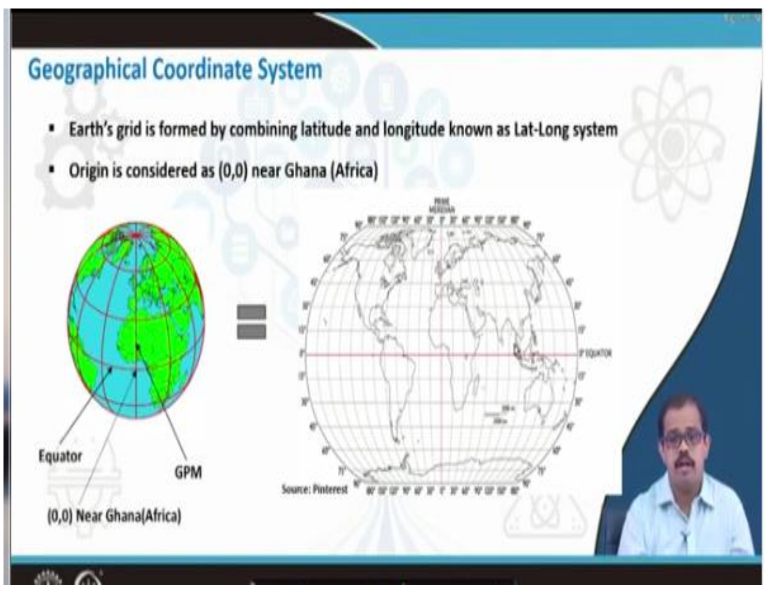

So when we are looking at the geographical coordinate system when we look at the entire earth grid it is actually formed by combining the entire latitude and longitude. So you cannot say if you are located at this particular point in India. So you cannot say that this is at only latitude of this, you have to represent latitude and longitude then only will be able to very clearly say this is the point and the earth surface where I am located on.

So you have to give both latitude and longitude in reference to equator and one with reference to Greenwich prime meridian, so without which your entire earth grid is not complete ok.

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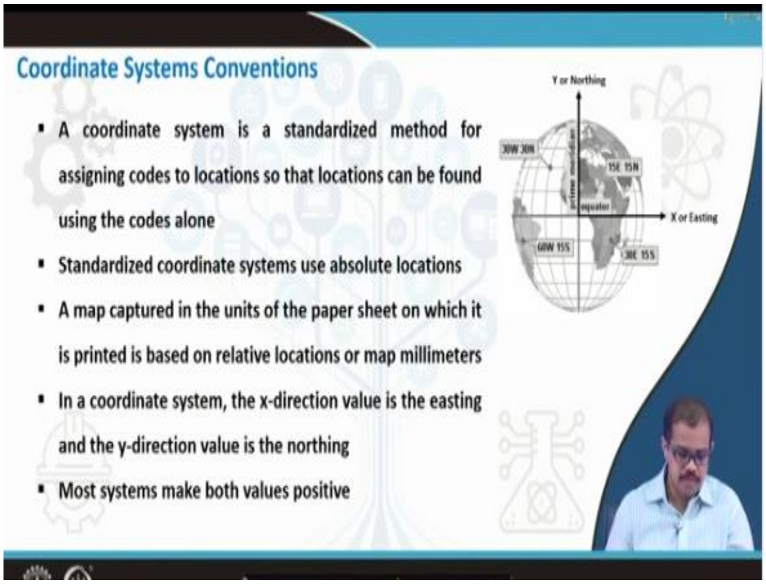

So a coordinate system as basically a standardized method, so how do you define a coordinate system which just is as a standardized method for assigning codes to location. So that location can be easily accessed by just codes ok, my latitude, longitude are just look as codes using those codes anyone can find. So every if let us say there are 4 people who are looking at for different locations if we have the same way of looking at the or same coordinates that we are actually looking at and everyone is looking at latitude, longitude of a particular place

So it is easier for us to compile the data if it is completely different, it may not be easy for us to compile the data. So it is a codes to understand a particular place, region, a phenomena etc. ok, then standardized coordinate systems use absolute locations, exact locations. A map captured in the units of a paper sheet on which it is printed is based on relative locations or map millimeters, so that we have to remember all the time.

In a coordinate system, the x direction values is the eastings and the y direction value is the northings. So that I have already shown x direction value is the eastings y direction values is the northings, so please keep this in mind, I have already explained how latitude and longitude is measured, where latitude intersects and where longitude intersects and how the values are measured in a latitude and longitude system. In a coordinate system, the x direction value is easting and (()) (13:14) most systems make use make the values as positive fine.

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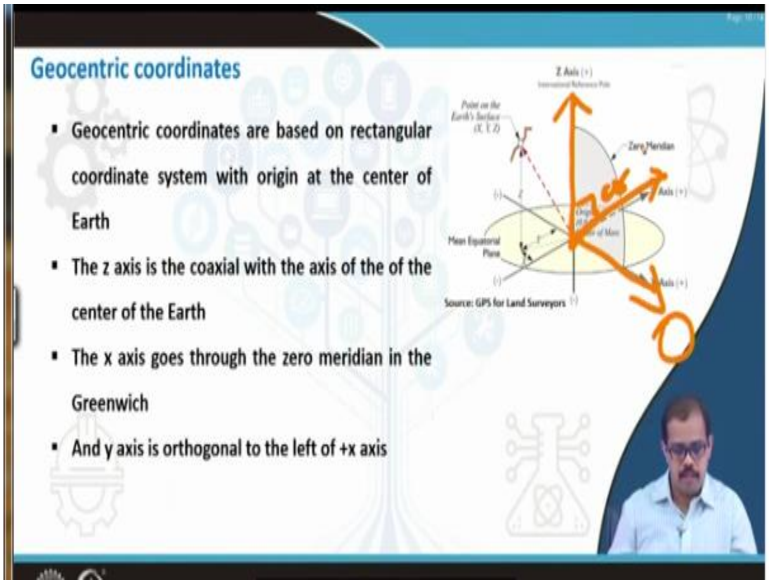

Then next comes a geocentric coordinates, geocentric coordinates was used a in various ways it is extremely important in terms of when you are trying to make the measurements. So geocentric coordinates are based on a rectangular coordinate system with origin at the centre of the earth surface. So if this if we consider this, this is the centre of the earth surface, the z axis is a coaxial with the axis of the centre of the earth.

So if you are representing the z-axis if this is the centre of the earth here ok, if you consider this as centre of the earth this is coaxial from the centre of the earth. Then the x-axis is through the 0 meridian when you are looking at x-axis it as 0 meridian and in the Greenwich and y orthogonal to the earth axis. So this is orthogonal to the yeah + x - axis.

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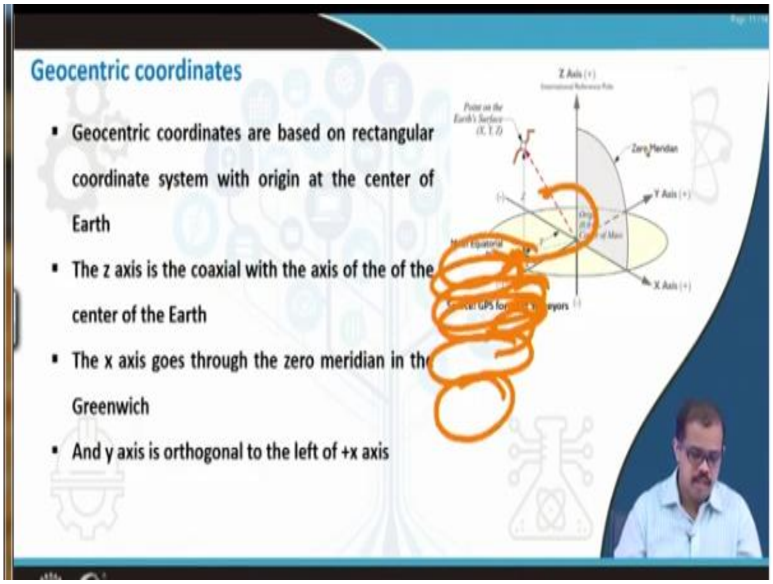

Now when you are looking at geocentric you have + and - also located and we look at some examples as we go to the next slides.

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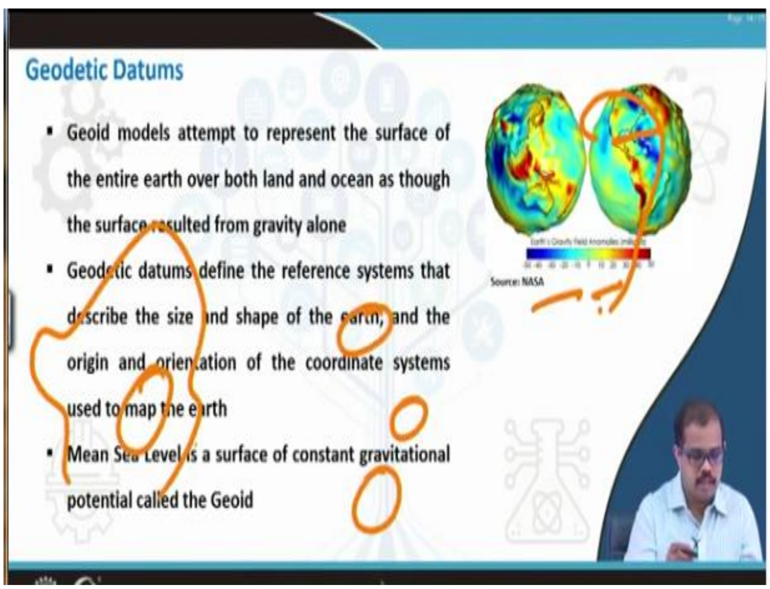

So when you are looking at geocentric systems. it is the first thing that you have to understand an geodetic datums. Geoid models attempts to represent the surface of the earth, if you are looking at this as a surface of the earth, it is actually representing the entire surface of the earth, where both land and ocean through surface resulted from the gravity alone ok. So now this is measuring in all the surface of the earth it is ok but it is based on the earth's gravity ok.

Geodetic datum define the reference system so be very specific here, that describe the size and shape of the earth and the origin and orientation of the coordinate system used to map the earth. So now when you are looking at this ok.

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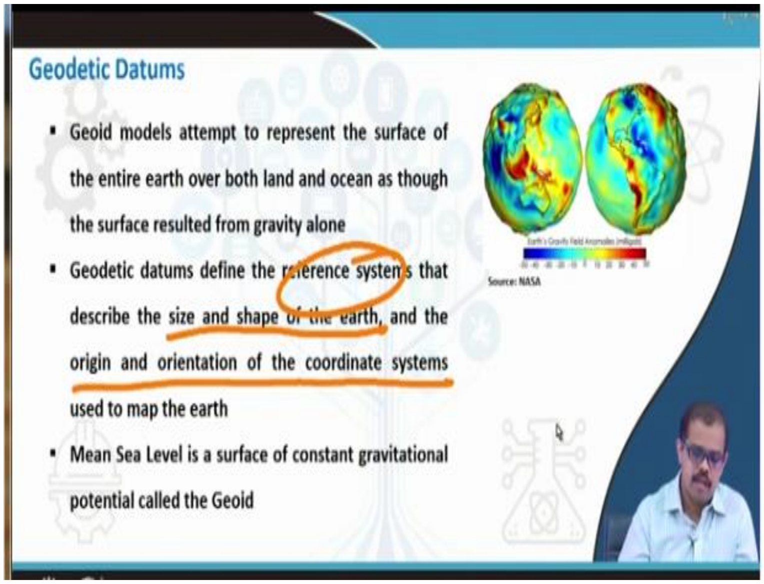

The thing that you have to look at geodetic datums are defining a reference system ok then it describes the size and shape of the what is the size of the earth, the shape of the earth and origin and orientation of the coordinate systems. So all of these together will form a datum ok, so mean sea level is a surface of the constant gravitational pull which I have already spoken about in my previous class ok.

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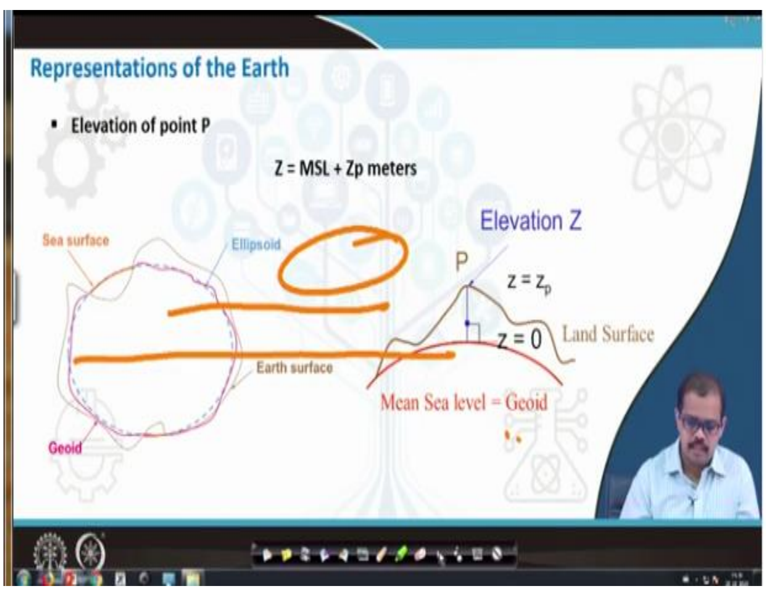

So when we are looking at are geoid let me go back to my previous slide. So when we are actually looking at a geoid we are actually looking at a constant gravitational pull on the earth surface.

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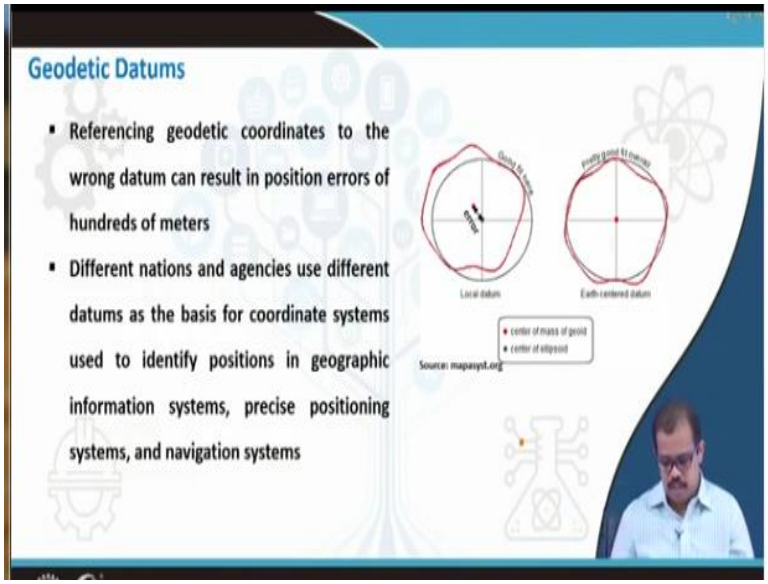

And this is called as a reference grid or a reference point, so when you are looking at a referencing any geodetic coordinates your wrong datum it can actually replicate the position errors to hundreds of meters. So if you are using a wrong datum and you are trying to reference a particular system, then you are if you are measuring it in India, it can even fallen somewhere in Africa, America in terms of where you are placing your map.

Then different nations and agencies use different datums ok as the basis for coordinate systems used for identifying positions in the geographic information system. So please remember this, so whenever you are looking at datum it can be in any different datums but you can always converted to the datum that you are actually looking at ok, to give you much detailed understanding.

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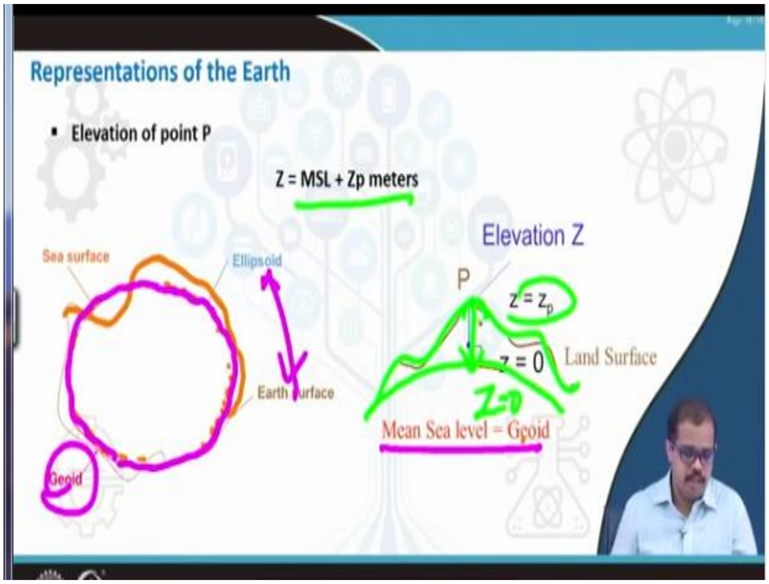

If this particular line that is a brown line as I am drawing is the earth surface ok and the dotted line here is your sea surface that we are trying to see ok. And if I draw line that is actually looking at the mean sea surface was a constant gravitational pull then it becomes your geoid ok. So as I said earth surface is nothing but an ellipsoid ok, so looking at a geoid is something like this. So now when you have your mean sea level which is equivalent to a geoid ok, you have a mean sea level that is equal into your geoid, if this is your mean sea level.

So your elevations z is 0 as you go on above your elevation will be equivalent to the point that is measured from the mean sea level to the height of this particular place that gives the elevation of that particular region which means elevation is nothing but mean sea level + zp in meters ok. So next time when you actually go to any of your railway stations in your city or region, please look at what is a elevation your city if say that particular railway station is in.

So you will get a fair idea of if you are moving and different cities, different regions, then you will be able to get different elevations how, where the city which elevation has is in the higher point and which is at the lower point. So you get you will understand if the way of representation of the earth surface or how the earth surface is there in the entire Indian subcontinent ok.

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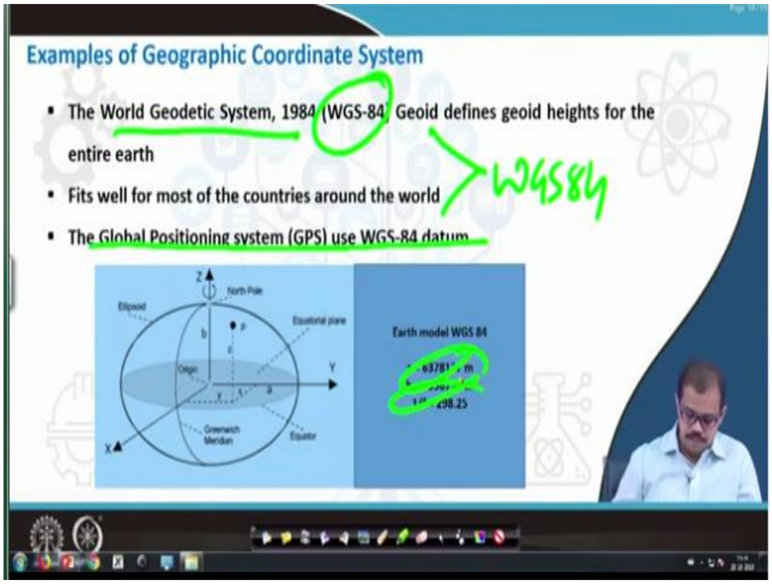

So now let us go to the examples of geographic coordinate system the very well known geographic coordinate system is the word geodetic system this particular geographic coordinate system was established in 1984 that is why it is called as WGS-84. This geoid reference the geoid height from the entire earth, so it is mostly used geographic, GCS system it fits well for most of the countries across the world.

So most of the work that is done today is in WGS-84 ok if you find I mean most of what whoever does is in common with this particular system then you have the global positioning system, which uses the WGS-84. So now you the collection system where you are collecting your data is also in your WGS-84, it is fair enough to use your system also in WGS-84. So it is , representing an earth model in terms of a WGS a ID 4 normally it is in the form of meters. both the measurements are in the form of meters, ok.

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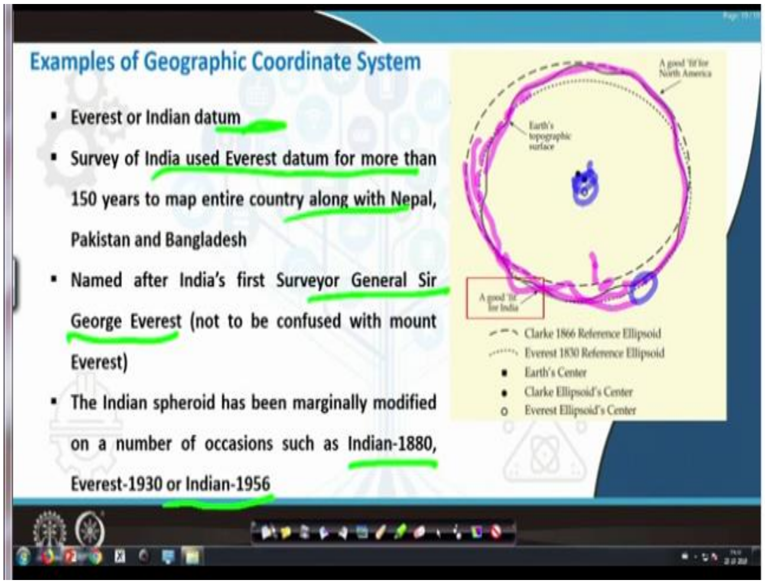

So understanding this will also go into some examples of other geographic coordinate system the very basic geographic coordinate system for Indian subcontinent you can see maybe if someone has use some of the older satellite data products it use to come in the Everest or Indian datum system. So this used to be the reference system that we used to use but today we can get in WGS-84 directly from the natural remote sensing centre.

So survey of India uses the Everest datum for more than 150 years to map the entire country along with Nepal and Pakistan and Bangladesh ok. So named after in a India's first surveyor general sir George Everest, so it is not with if you see in many of the theories they say it as based on the Mount Everest know, it is based on the surveyor George Everest. He was the first one who surveyed and made the physical geographical representation.

The Indian spheroid has been marginally modified on a number of occasions, for example Indian-1880, so that is again as called Everest 80 then you have Everest-1930 or Indian-1956. So these are different ways where this particular system has changed. Now for example whatever we saw in WGS - 84 there is a small change when we look at Indian system. Now what is that particular change if you look at as I said they if you take this as the earth surface that you have ok, if you are taking this as the earth surface ok.

Now this is your geoid ok, this is what something like this ok, this is the one that is for Everest if you look at WGS-84, you have something like this ok. So each of this representing this is a Clarke 1866. I will take some other colour. So Clarke 1866 this is representing the Everest 1830 then you have this representing the Everest ellipsoid. So ellipsoid is also important and this representing the earth center, so now each datum has a different earth centers that is clearly mentioned here.

So at based on that you look at the topographic surface and based on the topographic surface you fix your the entire datum ok that is what Indian datum is based on that is how it is different. But nowadays mostly it has not used whereas WGS - 84 is you have much used in various applications ok.

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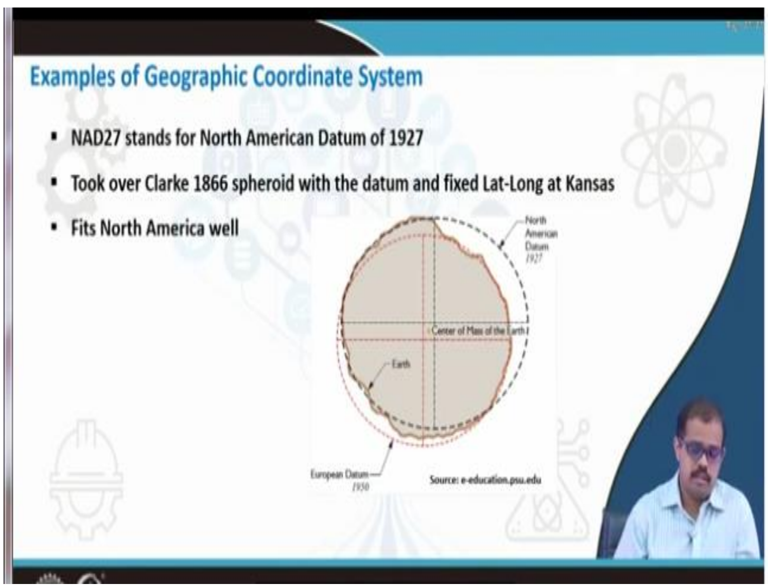

So then other example of a geographic coordinate system is a NAD27, this used to be used heavily when this particular datum was used was actually introduced in 1927 ok. So this particular system was had been took over by Clarke 1866 spheroid with the datum and fixed the lat-long at Kansas. So now this particular datum fits North America very well.

So, there are certain systems even today where NAD27 is you are used in very perfect manner. So NAD 27 system is extremely useful in North America but whenever it comes to other continents it is a bit distorted. So using a the same NAD27 system in terms of using it in on Indian subcontinent may not be much useful but whereas if you use Everest in a Indian subcontinent it is of much useful.

But because of the complexity involved in terms of having it on the system and converting it to other types this particular Everest system is not used. But WGS-84 is one system which is extensively used across the globe, anyone who is working on the aspects of a map today uses a WGS84 system. Most of your satellite data, most of your data from different sensors etc. or geo reference using the WGS - 84 as a geographic coordinate system.

So I would suggest and we would also in the course of giving certain examples or when you are looking at the software, you would primarily stick onto WGS - 84 as a geographic coordinate system ok.

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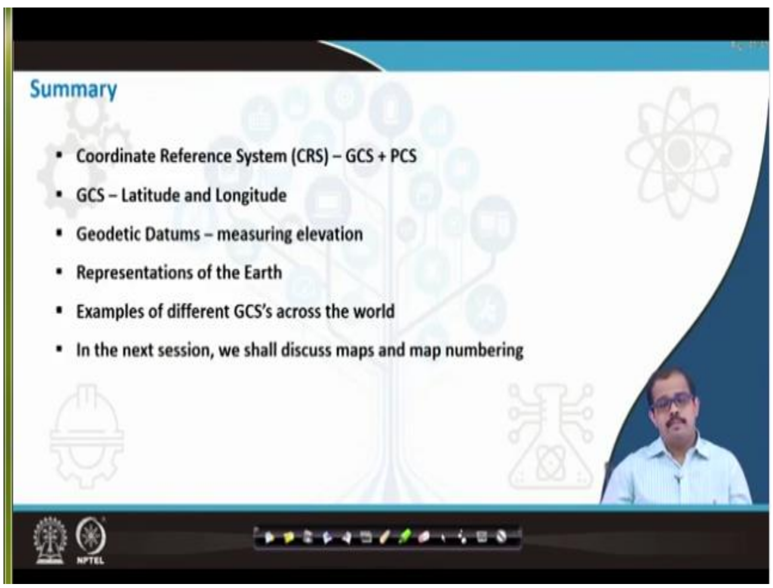

So with this now let me summarized today's class, so when we look at the coordinate reference system we have 2 types of referencing. One is geographic coordinate another one is polar coordinate, so when we are looking at this we have latitude, longitude, as the referencing system. But when we it may not be very useful in terms of measuring it measuring the distances when you look at geodetic datums, these are measuring elevations on the earth surface.

So please be careful, so you have I hope everyone has understood what you mean by a datum, what you mean by a coordinate system. So then we looked at the representations of the earth, so please remember this representation of earth is to represent how a particular landmarks is then subdued from the third dimensional earth to a 2 dimensional earth where it can be easily interpreted.

Otherwise, it is much difficult for anyone to visualize what is there on the earth surface. Then representations of the surface that we have seen, the examples of different GCS. So I am repeating again, so, WGS-84 as much referred system. We have various other systems if you just open any of for your toolboxes any of your software. For example and just go to the georeferencing tool.

And if you open up the referencing system, you can find a huge list of referencing system. So, each country has its own way, each the particular organization has its own way each particular I mean user has his or her own way of representation. So there are huge number of referencing systems, so that, with this huge number when you look at the Indian subcontinent. it is the Everest referencing system that is use the most ok which has evolved over a period of time from the 1800s are 1880s to till **9** 1956.

But now it is not much of use or it is not much use in for a referencing system whereas WGS-84 as much used in all terms. Because easiness in terms of measuring any distance of any object on the earth surface. So that we have seen then we looked at NAD-27 then which is actually for only for America basically north American part, it is extremely useful. But in other continents, it may not be much useful in terms of applications.

So now we have understood what is a coordinate system, what do you mean by coordinates, what do you mean by a datum and a geoid right. So, in the next class we will understand what is a map, how do you represent a map, what are the different standards of representing a map. Then if you have to build a map and presented, how do you actually presented and if in case you want the search of neighboring map, how you search a map, how particular map numbering is done as far as Indian subcontinent is concerned.

So, all of this will look at but only thing that you should remember whenever I am going to speak about a GCS please remember all the things that we have learnt from the datum to your coordinate system. Once we have done, we have understood what the map qualities, then we will look at what you mean by a projection. So that is the last part of this particular module where we would be looking at how you project the earth surface onto a map and what are the different qualities that you have to see, thank you very much, so we will meet in the next class.