Health, Safety and Environmental Management in Petroleum and offshore Engineering

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Module No. # 02

Lecture No. # 01

Environmental issues and management

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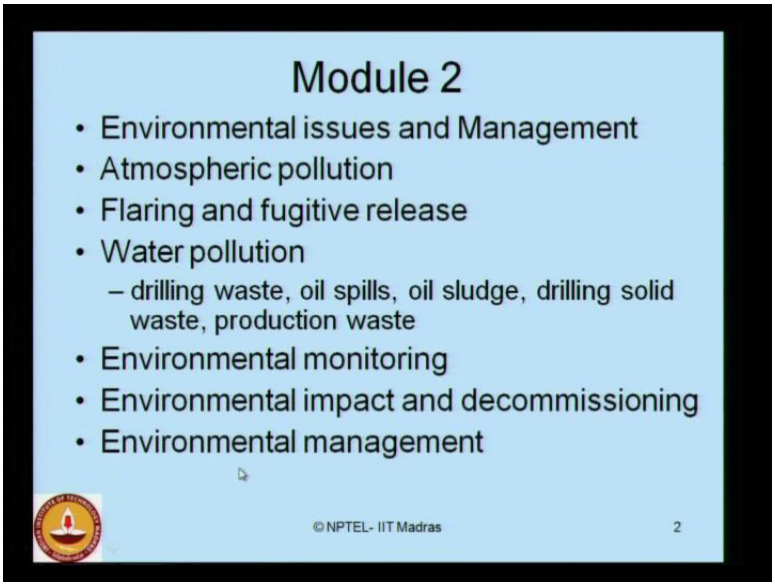

Ladies and gentlemen, now we will talk about module-2. In module-2 on HSE in offshore and petroleum engineering management, we will discuss about environmental issues and management related issues on this module. This module comprises detailed discussion on environmental issues in management; issues related to the atmospheric pollution; flaring and fugitive release models; water pollution arising from drilling wastes, oil spill, oil sludge, drilling solid wastes, production wastes etcetera. We will also talk about methods on environmental monitoring. We will discuss about environmental impact and decommissioning, and we will overall talk about environmental management issues in this module.

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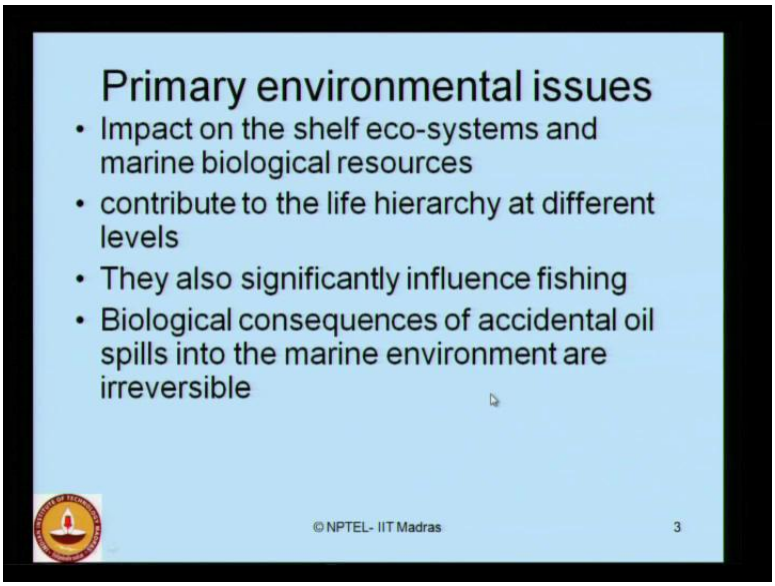

Then we ask a fundamental question, what are the primary environmental issues related to oil and gas industry? The main issue related to oil and gas industry on the environment is it causes a severe impact on the shelf eco-systems and marine biological resources. It contributes to the life hierarchy at different levels. They also significantly influence fishing. There are biological consequences of accidental oil spills into the marine environment and this process and consequences are basically irreversible.

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Let us look into some of the visible consequences which come from the oil and gas industry on the environmental impact. If you look at the visible consequence, then the complexity, urgency and variety of emerging problems in environmental management or the foremost visibility of the consequences come from oil and gas industry. There exists a very uneven distribution of marine life and its concentration in the shelf and coastal zone which is essentially resulting from the marine pollution caused by oil and gas industry. The coastal zones habitat for about 90 percent of marine commercial organisms exist get disturbed because of this.

Most of the known oil and gas fields are unfortunately located in the coastal zone, which amounts for about 90 percent of marine commercial organisms, and therefore these oil and gas fields which are located in that coastal zone, which habitat for about majority of marine organism cause the serious ecological disturbance.

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There are many reports which are published on these issues. We will mention critically some of them here. The ecological impacts on oil industry is discussed in 1987, by Dicks, edited in 1989, which discusses ecological impacts of the oil industry which is formed of a proceeding of international meeting organized by institute of petroleum London in November 1987. The publication is from New York about 316 pages. The other important report which discusses on this issue is on the North Sea and environment given by Cairns W.J in 1992. The report discusses the North Sea and the environment,

the developing oil and gas resources and their environmental impacts and responses published by Elsevier applied sciences New York.

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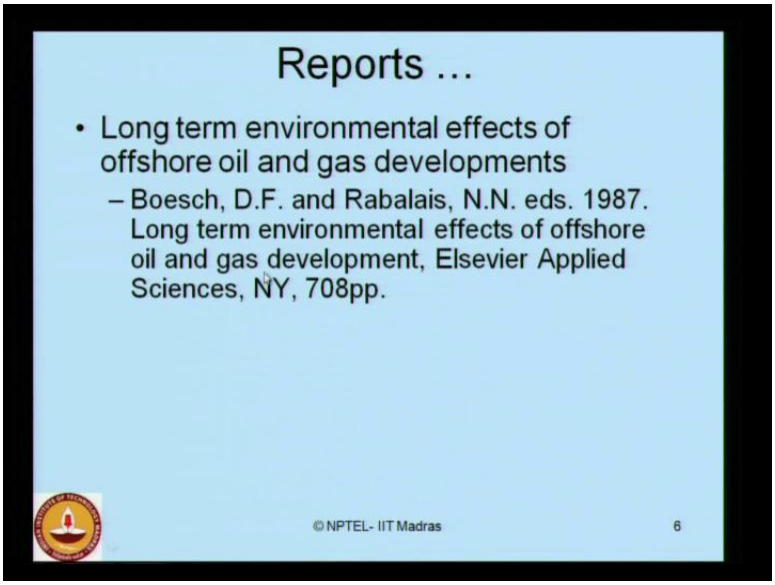

The third report discusses on the long term environmental impacts of offshore oil and gas developments published by Elsevier applied sciences authored by Boesch and Rabalais edited in 1987.

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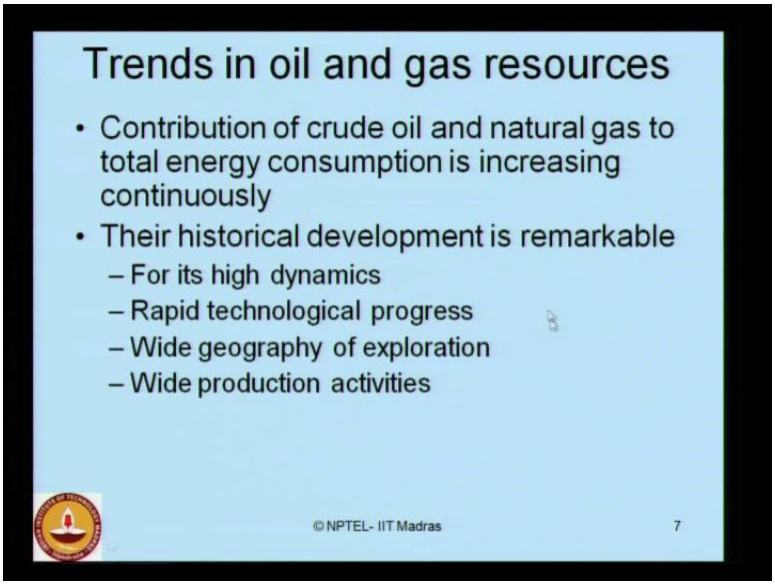

If you look at the trends in oil and gas resources in general, the contribution of crude oil and natural gas to the total energy consumption is increasing continuously and this is

undoubted statement. Their historical development is really remarkable, because of many factors few of them are very important to be mentioned here. The historical development is of a very high dynamics; it involves rapid technological progress; there is a wide geography of exploration all over the world; there is wide production activities happening all over the world, because of increasing demand in crude and natural gas towards the total energy consumption.

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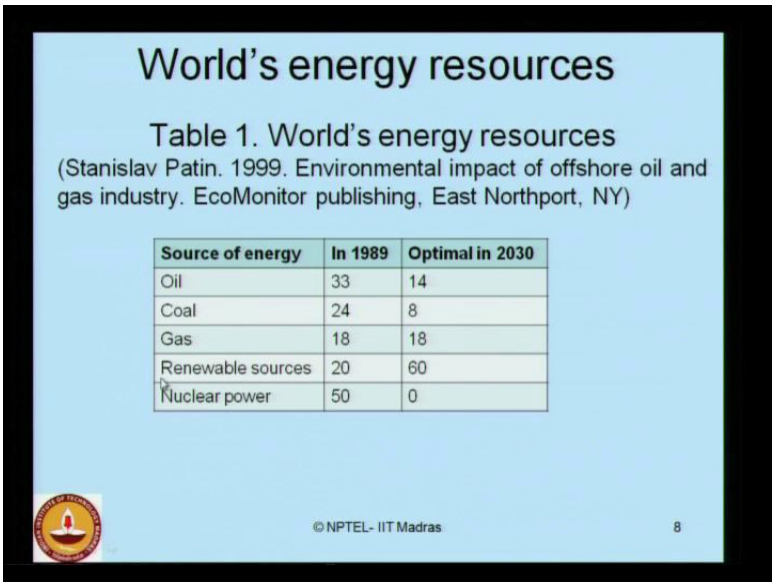

The World's energy resources as tabulated by Stanislav Patin, in 1999, shows a very good summary of different source of energy in the year 1989. And then what will be the optimal status of these energy resources in 2030? If you looked at the source of energy of different kinds, looking at the oil in 1989 the present energy resource from oil is about 33 percent which will get optimistically reduced to about 14 in another 20 years. Similarly, if you look at coal as a source of energy currently, it is contributing to about 24 to 26 percent which will optimally reduce to only about 8 percent.

Whereas the source of energy as gas is expected to remain constant for another twenty years; however, there is a phenomenal improvement on renewal energy sources which is currently about 20, 22 percent expected to grow to a tune of about 60 to 65 percent in next 20 years. Unfortunately, ladies and gentlemen, look at the nuclear power as one of the sources of energy it is now a dominating area of source of energy which will substantially get close to zero in another 20 years. On the other hand, the main source of

energy will remain for another 20 years will be renewable sources of energy. So, it is necessary that we must plan to protect our ocean environment to have a clean source of energy for the coming 20 years.

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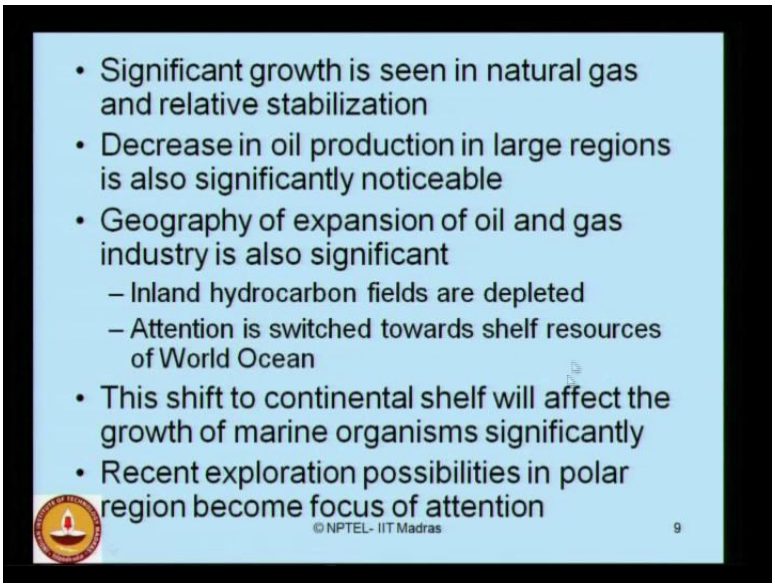

So, the table clearly showed, there is a significant growth in the natural gas and relative stabilization of this sources of energy. The decrease in oil production in large regions is also significantly noticeable which is expected to be seen in the coming 20 years. The geography of expansion of oil and gas industry; however, is very significant now. The Inland hydrocarbon fields are almost depleted; therefore there is a growing attention which is fixed from local to a global towards shelf resources in World Ocean.

This shift to continental shelf is expected to affect the growth of marine organisms significantly in the coming years. Recent exploration possibilities, even in polar region become a focus of attention to all world environmentalists.

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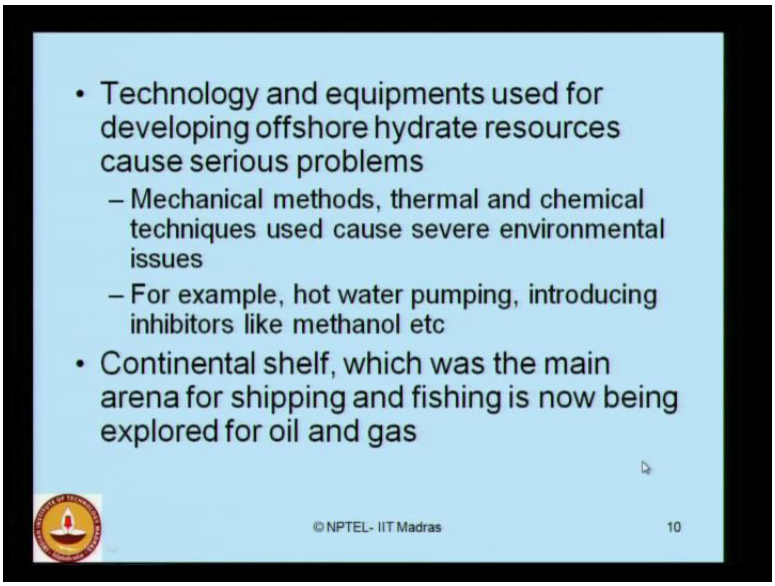

However, ladies and gentlemen, to perform deep water oil exploration - the technology and the equipments used for developing the offshore resources cause serious problems. Different modern mechanical methods being employed in oil exploration; the thermal and chemical techniques being used to improve the oil recovery from different wells which are employed currently pose a very severe threat to the environmental pollution. For example, the hot water pumping, introducing corrosion inhibitors like methanol etcetera pose a very serious problem.

If you look at the continental shelf, which was the main arena for shipping and fishing is now being explored for oil and gas. There is another major shift which is causing a very serious worry and posing a very serious threat to marine pollution in the coming years.

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Prospective locations of oil and gas fields in the shelf zone often overlap unfortunately with the regions of high biological productivity of world ocean. This is one of the very sensitive area where the oil and gas fields may be marginal may be definite fields of exploration or extensively overlapping with the biological productivity regions in the World Ocean.

Gas hydrates which are highly promising are found in the marine regions their development will certainly lead to severe environmental problems undoubtedly. Modern technologies which are being practiced for oil and gas exploration impose serious threat to the environment.

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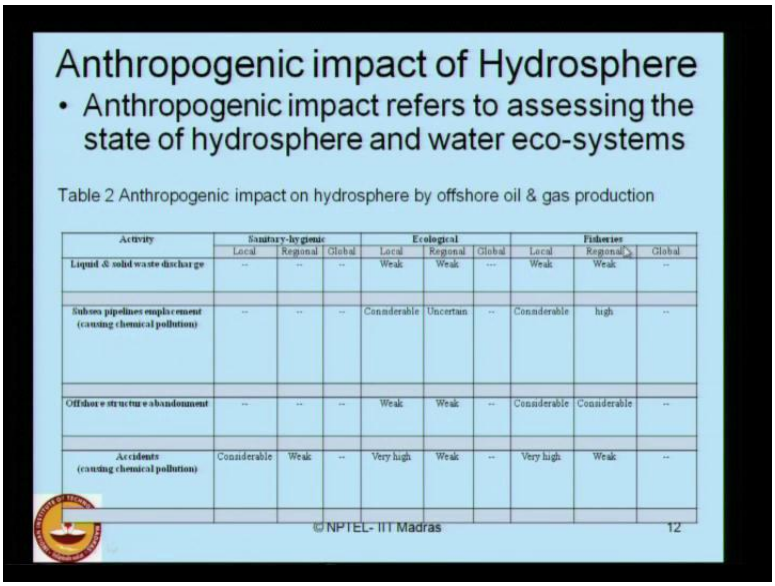

If you look at the anthropogenic impact of hydrosphere; this impact actually refers to assessing the state of hydrosphere and water eco-systems. Anthropogenic impact actually refers to the disturbance in water ecosystem.

Table -2 shows the anthropogenic impact on the hydrosphere which is caused mainly the offshore oil and gas production. If you look at the various activities and their consequential disturbance on different levels namely local, regional and global - they are very alarming, for example, look at the activity of liquid and solid based discharge happening because of oil and gas production. If you look at the sanitary hygienic segment of this consequence of the discharge they are insignificant; however, the ecological disturbances caused by these discharges though they are very weak as are today in local and regional level of course, they are unnoticed in the global level. And their consequence on the fishery segment in the local and regional is also noticed to be weaker.

If you look at the subsea pipelines emplacement, they cause a very severe chemical pollution; however, in hygienic region they are unnoticeable, but in the local region and ecological disturbances they cause a significant contribution. And there is contribution on the regional level on fisheries is very high. If you look at the offshore structural abandonment - that is if any offshore structure which is found to be unusable in the present state of location they are called as abandoned structures; these abandonment of

offshore structures cost; however, a considerable contribution in the fishery segment. Why because, these abandonments requires lot of explosions in the process to remove them from the location. These explosions underwater cause a very serious shift in the fisheries population of marine aqua culture from one location to another.

If you look at the accidents which are also resulting in chemical pollution, the sanitary hygienic contribution from these accident are considerably high in the local segment. And the ecological segment in the local area they are considered to be very high, and they also affect fishing population very significantly.

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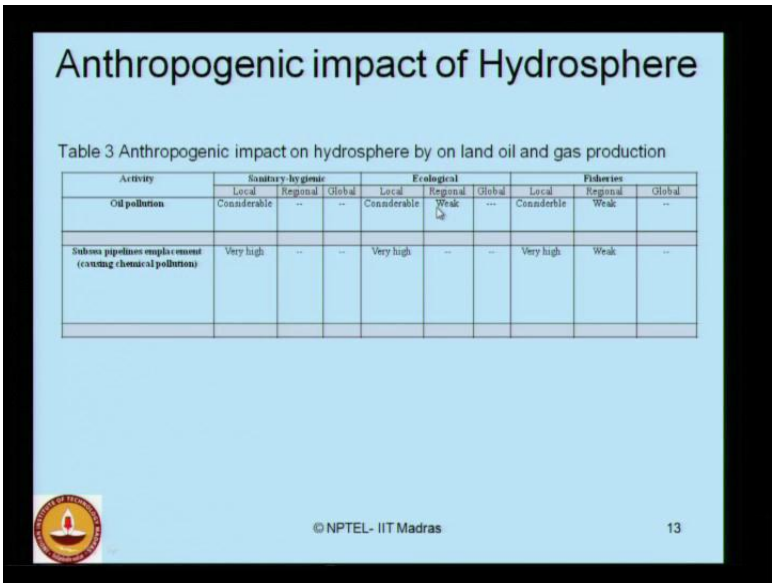

If you look at table three this shows anthropogenic impact on hydrosphere on land and oil gas production. If you look at the oil pollution in the sanitary hygienic segment in the local region, it causes a very considerable impact. It also causes considerable impact ecologically and in the fishery segment; however, most interestingly if you look at the subsea pipeline emplacement, they cause a very serious chemical pollution which are very high in hygienic point of view as well as very high in ecological and fishery's point of view as well.

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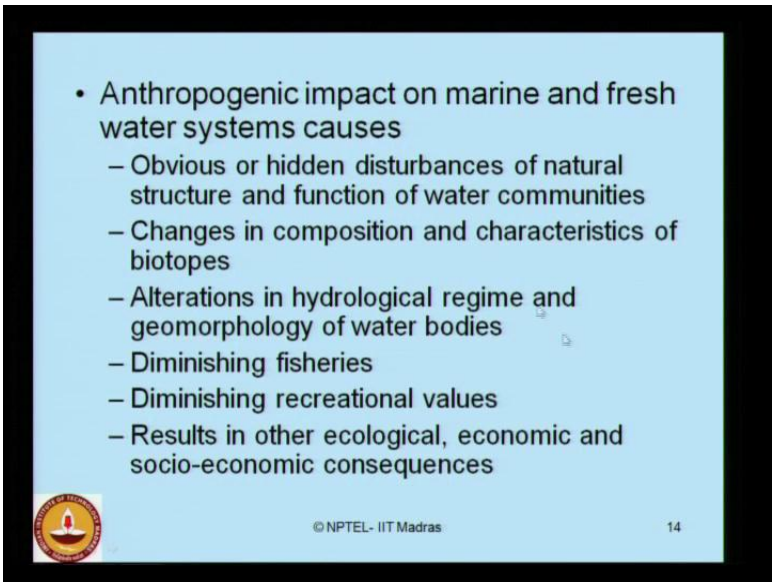

Therefore, anthropogenic impact on marine and fresh water systems cause very serious problems as listed below. There are obvious or hidden disturbances of natural structure and function of water communities. The changes in composition and characteristics of biotopes they cause serious alterations on hydrological regimes and geomorphology of water bodies. They cause very serious diminishing fisheries activities; they cause diminishing recreational values to the ocean environment; they also result in other ecological economic and socio-economic consequences.

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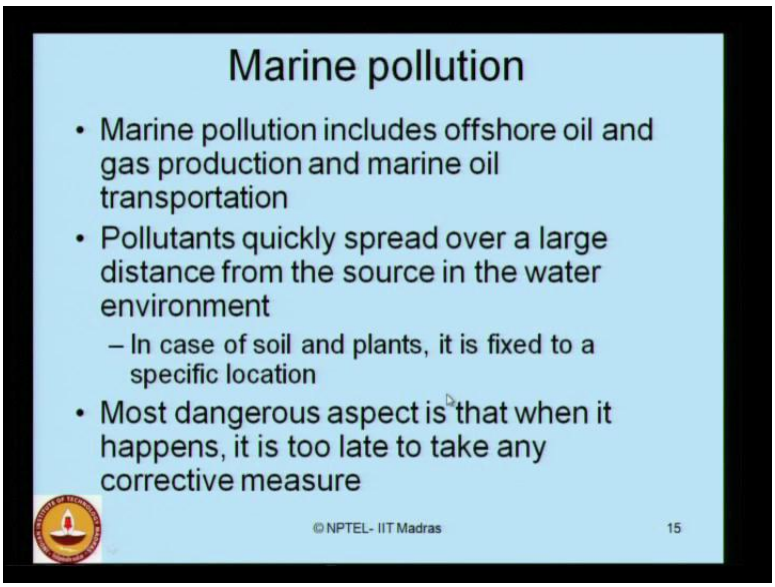

Ladies and gentlemen, let us look into the aspect of marine pollution. Marine pollution includes offshore oil and gas production and marine oil transportation together. The pollutants actually quickly spread over a large distance from the source in the water environment. Unfortunately, in the case of soil and plants, it is fixed to a specific location, but in the case of sea these pollutants spread quickly over a large area. This is one of the serious threat what we have in marine pollution cause essentially because of let us say, for example, oil spills

It is one of the most dangerous aspects because when it happens it is generally too late to take any corrective measure. It means the marine pollution in an overall looks as if they are non preventive and non correctable they can only ascertain marginally, but the action can be taken only after they rally occur, and generally it becomes too late to make a severe corrective measure, therefore marine pollution leaves a permanent remark on the ocean environment which becomes irreversible process.

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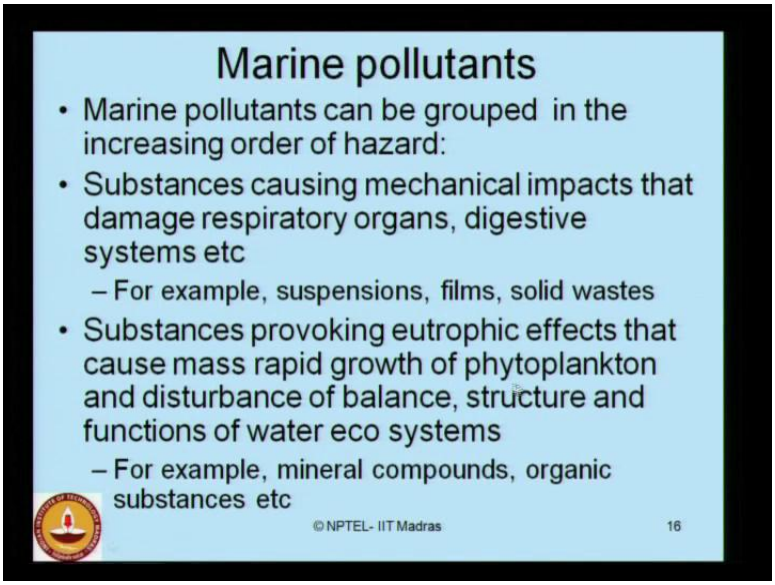

If you look at the marine pollutants responsible for such marine pollution, these marine pollutants can be grouped in the increasing order of their hazards. Substances causing mechanical impacts that damage respiratory organs, digestive systems etcetera, for example, suspensions, films, solid wastes.

Look at the next order of hazardous substances provoking eutrophic effects that cause mass rapid growth of phytoplankton and disturbance of balance, structure and functions

of water eco-systems, for example, mineral compounds, organic substances seriously affect and disturb the balance structure and functions of the total water eco systems.

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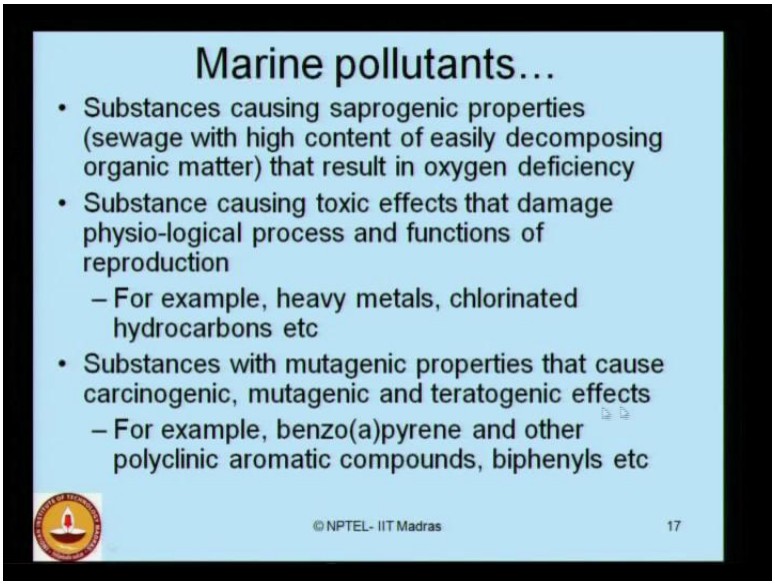

If you look at the next level of hazard of marine pollutants then substances causing saprogenic properties - result in oxygen deficiency; that is sewage with high content of easily decomposing organic matter results in oxygen deficiency in a serious order. If you look at the next order of hazardous substance causing toxic effects - damages physiological process and functions of reproduction, for example, heavy metals chlorinated hydrocarbons etcetera

Substances with mutagenic properties that cause carcinogenic, mutagenic and teratogenic effects, for example, benzo(a)pyrene and other polyclinic aromatic compounds and biphenyls etcetera cause carcinogenic effect on human organism in any marine living organisms.

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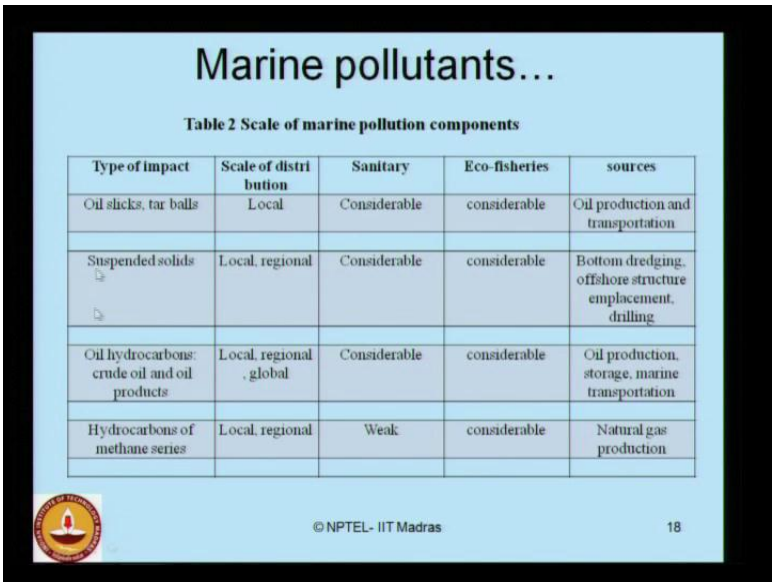

Ladies and gentlemen, let us look at this table which shows me the scale of marine pollution components occur in ocean. I have listed here a different type of impact caused by oil slicks suspended solids oil hydrocarbons like crude oil and oil products on hydrocarbons of methane series. We discuss about the scale of distribution in the function of sanitary, eco-fisheries, causing from different sources. Let us look at the oil production and transportation as a process which is identified as one of the main source of marine pollution. Oil production and transportation cause serious oil slicks and tar balls the scale of distribution of these is local however, but they cause considerable impact on sanitary and eco-fisheries segments.

If you look at the next activity like bottom dredging, offshore structure construction and drilling process for expletory drilling. They cause an impact resulting from suspended solids the scale of distribution extends from local, regional as well. They cause considerable impact on the sanitary point of view and eco-fisheries point of view. If you look at the oil production storage and marine transportation segment as a whole, they release lot of hydrocarbons which are crude oils and oil products in sea. The scale of distribution starts from local extends to regional and they also become global. It is very important to note that oil production leaves the significant scale of distribution starting from local till global segments. And their effect on the sanitary ecology and fishery segment are considerably high.

If you look at the natural gas production as one of the sources of pollution in a marine pollutant, they release lot of hydrocarbons in methane series. The scale of distribution extends from local to regional; however, they may cause a weak contribution in sanitary point of view, but ecologically and fishery segment their impact is considerably high.

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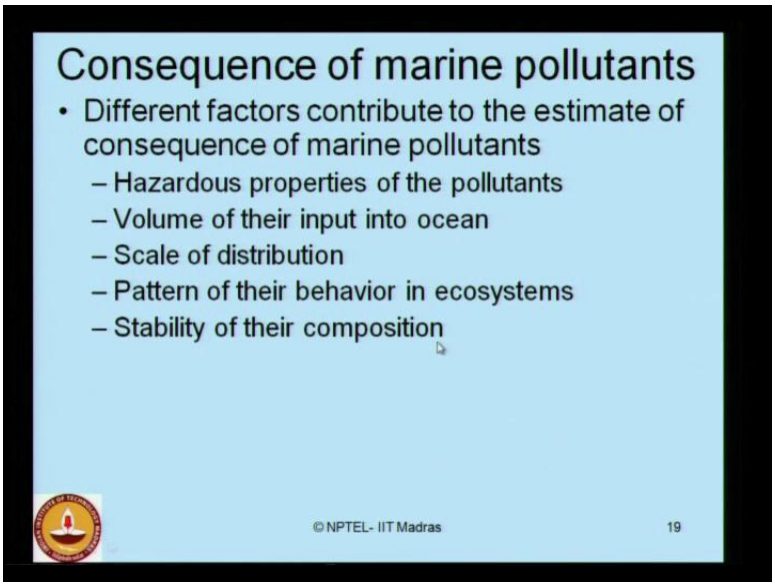

If you try to list the consequences of marine pollutants, different factors contribute to the estimate of consequence of marine pollutants - some of them are listed here which are very important. The hazardous properties of pollutants are major contributor for the consequence of marine pollutants. They are discharged in large volume actually the volume of their input into ocean is considerably high. You have just now seen the previous table, the scale of distribution starts from local and even extend to regional and further to global level as well. It is very difficult to probabilistically model, the pattern of their behavior in ecosystems because of their high complexities.

Unfortunately, these components which are released in ocean as marine pollutants are stable compounds by their composition, and they cause serious threat to the marine environment.

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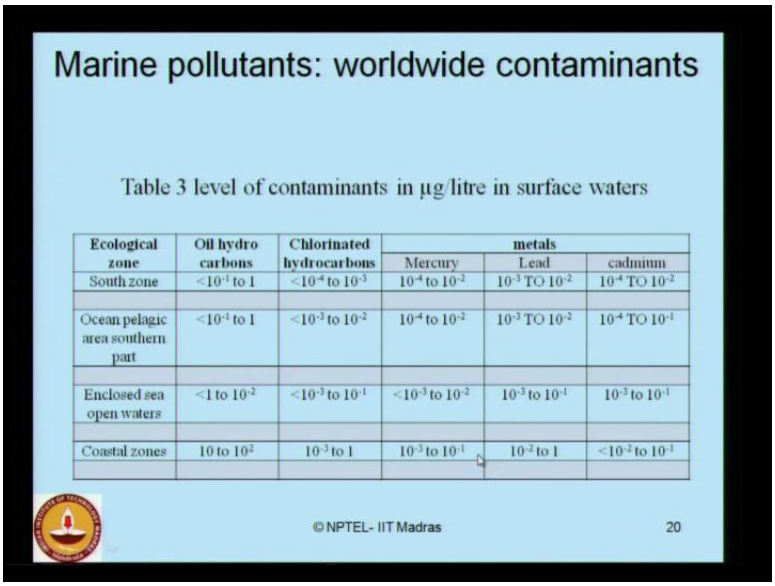

If you look at the worldwide contaminants in microgram per liter in surface waters, this table three gives a picture of different contaminants in this unit occurring in surface waters. If we look at the marine pollutants which are causing the worldwide contaminants, the table-3 summarizes different contaminants in mu g per liter in surface waters. If you look at the south zone ocean pelagic area southern part, enclosed sea open waters, and coastal zones. Let us look at the different level of contaminants as oil hydrocarbons, chlorinated hydrocarbons; and different metals in the form of mercury, lead, and cadmium.

In the south zone, the oil hydrocarbons varies lower than from 0.1 to 1 almost in ocean pelagic region southern part as well as southern zone. When it comes to coastal zone, the oil hydrocarbon contaminants value significantly increase from 10 to 100 as well. If you look at the chlorinated hydrocarbon contaminants concentration on different segments, it varies from 10 power minus 4 to 10 to the power minus 3 on southern zone, whereas when they move to the coastal zone it comes as significantly to the value of one on a relative scale.

If look at the contaminants of metals present in the surface waters significantly, there is an increase from the southern zone open sea waters to the coastal zone; the scale is varying anywhere from 10 power minus 4 to a half size value of 1.0. So, this table illustrates very clearly that there are different level of contaminants happening at

different ecological zone spread from southern zone to the coastal zones. Ladies and gentlemen, these are the zones where marine organisms basically essentially shift in a majority of their population. So, in this zone we have level of contaminants relatively very high compared to other zones which is quite alarming.

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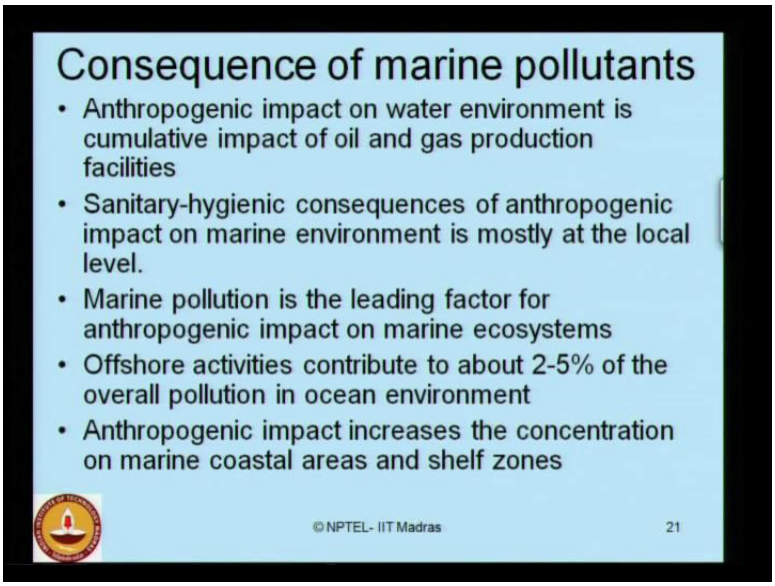

If you look at the consequences of marine pollutants in general, the anthropogenic impact on water environment is cumulative impact of oil and gas production facilities. The sanitary-hygienic consequence of anthropogenic impact on marine environment is mostly at the local level, but it extends to the regional and global level as well in rare cases. Marine pollution is one of the leading factors for anthropogenic impact on marine ecosystems. Offshore activities contribute to about 5 percent of the overall pollution in ocean environment. Anthropogenic impact increases the concentration of marine coastal areas and shelf zones; this is the area where the marine aquaculture is of a majority of their population and so on. In the next lecture we will look at the impact of oil gas industry on the marine pollution.

Thank you.