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Week – 04
Lecture - 26
Soil erosion management

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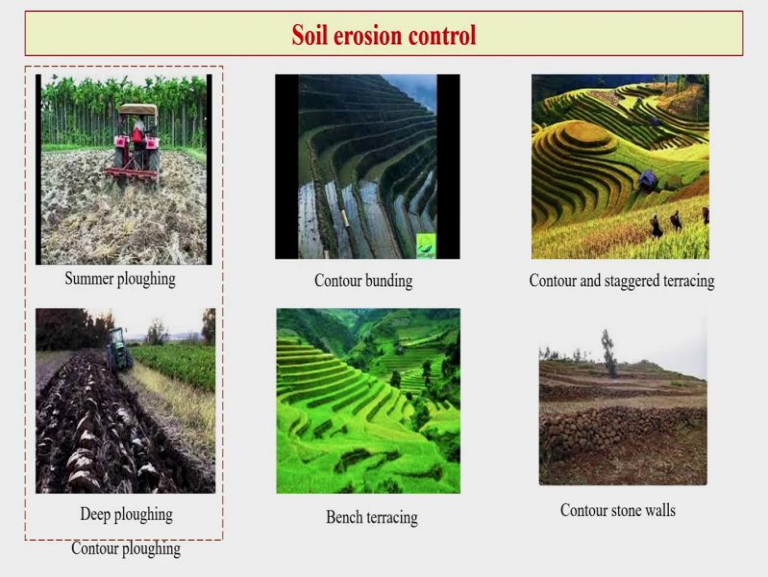

Continuing to soil erosion measures just in the previous slides, we discussed about various control mechanism.

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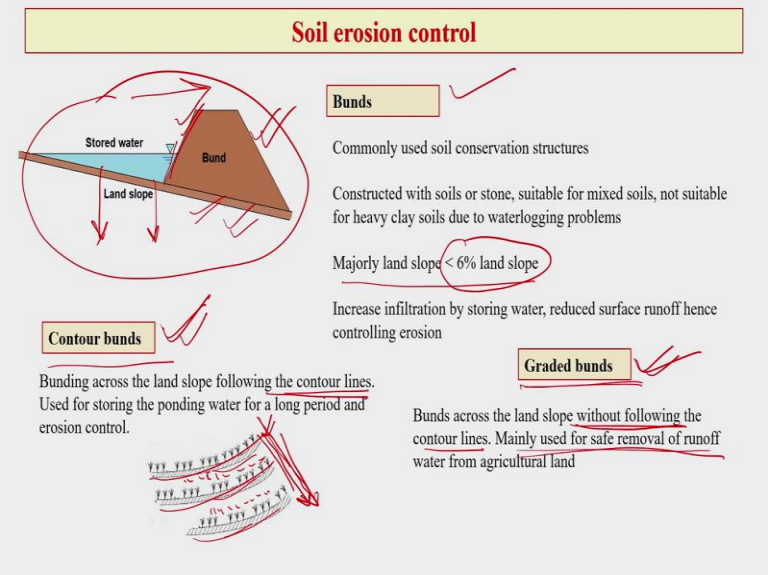

And if you see that, there are also certain technologies or techniques that are being used for soil erosion control and very popular in case of watershed management is bund, control bunds and graded bunds. So, if you look at this picture, this shows that how we use bunds and these are commonly used for soil conservation structures. Its generally constructed with the objective to conserve the water and also to restrict or stop the soil erosion and is normally suitable for all kinds of soil, but heavy clay soil is somehow not suitable for this kind of bund.

The basic reason is that heavy clay soil will somehow create waterlogging problems. And we know that why that happens because of this clay soil's property. So, majority of the lands, the slope that are that bunds is suitable is less than 6 percent of slope. And in case of bonding we will find that there is a increase infiltration by storing water because if water is stored because of this bund, then there of course will be water infiltration below the ground and that is how it can also enhance or increase the ground water level.So, there are as I said that in one way that it could reduce the soil loss, another way it can conserve the water store water and also increase the water infiltration capacity and thus increase the ground water level.

Next is contour bund, again very useful in certain topology. So, bunding generally is done across the land slope and it follows the contour line. Contour bund you can also see in plains also, normally, you will see that one contour will be made and then another contour will be made across the contour line.

So, like this way, even in planes, you will see that bunding across the land slope normally along the contour lines are being made. And these again are used for storing the water for a long period of time and also to stop or reduce the soil loss. So, if you imagine the slope from this side to this direction, then you can have these kinds of contour bunds. And along the wind or water flow, if the soil tries to go away from the system in this contour helped them to store in between the contours. So, that is how the top soil largely remains within the area within the system.

So, next comes your graded bunds; graded bunds are again across the land slope, but without following the contour lines. So, this is the basic difference between contour bunds and graded bunds, contour bunds, it follows the contour lines, in case of graded bunds, it does not follow the contour lines. These are mainly used for safe removal of runoff water from the agricultural land. And often you will find that areas where flood is very recurrent and also, there is lot of rice cultivation is being carried out, you will find that graded bunds are often used in those kinds of areas.

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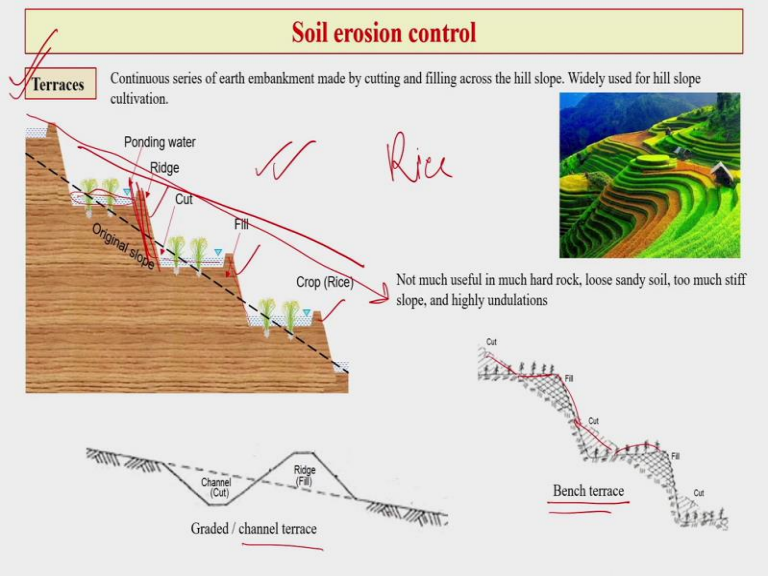

Continue with the soil erosion control measures, the next very popular technique is terraces. I just discussed in a couple of slides back also about this. Terraces are a continuous series of earth embankment. So, you see here 1, 2, like that. And from this picture itself you can very easily understand how terraces work. It is normally cutting and filling across the hill slope and it is used mostly in hilly terrain.

As you see that here you will create a kind of an embankment and the soil that you will find you will put here in the next pit here and then again you will have another ridge. So, what has happened that these ridges allow also to store little bit of water here, but certainly along the slope, if there is any chance of soil going down the slope, these ridges reduce that runoff loss. So it stores the water here, the plants you can grow in this water, rice can be grown very nicely in this kind of terraces.

And as I said that Banaue in Philippines is very famous. This picture is from there. So, this is one of the way that you cut and fill and then you have the ridges, you have the little bit of water here. So, while reducing the erosion along the slope, you are also storing water and you can grow crop. So, there is kind of a win, win solution that you can get in hilly terrain through terraces.

So, there are two more terraces that you can see that often in hilly terrain, one is graded or channel terrace and another is bench terraces. Bench terraces couple of slide back, I have also showed that how it looks like, there will be a cut and then a little bit of flatland and then you fill it again you cut it and then again you fill it.

So, it goes alternatively and then you see a kind of a bench kind of system, where you can grow again different types of crop. In many South Asian countries, you will find that rice being grown heavily in this kind of terraces. So, it is clear that through terraces in hilly ecosystem, you can reduce the soil loss or erosion and at the same time you can store water and you can also grow crop. So, this is a wonderful technique.

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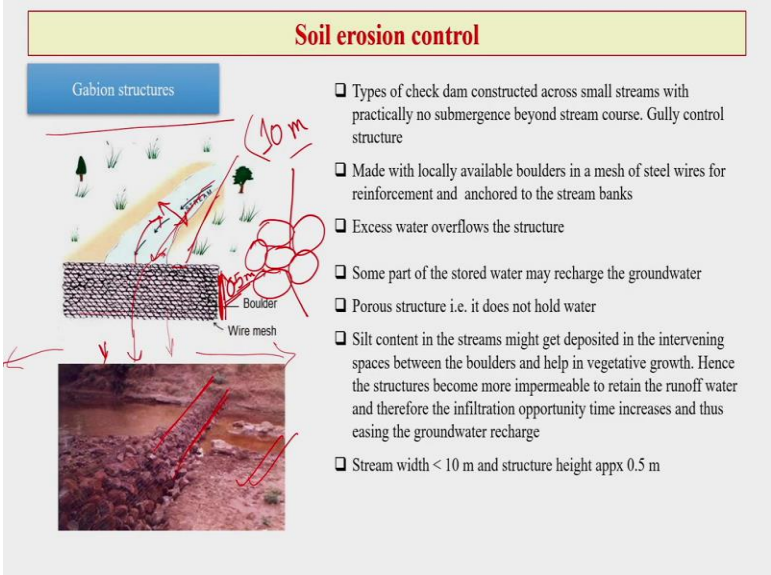

Now, next comes Gabion structure, which is a little bit you can say that technology is going now, from the hilly region it is slowly, slowly coming towards the plane and how we handle those kinds of soil erosion problem, when it comes to water flows from the hill towards the plain land. Gabion you can have made of locally available material, many places in Madhya Pradesh, in Orissa, we have implemented this kind of boulder and wire mesh type of Gabion structure. This helps the reducing the speed of the water and does the flush of water, taking the good quality topsoil from the system, it can be not totally stopped, but at least reduced quite significantly.

What we will do here is that these wire mesh with boulder, they have little in between every boulder there is a space like if I can draw it here. So, you see that there will be some gaps, these are the gaps. So, small gaps in between boulders, through that the water can pass through very easily, but soil will be somehow will be restricted there. And there is a chance that that in this side the other side you will be having a deposition of the soils which otherwise would have gone out of the system.

So, this is an real picture from a field that how the Gabion has been made using locally available boulder, wire maze and sometimes even in areas where resources are very poor community can be asked to use even the roots and the leafs also as a kind of a packing material. So, there are various ways that we can utilize the indigenous materials from the site itself. So, the types of check dam constructed across small streams with practically no submergence beyond the stream course, it is kind of a gully structure, where gabion works very nicely.

It is made normally with as I said locally available material, excess water overflows the structure. Suppose you have, this is the structures say this structure can store some water, but if the water flow inflow from the top from the mountain or hill is very high, the extra water will overflow these things and come on that side.

So, this Gabion structure also would somehow reduce the chances of flooding in the downstream area. Some part of the stored water and the other side of the Gabion can also help enriching the groundwater. So, as I said this is a porous structure, it does not completely stop the water; slowly the water speed goes down slowly it comes in the other side and this can be utilized for irrigation purpose growing crop in the both side of the water stream.

So, width of this stream this should be ideally less than 10 meter. So, beyond that probably the amount of volume of water will be higher and this kind of structure may not be able to withstand the pressure. The height of the structure should be ideally around 0.5 meter, this height 0.5 meter.

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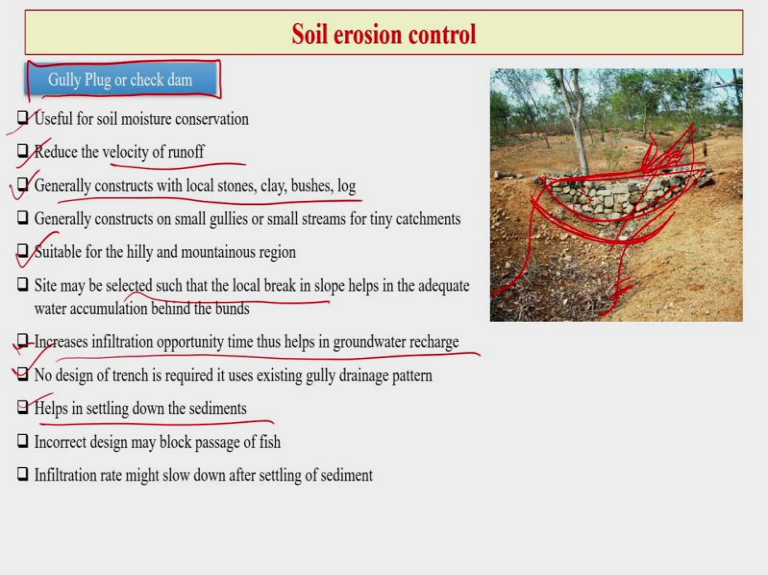

Now, next, after Gabion we have gully plug; another techniques that can be used for controlling erosion and water loss. As you see that here that this is a gully, this is the gully which has been plugged by again locally available material boulders stones, and as I said that it can be packed also with row dry root, dry leaves, etcetera whatever locally available, because certain area you will find that even communication or transportation of required material will be very, very difficult.

So, in that case, whatever material is available in situ can be utilized in a smart way to reduce the soil loss. It is useful for soil moisture conservation; it reduces the velocity of a runoff. Suppose, the water is flowing from this side it will definitely reduce the speed and thus faster way of losing soil from the system. Generally, it is constructed with the local stones, clay, bushes, etcetera.

Generally, people, community can be asked to construct on small gullies or small streams, but definitely for large volume of water, it is not suitable it can't withstand. Site may be selected such that local breaking slope it helps and it is adequate for accumulation behind the bunds. It also increases infiltration opportunity thus it helps in groundwater recharge. No design of trenches required; it uses the existing gully drainage pattern.So, you need not to worry for designing or doing something extra whatever naturally available in the area this particular very indigenous way of having gully plugging will work and it will follow the natural existing trench

whatever is there in that particular location. It also helps in setting down the sediments. If water flows on this side definitely it will allow some settling of sediments on the other side, but at times if it is made in correct manner to may block the passage of fishes which are coming with the water.

So, sometimes what happens is that most of the fishes will be stopped to come pass through these and it will be somewhere here. So, between the boulders or stones if you have a little porous structure, then there is always opportunity for water to flow in and also along with that fishes will also can come out.

Why it is done? The reason behind that if it stops the movement of fish completely, then only the people residing in this upstream area will get the benefit. So, that is how this is being done. Infiltration rate might slow down, after heavy settling of sediment here and that is why you need a little bit of spaces in between the boulder; otherwise you will have heavy sedimentation here upper side and then there will kind of a reduction of the water flow very significantly.

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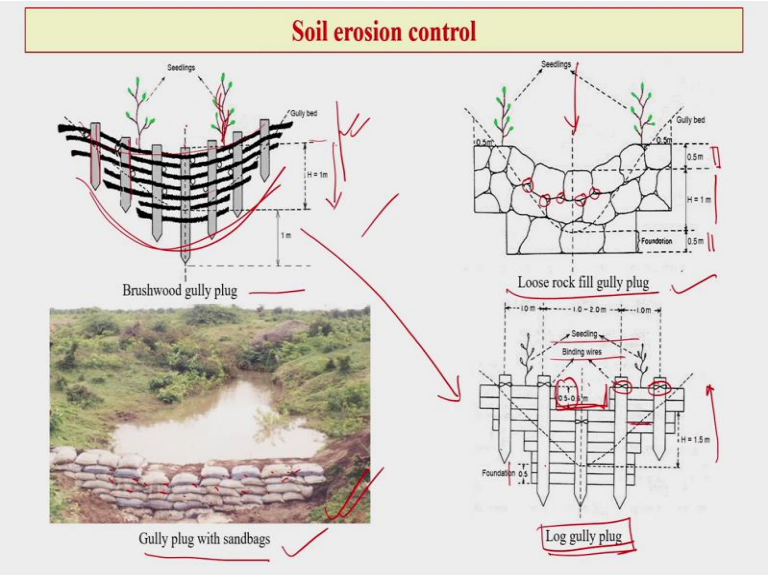

Now, we also will see that in watershed management there are uses or application of brushwood gully plug, then we have loose rock fill gully plug, we have gully plug with sandbags, very popular in certain parts of India, then we have log gully plug. As you see that these each one of these requires a certain amount of design and a certain amount of precision for them to work in a perfect manner.

Now, if you look at the brushwood gully plug, as it shows that there are certain planks that are being used, this can be made of bamboo, in areas where bamboo is easily available, and otherwise wooden planks can be used. And this is the way that you pluck the gully. The height of the center plank will be almost around 2 meter.

So, you can grow also plants and seedlings here on the other side of the gully plug because that not only allows you to anchor the soil, but at the same time it also reduces the flow of water, the speed of water, and you could also get some useful product in that particular area. Some places we see that rice can also be grown on the drainage line on this side of this kind of brushwood gully plug.

But one thing is important in this kind of system is to see that the height is quite important, because that will decide the amount of pressure that is going to fall on this kind of gully plugs. So, we need to keep in mind that how much water we will be allowed to store there. So, this height will decide that particular volume of water that will be allowed to store on the other side of the gully plug.And that will also decide in on the longevity or duration of this gully plug once it is made.

Now, if you come to lose rock fill gully plug, we just discussed in the previous slide that there is also a science and engineering is involved. So, ideal condition is that you have a foundation of 0.5 meter, then 1-meter depth of your rock feeling and then you have again top of 0.5 meter.

So, that one important point here as I said that in between the boulder there should be some spore space gaps so that the water from the upstream can slowly pass through these boulders, otherwise, there will be a different problem as I explained in the previous slides. Gully plug which sandbag very commonly visible in many parts of India. So, as you see that these bags are also kept in such a manner that in between you have certain number of gaps, certain amount of gaps through which the water will slowly flow from the upstream to the downstream.

Then finally, we come here log gully plug. Here also you have opportunity to grow plants seedling, this is one step I could say that advanced then the brushwood gully plug. Here also we have plank and we have horizontal plank as well as vertical plank and foundation is once again like the previous one 0.5-meter foundation, then you have here a 1.5 meter of height and then another 0.5 meter of top regime.

So, what we do here is that, ideally, we bind these planks with where, but again here as you see that ideally, we should also keep kind of gaps a in between this plank and this is the space that you leave for the water to flow. So, if there is excess amount of water on the other side upstream, then the water will flow over this plug. So, this is how you see that we have different types of measures that we can take for regulating soil erosion.

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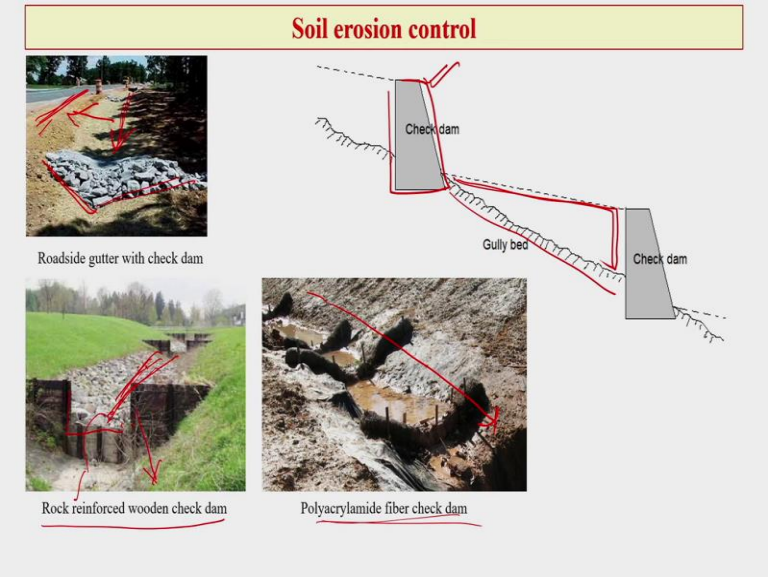

Now, next is roadside gutter with check dam, we mentioned a few slides back that this is a very common sight in parts of our country. And what we see is that along the road, you will find that there is kind of a channels or ditch are formed and those roadside channels also carry huge amount of water after heavy rainfall and this takes away a huge amount of soil. Sometimes it negatively affects the roads.

And on the other side of course it takes away a lot of amount of water and soil with the flow of water. So, here roadside gutter with check dam can also be done very easily to reduce the flow of water.

Now, we can also see that if you want to go for in a bigger scale from a small village or small community to a large area, then you will see that similar kind of concept can be used in making large check dam across a very big area of gully bed.So, here is the area where you will have the sedimentation of the soil that will come from upstream to the downstream, but this check dam basically will do the same as we discussed in the previous examples.

Rock reinforced wooden check dam is another approach which used in various parts of the world. So, in other side they use the planks and then other side they put rocks.

So, one way the rocks we reduce the flow of water, if the water flow is very heavy, then it will overflow and come this side. If the water flow is a little less then they will slowly move through the soil and will recharge infiltrate and recharge the groundwater.

Next comes polyacrylamide fiber check dam, this is again a little advanced and largely visible in a developed country. So, polyacrylamide fiber check dam is used again along the slope, but the principle is same to reduce the flow of velocity of water, allow the water to get stored, thus allow infiltration which will result into groundwater recharge.

So, the principle is same, but the way that you do different techniques are there it depends on the availability of resources and also manpower and primarily decided also by the amount of water or volume of water that come in particular area or system.

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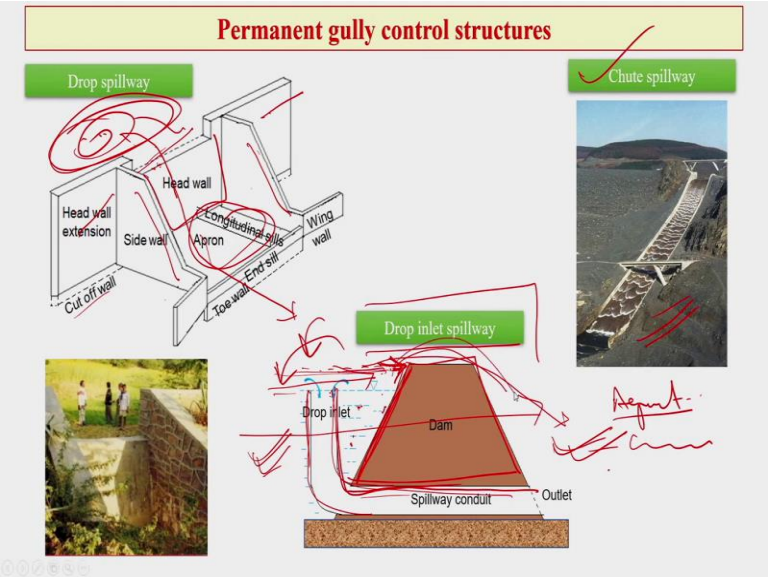

Then we have had another set of technology or techniques for reducing soil erosion and water loss is permanent gully control structure. These are little bit costly and require some investment and largely in our country, it is being done under different government schemes or sometimes some private party also comes in to help.

Now, as you see that we have this kind of structure in some places with a head wall and then you have head wall extension on the both side, you have side wall and mode mostly made of concrete cut off wall and then you have the apron here. So, the water will flow from there from upstream it will store up to this height if the water flow is extra it will come through this and then flow across that apron to the downstream. Till the water volume height is less than this head wall water will be stored here and there is chance that of course the siltation will also take place in this site.

Now, another way is chute spillway which can be seen in again various parts of the world. Now, this is also being used in with a similar kind of principle and then you have drop inlet spillway. Now, here what we do is that we have a small structural dam here and then you stop the water to flow directly from this side to the other side.

What you do here is that you have a conduit here in the other side, because when you have this dam up to this height, the water will be stored in the upstream area. So, what you do is that you have a conduit here and the water which is stored here, because only when the water will be even much higher volume of water and suppose heavy rainfall then the water level will come up and then we will cross and go other side. Till this height, the water will be stored here.

Now, in case of conduit, what it helps is that this water will pass through from this side to that side. So, even if the upstream, if there is not too much of rainfall or if the volume of water still not enough to cross the dam, still you can pass on the water from the upstream to the downstream through this conduit. This is the idea of having it.

Suppose if you have also good agricultural practices here, soil quality is good, then this could be drop inlet spillway could be one very good way to utilize the water from the upstream to the downstream even when the volume of water is not enough to cross the dam and come to the other side.