Availability and Management of Groundwater Resources
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Lecture-41
Estimation of Total Annual Replenishable Natural Groundwater Recharge (Contd.)

Welcome you all in the part 2 of the module 9 estimation of total annual replenishable natural groundwater recharge. In which we have discussed about the different methodology through which the groundwater recharge can take place. We know that the aquifer is recharging by the precipitated water, this precipitated water is infiltrated then percolated and then with the downward movement towards the cavity it reaches to the rocky formations which are holding the water, that is an aquifer.

So, we are discussing about the natural groundwater recharge, what are the different methods through which the recharge can take place in an aquifer which are lying underneath the earth's surface.

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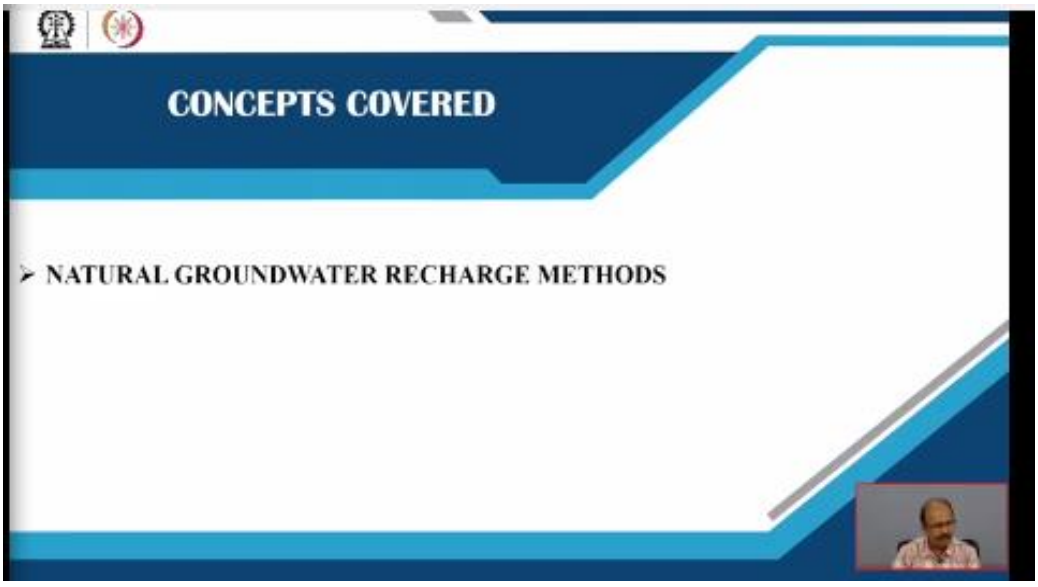

In this part 2 section we will discuss about these methods in a greater detail.

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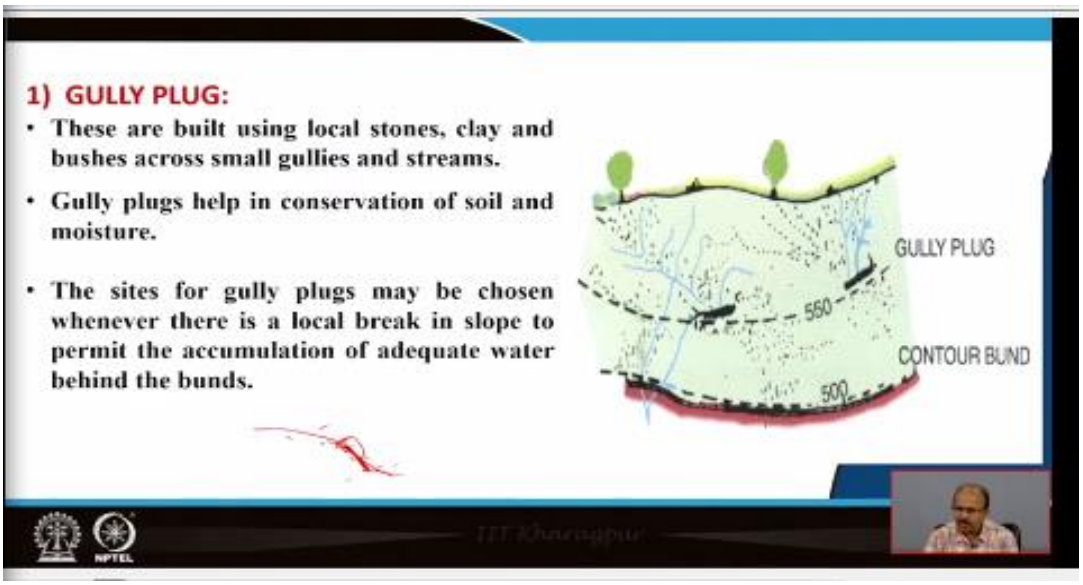

So, the first method through which just the first method which we are generally following for the recharging of the aquifer in rural or in urban areas is the gully plugging. So, this gully plugging, these gully plugs generally are built using the local stones which are available in the village in the urban areas and clay and the bushes across some gullys and streams so small, small gullys and streams remains in the rural areas as well as in urban areas.

So, what generally we are following that with the help of the local stones and the clay and some of the bushes which are just remaining near to the gullys that is the your thin coarse of water just the movement of water through the your coarse. And the streams that is your rivers like structure which is just passing in the village areas. So, gully plug helps in the conservation of soil as well as moisture.

So, through it the generally the water is being arrested because of the movement of water in the gullys and the streams and also the conservation of soil means soil erosion is also controlled with this type of structure. So, soil erosion is also important part because with the movement of the water soil may erode but because of some bushes it just remain in compact and it helps in the conservation of soil in and the soil moisture in the soil underlying soil layer.

So, the sites for gully plugs may be chosen whenever there is a local break in slope, so whenever there is a local break in slope means just a small break in slope is there just suppose your river is

flowing in this way and the bushes are lying in here. So, what is happening? Just a small break is coming here, so this site is the appropriate site because it will permit the accumulation of adequate water behind the bunds.

So, here the water will remain stored, there the water will remain stored you can see here also it is mentioned that this is the gully plug in which the small, small plugs, this is the course of water that is the stream. So, in this generally when a local break in slope will come then it is permitting for the accumulation of adequate water behind the bunds. So, in this way this gully plug structure is helping in making of in conservation of the aquifer underneath the earth's surface.

Because if the water will accumulate definitely the infiltration and the percolation will take place which will ultimately just recharge the underlying aquifer.

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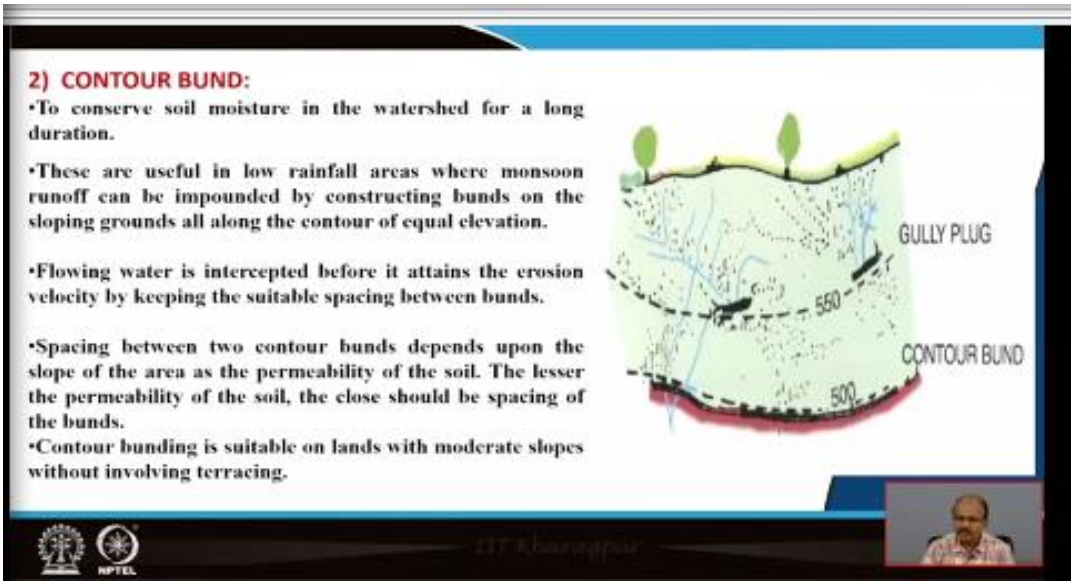

Second is the contour bunding. So, to conserve soil moisture in the watershed for a long duration generally the contour bunding method is being followed. So, this method is following because for the conservation of soil moisture in the watershed for a longer duration. And also these are useful in low rainfall areas where monsoon runoff can be impounded by constructing bunds on the sloping grounds all along the contour of equal elevation.

So, you can see here 1 contour is a 500, this is 550, so such type of contour bunding is important are useful in low rainfall areas. Low rainfall areas means where monsoon runoff can be controlled by constructing some bund like structure on the, where on the sloping grounds all along the contour of equal elevation. So, once if you will say these all are the contours your 500. So, just if you will construct a contour bund here, so it will arrest the water and thereby it will conserve the soil moisture in this area.

Flowing water is intercepted before it attains the erosion velocity by keeping the suitable spacing between bunds. So, this flowing water is just intercepted before it is attaining the erosion because erosion is important it may take place. So, this flowing water is intercepted by keeping suitable spacing between bunds. So, space should be there between bunds, so then only the flowing water can be remain controlled.

Now spacing between 2 contour bunds depends upon the slope of the area as well as the permeability of the soil. So, the 2 contour bunds always remain, it depends the spacing between 2 contour bunds always depends upon the slope of an area and also the permeability of the soil. Because the lesser will be the permeability of the soil, the close would be the spacing of the bunds.

So, this is generally the technique are being followed, this contour bunding is suitable on lands with moderate slopes without involving terracing. So, this type of contour bunding is very, very much suitable on those type of land which remains with the moderate slopes and without involving any sort of terracing. So, this is the second type of methods through which the recharge of the underlying aquifers can be done.

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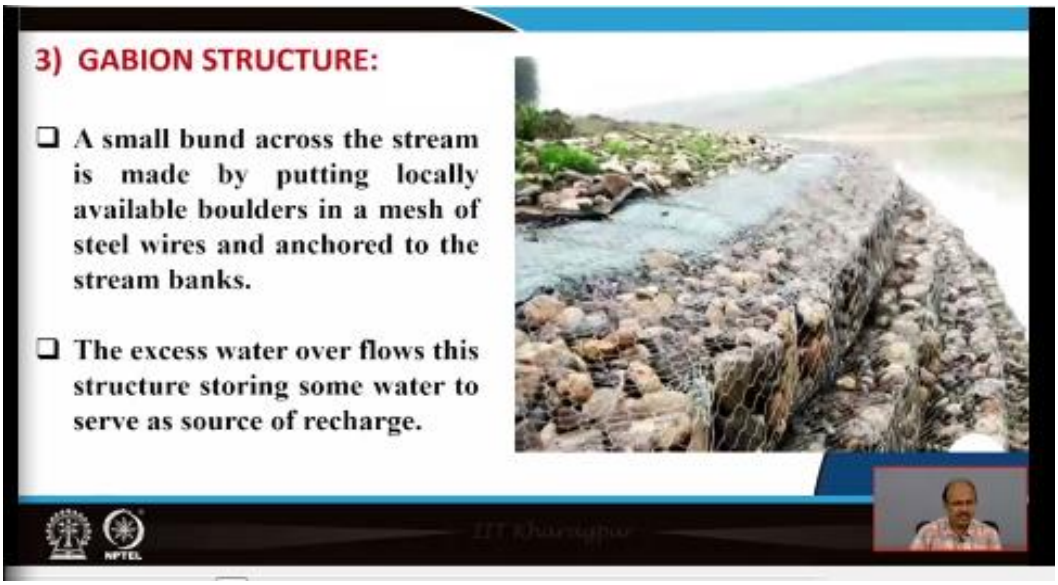

Now next is the gabion structure. So, this is also a very important structure through which the recharge can take place. A small bund but these bunds are made up of available boulders and you can see also some mesh like structure is clear in the figure. This is the mesh of the steel wires which are anchored to the stream banks, so a small bund, it is a small one where across the stream is made by putting local available boulders.

So, local available boulders are kept here just across the stream and these boulders are just compact in a mesh of steel wires. So, mesh of steel wires are also seen here because then only it will remain in compact position and anchored to the stream banks, just kept on the stream banks. So, what will happen? The excess water overflows this structure, so excess water will just overflow from this structure and it will store some water to serve as source of recharge.

So, through the your river or stream or through the stream banks if we are making a small bund across the stream by the available boulders and just anchored it to the stream bank by having the mesh of the steel wire. Then what will happen? The excess water will just overflow from this boulder structure and those water will store to serve as a source of recharge. So, this is another type of the structure which is helping in the natural groundwater recharge.

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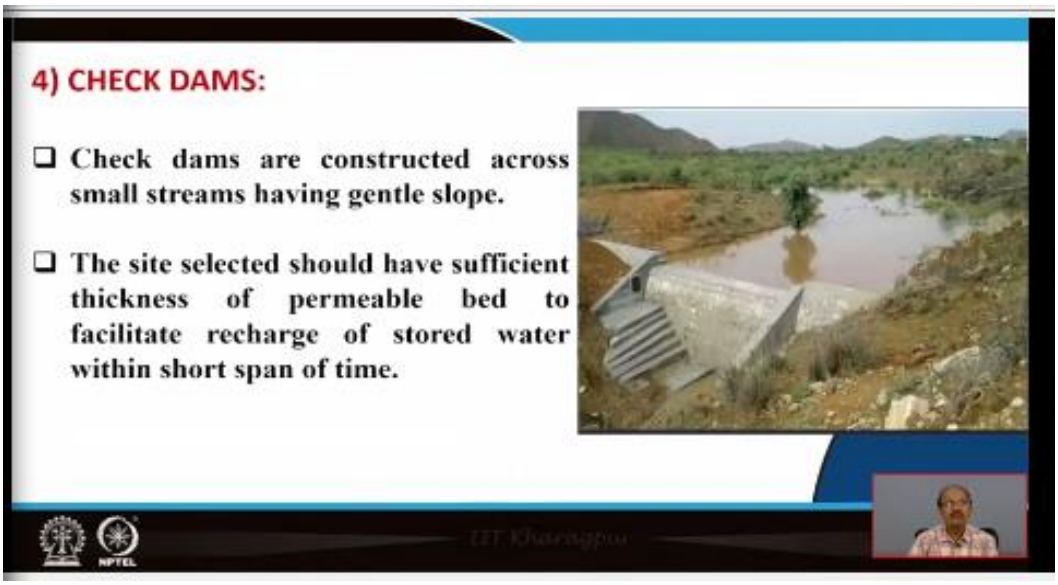

Now fourth is the check dams, check dams are also very important structure, these are constructed across the small streams having gentle slope. So, if the stream is having with gentle slope then check dams are the best structure which can be constructed across the stream. So, the site is selected, this would have sufficient thickness of permeable bed to facilitate recharge of stored water within short span of time.

So, this is also important that the site we should select in such a way that the sufficient thickness of permeable bed remains underneath it. So, what will happen? If the permeable bed will remain or thicker permeable bed will remain then it will facilitate the recharge of stored water within short span of time. So, it will just give the recharge of the stored water and without a shot span, no not a longer duration.

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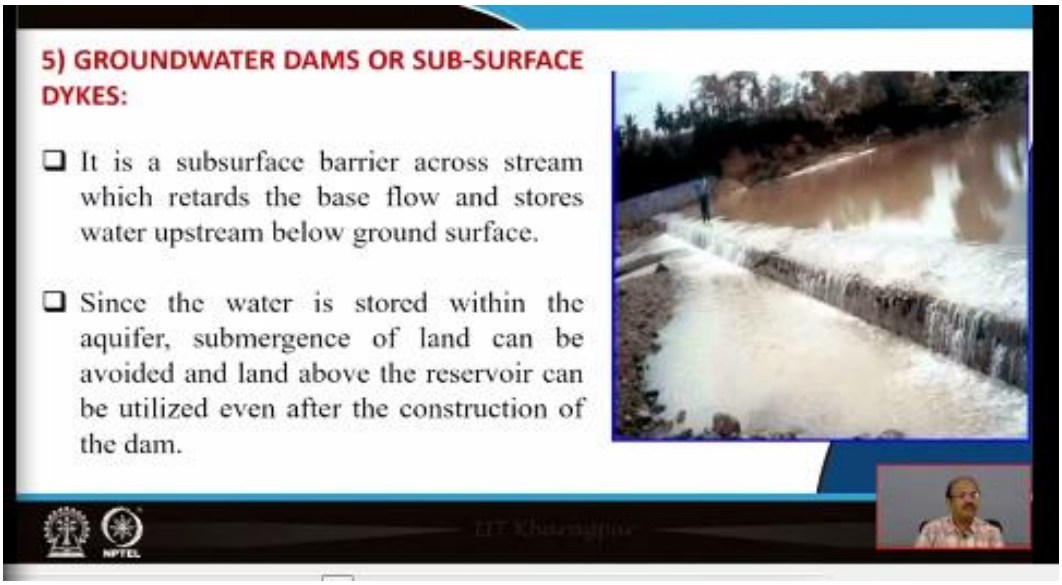

Now next is the groundwater dams or sub-surface dykes. So, dyke is a structure which generally remains embedded in the rocks, so dyke these are the 2 geological terms. It is a sub-surface barrier you can say it is a barrier also, across stream which retards which is control which stops the base flow and stores water upstream below the ground surface. So, we have read about the base flow also when we are discussing about the runoff. So, in this case what is happening?

The groundwater dam is just a sub-surface barrier, not the surface barrier; it is a sub-surface barrier across the stream which retards the base flow just control the base flow. Because base flow is contributing water to the stream also, stream channel also, so it is just retarding the base flow and then if it will once be retarded what will happen? It will store water upstream below the ground surface.

So, this is how the recharging is taking place by the construction of the groundwater dams. Since the water is stored within the aquifer submergence of land can be avoided and land above the reservoir can be utilized even after the construction of the dam. So, this is very good point, we know that the water is stored within an aquifer and the land is being submerged, in submergence of land should be avoided and land above the reservoir can be utilized even after the construction of the dam.

So, these are some of the structure which are very useful for the natural groundwater recharge in rural as well as urban areas.

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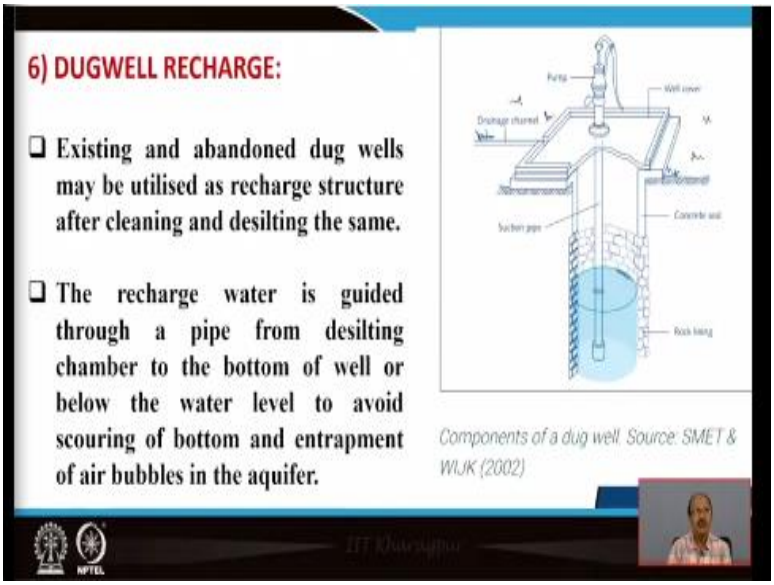

Now dugwell recharge, it also generally it is a very helpful method because we know lots of dugwells are remaining dry. So, existing and abundant dugwells dried, existing the dugwells or abundant those who have become dried we may utilize it as a reservoir structure, how by cleaning and desilting the same, just to take out the silt material outside and clean it and then we can utilize it as a recharge structure, what will happen?

The recharge water is guided just through a pipe the recharge water will be sent from the silting chamber to the bottom well or below the water level to avoid scoring of bottom and entrapment of air bubbles in the aquifer. So, here you can see the rock lining is here and the concrete seal and the suction pipe is here through which a hand pump is just connected. So, the existing and abundant dug wells which were earlier being utilized, in present day it is not working, this also can be reused as a recharge structure for recharging the underlying aquifer.

So, this can be utilized, sustainable structure can be utilized. Because, see lots of your wells are remaining on the surface and these wheels we are knowing that these types of wheels are remaining in the unconfined aquifer, not the confined aquifer. Because these types of dug wells are having

your upper portion just attached to the atmosphere, in the upper portion you just remain free and it will remain free with the atmosphere.

So, what is happening? So, atmospheric plays an important role in the fluctuation of the water table. So, water table may go down, water table may go up, so in this way we can see that if we will just have some mechanism to recharge such type of structure. Because here definitely if the water earlier in this very recharge well, so definitely some sort of silting or some bad elements, bad stones etcetera.

These are inside or some blockage has taken place then only the dug well is not having water, but once if it will be cleaned or in the resulting can be done from this dug well then and if the recharge water which is guided through a pipe within it. Then definitely this structure will have a good amount of water and also below it, it will just recharge the area. So, this is generally dug well recharge is a very, very important method especially for the existing and abundant dug wells which are remaining useless.

So, they may be utilized as a recharge structure after thoroughly cleaning and desilting the same. So, this is the point where we can see for the recharging of the underlying aquifer. Now we have seen the gully plug then contour bund, then Gabion structure, then dug well recharge, then groundwater recharge, so many structures are there. Only thing with the available soil parameters means having the experience of permeability and porosity.

We can have the choice of the construction of the structure also. And then by construction of such type of structures definitely there will be natural groundwater recharge in the underlying aquifer.

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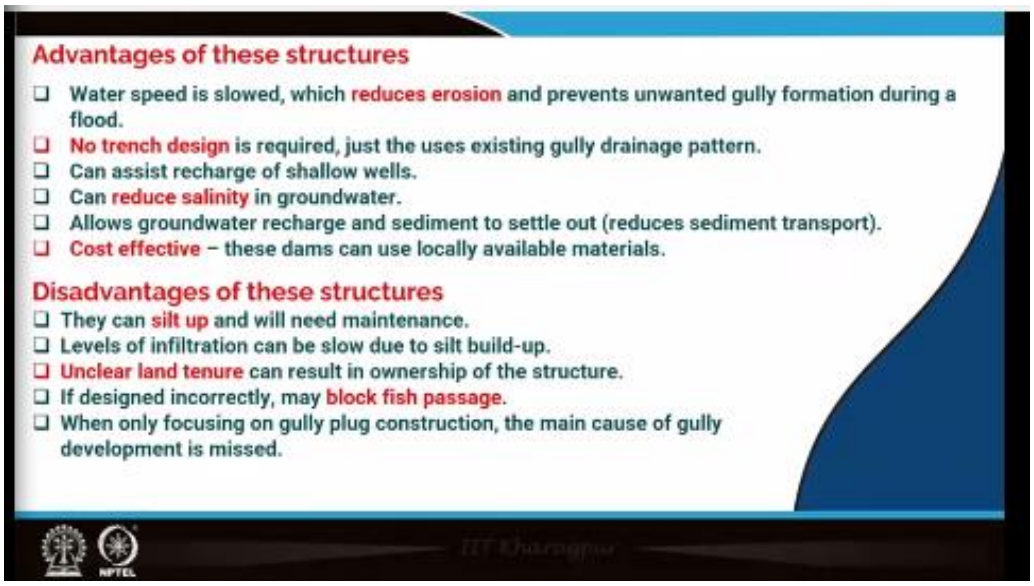

Now with this structure there are some advantages as well at disadvantages. So, we are having some advantage also. What is the advantage? See water speed is slowed which reduces erosion and prevents unwanted gully formation during a flood. So, since such type of structure cannot be made on the water speed in a high-water speed. So, since the water speed is remaining slow, so then it erosion will be also lesser that is it will reduce erosion and also prevents unwanted gully formation during a flood.

So, this is the advantage of such type of structure. Second is the no trench design is required, just to use existing gully drainage pattern. So, trench design is not important, only the existing gully drainage pattern should be followed. So, slowly, slowly it will move, so this type of trench design is not necessary. These structures can assist recharge of shallow wells only not the dug wells, so through this structure the recharge of shallow wells can be possible.

So, deep tube wells are not possible which recharging of deep wells are not possible with sustainable structure. And also, this structure can reduce salinity in groundwater; these are reducing salinity in groundwater. So, such type of structure is very important for enhancing the recharge in the area. Such soil structure also allows groundwater recharge and sediment to settle out, so this is also very good that point.

The sediment is there but it should settle out and allow the groundwater recharge at the place. But cost effective you can see these structures these dams can by locally available materials, so that is why it is a cost effective, it is not so costly because local materials are being utilized for making of such type of structure or dams. Now disadvantages of this structure is what are the disadvantages?

So, they can silt up and will need maintenance, so they can have the silt and if once the silt will accumulate then it will require some sort of maintenance. Second, levels of infiltration can be slow due to silt buildup. So, because of the silt buildup the infiltration rate will decrease, now unclear land tenure can result in ownership of the structure. So, land is not clear means it is difficult to find out the ownership of the structure.

So, this is one of the disadvantages because the land, we do not know how far this land will remain in the form of such type of structure. So, this is the biggest disadvantages. And if designed incorrectly then what will happen may block fish passage, so it is also essential that the designing of such type of structure should be in correct mode. If once the designing will be incorrect then definitely, they will become unstable also and they may block fish passage.

So, the movement of the fish will stop so when only focusing on gully plug construction the main cause of gully development is missed. So, this generally for gully plug construction, the causes of the development of the gully is generally remain unclear. So, these are the advantages and disadvantages of the structure. The point is that once we will decide for the formation of the structure in the ruler as well as urban areas, we must see the topography of the areas the slope of the areas because the gully plug or the contour bund or the Gabion structure.

These all depends on the slope of the area also; the slope of the area is also play very, very important role for the recharging of the watershed. Watershed is an area in which if one single drop of water will fall it will remain within those very areas only. So, every area are having some sort of drainage pattern or drainage lines. So, drainage lines are remaining, drainage lines are lines through which the water is just flowing.

So, with the help of some scientific studies we may design some sort of structure, say what we have discussed. And these structures will definitely help in recharging of the area because these areas are very, very important for recharging of the underlying layer. Yes, the soil component is important, soil component that is the soil if the soil will remain porous, it is the soil will remain permeable definitely the structure which will store the water.

Those water will just infiltrate and then percolate and then it will rust towards the aquifer because aquifer is a formation which is holding the water. So, this natural recharge with these means these types of structures are possible only with slow speed water movement that is the stream is having a very lesser speed. And also, the gentle slope is there, not a and deep slope is there because then it is repeating a bit difficult.

Then such type of structure with the available local stones etcetera, it can be built up and these structures can ultimately give us the area of the storage of the water which will ultimately help the groundwater recharge source that is the aquifer underneath the earth's surface. So, with this thank you very much to all.