Petroleum Economics and Management
Prof. Anwesha Aditya
Department of Humanities and Social Sciences
Indian Institute of Technology, Kharagpur

Module - 06
Depletion and Rising Costs
Lecture - 28
Cost performance of global oil industry and Oil Spills

Hi everyone. Welcome to the NPTEL course, Petroleum Economics and Management and I am your instructor Dr. Anwesha Aditya. So, if you remember we are currently in module 6 where we are trying to explain the oil price movement from the point of view of depleting resource. So, today is lecture 28 of our courses where we are going to discuss the Cost Performance of the global oil industry and the related Oil Spills.

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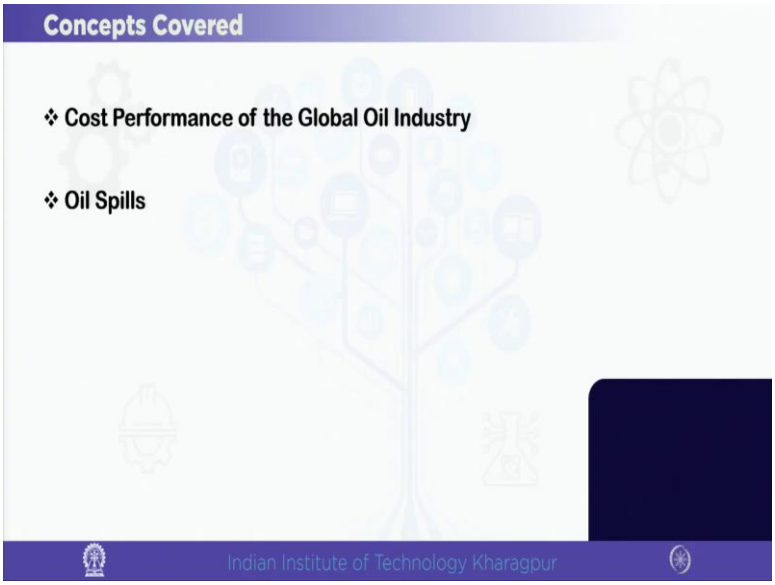

So, what is the motivation behind this lecture? So, if you just briefly recapitulate, we have spent quite rigorous amount of time in discussing the phenomenal movement of oil price and then we try to explain the oil price movement. So, we try to analyze from two points of view. One was from the angle of OPEC.

So, we analyzed how OPEC is responsible for the oil price movement. So, and we find that OPEC is not alone responsible for oil price movement because given the market

power OPEC could have exerted higher price of oil. So, that means, there must be other factors which are responsible for oil price increase.

So, the other point of view of analyzing this issue is regarding the fact that whether petroleum is a depleting resource or not. So, that is what we are discussing in module 6. So, if you remember we have already discussed some concepts related to depletion like the proof reserve, extractable resource, the reserve to production ratio and we have compared oil reserve to production ratio with other source like other natural resources like natural gas.

And we found that especially after the shale oil revolution the reserve to production ratio of oil has increased and we also discussed about the peak oil hypothesis. So, and we concluded that conclusively say that petroleum is depleting and that is why the price is increasing, ok.

So, in today's lecture what we are going to do? We are going to analyze the cost structure of the global oil industry, how the petroleum prices are whether they are responsible for I mean whether the increasing cost is responsible for increase in price. So, that is what we are going to analyze. And another interesting issue that I will bring your attention in today's class is regarding the cost related to oil spills.

Sometimes accidentally oil is spills into the water. So, that causes lot of damages to the ecosystem. So, environmental effects and as well as economic effects. So, we will discuss oil spills and the related cost in the second part of our lecture.

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So, to start with the cost performance of the global oil industry. So, what we see from the literature is that it is very difficult to find out the cost. Because the companies which are engaged in oil extraction and refining, they actually overestimate the cost they over represent the cost.

That is basically the idea that they want to under report the amount of profit. Because if you remember we earlier also we discussed profit is the difference between total revenue and total cost if the cost is less meaning if they want to means report on a less amount of profit, they have to show a higher amount of cost.

So, that is why they want to overestimate or exaggerate the cost. So, that the profit is less. So, they have to pay less amount of taxes because often the companies also have to pay taxes on their profits, ok. So, that is the incentive. So, it is very difficult to find out the exact amount of cost given that the companies want to suppress the amount of cost and marginal cost data is also not available.

See in economics we often are interested in finding out the what is happening at the margin. So, you see what is marginal cost? Marginal cost is the change in cost when one extra unit is produced, ok. So, suppose the total cost suppose initially the one firm is producing say 100 unit, ok. And the cost is say C capital C. So, what will be the marginal cost? Marginal cost is if the firm produces one more unit 100 first unit. So, how the cost will change if the firm is producing one more unit.

So, that is called marginal cost. Now, marginal cost data is easily not available because the companies do not report the exact amount of cost, they even they over report.

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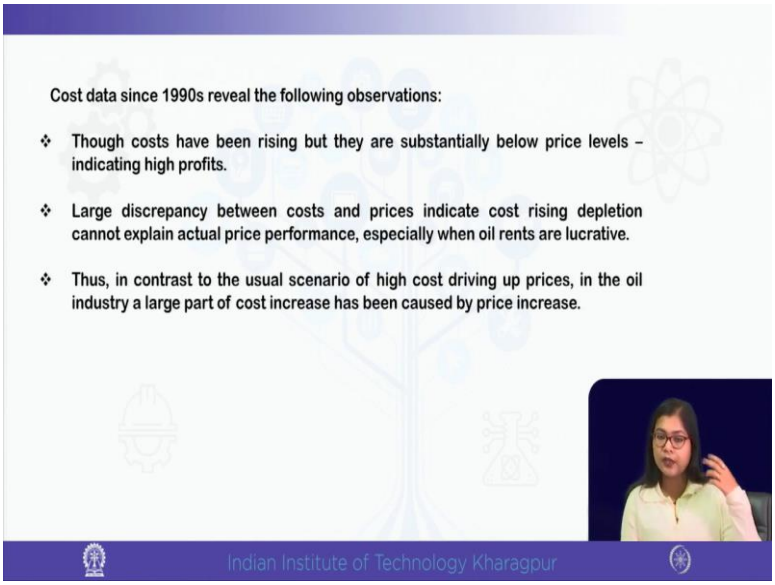

Because they can then suppress some amount when they are paying their taxes. So, if we analyze the cost data since the 1990s, we can find the following observations. The cost have been rising, but the rise in price is even greater, ok. So, cost is rising price is also rising, but the increase in cost is less than the increase in price, that means what? If profit is the gap between total revenue and total cost.

So, if price is increasing, we already know you have in many classes I have defined the profit function pi which is the difference between total revenue and total cost. And you know from your basic concepts we learnt in the economics part micro economics part total revenue is the price into quantity, right.

So, if price increases the total revenue will increase, but of course, if the law of demand is there then if price increases quantity demanded fall. So, we already discussed that if price increases what will happen to the total revenue that also depends on the elasticity of demand, right.

So, initially price increase so then total revenue can increase, right. So, but if cost is increasing, but less than the amount of price increase then what will happen? Then profits will increase, ok. So, what if we compare the increase in price and increase in

cost, we can see that cost has increased over time, but prices have moved faster prices have increased faster. Therefore, profits have increased.

Also, second observation is that we have a large discrepancy between price and cost which can conclude that depletion cannot explain the actual price performance. Especially when oil rents are, we know oil rents are very high till now. See in one of the classes we discussed about oil rents and we saw that especially the opaque countries they enjoy huge amount of their GDP comes from oil rent, oil rent is the profit, right.

So, if the oil rents are very lucrative so, we cannot say that cost increasing depletion is responsible behind price increase. Because see what happens, if cost increases price increases. In in perfect competition price is equal to marginal cost because the firms are very small in respect to the total market, they have insignificant market power they cannot influence the market price.

So, they take the price as given. So, the firms and there is free entry and exit also which makes price is equal to marginal cost. In imperfect competition price is slightly above the marginal cost depending on the degree of the market power in monopoly price is very high above the marginal cost.

So, we can say that in imperfectly competitive market price exceeds marginal cost by an amount which is given by the mark-up. And mark-up depends on the elasticity or to be more specific the mark-up varies with respect to the inverse of the elasticity. So, in imperfect competition we have mark-up pricing. So, that means, if cost increases whether it is a perfectly competitive market or imperfectly competitive market obviously, price will increase, right.

But in case of oil we cannot say that since cost has increased price has increased. Because price has increased faster than the cost increase. So, that means, depletion due to cost increase cannot be the reason for such phenomenal oil price movement. So, that is another conclusion if we look at the cost and price data.

Therefore, in contrast to the usual scenario of high cost driving a price in oil industry a large part of cost increase has been caused by price increase. Now, this is very interesting you see.

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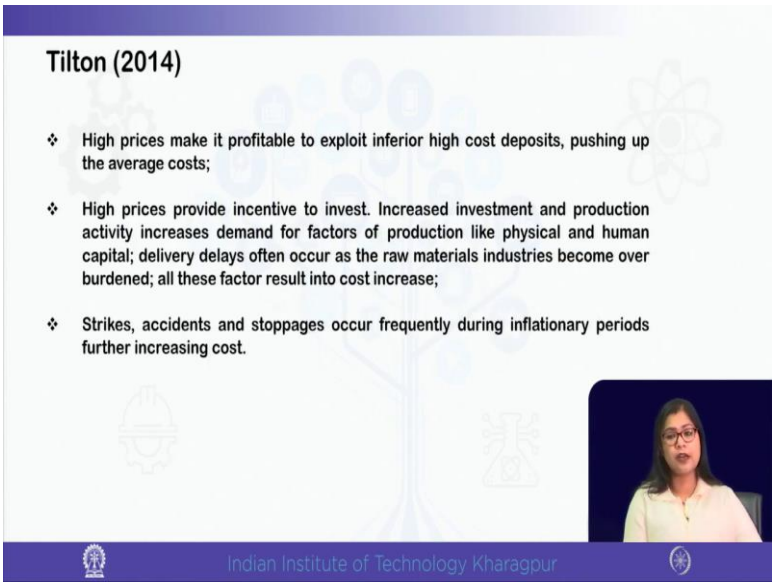

So, just now I told that you in perfect competition you have marginal cost pricing and imperfect competition you have mark-up pricing. So, in both the cases you see if cost increases price will increase right, in perfect competition cost price is exactly tied to marginal cost. So, if marginal cost increases obviously, price will increase. In imperfect competition price is equal to marginal cost plus some mark-up amount, ok.

So, again if marginal cost increases price will increase in imperfect competition also. But in oil industry you see again the oil industry how it is differentiated from other industries. Again, the cost and price nature has moved in opposite direction which is again an exception in if we consider all other goods or services ok, in all other markets where if cost increases price increases. Here in case of oil it has happened quite opposite.

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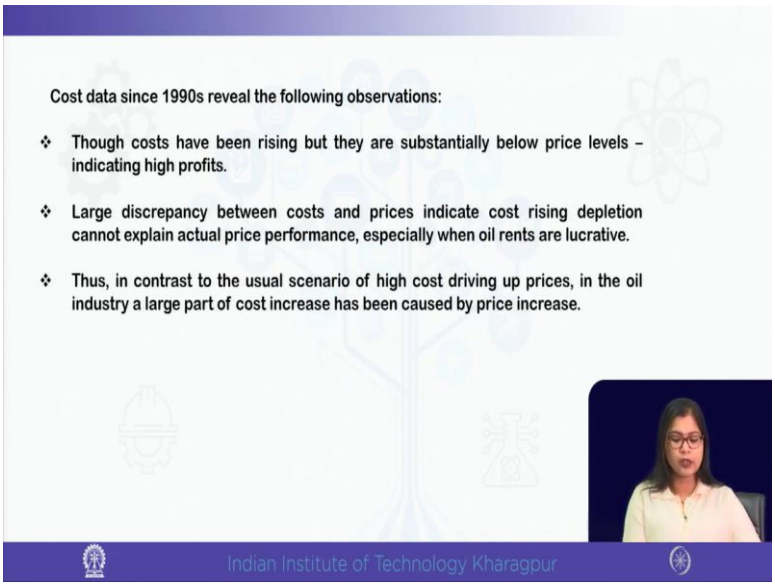

So, as Tilton (2014) pointed out that in the oil industry you see that is why we have concluded that high cost it is not that high cost has increased the price. But a large substantial part of cost increase can be explained by price increase. So, you see it is the other way round here as prices are have increased cost of production and extraction have also increased.

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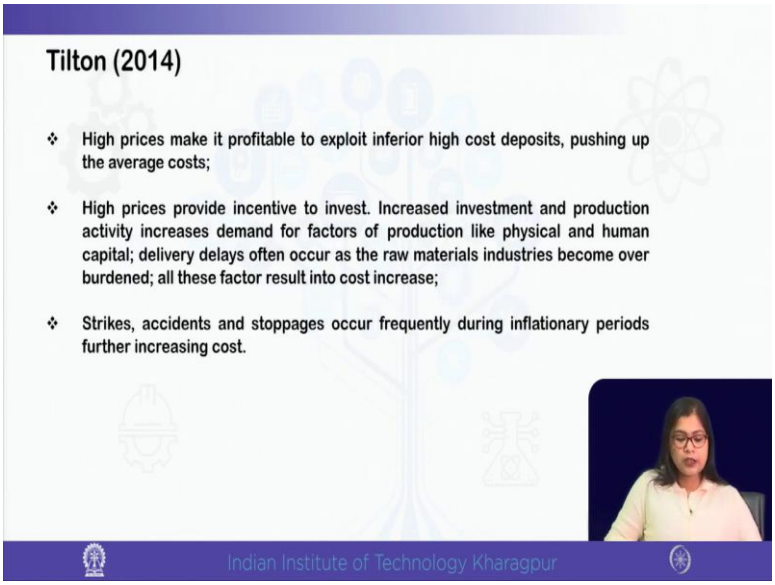

Why? So, these are the reasons three reasons that Tilton have pointed out. What is the first reason? The first reason is that see when price increases what happens? When price

increases it becomes profitable to exploit to extract even the high cost deposit. If you remember we have already discussed what are the stages of exploration right.

First the government does the nationwide mapping then the private firms enter and then they establish the proof reserve, right. And only when price increases substantially above a certain level then only the low cost means the high cost deposit will be extracted is not it? Because initially what will happen? You will be extracting oil from the fields where your cost of extraction is low, right. Because as you are going deeper than your cost of extraction will be high.

So, if your cost of extraction is greater than the price. So, it is not worth it, right. And also see if the oil quality is degraded, right. So, if you are extracting from a field where the quality is not good. So, your cost of refining the crude oil will also be greater. So, you may not have that incentive if the price is not high, but you see we have also seen that whenever there are demand side oil price shocks oil price increase.

So, the firms have had the motivation of going for extracting the low-quality fields, the high cost fields or going deeper into the ground where the cost of extraction is high. So, that is what has precisely happened in the oil market. So, when prices have increased it becomes profitable.

So, initially it may not be profitable. Suppose initially a company is extracting in the fields which are low cost. But if price increases very much so the companies can also have incentive to extract from the fields where the cost of extraction is very high and even the quality of oil is also not that good.

So, the cost of refining is also greater. But all these will do all these will increase the average cost and the marginal cost. But you see what is the reason for this increase in marginal average cost. So, the reason is nothing but price increase. Since price has increased that is why the firms had the incentive to go for extracting the high cost fields, going deeper into the ground or even extracting oil which is not very of not a very good quality. So, that is why the cost has increased.

So, it is the other way round relation here, it is not that cost increase has pushed up the price, but price is increased has motivated the firms to increase the cost because they are extracting the high cost fields. Or is the second explanation, second explanation is see,

when the prices are high. So, the investors also have greater incentive to invest in the oil market, right.

So, there is increase investment in the oil market, production also increases. And if production increases you know if you want to produce more, what do you need. You need more factors of production, see in the very initial classes we discussed about four types of factors of production land, labour, capital and entrepreneur, right.

So, if you have to produce more you have to hire more labour, more engineers mean you need more of both skilled and unskilled labour, you need more machineries, you need more equipments, you need more of chemicals to refine the crude oil. So, that means, overall, the demand for raw materials and factors of production increase, right.

So, demand for physical and human capital physical capital in demand increases, physical capital means the machineries equipments, you have to build a you have to you may have to increase the factory space, right. So, as prices are increasing there is greater incentive to invest. So, production activity increases, if production activity increases demand for factors of production increases, right.

Now, you see what is your cost of production? We define the cost of production is basically nothing but the cost incurred for hiring the factors of production. Suppose, you have only two factors of production labour and capital. So, what will be the cost? Cost will be your c is equal to wl plus rk (c=wl + rk), ok.

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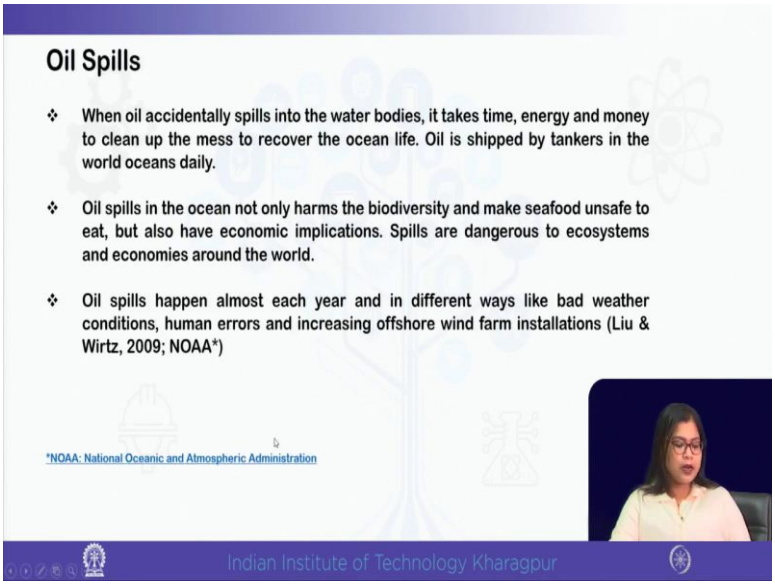

So, w is the power unit wage rate and l is the amount of labour that you are hiring to produce the good and say r is the rate of return to capital and k is the total amount of capital. So, the cost will be c is equal to wl plus rk, ok. So, if you see that the demand for labour increases as we have mentioned that demand for human capital increases. So, what will happen?

In a very short period of time especially you have scarcity of skilled labour, right. You see in most of the Middle East countries lot of Indians and other from other parts of Asia lot of foreigner's work. Lot of Indians also work in the Middle East countries. So, in the very short run if demand increases demand for skilled labour increases. So, these countries do not have sufficient amount of skilled labour.

So, they have to hire workers from abroad. So, how they can do so? They have to pay high they have to offer higher wage rate, right. So, if demand for factors of production increases their factor prices will also increase. Apart from unskilled workers where you have excess supply of unskilled workers like in many developing countries or underdeveloped countries.

However, in the Middle East countries also sometimes you do not have semi skilled workers also. So, if wage rate means the demand for labour increases. So, wage rate will go up, right. Similarly, demand for factory or other capital equipment increases their rate

of return to capital will also increase. So, that means, if there is increased production activity due to the high price incentive.

So, demand for factor prices increases and the demand for factors of production increase and factor prices also increase. Now, if factor prices increase cost of production finally, increases. So, you see the channel here is just opposite price increases leading to cost increase.

And then if you are producing on a large scale. So, what happens there may be delivery delays because the raw material industries become overstretched. Because you see you may need a lot of chemicals also say in the stage of refining the crude oil into the final use. So, in the refined oil. So, you need chemicals, you need fact machinery equipment. So, there may be scarcity of those factors in the very short run, right.

So, delivery delays will also happen because the raw material industries are now overburdened. So, all these because see time is also very important when delivery delays occur. So, that is also costly in terms of money as well as time. Because some of because your entire production chain is disrupted, right. So, if there is a delay in one stage of your entire production and refining process. So, the entire process gets delayed. You receive the payments lately.

Therefore, that also an implicit cost and also in terms of monetary losses will also be involved. So, you see high prices lead to in means high price of oil leads to high price of the inputs of production costly delivery, ok. So, all these lead to higher cost of production extraction refining, right. So, here in the oil industry again with respect to price and cost also is an exception as compared to other industries.

The third explanation of this opposite relation between cost and price in the oil market is regarding you see when prices we know that we have discussed it many times when oil price increases, what happens? Anyone knows if oil price increases then first and foremost cost of transportation increases.

If cost of transportation increases the price of all the goods and services, we are using in day to day life increases, right. Because say the agriculture price will increase because you have to transport the agriculture production from the field to the warehouses and to the markets, right.

Then manufacturing cost of production will also increase because we need to transport the raw material to the manufacturing unit and after the final good is produced that good is marketed, right. So, transportation is very important and of course, for services also we are using transportation in a day to day life. So, if price of oil increases transportation cost increases, then cost of production in all the sectors agriculture manufacturing services will increase, right.

So, that means, there is overall inflationary pressure. And of course, if cost of means oil price increases energy electricity in production cost also increases, though we have also discussed that from mid-1980 onward oil is mostly used for transportation, ok. So, mainly it is the transportation cost increase which has a spiralling effect on the entire economy. So, there is overall inflationary pressure when oil price increases, right. So, when oil price increases there is an inflationary pressure.

So, what happens? That leads to lot of political unrest, strike, labour strike, accidents, stoppages, right. So, these will also lead to increased cost of production because there is a labour strike. So, workers, so, because workers are now feeling the heat because prices have increased. So, if prices increase and the money income is constant. So, what will happen? The real income or the purchasing power of the workers fall.

So, workers may go for some strike, ok. So, if the workers are not working so, the production is disrupted, right. So, that will also lead to delay in production and the delivery of the good. So, these are also costly. So, you see it is the high price of oil that leads to overall inflationary pressure in the economy and which also further aggravates the scenario like that leads to occurrence of frequent political unrest, strikes and accidents and stoppages leading to further increase in cost of production.

So, here we see following Tilton (2014) we can conclude that in the oil industry this high price has sometimes lead to increase in cost of production which is which is again in contrast to other industries. Now, another type of cost means in addition to the cost of production and extraction another type of cost can be considered over here that occurs during oil spill. So, what do we mean by oil spill? So, when oil spill is when oil accidentally spills into the water bodies it takes time, energy and money to clean up that spill, right?.

So, we have to invest lot of money, its time taking and means we have to also hire workers and we have to have some machinery to clean up the mess to recover the ocean life. Because it is very harmful for the ocean life you can easily understand if the oil is mixed into the water, ok. So, oil is shift by the tankers in the world oceans daily we know, ok. So, if the oil spills in the ocean not only it harms the biodiversity of the sea and it makes seafood unsafe, but it also has economic implications, right.

Because you see the tourism let us say in the coastal area, we know that the coastal areas they are very good tourists spot they attract lot of tourists and these areas are the people or inhabitants of this area they are dependent to a large extent on tourism for their livelihood. So, if the tourism industry is adversely affected due to the oil spill so, the local livelihood is also adversely affected.

Those who are dependent on tourism the hotels the transportation sector the tourist guides they are all their income falls, right. So, these are the economic implications apart from the loss of biodiversity and seafood becomes unsafe to eat and also you see the spills are dangerous to ecosystems and economics around the world because the seas are connected.

So, even if there is a oil spill in some particular locality, but it will not be confined, right. Because it has happened in the water so, it will also percolate to the other countries of the world, right. Because the countries are connected via different seas. So, it will not be confined to that particular location where it has happened.

The extent of the damage will be greater, but the impact will be felt in other countries also other areas also. Now, oil spills happen almost each year and in different ways like bad weather condition ok, due to storm or other type of extreme weather events, human errors also because see the production system extraction system is all subject to human errors.

So, it may happen due to human errors and increasing offshore wind farm installation. So, these are the possible reasons for oil spill as mentioned by Liu and Wirtz in 2009. The NOAA reports over those who are interested you can go through the report for deep understanding regarding oil spill.

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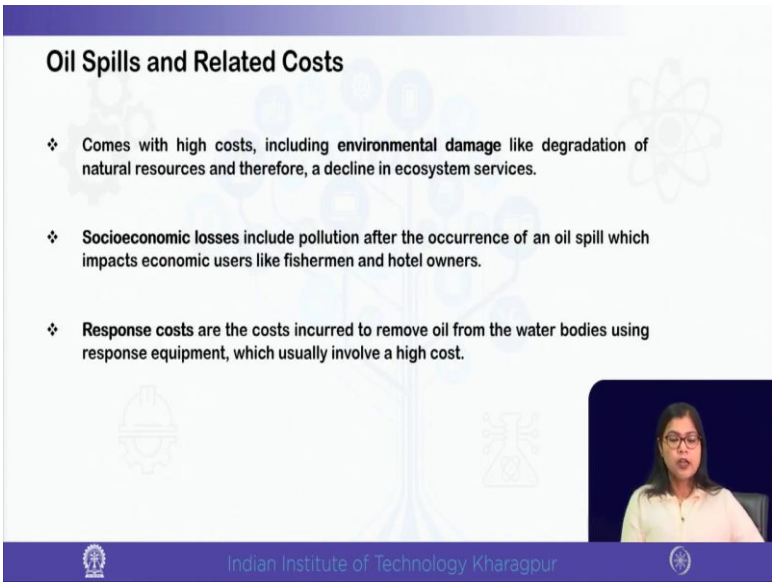

So, what are the related cost of oil fill oil spill if we just summarize. So, the oil spills are associated with high cost like we also talked about the environmental damage. For example, these are associated with degradation of natural resource and therefore, the decline in the ecosystem service, right. Because we the underwater habitation is greatly adversely affected by oil spill.

So, it causes lot of environmental damage and just now we discussed that it will not be confined to a particular locality, but it will spread in other areas other countries also. So, first is the environmental loss. Second is the socioeconomic losses. So, socioeconomic losses what are the reasons?

The reasons include the pollution after the occurrence of an oil spill which impacts the economic users like the tourist guide, the hotel owners, the fishermen because the fishermen in the coastal areas they are dependent on catching fish and selling the fish from the sea and of course, the transportation sector around the coastal area, if the tourism sector is affected.

So, these are the socioeconomic losses. And third is the response cost. So, what do we mean by response cost? These are the cost incurred to remove oil from the water bodies using response equipment which is very costly. So, that also because you have to take out the oil from the water and that is also very costly. So, that you can consider as a

direct cost of means removing the oil from the water because you need a lot of equipment's and that is very costly.

So, these are the related cost socioeconomic, cost environmental cost and the cost related to removing oil from the water. So, that is the response cost.

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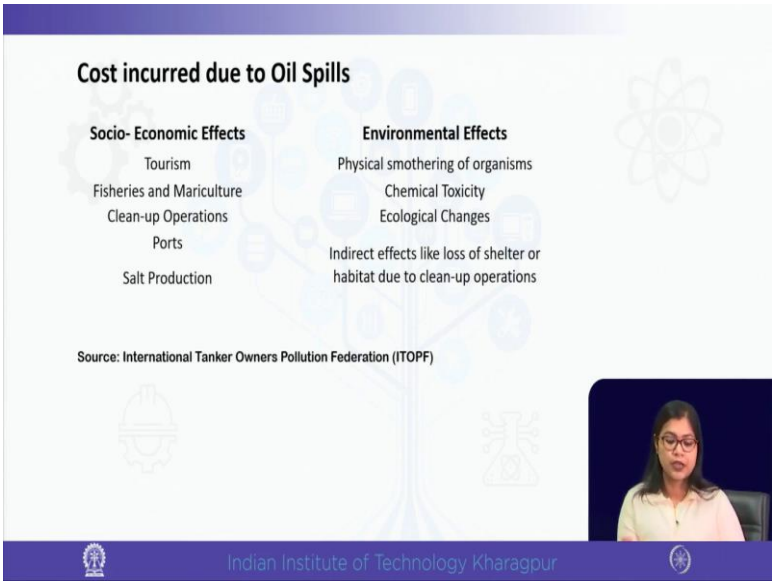

So, if we now just summarize or categorize the cost due to oil spill. So, we can classify them into two parts as we have already discussed. So, following the International Tanker Owners Pollution Federation report we have classified the cost associated with oil spill oil spill into two parts. One is the socioeconomic impact and another is the environmental impact.

So, what are the socioeconomic impact? As we already discussed the first and foremost in socio economic impact is on the tourism sector. And you see the tourism industry is the main source of livelihood and income for the people living in the tourist areas for the locals. Not only that tourism also provides, it is a very stable source of foreign exchange reason because if the foreign tourists when they come the foreign tourists come the size suppose, the foreigners are coming to India.

So, they are actually considered as source of the foreign exchange or dollar, right. So, tourism is also a very important source of foreign exchange earning. Because when the

tourists come, they come with the international currency and they convert the currency into the local currency.

So, that creates the source of the foreign exchange, ok. Because foreign exchange why foreign currency is very important because when we have to buy something from abroad, we have to use the foreign currency our domestic currency will not do. So, we have in our module you see the last module we will be discussing about how exchange rate is determined and what are the sources of demand and supply of dollar.

So, the foreigners coming to the domestic country constitute a major source of income of foreign exchange or mainly dollar, ok. So, if the tourism industries adversely affected not only the local people at the in the tourist areas are affected, but also the government revenue means the foreign exchange earnings for the government is also adversely affected.

Next is; obviously, we already discussed about the fisheries. So, the fisheries and the mariculture that industries are also affected. Third is the clean-up operation that also we just now discussed about the response cost. So, the clean-up operation that is removing the oil from the water is costly. Also, you see the cost in the port areas we will also increase because when the oil is removed from the water.

So, the normal day to day operation in the port areas are also adversely affected. And lastly see salt production is also adversely affected because we know that salt production also takes place in the coastal region. So, if there is an oil spill so, the salt production is adversely affected. So, these are the socioeconomic impacts or cost associated with oil spill oil spill.

And what are the environmental impacts? First is the physical smothering of organisms so, the ecological diversity is affected there are ecological changes also, right. The chemicals involved in the oil will affect the underwater habitants. There is chemical toxicity in the water which will also affect the habitants and that will not be confined because they are moving in the underwater animals.

They are also moving from one place to another. So, this chemical toxicity and ecological changes will be spreading to other parts of the world. And of course, there are indirect effects like the loss of shelter or habitat due to clean-up operation. So, after the

spill has taken place so, we have to remove that mess we have to remove the oil from the water.

So, this is a clean-up operation. And during the clean-up operation as we discussed that the normal activity in the port is affected also that creates that is disturbing from the underwater animals, right. And there is a loss of shelter for the underwater animals. So, these are the major cost associated with oil spills.

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So, you can see some figures very interesting figures which have taken from Al-Majed and others in 2012 paper and this each of the paper each of the photo is also taken from other sources like the AP photo, Geralt Harbour Herbert. So, we have mentioned all the sources and we have also referred to the original paper and we will be sharing this paper and we will be sharing with you the study materials, ok.

So, you can see the impact of oil spill visually. So, the first figure you can see that shows an oil-stained pelican where a hundred of pelican nests exist you see. It is very distressful to see the condition of the pelicans. Figure b points out to the fireproof boom used to contain in-situ burning, ok.

We have presented the source of each of the figure. The figure c you can see it is a shrimp boat and the figure d is a beach soiled with oil. So, you can imagine that how costly it will be to remove this oil from water, right. So, visually you can see the

damages that can happen due to oil spill all types of damages socioeconomic and environmental damages, damage to the ecosystem, biodiversity.

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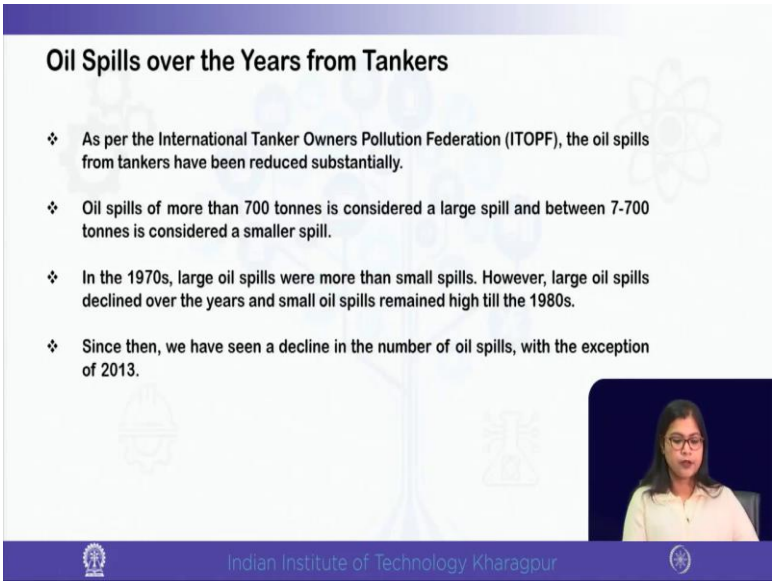

So, over the years we have lot of oil spill from the tankers. So, as per the International Tanker Owners Pollution Federation, the oil spills from tankers have been reduced substantially. Oil spills of more than 700 ton is considered a large spill. So, this in ITOPF they have divided the or categorized the oil spill into two types large spill and small spill.

So, large spill happens if the oil spill is more than 700 ton.

And between 7 to 700 ton of oil spill is considered to be a smaller spill. In the 1970s, large oil spills were more than small spills and you can easily understand that in the large spill the cost associated will be greater. The socioeconomic and environmental cost will be greater, the response cost will be greater because you have to use more efforts you have to put in more efforts to remove the oil from the water.

So, however, over time large oil spills have declined and nowadays we have high oil spills and that trend is there since the 1980s. So, since then since 1980s we have seen a substantial steady decline in the number of oil spill and whatever we have especially there of the small kind of nature and some exception was there in the year 2013.

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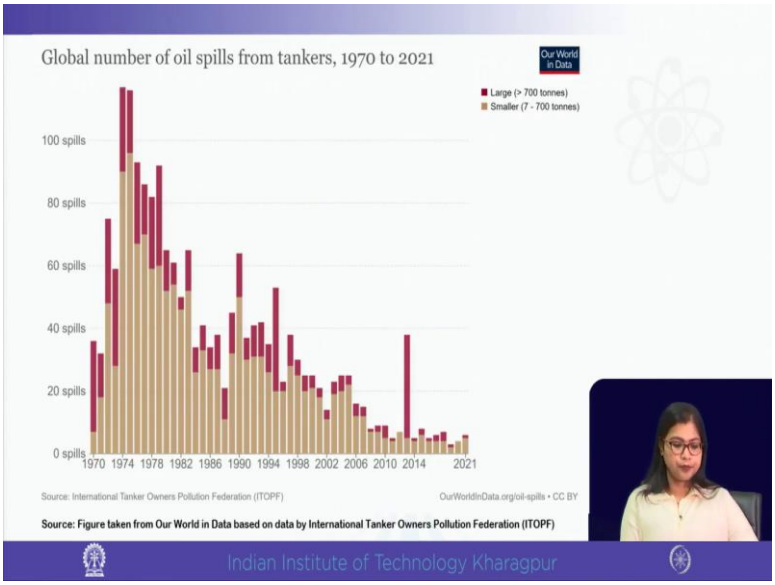

So, here we have reported the data from our world in data by showing the global number of oil spill from tanker ranging from 1970 to 2021. So, the red one you can see correspond to the large oil spills of greater than 700 tons and the yellow one is the smaller oil spills which is ranging between 7 to 700 tons.

So, you can see earlier during 1973, 1974 we had lot of large oil spill. And over time oil spill have reduced the main reason of reduction in oil spill is technological improvement, right. So, technological improvement oil spill has reduced and interestingly large spills have reduced because you can see from 1980 onward the greater amount of spill is the smaller oil spills and it has thoroughly declined. Large oil spills and small oil spills have thoroughly declined only there was an exception in 2013.

So, this figure is we have taken it from our world in data who again have taken the figure from the international tanker owners pollution federation, ok. And we have also reported the hyperlink over here.

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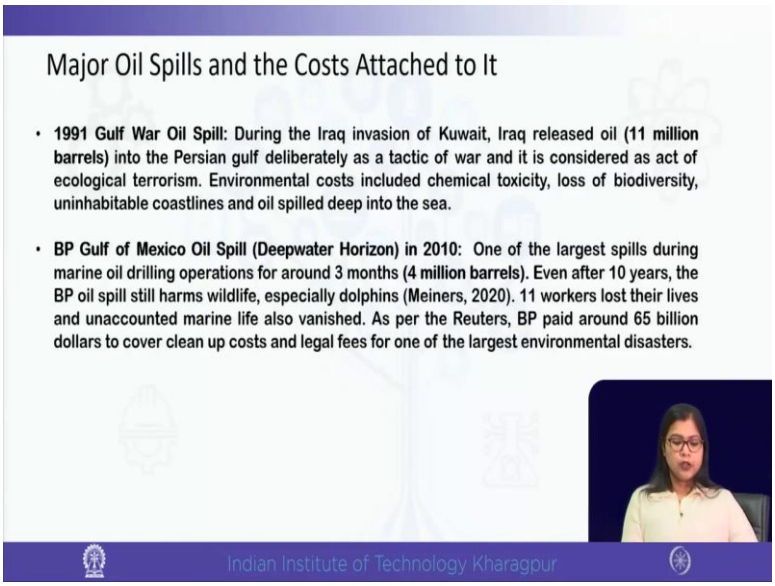

So, we can see some examples of some major oil spill. So, one was the 1991 Gulf War oil spill. So, if you remember I think we have also discussed this issue in the very initial classes when we discuss some geopolitics associated with the development of oil industry.

So, during 1991 Gulf War when Iraq invaded Kuwait Iraq released oil almost 11-million-barrel oil into the Persian Gulf and that was a deliberate action and it was part of their war strategy and it is considered as an act of ecological terrorism. So, the environmental cost included chemical toxicity loss of the biodiversity and uninhabitable coastline and oil spill dip into the sea. So, it was very costly.

So, you can consider this this was done deliberately. So, you can consider it as ecological terrorism and that was also responsible for increase oil price hike in 1991. Though we have already also studied that oil price did not rise much because Saudi Arabia intervene and it increased the oil supply.

But that is an example of a major oil spill. Another oil spill was the BP Gulf of Mexico oil spill a Deepwater Horizon that occurred in the year 2010 and it is this is one of the largest spills during marine oil drilling operation and it happened over a period of 3 months and the amount of oil spill was around 4 million barrels.

So, even after 10 years the BP oil spill is still harmful for the wildlife especially for the dolphins as pointed out by Meiners's in 2020. So, you see the effects last for a very long time it is not a short run effect because when the oil is mixed into the water. So, the effect will be there even after removing the oil some part will be there it may not be possible to remove all the oil. So, even after 10 years so, the incident occurred in 2010, but see even in 2020 the oil spill till is harmful for the dolphins in that locality.

And you see the associated losses there was loss of human lives also. 11 workers lost their lives and unaccounted marine life also vanished. So, that means, the loss to the sea animals that was just could not be calculated it was so huge. So, as per the Reuters BP paid around 65 billion dollars to cover the clean-up cost and the legal fees for one of the largest environmental disasters.

So, should be very careful the companies in the extractive industry should be very careful while extracting oils. Though we have to a large extent we have control the oil spill with technological improvement, but till there are scopes because you can see that this event the BP Gulf of Mexico oil spill it happened 12 years ago. So, we should be more careful, we need even better technology to prevent all kind of spill especially the large spills.

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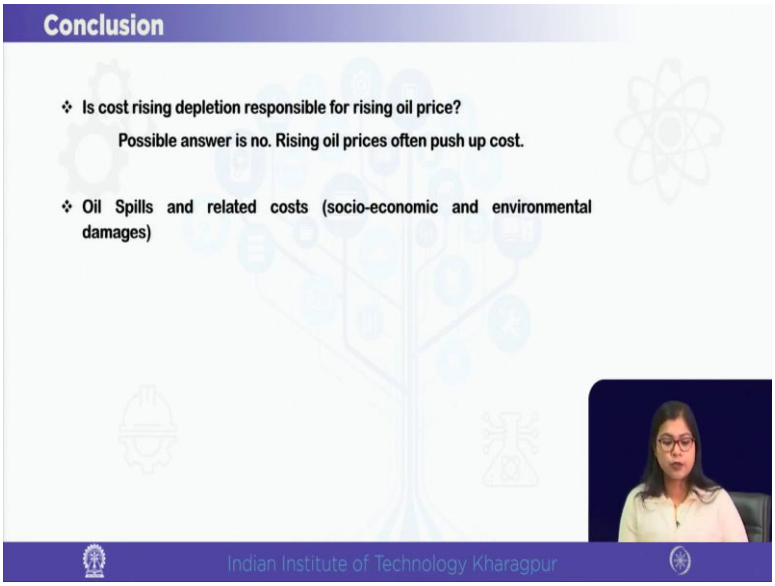

So, if we now summarize today's lecture what we discussed is, we explored we tried to address the question whether cost rising is in depletion is responsible for oil price

increase. But what we find is that no, the possible answer may be no, because in the oil industry again there is an exception with respect to the nature of cost and price.

In other industries when cost of production increases price increases. In oil industry interestingly it has been the other way round. In oil industry rising oil prices have often pushed up the cost as we have already discussed by referring to Tilton (2014), right. Because the high oil prices lead to increase demand for factors of production.

The high oil prices lead to provide incentive to the firms to go for high cost fields extraction all these increase the cost of production and also, we had discussed about the political unrest, the labour unrest leading to increase in cost. So, high prices have often increased the cost of production in the oil industry.

And second, we also discussed about the accidental spill and sometimes these are the deliberate action like we have discussed about the Gulf War. So, we have discussed about the related cost of oil spill and we saw that there are socioeconomic and environmental damages.

But due to technological improvement nowadays we have controlled the large spills, but small spills are still there, but there are also accidental spills which till occur still occurred few years ago also. So, we need more better technology and more technological improvement to prevent all kinds of a large oil spill.

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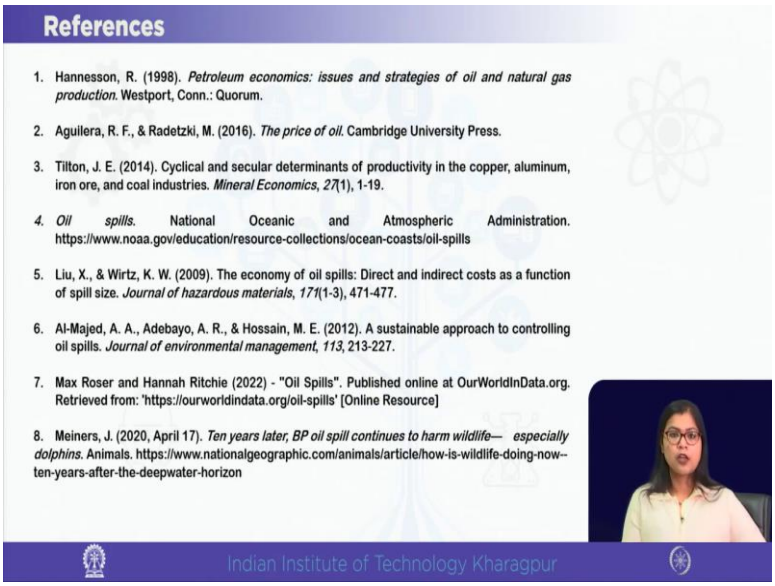

So, these are the references that we followed for today's class. So, thank you very much we look forward to have more intense and interesting discussion in the upcoming modules.