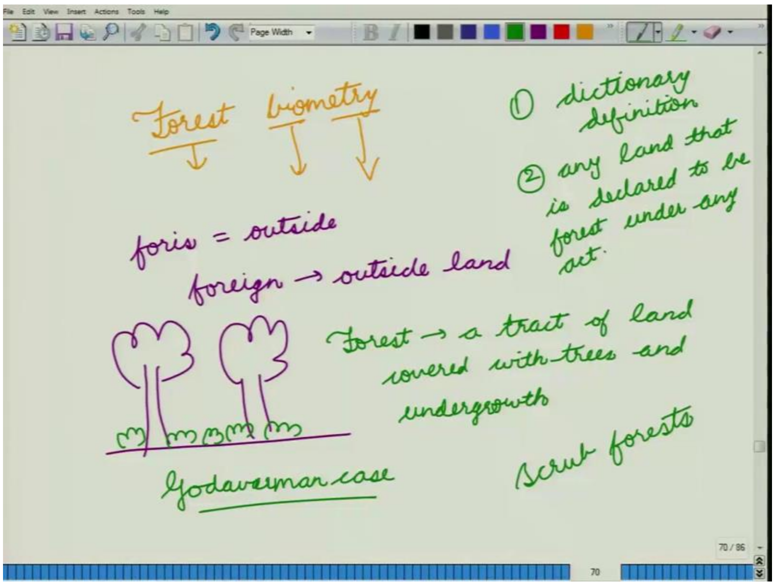
Forest Biometry
Prof. Mainak Das
Dr. Ankur Awadhiya
Department of Biological Science & Bioengineering & Design Programme
Indian Institute of Technology, Kanpur

Lecture – 01
Introduction

[FL] and welcome to this course on forest biometry. I am Dr. Ankur Awadhiya an officer in the Indian Forest Service. In this course, we shall look at what forest biometry is all about, what we measure in this discipline, how do we measure those things in this discipline, why do we need this discipline and so on. So, let us look at this term forest biometry. Let us look at the word roots.

(Refer Slide Time: 00:49)

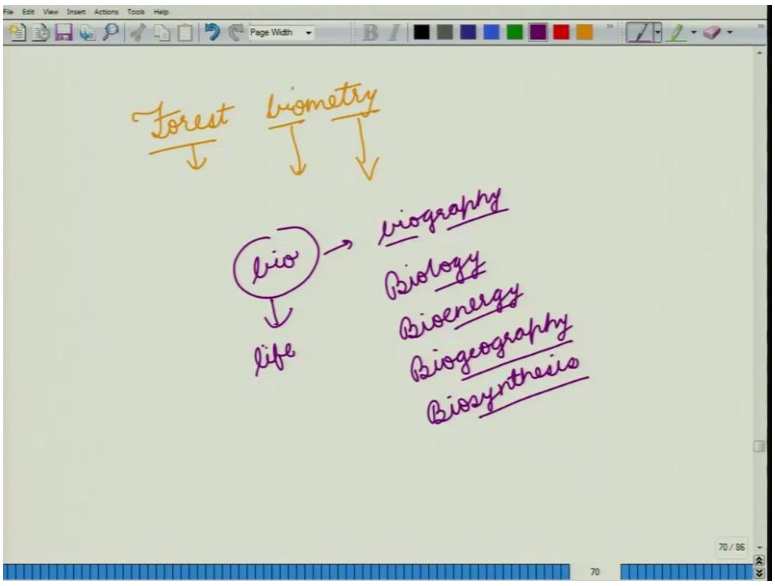


So, we have forest biometry. So, this has three words in total; one is forest the second is bio, and third is metry. The term forest is derived from the Latin word Foris, which means outside. So, this is the same word root that we have in the case of foreign, so foreign means in outside land. Why do we call forest as forest because in earlier times and also quite correct in today’s situations, forests are outside of residential areas. So, they are not where people live, so they are outside of village’s towns in cities, so which is why we call these forests.

Now, forests traditionally have been lands where you have a number of trees. So, this is a land that is covered with trees and also with some undergrowth. So, we could say forest is a tract of land covered with trees and undergrowth. In the case of our country India, we have had a case called as the Godavarman case. Now, in this case, our honorable Supreme Court has taken a dictionary meaning of forest. So, forest in India means two lands one from the dictionary definition so that is any tract of land that is covered with trees and undergrowth or also any land that is declared to be forest under any act.

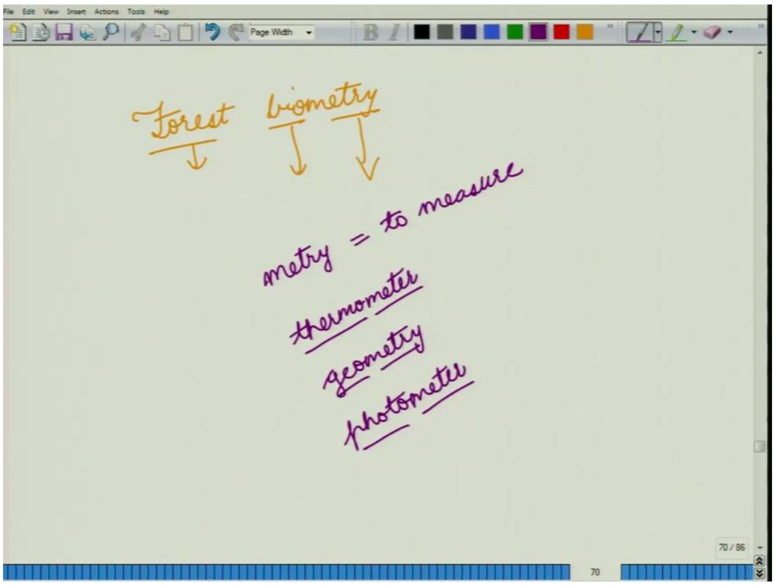
So, for instance, if you went to Rajasthan, and if you looked at the sand dunes there, you would be having vast expanses of land that do not have quite so many trees, but they might be having some undergrowth do we call these as forests, yes. If they have been defined as forests under any act or if they have been worked upon as forest traditionally, so we would call them as forests and we define them as scrub forests so that is what forest is about. The second term that we have in our definition is biometry. Now, biometry also is divided into two parts.

(Refer Slide Time: 04:23)



So, here we have bio, now bio means something that is related to life. So, this is the same word root that comes in say biography or in the case of biology or in the case of say bioenergy or say biogeography or say biosynthesis. So, again looking at the word roots bio plus graphing, graphy means to write, so biography is the writing of a life logy means study. So, biology is the study of life. Bioenergy is that energy that is created out of life forms. Biogeography is geography that deals with different life forms. Biosynthesis is the generation of the synthesis of chemicals by various life forms. So, bio means life something related to life.

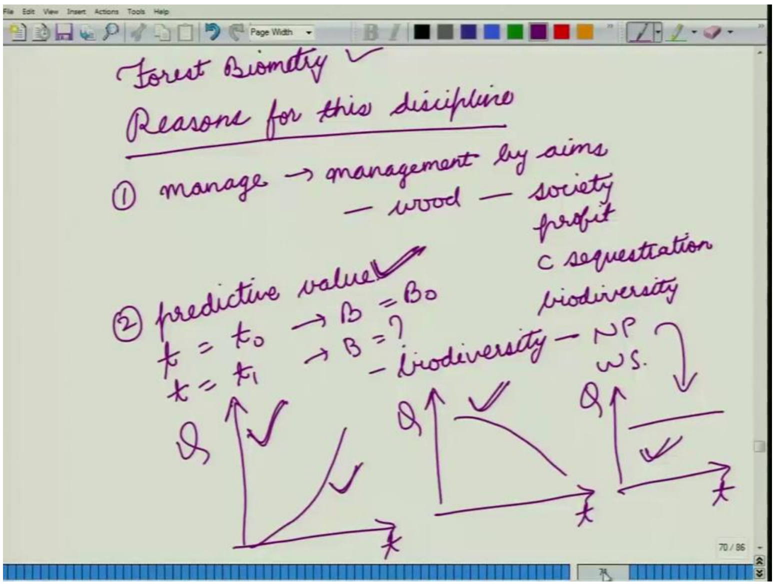
(Refer Slide Time: 05:45)



Now, the third point in this term is metry. Now, metry means to measure, so where do we see this word metry, we see it in thermometer, metron is to measure, thermo means temperature. So, it is something that measures temperature we see it in geometry, metry is to measure, geo means earth. So, the beginnings of the mathematical discipline of geometry related to the measurements of parts of earth so which is why we call it geometry.

We see it a photometer. So, meter means something that measures photo is light. So, photometer is something that measures light. So, now, looking at it into we have forest biometry. So, metry is measurement. So, what do we measure here, we measure something that is related to bio. So, we measure the life forms. Where do we measure it we measure it in a forest, so forest biometry is the science of measuring forest. Now, why do we need this discipline, why do we need a separate discipline of forest biometry, we need it for a number of reasons.

(Refer Slide Time: 07:14)



One, so let us call these reasons for this discipline. So, we have forest biometry. Why do we need this discipline one, we need this discipline manage things. Now, why do we need to manage forest? Well, because why do we need forest in the first place, we need forest for a number of reasons one they give us wood, what is something that is needed by the society we needed for the manufacturing of furniture, we needed for those, we need it for a number of things, one. We might need forest to overcome climate change because it is because when trees make wood they are essentially converting carbon dioxide into biomass, so that is leading to carbon sequestration. So, carbon sequestration is something that we need to bring down global warming, so that could be another reason to have forest.

We could also have forest just for the sake of having it because it feels good to know that you have forests around it feels good to go to a forest, you feel rejuvenated you see a number of life forms, you could be managing forests for biodiversity. Because there are so many species all around and they need for us to live, so that is called as management by aims. So, you could be having the aim of gathering wood for your society or to make a profit or for carbon sequestration or for biodiversity. You could also be managing a forest not for the wood for biodiversity, but for biodiversity persuade, for instance our national parks and the wildlife sanctuaries.

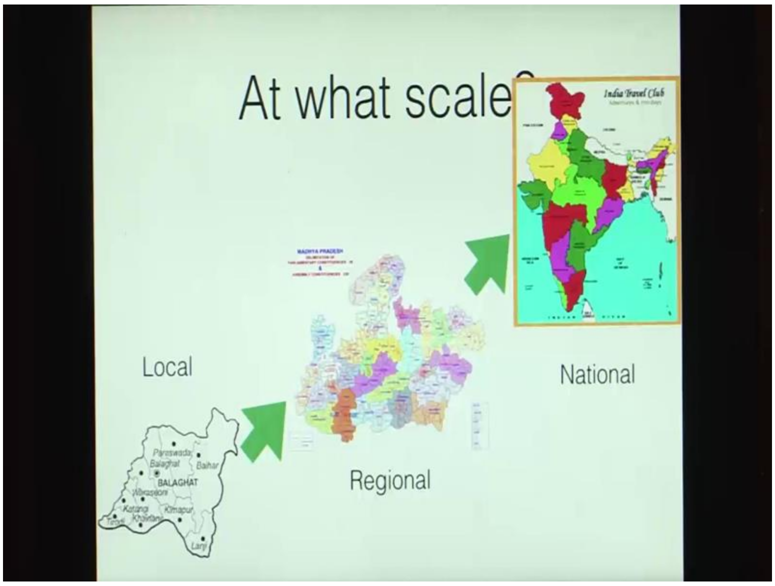
So, this is there we are managing forests, but then why do we need to measure forests for this, because you cannot manage anything till you know what you are managing. Till you know how much of your quantity is there only then can be tell whether that quantity is growing with time whether that quantity is reducing with time or whether that quantity is remaining constant with time. So, if we plotted Q versus t, now suppose you are managing your forests for biodiversity. You would wanted to maintain in a position of status curve. If you wanted to manage a tract of land that is scrub forests that that is a denuded land it does not have any forests and if you wanted to manage it in it in such a way that it would have for this later on in future you would go for this curve.

Similarly, if you figured out that your forests were having this curve, you would think of reasons in which you could bring it to a steady state or to an increasing trend. So, for all of these purposes, you need to measure your forests the second reason why we need this discipline is because it is predictive value. So, for instance, if we are making a plan, if you are making a plan to say mitigate climate change and if we say that today we have a forest of say 10 million square kilometers, and after 5 years will be having a forest of say 10.5 million square kilometers. So, would that change be substantial in our aim of a mitigating climate change, how much of more carbon would it be able to sequester?

If you wanted to know that we would need a discipline with a predictive value so that would enable us to predict if in time t equal to t naught, if we had a biomass B is equal to B naught. And at time t equal to t when we wanted we want to know how much would the biomass B, so which is why we need a discipline with a predictive value. Now, at what scale do we do these measurements? These scales could be at various levels. So, for instance, you could be measuring some trees that are growing in your backyard or you could be measuring some trees that are growing in a farmland because we are trying to promote agro forestry which is the application of forestry to agriculture and agriculture to forestry.

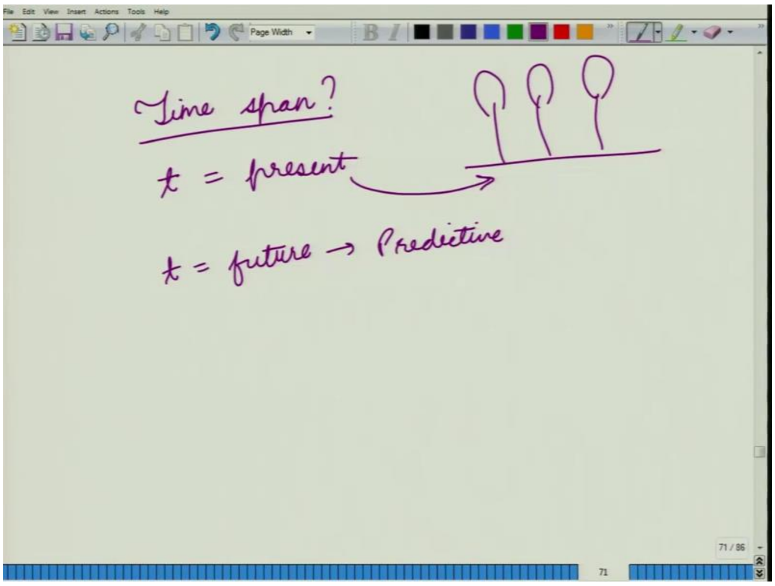
So, it is a mixed bag in which in the same plot of land you are you can grow some trees and you can also harvest it for agricultural purposes. So, it becomes a dual use. So, suppose you want to want to popularize agro forestry, you want to tell your farmers how much would there income b say after 5 years or say after 3 years. So, for those cases you will need to measure at a very small scale.

(Refer Slide Time: 13:01)



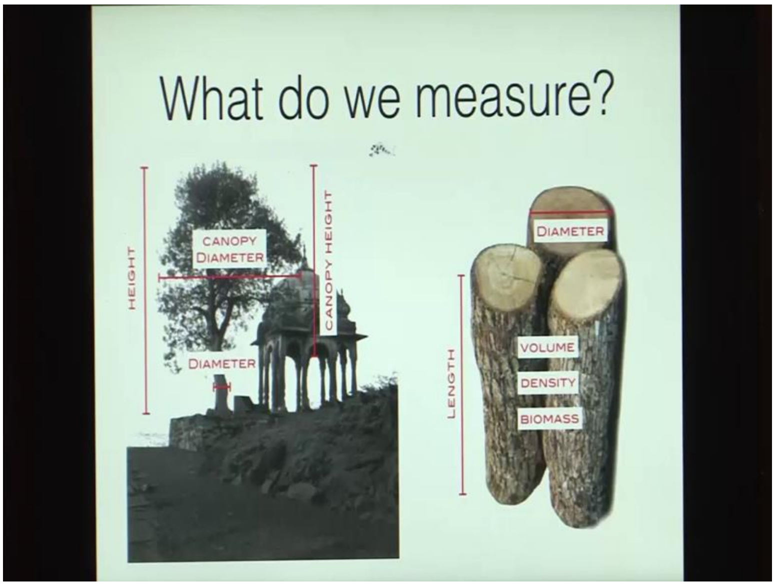
So, if we look at the slide we would see that we can have measurements at different scales. You can have local measurements or say even district level measurements, we could be having regional level measurements say in the case of states, we could be having national level measurements or we could be even be having international level measurements, which might be important for planning purposes say for climate change mitigation.

(Refer Slide Time: 13:27)



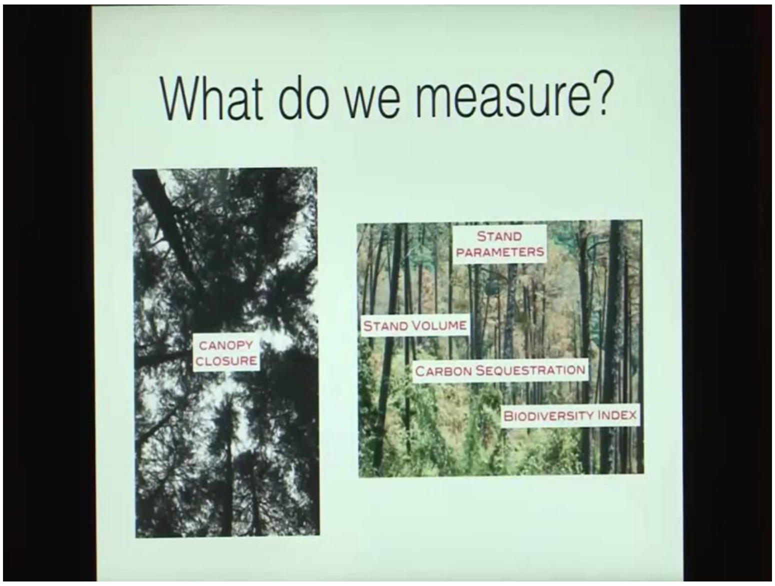
Now, what is the time span in which do we do these measurements. Now, as we talked before we can have the time of present. So, for instance, if you have a tract with some trees you want to know how much of what is this, so you would be measuring it now. You could also be having a time span of future, which is used for predictive purposes that is all about the time span of measurements. Now, what do we measure in forest biometry?

(Refer Slide Time: 14:06)



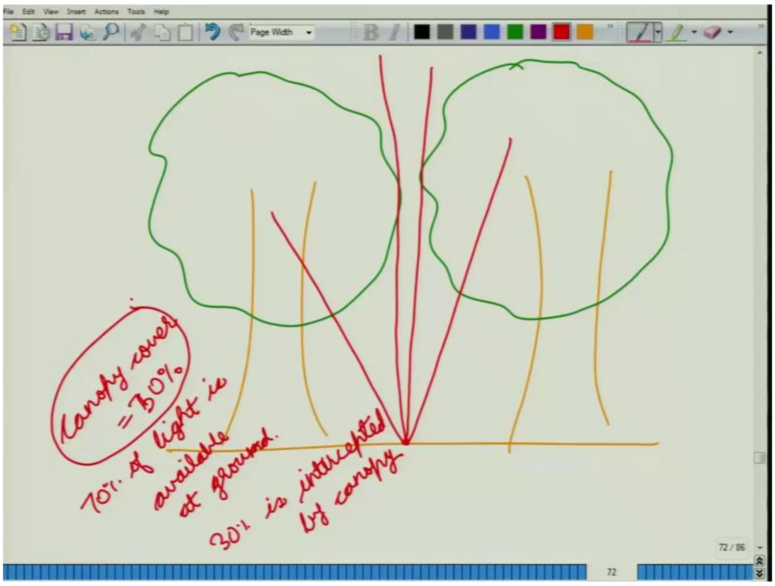
If we looked at the slides, here you can see that on the left side you have a monument and right next to it is a tree; on the right panel, you can see a few logs of wood. So, what can be measured using the science of forest biometry? In the case of a tree, you can measure a number of parameters say the height of the tree, the canopy of the tree. So, canopy is the upper layer is the uppermost branches and leaves in a forest that often makes an umbrella over the bare ground. So, as you can see in this figure, you can measure this the diameter of the canopy or the height of the canopy. You could also be measuring the diameter of the tree or in the case of the logs, you could be measuring the diameter and length of the logs from which you would be able to calculate the volume of the logs you could be measuring the density of the wood. So, volume multiplied by density would give you the biomass.

(Refer Slide Time: 14:59)



When you look up to the forest you can see the canopy. So, here on the left panel we are seeing a forest from bottom up. And on the right side of the panel, we are seeing or dense forest a view from inside the forest. So, what do we measure here? Well, we can look at canopy closure. So, canopy closure will tell us what is the percentage of the view above that is covered by the canopies. So, suppose you had a canopy closure of around say 90 percent or we could represent it as 0.9, so that would mean that 90 percent of the light that is coming from top is being intercepted by the tree cover. So, only 10 percent of the light is able to reach down below to the ground level. On the other hand, suppose you had this canopy closure of say around 0.3 that would mean that if we draw these trees on the ground.

(Refer Slide Time: 16:00)

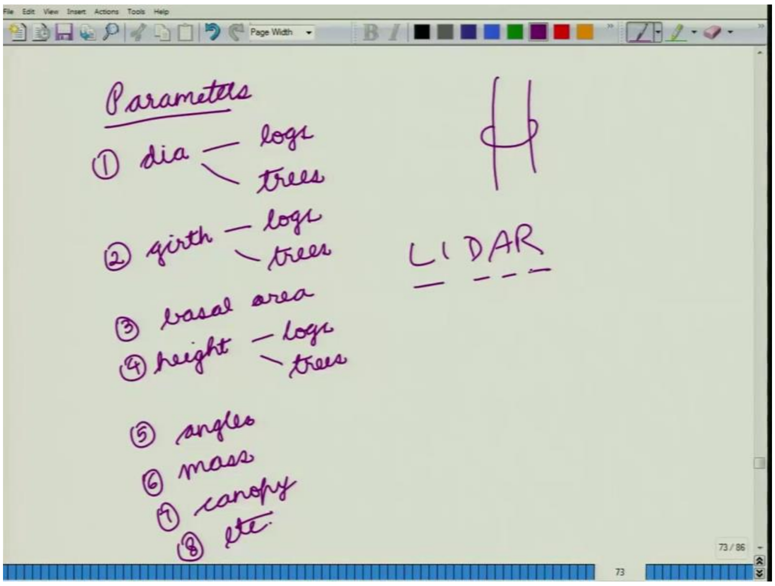


So, suppose this you have these two trees and you are trying to take a measurement at this point. So, from here you would see that only this much amount of space is available for light to penetrate; and all the other portions have been taken up by canopies. So, suppose if you had a canopy cover of say 30 percent, so that would mean that 70 percent of light is available at ground and 30 percent is intercepted by canopy. So, why do we need this figure, because if we had a canopy cover of 30 percent, so you have 70 percent of light that is available for your new growth. So, these are the locations that you could use for regenerating the forest.

On the other hand, if you had a canopy cover of say eighty percent. So, you have very little light now plants need light to grow, they need it for the process of photosynthesis to generate new biomass if your canopy was already very dense you might not be able to grow new trees. At the same time, there are a number of species that are light demanding species. So, if you have a light demanding species, and if you put it into the soil at an area where you have a very dense canopy cover, this species would die because it requires it demands a large quantum of light. On the other hand, there are some trees known as shade tolerant trees. So, if you had a very good canopy cover and if you planted your shade tolerant trees they would be able to two to thrive there, but if you planted them at a location that had very less canopy they might die. So, all these measurements are required to manage your forest.

Coming back to the slide if we looked at the forest on the right panel, you have a stand. Now, a forest stand is a contiguous community of trees with similar attributes that distinguish it from adjacent communities. So, basically it is a patch of forest that has very similar attributes that are different from other patches. So, the stand has stand parameters. So, stand parameters includes your stand volume carbon sequestration biodiversity index and so on. So, the volume of this stand, the sum total of all the volumes of different trees of the stand would give you the stand volume. Carbon sequestration would be a measure of the amount of biomass that we have there in this time. Biodiversity index would tell you how many different kinds of species are there in your stand.

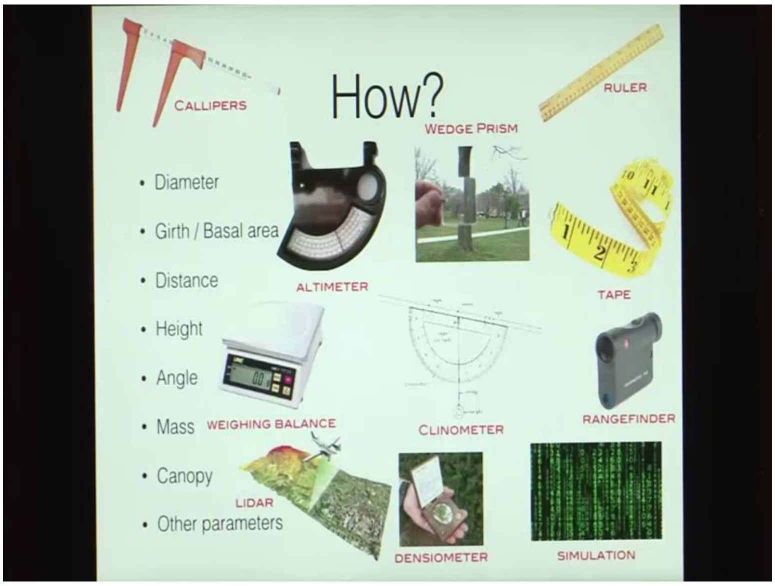
(Refer Slide Time: 19:22)



So, how do we measure all these parameters? So, we have a number of parameters. So, what are the various parameters that we have? We have diameters as we have seen in both in the case of logs and in the case of trees. We have the girth, which is if you have a tree the circumference of the tree would be this girth. So, you can also measure it for logs or for trees. You could also be measuring the basal area, which is the area of the cross section. You could be measuring height both for logs or for trees, you could be having a number of angular measurements or let us call it just angles.

You could be measuring mass. So, if you have mass in volume you could beginning density, you could be measuring canopy or you could be measuring other parameters. So, in this course we shall look at how do we measure all these and what are the standard ways of doing it what are the instruments involved.

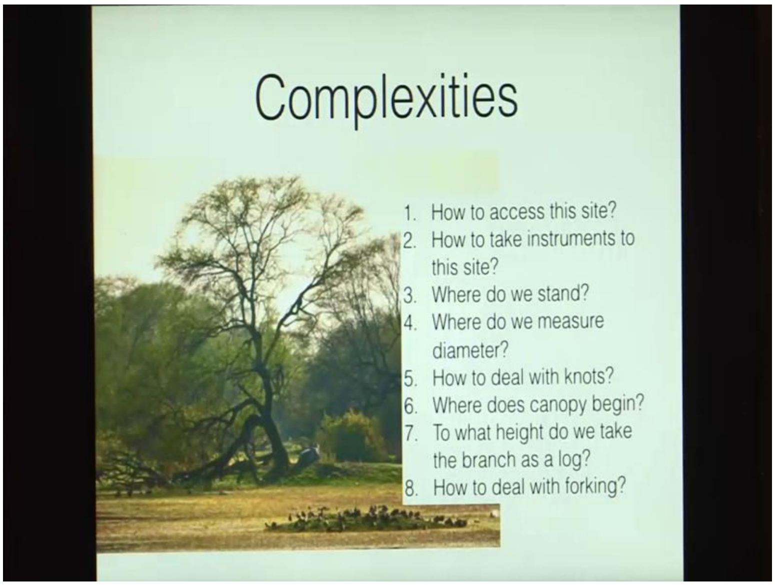
(Refer Slide Time: 20:42)



So, if we looked at the slide again. So, we have an instrument called calipers. So, you all have used vernier calipers in the schools. So, calibers can be used to measure diameters or lengths, but you could also be using a ruler or maybe a tape for the same measurement. So, which one do you use for what purposes. We also have an instrument called the wedge prism that you see in the central panel. So, it is a transparent piece of glass. And if you look through that wedge prism as you can see here it causes a displacement of whatever is in front of it. So, here you can see in the central figure that the central portion of the main stem is displaced towards the right. So, why do we need, that we will come to it in a later class.

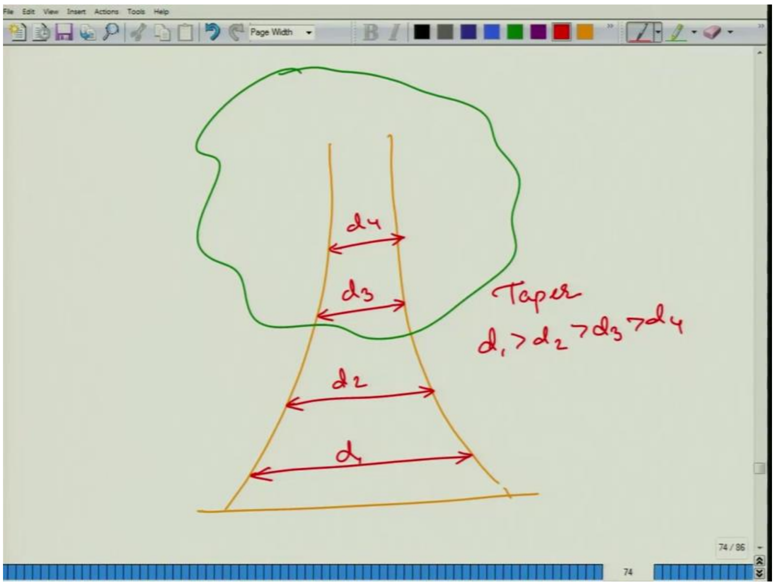
We also have altimeters we have weighing balances for masses. We have clinometers for angles, we have rangefinders, so these days laser rangefinders are a huge rage. So, we could use those to measure distances. We also have LIDAR know LIDAR stands for light detection and ranging. So, this is one technique that uses laser lights to get a three-dimensional picture of your scene as we can see in the slide. So, here we are seeing in an aeroplane that is going above our ground surface it is sending these waves in receiving goes back, and then we are having a simulation that is showing this the topography of the piece. We could be using a densiometer that is used for the measurement of canopies. We could also be using computer simulations.

(Refer Slide Time: 22:29)



Now, in the first class it might appear that that this is a very primitive science because it is very easy to measure these things. So, for instance, if we look at this picture, here we are seeing a few trees and suppose we wanted to measure the tree in the center. You would say that it is very easy you would go there with a tape or you go there with calipers of with a ruler and you would get the measurements it appears easy, but the devil lies in the details. So, as we can observe in this picture the tree is thicker near the ground and as we go up the diameter reduces.

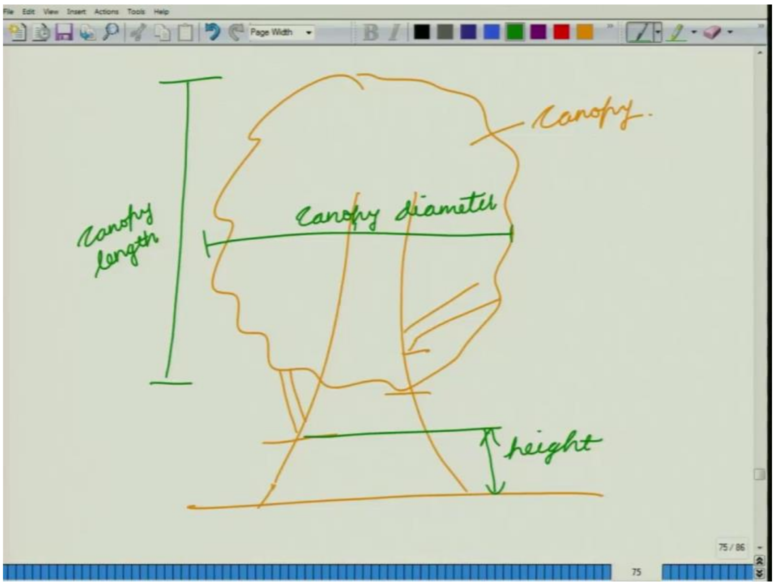
(Refer Slide Time: 23:02)



So, to represent it in a figure, if you have any tree the diameter, so suppose this is your tree, the diameter at the bottom would be greater than the diameters as you go up. So, suppose you had d 1, d 2, d 3, d 4 would having d 1 is greater than d 2 is greater than d 3 is greater than d 4 this is because of a thing that we call is taper. So, will come to taper in a later class. But now coming back to the figure on the slide here we can see that if you look at the very bottom of this tree it appears thicker; if you go up it becomes smaller. So, if you wanted to measure the diameter of this tree where are you going to measure it which is the correct region to measure the diameter. And if you choose any particular region as your standard would that be acceptable to others.

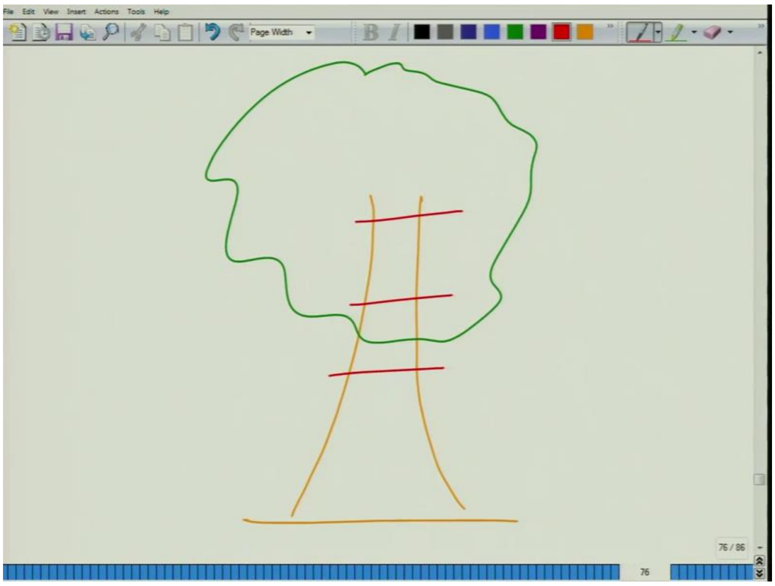
There are a number of other complexities. So, for instance if you looked at this site it appears to be a very much your swampy location, how are you going to access this site especially if you wanted to take your calipers along, how are you going to access it how do you take your instruments to this site. Even if you are taken your instruments, where do you stand this tree appears sloping towards the left side. So, do you stand to the right of it to the left of it, or where do you stand where do you measure the diameter. How do you deal with knots and branches. So, for instance in this case you can see that this tree as soon as it if you move up from the bottom, you can see that you have a large branch that goes towards the left. So, how do you deal with these? So, suppose you wanted to measure the length of the main stem is the central stem the main stem or is the left side in a stem is the main stem. Where it is the canopy begin? So, when we talk about parameters like let us draw a tree again.

(Refer Slide Time: 25:13)



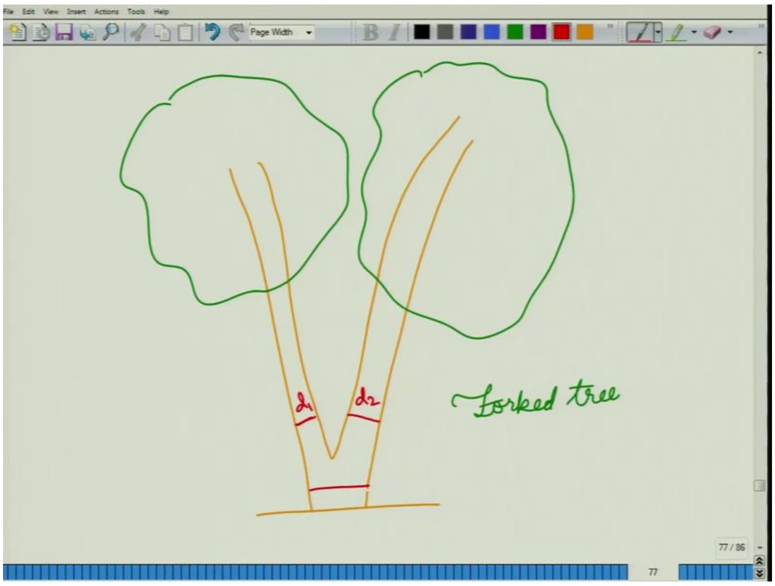
So, suppose this is your tree and this is your canopy. So, where does the canopy start does it begin here, does it begin it suppose you have a branch here, so is this your canopy or suppose you have a branch that goes like this is this your canopy. So, suppose you wanted to measure the canopy parameter, the canopy parameters include your canopy length, your canopy diameter, canopy height. So, how do you discern these values, where does the height begin to what height do we take the branch as a log.

(Refer Slide Time: 26:14)



So, this is your tree, if you wanted to cut this tree, do you cut it till here, do you cut it till here, do you cut it till here, this is at all these different heights you would be having a different diameter.

(Refer Slide Time: 26:38)



How do you deal with forking now forking is the situation in which you have a tree and it gives out branches like this, so this is a forked tree. Now, if you wanted to measure the diameter of this tree. Where would you measure this diameter is this one tree or is this two trees, how do you determine that. And where do you measure its diameter, do you measure the diameters here, do you measure the diameter here, do you measure the diameter here or is the your diameters the sum of d 1 plus d 2 or may be the average of d 1 and d 2. So, how do you deal with these complexities? So, we have a number of complexities; and in this course we shall learn about these and several other topics.

Thank you so much for your attention, [FL].