Rural Water Resources Management
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Rural Tanks and Lakes
Week 06 - Lecture 02

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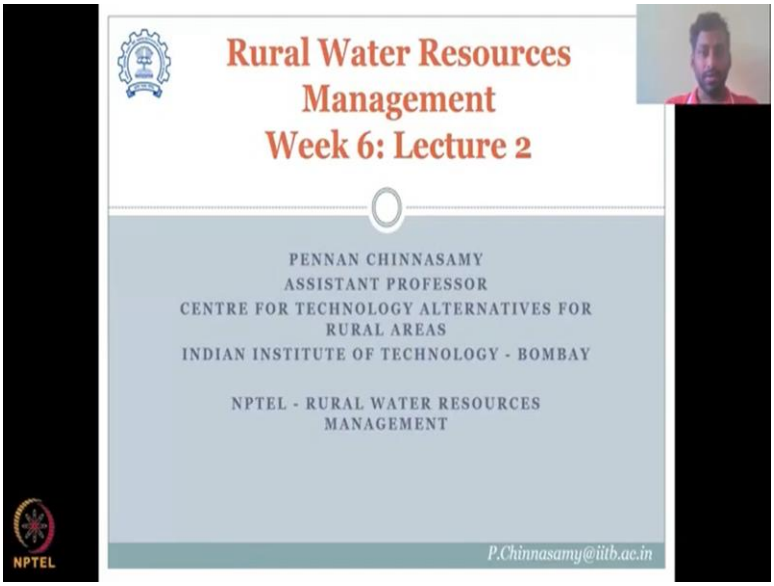

Hello everyone welcome to NPTEL course on rural water resource management. This is week 6 lecture 2. In week 6 we are looking at surface water structures and storages for rural water resource management. We are looking at the types of structures that can be made and also the size and is a traditional new natural or nature based or engineering based.

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From historic times there has been rural lakes and tanks and what they have been doing is? They have been silently helping a lot of farmers locals in capturing the rainwater and then using it during the lean season. We saw that how rainfall is skewed which means there is more rainfall during the monsoon months of JJAS June, July, August and September. But during the other months there is considerably very low rainfall. So, there is a need to build and monitor these tanks, so that we have more water for the lean season.

So, one of the prominent type of surface water storage system in India is rural lakes and tanks. You see multiple images on the right where they have set up these systems and mostly farmers and women use it for livelihood support and domestic water use drinking for example. It is one of the prominent types in India especially in rural villages and part of traditional wisdom is used while constructing and maintaining these structures. And most of it is done by local communities in India and they span to more than 2000 years.

So, if you see the first image here, there is a lot of scriptures about these tanks and how they evolved. If you notice that in villages there will be a tank and then around the tank or near the tank, there will be a temple. So, normally they will say that this is a water, so do not pollute it and that is why they had placed all these religious structures near the temple, so that people do not misuse the water. It is for domestic use wherein you can take and use the water for drinking, bathing, etcetera, but make sure you are not polluting the water.

Because the god idols and other things also would be bathed with the same water if it is a temple tank. So, the idea is same you would capture the water, you store the water and make sure you manage it using local participation, because it is the locals who are going to use the water. It is very prominent in the south part of India, because of the hard rock terrain wherein recharge is really less sometimes and sometimes the water just hits the land and runs away, because of slope and also low infiltration values. So, it is very important in these regions and they played a very prominent part.

It supports multitude benefits for example irrigation, which is for agriculture water supply flood control as I explained in the previous lecture. It captures the water and stores it in the tanks for flood and most importantly groundwater recharge. Domestic use is one of the dominant uses you can see women on the bottom collecting the water and taking it to the house for drinking and other uses.

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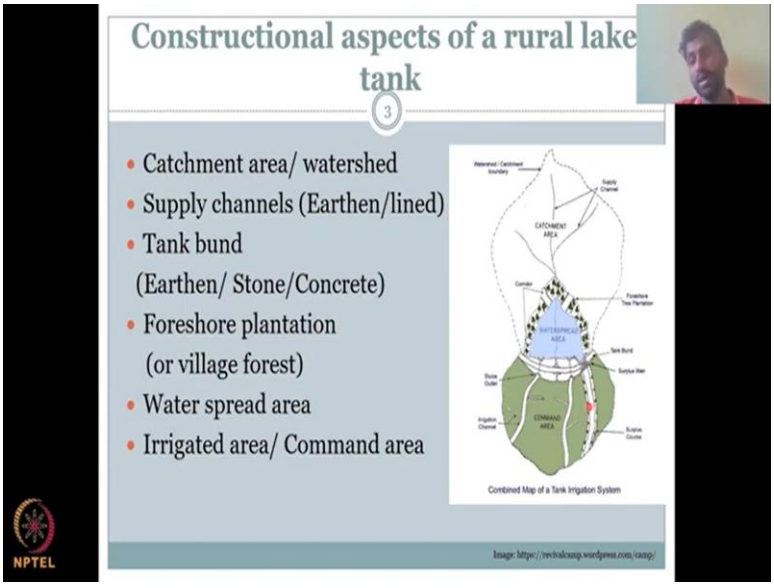

Let us see how they are constructed, mostly a methodology of how they construct. So, in on your right you have a map of a tank irrigation system, so a tank can also be for irrigation a tank can be for temple as I said or domestic use, but the same construction method is used. So, first they have to look at the catchment area, so where rainfall will be capturing to be drained into the tank. And depending on the area and the rainfall volume you should be able to consider as storage. You

cannot put a very small storage for a large area and large volume, because it will just break the tank.

On the other hand you cannot put too big also because land you cannot just evacuate all the land and then all the water which comes in just evaporates, because what happens is you are spreading the water thin and when you do that water can evaporate. So, catchment area is first determined and watershed area is determined. And then what you do is you have to look at supply channels and how water is going to be brought from these catchment areas into the tank. So, you demarcate a catchment area you demarcate a tank area and for the tank area you have to make the supply channels.

The supply channels can be earthen which is made by mud you dig and then put mud on the sides or it can be lined through cement and concrete which is really expensive. But if you want to arrest the groundwater recharge you do not want the water to go in the groundwater which is here but here it is okay, then normally people line it, because by the time the water comes it is gone.

Then you have a tank bund which is protecting the tank area otherwise that is actually the tank. Otherwise the tank if the bund area is not there what will just come and flow on others all other sides that is also made by earthen and stone and concrete. Normally it is made by stone and then like big stones are put and then mud in size and so it just is made like a big wall you could see and some concrete lining on top of it can be also used. So all these methods can be used or a combination of the method can also be used earthen stone and concrete.

Then we have the plantation area where it is the area the trees and shrubs and bushes that actually protect the tank. Most importantly it gives shade, so that evaporation does not happen rapidly and also it protects sediment and other things from infiltrating in or flowing into the tank, because it acts like a wind buffer. So, it is just a windshield where all the impurities can be blocked, so that does not get into the tank, paper, plastic, whatever it is, so it will be like a buffer which controls captures these impurities from getting into the water spread area.

It could be a village forest a small plantation also is accepted, then we have the water spread area where the water the tank area, so this is the actual tank area where the water is put and the volume is created. Then for the tank you have a irrigated area or a command area, so this is the

catchment area where water is caught and this is the area where the water is going to be used for irrigation, that is called the irrigated area or the command area. So, water is taken and from sluices and other channels water is being channelized to the irrigation plots small, small land where water has to be applied these water can be taken through this channel.

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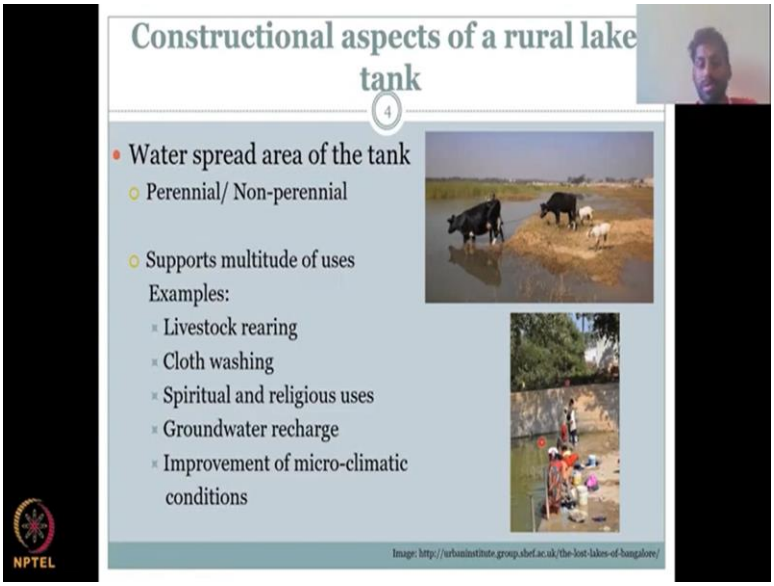

It does not only stop there it is not only just for irrigation and domestic use, let us see the other uses of tanks. Most importantly the water spread area of the tank can be used as a perennial and a non-perennial source, perennial means it is always there water and non-perennial because sometimes it evaporates. So, in the perennial season it is good that everyone knows that I do not have water in my well, but for sure the tank will have water they will go and fetch water from the tank.

The other is non-perennial use is when you have certain times in the year when you know the water is there, so you could go and use it for your domestic and other uses. As we said it suppose multitude for example livestock rearing you can see a women and men taking their livestock which is cattle, goat, sheep and then there to drink water to feed the grasses are there because of the water, so they can feed and wash them clean them etcetera. Cloth washing and other things are also being done you can see here women come there.

So, it is like a kind of a meeting for them every day you know they in the morning they finish breakfast, they cook the lunch and maybe then they take the clothes in the bucket. And then they

walk towards all of them walk towards the tank and then they wash it and then bring the clothes wash clothes. It is also used as spiritual religious uses as I said most of these tanks would have a temple with them and where the temple festivities would happen in the tank water.

It is for groundwater recharge it is an indirect recharge because you are ponding the water and for irrigation and domestic use, but also there is a loss which goes into the ground and that loss is a groundwater recharge. It also improves microclimatic conditions, because it gives a cool temperature when you go near the tanks, because of the evaporation so that gives a micro climate which means a different small level climate which is suited maybe for example raring livestocks, certain kind of crops etcetera.

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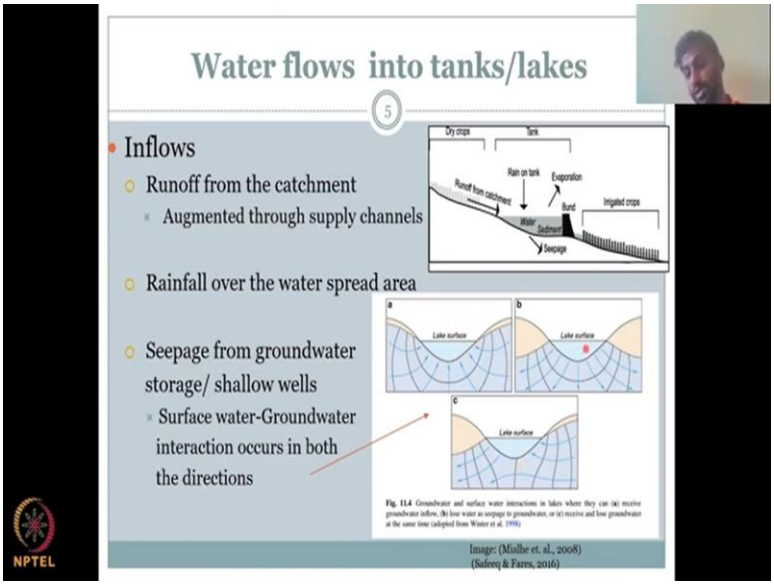

Let us see how water flows into tanks. I said there is a catchment area and then you put all these earthen channels and also runoff can also come. So, the first important thing is yes channelized water can come but also runoff can come into the tanks which is just your water hitting on the surface it cannot infiltrate most of it. So, most of it will just flow as runoff so that runoff from the catchment can go into the tank.

So, this is your tank and you have water coming in for the time. There is also direct rainfall, rainfall just on top can come into the tank, so that is the one of the inflows to the tank. And depending on the water spread area you can have a large area of influence where the rain water is coming in.

Then there is channels as I said earlier, so this is where how a tank is normally built you have a runoff coming into the tank rainfall capturing in the tank, there is some groundwater loss and then evaporation loss, but the water can be used later for irrigation. The other aspect is seepage, seepage is the either loss of water from the tank to the groundwater or groundwater into the tank, which is a discharge from the groundwater and seeping into the tank. So, seepage from groundwater storage or shallow wells, wherein surface water groundwater interactions occur.

And the one way is where the tank can lose water as you see here, but most of the times it also gains water. It can gain water, because it is actually sitting in a low lying area and so the groundwater can come in and store. There are some locations where groundwater neither comes in nor stores, because it just goes in and then the same volume comes out. So it does not affect the volume of the lake in this example the tank or the water storage gains water here it loses water here there is no change.

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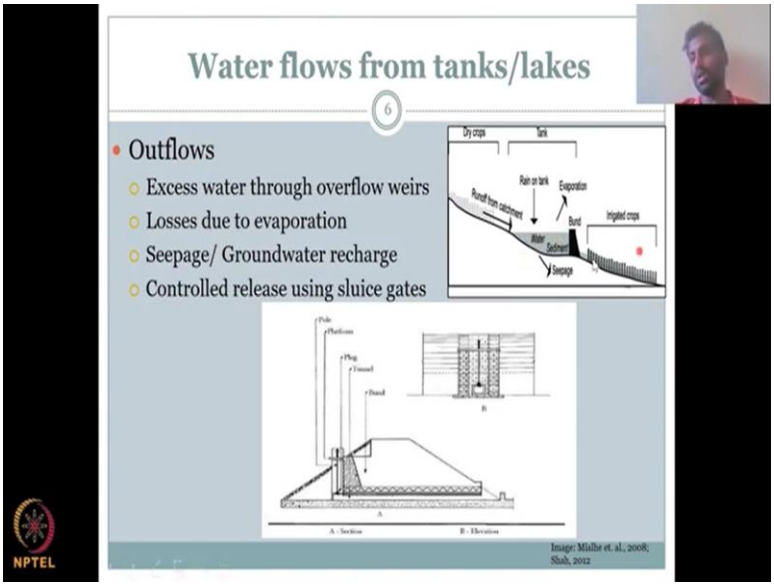

Let us look at the outflows, so what do you do with excess water from the tank? So the tank is full what happens is you have to release it and that is released by channels as I showed in the earlier diagram also. You have a channel that releases water into the irrigated areas crops or it can be through weirs and sluices or gate, which you just open and then water will flow. There and outflows does not only relate to water that we control, it is also the water that is lost from the

system we have to be very careful about how much water is lost, because in a hydrological water balance the losses are also called outflows.

So, excess water is released through channels that could be genuine we know about the outflow we remove it we let the water go. But there are other losses for example evaporation it depends on the radiation, it depends on the ambient air temperature and how much water vapor is there, so there is a lot of evaporation happens. There is seepage to groundwater as I showed the earlier diagram groundwater can also take water out from the tanks and then there is a controlled release using sluice and gates, so you always control it and there is an overflow what is the difference between a controlled gate is where you manually control it or automatically control it.

Whereas a flow or a flow or a overload flow weir what is overflow weir is this just a stop like this. So once water comes up it has to flow through, there is no opening there is no nothing needed it just flows through. We will show you some examples of these.

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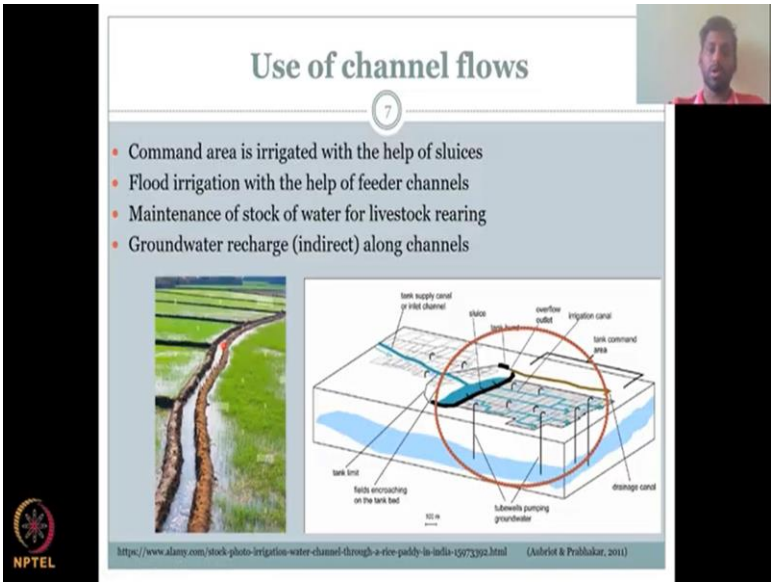

And there are a lot of multiple uses of the channel, so the tank does not stop just when the water is released. So, along the water channel along where the water release, there is multiple benefits. For example command area is irrigated with the help of these channels and sluice gates you see here how water is flowing from a tank or a lake. And then each place they will put a small inlet outlet and they can release the water inside.

So, normally farmers decide from themselves they talk to each other for example this is farmer A, this is farmer B or and this is farmer C, what they will do is, they will wait for the water and then when the water comes maybe A will open it here water will come and then flood irrigation this is called or fallow irrigation. So, it just comes in on the top and then irrigates the field.

Then water this guy number B farmer B would say I will also open after you done and then this filled up and then C fills up. Sometimes it is done on rotation, sometimes it is done as per need. But they have a good understanding of how much water is going to come and who gets it first etcetera. So, that is a good aspect, then we have a flood irrigation with the help of feeder channels. So, this is the main channel and then you have another feeder channel small channels that take water from the main channel. So, for example the water can go here and there could be another channel that can take another source into a different location.

Maintenance of stock water for livestock rearing, so sometimes these channel waters can actually put in a small storage, so this channel can also lead to a small storage not as big as a dam or a tank. A small very small storage for livestock's, like chicken those kind of rearing. And most of the time you would also see that you have excuse me you have a fish also growing in coming into these channels and the fish can also be growing along with the rice and paddy. Vietnam they have this very good agricultural system where fish is also reared with the rice.

And then ground water recharge does occur along all the channels, you see here this is a earthen channel there is no lining there is no concrete. So, water can easily recharge and this is less expensive, because you just have to dig and then use the same mud, same the soil on the sides to make a bund.

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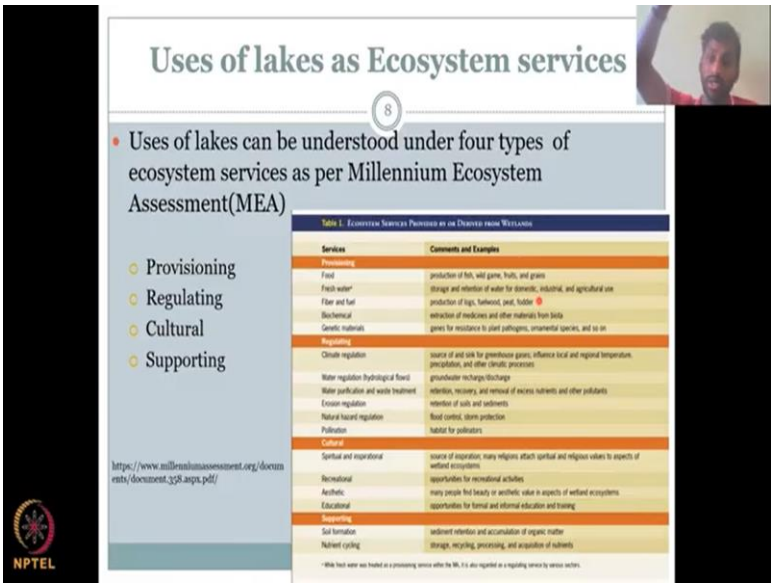

So, use of lakes does not stop here use of lakes or surface water storage systems do not stop just for irrigation dust for domestic. There are a lot of multiple things that it contributes which are very important for the overall picture, for example ecosystem services.

Let us define ecosystem, ecosystem is the interaction between the biotic which is your agriculture human all the life forms etcetera fungus worms. So, it is a interaction between the biotic and the abiotic. So, biotic is all your biological living organisms and abiotic is a non-living things like rocks, soil those kind of things. So, there is a beautiful interaction between them for example the soil has to be wet for the fungus to grow if you say no soil I do not give water I only have water for the fungus it does not grow.

So, there is a beautiful coexistence a system and the word ecosystem that is how the word ecosystem is coined. So, use of lakes can be understood under four types of ecosystem services as per millennium ecosystem assessment, provisioning, regulating, cultural and supporting. Let us see some examples of how these rural lakes, rural tanks, rural water storage surface water storage can help.

So let us see provisioning, provisioning food, food like for example production of fish wild game fruits and grains. So basically, you can just grow using this water you can grow your crops you can set it to a small tank and from the small tank you can rear fish. So, if you go to Nepal kind of regions they have this fish farms, so what they do is, they channelize this water into small tanks

like a small swimming pool for the fish and then they grow the fish in inside. And then they sell it for food, so it comes under the food production of fish wild game foods and grains not all fish is for food. So, there are some fish and that comes under the ecosystem services.

Then there is fresh water storage and retention for domestic industrial and agricultural use as I mentioned. I also did not mention much of industry, because not much industrial demand is there the rural water from these tanks maybe like cottage industries they can take this water for small activities. But other than that there is very limited use for industry, because agriculture itself is an industry. So, when you combine agriculture as an industry, then it is just one word agricultural industry.

Then you have fiber and fuel a production of logs fuel wood peat fodder these are the biotic systems that are grown using it not directly for food but for fiber paper and cloths cotton etcetera. And also for fuel for cooking all those things, so you can have the food like for example I can have the water for fish, but I need to cook it I cannot just eat it raw so what you do is? You have to have the ecosystem to survive and give you firewood and that wood is grown using this water also, biochemical extraction of medicines and other materials from biota, so that can also happen there is a lot of chemical reactions biological reactions, which can lead to some medicines etcetera.

So, genetic materials and genes for instance to plants pathogens, ornamental species etcetera. So, there are some things that you can specifically grow using these wetlands and small tanks and ecosystem services. Then you have regulating climate regulation as I said it gives you a micro climate and it is also a source of sink for greenhouse gases local temperature can be regulated precipitation can be caught all those things can be happening in a tank or a surface water storage system. Wetlands is kind of a rural surface water storage where water can come and it also has some growing stuff inside it already.

But those these examples that are given by MEA can also be used most of it for the tanks. So as I said when you go near a tank or a good water storage system small surface water solar system the temperature is different. And you see the buffer around it there is lot of forest and plantations growing.

So, water purification and wastewater retention so because water is held in that you can actually you know make sure that if it is too much polluted you do not open the water to drain into the irrigation land you just hold it and then do something else with the water right you can evaporate it and then do not release it to the ground water also. Erosion regulation, because you stop the water, so the sediments would stop so it will fall down and those sediment would not be going down in the irrigation channels.

So, you would have to evacuate the sediments so that is the maintenance part of these surface water storage systems and wetlands. Where you have to take off the sediments take off the eroded sediments and by slowing down the water you also prevent the water from eroding further downstream.

Because when water goes fast it starts to eat up the sands on the sides and under the bed, but when it stops in these storage structures or slows down, then sediments fall more importantly because it is slowing down it does not take off more erosion on the way. Natural hazard regulation flood control has been already discussed in this class storm protection is given through these systems pollination habitat for pollinators bees.

So if you look at bees and other insects, they normally go around these lakes because of these good water resource and cooling time and climate a lot of flowers will be there, so there is a lot of pollination that happens. Cultural, spiritual and inspirational source of inspiration religious attached beliefs are attached to this water bodies, if you see all these water bodies have a good religious connection which is held on through centuries and traditions.

So, it is not about a particular religion, but it is about how they have taken it through the tradition and how they lived along with this water bodies. It is a source of inspiration, because when you go there aesthetically you feel calm you feel natural, so those kind of things recreational some people. For example Coimbatore I have seen some village big tanks they use it for boating also so people go on recreational activities and you should not be polluting it but you can just use a boat you can just and those boats are non-electric, non-diesel it has to be manpower, so you have to pedal it, because if you have too much of this fuel coming in it leaks from the boat into the lake.

So if you go to Kerala for example all these motorboats have a negative impact on the water quality, because the oil the petrol leaves and whatever they use leaks into the system. Whereas in the for example Ooty and all if you go you see these pedal boats where it does not pollute the system, you cannot go long but it is for recreational. So it is still okay.

And aesthetic as I said aesthetic means it is pleasing to the eyes it is beautiful so it gives you a calm feeling when you see this water people go there and sit and then have a coffee a snack or something so a good aesthetic value is built educational because opportunities for formal and informal teaching training can happen there. A lot of information about the ecosystem services food production, climate everything, so these tanks can serve as a teaching material. Most importantly it supports a lot of natural processes soil formation, sediment retention, accumulation of organic matter all this is driven by water.

And because you are regulating the water you are slowing down the water it supports in your natural process of soil formation. Nutrient cycling it is very, very important, because storage it stores the nutrients within the system, it can recharge the nutrients recycle it and also because of the sediments all the nutrients will be attached to the sediments and those sediments can come along with your water body release channels. For example nutrients are coming in the field or in other aspects and sediments are there.

So, sediments attach nutrients attach themselves to sediment and then it flows in the water and while it flows in the water it can get accumulated in the tank or it can be released to different parts. So, a lot of nutrient cycling aspects are held in these water storage structures especially wetlands would have all tick marks for other types of storage structures it is limited application but still I could say that it can be applied for all these systems as we saw in the examples I gave in the class.

So, with this I think we have covered the rural water storage types, how they are constructed on the land in terms of what do you need, you need a elevation difference you need a smaller area and that area if it is beneficial if it is a low lying area. The elevation should be low so that water can come in there and you erect the bunds around it. And then you demarcate a command area where the area gives you the volume of water that comes into the system and you can play. So, this is a supply side management when it comes to water management I will just introduce this concept but we will get into this in detail.

It is a supply side management which means water is a supply and since water resources are low if you do not have the tanks the rainfall is very low as I showed in the previous class, so rainfall is like this so the supply is limited only to this region so these months. So what you do is you increase the supply by having a storage, so all the months mostly will get the water. So, it is a supply side scenario and also you release the water from the tank through channels to different areas and you pick and choose which areas to supply so it is a supply side.

For example there was no it was only two river streams and a tank here for example the water was stored nothing else but here this land is good fertile but it did not get water, so all you do is you put a channel from your tank to the land and that land now gets water. So, you are augmenting you are creating a supply, first you are creating a storage which is a supply then you are distributing the supply to a region where there is no water and so you are increasing the supply scenario. So, all this is very doable by even a small tank in the village mostly it is does not happen because of the funds and people not coming together to do it out of ownership.

So now, slowly with these classes and lectures I hope you could take the message across and then engage with more people to build these kind of systems I will see you in the next class thank you.

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