Availability and Management of Groundwater Resources

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Lecture-43
Estimation of Total Annual Replenishable Natural Groundwater Recharge (Contd.)

Welcome you all in the part 4 of the module 9 estimation of total annual replenishable natural groundwater recharge. So, so far we have learnt in the 3 different parts of the lecture that groundwater is storing in some sort of formation. The formation is the rock and the rock generally store the water inside the earth's surface. So, as per the storage of the groundwater resources we are also calculating the groundwater ability in any area for any sort of work.

So, for this generally we are estimating the total annual replenishable recharge of the area and there are several methods also. Because we know that rainwater after infiltration and percolation it reaches to the underneath aquifer where it is storing and from one aquifer to another aquifer the groundwater is flowing inside the earth's surface. So far different methods we have discussed the water balance method, the rainfall infiltration factor method, the groundwater table fluctuation method.

And among these methods generally the ability of the groundwater resources are being found out. So, we have also discussed in the last part few parts that which are the different techniques through which the recharging can take place in the rural and urban areas.

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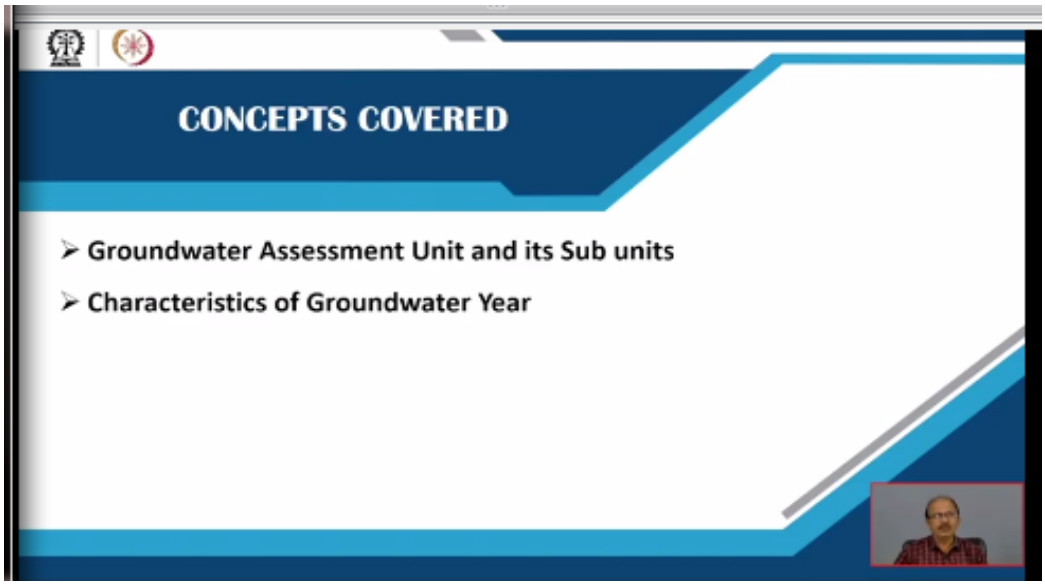

So, in this part of the part 4 we will discuss, just I will discuss about the groundwater assessment units and it is subunits and the characteristics of the groundwater year, so this thing we will do. Because our aim is to find out the ability of the groundwater resource inside the earth surface, so for this generally we have to assess the groundwater unit and it is subunits through which we can able to find out the TARR that is the total annual replenishable recharge.

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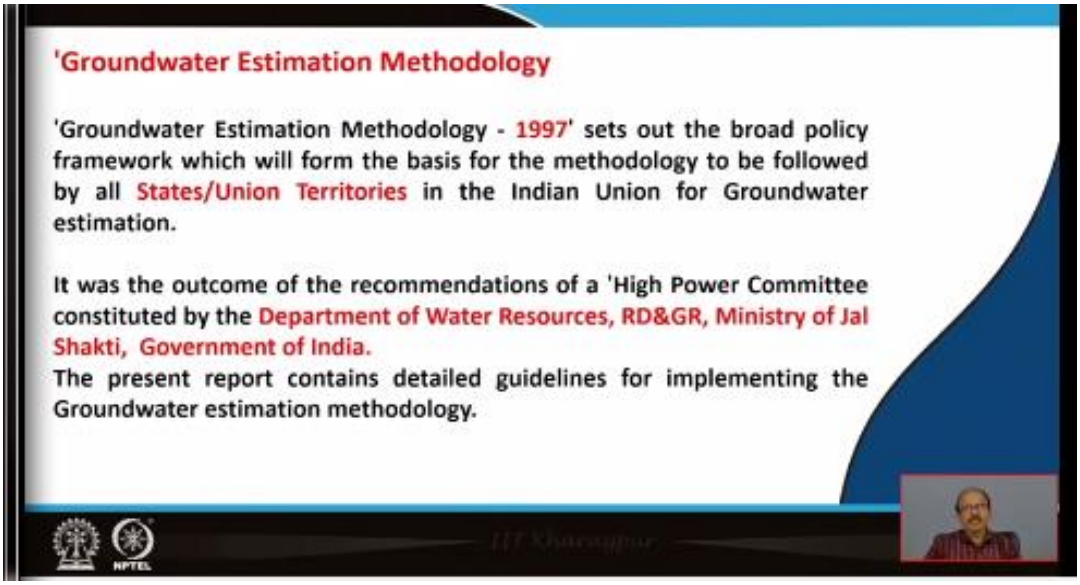

So, generally the TARR method is based on the groundwater estimation methodology 1997 which sets out the broad policy framework. And it is formed the basis for methodology to be followed by all states and union territories in the Indian union for the estimation of the groundwater resources in the area. So, it was generally the outcome of the recommendation of high power

committee constituted by the department of water resources min RD and GR the ministry of Jal Shakti, government of India.

And the report contains about the detailed guidelines for implementing the groundwater estimation methodology. How can we estimate the groundwater resources in any area? This report tells us in greater details.

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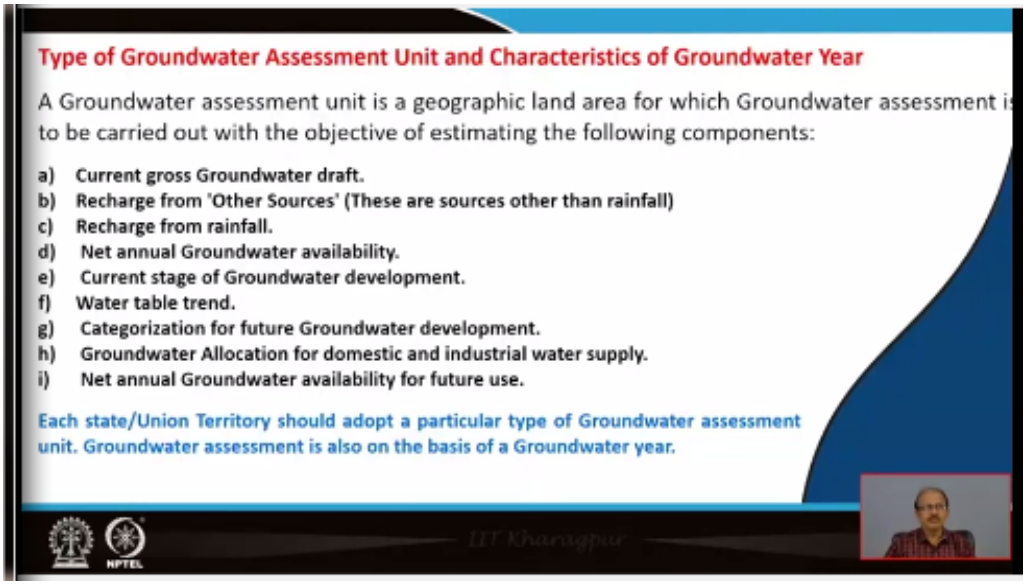

So, generally the groundwater assessment units are a geographical land area for which generally the groundwater assessment is to be carried out having some objectives for estimating the following components. The components are current gross groundwater dropped then the recharge from the other sources, other sources means these are the sources other than rainfall, then the recharge from rainfall then the net annual groundwater ability.

Current stage of groundwater development of the area, then water table trend, what is the trend of the water table location, then the categorization for future groundwater development unit and the groundwater allocation for domestic and industrial water supply and net annual groundwater ability for future use. So, generally these are the objectives for estimating the your groundwater resources.

Now each state union territories should also adopt a particular type of groundwater assessment unit, not necessary to have all the component but each state an union territory should adopt this assessment unit. And groundwater assessment is also the basis of a groundwater year. So, now let us know what are the different types of assessment unit?

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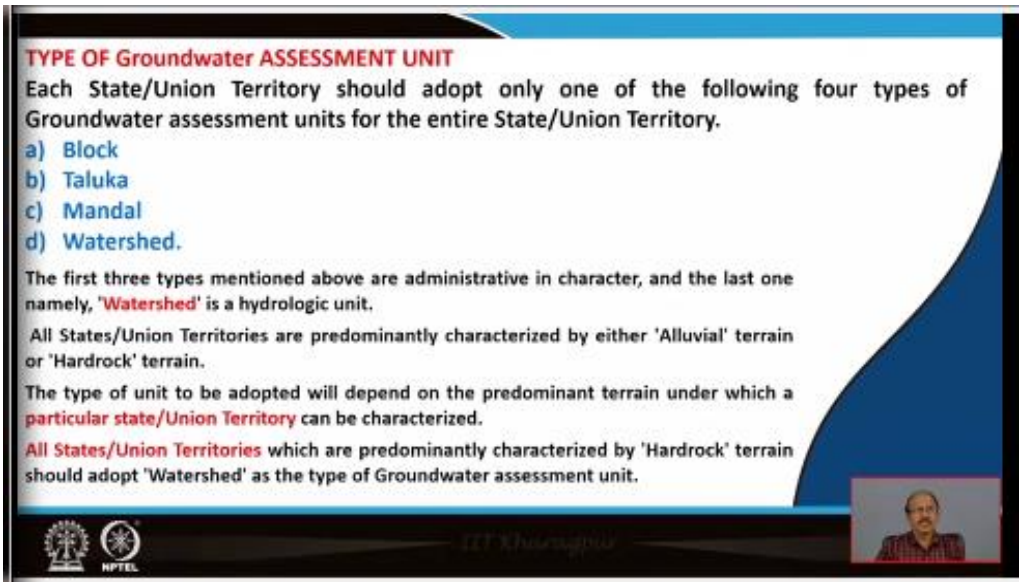

So, different type of **assessment** groundwater assessment units for entire state and union territory is generally of 4 types that is the block level, taluka, mandal and watershed. So, first 3 types mentioned above are administrative in character and the last one namely watershed is nothing but it is a hydrologic unit. All states union territories are predominantly characterized by either alluvial terrain or hard rock terrain.

As we have discussed in the last several lectures also that groundwater may remain stored in a sedimentary formation that is the soft rock formation, **or** in the soft rock formation it may remain in the pore spaces within it or the fractures and lineaments or some cracks in the hard rock. So, generally these are the 2 different rock types in which generally the groundwater remains stored inside the earth's surface.

So, Alluvial terrain or Hardrock terrain should be there. The type of unit adopted will depend on the predominant terrain under which the state or territory is characterized. And these are generally hard rock terrain should adopt watershed as the type of groundwater assessment unit. So, generally

all the states and union territory they are predominantly characterizing by hard rock terrain. And these hard rock steering should adopt the watershed as the type of groundwater assessment unit.

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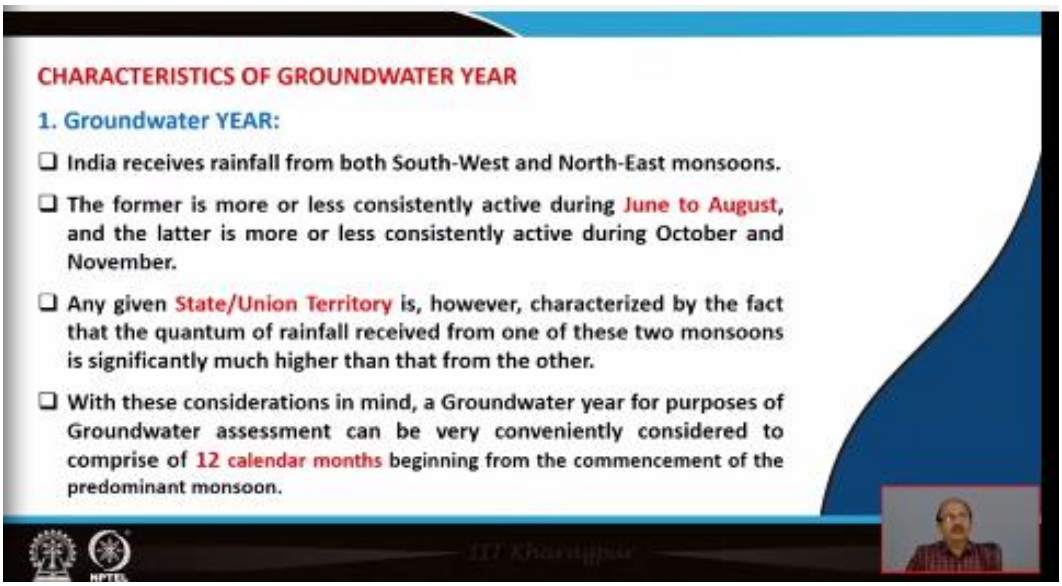

Now groundwater year is a term generally it is a term for the assessment of the groundwater resources inside the surface. That is India receives rainfall from both southwest as well as northeast monsoons. So, the former southwest is more or less consistently active during June to August and the northeast monsoons are more or less active during October to November. So, in the state and union territory these are the fact that the quantum of rainfall received from one of these 2 monsoons significantly much higher than that from the other.

So, generally it is felt that this type may occur with these considerations in mind a groundwater year for purpose of groundwater assessment because we have to assess the groundwater resources can be very conveniently considered. It can be considered to comprise of 12 calendar months beginning from the commencement of the predominant monsoon. So, it is groundwater year is having the 12 calendar months and it starts from the commencement of the predominant monsoon.

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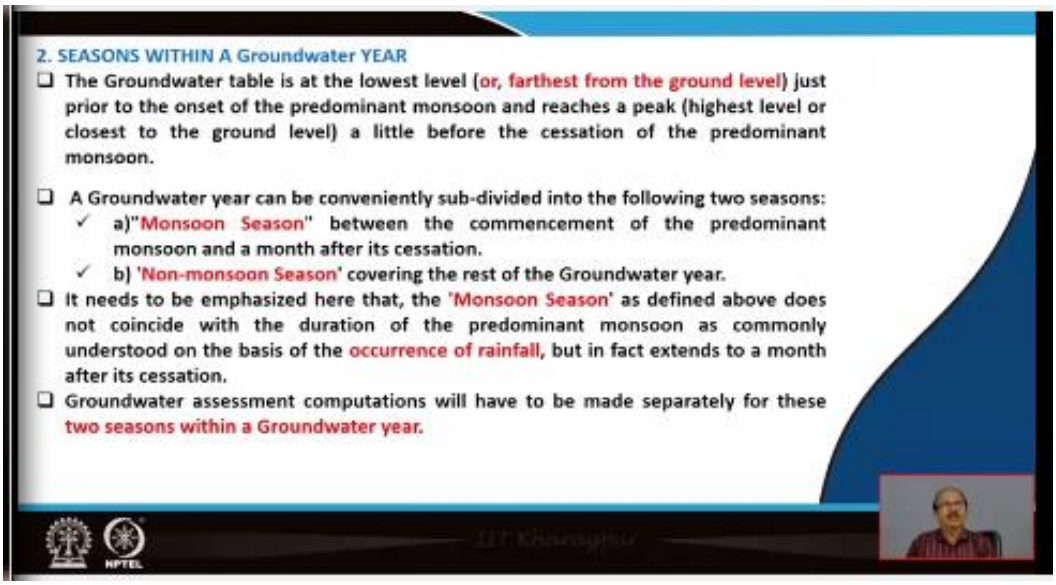

Now seasons within a groundwater year. Now what are the different seasons is which is coming in a groundwater year? No doubt groundwater year is 12 calendar months, so groundwater table remains at the lowest level or say farthest from the ground level just prior to the onset of the predominant monsoon. So, and reaches a peak that is the highest level or closest to the ground level or nearest to the ground level a little before the end of the predominant monsoon.

So, this monsoon is very, very important, the different seasons are very, very important within a groundwater year. A groundwater year can be conveniently divided into 2 different seasons, the first is the monsoon season. Monsoon season between the commencement of the predominant monsoon and a month after it is cessation and the non-monsoon season covering the rest of the groundwater year.

So, the commencement of the predominant monsoon and a month after it is end is generally considered as a monsoon season and then the remaining months of the 12 calendar months are characterized as a monsoon season. So, it needs to be emphasized here that the monsoon season as defined above does not coincide with the duration of the predominant monsoon as commonly understood on the basis of occurrence of rainfall but in fact extends to a month after it is cessation.

So, it is extending after it is ending the occurrence of rainfall generally it is called as monsoon season. Now groundwater assessment computation will have to make separately for 2 seasons

within a groundwater year. So, if you wish to have the groundwater assessment of any area, so separately you have to compute the different aspects for the 2 different seasons within a groundwater year.

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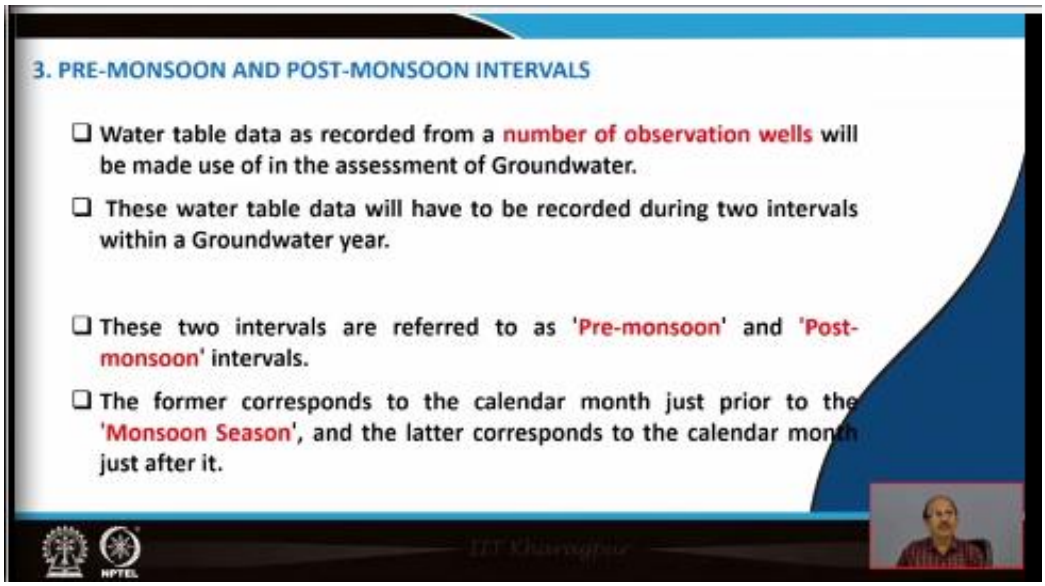

Now pre-monsoon and post-monsoon intervals. So, what is happening? The water table fluctuation data as recorded from a number of observation wells will be made used in the assessment of groundwater. These water table data will have to record during 2 intervals within a groundwater year. These 2 intervals are generally referred as pre-monsoon and post-monsoon intervals. So, the pre-monsoon corresponds to the calendar month just prior to the commencement of the monsoon season and the post-monsoon corresponds to the calendar month just after it.

So, now we came to know about 3 monsoonal season first is the pre-monsoon, second is the monsoon and third is the post-monsoon. So, before monsoon is called as pre-monsoon and after monsoon is called as post-monsoon.

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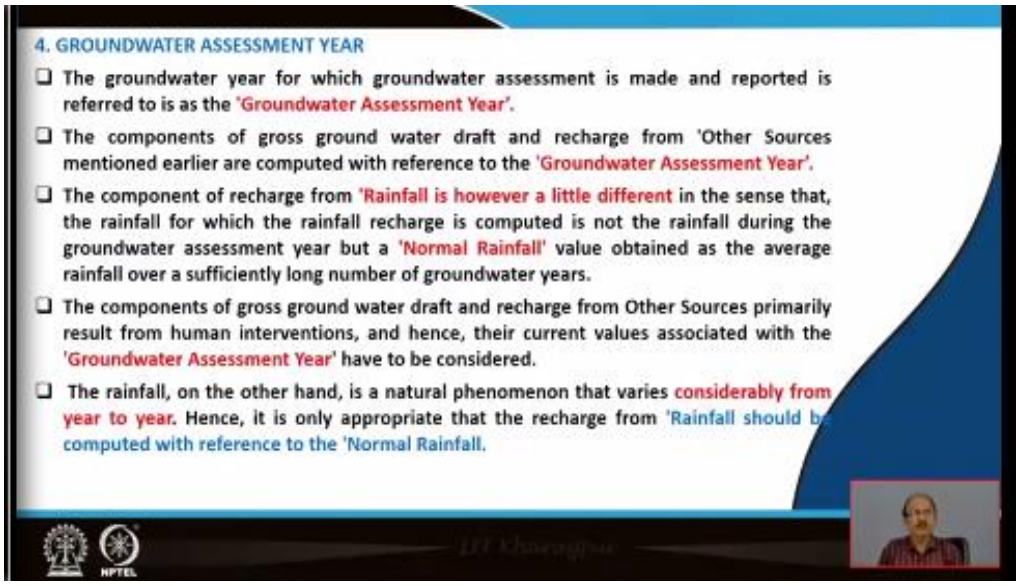

Now the groundwater assessment year, the groundwater year for which groundwater assessment is generally made and reported is generally referred as groundwater assessment year. So, the components of gross groundwater dropped and recharged from other sources mentioned earlier are computed with reference to the groundwater assessment year. The component of recharge from rainfall is however a little different in the sense that the rainfall for which the rainfall recharge is computed is not the rainfall during the groundwater assessment year.

But a normal rainfall value obtained as average rainfall over a sufficiently long number of groundwater years. So, this is important to understand, now the components of gross groundwater dropped and recharged from other sources primarily result from human interventions. And hence the current values associated with the groundwater assessment year have to be considered.

The rainfall on the other hand is a natural phenomenon that varies considerably from year to year; hence it is only appropriate that the recharge from rainfall should be computed with reference to the normal rainfall. So, the rainfall amount is varying from year to year.

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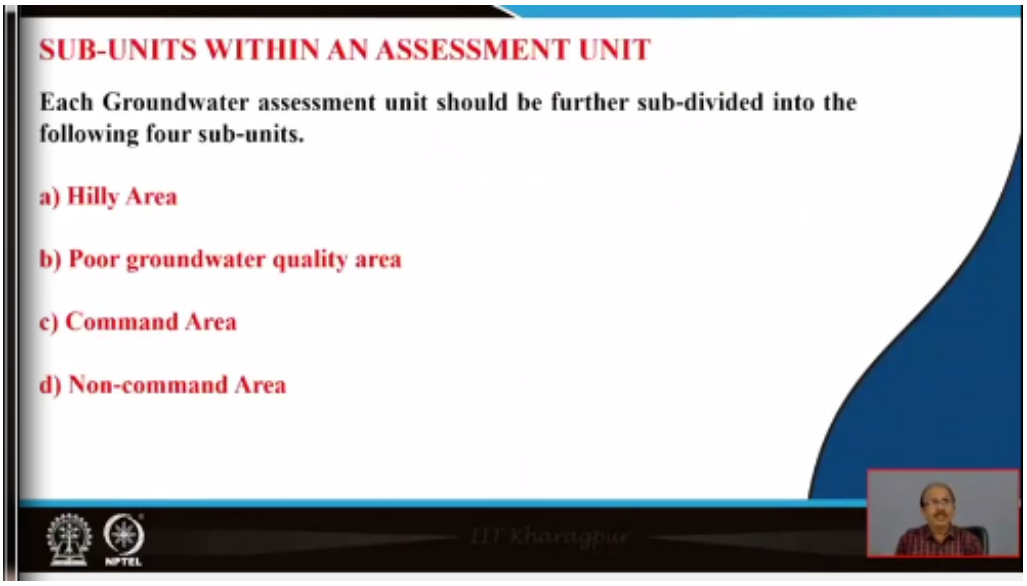

Now there are sub-units also within any assessment unit, generally groundwater assessment unit is further subdivided into sub-units. And the sub-units are hilly area, poor ground water quality area, then command area and then non-command area. So, in this way GC has just divided the 4 important sub-units the hilly area, poor ground water quality area, command area and non-command area.

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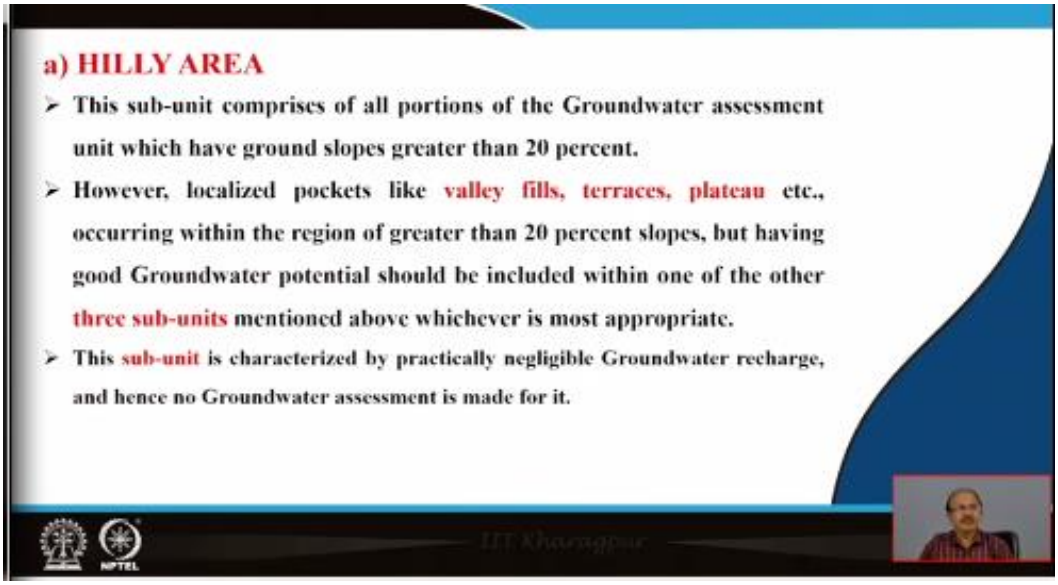

So, hilly area first is the hill area, this hilly area sub-unit comprises of all portions of the groundwater assessment unit which have generally ground slopes greater than 20%. So, localized pockets like valley fills, terraces, plateau etcetera, occurring within the region of greater than 20%

slopes but having good groundwater potential should be included within one of the other 3 sub-units mentioned above whichever is more appropriate.

The sub-unit is characterized by practically negligible groundwater recharge and hence no groundwater assessment is made for it. So, for hilly area making groundwater assessment is very difficult. So, generally the sub-unit is characterized by practically negligible groundwater recharge and here hence no groundwater assessment is made for it.

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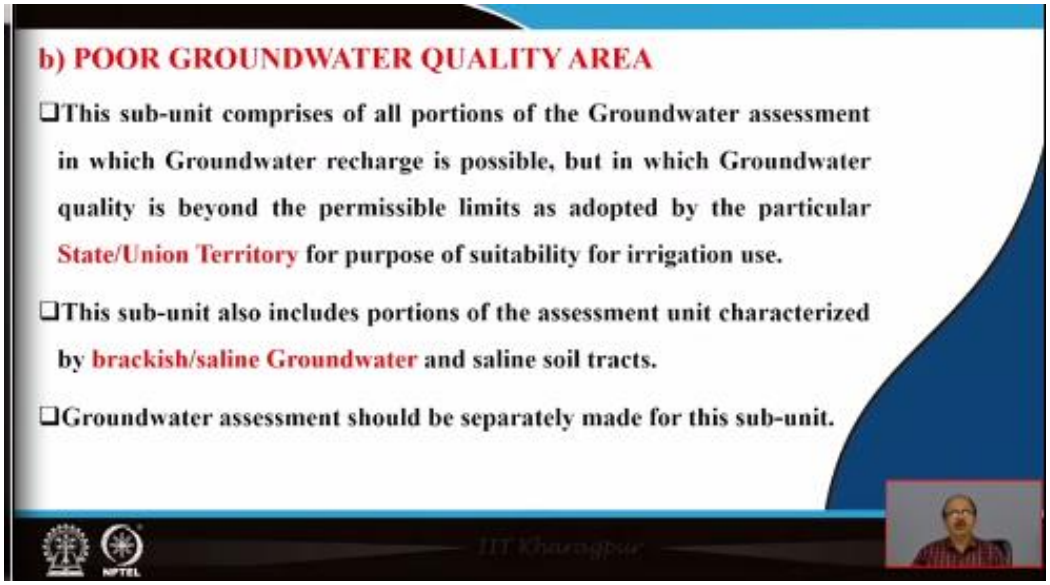

Now second area is the poor groundwater quality area. So, this sub-unit comprises of all portions of the groundwater assessment in which groundwater recharge is possible. Here the groundwater recharge is possible but in which groundwater quality is beyond the permissible limits as adopted by particular state or union territory for the purpose of suitability for irrigational use. So, this sub-unit also includes portion of the sub assessment unit characterized by brackish or saline groundwater and saline soil tracks.

So, groundwater assessments should be made separately for this type of sub-unit where the groundwater quality is poor.

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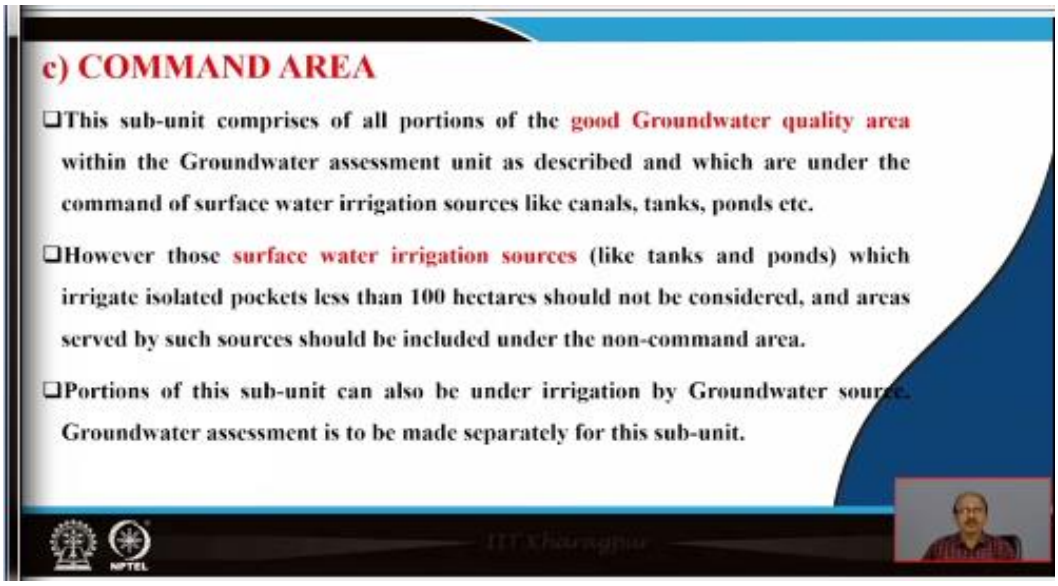

Now third is the command area, this is the third sub-unit, this sub-unit comprises of all portions of good groundwater quality area within the groundwater assessment unit as described and which are under the command of surface water irrigation sources like canals, tanks, ponds etcetera. However, those surface water irrigation sources like tanks and ponds which irrigate isolated pockets less than 100 hectares should not be considered and areas served by such sources should be included under the non-command area.

So, this is coming under the non-command area. Portions of this sub-unit can also be under irrigation by groundwater sources. Groundwater assessment is to be made separately for this sub-unit. So, this is for the command area where the all portions of the good groundwater quality remain. And generally, in this area surface water irrigation sources, we are having the surface water irrigation sources like tanks and pond which irrigate isolated pockets less than 100 hectare it should not be considered. And areas served by such sources should be included under the non-command area.

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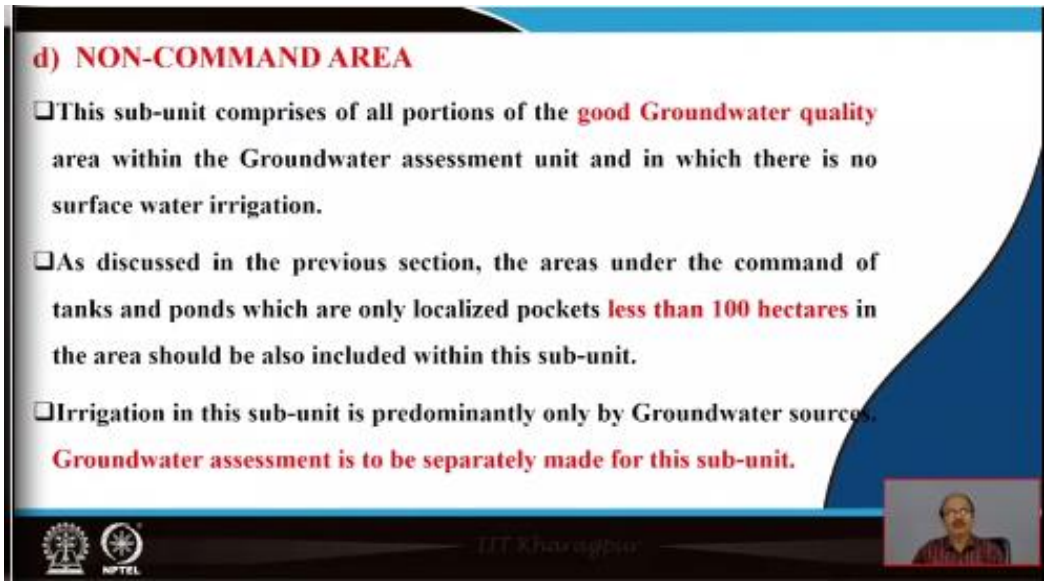

Now non-command this sub-unit comprises of all portions of the good groundwater quality area within the groundwater assessment unit and in which there is no surface water irrigation, here no surface water irrigation. So, as discussed in the previous section that is the command area under the command of tanks and ponds which are only localized pockets less than 100 hectares in the area should be also included within this sub-unit.

So, irrigation in this sub-unit is predominantly only by the groundwater sources and the groundwater assessment is to be separately made for this sub-unit. So, in every type of area you have to assess the groundwater assessment factor separately for the different sub-units.

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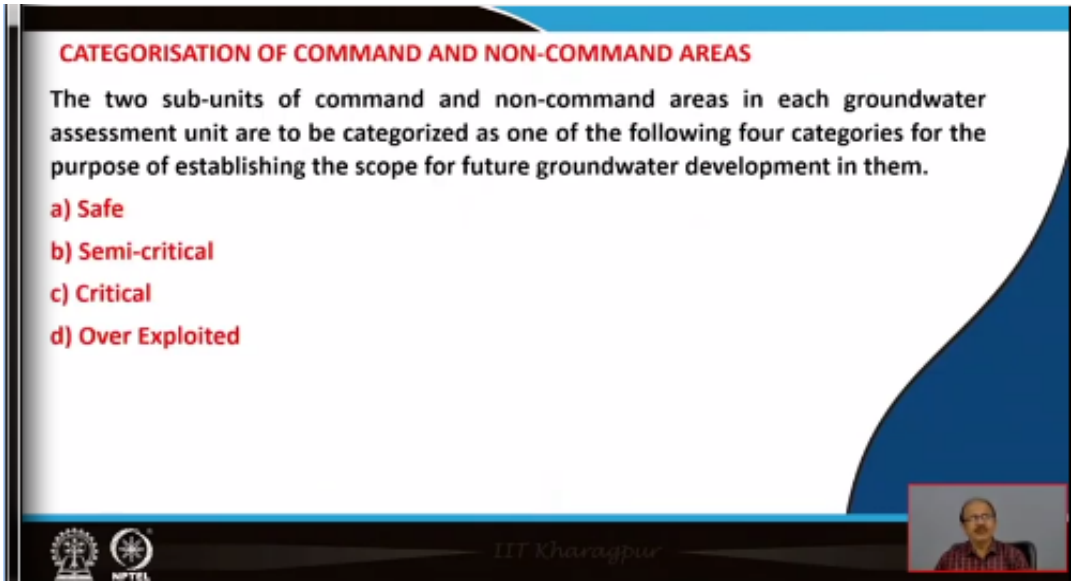

Now once we came to know about the groundwater year then the groundwater assessment year than the types of the sub-units. Then now categorizations are being done generally and these categorizations are done in terms of safe, semi-critical, critical and over exploited. So, the 2 subunits of command and non-command area in each groundwater assessment units are to be categorized as one of the following 4 categories.

And the 4 categories are the safe, semi-critical, critical and over exploited for the purpose of establishing the scope for future groundwater development in them.

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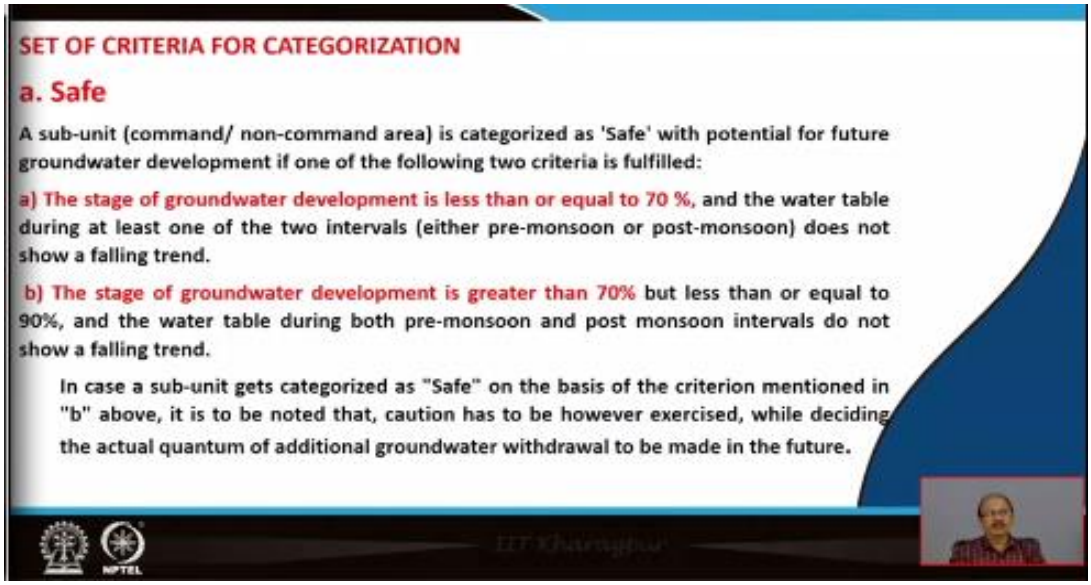

Now the set of criteria for categorization. So, different criteria for the different a sub-units just now we have discussed about the command area, non-command area, hilly area, so these are the subunits. So, the different criterion has been set up and these criteria are safe, critical, semi-critical and over exploited. So, the first is the safe a sub-unit that is command or non-command area is generally characterized as safe with the potential for future groundwater development if one of the following 2 criteria is being fulfilled.

The first criteria is the stage of groundwater development is less than or equal to 70% and the water table during at least one of the 2 intervals say either pre-monsoon or post-monsoon does not show a falling trend, it is not showing a falling trend this is the criteria 1. The criteria 2 is the stage

of groundwork development is greater than 70% but less than or equal to 90% and the water table during both pre-monsoon and post monsoon intervals do not show a falling trend.

So, these are the 2 different criteria for keeping any area under the safe category, these are the 2 different criteria's. In case a sub-unit gets categorized as safe on the basis of the criteria mentioned in "b" above then it is to be noted that caution has to be however exercised while deciding the actual quantum of additional groundwater withdrawal to be made in the future. So, it is very, very important.

Because see the 2 different criteria's are here, the first criteria is the groundwater development should be less than or equal to 70% and within the 2 seasons that is pre-monsoon and post-monsoon season there should not be any water table falling trend. Second criteria is that greater than 70% but less than 90% and the water table during both pre-monsoon and post-monsoon do not show any falling trend but we should have some sort of precaution.

That since it is the between is greater than 70% but less than or equal to 90%, so we should have some exercise also, we should remain causes also that actual quantum or additional groundwater withdrawal which is to be made in the future. So, for this we should think, we should decide what should be the actual quantum of additional groundwater withdrawal to be made in the future. So, this is under the criterion that is safe criteria.

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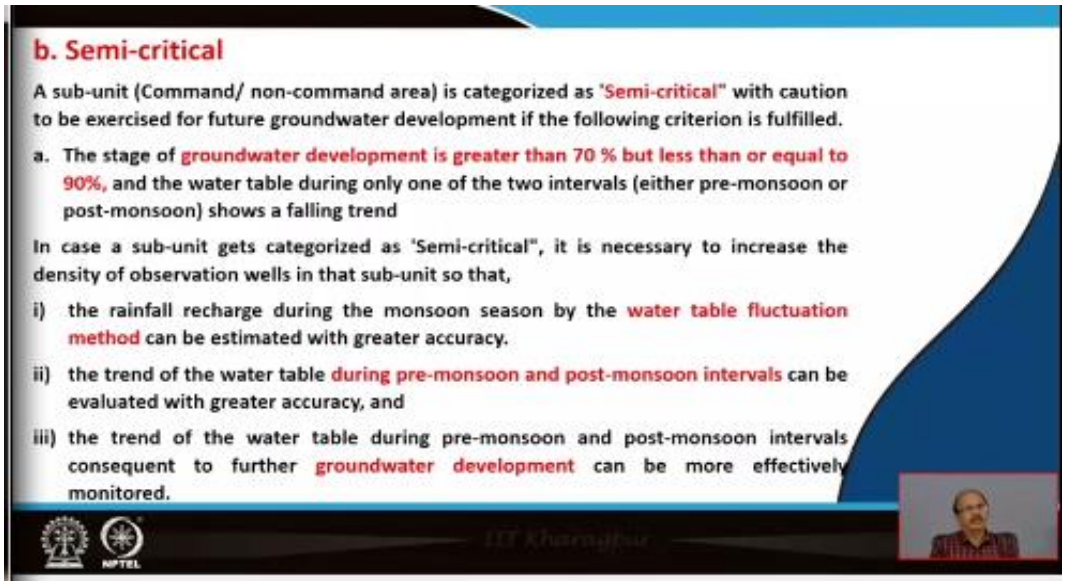

Now the second category is the semi-critical sub-unit that is command and non-command area is categorized as semi-critical on which it is characterized by semi-critical with the following criteria if it is being fulfilled. The criterion is the stage of groundwork development is greater than 70% but less than or equal to 90%. And the water table fluctuation during only one of the 2 intervals either pre-monsoon or post-monsoon shows a falling trend.

So, if it is one of the 2 intervals either pre-monsoon or post-monsoon in this season if there is a falling trend of the water table and the groundwater development is greater than 70% but less than 90% then such type of condition is coming under the semi-critical. So, in case a sub-unit gets categorized as semi-critical then it is necessary to increase the density of observation wells in the sub-unit.

For what the reasons are the rainfall recharge during the monsoon season is generally done by the water table fluctuation method and this method can be estimated with greater accuracy also. Because we have already the condition is that to enhance the density of observation wells if the criterion is semi-critical. So, now the trend of the water table during pre-monsoon and post-monsoon intervals can be evaluated with greater accuracy.

And the trend of the water table during pre-monsoon and post-monsoon intervals consequent to the further groundwater development can be more effectively monitored. So, this should be followed if the sub-unit is coming under the semi-critical.

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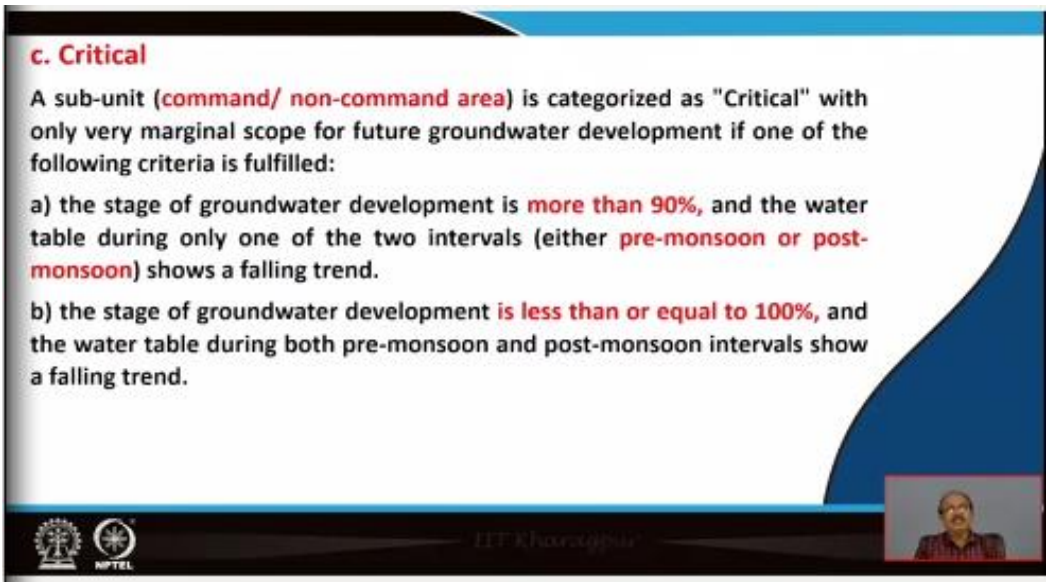

Now a critical sub-unit is generally a very marginal scope for future groundwater development if the following criteria if the criteria mentioned below is fulfilled. The first is the stage of groundwater development is more than 90% and the water table during only one of the 2 intervals that is either pre-monsoon or post-monsoon shows a falling trend. And the stage of groundwater development is less than or equal to 100% and the water table during both pre-monsoon and post monsoon intervals show a falling trend. So, then the sub-unit is characterized as critical.

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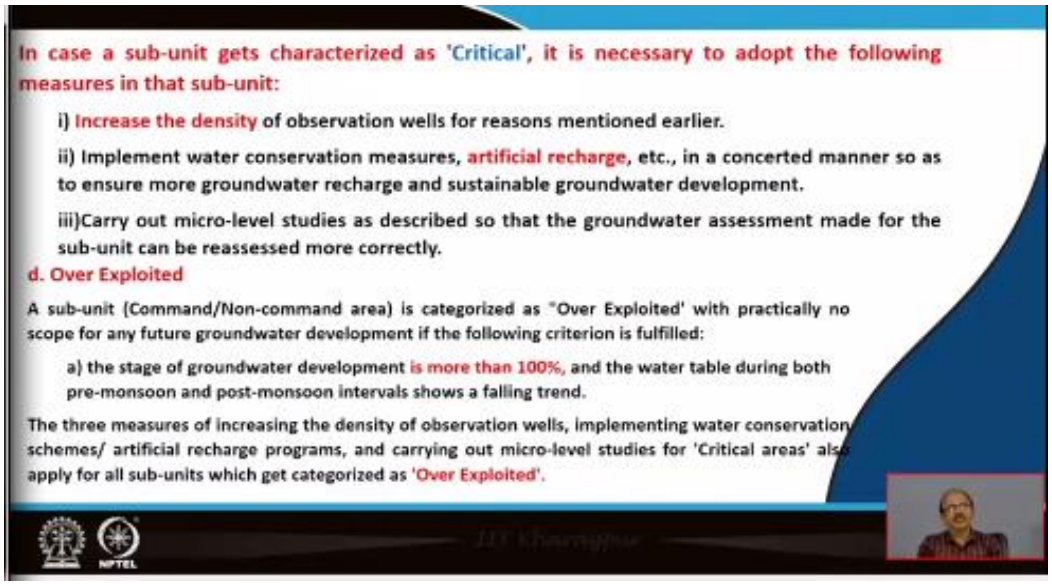

In case sub-units is characterized as critical then the different measures for the sub-unit is as the first measure is to increase the density of the observation wells for different regions which are mentioned earlier. Then the implement water conservation measures that is the artificial recharge etcetera in a concerted manner, so as to ensure more ground recharge and sustainable groundwater development in the area.

And also carry out micro level studies so that the groundwater assessment made for sub-unit can be reassessed more correctly. So, if the sub-unit is coming under critical category then these measures should be adopted increase of the observation wells number of the observation was then the implementation of water conservation measures. And also to carry out the micro level studies for the groundwater assessment so that the reassessment can be made more correctly.

And the third category is the over exploited. Over exploited category a sub-unit generally it is called as over exploited with practically no scope for any future groundwater development in the area. So, this is very important because if any area is coming under the over exploited category then from that area there are no scope for any future groundwater withdrawal etcetera. So, the stage of groundwater development in this type of category is remaining more than 100%.

And the water table during both pre-monsoon and post-monsoon intervals shows a falling trend, it is going down and down. So, generally the 3 measures of the increasing the density observation

wells implementing water conservation schemes, artificial recharge programs. And carrying out micro level studies for critical area also apply for all sub-units which get categorized as over exploited.

So, the 4 different categories we have learned, the over exploited then the critical, then the semi-critical and the last is the safe. So, in this way we have learned about the 4 different categories and through the 4 different categories generally we are just categorizing the area whether the area is coming under safe, whether the area is coming under critical and say over critical and over exploited. So, with this, thank you very much to all.