**Coastal Engineering**
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**Module - 3**
**Coastal Erosion Protection Measures**
**Lecture - 10**
**Coastal Erosion Protection Measures – X**

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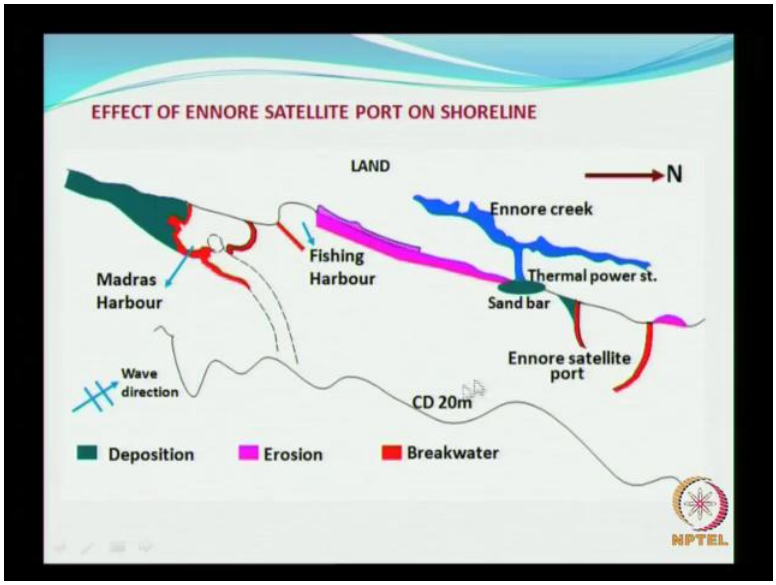


I should mention here in that the original proposal of the Ennore satellite port. Envisage a series of groins here and also a pair of training wall here. Unfortunately that never found its way and it was never implemented at all. So, that was the original proposal, so unfortunately we have we had to live with this coastal erosion here till we had the groins in place. And then the sand bar formation here, there is still a problem of sand bar formation there and which would of course need the training walls as we have already seen. Then we just move on to when while I was explaining about this problem this, there is a river here which is called as Cooum. This problem is also several decades old. There had been similar to the coastal erosion at Rayapuram, this was also there from quite the sometime.

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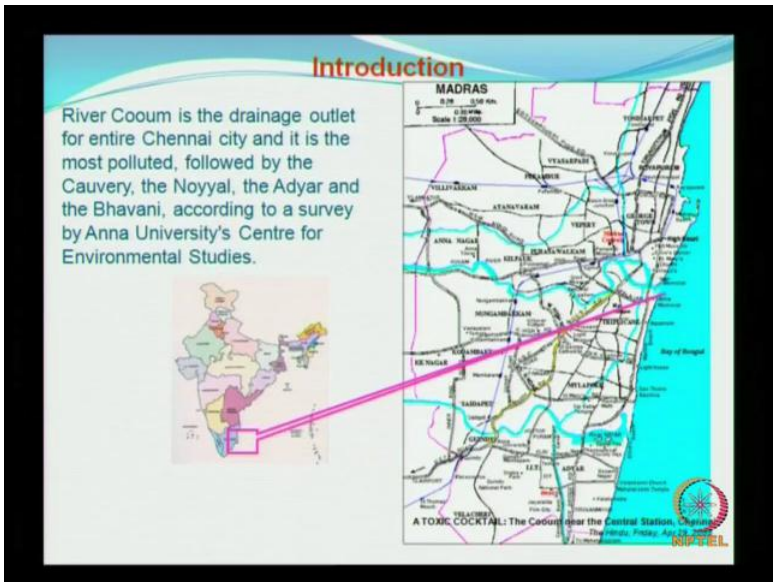


And this is the location the details of which are shown here this is the Chennai harbour and you see that this blue color and you see its configuration. It flows into the city of Chennai plus we have yet another river which is the Adayar river which is flowing here, south of Cooum river. This Adayar river also flows into the or flows through the city, let us concentrate on this.

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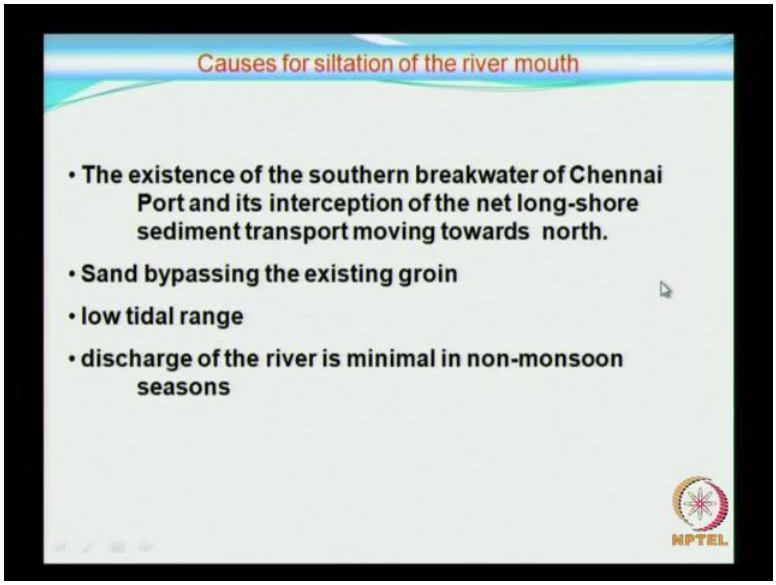

The existence of the southern breakwater of Chennai port and it interception of long shore sediment transport moving towards the north, that is the problem which we have already seen.

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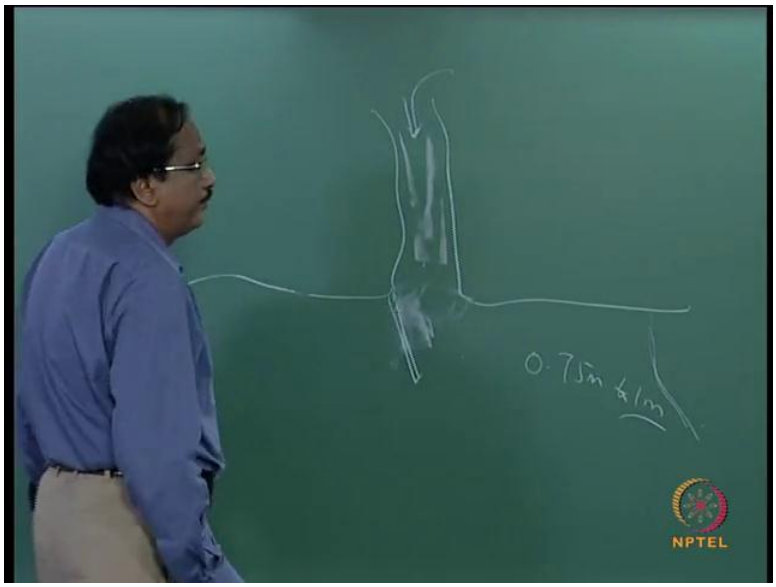


So, there was a groin, so there was a among the, so you have the you have the breakwaters of Chennai port which is creating the sand bar formation which also we know. That is not the only cause that is the major cause, but there are other issues also the tidal range of Chennai city is only of the order of 0.75 meters to 1 meter and there is not enough flow also in this in the river. So, all these things adds up, so you have on one side the accumulation of sand from the long shore sediment transport and on the other side there is not much of flow and there is no proper maintenance of the river. What do you mean by proper maintenance of the river?

If the river is getting shallower, it has to be dredged so that you have sufficient depth, so that the water can easily exchange. May be during monsoon when there is significant flow in the river then this gets flushed off. So, this this is a bit rare may be in the month of October or November, you may see that the mouth is open, but most part of the year this is closed. And only if you have the tidal prism that is tidal prism is the the tidal range in the ocean quite high, then you say, you see significant amount of water moving into the river and then bringing all the filth from the river back to the ocean. So, this is what is called as your tidal flushing. So, there was a groin put here somewhere, I mean a

training wall, but that is was not sufficient it started bypassing and then you had sand accumulation, we will come back to that later. And this is what is mentioned here as some few points what exactly is the problem.

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So, look at the some of the pictures where in your formation of the sand bar in process, there is a small portion of the, there is a small portion of the mouth which is open actually the width of the river is so much. This is a closer view so you see the sand bar.

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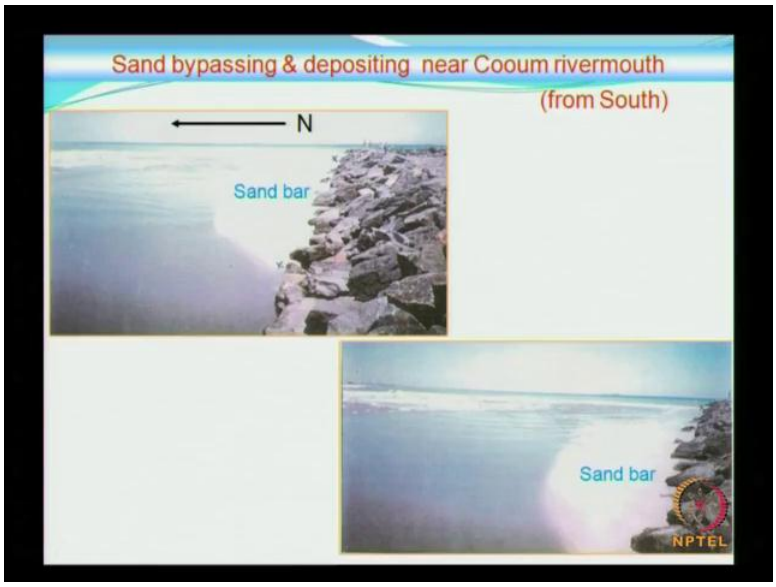


Sand bar also starts very close in this location.

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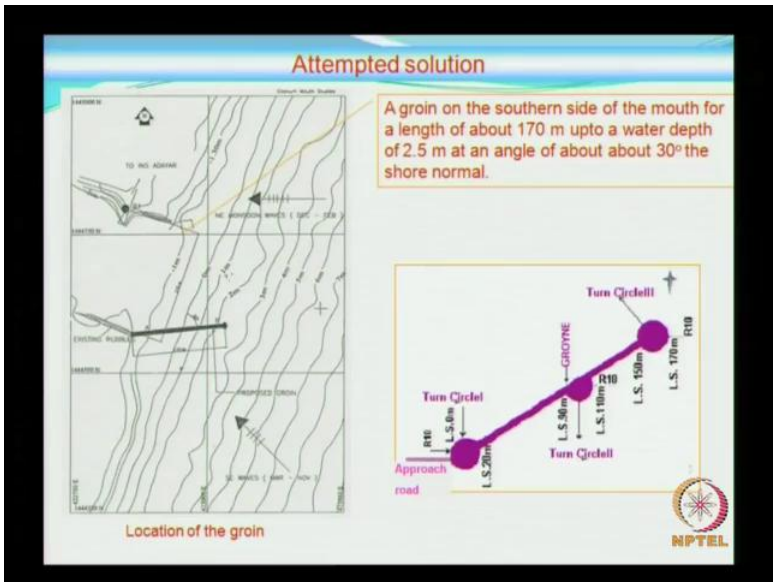


So, a groin on the southern side of the mouth of length of about 170 meters up to a depth of about 2.5 at an angle of about 30 degrees was subjected, was proposed. As you can see here you see those still because this these are supposed to be this is for the vehicle which carries the boulders to turn nothing else and these is not…

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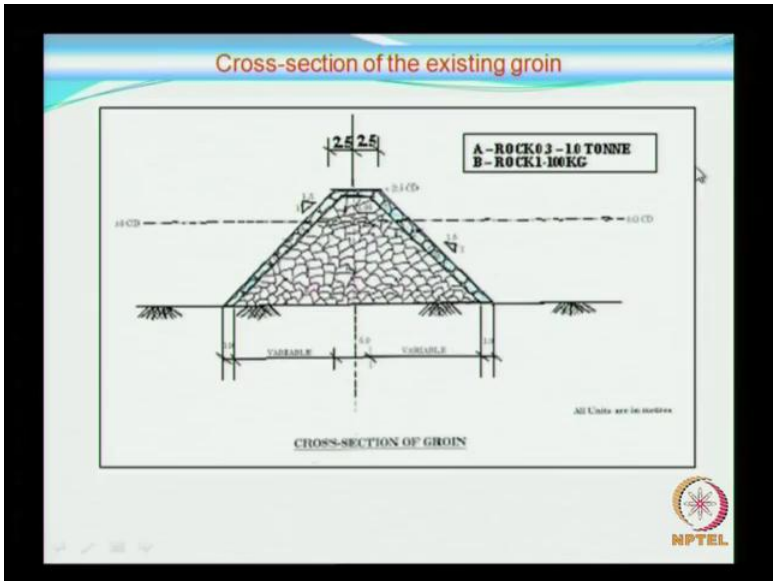


So, you look at the cross section that was adopted the cross section was one ton, and then inside the core layer inside the core layer it was around a it it was around 100 kg.

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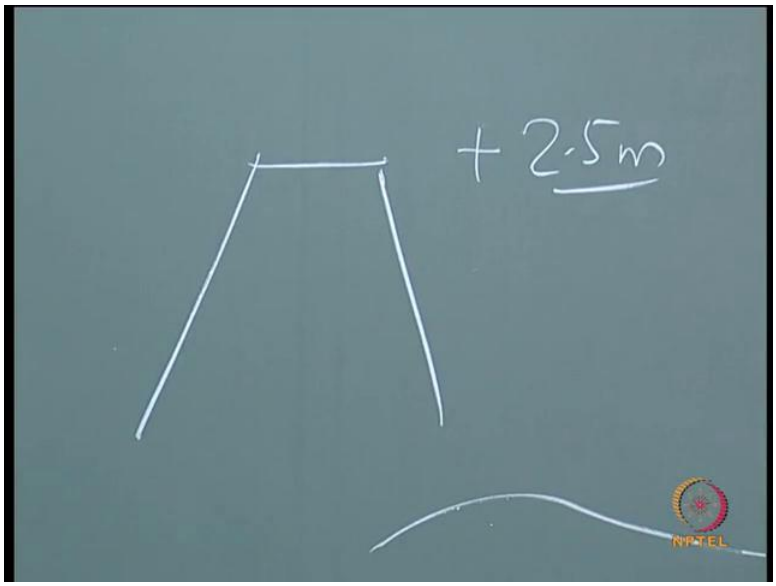


For such a groin the top level is also very important, here the top level was adopted as plus 2.5 meters plus 2.5 meters.

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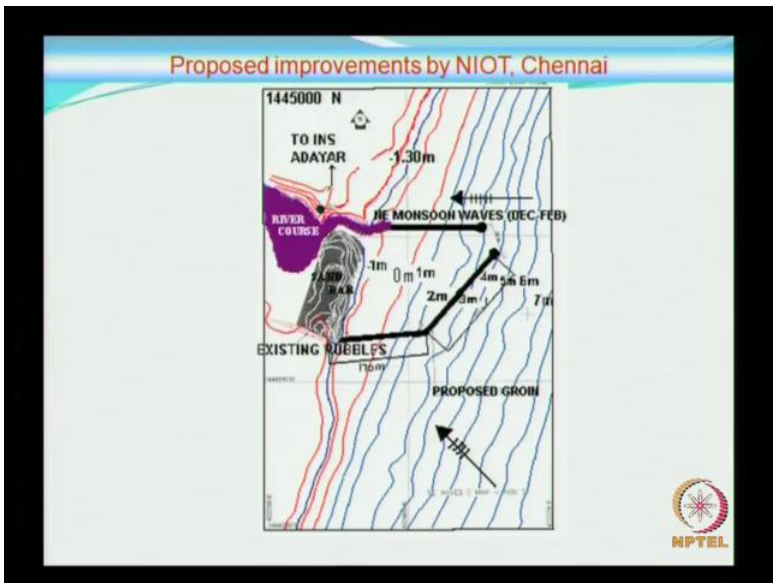


There was also some, I mean additional protection measure which that was suggested by another institute you know all of you know NIOT, that is national institute of ocean technology, which had an arm something like this.

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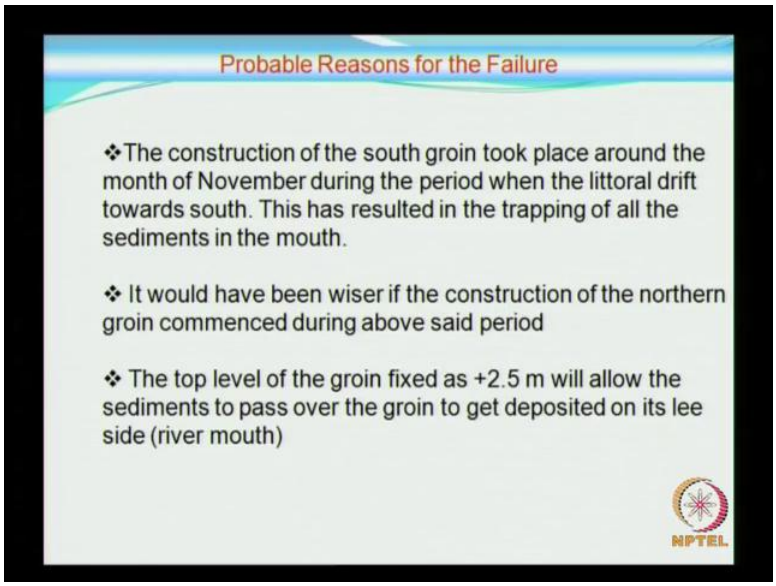


Which was never, which did not go through, but in spite of this groin, this I mean in spite of this training wall, the construction of the southern training wall took place around the month of November. Is that a right time for us to construct a training wall along the coast along the coast where the literal drift is in this direction?

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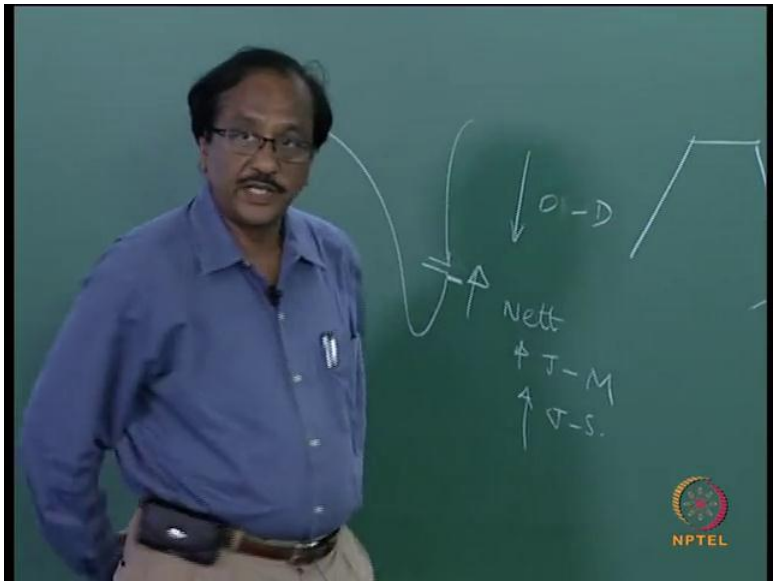


We are talking about the Chennai Chennai where the literal drift is towards the north and you have the river flowing and then you want to construct a a groin like this in the month of November, when there is a sand transport in this direction. This is the net sand

transport as I have said earlier and also January to May and June to September, but then October to December it is going to move in this direction. So, the whole thing got blocked, so this is during this time it would have been wiser if they had started the northern groin. So, that was the problem then the top level of the groin was fixed as plus 2 2.5 meters.

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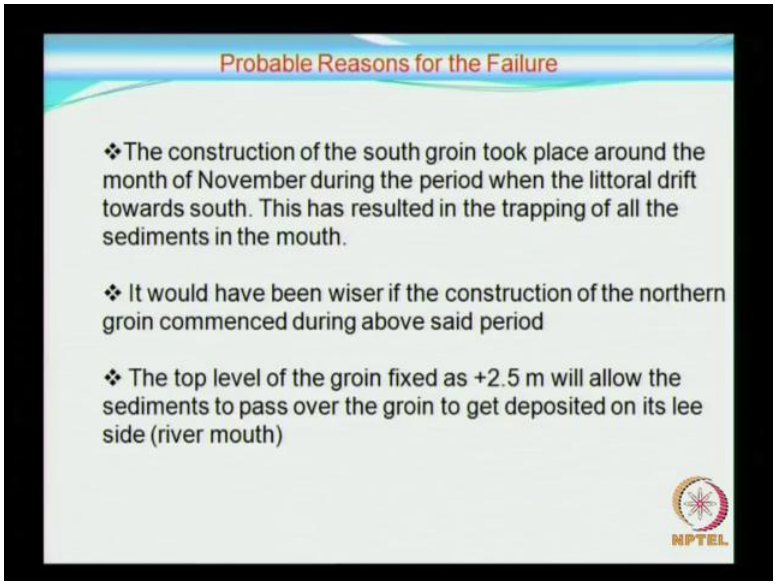


The original proposal was something like plus 4 meters the top level. If the level is less what will happen the suspended sediments which are moving will also automatically deposit here, it is not really going to serve as a 100 percent barrier, even when the sand is moving in this direction, it is supposed to, when it is supposed to intercept the movement of sand since, its top level is only plus 2.5, which is much less less then what will happen the sand will go mostly the suspended sand will go and deposit here. Later we will be seeing the phenomenon of wave run up overtopping etcetera. At that point of time you will appreciate all these things these problems. All these aspects have to be considered when you want to fix the top level of any structure, is that clear? So, these were some of the problems.

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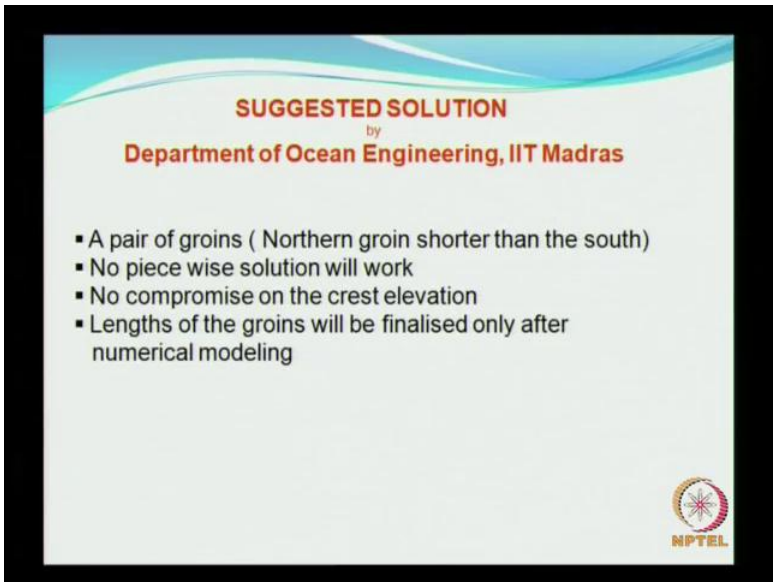


And then what we had suggested is a pair of groins again, the northern groin should be shorter than the south and no piece no piece wise solution. This kind of a problem if you face you have to solve it in total, there is no point in saying I have this much fund, this year I will construct this training wall, next year I will construct this training wall, you have to treat this whole thing in total. No compromise on the crest elevation, the top crest elevation has been raised something like plus 4.5 or something like that I do not know around 4.5, but the details have to be worked out.

This is based on our experience with the northern groins that is the groins which we have proposed for which we have constructed for the north of north of Chennai harbor. The length of the groin should be finalized only after numerical as well as physical model sets.

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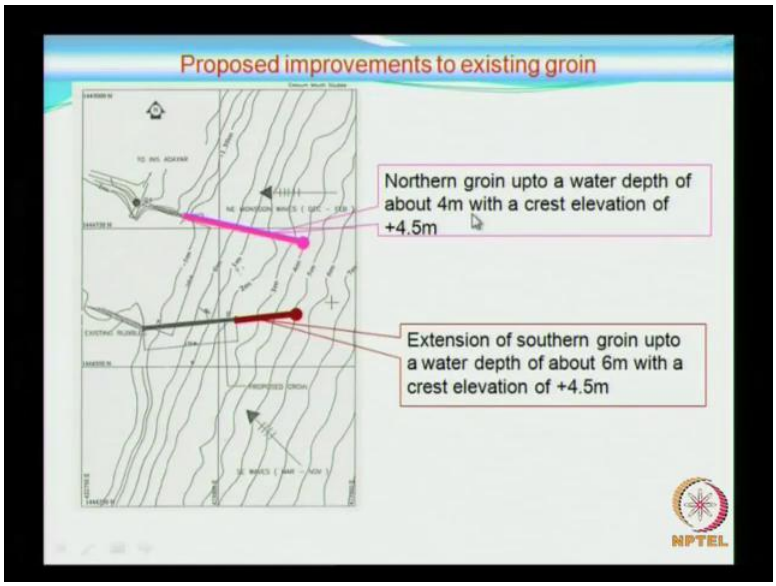


The proposal is the northern groin can be extended up to a water depth of 4 meters with the top with the crest level of 4.5 meters and the southern groin will be certainly longer and it will extend up to a water depth of 6 meters. Why 6 meters because of the huge sediment transport that is taking place in the direction of north has to be intercepted, it is not so easy to handle this much of sand. The only way to improve this Cooum is to prevent sand formation here and the other problem is and the another thing is initially you do capital dredging. And although you have a permanent kind of a permanent measure still, periodical dredging has to be carried out.

You cannot escape from periodical dredging because of the huge sediment the sediments that is moving along this coast. Why this six meters? When you calculate the surf with the breaker depth will be approximately 2.5 meters during monsoons during monsoon means during the period or during the month of June where you have maximum sand. So, maximum sand movement along the east coast of India would be around June to August and that is the time you have to be very careful or when you are planning a structure you have to have this in mind.

Later you will see that when you calculate the breaker depth, it is approximately around 2 to 2.5 meters. And further when you do the calculation on the sediment transport distribution along the surf zone, you will see that even beyond the surf zone you will have still some amount of sand moving. So, whatever sand is moving have to be trapped,

that is the basic principle and that is the reason why you have to raise the top level. And then trap all the sediments here and keep dredging. One more aspect is you consider having a pit something like a sand trap here, where in the sand will come and deposit here and then have pumps and then have pipelines where in you can throw the sand on the northern side, north of the northern break water.

What is this? This is a combination of hard structures that is the training wall plus a soft solution with dredging and nourishing the beach that is getting eroded. So, in this way you can solve the sand bar formation, but at the same time you need to keep following the maintenance dredging. Now, and then at periodically periodically you need to do the maintenance dredging and this will this is expected to give better results but all these information's need to be carried out or before implementing it has to be verified both numerically as well as experimentally.

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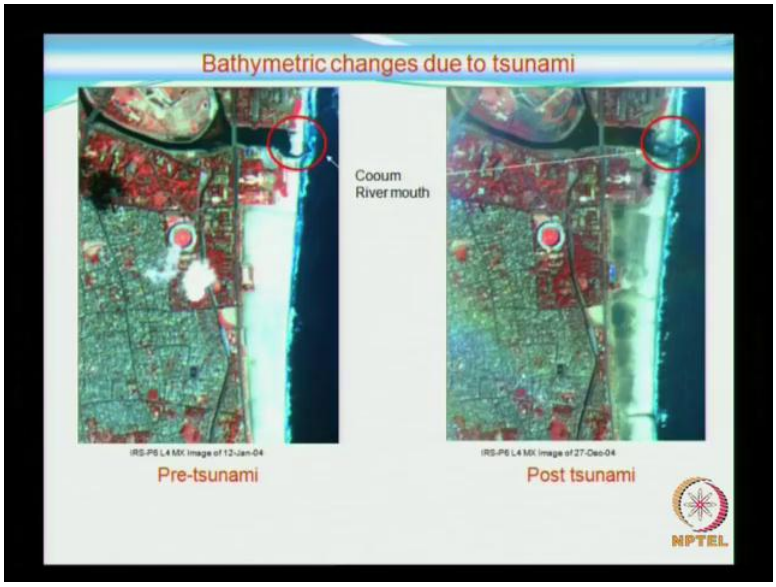


So, this these are some of the pictures which you see here this is the Marina beach and this is the sand bar, so the width of the width of the river is here. So, so much of sand has accumulated, so during the tsunami you see that this was one of the good things that has happened because of tsunami. This was the only good thing that happened during tsunami that is all the rivers or estuaries were kept or got open.

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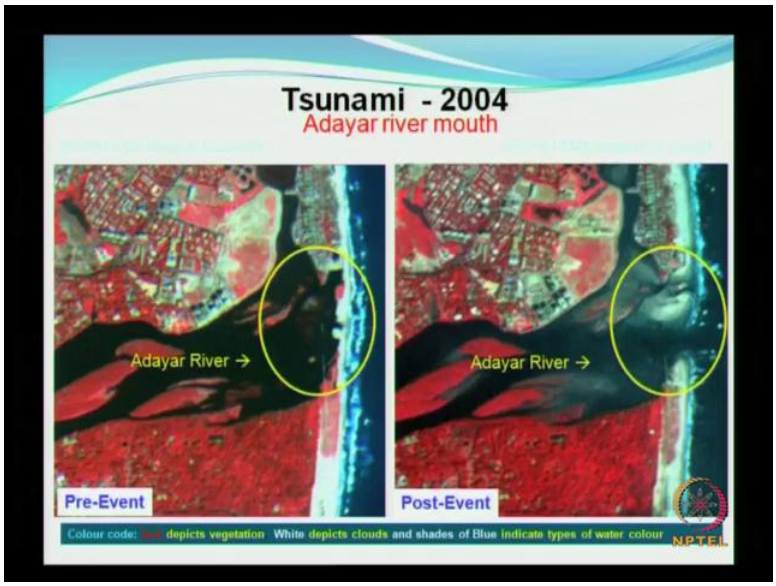


This is Adayar river which is south of Cooum. So, here again you see the sand bar formation and you see that this was the sand bar formation has been removed by the ingress of the tsunami. So, this is this is one kind of a solution for such kind of a a problem, which we had discussed. So, you can, this is somewhere in the Danish coast, this is this is our river Cooum.

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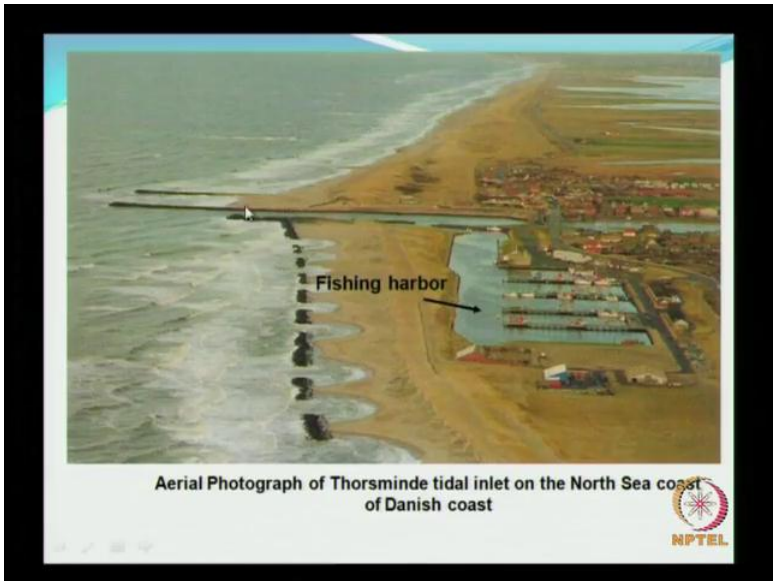


So, you have straight beach, I mean straight groins so one shorter groin and one longer groin, so you assume that this is the side of Marina beech, you so you look at the

variation of the shore line so you can have one more groin here there is no harm in it so that this can be used as a small Marina if you want. And then in order to tackle this problem they have a series of offshore detached break water. In our case I I did not mention to you we had again suggested small groins groin field because we are more comfortable with groin field, because it is easier to construct shore connected structures.

So, almost and this can be still be used for some kind of load out facilities etcetera. So, these are, this is the concept which I just wanted to show you because this can be, we can kind of duplicate the same kind of a scenario. So, many of the coastal engineering problems you will see that, it is almost similar, only the magnitude might be different.

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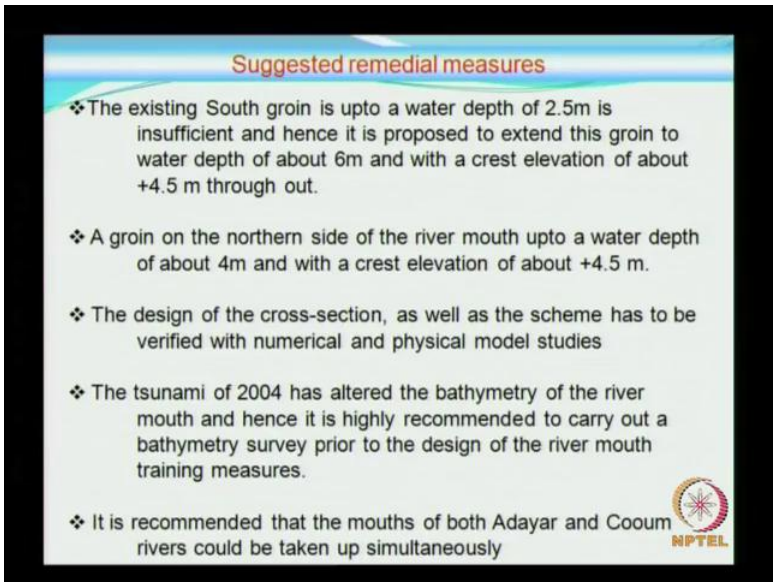


So, this I have already explained about the existing south groin is to be up to depth of about 2.5 this is not enough 2.5 meters so you we need to extend, so you can just read it on your own. There is not much of whatever I have said is available in these slide I will not go again and whatever suggestion we have made for the river Cooum, the same kind of suggestion can be implemented for the Adayar river also. Then we move on to further south of Chennai city, so this is Chennai city. We just moves further south so this is Chennai and we move further south and what is this? This is the place called Mahabalipuram.

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And which is a tourist place and another we have particularly the tourist from abroad it is a must for them to see this temple. This is famous rock temple of Mahabalipuram, it is believed that there were about seven rock temples similar to the one which we saw earlier.

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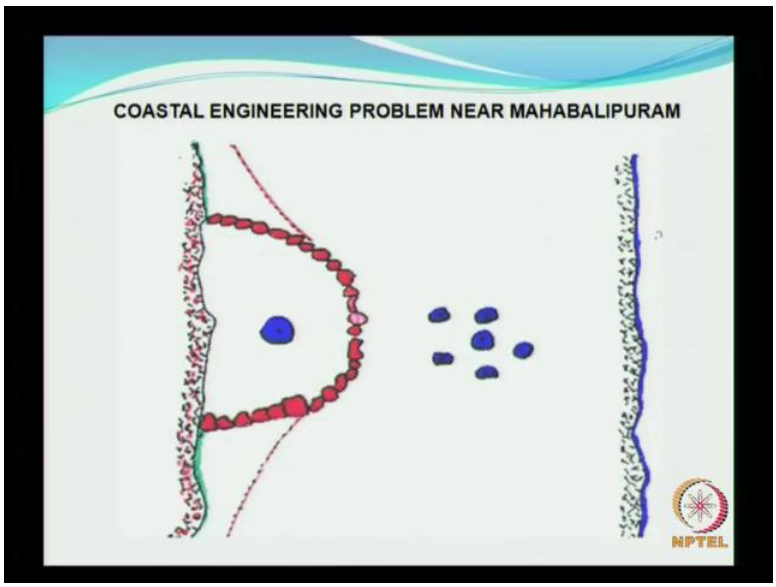


As decades rolled you see that all these six temples have already gone into the ocean and one fine day you saw, we see that there is only one temple and that had to be saved on a

war footing. How do you save this temple? So, this happened sometime around mid of seventies. What they did is initially they did a mistake in construction of a groin, not taking care of the direction of littoral drift, the same problem. So, when they were, so they started off with pair of groins, but this groin what happened when there was a northerly drift there was a very severe erosion along this area.

So, I do not want to go into the details of the problems that was created, but finally, what was happen what happened was that this had to be enclosed by a rubble mount, you call it as sea wall or you call it as groin. You you understood? The structure was supposed to take the shape of groin, it was supposed to perform the role of a pair of groins. Then finally, it was decided to close this also and then they started reclaiming some of this land and now you see that the size of stones they were, that was adopted is as high as some of 5 tons stones.

So, if you visit this temple you will see large amount of boulders all around. Out of desperate situation this temple had to be saved, so on a war footing they had to use 4 5 tons of stones, I mean individual stones to protected it now, the temple is in its position. And we do not have much of problem for simple reason only thing is this oscillation of the shore line on either side has become a routine. It is not a monotonous oscillation, it is a seasonal oscillation and it is not really very drastic, so we can live with that kind of a problem. As I said earlier they should have come under tsunami, but anyway since it has already come here I just tell you, during the tsunami you would have seen that when the you would have heard or if you have not heard, see usually these is the beach, during the tsunami the initial thing is the water level went up to this.

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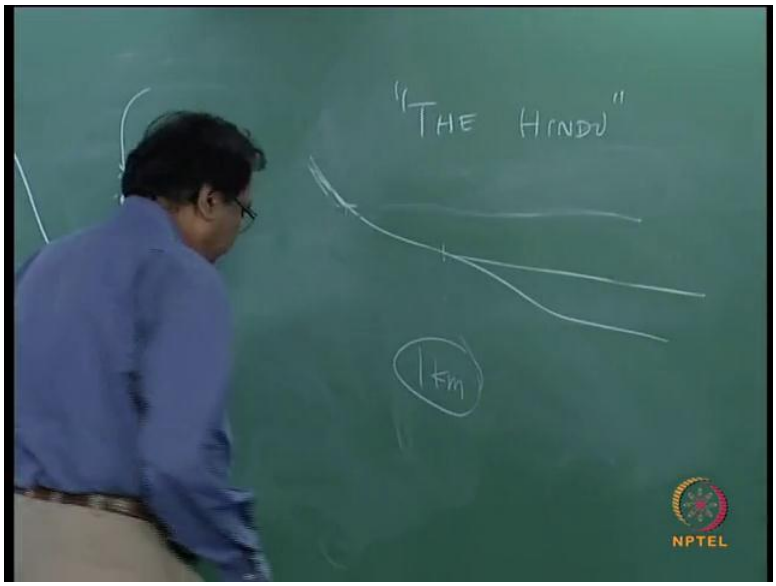


There is a fall or the water level went more towards the ocean, exposing significant portion of the land. I will elaborate on this later and this may be even 1 kilometers even up to 1 kilometer of land was exposed. During that time you see the relics of the old temples being exposed, this has appeared in The Hindu, during the… All of you know that Hindu is a newspaper coming in Chennai so during that time this was the beautiful photograph that was released in the daily. So, what did we see so far? We have seen a manmade manmade problem of Chennai coast then what we saw now Mahabalipuram was a natural problem. It is caused due to nature, there was no construction there. Now, we will go a still further south again.

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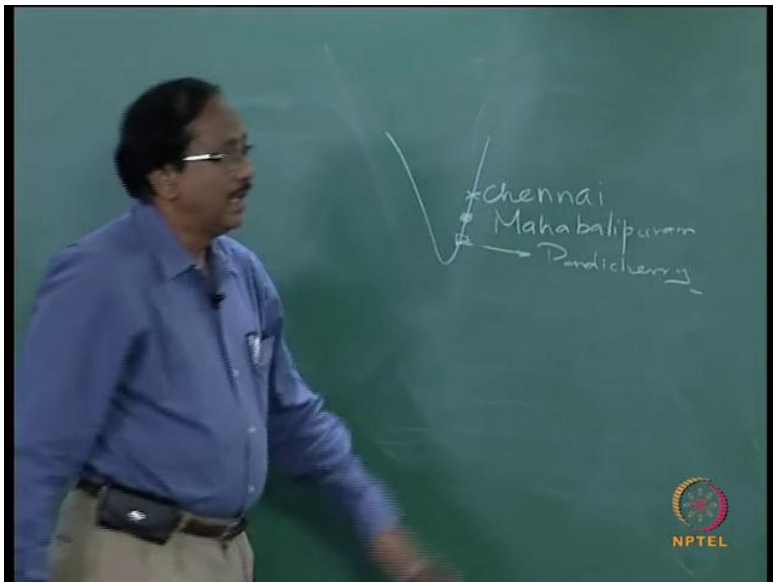


We are go this is Chennai, this is Chennai somewhere here is Mahabalipuram and then somewhere here is your Pondicherry, I am just showing you the… It is not to scale or I am not showing it any kind of a map.

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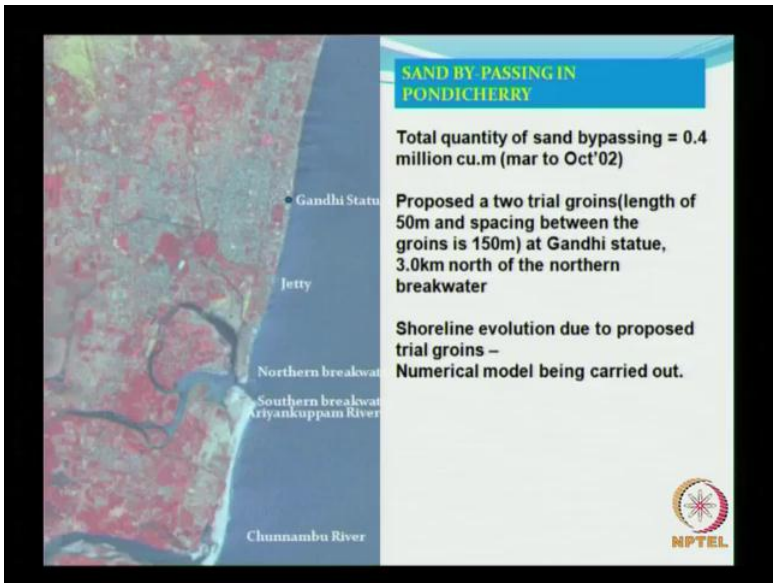


The lecture is just to make sure that things are clear, I mean the coastal process are clear that is much more important. So, you can always check check in a net go and Google it and Google for it and check for the locations sand bypassing in Pondicherry. Pondicherry is used to be a French colony, now here so this is along the east coast. So, naturally the

sand is moving from south to north. What happened here? You have a southern break water, look at this break water and there is a small northern break water in order to take care of the movement of sand and there is a harbour here.

A small harbour so the vessels come and go this is the entrance, this itself is used as a as the approach channel and this is the main city. So, what is the problem here? The problem is the advancement of the shoreline on the south and erosion on the north. Similar problem unfortunately the eroding area is the heart of the town whereas, this area where you have beach that is not that thickly populated it is a village, it is not populated at all. So, for something like a forest so we have deposition or the beach formation in that location, but we have erosion along the city, so what we did is what we had in mind is to dredge the quantity of sand that has formed here and nourish.

The beach which is called as this is a classical example for artificial beach nourishing method. So, the total quantity of sand to be bypassed was estimated to be 0.4 million metric cube, that is during the period of March to October. Why March to October? That is the time you will be having erosion here and that is the time when you keep receiving sand on the southern side, take this sand throw it on the north. So, we also has we also proposed two trial groins in order to check somewhere here in order to check how much would be the quantity of sand that would be retained for any project of this nature? You need to at least initially verify using a numerical model followed by some experimental model, I mean the physical model and then go into the fields. So, I will just skip this slide, it is not so important.

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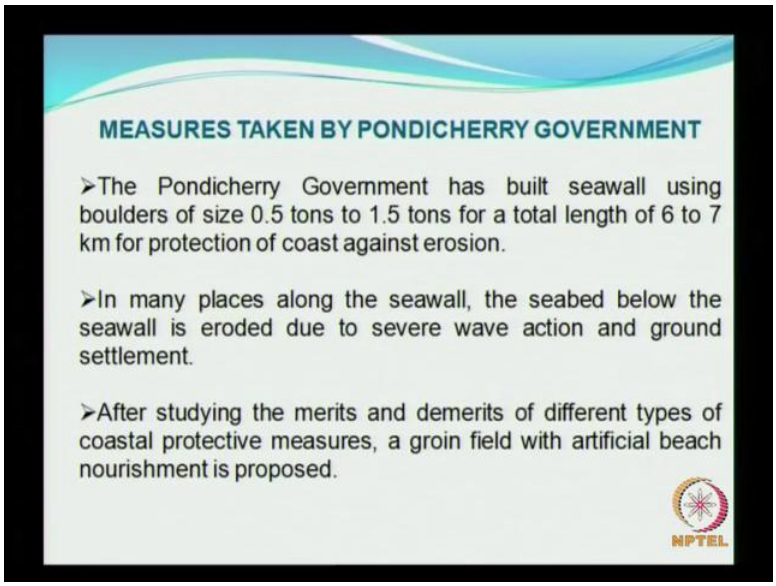


The government has built sea wall using boulders of 0.5 tons to 1.5 tons for a length of 6 to 7 kilometers along the north side, but in in a many places along the seawall the sea bed below the seawall eroded due to severe erosion. Try to recollect one of my earlier presentation we saw a a restaurant going into the ocean and that is this location. After studying the merits and demerits of different types of coastal protective measures or groin field with artificial beach nourishment is was proposed.

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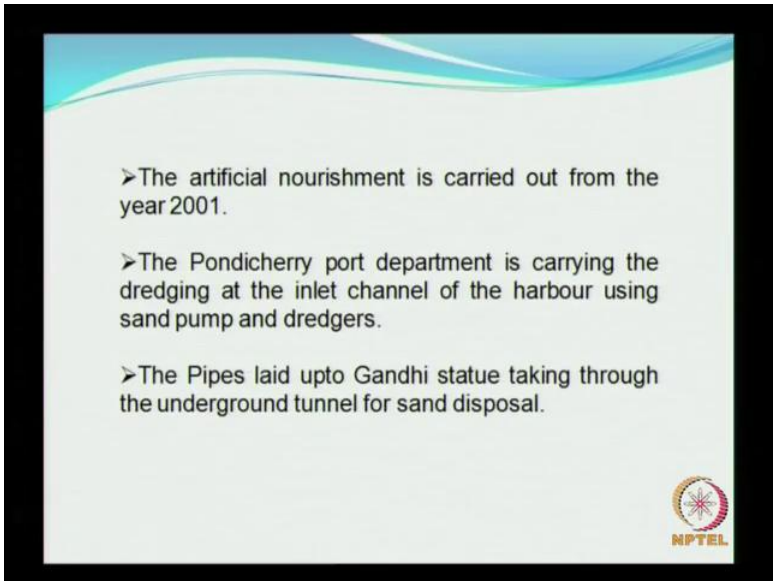

The artificial beach nourishment was carried out in the year 2001. The Pondicherry port department was carrying the, it not is carrying it is the the Pondicherry department was carrying out the dredging at the inlet channel of the harbour using sand pumps and dredgers.

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So, there were pipe lines laid. I will explain about this process in the original project around mid-seventies itself. The original project encompassed a artificial beach nourishment, but it was only in papers, in the report, it was never implemented. When we took the report and looked at all the possibilities, then we decided that the project can be revived and when we investigated we saw that there is a submerged tunnel here constructed already and it was in its place below the sea bed below the river bed. So, only thing what we need do is have pumps to dredge the quantity of sand, lay some pipelines across and then pump this sand, this is what we did in 2001.

So, you look at the process, this is the pipeline you see here and this is the submerged tunnel. You cannot see it is below the, so you just this is the offshore break water, that is the southern break water and this is the northern break water. So, here you can either call it as groin or (( )) or whatever because it is also serving as a river groining plus it is also guiding the vessels. So, when we did that, you look at this sand bypassing after the sand bypassing has taken place before the sand bypassing this was the situation.

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At the same location in October 2002, so the sand bypassing had taken place, that is to the extent of about 0.4 millimeter cube per year and this is what you see a different locations along the the effectiveness of artificial beach nourishment.

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So, look at this point, this is the same location. This proved that artificial beach nourishment did work.

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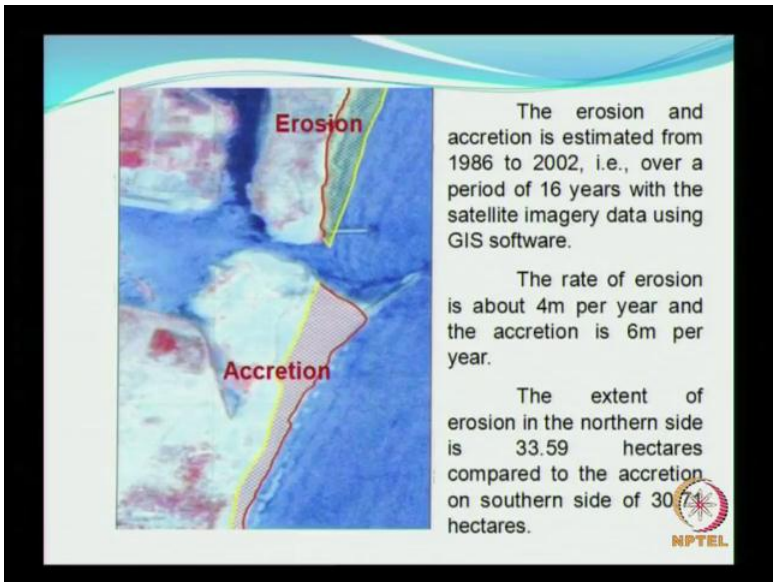


So, the erosion and erosion and accretion is estimated to be from 86 to 2002 over a period of 16 years with the satellite imagery using GIS software. The rate of erosion was found to be about 4 meters per year and the accretion about 6 meters per year. The extend of erosion on the northern side was about 33 point around 34 hectares compare to the accretion on the southern of about 30, still there is a kind of a deficit. Do you understood? So, this example gives you what is meant by artificial beach nourishment and once you do it perfectly, that is not be any problem, but when do you have problems?

Because now there is no problem concerning the supply of sand, you know that the supply of sand is going to be continuous and it is better to do this when there is more amount of sand getting accumulated. So, that you can easily nourishment the other side of beach. What happens if there is a severe power cut or if the pumps are not working, labour strike? Do you understood? What will happen? It is not like close the shop today and tomorrow we can open, no. If that happens for a one week or one month if the pumps do not work then you have other problems. What the, the capacity of the pump will be very less in order to handle the cumulative amount of sand that is going to come along that you need to accelerate, but then and at the same time the erosion rate of erosion also will be quite significant.

So, these are all some of the problems, but on the whole is a very clean job and you are not destroying the environment aesthetically. It is a very good very good way of protecting your coast, so you under any doubts, any of you? See Rayapuram you see that it is around 6 meters per year beach width, so it can even go up to about 10 meters per year. Every year 10 meters of you can imagine 10 meters of land going into the ocean and you look at the there, are so many inhabitants who are residing along the coast in spite of this problem you have lot of people living and you cannot blame them also because their lively, livelihood is only based on fishing.

They would, you cannot ask them to go because they are they says that they have prepared to take there is do you understand? So, those are socio economic aspects which we which we will not discuss in this course. So, all the while we have been looking at problems man made, nature problem, nature due to nature alone then we also had this harbour problem being solved using artificial beach nourishment. Now, the sand has also given us some positive aspects, like for example, Marina beach.

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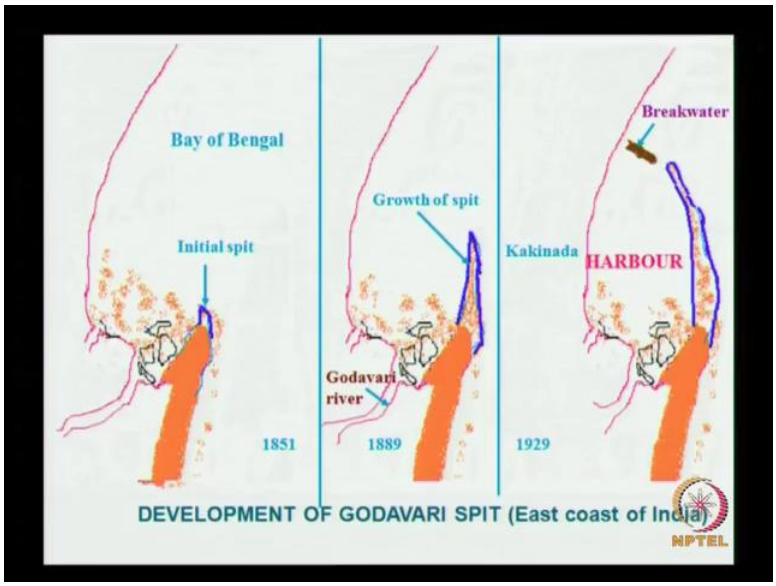


Now, this is again along the east coast of India, somewhere here, where the major river drains into the bay of Bengal that is river Godavari. So, Godavari is written there, so what happened was when the sand is moving along the north once it gets trapped slightly then it keeps on trapping sand, that is moving along this. I already explained about when I, when I was telling you about the spits in one of the earlier classes. So, as years progress because the net drift is in this direction, you see the growth of the spit. Spit is nothing but the accumulation of sand due to which the stator becomes harder and harder and harder.

Ultimately it becomes something like a barrier, so you see that this has grown all the way. What does that mean? That means nature or the movement of sand as given off a natural break water, it has given as a natural break water because this area something like a bay, with a nature break water can easily serve as a harbor, but you might still have some problems from waves which are approaching the coast in this direction. If you want to have your vessels birth here, so you need only a small length of break water here in order to take care of that problem. What is this port? What is this port? Kakinada port, so this port is called Kakinada port. Do you understood, how this can be, the formation of, so this is the satellite imagery.

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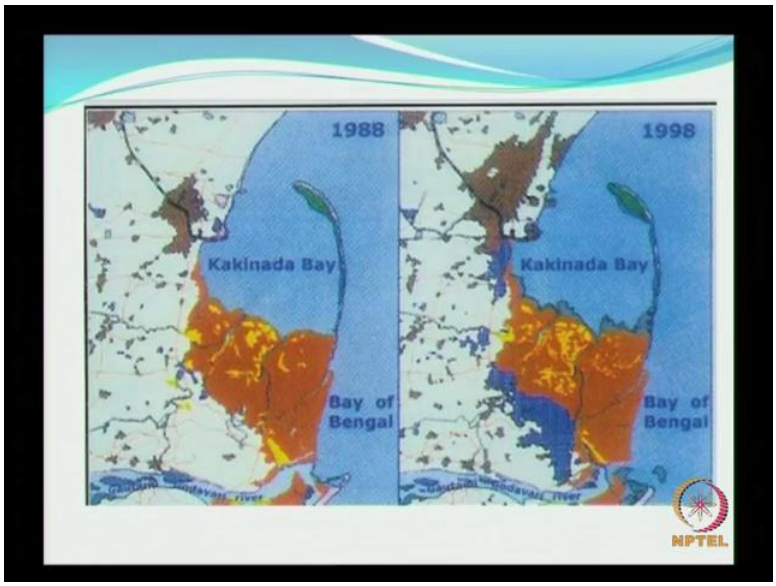


In 88 and 89 this is the Kakinada bay and now it is a a port.

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Typical formation of spits and then I will, I think probably if the, if I take the because that might take some time, I will try to finish this. Shall I continue, no problem? Well now we move on to Orissa.

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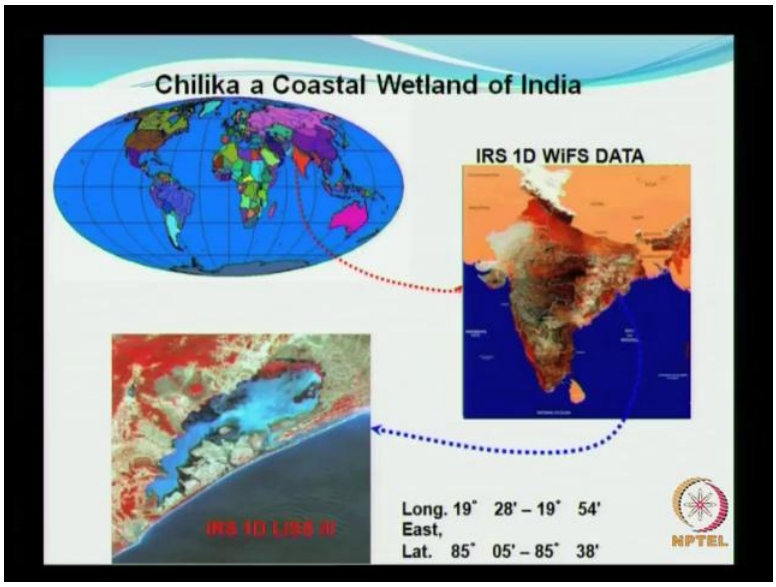


And we are talking about Chilika.

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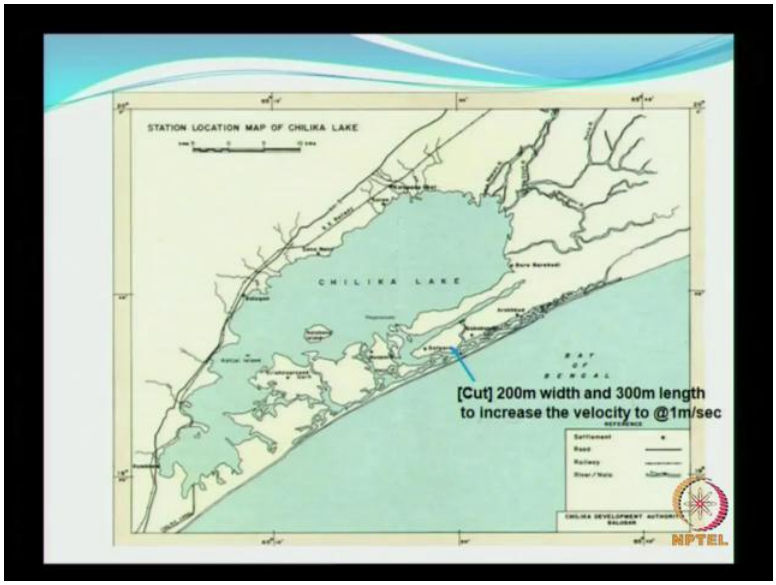


Chilika is Asias biggest blackish water lake. Why it is blackish water lack? There is a good amount of salt inside the lake, for the simple reason there is a very good exchange of sea water with the lake. And the livelihood of the people surrounding the lake is only fishing, through fishing. So, you look at this small strip, you see here, can you see this? There is a small gap here, earlier there was a gap somewhere here, the original mouth of

somewhere here, where in the whole somewhere somewhere here I think probably somewhere here probably. So, you had lot of exchange of sea water into the Chilika lake but that got closed and the spit grew on and then it has reached something like this.

How will the sea water propagate into the Chilika lake? It has to because of this sand bar there is no exchange of sea water from sea and the lake. So, the sea water has to travel through this narrow channel in order to have the exchange. On the other hand fresh water flow due to monsoon also flows into the lake. So, both sides you have problem with the lake, one side salt water is not coming inside, but the other side you have fresh water coming in. So, what will happen to the blackish water lake? So, the PPM, I mean the salt content will go down. So, how to restore this lake?

So, the idea was to cut cut open the bar or the spit and how do you cut the width of about 200 meters for a length of about 300 meters to increase the velocity of to about 1 meters per second, this was the idea. This was of course, done using numerical model. So, numerical model in can give all these kind of information, once that was done in addition to that so this is the new mouth in addition to that there was a a dredging taking place here in order to have free flow of the sea water.

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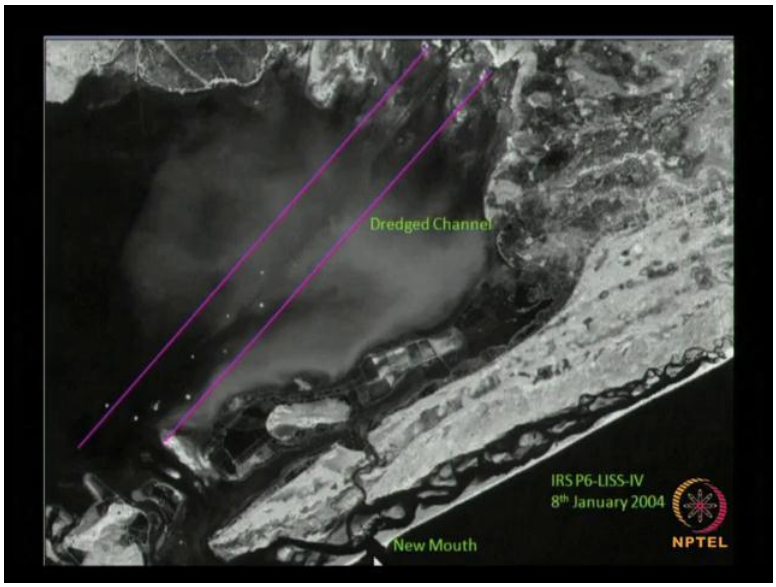

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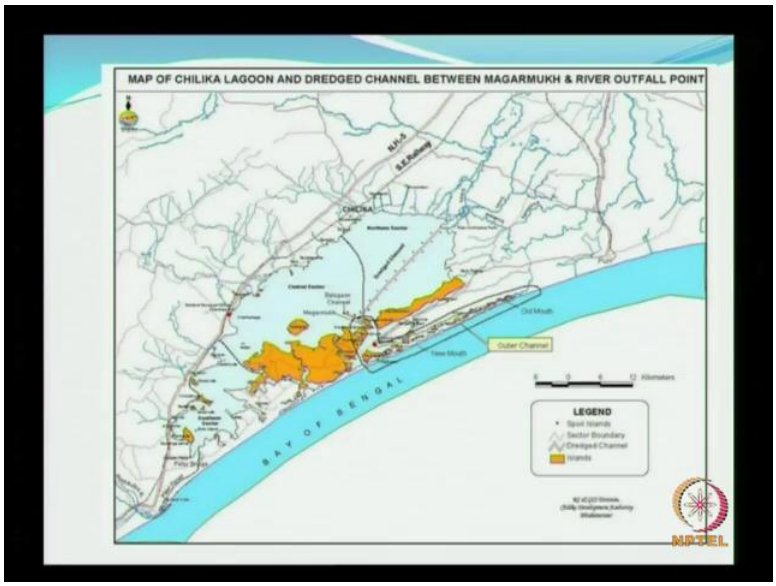


So, this is the cut taking place, so now you see that the location where the cutting is going to take place with using a dredger is shown here.

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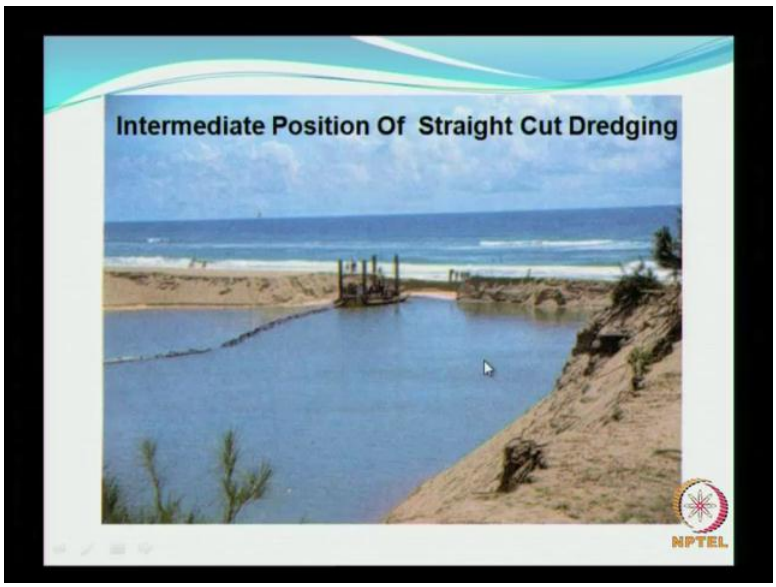

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This picture shows the straight cut, all these things are this is the a spit, this is a straight cut the dimension I have given already, so the dredger is in operation. Now, it is dredging here cutting the thing and now we have achieved some kind of an exchange between this and this. Now, you see that the sea water flows into the Chilika lake and now you see that the Chilika lake is connected and look at this, look at the height of the spit, it is quite something like of small hillock.

So, regular monitoring was taking place inside the lake, to find out what is the salt content etcetera. The salt content improved the fish catch also improved, so for all these details I suggest I suggest you visit Chilika development authority through google and then you get all the information concerning some of these problems also.

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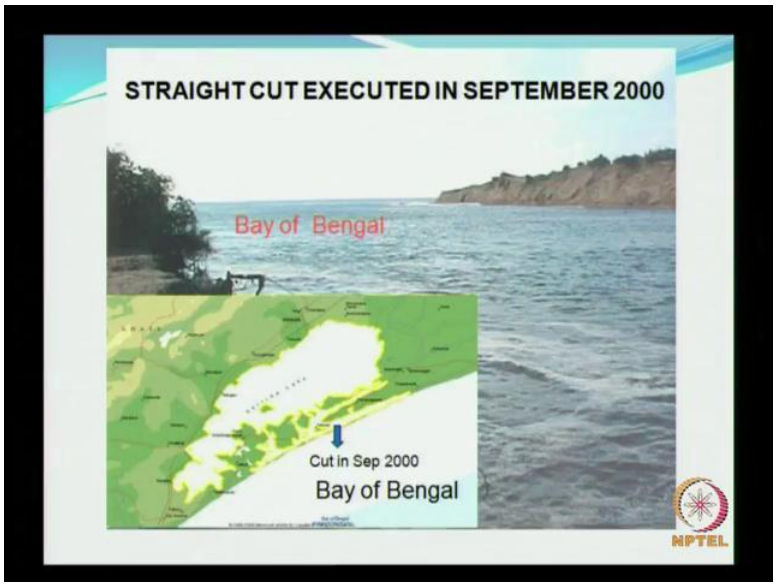


And now you see that the straight crest was established or executed in September 2010, 2000, September 2000.