Sustainable Transportation Systems
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Lecture 53
Case Study IV: Sustainable Water Transport

Hi friends, so in the series of case studies, today we will discuss about sustainable water transport. As you may recall we have already discussed Bus Rapid Transit System that is BRTS then mass rapid transit system and in that we studied this Delhi Metro case. And after that we had discussions on airports and different their dimensions related to the environment and sustainability and today we will see the water transport system with the perspective of sustainability. So, this is the contents list like water transport emissions though we have, superficially we have already discussed some emissions from sips etcetera. But again, we will address those issues and the environmental impacts of the water transport that in detail we will see.

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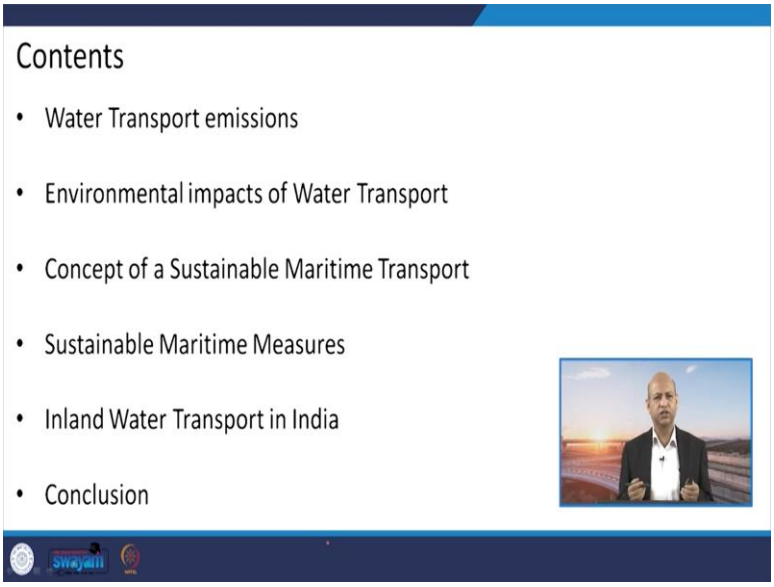

And the concept of sustainable maritime transport. So, whatever sips are going across the, oceans. So, what kind of sustainable techniques or technologies or ways they are incorporating in their operation and what are different majors they are taking into account and then inland water transport in India what is the potential how much we are harnessing already what is the scope and at the end we will see the conclusions of this particular lecture.

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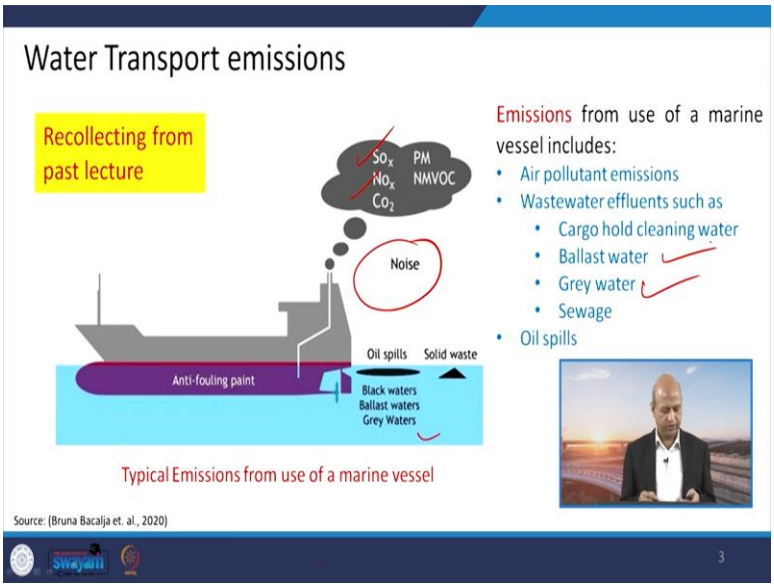

So, if you recall this particular slide we discussed earlier also like what are different emissions which come out of these fossil fuel-based ships like SOx, NOx, that is oxides of sulfur oxides of nitrogen, CO2, carbon dioxide, greenhouse gas particulate matter NMVOC Non Methane Volatile Organic Compounds noise is also they are so, because aquatic life is sensitive to noise. And all those pollution induced pH and then temperature oil spills may also be there we have seen this some case studies. Then solid waste because when you are traveling from one place to another then you are eating and packaged food is there.

So, a lot of solid waste is also generated then black water that is from wastewater from toilets that issue is and grey water that is from kitchen etc. And then this ballast water which we have seen that water is needed to make the balance when whether it is going the vessel is going empty or it is bringing some cargo accordingly those kinds of emissions or effluents may be there. And their impact will be on the environment whether aquatic at the shore etc.

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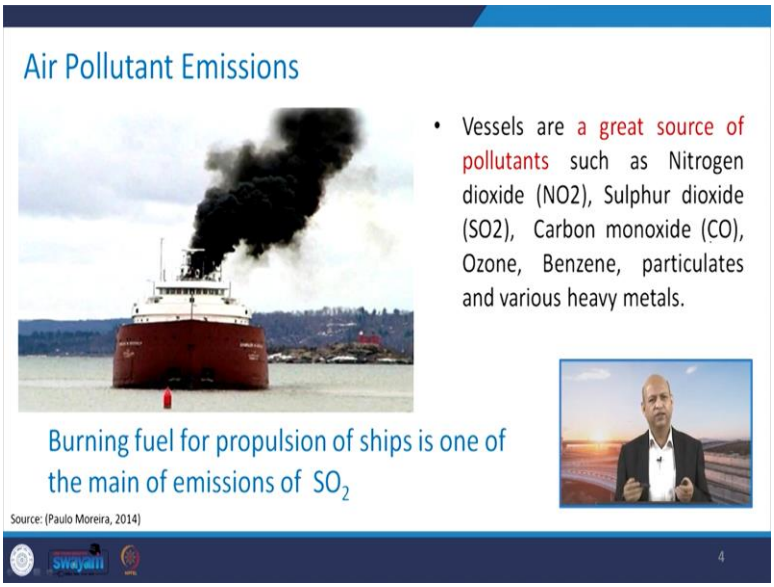

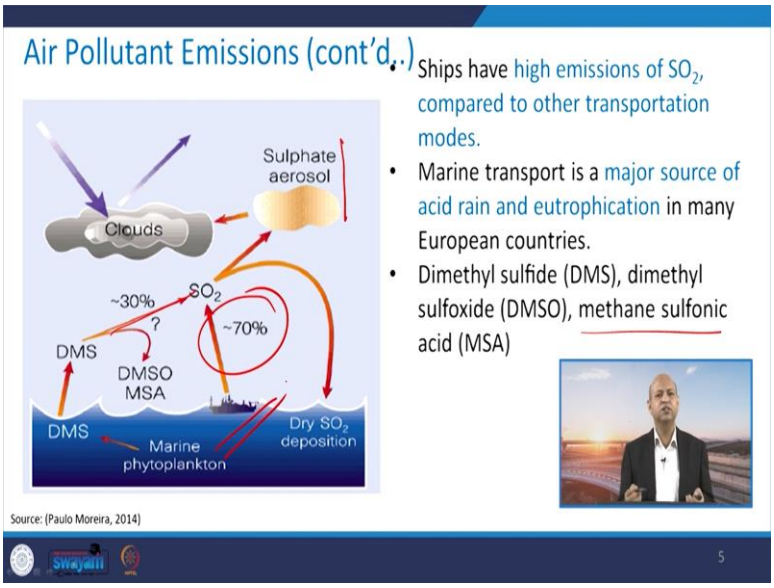

Air pollutant emissions we hold a disease that these oxides of sulfur and nitrogen they contribute into acid rain related phenomena and greenhouse gases are there because plus some like Ben gene and other harmful pollutants like heavy metals they can cause some toxic problems in the body. So, those are the issues both for human health as well as the environmental in this case environmental impact is more because exposure to the people is not so much as we see in the cities. So, environmental impact is mode when we see the emissions interaction in the sea or ocean. So, see there is a lot of emissions of this dimethyl sulfide, DMS from those surface

activities, biogenic emissions, these are and the contributing cloud formation because nucleation occurs, then some part of it is oxidized into dimethyl sulfoxide.

And others go towards this production of methane sulfonic acid MSA. But this has to again, it gets converted into sulfates, those aerosols, sulfates, aerosols are white in color, and they really reflect the solar insulation. So, in a way you can say that they do the cooling system. They are not warming kind of aerosols, they do not absorb the energy like black carbons, they reflect the solar energy. So, the cooling effect is induced by these sulfate aerosols. So, see our ocean get the cooling effect from this cloud formation phenomena in longer term. But this SO2, to which is coming from DMS its only 30 %, the 70 % part is coming from the sea itself or vessels itself.

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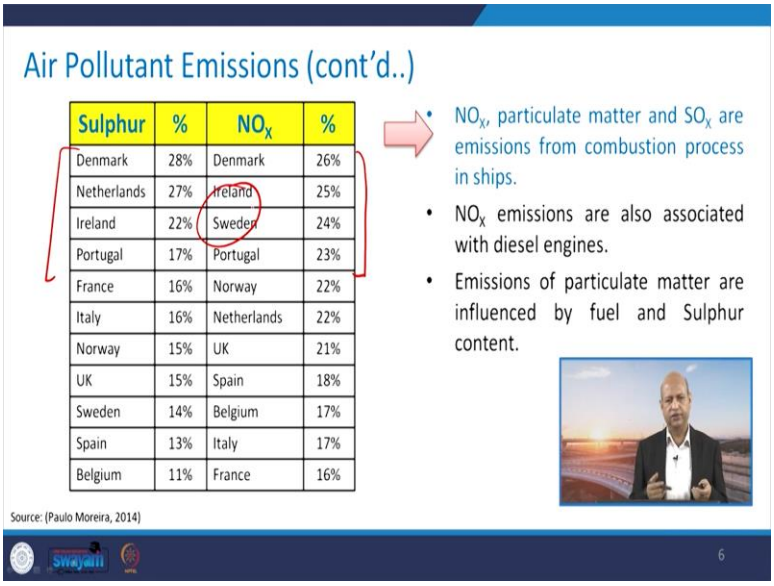

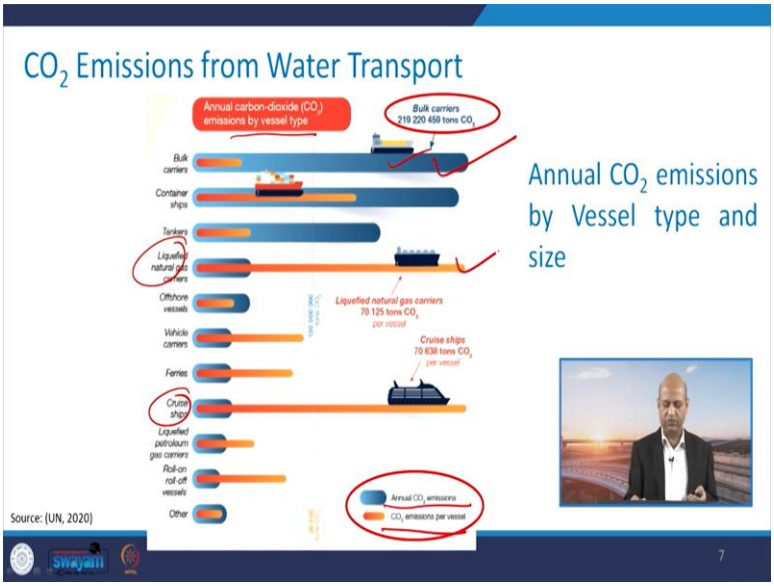

Well if you see the comparison of different seer of sulfur or NOx emissions in case of different countries and so, there is very interesting thing like for four top countries Denmark, Netherlands, Ireland and Portugal in terms of sulfur emissions. And the four top NOx emissions again from Denmark to Portugal, but two countries are different Ireland and Sweden earlier Netherlands and Ireland but at the top is Denmark and the fourth level is Portugal. And then other countries also are in the cities true means according to their activities, how much cargo they handle and so much ports the ports related activities they have.

So, their share occurs plus type of fuel and type of engines their ships are using all those matter in fact. Annual CO2 emissions if you see like emissions by visual type so, this is in case of LNG Liquefied Natural Gas or cruise ships they are having the maximum CO2 emissions per vessel type okay. And but if you see the bulk carriers the CO2 emissions bulk carriers then they are the most CO2 emitters in total 80 So, this is annual CO2 emissions and this is per vessel. So, this in orange color is for my supervisor and this is for annual emissions. So, annual emissions are their containers and ball carriers they are the real contributors towards annual emissions.

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Ballast water emissions you can see like whenever ships load or unload accordingly they use this ballast water with in empty they take ballast water. Then when cargo is loaded then they discharge it. So, as we discussed earlier also that one sort of water which is coming from another country and another location if it is this being discharged at a particular place where the ecosystem may be different it is competition may be different in terms of TDS or DO and whatever water quality parameters. So, they can affect the aquatic life of that particular ecosystem local ecosystem so that that is one big issue with this ballast water discharging at a particular place.

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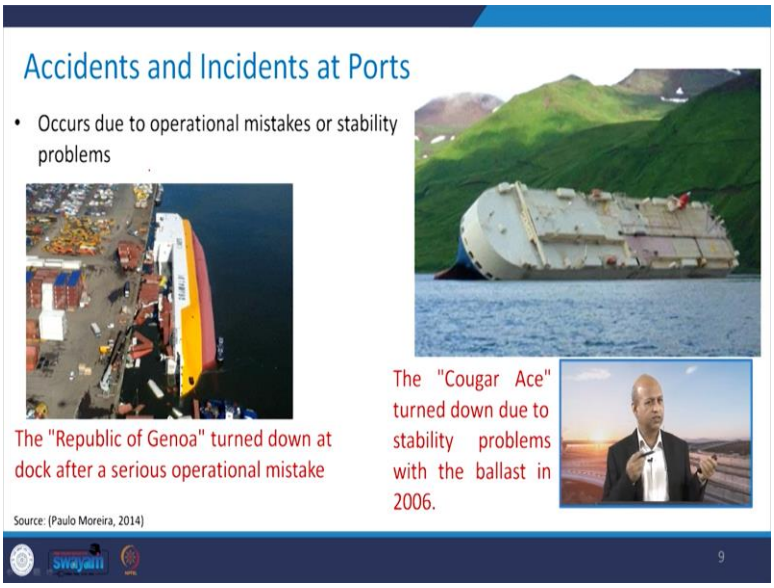

Then there are sometimes accidents we have seen in case of oil spills. So, this is one example like what happens if big accidents happen then this ballast water or other chemicals they can get away from the ship and they can damage the environment.

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Similarly, offshore accidents happened within the sea. So, this is one example of this largest oil spill in the history of Spain in 2002 when this whole ship got it sink because of some accident.

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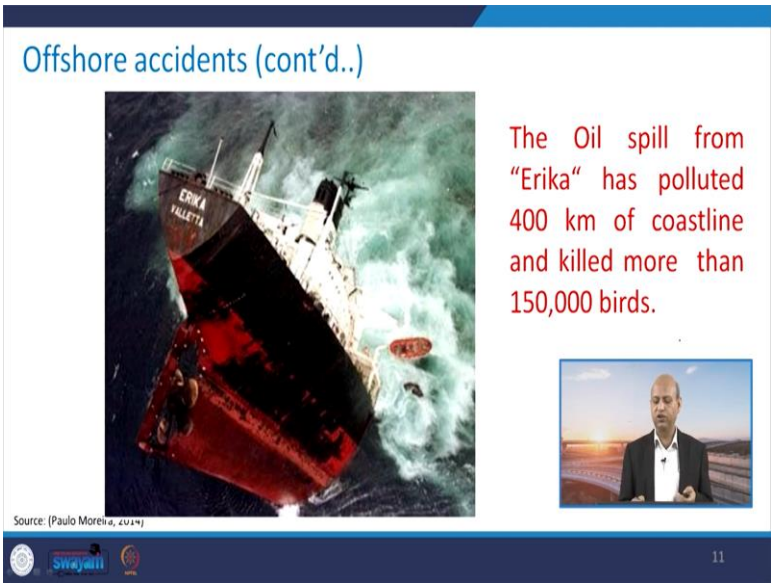

Then this is again the example of oil spill from this Erica and around 400 kilometers of coastline got polluted because of oil spill and then around more than 150,000 birds were killed because when the soil is there then they are, these wings get coated with oily slurs and they cannot fly and there are many other issues with chokes they are breeding system etc.

Plus, there may be like fire accident related fire can also be there and this is one example like hazardous material carrying container that got fire. So, you can imagine this is not simply smoke or particulate matter this is having toxic material. So, wherever does it go, it will get exposed to

some aquatic life or even surface life in forest nearby areas or in the coastal region people get exposed, then they may get serious problems health related problems.

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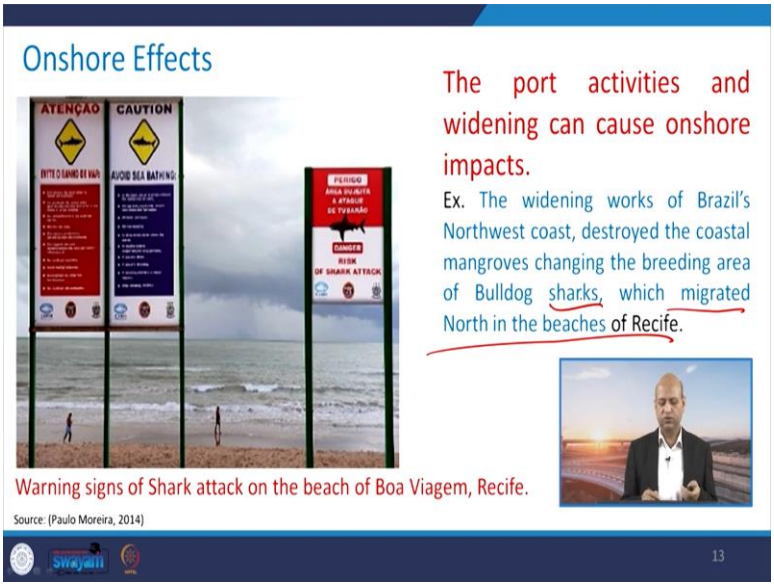

On shore effect one more example is there, which really, was reason for migration of this these sharks because of this accident, which was a region in the Brazil's coastal region. So, they are complete, cycled got to disturb because of these effects of Maritime transportation systems.

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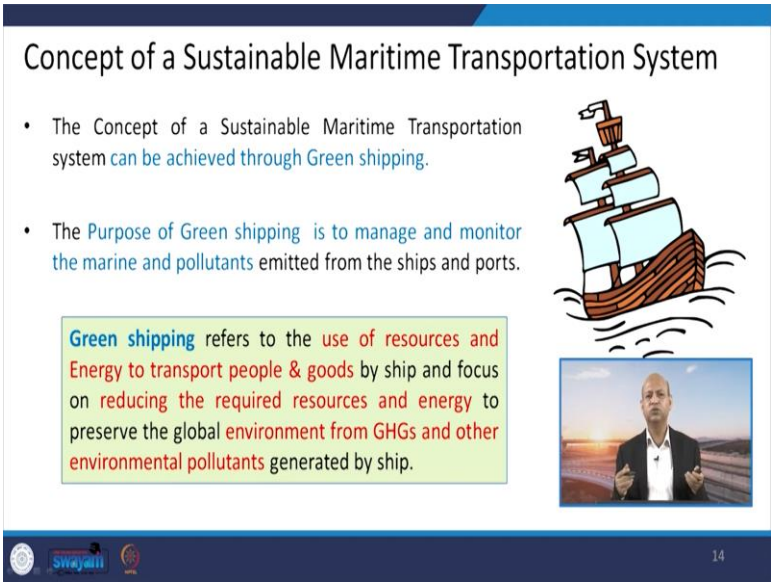

So, concepts if we see that the new concepts are coming like green sipping that means to use more and more natural resources the direction and the amount of wind currents all those. Those

were the earlier ones, but now in new fashion with new technology people are using and so that they can optimize the usage of fossil fuels and minimum of the fossil fuel quantity get used so that emissions get also reduced drastically.

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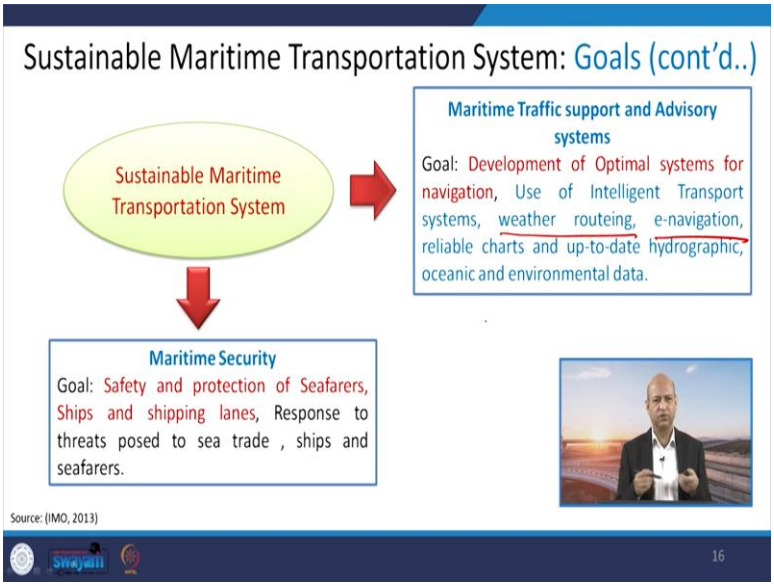

So, you can see like this access to clean energy is promoted and partnership between energy supply and shipping sector all those so that they join hands for environmental related issues and then efficient port facilities. So, that not much time is taken because as much time you take then there are chances of missions and other ill effects. Security related issues are there then weather routing or E navigation, all these systems are, being incorporated into this smart navigation which helps in saving time saving fuel.

Similarly, you can see this development and maintenance of hydrographic and meteorological information. So, they are clubbed into information intelligent Information System. And then this integrated approach whether it is technological part or fuel related issues and then the regulations and environmental requirements all these things are clubbed together to achieve the minimum impact negative impact on the environment and maximum efficiency in terms of , transportation of the goods and time saving all those things.

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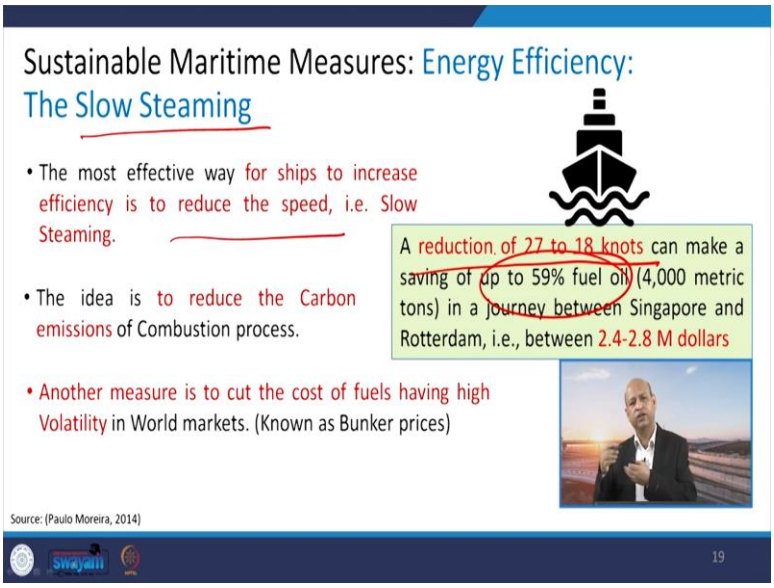

So, the when we talk about energy efficiency, this slow steaming concept comes into picture and it has been observed that most effective way for safe to increase the efficiency is to reduce the speed the slowest dimming it is known as So, when you reduce the speed then you get this 59 % saving of the fuel and this 59 % saving of the fuel that means you are saving in terms of environmental impacts, which would be otherwise because of emissions. So, that is the advantage in this kind of system

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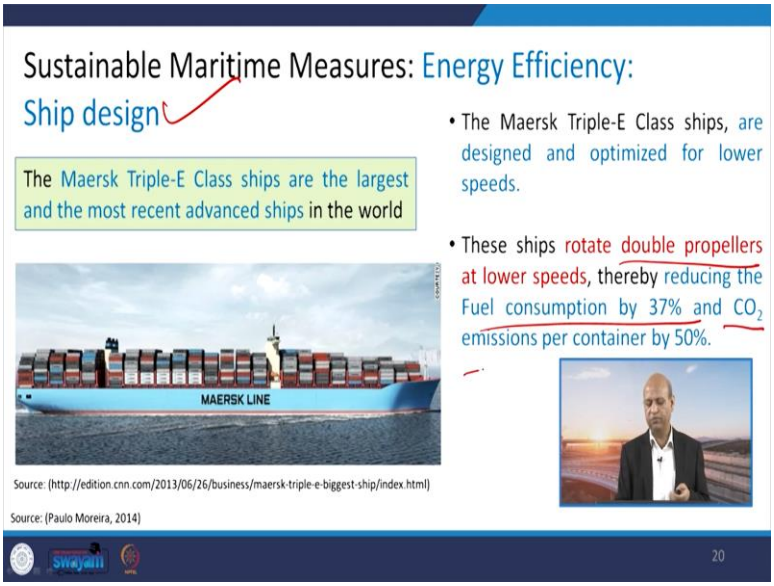

Well, when sustainable maritime measures of energy efficiency again, we see then the ship design is also one important aspects. So, you see if you can have a big ship design, so, let a lot of cargo you can take at a time and this double propeller with lower speed, the fuel consumption was achieved around 37 % reduction in the fuel consumption and the CO2 emissions per container was reduction of 50 %. So, those kind of, these new classes of ships are being built these days, very big size and fuel-efficient energy efficient cargoes they can take.

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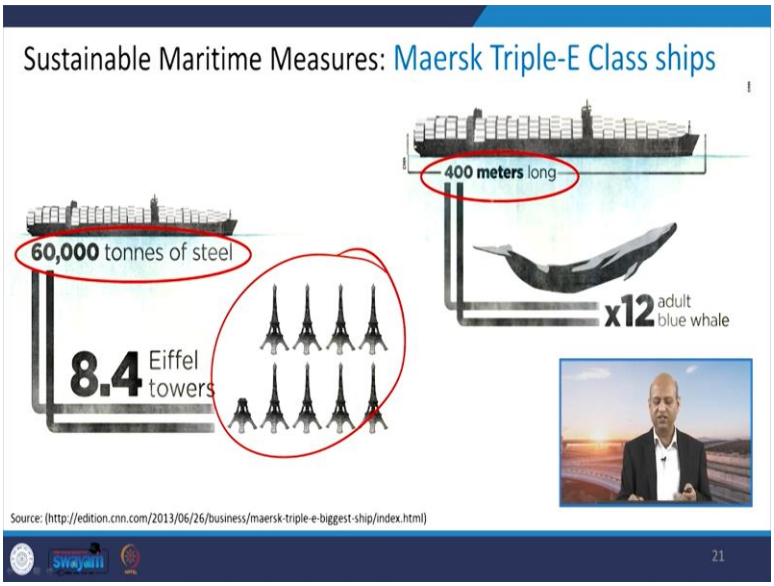

So, see these dimensions which can we can perceive we can imagine what kind of big dimensions are there like 60,000 tons of steel has been used and that you can visualize like around 8.4 Eiffel towers can be built out of this particular steel. Similarly, the length is around 400-meter-long that is 12 adult blue whales if you compare those kinds of sizes now, these new ships are new class of the ships are being built.

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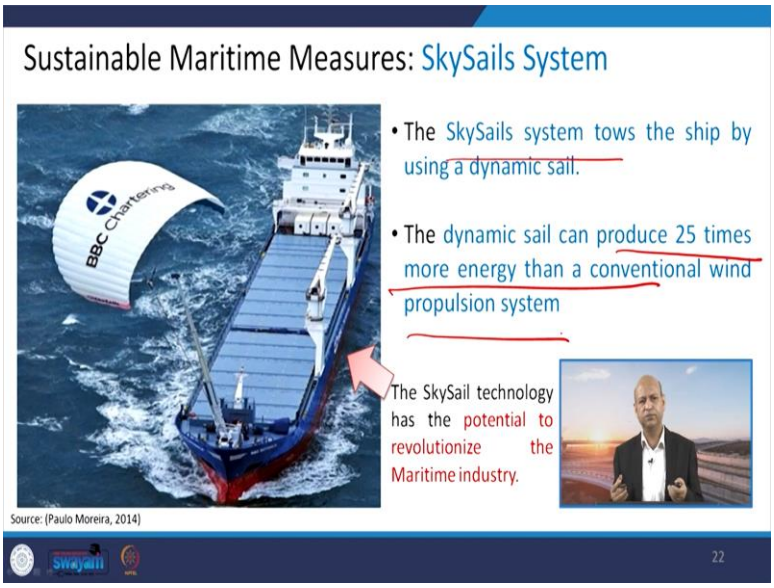

Plus, now the uses of renewable resources that is the sky sail system which produces around 25 times more energy than the conventional wind propulsion system. Earlier we have seen in the, movies etcetera those kinds of majors which we use or appliances or facilities. But now, these kinds of things they are using with more aerodynamic dimensions. So, they can get more energy with the same kind of system, but with technological advancement.

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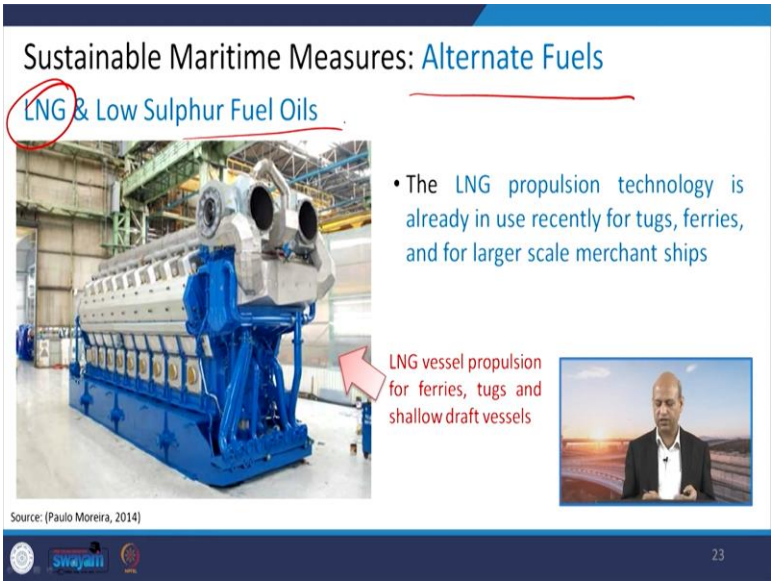

So, then in alternate fuels are also one thing which we can use to reduce the emissions like liquefied natural gas, low sulfur fuels, so that particulate matters and sulfur related emissions are minimum. So, those kinds of new technologies are into place.

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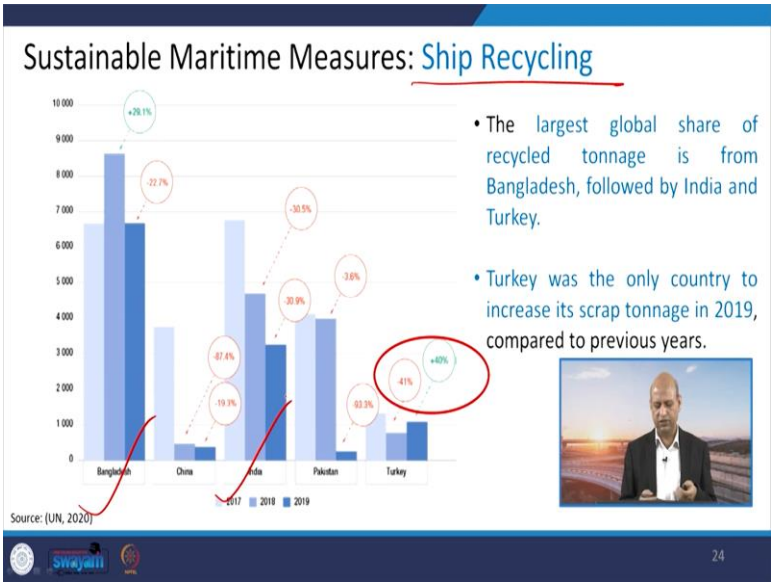

Then, there is like ship recycling means if you discard then whole system you have to build and a lot of virgin material you need. So, mining and those environmental impacts again connected with each other. So, this ship cycling big businesses also there although there are issues like Bangladesh and India they have largest business in this kind of ship recycling we are a lot of old ships are sent and then huge business opportunities there. But there are issues like some environmentalists argue that because of some law related issues or regulations the facilities are not so, good and people are exposed to bad elements or some fumes or not so, good condition and their health get affected by these kinds of activities.

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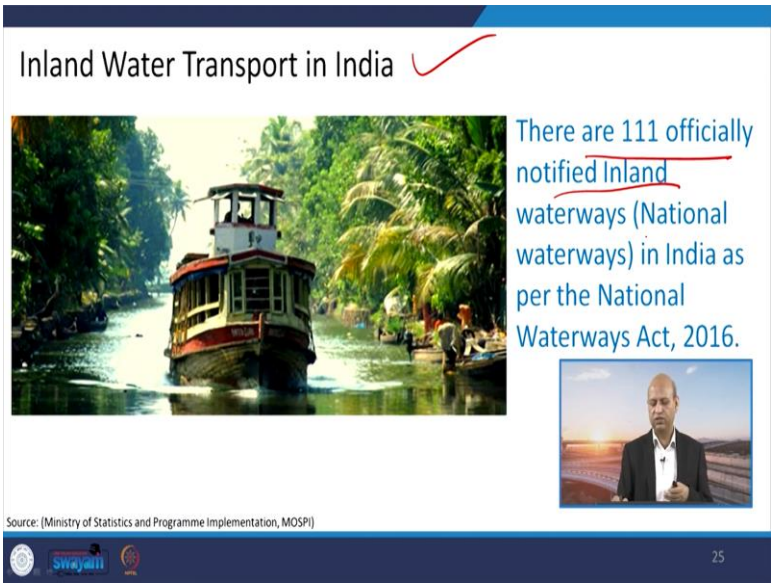

Then we come to the inland water transport in India, this is one big opportunity, in case of India because India is known for so, many rivers and waterways but unfortunately, we have not harnessed this opportunity. So, abundantly so, you will see how much the scope is there. So, around 111 officially notified inland waterways are there like we have national highways. So, inland waterways are they are our national waterways are also there according to the waterways act 2016. Then, there are some like navigable length miss it has not been used, but you the scope 20,000 kilometers is spread across 24 states. So, that means, the scope is there if you can use this but only fraction of it has been used so, far.

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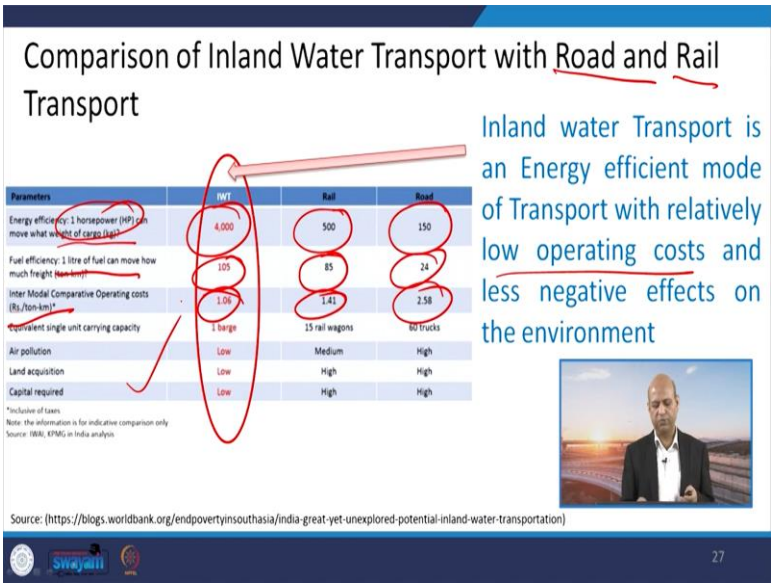

If you see the comparison of inland water transport with the road and rail transport, so, there are issues like energy efficiency one horsepower, how much you can use in terms of the weight. So, in inland water transport you can you take 4000, kilogram of the cargo weight varies in rail, 500 kilogram and on road it is 150 with respect to one horsepower of the power.

And then if you compare with one liter of the fuel then around 105 kilometer freight can travel and this is 85 in case of rail and only 24 in case of road so, highly efficient is this inland waterways. Similarly, air pollution is low and the cost parameter if you see rupees per ton per kilometer, so, only one around one rupee you can say around 1.4 in case of rail but around 2.6 rupees in case of road.

So, in comparison to road it's quite less or very low operating costs you can see So, that we there are many many advantages in all dimensions whether emissions CPUC capital investments you can see all those things are less in comparison to other transport systems like rail or road.

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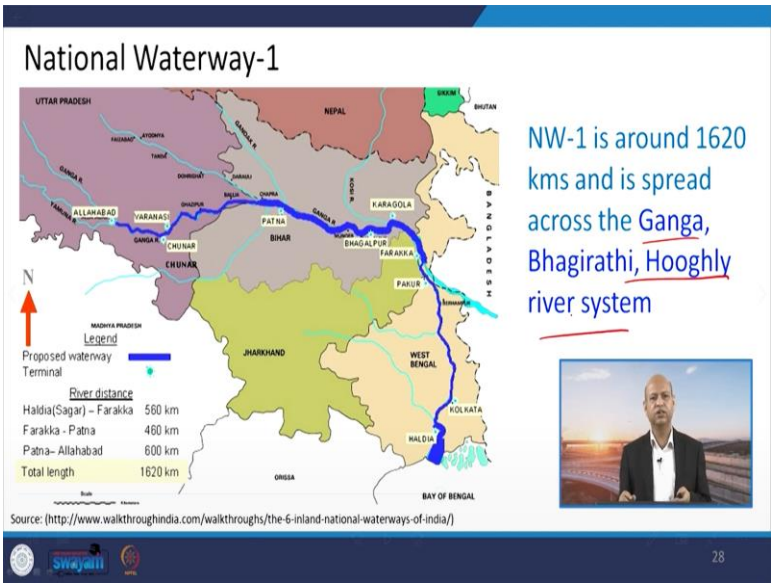

Well national waterways one is basically the Ganga basin you can see Ganga, Bhagirathi, Hooghly that all river system is known as the National waterways 1 and it is around 1600 kilometers in the length.

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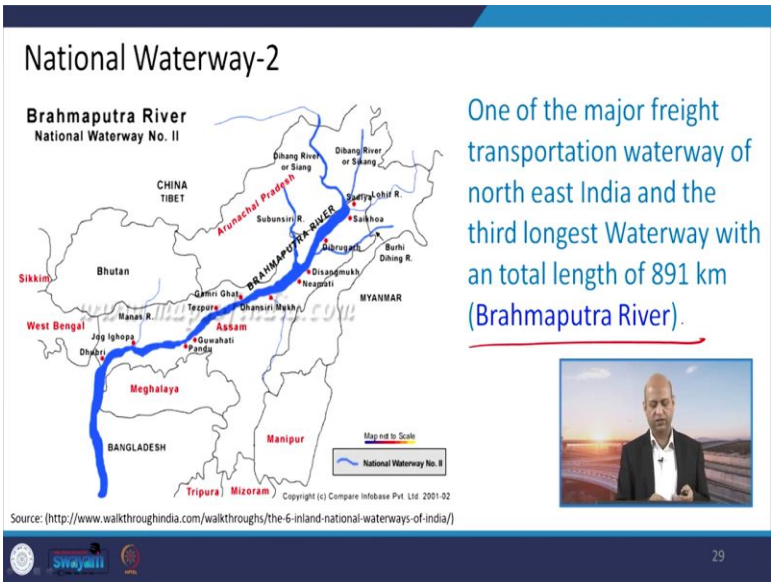

National waterways 2 is basically, Brahmaputra River related that particular territory. So, you can see the whole length is around like 900 kilometer. So, there is the scope bigger scope.

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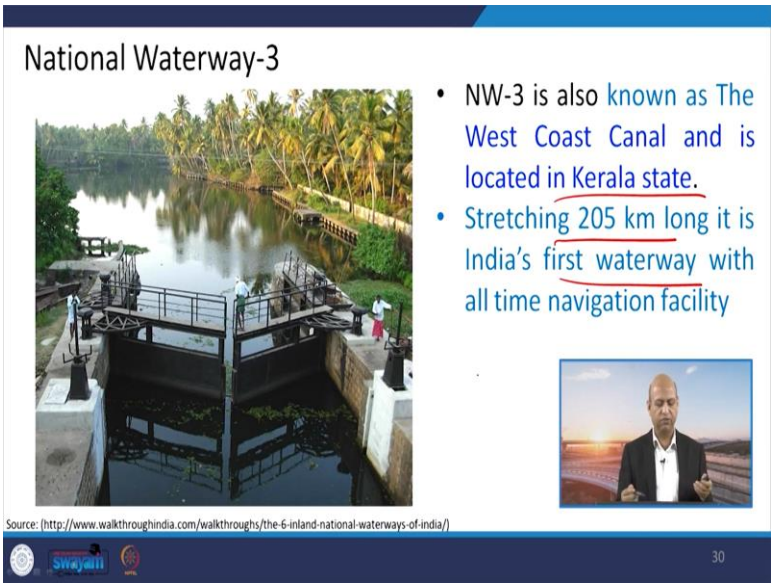

National waterways 3 is in West Coast can canal or Kerala state and around 205 kilometer long India's first waterway which has been navigation navigable and prepared for this waterways.

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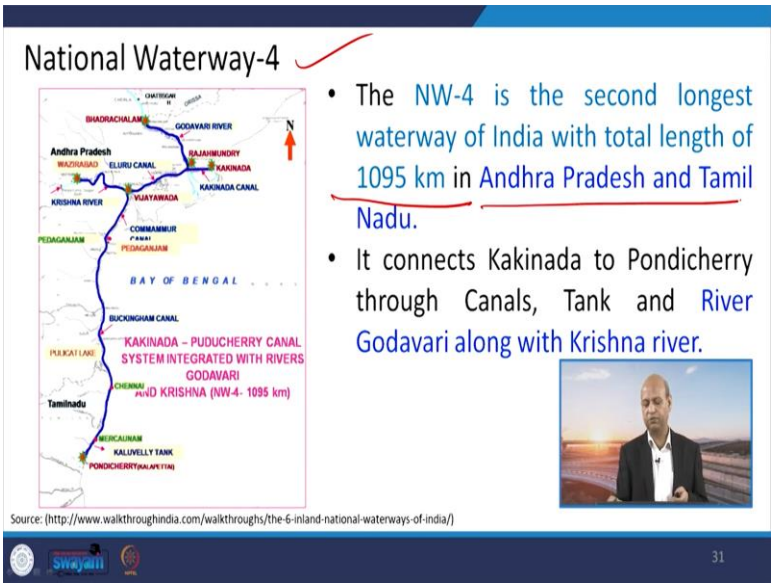

Then National waterways 4 is the around 1000 kilometer or 1100 kilometer that is in Andhra Pradesh and Tamil basically Godavari and Krishna river related basin which have been used for these particular waterways.

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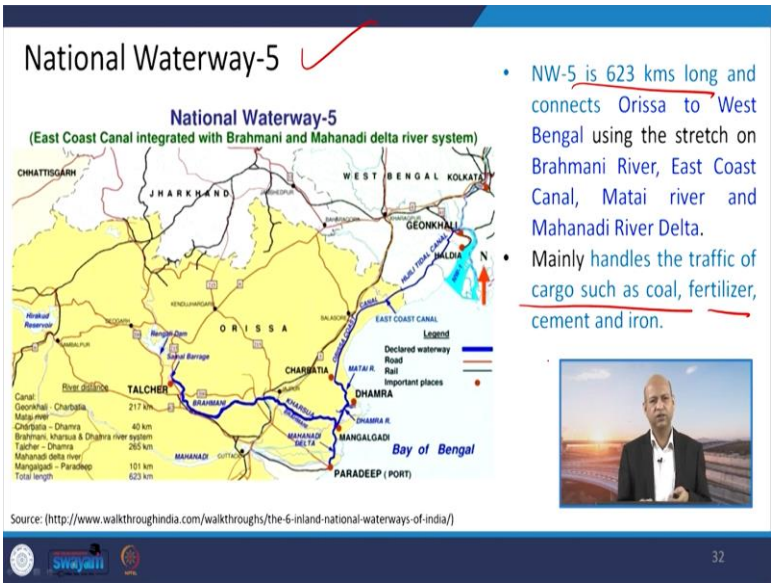

National waterways 5 is around 600 kilometers in Orrisa and West Bengal. So, mainly for cargo like coal, fertilizer, cement tire and all those things one can take from these particular national waterways but as you see we have seen the table like if we transport all these things with the road, the lot of cost is there as well as lot of emissions are also there.

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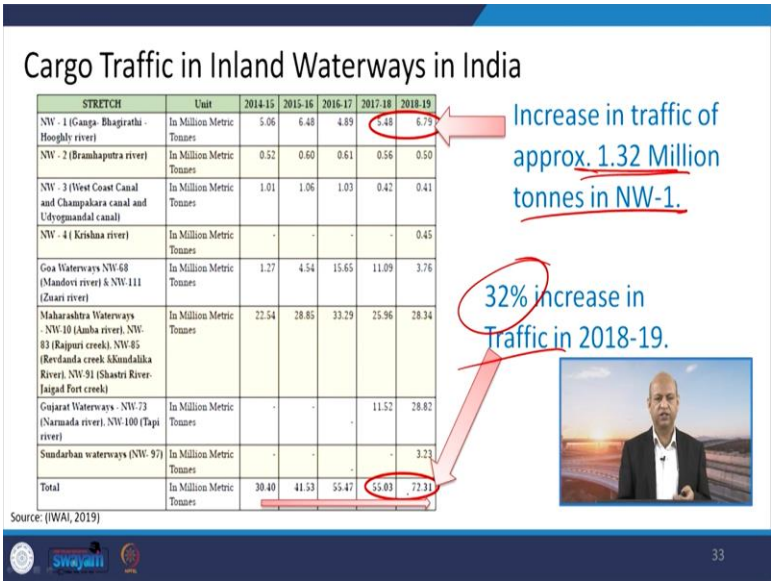

STRETCH	Unit	2014-15	2015-16	2016-17	2017-18	2018-19
NW - 1 (Ganga- Bhagirathi - Hooghly river)	In Million Metric Tonnes	5.06	6.48	4.89	5.48	6.79
NW - 2 (Brahmaputra river)	In Million Metric Tonnes	0.52	0.60	0.61	0.56	0.50
NW - 3 (West Coast Canal and Champakara canal and Udyogmandal canal)	In Million Metric Tonnes	1.01	1.06	1.03	0.42	0.41
NW - 4 (Krishna river)	In Million Metric Tonnes	-	-	-	-	0.45
Goa Waterways NW-68 (Mandovi river) & NW-111 (Zuari river)	In Million Metric Tonnes	1.27	4.54	15.65	11.09	3.76
Maharashtra Waterways - NW-10 (Amba river), NW-83 (Rajpuri creek), NW-85 (Revdanda creek &Kundalika River), NW-91 (Shastri River-Jaigad Fort creek)	In Million Metric Tonnes	22.54	28.85	33.29	25.96	28.34
Gujarat Waterways - NW-73 (Narmada river), NW-100 (Tapi river)	In Million Metric Tonnes	-	-	-	11.52	28.82
Sundarban waterways (NW- 97)	In Million Metric Tonnes	-	-	-	-	3.23
Total	In Million Metric Tonnes	30.40	41.53	55.47	55.03	72.31

If you see how much we are increasing in using the waterways, so around between 2017 so, one year, around 1.3 2 million tons in national waterways one the traffic related this video is related

traffic increase. And 32 % increase in the total traffic if you consider all kinds of activities if you take account.

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There are certain milestones which have been achieved. So, far which can be seen in these pictorial representations like around 1233 metric tons of the flyers was transported around 2100 kilometers from this gal Kahalgaon in Bihar to go Guwahati that is through national waterway one.

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Similarly, like around 900 metric tons of imported coal was transported in on these national waterways one from Haldia to Dhubri. So, this stretch total stretch was around 1200 kilometers. So, this is Indo-Bangladesh this protocol route which was followed in this particular example.

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There is first time in post-independence India This was achieved that around 1200 kilometers and 9 days journey it was covered from Kolkata to Varanasi and the big , this container glittered cargo was transported, you can see this picture. So, that was a big achievement in fact.

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Then if you again see another example, so, in NW 1 that is National waterways 1 and National waterways to our national waterways three so, all these around more than 15 over dimensional cargo movements have been achieved integrating these 3 waterways well then there are container operations and goods transportation related some infrastructure facilities which have been built.

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And then there is like roll on and roll off or Ro-Ro that is roll on and roll up means you can just take on vehicles and then you take off the vehicles there. So, motorcycles or cars and other such vehicles can be transported very easily on these big, ships kind of structures.

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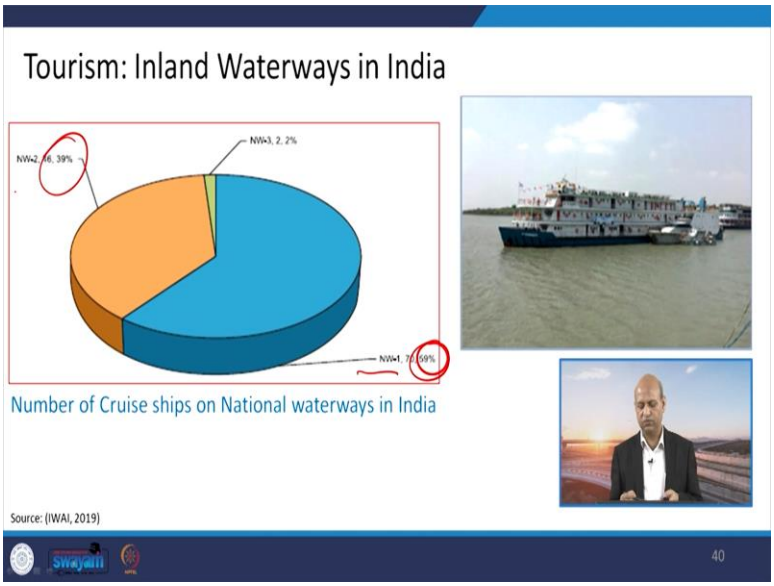

If you see that now these tourism, inland waterways tourism, so, cruise related activities in national waterways one around 59 % and 39 % is National waterways 2. Others are in order so much tourism has been increased, but there is a lot of scope that means we have so many national waterways and a lot of scope is there.

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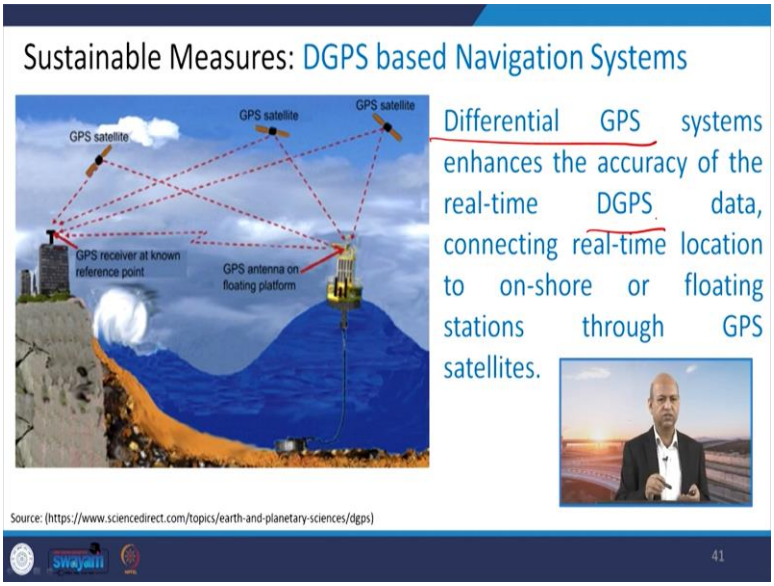

Then there is like new systems new technologies which have been taken into practice so that navigation can be more efficient, more safe, more secure. So, this differential GPS DGPS data sharing and real time location sharing on shore floating stations all these things are with satellite or and that is information fluids in real time operation can be achieved.

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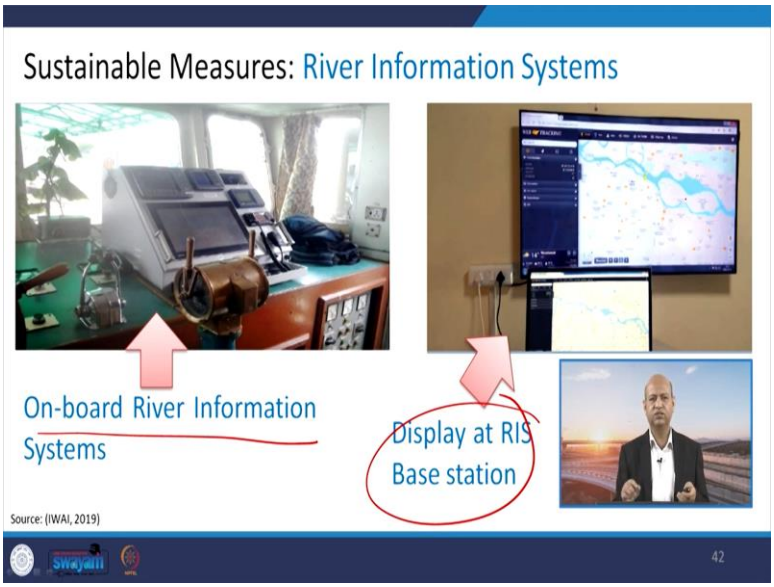

So, on board river information system you can see and the display at the base station. So, we are ships are moving, what is the speed and where they are heading towards all those things, real time information are processed and communicated to the stakeholders or the those who are responsible for their management.

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Well, there are also like, because certain depth is needed for the convenient movement of the ships or these cargo vessels. So, dredging is required sometimes because of siltation, depth becomes less, but dredging is not so, environment friendly activity. In fact, there are new

technologies, researchers and technocrats are recommending nowadays, but this is a picture of environment friendly dredging. So, taking from one particular place and where more depth is there, so, putting there but this is a repetitive, very costly affair. So, nowadays, less and less, these kinds of techniques are being used and new technologies are natural, like training of the reverse for dredging kind of things are taken into practice.

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Here you can see these natural ways of preventing erosion. So, some bundling have been by bamboo and other things. So, these kinds of situations maybe they are so to prevent these kinds of erosions, this technique is being successfully used in the reverse.

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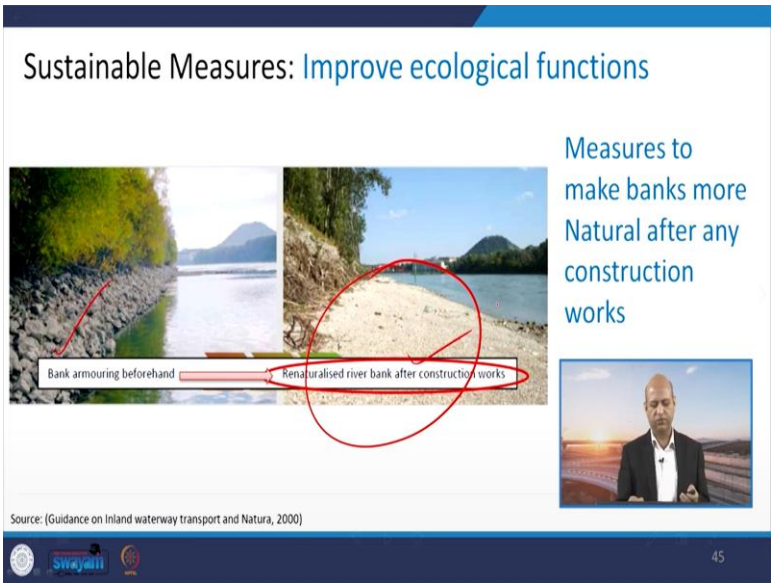

Similarly, after sometime this natural riverbank after construction work is left and then the nature takes place its own course and you can see the earlier one and the afterwards. So, there bank is there and river is taking its natural course so that that is there.

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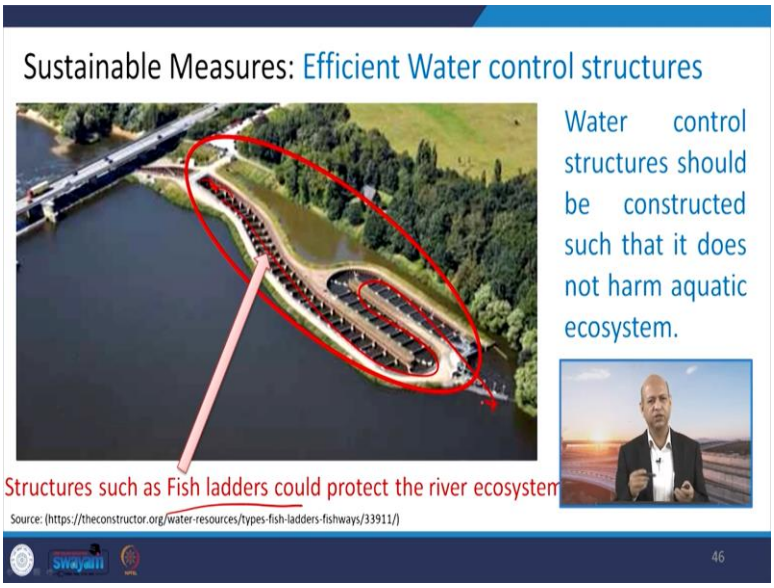

Plus, these kinds of structures which are like ladders fish ladders that means, water comes from here and then go a little bit disturbed then steps are there so, that illusion does not happen. So, water slowly goes like this and ultimately it goes to the river. So, these are the structures which

are being frequently used to prevent the erosion etcetera new technologies although old practice but in a new way and new design are coming.

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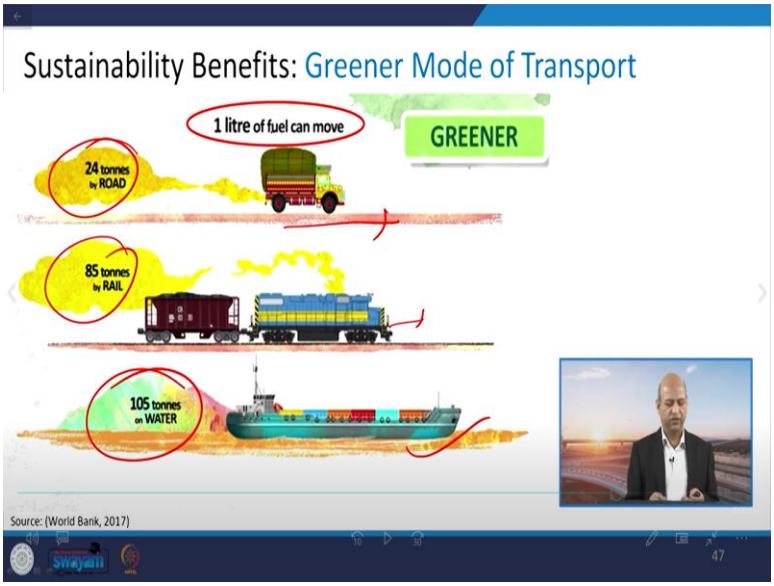

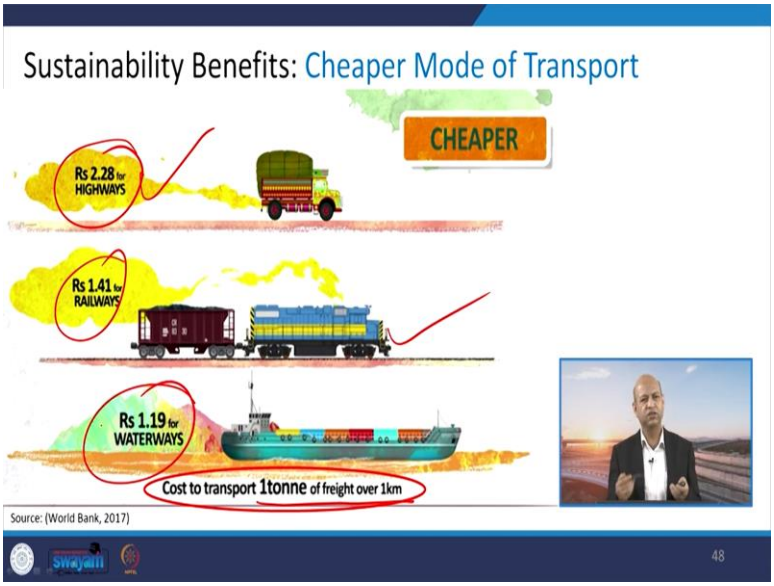

Again, we can see that particular table, we have seen that one-liter fuel consumption how can we compare with which particular transportation system is greener So, like 24 tons in one liter by the road and by railways 85 tons, but in these inland waterways it is 105 tons through the water. So, you can see around 5 times of this load from the road is being carried by this vessel in the waterways with 1 liter of the fuel So, fuel saving is used and then also saving of the or reduction of the air pollutants you can say.

Similarly, other comparison like cost effectiveness which is cheaper So, around 2.28 rupees for highways. And like 1 ton of the freight over one kilometer means 1 ton if you take from one place to another between one kilometer then how much cost is there. So, around 2.28 rupees in case of road 1.4 in case of railways and only 1.19 or around 1 rupees in case of inland waterways. So, these are the reasons that we should really promote our inland waterways or water transport systems because it is much environment friendly it is much much cost effective.

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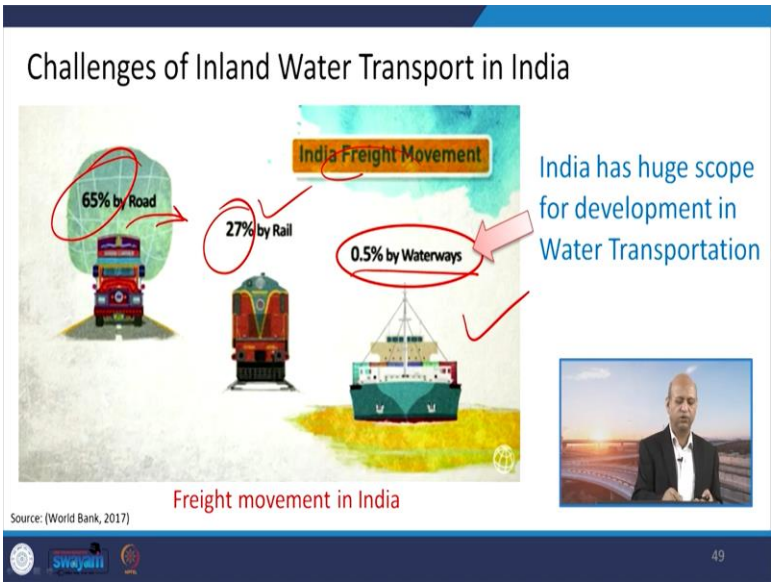

Then, but there are challenges because you see only 0.5 % of the waterways have been used so far, but again there are opportunities in adversities as people say so, this is a huge scope also in that sense 27 % Indian freight movement is by rail and 65 % is still through road. So, if we shift this low this road freight to railways and especially in water ways we can save huge amount of money as well as far as we can save our environment or people's health because less emissions will be there. And we can feed the road for cars or those public transportation system like buses etcetera. So, that way be less congested. So, win win situation can be achieved in that case.

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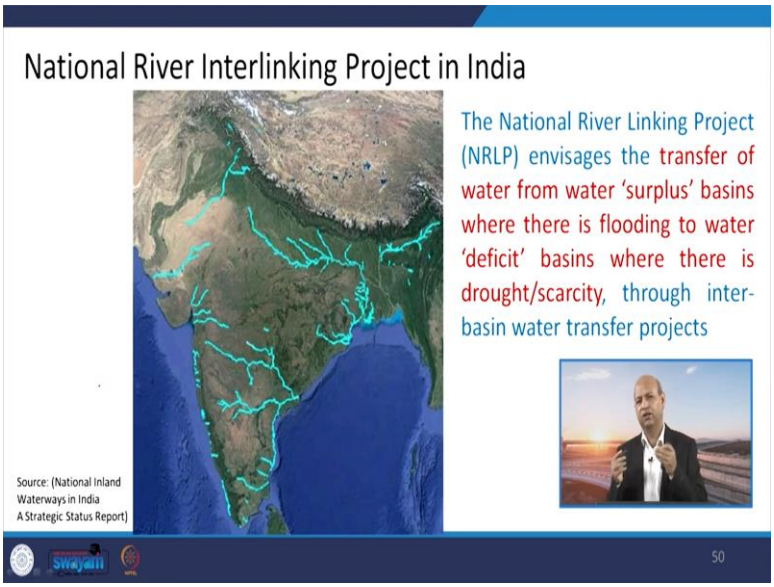

Well there is one more very important issue you might have heard about interlinking of the rivers. Since several decades this topic has been debated and there are pros and cons some people argue that it is not good. Because there are many environmental aspects which can be disturbed because every basin has its own geomorphological issues and environmental issues and they all have their own ecosystems and if we take water from one to another, then it can disturb the ecosystem that is one big argument.

But then there are also issues who are in support of this because a lot of flood occurs in certain basins and if we can divert that, water into water deficit kind of areas, then again means very intelligently and not affecting the ecosystem of the main river systems of each region. So, we can achieve that we can reduce this flooding related systems or Haavoks and we can transport that water into water deficit areas like you might have seen because of this Indira Gandhi canal in Rajasthan and then Narmada, canal system Narmada river dam, lot of positive impacts have been seen into in downstream side villages. And the water supply for irrigation for drinking, lot of accessibility to water has been achieved. So, those kinds of things can be achieved through these interlinking projects if we do it intelligently.

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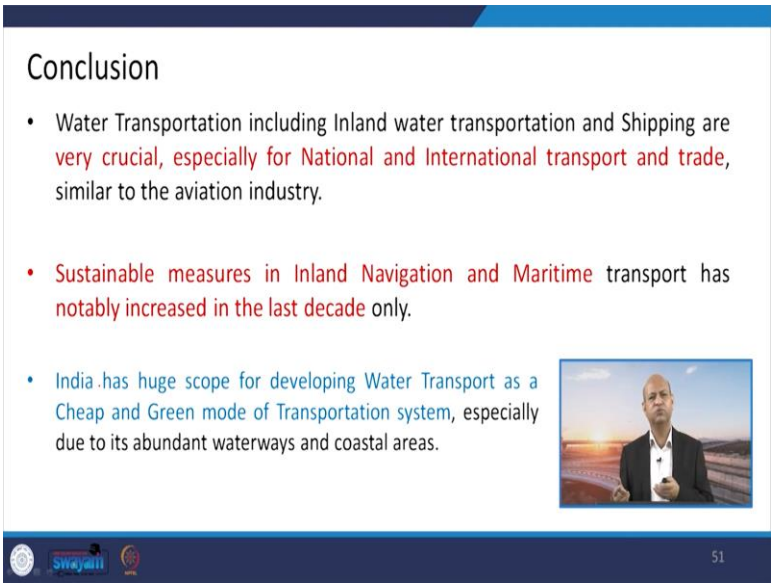

So, ultimately, we can conclude that there is huge a scope in case of water transport system in context of India, because very a fraction of it has been used so far and there is a lot of opportunities we can harness and if you use it, we can achieve, cost reduction as well as environmental improvement and health improvement. And of course, when some infrastructures come into place, then the local areas and they also get developed because of economic activities.

So, new job creations can also be there, so, that it can be wonderful project if we and, central government is taking it into effect a great way. And in future I hope and believe that this water transport system through inland navigation or inland waterways will increase usually, and the whole country will be benefited in a great way.

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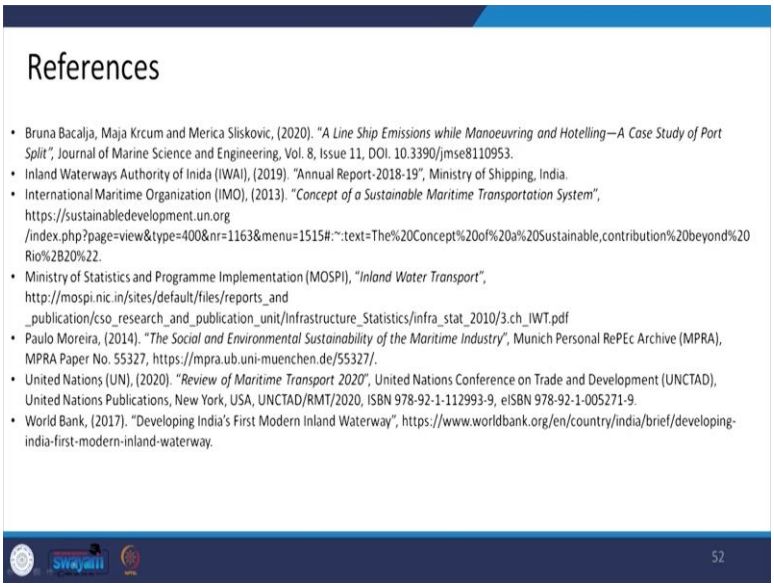

So, this is all for today and these are the references if you want to have, additional information regarding inland waterways or water transportation systems. And thank you for these case studies. Listening so carefully and attentively. I hope these case studies might have, given you a kind of overall picture that how different transportation systems differ from each other, and how do they contribute into economy, as well as what are the important environmental aspects which we should take care of. Thank you again.