Rural Water Resources Management
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Community managing of rural water bodies
Week 06 - Lecture 05

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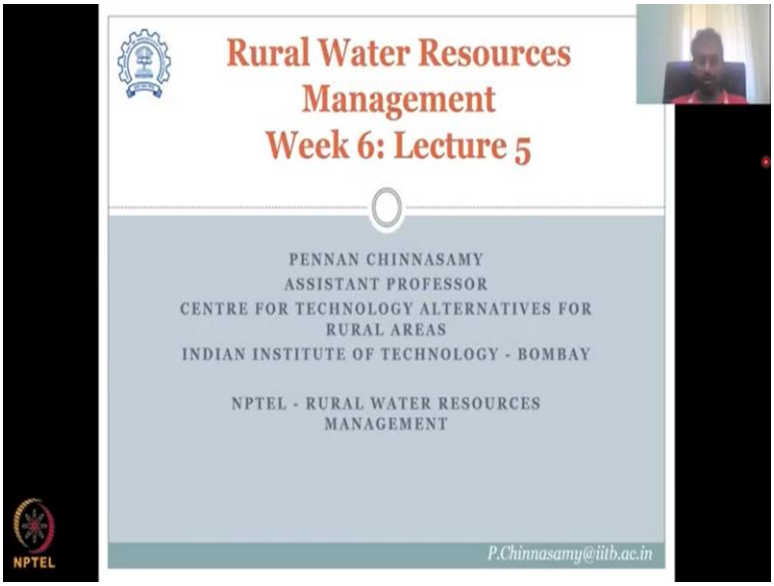

Hello, everyone welcome to rural water resource management NPTEL course, this is week 6 lecture 5. In this current week we have been looking at surface water storage systems for rural water resource management. We have also looked at the types and what are the issues concerning each type. In today's lecture, we would go through some of the issues and concerns and how to get out of those issues and also recap of this week's lecture.

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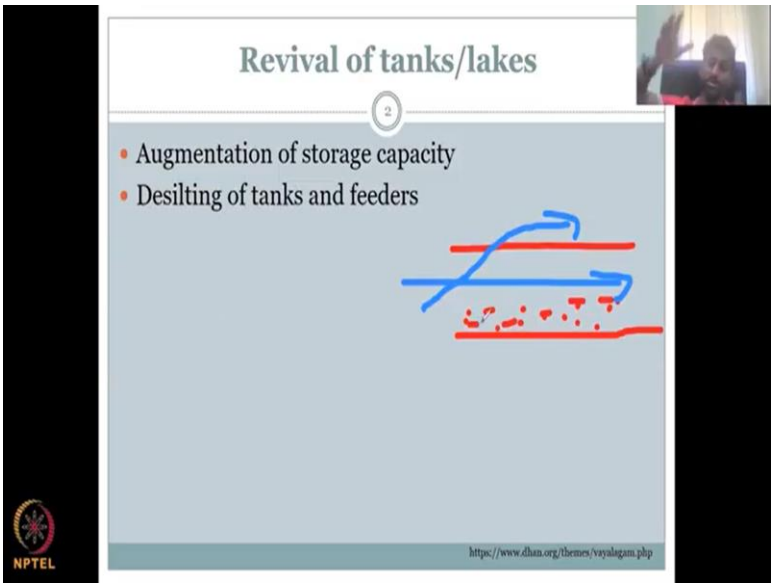

Let us start with revival of tanks and lakes or the water bodies. In the previous lecture we have a case study of Bangalore, where we saw that water lake area has been diminishing and because of that the agricultural farmers are driven out of the system and there is less water for domestic use. Because the same urban people have started polluting the water and that water is not good for urban not good for agriculture and it is a pure waste. Also the ecological balance has been disturbed which is the plants, animals, fish and other insects and organisms depending on the water have vanished.

So, it is very important to save and revive these water bodies what do you mean by revive is once it is polluted to a particular extent you want to reproduce it to the a particular level, so it is a revival of excuse me the water bodies. How can we do that, let us look at some measures, augmentation of storage capacity. So, I mentioned that if you have a check dam a water storage device and water is coming and storing some of the sediments are deposited on the check dam. This actually leads to a lessening of the volume and also breaking of the dam.

So, what you can do is? You need to augment the storage which means maintain the sediment level like dug it and take it out and also make the bunds stronger. So, maintenance is very important and augmenting adding to the storage capacity is important. Some people raise the level of the check dam some people will dig more deeper, so that water can come and store more so those are some measures. Desilting of tanks and feeders are very important not only in the major tanks and dams but also the feeder channels which take the water to the farm can have sediments.

It has to be clean and free-flowing if you have sediment levels then it will oppose the water movement and stop it and also the water would flow out of the system. Let us see a drawing for example this is your channel, I am just drawing a cross section and initially water is flowing which is fine slowly if sediment is building up.

Now, what would happen is the water which was initially flowing through now would flow over because of the sediment. And when it comes over it comes out of the channel and that is a loss because they want to supply from the dam to the farmer but in between if the water is flowing out it is a loss. So, you need to be very careful with this aspect. Wherein, Desilting of tanks and feeders is needed.

Regular up keeping so you always have to monitor the bunds the embankment the check dam etcetera I am just taking check dam for example. If you do not do maintenance and monitoring they will fail so one of the big ponds that were supplying water for agriculture and domestic use in outskirts of Chennai the Chembarambakkam lake broke and once it broke the entire city of Chennai was flooded. So, if it is very important to make sure the bunds and monitoring keeping on checking all these infrastructure is very important.

Participation of farmers and revival of tanks, so we cannot just wait for the government to release funds time and labor every time to save these tanks. We are not getting into the question is it a mandate or not we are trying to tell sometimes there is a delay and sometimes there is no funds. So the farmers and stakeholders who are predominantly using these systems have to get together and solve it. If it was one man's problem, then it is different you have to spend more money and time, but if it is a community problem not my own water problem but it is the problem for the entire village then all the villagers can come together and work on it.

So, this is called the public participatory network or public government participatory, because the tanks and the land is owned by the government and the farmers use it. And so they participate in revival of these times, so this is the public participation which is very important this creates the ownership among farmers.

So, if you look at this NGO work from DHAN foundation you could see all the local farmers getting in and digging it out clearing the tank debris etcetera. Just look at the tank walls all have a lot of sediments sand like here uneven sand. So, all this has to be taken out sediments have to be taken out and dump so that you can revive the tanks so look at all the carrying is just the debris the sediments and out of the tank system.

As I said not always you can get all these bulldozer's and JCB's to come in but farmers if they can just quickly combine and work you can get it out. Sometimes you can be smart in using the government funds like MGNREGA, so the MGNREGA money can be used for Desilting of these tanks maintaining these water bodies. So the farmers have to come together first say let us work together we will put our time and some money can come from MGNREGA and the MGNREGA can be given for like strengthening the concrete labor, labor cost can be brought in.

So this sense of urgency for participation is starting and a lot of other villagers are learning between each other from like Kesari from Madurai, DHAN etcetera. And they also want to do because you do not need a government to come and tell you to do it you just watch them how to do and then you do it and that is the role of NGOs.

And the media like YouTube everywhere you can see these structures being managed and what activities can be done. For example this lecture is on YouTube so a lot of people are getting

benefits. Same way if these monitoring networks and management revival work can be shot on YouTube and shared in the open platform a lot of farmers can look at it and get benefits.

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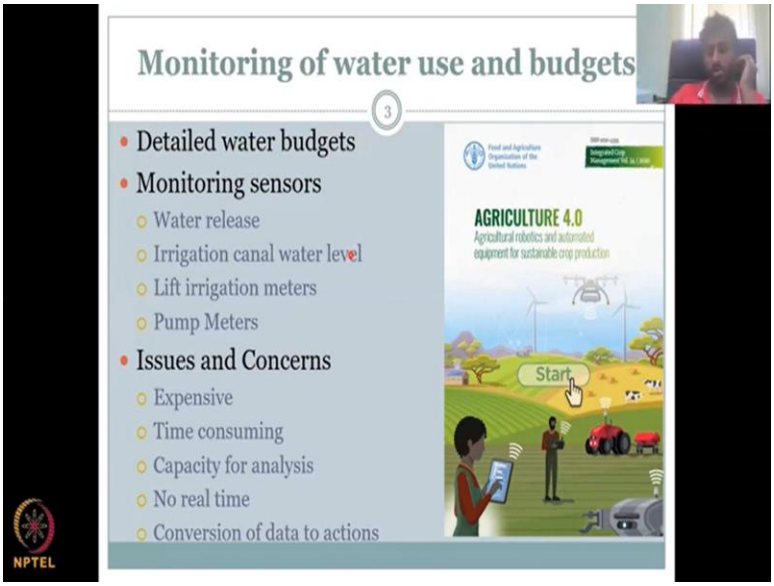

Along with it so now I have managed let us say I have asked the community to manage the water body like diesel make the bunds stronger etcetera. What is also needed is monitoring because you cannot manage what you cannot monitor. There a saying for water especially you cannot manage something if you cannot monitor it. So, monitoring is very important to understand what is the water coming in supply and demand what is the water use and creating budgets. Detailed water budgets is necessary, so that you can know who is doing water types whose lift irrigation without telling the community etcetera.

The monitoring can be used done by mostly sensors electrical sensors battery operated solar power operated etcetera which are nowadays very cheap you can buy these from the market and they can be used for multiple monitoring. One can be used for water release for example I have the reservoir and from the reservoir water is released so there is a reservoir level if you know that 5 hours the sluice gate was open you can say how much the level was before and after and you can know the volume of the water.

Also, you can put meters along the channels to regularly monitor the flow discharge out of the structures, the irrigation canal water levels can also be monitored. Remember that the irrigation canals are like a weir which means it forces water to flow through them. And so there only a

constant velocity discharge that can go through. So, if you know the engineering aspects of the canal like a weir if you put it in and the height of water you can readily calculate the discharge.

Lift irrigation meters, so those pumps that are pulling the water and distributing the water against gravity. Those water should be monitored using meters because the lift can maybe be assume that I am going to lift and put it into a small tank and then distribute the water. While you distribute the water that could be meters and more importantly pump meters. Pump is the pumps that you use for lift irrigation and or you can use for groundwater pumping and putting it into farm ponds etcetera.

So, these can actually give you good data about how much water you take and how much water you use. Some of these can also be estimated using proxy data, proxy data is for example for the pump meter, the connection electricity connection is different for domestic use for agricultural use. So, if you know a particular farm area and a pump is only using one connection the meter and the pump efficiency can be used to estimate how many hours the pump ran and based on the efficiency how many liters it was pumping.

So, all these can be done what it is missing is people and capacity to do it that is put in the issues and concerns. Some people claim meters and data collection is an expensive work a lot of people do not do it, because of the cost involved meters etcetera. It is time consuming you have to set it up you have to collect the data and then a lot of capacity has to be built for analysis as I said you can have these meters, but the meter data has to be converted to a water budget. All the units has to be normalized and that takes some capacity. Simple budgets can be done for example a tank how much water is there how much release so you do not need big capacity.

But for most of the other work there is some capacity needed training needed and that can be done by NGOs. No real time data is available and I just showed a teaser of what can come for the real time but I will come back again. So no real time data is available which means right now what is the water level you know. In small irrigation structures it is not a big dams maybe and that is also sensitive data. But small structures farm ponds we do not have because of the cost and time involved.

And conversion of the data analysis to actions who is the body that has to take care of these actions is limited. Right now we have pushing the community farmers to take these activities and

then manage water better, so the conversion from data to action is done by the community participation.

So, this real-time monitoring can be taken up by smart agricultural systems and it is called agriculture 4.0 where you use a lot of robotics automated equipment ICT, IOT and IOE, ICT is the information communication technology, IOT is internet of things and IOE is internet of everything. So, all these different Names can be used for or methods can be used for procuring the data at a low cost. And then converting it into information for water budgets, especially for these rural surface water storage systems.

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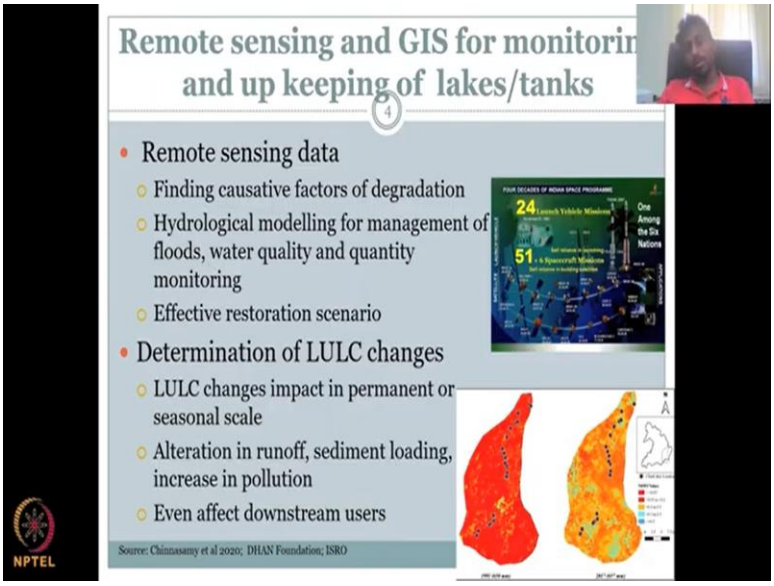

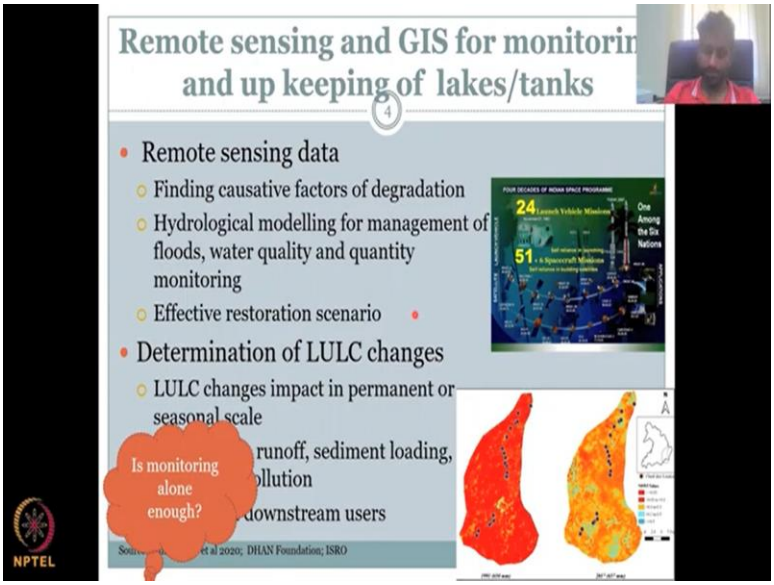

Remote sensing tools can help in performing these so-called monitoring and metering activities and GIS networks can be made. Let us look at some examples for monitoring lakes and tanks and water bodies. Remote sensing data, so what is remote sensing? It is collecting data without touching an object. And we have here a lot of different tools and techniques that can be used for collecting data without touching which are which is by using drones, satellites, cell phones etcetera. And they can be used for finding the causative factors causalities of the degradation of the lakes and tanks.

Hydrological models can be based on these remote sensing data wherein results such as floods water quality and quantity can be obtained and they can be used for monitoring. You can also plan for effective restoration scenarios based on the remote sensing data. And these data can be used for models whereas other scenarios can be used for example climate change I want to convert a lake into smaller tanks for example those kind of scenarios can be effectively tested in a hydrological model which is driven by remote sensing data and then we give it back to the system.

Determination of land use land cover change is very important, we need to understand how these lakes and water bodies are changing. How is the land around the water body changing, and that can be done only by proper monitoring and evaluation based on data. Since we do not have the data we are going to use satellite data to look at how the land has changed if you remember in the last class I showed you an image of the Bangalore lake. The Bangalore lake has evolved so during the evolution it has lost a lot of land for agriculture and urbanization has come up.

In those days you have to go down and do surveys but now you can just use a satellite image and then take the classification based on the image. The use is basically the spatial resolution and temporal resolution are very high which means I can send a satellite every 2 weeks. And then take this data and it is really less expensive because most of this data is open source free.

So once you establish the land use land cover change then alteration and runoff sediment loading increase in pollution can be monitored. So, these determinations of LULC change which is once you change the land there is alteration in runoff sediment loading etcetera can be established easily once you have the change in land cover.

And also the downstream users how they are impacted, you have a lake on top and if you manage it un-properly or polluted the downstream community also faces the change. And those all can be monitored using remote sensing data. Let us see some at least one or two case studies, but before that please understand that these data are free and even our own Indian space research organization ISRO has multiple satellites. The satellite data is free and also very focused on these land use land cover change and mapping of water bodies.

So, you could quickly run some analysis at least the area leave the volume for now but at least the area water spread area if you know it is shrinking you know that it is not pushing it down it is not like a square is being pushed as a cylinder no it is not. So, it is just a area which is losing water because the area of the water is gone it is being encroached and the volume will also be gone because of sedimentation etcetera. So, as a case study I am going to show you a region in Dakote and the blue points you see is the check dams so there are been check dams and I am comparing data between 1991 and 2017.

So this NGO has put in these check dams but they do not have money to you know monitor them as I said it is expensive and also time consuming so we use remote sensing data to look at how the land water availability has changed from 1991 to 2017. And it is very important to take the same or similar rainfall time so you could see that the rainfall is not much different it is 650 millimeters versus 657 millimeters.

And what the study found out is very interesting, we found out that in most regions where the check dam was there the water availability increased in the land and that is an indicator the ND WI, which is an indicator of water availability in the soil in that particular area. Shows a considerable increase from red to blue at least in most regions and this is purely because of the check dam and the check dam has some lift irrigation which lifts the water into remote areas. For example this is the river network and there has been a lot of check dams and lift irrigation from here the water is now available to this spot.

Where in 1991 there is no availability, so even though you do not have data these kind of remote sensing methods can help in assessing the benefits of these structures and also putting water budgets which can be used for further management. But a quick question is monitoring alone enough?

So, for example I am doing water monitoring throwing remote sensing I am putting a satellite to monitor where the water is being used how much water is being used etcetera. Is that alone enough? No, as I clearly explained in the previous slide you need to collect data to understand the water budget. But after that you have to create new monitoring plants and management plans so that sustainably the water can be used.

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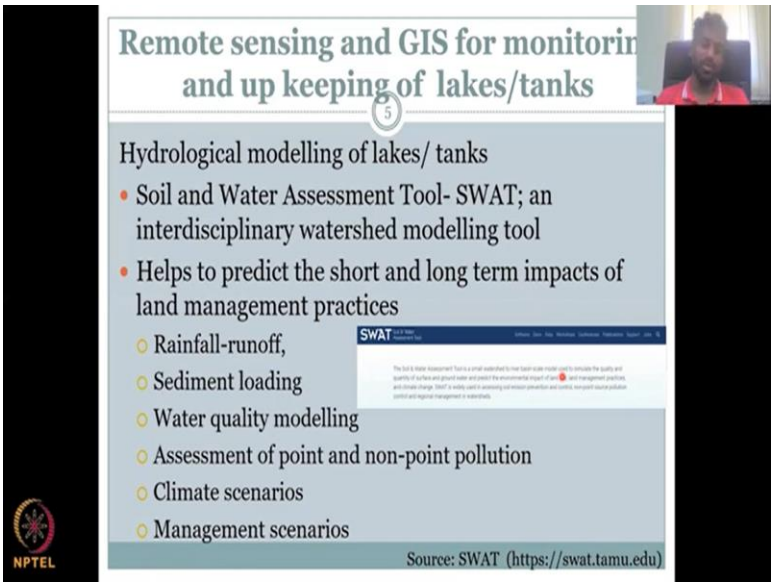

And for that there is lot of hydrological models that are driven by these remote sensing data or observation data one such model is called the swat, which is the soil and water assessment tool and you could see that the swat actually is a very sophisticated model. Most importantly it sets up the hydrological condition for your study area. And it gives multiple scenarios that you could use for using the water.

Let us take some example, so first what you do is you can model the lake tank how much water comes into the lake because the surface runoff is monitored and modeled using this water model you give a land use land cover. And the swat model converts your land use cover into a runoff coefficient, so now I know how much rainfall is happening of that rainfall how much water is coming into the lakes and stuff. It is a very interdisciplinary watershed tool it is not only for soil it is not only for water it is integrating all these multiple disciplines into one tool.

And it helps to predict short and long term impacts of these management practices or conversions. Yes, it basically does rainfall and runoff but it also looks at sediment loading so

once I convert rainfall into runoff the runoff can pick up sediment so I can look at sediment loading. And the water quality modeling can also be done because once the sediment is done the movement of fertilizers etcetera pollution sewage if you have to give data then it can model how it moves from one place to the other. It can also be used for assessment of point and non-point pollutions and climate change scenarios.

Most importantly the different climate change model data can be given and management scenarios can be made, so this is a very important application of this swat model. It not only stops in creating an understanding of the water budget which is by converting rainfall into runoff and compatilizing different water uses.

It also includes climate change for the future predictions on how the hydrology will change, it does not stop there you can also give scenarios. Which means, for example I can say I do not want to grow sugarcane I want to grow different crop how will the water balance be. So, those are the scenarios management scenarios that you can put in the model before you ask the farmers to do it.

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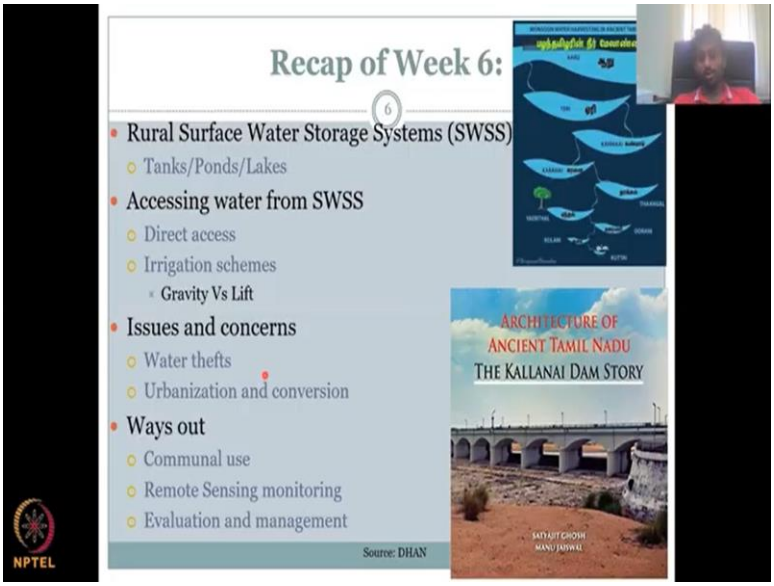

So, with this we have come to the end of week 6 looking at surface water storage systems in rural areas. I will do a quick recap of week 6, we looked at the different water structures present in the rural setting starting from lakes, tanks, ponds and how water are being stored even big dams. We then looked at the axis of water from these sources there direct access where you have a big

channel bringing the water from these dams or reservoirs to your location. There is indirect access by which you have one direct access to the village and from there you take water to your own farmland. So those kind of things are coming under the irrigation schemes.

The irrigation schemes can be divided further into gravity versus lift whereas gravity just is basically the water when you open the gate it flows down into your farm because of gravity you do not have to spend energy to bring the water down. Whereas, lift irrigation is a very particular scheme which is used to pump the water from the main channel to locations which are not connected by the channels. It has been very beneficial especially for highly undulating areas where undulation is present change in elevation.

And the water body is present very low in the elevation whereas the land is present very high. So water is being pushed for pump from that location low elevation location to a higher location using different energy sources. We also looked at issues and concerns both in the last and this class especially the water theft and water fights. Again water theft is not only in rural areas a lot of people have predicted the next war would come because of water wars.

You could see countries transboundary countries always fighting for water. For example in the African regions the countries have to sign back for using the Nile water. And there always some issues and protections for the water concerns. In fact the Kaveri even not even national but even the India within the national I am saying. You have issues like the Kaveri water issue which has been one of the oldest water issue in the world in terms of law and still not resolved.

So, because of that there is a lot of water theft so that is one thing and also people do not get access people are greedy they want to grow cash crops rather than small crops with small water demand then there is lot of water that is happening. And then you have urbanization and conversion whereas the land around the lake is being first converted into urban and slowly the encroachment happens into the water bodies and the water bodies are also converted into urban.

If you go to Bangalore and Chennai you would see a lot of land or areas named after a water body because initially it was a water body for example Velachery, Velachery was the name of the water body that was present in that area. And that was drained and once it got drained the land was dried and then the construction happened. So, all this is kind of your water theft

because you have taken it out and now it is a water theft. Those people do not have good access to drinking water they buy the water from far away and that is also not sustainable.

What are the ways out? There are multiple ways that we used to see in this lecture, one is communal use coming together as a group rather than individually maintaining or managing the water. You combine together as a farmer group for example and look at what is the demand for all the farmers not only one farmer and then you take a collective decision on the water budget how much water to be stored how much water to be used. So, the first is communal use and communal monitoring evaluation and revival so the tank revival is based on community participation.

Then you have remote sensing monitoring and evaluations where data if you do not have data you still can use the freely available satellite and drone data for monitoring and evaluating your water bodies. And evaluation and management is a key you cannot just have water levels it has to be converted to an evaluation of how much water is there and how much can be stored and those have to be converted to a management plan. These are not new for example the Kallanai dam or Anicut is one of the oldest water body serving still now.

It was not built by the Britishers it was built by the Cholan king Karikala and it still stands and does its duty of storing the water diverting the water etcetera. So, all this is not new what we have done is we have not picked up the traditional knowledge and we have abused the system. For example, urbanization I am saying without looking into the water demand. So, all this has to be detached reworked and then go back to traditional knowledge on how these water bodies are managed and also look at new technologies and solutions to manage water better.

With this I am concluding the surface water storage system lecture for rural water resource management. In the future lectures, we will look at some case studies and how to come out of these issues collectively thank you.

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