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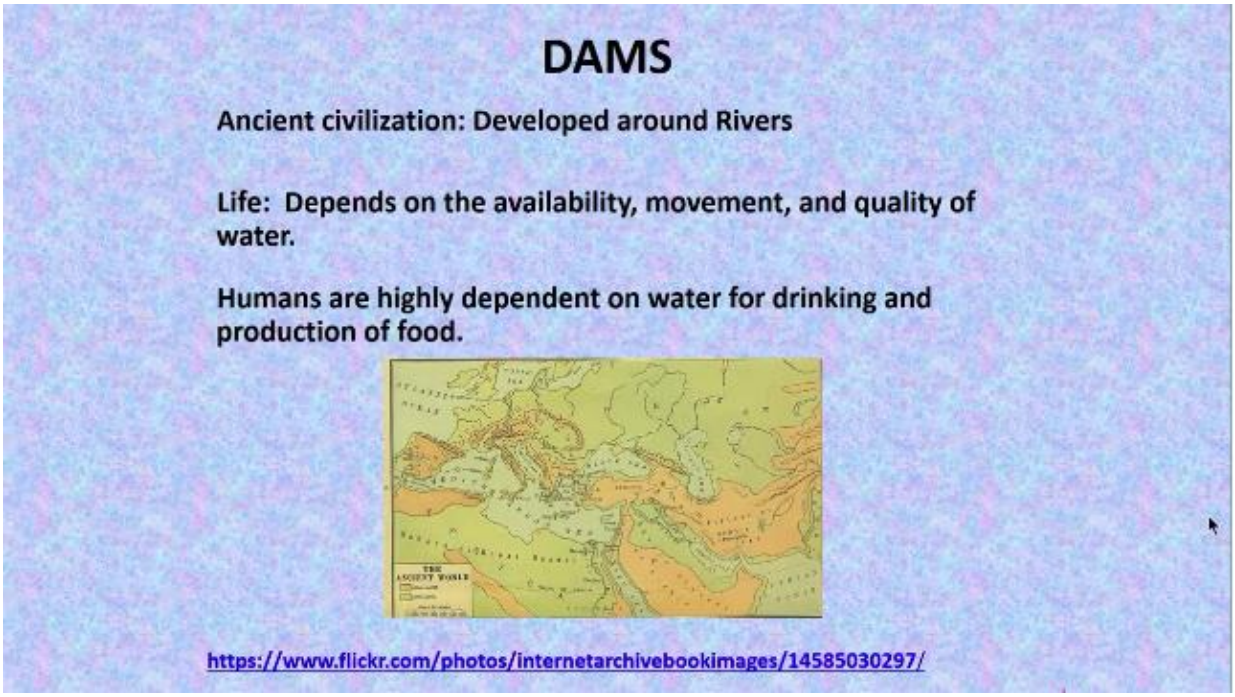
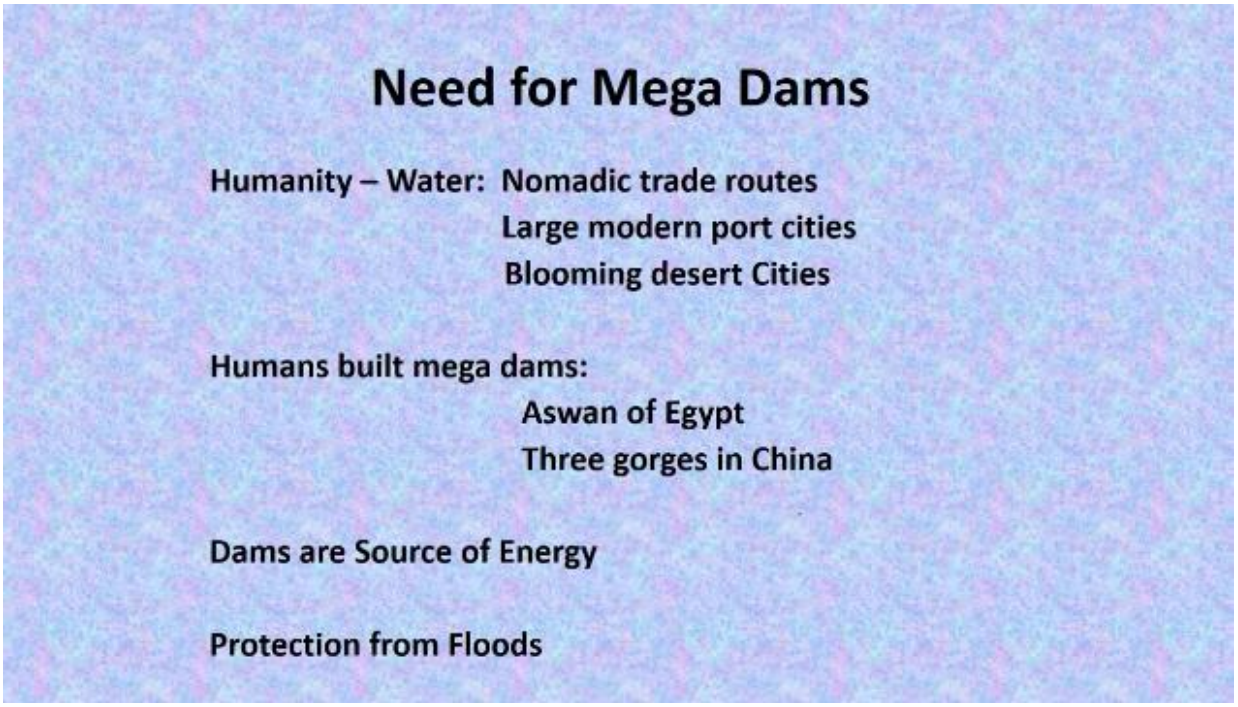
NPTEL ONLINE COURSE
ECOLOGY AND ENVIRONMENT
Sustainability and Case Studies
Prof. B.S Murthy
Department of Civil Engineering
IIT Madras

In this lecture, we will discuss the issues of sustainability in the backdrop of dams, in the framework of dams. As you all know most of the ancient civilizations have been developed around rivers, life even now depends on the availability, movement and quality of waters.



We need water for drinking, we need water for the production of food, with an increasing population, if you need to have food security then we need to increase agricultural productivity. And to increase agricultural productivity we need to resort to irrigation, that means we need to store water when it is available during the rains. We construct dams across the rivers, channels, and then store the water when it is available and then, later on, use it over a period of time to supply water to the fields, agricultural fields and then to grow the food.

So, this has been the situation ever since humans have settled down, I mean from the nomadic lifestyle they have settled down and then started agriculture. As you can see, many well-known ancient civilizations thrived on the river banks like you have in Egypt, the Nile river civilization and in Mesopotamia, Euphrates and Tigris rivers and then of course Indus Valley civilization. These are all very well-known ancient civilizations which thrived on the, in the river valleys on the river banks.

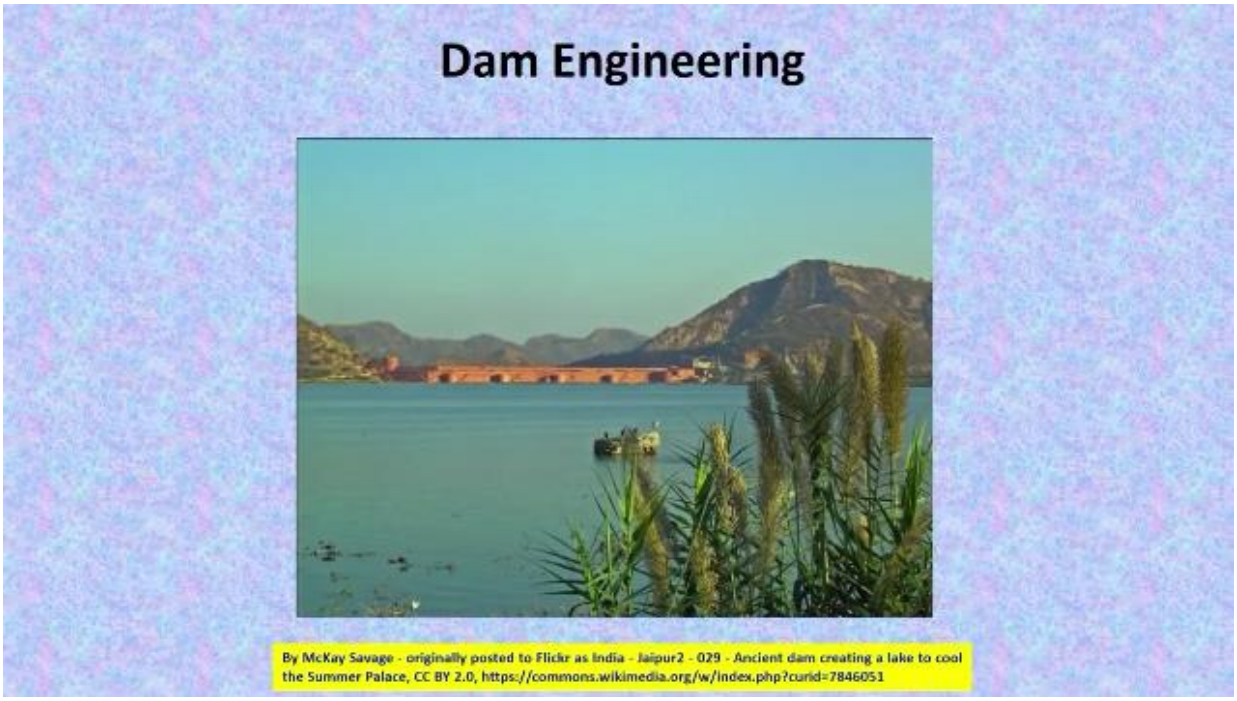


And as I mentioned there has been a need for mega dams above since the times of nomadic trade routes where people used to go from one oasis to another oasis in the desserts till the time we developed large modern port cities and blooming desert cities there is always a very strong dependence of humanity on water. So, we have been building mega dams like the high Aswan dam on the river Nile in Egypt, the three gorges dam in China and closer home, in India we have many mega dams that we have built since ancient times. And of course we have increased our activity since the independence in 1947, we have built Bhakra Nangal dam, Hirakud dam, Nagarjuna Sagar dam and so on and so forth.

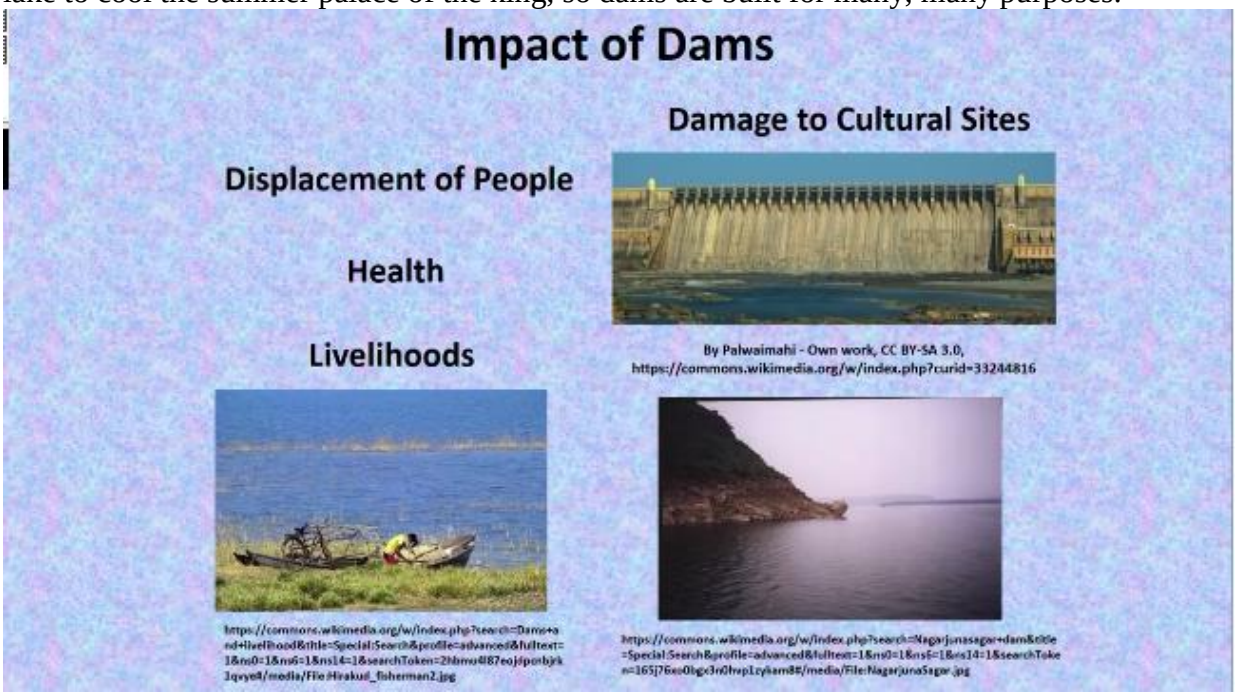
As I mentioned, we built these dams for supplying irrigation water, not only that, the dams are also sources of energy, the dams are also built for protection from floods, for example, Bhakra dam which was built in Punjab right after our Independence. It is one of the largest dams, at the time of its commissioning, Pandit Jawaharlal Nehru the Prime Minister of India at that time described these dams as the modern temples of India. This was built to supply water for irrigation and probably one of the key players in making India self-sufficient in food, of course, there are some problems which we realized a little later on which we would discuss later.

This is the picture of the Hirakud dam which is built on river Mahanadi in the state of Orissa in India. This is a probably one of the longest earthen dams in the world, and once again this is a multipurpose reservoir where the water from this reservoir is used not only for irrigation and power generation, but one of the main purposes of Hirakud dam is to protect the coastal cities like Cuttack in state of Orissa from floods. Before the construction of this dam there was no control of floods in Mahanadi river, and there were frequent floods, and this floods would inundate one of the largest cities in Orissa that is Cuttack which is on the downstream side closer to the coast, and we wanted to protect that city. And so this dam was built as one of the purposes of this dam was to do the flood control.

During the monsoon season or during the heavy rains when the water comes from the upstream areas, upstream catchment areas that is stored in the reservoir, you keep some space for storing the water in the reservoir. And then after the season is over, this water is slowly released, or after the peak rain period is over, you start releasing the water to the downstream side in a gradual way. That way one would reduce the peak discharge on the downstream side and so one would reduce the flooding on the downstream side, this was one of the purposes of the Hirakud dam. Of course flood, I mean the dams are also built for other purposes.



Here I am showing a picture of an ancient dam built in Rajasthan in Jaipur where they created a lake to cool the summer palace of the king, so dams are built for many, many purposes.



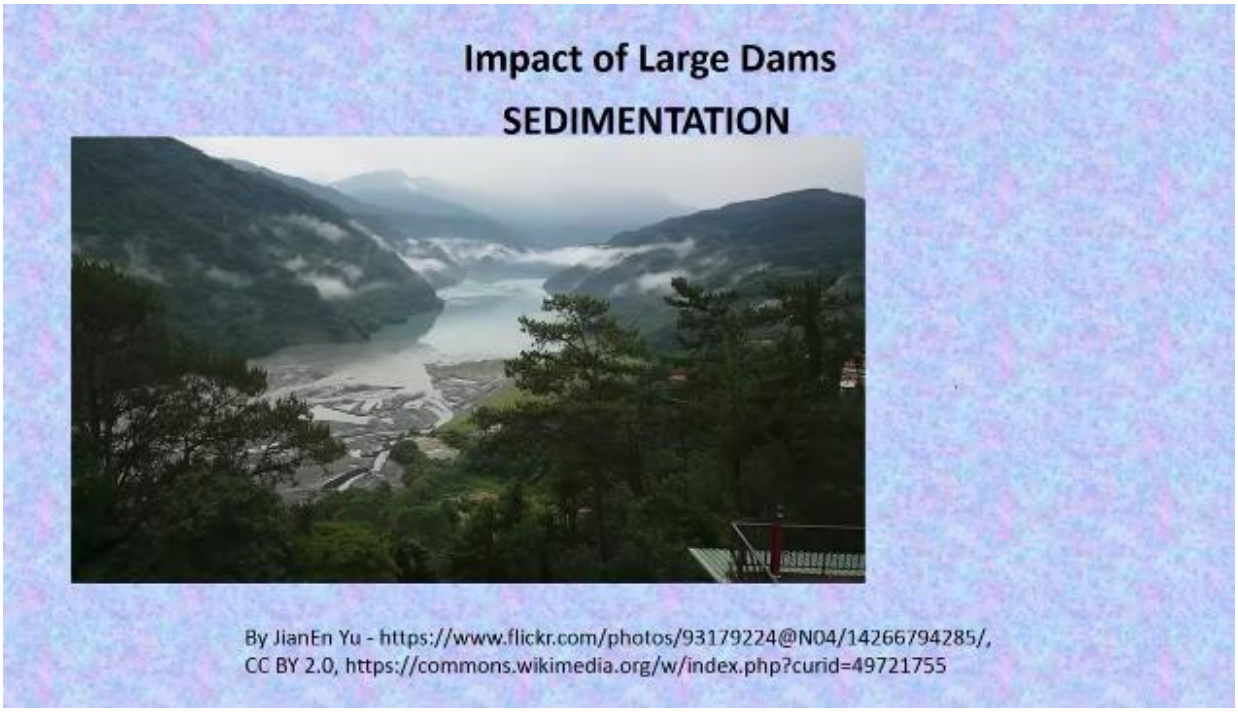
Now let us look at the impact of these dams, first and foremost there is the displacement of people. When you build dams, and then you create large reservoirs, you are going to inundate large areas of land on the upstream side. And due to this inundation people who have been living in those areas will have to move to higher lands or some other location where there is no inundation, this displacement of people, the consideration for the displacement of people has become very important and serious in the modern times. Because they have rights and then we

have to honor their rights too, and when we displace them and when we find alternative sides for them to live, that has to be done with little sensitivity for their lifestyles.

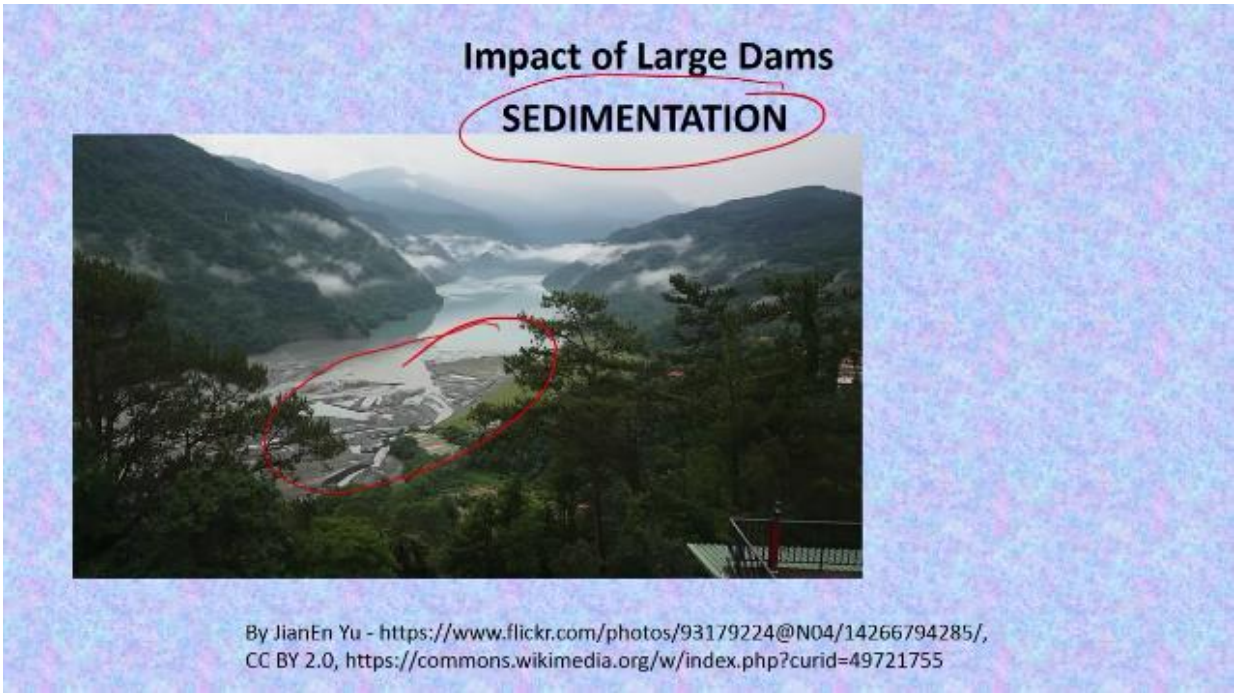
For example, when the Hirakud dam was built, and the people are displaced, they have been living in hilly areas, and they are used to that kind of a lifestyle. If you one day asked them to move and then you give them the land somewhere else where they do not know how to live off the land somewhere else because they are used to a particular lifestyle. So, this thing one needs to consider while talking about resettlement of displacement of people, it is not just the compensation, but of course, the compensation itself runs into a huge amount of money. Then there is an issue of health. Yes by building dams we get more water, and we can supply more water to the people, and that will improve the health of people, but then this large masses of water are also very nice breeding grounds for mosquitos and others which cause vector-borne diseases. We have to consider that what is the effect of these things on public health.

Then there is a question of livelihood, here in this picture this is the reservoir created by Hirakud dam, and we show a boatman here, they go every day into the reservoir, and then they catch fish, and we have created a livelihood for such people by creating this reservoir. On the other hand by storing the water here and not letting it go naturally to the downstream side that may have an impact on the fisheries. Okay, on the fish population on the downstream side, there people lose their livelihood. So, when we construct these dams, we have to think about what we are doing to the livelihood of people in the locality. Then there is damage to cultural sites; this is important too. Here I am showing a picture of Nagarjuna Sagar dam and then the reservoir created by it, when they were constructing this dam and creating this reservoir they found that there are a lot of, you know, heritage rivers, a Buddhist, you know, sites like that is where the monk Nagarjuna used to live. And they were very important archeological findings in that area, so the creation of this reservoir made people to take those whatever they found there from those archeological sites and then relocate somewhere else. So, one has to really think about when we are constructing these dams what they are doing to the existing cultural sites.

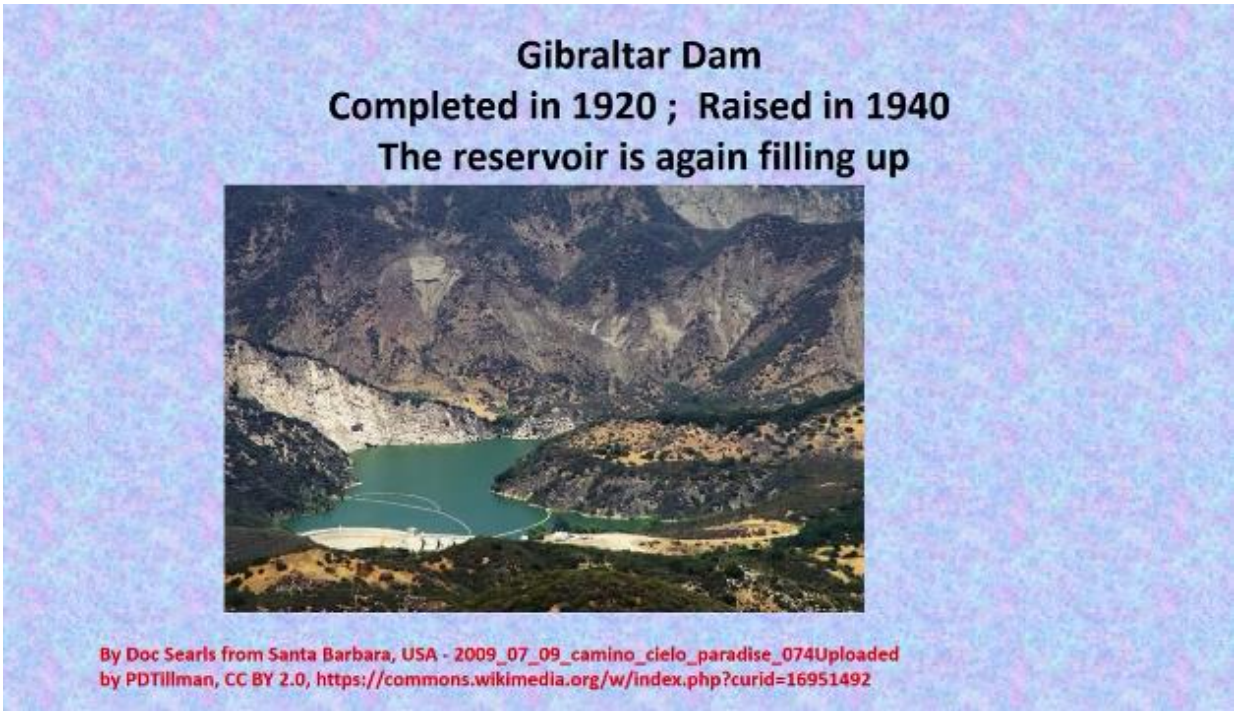
And of course, as I already mentioned there is a significant social impact. We are displacing the native people from their place sometimes without proper compensation, sometimes when we give the compensation but it is not in the right way. And huge resettlement programs are needed on the upstream because of inundation and on the downstream side because of huge irrigation plans.



There is another issue with the construction of these are the implementation of this large dams. Little bit more engineering here, it is sedimentation. When we create a dam here, then the water that is flowing in the river on the upstream side of the dam because of inundation and because of increase in the depth of the flow there would be a reduction in the velocity. This water which is flowing in the river is also carrying a lot of sediment, the soil that is eroded by the rain in the upstream areas or in the catchment areas, all that soil, sand, and sediment basically is moving along with this water. If the velocity is high, this sediment is kept under suspension and of course, if there is no dam it just keeps moving to the downstream side until it goes to the sea. Now that we have constructed a dam and reduced the velocity and reduced velocity cannot support this sediment in suspension, all that sediment starts depositing in the reservoir. You can see here this is the whole place where you have sediment deposition.

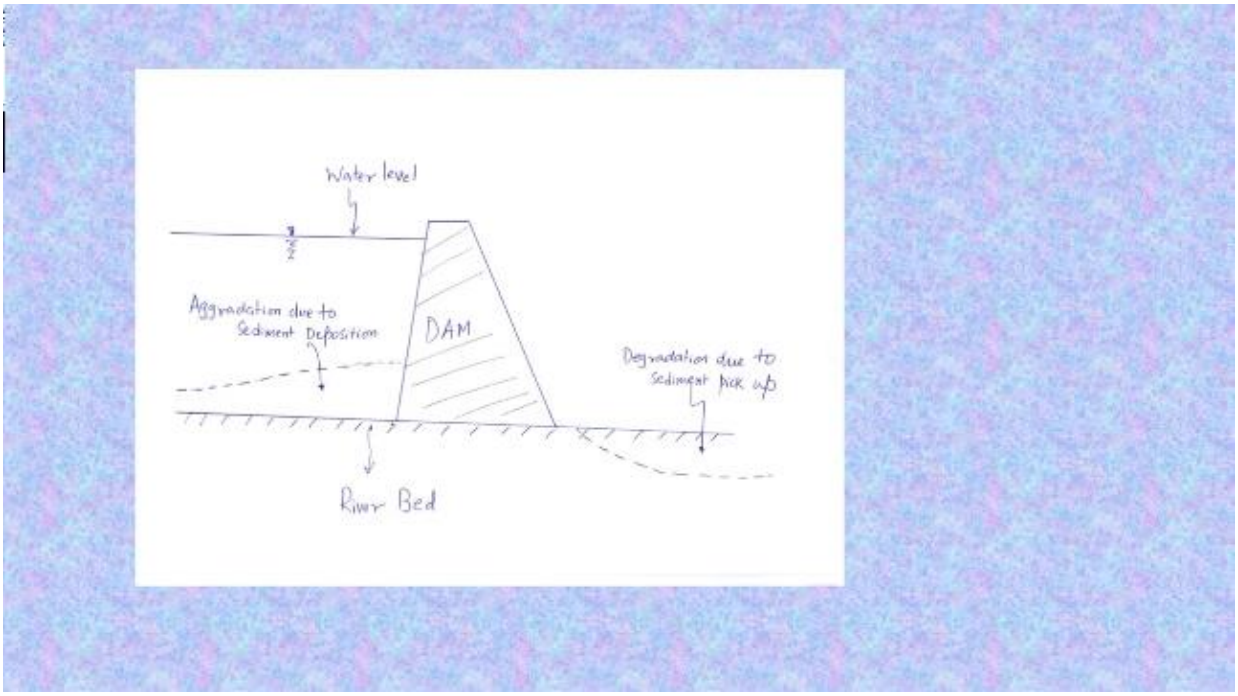


Now this sediment deposition in the reservoirs is something that we need to worry about because as the sediment gets deposited it starts reducing the storage available in the reservoir and that way it may reduce the life of the reservoir, the useful life of the reservoir itself, for example, this is the Gibraltar dam in the US.



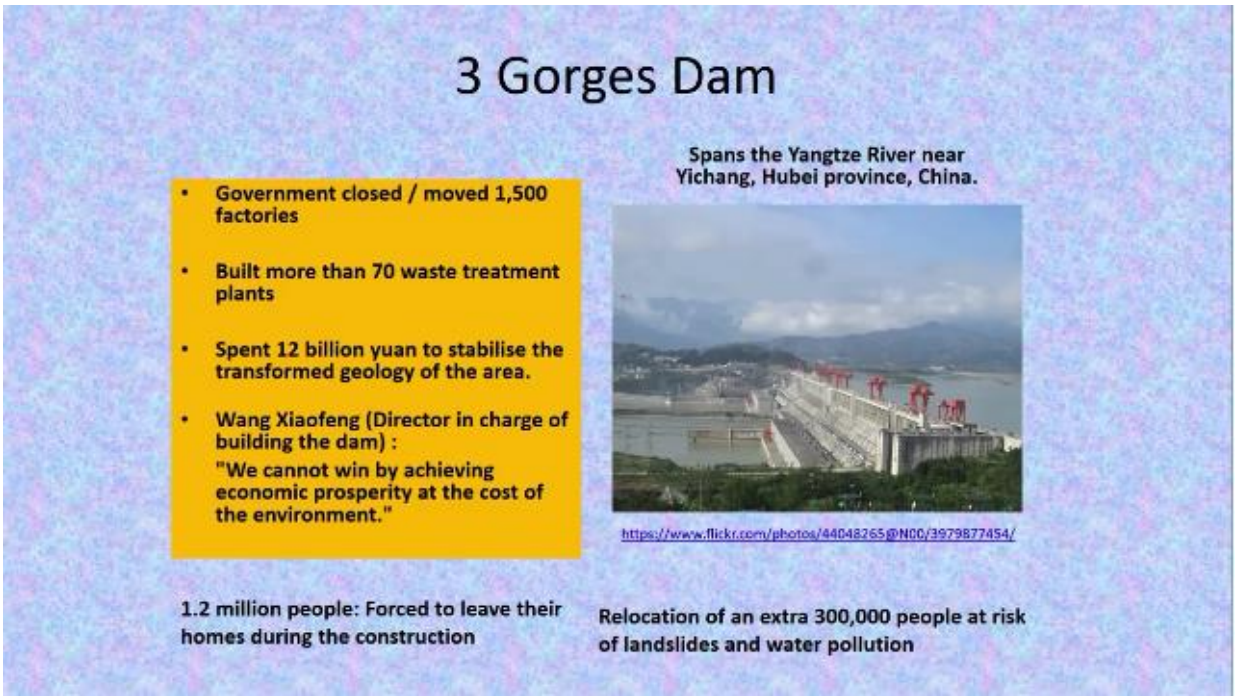
It was completed in 1920. Completed and commissioned in 1920. However, within 20 years that is from 1920 to 1940 within this 20 years because of a significant amount of sedimentation

and because of reduction in the useful storage of the reservoir they had to raise the dam height in 1940. Yes, we raised the dam height but then the reservoir again start filling up, so how long are we going to keep this dam alive, and the useful life of this dam alive, or how high can we raise this dam height? These are some of the questions which are, which need to be answered. Which need to be you know considered while designing and operating the dams. Ya, the sedimentation on the upstream side is going to cause some problems on the downstream side too. Give us a schematic of a river, this is the river bed and let us say I am constructing the dam and impounding water on the upstream side, this is the water level as I already mentioned to you there is going to be a deposition of sediment on the upstream side.



The water that is coming on the downstream side is relatively free of sediment. However the water has some power to transport the sediment but then it does not have the load, it does not have the sediment load, so what it does is it starts picking up the sediment from the bed. This process of deposition and a general rise in the channel bed is what we call aggradation, and this process of picking up the sediment from the bed and general lowering of the channel bed or the river bed on the downstream side is what we call degradation. So, whenever we construct these dams or any other storage works across the rivers we find a significant amount of channel-bed degradation on the downstream side, this has been found out in many, many, I mean for many, many of these dams, and this degradation could be very significant.

Now you may ask so what is a problem with this degradation, let us say on the same river, on the downstream side of the dam you have a bridge, now this bridge is standing on these piers. You take these piers into the river bed or below the river bed level to a certain level that is the foundation level. And because of construction of a dam on the upstream side and there is a degradation, the general degradation of channel bed and that degradation goes below the foundation level of these piers then these piers will get just exposed, and the safety of this bridge will be under quest. I mean there is a risk to the stability of this particular bridge, it may get washed away very easily if that happens. So, whenever we construct the dams, then we have to think about in the long run what it does to the safety of the structures which are built across this river, and these things do take time. That means if we construct the dam, the river bed does not go by 10 feet or 10 meters on the downstream side all of a sudden, it does take a lot of time depending upon the sediment size, depending upon the flow conditions and depending upon other geological conditions and so on. But then we know that it does affect the flow on the downstream side, and so it affects the safety of the structures on the downstream side.



We take the case of 3 gorges dam, this spans the Yangtze River near Yichang in Hubei province, in China. It is one of the largest hydroelectric dam, a power supply dam, yes there is lot of benefits because of this power generation, and it is an engineering wonder too. However after constructing this dam, the government had to close or move about 1500 factories which were existing at that time, they also had to build more than 70 waste treatment plants.

Thank you