Availability and Management of Groundwater Resources
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Lecture - 12
Vadose and Saturated Zone (Continued)

Welcome you all once again in the third part of the lecture vadose and saturated shown. So, in this we are just discussing the important locations beneath the earth's surface which plays very important role for the making the groundwater resources inside the earth's surface. So, this zone just below the earth surface generally we get two important zones one is the unsaturated zone and other is the saturated zone.

So, from the previous lectures we came across that this unsaturated zone is having different layers till it reaches to the water table and below the water table is the zone that is the saturated zone. So, in this lecture in this part of the lecture we will try to understand the different zone of the vadose zone areas.

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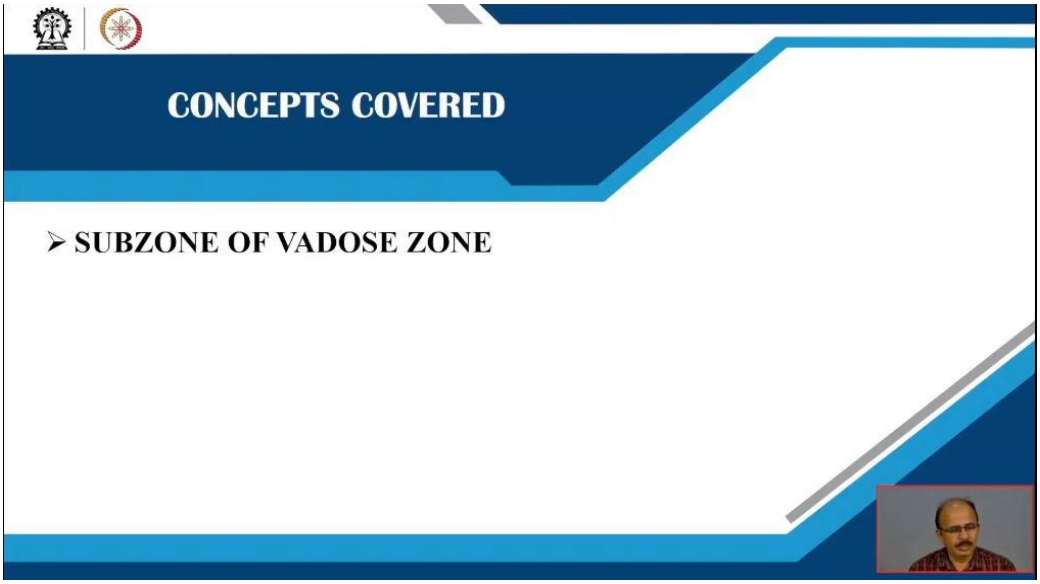

So, we will try to discuss this thing.

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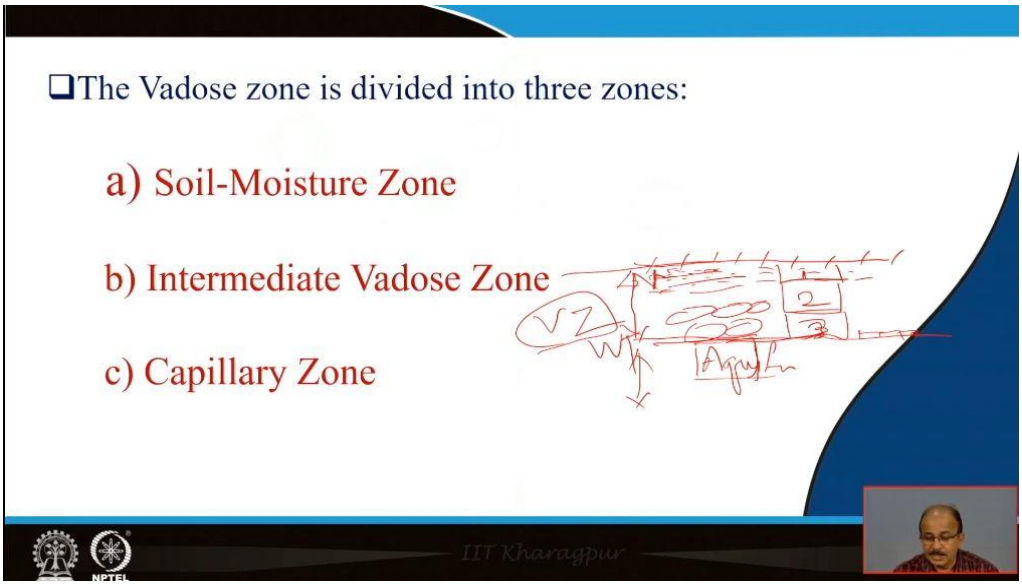

Now, this vadose zone just we have seen, this is the earth's surface and within this, this is the soil layers of the soil these are the layers of the soil different layer of the soil then, this is generally called as top soil. This soil is very important in terms of the growth of the plant because the top soil the top upper soil is raised with the nutrients. So, which these nutrients are very helpful for the plant's growth so just beneath the earth's surface we are getting the soil layer.

And then we are getting some rock formations in these rock formations some rock formations are having very good amount of porosity and probability. So, the formations we are getting in terms of aquifer and the top layer of the aquifer we are getting the water table and the depth or thickness of the layer of the subsoil layer of the earth, that is from the earth's surface to the water table is generally known as the vadose zone.

So, this is the vadose zone which is unsaturated zone which is arid zone operation and this is the saturated zone that is the zone of saturation. So, here we are getting the aquifer and here we are getting one zone which is very important from both hydrological as well as geochemical study point of view very important rule. Now further we will understand that this value zone is divided into three important zones that is the soil moisture zone first.

Then the intermediate zone second and then the capillary fringe third. In the previous lecture we have understood that capillary fringe is thus the one meter or less thickness above the water

table. So, this area is known as the capillary fringe, so this soil moisture zone intermediate vadose zone and capillary zone these three important sub zones make one zone and that zone is the vadose zone that zone is the vadose zone.

So, now earlier we have only understood that this is the vadose and this is the zone of saturation. Now this vadose zone is distributed into three input important zones that is the soil moisture zone intermediate vadose zone and the capillary zone. We will try to understand each one by one.

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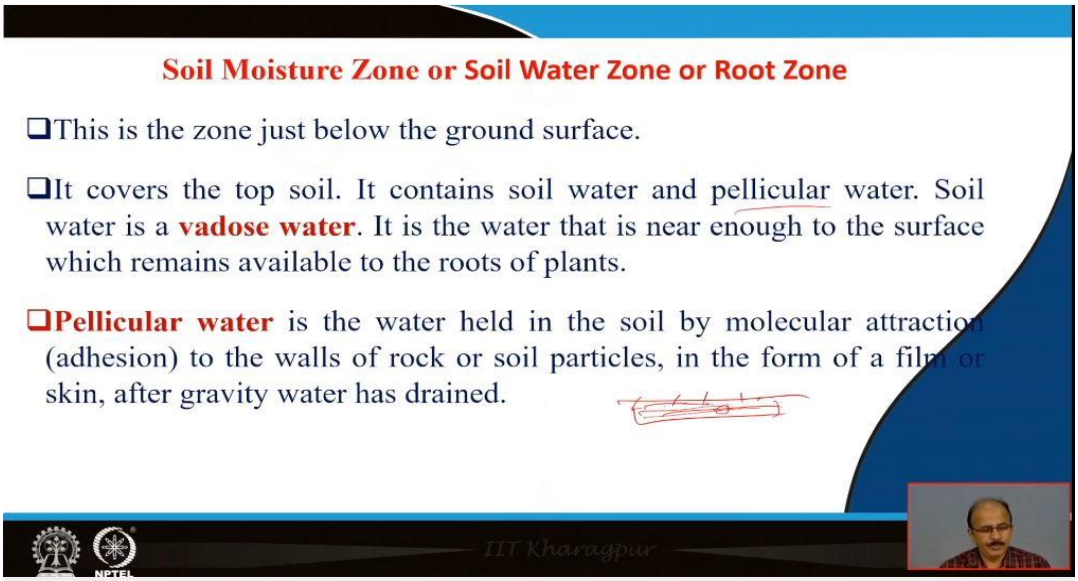

So, first the soil moisture zone, which is also known as the soil root zone which is also known as the soil water zone. So, different terminology I have given here because in different types of exams the different terminologies are coming. So, soil moisture zone or soil water zone or root zone all are of the same meaning. This is the zone which lies just below the ground surface. Only just beneath the ground surface this is the ground surface.

So, this soil layer of thickness of the layer of the soil it is the soil water zone or root zone. It covers the top soil means the soil which is reached with the nutrients, it contains soil water and pellicular water. So, one new term is coming here pellicular water, soil water is nothing this is only the water which is present in the water zone. So, we can also tell it the water it is the water that is near enough to the surface which remains available to the roots of the plants.

So, this is called as vadose water but water, pellicular water is the water held in the soil it remains in the soil by some molecular attraction to the walls of rock or soil particles. Pellicular water is the water held in the soil it remains within the soil rock formations by molecular attraction to the walls of to the walls of rock or soil particles in the form of film or skin, skin like pattern after gravity water has drained.

So, after gravity water has drained then if we are having some amount of water remains attached with the walls of the rock or soil particles then such type of water which looks like a film like or skinny like is known as the pellicular water. So, two important terms we have understood the first is the vadose water and second is the pellicular water. Vadose water is nothing but the water which remains within the soil zone, soil moisture zone is the vadose water.

And the within the soil moisture zone one another type of water is there which remains fixed with the soil or rock walls in the form of molecular attraction in the form of film or skin like skin like then this type of water is termed as the pellicular water, this is termed as the pellicular water. So, first part of the vadose zone is the soil moisture or soil water zone or root zone.

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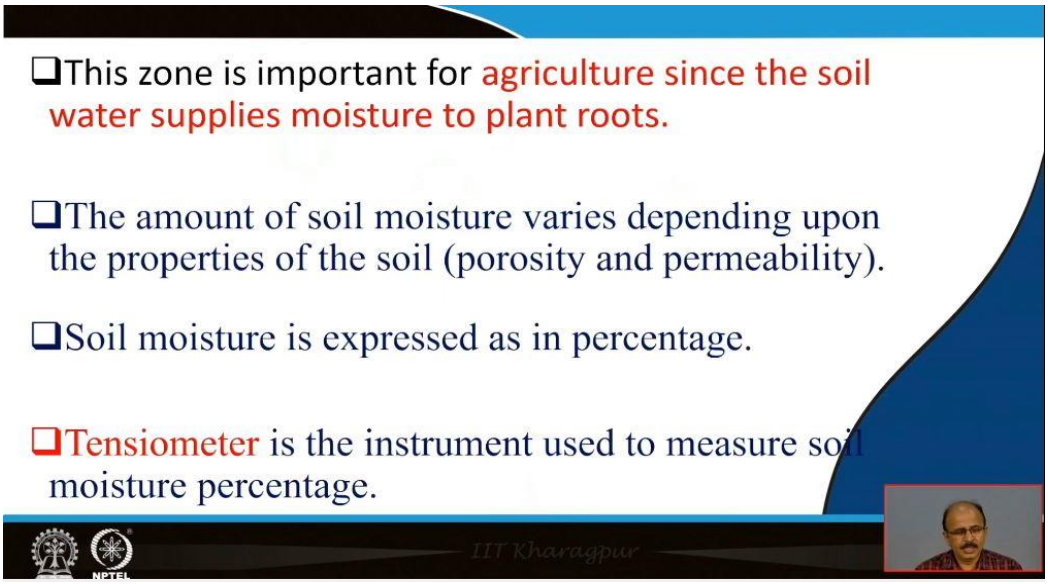

Now, next this zone the soil moisture zone or soil water zone root zone is very important for agriculture. Since the soil water supplies moisture to the plants, it supplies moisture to the plants. So, the plants just taking the moisture from where from the soil water zone. So, this zone is very

important from agriculture point of view. The amount of soil moisture where is depending upon the property of the soil.

Whatever amount of soil moisture remains in different rocks or soil particles it varies. Why? Because, it depends upon the properties of the; soil and what are the properties the porosity and permeability. So, porosity and permeability is now clear to all of you and the amount of soil moisture definitely have certain role with respect to two important properties of the soil and rock particles.

Soil moisture which is being taken by the plant roots is generally expressed in terms of percentage it is being expressed and tensiometer is the instrument used to generate the soil moisture percentage in general. In generally, we are using one, equipment named as tensiometer through which we can measure the soil moisture percentage.

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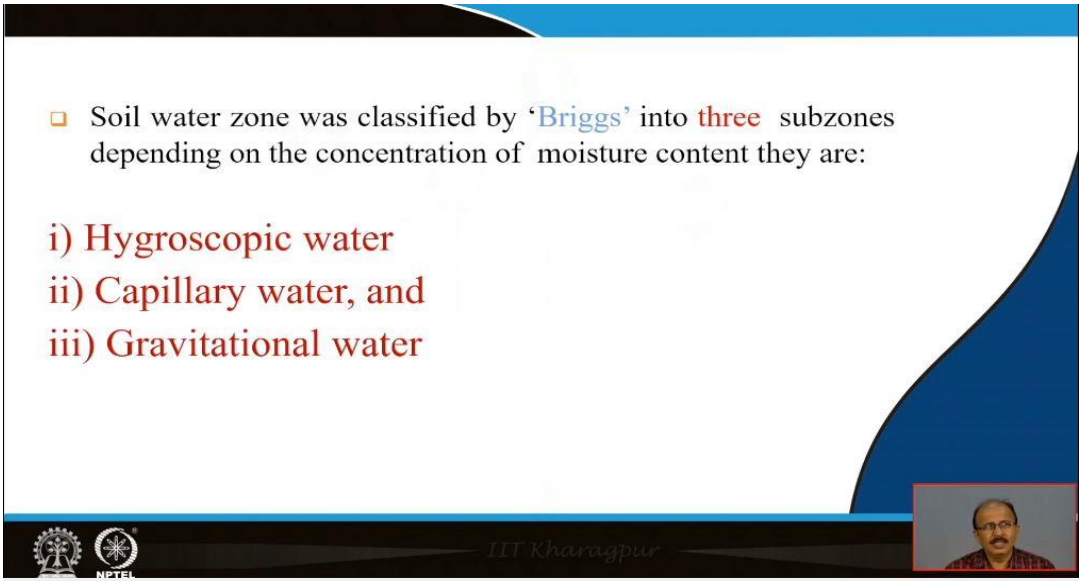

Now this soil water zone was classified by one of the scientists named as Briggs into three sub zones depending on the concentration of the moisture content. So, on the basis of the concentration of moisture content, the three important sub zones of the soil water zones are hygroscopic water capillary water and gravitational water. So, three important types of water are there.

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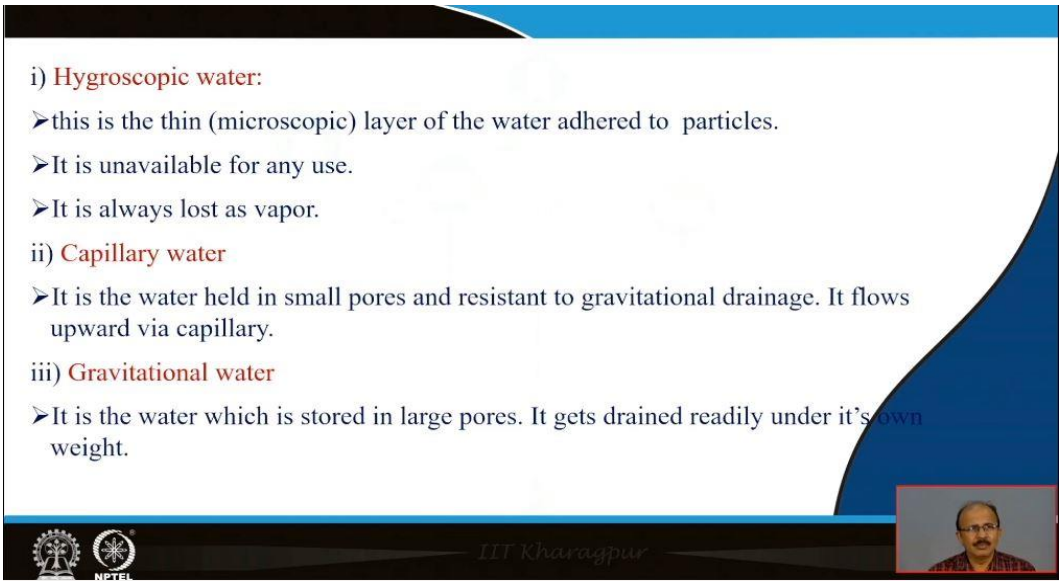

So, let us see one by one, hydroscopic water is the thin microscopic layers of water are there two particles. It is a thin microscopic layer of particles which remains unavailable for any use because, it is not being used and it is always lost as vapour it is generally lost as vapour. So, hydroscopic water is generally lost as vapour and generally remains unavailable for any uses. Second is the capillary water, it is the water held in small pores and resistance to gravitational drainage.

This type of water is generally remaining within small pores and it is resistant to gravitational drainage means it is not flowing towards the gravity it flows upward by a capillary. So, it flows upward movement it is having upward movement it is not flowing downward towards the gravity. So, this type of water which flows upward against the gravity is generally termed as capillary water and gravitational water it is the water which is stored in large pores.

This type of water is stored in large pores it gets drained readily under its own weight. So, generally this type of water is drained readily, so this type of water is termed as gravitational water. What we have seen? That three important types of water generally we get first is the hygroscopic water second is the capillary water and third is the gravitational water. And in it the important type of water which is very important for the growth of the plants is generally capillary water. Capillary water is being used by the plants for their life processes.

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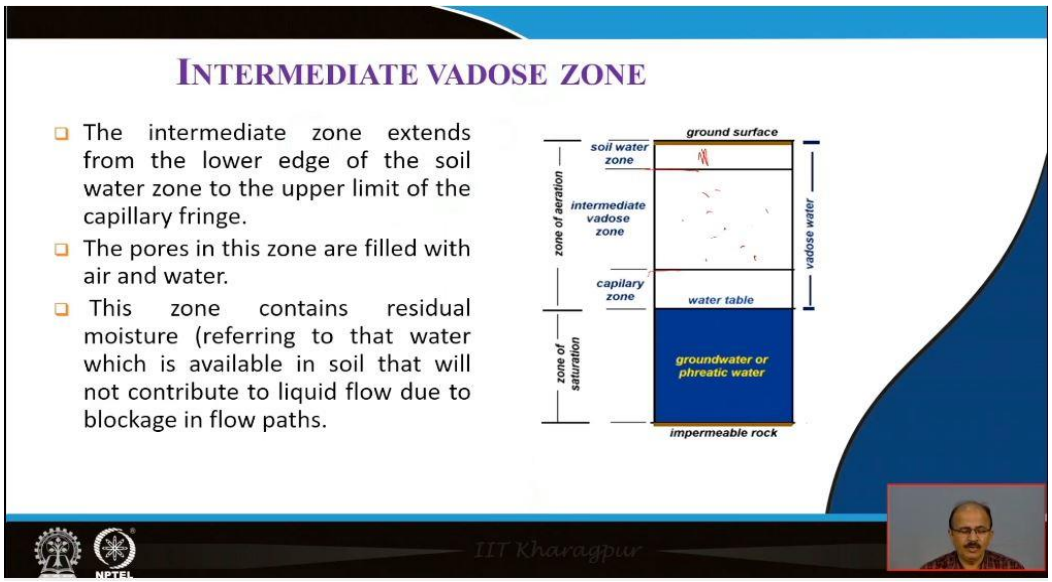

So, these soil moisture zone, soil water zone we have already understood. The first layer this beneath the ground surface these holes are the vadose zone. So, firstly the soil water zone I have discussed already. Now second is the intermediate vadose zone. So, this is the intermediate vadose zone, the intermediate zone extends from the lower edge this lower edge of the soil water zone this is the lower edge of the soil water zone to the upper limit of the capillary fringe.

This is the upper limit of the capillary fringe. So, it extends from the lower edge of the soil water zone to the upper edge of the capillary zone. This zone is termed as intermediate vadose zone, the pores in this zone are filled with air and water here, whatever the pores are here all are filled up with air and water. So, this zone contains a residual moisture, residual moisture why because it refers to that water which is available in soil.

That will not contribute to liquid flow due to blockage in flow path the zone contains only the residual moisture this zone contains the residual moisture. So, this is the characteristics of the intermediate zone, intermediate zone generally extends from the lower limit of the soil water zone to the upper limit of the capillary flowing zone. So, this zone is generally filled with air and water.

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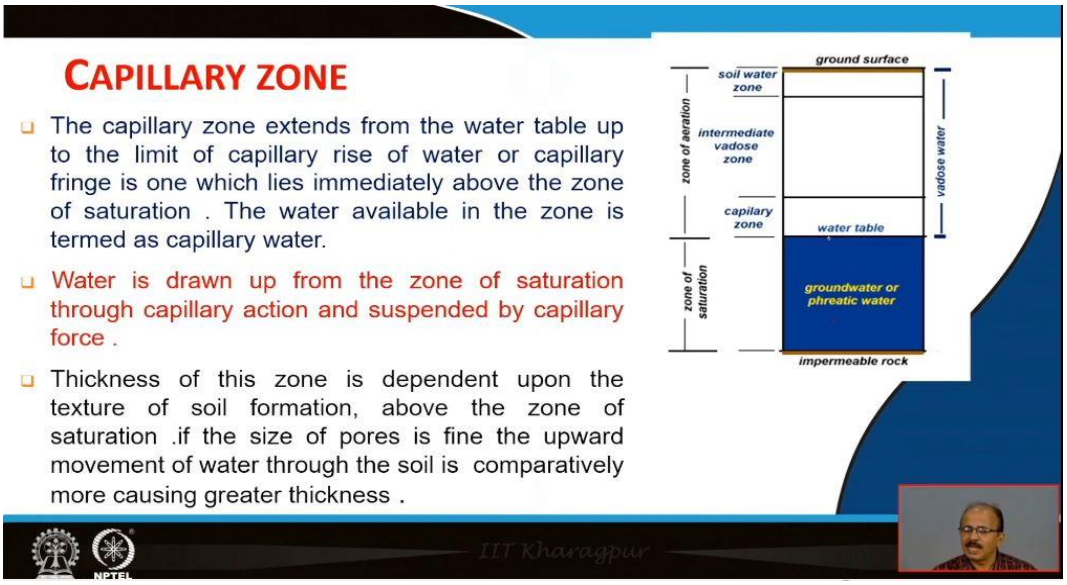

Now third is the capillary zone. So, in the vadose zone the first part was the soil water zone soil moisture zone second is the intermediate zone and third is the capillary zone. So, capillary zone extends from the water table up to the limit of the capillary rise of water or capillary fringe. So, from here to here it is the capillary zone, which lies immediately above the zone of saturation this is the zone of saturation. So, capillary zone is lying just above the zone of saturation.

Water is drawn up from the zone of saturation in the zone capillary action fringe area whatever amount of water is coming that is coming from the zone of saturation only. So, water is drawn up from the zone of saturation through capillary action and remains suspended by capillary force in the capillary zone area. Thickness of this zone capillary zone is dependent upon the texture of soil formation. What is the type of texture of the different soils?

So, depending on this the thickness of this zone varies, above the zone of saturation so this thickness of this zone means capillary zone is dependent upon the texture of soil formation. Above the zone of saturation this is the zone of saturation so, above it which type of texture of soil is there this generally guide the thickness of the capillary zone in the area because this area is fully saturated fully filled up with water.

Whatever amount of moisture is coming here in the capillary zone that is the water is being drawn up. From where? From the water table where to the capillary zone. So, the texture of the

soil plays very important role for this very important role. This type of texture of soil is present just above the zone of saturation plays very important role in the decision of the thickness of the capillary zone in the area.

If the size of pores is fine, suppose the soil is having very finer pores, the upward movement of water through the soil is comparatively more. What will happen? There will be the greater thickness of the capillary fringe. So, if the soil is having very good pores definitely the water drawn up will be more definitely the capillary thickness of capillary zone will be more. So, in this way we can see that this zone that is the last or the bottom most part of the vadose zone is known the capillary zone.

And this capillary zone is having the availability to take up the water from the water table and it is just one meter or less in thickness just above the water table is the capillary fringe called as capillary fringe. So, this zone is dependent upon the texture of soil formation.

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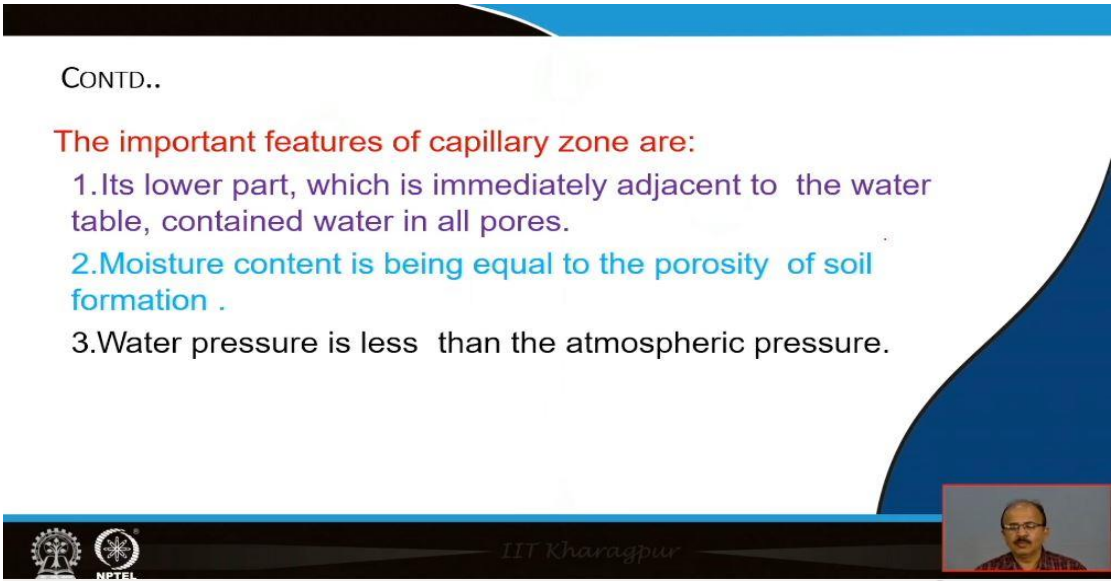

So, what is happening the important features of capillary zone are its lower part which is immediately adjacent to the water table contains water in all pores. So, in the lower part which is just adjacent to the water table contain water in all pores. Moisture content is being equal to the porosity of the soil formation. What are the types of the soil formation? The type of the moisture content is will be there and water pressure is less than the atmospheric pressure.

So, this capillary zone is very important with respect to the growth of the plant and the amount of water which remains just above your water table.

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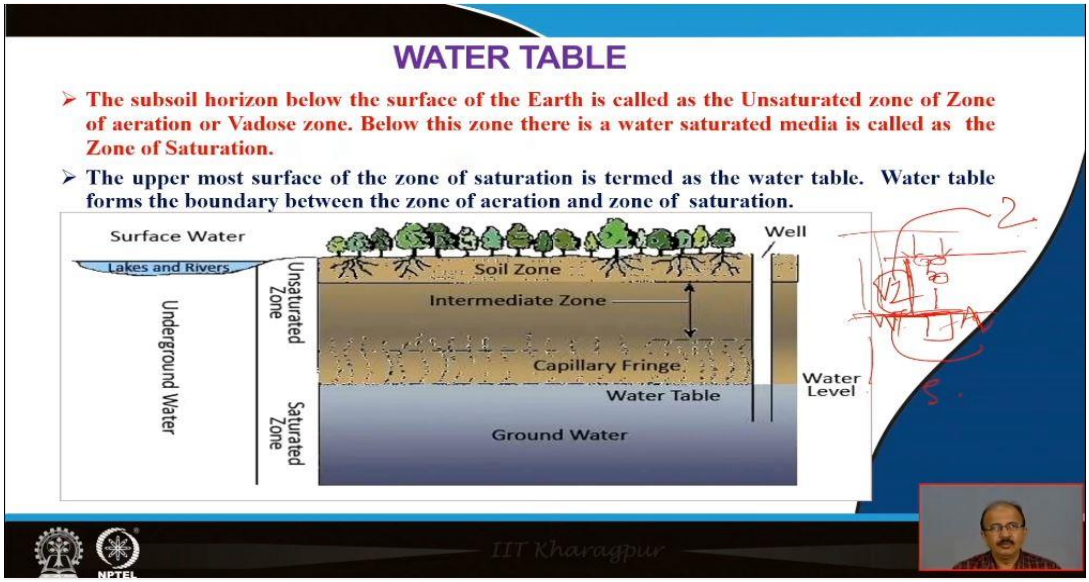

Now the concept is quite clear now, that the rain water just heated the earth's surface and this rain water enters into the ground by infiltration and by percolation process it reaches to the aquifer which is a formation which holds the groundwater. The thickness from the bottom of the surface from the top of the earth's surface to the water table is termed as vadose zone. So, this vadose zone is zone of aeration whereas zone of unsaturated zone whereas is saturated zone this is only saturated zone.

So, saturated zone is having upper layer of water and this upper layer of water is generally termed as water table in other words this unconfined aquifer the water table in the unconfined aquifer we are getting the water table and this water table is a horizon below the surface of the earth which is generally lie just above the unconfined and unconfined aquifer. It forms water table forms the boundary between the zone of aeration and the zone of saturation what we have seen in the previous lecture.

This is the zone of aeration and this is the zone saturation. So, it forms the boundary it is just the water table is the boundary which differentiate the two important zone inside the earth's surface one is the zone of aeration another is the zone of saturation. So, in this way what we have seen

now that the rain water which infiltrated and percolated down through the vadose zone through the different layer of vadose zone through the soil water zone intermediate zone.

And capillary fringe zone of the vadose zone then only it reaches to the saturated formation that is an aquifer. So, in this way the movement of the water rain water because rain water is the only recharge source of water on the earth's surface. In this way what we are seeing we have seen that the rain water amount is reaching differently in different places on the earth's surface at different, different seasons also.

So, now the concept is quite clear till here because we have started the journey from the hydrological cycle but first, we have seen what are the points which are responsible for making groundwater. So, from the first lecture we have understood that yes rain water is the only and only source through which we can had get the groundwater because, generally the rain water infiltrates and percolates and then it moves downward towards the area towards the zone towards the formations which generally holds the groundwater.

So, in the very first lecture we have seen about the different rules of the parameters of the hydrological cycle and then in the second lecture of this course, we have seen the different formations which are responsible for making any rock or soil formation a very good water bearing formation that is the very good repository of the groundwater resources inside the earth's surface.

In the third lecture we have cleared the concept that rain water now it has entered into the soil. And then it is about to reach the rocky formation that is aquifer. So, in the third lecture we have discussed this area the from the earth surface to the upper part of the water table because we have to see about the water aquifer. So, in the very next lecture we will come across with this so thank you very much for your patience hearing, thank you.