Availability and Management of Groundwater Resources

Prof. Prasoon Kumar Singh
Department of Civil Engineering
Indian Institute of Technology (ISM), Dhanbad

Lecture - 48
Groundwater Resources Planning and Management (Continued)

Welcome you all in the part 4 of the module 10 groundwater resource planning and management. So, from the first part we have learned about the different strategies, different challenges and different scopes for the groundwater resource planning and management.

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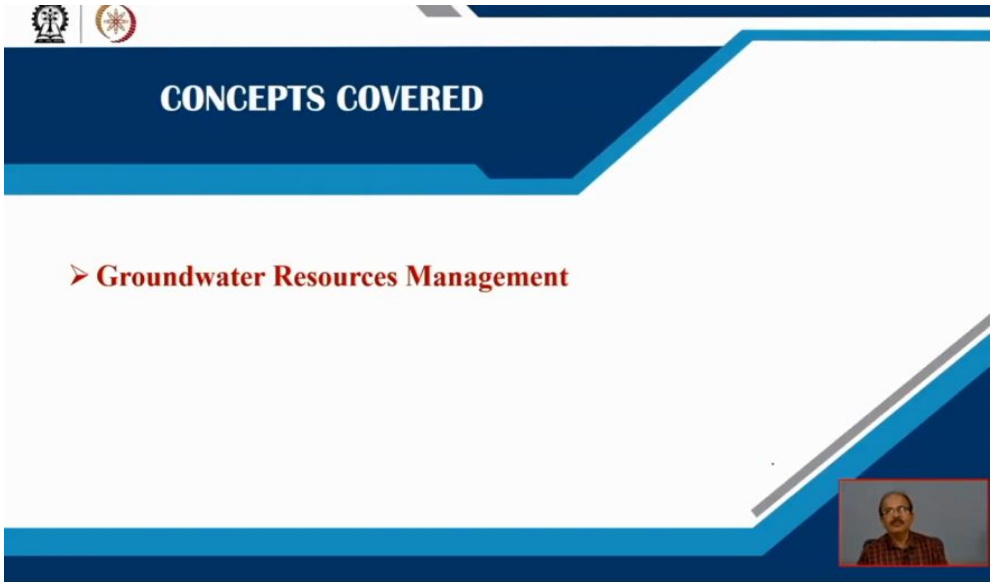

In this part I will again discuss some key issues related to the groundwater resource management.

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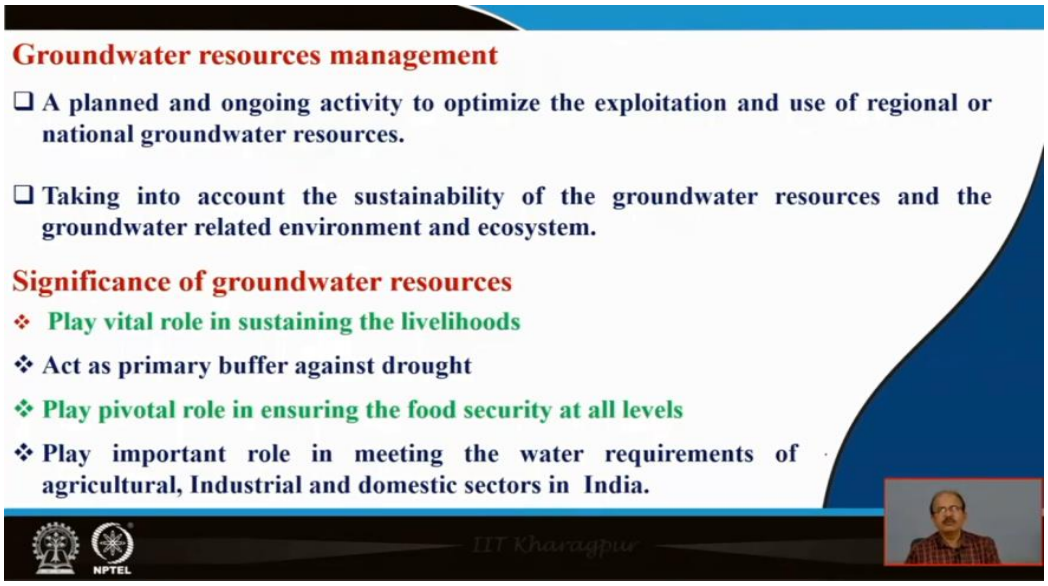

So, generally a planned and ongoing activity is being done to optimize the exploitation and use of the regional groundwater resources. Because see for every use for industrial users, for commercial users, for industry, for domestic users generally we are exploiting the natural resource here the since we are discussing with the groundwater so we are just we will just think about the resource management of the groundwater.

Taking into account the; sustainability of the groundwater resources and the groundwater related environmental and ecosystem problem. Generally, the resource management is being done for the groundwater specifically. The significance of the groundwater resources are that is it plays a vital role in sustaining the livelihoods. This act as primary buffer against drought because in during the drought we know that that time people are facing the scarcity of the groundwater.

It also plays the important role in ensuring the food security at all levels. So, without irrigation we cannot expect for the production of the food, production of the different crops and it also plays important role in meeting the water requirements of agricultural industrial and domestic sectors in India. So, the groundwater resource management is at most important because these are the important points which can be solved by having the plenty of groundwater resources.

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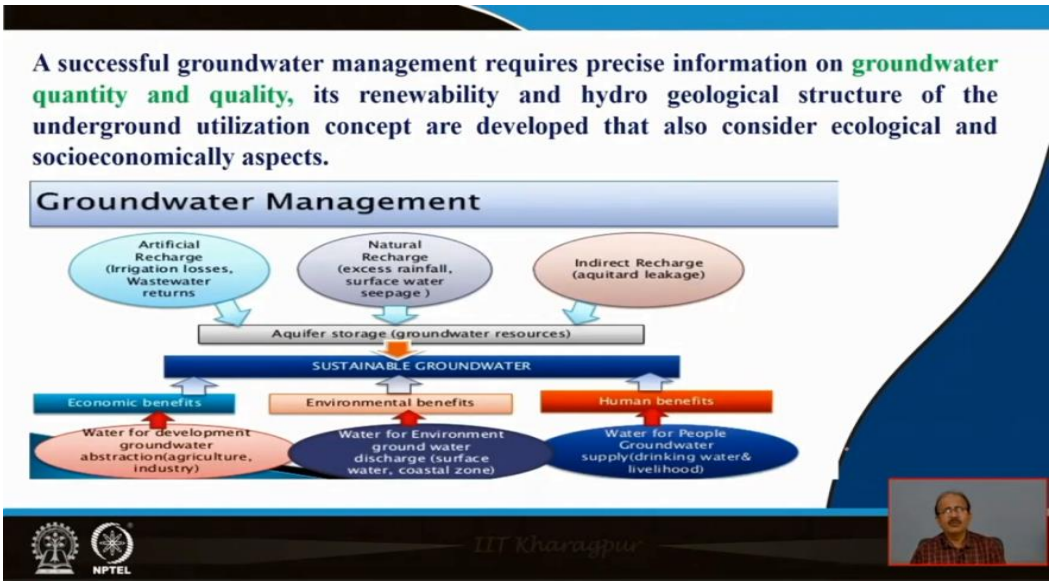

Now a successful groundwater management requires precise information of groundwater quantity as well as its quality. So, from the very beginning just if you will recall the previous lectures from the very beginning, I have repeated several times that the groundwater resource can only be replenished by the your incoming of the precipitated water that is infiltrated precipitated water than infiltrated water then your percolated water.

It ultimately reaching to the aquifer where the groundwater stores underneath the earth's surface. So, not only the quantity issue is important both quantity as well as quality both are required in a great better way because suppose with too much groundwater is remaining in a certain geological formation but the quality is not good, so it is of no use. So, for the successful groundwater management policy it requires information on groundwater quantity and quality both.

And its renewability and hydrological structure of the underground utilization concept are developed. That also consider the ecological and socioeconomical aspects because the renewability is also one of the important whether the precipitation is okay in the area or not if the there will be some error in the precipitation, some variation in the precipitation pattern then definitely will the resource in the terms of quantity will be lesser.

So, these whole aspects are generally covered for the groundwater resource management. You can see with the diagram also that one way is the artificial recharge, second is the natural recharge and

third is the indirect recharge. So, in this way generally the aquifer storage means aquifer ah storage is being maintained means the groundwater resource stores in the aquifer. Artificial recharge can be done with the help of irrigation losses waste water returns if these are just coming.

So, suppose we are irrigating the field agricultural field and because of the irrigation losses some of the water will move and it will store in the geological formation or in the aquifer. Natural recharge generally take place when the excess rainfall for excess rain will fall surface water seepage will be there then it is also just making the aquifer your storage in a better way. Indirect recharge is also there.

Sometimes the aquitard which we have learned which remains even the unconfined aquifer for a special type of aquifer generating unconfined layers just below it makes a specific type of aquifer. So, some if there is leakage from the aquitard that is the confining beds then also the aquifer gets some amount of water. So, in this way if recharging is being done naturally artificially as well as indirect then definitely the aquifer will have the storage of water inside it.

In the other in the from the bottom side you see the economic effects and benefits are there, environmental benefits are there and the human benefits are there. Water from development of groundwater your abstraction agriculture industry. Then the water for environment, groundwater, your discharge groundwater discharge and the water for people groundwater supply drinking water and livelihood.

So, these whole concepts that is the economical environmental and human benefits puts the sustainable groundwater resources then only the groundwater will remain in a better way then only the resource management will remain in a better way, in any geological formations, if the whole cycle will operate continuously. So, these are the some of the key issues which should be we should kept in mind while thinking of the groundwater resource management.

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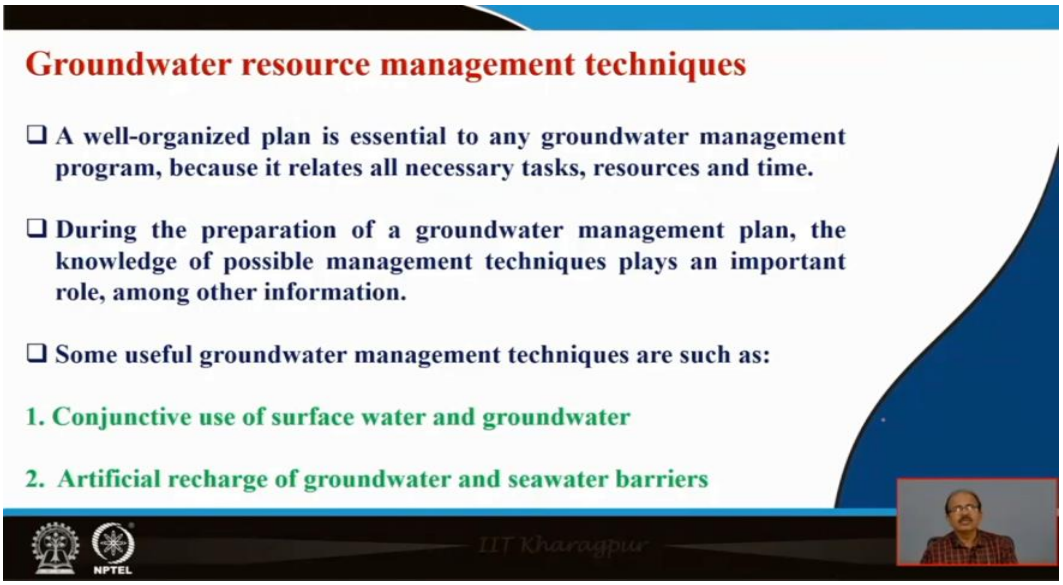

Now this technique; there are some technique also. So, groundwater resource management techniques are a well-organized plan is essential to any groundwater management program why because it relates all necessary tasks resources and time. During the preparation of groundwater management plan the knowledge of possible management techniques plays an important role. It plays a very important role possible management technique.

Because it is not necessary that; whatever technique you are going to apply for a certain place it this technique will be suitable for the different place also. So, it depends it varies from place to place, so management techniques also varies from place to place. So, some of the useful groundwater management techniques are like conjunctive use of surface water and groundwater. So, this is if we are using both water surface water that is the river water, stream water, pond lake water and groundwater.

And when it is conjunctive use will be there then definitely the groundwater management will be in a better way. Artificial recharge of groundwater and sea water barriers, so artificial recharge has become one of the important techniques for improving the recharge in an aquifer. So, this through this also the groundwater management can be done in a better way at any location.

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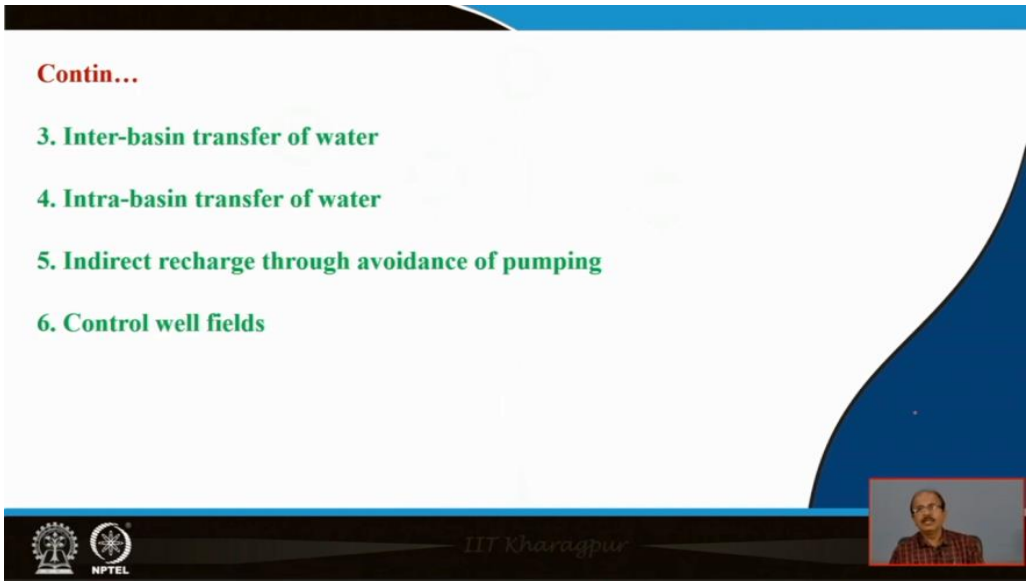

So, inter basin transfer of water this is also important because we have learned that watershed and we have learnt the different water in different water shed the different quantity of water remains underlying the earth's surface. So, when the inter basin transfer of water will take place then definitely if there will be shortage of water in one basin then it will can fulfil the water the water demand of the other basin.

Intra basin transfer of water is also very important technique through it also the groundwater resource management can be done. Indirect recharge through avoidance of pumping and sometimes we are pumping continuously for the exploitation of the groundwater resources. So, for this also if we will we can able to avoid the pumping definitely we are indirectly recharging the aquifer and some of the control well fills should be there.

So, in those very fields only we can just withdraw the water. So, these are some of the techniques through which we can just control it we can think for the groundwater resource management

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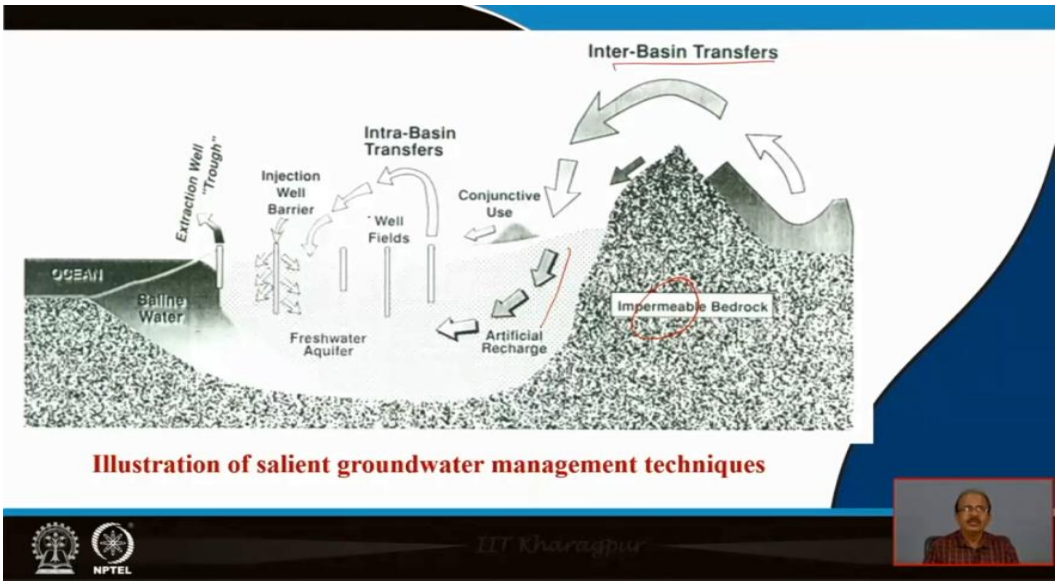

Here in this figure, we can see the illustration of some of the groundwater management techniques here given in a better way the impermeable bedrock is present here we are having the impermeable bedrock. So, this is in the area see here from here to here inter basin transfer is there one way this is one base in this another so one basin into another basin. Whereas in intra basin we can see the area is here but here we are just artificial recharge is taking place from this place the water is coming and recharging this area.

And then fresh water aquifer is already existing here and in it several well fields are also there injection well barrier are also here. So, here from here we can see that the extraction will ah trough is here so from the fresh water aquifer extraction wells are also through which the water are being just sent and out from this very basin. So, this figure tells us that groundwater management is also a important technique.

And if we will follow the techniques definitely, we can able to improve the groundwater recharge of any location.

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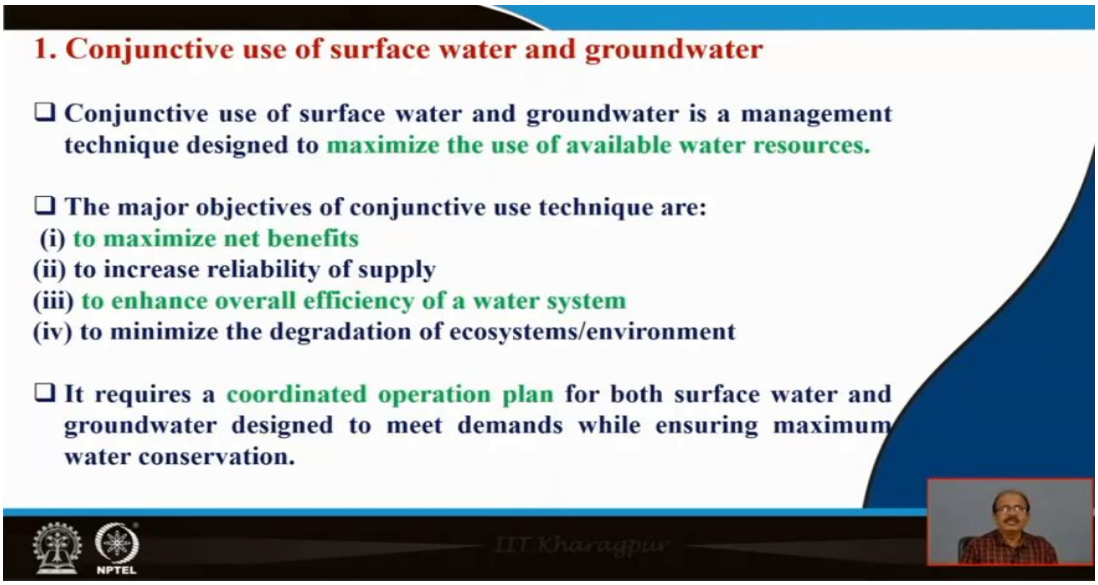

Now one by one we will discuss conjunctive use of surface water and groundwater. So, this is generally this technique is designed to maximize the use of available water resources in any basin. So, when we are thinking for the conjunctive use of surface water and groundwater, so this technique will help us to maximizing the use of available water resources in an area. The major objectives of this technique are to maximize net benefits in total benefits we can maximize it.

To increase reliability of supply, to enhance the overall efficiency of a water system and to minimize the degradation of ecosystems as well as environment. So, these are the few objectives of the conjunctive use of surface water and groundwater. It requires a coordinated action plan for both surface water and groundwater designed to meet the demands while ensuring maximum water conservation. This is the generally your views of the conjunctive use of surface water and groundwater.

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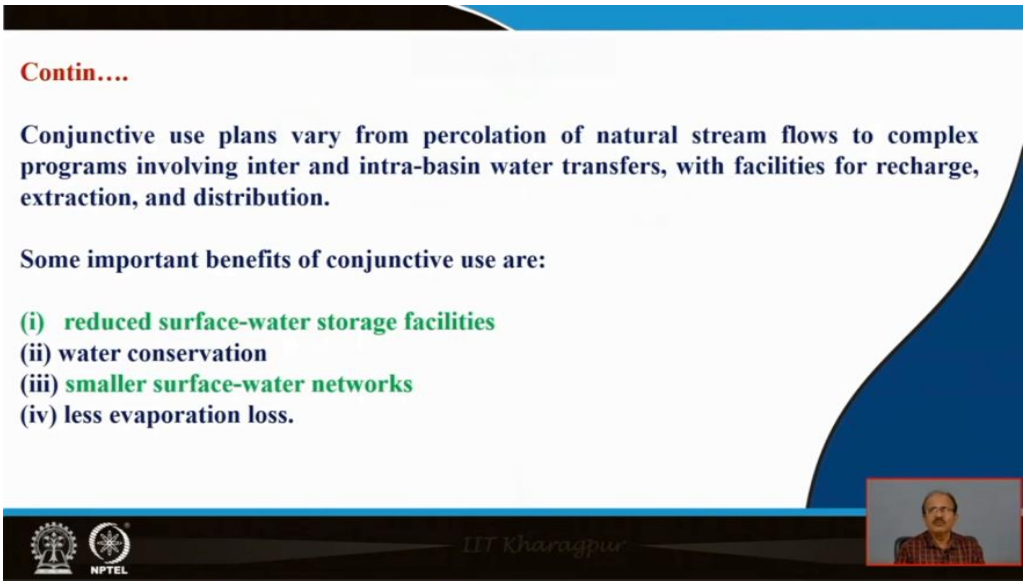

Apart from this conjunctive use also plans vary from percolation of natural stream flows to complex programs involving inter and intra basin water transfers what we have seen in the previous slide through a picture with facilities for recharge extraction and distribution. So, some important benefits of this conjunctive use that it is reduced surface waters to the facilities are there, water conservations, then the smaller surface water networks and less evaporation loss. So, this is the mainly the technique of the conjunctive use of surface water and groundwater.

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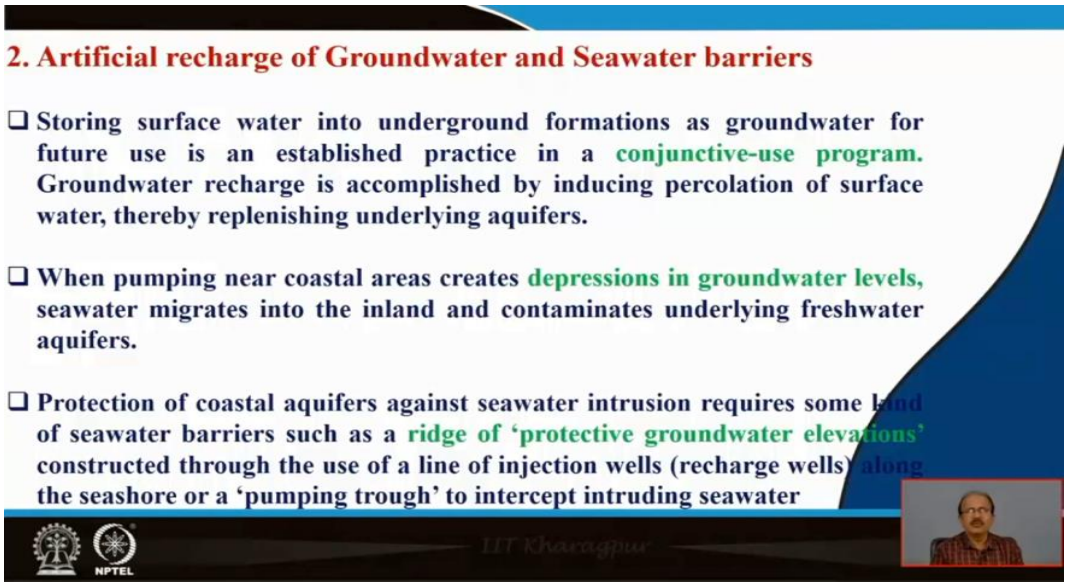

Now next it was the artificial recharge of groundwater and seawater barriers. Storing surface water into underground formations as groundwater for future use is an established practice in a conjunctive use program. So, just we are storing the surplus surface water into some any

underground formation as a groundwater for future uses. So, it is actually the basis of the conjunctive use program.

Groundwater recharge is accomplished by inducing percolation of surface water and thereby replace the groundwater recharge will be there then definitely it will replenish the underlying aquifers. When pumping near coastal areas creates depression in groundwater levels in the coastal area near to a coastal area when pumping will create depression in the groundwater level. Then what will happen sea water will migrate into the inland and it will contaminate the underlying fresh water aquifer.

This we have learned in the previous lectures also. So, near to the coastal areas if pumping will be well will be done then what will happen it will just depress the groundwater levels. And once the groundwater level will go down what will happen the sea water will migrate into the inland and ultimately contaminate the underlying fresh water aquifer or freshwater groundwater resources.

So, protection of coastal aquifers against sea water intrusion requires some of the sea water barriers such as ridge of protective groundwater elevation, constructed through the use of a line of injection wells that is recharge wells along the seashore or pumping trough to intercept intruding sea water. So, this is important for the artificial recharge of the groundwater and sea water barriers.

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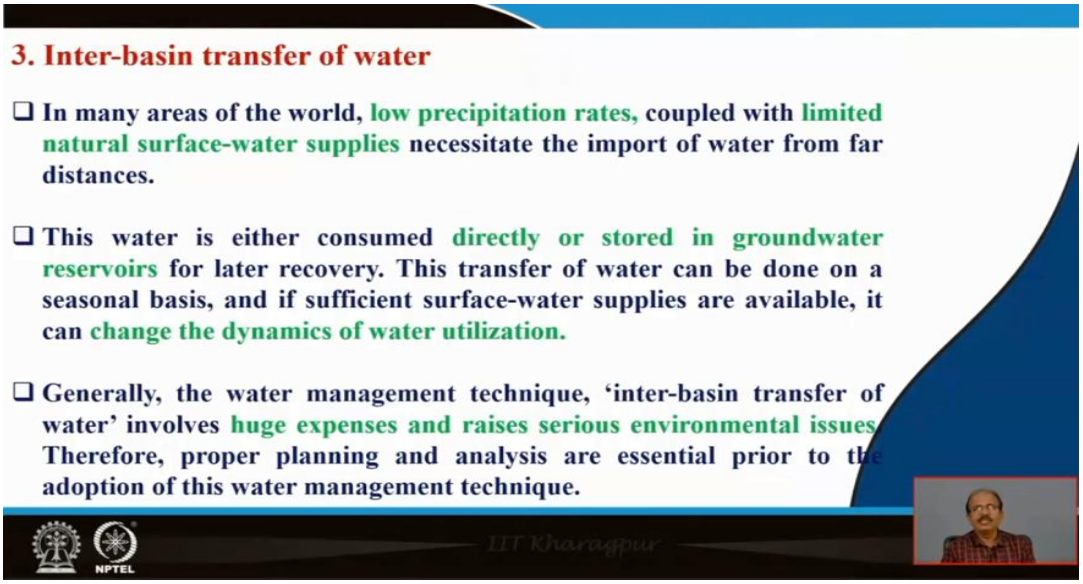

Now inter basin transfer of water in many of areas of the world low precipitation rates coupled with limited natural surface water supplies necessitate the import of water from far distances. So, the areas which is receiving low precipitation and also the surface water supply is minimum limited then what will happen for the sake of the utilization of the water resources the areas of the world are importing the water from some distant places.

This water is either consumed directly or stored in some groundwater reservoirs for later recovery. Either it will consume directly or it can be stored in some reservoirs made there in groundwater a reservoir. This transfer of water can be done on seasonal basis so this is done on seasonal basis. And if sufficient surface water supplies are available it can change the dynamics of the water utilization also.

So, this should be kept in the mine while thinking for the inter basin transfer of water because our aim is to have the groundwater resource management. So, for management of the ground water resource this concept can also be taken, in those very areas where the low precipitation rate exists and limited natural ground surface water supplies also. So, in those areas the inter basin transfer of water is a very good techniques through which we can just improve the groundwater resources.

Generally, the water management technique inter basin in transfer of water involves huge expenses and rated serious environmental issues also. Therefore, proper planning and analysis are essential prior to the adoption of this technique that is the inter basin transfer of water technique for the water management. So, this is a good concept for the water resource.

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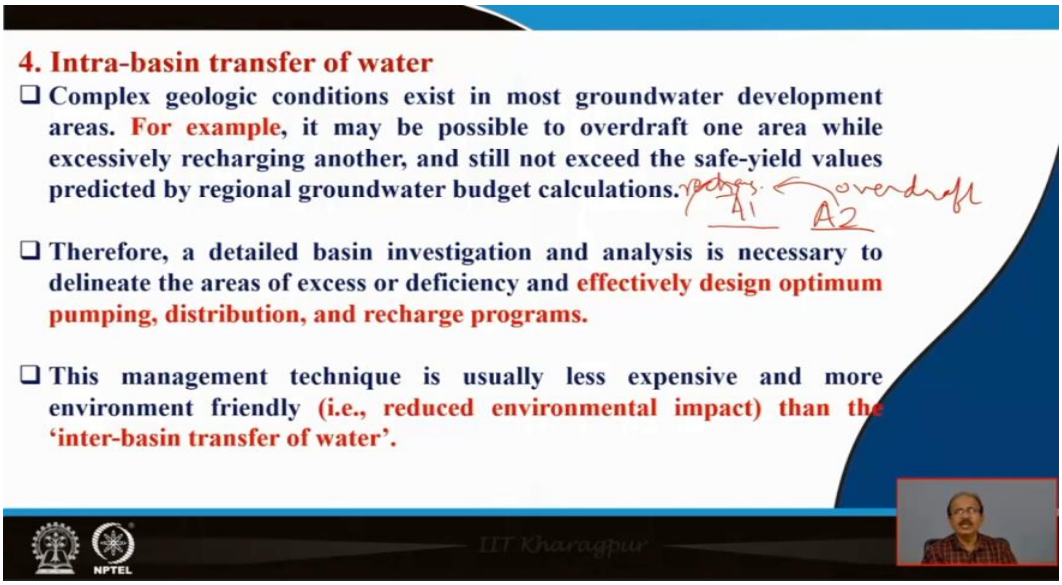

We have discussed about the inter basin transfer of water which were the costlier one also affecting the environment but this with respect to the inter basin transfer intra basin transfer of water technique for the groundwater resource management is a little bit lesser expensive and also more environmentally friendly. So, in general what is happening the ground the aquifer remains in some formation that is in rocks.

So, the geological conditions generally it exists in a complex manner not a simple manner. The geological conditions remain complex in most of the groundwater development sides, it remains complex because several rocks are there in some rocks the porosities if the porosity will be there definitely it will be able to store the water. So, in this technique the point is that it may be possible to overdraft one area just if the two areas are there.

So, in this is the area 1 and this is the area 2, so just one area you just overdraft it. So, one area is over drafted and the one drafted one area. While the other area is just the recharging here the recharging is taking place. So, from one area we are exploiting the water and other area we are just sending the water to the your geological conditions. So, what will happen we will in it may be possible to overdraft one area while excessively recharging another.

And still not exceed the safe yield values because that is very important safe yield value should not be exceeded which is the predicted by the regional groundwater budget calculations. Safe yield

can be protected by the original groundwater budget calculation. So, this point should be kept in mind while thinking for the intra basin transfer of water technique for the management of the water resources in any complex geological conditions in general it happens.

Because groundwater stores in the; aquifer and aquifers are the rocky formations and the rocky formations are having the geological having some geological setup inside the earth surface. So, this thing should remain in the mind. Now a detailed basin investigation is also important detailed basin investigation is very important not only basic investigation with its analysis also it is necessary to delineate the areas of excess or deficiency.

And then effectively design the optimum pumping pattern in the area distribution and recharge programs of the area. So, this can be done only when there will be a detailed investigation of the basis the detailed analysis of the basin for delineating the areas of excess or deficiency. So, this inter basin transfer of water technique is important technique through which we can think for we can go for the ground water resource development.

This management technique is as I have told you that less expensive and also more environment friendly. Because the radio used the low level environmental impact is there then if you will compare it with the inter basin transfer of water. So, these things would be followed. The point is that in this type of technique there it is a less expensive technique and having the more environmentally friendly technique also.

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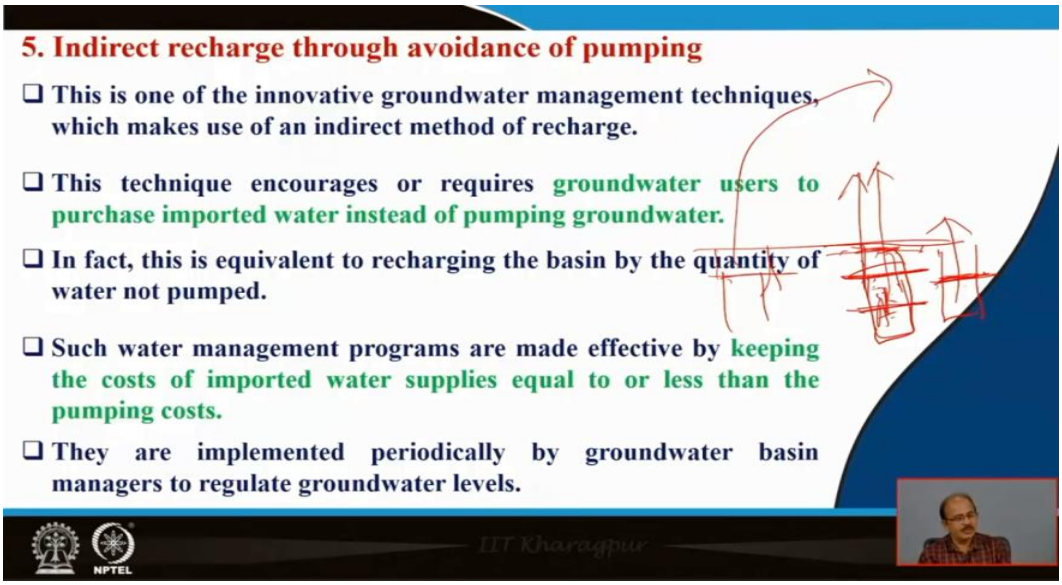

Now the next is the indirect recharge through avoidance of pumping. See what is happening in the earth's surface just what we are doing is suppose this is the earth surface and we have just beneath it is an aquifer this is an aquifer and this is the water level or this is the water level, so this is the water level of this aquifer. So, what is happening suppose if we will pump the water out then what will happen the water level will decline it will decline.

So, here for in the case of the groundwater resource management the indirect recharge technique through avoidance of pumping is also a very important technique through which the resource can be managed the ground water resource can be managed. So, this is one of the innovative groundwater management techniques which make use of an indirect method of recharge this is not the direct method of recharge this is only the indirect method of recharge.

And in this technique, it encourages or requires groundwater users to purchase imported water just to take the water from some other areas instead of pumping the groundwater from your own areas. So, this is the concept behind this indirect recharge through avoidance of pumping. Whatever use you are having just import the water from some surplus water areas and avoid the pumping because through pumping also we are just extracting the water.

So, this pumping should be controlled this should be avoided. And if we are avoiding the pumping in another way, we are just keeping the storage of the water as usual. So, that amount of

groundwater remains as usual within the geological conditions. So, purpose just to import the groundwater from some other places and avoid the pumping in its own place. So, in fact this is equivalent to recharging the basin by the quantity of water not pumped.

So, another way what we are doing we are doing just recharging this area. Suppose in this area this is an aquifer and in this aquifer the ground water level water is there stored water is there and this aquifer the stored water is there, so level of the water is here. If we will avoid just, we will take water from some different places suppose from different places we are taking water for just importing water and we are avoiding to take water from in this aquifer.

So, the level will remain as usual so in another way what we are doing we are recharging the basin just we are realizing the basin by the quantity of water not pumped out, just remaining as usual. So, this technique is also this although it is an indirect technique indirect recharge and in it we are just avoiding the pumping because by doing pumping only we are just extracting the water we are just taking out the groundwater resource outside.

So, such water management programs are made effective by keeping the cost of the imported water supply, this is also a matter to think, what is the cost of the imported water supply because it should be equal to or less than the pumping cost. So, they are implemented periodically you just have your track on this by groundwater basin managers good managers who is just implementing such type of technique to regulate the groundwater levels in the area.

So, that the resource can be managed properly in the area. So, this is another technique through which the recharge and the groundwater resource management can be done.

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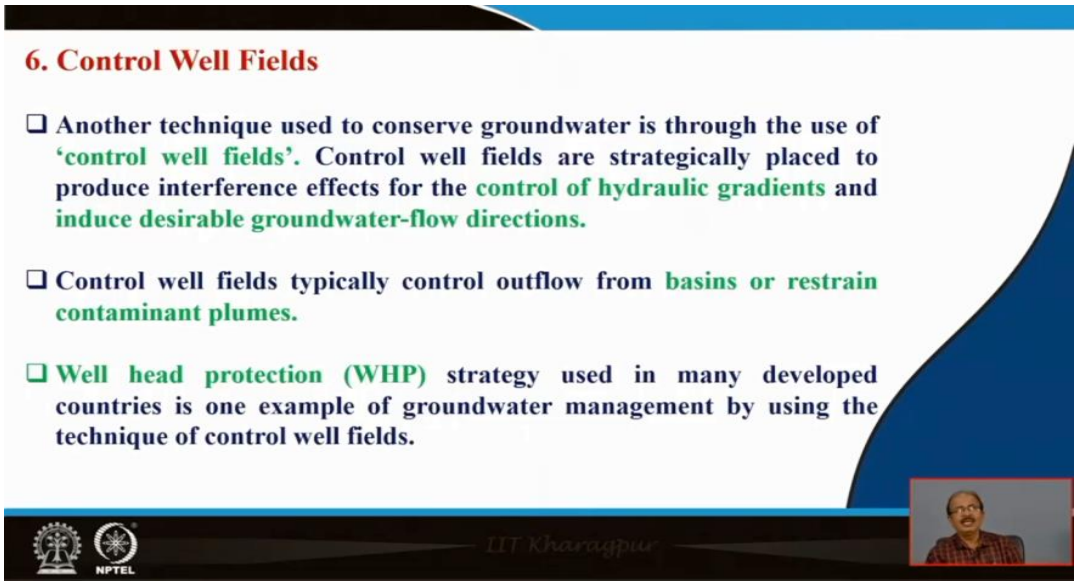

And then the control well fields this is also one of the techniques which is used to conserve groundwater through the use of control well fields, this is another technique. The control well fields are strategically placed to produce interference effects for the control of hydraulic gradients because hydraulic gradient is important factor for the extraction of groundwater resources also or for the availability of the ground resources hydraulic gradient is one of the important factors.

So, the control well field should be placed strategically to produce some disturbance the interference effects for the control of hydraulic gradients and induce just induce desirable groundwater flow direction. So, through this why the establishment of control will fill the control of hydraulic gradient can also be maintained and to induce the desirable groundwater flow direction.

Control well fields typically control outflow it typically controls outflow from basins or restrain the contaminant plumes just restraining the contaminant plumes. So, well head protection strategy used in many developed countries is one of the good examples of groundwater management by using the con technique of the control well fields. So, this technique well head protection because see the control well fields can be developed strategically at different place.

Why? To produce the interference effects, for what, for the control of hydraulic gradients and induce the desirable inducing the desirable groundwater flow directions in the area. Through it the

groundwater resource management can be done in a better way. Besides other techniques this is also one of the techniques through which it can be done in a better way. So, with this; thank you very much to all.