Rural Water Resources Management
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Week 09 - Lecture 05
Comparing Rural water infrastructures

Hello everyone, welcome to NPTEL course on Rural Water Resource Management, this is week 9, lecture 5. In this week's lecture, we have been looking at methods for engineered use of structures to manage water resources, we looked at surface water body structures and groundwater structures. And in the last lecture, which is lecture 4, we looked at methods that can help for groundwater recharge and we mentioned that it is not just groundwater recharge; you will be capturing surface water and then putting it into the ground.

So, there is some surface water hydrology happening and there is some surface water management activities along with that there is groundwater, all of these methods that I discussed have an engineering component which means, either you have to construct something channelize something or capture and recharge using techniques. By capturing part is where engineering would be used by rooftop or say or channelizing water into a particular ditch for groundwater recharge.

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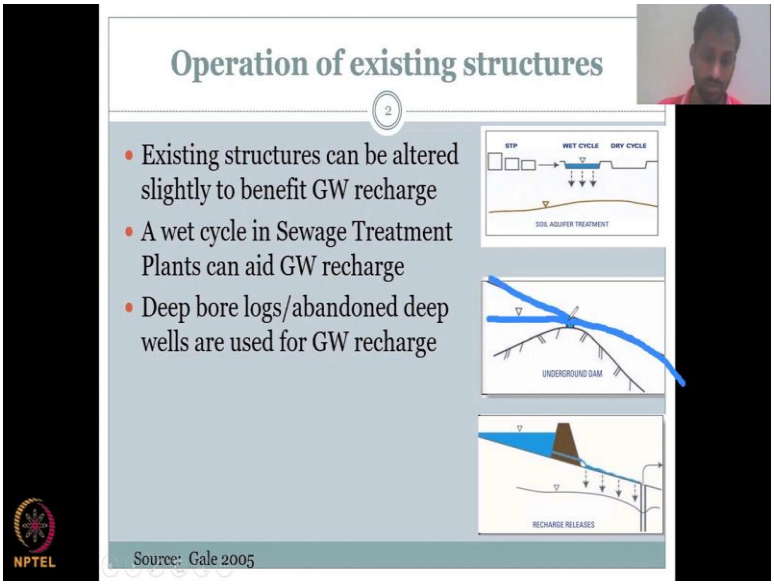
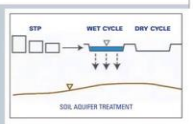
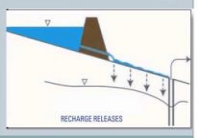


Operation of existing structures

2

- Existing structures can be altered slightly to benefit GW recharge
- A wet cycle in Sewage Treatment Plants can aid GW recharge
- Deep bore logs/abandoned deep wells are used for GW recharge





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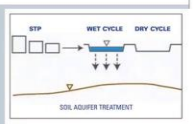

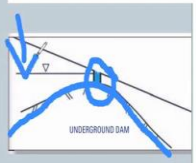

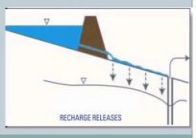

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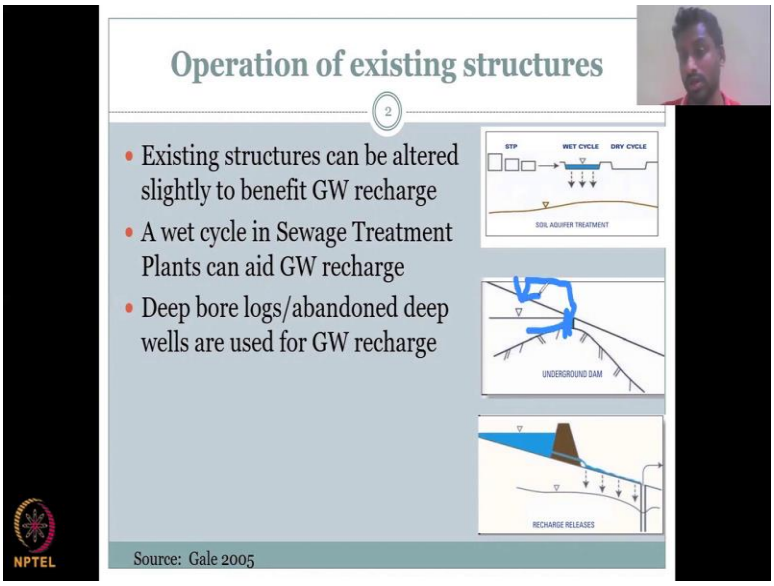

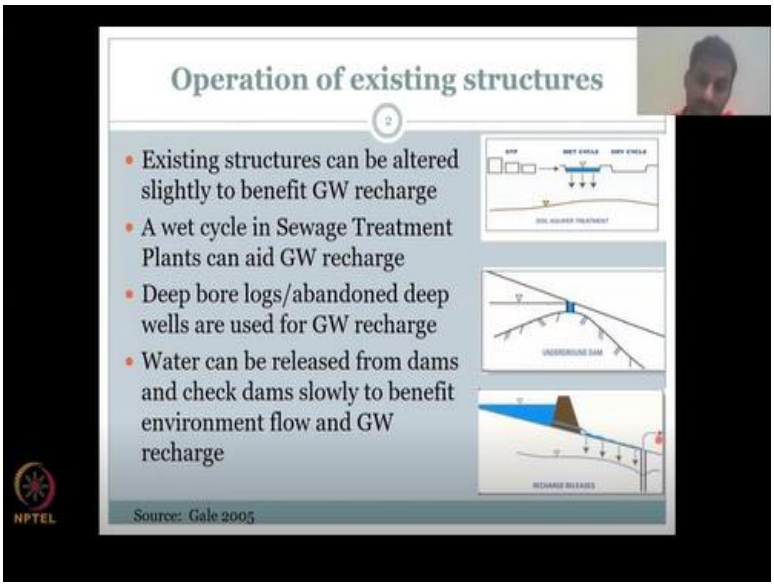

Let us kind of start with today's lecture on operations of existing structures. So, these are structures which are already there. And within that, along with that, you could add some more techniques to augment water resources especially groundwater resources in rural areas. The first one is your soil aquifer treatment which is achieved by using an existing structure slightly altered to benefit groundwater recharge. A wet cycle in sewage treatment plants can aid groundwater recharge, so, you know that in sewage treatment plant sewage is collected and then multiple treatment is done.

And one of that is a wet and dry cycle where in the wet you put sewage into the open surface very spread areas and let it evaporate, dry cycle is what you do with the evaporate or remaining

behind, but the wet the water part, some of it can recharge into the groundwater and your soil acts as the treatment material here or the filter material.

Wherein the space this space between the structure and the aquifer acts like a filtrate where it filters all the bad things and just the water goes in. this is what nature has been doing forever. You could see that the groundwater is at a better quality compared to the surface water pollutants because your soil particles act as a filtrate by taking off or holding on to the pollutants and just the water comes down.

Then we also have deep bore logs or abandoned deep wells which can be used as groundwater recharge mechanisms. Let us take an example you have a village and in the village there is a rural dug well, the dug well is not working anymore, which means there is no water that is coming in the tub well. So, what can you do? You could channelize the runoff into the dug well thereby the dug well now acts like a tank by storing the surface runoff into the dug well and if you let it to settle all the impurities, the sediments will settle at the bottom and the water is more clear on the top.

So, you could access it for domestic use or even for agriculture. Some tests can be done to see what the water has impurities but at least for agriculture you could use, domestic and livelihood options might be after test but you can use it for agriculture, cattle livestock feeding those kinds of things. An underground dam is nothing but you have a slope and the water table would eventually flow as you know, because it flows from high potential to low potential, but you could put an engineering boundary in between the high elevation so the water table does not flow. Let us look for example, you know that this is the water table and the water would flow like this. However, this is under the ground.

So, this is ground level on the top. And in the in the ground, you notice that there is a bedrock which goes like this, which means it is not straight, but some undulations what you could do is? You can drill down and then close this boundary so, that all the water recharge under the ground will just remain here, it will not pass and then come this material is supposed to be an impervious material, where water cannot pass. So, all the recharge which is happening on one side will just go into the ground and stay inside the ground.

The author claims here is happening is you have an impervious layer, but also you have a well in that well where you could pump this water out and use it for agriculture for any other use domestic supply. This is called an underground tank, so the deep bore holes also can be used for recharge. And then water can be released slowly from check dams and large dams to benefit environment flow and groundwater recharge. So, you know that these dams have large walls prevent water from flowing.

However, there could be some sluices or we call some channels inside the walls that can be present, open and close with mechanism. And with this open close mechanism, water can pass slowly out of the dam, which is enough to recharge you can see that it comes slowly out and slowly means it also does not go fast out of the watershed it moves very slowly. And that movement encourages more infiltration. So, there is a lot of water infiltration, which can improve the recharge.

Here the improved recharge is again pumped for groundwater agriculture, which is fine. So, this water can be used for groundwater recharge, and also for some agricultural aspects and environmental flows. So, all you have sun seen today here in today's lecture, this slide is on how to use an existing structure in the rural areas for better water resource management. You can start with STPs, underground dam, recharge releases or abandoned wells and abandoned bore wells.

A lot of exercises have been seen, for example, in some villages, tankers are given for water domestic drinking water for the villagers by some NGOs or by some philanthropy CSR agencies. But they do not have a tank. Where will you store the water? For example, in cities, you can buy water in a tank, put it in the sump underground you have a tank or an overhead tank and then whenever you need water, you can use it. But that is not the same in villages, villagers do not have that luxury, they do not have the money.

So, what you could do is clean an abandoned well. And you can use that well for storing. But you have to make sure that the water does not flush inside the aquifer. Maybe some linings some cement lining can be done on the sides to prevent water from flushing down into the deep aquifer, thereby causing loss.

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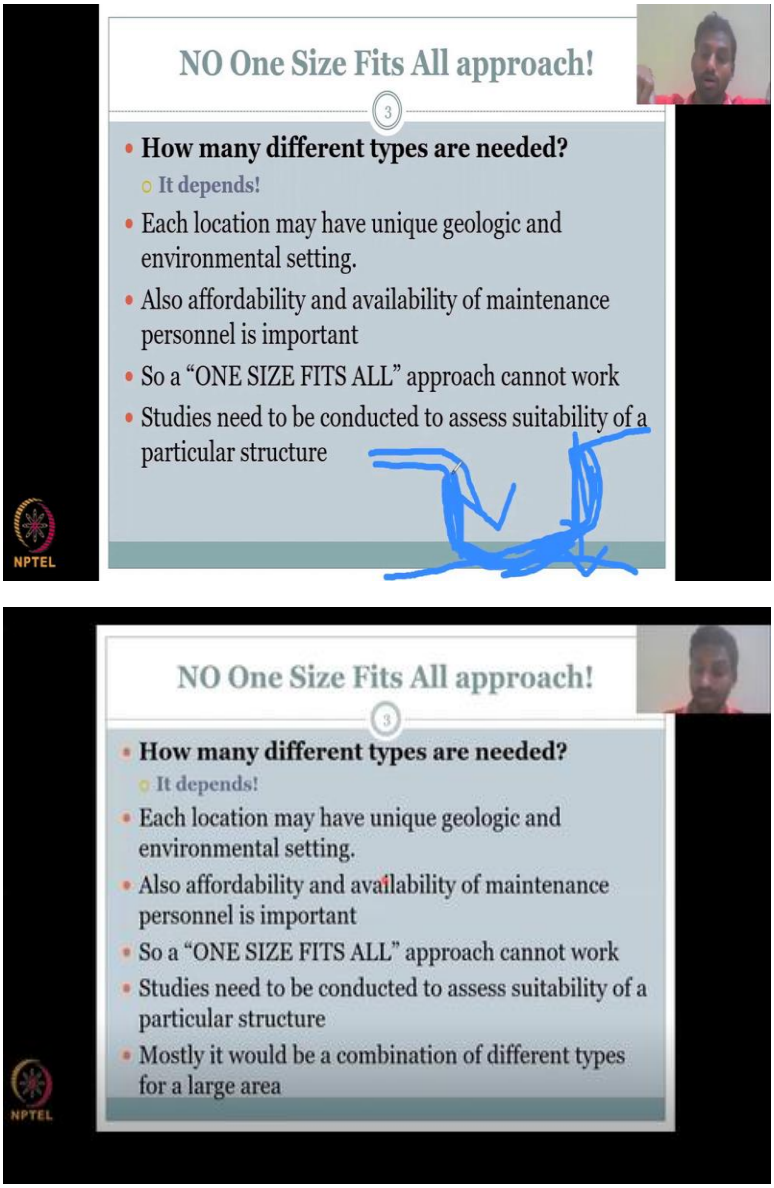

I want to re assess this point. No one size fits all approach. See if one approach is good. Then the book can only talk about one approach, let us say check dams. They could just say check dams is the best do not do anything else. Just keep on building check them and you will be happy they do not do that, they give you multiple methods at least 10, 15 we have seen why because every location might be different.

The politics, the social structure, the economic structure can be different, what can be approved and what can be funded might be different. So, it is up to you to understand these externalities which means outside drivers to find you and pick one method that is best. How many different

types are needed? Someone might ask me so sir you said 15 types we have discussed how many more do should we discuss? It depends, it depends on the state depends on the study area, the village area, and the people. It also depends when I say study village area depends on the hydro climate, the aquifer conditions, the soil conditions etcetera.

Each location may have unique geologic and environmental setting you need to understand this it is not the same the soil, the soil nutrients, why a particular plan was one area is not the same. How many times you will have noticed that your groundwater is much better than the surrounding groundwater, even though your neighboring well is just 10 feet away? It is because it is heterogeneous it changes the geology condition and the depth of the aquifers are different.

Also, affordability and availability of maintenance personnel is important. What we have been seeing in this week lecture is methods. But however, the week lecture we did mention that maintenance capacity is as important as capturing the water, capture the water no one is there to maintain the structures within two or three years you will come back to base one. Base one means level 0. Suppose you are at level zero you build these check dams you get more water, you will do level 2, level 3 where you are profitable farmer but if you do not manage your check dam, then you will be broken again come back to level 0.

So some things that need to be maintained have to be maintained, periodical checks, periodical maintenance have to be done. Ownership has to be there for periodic maintenance, one size fits all approach cannot work, because locations are not unique. So, locations are unique in terms of structure, the geology, everything's one size fits all does not approach a work, you would need to find why and how the things can be used. For example, dams are same; dams can be built in all these high elevation areas.

But the type of dam is a different it differs as per the elevation gradient, the geology around it, the velocity of the water that can come in, and the volume of the water, the material used to build the dams might be different, for which you also need to understand the differences. So, a lot of groundwork has to be done.

We call it reconnaissance survey, where you go and understand what are the problems, what are the soil type, the flowers, the agricultural need, and then we sit on the drawing board and do these calculations. You cannot just take like, it worked in Odisha it should work in West Bengal

let us take it, no that has happened. Yes, please go and read some news articles about these programs. Some programs have been taken and done in other regions, but it did not work. Who to be blamed is not a question, but the science should be understood and that is the whole point of teaching this unique course in NPTEL.

Studies need to be conducted to assess stability of a particular structure. When you want to change or improve the existing structure? Detailed studies have to be done to assess the nature and the suitability of the structure. I was saying the well, right abandoned well. Abandoned means no more water is coming in the well. So, if I say can I use it as a tank a small storage tank? Theoretically yes, but why is the water not there can be understood.

I will draw an example. So, this is the well and the water table is somewhere here, which means the water is not in the well ever because the water table has come down. Now, if I channel the water inside surface runoff, the water will be there as long as it is not leaking into the aquifer. But once it starts to leak, then all the water would go into the aquifer which is lost and you have put money to bring the water to the wells. So, all this is lost. So, it is better to maintain these structures. Like for example, I put lining of cement or more gravels and sand to prevent water from flowing out and keep it inside this is one example I would give.

Mostly it will be a combination of different types for large areas or rural areas. I would suggest that in rural areas, do not go for one method, most of the time one just one method will not work. This is my small experience. It is better to have multiple assets in a village which can help in groundwater management. But there are some limitations and challenges. If you have one type you can teach that to the public and let them maintain it capacity is built for the year 10 types and 50 household how many how can you train and how many of them can be well trained is the question. So, think about the plans, the budget, the number of types needed and the maintenance also.

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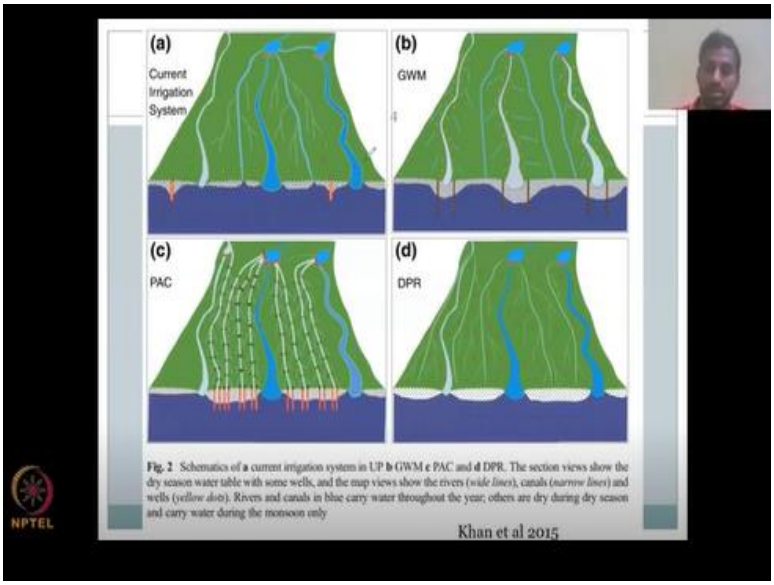

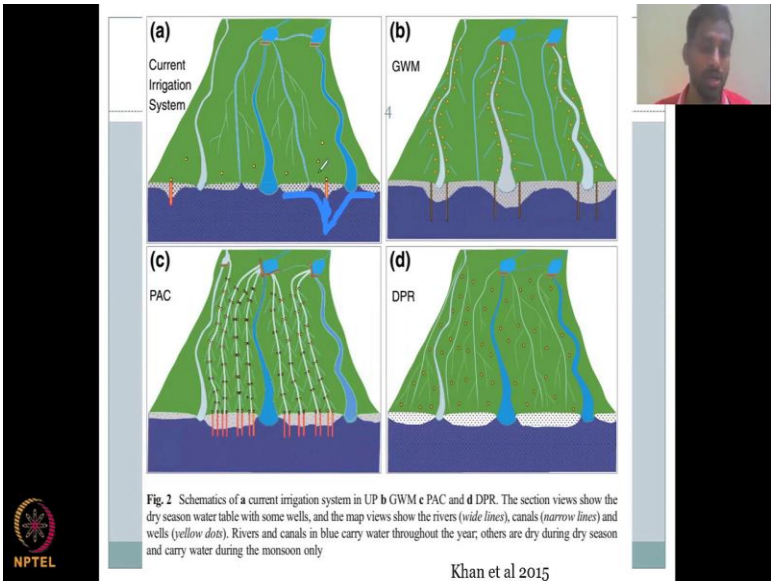

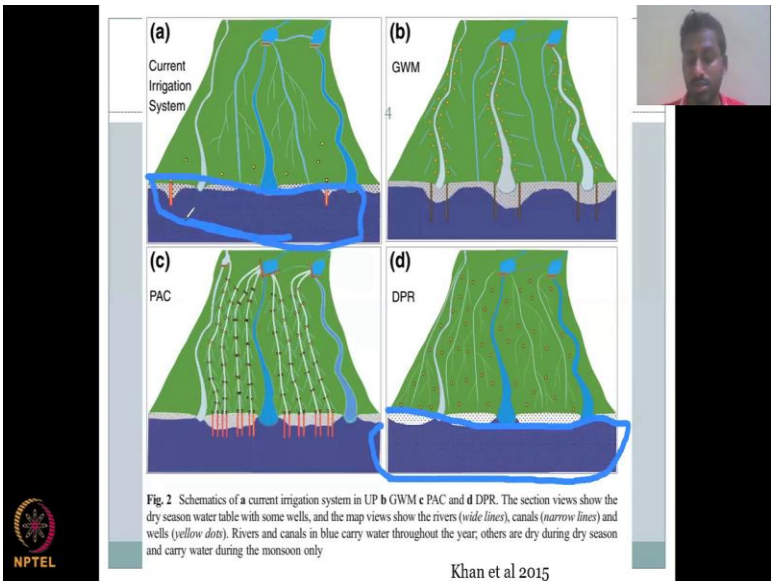

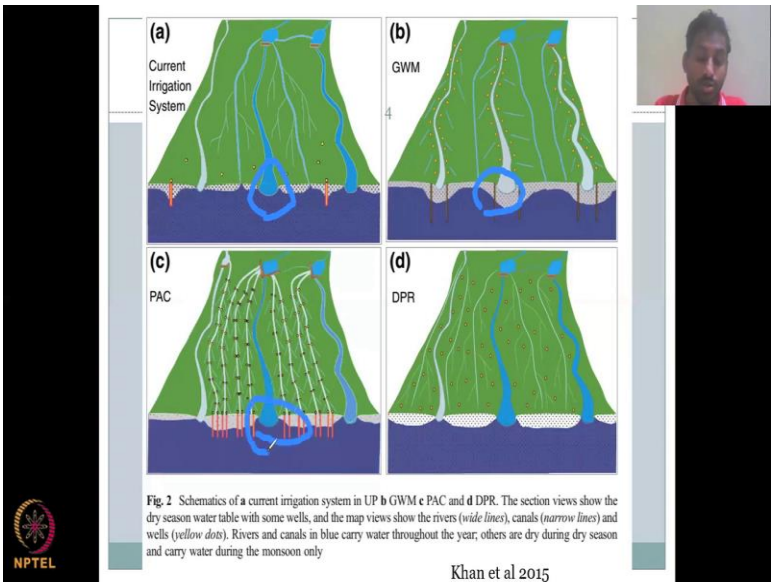

Now, as I promised, I will discuss this comparative study between using a particular engineered method for enhancing the groundwater recharge and also reducing the floods, so this study was by Khan et al in 2015, read the paper it is very interesting paper where they show the current irrigation system. So, in the current irrigation system, you have water coming there is a dam and then from the dam there is channels you see the channels are light blue in color, the river network is dark blue in color and this is also channel different channel.

So, what you see in this dam there is water and between these two water bodies, there is a connection and then there is a channel down, etcetera. And the yellows are groundwater pumps, where they pump water and they proceed that is why the water table goes down at this yellow

point. It is a cross sectional view here this part is a cross sectional view, this is a topic view you are looking from the top.

So, now you could see that the groundwater is being formed. So, the water table is going down here same thing should happen here and here all these wells you cannot see it because the cross section is not there only for these two wells the cross section is there. Let us look at the first current irrigation scheme you have water coming, you have a dam and the dam releases water in the canals and then there is recharge happening assuming the canals are not lined. So, there is some recharge happening wherever the groundwater is being pumped there is less water otherwise if you see all these channels there is a peak there of groundwater because groundwater is recharging the canals.

Here you do not see a peak because this is a lined canal, you have lined with cement. What you see here? Is the first one is the Ganges water machine which we discussed in the book in the last class, what is happening in the Ganges water machine, you are pumping along the riverbed wherever the water is flowing, you are pumping along the riverbed. So, all these are riverbeds, the white lines riverbeds, this blue lines are canals that is why it is straight and what is happening all of them are not lined I mentioned here it could be lined, but just in this experiment, but from now on all of them are not lined.

So, what happens is you have pumping and wherever the pumping is happening groundwater is reduced and since it is along the river channel along the canal area, you have groundwater depleted at the monsoon stage, and as I said, tremendous amount of energy is needed each yellow dot is a groundwater, so, you need to pump tremendously at each location along the riverbed. So, this is b and c is pumping along the canals, So, wherever the canals is so, you have a dam, you have canals breaking off from the dam and only along the canals, you are having groundwater pumping, whereas other regions there is no pumping.

So, you could see that all these areas of groundwater recharge is okay, but along here the canals the water is low and the water in the canal is not enough for groundwater irrigation and also surface water irrigation methods. So, this method also is very energy intensive and also results a lot of loss because it is only considerably recharging outside the basin and not inside the basin so, outside the water bodies.

Here you could see it is not better than the initial situation, you need something close to the initial situation which is a and that is less groundwater pumping, you want to show the policymakers who rule village people that if you pump this way, you will get less disturbance in the groundwater table. So, you can still continue if you look at it that means only this is better, you see the groundwater table, it is as close as your a which is not much groundwater scenario happened. Why is this happening? So, what is DPR? Distributed pumping is what DPR is and recharge.

So, wherever you are pumping, you are also recharging and the water, but it is more distributed pumping, it is randomly distributed, if you see here it is distributed only along the river channels, here it is distributed along the canals the pumping, but here it is randomly distributed everywhere along the areas distributed. So, wherever the pumping is happening, the groundwater table goes down.

And those areas can also recharge the water because water is going to come in the canals and rivers and it recharges the aquifer. So, instead of closely recharging see it is closely recharging this part is recharging, here is recharging. So, instead of recharging in one location, this method is recharging all the locations, because it is distributed pumping.

And here it is not a centralized pumping it is wherever the farmers need they can pump and that has been the best method as per energy conservation and also water conservation. E which is distributed pumping and recharge is the best groundwater plus surface water method, storage method, conservation method in this village, which has dams, river, canals etcetera. So, you cannot stop suddenly people from using groundwater because they have been using and they see the benefits. But now the depletion is too much that you cannot continue as is you have to do some difference in attitudes and that is what we are discussing today.

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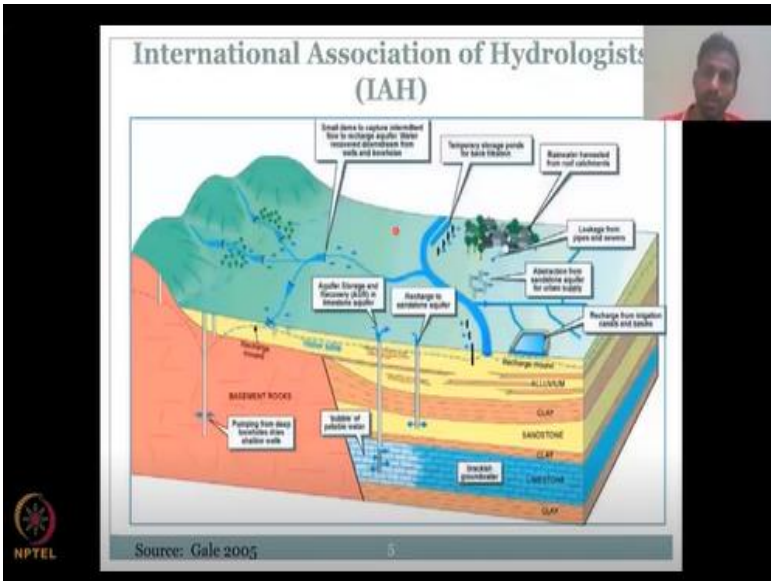

So same as what the IAH has said, you have to use multiple assets to manage surface and groundwater recharge structures, surface storage structures, using engineered themes, just not using one is enough.

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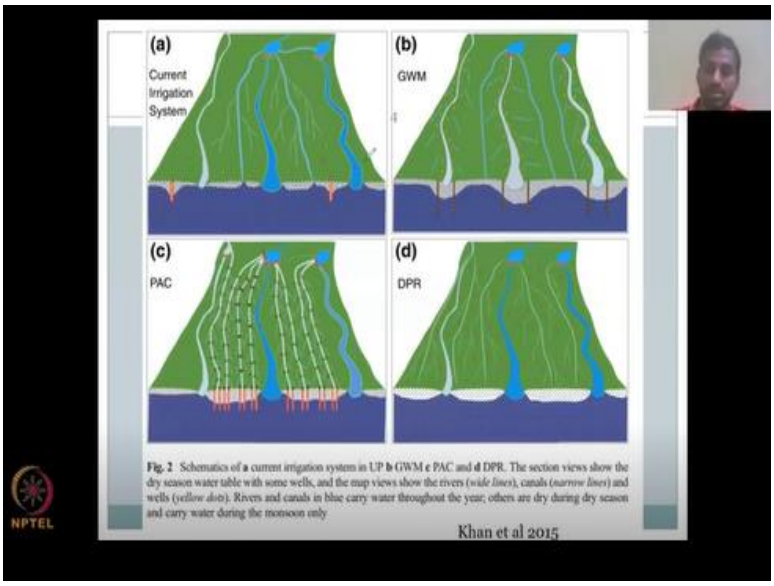

So, what is the future needs? You could have new methods which are good to measure and optimize manage aquifer recharge and also club the surface recharge with groundwater recharge. That is what is happening here. This is your surface water, you take the water for treatment, and then recharge basin surface water body and some part of the water is recharged you can see here it is recharging, some water can go back into the groundwater aquifer, deep aquifer by injection. And also, you could pump a lot along the rivers.

So, you have seen a previous example, you can pump near the river very, very high. So, the river water can go into the well and then into the surface body. This exercise show that you have to be cautious about pumping along these rivers and channels and use only how much is needed for the rural water supply. If you overdo it, then there is potential loss of the water for all the users.

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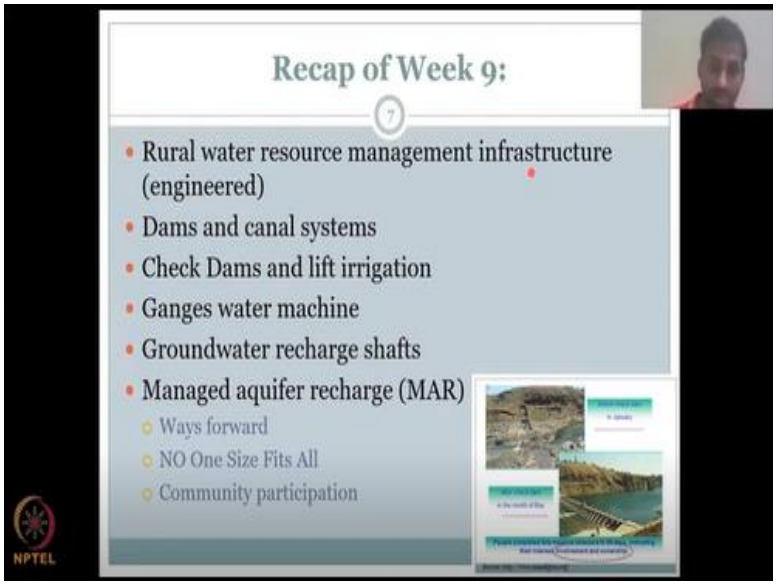

So, let us recap week nine total water resources management infrastructure have been discussed and only engineered parts in the engineering we looked at surface water and groundwater. And in the groundwater, we looked at artificial recharge methods manage aquifer recharge, which can be divided as direct and indirect.

Dams and canal systems were looked at in the surface water structure system. Check dams and lift irrigation were discussed how small check dams decentralized versus centralized was discussed. The decentralized approach is the check dams whereas centralized approach is the large dams.

Ganges water machine was discussed to see if it is a potential method that can be used still it is being tested and a lot of books have been written. Groundwater recharge shafts in the UTFI and deep groundwater recharge methods have been discussed and looked upon. Then finally, we looked at different MAR structures managed aquifer recharge structures, the ways forward is to use multiple methods my different assets in one location, make sure that the changes done to it reflect the need not just you have the money and so you could change the structure it has to have the need.

And we also have to look at the ways forward in monitoring and measuring these MARs, because there is no one size fits all approach. And if we monitor and share the data, we can let others understand why this is happening. And will it happen will the benefits happen in every

location? Most probably it can happen if the other externalities are arrested for example, leakages, losses of water etcetera are taken care of.

The final thing we looked at is the community participation is key. A community as a whole can take part in all these water body actions, water body conservation methods and schemes. If they do not, then the NGOs and government will do it, but they will leave after some time. And when they leave most of these schemes collapsed. So it is best for rural people to be trained in these kind of methods and they take care of these small community projects.

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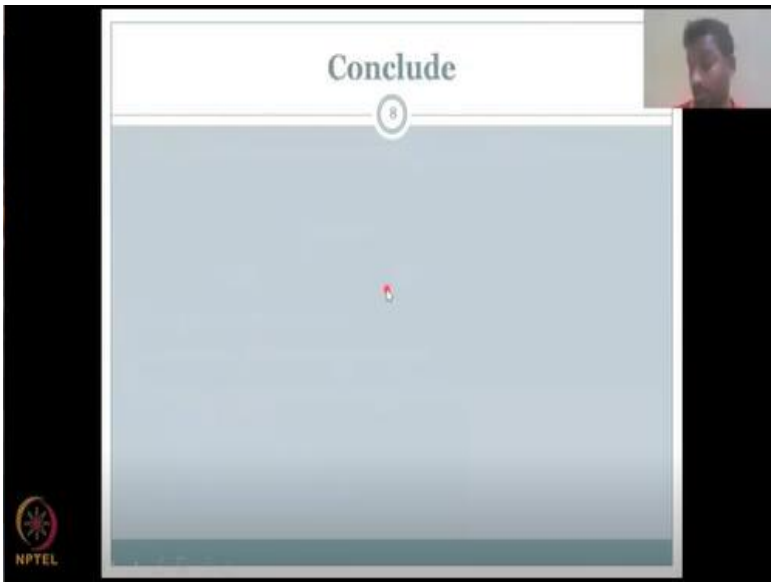

With this, I would like to conclude week nine, I will see you in week ten. Thank you.