Availability and Management of Groundwater Resources
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Lecture - 53
Rainwater Harvesting and Artificial Groundwater Recharge (Contd.)

Now welcome you all in the part 4 of the module 11 rainwater harvesting and artificial groundwater recharge. So, from the first part we have understood about the system that is the rainwater harvesting is one of the methods through which we can collect the rainwater sample volume rainwater in different volumes in the earth's surface. We can at least send it in different storage structure from where after removing the impurities we can utilize it for different purposes.

Or in another way it is just infiltrating down and then switching to the aquifer so in another way it is also recharging the underlying aquifer. So, this system is absolutely being used where the area is receiving very variation in the rainfall pattern. Now the second aspects is the artificial groundwater recharge so what are the defining what are the meaning of the artificial groundwater recharge this details we will learn in this part in greater detail.

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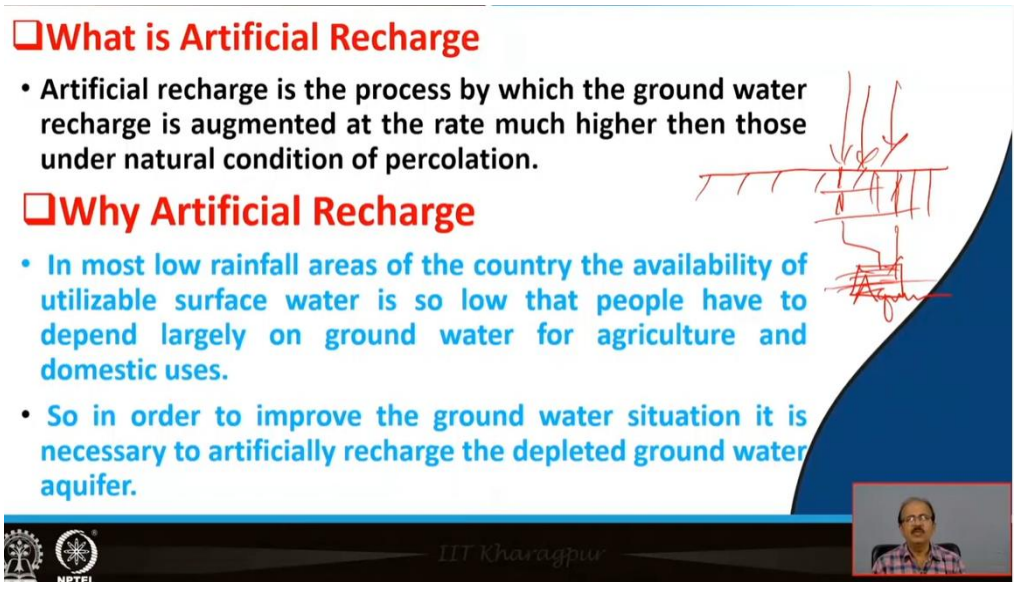

So, artificial groundwater recharge is the process it is a process by which the groundwater recharge there is augmented at the rate much higher than those under natural condition of percolation. So, from the very beginning we have understood already that suppose this is the rain and this is the

earth surface and, on the surface, if the rain will drop will fall so infiltration and percolation will take place and then this water will ultimately reach to the your aquifers this is reaching to the aquifer.

So, this thing this concept has already in our mind now the place where the people are facing the groundwater problem there what to do? So, there we can think over for the artificial recharging of the water or in the area so there we can think this technique. So, it is a process by which the groundwater is recharged this groundwater which is remaining here in the aquifer is recharged at the rate much higher than those because some by some means it is recharged by some pressure or something else.

So, the rate of recharge is much higher than those under natural conditions what the natural condition infiltration, percolation than the water reaching to the display so this is called as artificial recharge. Now in most low rainfall areas of the country I told you where the problem of the rainfall groundwater is there means they are in low rainfall in the area exists. So, in most low rainfall areas of the country the ability of utilizable surface water is so low that people have to depend largely on groundwater for agriculture and domestic union.

So, one side what we are seeing that the areas is receiving very less rainfall the area specific is receiving very less rainfall and other side we are seeing the country the ability of utilizable surface water is very low so there are no means of receiving the water from rivers or lakes or ponds because too low. But then what the people will do the people will just take out water through pumping the groundwater.

Just the people will because they are not getting the rainfall in the area also the surface water ability is very poor so what the people will do? They will just withdraw the groundwater for agriculture and domestic uses. So, in order to improve the groundwater situation in the area it is necessary to artificially recharge the depleted groundwater aquifer; means the aquifer has already reached to the depletion means the water has gone has just stopped adding the groundwater.

So, the process should be adopted through which the groundwater accumulation will be you can be enhanced so depletion can be reduced. So, this is the only technique this is the artificially

recharge is the only technique through which we can improve the groundwater situation in that condition.

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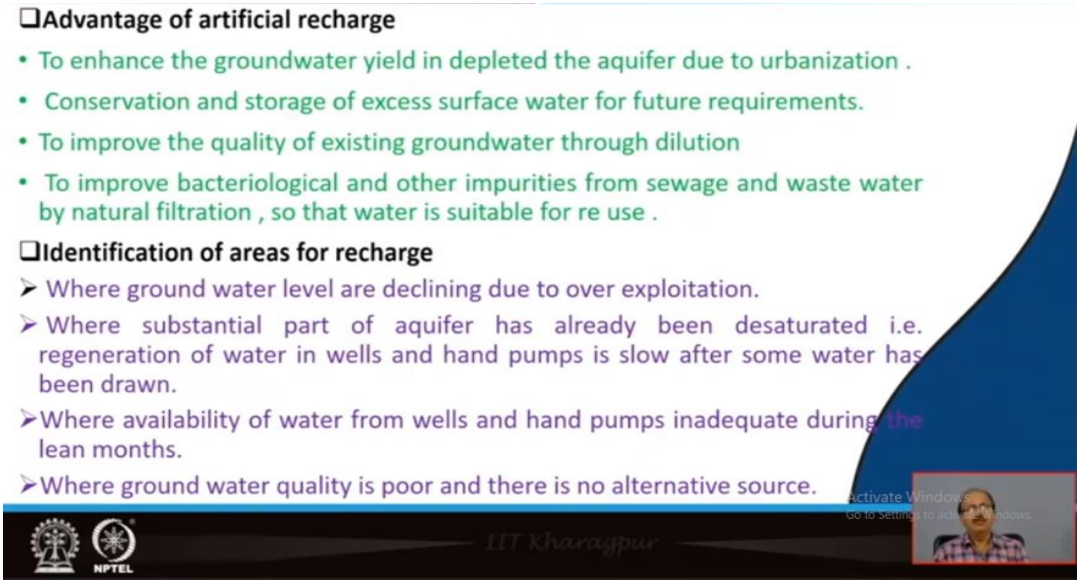

Now, what are the advantages of the artificial recharge to enhance the groundwater unit in depleted aquifer due to urbanization? So, due to urbanization because urbanization means what the more construction will be there the more population will be there the more usage of groundwater will be there. So, if we will follow the procedure of the artificial recharge definitely in one way we are just enhancing the groundwater yield in that aquifer which has just depleted.

Second is the conservation and storage of excess surface water for future requirement so if we will we can adopt the artificial recharge. So, we can conserve and store excess surface water for future requirements also. Next is that to improve the quality of existing groundwater through dilution so if we will follow the artificial recharge procedure so by following this procedure the improvement in the quality of existing groundwater is also with their true diagnosis process.

So, it helps the quality of the groundwater existing groundwater also and next Advantage is to improve the bacteriological and some other impurities from sewage and Wastewater by natural filtration. So; why natural filtration also this bacteriological and other abilities from sewage wastewater are just improved. So, that the water is suitable for use so the water is suitable for reuse so this is the advantages.

Now the first point is the identification of areas for recharge this is also very important point where to recharge? Which area to recharge? Suppose we know the procedure of artificial recharge but now the question is coming where to recharge? So, where to recharge? Where the groundwater level is declining, due to over exploitation that is also a good area for recharging. So, where; groundwater level is declining due to the overall exploitation the first point.

Second where substantial part of an aquifer has already been saturated desaturated means the more part of the aquifer has already been depleted that is regeneration of water in Wells and hand pumps is slow after some water has been drawn. So, in those areas where there is the desaturated condition existing there we can go for the recharge where ability of water from Wells and hand pumps inadequate during the lean months.

So, during the lean months suppose you are not having sufficient amount of water in wells and hand pumps then what has happened definitely there is a decline of water table there. So, but that area is very much suitable for the recharging purpose so those areas are also very good where the water from wells and hand pumps inadequate during the lean months. Now where groundwater quality is poor and there is no alternative source.

So, where we can also the recharge that very area where groundwater quality is poor and also there is no alternative source for getting the groundwater so those ideas, we can generate these areas we can prefer for the recharging through the artificial recharge process.

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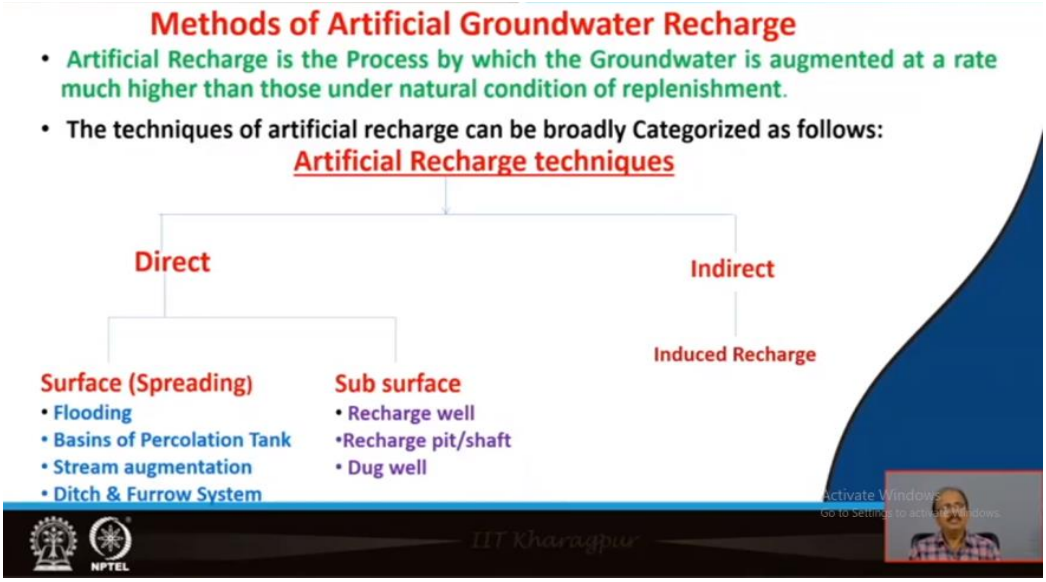

Now these methods of artificial groundwater recharge is by which the groundwater is augmented is and which is higher than those under natural condition is generally followed the 2 techniques that is direct and indirect techniques. So, direct techniques are generally divided into 2 type's surface that is spreading and subsurface. And indirect technique generally it is divided into only 1 type that is the induced recharge.

So, this method of artificial groundwater recharge is broadly categorized as direct techniques or indirect techniques. Surface direct technique is divided into 2 types surface that is the spreading and subsurface. Surface spreading technique consists of flooding, basins of percolation tanks, stream augmentation and ditch and furrow system. So, these are coming under the view of the stream surface spreading.

Now for in a subsurface training the subsurface study the direct technique is rechargeable either you construct a rechargeable there or recharge pit shaft to construct the shaft recharge pit or shaft or the dug well; dug well is also a very good alternative although it is subsurface technique but it is a direct technique to recharge the aquifer. Now indirect technique is the induced recharge it is the induced recharge so by induced which are also we can recharge the aquifer.

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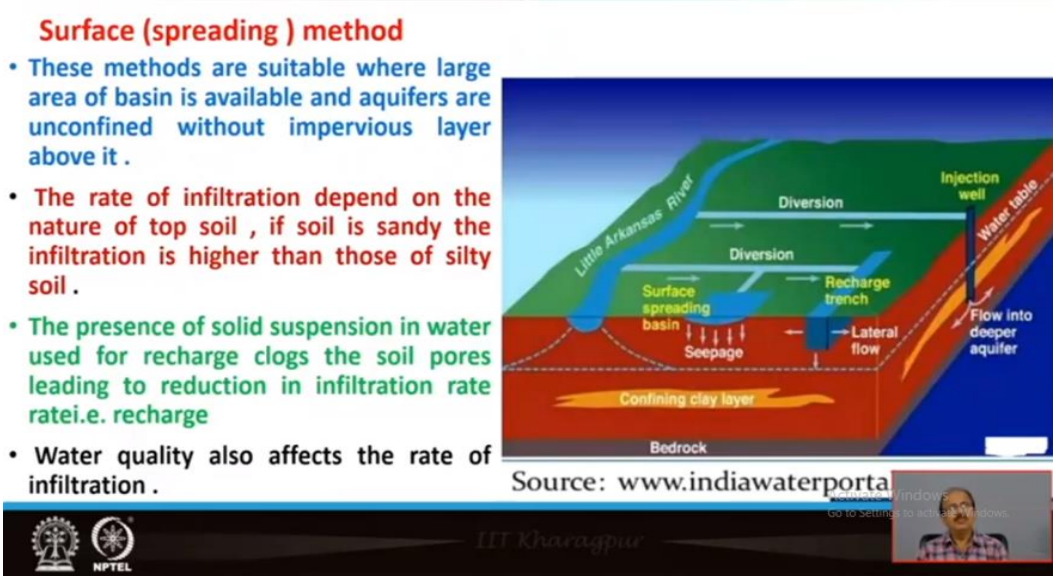

Now spreading the surface spreading this is the first method so these methods this is the first direct method so these methods are suitable with a large area of basin is unavailable. So, large area of basin is not present last area of basin is available and it aquifers are unconfined without impervious layer above it. So, surface spreading method we have seen that direct method is divided in 2 types surface spreading and subsurface spreading method.

So, these methods are suitable where large area of basin is available and aquifers are unconfined that is without impervious layer above it only that very condition only the aquifer is classified also. Unconfined case the impervious layer will be at the top as well as at the bottom whereas in unconfined condition the impervious layers will remain below it but never above it so the rate of infiltration depend on the nature of topsoil.

If soil is sandy the infiltration is higher and if it is silty then infiltration is a little bit lesser. So, generally the rate of infiltration depends on the nature of the top side the presence of solid suspension in water used for recharge clogs the soil pores leading to reduction in infiltration rate that is recharge. So, generally the solid suspension if it is remaining some clog the soil pores are clogged by some means then the infiltration rate will be decreased.

Definitely the recharge will decrease and water quality also affects the rate of infiltration. So, water quality is also affecting the rate of infiltration and infiltration is the important process because then

only the water can reach to your aquifer system so to this method the water can be stored at some specific location.

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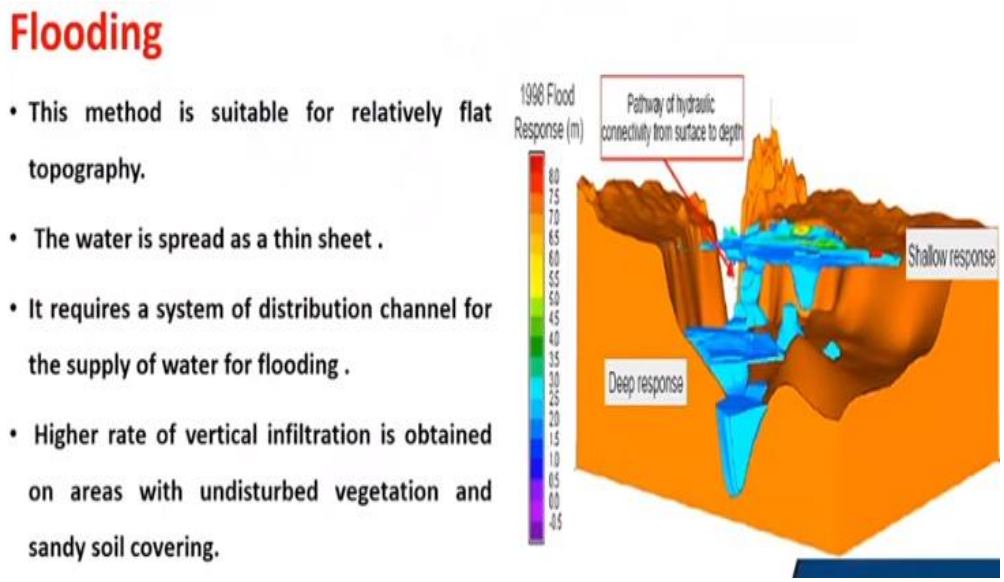

Now flooding this method is suitable for relatively flat topography. So, if the Topography is flat then this method is suitable the water is spread as a thin sheet it is just spread it thin sheet it requires a system of distribution channel for the supply of water for flooding. So, it requires a system for distribution channel for the supply of water for flooding and the higher rate of vertical infiltration is obtained on areas with undisturbed vegetation and sandy soil covering. So this is the case of the flooding generally used for generally this procedure is followed at the fluid topography area.

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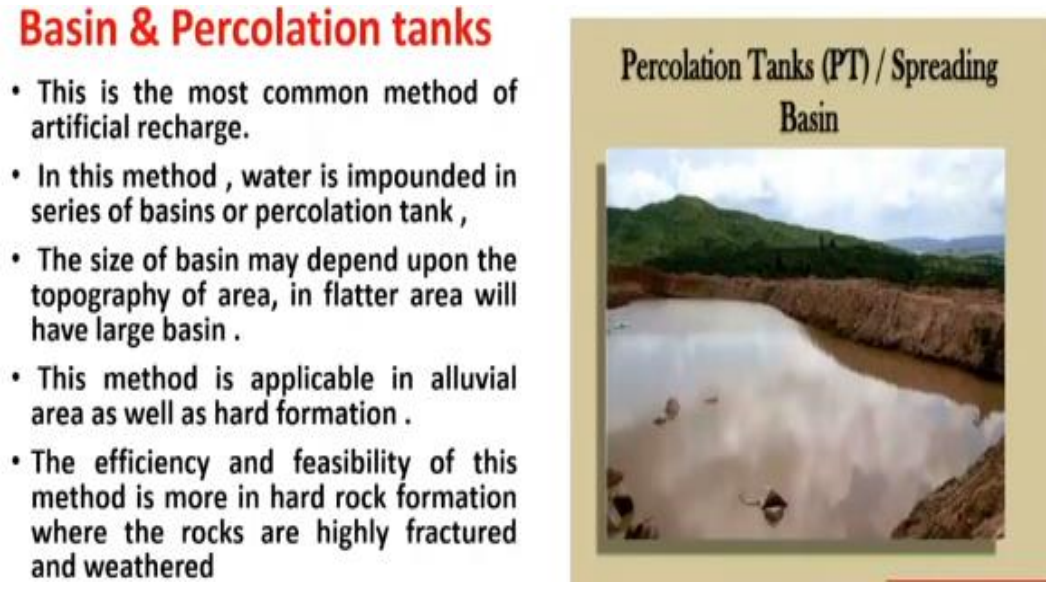

Now next is the Basin and percolation tanks so this is the most common method of artificial recharge in this method water is impounded in the series of basin of percolation tanks. So, this is a series of you can see here some small basin is there and this basin the water is stored so this method is the most common method of artificial recharge here water is just stored in the basins or percolation tank.

The size of the Basin may depend upon the Topography of the area so and in federal area it will have the larger basin. So, this size also varies from place to place it depends upon the Topography of the area this method Basin and percolation tanks method is applicable in alluvial areas as well as hard formation. So, in both the areas alluvial areas as well as in hard formation this type of your artificial storage structure can be developed.

Because this is the most common method of artificial recharge the efficiency and feasibility of this method is more in hard formation whereas the rocks are highly fractured and weathered. So, when; the rocks are highly fractured and weathered the efficiency of this method in more in the hard rock formation area. So, this is good for the hard rock formation area where it can be stored the water to this means the water can be stored.

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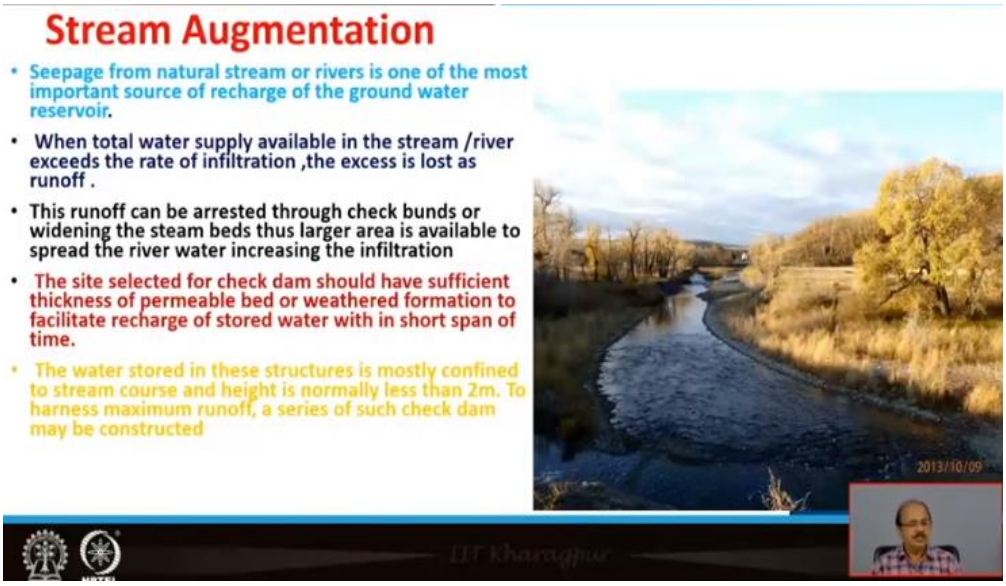

Now a stream augmentation, so this stream augmentation here the seepage from natural system stream or rivers is one of the most important sources of recharge. So, seepage from natural stream or river sometimes the rivers solution system which is flowing through the area is just shipping in

its water and just recharging the groundwater system boundary reservoir. When; total water or supply available in the stream reservoirs river exceeds the rate of infiltration.

Then what will happen the excess is lost as runoff the excess water will just throw away and known as runoff. This runoff can be arrested through check bunds so now the runoff can also be harvested this can be harvested by creating some sort of check bunds or widening the stream beds therefore the larger area is available to spread the river water and then it will increase the infiltration rate.

So, for this whole process the stream augmentation is also a method for the artificial recharge the site selected for check dam should have sufficient thickness of permeable bed or weather formation to facilitate the recharge of stored water within short span of time. So, you can see in the diagram also this is the check bund which is created generally so here water will store and then by infiltration this water will recharge the underlying aquifer also.

The water stored in these structures is mostly confined to stream course near to the stream course it will remain and the height is normally less than 2 meter. To harness maximum run of a series of such check dam may be suppose you wish to have to harvest more water then we can just construct some more check bunds and we can accumulate water at different distances.

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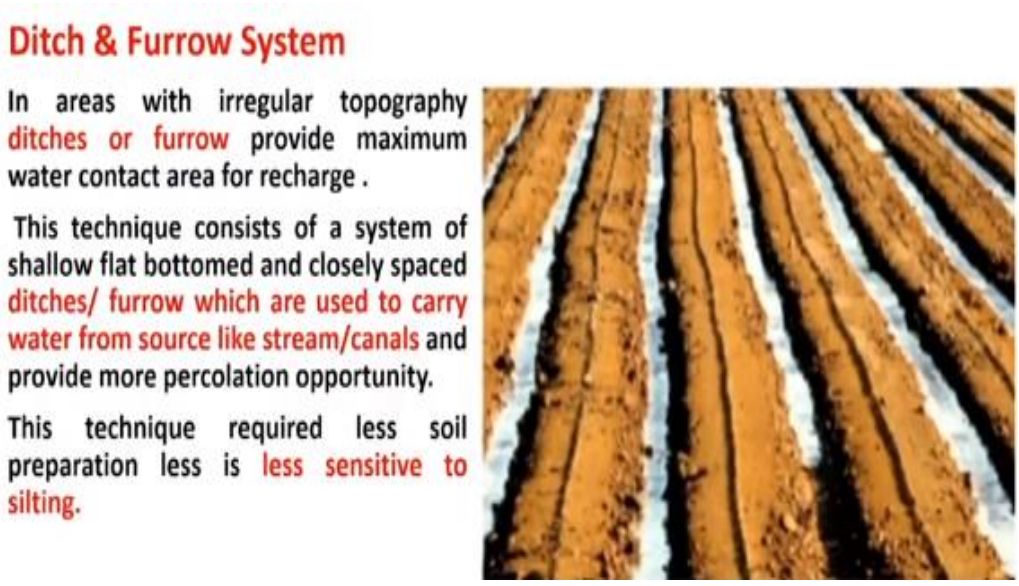

Now ditch and furrow system this is generally followed in the regular topography system in areas with irregular topography they may reach of our system is providing maximum water conduct area

for recharge. This technique consists of a system of shallow flat bottomed and closely space ditch and furrow which are used to carry water from sources like a stream canal etc. and provide more population opportunity.

So, this ditch and furrow system is a very good system for the irregular topographical areas and it required less soil preparation as well as the less sensitive to silting also so this technique is a good for the artificial recharge in this very area.

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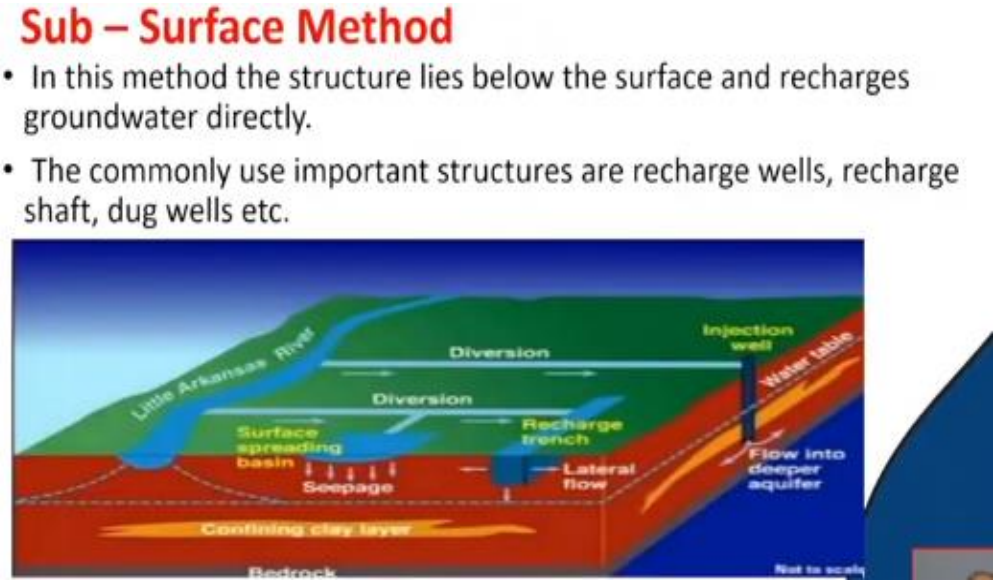

Now the subsurface method whatever we have discussed in the previous slides that were those were the different techniques of the surface method. Now the subsurface method means artificial recharge is the process but this can be done in the below the surface of the earth. So, in this method the structure lies below the surface and then it recharges the groundwater directly.

The general the commonly used important structures are generally recharge wells; recharge shaft, dug wells etc. These are the commonly used important subsurface structure which just helps in the recharging of the groundwater through the structures are recharge wells, recharge shaft, dug wells etc.

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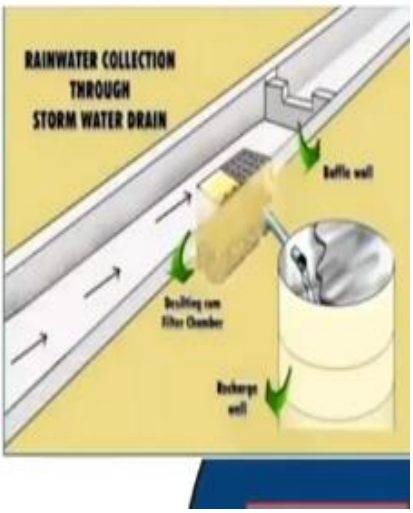
Recharge well

- The recharge well for shallow water table aquifers up to 50 m are cost effective because recharge can take place under gravity flow only.
- These wells could be of two types, one is dry and another is wet.
- The dry types of wells have bottom of screen above the water table. In such well excessive clogging is reported due to release of dissolved gasses as water leaves the well and on other hand redevelopment methods have not been found effective in dry type of well.
- The wet types of wells are in which screen is kept below water table. These wet type wells have been found more successful



Now recharge wells for shallow water table aquifers we have learnt water table may exist at the lower depth or may remain at a deeper depth. When it remains at the shallower depth then the recharge well is best suited technique for the artificial recharging in such type of well. So, the recharges well for shallow water table aquifers up to 50 meter are cost effective because recharge can take place under Gravity flow only.

These wells could be of 2 types one is the dry another is wet. So, this recharge well is of 2 different types one is dry another is wet; the dry types of wells have bottom of screen above the water table so in this type of ways dry type of wells have the bottom of screen above the water table. In such a well excessive clogging is reported and due to the release of dissolved gases as water leaves the well and on the other hand redevelopment methods have not been found effective in right type of well so this method is not found generally in the dry type of well.

So, the wet types of wells are in which screen is kept below water table in wet type the screen is kept below water table and in dry type the screen is remaining at the bottom of screen bottom of the well. So, these wet type wells have been found more successful so with respect to dry type the wet type wells in which the screen is kept below water table these wet tables have been reported more successful for recharging the area for making the artificial recharge of the area.

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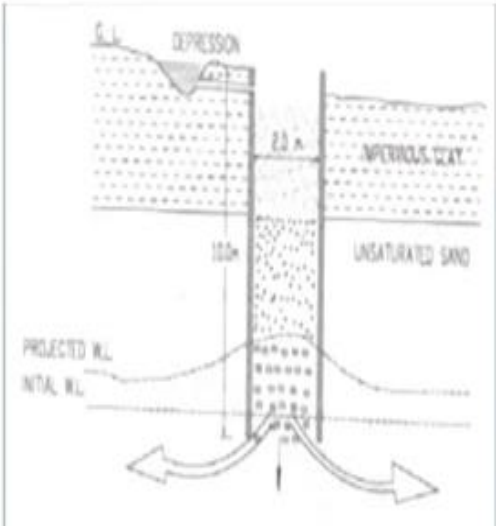
Pitch & Shafts

- In area where impervious layer is encountered at shallow depth the pits & shafts are suitable structure for artificial recharge.
- These structures are cost effective to recharge the aquifer directly.
- The diameter of shaft should normally be more than 2m to accommodate more water.
- The advantage of shafts/ pits structures is that they do not requires large pieces of land like percolation tank & other spreading method.
- There are practically no losses of water in form of soil moisture and evaporation like other methods of spreading.



Now pitch and shafts in area where impervious layer is encountered not pervious imperviously are encountered at shallow depth the pitch and shafts are suitable structure for artificial recharge. So, in this case the pitch and shafts are the suitable structure for artificial recharge the structures are cost effective to recharge the aquifer directly the diameter of shaft should normally be more than 2 meter to accommodate more water.

So, the diameter of this very structure is remaining grounding more than 2 meter to accommodate more water the advantages of shaft pitch structure is that they do not require large pieces of land like percolation tank and other spreading method. So, that's why this is the advantage of shaft pitches structures and now there are practically no losses of water in form of soil moisture and evaporation like other methods of spreading. So, in this these there are practically no losses of water in form of soil moisture and evaporation so this is the generally used in the area where impervious layer is generally encountered.

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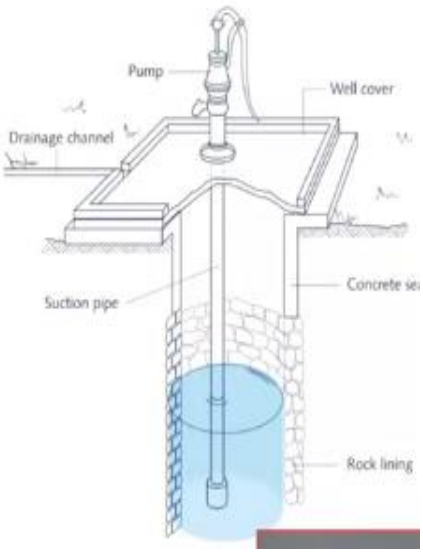
Dug Wells

- In alluvial as well as hard rock areas there are thousand of dug wells have either gone dry due to considerable decline of water levels.
- These dug wells can be used as recharge structure storm water and other surplus water from canal etc. can be diverted into these structure to directly recharge the dried aquifer.
- The water for recharge should be guided through a pipes to the bottom of well to avoid entrapment of bubbles in the aquifer.



Now next are the dug wells in alluvial as well as hard rock areas there are thousands of dug wells which have either gone dry due to considerable decline of groundwater levels. So, we may get we may encounter several degrees in a ruby and hard rock areas and few of them is considerably decline of groundwater levels in them. So, these drug wells can be used as a recharge structure as a recharge structure the dug wells can also be used storm water and other surplus water from canal etc. can be diverted to this structure to directly recharge the dried river.

So, this can also be diverted and the different types of water can be diverted and it should be rooted through the dug wells for recharging the underlying aquifer. The water for recharge should be guided through the pipes to the bottom of the well to avoid entrapment to the bubbles in the aquifer. So, from the recharge the water recharge water or the water for recharge should be sent through the pipes to the bottom of the well to just avoid the entrapment of bubbles in the aquifer.

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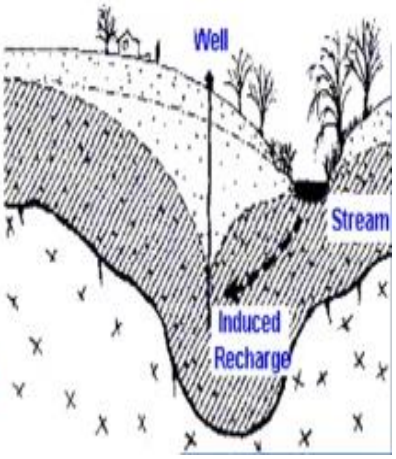
Induced Recharge

- It is an indirect method of artificial recharge involving pumping from aquifer hydraulically connected with surface water such as perennial streams, unlined canal or lakes.
- The heavy pumping lowers the groundwater level and cone of depression is created . Lowering of water levels induces the surface water to replenish this ground water .
- This method is effective where stream bed is connected to aquifer by sandy formation .



Now induced recharge it is an indirect method it is an indirect method of artificial recharge involving pumping from aquifer hydraulically connected with surface water such as perennial streams, unlined canal lakes. So, it is an indirect method of artificial recharge it involves pumping from aquifer hydraulic which is aquifer hydraulic connectivity connected with surface water such as perennial streams, unlined canal or lakes.

The weak pumping lowers the groundwater level and cone of depression is created. The heavy pumping lowers the pumping will continue for longer duration it lowers the groundwater level and cone of depression is created. Lowering of water level induces the surface water to replenish this groundwater so this if the water level will go down if it is the water from the surface water sources will come to replenish the groundwater resource in the area. So, this method is effective where stream bed is connected to the river by sandy formation.

So, if the stream bed or river bed is connected by some means to the Rock bed your rock having the water that is the aquifer by Sandy formation then already the water from the stream will lead towards the aquifer and it will be recharged. So, this is generally called as the induced recharge means we are just inducing for recharge by some means so in this lecture we have understood about the artificial recharge technique and its processes thank you very much to all.