Forests and Their Management
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Module - 12
Revision
Lecture – 35
Revision (Part 2)

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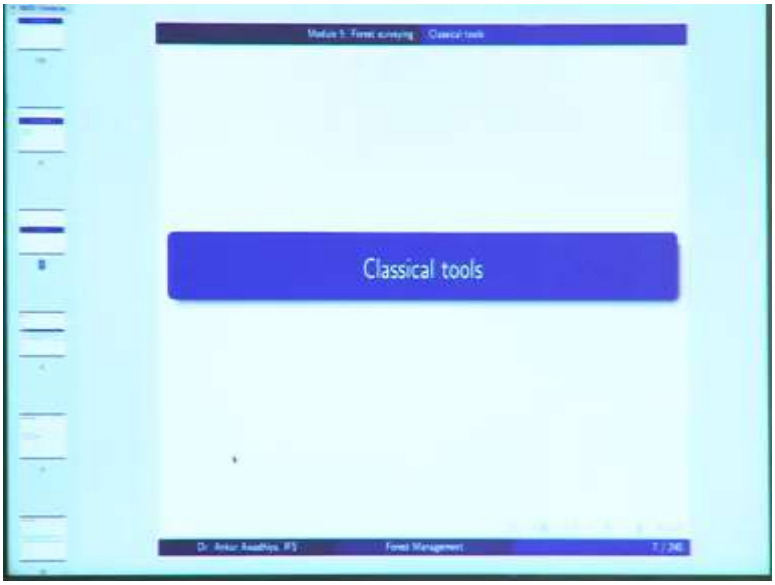

[FL] We move forward with our revision and today, we will start with module 5 forest surveying.

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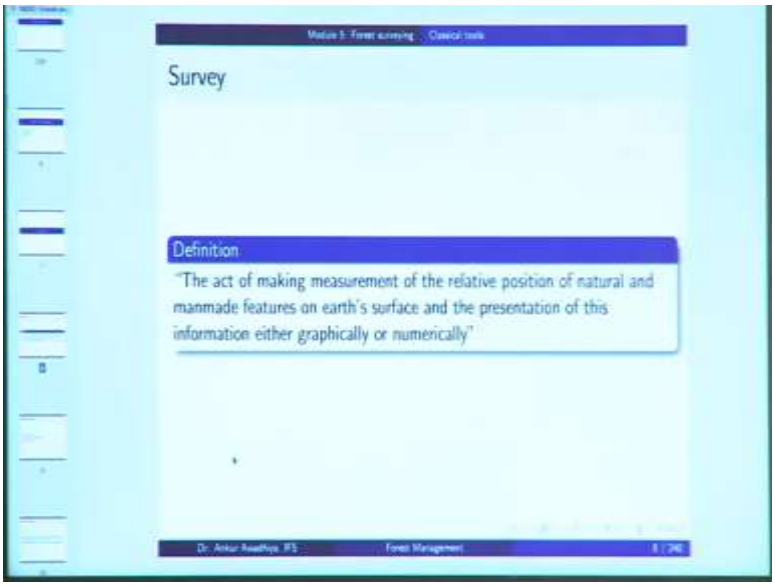

So, we saw that survey is the act of making measurement of the relative position of natural and man-made features on the earth surface and presentation of this information either graphically or numerically.

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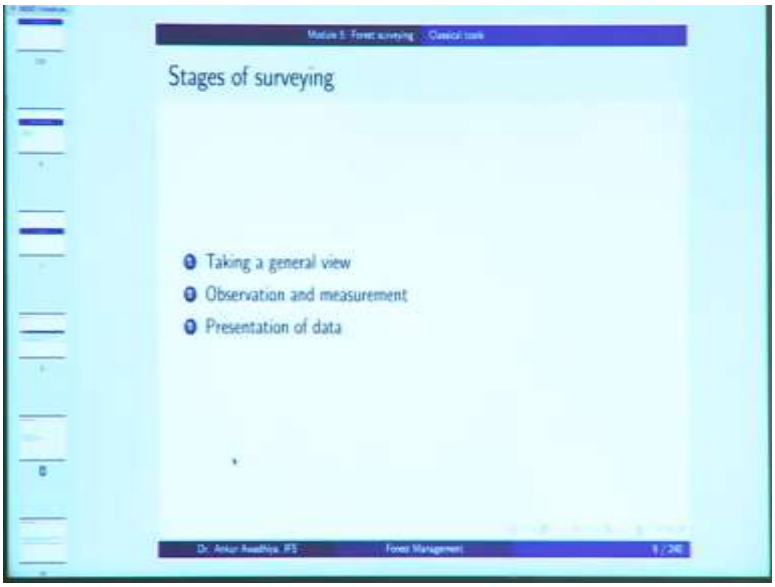

So, you take measurements, and you also have to present this data either graphically or numerically. There are three stages of surveying; taking a general view or the reconnaissance survey, observation and measurement, and presentation of data.

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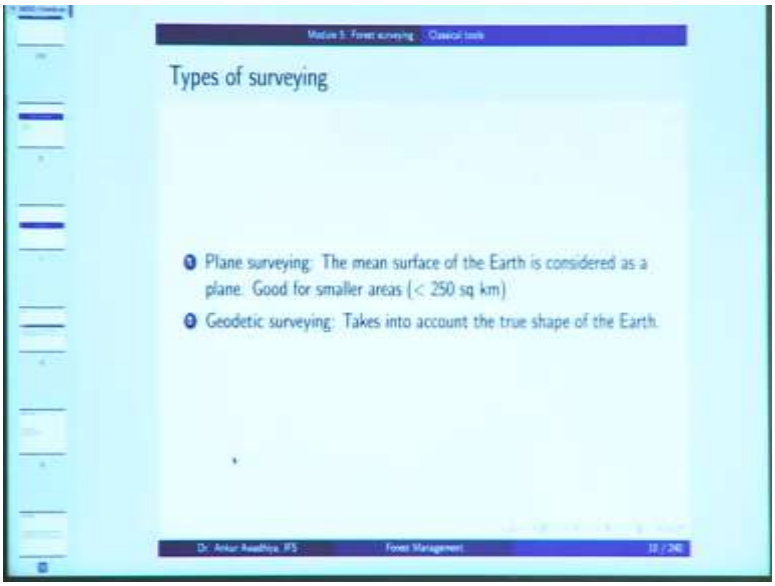

Then, we saw that there are two types of surveying. Plane surveying, when you take the surface of the earth to be a flat plane and this approximation is generally true, when you are surveying smaller areas less than 250 square kilometers in size.

If you have larger areas, then you have to take care of the curvature of the earth; the true shape of the earth, which is a geode; and in this case, it is known as a geodetic surveying.

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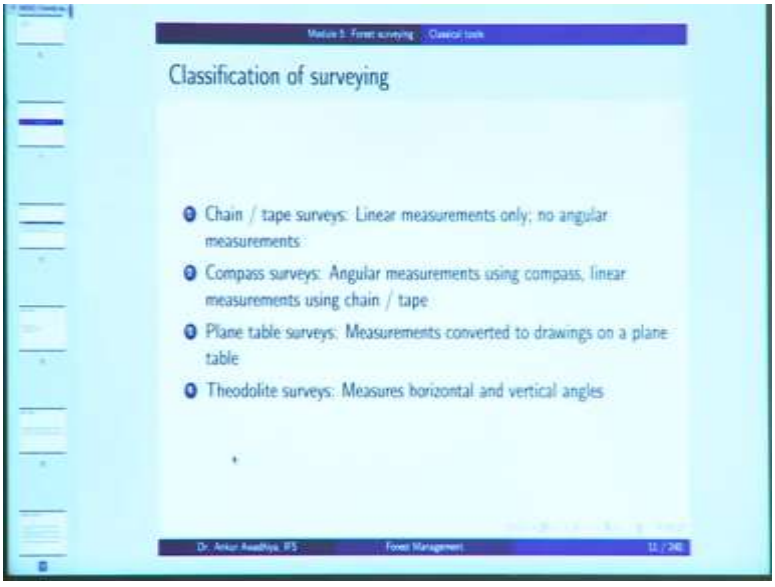

Now, surveying was generally done with classical tools such as chain and tape survey. Now, in the cases of chain and tape survey, you only take linear measurements; there are no angular measurements that are involved.

Secondly, you have compass survey in which case you take angular measurements using compass, and linear measurement using a chain or a tape. Then, you have plane table surveys in which you take measurements and they, these are converted into drawings on a plane table. And typically, you only need to have two points; you know the distance between both of these points, they are in the straight line and for the rest of the points you only take the angular measurements. And, just by taking angular measurements you are able to plot them out on the sheet, where you have to measure the horizontal and the vertical angles both.

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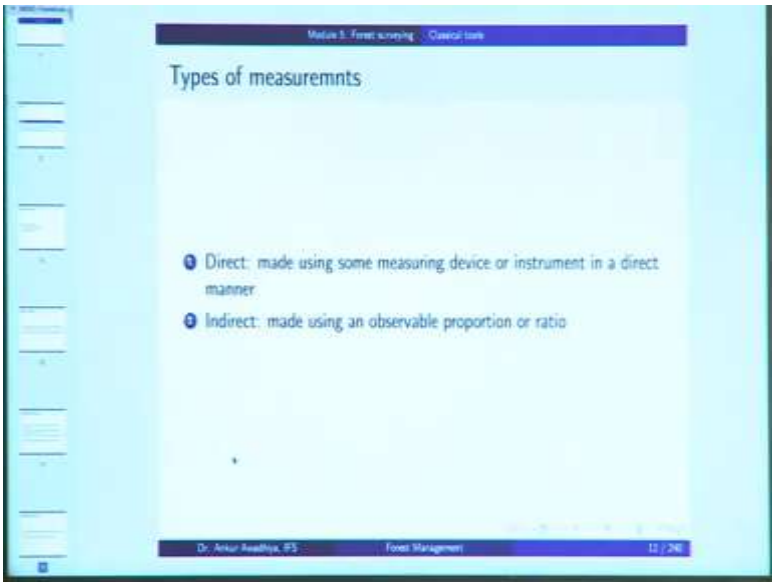

Now, measurements can be direct measurements; made using some measuring device or instrument, or indirect measurements that are made using an observable proportion or ratio such as the stake and shadow method.

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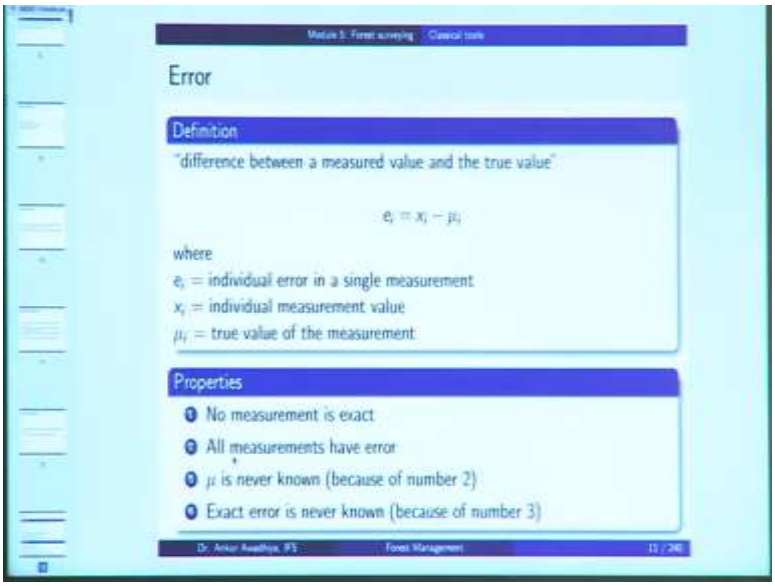

Then, we defined error as the difference between a measured value and the true value. And, the properties are that there is no measurement that is exact; all measurements have some error, and because of this error, you can never know the true value of anything.

Now, if you do not know the true value, you also cannot know the exact error; because your definition of error involves this true value. And, you cannot you can never measure the true value, because even if you are trying to measure the true value, there will be certain errors that will be involved. So, we try to take measurements in a way that the relative between the measurements cancel out the errors.

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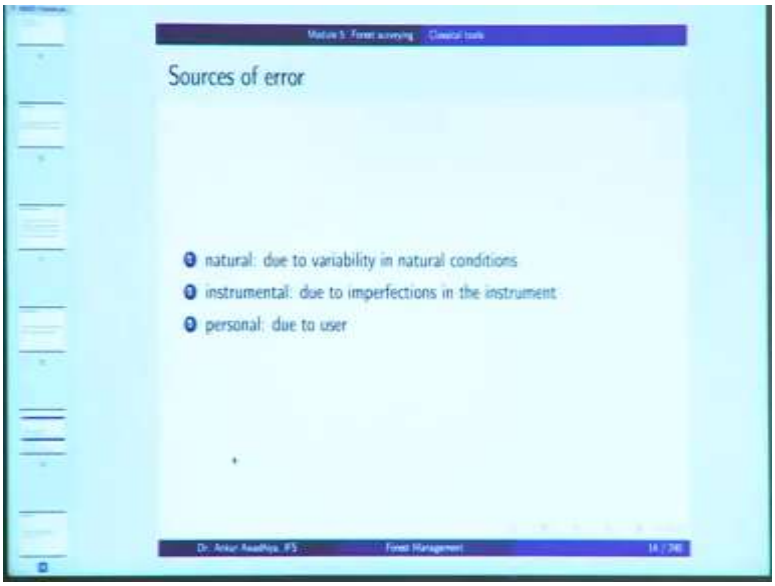

Next, we have the sources of errors; there are three main sources. Natural, due to variability in natural conditions such as temperature; or you have instrumental errors, if your instrument was not built properly or over time it has become worn out; or there are personal errors, when you are doing an error in the measurement, because you are not following the correct procedure.

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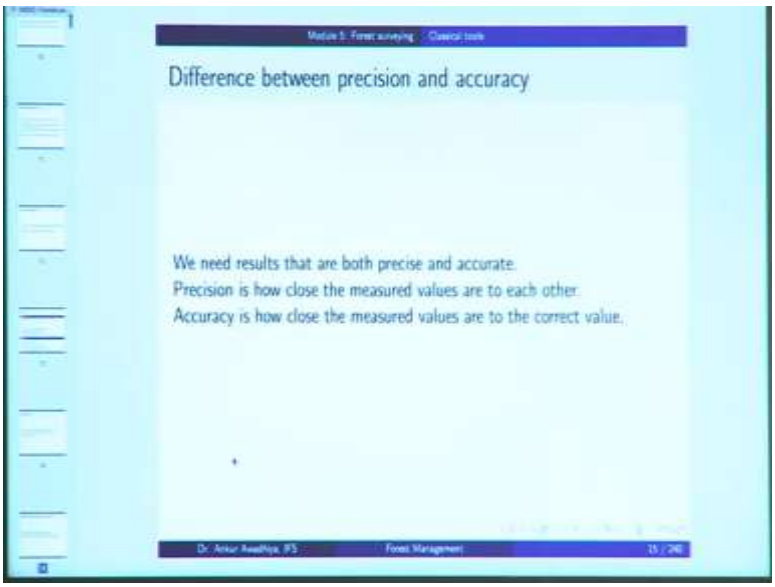

Then, we looked at the difference between precision and accuracy. Precision is how close the measured values are to each other, and accuracy is how close the measured values are to the correct value.

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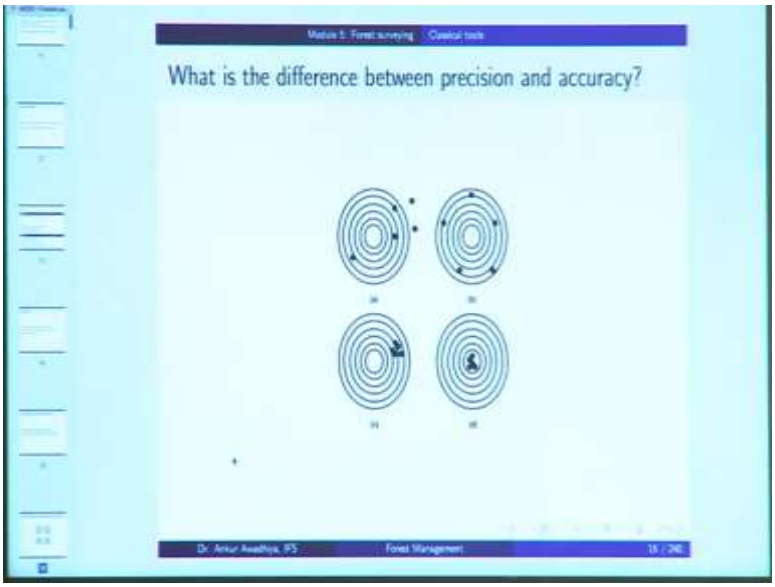

And, we represented them in the form of these shots on a target board. And, here we said that these measurements are precise and accurate; these are precise, but not accurate; these on an average are accurate but not precise; and these are neither precise nor accurate.

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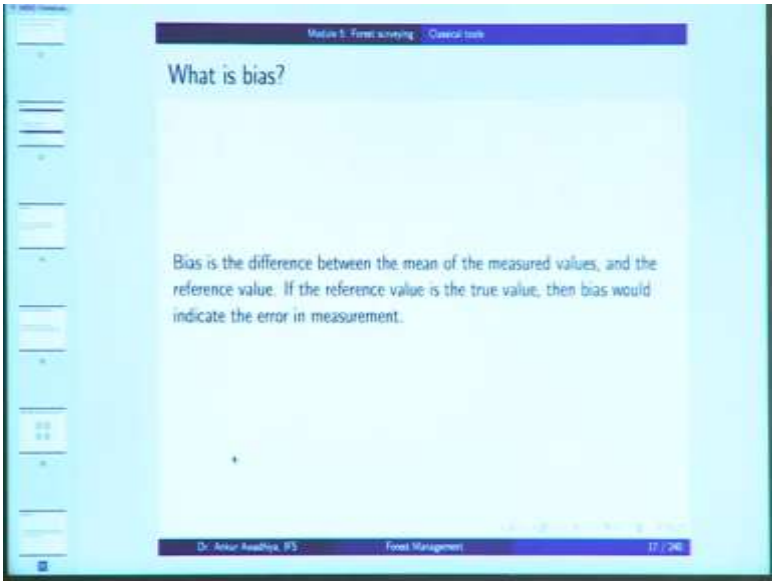

Then, we defined bias as the difference between the mean of the measured values and the reference value. And, if the reference value is the true value, then bias is the error in management in measurement.

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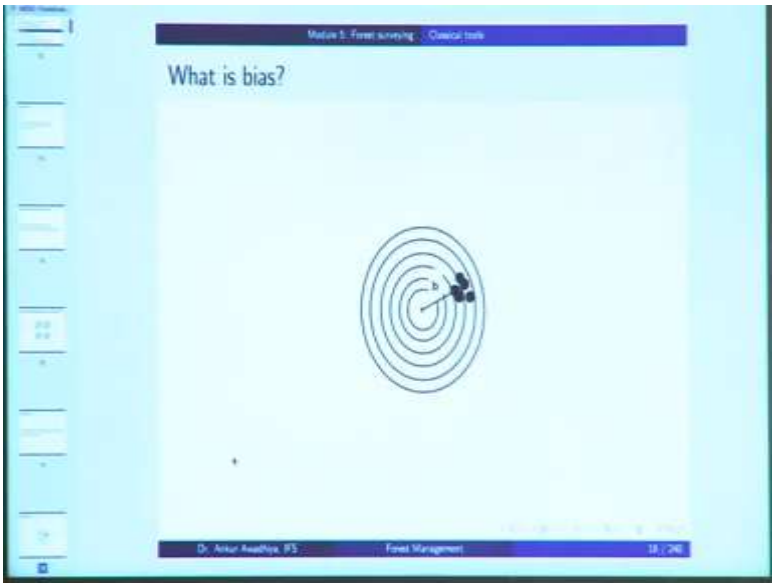

So, this is the bias; the shooter wanted to shoot at the bulls eye; so, the measurements are precise, but these are not at the bulls eye.

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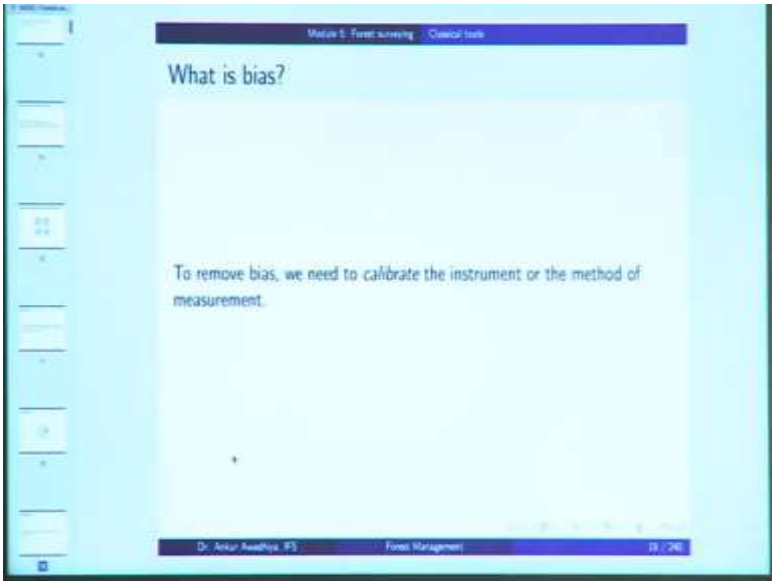

So, they are at a distance and this difference is the bias; and, biases can be removed by calibrating the instrument or the method of measurement.

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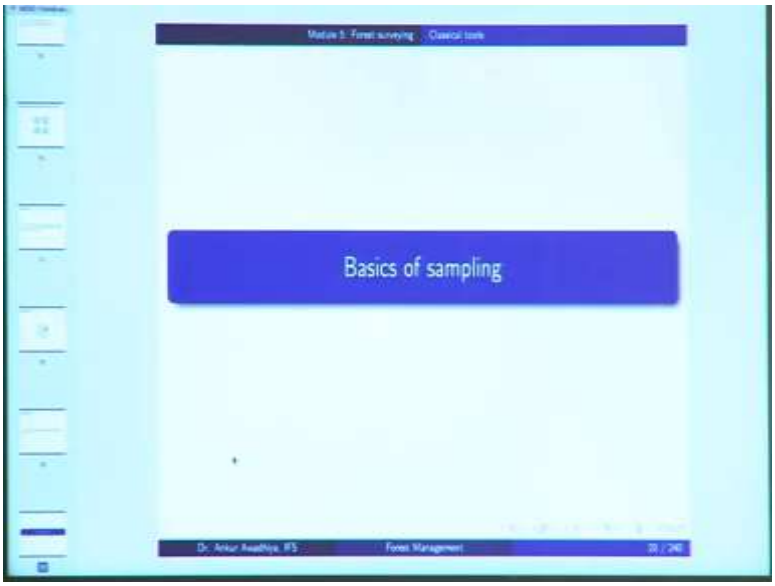

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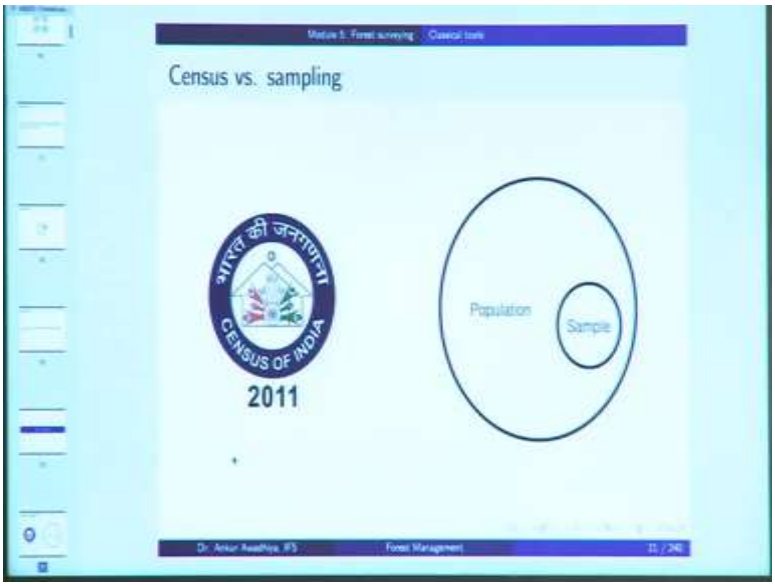

Next, we looked at basics of sampling. So, there is a difference between census and sampling. In the case of a census, you take or you measure everything. In the case of sampling, you would measure only a small portion of the whole population.

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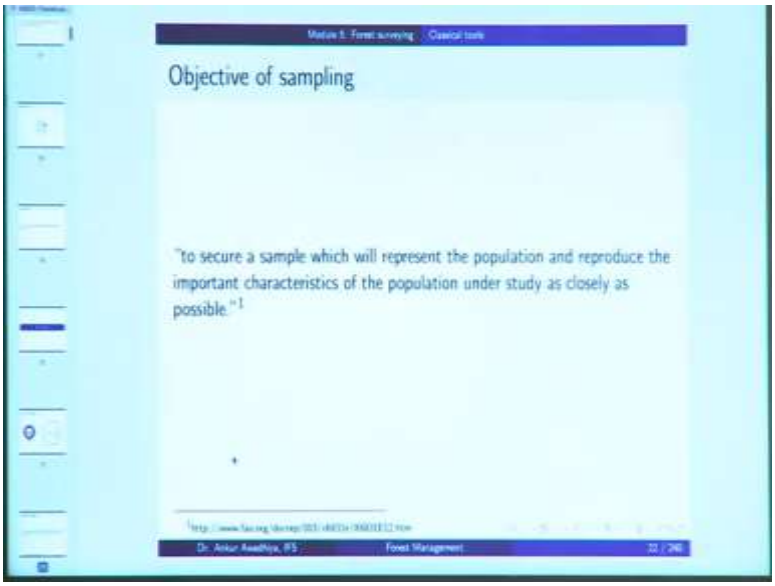

The objective of sampling is to secure a sample which will represent the population and reproduce the important characteristics of the population under study, as closely as possible.

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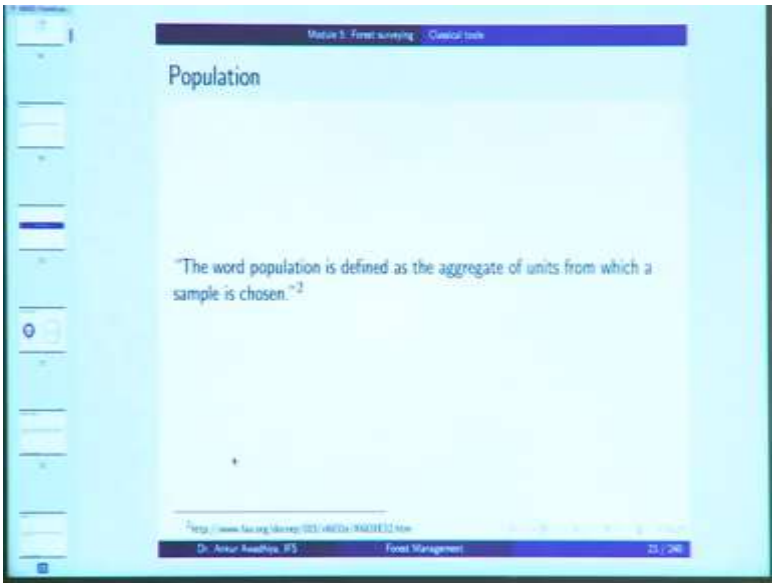

Then, population is defined as the aggregate of units from which a sample is chosen.

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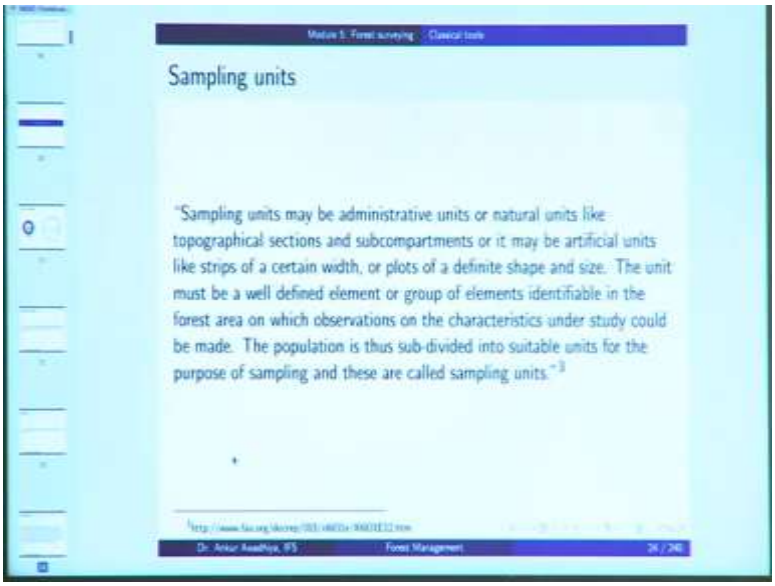

And, sampling unit is defined as the subdivision of the population for the purpose of sampling. And, these can be administrative units or natural units, such as topographical sections, or sub compartments, or even artificial units like strips or plots and so on.

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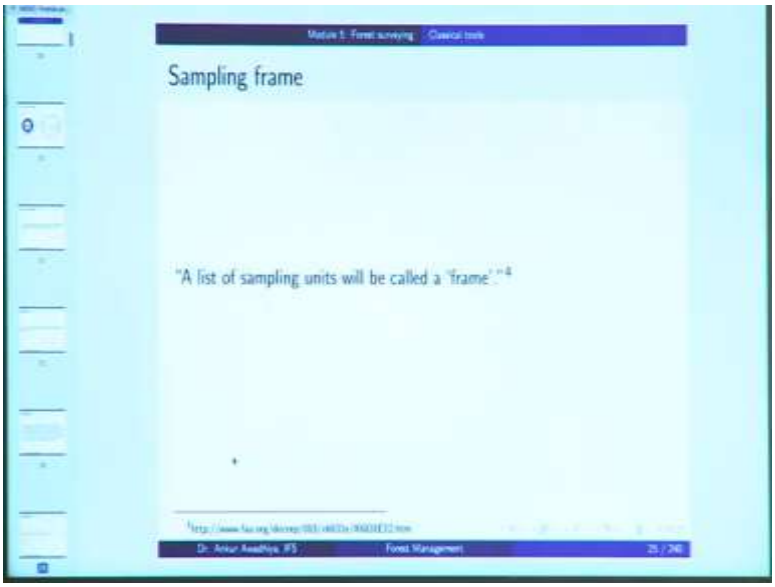

Now, a list of all the sampling units is called as the frame, and out of this frame you select a few of the samples.

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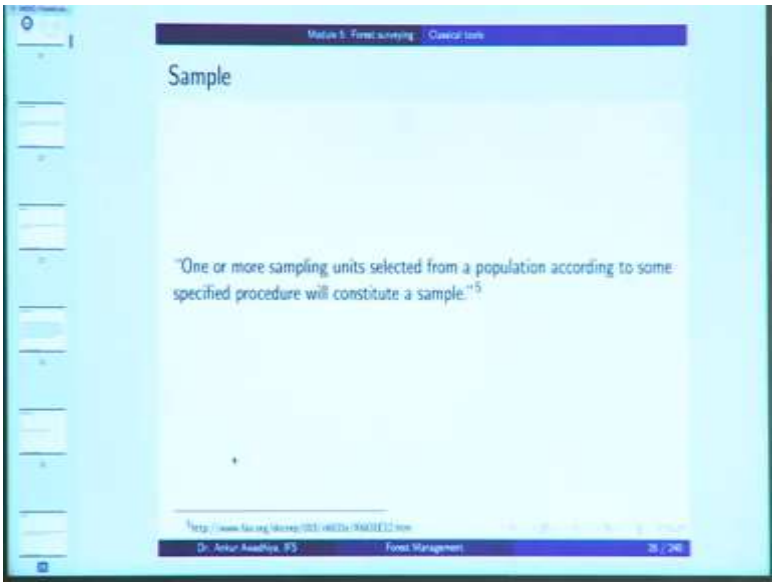

So, one or more sampling units that are selected from a population according to some specified procedure will constitute a sample.

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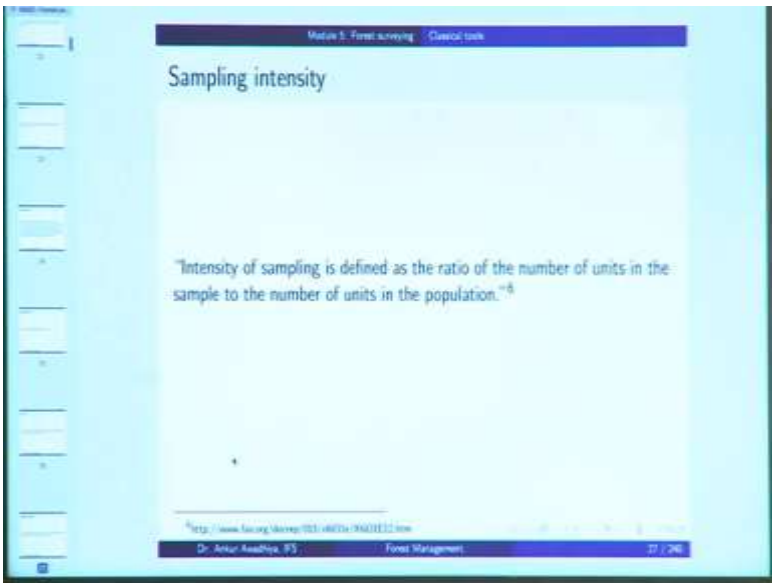

And, we also have the sampling intensity, which is the ratio of the number of units in the sample to the number of units in the population

So, if you have more number of units in your sample, then your sampling intensity is more. So, say you have 100 individuals and if you are measuring 10 individuals, then

you have a sampling intensity of 10 percent. If you are measuring 90 individuals, then you have a sampling intensity of 90 percent.

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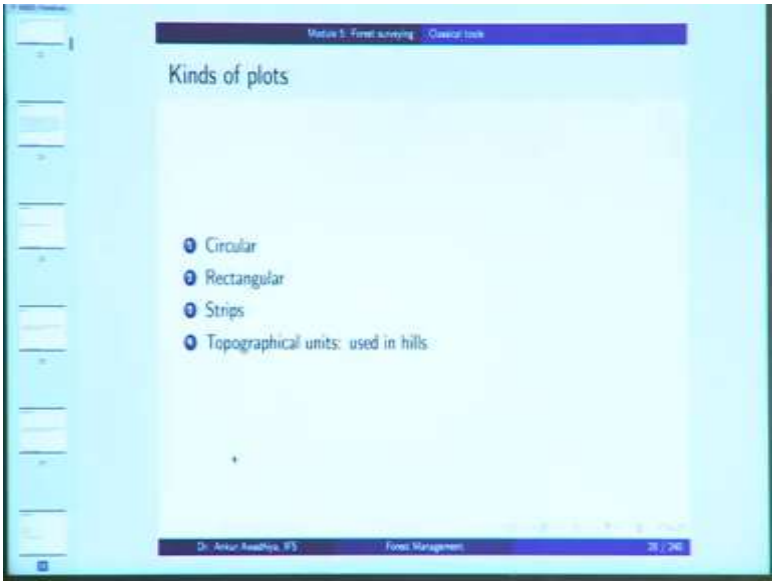

Now, we looked at the kinds of plots; you they can be circular, rectangular, strips, or they can even be topographical units, as are used in hills.

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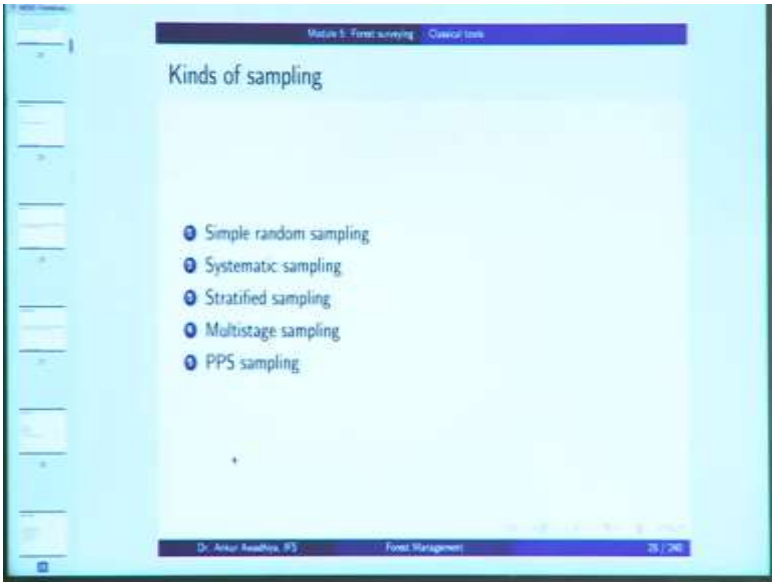

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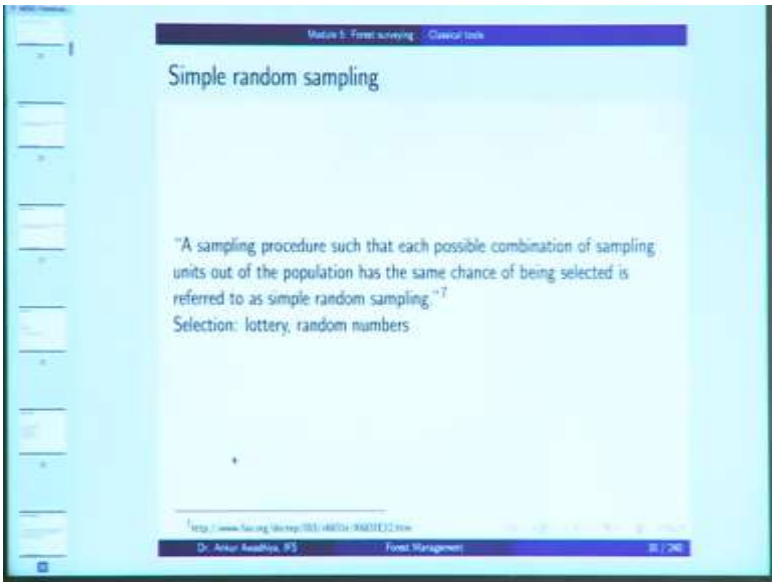

Now, depending on the procedure, we defined simple random sampling, in which case, the each possible combination of sampling units out of the population has the same chance of being selected; such as a lottery.

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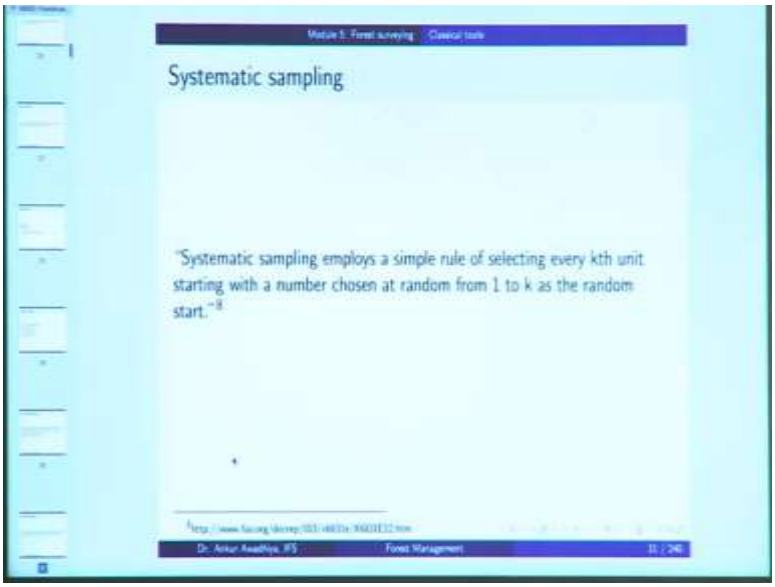

Then, there is systematic sampling which uses a formula of selecting every kth unit starting with a number that is chosen at random.

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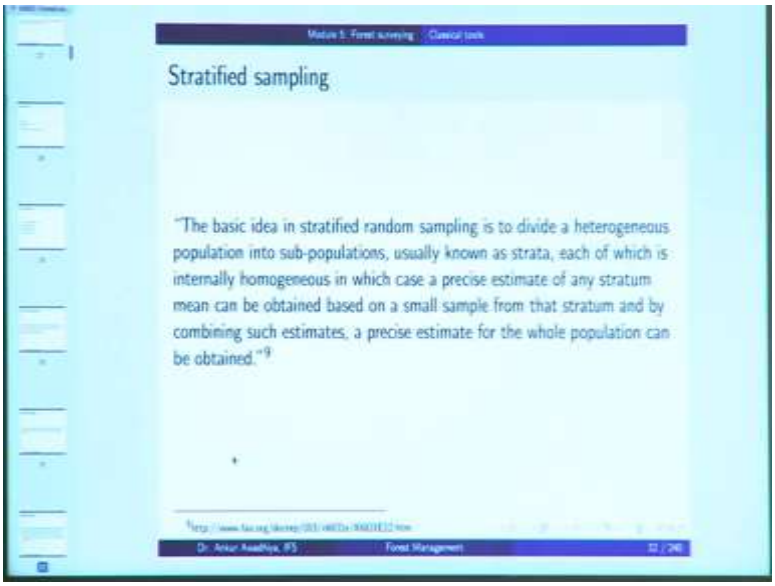

Next, we have stratified sampling in which case you divide the heterogeneous population into sub populations known as strata; each of which is internally homogeneous in which case a precise estimate of any stratum mean can be obtained.

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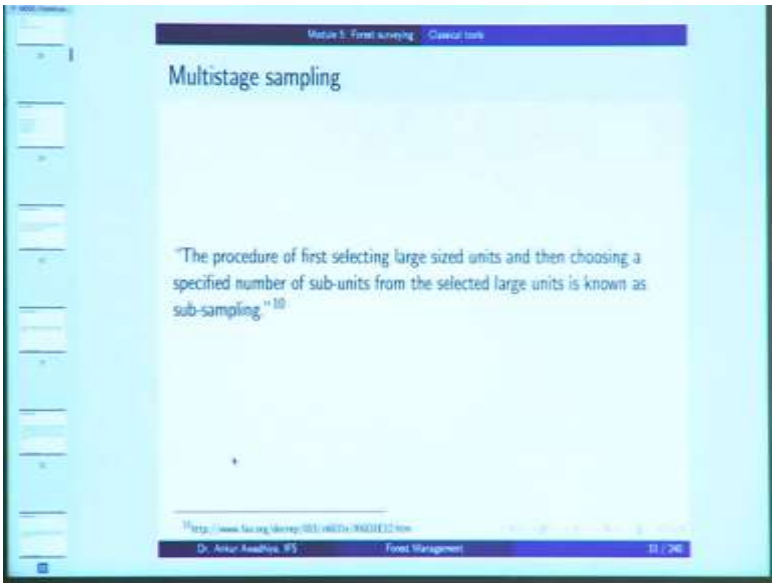

Next, we have multistage sampling, in which you first select the large scale the large size units. And, then you choose a specified number of sub-units from these selected large units.

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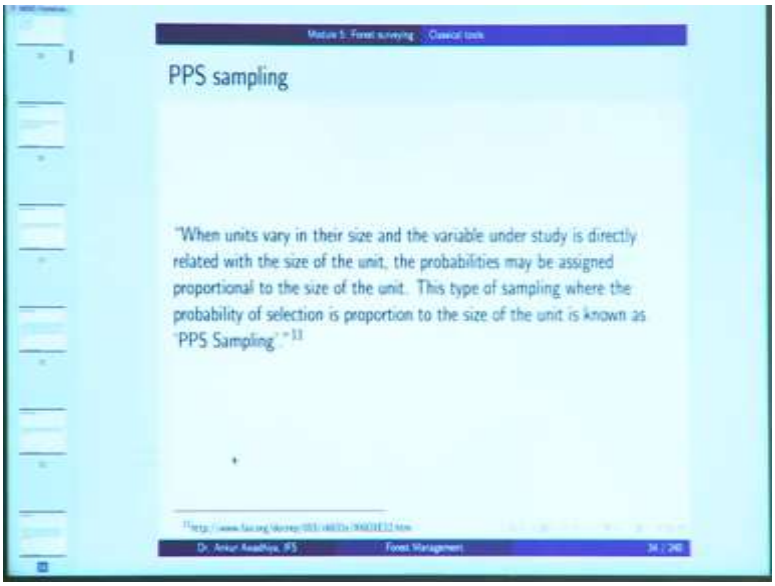

And, then you have PPS sampling or the probability proportional to size sampling; in which case, when the units vary in their size and the variable under study is directly related to the size of the unit, such as the mass or the biomass the probabilities, may be assigned that are proportional to the size of the unit.

So, in a PPS sampling the larger sized individuals are more are better represented.

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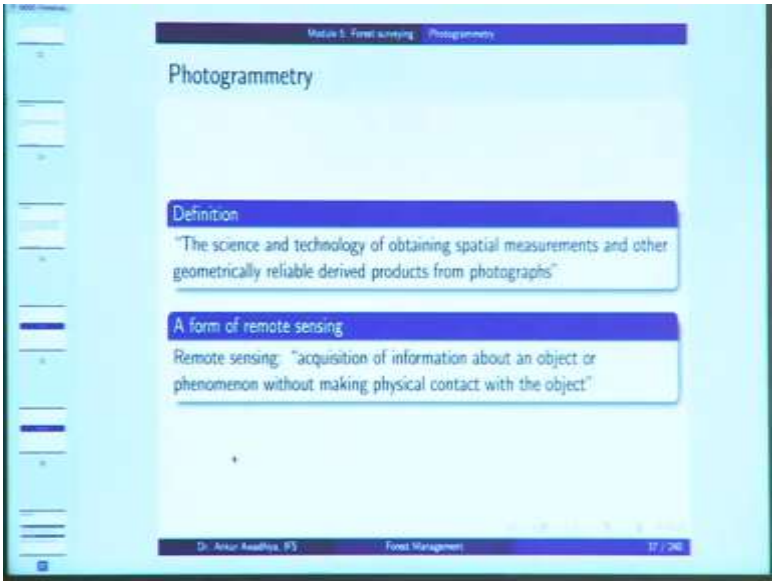

Next, we looked at photogrammetry; photogrammetry is the science and technology of obtaining spatial measurements and other geometrically reliable derived products from

photographs. So, you are obtaining spatial measurements and other geometrically reliable derived products.

So, in this case, we are doing some sort of a survey that is being done using photographs. And, the survey is being done in such a manner that you are able to measure things out. It is a form of remote sensing; defined as the acquisition of information about an object or phenomenon without making a physical contact with the object.

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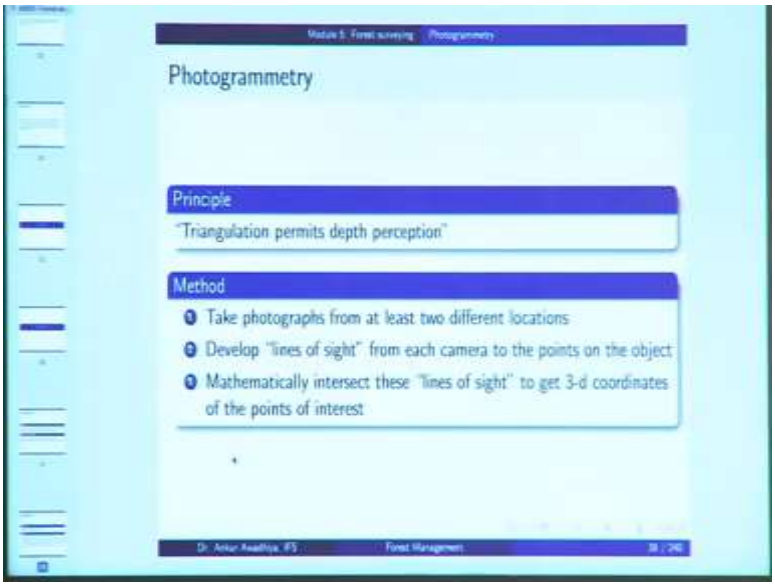

Now, photogrammetry is based on the principle that, 'triangulation permits depth perception.' So, you have, for instance, you have two eyes and with both these eyes you are able to perceive the depth of different objects; depending on what is the angle that your eyes are subtending or what is the parallax error that you are seeing. So, in this method, you take photographs from at least two different locations; develop lines of sight from each camera to the points on the object. And then, mathematically intersect these lines of sight to get the 3-d coordinates of the point of interest.

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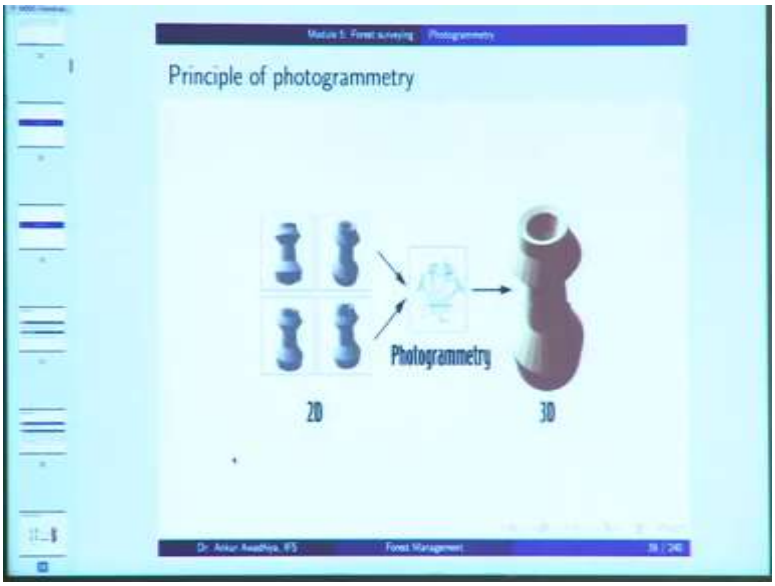

So, this is the principle you are taking different photographs in a two-dimensional manner. And then, putting them through the mathematical computations of photogrammetry to get a 3D representation of what the actual object is.

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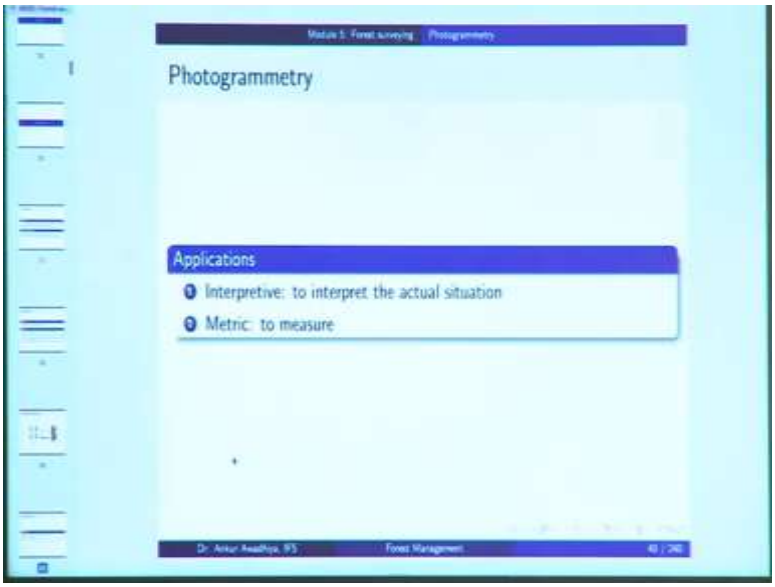

So, the applications can be interpretive; to interpret the situation, or metric to measure something.

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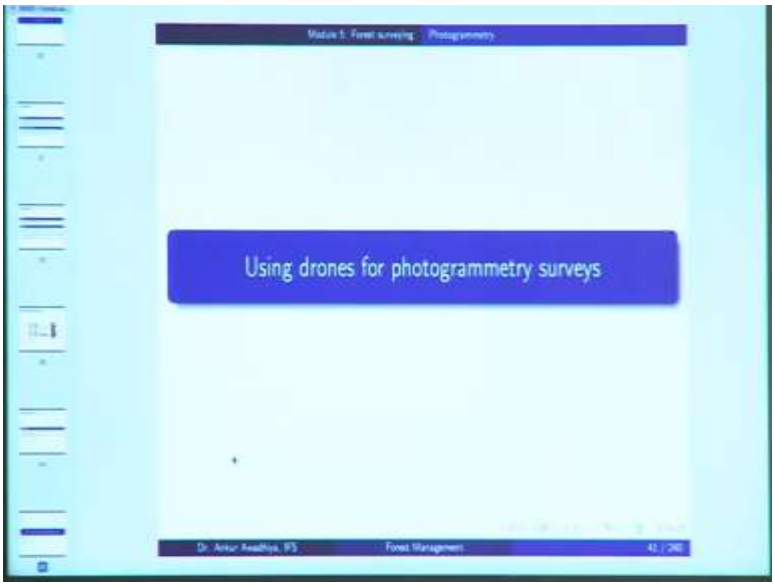

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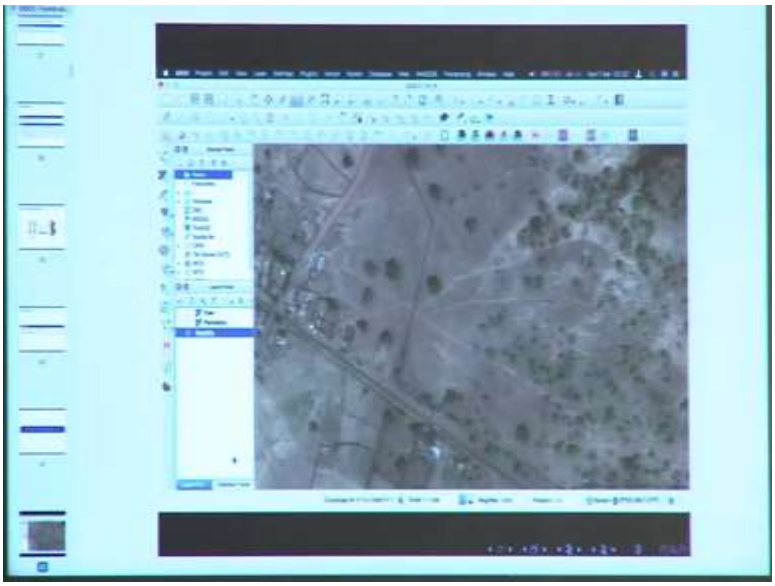

Then, we looked at the use of drones. So, this is a satellite image; this is the drone image.

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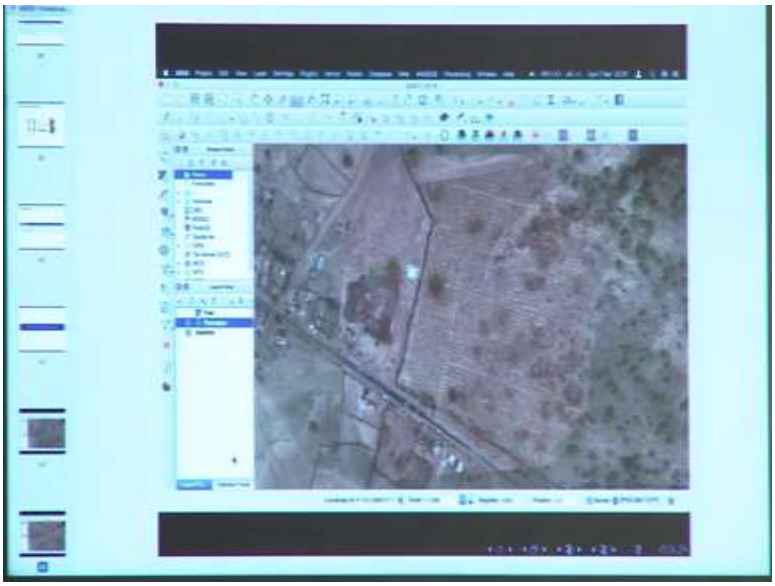

So, we can use it for interpretations such as, we saw that this building was not there in the satellite image, but it is there in the drone image. So, it was built after the satellite image was taken and before the drone image was taken. So, it can be used for such interpretations; you see difference in the land use.

So, earlier these areas were plain like this; now, these areas are dotted, which means that there have there is a plantation that has come up in this area.

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Next, we saw that, in the case of drones, you can fly them at a lower height, in which case you will start seeing the plants themselves.

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So, these green spots are the plants. And, when you are seeing these plant,s you can even use this data for finding out the viability of different plants.

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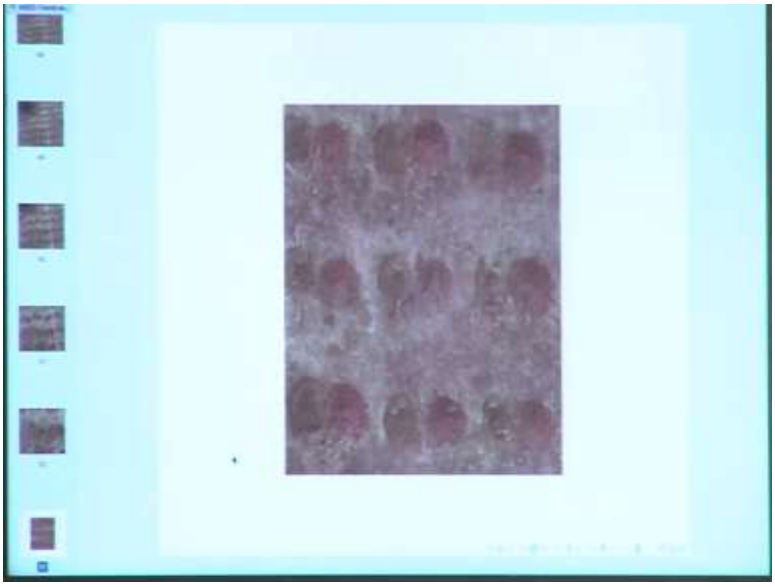

Then, we looked at how we can we can perform this computation in an automatic manner.

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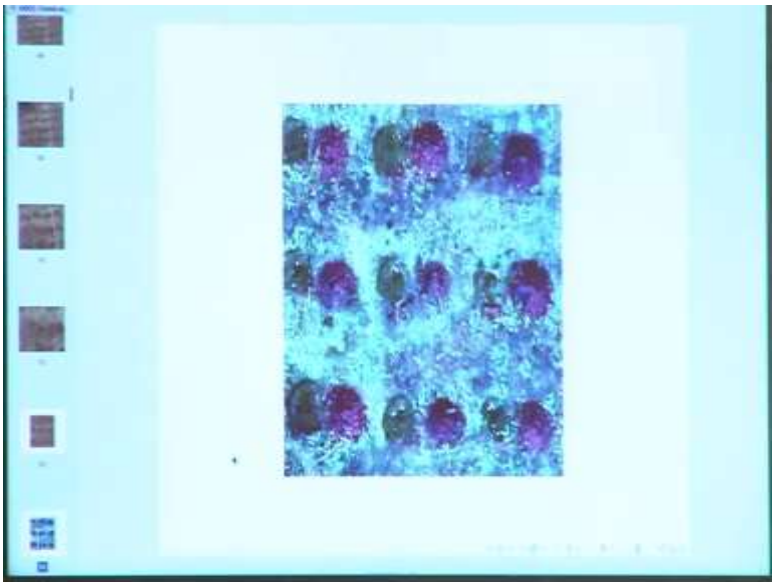

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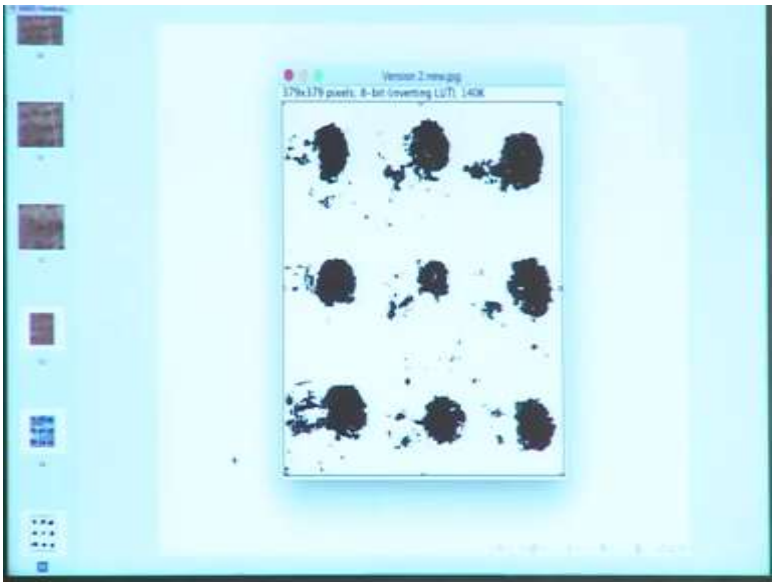

So, there we started with this image of the pits that are dug, and the soil that is there along with the pits; we converted them into a black and white image a binary image.

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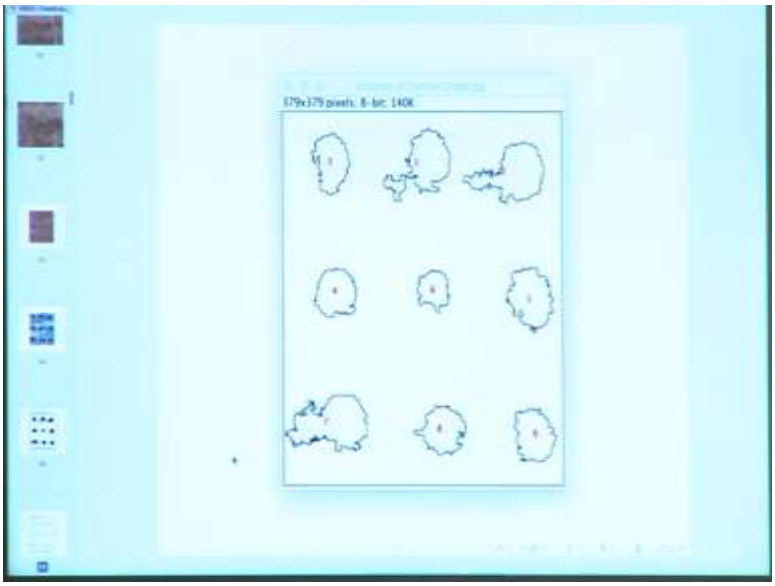

And, with this binary image the computer was able to tell us what are what is the number of pits that are dug.

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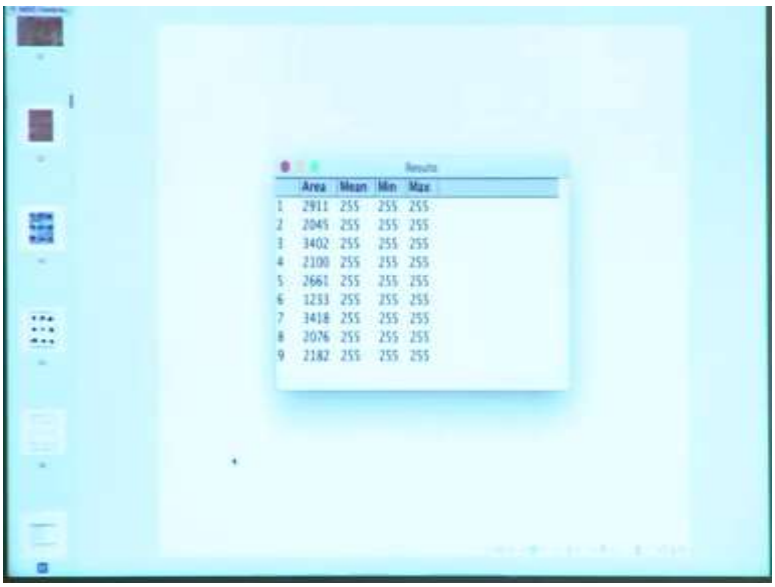

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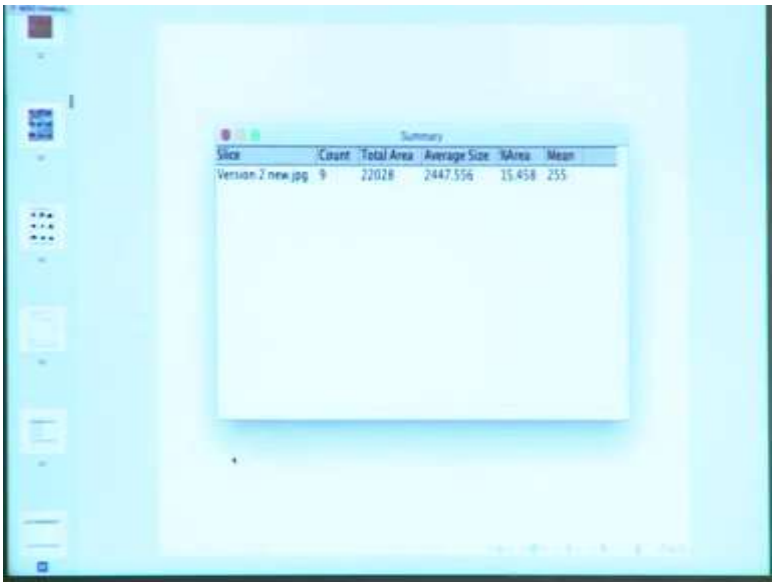

What are the sizes of different pits? what is the average size of each pit? and so on.

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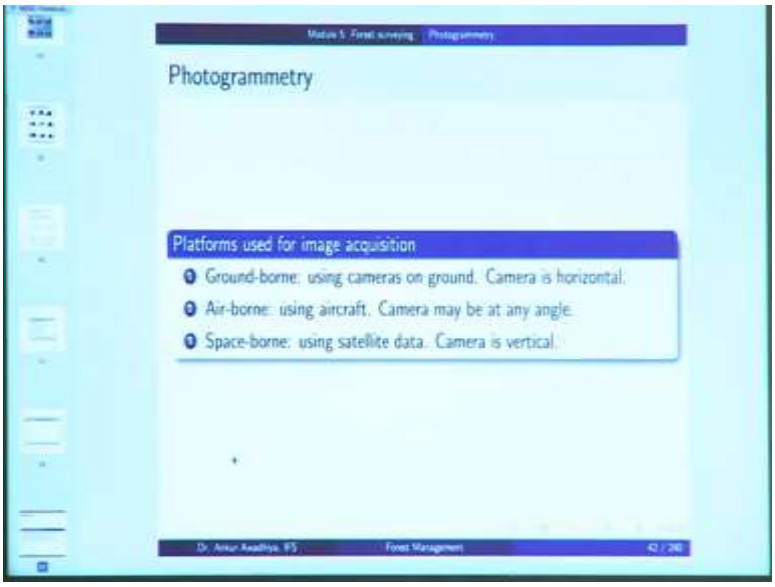

And, in the case of photogrammetry, we typically use three different kinds of platforms. They can be ground-borne platforms, in which case, you are using cameras on the ground. And, the camera is horizontal or you can make use of space-borne platforms, in which case, you are using satellite data, and in this case the camera is vertical. The third option is that you can make use of air-borne platforms, in which case, you use an aircraft or a drone and in this case the camera may be at any angle.

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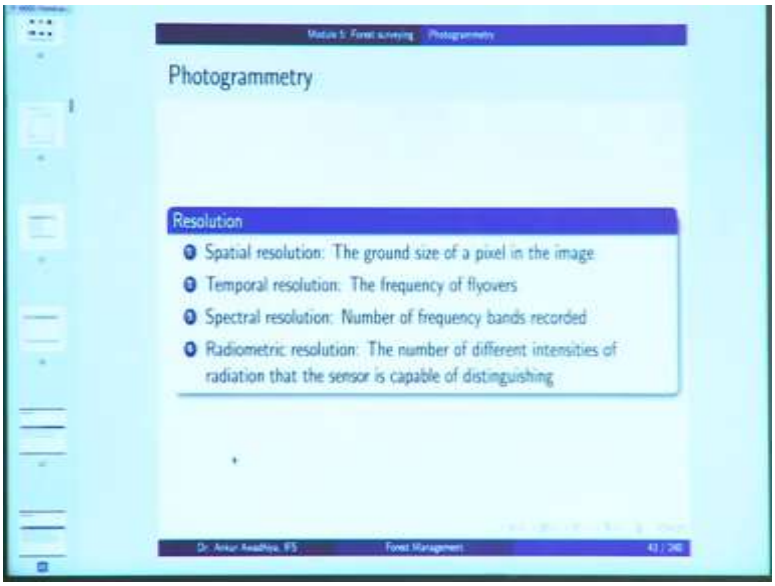

Now, we defined spatial, temporal, spectral, and radiometric resolution. Spatial resolution is the ground size of a pixel in the image; essentially how many megapixels do you have in your camera. Temporal resolution is how frequently are you taking pictures or the frequency of flyovers. Spectral resolution is whether you are taking a black and white image or you are taking a colored image in three different bands or even more number of bands.

So, it is the number of frequency bands that are recorded; it is just 1 band in the case of a black and white image, 3 bands in the case of an RGB image, and even more number of bands when you are also taking into account the infrared bands and the UV bands and so on. Next, you have the radiometric resolution which is the number of different intensities of radiation that the sensor is capable of distinguishing.

So, essentially here, you are talking about what is the amount of information that is there in each band; what how many how many bits of information can be distinguished.

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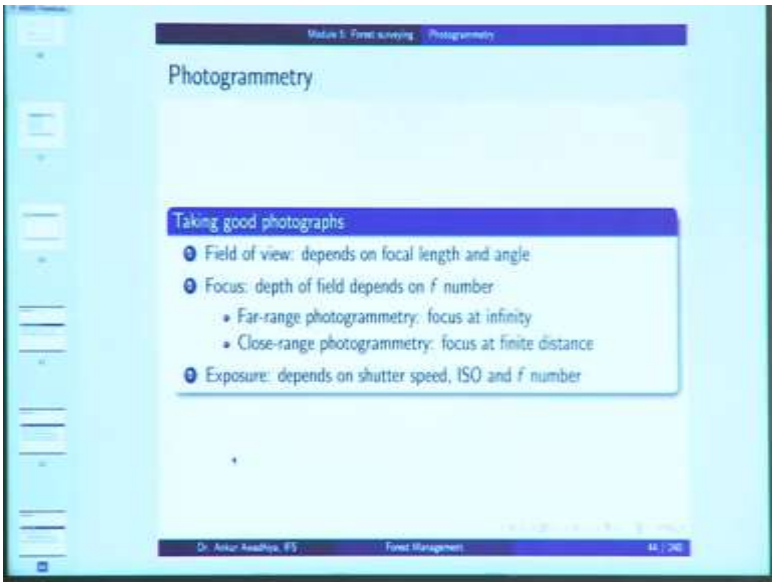

Next, we had a look at the parameters that define a good photograph. So, you have to look at the field of view; it depends on the focal length and the angle at that the camera is subtended to the object.

Next is the focus, and we said that the depth of field depends on the *f* number.

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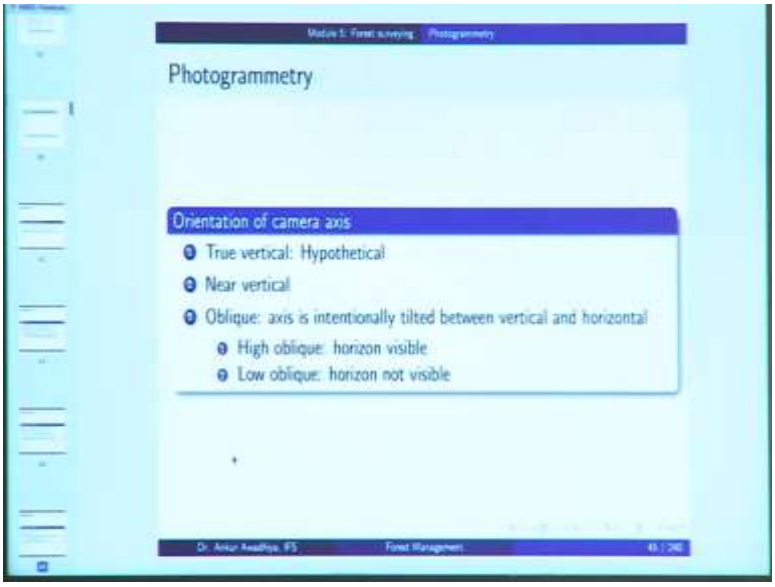

So, if the f number is large, such as see f 11 or f 20 in that case, the aperture is very small in size and the depth of field is very large. On the other hand, if the f number is small; say f 2 in that case, you have a large sized aperture. And, in this case, you have a very

small depth of field. Here, we defined far range photography or far-range photogrammetry where the focus is at infinity and close-range photogrammetry where the focus is at a finite distance.

And, we saw that exposure depends on shutter speed, ISO, and the f number. Next, we talked about the orientation of the camera axis you have true vertical, near vertical and oblique axis or oblique orientation. In the case of true vertical, it is a hypothetical thing; the best you can get is a near vertical. And, in the case of oblique orientation, you have high oblique where the horizon is visible and a low oblique where the horizon is not visible.

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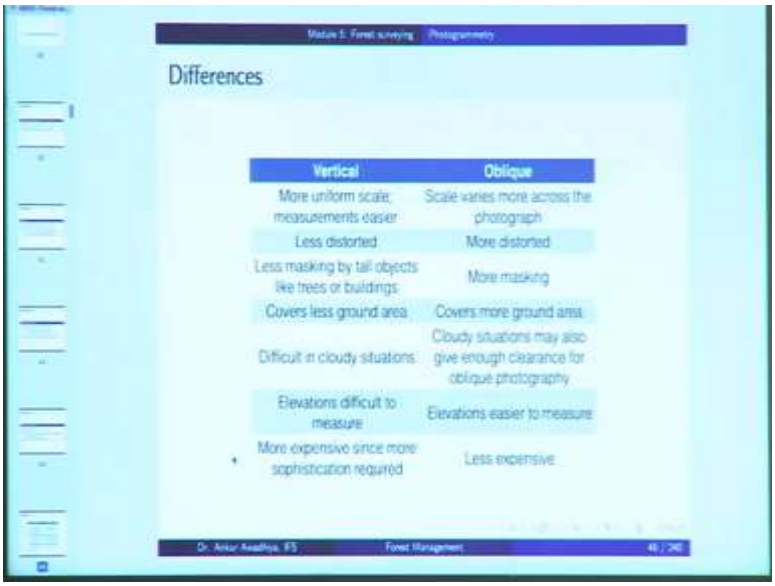

Then, we looked at differences between vertical and oblique photographs. In the case of vertical photograph, it is a more uniform scale measurements are easier. In the case of oblique, there are differences as you move across the photograph and so on.

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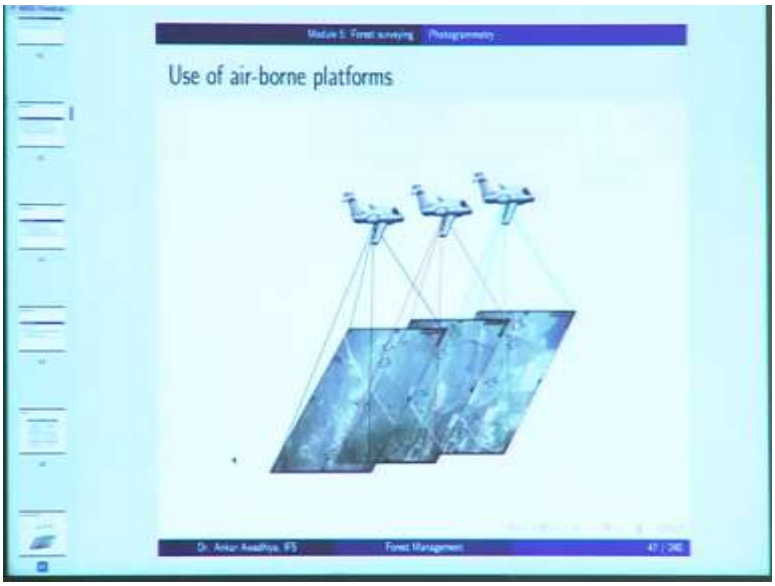

Now, in the case of air-borne for platforms, you need to ensure that there is a sufficient amount of overlap between different images.

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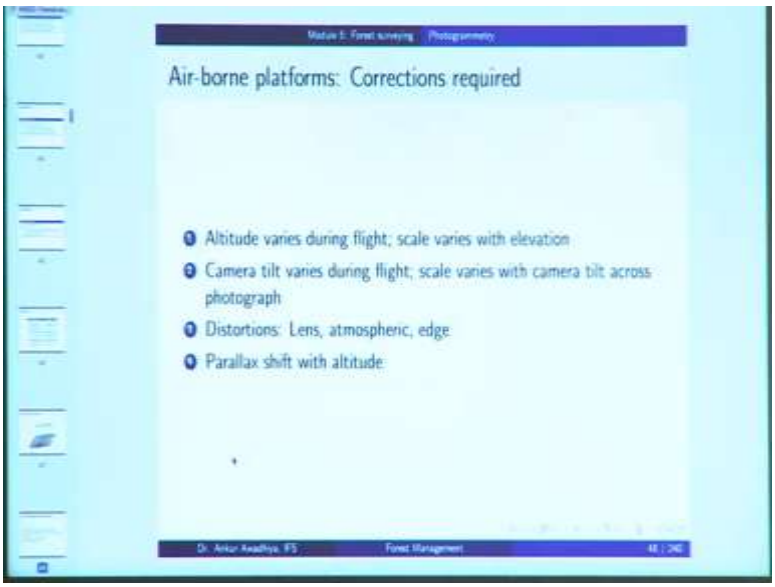

And, there are certain corrections that need to be done, the if the altitudes varies during the flight the scale will vary.

So, you try to fly your aircraft at the same altitude, and also you record the altitude. So, that if there are any changes to be made according to the altitude in the final image that can be made. The tilt; if it varies during the flight, then the scale will vary with the

camera tilt across the photograph. Then, there are several distortions; the lens distortion, atmospheric distortion, and edge distortion. And, there is also a parallax shift with the altitude.

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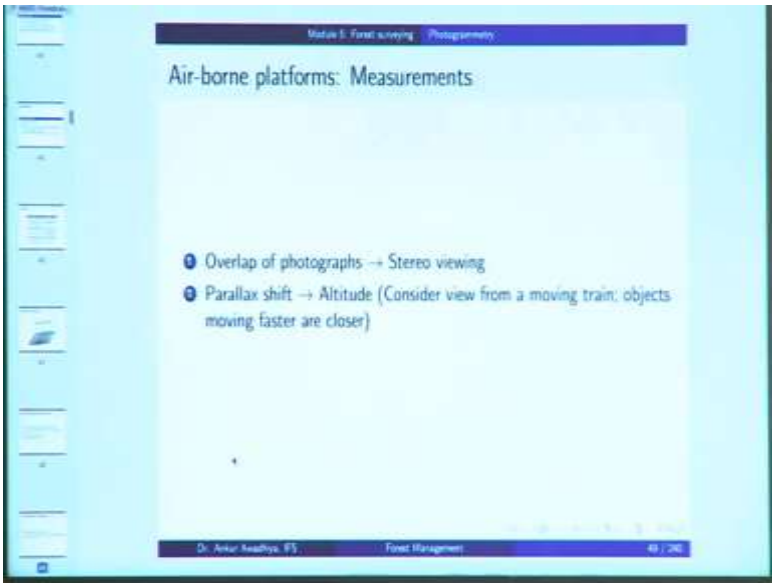

Now, in the case of measurements, you try to take a good overlap, so that you are able to have stereo viewing of the of these different locations, and you can make use of parallax shift to get a an idea of the altitude.

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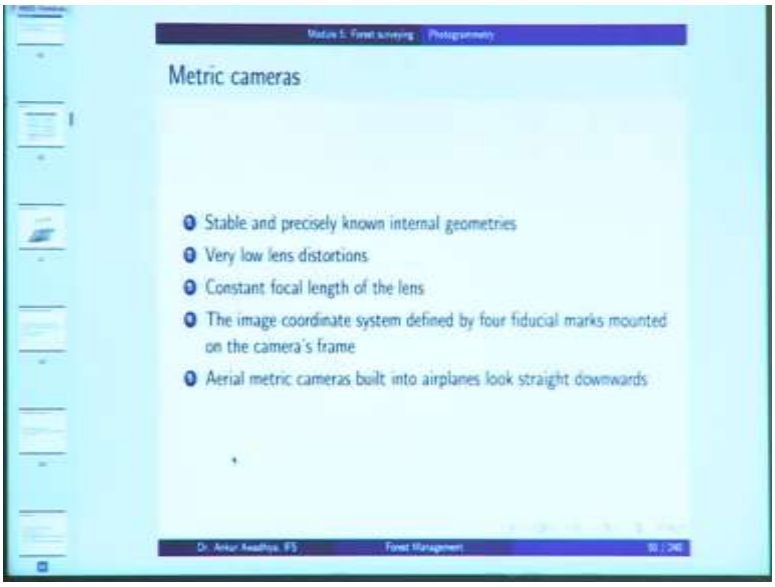

Now, in when you are using photographs to take measurements, it is good to use a metric camera, which is the stable; which has stable and precisely known internal geometries; low lens distortions; constant focal length of the lens.

The image coordinate system is defined by four fiducial marks mounted on the cameras frame, and the aerial metric camera built into the airplanes look straight downwards.

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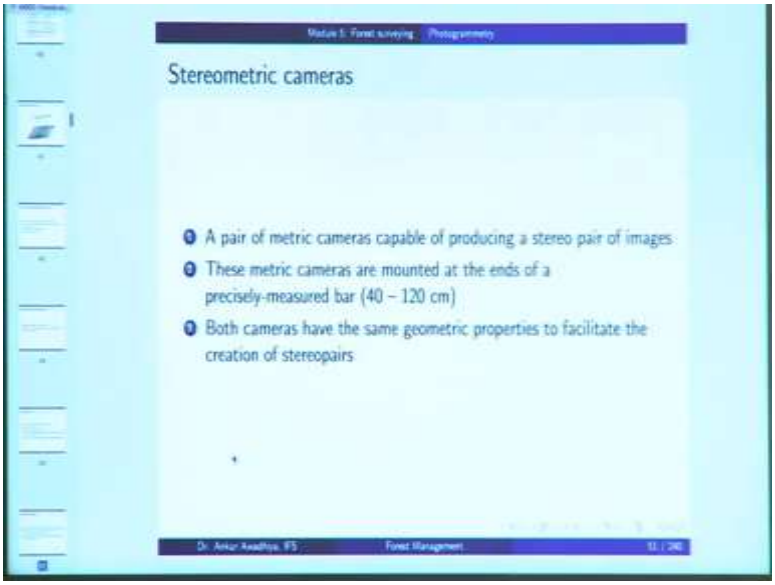

If you want to take stereo measurements, you take a stereometric cameras; in which case, you have to metric cameras that are mounted at the ends of a precisely measured bar.

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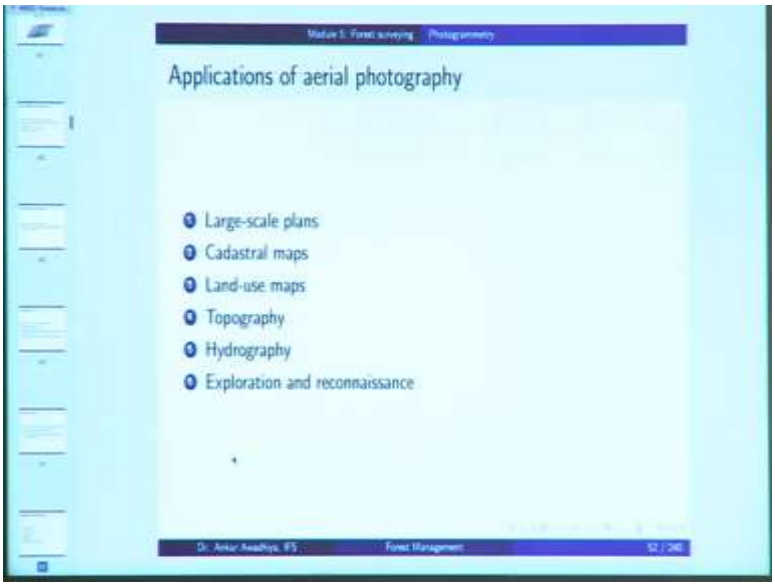

And, both of these have the same geometric properties. Now, applications of aerial photography; to make large scale plans, cadastral maps, land use maps, topography, hydrography and exploration and reconnaissance.

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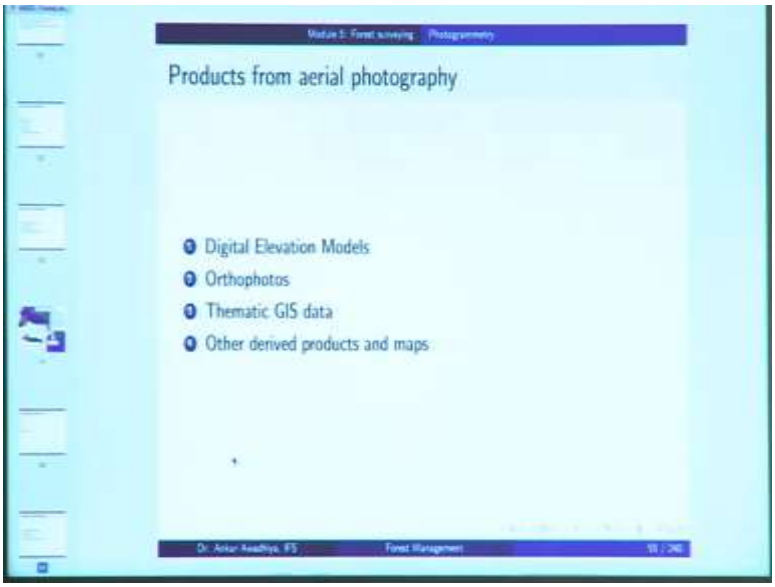

Products you can get; a digital elevation model, orthophotos, you can get thematic GIS data and other derived products and maps.

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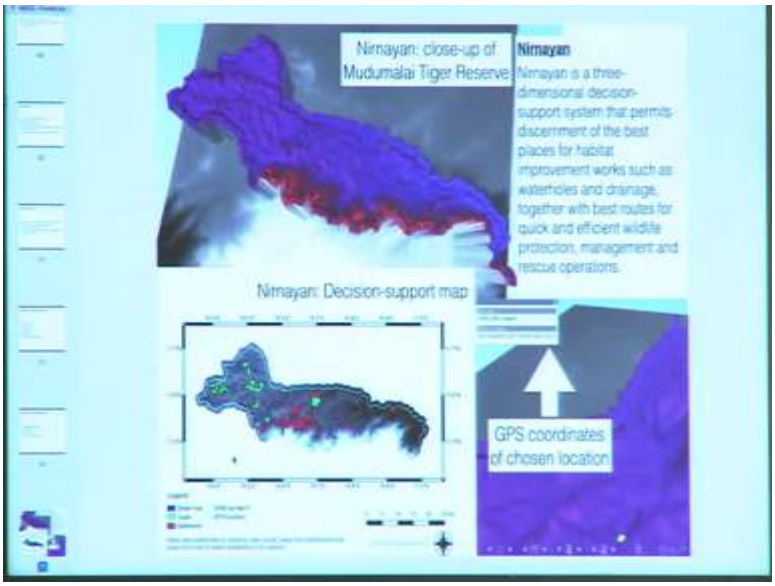

And, then we looked at how we make use of the of photogrammetric principles to get a 3D view. And here, we saw a 3D view of the Mudumalai Tiger Reserve, and we are also getting certain thematic information such as where the streams are located.

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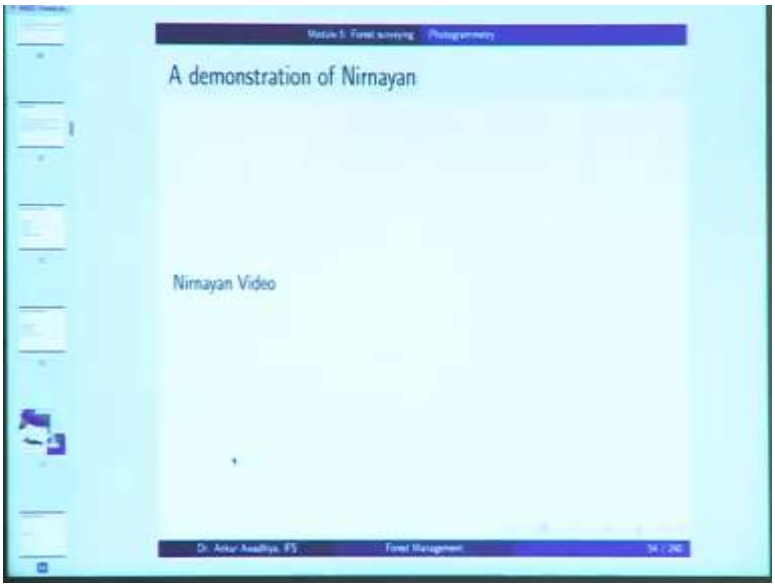

Next, we had a demonstration of this 3D video.

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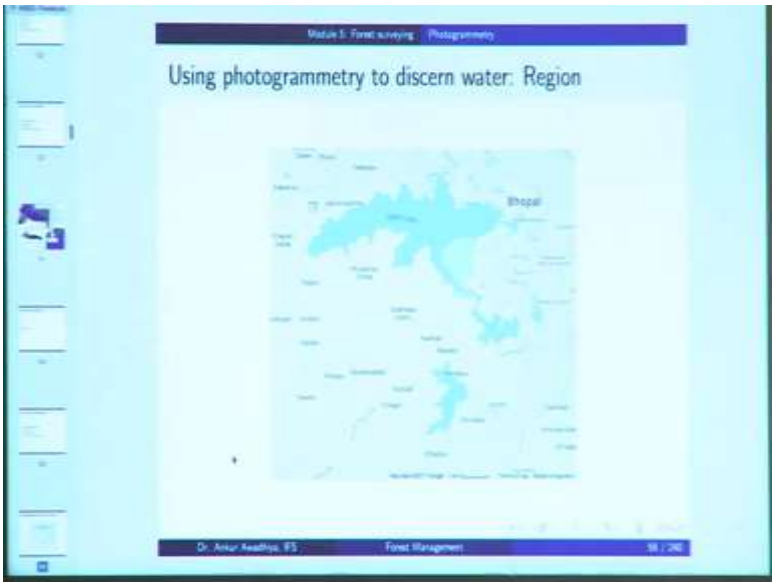

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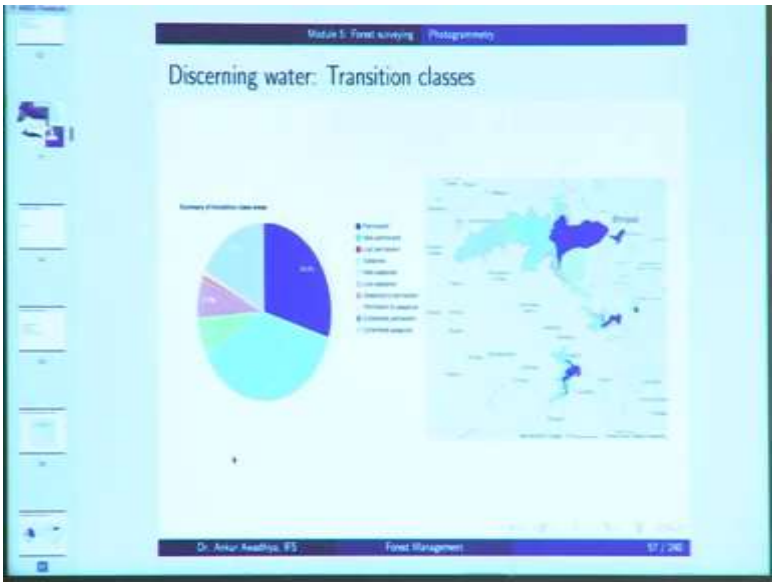

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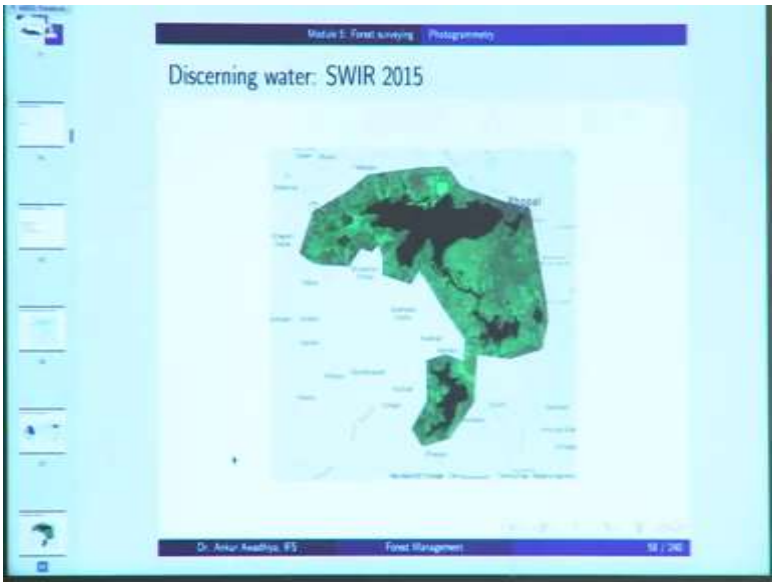

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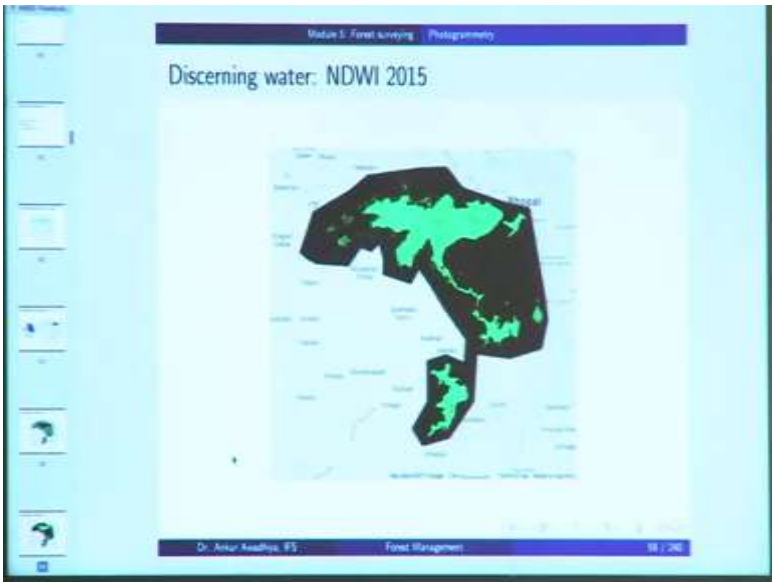

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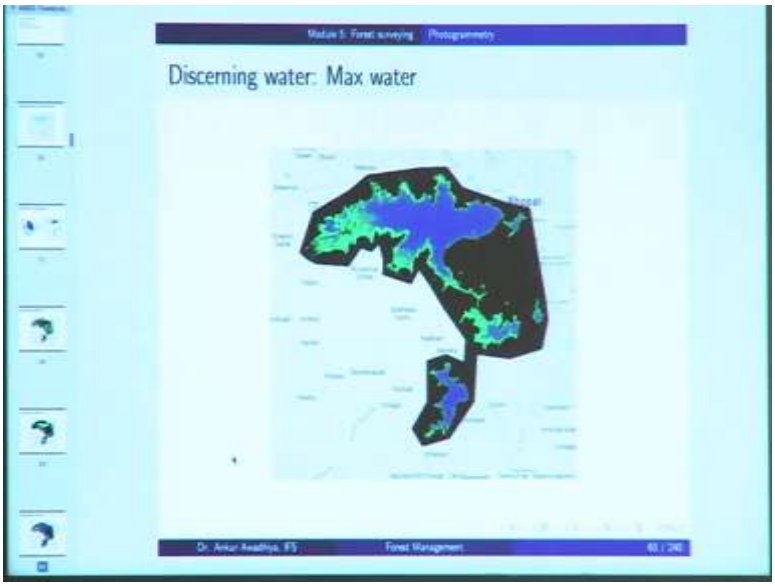

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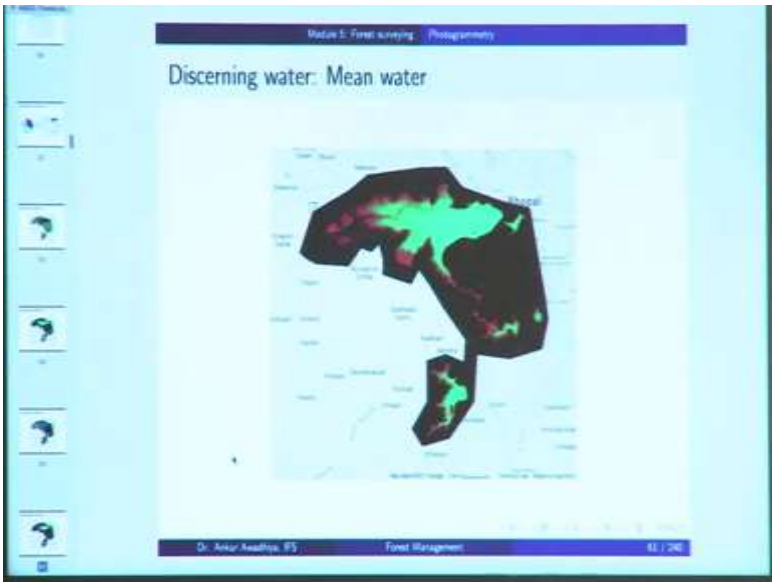

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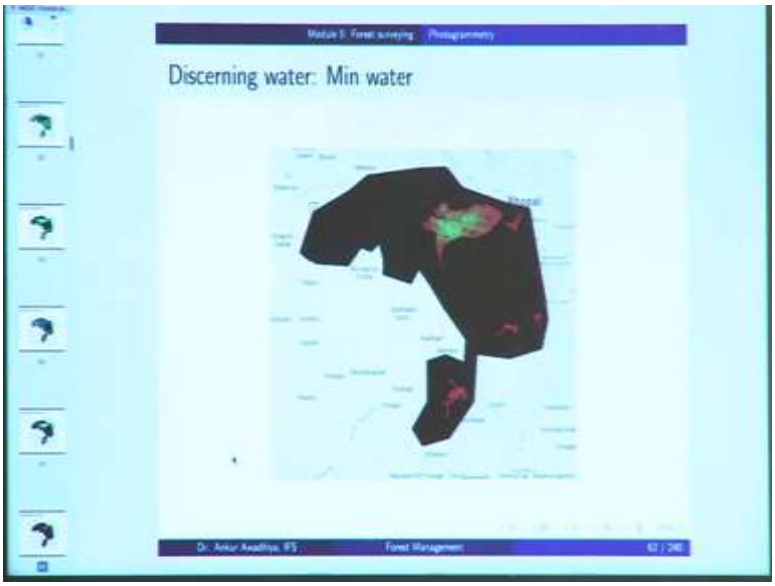

Then, we saw how we can use photogrammetry to discern water in a region taking the example of the Bhoj lake or the upper lake in Bhopal.

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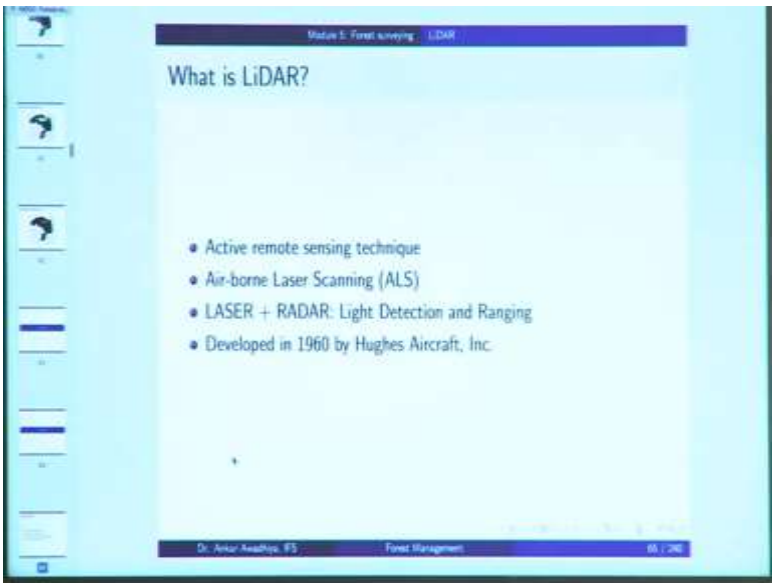

And, in the next lecture, we had to look at LiDAR which is Light Detection and Ranging. It is the word is made from a combination of laser and radar; where radar is radio detection and ranging.

So, in this case, this is an active remote sensing technique, in because you are because, you require energy to illuminate the object using the lasers. It is an Air-borne Laser Scanning system or an ALS system, developed in 1960 by Hughes Aircraft.

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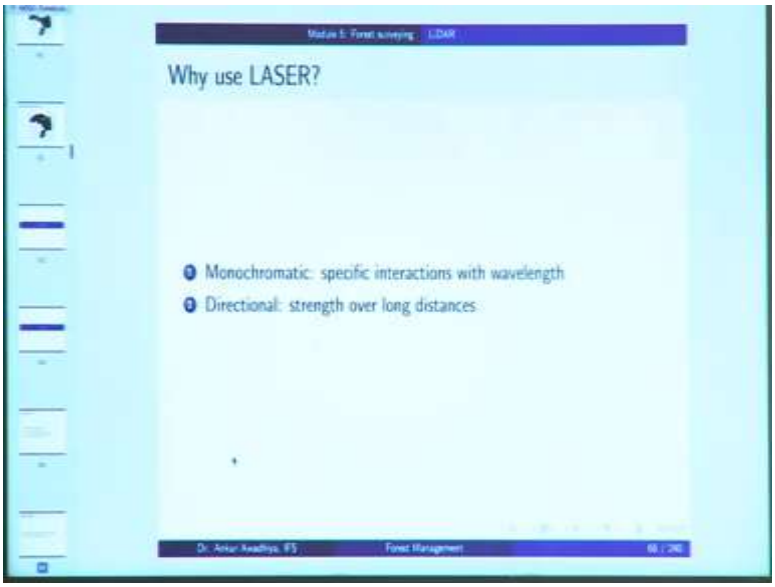

We use laser, because it is a monochromatic beam; it is a directional beam; it retains its strength over long distances.

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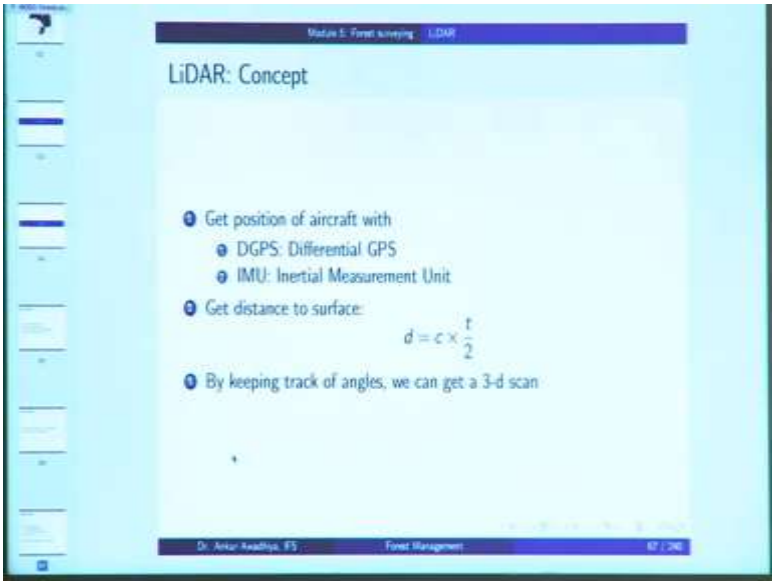

The concept is that you get position of the aircraft using differential GPS, in which case you have two stations. The ground station and also one station which is located in the aircraft.

So, you use differential GPS and inertial measurement unit to get an idea of the acceleration and the orientation of the aircraft you. And, when you shine a laser beam, it goes interacts with the surface of the object and then it comes back. So, how much time does it take for the laser beam, to go from the aircraft and back, is then calculated. And, the distance to the surface is given by c into t by 2, where t is the time it takes for the laser beam to come back. And, by keeping track of angles, we can get a 3D, 3D scan.

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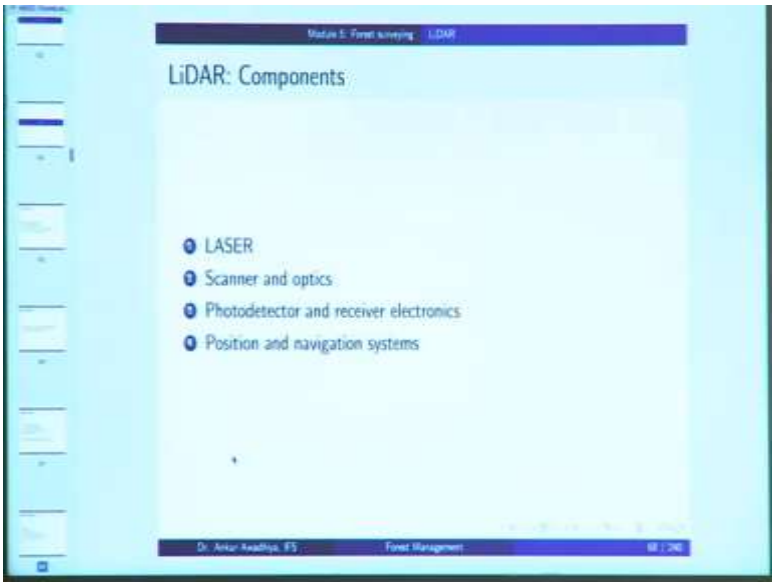

The components are laser, there is scanner and optics, photo detector and receiver electronics, and positional and navigational systems.

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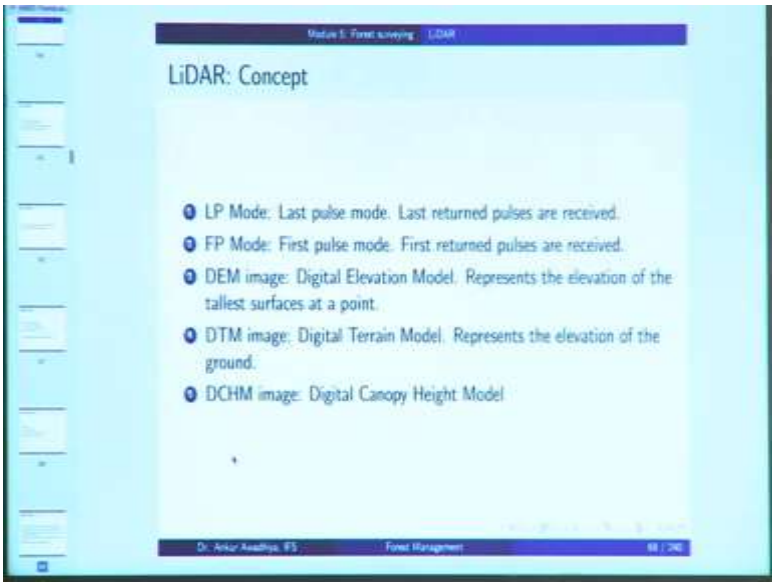

We saw that it works in two modes; LP mode which is the Last Pulse mode where the last return pulses are received. And, the FP mode which is the First Pulse mode where the first returned pulses are received. And, you can make use of LiDAR to get a DEM image, which is a Digital Elevation Model, which represents the elevation of the tallest surfaces at a point.

And, a DTM model, which is a Digital Terrain Model representing the elevation of the ground. And, you can subtract DTM from DEM to get a DHCM which is a Digital Canopy Height Model.

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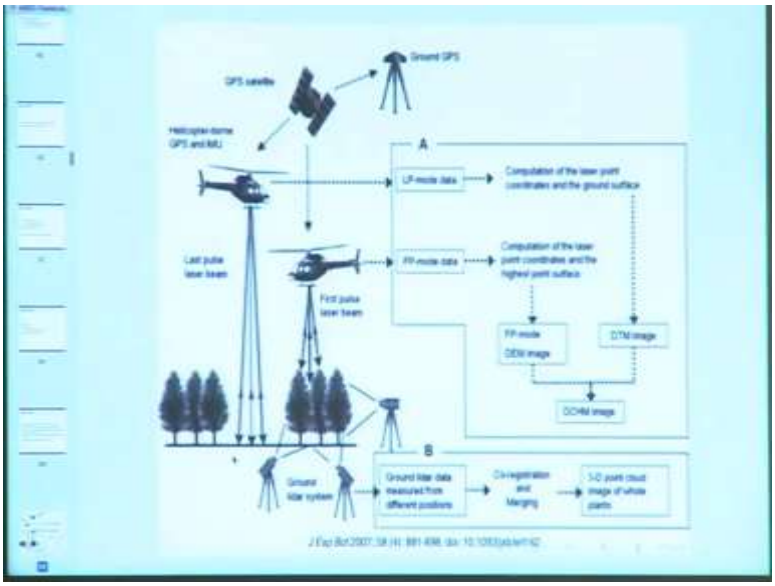

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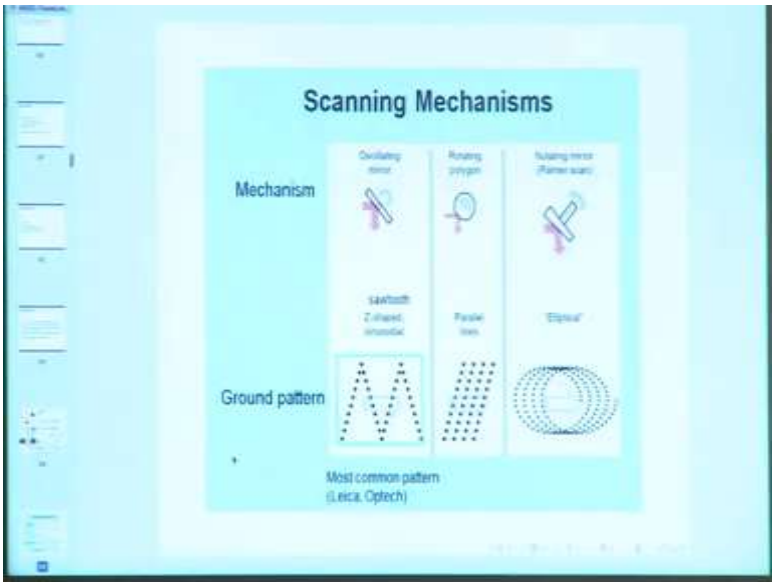

And so, now, in the case of scanning mechanisms, there are three typical scanning mechanisms that are used in oscillating mirror, which gives you a sawtooth pattern; a rotating polygon, which gives you parallel lines; and a notating mirror, which gives you elliptical shaped ground patterns.

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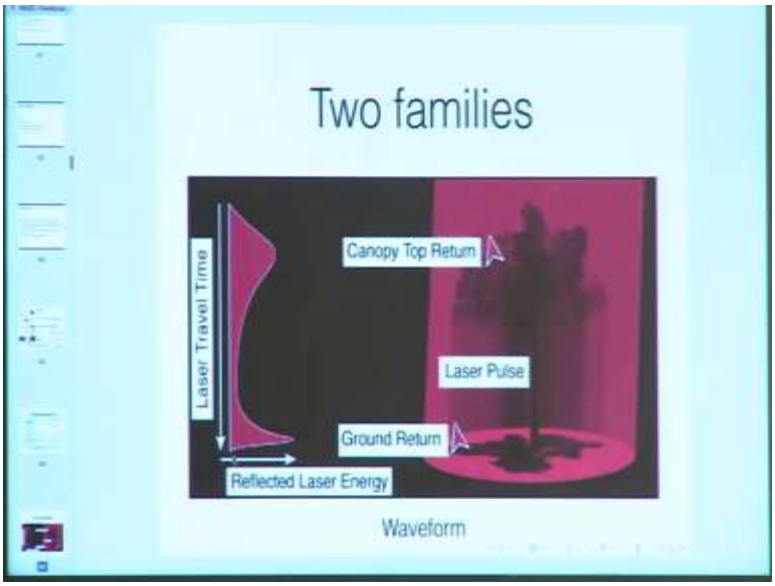

Now, you can make use of a LiDAR in two families; you can make use of waveforms or you can make use of information in a discrete pattern.

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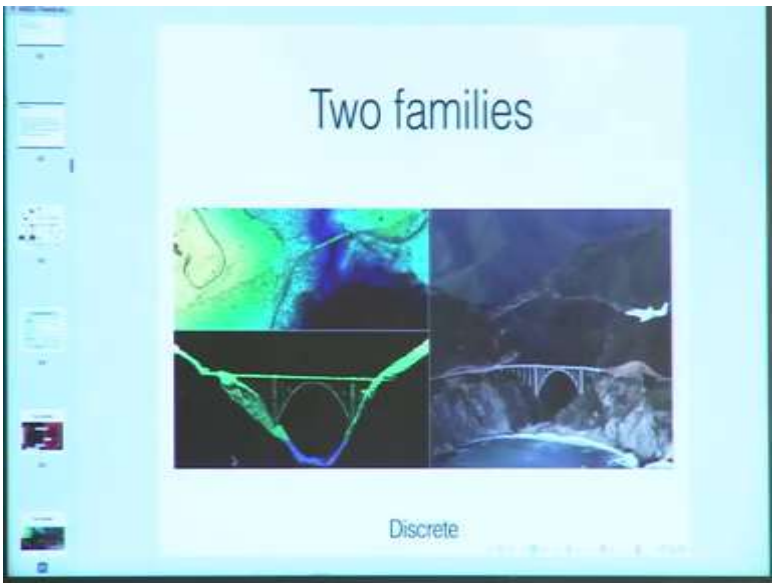

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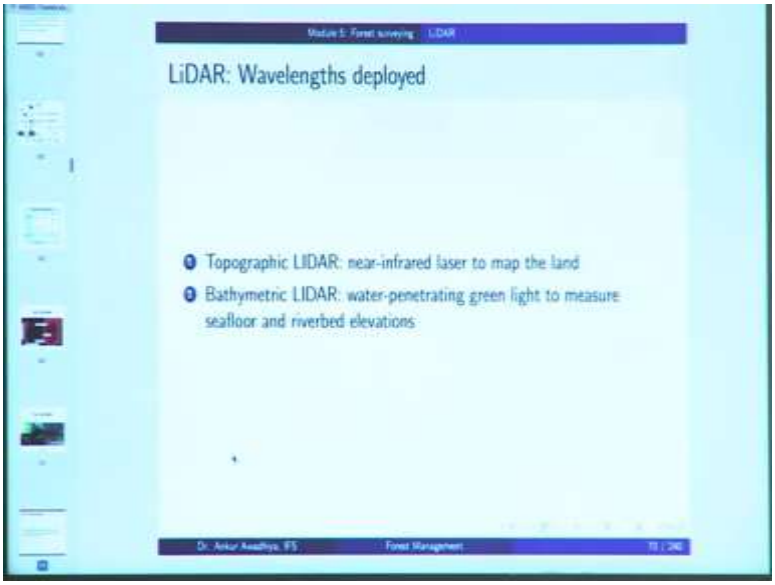

When talking about the wavelengths, you have the topographical LiDAR; in which gives near infrared light laser is used to map the land; or you can make use of bathymetric LiDAR; in which case our water penetrating green light is used, to measure the sea floor and the riverbed elevations.

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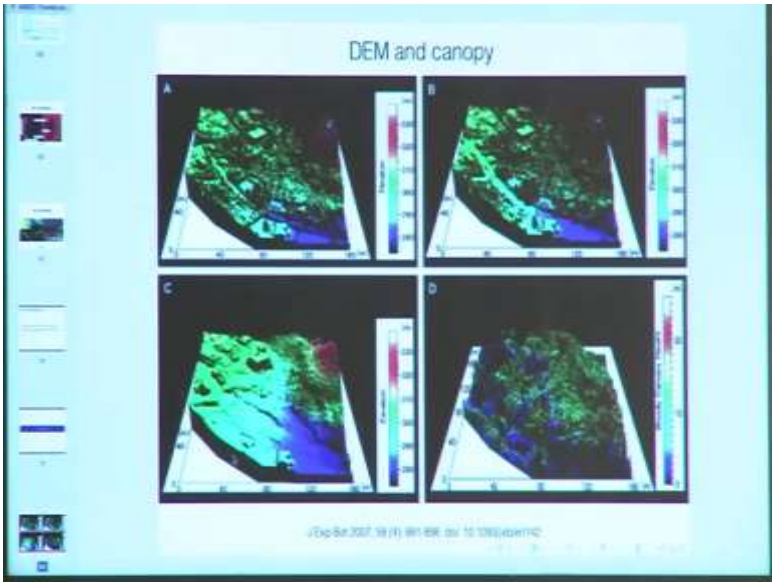

In forestry, you can use LiDAR to get an idea of the DEM.

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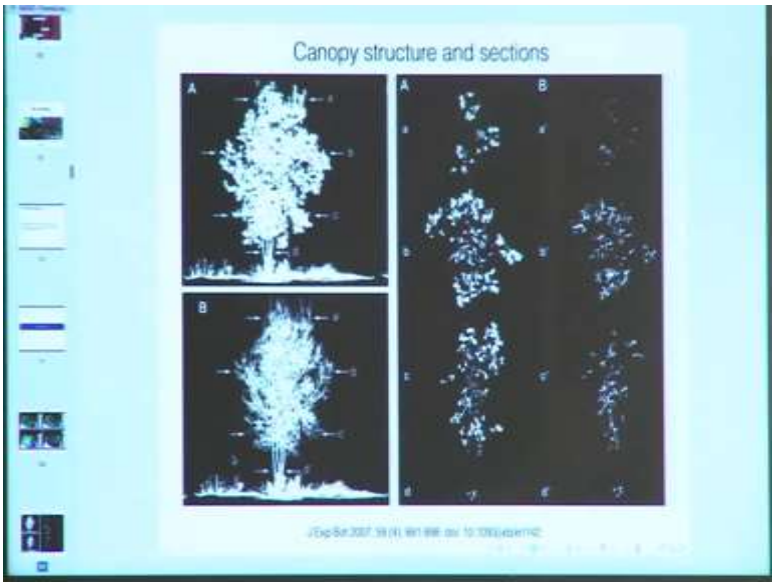

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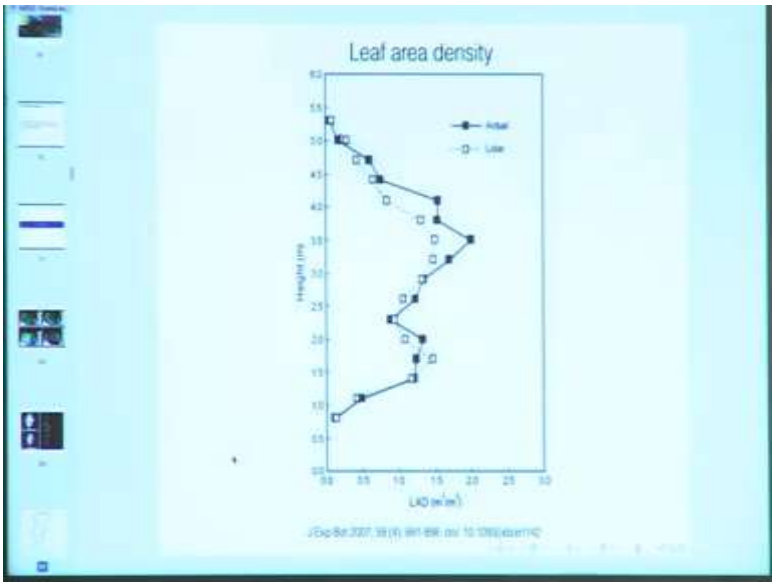

Canopy structure; even the different cross sections of a tree.

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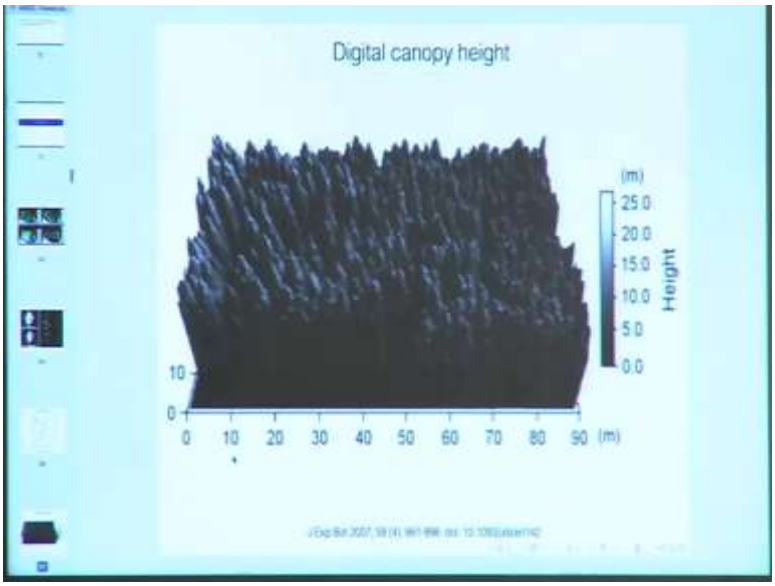

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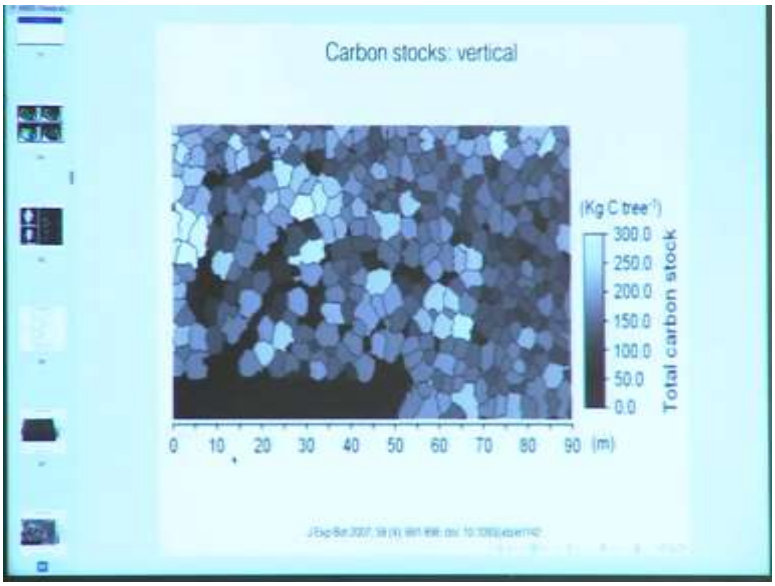

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Leaf area density, digital canopy height; you can measure carbon stocks; you can use a horizontal Lidar.

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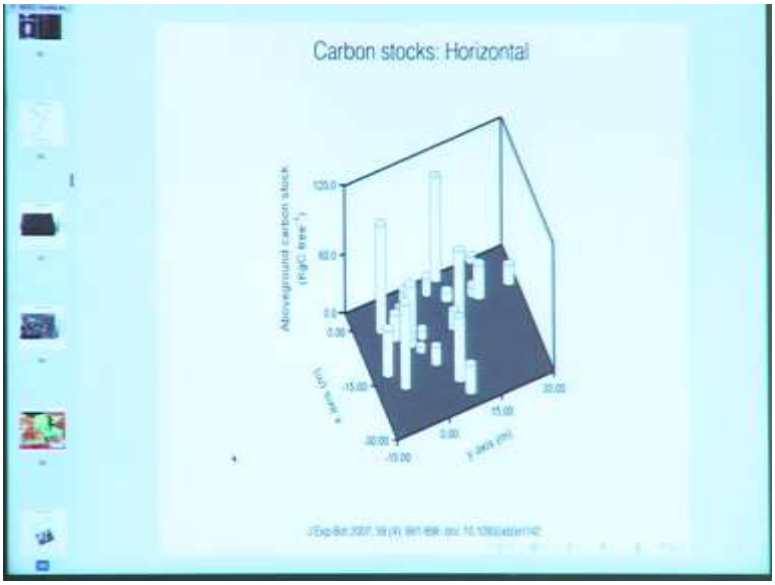

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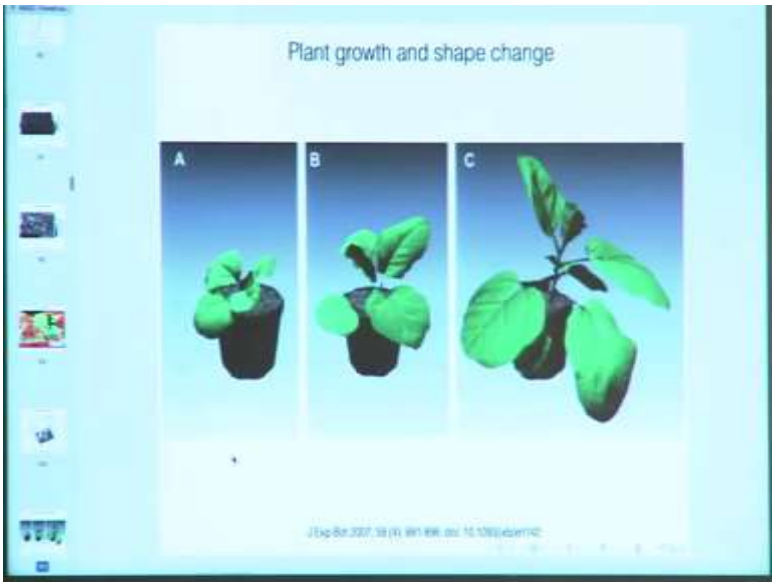

And, get a better idea of the carbon stocks, or you can even study the plant growth and shape change.

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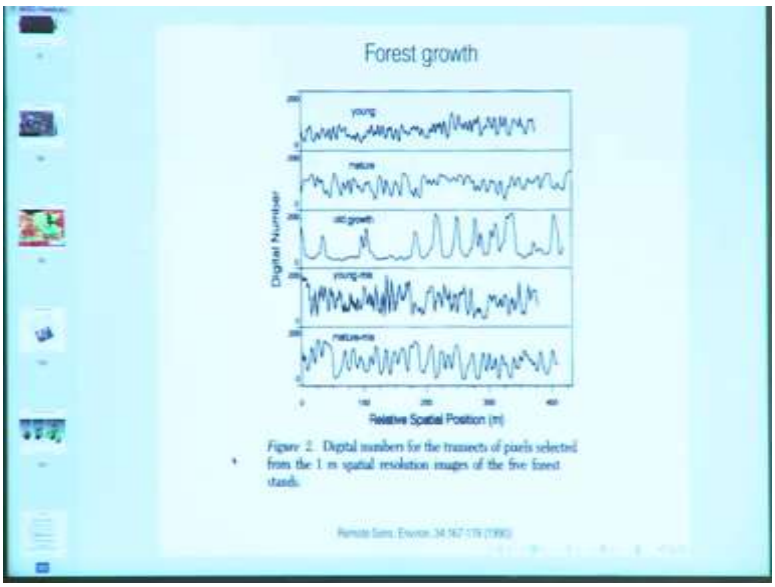

As the plant grows, or you can use it to understand how your stand is behaving; do you have only young crops? do you have mature crops? do you have old crop? or do you have a mix?

So, you can get a very good and a very fast idea in a very economical way.

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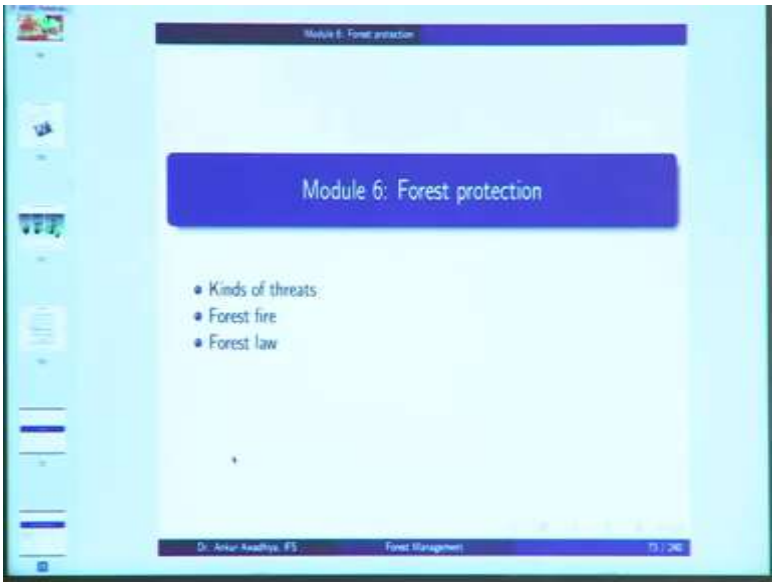

Next, we looked at forest protection.

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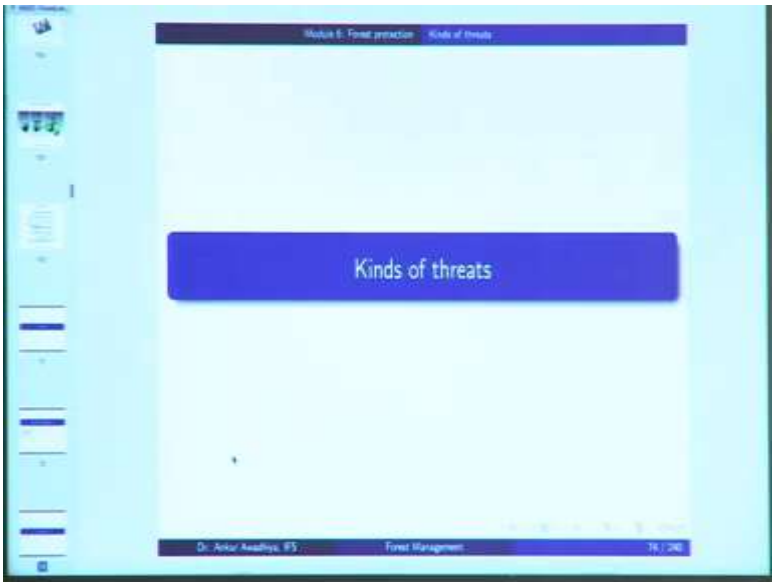

So, here, we started with the kinds of threats.

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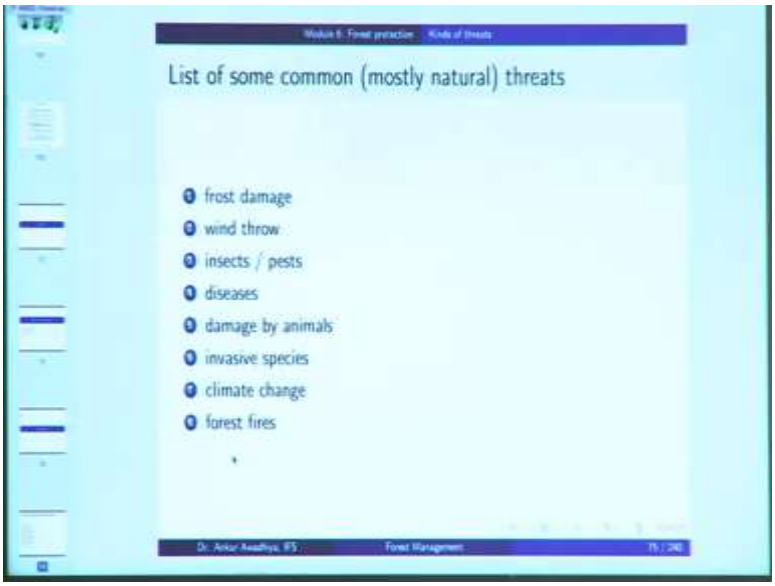

So, the you have natural threats and you have man-made threats. Natural threats are frost damage, wind throw, insects and pests, diseases, damaged by animals, invasive species, climate change, forest fires.

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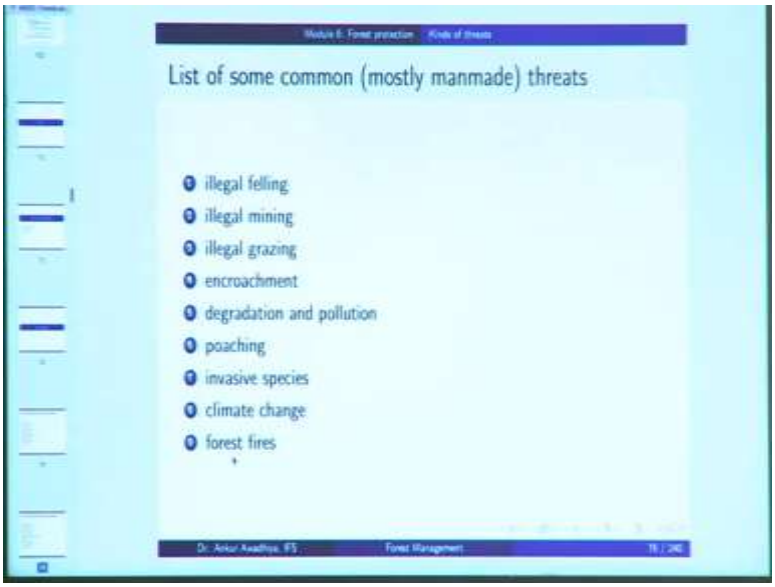

And man-made threats include illegal felling, illegal mining, illegal grazing, encroachment, degradation and pollution, poaching, invasive species, climate change and forest fires.

And, we can emphasize that, in the case of invasive species, climate change, and forest fires, you can have both natural as well as man-made causes.

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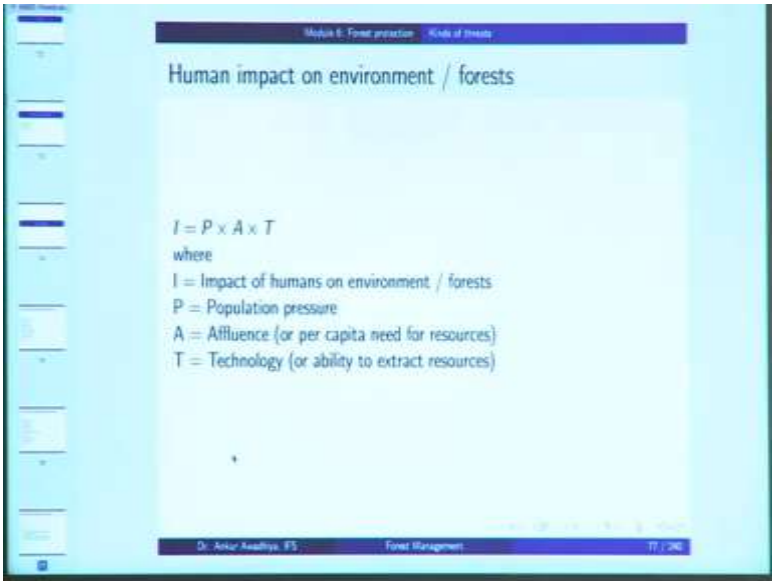

Then, we saw the impact of humans on the environment of forests is given by this equation I is equal to P into A into T, where I is the impact P is the population pressure A is the affluence or the per capita need for resources and T is the technology or the ability to extract these resources.

So, if you have a large size population; everybody needs more resources and you have the technology to extract these resources; and that is the impact, will be very high.

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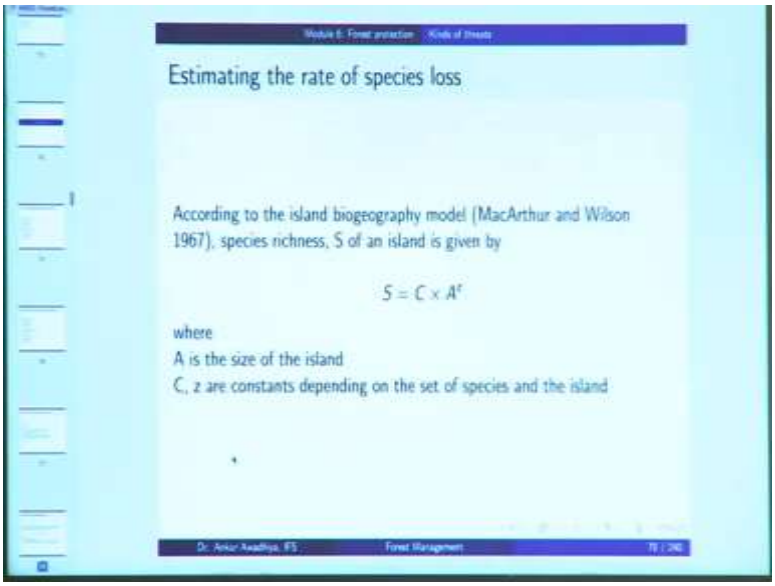

Next, we saw how to estimate the rate of species loss using the island biogeography model; in which case,, S or the species richness is given by C, a constant of proportionality times A, or the size of island to the power of z, which is again another constant which.

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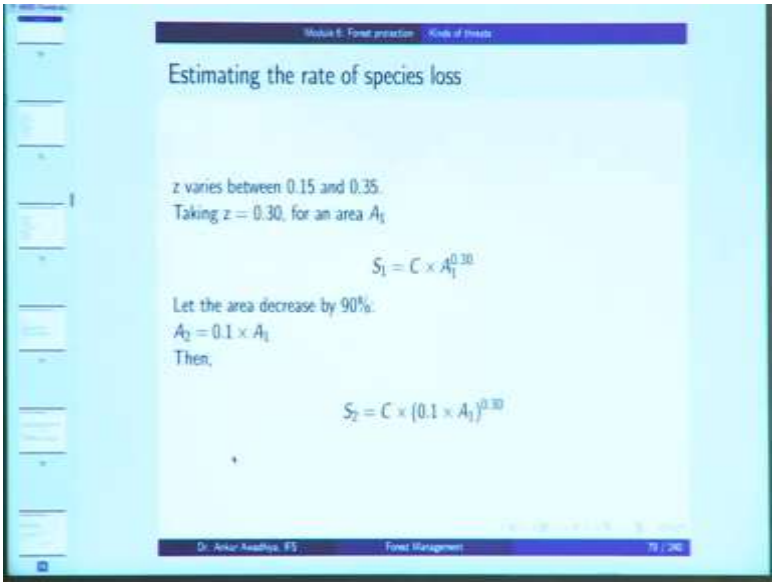

And, this constant varies in different locations, and the way the values are typically between 0.15 and 0.35.

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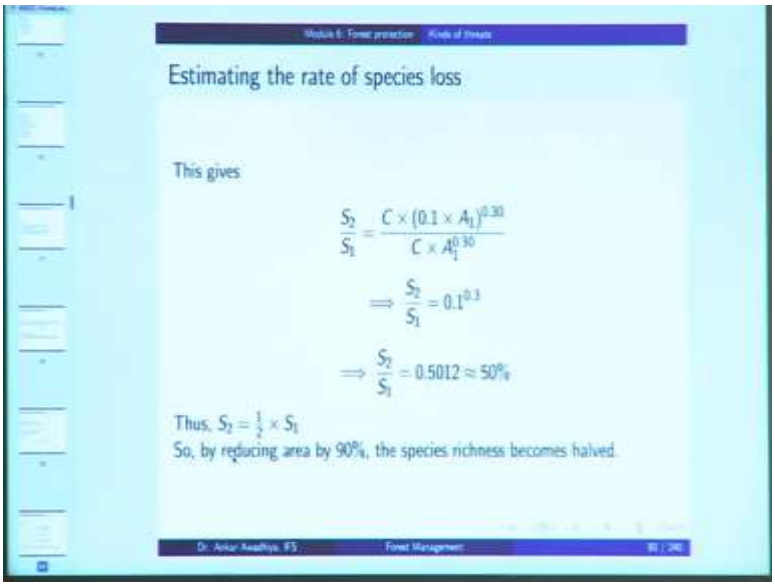

And, in this case, we saw that even if an area decreases by 90 percent, you still have a roughly 50 percent of the species richness that remains in that area.

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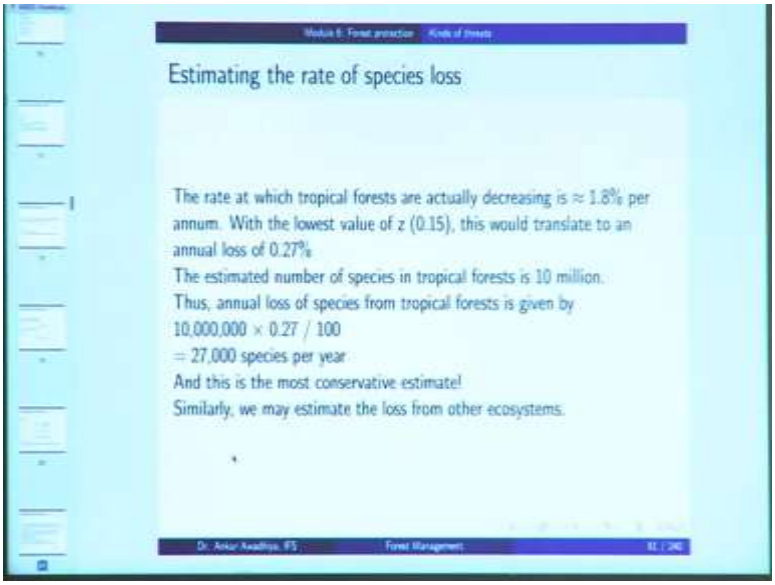

So, there is ample scope for hope, but you cannot be extremely hopeful because then we calculated the rate of species loss. And, we saw that, in the case of tropical forests, we are losing as many as 27,000 species every year in a very conservative estimate.

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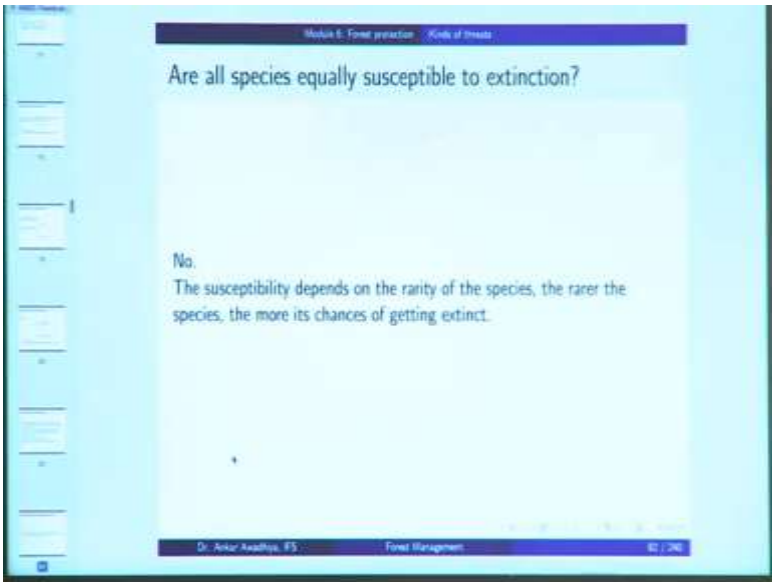

Then, we say then we saw that all species are not equally susceptible to extinction. It depends on the rarity of species; if a species is rarer, then it has a greater chance to be extinct.

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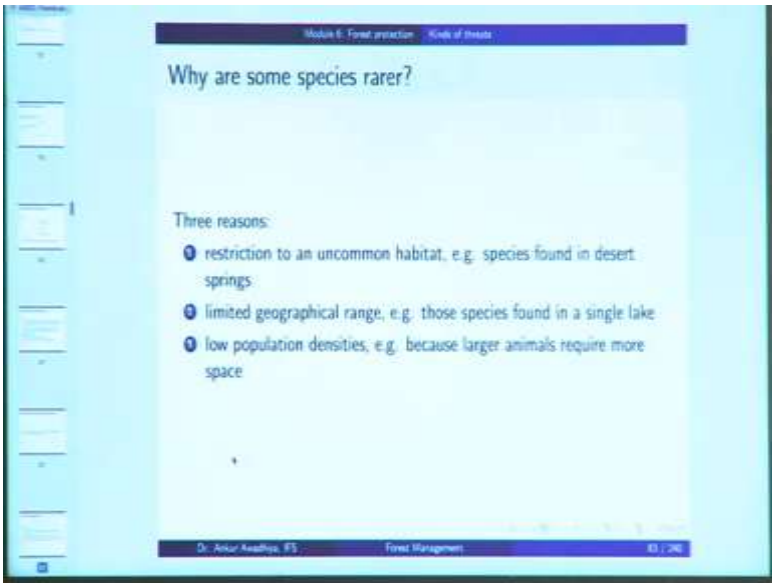

And, species some species are rarer because they are restricted to an uncommon habitat; they have a limited geographical range or they have low population densities.

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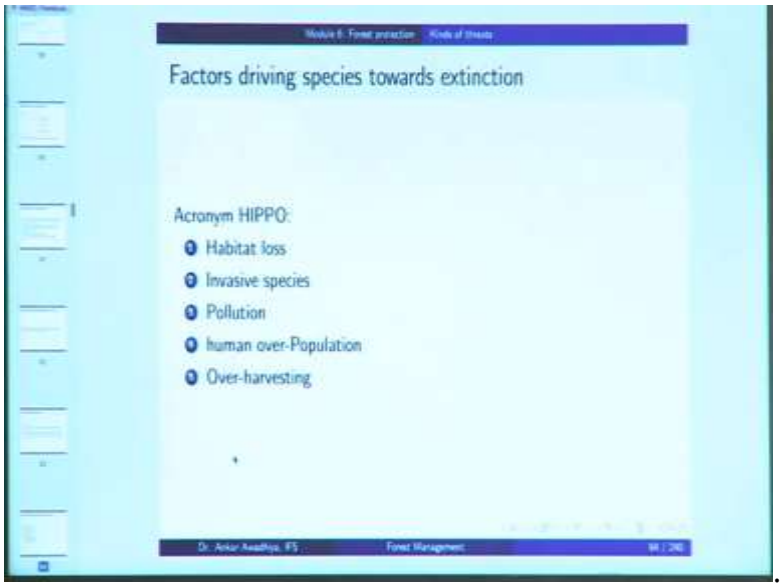

Then, we look at this acronym HIPPO, which which is a good mnemonic to remember the factors that are leading species towards extinction. So, H is habitat loss, I is invasive species, P is pollution, the other P is human overpopulation, and O is over harvesting of resources such as overfishing or over extraction of timber.

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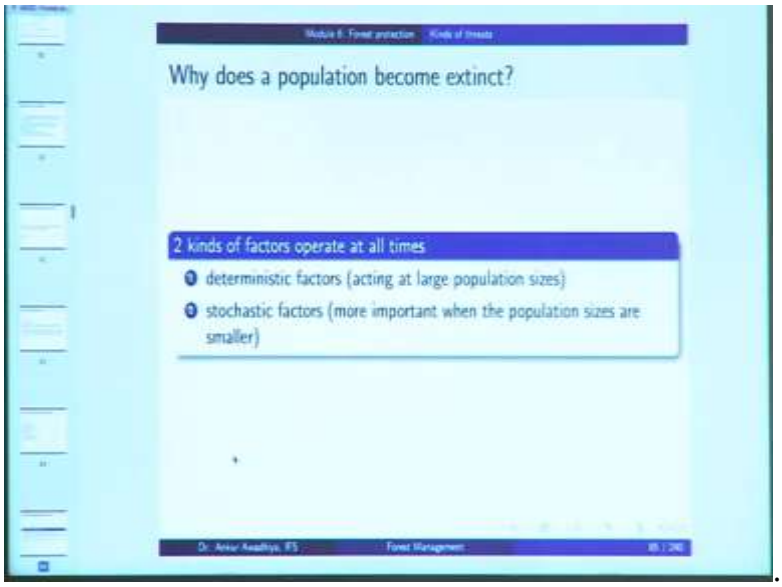

Now, why does a population become extinct? You have two different kinds of factors; you have deterministic factors that act at large population sizes, such as birth rates and death rates. And, you have stochastic factors that act at small population sizes.

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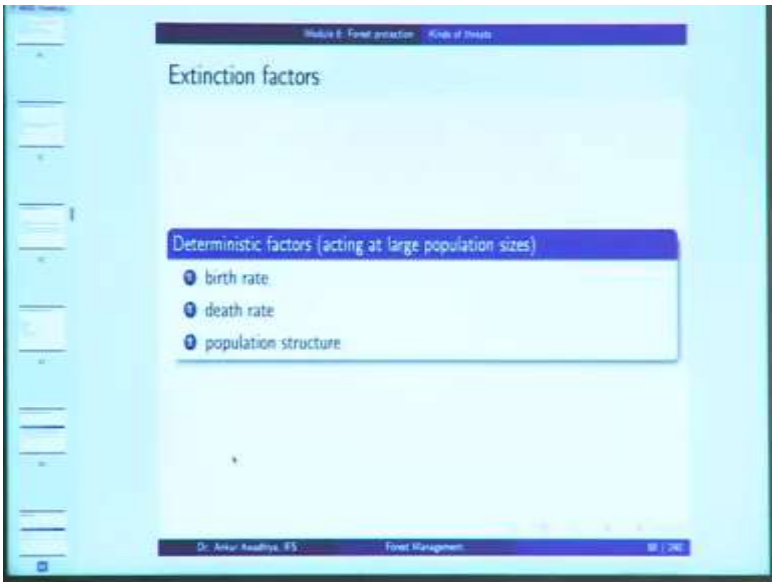

So, deterministic factors include birth rate, death rate, and the structure of the population; whether most of the individuals are young, most of the individuals are old, or most of the individuals are of a mature stage.

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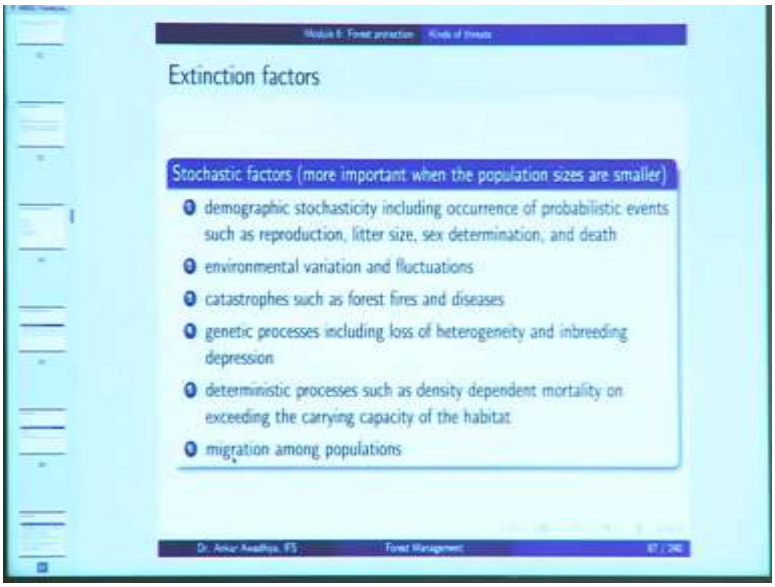

In the case of stochastic factors, you have demographic stochasticity which is the probabilities in reproduction, litter size, sex determination and death. So, it is just possible that most of the animals are having a very small litter size, just one progeny. And, if that happens; then the population is more pushed towards extinction, if the

population size already is very small, or if all the progeny turn out to be males, or all of them turn out to be females.

Then, we have environmental variation and fluctuations, catastrophes such as forest fires and diseases, genetic processes, deterministic processes such as density dependent mortality and migration among populations; and all of these are the stochastic factors.

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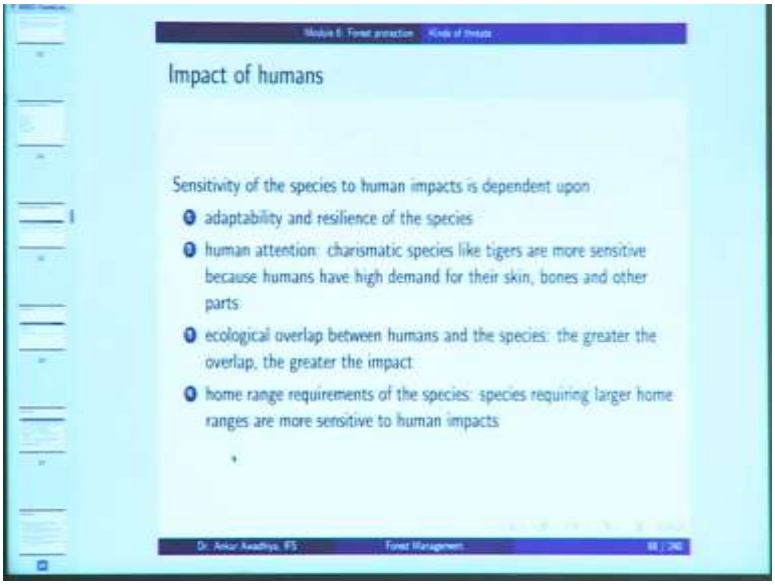

Now, then next, we saw that the sensitivity of the species to human impacts is dependent upon the adaptability and resilience of the species, the amount of attention that humans are given to the to the species. So, charismatic species like tigers are more sensitive.

Ecological overlap between humans and the species, and the home ranges requirements of the species; in which case, the species that require a larger home range size are more susceptible towards extinction; because if their home range reduces, then they are unable to cope with it. So, there is a need for protection.

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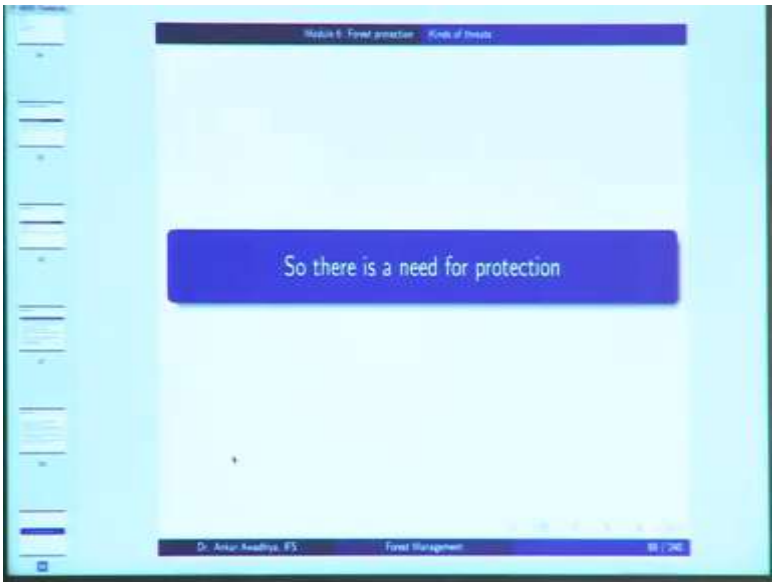

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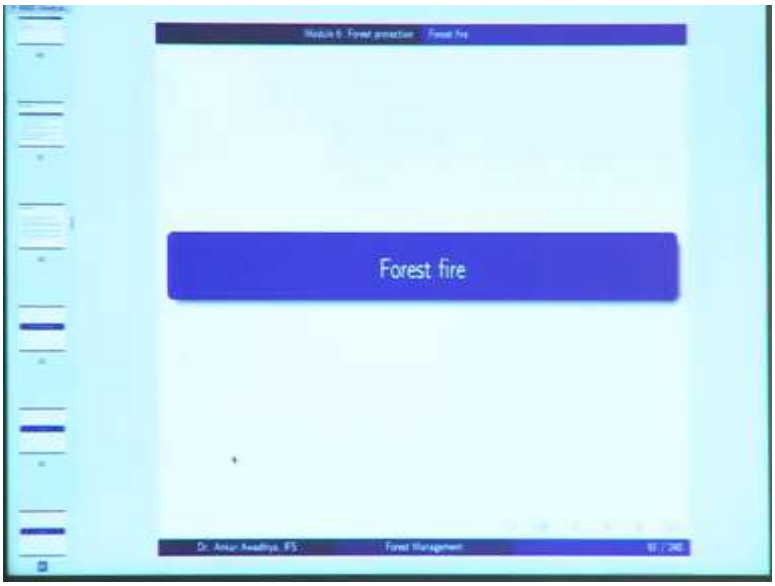

In the next lecture, we started with forest fires.

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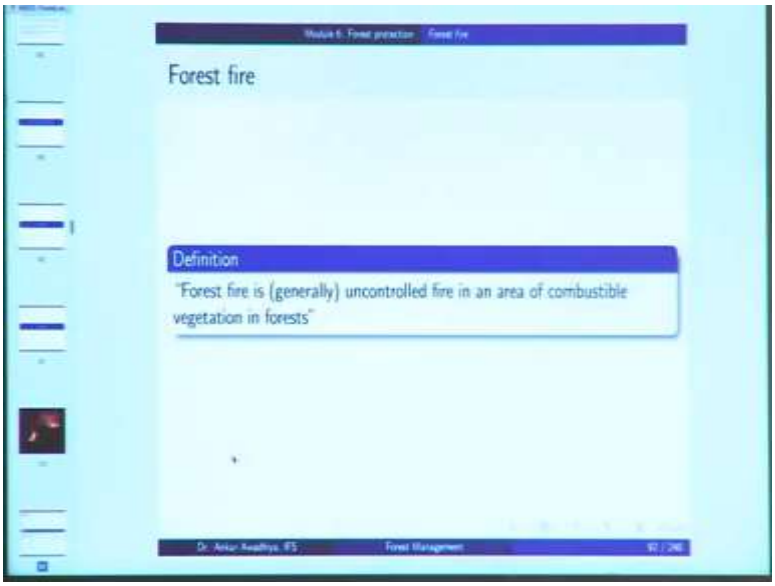

This is an example of a forest fire, and the forest fire is defined as a generally uncontrolled fire in an area of combustible vegetation in the forest

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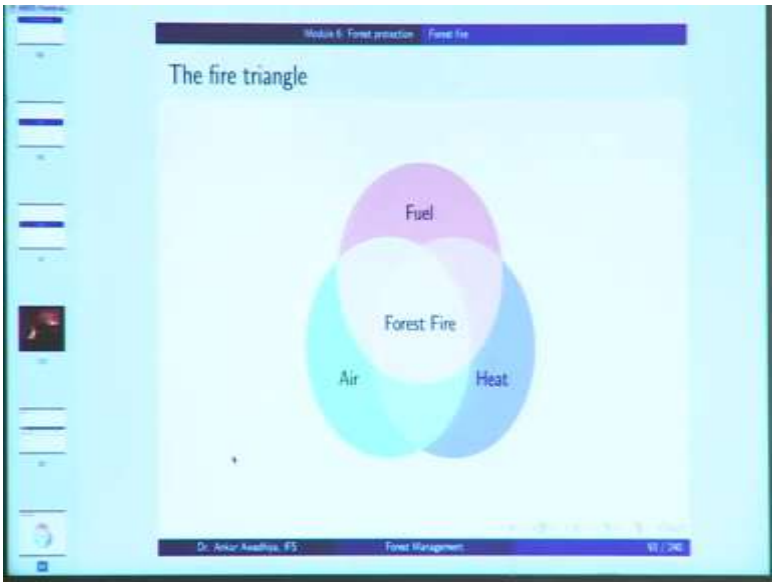

And, we saw that a forest fire occurs when you have all the three vertices of the fire triangle. So, you need to have fuel, you need to have air, and you need to have heat; when all three of these are there together, then you have the forest fire.

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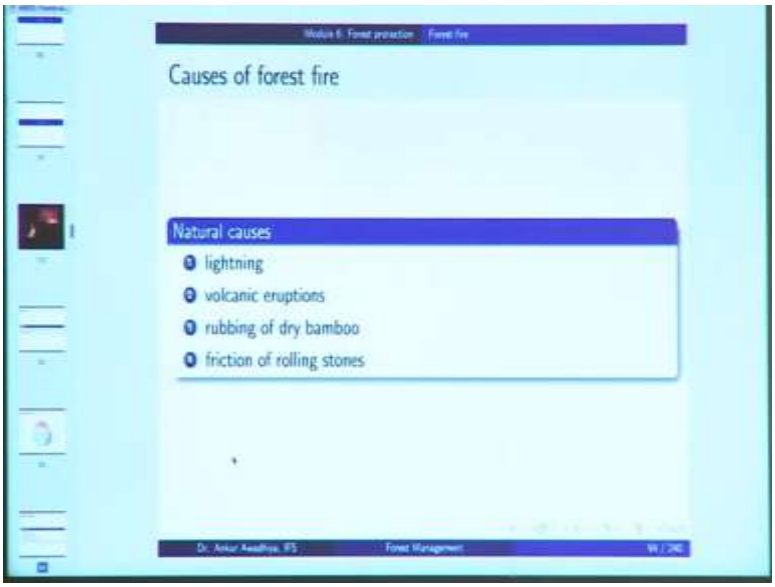

There are certain natural causes of forest fire such as lightning, volcanic eruptions, rubbing of dry bamboo, friction of rolling stones.

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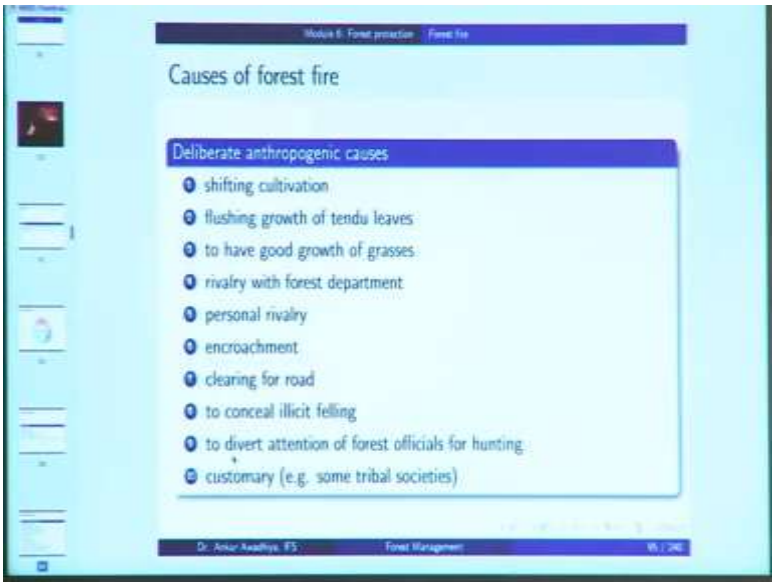

But most of the causes these days are anthropogenic causes such as shifting cultivation, flushing the growth of tendu leaves by exposing the plants to fire, or burning an area to have a good growth of grasses, rivalry with the forest department, personal rivalry between two people, encroachment, clearing for road, to conceal illicit felling, to divert the attention of forest officials for hunting, and certain customary causes such as in the case of certain tribal societies.

Now, these are all deliberate anthropogenic causes.

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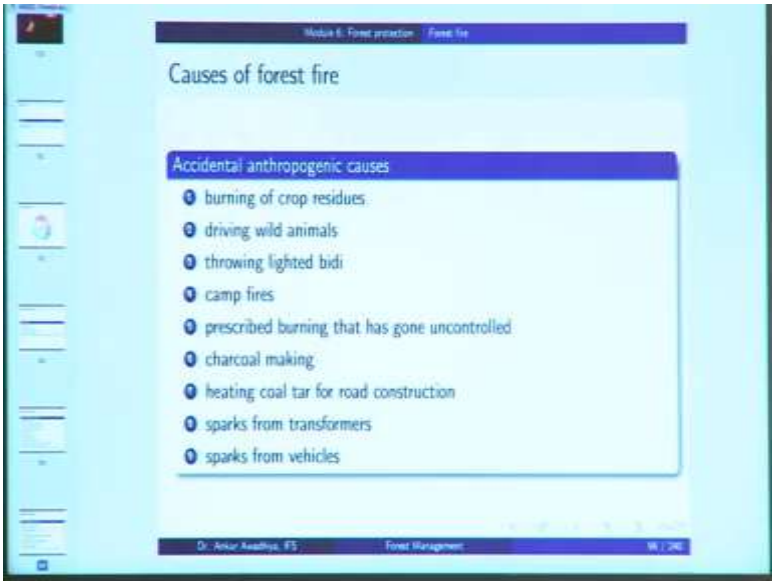

You also have certain accidental anthropogenic causes such as burning of crop residues; there is a chance that some of these burning fragments and because of the wind they move to the forest areas and they start a forest fire, or driving of wild animals, throwing of lighted bidi, campfires, prescribed burning that has gone uncontrolled, charcoal making in the forest, heating of coal tar for road construction, sparks from transformers, sparks from vehicles. And, all of these are the accidental anthropogenic causes.

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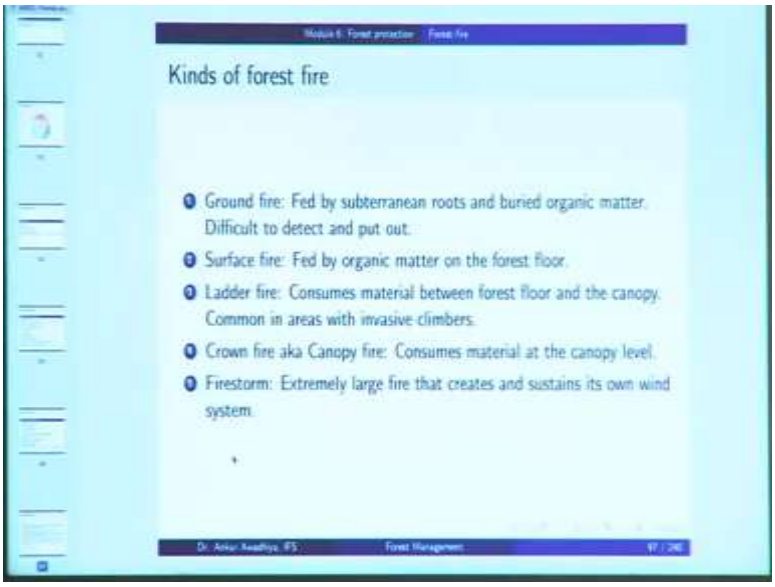

Then, we have five different kinds of forest fire you can have a ground fire which is fed by subterranean routes and buried organic matter; difficult to detect and put out, and it is very easily detected, if you have a snag tree, because you will suddenly find a tree that has started to burn. Then, you have surface fire which is fed by organic matter on the forest floor. You have ladder fire which consumes the material between the forest floor and the canopy; common in areas with invasive climbers.

You have crown fire or the canopy fire which consumes material at the canopy layer level. And, you have the firestorm; in which case, you have an extremely large fire that is creating and sustaining its own wind system.

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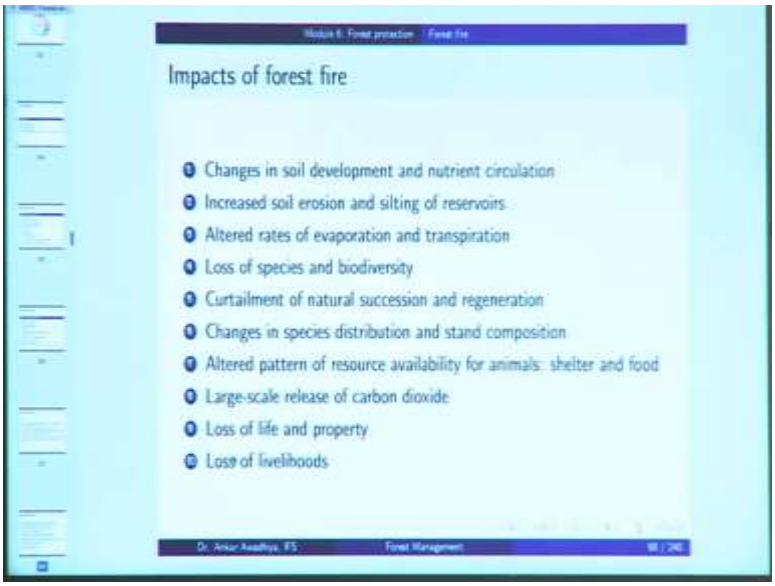

Now, the impacts of forest fire there are; changes in soil development nutrients circulation, increased soil erosion, silting of reservoirs, altered rates of evaporation transpiration, loss of species loss of biodiversity, curtailment of natural succession and regeneration, changes in species distribution and stand composition, altered pattern of resource availability for animals; especially shelter and food, large scale release of carbon dioxide, loss of life and property, loss of livelihoods

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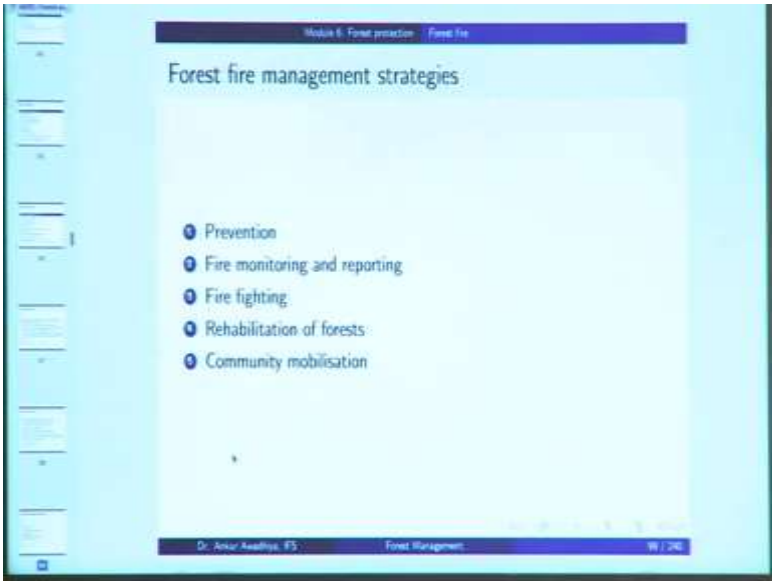

And; so, it is important to manage the forest fires. And, this management is done by taking the steps for prevention, fire monitoring and reporting, firefighting, rehabilitation of forest and community mobilization.

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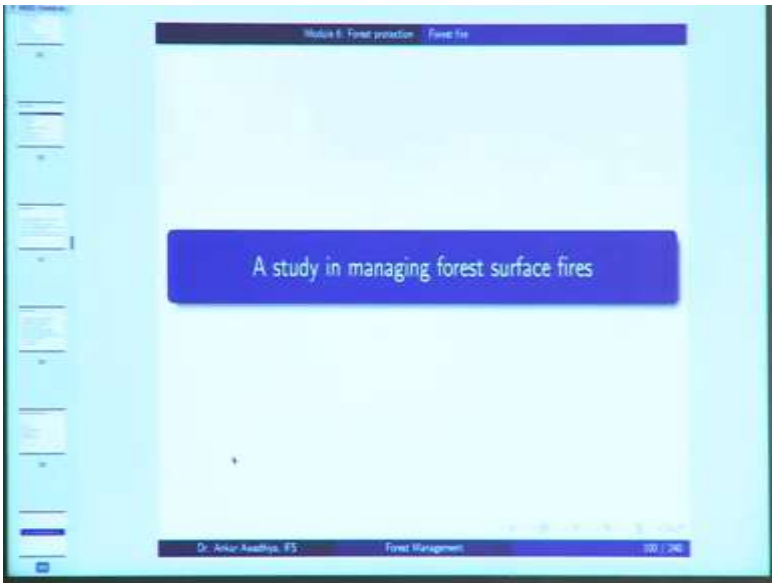

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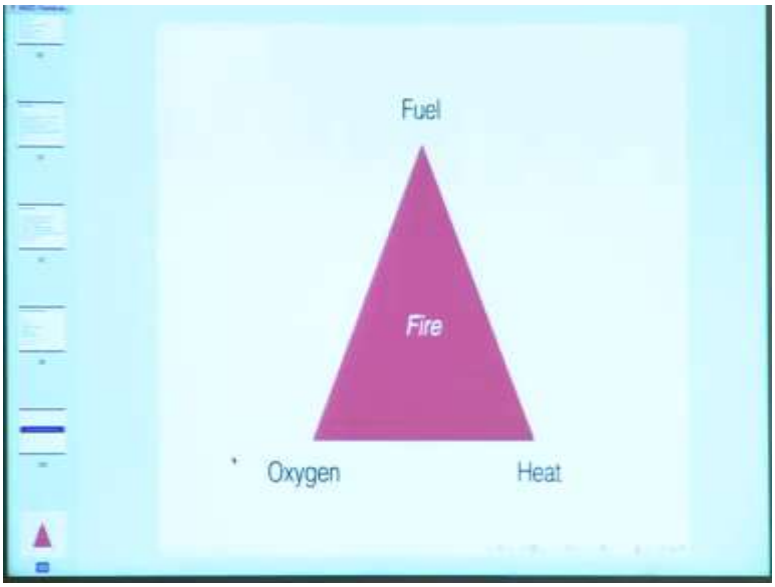

Now, we looked at a study in managing forest fires. So, you need to break the fire triangle.

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And, because in the in a tropical forest or in a deciduous forest, you have a very good ground cover. It is in the summer seasons; it is all full of dry leaves that the trees have shed.

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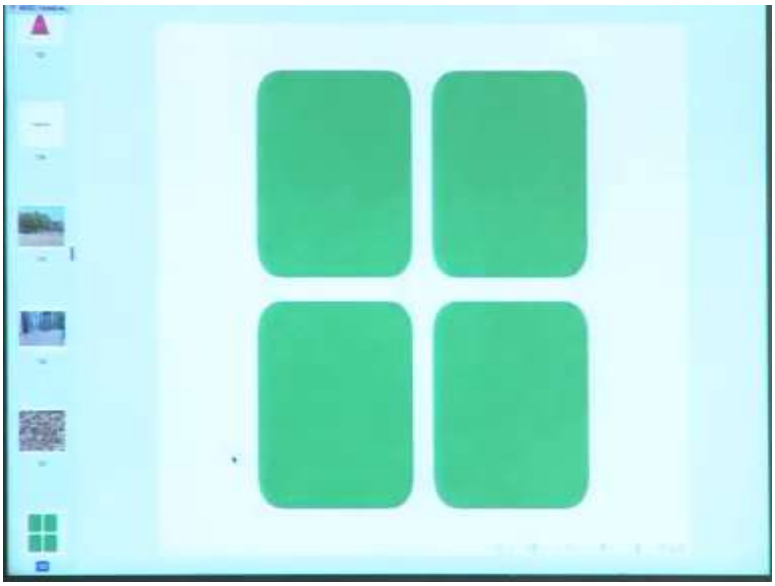

So, in that case. we go for the construction of fire lines. Now, our fire line works on the principle that. if this section is burning and you have these areas that do not have any fuel. then the fire will be unable to cross into the second section of the forest.

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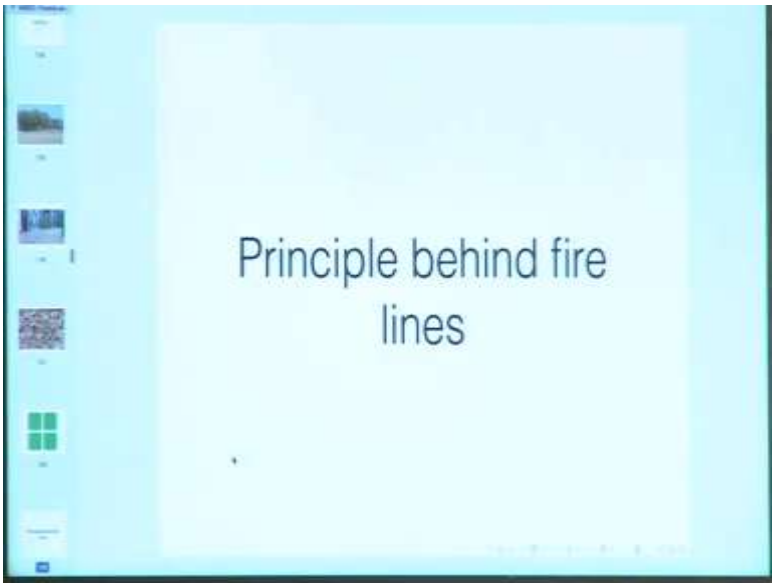

So, what is the principle you have to forest floors?

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So, this is the simulation.

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And. the fire is burning its coming towards the front; is coming towards the fire line.

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And, because it does not get any more fuel so, it gets burnt.

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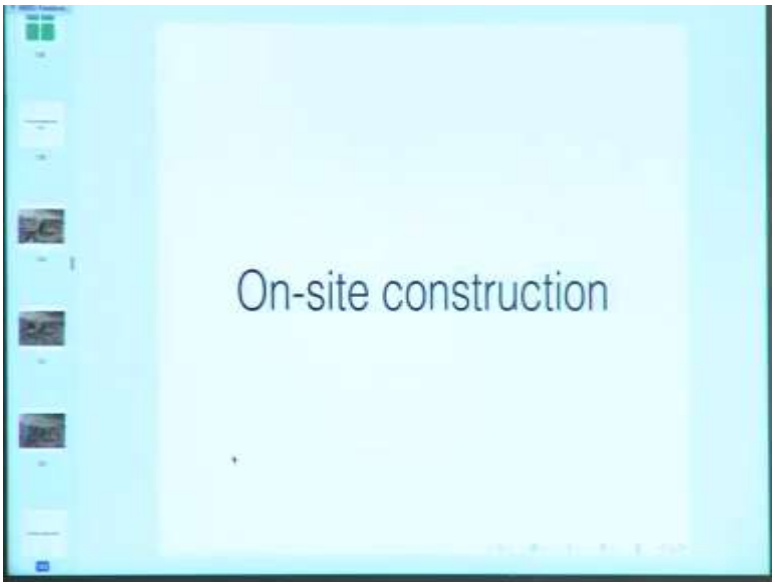

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The on-site construction in the months of October in November; typically the ground cover is removed in these areas; the plants are left to dry out; and once they have dried, they are burnt.

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And on a larger scale, if you have the, so, here you are seeing a wider fire line.

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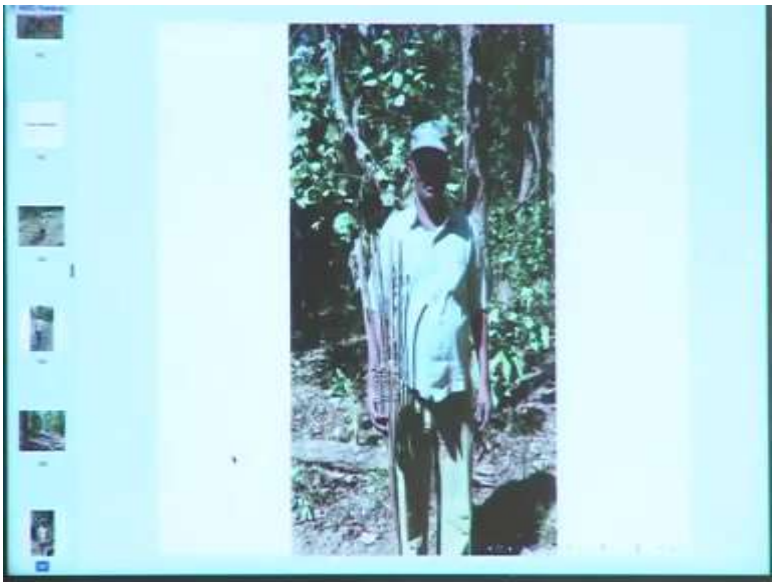

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And; so, the staff will make use of rakes to bring all the dry leaves towards the center.

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And then, they will use a stick converted into a torch and this torch is used to burn the accumulated leaves and this burning will be done.

So, you burn it from the side; so, that it enters here. And, you burn from the side so that a fire front moves towards the center.

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And, when both of these fire fronts meet, then the fire gets extinguished.

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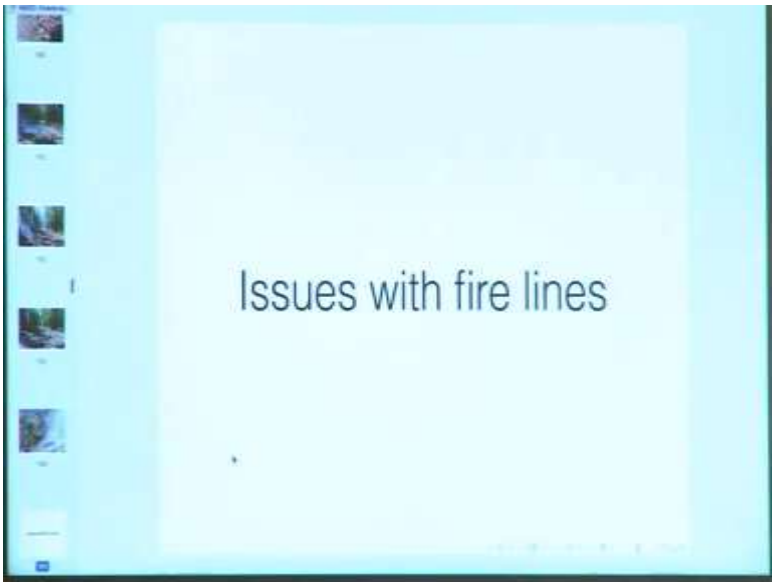

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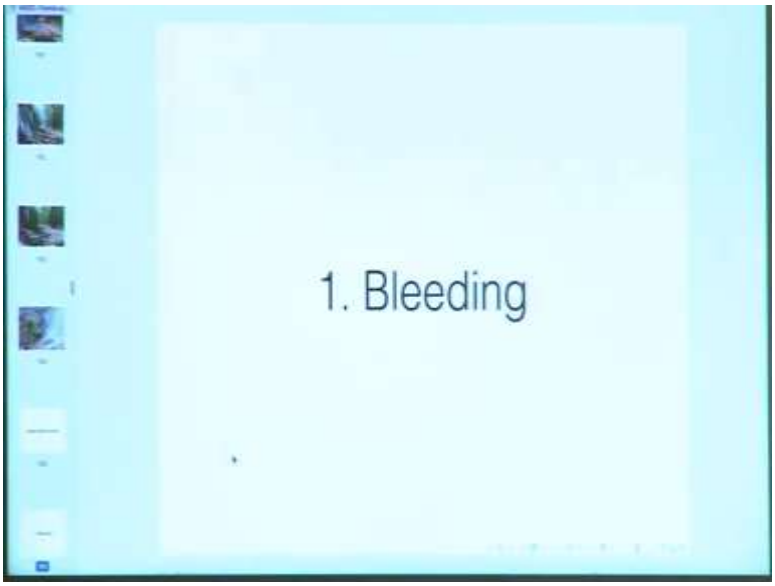

And, this is done on a large scale, but there are certain issues there is the issue of bleeding.

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In which case, you are constructing a fire line, but then when you were burning it burnt the whole forest.

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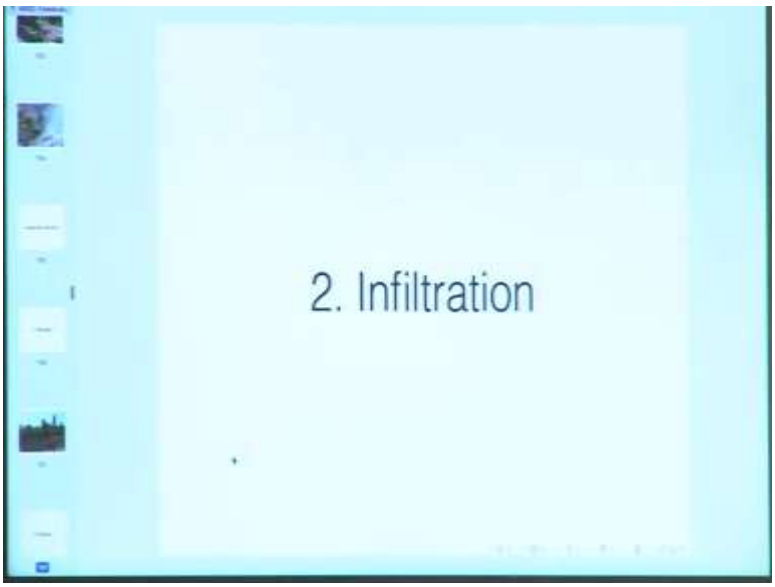

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Then, you have the issue of infiltration; in which case, once the fire line has been made the leaves are coming and on top of these filings, because the trees are still shading the leaves.

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So, if you have the leaves here, then you still have fuel in the fire line.

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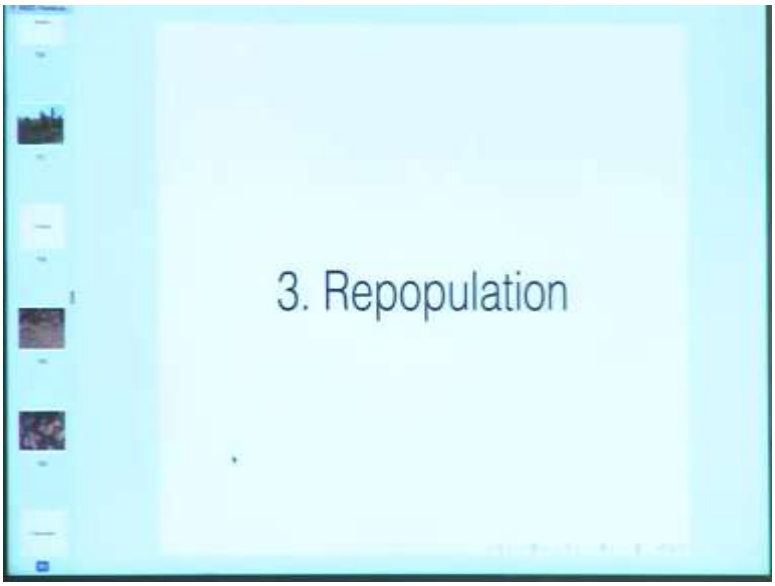

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Next, you have the issue of repopulation in which case once you have constructed the fire line; after a while, new flesh of grasses can come in.

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And, when these grasses die or when they dry up, in that case, will again have fuel in the fire line which then defeats the purpose.

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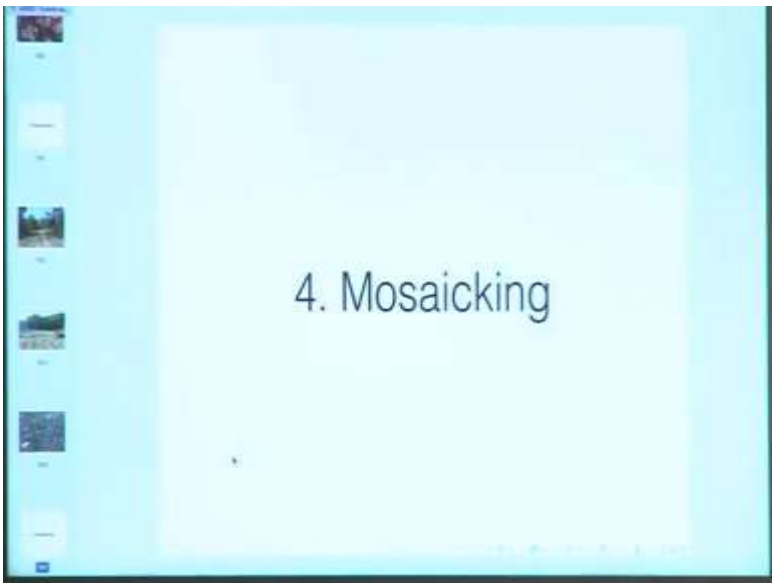

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Next, you have mosaicking in which case a certain portion are left out; they are not burnt and here again, you have a discontinuity in the fire line.

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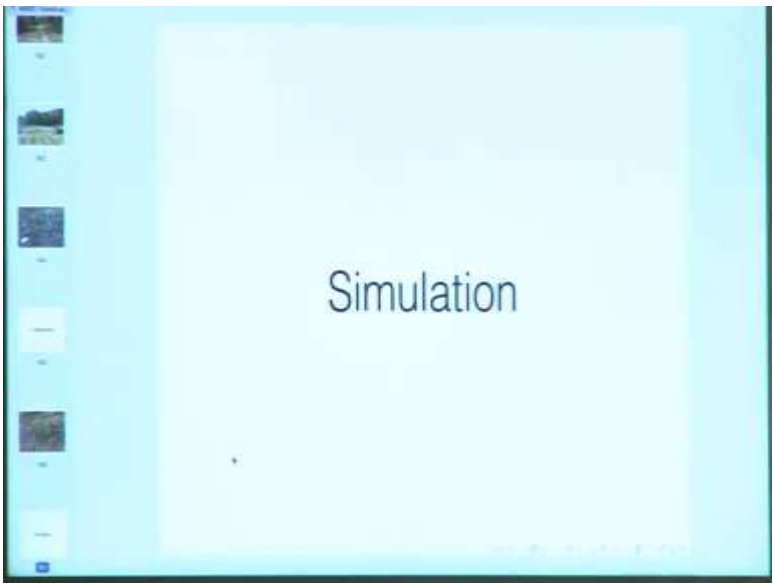

Now, if you have these kinds of discontinuities, then that can that can hamper the working of your fire line.

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So, a simulation is shown here. So, you have two forest floors, you have a fire line, but in between you have the leaves.

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And, once that happens, the leaves make a channel between both the fire; between both the forest floors, and the whole forest burns.

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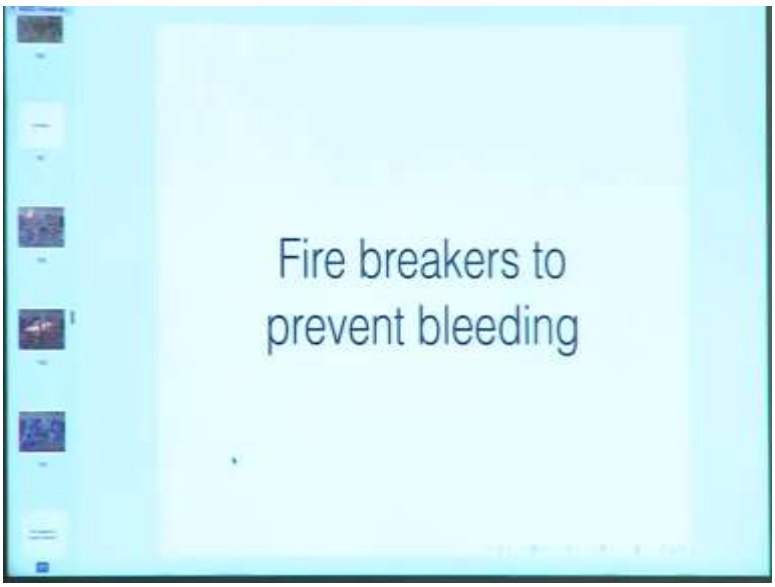

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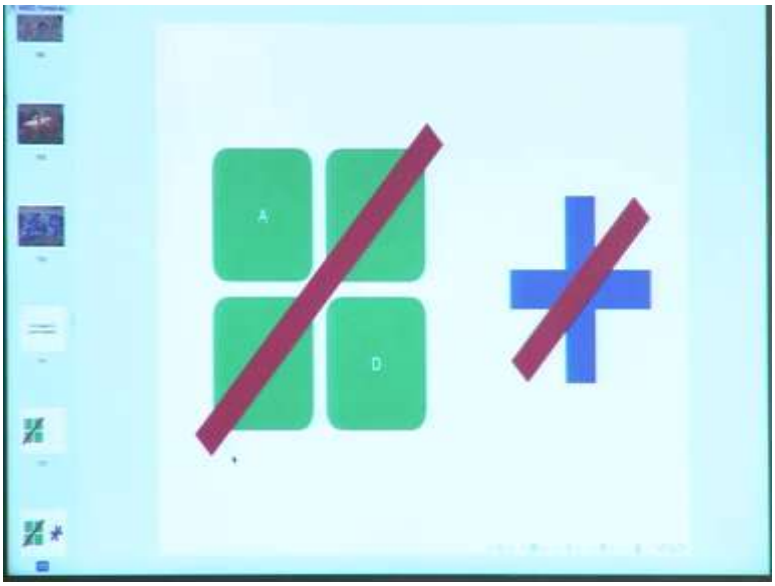

So, then, we constructed fire breakers to prevent bleeding. The there were two aims; they should not be habitat fragmentation.

So, you can have - you cannot have very tall walls, and you do not want to add anything to the system. So, it has to be made from natural materials that are locally available.

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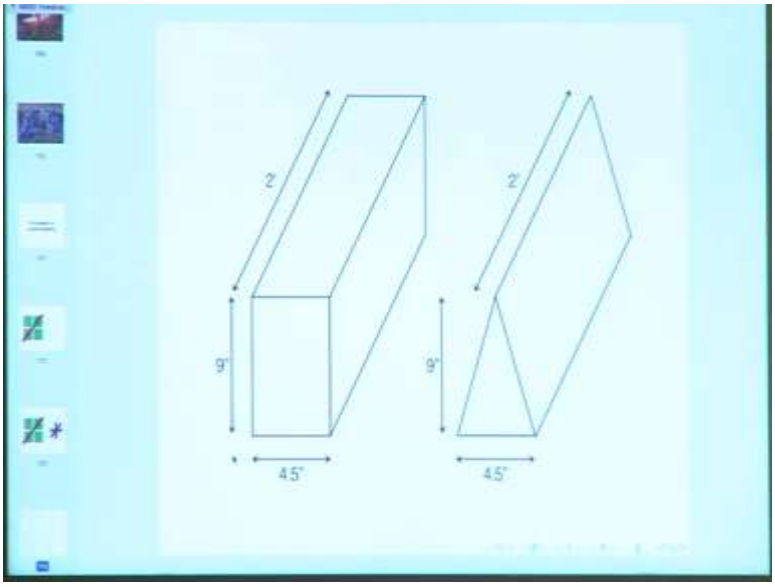

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So, mud fire breakers were made, and these they were in two shapes and both of them work.

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So, you have a fire that is coming from the left side and reaches the fire breakers. Because it because it is made of earth which is our non-combustible material; so, it stops there.

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Now, if you say try to simulate the leaf fall; if it comes on top of this cuboidal fire breaker, then it will burn. I mean the flames will be able to reach the top.

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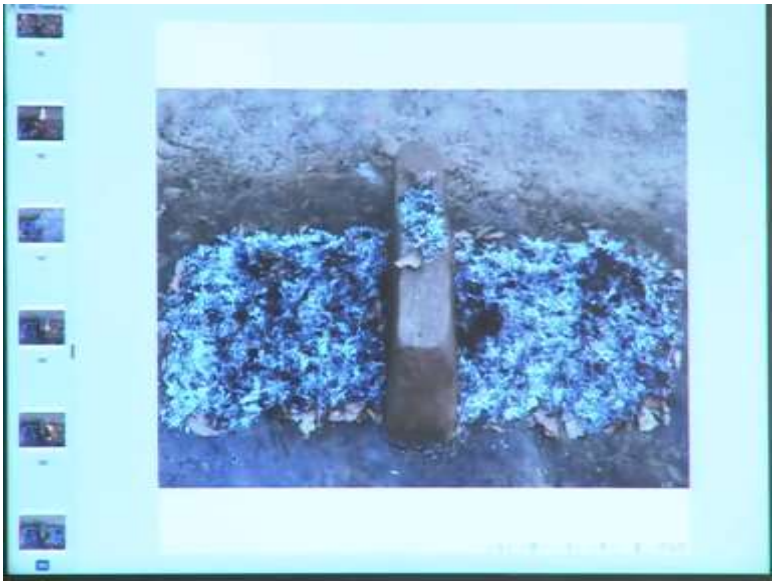

And, after a while, if there is a wind movement, then there is a possibility that the fire will reach to the second side and it will burn the second side as well.

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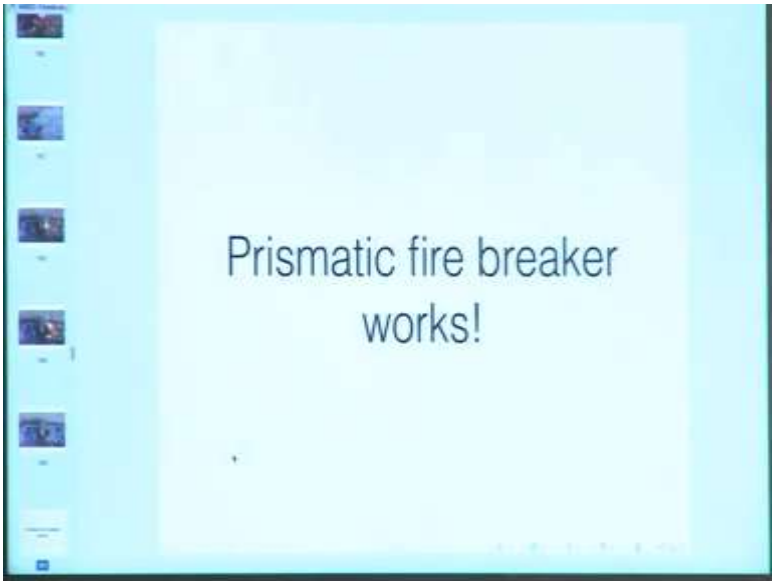

But, in the case of a prismatic fire breaker; because flames can only go up, they cannot go down.

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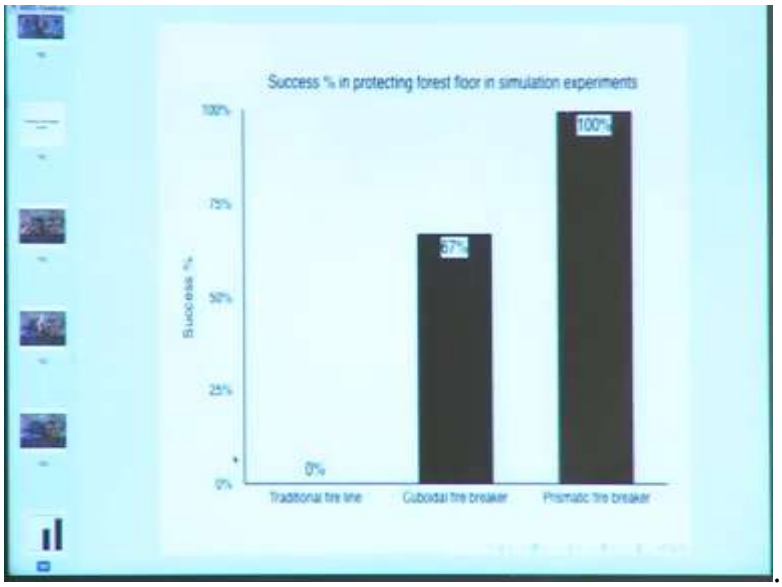

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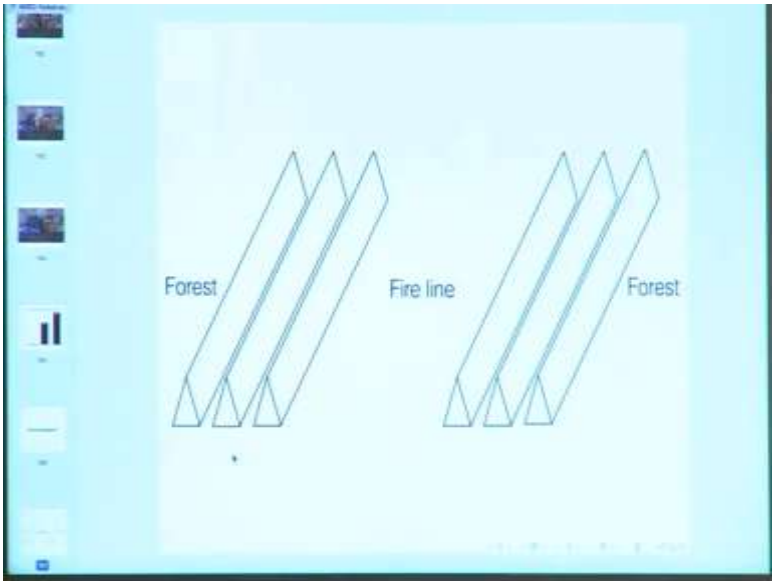

So, on the second side is much more protected. And so, we recommended that in the case of a fire line on both the sides, we should be making the fire breakers.

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Now, we looked at the elements of a fire management plan. It has to look at the forest areas and the fuel types. What are the responsible organizations that you can look forward to? You need to have a fire prevention plan with fuel hazard reduction, a fire danger measuring system, detection plan, reporting plan, you need to have alarm systems in communications. There has to be a plan for fire suppression, personal management, equipment and tools supplies, safety measures and maps and records.

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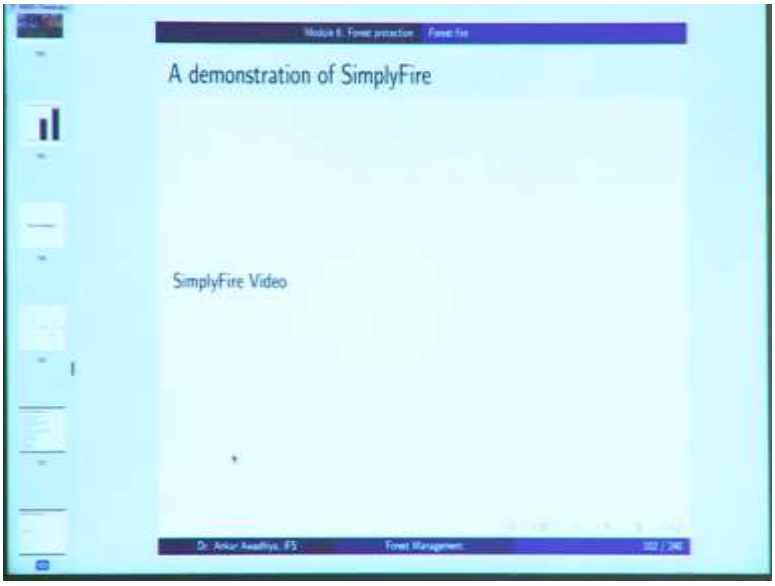

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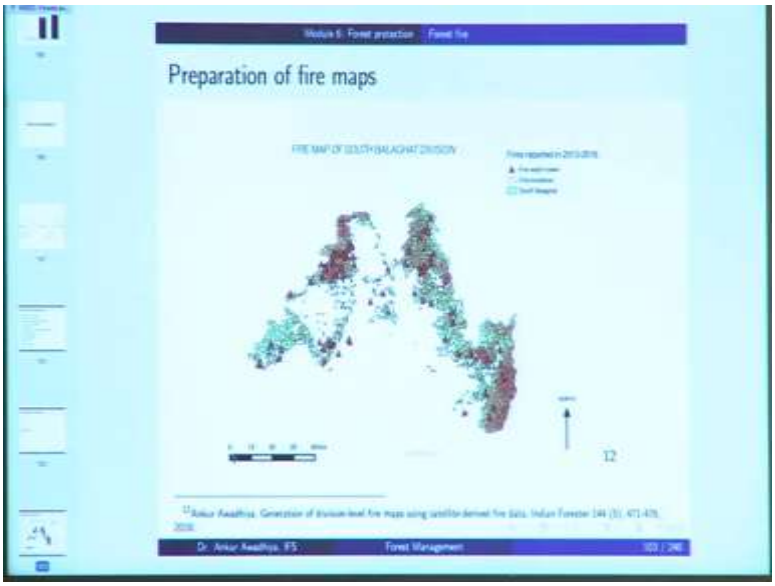

And, you look at Simplyfire which is another method, in which we are getting a near real time reporting of the forest fires. And then, we also looked at the working of fire maps which helped you to discern which locations are having a greater possibility of fire and which locations have a lesser possibility of having a forest fire.

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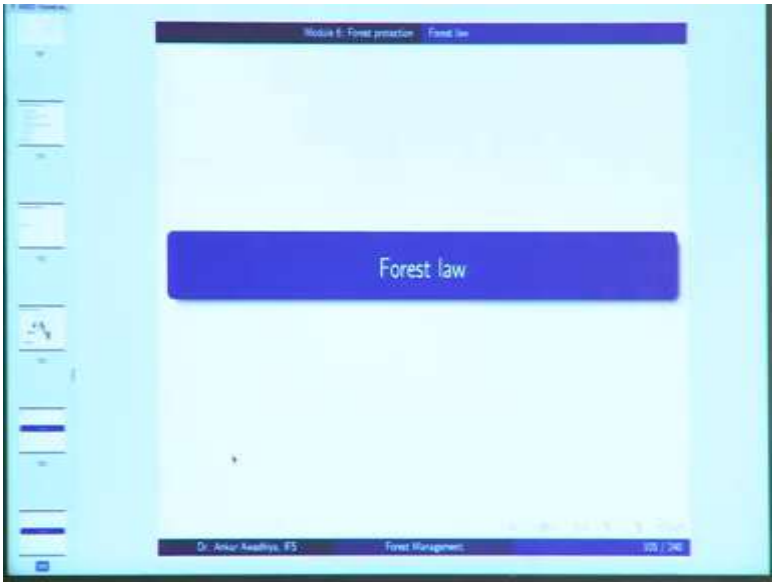

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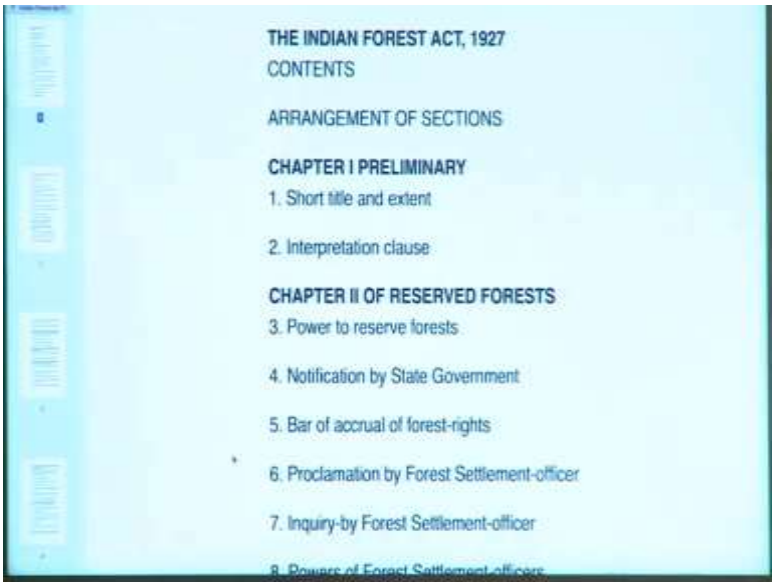

Next, we looked at Forest Law. So, we began with the Indian Forest Act 1927.

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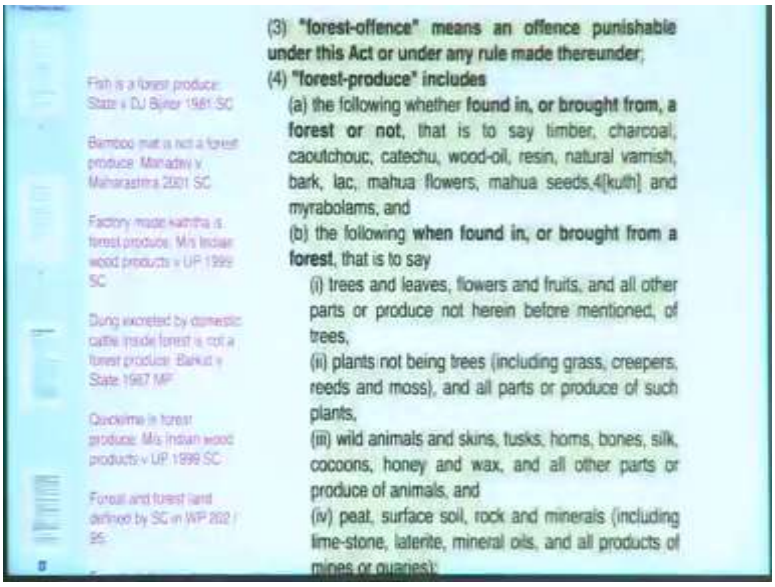

And,, we saw that in the case of the Indian Forest Act, you here you have defined the forest offense; you have the forest produce timber tree.

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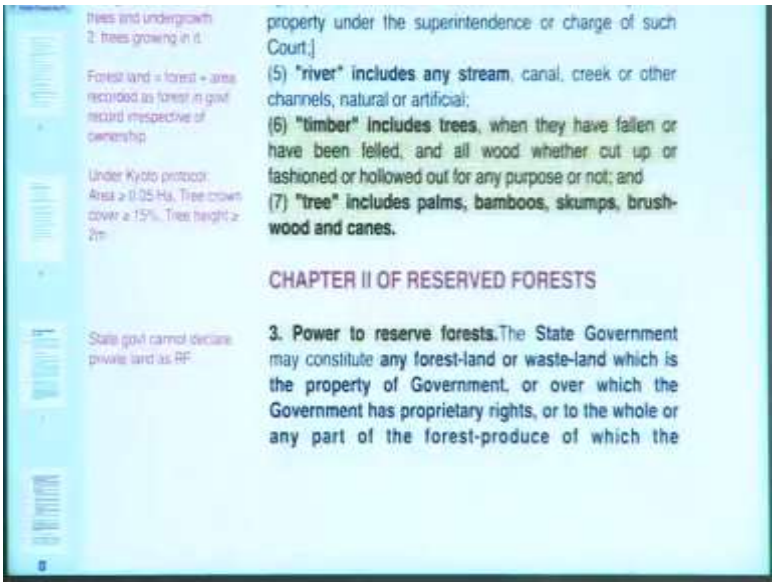

And, the government has the power to reserve the forest.

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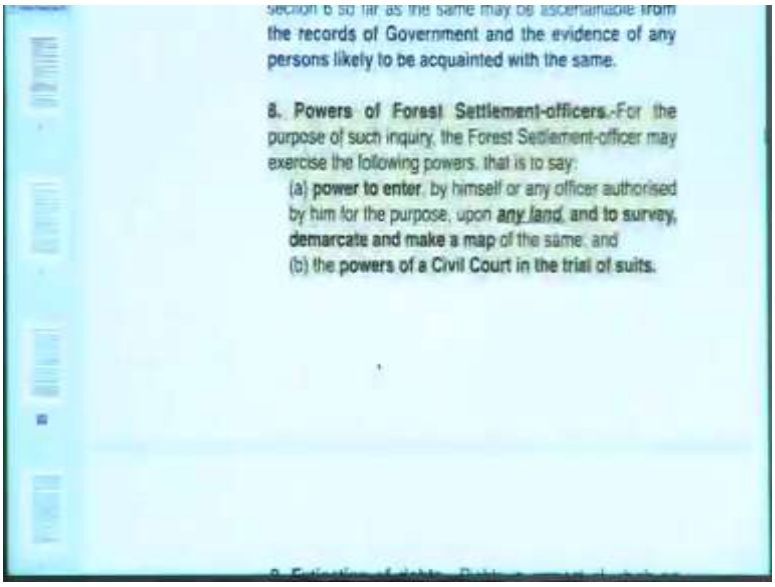

And, in the case of in the case of reservation of forest, the government needs to appoint for a settlement officer; the forest settlement officer has certain powers and.

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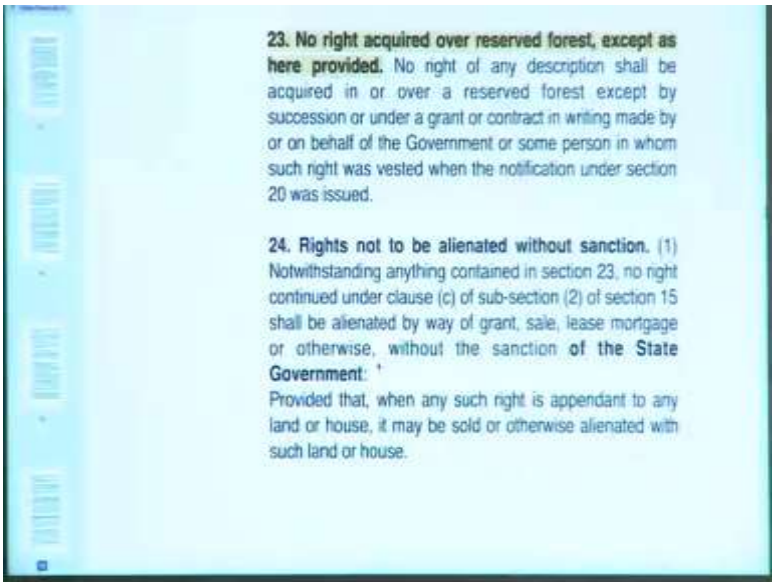

So, no right can be acquired over a reserve forest, except as here in provided.

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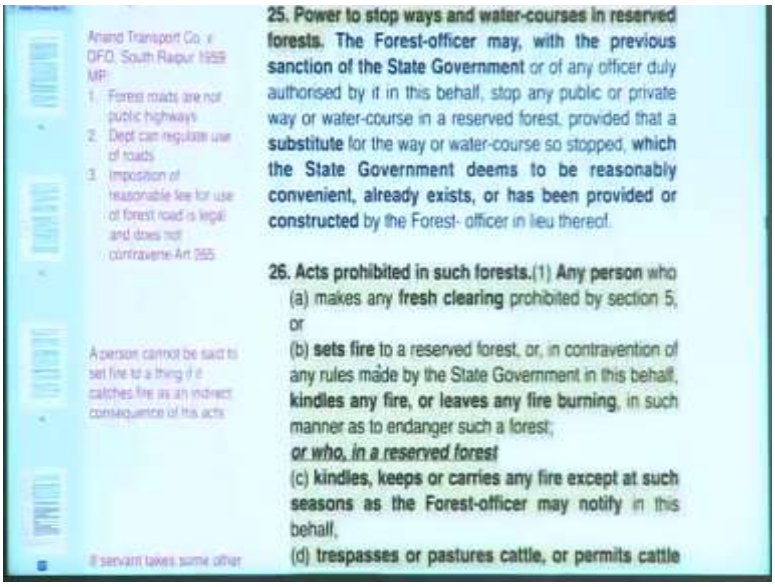

The government has the power to stop ways, and watercourses, and this power can be given to the forest officers by the government. Then, there are certain acts that are prohibited in such forest.

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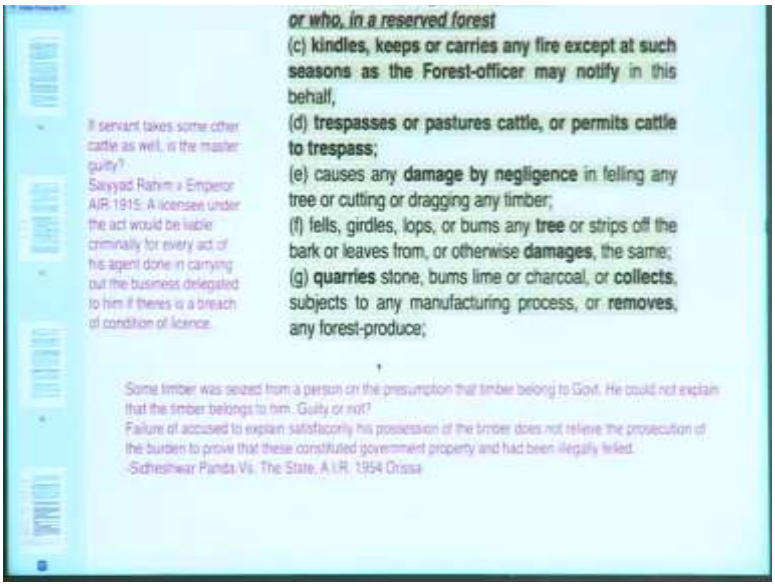

So, these laws are now providing powers to the forest officers to protect the forest.

So, what are the things that are prohibited; making a fresh clearing, setting fire, kindling any fire, leaving any fire burning, or trespassing, pasturing of cattle, damage by negligence damage of true trees

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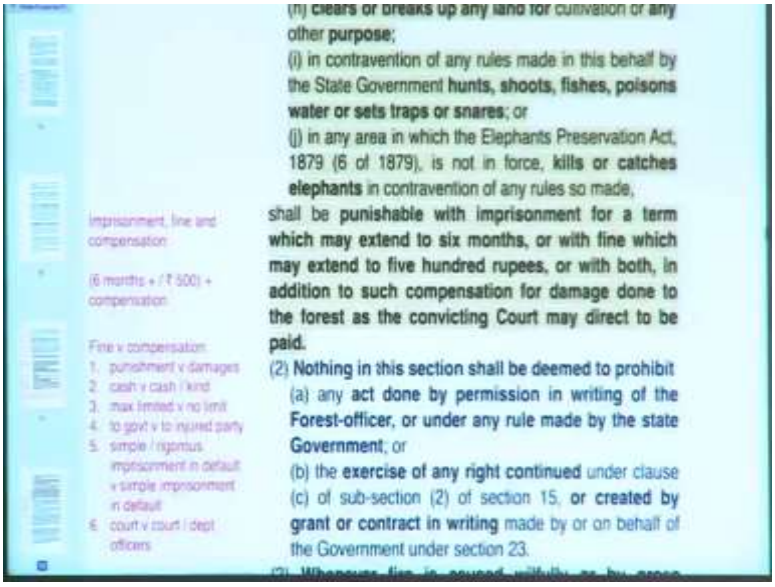

quarrying, collection, removal, breaking up or clearing of land for any purpose, hunting, shooting, fishing, poisoning water, setting traps or snares killing or catching elephants and so on.

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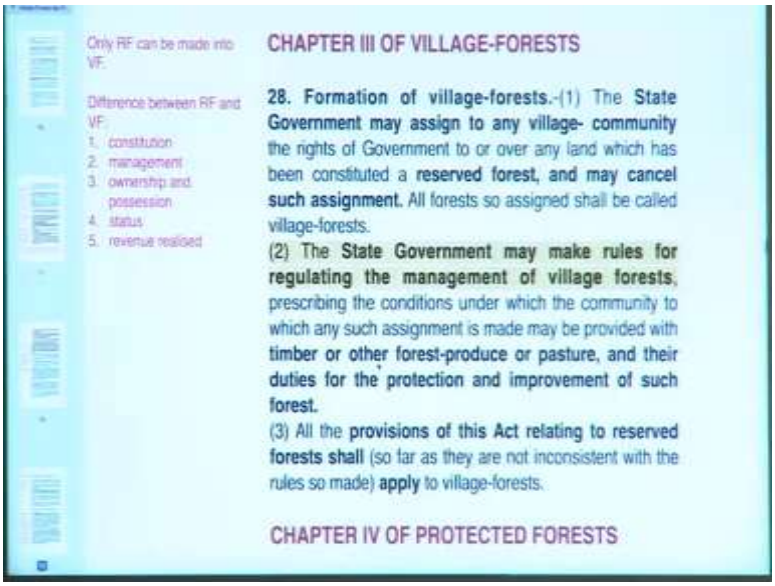

So, all these things are prohibited in a reserve forest. Next, we have village forest. And, the state government may make rules for regulating the management of village forest.

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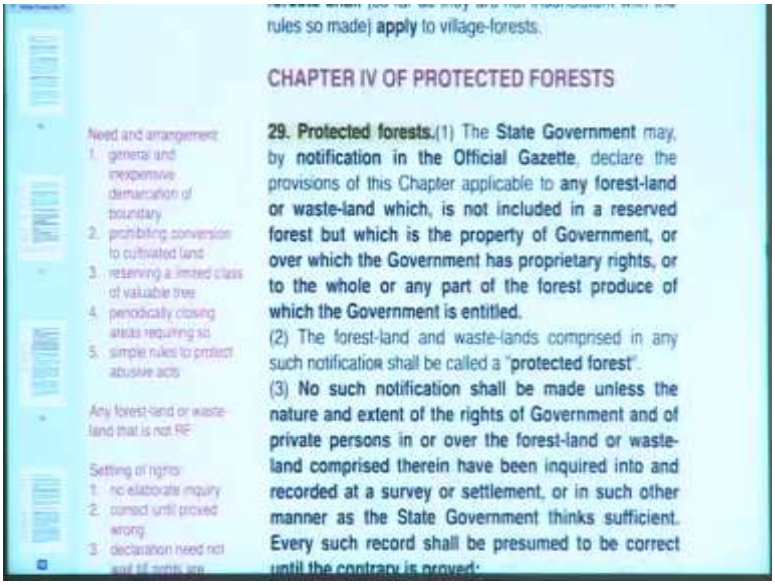

Then, we have protected forests.

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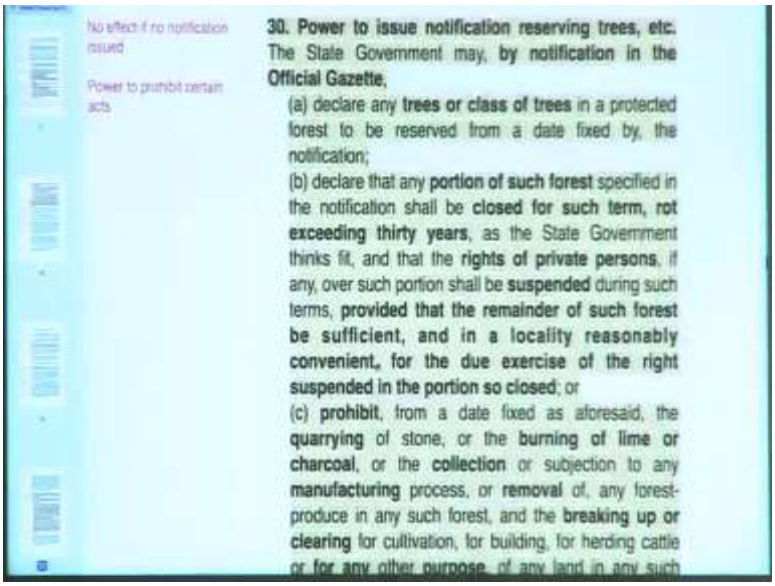

And, even in the case of protected forests, the government can declare any trees or classes of trees to be reserved. And then, you have no options of closing certain portions of the forest.

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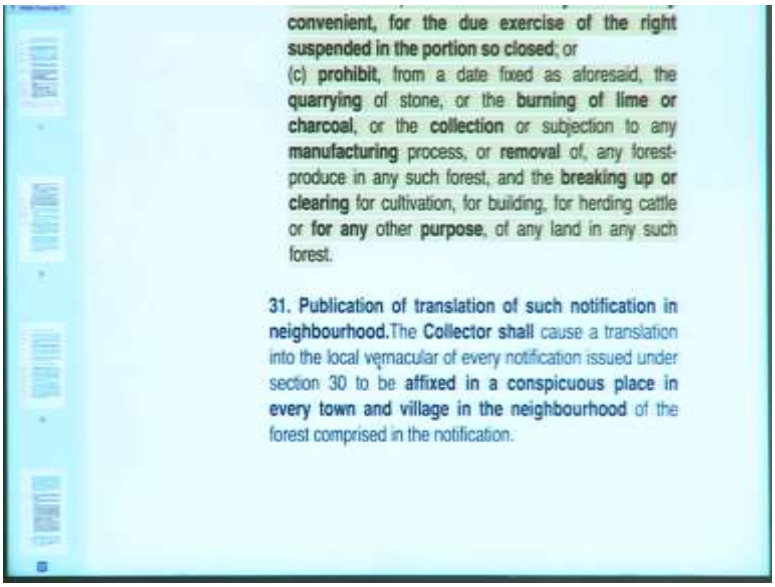

So, when you are closing it, then it is closed for grazing. Then, you have a prohibition of quarrying, burning of lime, charcoal, collection of collection and manufacturing, removal of forest produce, breaking up or clearing of land for cultivation, building, herding cattle or for any other purpose.

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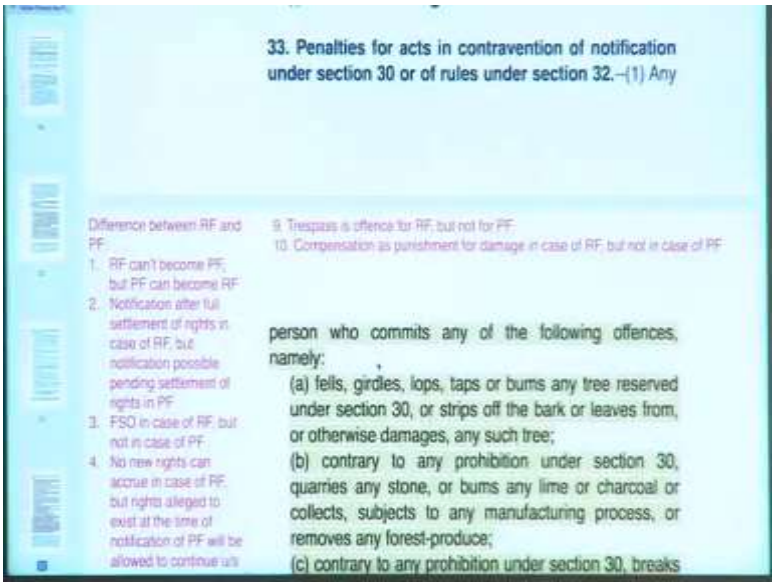

So, this was about the protected forest. Then, penalties have been set in.

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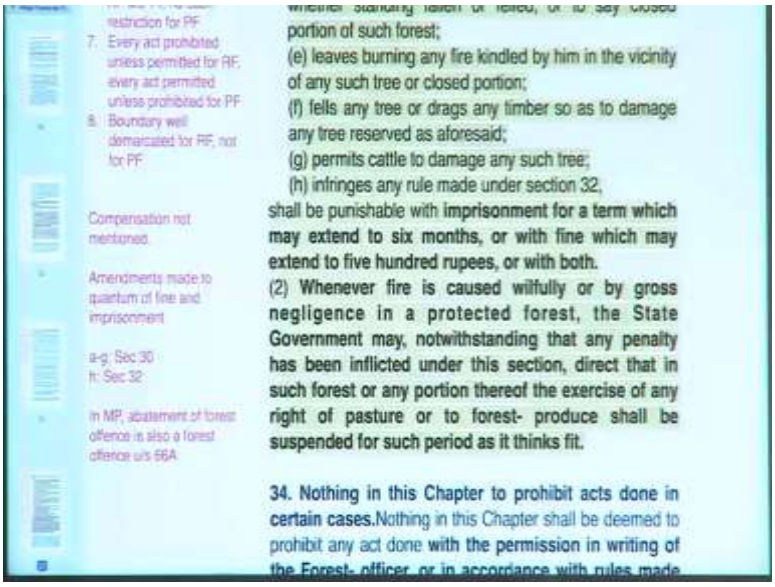

And, in the case of in Forest Act, the imprisonment is for a term which may extend to 6 months or with a fine; which may extend to 500 rupees or both.

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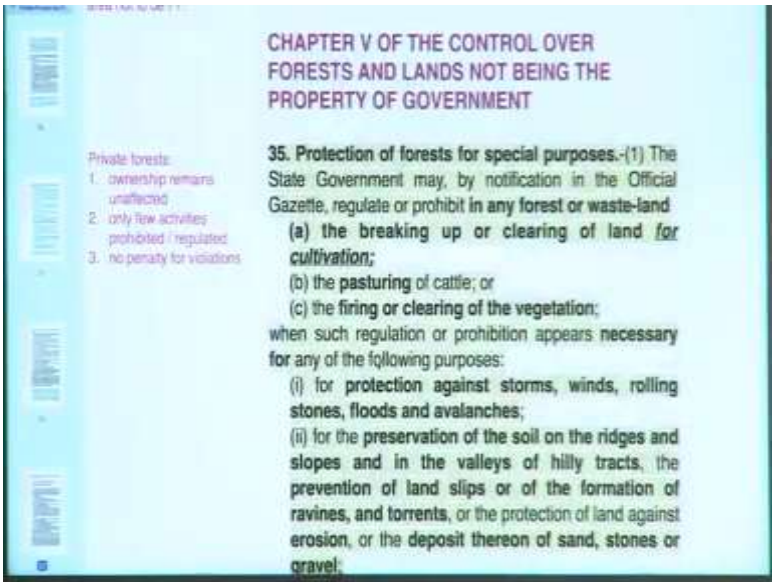

Then, we have the protection of forest for special purpose; this can be taken up by the government or for in.

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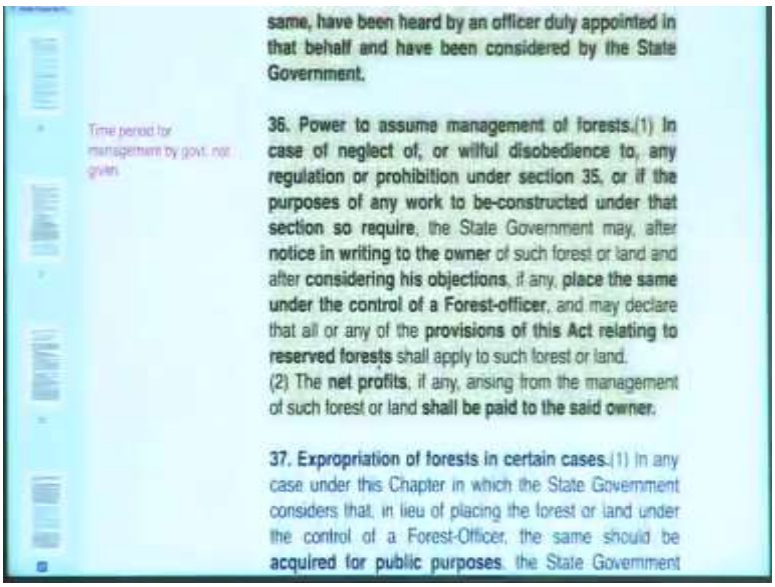

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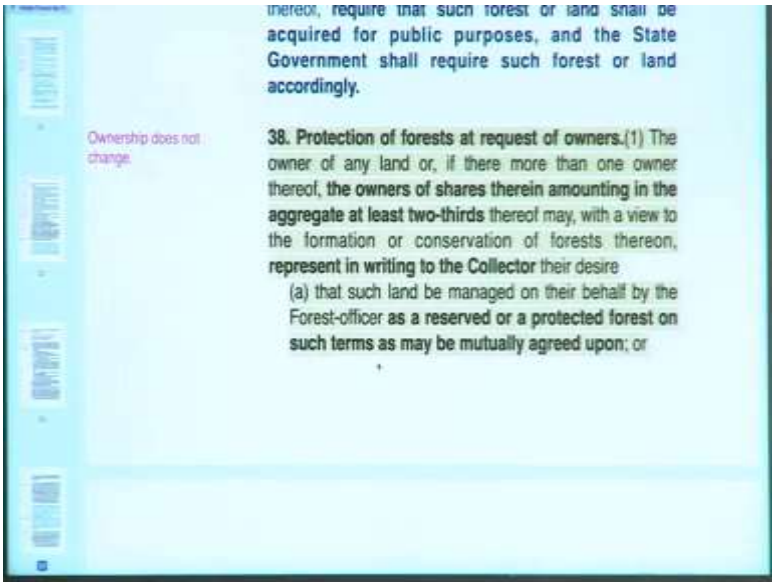

or in certain cases, the protection of forest can be done even at the request of the owners of the forest.

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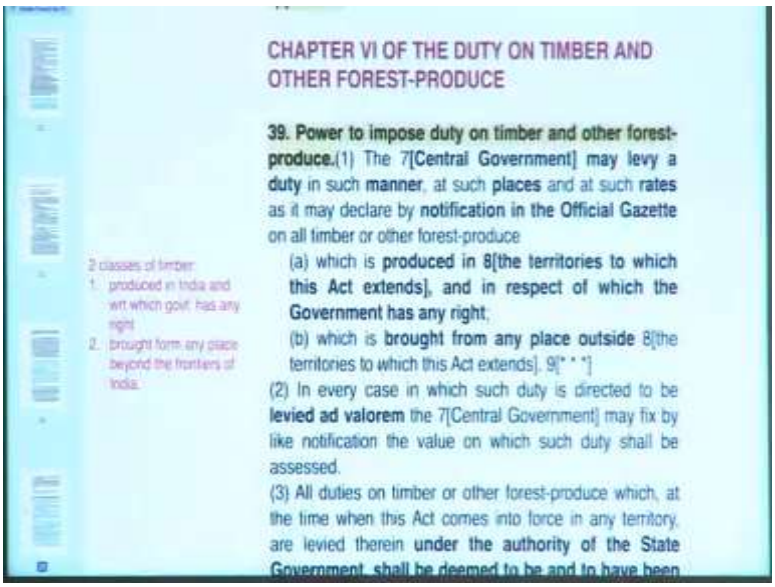

Then, the government can impose duty.

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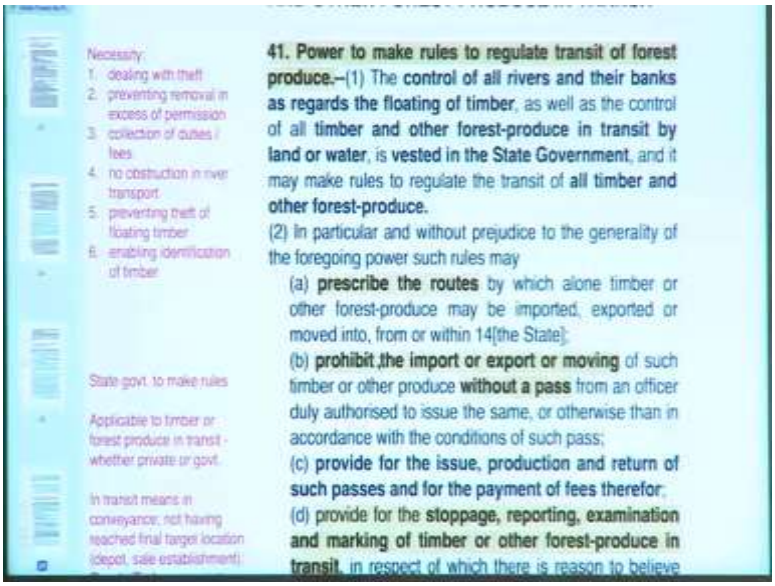

The government can decide what are or prescribe the routes from which the forest produce can be moved. We can have prohibition of import and export, and moving of timber and the produce without a pass.

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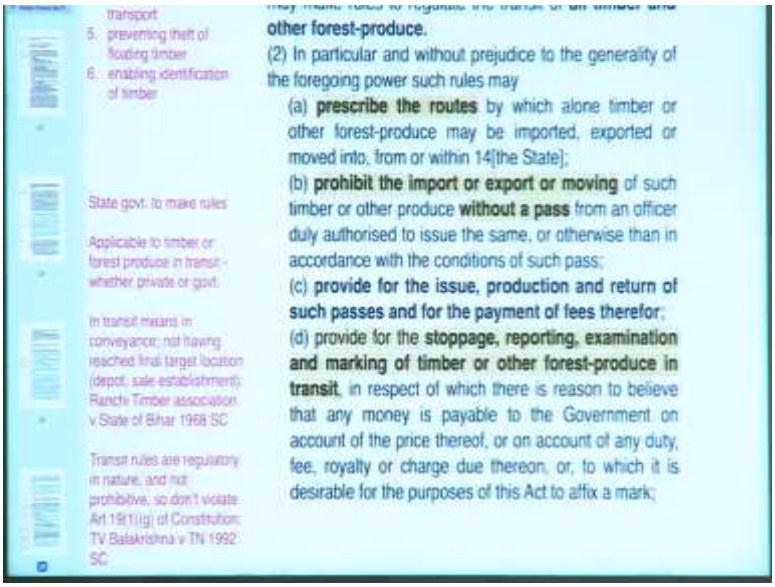

We can set up nakkas and chowkies where we can look at these forest produce, and we can stop people, we can there is a system of reporting examination and marking of timber, and other forest produce in transit.

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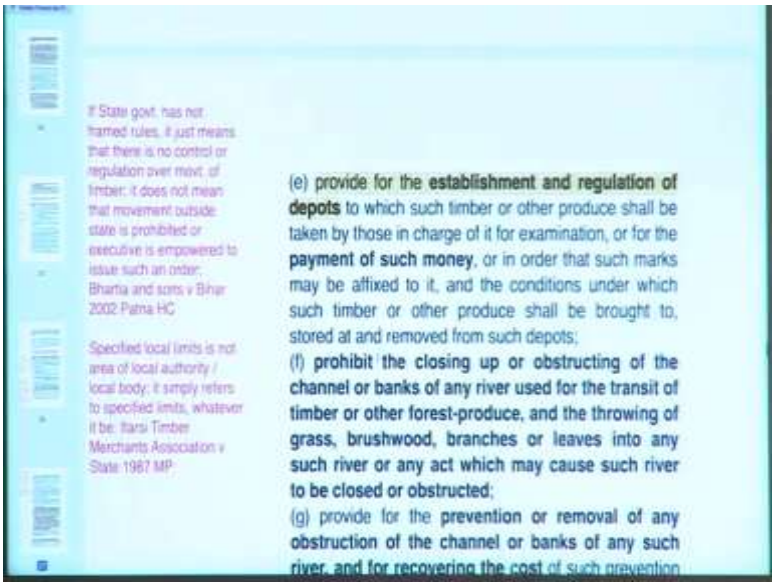

In which cases, you issue that transit passes. Then, you have provision for the establishment and regulation of depots and so on.

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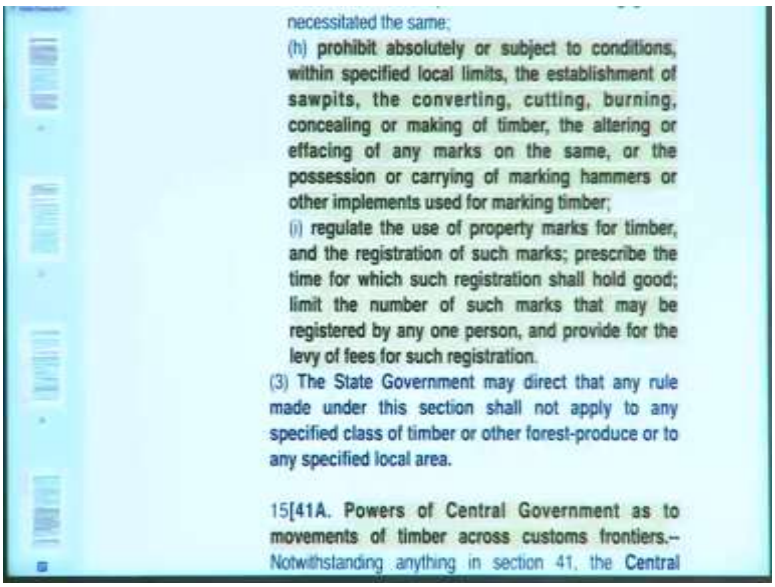

You can, the government can control where the sawpits will be will be set up or not set up. And, you have the converting, cutting, burning, concealing, marking of timber; all of these can be controlled.

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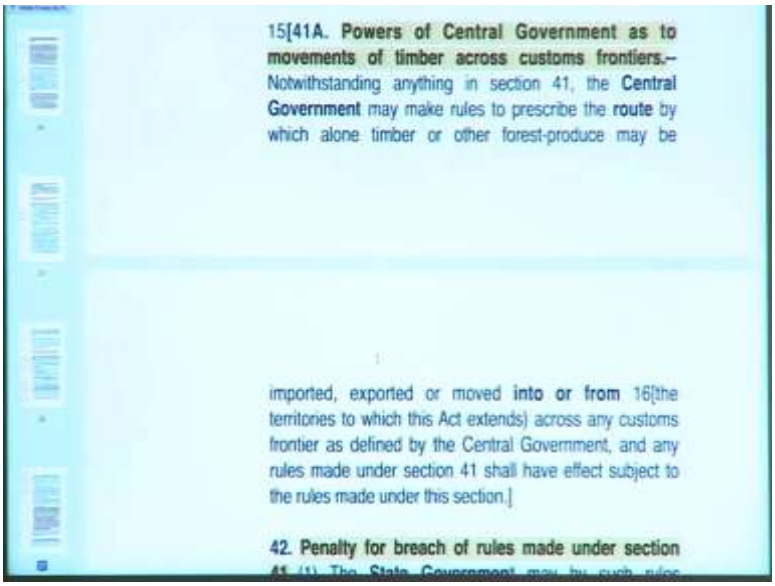

There is also a provision of use of property marks which we generally refer to as hammers.

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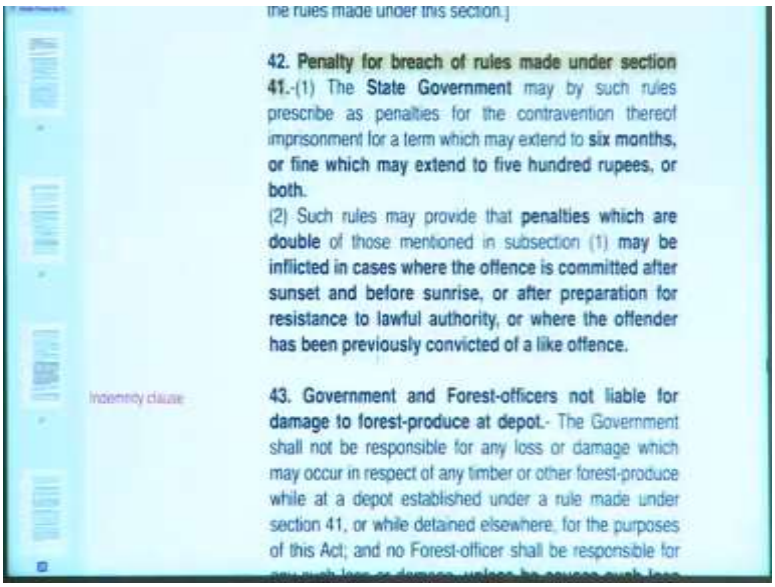

And then, you have the powers of the central government to the movement of timber across custom frontiers penalty for the breach of rules.

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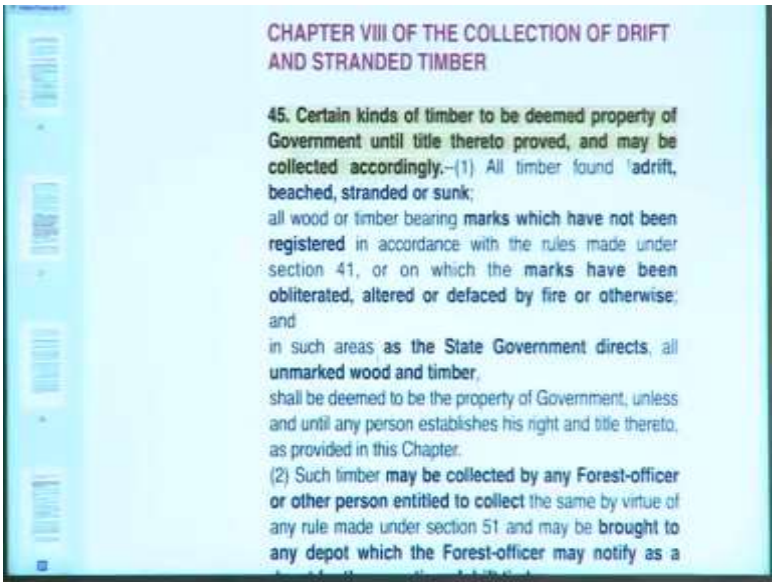

CHAPTER VIII OF THE COLLECTION OF DRIFT AND STRANDED TIMBER

45. Certain kinds of timber to be deemed property of Government until title thereto proved, and may be collected accordingly.–(1) All timber found **adrift, beached, stranded or sunk**;
all wood or timber bearing **marks which have not been registered** in accordance with the rules made under section 41, or on which the **marks have been obliterated, altered or defaced by fire or otherwise**; and
in such areas **as the State Government directs**, all **unmarked wood and timber**,
shall be deemed to be the property of Government, unless and until any person establishes his right and title thereto, as provided in this Chapter.
(2) Such timber **may be collected by any Forest-officer or other person entitled to collect** the same by virtue of any rule made under section 51 and may be **brought to any depot which the Forest-officer may notify as a**

Then, drift and standard timber are also government property. So, you cannot say that you found out a piece of timber which was just lying around.

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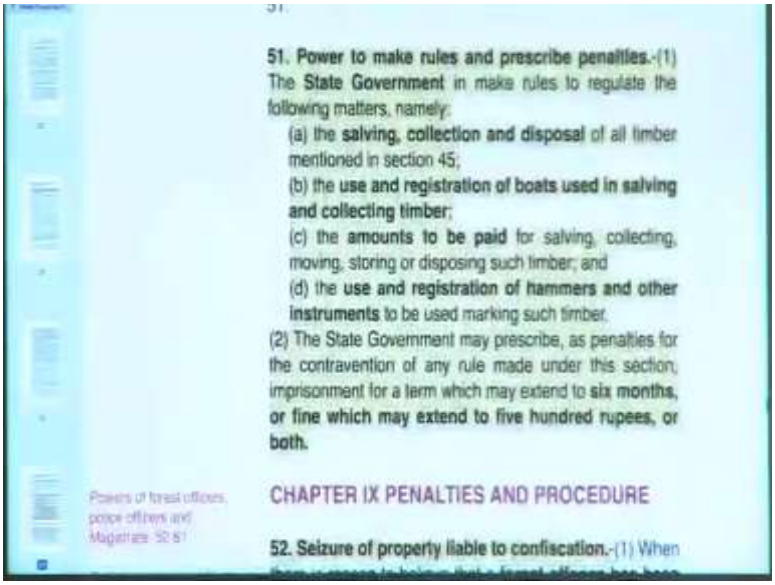

51. Power to make rules and prescribe penalties.-(1) The **State Government** in make rules to regulate the following matters, namely:
(a) the **salving, collection and disposal** of all timber mentioned in section 45;
(b) the **use and registration of boats used in salving and collecting timber**;
(c) the **amounts to be paid** for salving, collecting, moving, storing or disposing such timber; and
(d) the **use and registration of hammers and other instruments** to be used marking such timber.
(2) The State Government may prescribe, as penalties for the contravention of any rule made under this section, imprisonment for a term which may extend to **six months, or fine which may extend to five hundred rupees, or both.**

Powers of forest officers, police officers and Magistrate 52 61

CHAPTER IX PENALTIES AND PROCEDURE

52. Seizure of property liable to confiscation.-(1) When

And then, government has a power to make a rules and prescribe penalties there can be a seizure.

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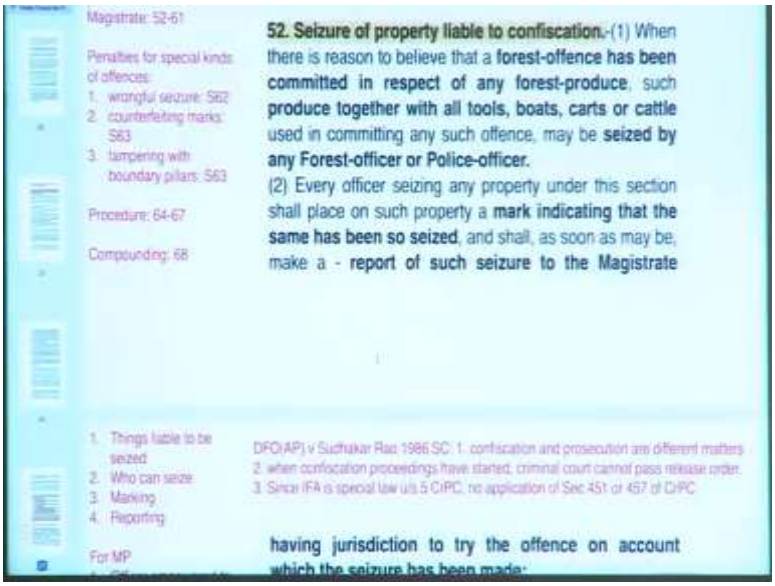

So, if somebody is doing a forest offense, then the forest produce together with the tools, equipments, carts. Animals; whatever is being used for doing this forest offense, they can be seized and they can even be confiscated. When something is confiscated, it becomes a government property.

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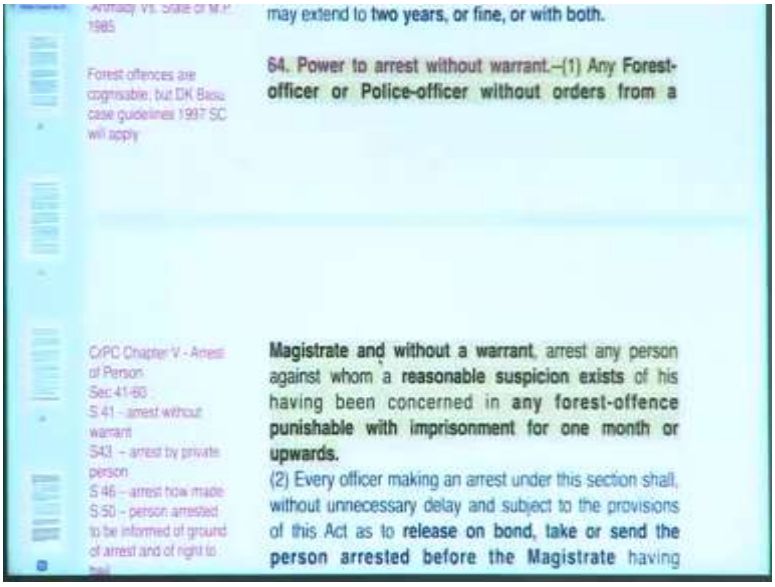

Then, we have the power to arrest without warrant. So, everything is cognizable.

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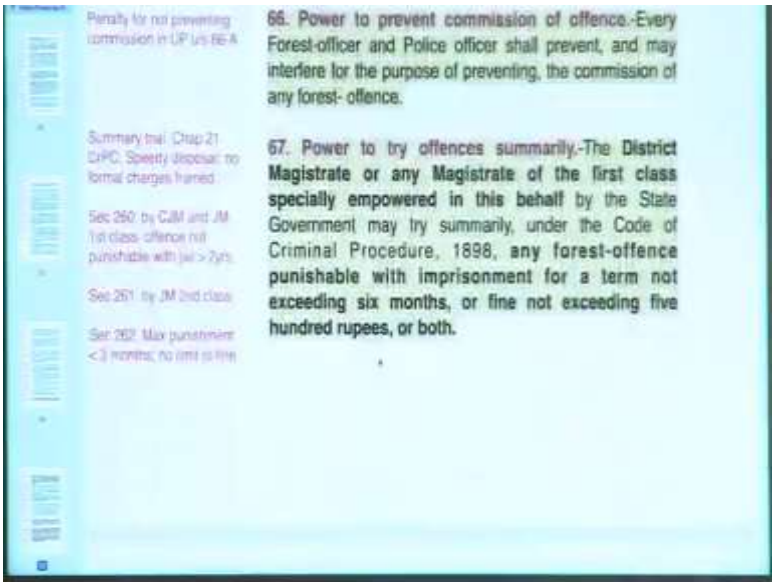

And, power to prevent commission of offence, power to try offenses summarily, power to compound the offenses.

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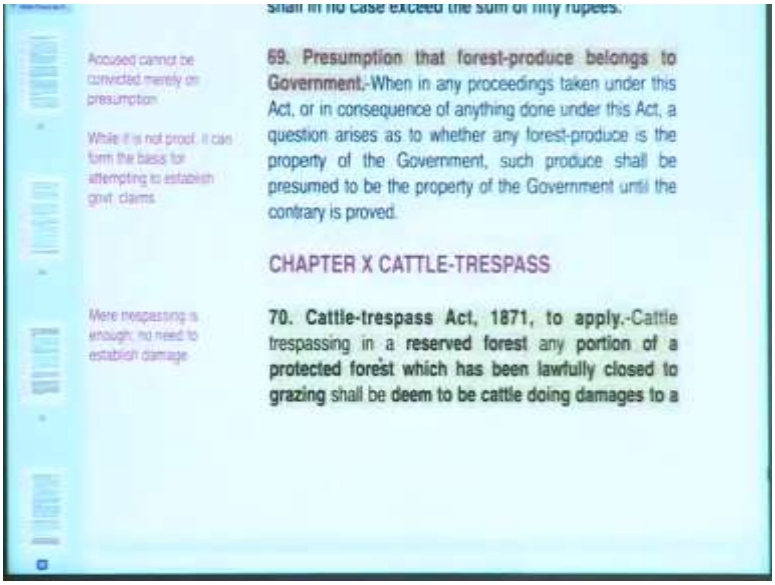

There is a presumption that all the forest-produce belongs to the government. Cattle trespass act still applies.

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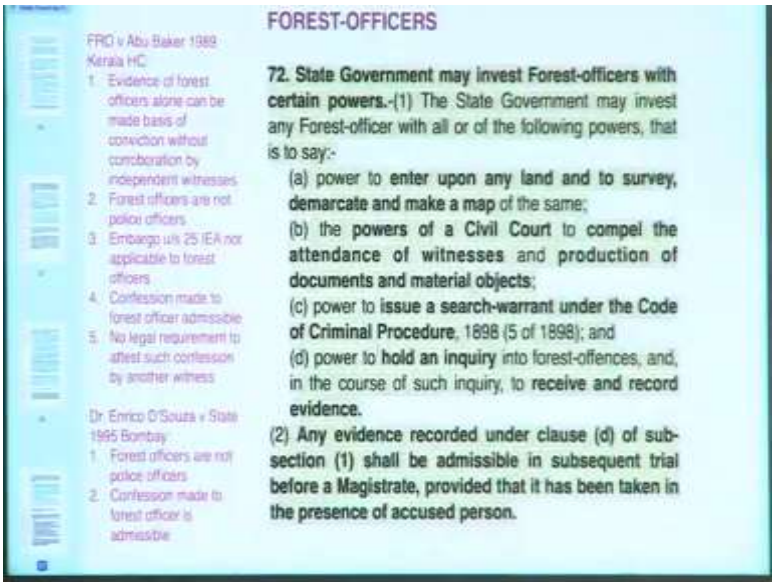

And, the government may invest forest officers with certain powers such as power to enter upon any land, survey any land, demarcate any land, make a map of any land. Powers of a civil court to compel the attendance of witnesses, production of documents and material objects, power to issue a search warrant under CrPC power to hold an inquiry to receive and record the evidence.

And, all such evidence shall be admissible in the subsequent trial before a magistrate provided that it has been taken in the presence of the accused person.

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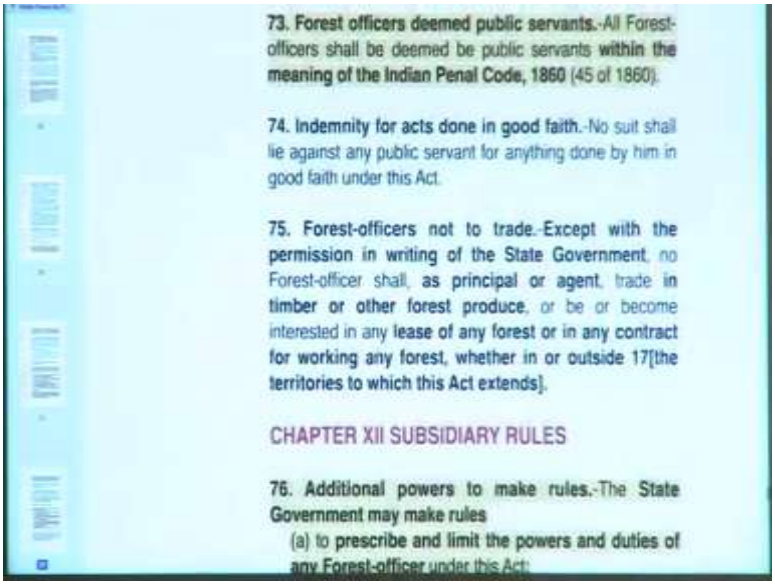

And, the forest officers are deemed to be public servants.

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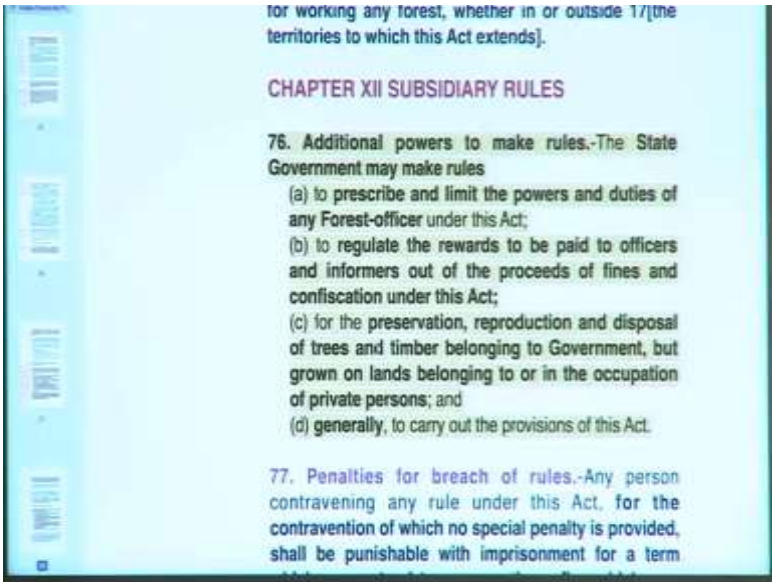

And, the government also has the power to make additional rules. So, this is about the Indian Forest Act.

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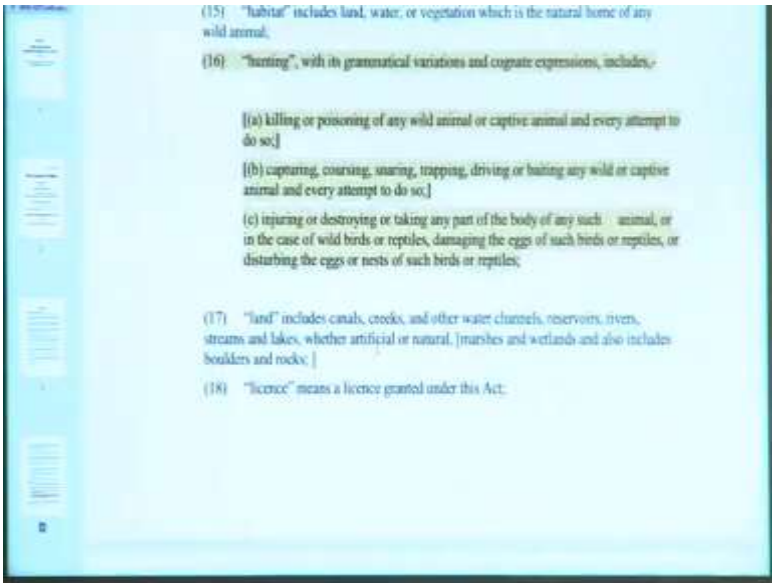

Next, in the Wildlife Protection Act, we saw that hunting is defined in a very large terms.

So, killing of animals, poisoning of wild animal or captive animal, or every attempt to do so; capturing, coursing, snaring, trapping, driving, beating of any wild or captive animal,

and every attempt to do so; injuring, destroying or taking any part of the body of such animal; or in the case of wild birds or reptiles, damaging the eggs of such birds or reptiles, or disturbing the eggs or nests of such birds or reptiles; all of these are hunting.

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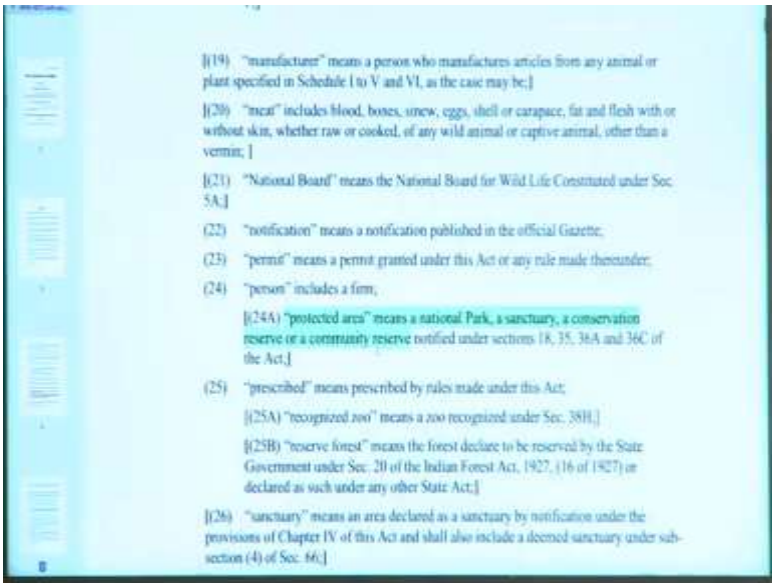

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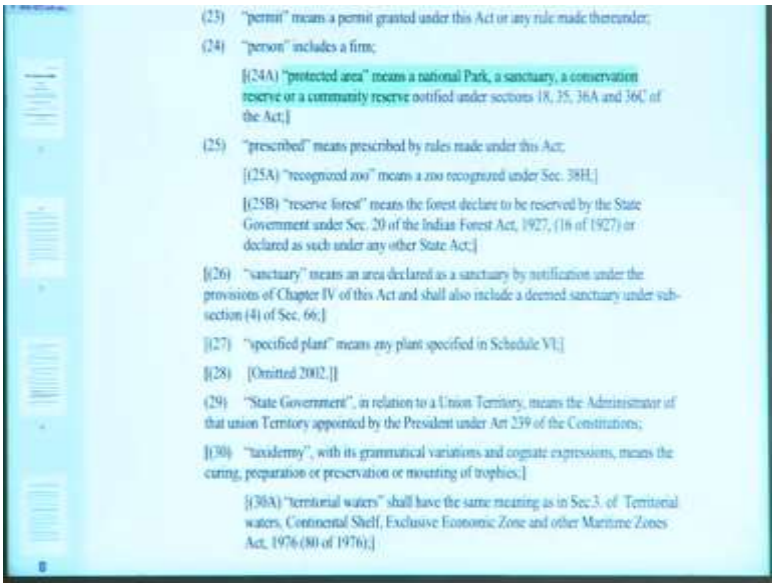

Now, protected area means national park, sanctuary, conservation reserve, or a community reserve. So, these are the four different kinds of protected areas that the wildlife protection act sets up.

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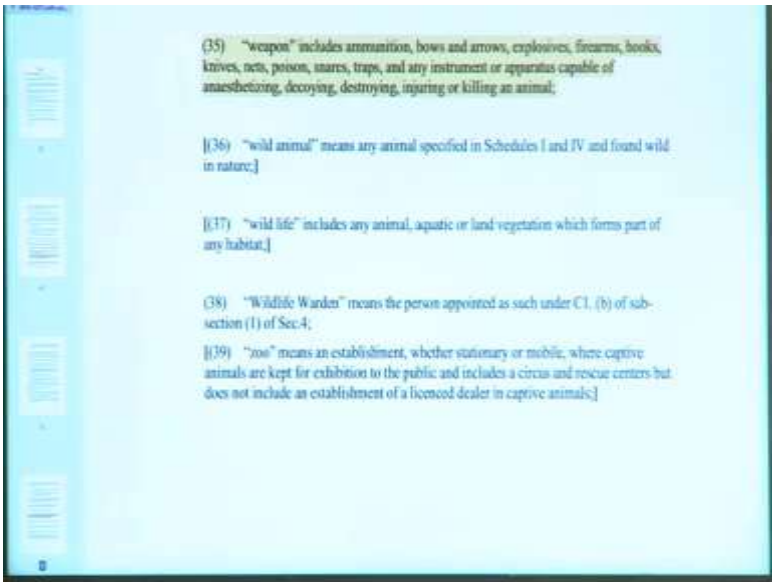

Then, we have weapon which includes ammunition, bows, arrows, explosives, firearms, hooks, knives, nets, poison, snare, trap or any equipment or apparatus capable of anesthetizing, decoying, destroying, injuring or killing an animal.

So, for instance, if somebody goes into a forest with the darting gun and uses that darting gun to immobilize an animal and to capture that animal; so, in this case, this darting gun becomes a weapon, because it is something that is capable of anesthetizing the animal. And, the act of immobilizing or anesthetizing the animal or even the attempt is hunting as per the Wildlife Protection Act.

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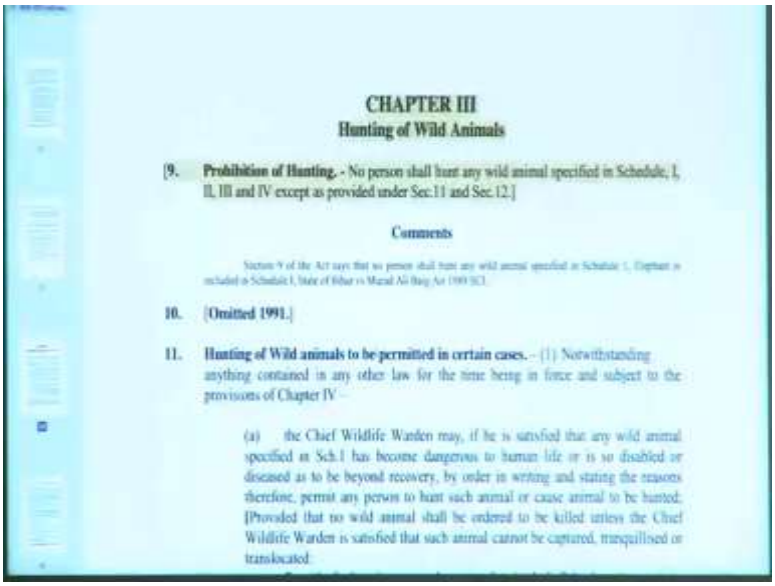

CHAPTER III

Hunting of Wild Animals

[9. **Prohibition of Hunting.** - No person shall hunt any wild animal specified in Schedule, I, II, III and IV except as provided under Sec.11 and Sec.12.]

Comments

Section 9 of the Act says that no person shall hunt any wild animal specified in Schedule 1, Elephant is included in Schedule I, State of Bihar vs Murad Ali Baig Air 1989 SC]

10. [Omitted 1991.]

11. **Hunting of Wild animals to be permitted in certain cases.** – (1) Notwithstanding anything contained in any other law for the time being in force and subject to the provisions of Chapter IV –

(a) the Chief Wildlife Warden may, if he is satisfied that any wild animal specified in Sch.1 has become dangerous to human life or is so disabled or diseased as to be beyond recovery, by order in writing and stating the reasons therefore, permit any person to hunt such animal or cause animal to be hunted; [Provided that no wild animal shall be ordered to be killed unless the Chief Wildlife Warden is satisfied that such animal cannot be captured, tranquillised or translocated

Then, we have prohibition of hunting under Section 9. So, in this case, we have a prohibition of hunting; there is not a ban on hunting. So, basically, you cannot do hunting unless otherwise permitted as per Section 11 or Section 12.

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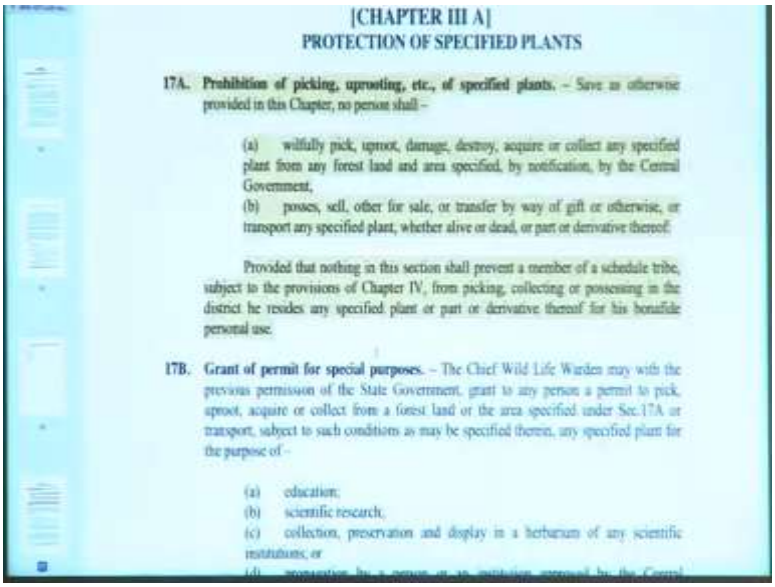

[CHAPTER III A]

PROTECTION OF SPECIFIED PLANTS

17A. **Prohibition of picking, uprooting, etc., of specified plants.** – Save as otherwise provided in this Chapter, no person shall –

(a) wilfully pick, uproot, damage, destroy, acquire or collect any specified plant from any forest land and area specified, by notification, by the Central Government,

(b) posses, sell, other for sale, or transfer by way of gift or otherwise, or transport any specified plant, whether alive or dead, or part or derivative thereof.

Provided that nothing in this section shall prevent a member of a schedule tribe, subject to the provisions of Chapter IV, from picking, collecting or possessing in the district he resides any specified plant or part or derivative thereof for his bonafide personal use.

17B. **Grant of permit for special purposes.** – The Chief Wild Life Warden may with the previous permission of the State Government, grant to any person a permit to pick, uproot, acquire or collect from a forest land or the area specified under Sec.17A or transport, subject to such conditions as may be specified therein, any specified plant for the purpose of –

(a) education;

(b) scientific research;

(c) collection, preservation and display in a herbarium of any scientific institutions; or

Next, we looked at a prohibition of picking, uprooting etcetera of specified plants.

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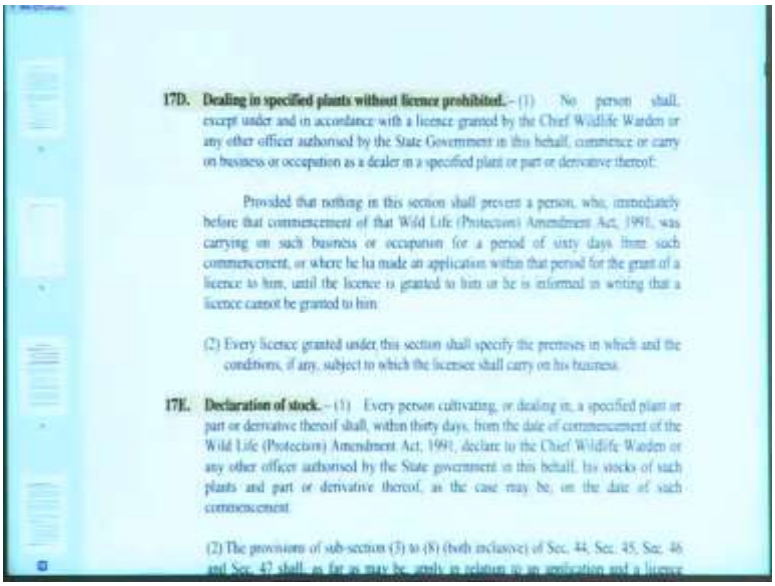

17D. **Dealing in specified plants without licence prohibited.**– (1) No person shall, except under and in accordance with a licence granted by the Chief Wildlife Warden or any other officer authorised by the State Government in this behalf, commence or carry on business or occupation as a dealer in a specified plant or part or derivative thereof:

Provided that nothing in this section shall prevent a person, who, immediately before that commencement of that Wild Life (Protection) Amendment Act, 1991, was carrying on such business or occupation for a period of sixty days from such commencement, or where he ha made an application within that period for the grant of a licence to him, until the licence is granted to him or he is informed in writing that a licence cannot be granted to him

(2) Every licence granted under this section shall specify the premises in which and the conditions, if any, subject to which the licensee shall carry on his business.

17E. **Declaration of stock.**– (1) Every person cultivating, or dealing in, a specified plant or part or derivative thereof shall, within thirty days, from the date of commencement of the Wild Life (Protection) Amendment Act, 1991, declare to the Chief Wildlife Warden or any other officer authorised by the State government in this behalf, his stocks of such plants and part or derivative thereof, as the case may be, on the date of such commencement

(2) The provisions of sub-section (3) to (8) (both inclusive) of Sec. 44, Sec. 45, Sec. 46 and Sec. 47 shall, as far as may be, apply in relation to an application and a licence

So, Wildlife Protection Act even protects the plants; dealing in plants prohibited without license declaration of stock, position, purchase; plants to be government property.

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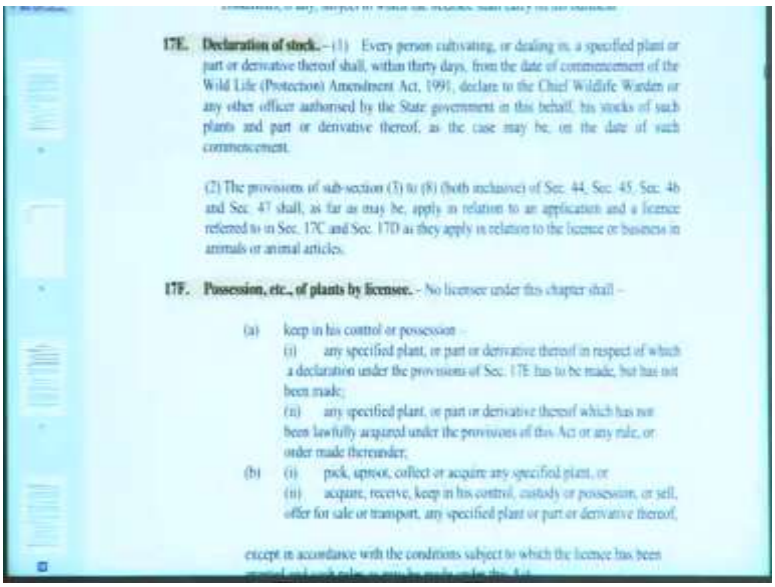

17E. **Declaration of stock.**– (1) Every person cultivating, or dealing in, a specified plant or part or derivative thereof shall, within thirty days, from the date of commencement of the Wild Life (Protection) Amendment Act, 1991, declare to the Chief Wildlife Warden or any other officer authorised by the State government in this behalf, his stocks of such plants and part or derivative thereof, as the case may be, on the date of such commencement.

(2) The provisions of sub-section (3) to (8) (both inclusive) of Sec. 44, Sec. 45, Sec. 46 and Sec. 47 shall, as far as may be, apply in relation to an application and a licence referred to in Sec. 17C and Sec. 17D as they apply in relation to the licence or business in animals or animal articles.

17F. **Possession, etc., of plants by licensee.** – No licensee under this chapter shall –

(a) keep in his control or possession –
(i) any specified plant, or part or derivative thereof in respect of which a declaration under the provisions of Sec. 17E has to be made, but has not been made;
(ii) any specified plant, or part or derivative thereof which has not been lawfully acquired under the provisions of this Act or any rule, or order made thereunder;
(b) (i) pick, uproot, collect or acquire any specified plant, or
(ii) acquire, receive, keep in his control, custody or possession, or sell, offer for sale or transport, any specified plant or part or derivative thereof,

except in accordance with the conditions subject to which the licence has been

So, all these things are being regulated by the wildlife protection act. Then, you have declaration of the sanctuary; and, once a sanctuary is declared, there are certain restrictions

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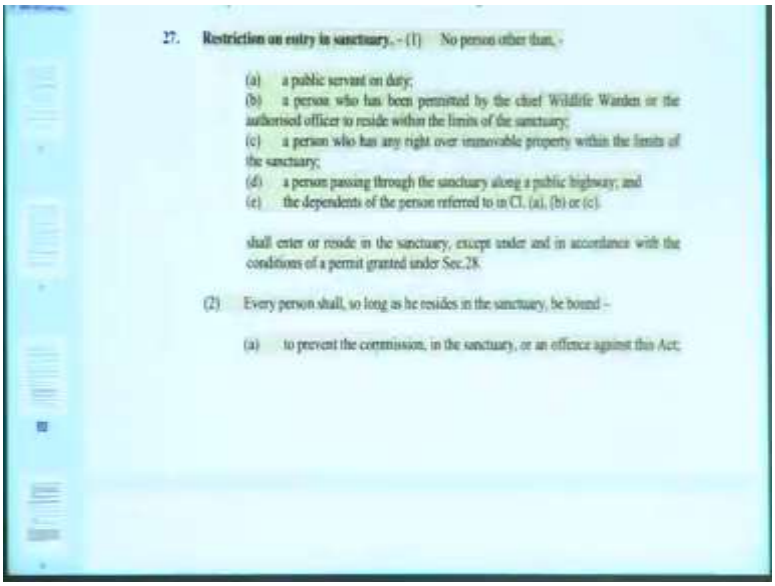

So, no person other than a public servant on duty; a person who has been permitted by the wildlife warden or the authorized officer to decide within the limits of the sanctuary; a person who has any right over immovable property within the limits of the sanctuary; a person passing through us the sanctuary along a public highway; and the dependents shall enter or reside except under and in accordance with the conditions of the permit. And, every person shall so long as he resides in the sanctuary.

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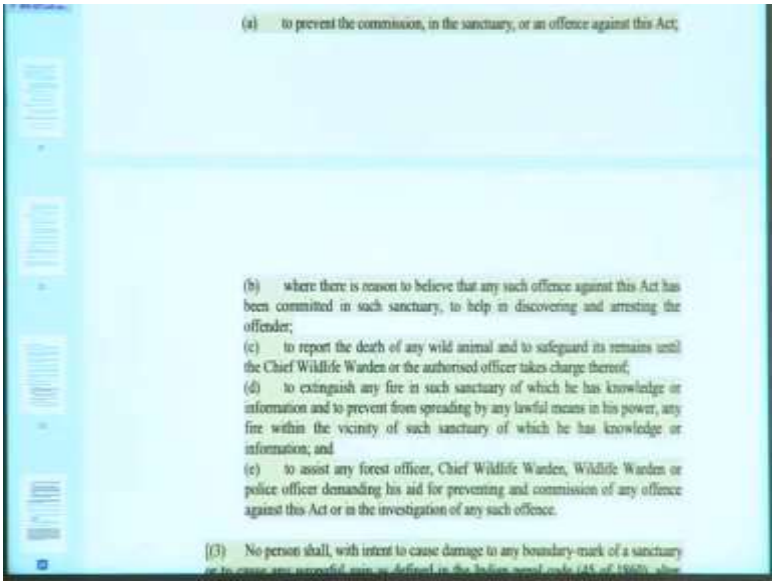

So, every person is bound to do certain things, such as prevention of commission of an offense.

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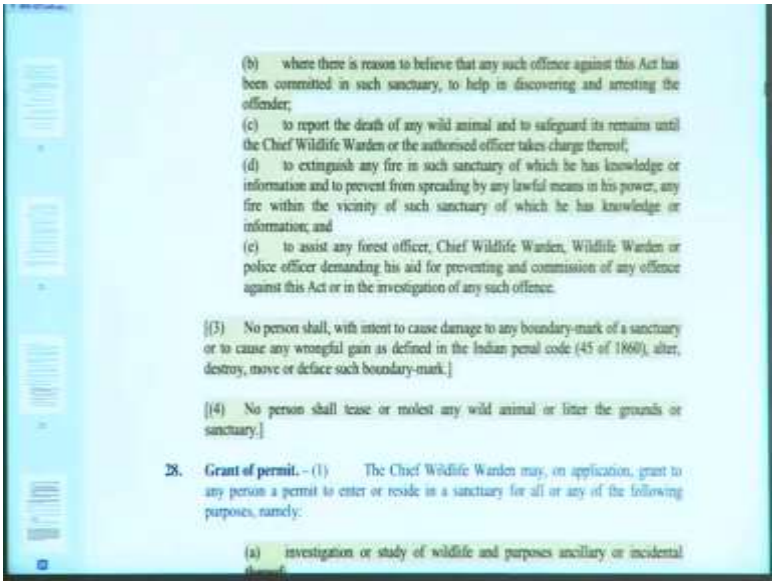

(b) where there is reason to believe that any such offence against this Act has been committed in such sanctuary, to help in discovering and arresting the offender;
(c) to report the death of any wild animal and to safeguard its remains until the Chief Wildlife Warden or the authorised officer takes charge thereof;
(d) to extinguish any fire in such sanctuary of which he has knowledge or information and to prevent from spreading by any lawful means in his power, any fire within the vicinity of such sanctuary of which he has knowledge or information; and
(e) to assist any forest officer, Chief Wildlife Warden, Wildlife Warden or police officer demanding his aid for preventing and commission of any offence against this Act or in the investigation of any such offence.

[(3) No person shall, with intent to cause damage to any boundary-mark of a sanctuary or to cause any wrongful gain as defined in the Indian penal code (45 of 1860), alter, destroy, move or deface such boundary-mark.]

[(4) No person shall tease or molest any wild animal or litter the grounds or sanctuary.]

28. **Grant of permit.** – (1) The Chief Wildlife Warden may, on application, grant to any person a permit to enter or reside in a sanctuary for all or any of the following purposes, namely:

(a) investigation or study of wildlife and purposes ancillary or incidental thereof;

If any as such offense has been done, to help in discovering and arresting the offender to report the death of wild animals and so on.

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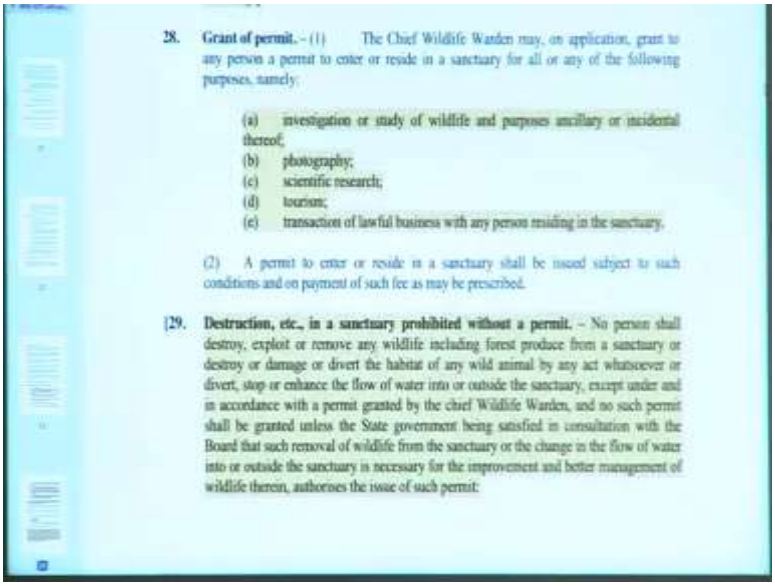

28. **Grant of permit.** – (1) The Chief Wildlife Warden may, on application, grant to any person a permit to enter or reside in a sanctuary for all or any of the following purposes, namely:

(a) investigation or study of wildlife and purposes ancillary or incidental thereof;
(b) photography;
(c) scientific research;
(d) tourism;
(e) transaction of lawful business with any person residing in the sanctuary.

(2) A permit to enter or reside in a sanctuary shall be issued subject to such conditions and on payment of such fee as may be prescribed.

[29. **Destruction, etc., in a sanctuary prohibited without a permit.** – No person shall destroy, exploit or remove any wildlife including forest produce from a sanctuary or destroy or damage or divert the habitat of any wild animal by any act whatsoever or divert, stop or enhance the flow of water into or outside the sanctuary, except under and in accordance with a permit granted by the chief Wildlife Warden, and no such permit shall be granted unless the State government being satisfied in consultation with the Board that such removal of wildlife from the sanctuary or the change in the flow of water into or outside the sanctuary is necessary for the improvement and better management of wildlife therein, authorises the issue of such permit:

Next, certain permits can be granted. So, even regulation; even the granting of permits is regulated by this act; destruction etcetera in a sanctuary is prohibited without a permit,

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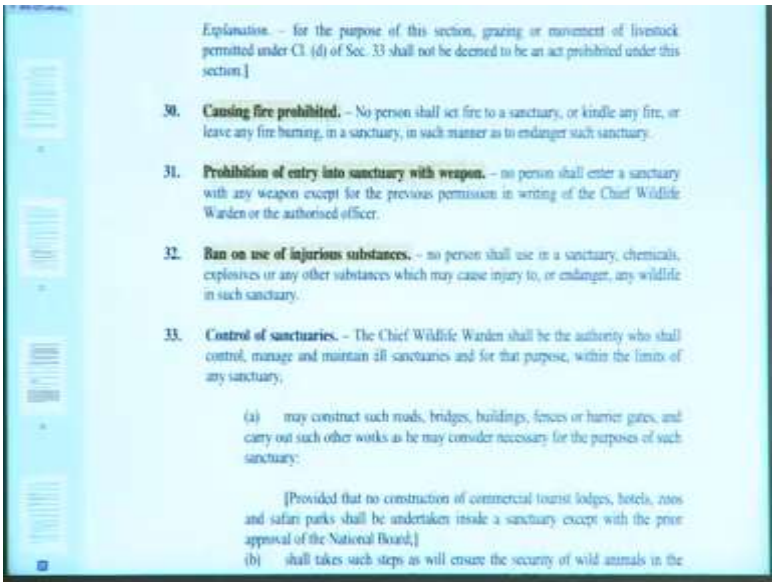

Explanation. – for the purpose of this section, grazing or movement of livestock permitted under Cl. (d) of Sec. 33 shall not be deemed to be an act prohibited under this section.]

30. **Causing fire prohibited.** – No person shall set fire to a sanctuary, or kindle any fire, or leave any fire burning, in a sanctuary, in such manner as to endanger such sanctuary.

31. **Prohibition of entry into sanctuary with weapon.** – no person shall enter a sanctuary with any weapon except for the previous permission in writing of the Chief Wildlife Warden or the authorised officer.

32. **Ban on use of injurious substances.** – no person shall use in a sanctuary, chemicals, explosives or any other substances which may cause injury to, or endanger, any wildlife in such sanctuary.

33. **Control of sanctuaries.** – The Chief Wildlife Warden shall be the authority who shall control, manage and maintain all sanctuaries and for that purpose, within the limits of any sanctuary,

(a) may construct such roads, bridges, buildings, fences or barrier gates, and carry out such other works as he may consider necessary for the purposes of such sanctuary:

[Provided that no construction of commercial tourist lodges, hotels, zoos and safari parks shall be undertaken inside a sanctuary except with the prior approval of the National Board;]

(b) shall takes such steps as will ensure the security of wild animals in the

causing a fire prohibited, prohibition of entry into sanctuary with a weapon.

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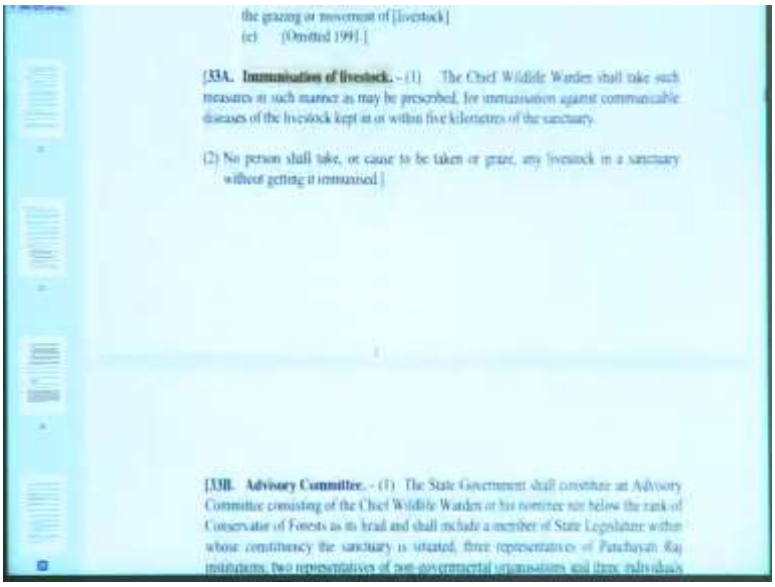

the grazing or movement of [livestock]

(c) [Omitted 1991.]

[33A. **Immunisation of livestock.** – (1) The Chief Wildlife Warden shall take such measures in such manner as may be prescribed, for immunisation against communicable diseases of the livestock kept in or within five kilometres of the sanctuary.

(2) No person shall take, or cause to be taken or graze, any livestock in a sanctuary without getting it immunised.]

[33B. **Advisory Committee.** – (1) The State Government shall constitute an Advisory Committee consisting of the Chief Wildlife Warden or his nominee not below the rank of Conservator of Forests as its head and shall include a member of State Legislature within whose constituency the sanctuary is situated, three representatives of Panchayati Raj institutions, two representatives of non-governmental organisations and three individuals

ban on use of injurious substances, immunization of livestock, registration of persons in possession of arms, power to remove encroachment.

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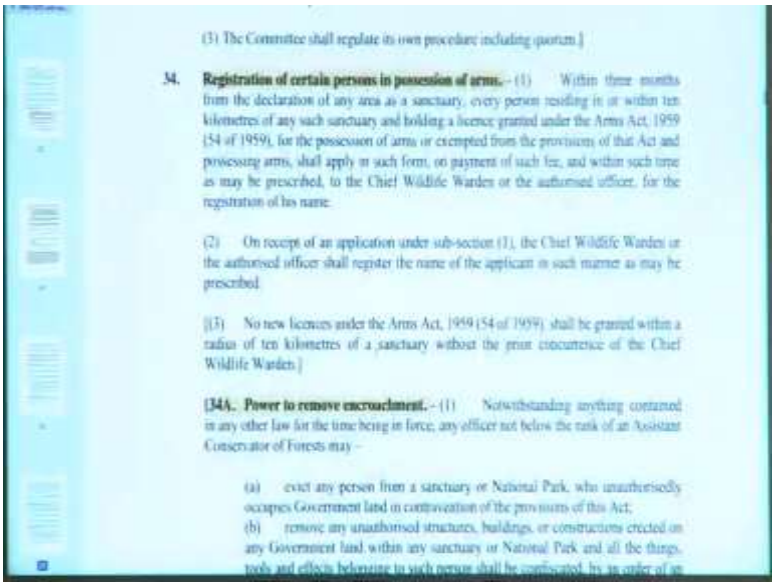

(3) The Committee shall regulate its own procedure including quorum.]

34. **Registration of certain persons in possession of arms.** – (1) Within three months from the declaration of any area as a sanctuary, every person residing in or within ten kilometres of any such sanctuary and holding a licence granted under the Arms Act, 1959 (54 of 1959), for the possession of arms or exempted from the provisions of that Act and possessing arms, shall apply in such form, on payment of such fee, and within such time as may be prescribed, to the Chief Wildlife Warden or the authorised officer, for the registration of his name.

(2) On receipt of an application under sub-section (1), the Chief Wildlife Warden or the authorised officer shall register the name of the applicant in such manner as may be prescribed.

[(3) No new licences under the Arms Act, 1959 (54 of 1959), shall be granted within a radius of ten kilometres of a sanctuary without the prior concurrence of the Chief Wildlife Warden.]

[34A. Power to remove encroachment. – (1) Notwithstanding anything contained in any other law for the time being in force, any officer not below the rank of an Assistant Conservator of Forests may –

(a) evict any person from a sanctuary or National Park, who unauthorisedly occupies Government land in contravention of the provisions of this Act;

(b) remove any unauthorised structures, buildings, or constructions erected on any Government land within any sanctuary or National Park and all the things, tools and effects belonging to such person shall be confiscated, by an order of an

Then, in the case of a national park, you have you again have a number of regulations about grazing; about other protection measures.

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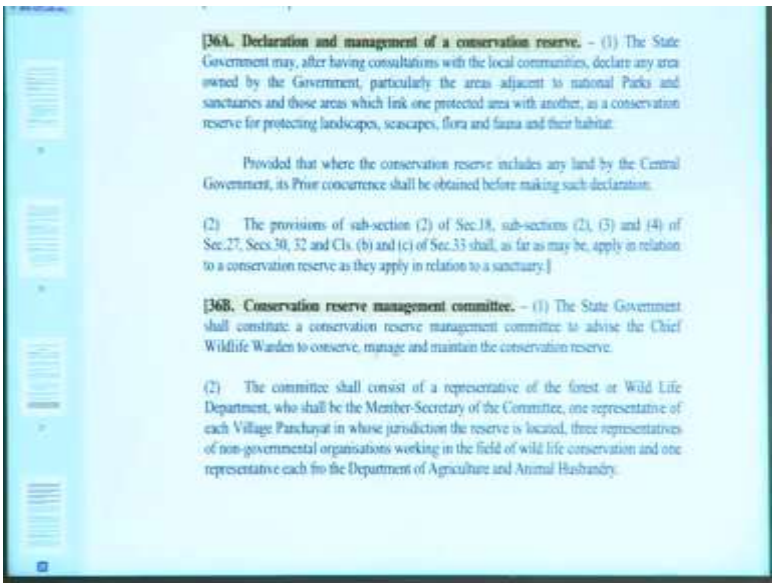

[36A. Declaration and management of a conservation reserve. – (1) The State Government may, after having consultations with the local communities, declare any area owned by the Government, particularly the areas adjacent to national Parks and sanctuaries and those areas which link one protected area with another, as a conservation reserve for protecting landscapes, seascapes, flora and fauna and their habitat.

Provided that where the conservation reserve includes any land by the Central Government, its Prior concurrence shall be obtained before making such declaration.

(2) The provisions of sub-section (2) of Sec.18, sub-sections (2), (3) and (4) of Sec.27, Secs.30, 32 and Cls. (b) and (c) of Sec.33 shall, as far as may be, apply in relation to a conservation reserve as they apply in relation to a sanctuary.]

[36B. Conservation reserve management committee. – (1) The State Government shall constitute a conservation reserve management committee to advise the Chief Wildlife Warden to conserve, manage and maintain the conservation reserve.

(2) The committee shall consist of a representative of the forest or Wild Life Department, who shall be the Member-Secretary of the Committee, one representative of each Village Panchayat in whose jurisdiction the reserve is located, three representatives of non-governmental organisations working in the field of wild life conservation and one representative each fro the Department of Agriculture and Animal Husbandry.

Declaration and management of a conservation reserve. Now, in this case, the management is done by a conservation reserve management committee.

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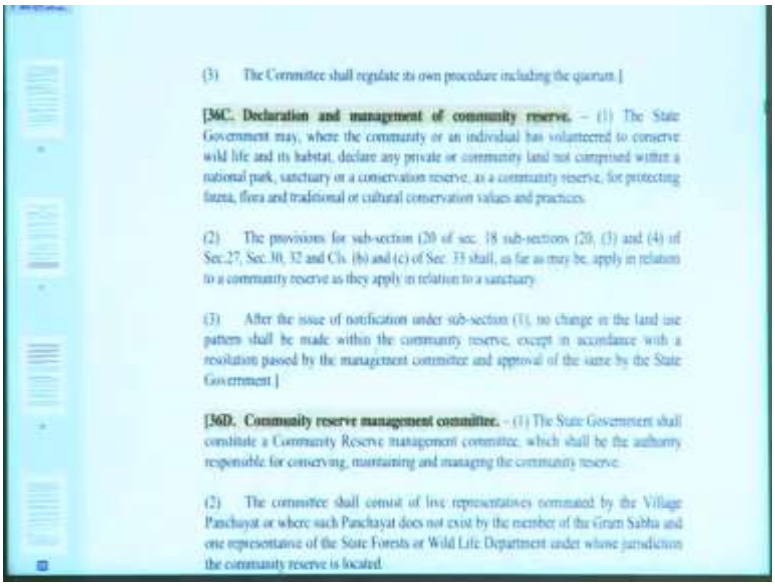

In the case of a community reserve, it is done by a community reserve management committee.

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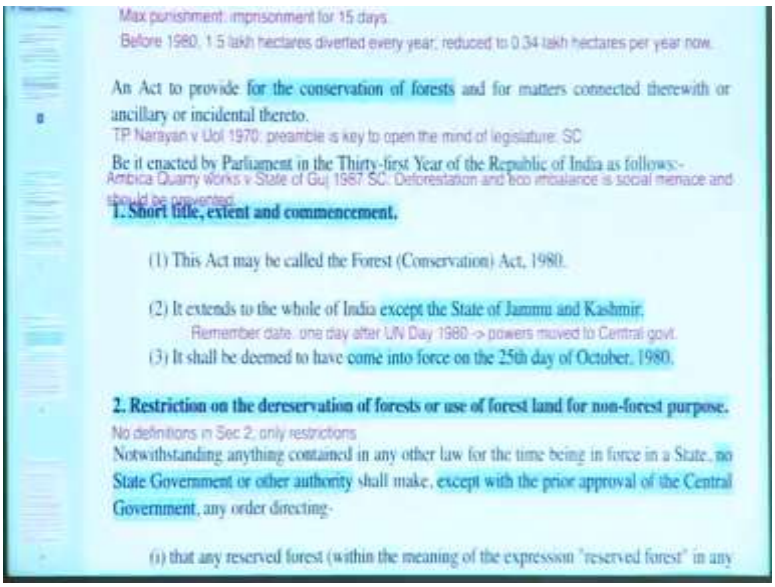

Then, we also had to look at the Forest Conservation Act.

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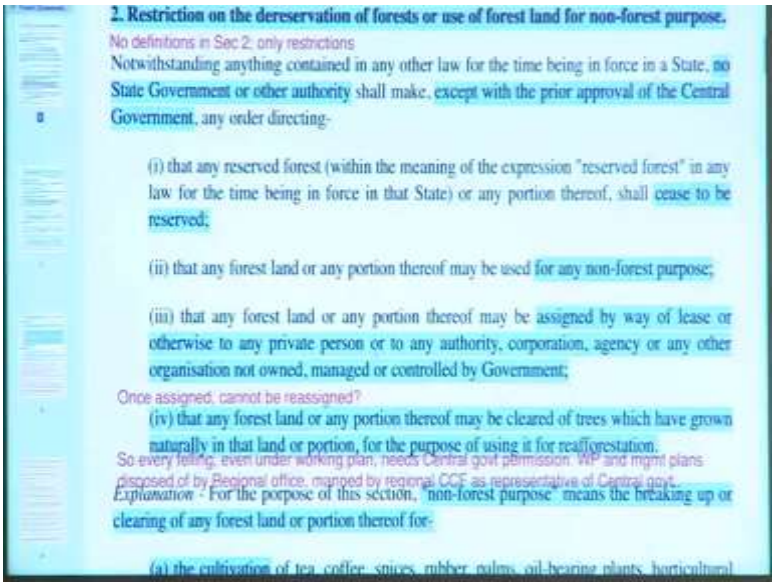

Which, Section 2 says restriction on the reservation of forest, or use of forest land for non-forest purpose. So, it here also it says that there is a restriction; there is not a ban, if you want to use it for a non-forest purpose, if you want to deforest certain portion. It has to be done under certain provisions.

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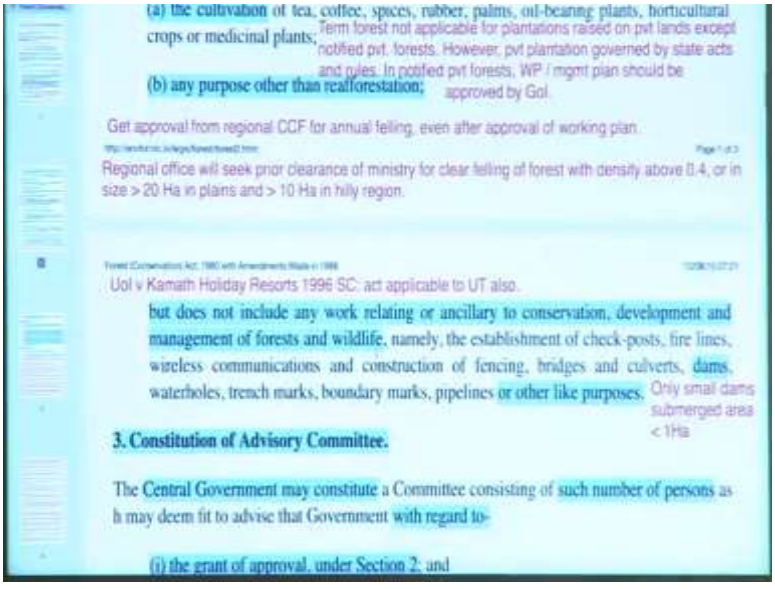

And, the non-forest purpose has been defined as breaking up of or clearing of any forest land or portion; for the cultivation of tea, coffee, spices, rubber, palm, oil bearing plants, horticultural crops or medicinal plants, any purpose other than reafforestation. But it

does not include any work relating to or ancillary to conservation development and management of forest and wildlife.

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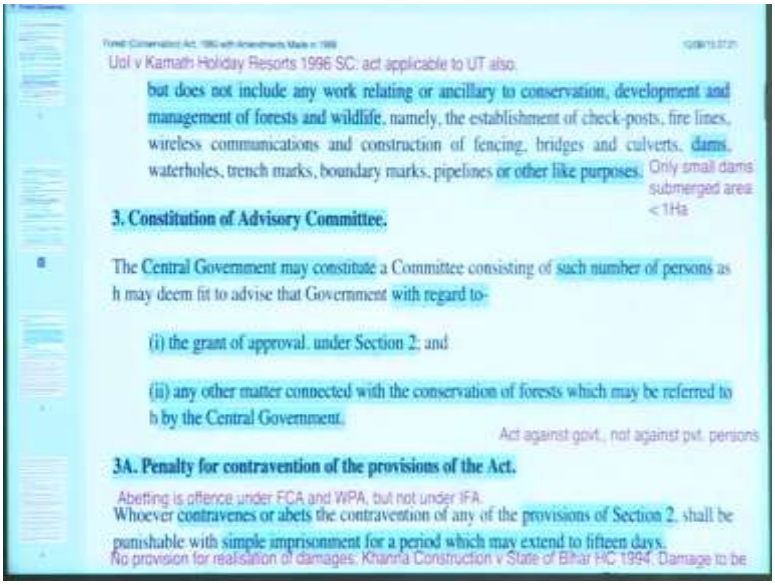

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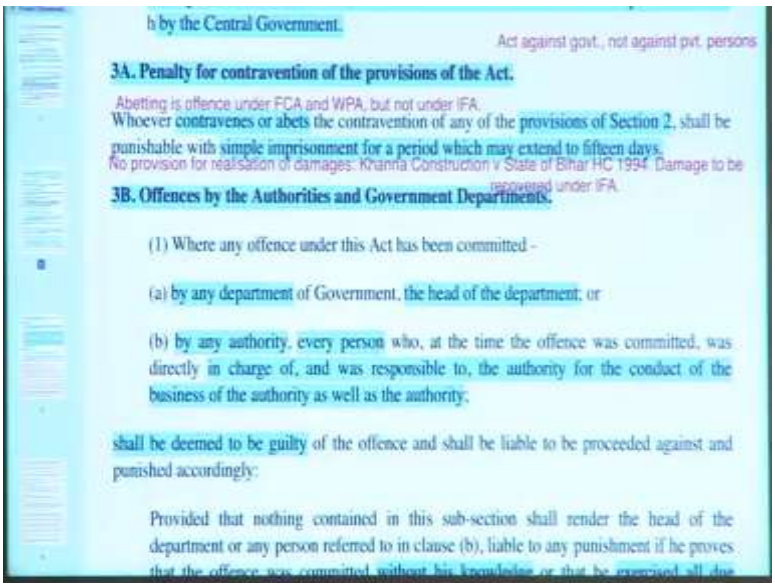

Then, this act also prescribes the penalty for contravention, and the penalty is a simple; imprisonment for a period up to 15 days.

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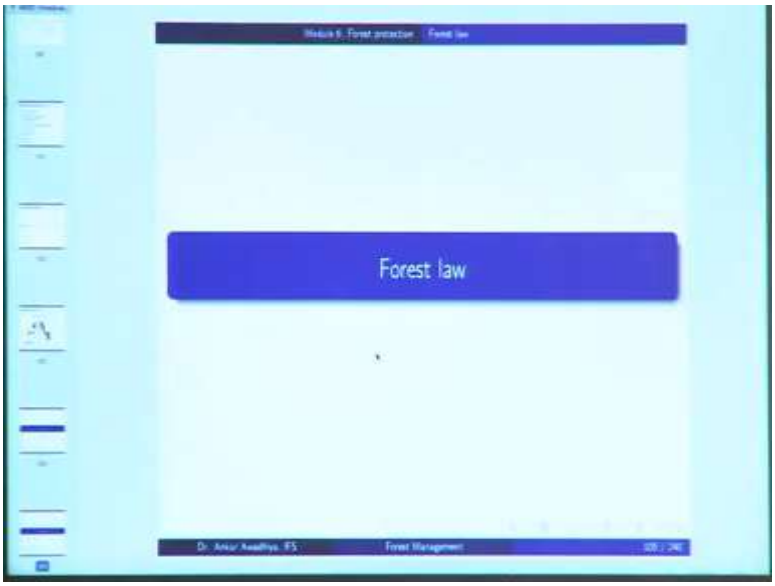

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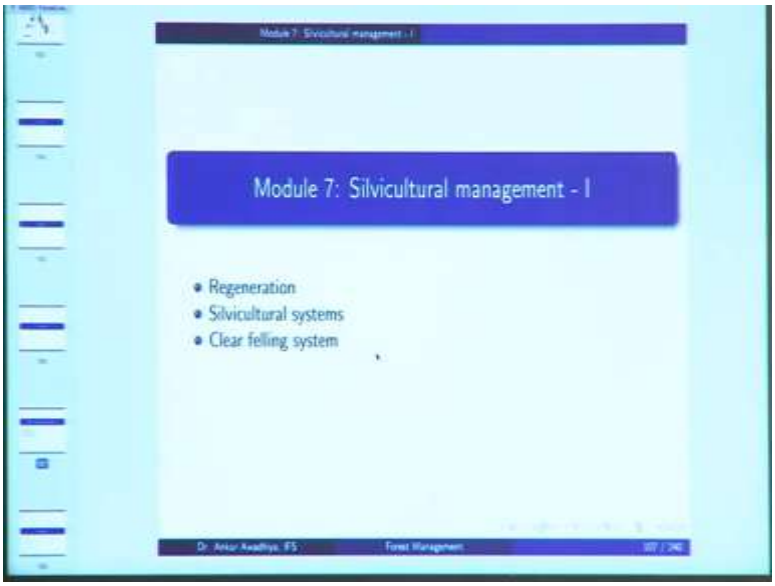

So, that was about forest law. Now, in the next module, that is silvicultural management part 1.

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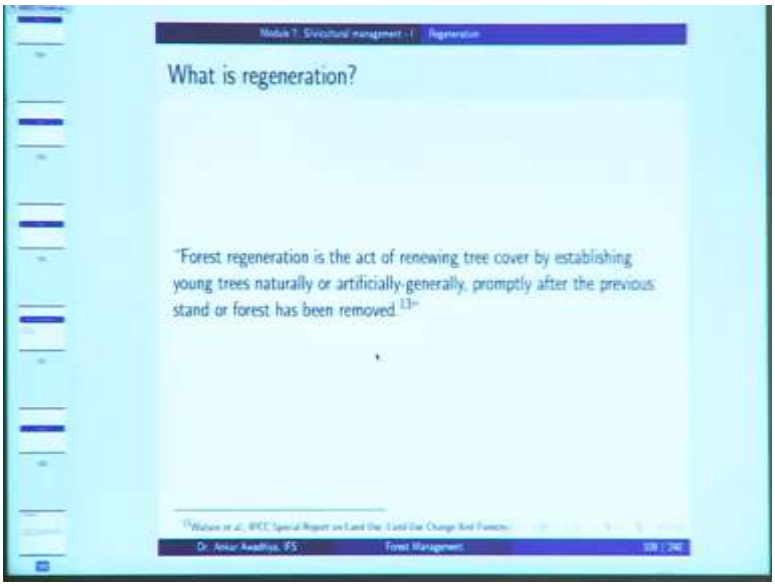

We looked at regeneration.

So, regeneration is the act of renewing the tree cover by establishing young trees naturally, or artificially. And, generally this is done promptly after the previous stand of forest has been removed. There are three ways of regeneration; natural regeneration artificial regeneration, and assisted natural regeneration.

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So, we refer to these as NR, AR, and ANR. Now, in the case of Artificial Regeneration, you can have Artificial Regeneration by direct sowing or by planting of seedlings.

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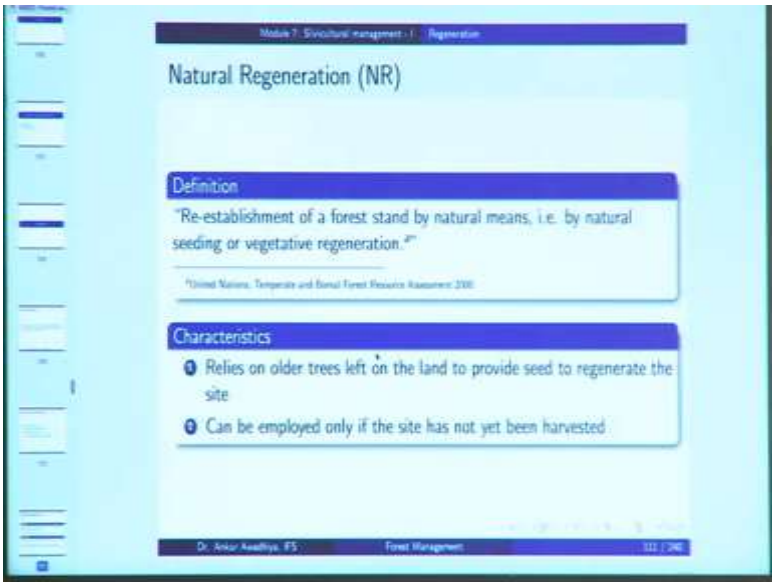

Now, natural regeneration is defined as re-establishment of a forest stand by natural means; that is by natural seeding or vegetative regeneration. It relies on older trees that are left on the land to provide seed to regenerate the site; and it can be employed only, if the site has not yet been harvested.

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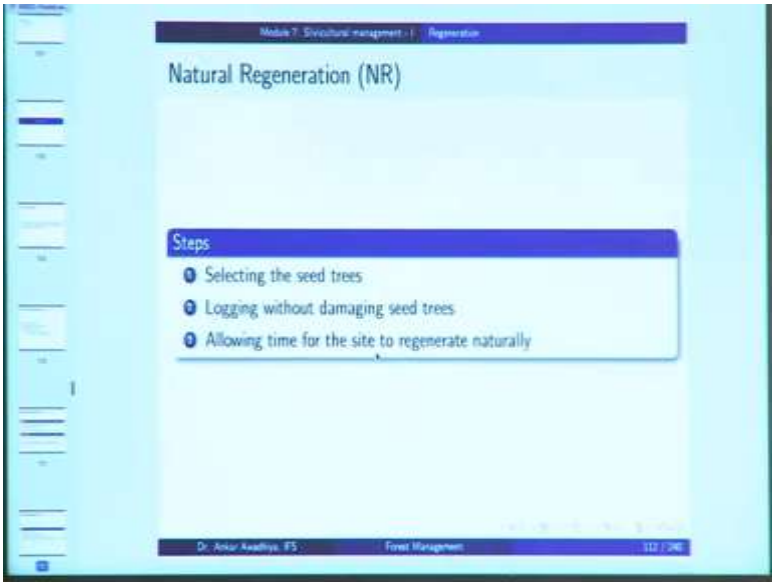

So, the steps are selecting the seed trees, logging without damaging the seed trees, and allowing time for the site to regenerate naturally.

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It dip the depends on seed production, seed dispersal, seed germination and establishment of the new crop.

Now, seed production depends on seed year, age of the tree, size of the crown, climate and external factors. Seed dispersal can be done by wind, water, gravity, birds, animals. Germination depends on moisture, temperature, seed viability, permeability of seed coat and so on. And, establishment refers to the development of a new crop to a stage where the young regeneration is considered safe from normal adverse influences like frost, drought or weeds.

So, once your new crop has become established, it means that now you can be lets assured that any normal adverse influences will not have a major impact on the young crop.

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Now, the advantages of natural regeneration are low cost, less requirement of heavy machinery and labor, it gives you an aesthetically pleasing natural forest look, there is preservation of locally adapted populations, good adaptation to micro sites and preservation of genetic variability.

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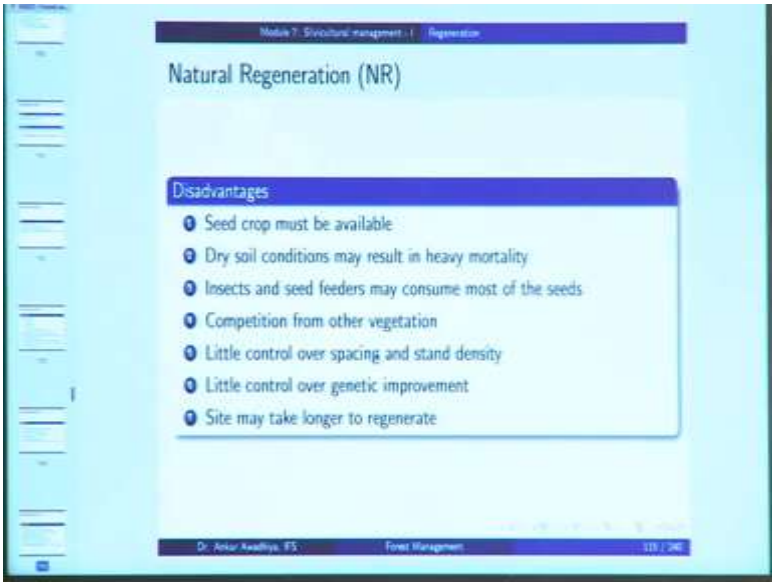

The disadvantages; the seed crop must be available, dry soil conditions may result in heavy mortality, insects and seed feeders may consume most of the seeds, competition

from other vegetation, little control over spacing and stand density, little control over genetic improvement and the site may take longer to regenerate.

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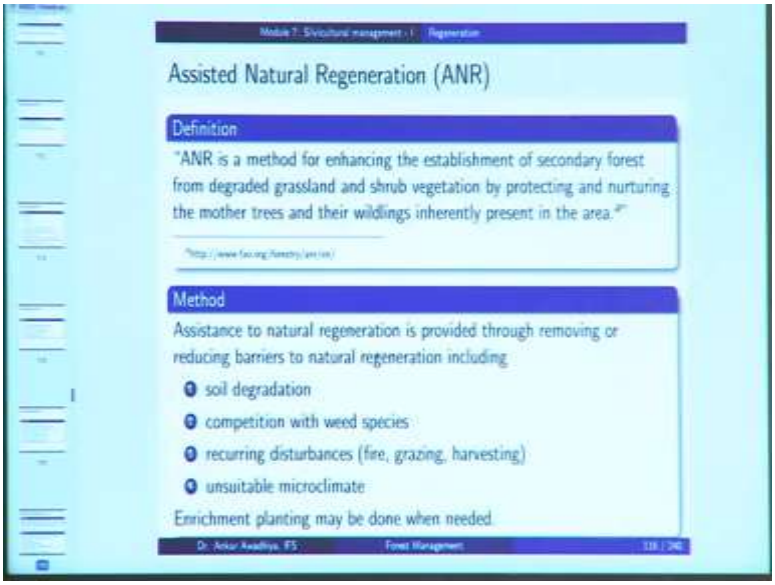

Next, we have Assisted Natural Regeneration. It is a method for enhancing the establishment of a secondary forest from degraded grassland and shrub of vegetation by protecting and nurturing the mother trees and their wildlings inherently present in the area. So, what you are doing is that you are protecting and nurturing and not only the mother trees, but also their wildlings.

Now, what kind of assistance do you give you; it is done through removing or reducing barriers to natural regeneration, such as soil degradation, competition with weed species, recurring disturbances like fire, grazing and harvesting and unsuitable microclimate, and at times enrichment planting may also be done.

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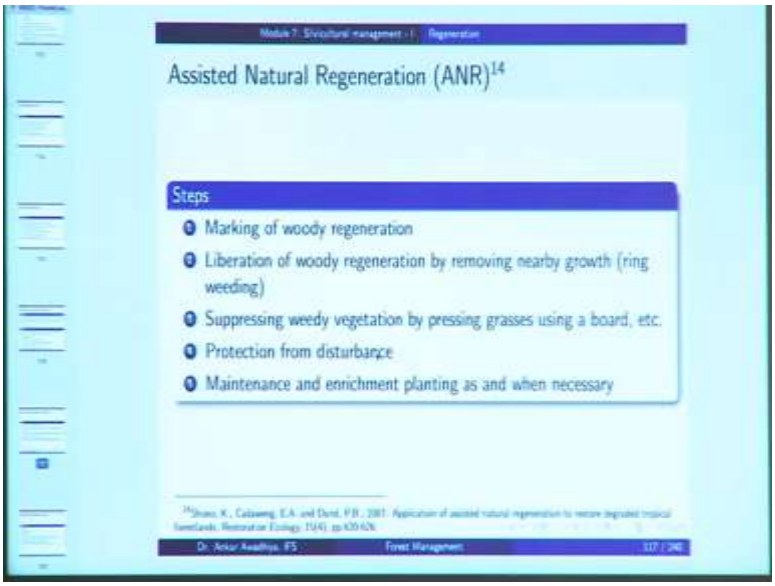

Now, the steps mark the woody regeneration, liberate the woody regeneration by removing nearby growth in a ring weeding fashion. So, in the case of any young plants, you are removing all the weeds in a ring fashion around the plant. Next, you have suppression of weedy vegetation by pressing the grasses using a board, protection from disturbance, and maintenance and enrichment planting are done as and when necessary.

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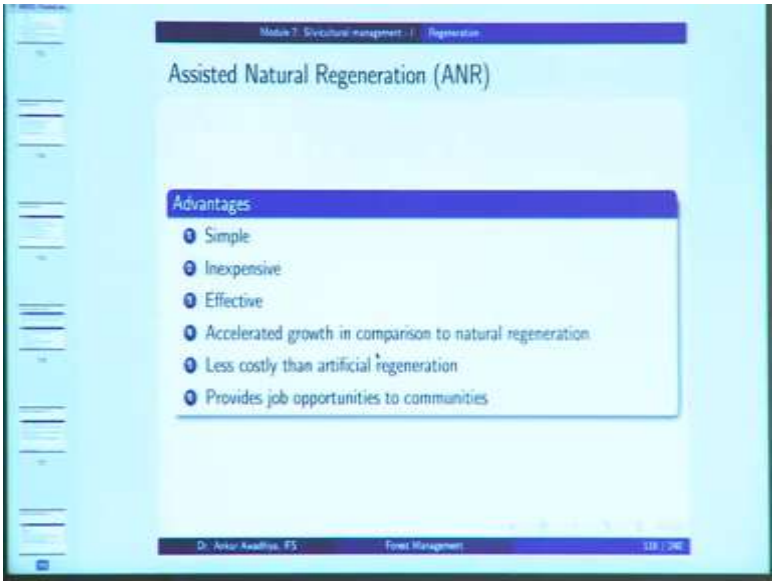

Advantages; it is simple, it is inexpensive, it is effective, there is an accelerated growth in comparison to natural regeneration, it is less costly than artificial regeneration. So,

essentially this is having the benefits of both the natural regeneration and the artificial regeneration. It is simple and, yet, it is cost effective, it provides job opportunities to communities which is very important for a safe social forestry.

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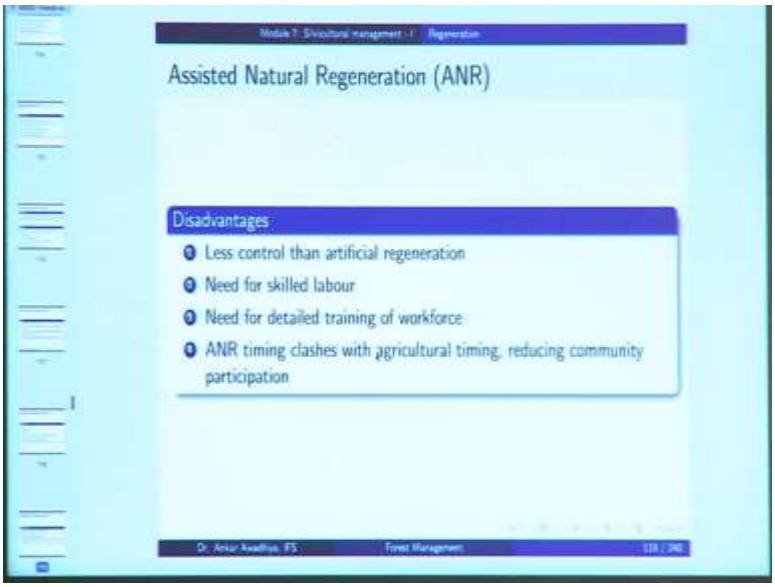

The disadvantages are that you have less control than natural regeneration than artificial regeneration, there is a need for skilled labor, there is a need for detailed training of workforce, and the timing often clashes with agricultural timing which reduces community participation. But if you do not have adequate amount of community participation; for say ring weeding or for the use of the board to suppress the grass, then the ANR process may come up in jeopardy.

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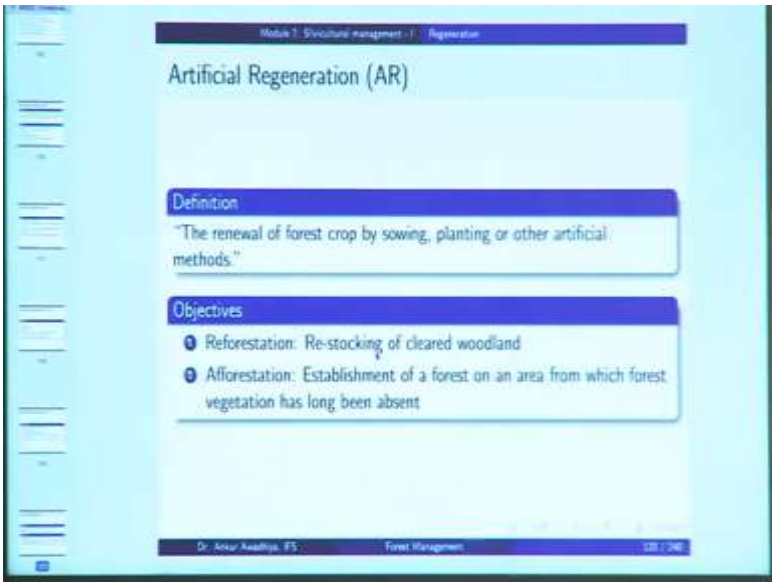

Next, we have Artificial Regeneration; the renewal of forests crop by sowing, planting or other artificial methods. Objectives are to either to reforest, in which case, you are re-stocking the cleared woodland; or afforestation, in which case, you are establishing a forest on an area from which forest vegetation has long been absent. So, you are essentially creating a new forest steps.

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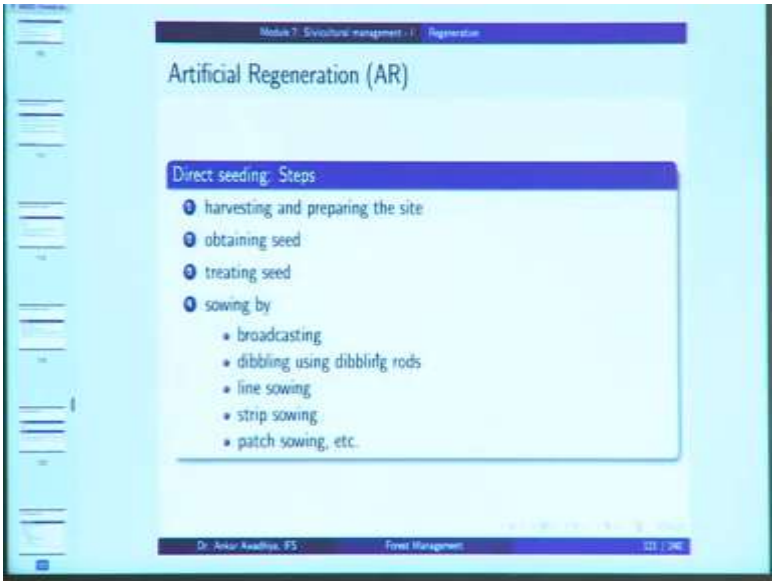

So, it can be done through direct seeding or through planting. In the case of direct seeding, you do harvesting and preparation of the site, obtain the seeds, treat the seeds

say by adding water to it or by adding fungicide to it, then you do sowing; sowing can be done by broadcasting, in which case, you are just spreading the seeds by throwing them; or you can do dibbling, by using a dibbling stick or a dibbling rod, or you can go for a line sowing, strip sowing, patch sowing and so on.

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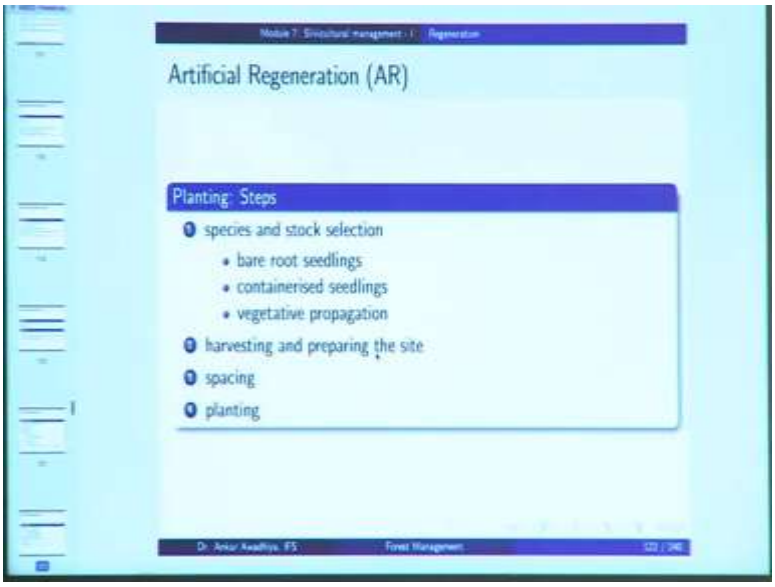

If you are doing artificial regeneration through planting; first of all you do a species and stock selection, and your stock can be in the form of a bare roots seedlings, containerised seedlings or vegetative propagation. Then, you do harvesting and preparing the site, choose a planting. And, once you have choose a spacing and with that spacing you dig pits, and then on those pits you do the planting operation.

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Advantages. You can have you have a very good control over plant density, there is a high flexibility including to change the species or variety, low management intensity, option to introduce improved seed or planting material, quicker results, better yield and it creates even-aged forests.

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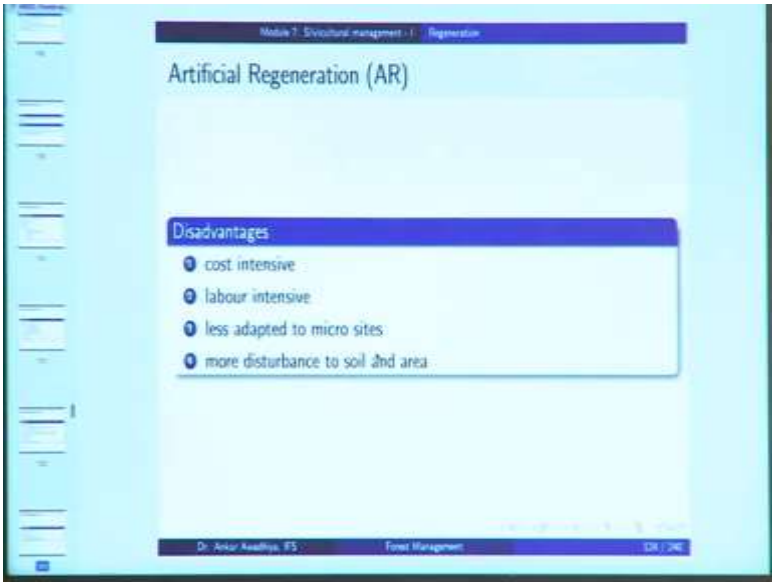

The disadvantages are that it is cost intensive, labor intensive, less adapted to micro sites and there is more disturbance to soil and the area.

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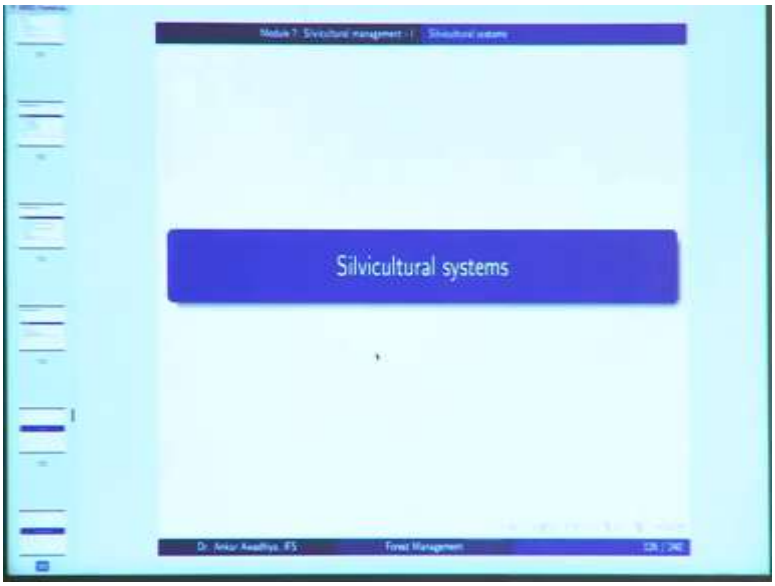

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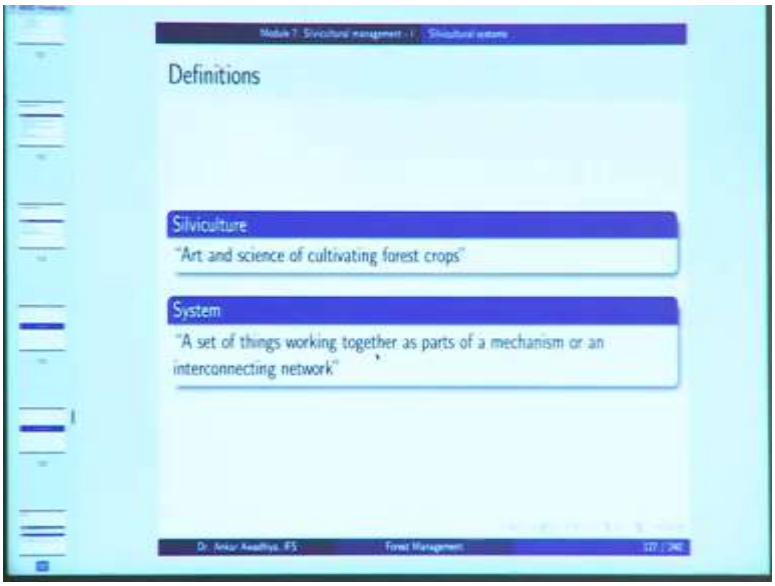

Then, we looked at silvicultural systems. Silviculture is the art and science of cultivating forest crops. System is a set of things that is working together as parts of a mechanism or in an interconnecting network.

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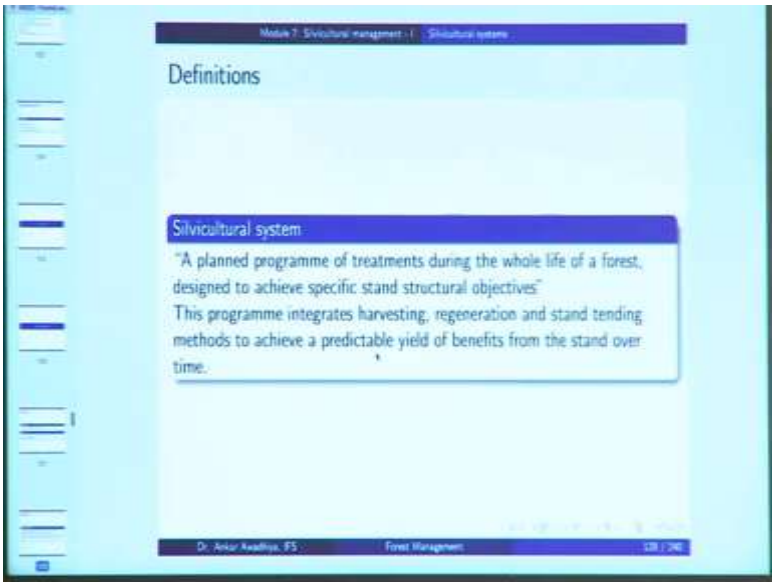

So, silvicultural system is a planned program of treatments during the whole life of a forest, designed to achieve specific stand structural objectives. So, you are integrating harvesting, regeneration and tending methods

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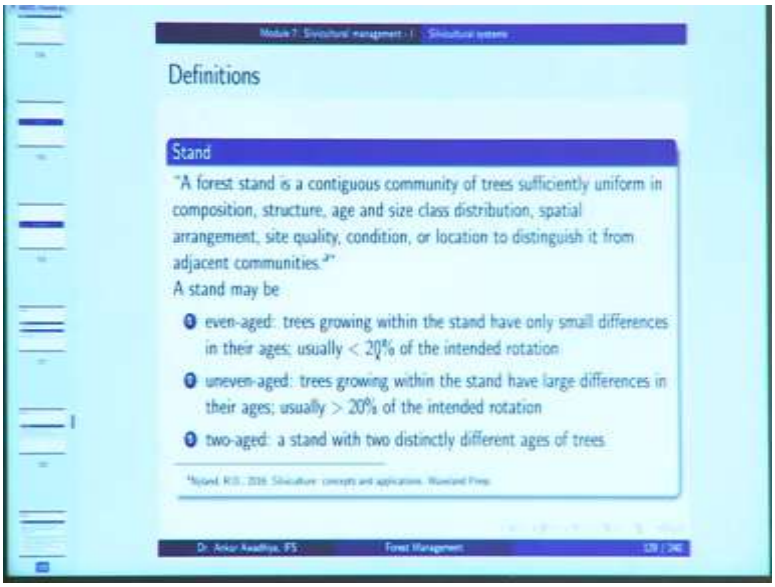

So, what is a stand? A stand is a forest stand; is a contiguous community of trees that is sufficiently uniform in composition, structure, age and size class distribution, spatial arrangement, site quality, condition or location to distinguish it from adjacent communities. It may be even-aged in which case the tree is growing within the stand

have only small differences in their ages; usually less than 20 percent of the intended rotation.

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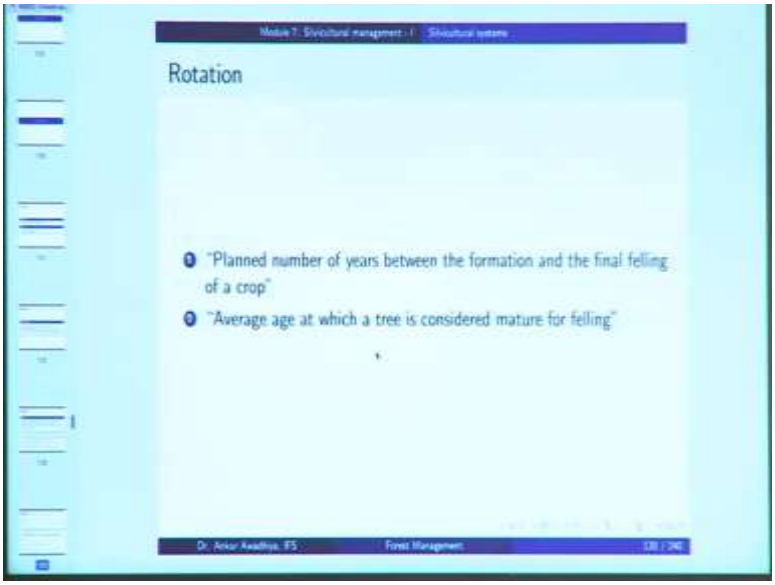

Uneven-aged; they have large age differences. And, two aged; in which case, you have two distinctly different ages of the trees. Then, we defined a rotation as the planned number of years between the formation and the final felling of a crop, or the average age at which a tree is considered matured for felling.

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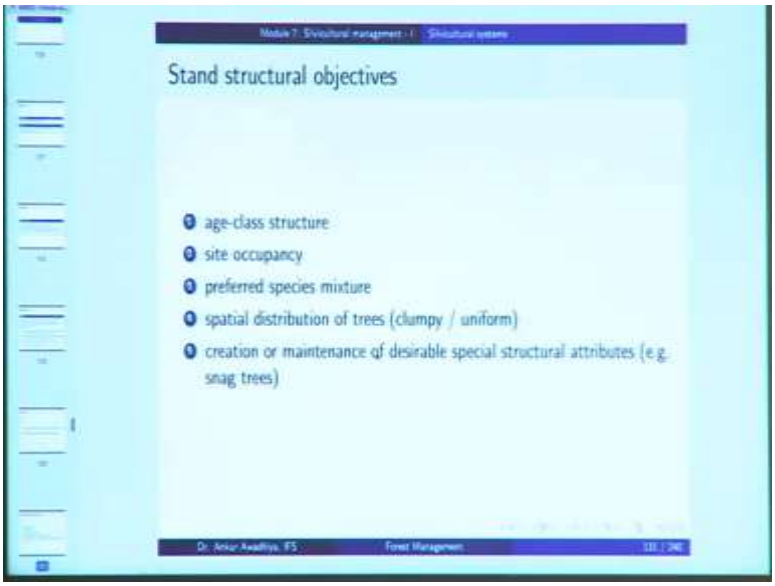

Now, silvicultural system is used to achieve specific stand structural objectives which can be age-class structure, site occupancy, preferred species mixture, spatial distribution of trees - in a clumpy fashion or in a uniform fashion, and creation and maintenance of desired special structural attributes such as snag trees for wildlife.

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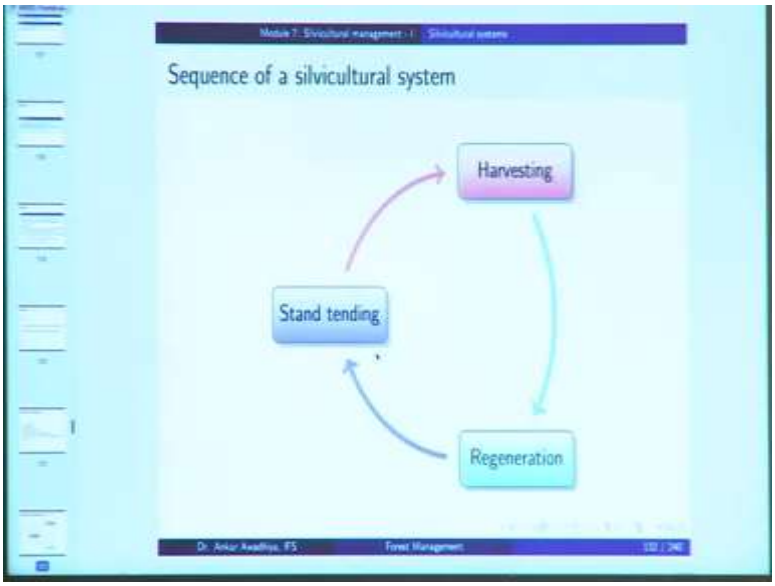

Now, in the case of a silvicultural system, this is the sequence you begin with; harvesting of the site. So, you are cutting the trees, removing the timber, then you regenerate the site. So, that the young generation comes up and then you do a tending of the stand. So, that it is able to form the new forest once again.

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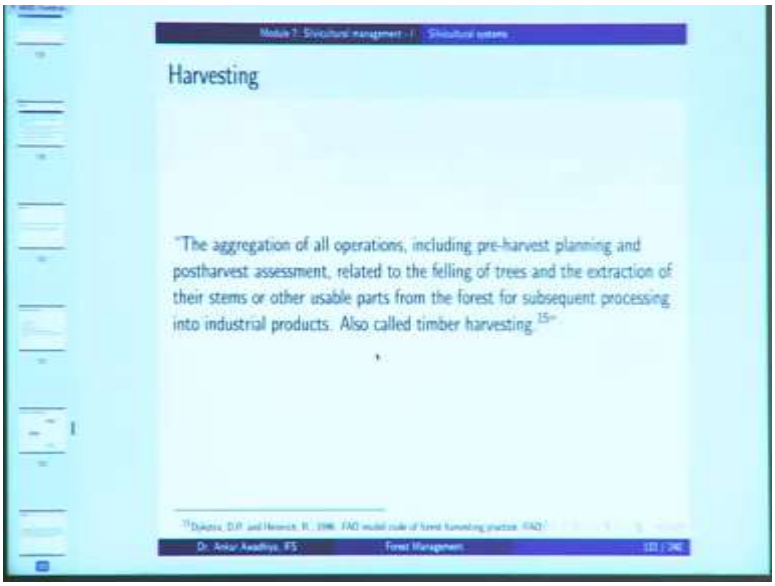

Now, harvesting is the aggregation of operations, including pre-harvest planning and post harvest assessment, related to the felling of trees and the extraction of their stems and other usable parts from the forest for subsequent processing into industrial products. Also called timber harvesting.

So, harvesting is all set all operations from pre-harvest planning to postharvest assessment.

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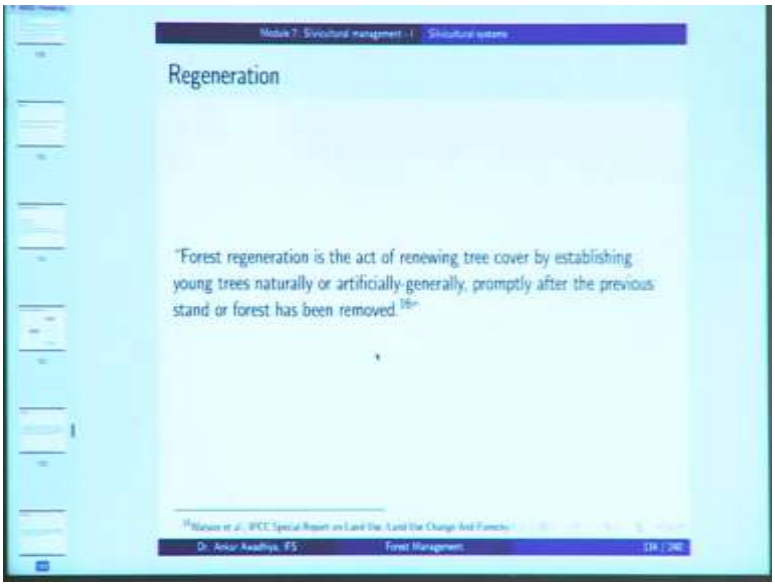

Next, you have regeneration; the act of renewing tree cover by establishing young trees naturally or artificially-generally, promptly after the previous stand of forest has been removed.

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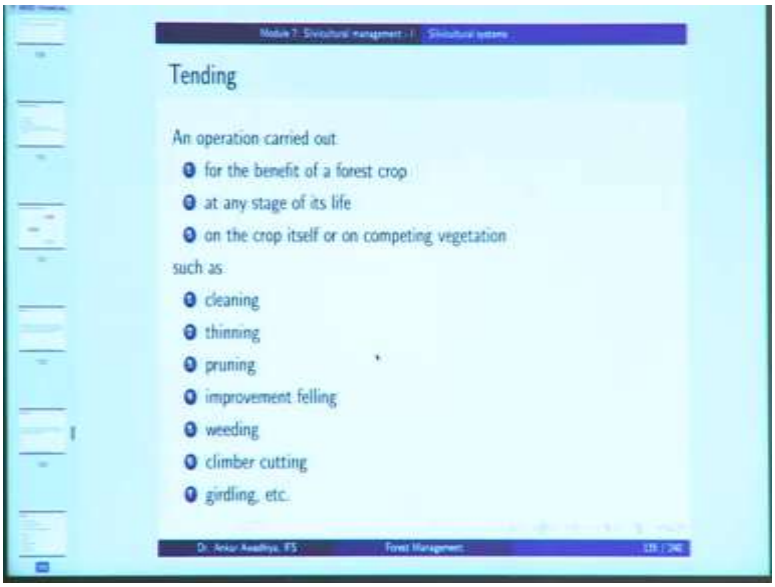

Next, we have tending an operation carried out for the benefit of a forest crop, at any stage of its life; on the crop itself or on the competing vegetation.

So, this is a very important definition; it is done for the benefit of the forest crop, at any stage of its life, and on the crop itself or on the computing vegetation. It includes things like cleaning, thinning, pruning, improvement, felling, weeding, climber cutting, girdling and so on.

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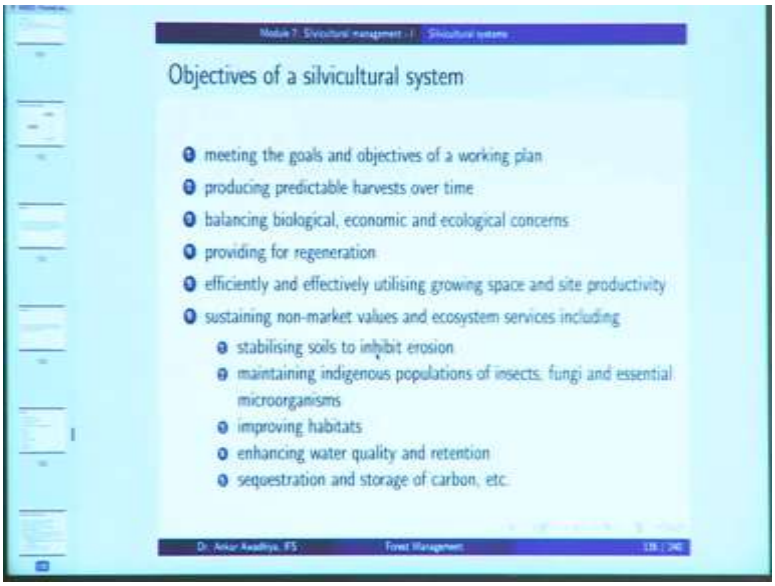

Now, what are the objectives of a silvicultural system? First is to meet the goals and objectives of a working plan, producing predictable harvest over time, balancing biological, economic and ecological concerns, providing for regeneration efficiently and effectively utilizing growing space site productivity and sustaining non-market values in ecosystem services.

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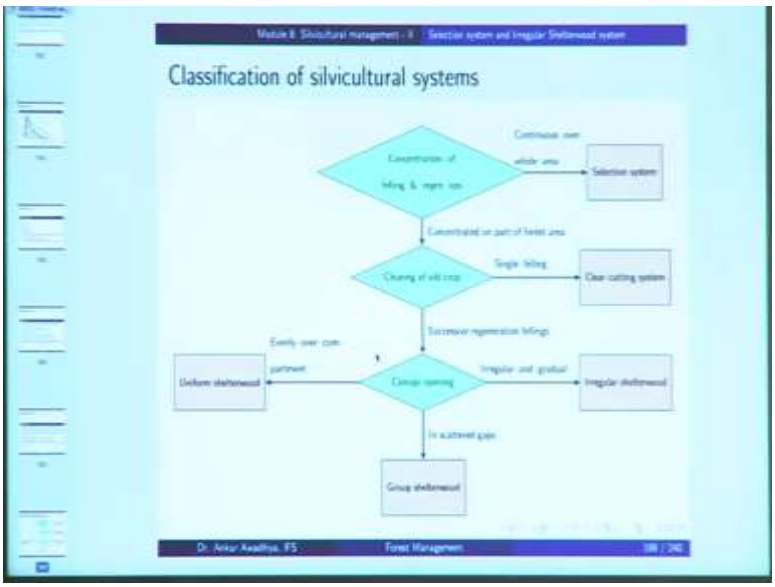

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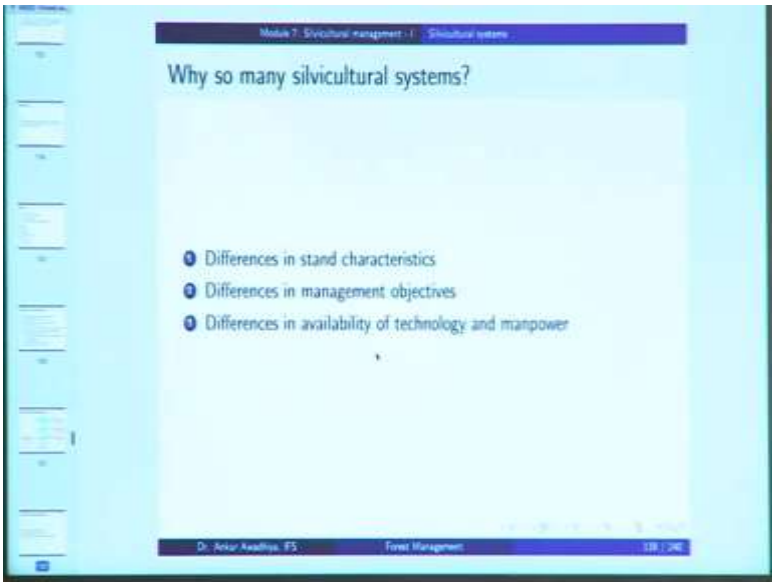

Then, we looked at a classification of silvicultural systems. And, we require different silviculture systems because there are differences in stand characteristics, management objectives and the availability of technology and manpower.

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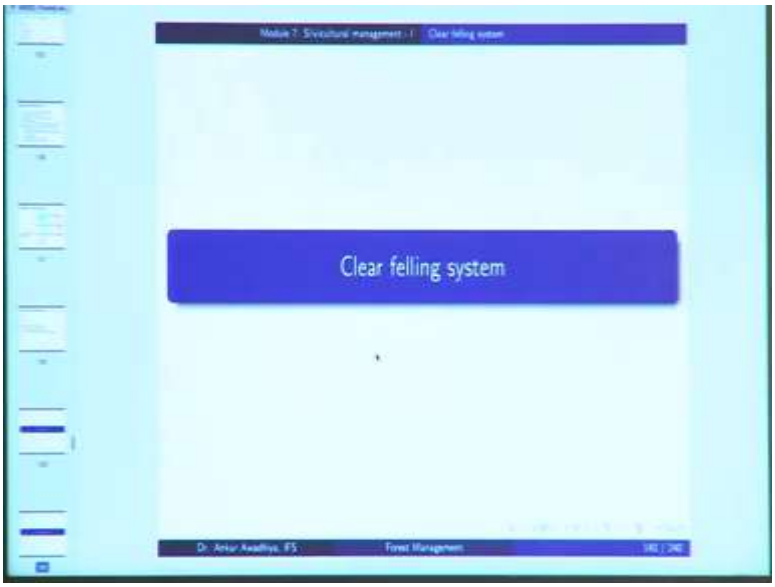

Then, we looked at clear felling system; in which case, you have a concentration of felling and regeneration operations on a part of the area, and the whole of the old crop is cleared in a single felling.

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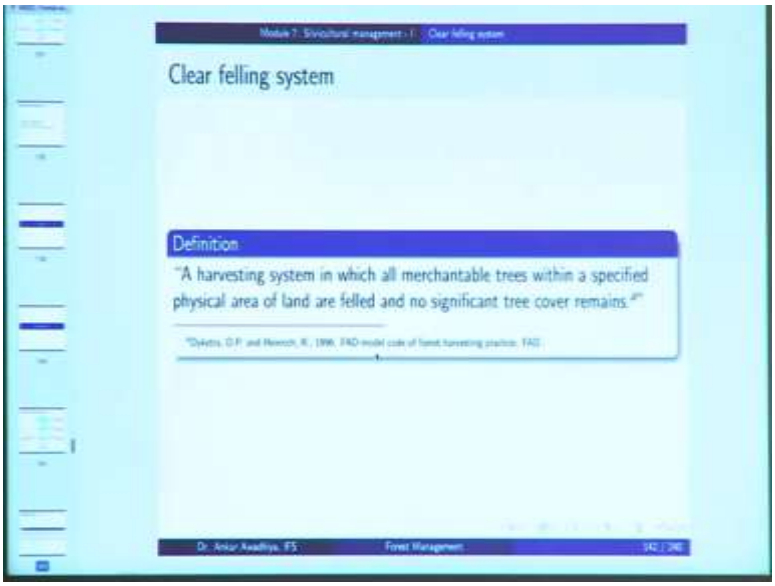

Harvesting system in which all merchantable trees with us within a specified physical area of land are felled and no significant tree cover remains.

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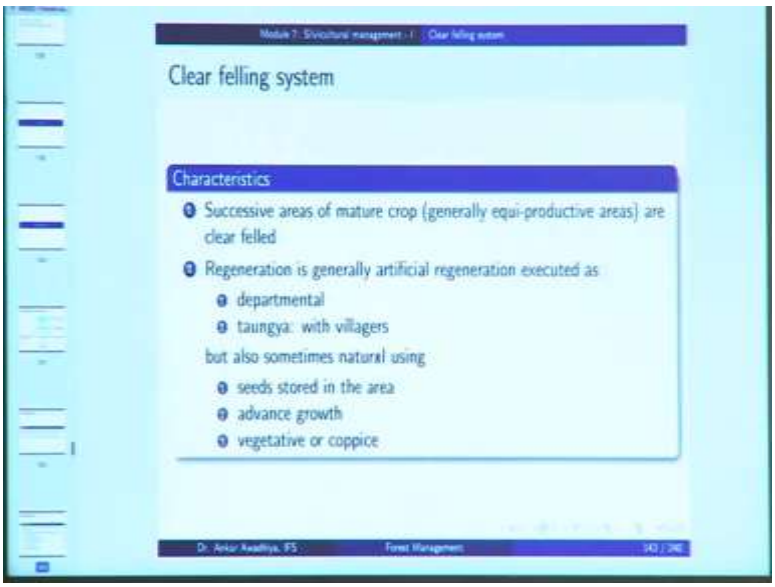

Characteristics; successive areas are clear felled, it can be done in a departmental, the regeneration is generally artificial. And, generally done as departmental regeneration or taungya; in which case, we take the help of villagers. And, also sometimes natural regeneration is used in the form of seeds stored in the area, making use of advanced growth or vegetative or coppicing methods.

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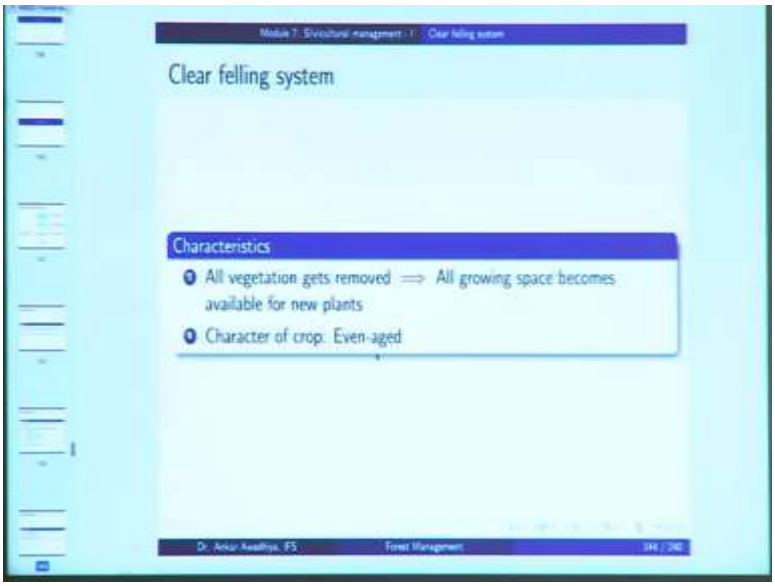

The characteristics; all the vegetation gets removed, all this growing space becomes available for the new plants, the characteristic of the new crop is an even-aged.

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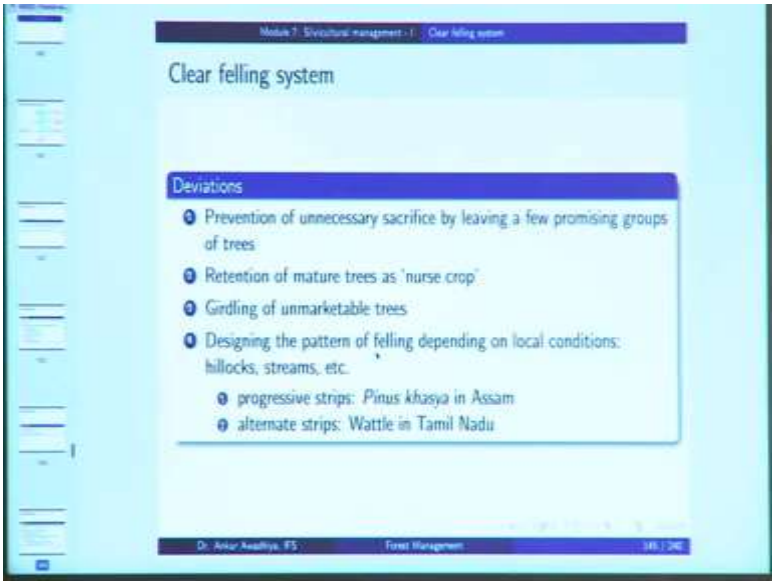

And, the deviations; you can prevent unnecessary sacrifice by leaving a few promising groups of trees, regeneration of mature trees as a nurse crop, girdling of unmarketable trees and designing of the pattern of felling depending on the local conditions.

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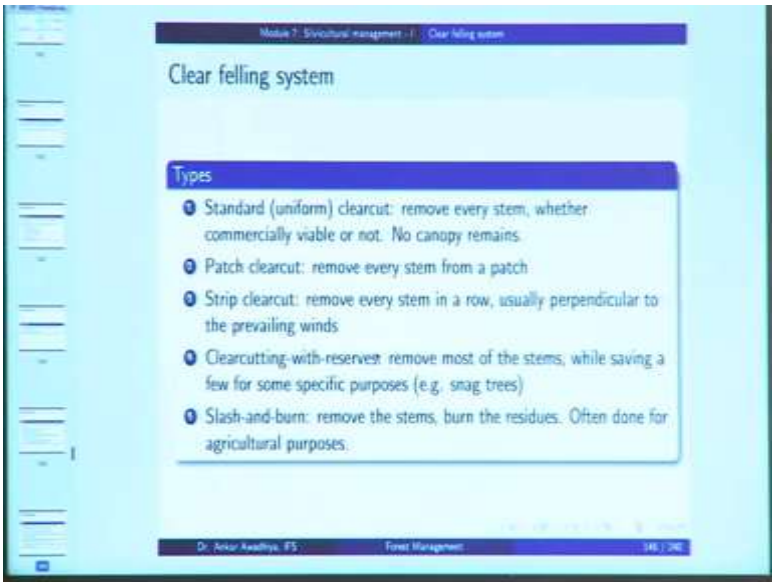

Now, types include standard or uniform clear cut, patch clear cut, strip clear cut, clearcutting with reserves, and slash and burn.

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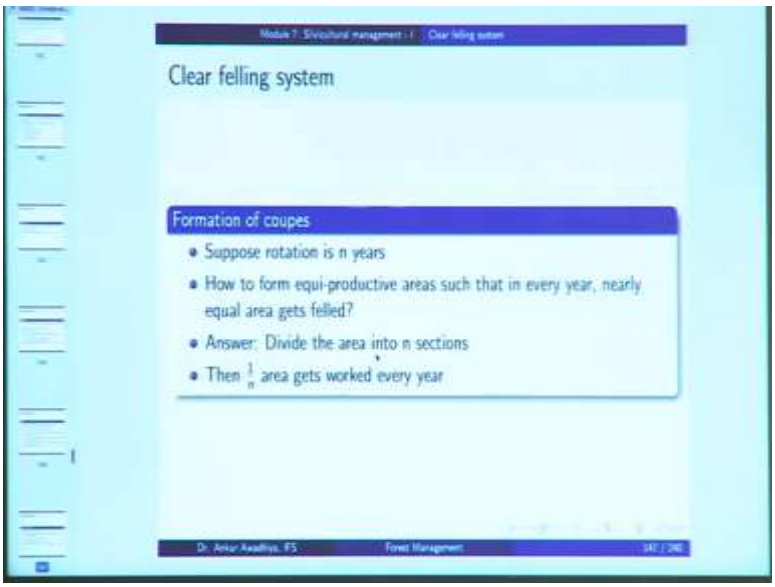

Now, there is the formation of coupes. Now, coupe is if you have a rotation of n years and you need to form equi-productive areas, so that, in every year roughly, equal area gets felled. Then, you divide the area into n sections, and 1 by nth of the area gets worked each year and these are the coupes.

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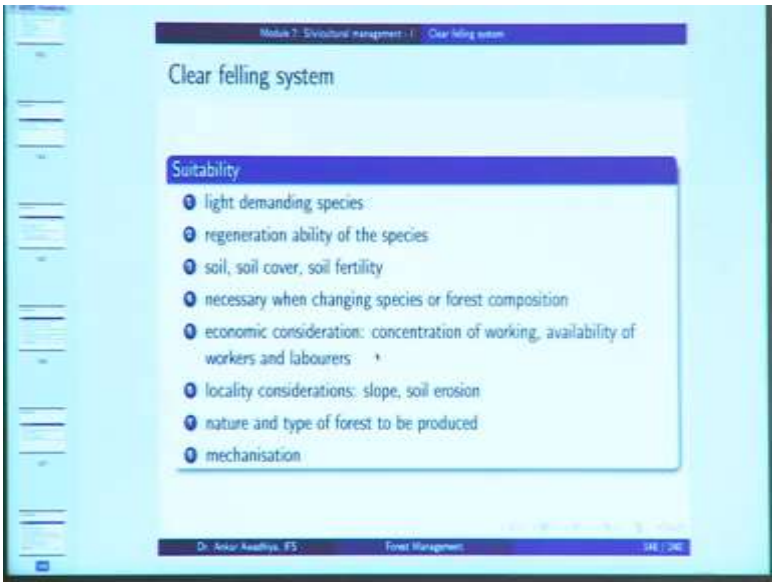

Suitability; it is good for light demanding species. Regeneration; it depends on the regeneration ability of the species, whether or not you will use clear felling will depend on soil, soil cover and so, on.

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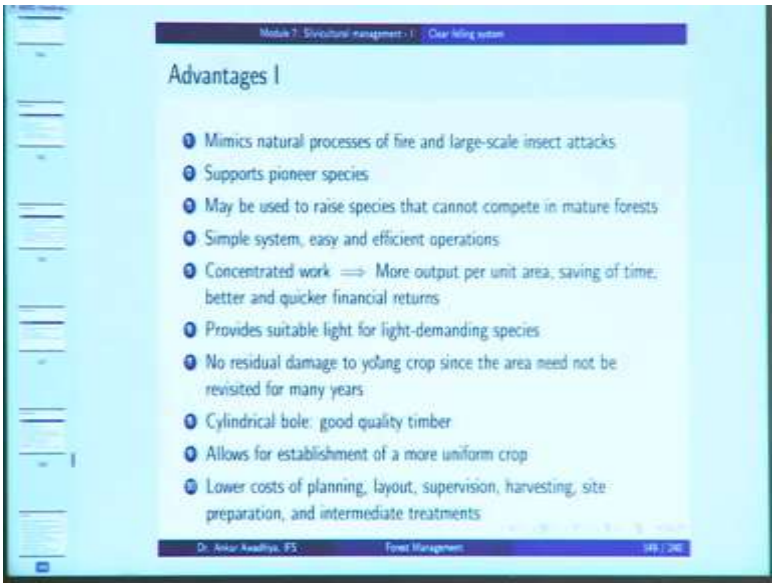

Advantages; it mimics the natural processes of fire and large-scale insect attacks, supports the pioneer species, and may be used for to raise certain species that cannot compete in mature forests. It is simple, easy and efficient operations, concentrated work, better financial returns, suitable for light demanding species and so on.

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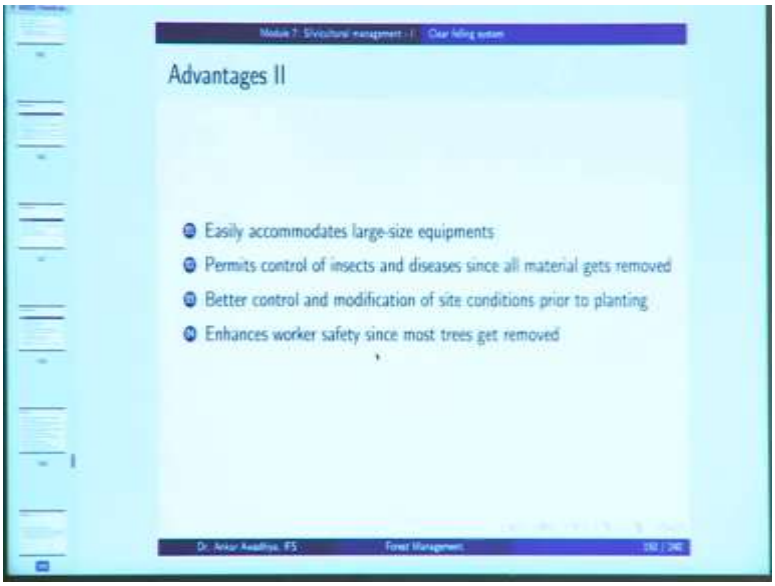

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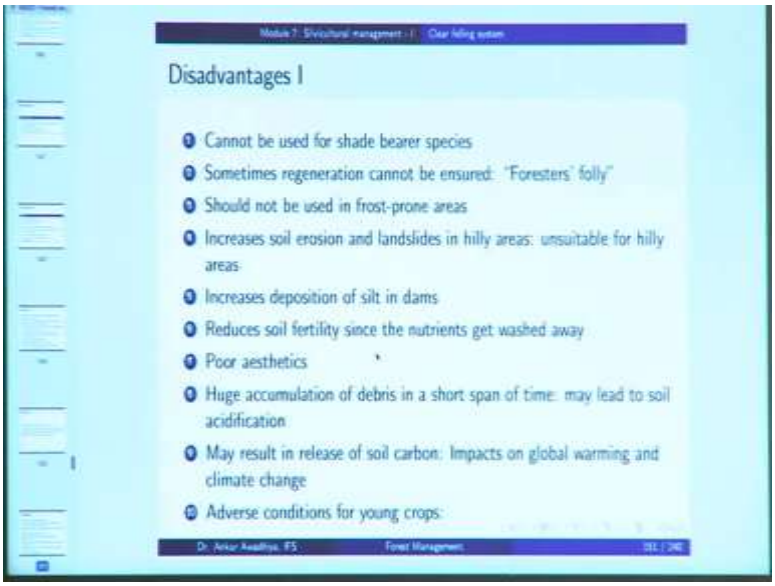

In the case of disadvantages; you cannot use it for shade bearer species, and at times if you cannot ensure the regeneration, then you will have the denudation of the forest cover. And, it cannot be used in frost-prone areas and areas that are most prone to soil erosion and so, on.

Next, we looked at shelterwood system. So, in the case of shelterwood system, the concentration and the concentration of felling and regeneration operations is on part of the forest area. The clearing is done in terms of successive regeneration fellings, and the

canopy opening can be done evenly over the compartment. in the case of uniform shelterwood - in the scattered gaps - in the group shelterwood and in irregular and gradual manner, in the case of an irregular shelterwood.

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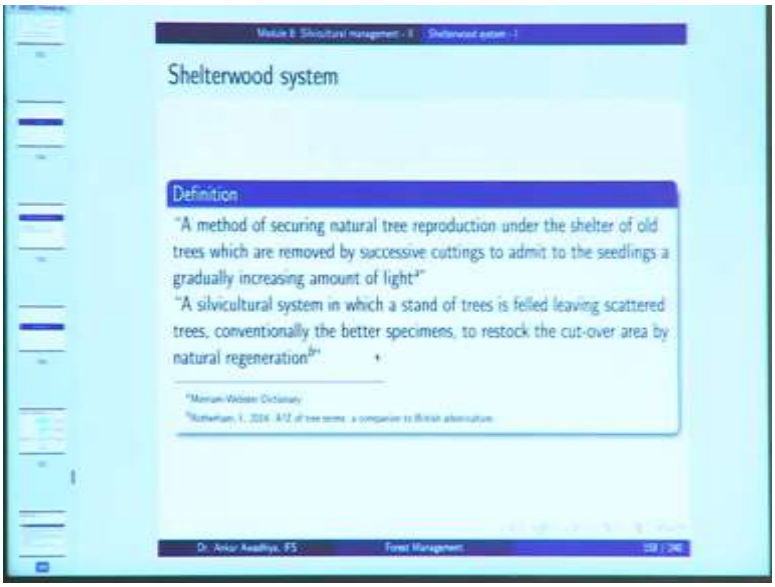

Now, shelterwood system is a method of securing natural tree reproduction under the shelter of old trees, which are removed by successive cuttings to admit to the seedlings a gradually increasing amount of light.

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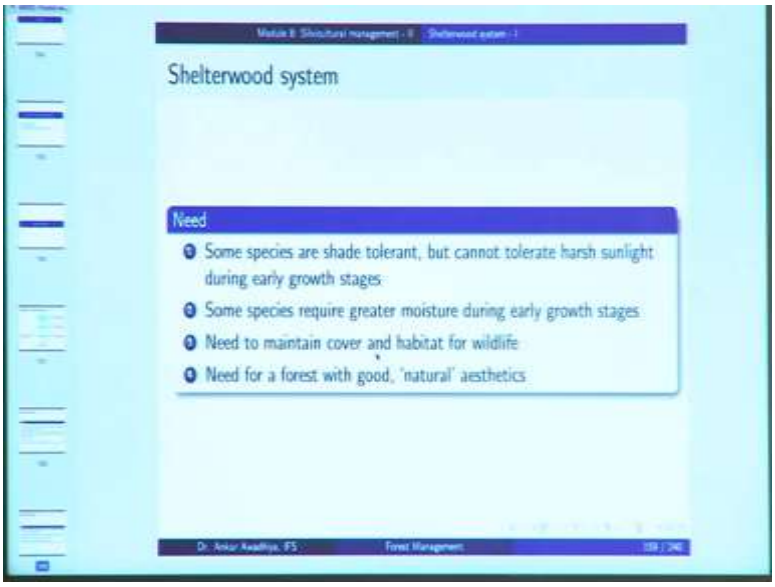

Now, the need is that some species are shade tolerant, but they cannot tolerate harsh sunlight during the early growth stages. Some species require greater moisture. You may need to maintain cover and habitat for wildlife or there may be a need to grow a forest with good natural aesthetics

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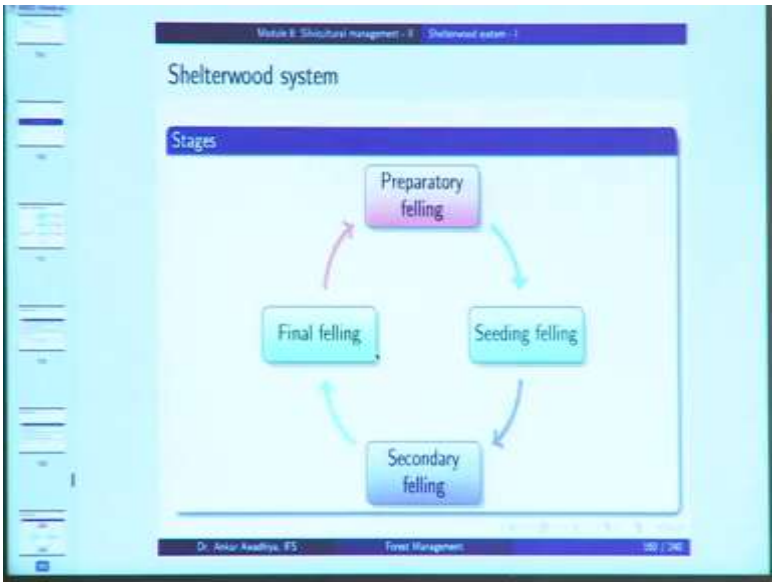

So, you have four stages, or you begin with a preparatory felling, followed by seeding felling, followed by secondary felling, followed by the final felling.

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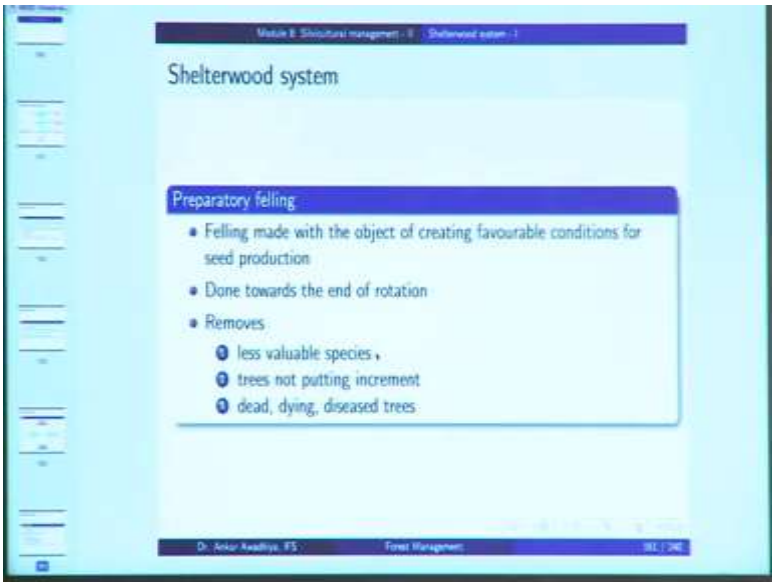

Now, preparatory felling is felling made with the objective of creating favorable conditions for seed production. Generally, done towards the end of rotation when you are now ready to harvest the timber. And, in preparatory felling, you remove less valuable species, tree is not putting increment and dead dying and diseased trees.

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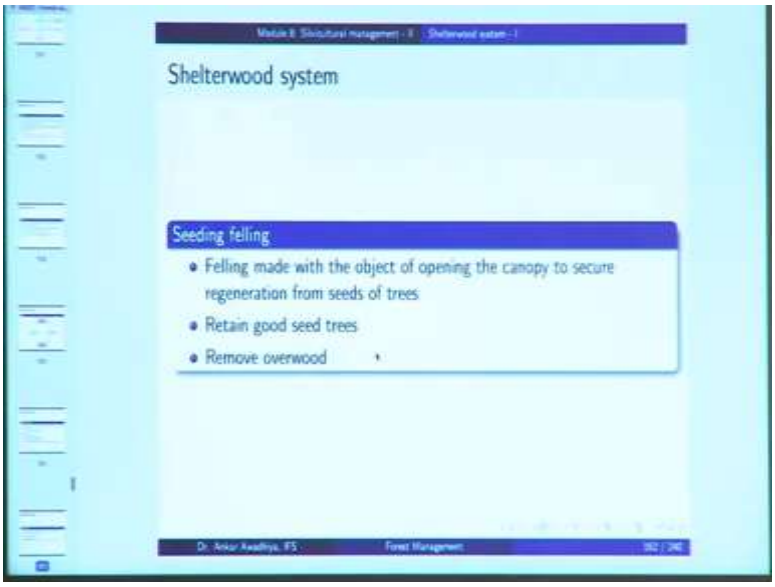

In the case of seeding felling, it is made with the object of opening the canopy to secure regeneration from the seeds of trees. So, the seeds have already fallen down or are in the in the stage of coming down. And, you are now giving it is a bit more light. So, that it can get regenerated.

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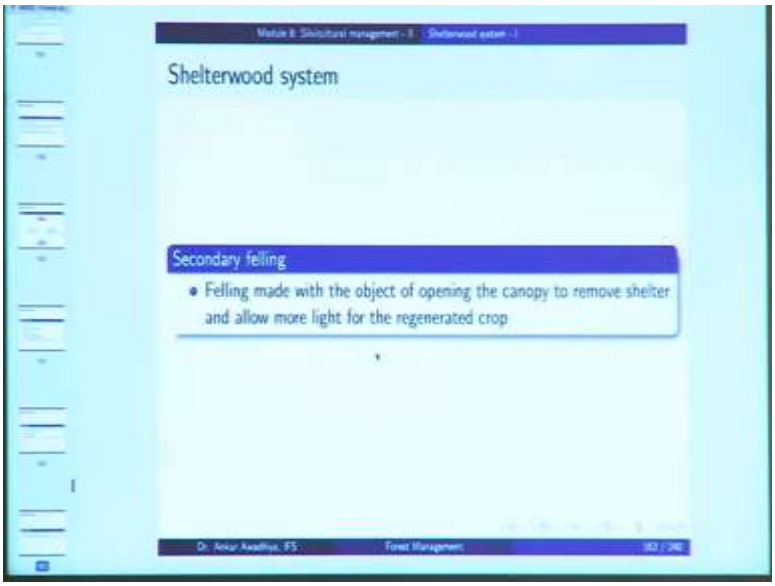

So, you retain good seed trees, remove the overwood in the case of secondary felling. It is a felling made with the object of opening the canopy; to remove shelter and allow more light for the regenerated crop.

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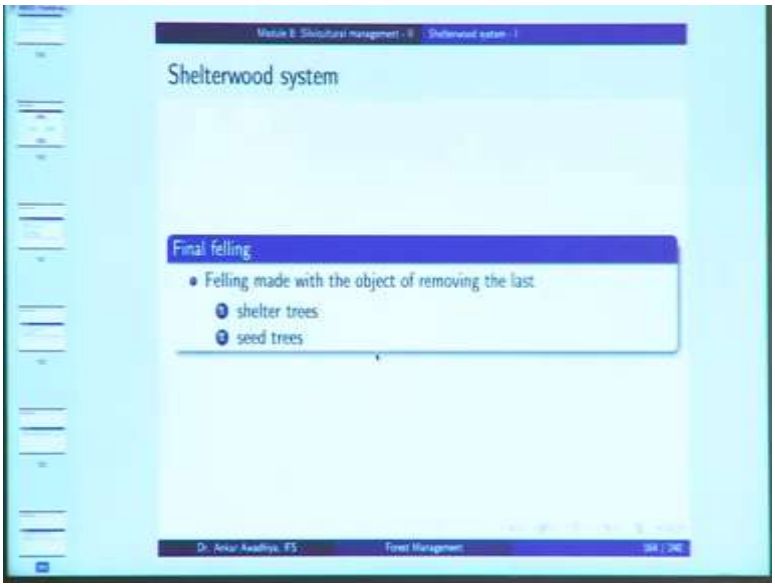

And, in the case of final felling, you remove all the last shelter trees and their seed trees.

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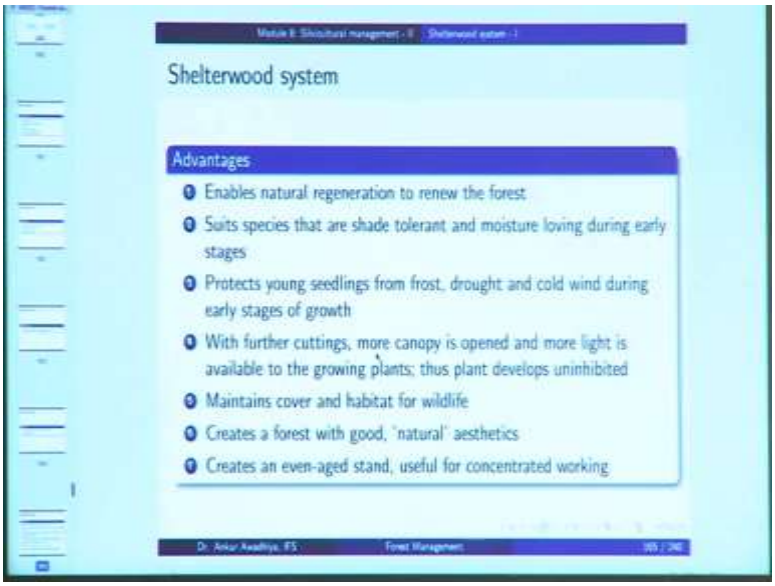

Advantages; it enables natural regeneration to renew the forest, suits the species that are shade tolerant and moisture loving during the early stages, it protects the seedlings from frost, drought, cold during early stages, and with further cuttings more and more canopy is open and more light is made available to the growing of plants. Thus, the plants develop uninhibited, then it maintains cover and habitat for wildlife, creates a forest with good natural aesthetics and creates an even-aged stand, which is useful for concentrated working.

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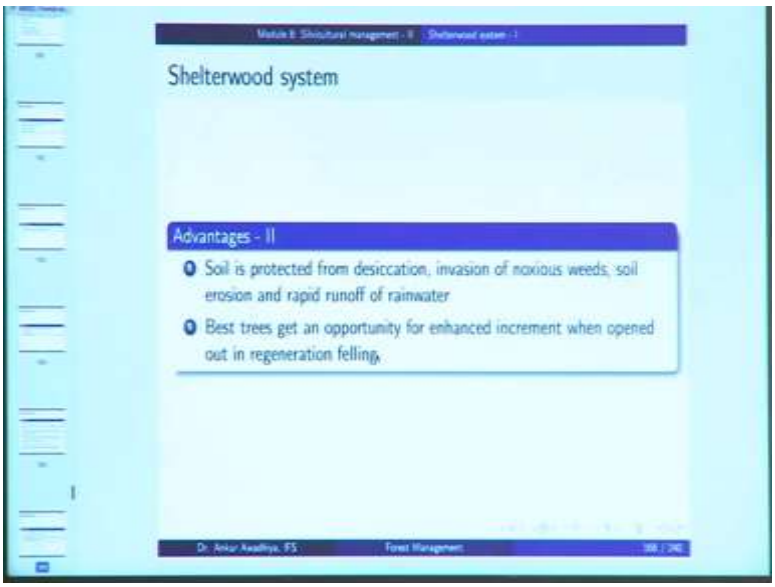

Soil gets protected and the best trees get an opportunity for an enhanced increment when opened out in the regeneration felling.

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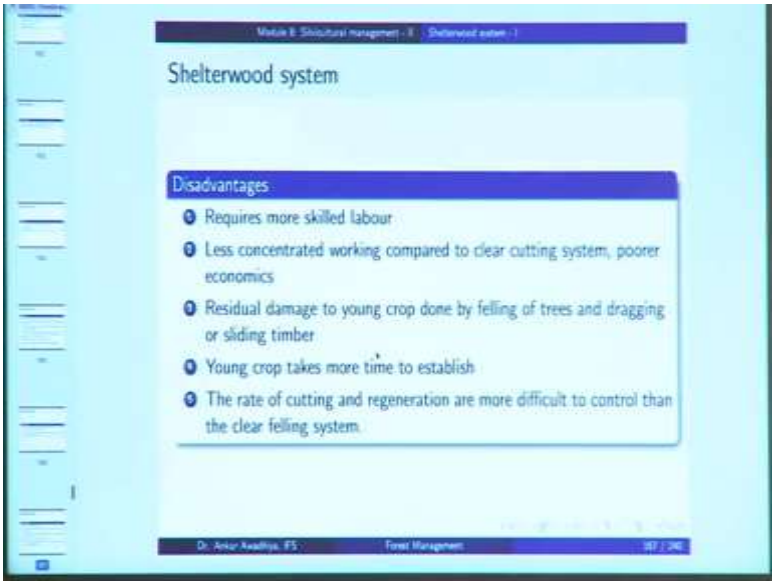

Disadvantages; you require more labor, more this more amount of skills that needs to be imparted, there is lesser concentration of forgiving residual damage, young crop takes more time to establish, and the rate of cutting and regeneration is more difficult to control.

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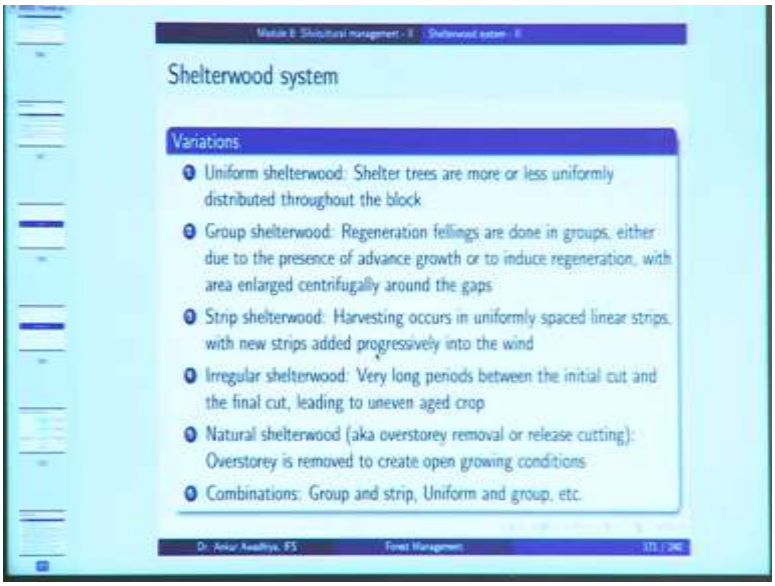

Next, we looked at the other variations. So, you have uniform, group, strip, irregular, natural shelterwood, and combinations of these different shelterwood systems.

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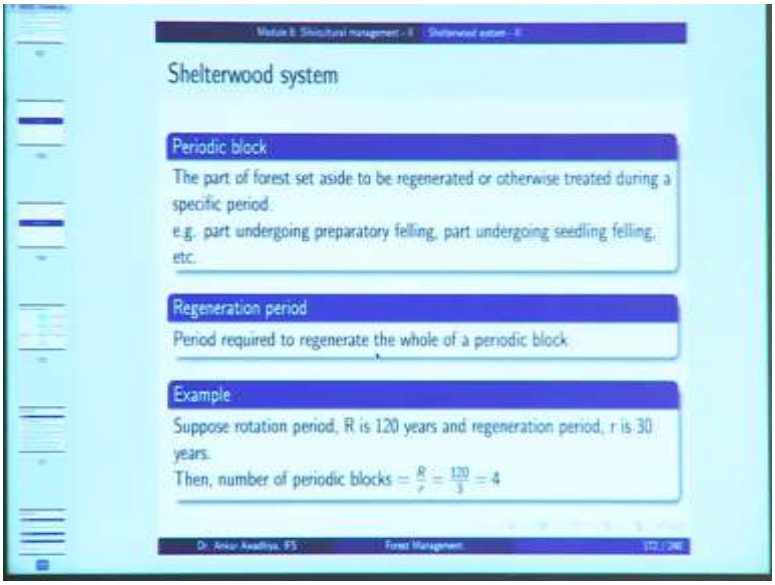

We looked at periodic block which is the part of a forest set aside to be regenerated or otherwise treated during a specific period. Regeneration period is period required to regenerate the whole of a periodic block, and the number of periodic blocks is given by rotation age divided by the regeneration period.

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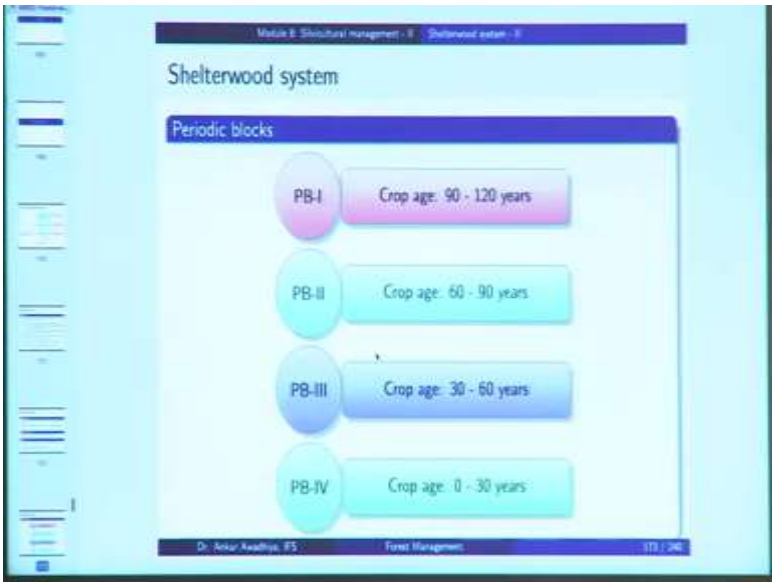

Now, in the case of shelterwood system, we typically have a four periodic blocks; the PB 1 is the 1 where you are going to do your felling operations followed by PB 2, 3, 4 and so, on.

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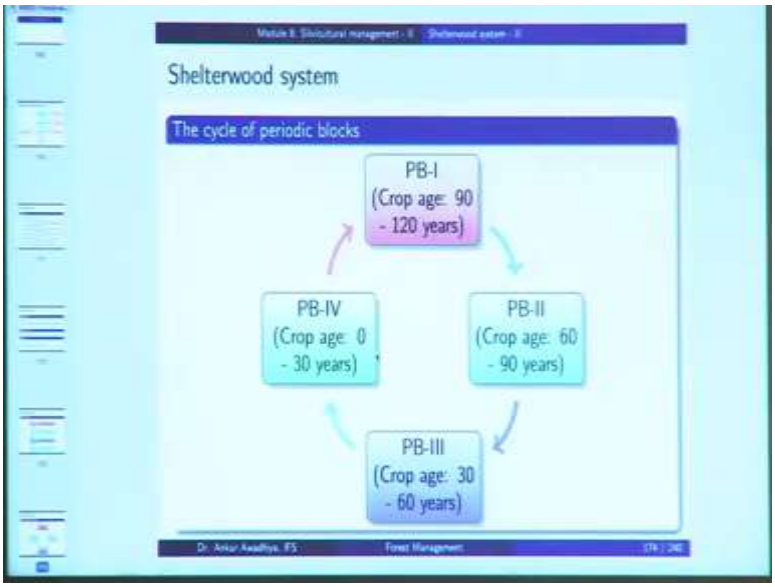

Now, the cycle of periodic blocks, if you look at PB 1 it is containing trees from 90 to 120 years.

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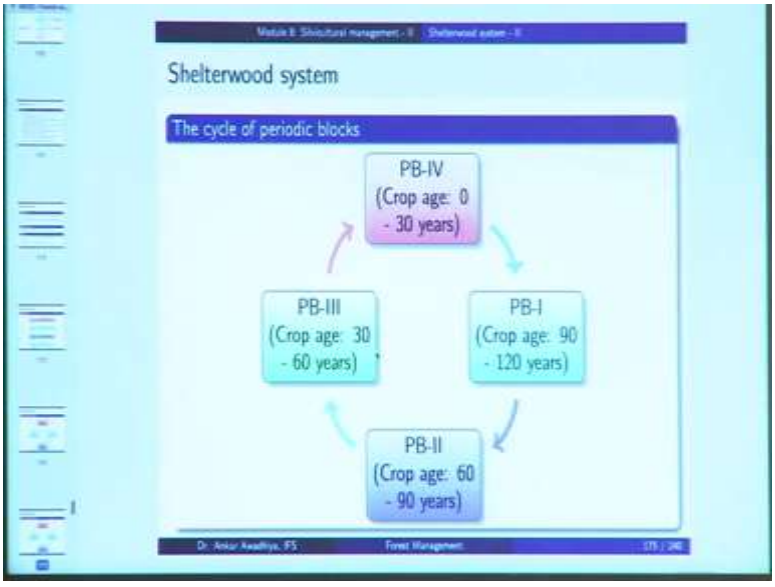

Once you have harvested these trees, then it becomes PB 4 from 0 to 30 years.

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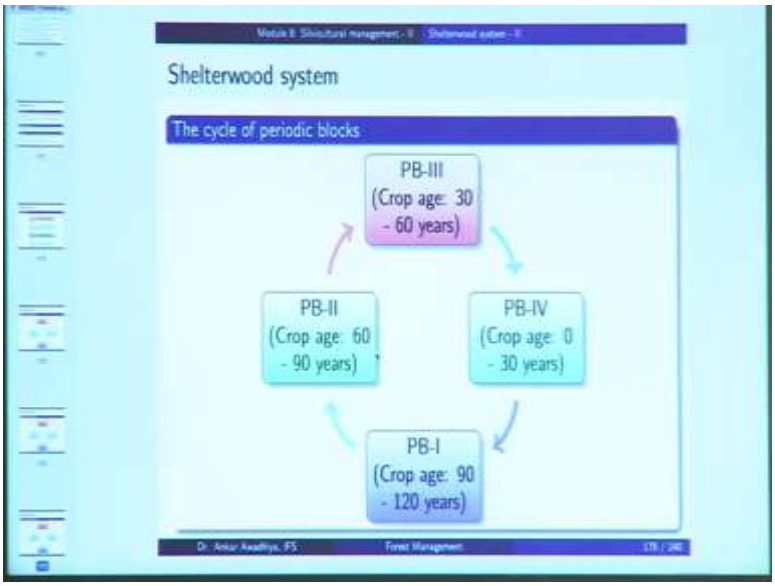

Then, it becomes PB 3 from 30 to 60 years.

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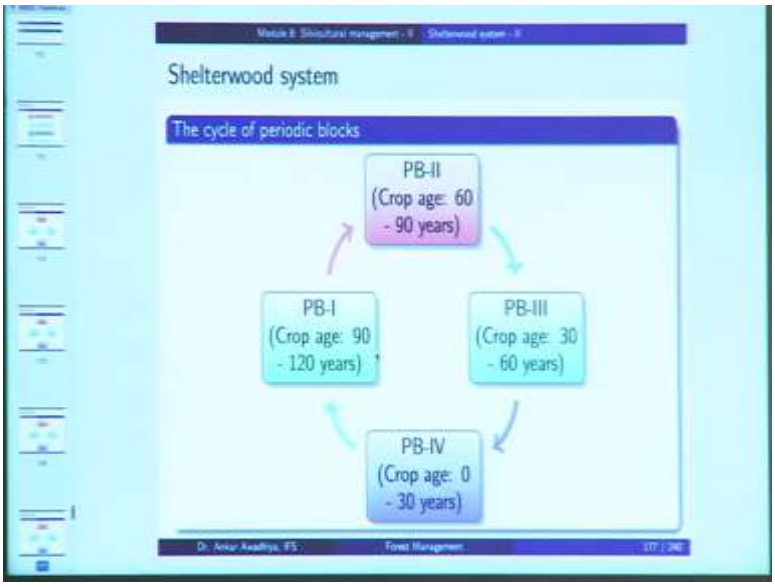

Then, it becomes PB 2; then, it again becomes PB 1.

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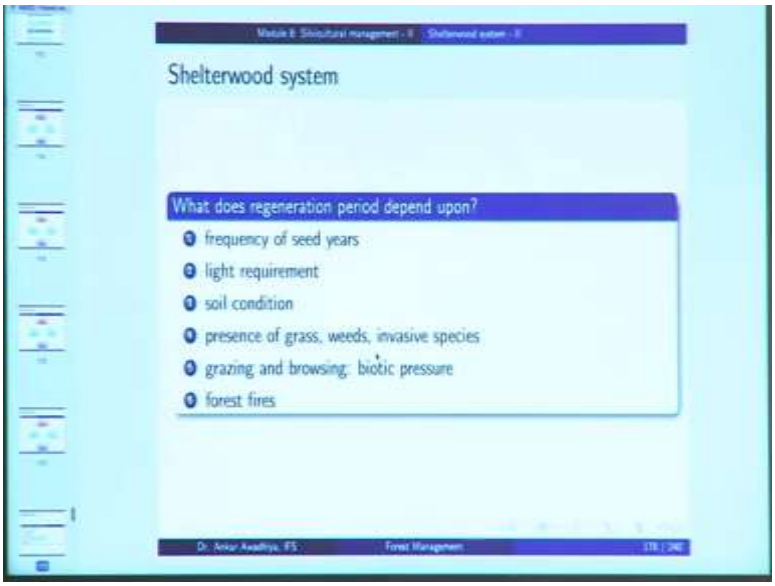

Now, regeneration is dependent on the frequency of seed years, light requirement, soil condition, presence of competition invasive, grazing and browsing biotic pressure and forest fires.

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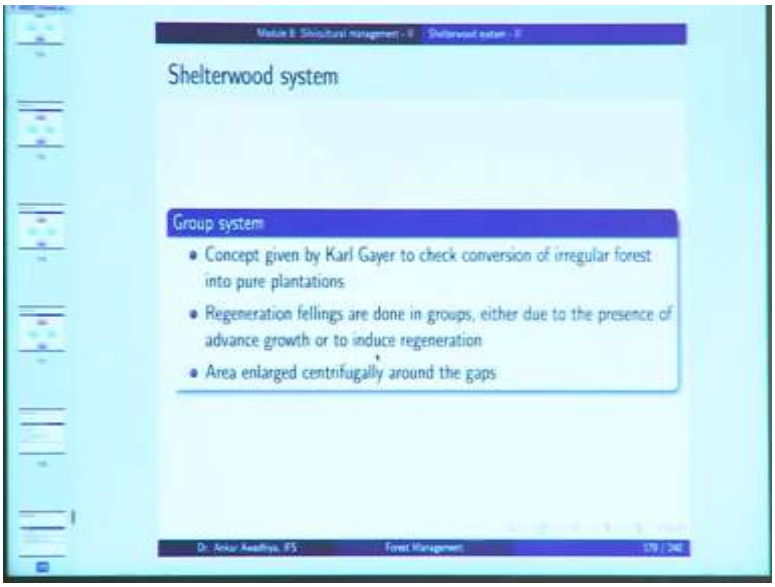

Next, we looked at a group system which is a concept that was given by Karl Gayer.

In this case, the regeneration felling is done in groups, either due to the presence of advanced growth or to induce regeneration, and then the area is enlarged centrifugally.

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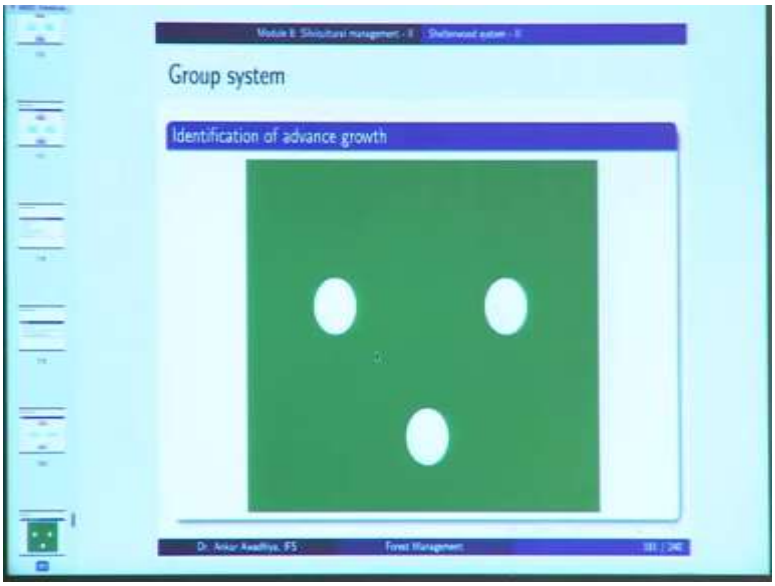

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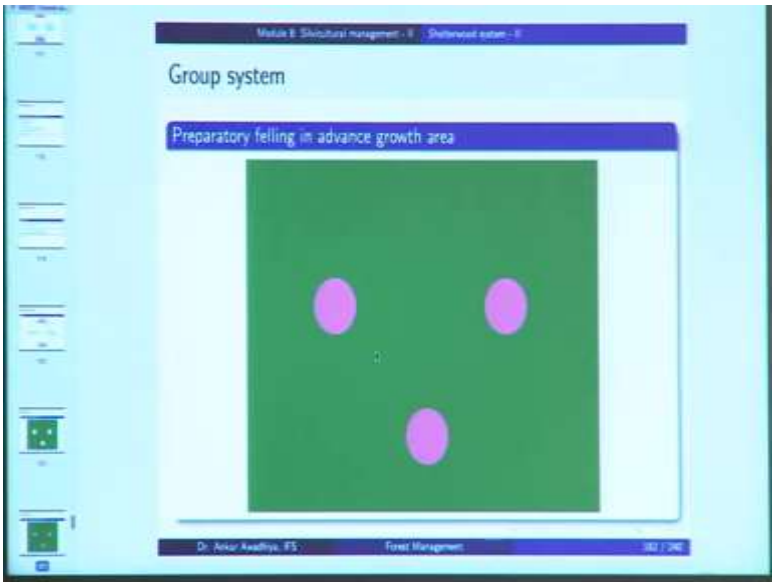

So, in this case, you identify the advance growth; do the preparatory felling.

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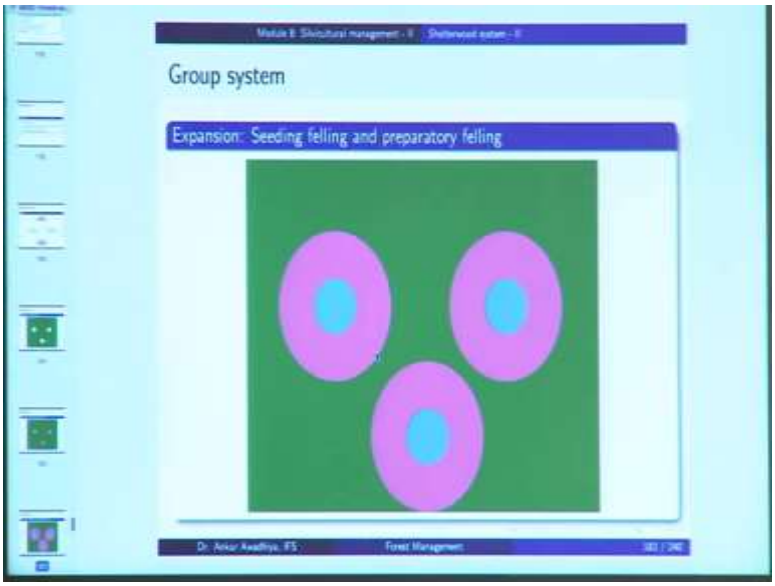

Then, in the next stage, you do seeding felling in these areas. And, you are also increasing the areas centrifugally were you will be doing the preparatory felling and slowly and steadily these areas will increase.

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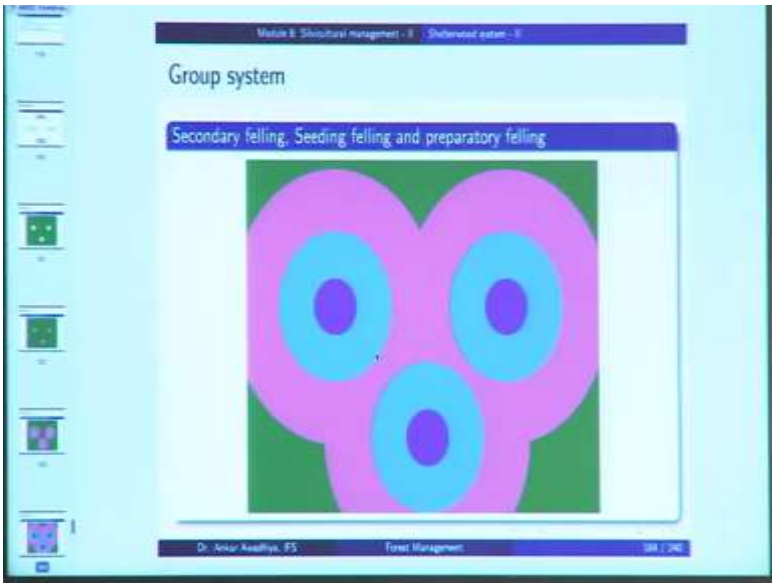

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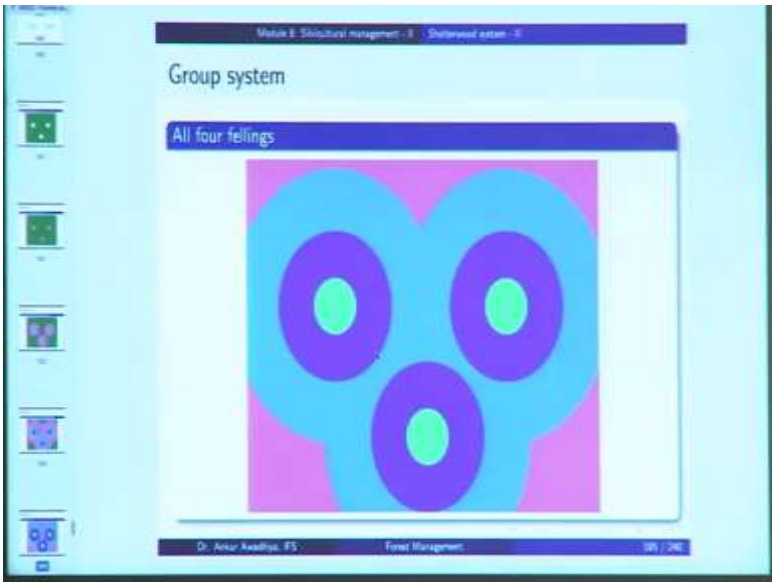

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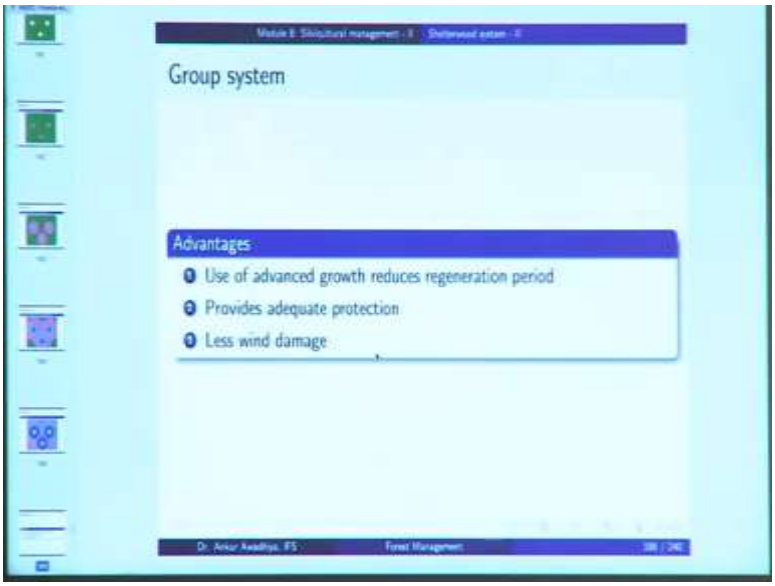

Advantages; the use of advanced growth reduces the regeneration period, provides adequate protection, less wind damage.

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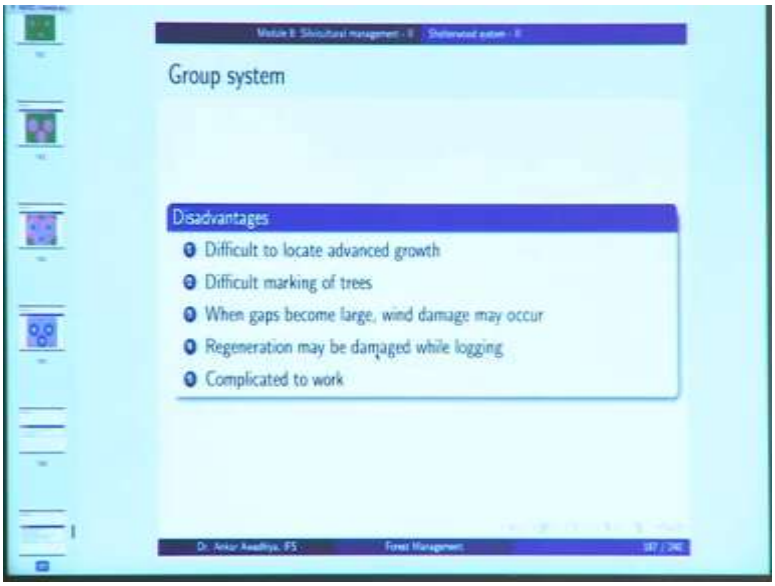

The disadvantages; it is difficult to locate advanced growth, difficult to mark the trees, when the gaps become large wind damage may occur, and regeneration may be damaged while logging and it is complicated.

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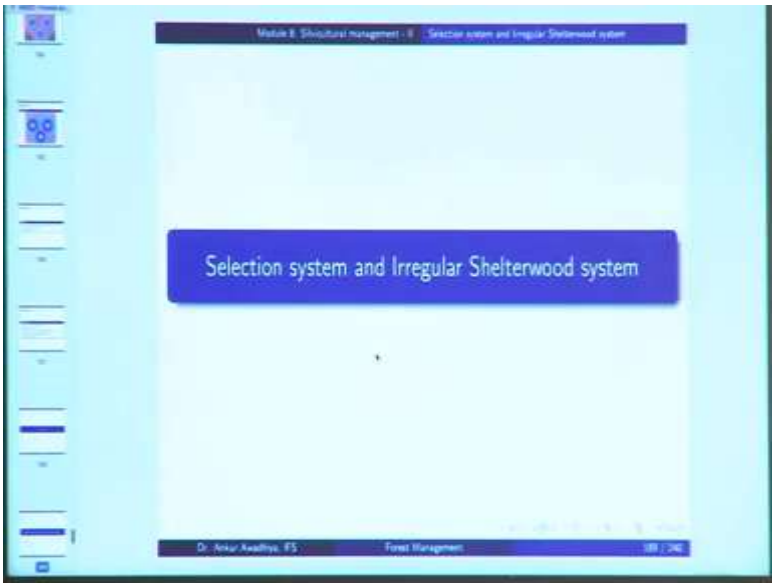

Next, we looked at selection system; in the case of selection system, concentration of felling and regeneration operations are continuous over the whole area.

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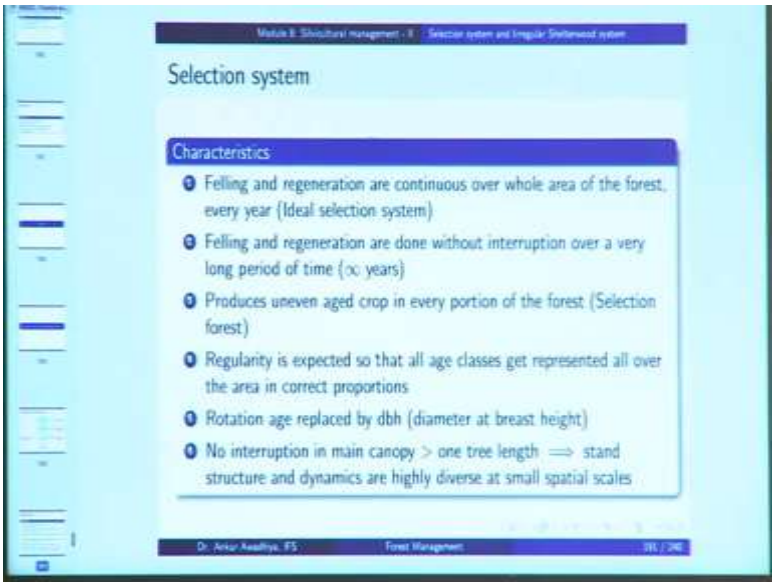

So, felling and regeneration are continuous over the whole area, every year, in an ideal selection system. Felling and regeneration are done without interruption over infinite number of years or a very long period.

It produces uneven aged crop in every portion of the forest, regularity is expected. You do not have a rotation age, but you have a selection dbh or selection diameter at breast height and because there are no interruptions in the main canopy. So, greater than 1 tree length. So, the standard structure and dynamics are highly diverse at small spatial scales.

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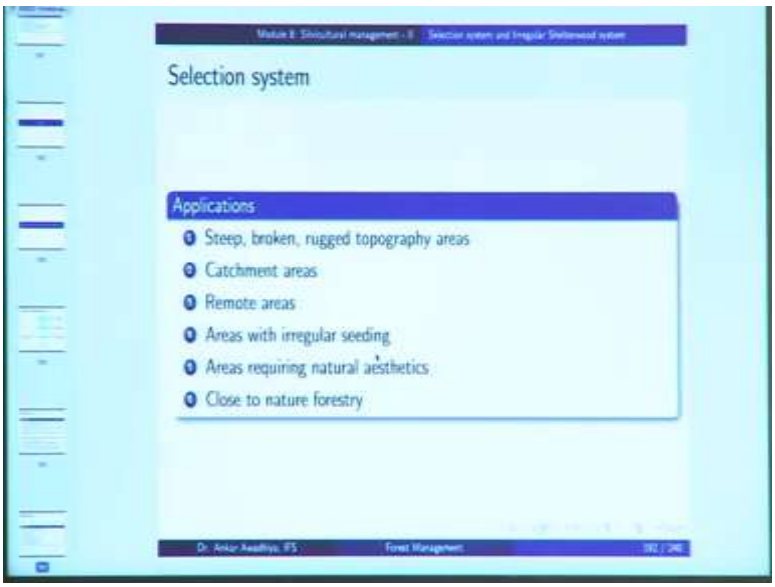

Applications; we generally use it for steep, broken, rugged topography areas, catchment, areas, remote areas, areas with irregular seeding, areas requiring natural aesthetics and close to nature forestry.

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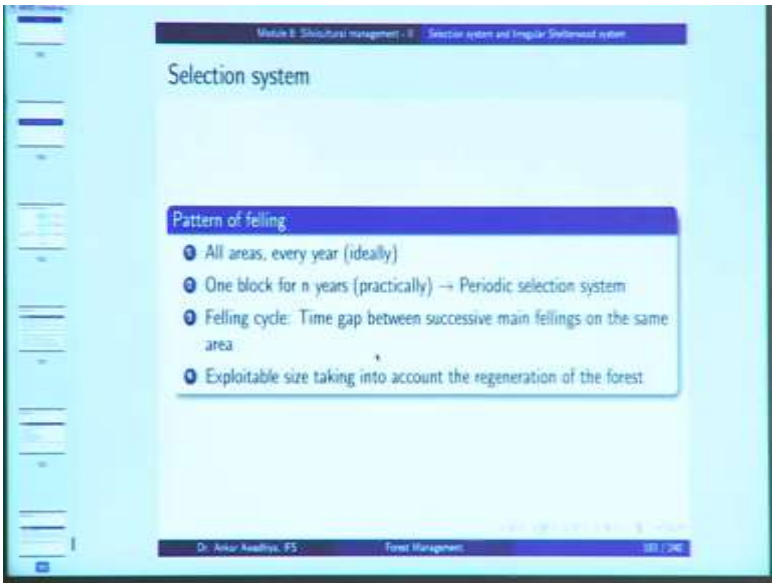

Pattern of felling; you can have all the areas, all every year, in an ideal system or you could go for a periodic selection system, in which you work on one block for n years.

Felling cycle is the time gap between successive main fellings on the same area. And, exploitable sizes is determined taking into account the regeneration of the forest.

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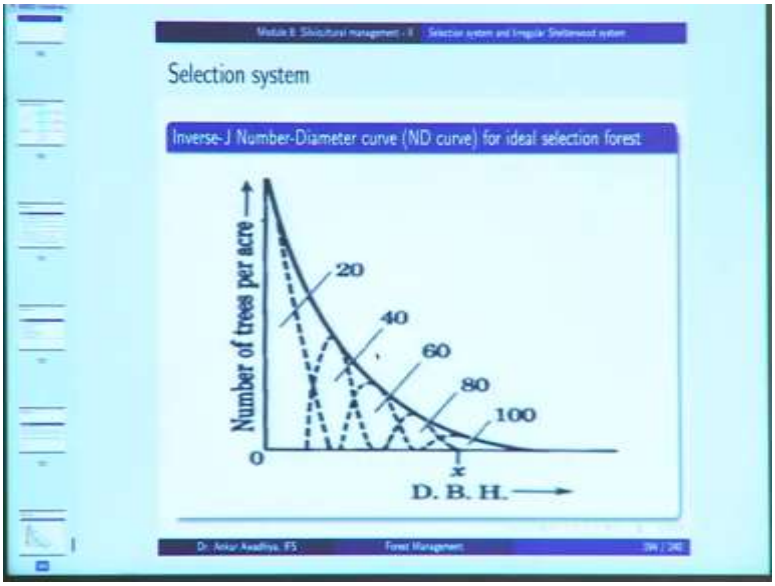

In the case of a selection system, you get an inverse J type of a number diameter curve.

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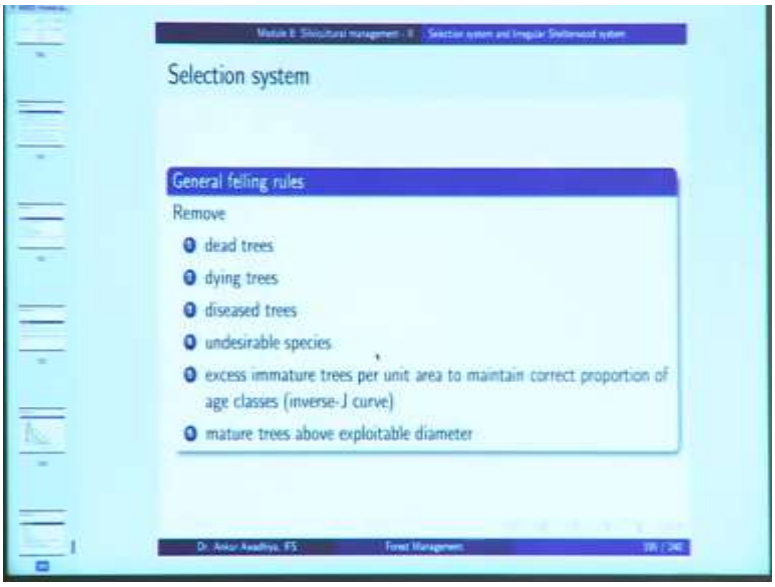

Felling rules you remove dead, dying, diseased trees, undesirable trees, excess immature trees to bring it bring your system close to the inverse J curve, and mature trees above the exploitable diameter.

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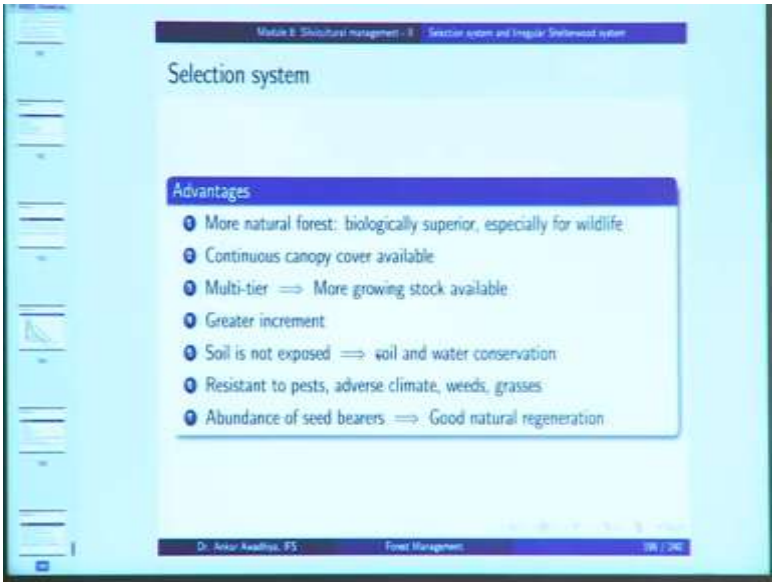

The advantages are more natural forest, continuous canopy, a multi-tier system. So, more growing stock is available, greater increment, soil is not exposed, it is resistant to pests,

adverse, climate, weeds and grasses, and they and abundance of seed bearers gives you a good natural regeneration.

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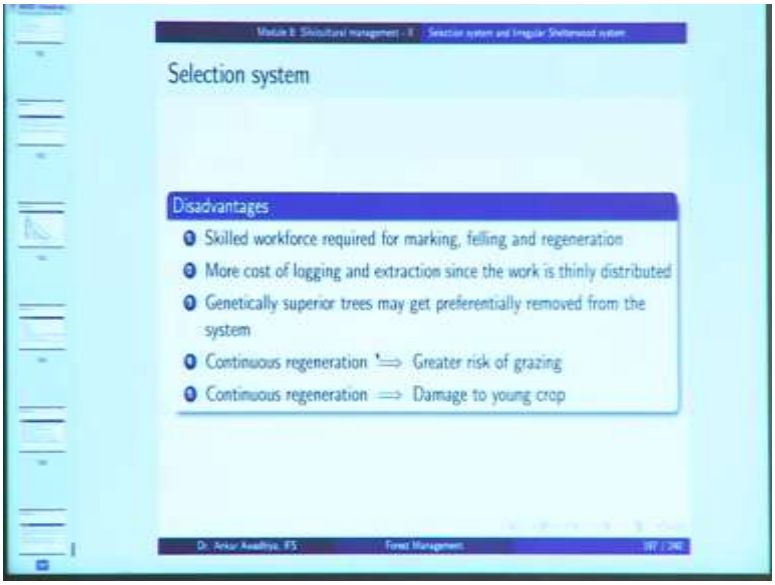

Disadvantages; again you require more skilled work workforce, more cost of locking, genetically superior trees may get preferentially removed, and there is a greater risk of grazing and damage to the young crop.

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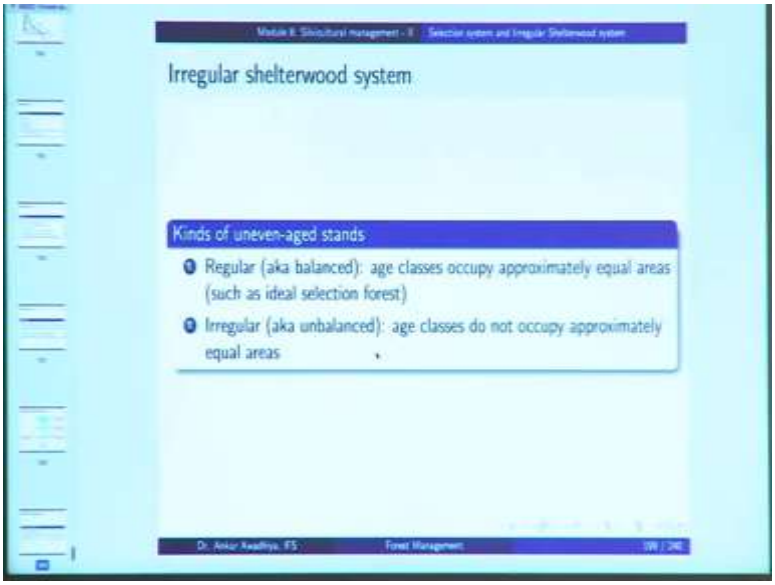

Next, we looked at irregular shelter wood system; in which case, an irregular stand is a stand where the age classes do not occupy approximately equal areas

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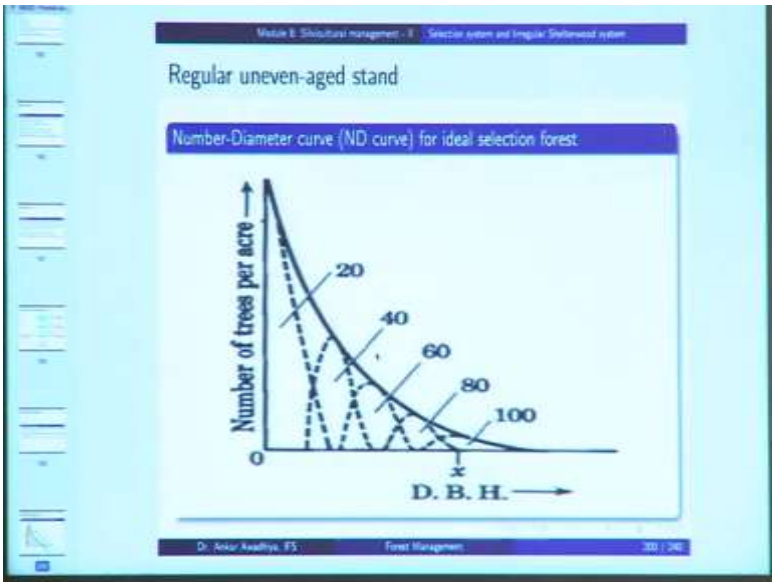

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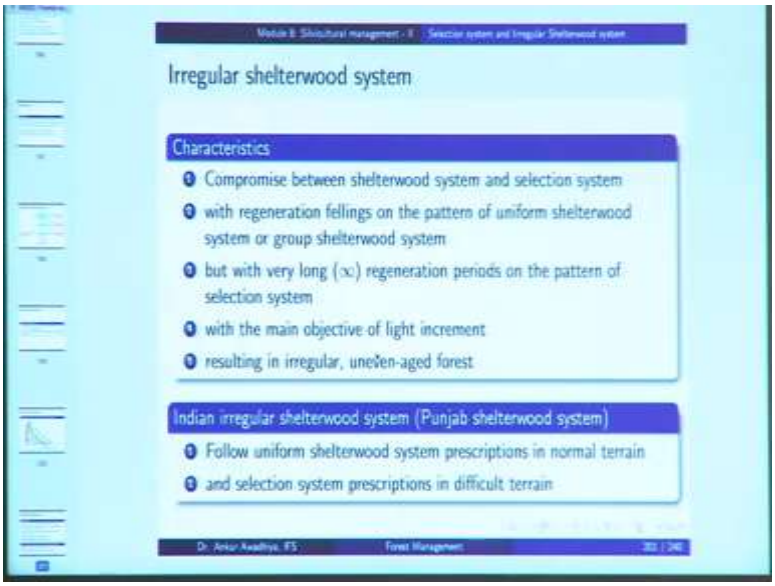

And if you have such a forest, and if you want to maintain the irregular characteristic, then you can go for an irregular shelter wood system.

The simplest which is the Indian irregular shelter wood system, in which case you follow the prescriptions of a uniform shelterwood system in a normal terrain, and the prescriptions of a selection system in a difficult terrain. So, you are maintaining your trees according to both shelter wood system and the selection system and so, with the forest is retained as an irregular stand.

Now, the characteristics; it is a compromise between shelter wood system and selection system with regeneration fellings on the pattern of uniform shelter wood system or group shelter wood system, but with very long regeneration periods on the pattern of selection system, with the main objective of light increment resulting in irregular uneven-aged forests.

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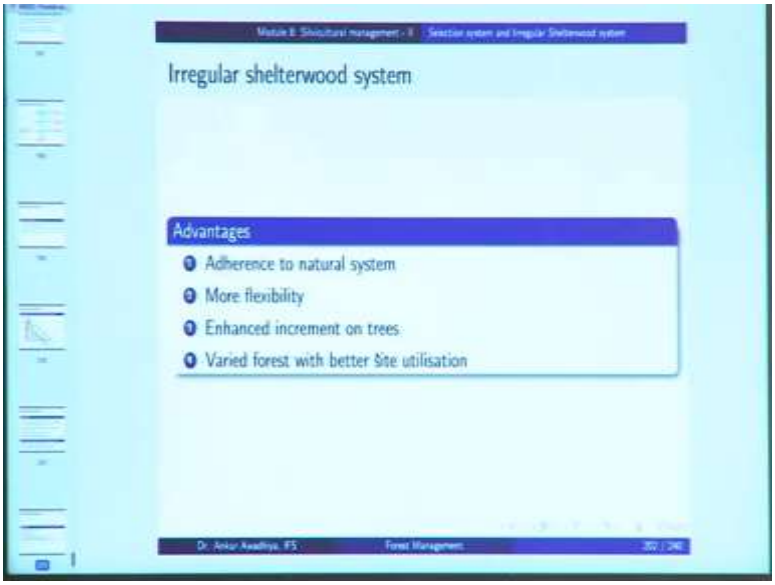

Advantages; there is adherence to natural system, more flexibility, more increment varied forests with bitter site utilization.

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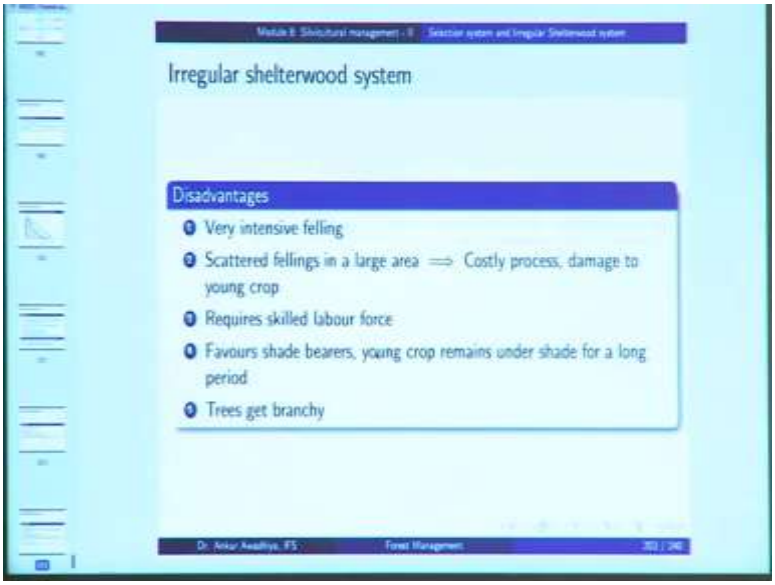

But the disadvantages are that there is very intensive felling, scattered fellings in a large area leads to a costly process, there is a regular damage to the young crop, requires skilled labor force, favors the shade the shade bearers, young crop remains under shade for a long time, and the trees make it branchy.

Now, with a choice of all these different silvicultural systems, you can choose which one you want to use depending on which crop you are using; whether it is shade tolerant or light dependent, what is the kind of site that you are working with, and your silvicultural objectives. So, that is all for today.

Thank you for your attention [FL].