Natural Hazards
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Lecture – 36
Flood and Related Hazards Part V

Welcome back. So, in the previous lecture we discussed about the recurrence interval of any particular river if you take.

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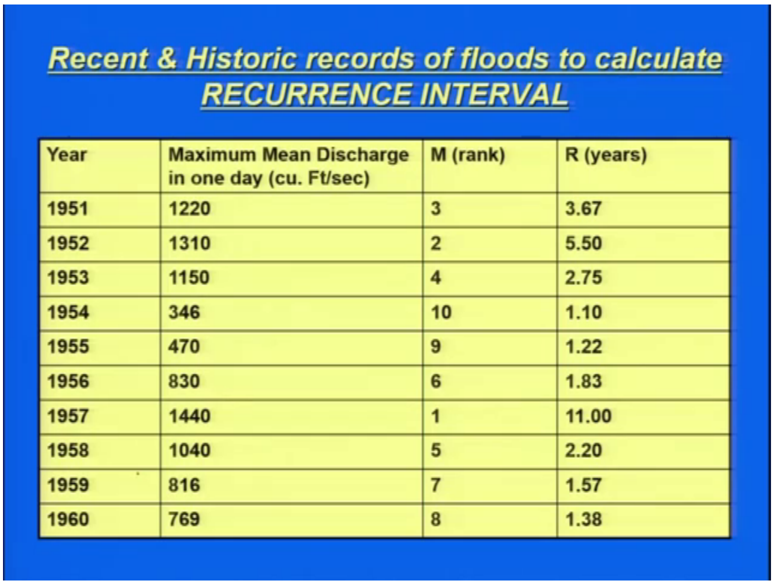

So, if you have good data which is available for example, here it has been listed for 10 years and depending on the maximum discharge, you can rank it and then you can calculate the a recurrence interval of that, but as I told that it is very much important that all other the parameters or the factors remains the same. Then we will be able to achieve or talk about the recurrence interval.

Because for example, if the flooding event which took place in 1951 and the maximum discharge was 12 20 cubic feed per second; so, for this the precipitation would remain the same as well as the cross sectional area of the channel remains the same. And there is no man made interference in the river basin. So, those things need to be taken into consideration.

But nevertheless what recurrence interval we see here we will play an very important role in flood controls and hazard analysis.

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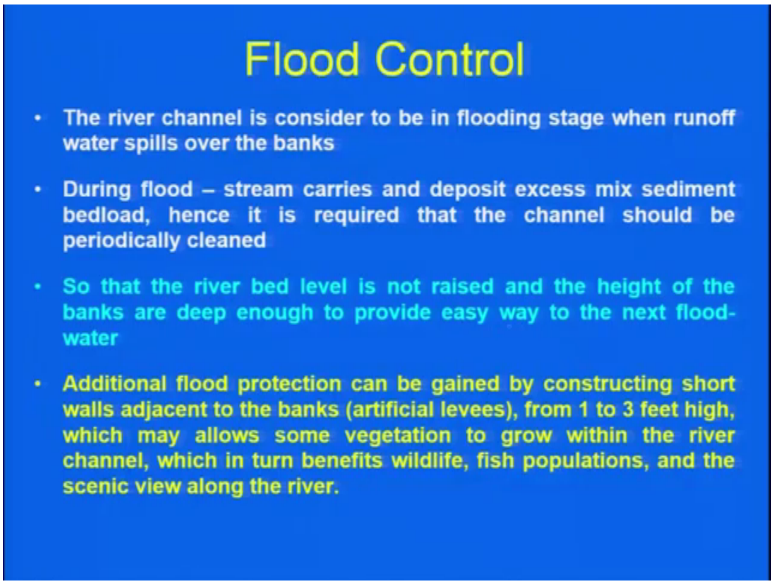

So, flood controls mainly if you look at the river channel is considered to be in flooding state when runoff and water spills over the bank. So, this part which we were talking about that based on the cross sectional area and amount of the precipitation and the runoff will be controlled by the deposits or the mythology of that area of particular site or the basin.

So, we have also saw one few examples in terms of that if you are having the sandy soil or the lithology is purely sandwich very porous. So, infiltration will be very fast and we will have restless runoff. And even that can be reflected in terms of the drainage density which we were talking in the previous lectures. Now during floods stream carries and deposit exists mix sediments that is bed load as it is required that the channel should be periodically clean. So, there is one example which I will be coming quickly in the next slide.

So, this point is mainly for the or the cross sectional area. So, if you does not clean the channel because during the floods it will try to deposit excess load which has been carried because it will be in the more water is available as well as the velocity will be different will be on the higher side. So, you will have more mix sediments as in bed load which are coming and get the will be deposited after the flood is over, but the end, but in the sense that will reduce the cross sectional area of the channel. Hence you need to have periodic cleanup of the channel. And this is required so that the river bed level is not raised and the height of the banks are deep enough to provide easy way to the next flood water. And in most of the developed countries and even there are few examples from India also where the river training has been done or a river is forced to flow through a particular path.

So, that you siphon out the water as early as possible that is it provides easy way to move to the water to flow as early as possible. Additionally, flood protection can be gained by construction of short walls adjacent to banks that is we have seen the example of artificial levee and from 1 to 2 3 feets high which may allow some vegetation to grow within the river channel. So, there are few more examples from Japan and all that which we will be discussing in and couple of slides later.

But this these are the all the different techniques which will also benefits the wildlife fish population. And also it will create an scenic view. In Ahmadabad the Gujarat government has done the what we say created a riverfront, which has also like created several parks along it is banks as well as the parks which or the road for the pedestrians and beautiful roads which are being constructed along that.

At the same time, the depth of the river channel has been maintained because it is completely lined up either we say that they have put the artificial levee, but that has resulted into the easy way of the water to pass through.

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So, this is the example which I was talking about and we also discussed this when we were talking about the landslide, but if you talk in terms of the floods then what was happening here this is an old photograph taken in 1960. So, we have a landslide here the active landslide where the material is or the shear zone has been present because of main boundary thrust.

So, lot of material loose material is available and if there is even smaller amount of rain the material will be put into the this channel. And slowly what was happening is not this bridge is getting covered up. So, the water will definitely spill over on this road or the connecting bridge connecting 2 sides of the banks.

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So, what they do is that periodically they keep dredging and then allow create enough cross sectional area that is allow the water to flow down. So, to stop the sediments getting filled up in this part particularly they constructed and retaining wall, but that did not work as I was I discussed in the previous lectures of when we were talking about the landslide. It broke it because of the sub surface erosion within the channel.

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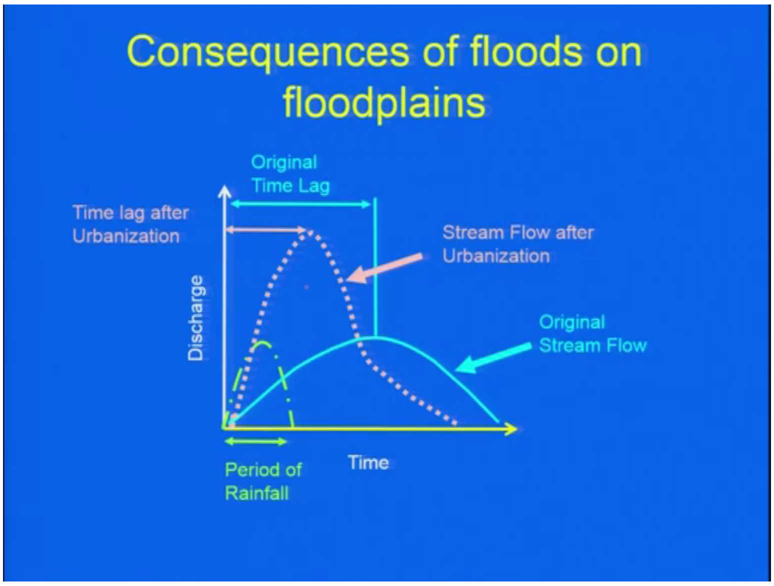

Now, consequences of floods on the flood plains this is of course, because of our own mistakes we do. So, if you take the way in the hydrograph discharge on the y axis and time on the x axis, then what we see is that period of rain here remains the same. And this hydrograph is quite smooth, it is not picked up, but it is quite smooth this is original stream flow. So, if you are not having anything within the stream or you have not altered the a stream you have not like constructed your houses or these settlements on the way of the of the stream then the natural flow was this that is the hydrograph.

So, it will take in time to come up in the flooding state; however, this hydrograph is after urbanization. So, basically what we have seen and experienced in most of the cities that we will fill up several low lying areas or maybe the channels and block the channels and after doing the artificial filling, we will use that land for urbanization. And this is very common either for the construction of parks or you will come up with some colonies or the settlements that is the construction civil structures.

So, this is this hydrograph is after your urbanization. So, the time lag which has been seen from the original is this one here ok. So, this is your time lag also very short in very short time after the rainfall remains constant here, but the discharge has increased at the same time the time which was between the rainfall and the these river getting into the flooding state has also reduced.

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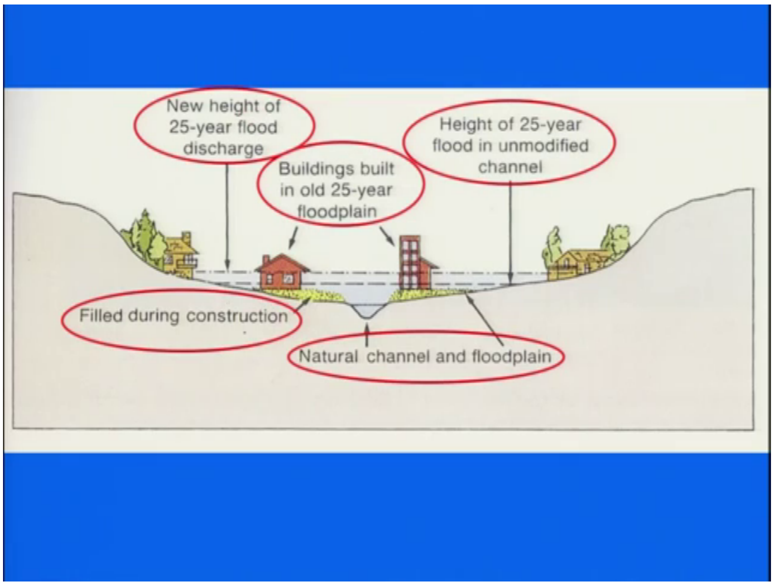

So, this is very, very important to understand. And this example shows that how things will work and how we will be affected if we are not having the complete understanding that what has happened in the past in terms of the flooding events or the water levels which rose in particular channel in during the historic time.

So, let us understand what exactly it is been given here. So, you have a natural channel which was which is here. And then you have and floodplains adjacent to that which is mostly commonly is most common in all the river system. So, height of 25-year flood in unmodified channel; so, it used to come to up to this one. So, this was the peak during the peak flood or the peak discharge you will have the inundation of the it is own floodplain.

Now, what you have done you have filled up the area during construction. So, you have taken away the space which used to be and then you constructed the houses. So, what you are having you are having buildings built in old 25 years' floodplain. So, in this floodplain this used to be the level where of course, this will be submerged. Now this will happen this floods may be in 100 years or 200 years it will be repeated, but ultimately what has been done is that a new height has been I mean created or we induce this by occupying the its floodplain here.

So now the water which used to remain up to this in the peak flood, but in the peak discharge, we are having the new height of 25 year flood plain discharge. So, this is what so more area is getting affected because we have choked up its own flood whole floodplain area. There is a now when you find that for in urban flooding if you are able to see this type of things you try to understand that what we have done in the past way you can what best exercise one can do is that you can examine the old satellite photographs or the satellite data which was been collected before the these the urbanization. And try to find out that which what areas we have or which are the areas we have occupied in last 25 30 years.

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So, this is an picture from Ahmedabad city. Of course, we admire and to see the development in Gujarat is amazing, but this flooding state was in urban area. And this was just in half an hour of rain this was completely and this in the main road which connects the Gandhi Nagar and the other part of the of the region. And this was one on road, but the subway or the low lying areas or the under bridges areas were completely filled up.

So, you were not having any connectivity. So, this photograph was taken by me. When I faced this at night and I faced the pre issues like reaching home and the starting point of mine was so Gandhi Nagar and I used to reach my home by almost like 30 minutes, but it took all it took me on that day almost 4 hours to reach or that our cover that distance. So, this is mainly because of the inadequate drainage which was not available because we have we kept on using the areas of the river channel itself.

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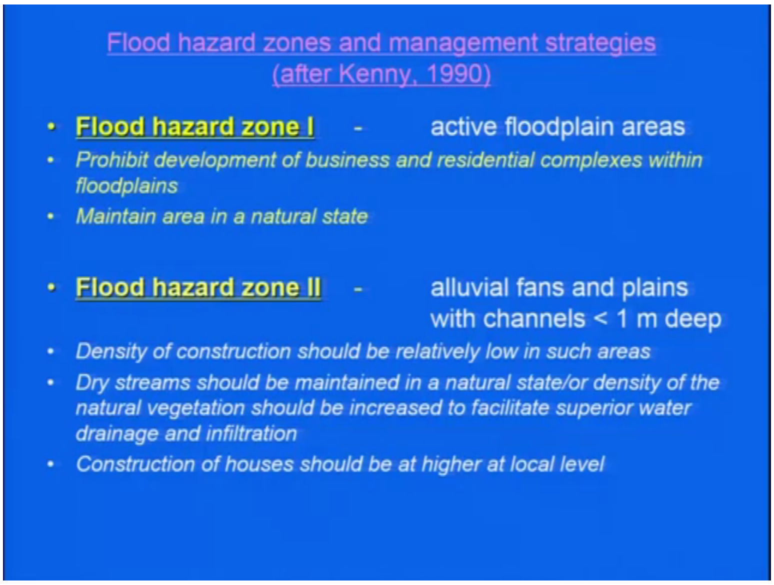

Now, flood hazards donation and management strategies is very old, but you can as I told that you can come up with your own hazard map depending on the areas which are going to be under flooding states ok. So, flood hazard zone I: which we will say active flood zone areas, we what one can do is that it prohibits development of business and residential complexes with the flood pain maintain the area in natural state. Flood hazard zone II: mainly in the areas where we are having alluvial fan deposits or the landforms and the plain areas like Indo-Gangetic plain and within channel depth less than one meter. So, the density of construction should be relatively low in such areas ok.

Dry steam should be maintained and the in natural state or the density of the natural vegetation should be increased to face create superior water drainage and infiltration. So, that will reduce your runoff mainly. Construction of houses should be at higher at local level. So, doing so like for this you can use high resolution satellite data and also now you can work out with the mapping with UAVs and all that.

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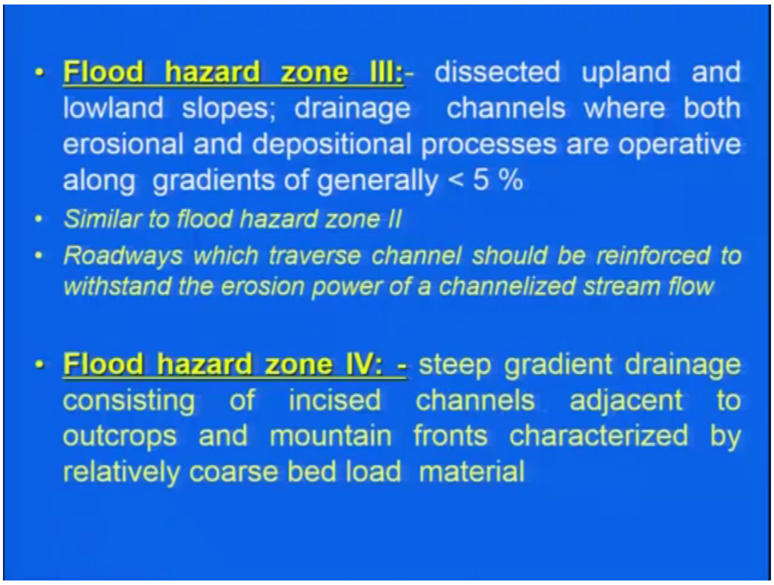

So, detailed geomorphic map should be available which will talk about the digital elevation model and based on that you can work out that how much area will get inundated during the flood if you are having the water levels of the from the passwords.

So, flood hazard zone III: dissected uplands. And lowland slopes drainage channels where both erosional and depositional processes are operative along gradients of generally less than 5 percent ok. Similar to the flood zone 2 you can take the precautions here. Roadways which transverses channel should be reinforced to withstand the erosion because this is a very important ok. And then the you should take into consideration the landforms also which you will come across in that river basin whether it is meander braided or you are looking at the straight channel.

So, those all points we have discussed also we have discussed about the landforms and channel forms ok. We also discussed about the drainage pattern which will help us in understanding that what will be the erosional pattern and what is the rock type of the lithology of that area flood hazard zone 4 or the steep gradient drainages consisting of inside channel. So, we will have deep channels deep cut channels in the area adjacent to the outcrops and mountain fronts.

So, this will be closer to the mountain trends. So, what we expect us that we will have in course a bed load. So, that can also affect the coarser bed load if in during the flood can affect the if there is an residential areas and that region.

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So, flood controls another most common methods for the controls or the construction of dams. You can do in upstream area so that you can channelize the or you can release the water accordingly and you will allow the water storage also as well as you protect the areas in the downstream region.

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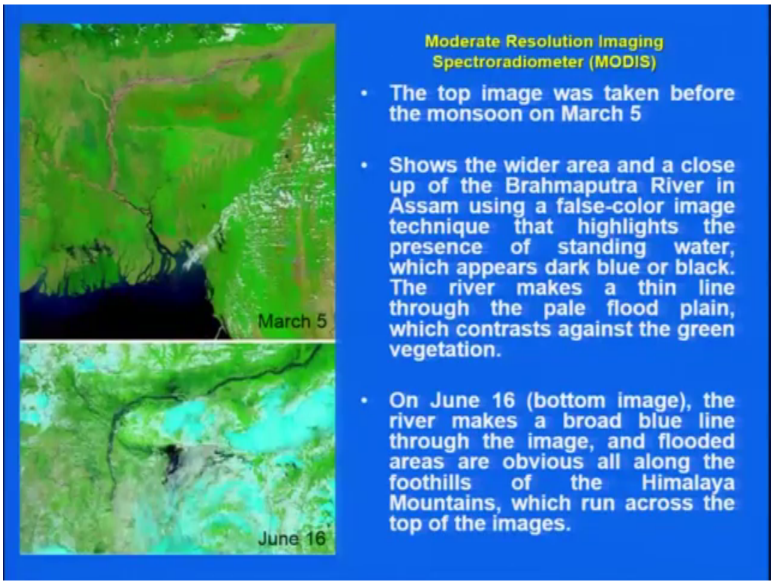

This is very commonly done. Now this is again you can as we were talking in the couple of slides in the beginning that the monsoons or the floods are predictable during the monsoon season because we have this data available every year. So, in that sense we have very good amount of data which can be helpful for us in understanding the flooding state of that particular region. This photograph is from Modis and from the Brahmaputra valley which shows that this area will be affected because of the heavy rain. So, you can we should a warnings, but you have to take into consideration that the which part you are you are particular site either you are in the upstream or the downstream or in the middle part of the basin based on that one can issue the warnings.

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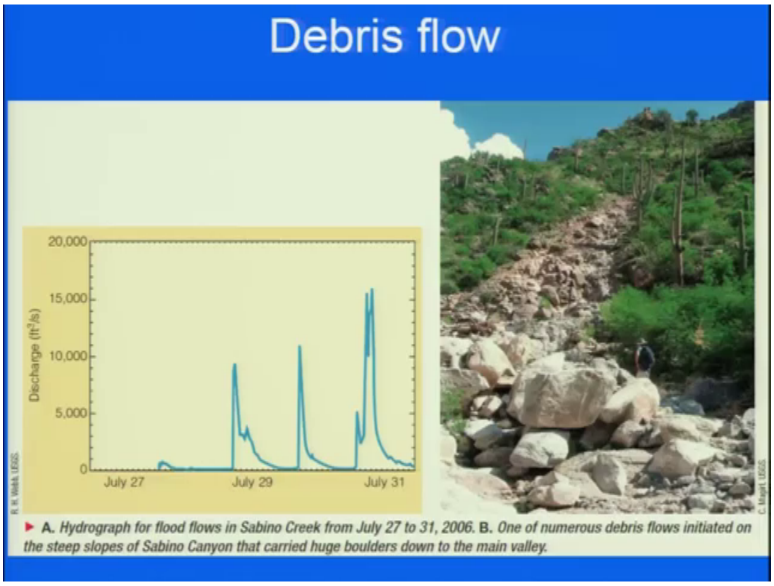

Now, there is an example for the if you are closer to the mountain front then you can expect in torrential rain or maybe during heavy rain as such coarser better load which is coming down to the slope. So, you need to avoid such locations.

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Similar type of photograph where it has been shown that this house is gone because of the huge boulder tumbling down from the from the slope.

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So, this example already we have discussed. So, I will quickly move, but which is very important again. If you look at that the low lying areas without having proper understanding of that what will be what will happen during the peak discharge. As we were talking in that what is the hydrograph which we were having in the normal channel original. And then after occupying it is floodplain areas what has happened. So, you eventually what was been seen or we saw in the previous slide was that the flow depths increased in this area.

So, this was the photograph in 1978 as we were we discussed this for the landslide, but this also is true for the for the flooding events within the channel and for the landslide I was talking more important was the undercutting of the channels or the cliffs, but for this, what is most important is that we have allowed the people to go for construction. And the just adjacent to the riverbed and definitely with the with the sediment size and all that if you look at closer to this area where I am pointing out here there is an photograph maybe, but here what we found was that the sediment size were almost like 2 meter in diameter.

So, you can understand that what sort of magnitude of flood one can expect in this channel and what will be the flow that is and what will happen definitely when there is an peak discharge in this channel. All these houses which are sitting along the close to the river valley that is on the terraces will be affected.

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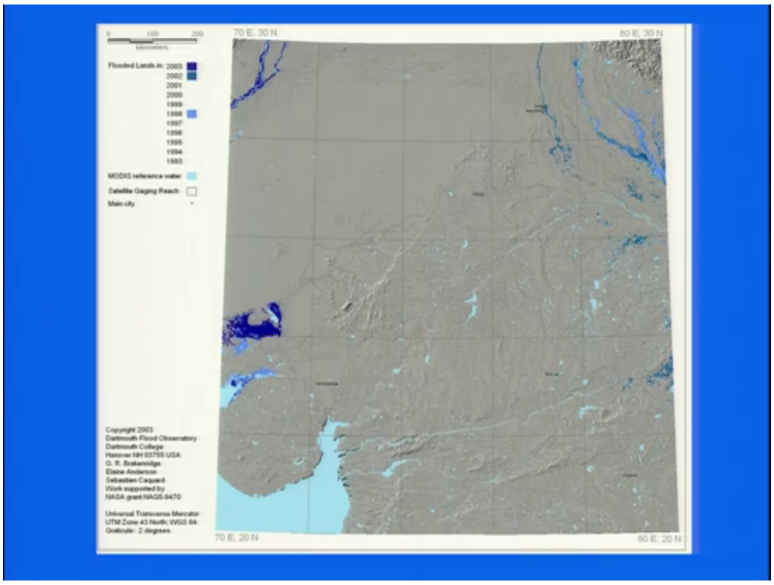

There is again one can easily monitor this is from the dearth mouth flood observatory. These are all done by remote gating stations. And this map shows 2000 flooding events in 2003 2002 and 1999. So, based on this one can prepare the flood hazard maps.

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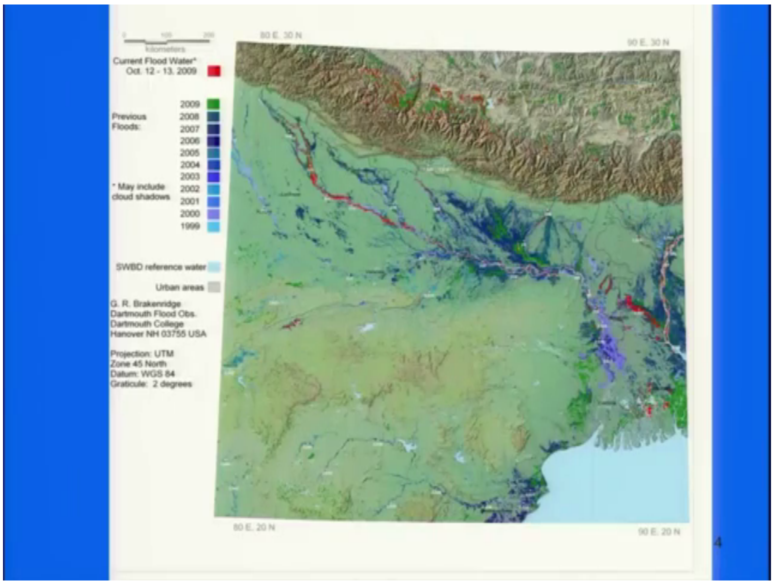

Another satellite picture which is very important and we discussed in the previous lecture also that how the channel of Kosi which used to flow through this region and it flood for several years took up the new path.

And, but this path is it is own path that is in value channel and this happened in 2009 ok. So, with the help of the data which has been so the satellite data and the gauging stations you can understand that what will be the peak discharge and which are the areas which will be under flooding. So, where the red portion this images from up to 12 to 13 2009, but it also shows the inundated areas close until 1999 this region. So, most of the time this areas like in 2009 this river was under flooding that is your (Refer Time: 21:21) I this is I and then even Brahmaputra was on the running state on that and the inundation which has been shown here. So, we understand that this region of in the Indo-Gangetic plain has affected every year, almost every year.

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So, these are the gauging stations these are all satellite river watch of Indian subcontinent from that (Refer Time: 21:43) flood observation close up of that. So, based on this gauging stations one can also try to find out that what will be the discharge and what is the current discharge which is available during the a monsoon season.

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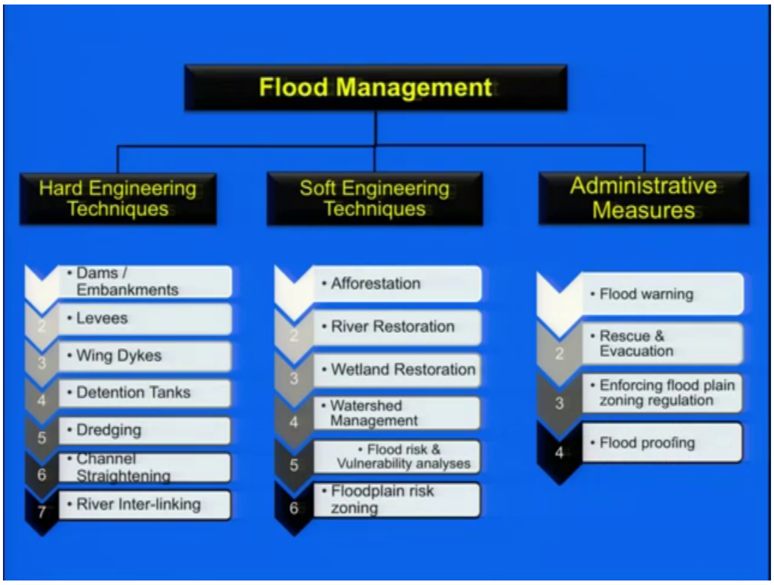

Now, flood management base of course, and very important aspect where people have been about adopting different techniques like hard engineering, soft engineering and administrative measures ok.

So, and after doing all that of course, the administration should be quite active in playing it is role. So, you have what you do is hard engineering you can come up with the based on the recommendations of the service and all that and having understanding of the past floods one can come up with the construction of embankments, dams, levees, wing dykes, this we will come in the what are the wing dykes and then density tanks did not oh sorry detention tanks. So, this can help us in putting the water away from the channel in some other a area or the storage areas and then slowly can be released, the dredging of the channels, channel straightening and the river interlinking.

So, river interlinking can be done where you are having, we have the understanding that one river basin is having enough water and can get into the flooding state every year. Whereas, other regions in the in the nearby regions are not have or the or the rivers in the nearby regions are not having enough water. So, you can put that excess water to those river and that can help also in terms of rejuvenation of the rivers as well as we can use the water for irrigation and for the mankind in that region. Ok, but the issues remains is that in India or maybe in any other countries are that the when the river basins or the river flows through any particular region it has an different lithology.

So, chemistry of the region of the water will differ from one place to another place can have we can have very like long discussion on this part, but yes of course, this where the points which have been raised by one of the leading one of the workshop, where we talked about the river linking. So, how we can we can control the chemistry it is quite difficult of that is the water chemistry oven particularly. Anyways then we comes to the next one then we have the software engineering, where you can do a forestation, river a storage wetland restoration watershed management flood risk and vulnerability analysis floodplain risk zoning.

So, there are few more things here ok. And then finally, with this information you can issue the flood warnings, rescue an excavation evacuation plants what you are having enforcing floodplain zoning regulations. So, what I was showing in the previous one of these side from Himalayas that we if we enforce the floodplain zoning and regulations that we will not allow you to settle down here that will help us and finally, saving the life’s and flood proofing ok. So, you can do that also by having issuing the warnings and all that.

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So, hard engineering that is these are what is the wing dykes which have been constructed and there is an example from the on the Chinese river where they have constructed the wing dykes and this also tries to distract the flow ok.

And finally, what you see here and you can have the fantastic development in this region. So, basically the wing dykes will be helpful in slowing down the velocity here. And to some extent it will reduce the impact on the areas in terms of the ocean and all that.

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Now, this is one of another very state of art example from Japan where what they have done is then they put the pillars which you see here is are basically tank securing. So, it says the G-Cans project and this is all at the end underground discharge channels.

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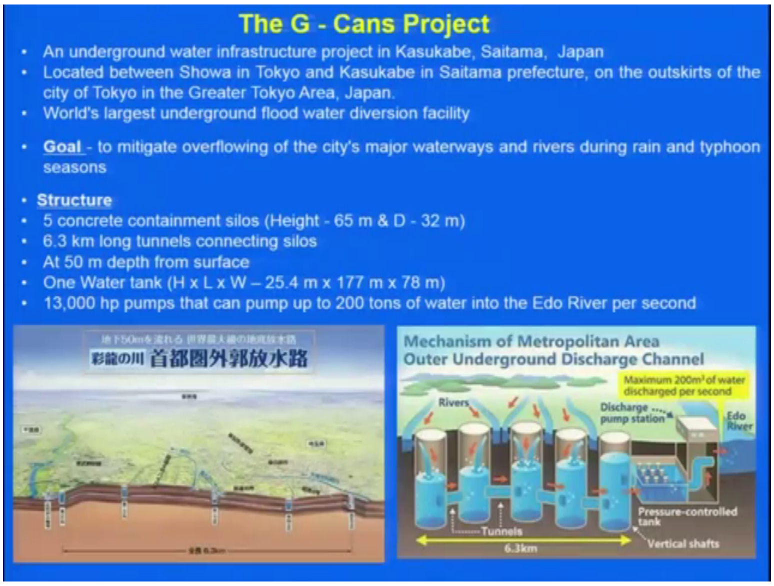

So, what they do is basically is they have the underground tanks which are interconnected and again those tanks are connected to the different channels.

So, you have the excess amount of water during the flooding state getting filled up or is been diverted to these tanks and these things will keep filling up. And then finally, what will happen that if you are having enough water which is available or these tanks are getting filled up depending on the capacity if it flows it has more water than the it will be released to the nearby main channels. So, most of the tributaries are being diverted or the water has been diverted from these smaller tributaries which are definitely a part of the major river system here that is edo river, but whenever there is like. So, this will what basically it will do is it will reduce the water getting into the main channel and it will restrict the flooding in the main channel because. If this channel gets more water or runoff then you will have the flooding state very soon.

But so that has been reduced and slowly it has been released in the area where you are having less propagation. So, it will be completely siphoned out and from that where or we can say that it has been diverted and even this can be used for other purposes also.

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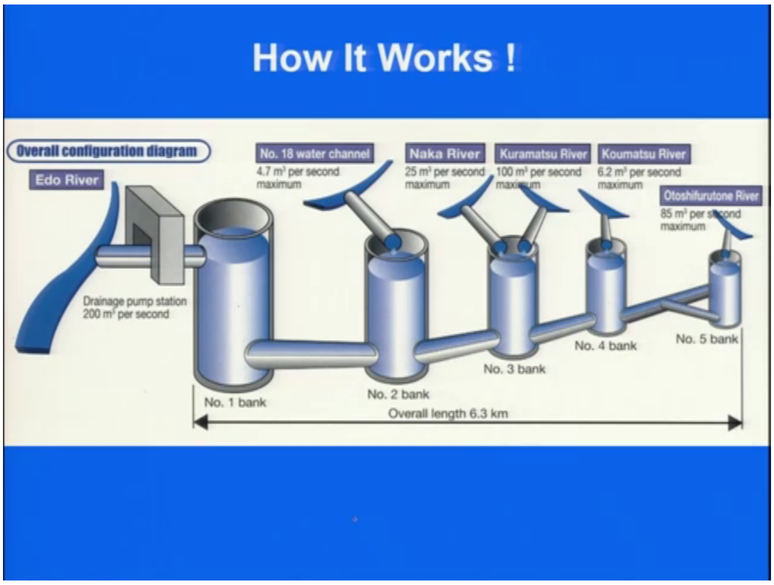

So, this is what how it works actually. So, you have the collection from different channels here the water is getting in. So, these are the names of the different channels which are the tributaries of this main channel Edo channel. And of course, it will be released in the same channel. So, you are not wasting the water, but you are siphoning out the water or in the urban settlements ok.

So, you are not allowing the water to flow overflow in the urban settlements. So, here in case in that case you are protecting that.

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So, this is one example and the restoration of the banks are most commonly seen in many areas, where with an understanding of the channel form what which will be the erosive side and which will be the depositional side you can go on for the selection. So, this has been shown as the construction is in the restoration of the banks with the rock blocks. And then you can have an very channelized force which are available. So, this photograph is before and while doing the construction or restoration of the bank and this is after that.

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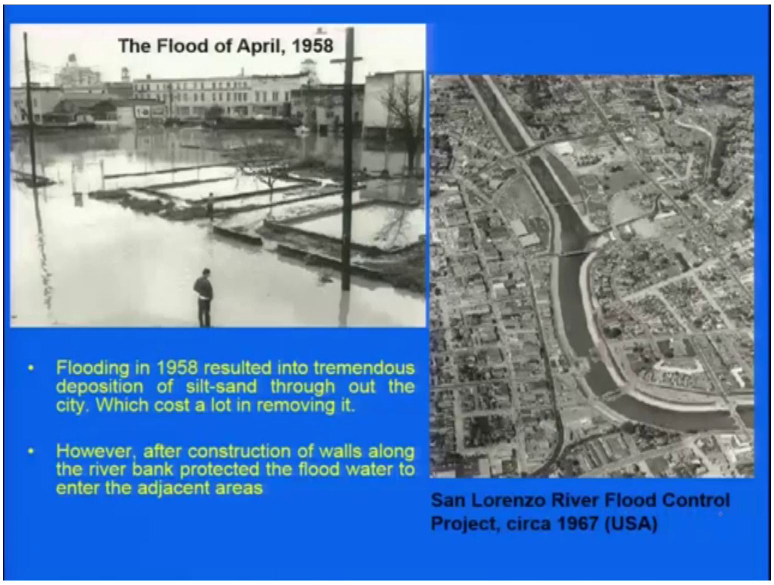

There is an flood from these 1958 and from US. So, this is before the channel was the river training was been done that is the flow was channelized and then this is this one is before and this one is after in the same river ok. So, this is one of another technique what we were talking about the flood control.

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This is from Tokyo. So, even you can see that the river has been channelized and the houses are setting at the depth very close to the river bed actually or the this flow depths are very close to this. So, these are the examples which are one of the good examples how the channels have been trained or the river training has been done, this is the photograph from Ganga river close to Kanpur.

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Where mostly in almost all seasons the low lying areas have been submerged and this photograph is from Ahmedabad, where again the river training was been done.

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And this area which is known as riverfront was been constructed as I was talking about that.

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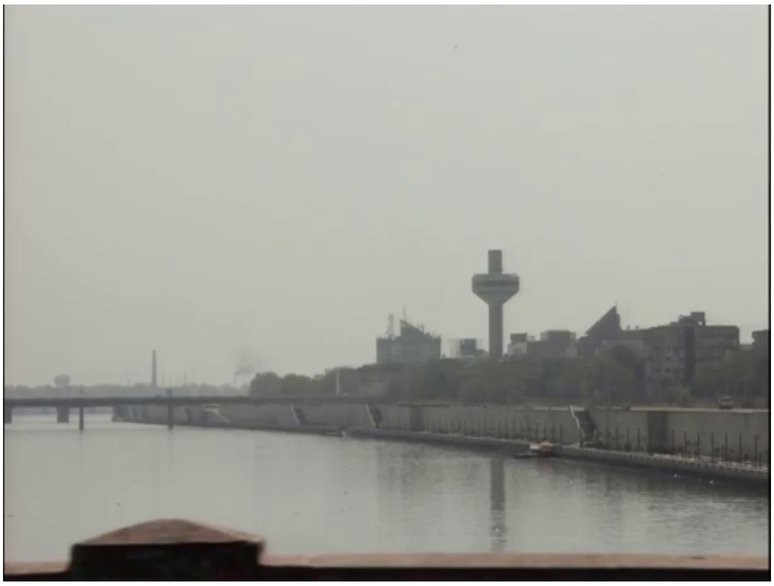

And now if you see this is also at the time of the construction which was been done. So, lot of like assuming like the parks were been created here and then you have for like Chopati in Bombay.

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So, this is what it looks like now the same area so they in the. So, we have the pedestrian path here and then you have the parks on the top here. So, thank you so much of and we will continue with the next topic on tsunamis. And we also plan to give you one like project or maybe we can have on discussion on that tsunami modeling part.

Thank you so much.