Availability and Management of Groundwater Resources
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Lecture - 05
Hydrological Cycle, Need for Conservation of Groundwater Resources (Continued)

Welcome to you all in the fifth part of the lecture 1 which is based on the knowledge on various types of groundwater conservation measures as well as the different strategies which supports the water conservation. What we have discussed in the last four part of the lecture 1 that groundwater remains inside the earth's surface.

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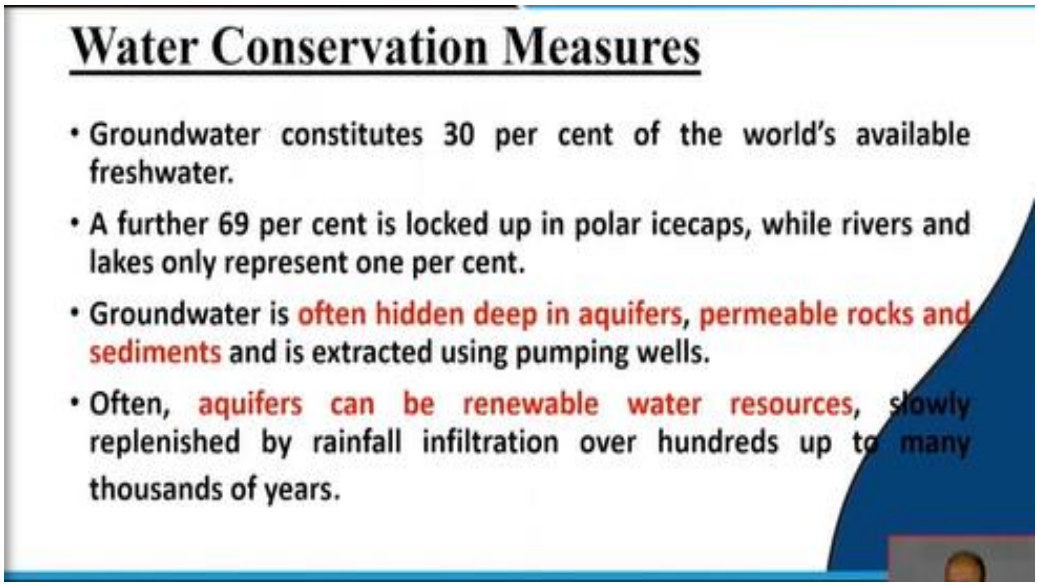

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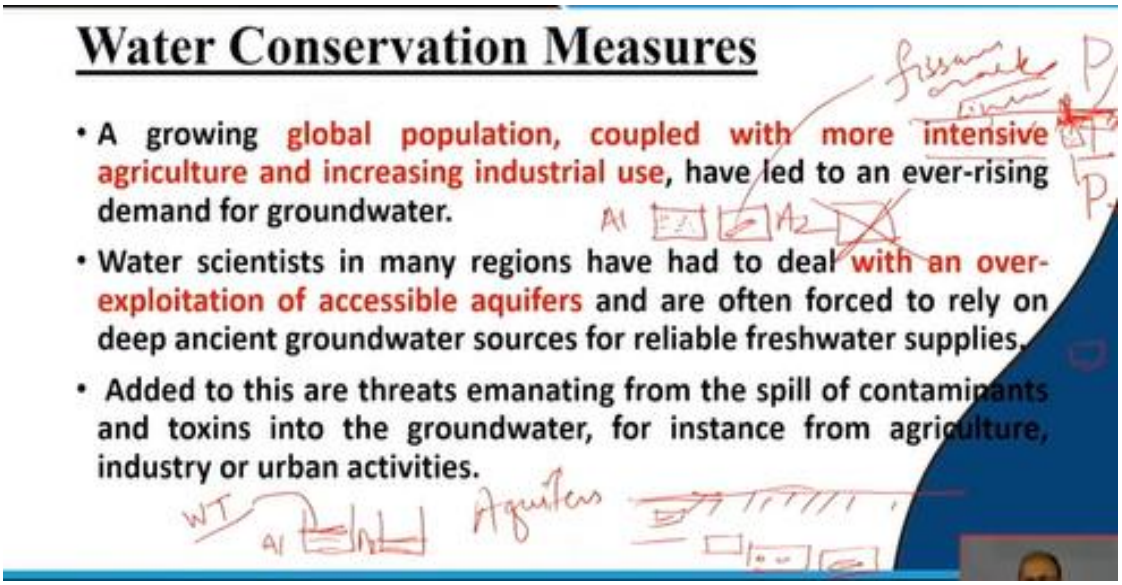

So, groundwater whatever the water we are getting it remains inside the earth's surface. Inside the earth's surface generally it remains within some rocky formations say this is the earth surface. So, groundwater remains in some rocky formations which are having the pore spaces or lineaments some space. So, in it generally the groundwater remains. We have seen that these formations are termed as aquifers.

So, aquifers hold the groundwater inside the earth's surface the depth may varies because sometimes we are getting the shallower aquifer just near to the surface or sometimes, we are getting the deeper aquifers deep from the earth surface. So, but in both the aquifers shallower or deeper we get only the fresh water, fresh water means groundwater which is a easily potable water we can drink it, we can cook from it etcetera.

So, this thing we have learned in the part one of the lecture one. We have seen that the water level of in any aquifer varies from space and time. In space and time, the level of the water in any aquifer it varies say if this is aquifer one and this is aquifer two. So, the level of the water varies at different aquifers. So, this level of the water is termed as if you will recall yourself it is termed as water table. So, water table varies from place to place.

If the water table is near to the surface, we may get plenty of groundwater. If it is at deeper depth, we may not get plenty of groundwater. So, this is one condition for getting the

groundwater from the earth's surface from the rocky formations say aquifer. Second condition is why not we are getting water at every place. The point is the two aquifer one and aquifer two are here but this aquifer is having the behaviour of number of pores in it.

We are getting number of pore spaces but this is also one aquifer. But in it we are not getting the number of pores rather we are getting only small fracture lineaments. And third type of aquifer is also the third type we cannot say heat aquifer because it is unable to hold the water. So, this is not good some rocks, hard rocks they have they are having no pore spaces within it. So, hard rock is hardly carrying the ground water.

Hard rock which is deriving from the soft rock may say sedimentary rocks then it will have some species termed as freezers or cracks. So, some cracks will remain there some lineaments where there are. So, these fractures lineaments cracks will store water but limited amount if you will compare it with the sedimentary rocks which are having the large number of porous spaces. And in the porous bases it will hold the groundwater. So, two things are very clear.

First the groundwater remains inside the earth within some rock formation known as aquifer. This aquifer is having some level which is known as water table and the rock formations are also having some characteristics if the rock is having good pores number of pores. Then it will hold more amount of groundwater within the aquifer. So, this thing we have understood but when we were discussing about your part two or part three of the lectures.

We have seen that if we wish to compute the water availability of any area, we should focus on the water budget equation. And water budget equation we have seen in the previous lectures. Water budget equation is basically deriving from the various components of the hydrological cycle. So, we have learned that precipitation is one of the important components. This component is deriving the giving us the rain water and rain water is the only source which is recharging the aquifer.

So, precipitation is one of the components, second is the infiltration then percolation then through this these are the just coming down to the surface. So, precipitated water will become

into infiltrated water, it will become percolated water and lastly the percolated water will reach to the aquifer. Other thing when the precipitation will fall on the earth's surface what will happen? It will infiltrate first then percolate then move to the aquifer.

But when this level the soil layer will become saturated then it will not allow the water to move inside. Then what will happen? It will just follow it will come to the earth surface but will not enter inside the earth rather it will move towards the topography and will ultimately join the river or some your surface water sources, it will ultimately join. So, this type of precipitated water which is not going down to the aquifer rather it is moving towards the topography is known as the runoff.

So, this is also runoff is also one of the basic components of the hydrological cycle, we have seen already in the previous lectures. Two components of the hydrological cycles are again coming to the surface precipitated water is coming to the earth's surface. But two components are evaporation and transpiration which is again sending back the content to back to your atmosphere.

So, again through the evaporation and transpiration the precipitated water is moving back towards the atmosphere. So, these all the precipitation infiltration, percolation, evaporation, transpiration these wholes are the various components of the hydrological cycle. And with these components we are generally deriving the different quantum of storage of groundwater at different, different places with the help of water budget equation we have seen in the previous lectures.

Now after seeing all these concepts has come that if we will not conserve the water resources. Then a day will come when we will not remain available with the fresh water for even for drinking or cooking etcetera. So, we must be very aware about the water conservation measures and this is the main focus of this last part of the lecture one. Why? Because a growing global population we are knowing the population are gradually increasing coupled with more intensive agriculture and increasing industrial use.

Industrial activities are also increasing, agricultural activities are also increasing, side by side the population is also increasing. So, what will help? The more quantum of water is required for different demand. So, ultimately there will be pressure on the groundwater which is lying in certain aquifer inside the earth surface. So, water scientists in many regions have had to deal with an over exploitation of accessible aquifers.

So, definitely if there will be no surface water source there nearby to the industrial unit or the agricultural area then what will happen? The persons will depend on what on the exploitation of aquifer. Only the groundwater they get from aquifers, underlying aquifers. So, this will force to rely on the deep ancient groundwater resources for reliable fresh water supplies. So, if you will over exploit the any aquifer then a time will come when you want to get single drop of water from that very aquifer then what will do.

Then you will go for the deep and then you may get the water from the deeper aquifers for the specific purposes. So, these all are very-very important for the conservation of the water resources. Side by side we have also seen that the contaminants which are just mixing with the groundwater contaminants from the industries, contaminants from the agricultural activities, fertilizer, pesticides etc due to the construction activities.

So, these contaminants are ultimately mixing with the groundwater and making it quality poor. So, poor quality of groundwater is also not being used by the person for drinking or cooking purposes. So, these all points should be kept in mind and then only we should think for the conservation measures.

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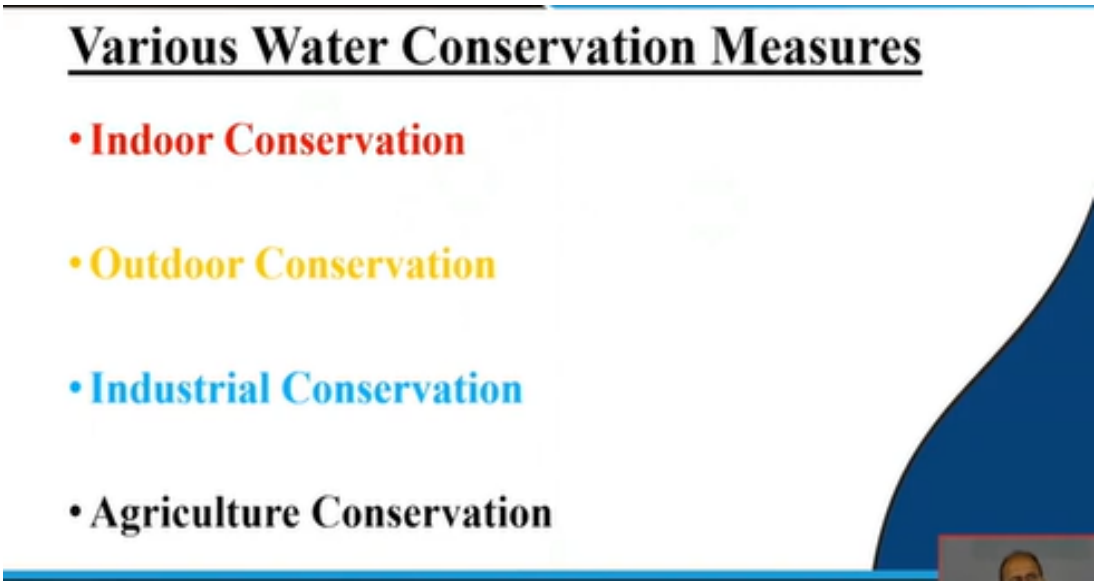

So, various water conservation measures are there indoor conservation, outdoor conservation, industrial conservation, agriculture conservation. There are several measures one by one, we will discuss.

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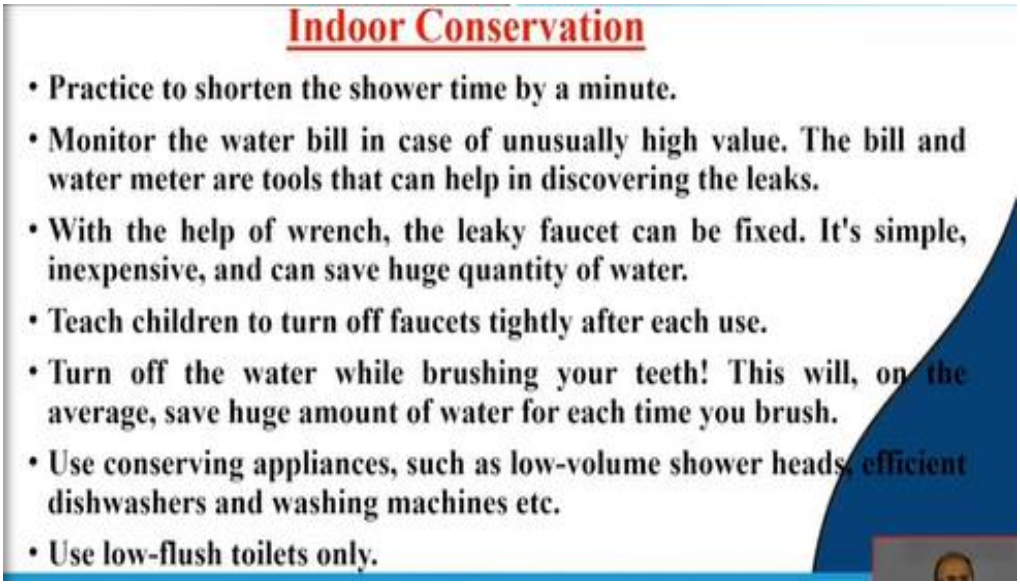

In indoor conservation how can we conserve the water? Because water we have seen the water is very limited inside the aquifer. So, we should take the optimum water for the different activities. So, first for indoor. Indoor conservation can be done by practicing to shorten the server time by a minute. If we will practice it definitely, we will consume lesser amount of groundwater then monitoring the water bill in case you are getting usually high value.

So, the bill and the water meter are very good tools which can help in discovering the leaks also. So, this is a very good tool through which we can assess how much water are being used for the specific purposes. If there will be some leakage, we can fix this leakage with the help of wrench. It is very simple also inexpensive and can save use quantity of water because if the leakage will be there more amount of water will go out.

So, these points should be kept in the mind for the indoor conservation measures. Teach the children to turn off faucets tightly after each use. It should not remain loose otherwise again the drop of water will come out from the tab. Turn off the water while brushing your teeth this is unusually, we have seen that the people are brushing and keeping the tap on. So, it should not be kept open, it should be just closed.

So, this will save huge amount of water whenever you are brushing your teeth. Use conservation appliances like low volume shower heads. Nowadays it is very simple you can get in the market low volumes overheads, efficient disk washers which will consume lesser amount of water and washing machine etcetera. So, through this way we can even for low floss toilets also are in the market which can be used which will consume lesser amount of groundwater. So, these are some of the measures for the indoor conservations.

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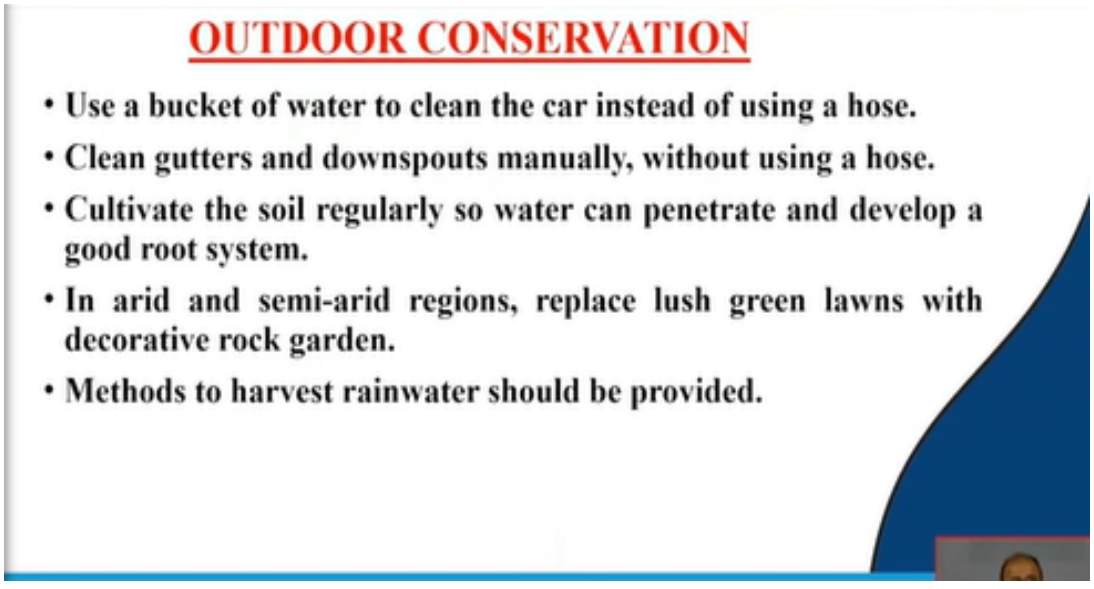

Now for outdoor conservation measures we can see certain points like use a bucket of water to clean the car instead of using a hose. Because through the huge amount of water are being rested. So, whenever you are willing to just wash the car or any vehicle take a bucket of water and through it try to clean the vehicles, clean gutters and down spots manually without using hose. Sometimes gutter remains chopped so we are what we are doing we are just opening the hose and we are washing the area.

So, clean gutters always try to clean gutters and do not to use it with a hose. Now cultivate the soil regularly. The soil should be cultivated regularly then what will happen? If we will cultivate the soil the soil texture will remain fresh. So, water can penetrate through it and develop a good root system also. So, lesser amount of water will be used in that area. In arid and semi-region replace the lush green lawns with some decorative raw garden.

So, raw garden will consume lesser amount of water even no water in the area. And lastly the outdoor conservation important method is the rain water harvesting. It is a very important method we will discuss in detail in the later chapters also. So, through the rain water harvesting because you should put the rain water in such a way that it can recharge the local area where it is just pouring. So, nowadays lots of scientific studies are on the green water harvesting.

We will also discuss in this course in the NPTEL course. We will discuss the different methods of the rainwater harvesting in greater detail. So, these are few measures of the conservation measures in during the outdoor situations.

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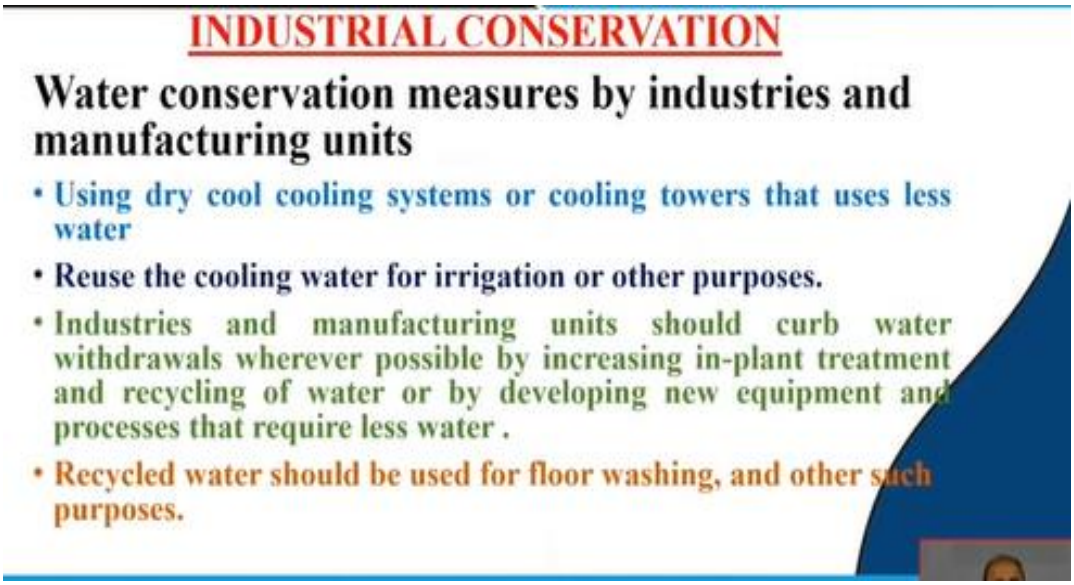

Now industrial conservation. See if any industry requires water for their industrial activities if you will see they are having the plan also how much water they will withdraw for running the industries. So, they are also making some conservation measures plans. They are having the conservation measures plans but they should use dry cooling system or cooling towers which will use lesser amount of groundwater.

So, for these dry cooling systems are very efficient then we use the cooling water for irrigation and other purposes. If some cooling waters are coming then it should be reused for irrigation and for other industrial purposes. Industries and manufacturing units should curve water withdrawals wherever possible we will see. If the industry will require certain water definitely it will withdraw water from the area where it is located.

So, but as much as possible it should withdraw water by some good aquifer. So, that wherever possible implant treatment and recycling of water is very important for any industrial activities. So, if in the industry will recycle or reuse the water then it will help to minimize the water table in the locality. So, recycling water should be used and this recycling water should be used for floor washing and other such purposes.

So, industries should often take care of these points that they should use the recycled water as much as possible.

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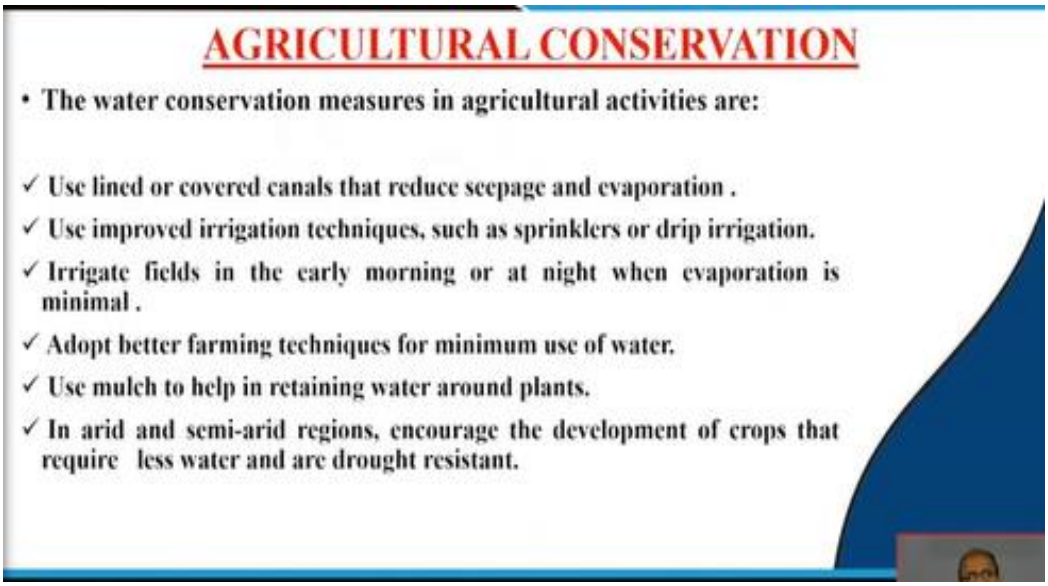

Next is the agriculture conservation. In agricultural activities we are knowing the lots of water are required. So, minimum number of processes if you will see in the agricultural activities, they require much ground water. So, for this use lining or covered canals that will reduce the seepage and evaporation. If you are using during the agricultural activity you are using the lining covered canals just covering the canals then it will reduce the seepage as well as evaporation.

Use improved irrigation techniques there are several techniques irrigation techniques such as sprinklers or drip irrigation through which minimum amount of water will require for the purposes. Irrigate fields in the early morning or at night when evaporation is very less. So, in this way we can save some amount of water. Adopt better farming techniques for minimum use of water. If the farming technique is good the amount of water requirement will be also less.

So, farmers should adopt the better techniques for minimum use of water. Use mulch to help in retaining water around plants. Around pants if you will keep some mulch definitely the water will remain there so it will not need further water for its growth. In and semi-arid regions encourage the development of crops that require less water and are drought resistant. So, these are some of the conservation measures in the agricultural activities.

So, we have seen the indoor, outdoor, industrial and agriculture conservation measures for the groundwater.

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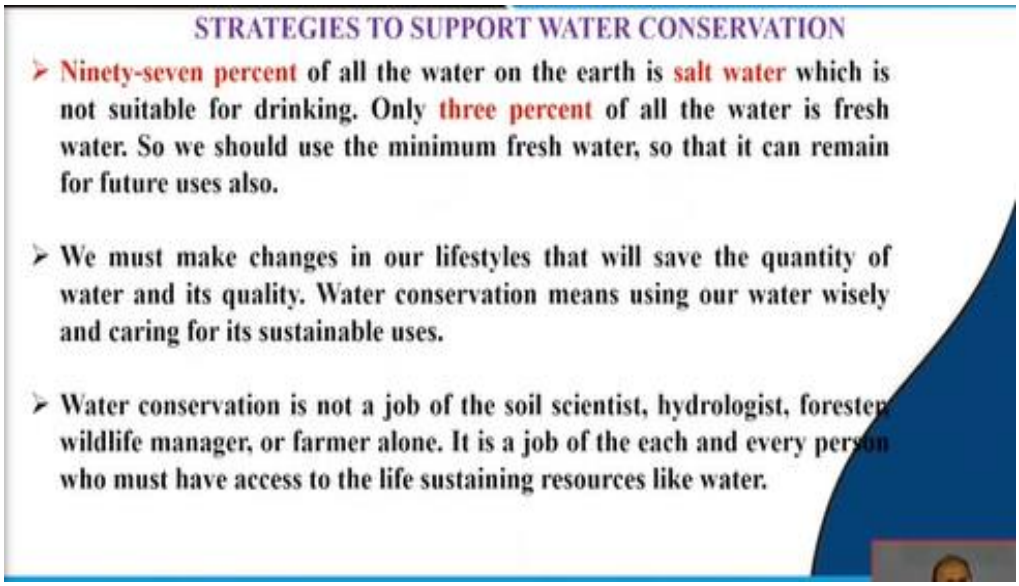

Now some strategies are also supporting the water conservation measures. These points should be there in the mind because we have just started a very interesting subject availability and management of the groundwater resources. Regarding availability we have come across that water groundwater remains in rock formation known as aquifer, the water table varies from place to place.

So, we are also knowing that somewhere we are getting sufficient amount of groundwater, somewhere we are not getting. This whole thing we have come across in the previous your lectures. Now some of the strategies because we have seen in the earlier slides, we have seen that 97% of all the water on the earth is salt water. So, salt water is not suitable for drinking purposes so it is not good.

Only 3% of the water is your fresh water and so fresh water is very less only 3%. So, this fresh water should be used at present also and we should keep in mind that it should remain for future usage also. So, we must make how it will remain we must make changes in our lifestyle then only we can able to save the quantity of water as well as we can preserve it from that contamination. So, the quality will good then only it can be used.

So, water conservation means actually using our water widely and caring for its sustainable use. Today also we can use it and for tomorrow also we can keep it in good quantity as well as in good quality. So, water conservation is not a job of only the soil scientist, a hydrologist, a forester, a wildlife manager or farmer rather it is a job of each and every person who must have access to the life sustaining resources that is water. So, it is job of each and every person to keep the water in good quantity as well as in good quality.

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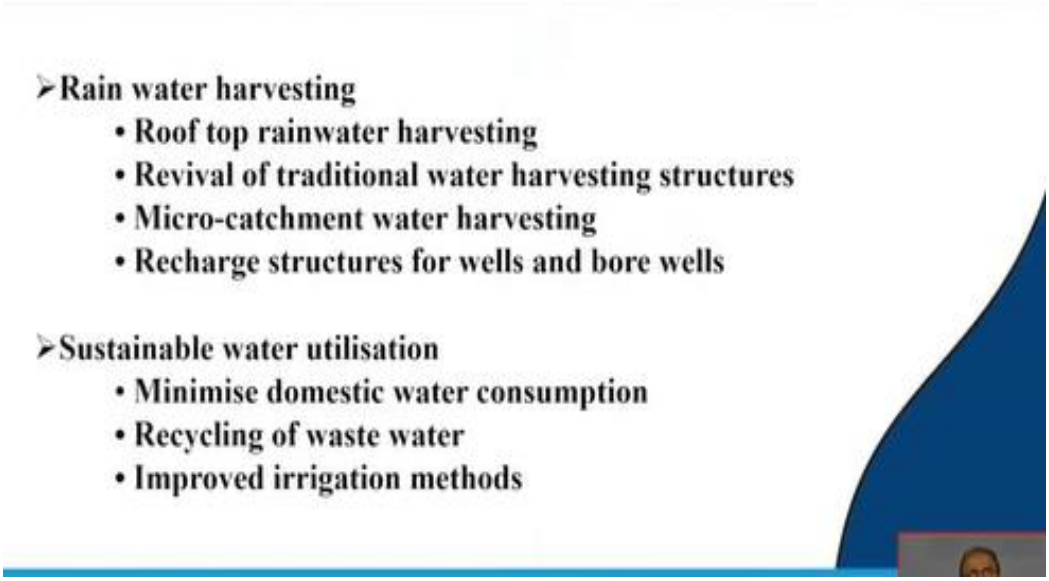

Rain water harvesting what we have discussed here. If we will see this is the best technique for the conservation. We can choose our own roof of the house where we can just arrest the rain water and then by some means we can send it to the down to the earth. So, roof top rain water harvesting is a very good conservation measures, revival of traditional water harvesting structure. See if you will see in different places earlier say 10-20 years ago the plenty of groundwater was remaining in some area.

But today if you will see the area is having no groundwater. The reason I have discussed not in greater detail but I have told you we will discuss in the coming lectures. I have told you that if you will wish to take water from this area and this area you may get water from this area you may not got water from this area. So, this we are knowing that water remains in some standard rock formations which are having some space known as pores only then the water will hold there.

Otherwise, we will not get water if the formation is not good not having pore spaces not any your fractures or lineaments it will not hold the water. So, but ancient period people have recognized that this area having some water 10 years ago, 20 years ago they had noticed that the water were there at that time. So, this traditional structure earlier the water was here but now at present it is not here.

We can just recharge the area having some scientific means we should just revive these traditional structures which were earlier the water but at present it is not having water. So, this is also very good strategies. If we can revive the some of the old traditional water harvesting structures say a well. Earlier in the well in the dug well the water were there say 20, 10 years ago, 5 years ago the water was there but at present it is not here.

I have told you already I had discussed it in the previous part of the lecture one that this water say one aquifer is here one aquifer is here. So, people are withdrawing water from this aquifer also from this aquifer also. So, if people will withdraw water from this aquifer in excess what will happen? This water will go out. So, what will happen? This will become dry. But if there will be no source of supply of water in this aquifer then this well will become dry.

But this is a well in which earlier the water was there. So, if possible if we are seeing it that this is the small aquifer in which little amount of water is remaining but still it is having the tendency to store the water. So, formation is good then what should be the strategy? We should revive these traditional structures. Earlier it having the water at present is not having the water it means if we can just think for the revival of this traditional structure then after sometimes, we may get the water in this aquifer also.

So, this is very important strategies, revival of old water harvesting structures. Now micro catchment water harvesting. Small areas wise say if in a village there are or in a town there are some areas where there are some good formations. After some studies we are knowing that some good formations are there. So, we should just delineate the small area and we should try to put the rain water whatever rain water is coming within this small catchment area only.

So, what will happen? More amount of water we can store in this very village or town area. If we will have the just the scientific studies as well as information that this much amount of water is coming so we can just accumulate much more groundwater in the area if we will go in the micro catchment wise study or micro catchment wide water harvesting. So, this is also one of the good strategies to go for the micro catchment wise not as a total.

Now in some towns or villages we are seeing we have discussed just now that some wells or bore wells were earlier having the water but at present it has become dried. So, we have seen that earlier it was having water but today it is just useless for the people because no water is there. So, just use this well or bore well as a recharge structure just send the water and keep it there. So, it will gradually recharge the surrounding area and after few months or years you will notice that the well which has become totally dried is having some quantity of water within it.

So, recharge structures for wells and bore wells are also very good strategies for the water conservation. Next is the sustainable water utilization. We have discussed it that try to minimize the domestic water consumption. If we will think as a whole we have to use the as much possible as you will use the lesser amount of water for the different domestic activities. Definitely the consumption will be lesser and then we can save the groundwater resources.

Second is the recycling of wastewater. So, wastewater should not go out on the earth's surface or in some river bodies nearby it should not go out. Try to recycle the wastewater which is coming out from certain activities say from industrial activity, from commercial activities, from agricultural activities. If it is coming out put some means through which it can be recycled and then this cycled water can be used for different purposes which is suitable.

Then we should also think over the improvement of different irrigation methods which is consuming lesser amount of water. So, through this we can save the groundwater resources to a greater extent.

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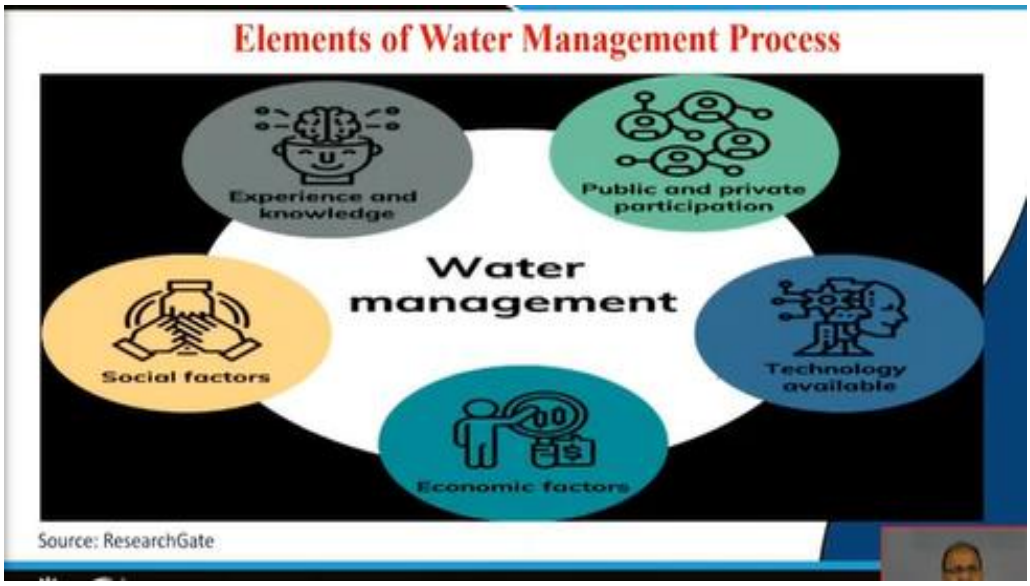

So, this thing can be sum up in this way that elements of water management process are first the experience and knowledge what we are getting here. We are getting the experience; we are getting the knowledge because first we should have the knowledge what is groundwater. Generally, water is not the groundwate. There are different types of water importantly surface water and groundwater are the two different types of the water.

Surface water is the water which is present on the surface in some lakes, in some ponds, in some rivers. If we are getting water, these are the surface water and when the water remains inside the earth it is underground water or your groundwater. So, first of all for the water management process we should learn about that we should gain the knowledge then public and private participation. See this is also very important, alone people cannot manage the water.

So, public and private participation is very important. After getting knowledge and the community help then see what are the technology available for the management of groundwater resources or the water resources. So, technology available is also very important point then the economic factors whether whatever we are adopting is good or not. It should not be costlier and then whatever we are doing whether the society is okay or not.

So, keeping all these five different parameters we can help and we can go for the efficient water management conservation measures.

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Now we have learnt already the several point again I am just repeating that watershed or river basin management especially in water stressed region. We have seen if we are not getting the water then it is water stressed regions. So, river basin wise or watershed device management is important. Enacting and enforcing some water legislation and regulations so that losses will be less we can able to conserve the water. Valuing fresh water resources, we should keep the value of the fresh water resources.

Creating competent administrative and legal structures which can control the overuse of the water resources. Making institutions more responsible and effective. Training senior water managers for making effective water management plans and connecting water management to the needs of agriculture industry and municipality and public health requirements for proper sanitation and disease prevention. So, these are some of the strategies for the management of the water resources.

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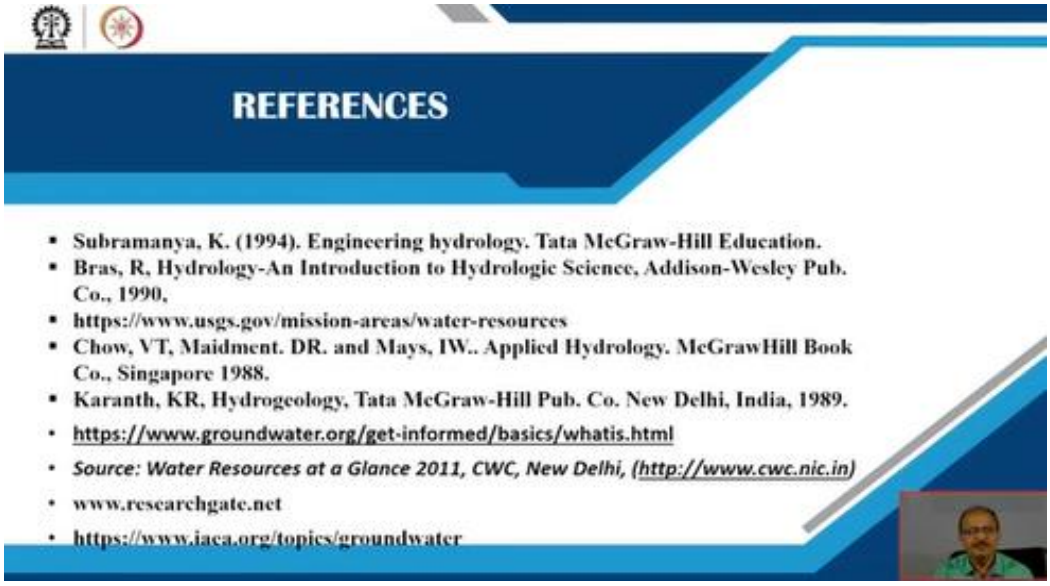

So, now after learning all these things these are some references.

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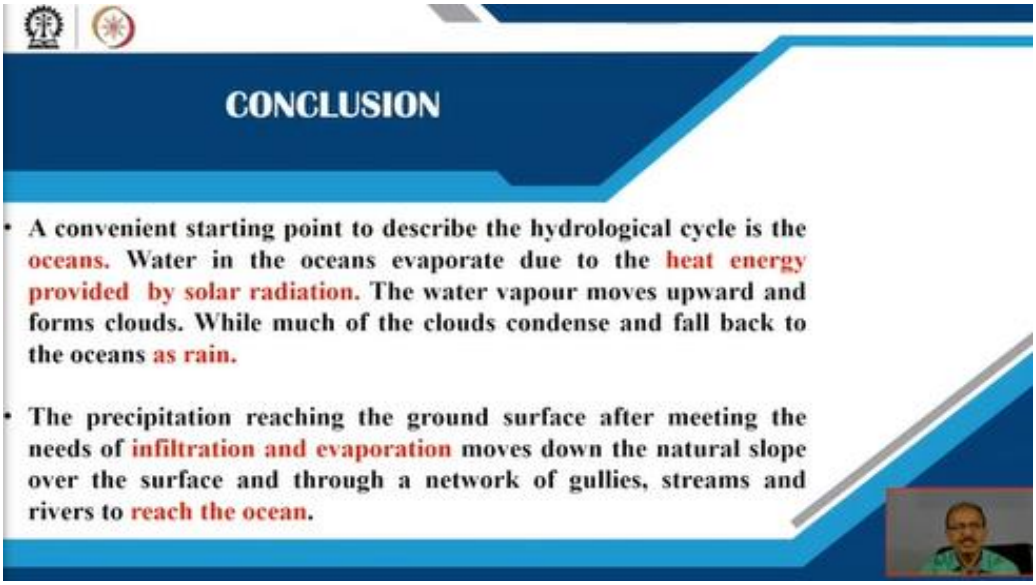

The conclusion is a convenient starting point to describe the hydrological cycle is the oceans. We have seen this is the first lecture introduction to hydrological cycle and need of conservation of water resources. So, we have seen that the starting point of the hydrological cycle is the ocean and the water in the ocean generally evaporate because of the heat energy provided by the solar radiation.

So, this water, the water vapour moves up and form the clouds and when much of the clouds condense again the water fall back in the form of rains. So, this we have seen already in the

previous lectures. The precipitation reaching the ground surface after meeting needs of infiltration and evaporation will ultimately comes down and will meet to the aquifer.

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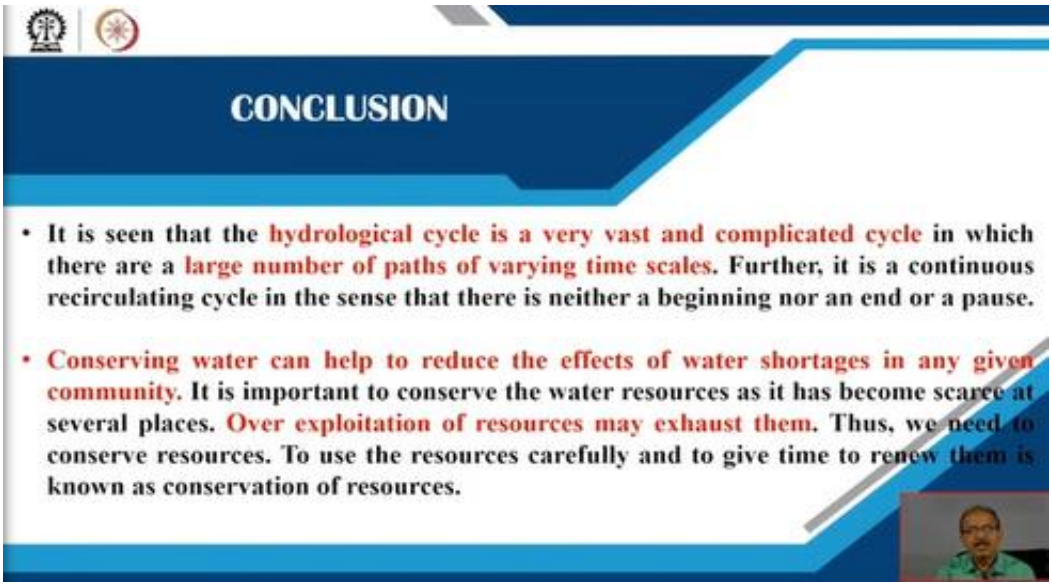

So, this thing we have seen. We have also seen that hydrological cycle is a very fast and complicated cycle in which there are large number of paths of varying time scale. So, different paths we have seen transported and as well as storage path we have seen in the hydrological cycle. It is a continuous recirculating cycle means it is not having any beginning or end. So, conserving groundwater can help to reduce the effects of water shortages in any given community any community it will be lesser there.

If you will able to conserve the water resources it is important to conserve it. Because over exploitation of resources may exhaust and then what will happen? We will need to conserve the resources as much as possible to use the resources carefully and to give time to renew them is known as conservation of resources. Basically, this is known as the conservation of resources. This is all about the lecture on the specific topic. Thank you very much.