Availability and Management of Groundwater Resources

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Lecture - 46
Groundwater Resources Planning and Management (Continued)

Welcome you all in the part two of the module 10 groundwater resource planning and management. So, we have discussed in part two about the key challenges and the goals which is required for the resource planning and management with respect to groundwater resources.

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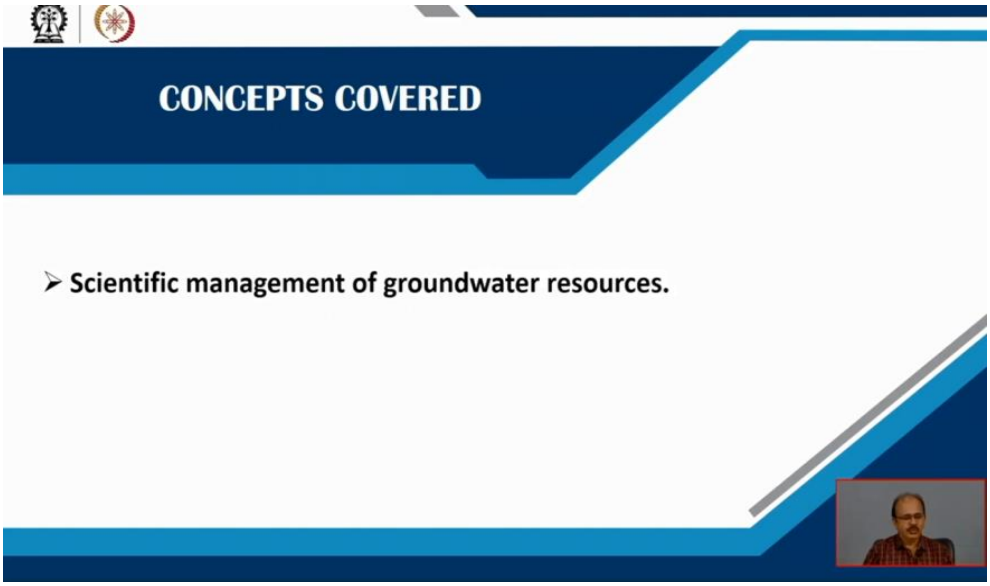

So, here in this part we will discuss about the scientific management of the groundwater resources.

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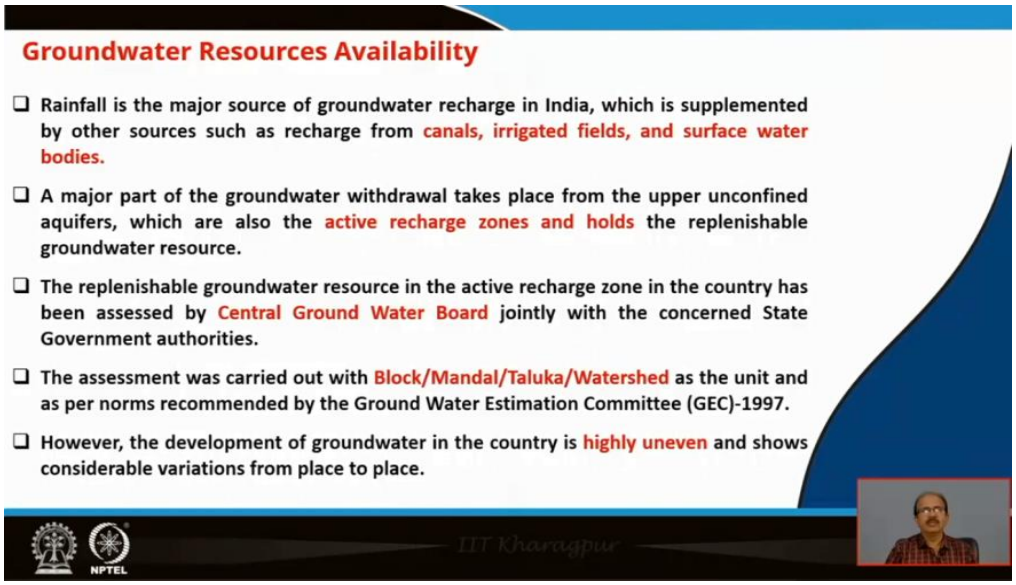

So, what we have seen that the resource availability is groundwater resource availability especially is really because of the rainfall because rainfall is the major source of groundwater recharge in India which is supplemented by some of the other resources also that is recharged from the canals initial recharge from the irrigated fields or recharge from some surface water bodies say lakes ponds rivers etcetera.

So, the rainfall is the major source of groundwater recharge in India. A major part of the groundwater withdrawal takes place from the upper unconfined aquifers. We have discussed this thing in the previous lectures that generally groundwater withdrawal is taking place from the shallow aquifer that is the upper unconfined aquifers which are also the active recharge zone and holds the replenishable groundwater resources.

This creates the zone of your recharge also of the groundwater resource. So, this is the major part which should be discussed while the groundwater resource planning and management concept is coming. The replenishable groundwater resource in the active recharge zone in the country has been assessed or evaluated by the central groundwater board jointly with the state groundwater board and the different government authorities.

These recharge zone has been delineated active recharge zone in the country has been delineated by the central groundwater board or the state level and ground government authorities. The

assessment was carried out with the block, mandal, taluka, watershed wise either block wise then mandal wise then taluka wise or watershed wise as the unit. These are the units of the assessment of the replenishable groundwater resource.

So, we according to the norms recommended by the groundwater estimation committee that is GEC 1997. So, as per the norms which has been laid down in the groundwater estimation committee. So, this assessment is generally been done with the government and CGWBN and state government authorities in block level, mandal level, taluka level and watershed level and then these recharge zones as we are being delineated.

However, the development of groundwater in the country is highly uneven and shows considerable variation from place to place. As we have discussed in the previous lectures that groundwater development in the country is not even it is highly uneven somewhere the groundwater development remains in the safe category somewhere in critical semi-critical or overexploited.

So, in all the four different categories generally the development of groundwater remains in our country. So, for this we need to have some resource planning and management for the these resources.

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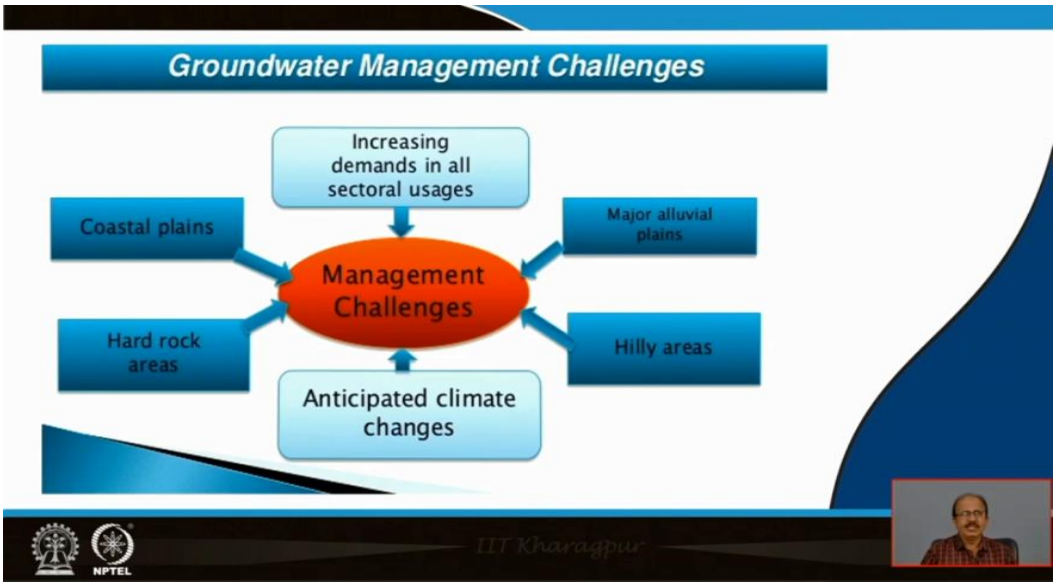

See groundwater management challenges if you will see the challenges some points are already mentioned here you can see that management should be with respect to the increasing demands in all sectoral uses. So, in all sector, we have to finalize the demand first and accordingly the management issue or the challenges will be there. Next for major alluvial planes so, we have read already that groundwater resource availability is will remain different in different geological your resources different geological formations.

So, in major alluvial plants the management will be something different then the coastal plains or the hard rock areas or the hilly areas. So, in all these areas see in plain areas, in alluvial plane areas, in hilly areas, in hard rock areas the availability of the groundwater resource will remain different. So, if the availability of the groundwater resource will remain different then definitely the management issues will also be different at different places.

So, in this for this management challenges the one important point is to know about the increasing demands in all the sector. So, this is and also to anticipate the climate change issues also just to anticipate also, then only the groundwater management challenges can be in a good way. So, the groundwater management challenge is encompasses all the areas that is the plane areas especially the alluvial plane areas then the hilly areas.

The coastal areas the groundwater availability will be different the replenishment of the groundwater resources will also remain different and in the hard rock tyrant also we have read. That in the hard rock tyrant generally the groundwater stores within the fractures or lineaments or some your weaker sections of the hard rock. So, in this way the availability will vary in the different types of the geological formations.

And accordingly, the effects will also vary the replenishment will also will vary at the different locations. So, accordingly this management challenges is we should find out and then we should proceed for the resource planning and management.

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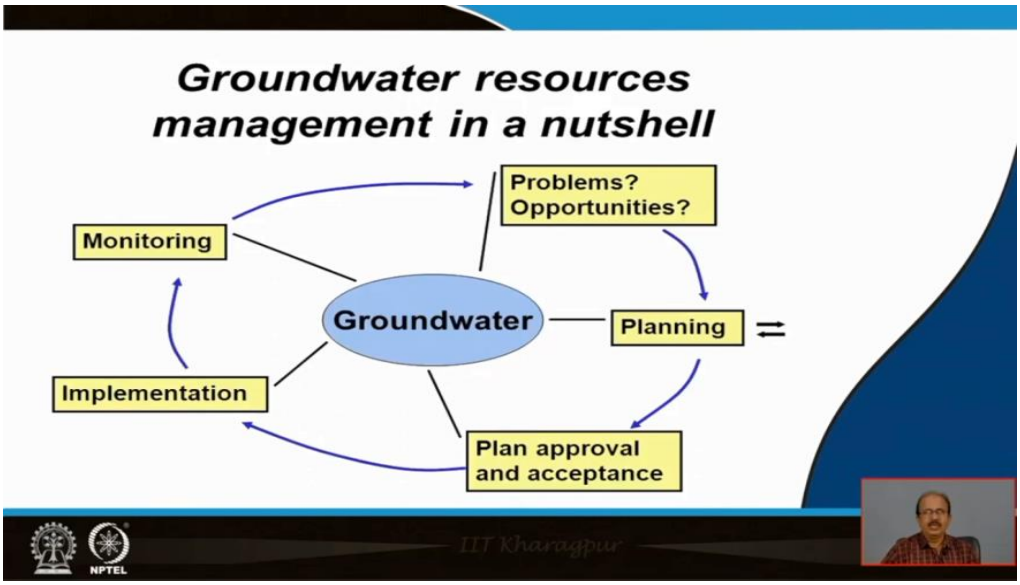

See this groundwater resources management in a very simple way that groundwater is availability in groundwater availability we know that it remains in certain formations underlying the earth's surface. So, it may remains at the shallower depth, it may remain at the deeper depth, so what is happening that first of all we should see the monitor we should monitor the groundwater availability in the location.

And there we should find out the problems what are the problems; what are the opportunities. So, whether the groundwater status is good or not once we came to know about this thing that the groundwater scarcity problem is there or groundwater is in abundance, then we should plan accordingly for its management. These plants should get approval as well as acceptance. Once these plants will get approval and acceptance then it will be implemented.

And once it will be implemented again, we will monitor the groundwater ability in a continuous manner in a systematic manner. And then if this whole process will remain in a better way definitely the groundwater resource will be remain in plenty at any locations. But the point is that this resource management needs all the various points that are the monitoring of the groundwater problems and opportunities therein.

Then the planning, once planning is done then the plan approval and acceptance once the plan approved and accepted then the implementation and then accordingly the continuous monitoring. So, this shows the groundwater resource management in a brief way.

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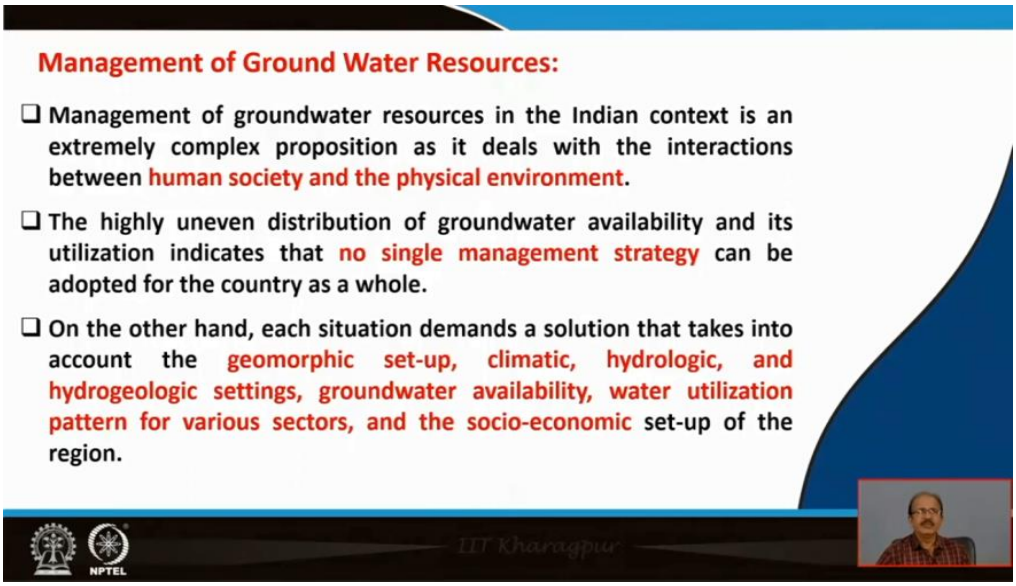

Management of groundwater resources in Indian context is an extremely complex proposition. Why? Because it deals with the interaction between the human society and the physical environment. Human society actually accepts the groundwater resources in various forms and the physical environment tells us about the availability of this very important resource. The highly uneven distribution of groundwater availability and its utilization indicates that no single management strategy can be adopted for the entire country.

Never, not a single policy not a single issue management strategy will can be followed for the entire country, why? Because the availability of the groundwater resource will remain different in different locations at different locations why because groundwater remains within the geological formations and there is a variation of geological formation in the entire country. So, the distribution will remain uneven.

And if the distribution will remain uneven definitely its usual utilization is also remain in uneven. And both will remain uneven then what will happen it is just indicating that not a single management strategy will be can be followed for the solving the problem of the scarcity of the

groundwater resources. So, on the other hand each situation this total situation demands a solution that takes into the account of the geomorphic setup.

So, what are the different types of the geometric setup in the different locations climatic, hydrologic and hydrogeologic settings. These are also very important because climate varies from place to place, hydrogeological settings also varies from place to place somewhere we are getting the confined aquifer, somewhere we are getting the unconfined aquifer, somewhere we are not having the your groundwater resources.

Somewhere we are having the plenty of groundwater resources, somewhere we are getting the groundwater availability, some water utilization pattern of various sectors differs from place to place and the socioeconomic setup of the region also varies from place to place. So, in such type of flexible or variable situation the availability of the groundwater resources. The management of the groundwater resources remains different, not a single management strategy will work for the management of the groundwater resources in the entire country.

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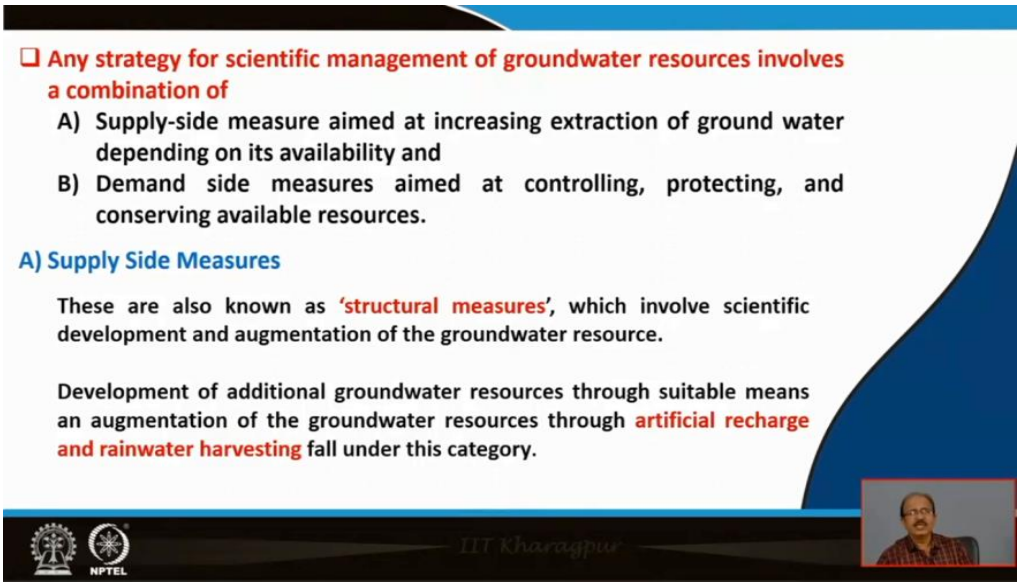

Next is the any strategy for scientific management of groundwater resources generally involves a combination of two measures one is the supply side measures and other is the demand side measures. So, for this supply side measure aimed at increasing extraction of groundwater

depending on its availability. So, how much water is being extracted as per the availability of the groundwater resources.

Whereas the demand side measures aimed at controlling protecting and conserving the available groundwater resources. This is the two different measures or you can see the strategy for scientific management of groundwater resources, supply side measure and the demand side measures. Supply side measures are also known as the structural measures these are also known as the structural measures which involve scientific development and augmentation of the groundwater resources.

So, this is just structural measures involving the scientific development as well as the augmentation of the groundwater resource. Development of additional groundwater resources through suitable means and augmentation of the groundwater resources through artificial recharge and rainwater harvesting fall under this category. So, the artificial recharge means recharging an area artificially and the rain water harvesting generally rainwater is being preserved at certain locations fall under the category of the supply side measures.

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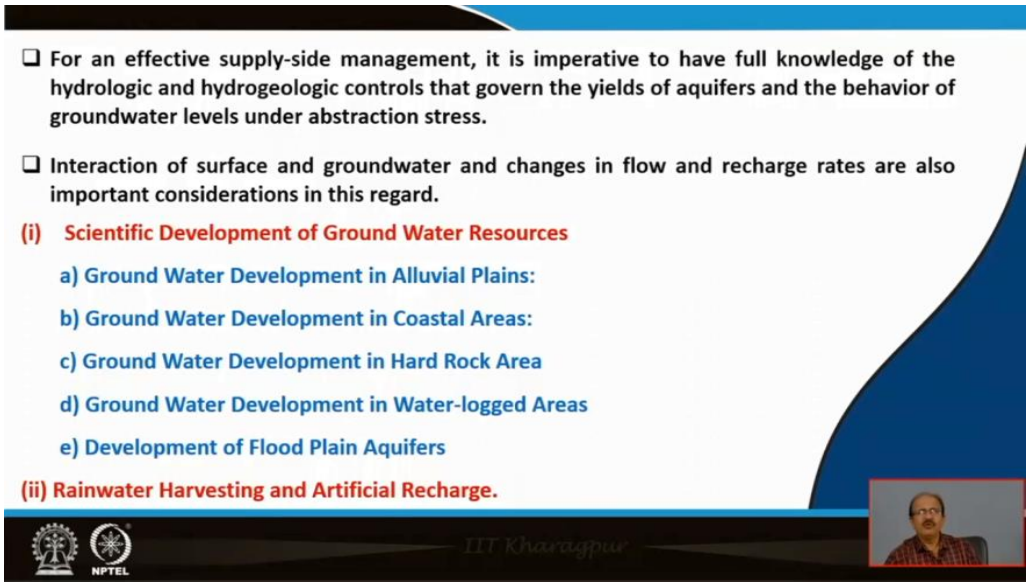

For an effective supply side management, it is important to have full knowledge of the hydrologic and hydrologic controls which governs the yield of aquifers and the behaviour of groundwater levels under abstraction stress. So, once the groundwater will be expected definitely the level of

the groundwater will varies differently at different places. So, this is important to have full knowledge of these hydrologic controls.

Interaction of surface and groundwater and changes in flow and recharge rates are also important consideration in this regard. So, once the groundwater will be extracted definitely there will be change in the your level of the groundwater the your because of the interaction of surface water and groundwater resources what will happen there will be change in the flow and recharge rates. So, this is also one of the important consideration important considerations.

Now some of the scientific development of groundwater resources or groundwater development in alluvial planes as we have discussed earlier. Groundwater development in coastal areas, groundwater development in hard rock areas, groundwater development in water logged areas and groundwater development of flood plain aquifers, so, for different areas the different policy will be should be there different types of management criteria's will be there.

Rainwater harvesting and artificial recharge is also one of the important issues for the groundwater resource planning and management.

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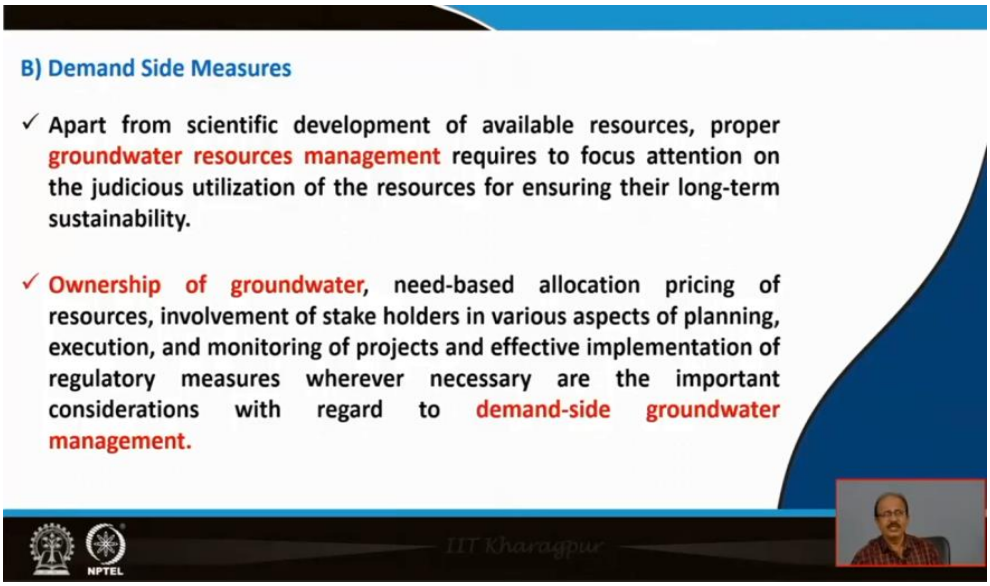

Now that supply side, we have discussed what are the demand side apart from scientific development of available resources. Proper groundwater resource management requires to focus

attention on the judicious utilization of the resources for ensuring their long-term sustainability. So, for availability of the groundwater resource for a longer duration or in other way you can see that the next generation also requires the groundwater resource.

So, any sort of scientific development for this resource the proper management ground water resource management requires to focus the attention on the judicious utilization of this resource for ensuring its long-term sustainability. Ownership of groundwater need based allocation pricing of resources involvement of stakeholders in various aspects of planning, execution and monitoring of projects.

And effective implementations of regulatory measures wherever necessary are the important consideration with regard to demand side groundwater management. So, for the demand side groundwater management, the ownership of groundwater need based allocation pricing of resources. So, this is very important in terms of your groundwater which is required for the industrial uses.

Involvement of stakeholders in various aspects of planning and execution, monitoring of projects and effective implementation of the regulatory measures wherever necessary are some of the important consideration with regard to demand side groundwater resource management.

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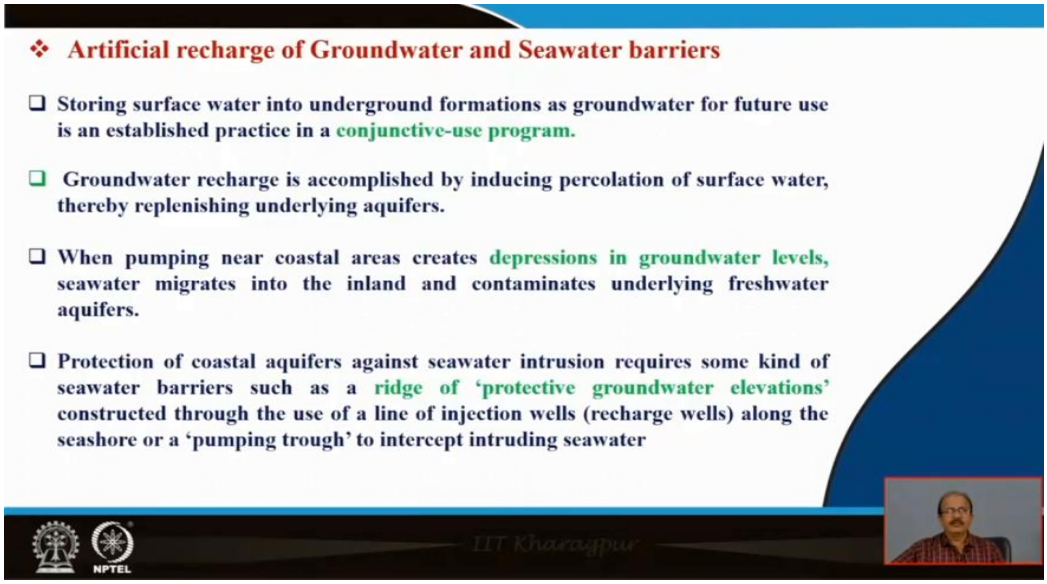

Now the artificial recharge of groundwater and sea water barriers these are very very important issues with respect to the water resource planning and management. A storing surface water because we are having two types of water important types of water one is the surface water other is the underground water. So, storing surface water into underground formation as groundwater for future use is an established practice in a conjunctive use program.

So, because of the scarcity of the groundwater resources nowadays we are we have seen that the storage of the surface water resources into any underground formation. Underground formation means what the geological formation and then as groundwater for future use is a very established practice. Groundwater recharge is accomplished by inducing percolation of surface water. See percolation if infiltration and population takes place then only the water will reach to the aquifer.

And then only the water groundwater will be recharged because your groundwater precipitated water or surface water will first infiltrate and percolate and moves towards the aquifer, then only the aquifer will be recharged. So, the groundwater recharges generally accomplished by percolation of surface water thereby replenishment of the underlying aquifers take place. Generally, when pumping near coastal areas are being done or when pumping near coastal area creates generally depressions in groundwater levels.

Then what will happen? Once the depression in groundwater levels will be there then the sea water will migrate into the inland and contaminates the underlying fresh water aquifers. So, this is very important point if any sort of pumping are being done near the coastal areas it is just lowering the groundwater levels in the area. Once the gravity level will lower then what will happen sea water will migrate into the inland. And if then it contaminates the underlying fresh water aquifer.

So, pumping is also a very your effective method or very your tough method near the coastal areas. Protection of coastal aquifer against the sea water intrusion because coastal areas are having also the coastal aquifers. So, protection of these coastal aquifers against the sea water intrusion it requires some kind of seawater barriers such as ridge of protective groundwater elevation constructed through the use of a line of injection wells recharge wells along the seashore or a pumping trough to intercept intruding sea water.

So, this is very important because the coastal areas are also having the coastal aquifers just in the coastal aquifers. So, this protection required in the coastal aquifers also against the sea water intrusion because we have seen that once the pumping are is done what is happening in the depression in groundwater levels takes place and as the groundwater levels will go down the sea water will migrate and makes the water fresh groundwater or fresh water aquifer contaminated.

So, this there should be production of coastal aquifer against sea water intrusion by some sort of sea water barriers. Generally, a ridge of protective groundwater elevation which is constructed through the use of a line of injection wells that is the recharge wells along the seashore or a pumping tub to intercept the intruding sea water. So, these are few issues for the through which we can plan for the resource management that is the groundwater resource management.

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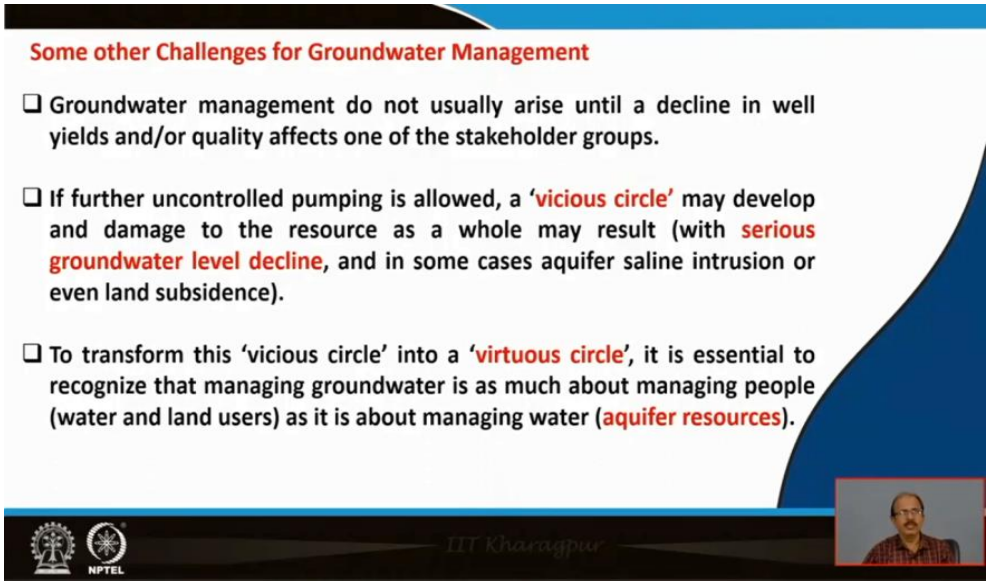

So, after seeing supply side and demand side measures for the groundwater resource management. Now some other challenges are also there for the resource management especially the groundwater resource management because groundwater management do not usually arise until a decline in well yields and quality affects for some stakeholder groups. So, if further uncontrolled pumping is allowed suppose pumping is continuously being done so it has become uncontrolled pumping.

Then a vicious circle is developing and damaging the groundwater resource as a whole and this will result very serious groundwater level decline and, in some cases, even aquifer saline intrusion or even land subsidence takes place. So, for because of the uncontrolled pumping a vicious circle is developing and damage the resource ultimately damaged the groundwater resource ultimately.

And this happens why because the serious groundwater level decline takes place. And because of the groundwater level decline what is the ultimate problem, problem is that aquifer in the aquifer the salinity will come through the intrusion of the sea water or even the land subsidence takes place. To transform this vicious circle just to transform this vicious circle into a virtuous circle it is essential to recognize that managing groundwater is as much about managing people water and land users.

Because people are using the water, they are using the line and it is about managing water that is the aquifer. So, in the when the vicious circle is developing because of the groundwater level decline due to some serious concern because of the level decline in an area the because of the uncontrolled pumping then what has happened with management we can just transform this vicious circle with the help of certain regulations certain activities into a virtuous circle.

So, this vicious circle and virtuous virtual circle in the groundwater resource management is a very important steps for controlling the groundwater resource management for restoring the groundwater resource management, for proper management of groundwater resource the vicious circle should be transformed into the virtuous circle.

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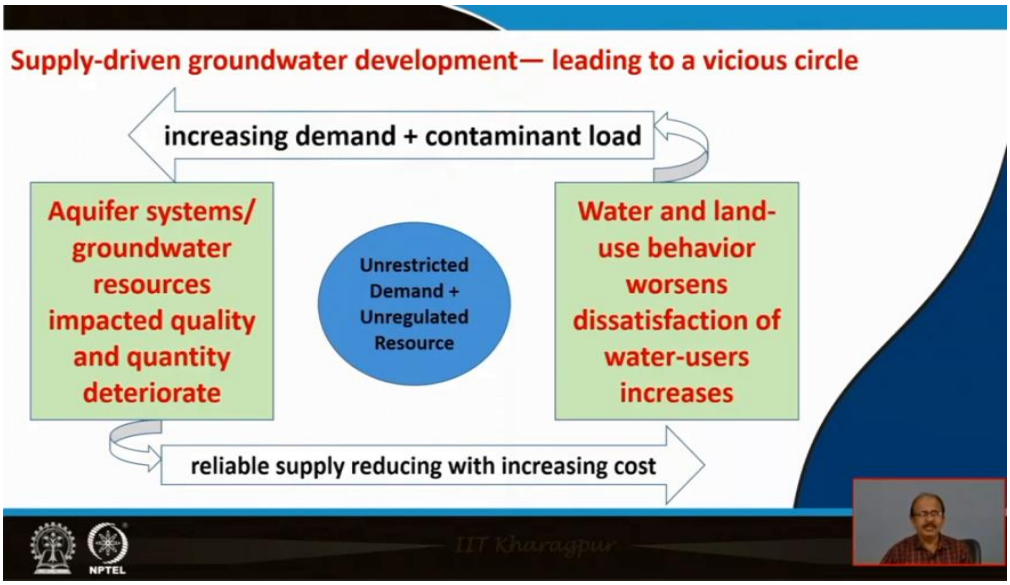

Now we can understand in why this diagram also; see here unrestricted demand plus unregulated source are available the groundwater resource which is available inside the aquifer. The demand is unrestricted and the resource is also unregulated. So, if the increasing demand will take place or the contaminant load will be increased, what will happen the aquifer systems that are the ground geological formations the groundwater resources which is just lying within it.

Impacted quantity as well as quality and therefore, there will be the deterioration in the quality and quantity of the groundwater resources within the aquifer systems. So, this will take place because of the increasing demand and because of the increase of the contaminants within the resource. Just in the previous slide we have discussed because of the uncontrolled pumping regularly pumping is being done then what will happen the groundwater level will decline.

Once it will decline there will be chances of the seawater intrusion or salinity in increase of salinity as well as the land subsidence. So, for this then what will happen if one aquifer systems will disturb groundwater resources will have a impact on its quality and quantity its deterioration will take place, then what will happen the supply will be reducing supply will take place with increasing cost, so cost will increase.

Now the water and land use behaviour worsens because this will take place then what will happen the water and land use behaviour will worsen and dissatisfaction of the water users increases

because of the supply reduced supply with increase of cost. So, you can see this if this will worsen why it is worsening because of the increasing demand and contaminant load the aquifer systems are poorly you are getting impact on its quality as well as on its quantity.

So, this is the example of a vicious circle the supply driven groundwater development side. Now the virtuous circle we will see.

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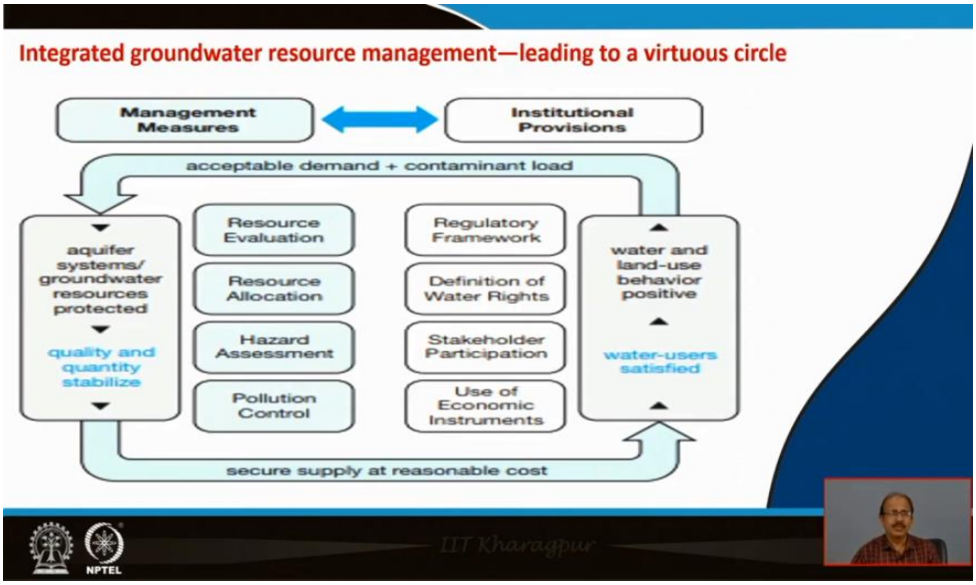

Virtuous circles will be along with the integrated groundwater resource management aspects. So, this circle virtuous circle because we have to transform the we should have some steps some your path for just transforming the vicious circle to virtuous circle for the groundwater resource management. So, in this virtuous circle we can see here there are the management measures as well as the institutional provisions.

So, if the acceptable demand plus contaminant load will be there then what will happen the aquifer system groundwater resources will be protected quantity and quality stabilize that will stabilize. So, then why because see we here we should think over the resource evaluation. We should evaluate the resource how much resource is available at a particular side then it resource allocation, allocation of the resource, hazard assessment, pollution control.

So, these are the some of the management measures which should be accepted for the groundwater resource management integrated groundwater resource management whereas the institutional provisions you can see the regulatory framework should be there. Definition of water rights would be made then will be should be clear stakeholder participation should be clear use of economic instrument should be in the criteria.

So, in this way on one side we are seeing the acceptable demand with contaminant load whereas second side we are seeing the secure supply at reasonable cost, since the uncontrolled pumping is being done so the geological formations that is the aquifer that will the level of the water will decline in that very aquifer. So, it needs some management aspects, it needs to have a virtuous cycle in this and in this way the vicious circle will just transform into the virtuous circle.

So, here with the management measures and the institutional provisions this can be done and for the groundwater resource management rather we can say the integrated groundwater resource management. So, these are some of the criteria for the management of the groundwater resource in any area and with this we can just protect our valuable resource for the present generation as well as for the future generation. So, with this; thank you very much to all.