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ECOLOGY AND ENVIRONMENT
Sustainability and Case Studies
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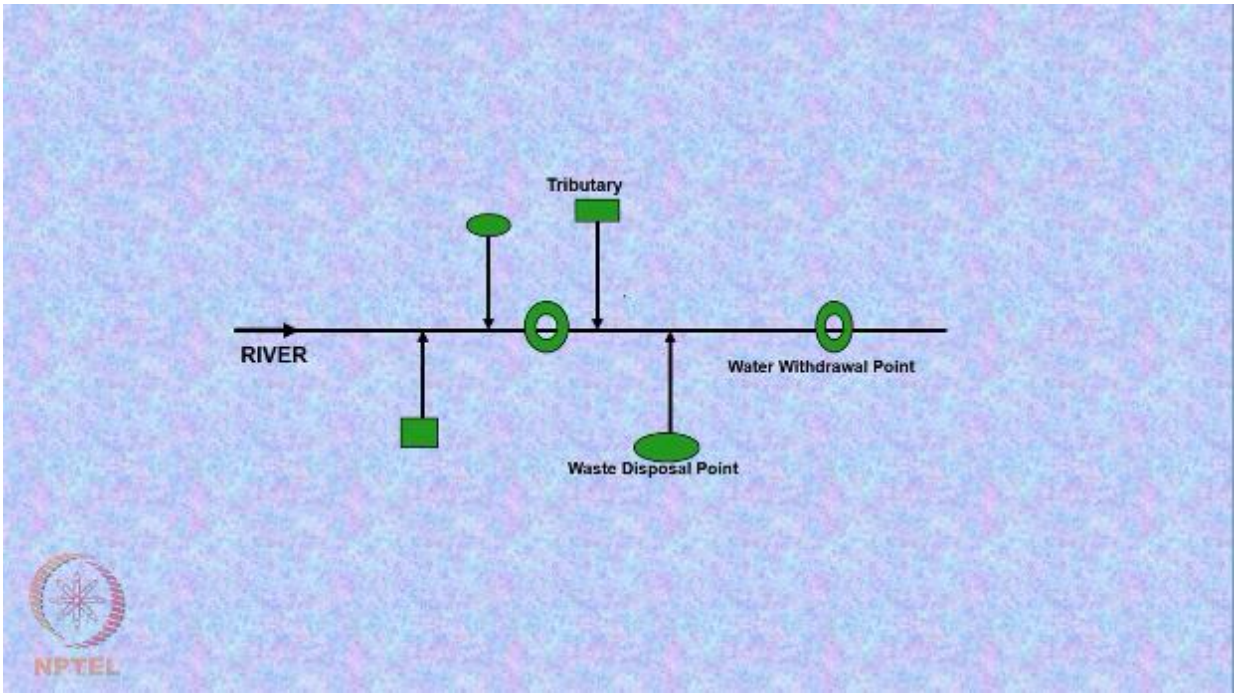
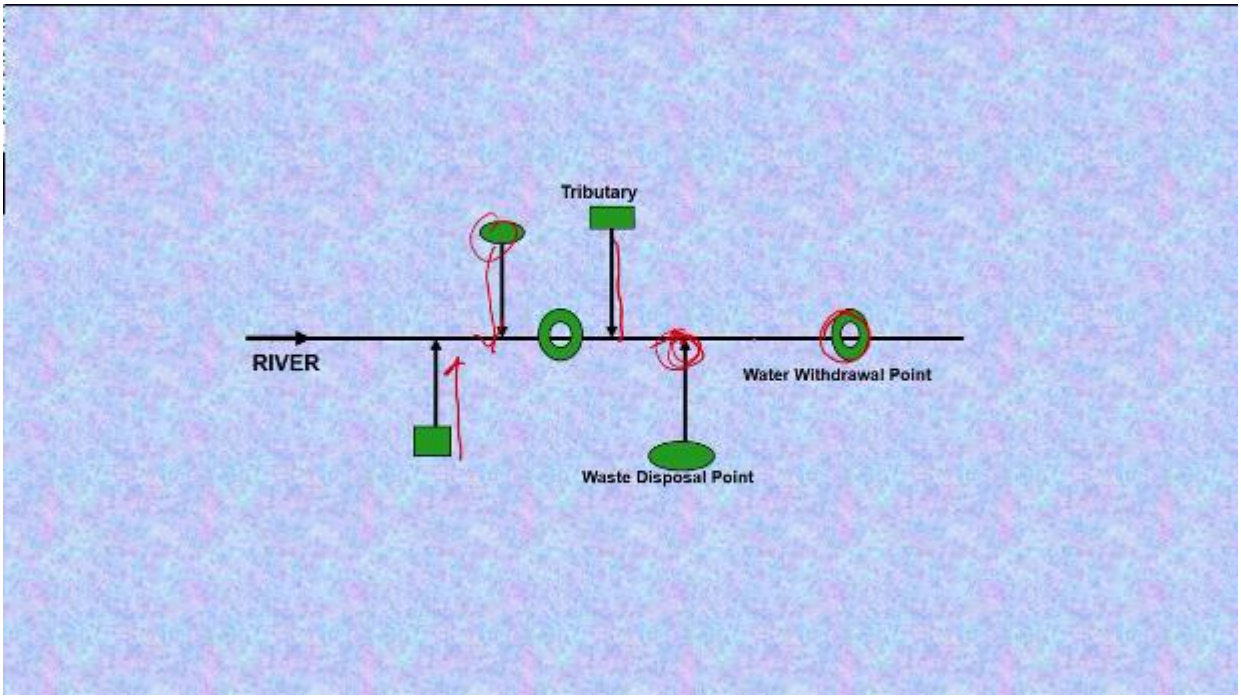
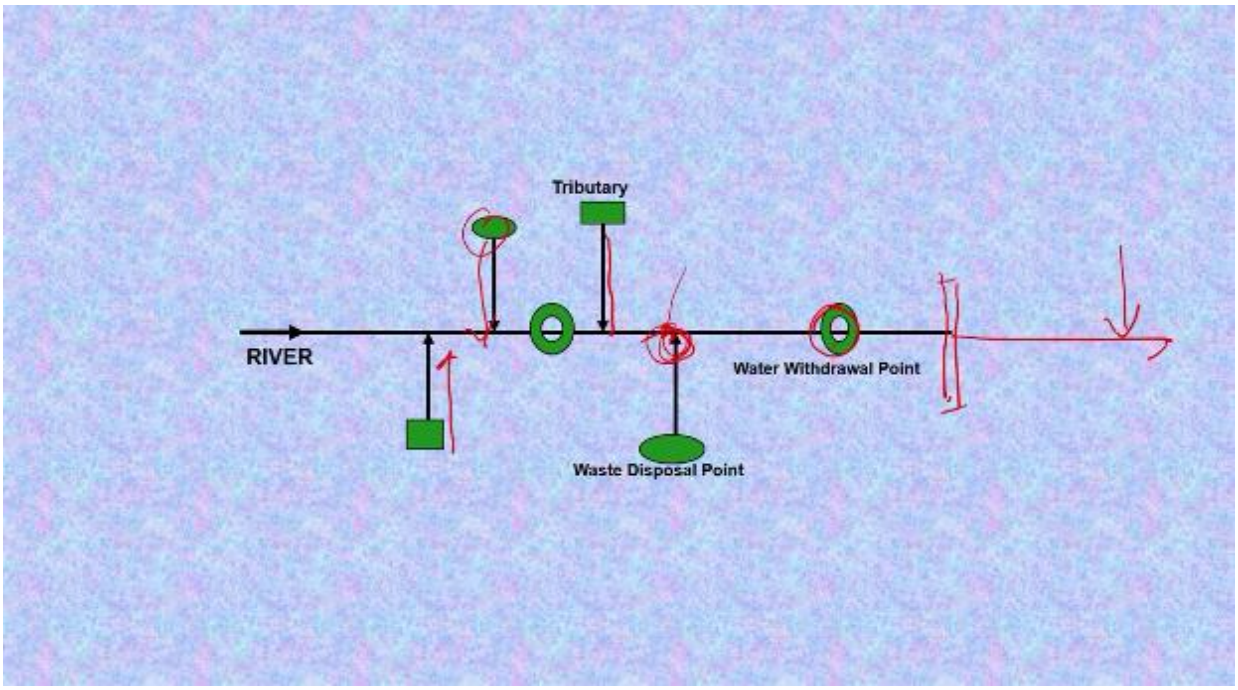


To give you a schematic picture of a river and then the tributaries that are coming in. And there are some locations where the wastewater from the nearby cities is treated to a certain level and then it is the treated wastewater or untreated wastewater or partially treated wastewater is mixed with the river flow. There is one waste disposal point here, then there is a waste disposal point here, like this, whereas on the downstream side we take water from certain locations, these are water withdrawal points for our daily use.

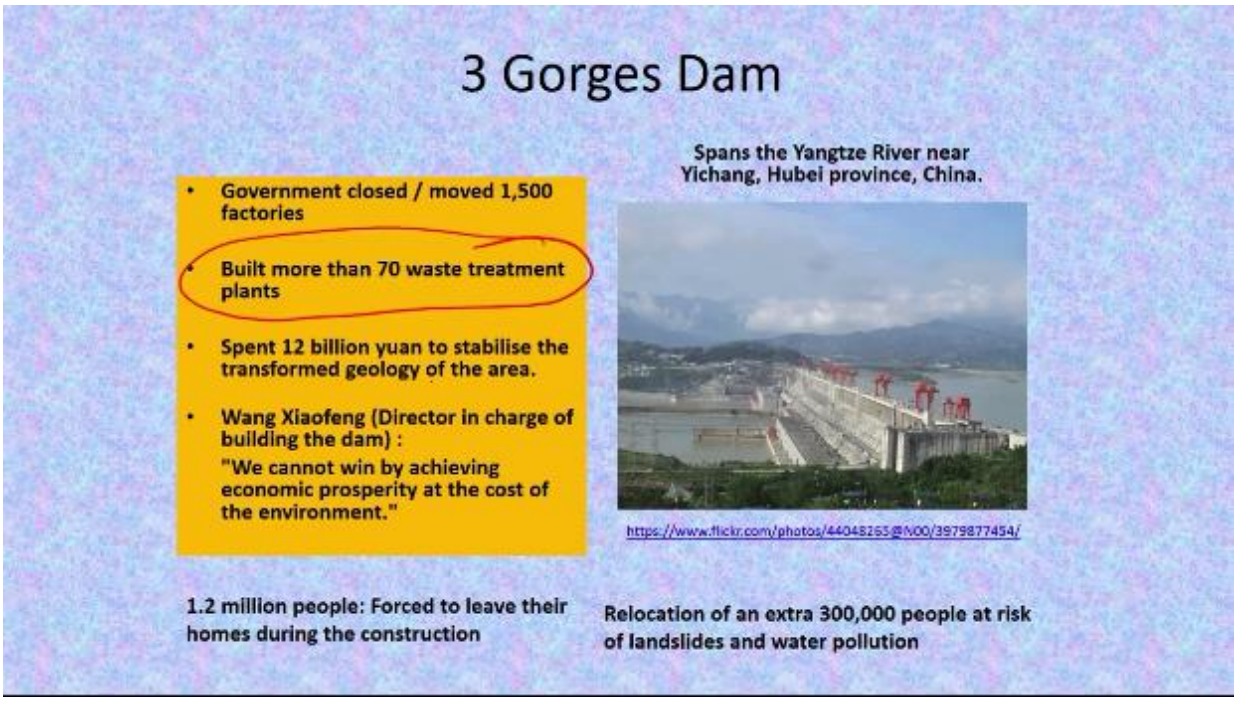


When we dispose the waste here, and as the waste is going through the river, the river has a self-cleansing ability. Self-cleansing nature of the river is there because the bacteria which is there in the river, they do biodegrade the biodegradable material utilizing the oxygen that is available, the dissolved oxygen that is available. And as the dissolved oxygen gets depleted by the bacteria for biodegrading this biodegradable material, oxygen from the atmosphere enters into the water through the re-aeration process. So, there is a balance, and probably if I introduce the waste here and that kind of stabilizes I mean the utilization of oxygen and then the re-aeration and so on, and when I take the water from here it is not contaminated by the waste which is discharged into the river on the upstream side. This re-aeration rate or the self-cleansing ability of the river depends on the flow conditions. If the velocity is very high, if the turbulence levels are very high, then there is more mixing, there is more re-aeration, and the self-cleansing ability of the river will be high if the velocities are high.

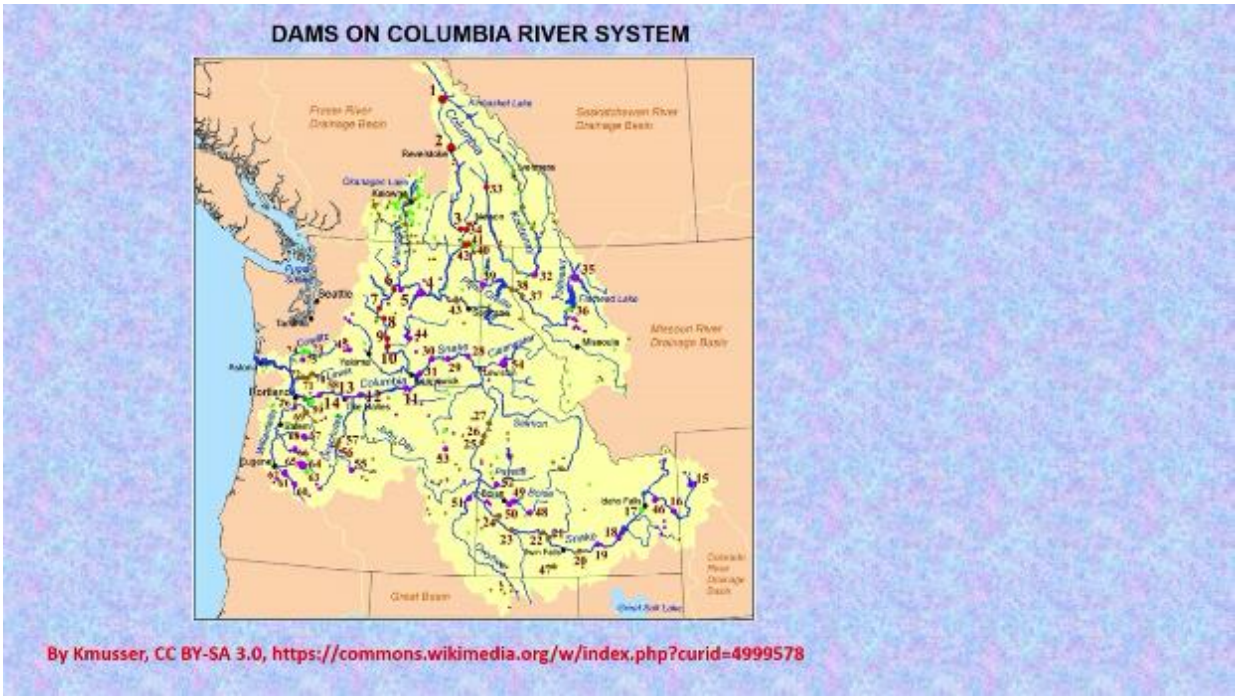
On this let us say if I put a dam here, what this dam would do is it would increase the water level on the upstream side, and if it increases the water level on the upstream side then the velocity gets reduced. If the velocity gets reduced then the self-cleansing ability of the river gets reduced and for the same level of contaminant loading at this location for the same level of contaminant loading at this location the water may not be remaining uncontaminated at this location. That is after constructing the dam all though at this point was relatively free of contamination earlier, but because of construction of this dam, this becomes contaminated now.



So, if that happens, then I should not load the river with pollution at this location if I want to use the water here for any useful purpose. If I do not want to load the river with contaminated domestic wastewater or contaminated water or domestic wastewater, then I have to treat it, and that is the reason why whenever we construct these dams we have to see what it does to the water quality on the upstream side and accordingly take the necessary actions. There, the effect is not only on the upstream side, the effect is also going to be felt on the downstream side too because of the construction of the dam, the amount of water available on the downstream side is less. If the water availability on the downstream side is less for the same level of contaminant loading, you will not have dilution effect, and so the concentrations of the contaminants will go up, and that again will spoil the river health. So, that is why they had to build more than 70 waste treatment plants; they had to spend 12 billion Yuan to stabilize the transformed geology of the area.

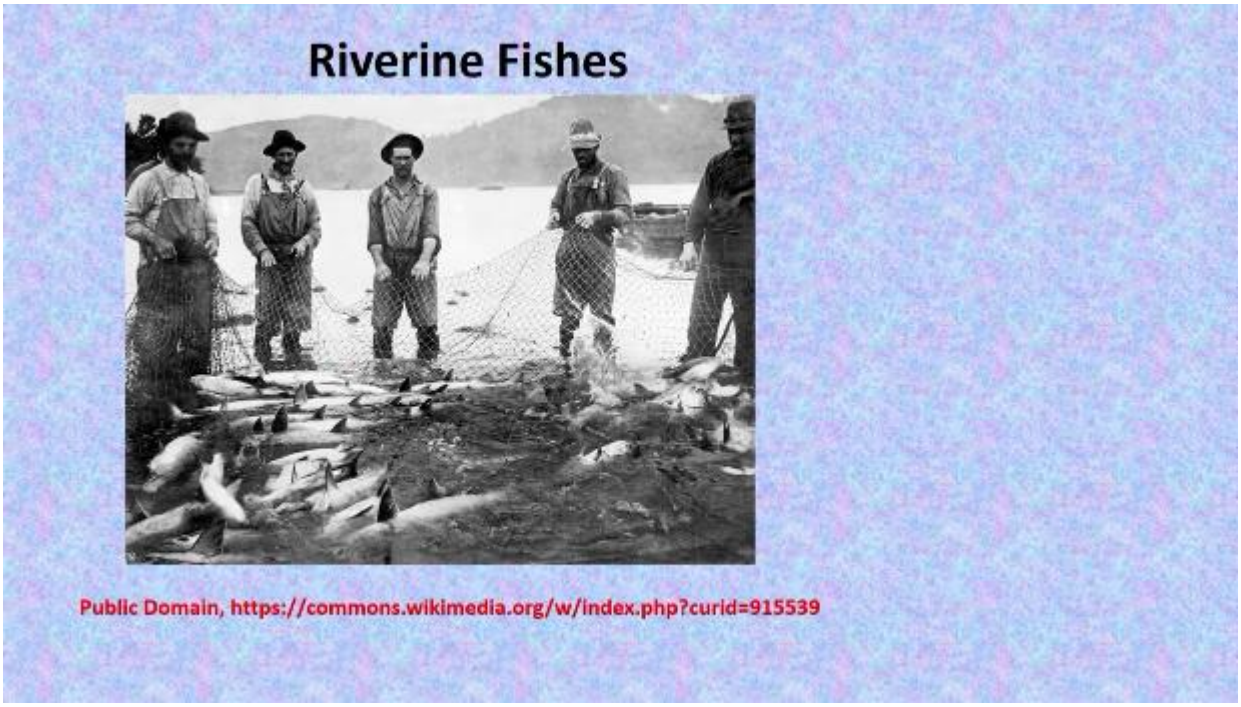


In fact, Wan Xiaofeng who was a director in charge of building this dam, he is supposed to have commented we cannot win by achieving economic prosperity at the cost of the environment, regarding the displacement 1.2 million people. It was estimated that 1.2 million people were forced to leave their homes during the construction itself, and 300 thousand more people were found to be at risk due to landslides and water pollution.



I will like to now discuss the story of the dams on Columbia River system in the United States. Columbia River originates, I mean it has a catch bend both in the United States as well as

Canada, it is located in the North Western part of United States. And you can see here so many small, large, and medium dams have been constructed on the Columbia River. This is the Columbia River here, this is hatchery, and then this is the Columbia River and on its tributaries like snake river, clear water river, and then you know this there Jordan river and so on and so forth.



Now, what is the effect of constructing all these dams on fish population? You have a lot of riverine fishes like steelhead and salmon in this river which are migratory fish, and they are used to be an abundance of the fish in Columbia River system before they constructed these dams. And as I mentioned, these are migratory fish that is after they born and they grow up they swim all the way from the mountainous areas through these rivers into the Pacific ocean, and when they want to rear or lay eggs, they swim back all the way to their homes. And this was possible before the construction of the dams, but once you construct these dams and you are obstructing their paths, and the fish cannot jump over the dams then it had an effect on their population. The fish population had come down significantly, of course, the once very abundant fish are not found anymore. I mean not found in same quantities now, not only because of the construction of these hydro-dams, because of the changes in harvesting methods, changes in ocean conditions, habitat alterations and so on.

Anadromous fish (Steelhead , Salmon etc.): Important part of life in the Columbia River Basin

Once very abundant.

Decline in the population:

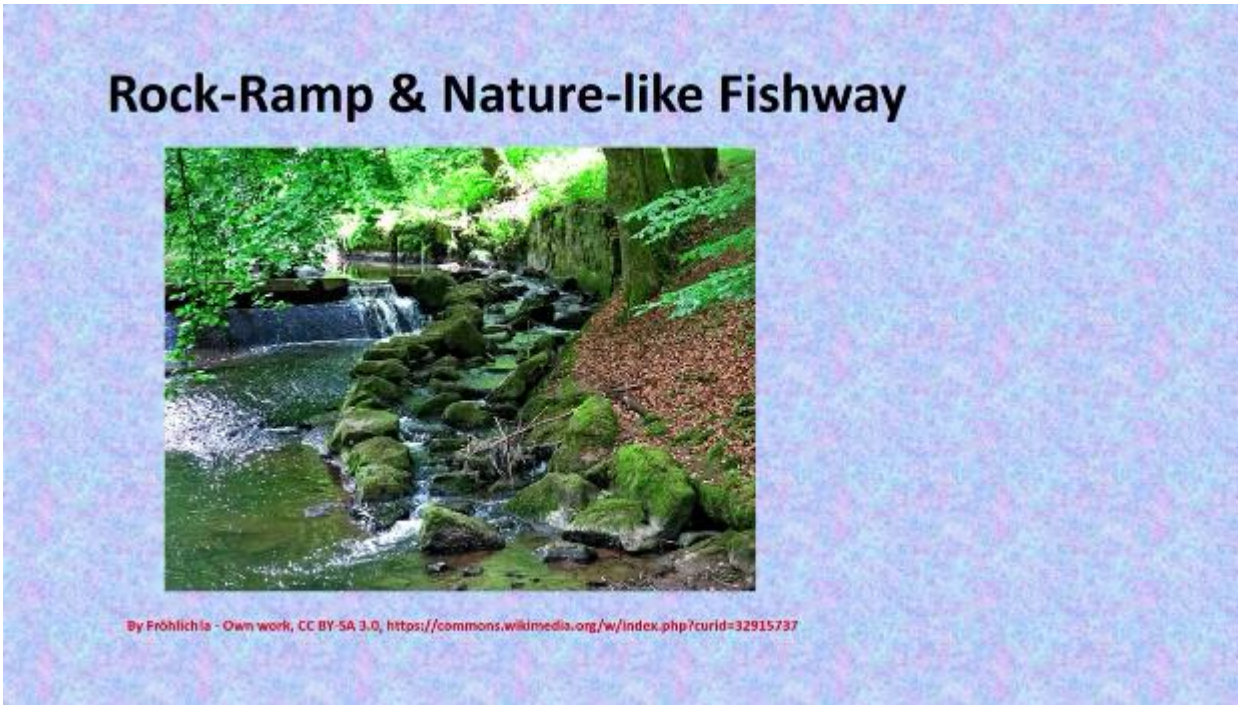
- Habitat alterations
- ocean conditions
- Harvesting methods,
- Construction of hydro-dams

www2.uvm.edu/.../PRESENTATION_Columbia_River.... - United States

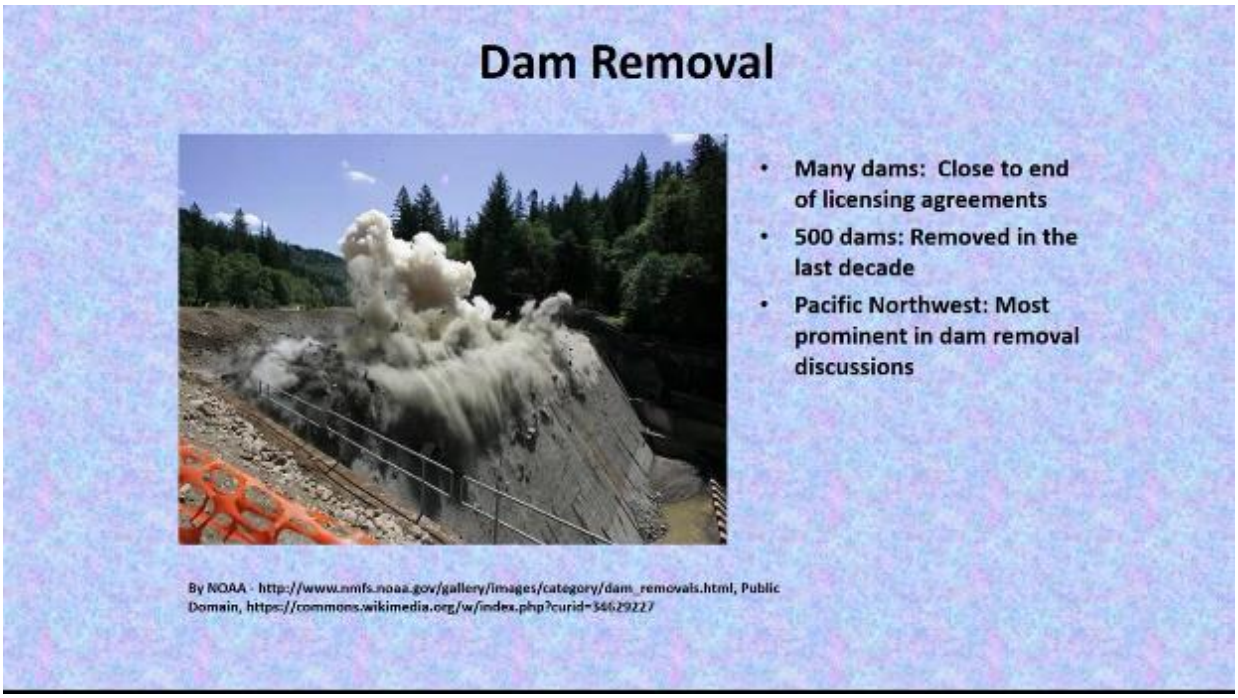
Fish Ladder

But construction of dams is one of the major reasons for the decline in the fish population in the Columbia River system. So, people want to increase their population. How do you want to increase their population? You create structures for fish to swim upstream across the dams, so when you construct a dam, you also construct what we call the fish ladders. Fish ladders connect upstream of the dam to the downstream of the dam with probably some kind of a gentle slope and try to mimic the flows that were existing before the construction of the dam. So, all the dams, when they were constructing, they were accompanied by the construction of this fish ladder. Now to make it easy for the fish to migrate from the downstream side to the upstream

side, and upstream side to the downstream side. And then many different designs of fish ladders evolved over a period of time through research, and you know, through the research like we have rock, ramp, and nature like fishways.

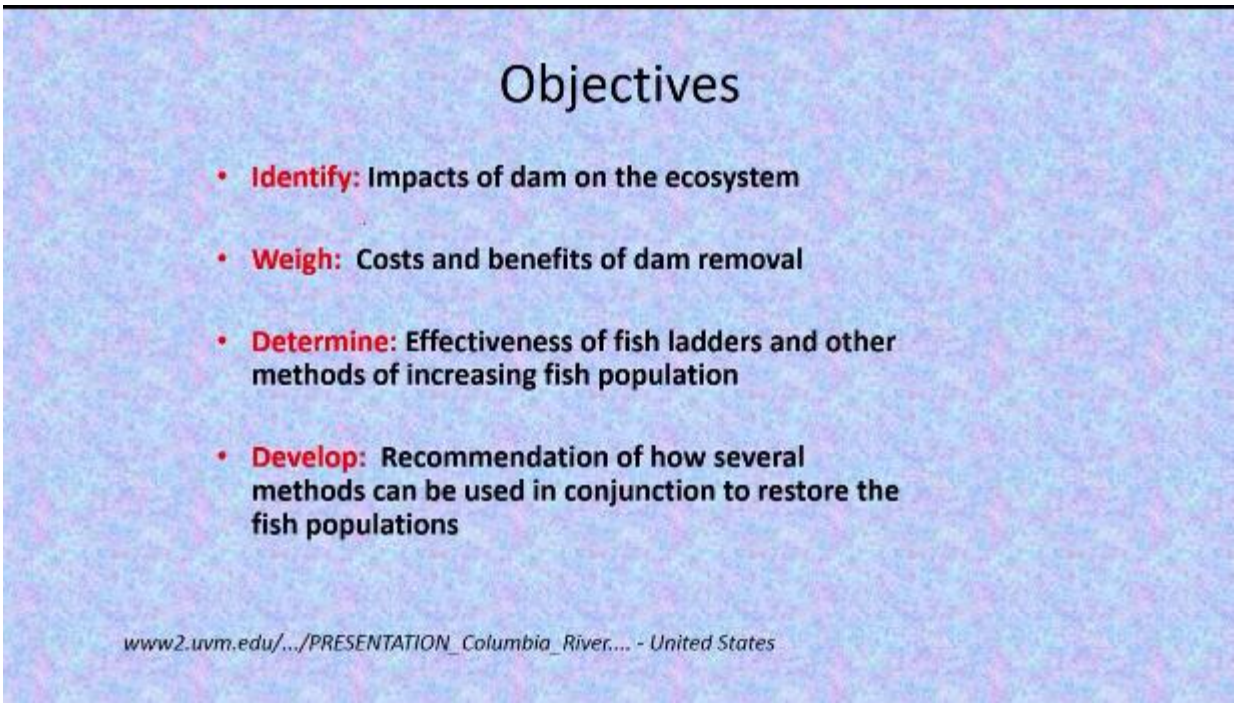


These are all, this is a fishway made by humans to assess fish to move up and down in the river across the dam, but the design here is mimicking the nature more closely than before. All this is nice you can construct this fish ladders and fishways, but how do fish know that there is a fish ladder there? Or there is a fishway there? And that they have to go through that? Then we need to understand fisheries biology before we design these things, and how the altered flow conditions are restored, altered flow conditions by the dam and somewhat restored flow conditions by these fish ladders and so on and so forth. Whether they are having any effect on the migration of the fish. One has to study, one has to understand that, they may not be effective all the time, and they may not be effective to the level that we desire, people in that region started demanding the removal of the dams, the dam removal is a very serious issue.



Many of these dams across the world are close to their end of licensing agreements. So, they say anyway the licensing agreement is getting over, so why don't we remove this dam? So that the fish can move more easily. Approximately 500 dams have been removed in the USA in the last decade. Pacific Northwest, as I mentioned Columbia River is one of the major river systems in the Pacific Northwest is the most prominent in dam removal discussions. So, I am showing a picture of putting some detonators and then trying to remove the dam here, okay, we would like to remove the dam, but removing the dam, will it achieve what we want?

So, before we remove the dam, we need to have some objectives. The objectives are, we have to identify, we have to do some projects, we have to study, we have to plan, we identify impacts on the dam, impacts of the dam on the ecosystem, we have to weigh the costs and benefits of this dam removal, what are the costs in removing the dam, what is the benefit that we are going to get. Then we have to determine without removing the dam if you put the fish ladders, what is the effectiveness of fish ladders? And many other methods of increasing the fish population, do we really need to remove the dam or can we do this, I mean increase the fish population through some other means.



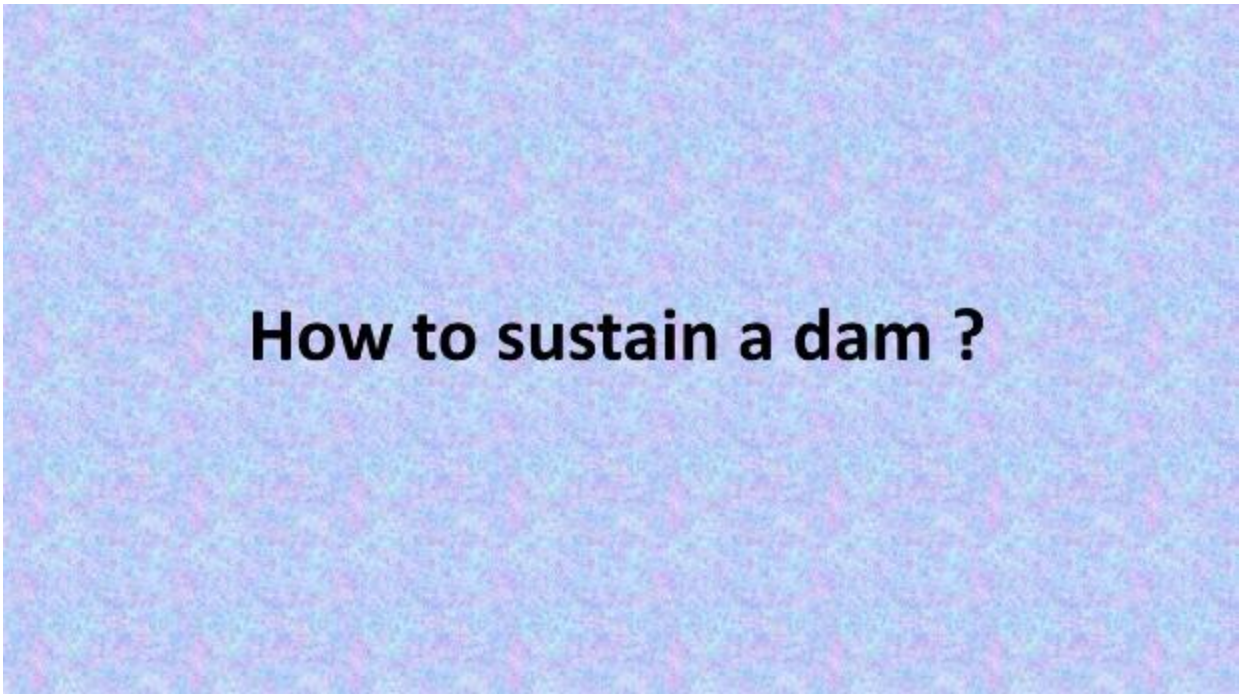
And then based on the studies we have to recommend how several methods can be used in conjunction to restore the fish population and convince the stakeholders that that is the best way to go about. But before we go and then remove the dam, we ask one question. Yes, I remove the dam then what do I do with all the sediment that has been deposited on the upstream side of the dam in the reservoir over the past few decades. Remember I was discussing about aggradation on the upstream side of the dams are deposition of the sediments in the reservoirs, there is huge volume of sediment that is existing on the upstream side of these dams.

Now if I remove this dam, what will happen to all that sediment, where does that go, if I just remove the dam and don't do anything else the answer is obvious, all that sediment which is there in the reservoir will eventually start moving to the downstream side along with the water. And as it starts moving downstream side, and as the river starts widening on the downstream side in the plain areas, this sediment will start depositing because on the downstream side velocities will be less as the river widens. The velocities gets reduced, this sediment starts depositing on the channel bed, so there will be a aggradation of the channel bed now due to removal of this dam. And if the channel bed is a grading and with the same amount of rains that are coming down, you will have a higher frequency of floods, so naturally the people who are leaving on the downstream side they would demand that we do something about the sediment in the reservoir before we bust the dam.

Now that is not an easy question to answer because there is a huge amount of sediment and if need to dredge all this sediment from the reservoir before we bust the dam that is going to cost lot of money. It is not only the money that is the issue but what do we do with this sediment that we have dredged from these reservoirs? If we take the sediment out of the reservoir and simply dump on the banks of the river, on the sides of the, on sides I mean on the sides, then eventually that sediment will find its way into the river again when there is rain, and there is

overland flow. So, we cannot simply go and then dredge the sediment and then dump it on the river banks, we have to take it somewhere else. If you have to take it somewhere else then we have to think about the transportation cost of this sediment, we have to find a proper location where we can utilize the sediment or dump the sediment and then we need to worry about how we take it to that location and so on and so forth. So, the management of dredged sediment becomes an important issue, and it could be a limiting factor too.

There is one more question, we are assuming that by removing this dam we would go to the same pristine conditions that existed before the construction of the dam. How true is that assumption? Is that assumption right? The ecology has evolved to a particular state over the years because of the flow of water and other hydrological conditions and climatic conditions, and we have changed that by constructing this dam. We have changed those input conditions, so because there is a change in this input conditions and these dams have been existing for let us say 30, 40 years, the ecology has evolved to a new state. Let us say state B, and it tried to come to a balance to this altered input.
Now we remove this dam and then again change the flow conditions and other input conditions. How do we know that the ecology goes back from state B to original state A? it may go to state C. So, how the ecology of that area evolves over a period of time in response to the removal of the dam, in response to the altered conditions now, is a big question that one has to answer.



So, the thing is how to sustain a dam? As we have seen earlier we need these dams for achieving food security, for generating power and then for protecting our cities from flooding and for recreation and so on and so forth. But then the construction of the dams will have a significant impact on the ecology and social life on the people who get displaced. There are some people who get displaced, or at a disadvantage, then there are some people who get benefitted by this dam on the downstream side because of the increased availability of water. So, how do we take these decisions? This is a very good example of the sustainability concept.

Where, if you build large dams the economy of scales comes in and then the benefit-cost ratio will be increasing. If you increase the height of the dam, but then if you increase the height of the dam more people on the upstream side will get affected, that is a social issue.

And in the last 50 minutes, we also have seen what is the effect of the dam on the environment. So, when we design, plan, design and implement these dams, we have to give due consideration to sustainability aspects.

Thank you