Rural Water Resources Management
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Lecture 48
Nature based wetlands and rain gardens

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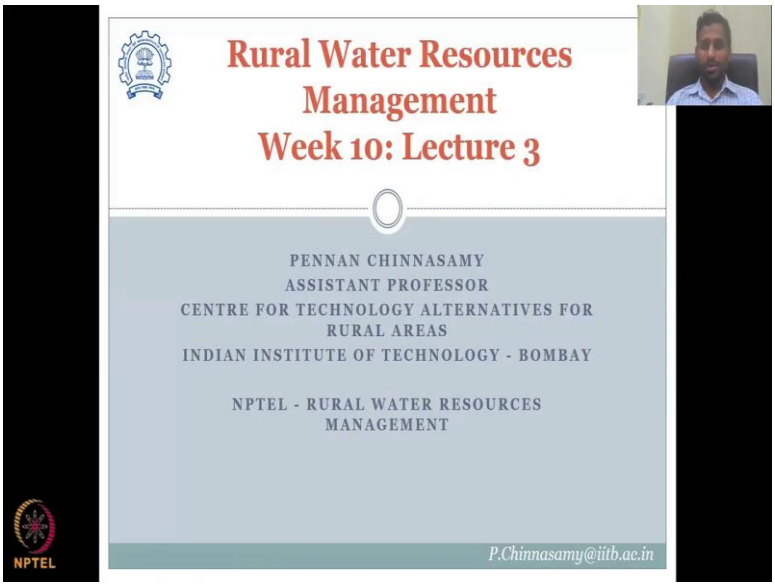

Hello everyone, welcome to NPTEL course on Rural Water Resources Management. This is week 10, lecture 3. In this week, we have been looking at different water resource methods, infrastructures that can be created using nature-based solutions to increase the rural water resource. All these are been looking at this the supply side management because you are increasing the supply.

So, in the constructed methods we looked at dams and big cemented structures to capture the water pools, etcetera, whereas in this week, we are looking at more nature-based solutions.

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And nature-based solutions are more important, because they preserve the ecosystem. The last class we looked at check dams and channels along the hillslopes. Today let us look at rain gardens and sponge networks. Name Rain garden think about how that name has been coined. It is a garden which is grown by rainwater and also stores rainwater.

So, it is kind of a location in a depression where you have land depression it is filled with soil and some native plants are put which actually controls the rainwater from flowing as runoff. And also it goes the plants, like the word sponge, like a sponge, if you put it in a water plate, I have a thin plate and then you squeeze a sponge and put it, this is all the water will be taken up by the sponge.

So now you do not have flood in the plate, same thing in the land, you can have water moving everywhere, but in certain locations, you can have a rain garden, which can act like a sponge, it will absorb all the water, it is kind of a newer method, because those who have studied the ecosystem services and the benefits of native plants and species have invested in the science and technology of having rain garden.

Always these were naturally there, nature-based solutions, but it was not in a very systematic way maintained. And this is where a lot of people have started using these methods after studying them. Basically learning from nature and reapplying it to nature. The garden consists of only native plants, I should underline only why because if you have an invasive species like eucalyptus, then it can actually degrade the groundwater.

Yes, you need to store the water, you need to reduce the runoff, but it also has to be done using a native plant. It is planted in local systems. In a local small depression and channel runoff, you are not taking all the runoff to a different location and putting the rain garden you are putting it inside your own location. By channelizing the runoff into the location.

Here the location can be anywhere inside your area it could be inside the village it could be inside a city but more importantly, it is decentralized because it is small small rain gardens in pockets which can control all the water runoff. First, the plants to store down the water so it is two aspects which is actually beautifully working.

When water comes let us see what happens so water is coming through, this way. It is first hitting the plant and slowing down when it starts to slow down the soil underneath the plant is very loosely bound and has a lot of infiltration capacity because of the roots, loosely means it is not going to fall. But it is not as like a grassland, water can still penetrate.

So first your water slows down, then the mulch soil around the plant then aid to infiltrate, as I said you put the depression, you fill the depression with mulch. It is a mixture of wood, soil and other particles, natural based particles that can increase the infiltration rate, have a lot of storativity, storage and also has space for the roots to grow.

Basically it is a medium with high porosity a lot of space for air and water to move. Mostly has plants that have high density example shoots and grass because you want the plant to slow down the water. So it is like a bridge, it is like a dam that is built with plants, it is like this and water cannot flow through so it is just going to get hit and stay there for a long time. So it runs and then hits these grasses and then slows down into the groundwater as recharged.

Now, what can be the use of the plants, so these grasses these shoots can be taken and given to the livestock like cattle and cows, which actually feed on them. So it is not going to waste you are just building an ecosystem. So now you see how everything adds up, you slow down the water, you reduce the runoff have more water for agriculture and drinking.

Also, the process in which you are slowing down the water is letting you grow grass and that grass you can give your cattle unlike a constructed dam where it is just cement, it does the same work, but here it is more nature-based. It does not pond water. Think about it, there is no ponding of water because the plants are growing.

So, it does evapo-transpirate which is it takes the water and pushes it up, but water goes down and that is needed because in these areas with lot of shoots and plants if you have ponded water then mosquitoes can come. So because of mosquitoes you see a lot of these small rain gardens you know taken off so that can be changed, it increases infiltration. That is what is the main driving point here.

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The next one we want to see is harvesting and harnessing. First, you harvest the runoff, the runoff is the water that goes wasted on the agricultural fields, you harvest it and then harness it which is use it. So, how do you harvest it? Here in Africa, you can see that the FAO's work, what they are doing is they are making on the dry land on the dry land small small depressions with plants, initially the plants might find it difficult to grow because it had it needs water and it cannot wait for a water to come in and seep and go.

So initially you will have to take care of it, maybe for a month or so, and then the rainfall, when the rainfall comes in all these small pockets are going to be individual rain gardens by itself, which means water will flow into this small small locations and get stored and recharged locally, there is a root zone there because there is a plant and that plant will take the water and grow. So you are harvesting and harnessing at the same time.

You can see here you can also put these in channels along the fields and other networks where water can flow. So either you can work on a sloppy land where nothing is growing and water just flows off as runoff or you can also have water waves and so on the side you can plant it where the water can feed the plant and then the plant grows.

So, thereby increasing the uptake of the water. So, all is happening is, water is flowing make sure you uptake the water as a plant and then store it in the plant or you can store it in the soil around the plant, what do you mean by storing in the plant? Is leaves fruits food etcetera, all these have water in it, what do I mean by storing it in the soil?

It is because of the root zone, the root will always be moisture content high because the plant is growing. The plant just pulls the water and stores the water there. It does not let it go that easily. So these are also called as Bio-retention systems because it is holding onto the water so it is called a retention system. It is biologically based bio its living organism which is a plant or a sapling here and that is why it is called a Bio retention system.

Rainfall is first scattered, I will go through the steps again. Rainfall is first captured through these channels or through these small depressions. Then use for plant that needs less maintenance. Here the key is less maintenance, look at it is an Africa and other regions dry regions. The maintenance should be less, you should not be going off and checking the bank, checking the rocks and stuff.

There is nothing here, there is no movable parts, when water comes it will eventually flow into the depression thereby increasing the storativity on the land and then recharging the structure. Benefits apart from the rainwater harvesting, what are the benefits are you getting? It filters the pollutants. For example excess fertilizers, as you see here there is excess plants that are growing, your rice and other wheat and other things.

So, these are growing and when water is having the fertilizer it can go and slowly get down into these depressions and recharge. While it is recharging your fertilizers are placed on the soil pits. So, all you can do is you can go there and remove the soil top part of the soil and then recycle the soil so that, your fertilizers are remove, excess fertilizers.

You are growing native vegetation thereby growing native species to support the ecosystem there, the plants, the animals, the insects which are dependent all will be there because they are growing native vegetation. Can also aid in storm control measures and attracts biodiversity because you have these depressions if you do not have this depression, what will happen, water will flow and remove out of the watershed.

So, it is kind of a storm which comes and passes through thereby increasing the storm. But when you have these small small volumes that store the water then what happens is, the water

can flow and get into the storm locations thereby recharging and creating more storm control measures. It attracts biodiversity because as I said you are going to grow native plantations and native plantations do attract biodiversity.

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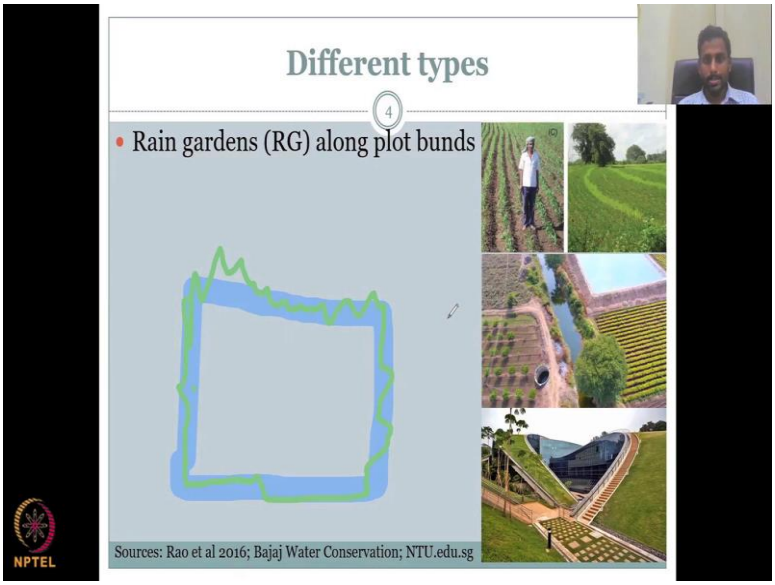

What are the different types? There are multiple multiple types of these, nature-based rainwater harvesting. Basically, it is a thick soil, on top of which there is a plant and the plant and the soil are acting together to slow down the water and infiltrate. So, first slowing down is done by the plants and then the root zone and the soil are in a particular fashion like mulch or treated soil which can actually increase the movement of water.

Let us see what are the different types, Rain gardens along plot bunds. You know the plot, the plot where you do agriculture. For example, this is your plot and you can have your rain gardens along these plots, so, you can grow along these plots thereby increasing the soil water uptake and reducing the fertilizer from going out and mixing with other water and then holding the water inside slowing down the water.

So, you have this water will come go into it but then it slows down because it cannot flow out then water goes inside the block. Rain gardens before entry into the water bodies, this is very important, which you see, the first example is this, you see a rain garden in between the plots along the bunds, you can see here people standing along the bands and making these kinds of rain gardens so that water does not flow out of the body, it just stays inside your take.

So, for example, water flows like this, it gets slowed down and go into as infiltration. Same thing here water flows, hits this you can see a different color, Rain garden and it goes down. What happens here, here you are having a different type of rain garden along the boundary of the river bodies. The river body is your stream or river, the water bodies.

The water body is your stream or river and what happens is, you have a rain garden which is just before the entry into the water. So this is the entry into the water and you have a rain garden. What it does is, it arrests your soil from entering into the water body thereby reducing sediments. It arrest the fertilizers from entering the water body.

It also arrests the water from entering into the water body because you want more water on the soil. So it prevents loss of water as surface water body, surface water movement. So, this is being stopped and then reduces goes into as runoff inside the soil as groundwater recharge can also act as a filter for river quality because if you want to preserve, if you want to keep the river clean, then you need to reduce the sediments entering you need to reduce the agricultural fertilizers entry.

So, for example, here is fertilizers, it should not go into the water and these rain gardens you can see can prevent that, the rain garden will stop the water and prevent the fertilizers from mixing into the river body and keep the water inside the plot the fertilizer inside the plot. Rain garden on rooftops.

So, you can see on the top of the roof you can see that there is, you can put a rain garden you can put a soil and on the soil if you have some plants, the plants will first capture the rainfall

and then let the rainfall not pass it because it blocks the rainfall and the rainfall would just go into the soil as recharge, then by growing the plants.

Here there is no storage there is no groundwater because it is a rooftop, on the roof you do not have grown water. So the idea is on the roof you put soil and in the soil some seedlings can grow like grass and shoots. So when there is a rainfall, the grass and shoot will lower the runoff potential because it slows down the water and the slow down water can enter the soil as the recharge.

Increase capture, as I said the plants will capture more rainfall slows down the runoff, it is blocking the runoff and growing more as infiltration, can reroute the water, best for locations with less land. What do you mean by rerouting the water? Is because you can capture the water in the soil. And then from there a tube can be put to take it out into the field or tanks as recharged.

So even though it is a constructed one because on the roof here constructing the solution is a nature-based, solution which is soil and plant. So the active part is soil and plant. And you will be amazed to know what this is. This is the Nanyang Technological University, Singapore's library. So on top of the roof of the library, they made this small piece of rain garden kind of effect where they put soil and grass and when there is rainfall, this grass flourishes and it reduces the runoff coming down.

During the hot season and during non-rainy period, the students can climb the stairs and sit on top of these rain gardens. They can sit and read a book on top of the library. How many people can read a library on the roof of the library? So this is how Singapore does this nature-based solutions because they have less land and but they have the good money to study these scientific topics and they have done very well in reducing the runoff increasing the green color in the campus.

So you see this runoff is reduced more infiltration into the soil and plant would grow. So people can enjoy reading a book, having coffee on top of the library. So, the library was done by clearing the land but on top of the land, on top of the library they make sure, some ecosystem can be preserved some plants can grow. Note only that some gardens are also there, it is not only grass.

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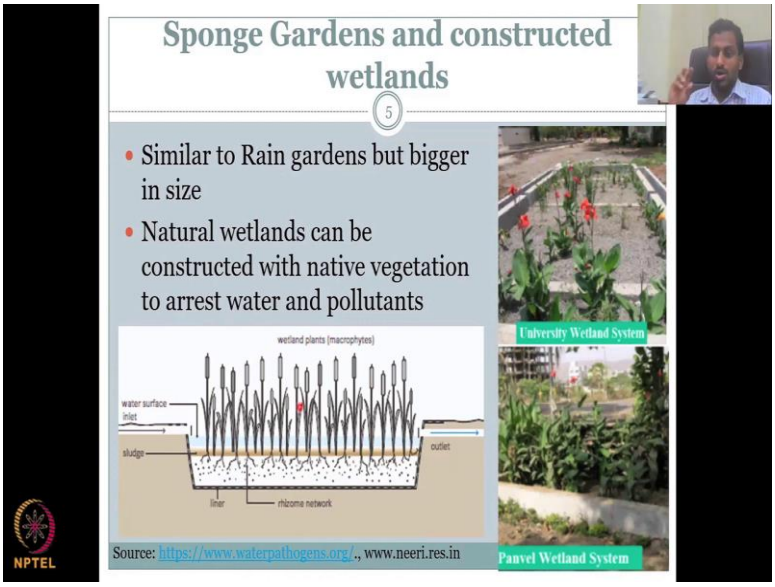

The next one we want to look at sponge garden concept is constructed wetlands. So the wetland itself is a nature-based solution. But you can also construct a wetland. So, all the wetland is, it has to have the specific wetland ecosystem vegetation, and a soil with water always a lot of water which can reduce the runoff and flourish the plant's growth.

So how do they do it? The government agencies like NEERI, etcetera. They use these nature-based solutions. So here they want to clean the water, not only store the rainwater, they want to clean the water in the rural system, thereby giving cleaner water to cattle, cleaner water to agriculture. Similar to rainwater, but bigger garden. Similar to rain garden, but bigger insights. Look at how the size is, it is not small as a rain garden but bigger.

And most importantly, the plants that grow inside this constructed wetland or sponge garden is plants that can see stay in water for a long time and plants that can take off the impurities from water. So, they convert the impurities into plant growth material like leaves, flowers, foods, etcetera. Here there is some construction as I said, there is some construction to just make sure that you have a land bounded inside where water can grow.

This can be used in urban system, they can be used in rural system. Let us take a rural system because this course is on Rural water source management, there you need not do a construction you can just cut down a land, dig the land and small lining can be given, so that the impure water cannot go into the aquifer.

So, then what you do is, you route all the polluted water. So, in your rural areas, you may have sewage water coming, you may have the bad water or unclean dirty water from poultry which is chicken, chicken farming or your livestock which is your cattle and other things can have a lot of water coming.

So, all these water can be channeled into these wetlands and these plants have the capacity to uptake these impurities grow and break down the impurities into good components, because plants while uptaking it can make it soluble and actually break down the components so that it can be readily uptaken and whatever comes out which is your plants products, fruits, leaves etcetera, can be given back to the livestock the cattle to eat and then as long as it does not have any symptoms or signatures of the impurities, because most of the time it is broken.

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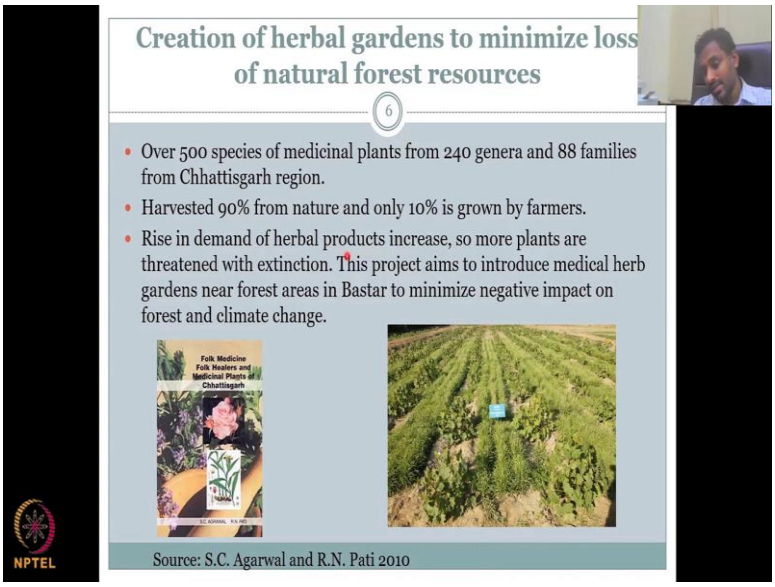

So, not only does these arrest the water, but also it cleans the water and that is also needed for Rural water resource management, because most of the time it is bad water is available and you need to clean it. So, the bigger size gardens are, these kinds of herbal gardens in forested area, because it mostly the forests are lost in some villages.

Thereby you can go there and identify the native herbal species, you can plant these species in the garden, small small gardens and let them grow. So these are can be done by the local villagers tribals who are their, minorities because they know the system. So for example, this statistical book on folk medicine and folk healers are based on traditional knowledge.

Traditional knowledge from the locals, the tribals who live there, and they can actually grow these better because the native species do not need any management, they just grow there. They have been there for centuries, the plants they know, the soil they know, the rainfall pattern. The climate change is impacting but the soil and other things are similar. So these can actually help in regrowing the forest, regrowing these natural systems, thereby increasing more water capture, increasing recharge into the ground.

Over 500 species of medicinal plants, from 240 genera and 88 families are there in Chhattisgarh regional alone. There is a very rich biodiversity of medicinal plants that have been identified in this book. And those can be used as your Rain gardens, as your constructed wetlands. Harvested 90 percent from nature only 10 percent is grown by farmers, so these are not easily to be grown.

Because even farm for these it is just nature grows by itself 90 percent. So rise in demand of herbal products is also increasing. So what I am saying is you can also make a business out of it, a startup can be made just based on converting these depressions into rain gardens and inside the rain garden you can put these kinds of species that can help in increasing the availability of medicinal plants and the medicine plants can be sold to industry.

Let us see for example, there is a lot of herbal products that are being needed in the current generation you see a lot of products that are more nature-based herbal etcetera. So more plants are needed for that, more herbal Ayurvedic plants are needed. So, this project by the, Folk medicine Folk healers Association and other things in Chhattisgarh.

They grow more medical plants near the forested area Buster where there is there is no forest and they reduce the impact of climate change because these actually capture rainfall and recharge the water. Again as I said these are been there for centuries. They are not new medicinal plants from other countries, it is the local folk, what do you mean by folk?

Is local, folk medicine, folk art, folk culture they say, which means local culture from the village, local food from the village. These can actually be used to recharge the ground water and enhance the ecosystem services. Please remember that these plants have been there for centuries, which means they know how to adapt to that situation better than any other plant. That is why they will be more successful.

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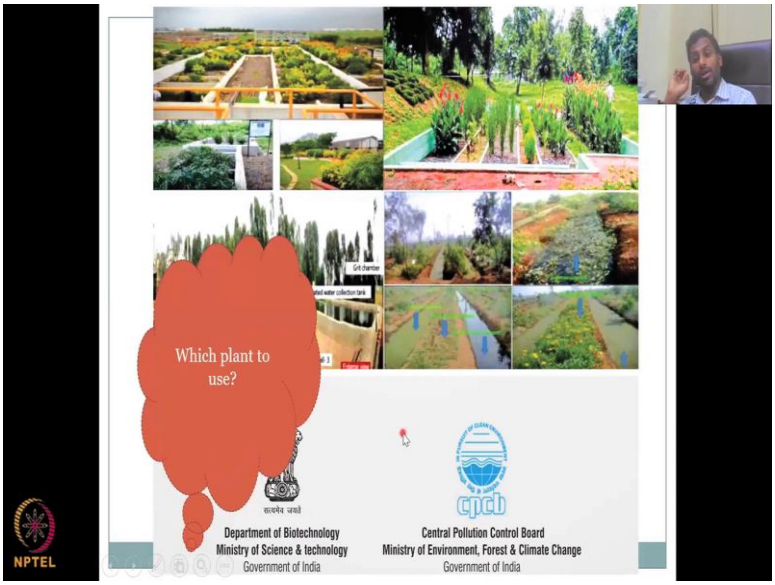

But how do others grow. Like for example, you and I when we want to go to the rural village and want to grow a plant. To make sure that I reduce the runoff like here, treatment plots, or I use wetlands constructed wetlands to treat the bad water, here what they are doing, the are bringing the polluted water inside and then the plants are uptaking the polluted water thereby leaving only the good water in the recharge and other networks also on the stream depressions etcetera.

So we have identified the location, but how do you identify the plants? So, these books by the Department of Biotechnology Ministry of Science and Technology and the CPCB have

identified a lot of plants that can be grown and you would be amazed to see that both the Department of Biotechnology, Minister of Science and Technology.

And also the CPCB which is the Central Pollution Control Board have joined hands together in identifying these types of systems not fully constructed, but nature-based solutions, where a nature-based solution can impact or clean the water at a much lower cost and at a more sustainable rate. Also, these are decentralized options that can be made these major based solutions rather than centralized applications, which are not that good or it cannot be justifiable to keep on constructing everywhere.

As you see here there is less construction more on nature-based, how will this look like in a constructed fully engineered one, you will not have these plants, you will have an area where water comes, a spreading area, a drying area and then UV and other machines and then the water is purified. Then you take a sewage treatment plant.

There is no plants there, so only engineering products. So please understand this is what is needed in the new system lot of nature-based solutions and we will be using these books and knowledge from other literature on what plants to use. With this, I would conclude today's lecture. Thank you.