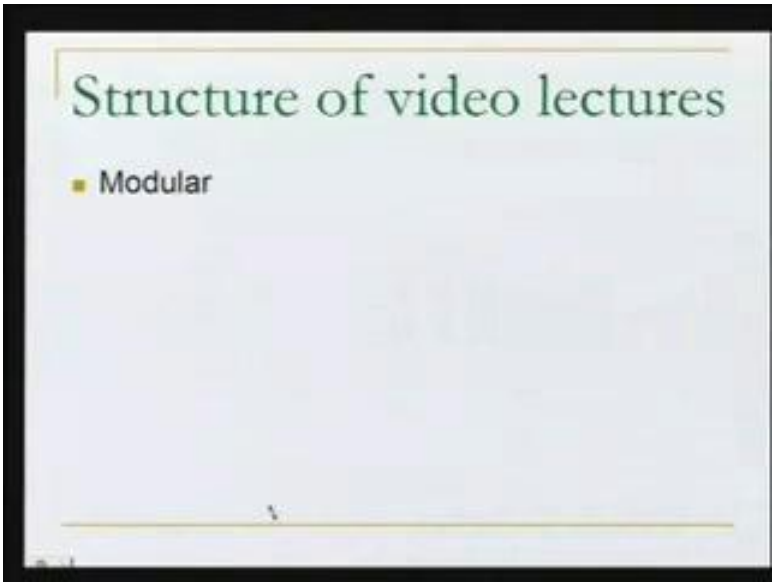
Surveying
Prof. Bharat Lohani
Department of Civil Engineering
Indian Institute of Technology, Kanpur

Module – 1
Lecture - 1

Introduction to Geoinformatics

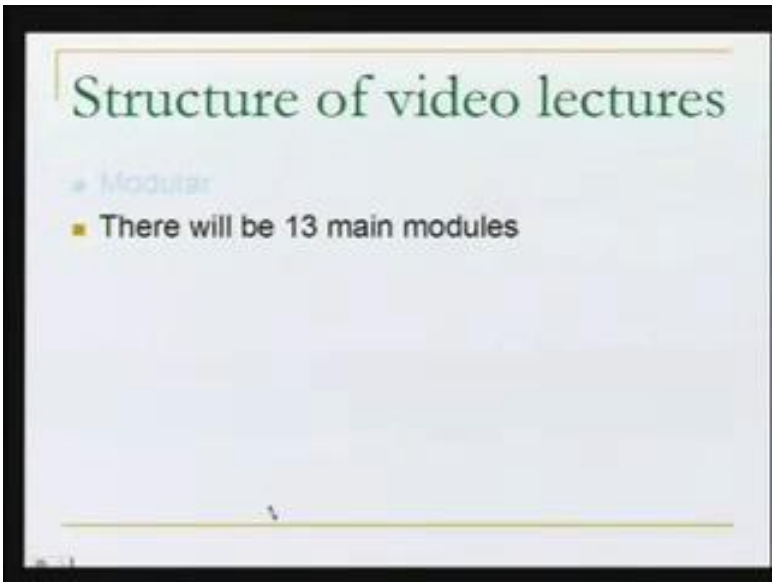
Hello! So, we are going to talk about a very interesting area which is basic surveying. And let me introduce myself: I am Dr. Bharat Lohani, I am a faculty in department of civil engineering in IIT Kanpur, and over the course of all these lectures, I will be talking about this basic surveying.

(Refer Slide Time: 00:49)



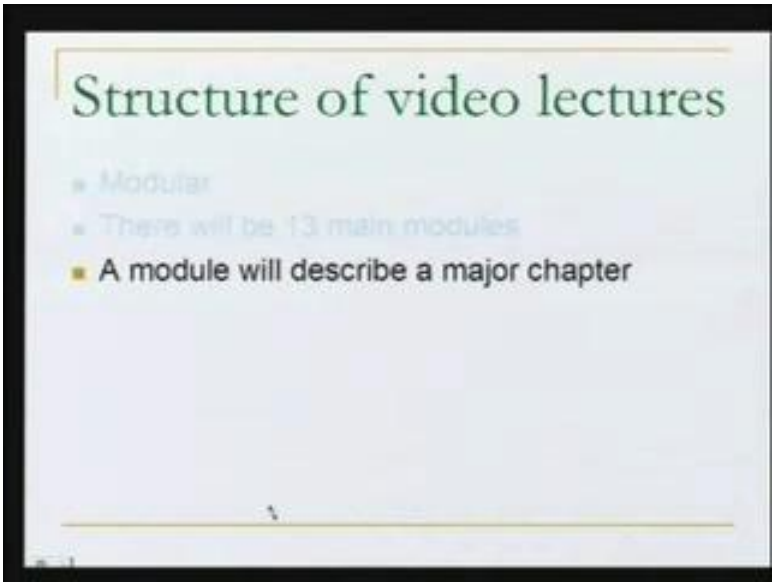
What we would like to do: we would like to start there with that; what is the kind of structure for these lectures is, because I have organised these lectures in a modular way. Now, what is the meaning of the modular way in this case is, all the lectures are clubbed in such a way that, if you take one lecture, it is a kind of independent one, but it will be always helpful if you can go through all the lectures.

(Refer Slide Time: 01:07)



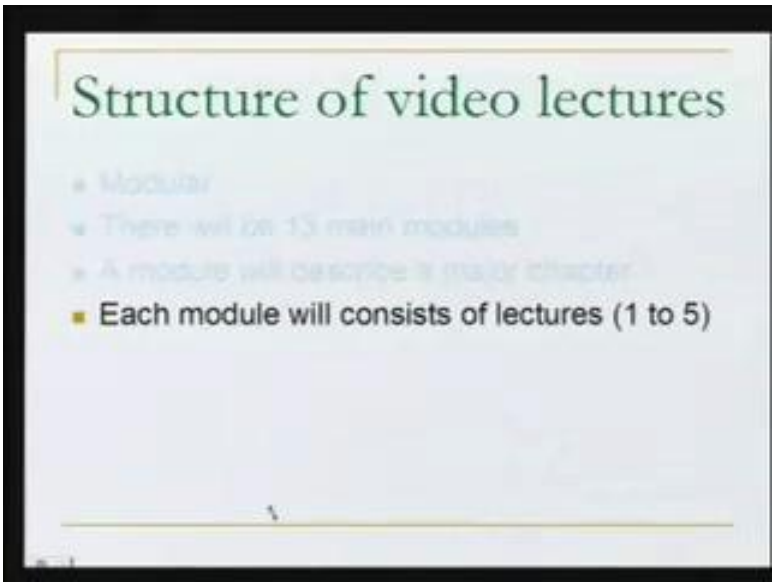
So, in all, we have defined around 13 main modules and in all these main modules, there will be further chapters.

(Refer Slide Time: 01:14)



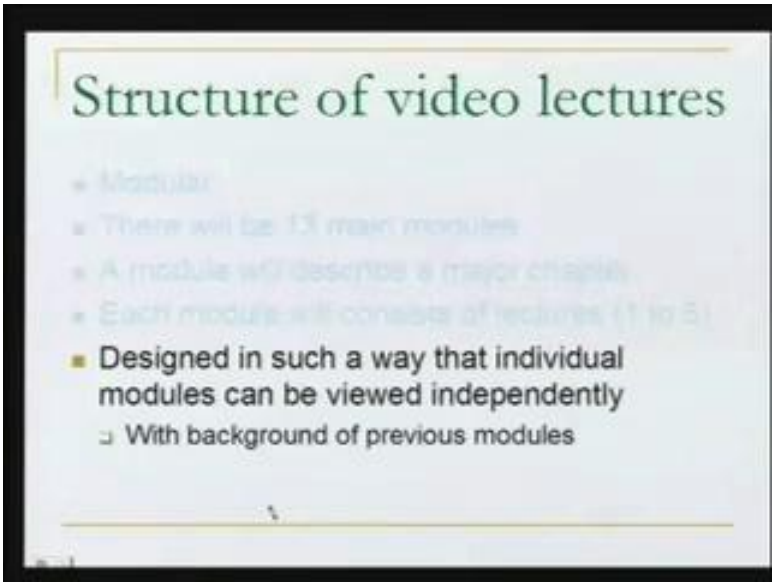
So, a module is basically a major chapter in basic surveying.

(Refer Slide Time: 01:25)



So, there are 13 basic structures and in each chapter there will be further lectures 1 to 5.

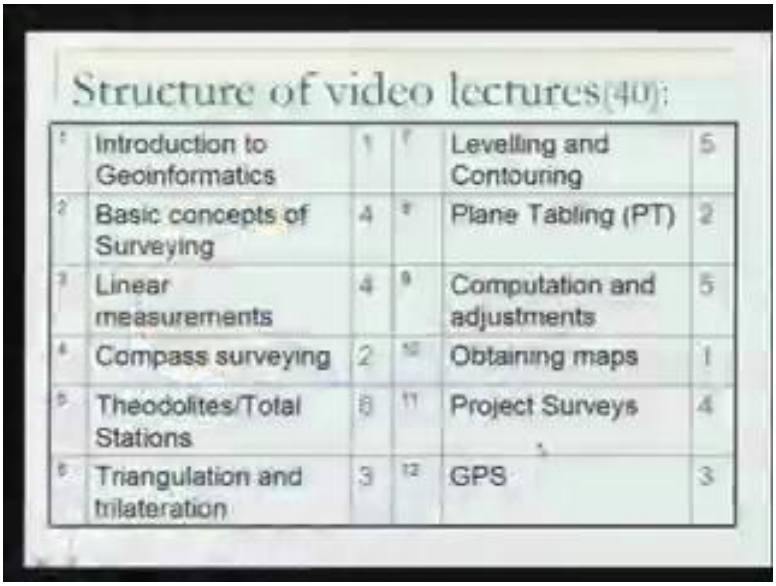
(Refer Slide Time: 01:30)



Now, it will, it is suggested to you, because when you are viewing this video, that you should view these videos in a series starting from one to the end. So, in all, there will be around 40 lectures. However, if you cannot do that, you can still manage by viewing individual modules independently. Because this is how these modules will be designed, the only thing is you need some background of the previous modules, so

that you can understand what is there in the next module, or what is in the present in a module.

(Refer Slide Time: 02:11)



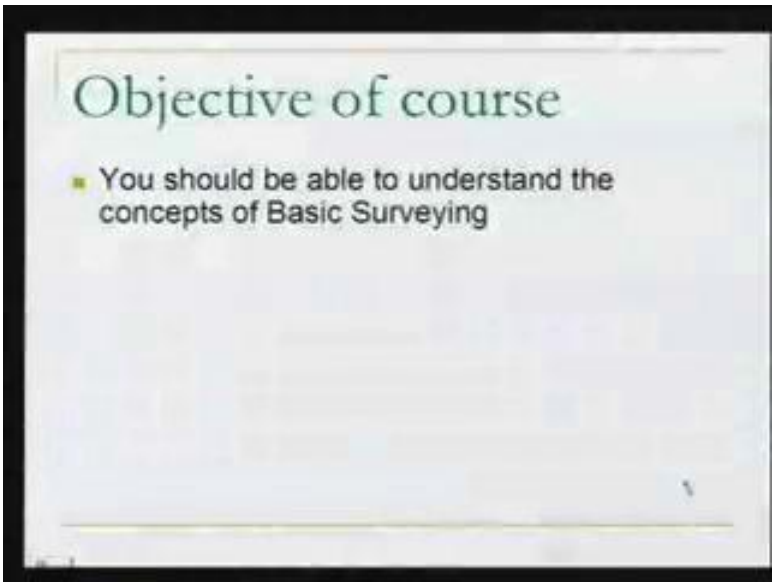
Well, in all the modules, I have to give you some introduction of this. The module number 1 is about an introduction. This is the introduction to the geoinformatics. Though the name of the video is basic surveying, but I would like to start with this geoinformatics thing, because geoinformatics is an area of which the basic surveying is the little part. So, we will be talking about the concepts of surveying in the second module, which will have 4 lectures. Then, we will be talking about an important area in the surveying, which is the linear measurement, followed by the compass surveying, where we will have 2 lectures. Then, we will be also looking into the theodolites and the total stations. These are the instruments which we make use for angle measurements - a very, very basic thing in basic surveying.

And later on, we will be going for some control surveying that we will cover in triangulation and trilateration. Then, the seventh module is about levelling and contouring. The seventh module of levelling and contouring is about basically the control in the dimensions or control in verticals. There is a very interesting technique of plotting the details in basic surveying, and this technique is called plane table or plane tabling. In short, we write it as PT. So, we will cover this in 2 lectures. Finally, all the measurements which you take in basic surveying, because there is lot of

computation involved. We will need to compute a lot, we will need to adjust for the errors, because all the measurements which we will be taking, or we will, which we will be talking about will be subjected to some kind of errors. So we will need to adjust for those errors and this is very, very important module of the chapter in basic surveying. So please do not miss it if you are following this video lecture. Well, when we are talking about the basic surveying we must also talk about the maps.

Now in the maps, or in this particular module, we will see: what is the address in India which can provide you the maps, what are the states at which these maps can be obtained, what are the prices and where from you can purchase a map. So all this will be covered in one lecture. Finally, we will talk about the project surveys. There, we will talk about some civil engineering structure where we would like to apply the surveying. Whatever we learn in other modules, we would like to apply it there. Then, towards the end of my video lectures we will be talking about - in 3 lectures - about a technology called GPS. This Global Positioning System is a new method of doing the surveying.

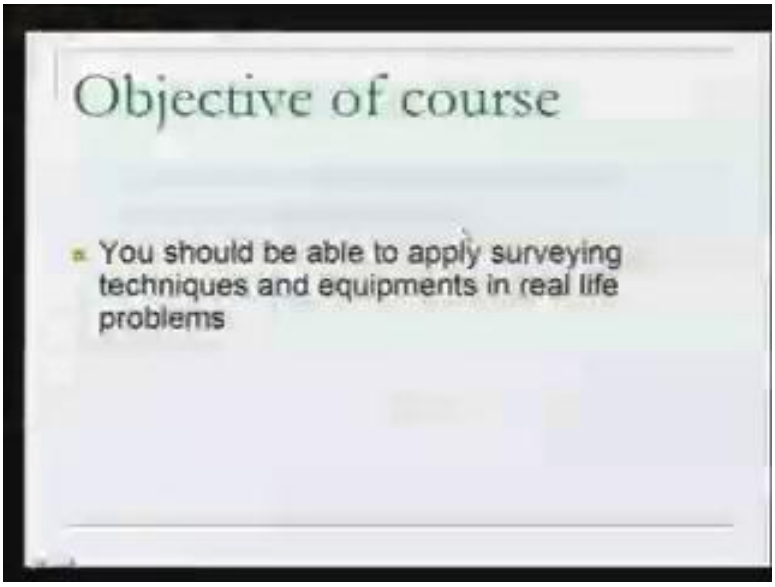
(Refer Slide Time: 05:15)



Well, how I have designed this course's structure and what is the objective that I am keeping in mind? Because when I am talking to you through this video lecture, I am thinking in my mind that you should be able to do certain things: number one, you should be able to understand the basic concepts of basic surveying. You should be

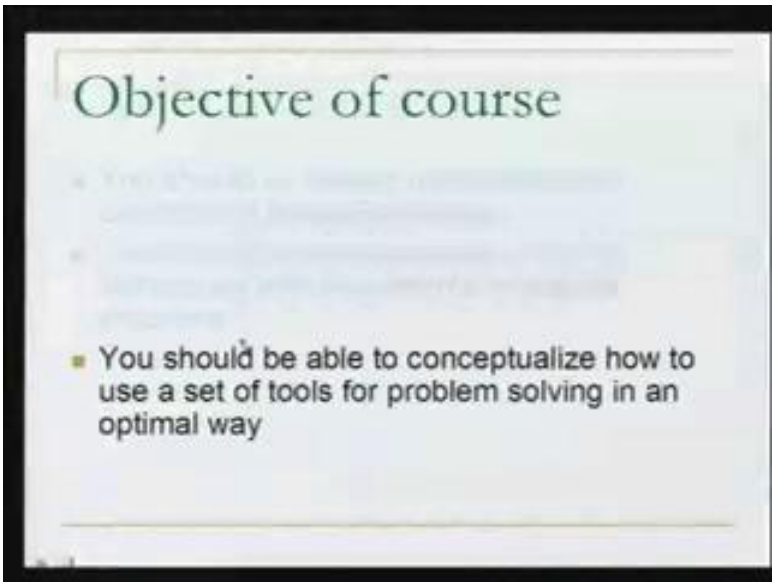
able to understand that what this area is, how to do it, why we do it, what are the techniques, what are the instruments and everything.

(Refer Slide Time: 05:37)



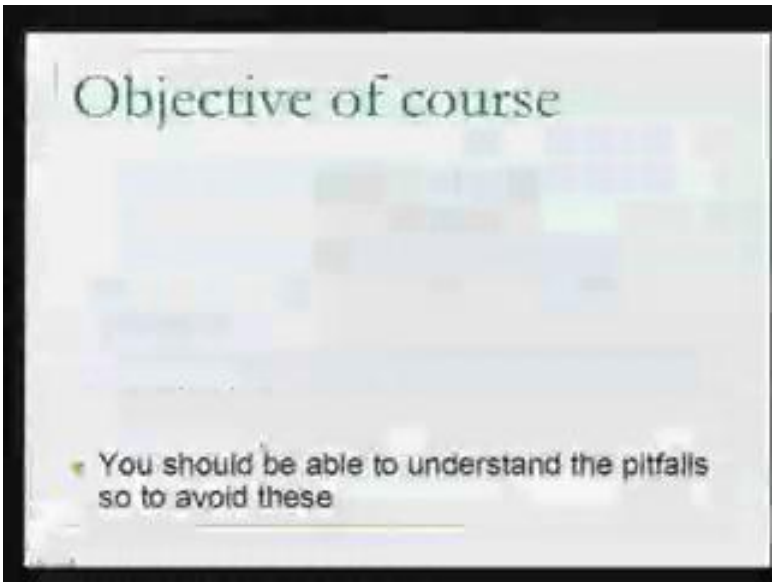
Another important point: you should be able to apply surveying techniques and equipment in real life problems. This is very important. If you follow the video lectures carefully, if you understand each and everything in the video lectures, I am sure you will be able to apply these techniques and these equipment in any real life problem because, once you are in a field, you have an actual problem in front of you where the measurements are involved; you will need to apply these techniques. So, my aim of these lectures is so you feel confident now, at the end of the lectures, that you can apply these techniques.

(Refer Slide Time: 06:20)



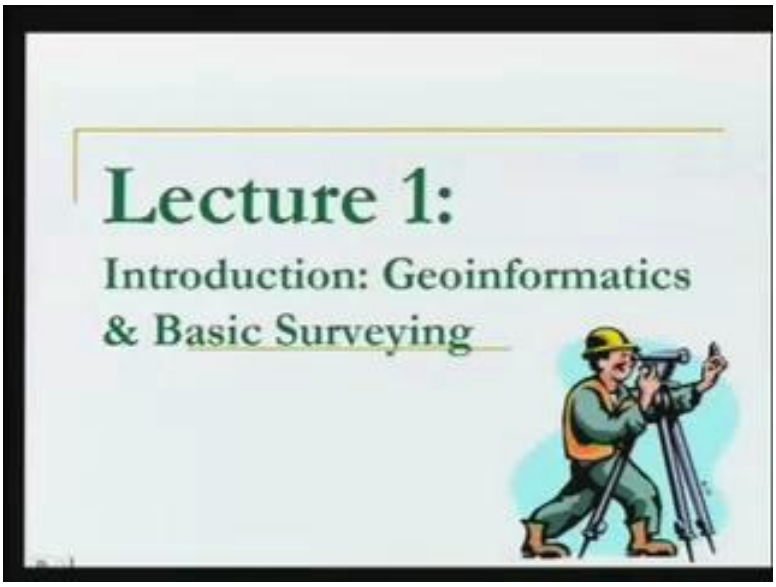
Another important point, and that is: problem-solving in an optimal way. While we do surveying in the field there are many possibilities, hundreds of possibilities a single problem can be solved by. Now, out of those hundreds of possibilities which one is the best one? That is the point. So, what we have to do is to find a solution which is optimal. Optimal in the sense that: optimal in terms of the cost, the time, the resources, accuracy and all those things. So, while doing this course, I will keep talking about these issues time and again. I will keep informing you about the accuracies which are there, the limitations of the methods, the strengths of the methods. So, whenever you are in the field, you are going to apply these methods. You should make use of these things which we are talking in this course, so that your solution in the field is an optimum solution.

(Refer Slide Time: 07:24)



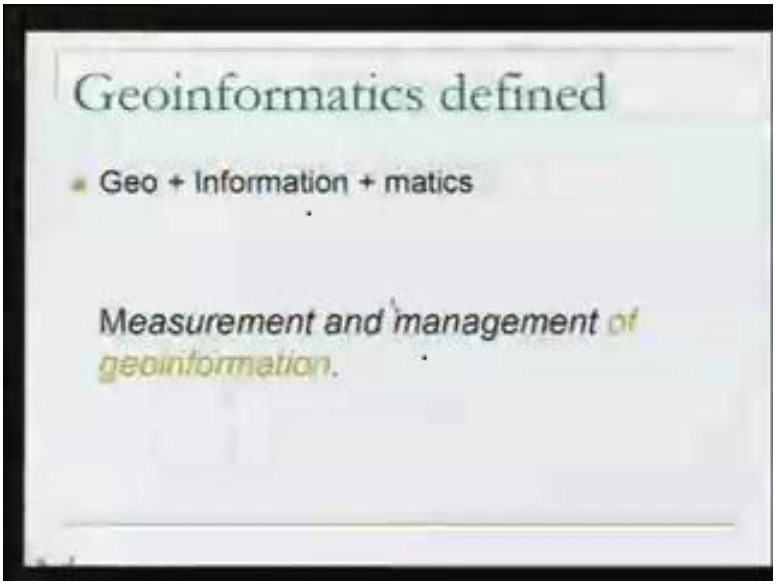
And at the end - this is very important point - that I want you to understand the pitfalls; the pitfalls of this particular basic surveying. When I say this, I mean: what are the sources of error? Because if you do not understand this, it might happen that you will end up with: your data, your problem or your result will come error. We do not want to do that. What we want: we want to do the work in the most optimal way so we have to understand that, what are the pitfalls in this particular technique.

(Refer Slide Time: 08:01)



Well, so our first lecture today is about an introduction and this is introduction to the geoinformatics and basic surveying. Mostly today, I will talk about geoinformatics, because geoinformatics is an area which encompasses many disputes, many fields, of which basic surveying is a little part. Because we are going to talk about basic surveying, so we should know where it belongs to. If you are reading about the basic surveying, you should know: where you are ultimately going to, what are the modern techniques in order to carry out basic surveying.

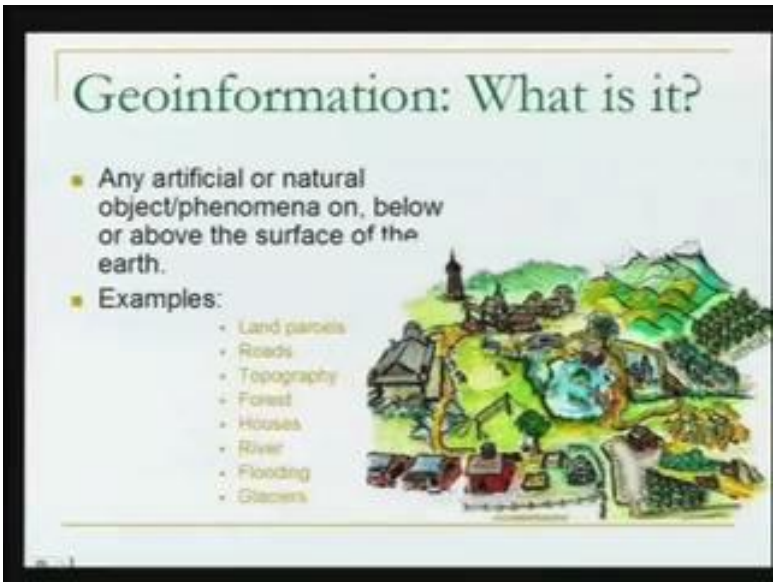
(Refer Slide Time: 08:38)



So in order to understand that, we will start with the basics of geoinformatics. What is the definition of geoinformatics? The definition of geoinformatics is: 'geo', 'information' and 'matics', as written here. So, the 'geo' plus 'information' plus 'matics'. The meaning is: 'geo' stands for anything which is on the surface, slightly below, slightly up of the earth. 'Information'? Information about those features which are there on the surface of the earth. Then 'matics': 'matics' stands for measurements. So we are going to measure whatever is there on the surface of the earth slightly below, slightly above.

In addition to the measurement, one more aspect of geoinformatics is: that is the management. So, we measure that information, as well as, we manage that information. So, this measurement and management of geoinformation, put together, is called geoinformatics.

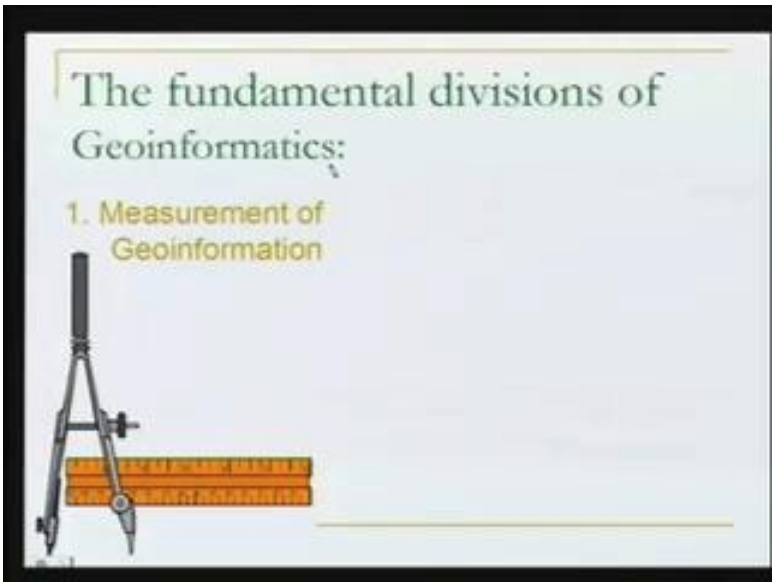
(Refer Slide Time: 09:47)



Well, to start with, we are talking about geoinformation, what the geoinformation is, which is on slide there. As far as the definition of geoinformation is concerned, we can say, as it is written here: any artificial or natural object/phenomena on, below or above the surface of the earth. Well, some examples of that: now, here in this diagram, or in this, I can say in this sketch, what is the geoinformation? You can find the geoinformation in terms of: the road, or the houses, maybe a tower, the topography, it is here, the jungle - the forest, a water body, the hedges, a playground,

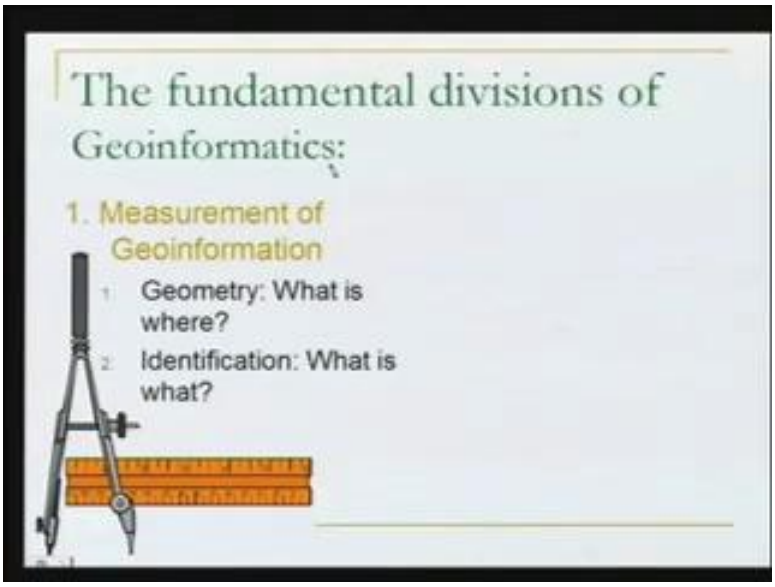
another playground, or maybe some house, and the field, some other land use or land cover. So, this is all the geoinformation. So, whatever is, whatever you see on the surface of the earth, or we also know, slightly below it or maybe slightly above it, is the geoinformation.

(Refer Slide Time: 11:27)



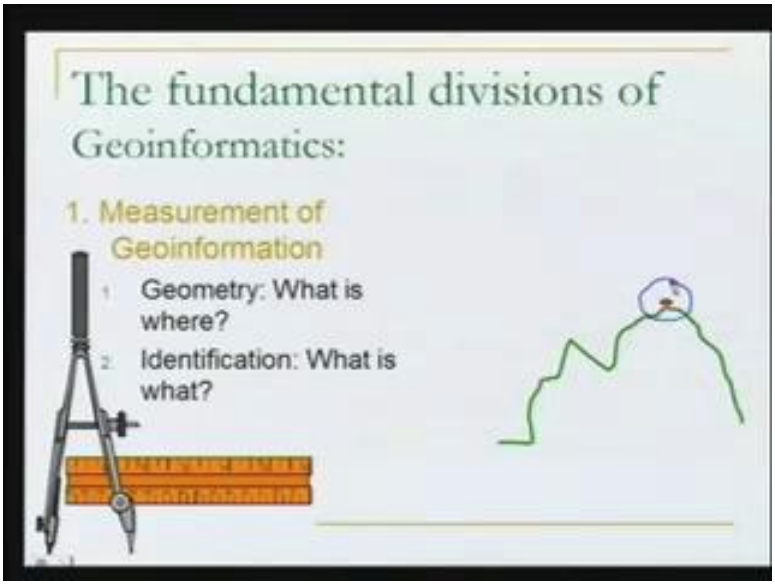
Now, for this geoinformatics, generally what I do, I try to define geoinformatics in two basic divisions, because this is very important in order to understand geoinformatics. Whatever we will be doing henceforth, we should understand these two philosophical divisions in the geoinformatics. What these two divisions are: number one is measurement of geoinformation. We need to measure what is the geoinformation because we have to see what the geoinformation is, as a thing on the surface of the earth. So, we need to measure it.

(Refer Slide Time: 11:47)



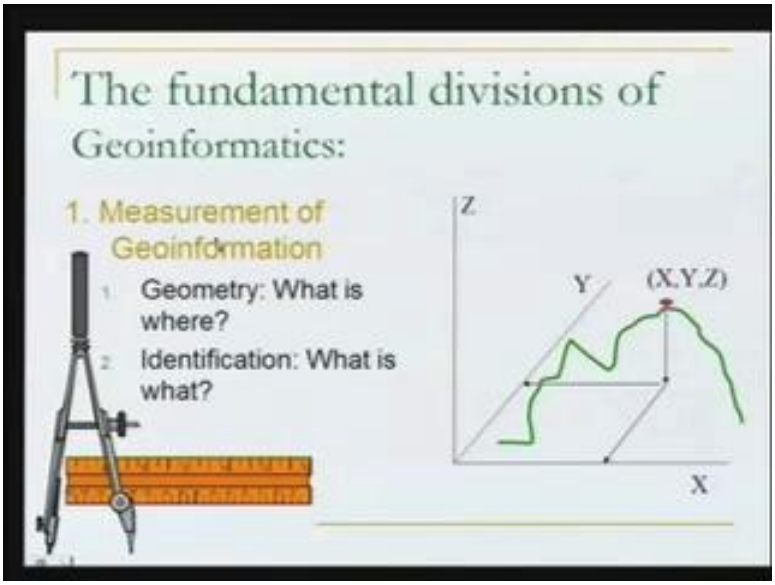
But in measurement also, there are two parts. This is very interesting and very fundamental, so this is on the slide there ((11:47)). First part in measurement of geoinformation is geometry. We want to see what is where - we will explain it by an by an example in a moment. Then, we also want to know that, what is what. That is, the identification.

(Refer Slide Time: 12:20)



Here is an example: well, let us take - this is the terrain, or the ground, and on that ground there is a certain object. Now we will - this is the geoinformation here; this object is the geoinformation. (Refer Slide Time: 12:19).

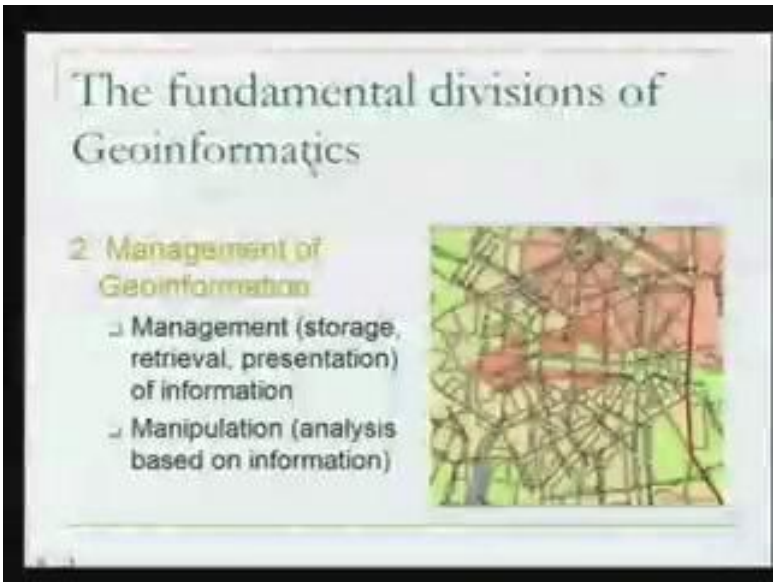
(Refer Slide Time: 12:36)



Now, we want to measure the geoinformation. What is the meaning of that? The meaning of that is, we need to define a reticle ((12:30)) system like the coordinate system shown over here and we need to face the coordinates of this – of this geoinformation, this feature. ((00:12:36 min)) So we want to measure the X, the Y and the Z, so the moment we read the XYZ in our reference system, the geoinformation is measured. But measurement is not enough. It is not enough because we need to also do another thing that, what we have measured - what is there on the ground, what is the feature? So we need to go for the identification.

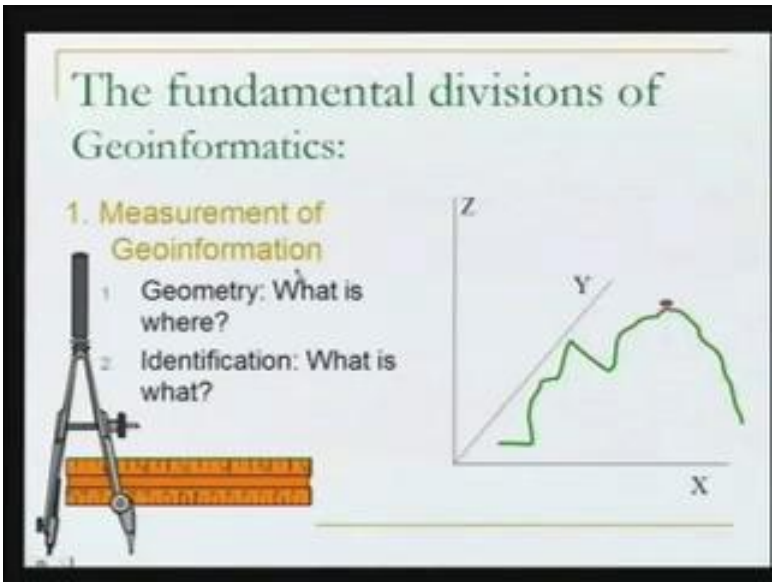
Now, what is the meaning of the identification? Identification means: what we have measured. Is it a tree? Is it a road, or is it a house, or a garden, or a hedge, or a boundary wall, or the hill, or the river? So we need to identify this also. So basically, whenever we are talking about measurement of geoinformation we will be doing these two things: number one, we will be measuring it in terms of a coordinate system.
We will fix the XYZ coordinates and the second thing that we will do, we will try to identify that what we have measured.

(Refer Slide Time: 14:20)



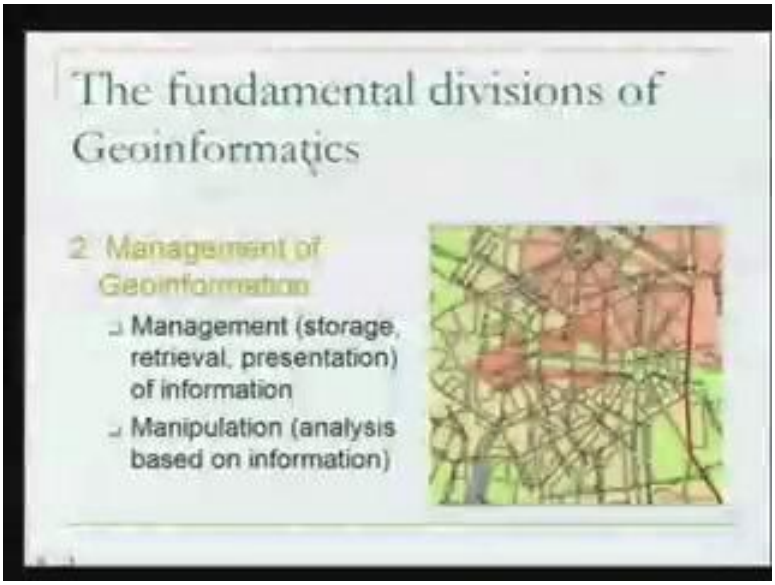
Well, the second aspect of geoinformatics - because I was saying that Geoinformatics has got two fundamental divisions; one is the measurement of geoinformation - the second one, second one is about, well, take it like this: we have measured the geoinformation, we know the XYZ coordinates of a particular feature, we also know what the feature is, but what to do of this? What to do of this information? So, the second aspect of geoinformation is - or the Geoinformatics is - Management of Geoinformation. As we have written here in the slide, we want to manage the geoinformation because just measurement, identification is not enough.

(Refer Slide Time: 14:41)



Now for example here, if you look at the slide, here in the previous slide, we are talking about the measurement of geoinformation and now, here we are talking about the management of geoinformation (Refer Slide Time: 14:49).

(Refer Slide Time: 14:20)



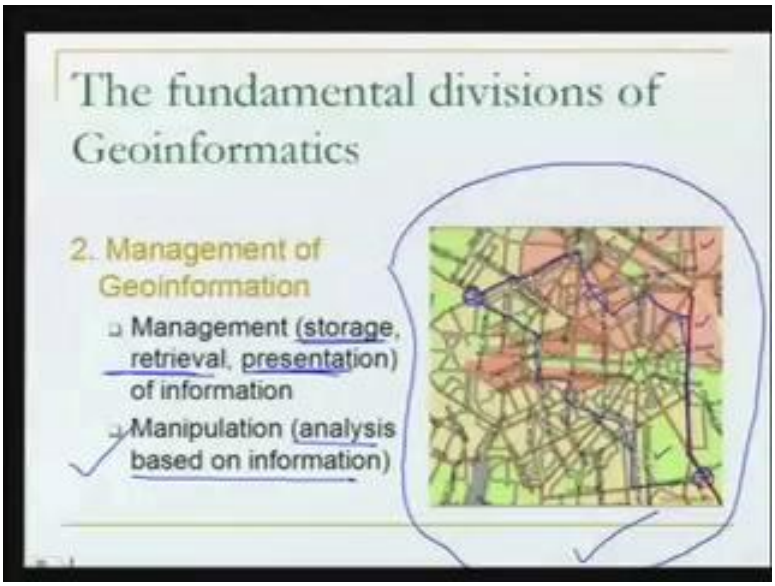
The management means, all the things which we have measured, we have identified, we are trying to plot them here - and if you see in the slide - using a map. So we are detaining them for our use later on; we are storing the data in a particular format. What we have done - for example, in this map, we had measured where is the ground, all the roads - where they were, we also identified what are the roads, where they are leading to. We also identified where are the fields, we also identified where are the areas which are occupied by houses. So our measurement and identification was complete.

So, the management of this information means: we want to put this information in such a way, so that we can store it properly. Not only storage - we want to retrieve this information later on, so the retrieval. Now, with this map, what all we have done - we have stored the information in the form of a map. Anytime we want to know about the map; we want to know about the geoinformation, what we need to do, we just take the map out and start looking at the features. So what we are doing? You are retrieving the information from the map.

And then, the presentation - of course, the map is a way of presenting this information. We could have presented this information what we measured there in the ground maybe in some other way also - for example, the names of the roads, their lands - so you could have made a table. So, that is also a way of presenting this information, or maybe managing this information. But our information here is the geoinformation – 'geo' means 'which is expressed in the terrain'. It is a special information, so we want to present it in such a way so that information retains its own characteristic; that the information is presented also in a special way, and this is how this map come into the picture.

Now, another aspect of management of geoinformation is manipulation. Now, as I am writing here in the slide, (Refer Slide Time: 17:00) manipulation is: analysis of geoinformation so that we can come out with some results; some answers.

(Refer Slide Time: 17:40)



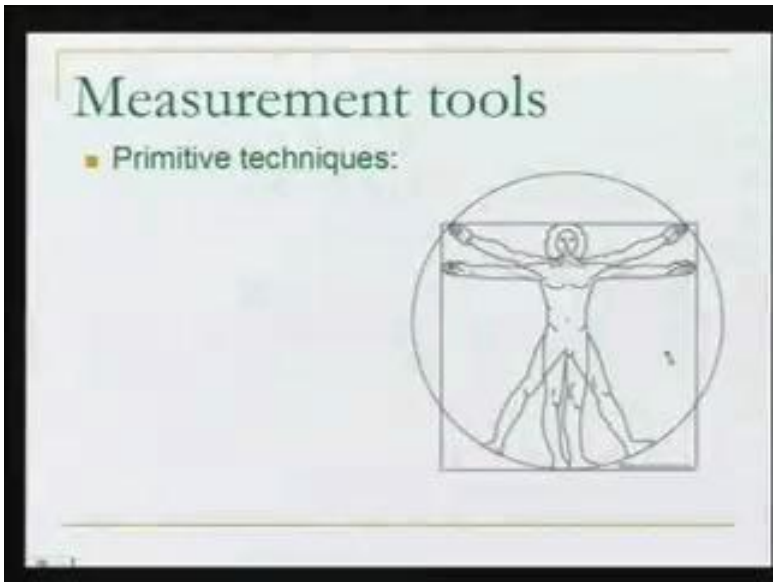
One example here could be: as we can see in this map, let us say, I want to start from the particular junction in the town, and I want to reach the other junction here in the town. Well, throughout this street network, there are various possibilities: you can change the route, well, like this, or you may like to take a route like this (Refer Slide Time: 17:31). But the question is, which of these two routes is bad. So what you need to do, you need to analyse this information. You need to do some kind of network analysis in your information. So that is also a part of Geoinformatics.

So what we do in geoinformatics: we measure the geoinformation from that field - we measure it by recording the co-ordinates XYZ - and we also identify that information that what we have measured. Then, we come to the office, we present the information; we will store the information in such a way - either in the computer or in the form of the maps - so that you can retrieve it later on, you can present it in a proper way and also, with the help of the information, we want to analyze the information so that we can arrive at certain result. Well, having said that - as I was saying that - we have to measure the geoinformation and we have to manage the geoinformation.

(Refer Slide Time: 18:47)

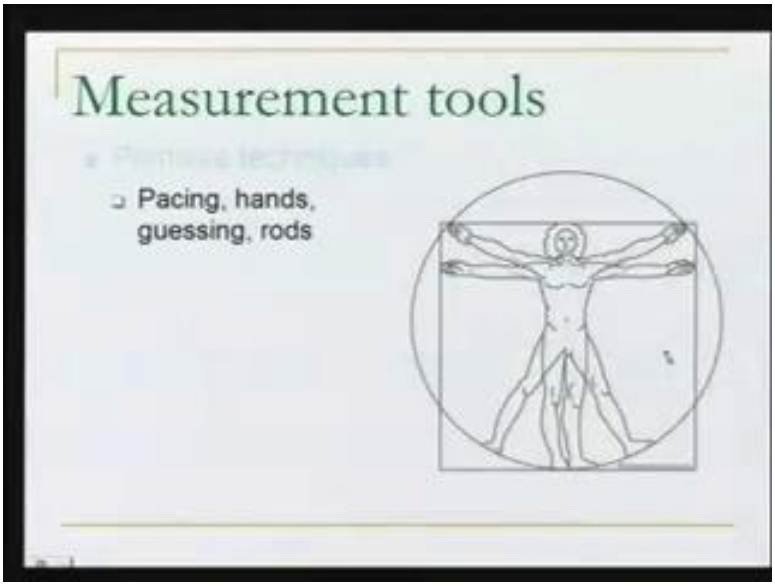
So what I will do, I will give you a brief introduction of the tools which we use for measuring geoinformation, and then I am talking about this - we will talk about this - measuring tools for geoinformation in the way they were developed. So we will start from the very, very primitive time, how people used to measure it; and we will come to the latest stage, that how we are measuring the geoinformation now.

(Refer Slide Time: 19:16)



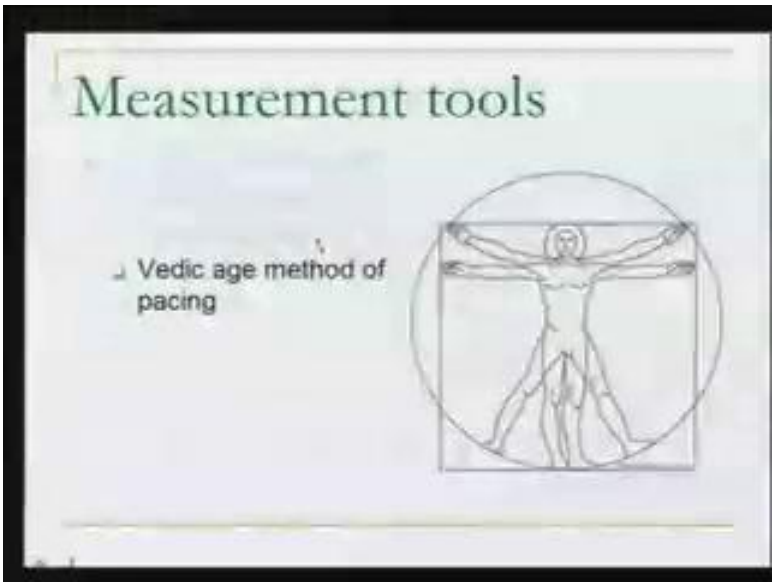
Well, initially, the primitive techniques: as we all know that still, if you go to the villages you will find people doing it.

(Refer Slide Time: 19:19)



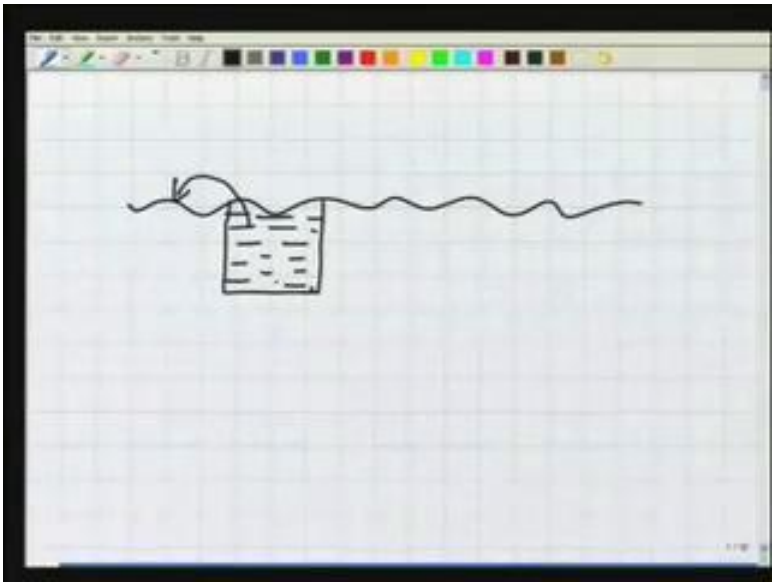
You use either pace - pace means you walk along it - or maybe use the hand, you know, you could ball it (00:19:26 min) - okay, a particular land is so much (Refer Slide Time: 19:29). You will make use of your hand, then you measure it. Or maybe you can make a guess, or maybe you also make use of some rods - some standard rods - so these are the primitive ways of measuring the distances.

(Refer Slide Time: 19:43)



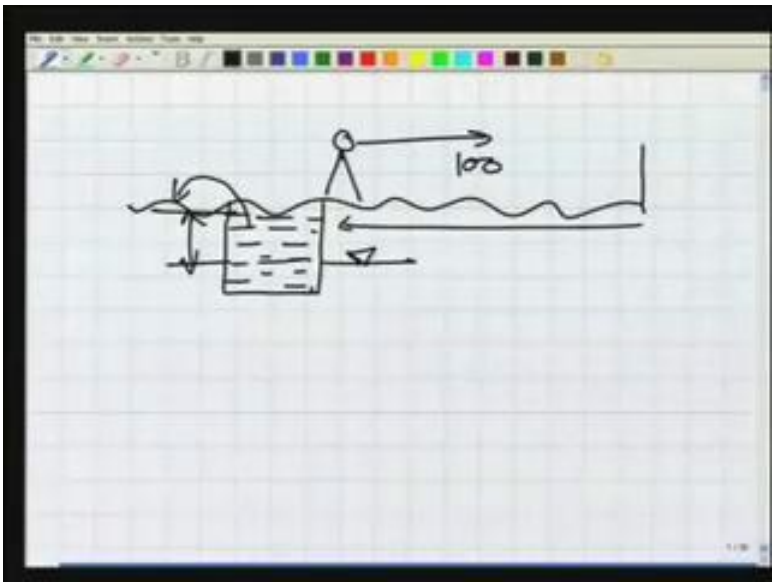
There are some very good examples in Vedic-age methods of pacing. I'll give you one example right now, and for that I will need to change the slide.

(Refer Slide Time: 20:38 min)



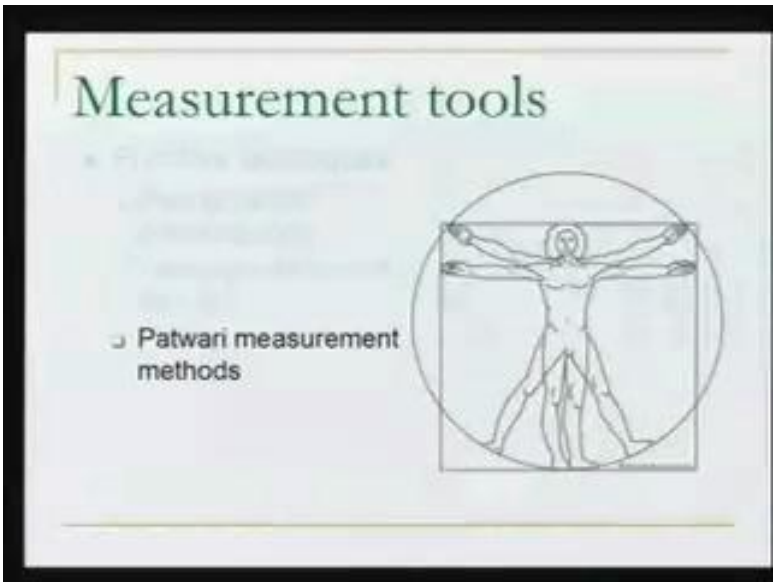
So we are here in the new slide, and what did the Vedic age people used to do? I will give you just one example of this pacing: let us say this is the ground, and we would like to measure the quality of the soil. So what they would do, they would dig a hole there in the soil - or in the land - and they will fill it with water. So this hole has been dug and the soil is cut out and now, it is filled with water.

(Refer Slide Time: 21:09)



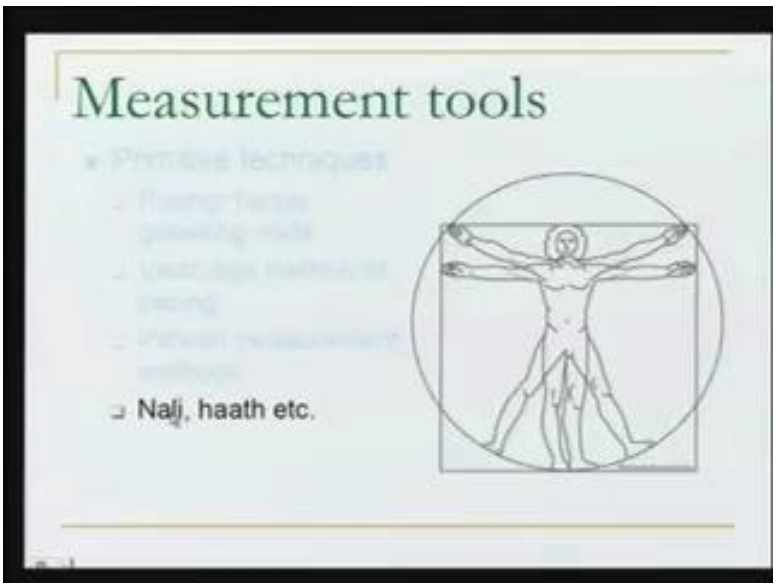
Now, in order to measure the time what they would do: a person who is doing this job, or maybe another person, will walk to this side - for example, let us say a hundred paces - so he will do this pacing hundred times. He is at a certain distance and from that point he will come back. While he comes back, they will check again that where is the water level now. Depending how much the water level has gone down, they will come to know about the soil. So basically why I am talking about this - I am talking about this because the people were making use of pacing - measuring distances, measuring time using the human body - in Vedic age also.

(Refer Slide Time: 21:44)



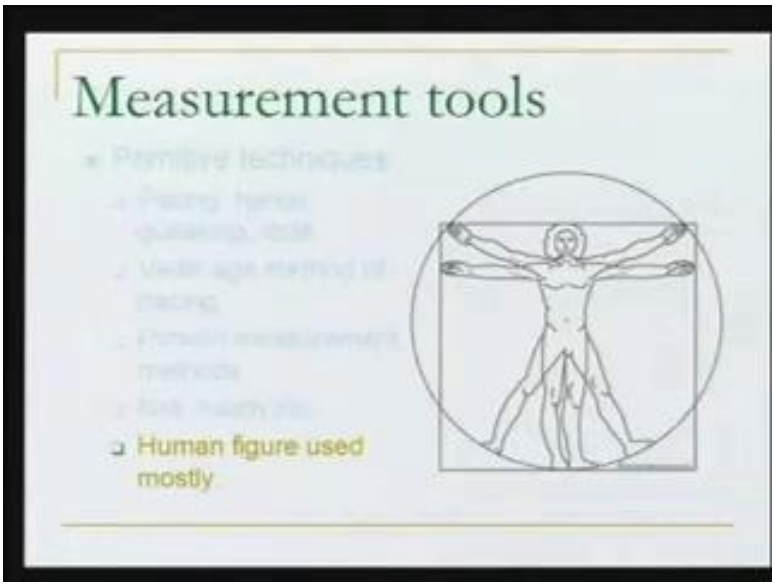
Now we go back to our previous slide. So we talked about this: just one example how people were making use of the human body for measuring distances. Another one you must have seen in villages - this is very, quite common. The Patwaris, who are the grassroot level workers in a village who measure the land there - they also make use of some devices, maybe in form of a rod or some chain, in order to measure the land parcel ((00:22:03 min)). So that - it – that is also - you know, I would, I would like to say - quite a primitive way of measurement.

(Refer Slide Time: 22:16)



Then, if you further go into the villages, still, people they measure their land area using, for example, the ‘nali’ and ‘haath’. So these sounds may differ - I am writing nali and haath because the area from where I belong to, people use this. ‘This particular area is one nali or two nali’ - that kind of thing. Now, how it is related with the area of the ground is, how much wheat or rice will be produced in that particular area. So this is how a relationship is there in how much wheat is produced for a particular period, and this is how they are coming to know about the area.

(Refer Slide Time: 22:56)



So, what we observe in most of these cases: the human figure was used - either the face, the hands or these things.

(Refer Slide Time: 23:06)

Now, after some time, when people started requiring accurate measurement, what they thought - that the human body was not good enough, because all humans, they differed in the measurement. So if, for someone, a distance is hundred paces, for other person who is short in height, the distance would be hundred twenty paces. So they wanted to standardise these things. So some new methods came for making these

measurements. So, that was the time when the land surveying - measuring the lands - started.

(Refer Slide Time: 23:50)

So the extended methods of measuring distances are: chain or maybe tape; at the same time, people also wanted to measure the angle because in order to determine the area, you also need the angle. Here is an instrument which is called compass – it is a very simple instrument, and it works on the principle of magnet - magnetic needle. So there is a magnetic needle which will align itself in the magnetic field, and making use of that, it is possible that we can measure the angle. So people started making use of compass also.

(Refer Slide Time: 24:22)

Some more instruments - for example, the theodolite. This is also an instrument which is used for making the measurement of angle in a more sophisticated way; more accurately. However the problems with the land surveying methods was: in most of the cases these methods are very cumbersome.

(Refer Slide Time: 24:44)

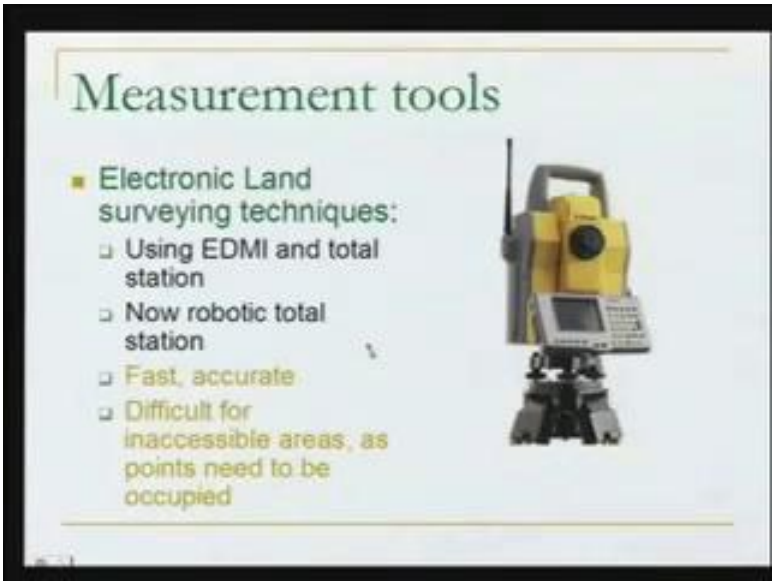
As I am writing in the slide, they cannot be done in inaccessible areas, so that what we need to do: you need to go to that area and you need to occupy the point, then you

need to carry out the measurements. So all these methods are kind of, very, very cumbersome; they will take long, long durations in order to complete the survey.

(Refer Slide Time: 25:12)

So considering the time, people have started thinking of some other methods.

Refer Slide Time: 25:17)

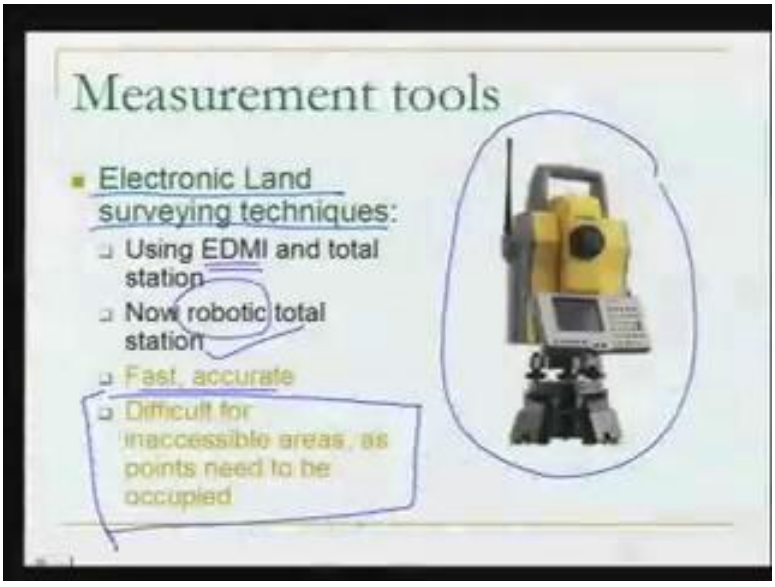


So, the other methods came in the same form of land surveying, but with the development of electronics. What people started doing, they converted these instruments, which were conventional mechanical instruments earlier, into the

electronic instruments. As it is written here (Refer Slide Time: 25:40), we have the methods now which are mostly relying on the instruments which make use of the electronics, and in this case we have the instrument, for example, the EDMI. It is an electronic distance-measuring instrument. Now to measure the distance, you need not do the pacing, you need not spread the chain; but what you need to do, you need to simply fire an electromagnetic pulse and it will tell you the distance. So these instruments are very, very sophisticated.

Also, as seen here in the slide (Refer Slide Time: 26:14), we have a total station. This total station can measure angles, can measure distances - all automatically, without much involvement of the human being. So now the things are become very, very fast - it can do a very accurate survey; it can do them very fast. Here is another word which is seen in the slide: it says robotic (Refer Slide Time: 26:40). Sometime back, the total stations were like that, that a human being has to operate it. But now, total stations are developed to such a stage that the total station is kept in a place independently, while the surveyor moves with the rod - which is also a part of the total stations - everywhere in the ground. Total station will target that road automatically; the surveyor who is moving with the rod will just press some buttons, and with the press of those buttons the total stations will carry out the measurements.

(Refer Slide Time: 27:30)



So it is really very fast - a single person can do the surveying. However, in these electronic methods also, as you see in the slide (Refer Slide Time: 27:29), they are still difficult - difficult because you have to go to the ground, you have to occupy the point. I will give you one example: let us say you want to measure for a power line. This is the power line between two poles (Refer Slide Time: 27:43). You have to measure the coordinates of several points there in the power line. If you need to do it, using the total station is a very difficult exercise because you need to bisect every point.

Then, another example: if we want to measure, let us say, an area which is flooded, it is very difficult to go to that area; you cannot occupy the point there because, as you know, it is flooded. So you cannot carry out the measurements. What you need to do, you need to wait so that the flooded water level will recede, then we will go to the ground, occupy the ground, then carry out the measurement.

So in all the methods that we saw so far - either the primitive ones, land surveying ones or the electronic surveying ones - in all the cases, you have to go to the ground, occupy the ground, and then take the measurements. So this is really difficult in case of difficult terrain; in case of inaccessible terrain. So considering this, people have started thinking of something more; some new measurements to escape ((28:44)) from measuring the geoinformation.

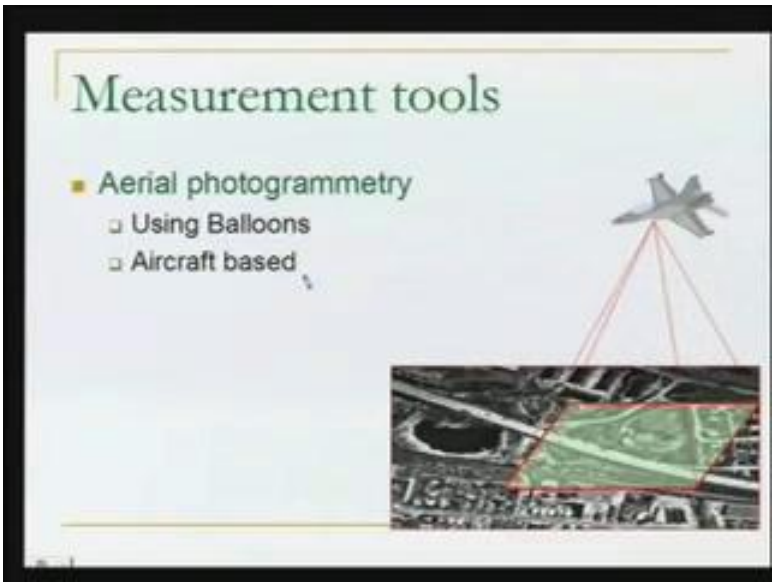
(Refer Slide Time: 28:48)

And here is one which I am writing in the slide, that is, the aerial photogrammetry. As you see here in the picture, in case of the aerial photogrammetry, once it was developed, initially - during the time of world war one and two - people used it for flying purpose. What they would do, they would fix a camera in the body of the pigeon, and the pigeon will fly in the enemy terrain, and it will take a single photograph and it will come back. So it was a very nice way, a very smart way, of taking the photograph from the air in this enemy area so we have all the information about the enemy movement. So this is how the aerial photogrammetry developed.

(Refer Slide Time: 29:41)

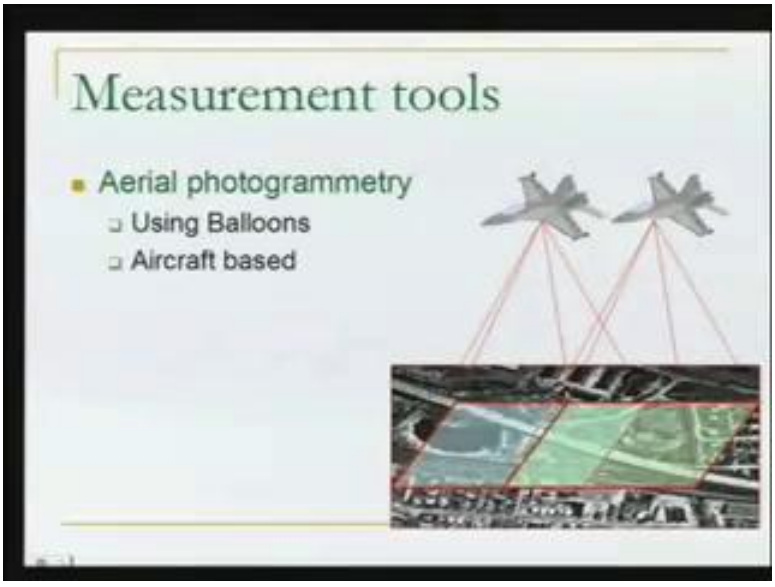
However, later on, we have started making use of balloons and, as well as, aircraft based. What we do now, I am going to give you an example in the case of the aircraft.

(Refer Slide Time: 29:50)



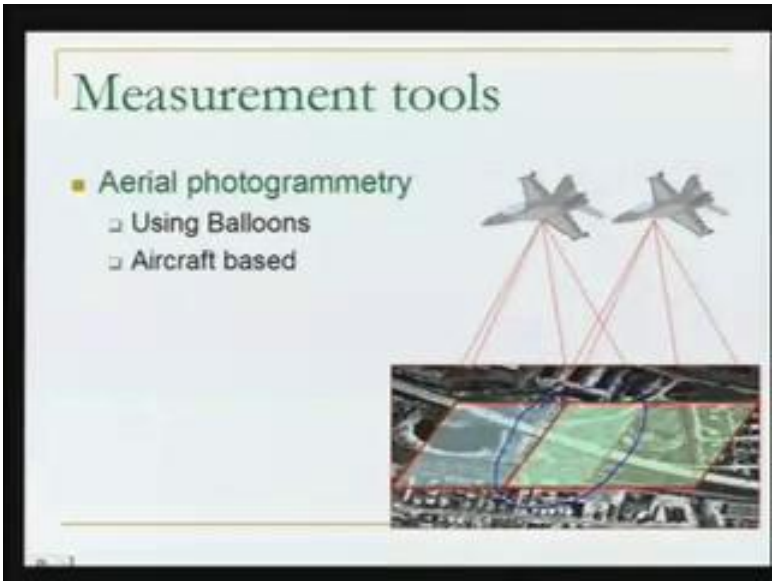
The aircraft will fly at an altitude of, for example, 2000 metres, 3000 metres, 4000, 10000 - depending what kind of application, what kind of photograph we are looking for. So while the aircraft is flying over the ground, it will take an image; it will capture one photograph of the ground.

(Refer Slide Time: 30:13)



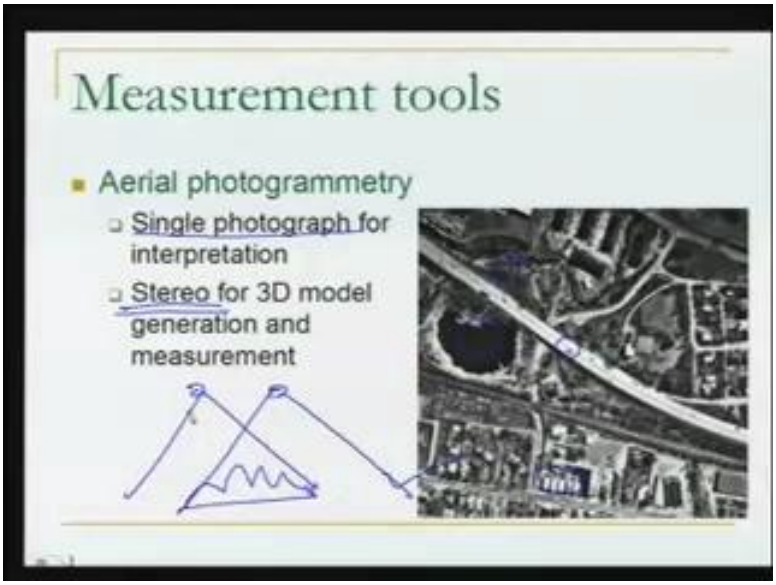
The aircraft moves further; it will capture another one. So, like that, a series of photographs will be captured for the terrain, and these photographs we say ‘aerial photograph’.

(Refer Slide Time: 30:30)



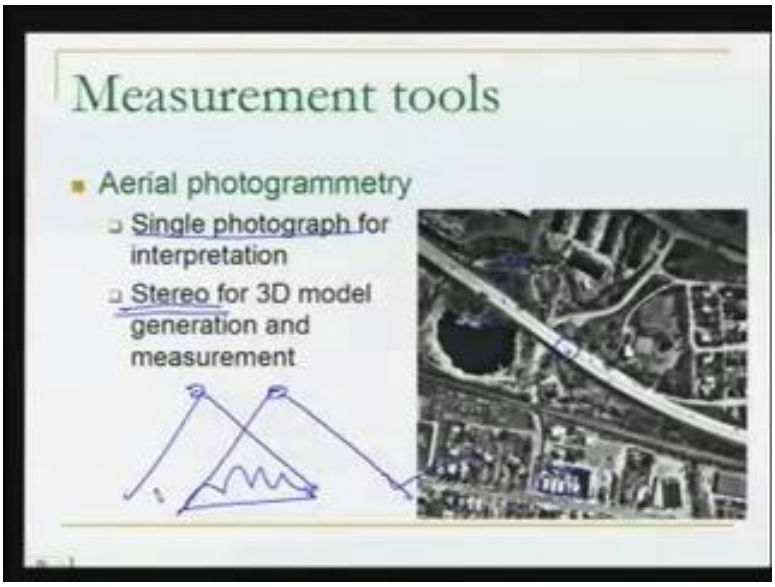
As you can see here, in these aerial photographs, we have some areas which is overlapping. We will make use of these in a minute.

(Refer Slide Time: 30:34)



Now this is a photograph - could be either a single photograph as you see here.
This is a single photograph of the terrain, and you know, in this you can see the road, the vehicles on the road, houses, the trees, some water-pond; so we cannot identify the same - one aspect of geoinformation.

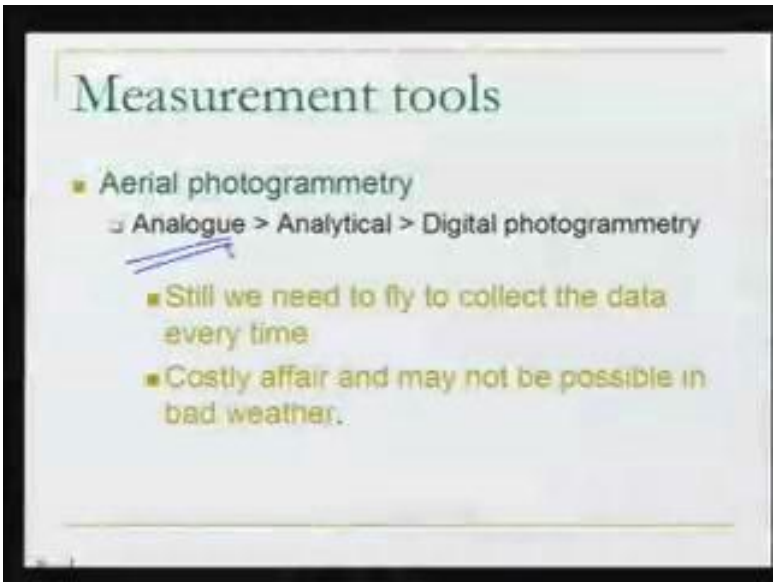
(Refer Slide Time: 31:14)



Not only that; if our photograph has stereo - stereo means, as we are talking in the earlier case, two overlapping photographs from two positions of the aircraft - we have the area which is common in two photographs. So that kind of photograph - this photograph and this photograph put together – this is stereosphere. So, if we have the stereosphere or the stereo photograph, is it possible to generate three-dimensional model of the ground?

Now, once you can generate a three-dimensional model of the ground - what is the meaning of that? The meaning of that is: you can now start measuring on that 3D model various things - you can measure the distances, you can measure the coordinates, you can measure the angles. So with the help of the photograph, as you are looking here (Refer Slide Time: 31:51), you can measure the XYZ coordinate, you can identify the things, so we can get our all geoinformation that we need to.

(Refer Slide Time: 32:06)



This aerial photogrammetry also developed like anything - earlier we had some analogue way of taking the photograph, also processing them; in between changed to analytical way; and now the modern one - just for your information - is the digital photogrammetry. Well, most of the things are automatic now. However, as we are writing here (Refer Slide Time: 32:26), still we need to fly to collect the data every time. Whenever you need the data, we need to fly with the aerial photograph and this is not always possible. Why it is not possible? Because, for example, some area is flooded and you need to take aerial photograph of that area because you want to see how much of the area is flooded; you want to take the measurements. So, in order to measure this, you need to fly using the aircraft. Now the problem: the aircraft may not be available or the aircraft, where it is available, may be very, very far from the side where the flooding is taking place. So it is really very difficult to fly every time - you cannot do it immediately in many instances.

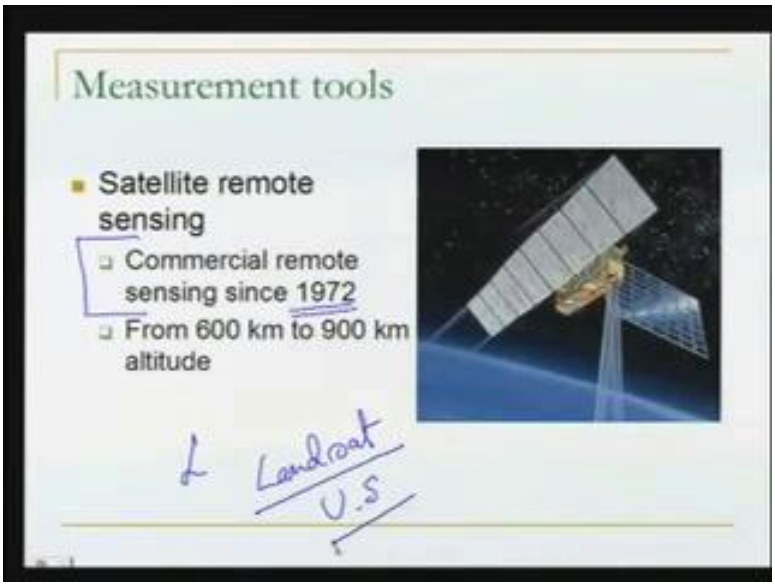
The second thing: even if you can fly every time, it is a costly affair; the aircraft will cost a lot, the crew will cost a lot - so it is a costly affair. So, though the aircrafts were able to give us very fast, very accurate and very, very synoptic- everything on the ground – geoinformation, we had some limitations from the aerial photogrammetry. Aerial photogrammetry - it is being used now depending upon the application, but people started thinking something more: well, can there be something in the space

which can go around the earth; can take the observations regularly? And the idea of satellite came in mind.

(Refer Slide Time: 00:34:01 min)

So, the satellites are such things: as you can see in the slide, they will rotate around the earth. They will keep rotating around the earth and they will keep taking the images of the earth. They take it because while the satellite is rotating - it is orbiting - the earth will spin. So it is possible that ((00:34:19 min)) that that the images are taken all over the earth, everywhere. So what do you have? You have now the system which can take the images repetitively - after five days, after ten days - depending the satellite.

(Refer Slide Time: 35:09)



So this satellite remote sensing, it actually started – commercially, I'm saying, because there were some 5 satellites earlier also; the data of those satellites was not available earlier with the civil users. So the commercial remote sensing, it in fact started in 1972 with a satellite that was called Landsat - sorry about that - Landsat. That was a satellite by United States, and this data was available to the civil users.

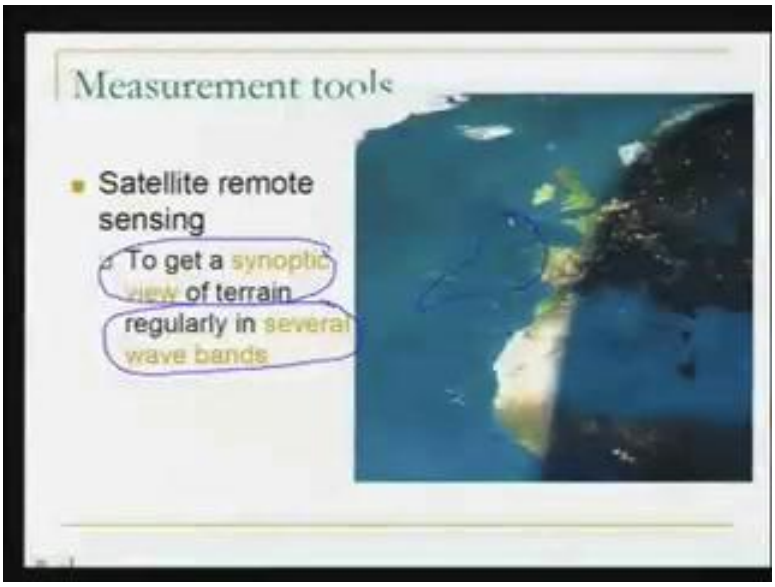
Daily ((00:35:12 min)) these satellites which we use for the up ((00:35:13 min)) observation, they will be found 600 kilometres to 900 kilometres altitude. So, from those altitudes - you just think of that, you know this is a very, very high altitude - the satellite is orbiting there, and you are going to capture the images of the earth.

(Refer Slide Time: 35:40)

So, what you capture from the satellite may be a case like this. Now here in this, a satellite has captured an image of European country, while you can see the Africa also there - the north part of the Africa - you can see the United Kingdom. Part of the Europe is in dark because it is an image of evening time. Part of the Europe – here in the UK; the London, the Ireland - they are still towards the evening; it is not dark there, while in the other parts – the far from other parts ((36:04)) - you can see the lights on.

So, satellites which are at very high altitude can capture images like this. Now this kind of view of the satellite, because it is capturing, in one view, everything, whatever is there - I mean huge area - we said is a synoptic view of the terrain. But this kind of view was not possible earlier. If you are doing land surveying, if you are doing aerial photogrammetry also, this was not possible. Then, the second aspect: satellites also take images in several wave bands. What is the meaning of this? The meaning is, it does not take the image only in optical; it can take images, it can take the photograph or the imageries also in microwave.

(Refer Slide Time: 37:04)



Now, if there are some cloud covers over the area - for example, let us say, in this slide there are some cloud covers; these are the clouds (Refer Slide Time: 37:02). If we are taking the image in optical, then because of the cloud we cannot observe the ground. In the satellite image, we will have all the cloud. So if you are using - if you are using the microwave remote sensing, it is possible that you can see beneath the clouds.

(Refer Slide Time: 37:31)

So, there is a term called spatial resolution in satellite remote sensing. Earlier, the satellites - the commercial satellites also - they had a spatial resolution of 80 metre.

(Refer Slide Time: 37:48)

Now, what is the meaning of that? To understand the meaning of that you need to see this slide (Refer Slide Time: 37:48). In this slide, it is a synoptic view - we can see the entire continent, but we cannot see the individual spatials; we cannot see the individual houses, so the resolution of data is very poor.

(Refer Slide Time: 38:07)

However, in this slide, as you see, we can see the individual cars on the road, the houses, bridge, maybe some more ((38:17)), some more cars, individual trees - everything is singly visible. Now this is the data from external satellite - the resolution of this satellite is 1 metre. So we have, in commercial arena, some satellite which can give you the resolution varying from kilometre to metre - it depends, what kind of your application is.

If your application demands huge areas, big areas, then you will go for resolution in kilometre. Your application is something like, you know, forest mapping, you do not want to measure each and every tree. The area – you, you want to measure the entire acres of the forest, so it is advisable not to go for a data which is very accurate; the resolution is only 1 metre or half a metre. But if your application is: you want to measure the individual car on the road, you want to measure the outlines of the building, you have to measure where exactly the trees are, you want to measure what is the outline of the river - exactly, very accurately.

So, for most of engineering applications, we need accurate measurements. So it is possible that we can get these accurate measurements with the satellite which has a spatial resolution of order of 1 metre or slightly around. So we have, at the moment, the best resolution commercially available of around half a metre. So it is a very, very good resolution; we can see many details, a lot of information in the data.

Now this satellite data also - because we are talking about - I will take you back again to where we started with. We started with the Geoinformatics - basically two divisions: measurement of geoinformation and management. Then in measurement of geoinformation again two things: where the information is, that is the XYZ co-ordinate, the second thing: what the information is.

(Refer Slide Time: 40:44)

So we can make use of satellite data - as you can see in the slide - for both the purposes: we can do the measurement here and also we can do the identification. Well, you can identify in this figure the bridge, building, road or everything. You know, this same process which we do in remote sensing, it is possible that I can assign co-ordinates also to each and every point - not only X and Y but also Z. So by that measurement, you know the XYZ co-ordinates also of each and every point.

So if you want to measure the distance along this road, the distance is known to you. So now see how the things have changed: earlier we were supposed to go to the ground, occupy this point; but now we are not going to the ground, rather, we are making use of satellite image, and using that image - satellite image - you can measure the distances. You can also measure the angle, for example the angle between these two streets (Refer Slide Time: 41:46); what this angle is.

So we can make use of satellite remote sensing for both measurement and identification.

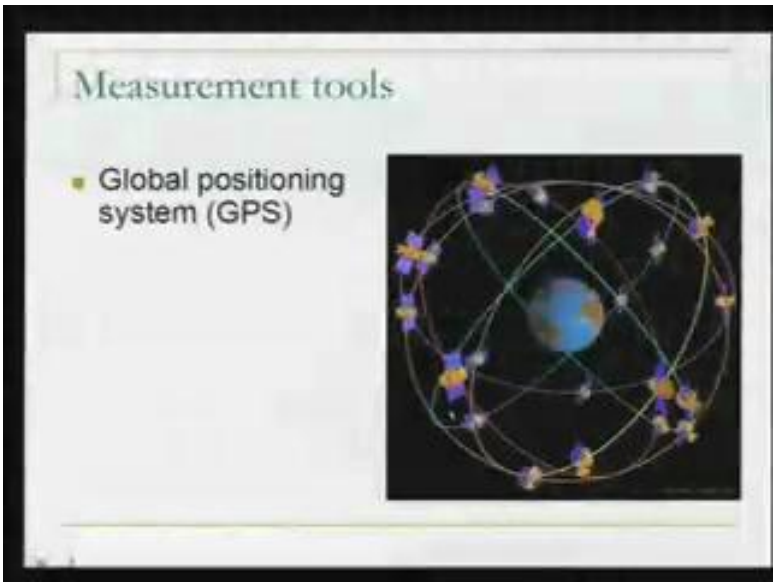
(Refer Slide Time: 42:49)

Another interesting thing - I just wanted to show you because this is very important data; the satellite will take repetitive data. As I told, they will cover your earth every fifth day, ninth day, eighteenth day, twenty second day, depending which satellite we are talking about. Here is the data from ((42:09)). The name of the satellite is ((42:15)) and the resolution is half a metre. This is the data from Indonesia and this is the data just before the tsunami of 26 December 2004. So this is the area which was - the area used to look like this before the tsunami with houses, fields, the trees, more fields, houses, the jungle.

(Refer Slide Time: 42:53)

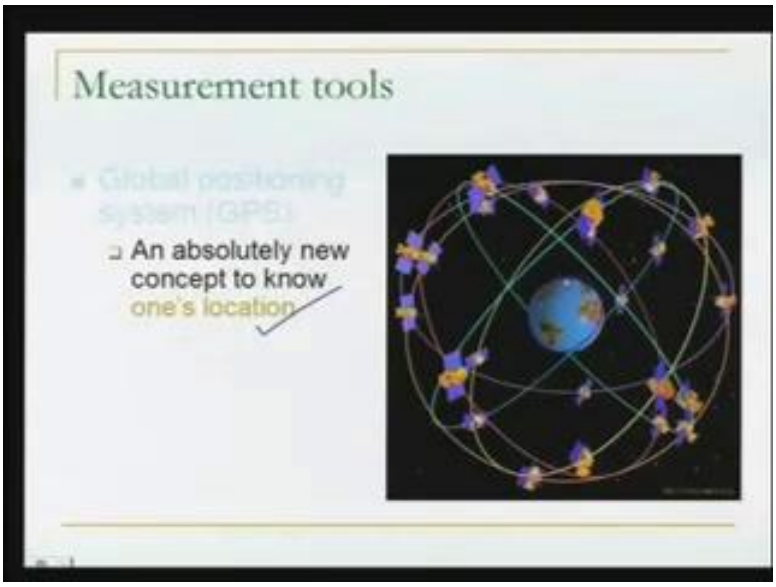
Now, after the Tsunami, again the satellite recaptured the data. Now how the data looks like - the data look like this. Wow! Here (Refer Slide Time: 42:29) and here, both are same. So we can see the area which has been flooded now, so you can do this mapping very quickly, using the satellite, of all the areas which have been flooded. You can also make use of this data in order to see the damages to the buildings. All the buildings have been damaged. One little building over here (Refer Slide Time: 43:20) - still the roof is intact. So you can guess that this building didn't damage while for all other buildings, they have been damaged. You can see the debris - everywhere the debris is falling. So this is how, you know, we can make use of satellite image in order to collect geoinformation - about measurement of the geoinformation as well as … management we will talk later on. But for geoinformation; knowing where it is, also knowing what it is.

(Refer Slide Time: 43:55)



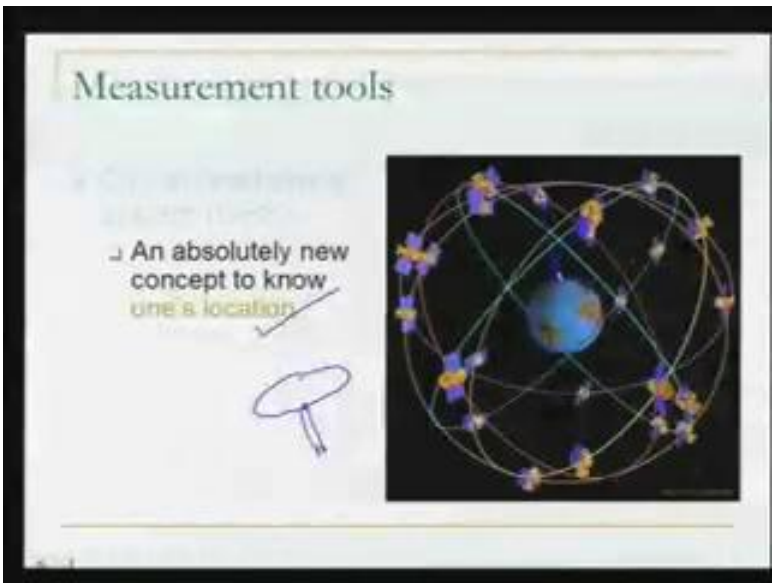
One more modern tool - this is the modern tool which we say the GPS; Global Positioning System. Now what this GPS is: we saw in the beginning itself, we always wanted to know where we are. Okay, in the Vedic age also, people found some ways to know where they are - they made use of the stars, the sun, the moon and all those things.

(Refer Slide Time: 44:39)



We wanted to know our location because our location is very important to us; because I want to see what my location is in relation to other things. So the GPS is the instrument which can give vast location very accurately

(Refer Slide Time: 45:19)



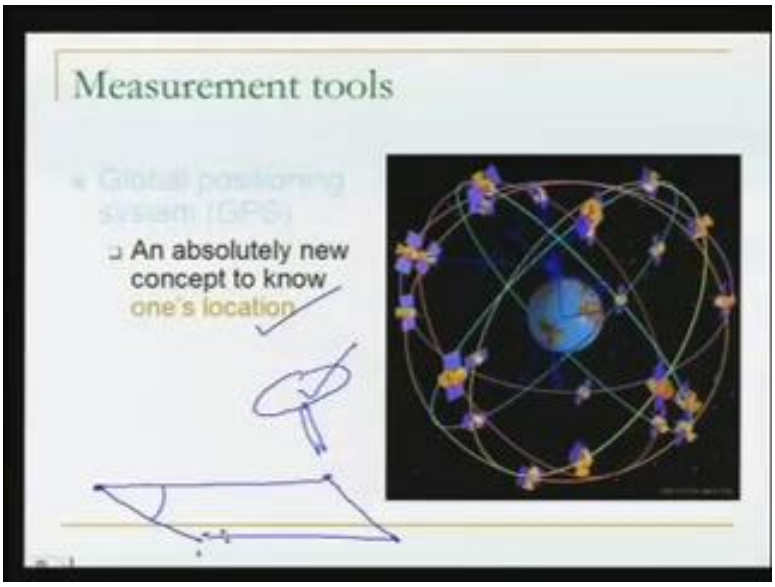
What the GPS is: in the case of the GPS, as you can see here, all around our earth we have around 24 - I am saying 24 at the moment though it is not exactly 24, it is more than that - number of GPS satellites and these satellites are orbiting the earth in such a way that at any moment of time, if you are standing anywhere, you can see at least 4

satellites - of course, more than that. What do you have? You have a receiver - a receiver of the GPS may look like this or maybe it will be a simple handheld device like the mobile phone.

This receiver measures your distance to 4 satellites, as you can see here. There is a method - we will see this method later on. So by measuring these 4 distances, also by knowing the location of these satellites - exactly at the time when we are measuring the distance - in a coordinate system which is defined at the centre of the earth, it is possible for us that we can determine where this receiver is.

So wherever you go on the surface of the earth, you are standing here and using this GPS receiver, you should be able to determine where you are in this coordinate system. It is a very good instrument - that little instrument which has the size of only a mobile phone. You go about with this anywhere; if you are walking with this instrument, it is possible because the receiver is measuring the distances to four satellites and immediately, by the computations, I will come to know where I am; what are the latitudes, longitudes and altitudes of the point where I am standing. So anywhere you go around the earth, this is possible.

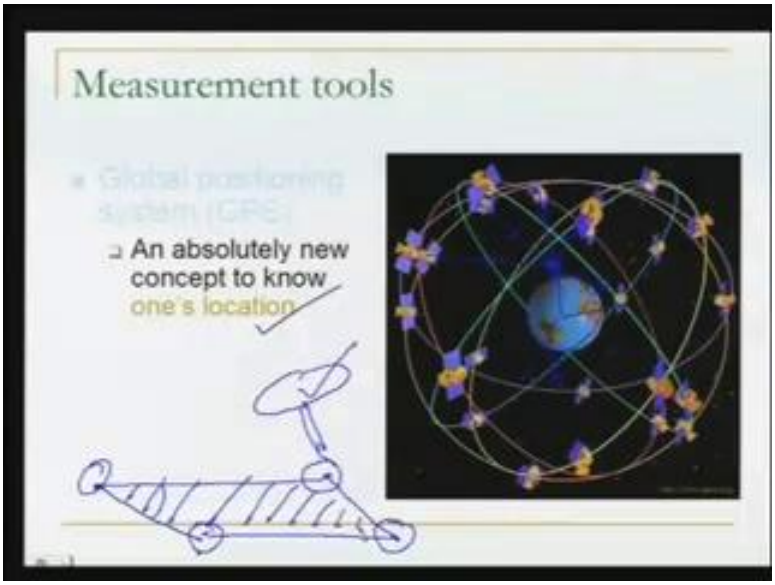
(Refer Slide Time: 47:07)



Now what you can do? If you know the latitude of this place; of this place (Refer Slide Time: 46:45) - all the coordinates, latitude, longitude and altitude - of two points

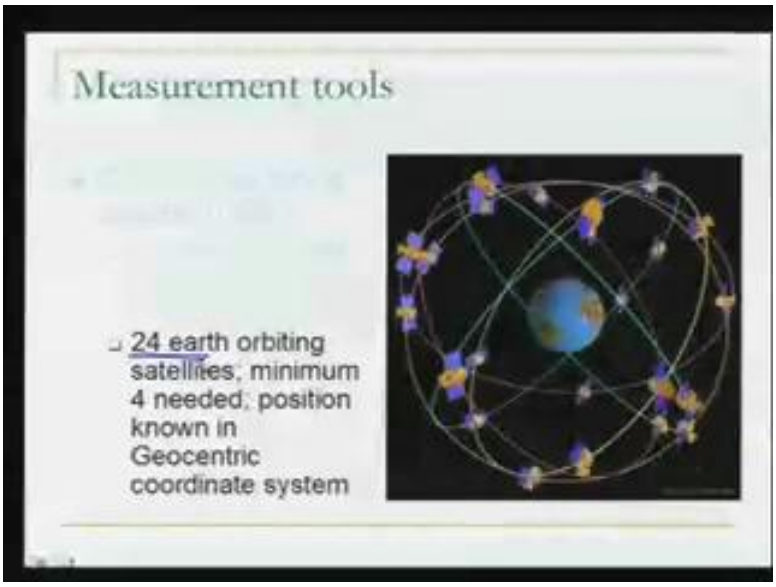
on the surface of the earth, you can measure the distance between two points (Refer Slide Time: 46:54); if you know the lat, long and altitude of the third point also, you can also measure the angle (Refer Slide Time: 47:03). Well, one more point, you can find the area (Refer Slide Time: 47:07). So now with this - a single GPS - as you move, your coordinates are being measured automatically and independently.

(Refer Slide Time: 47:34)



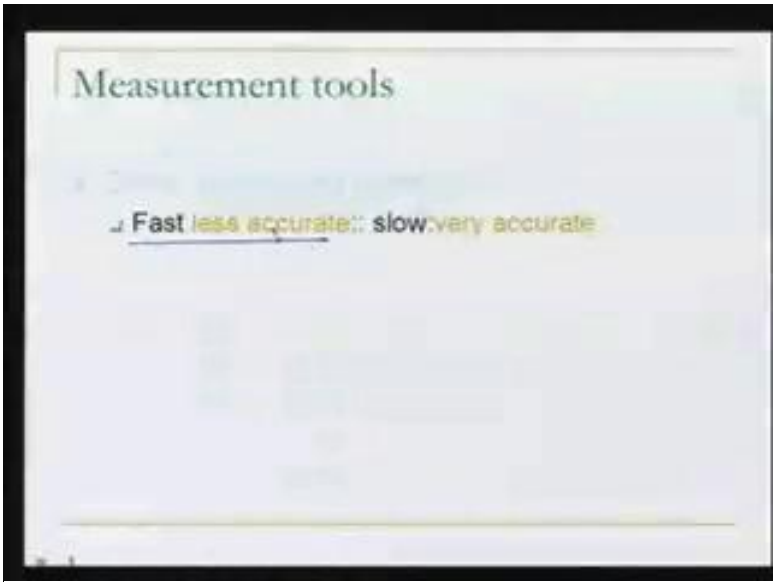
So you know the co-ordinates of this point, co-ordinates of this point, co-ordinates of this point, co-ordinates of this point (Refer Slide Time: 47:22), and if you know the co-ordinates of all these points, the area of this field is known to you (Refer Slide Time: 47:32). So it is very interesting way of carrying out the measurements and a very, very modern way.

(Refer Slide Time: 00:47:47 min)



Now, as you are seeing, there are at least 24 satellites which we need to make use of and the coordinates are given. I am going to give the term here; it is called geocentric coordinate system. The meaning is: the centre of the coordinate of the origin is at the centre of the earth. So all the coordinates where we are going with the GPS receiver will be measured in this particular coordinate system.

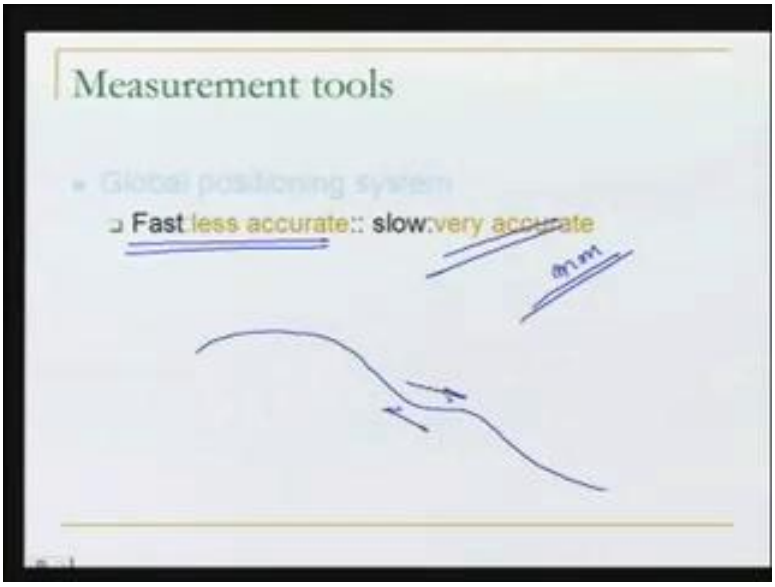
(Refer Slide Time: 48:21)



Now, about the global positioning system: it is very fast if you want to take slightly less accurate measurement. Okay, you can just run - you can - you are in a car, you

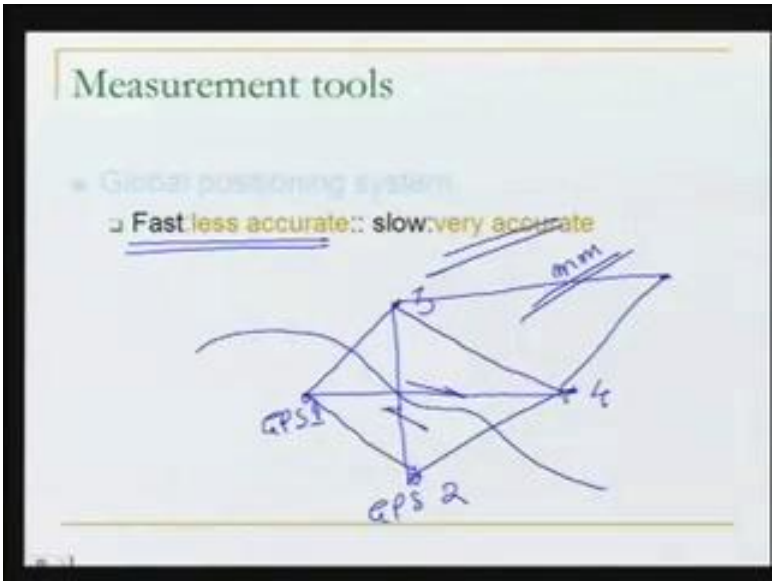
are moving in a car, and the GPS with you which is in the car is looking at the satellite, measuring the distances to the satellites and finding the location.

(Refer Slide Time: 49:05)



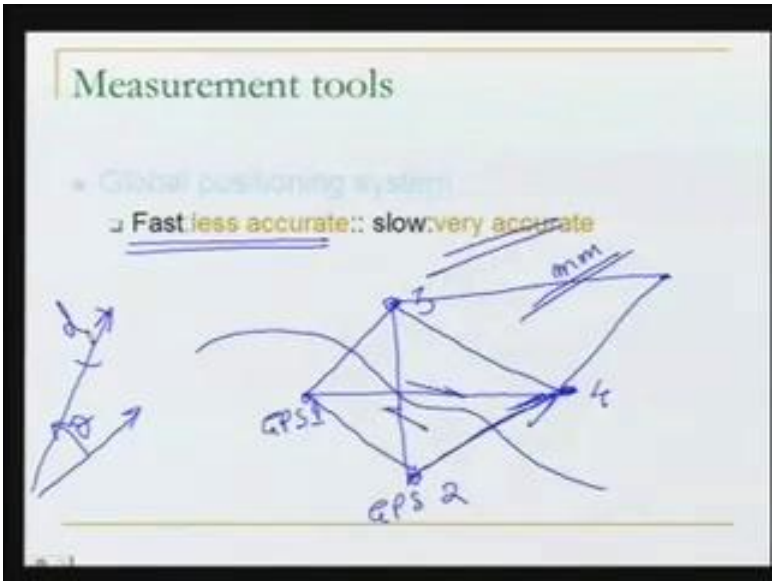
If you want to do it very, very accurately, say in millimetre level; you want to do it very accurately for some applications, for example in the case of the earthquake, where, let us say I am drawing this diagram - this is a fault (Refer Slide Time: 48:56), and there is likelihood of a movement along this fault. Let us say I draw it this way.

(Refer Slide Time: 49:40)



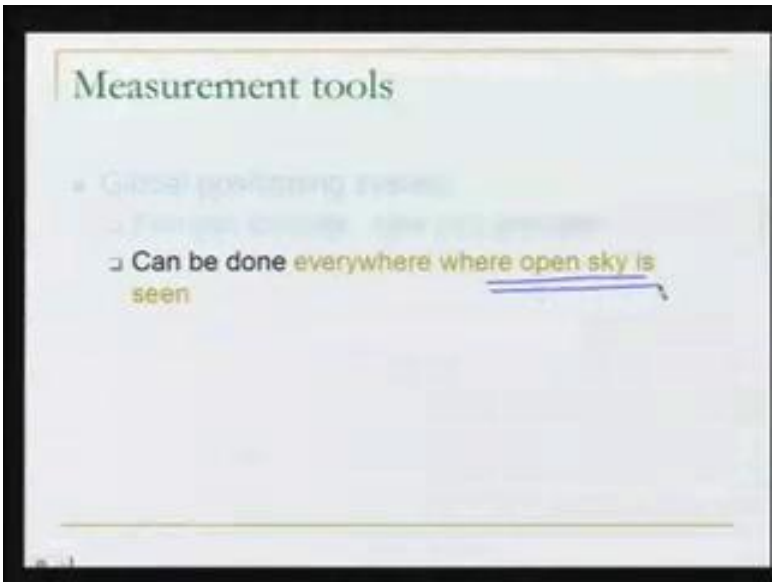
So we need to monitor this fault - if any movement is taking place there. So what people are doing now, several distances they are putting the GPS - GPS 1, GPS 2, similarly here also (Refer Slide Time: 49:24) – 3, 4 and so on. So what we have, we have a network of GPS's reflected along - all along the fault line. So we have the network like this. Now, if there is any relative movement in between these two plates, so these points will move in relation to these two (Refer Slide Time 49:50). What the GPS is giving us? GPS is giving us the coordinates regularly. So we know the coordinates of this, so we know this distance, or rather I can say we know this vector (Refer Slide Time: 50:05). So between two points, I know the vector.

(Refer Slide Time 50:26)



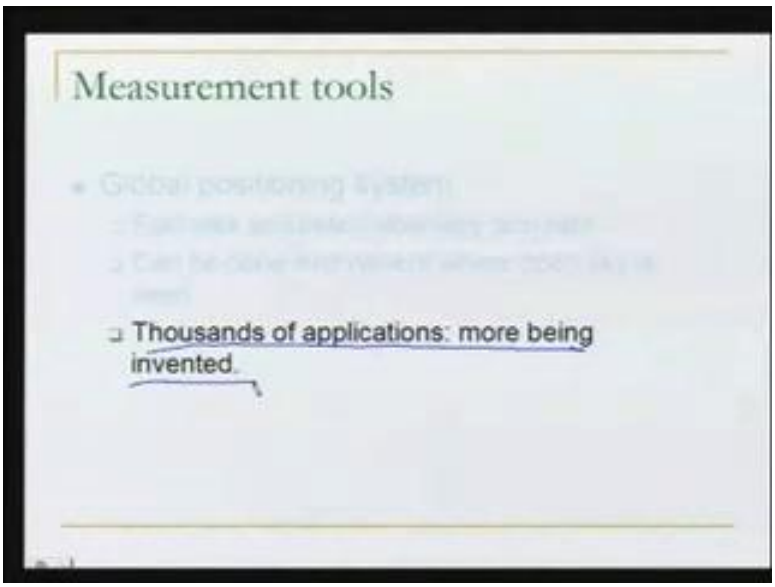
Now, this was my initial vector (Refer Slide Time: 50:12). Now, this initial vector may change after some time (Refer Slide Time: 50:18). So, this change in the vector in terms of the angle, in terms of the distance - it is because of the relative movements of these two plates. So, people are trying to make use of this kind of observation - the GPS observation - in order to predict the earthquake.

(Refer Slide Time: 50:50)



Now another thing, another good thing about the GPS - you can use it everywhere, all over the earth - wherever you can find open sky. You cannot do it inside the room because you need to see the satellite.

(Refer Slide Time: 50:58)

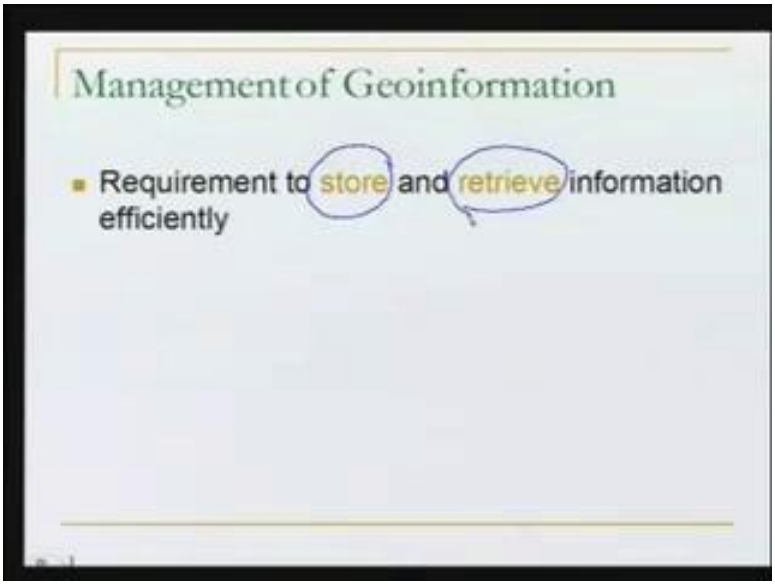


So because it gives you a location, there are thousands of applications which are possible, and many more applications are being invented. GPS is going to be an essential part; in many mobile phone models the GPS are there. Even in many watches - people are wearing the GPS in their watch. If someone is going to a forested

area; they want to go to, you know, they want to go to a forested area - so there in the forest, they want to locate where they are moving. They carry a handheld GPS of the type of a mobile phone and it keeps telling you: okay, you are moving in this direction. If you want to come back, look at the movement how you had reached a particular point - so you have to just backtrack. So all these things are possible with the GPS.

Now having seen all these, as initially I taught, for the Geoinformatics, there are two fundamental divisions: one, measurement of geoinformation. Now whatever we have discussed so far - the primitive techniques, land surveying, electronic surveying, aerial photogrammetry, satellite remote sensing or the GPS - all these are the methods for taking observations; for measuring geoinformation. Also, all these are the methods by which we can not only measure XYZ of the geoinformation, but we also know about what they are.

(Refer Slide Time: 52:37)



Now, the next aspect: once you have measured this information we want to manage it, you have to store it properly. So, that is the second aspect or the fundamental division of geoinformatics area, which is the management of geoinformation. So, as we saw a little bit earlier also, we need to store our data - there is a requirement to store the data, there is a requirement for retrieving the information. You have to store it

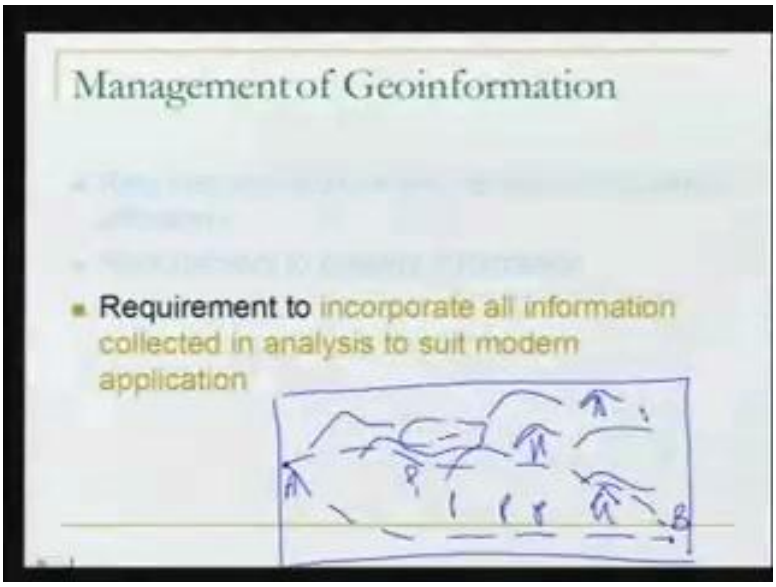
properly and whenever we need it, we need to retrieve it; we need to get it back. So, that is the management of the geoinformation.

(Refer Slide Time: 53:18)

We also need to present the information. What is the meaning of that? Whatever you have accumulated, whatever we measured in the field, you need to present it. Maybe you want to make a map, maybe you want to make a table, may be you want to make an action ((53:28)) - you know, you want to give to a leader, a political leader - you want to show him, okay, how much of the area is flooded; he is interested in that. So what you do, you use the map of the town - on top of that you want to draw a line which shows the area which is flooded. So that will - it forms a presentation.

So, that is also a part of the management of geoinformation. Most important of all - because storing, retrieving, presentation these are all important aspects - but the most important of all is, whatever geoinformation that you have stored with you, you want to analyse it. You want to put all the information together so that you want to come out with some kind of final answer.

(Refer Slide Time: 54:23)

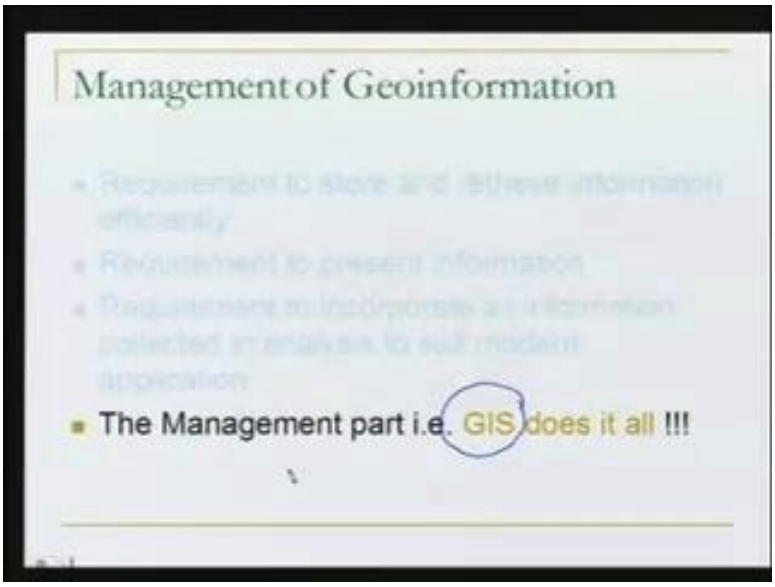


One thing could be - one example - let us say we have a map of an area, and in that map we have the topography zone - I am just drawing it this way right now (Refer Slide Time: 54:32) - we have some trees, here, the houses - everything - here some villages here, you know, having the houses and all that - fields, pools, river – everything.

Now your job is, you want to start from a point A and you want to reach point B - so far there is no road in between A and B. So what you do, you want to join A and B by a road. So there are various possibilities: you can join them by a road which may go like this (Refer Slide Time: 55:07), you can join them by a road which may go like this (Refer Slide Time: 5 5:11). Which way? What is the best here?

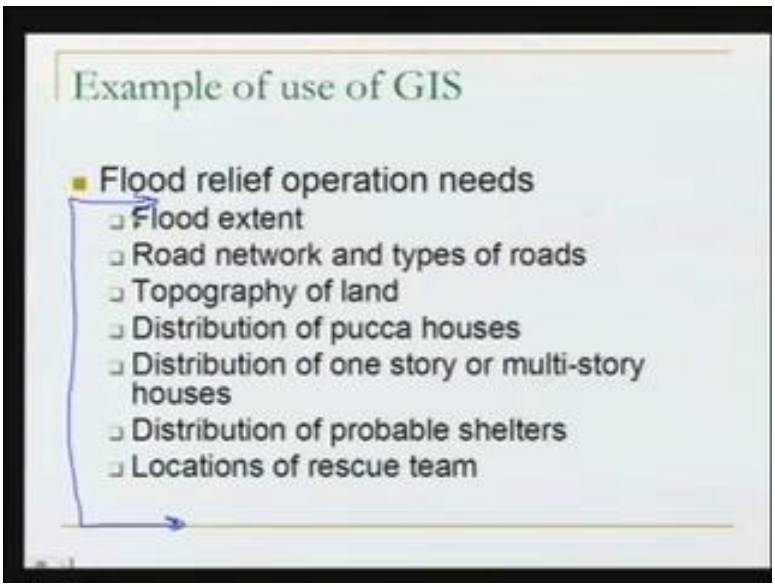
So what you do, you make use of the geoinformation which is collected. So, for a problem like this, the geoinformation could be the geology of the area, the rock types, where the villages are, where the trees are, where the streets, where the schools, where the towns - all this is the geoinformation. So you put all this geoinformation together, and then your computer, where this information is kept, analyses this in order to find the best possible route alignment between these two points A and B. So that is an aspect where we do analysis of the geoinformation.

(Refer Slide Time: 55:53)



Now, in geoinformation there is a term which is called GIS. GIS stands for Geographical Information System, and this GIS does all this management part; whatever we are talking about. Everything will be covered in GIS.

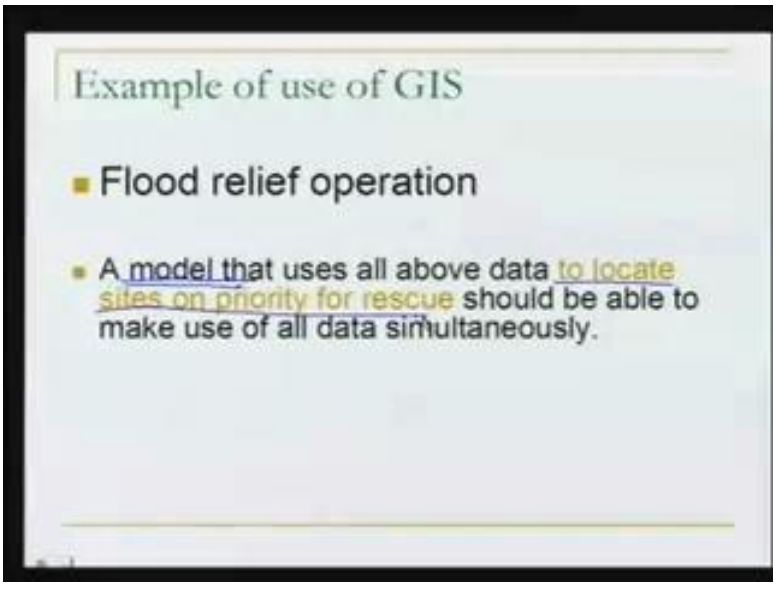
(Refer Slide Time: 56:33)



Now, I would like to end this presentation by one example of the GIS, and this is - the example is - there in some town where there is the flooding, and we need to locate the area where we need to provide the relief. This is a very important decision - we want to provide the relief in those areas where it is required. Now this is the problem; now

start thinking - in order to answer this problem to provide relief to those areas where it is flooded, what all information you need; what all geoinformation you need? So the geoinformation that we need: okay, how much area is flooded? We need to measure it. How do you measure it? We can make use of the satellite or you can go to the ground if possible and map it. We need - because we have to provide the relief - we need to know what is the road network in the area and what are the types of the roads. What is the chance that a percent of road have been washed away? We need to know about the topography – why topography? We need to know about the topography because, those areas which are elevated, if we know that the stage of the river or the height of the flood water is so and so. So we can make an assessment - what all areas will be flooded - if we know the topography of the land. Topography means undulation, so those areas which are higher will not be flooded. We need to know about the pucca houses - if you know about the pucca houses - the school building, any government building there - so we know that these are the buildings which will not be damaged, so the chances are people are occupied in these buildings, because these are not damaged. Okay, so distribution of where the one story and multi-story houses are - we need to know the probable shelters where the people are willing to stay in the event of the flood.

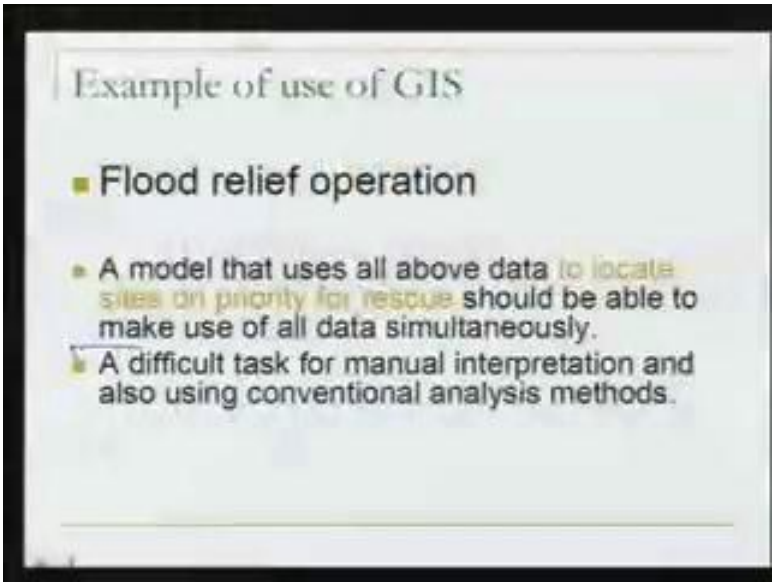
(Refer Slide Time: 56:33)



So having known all this information, there is a requirement now to take a decision

where all these information will be put, and a decision will be taken on the basis of this geoinformation. So what we need to do, we need to put all this information in a model. Now this model will run under GIS, which will make use of all these information to find the sites on priority basis for the rescue. So we need a model, and that model can be run on this GIS data; the geoinformation. So this is the management part of the geoinformation, where we are coming out with the areas – there, this is the area where the relief has to be provided.

(Refer Slide Time: 59:24)



This task, if we do it manually is a very difficult task, so manual interpretation is involved and conventional methods are involved, this are very, very difficult to carry out. So carrying out this task in a computer in the GIS is suggested.

(Refer Slide Time: 59:52)

Now finally, whatever we have done today, in our next video lecture, we will talk in detail about the basic surveying. Because today we saw that what the geoinformation is, what is geoinformatics, and tomorrow we will see what the basic surveying, though we saw about it a little bit today.

So this is what we will cover in our next video lecture. Thank you.