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NPTEL ONLINE COURSE

Ecology and Environment

Risk Assessment and LCA: Lecture 5

Remediation and Liability

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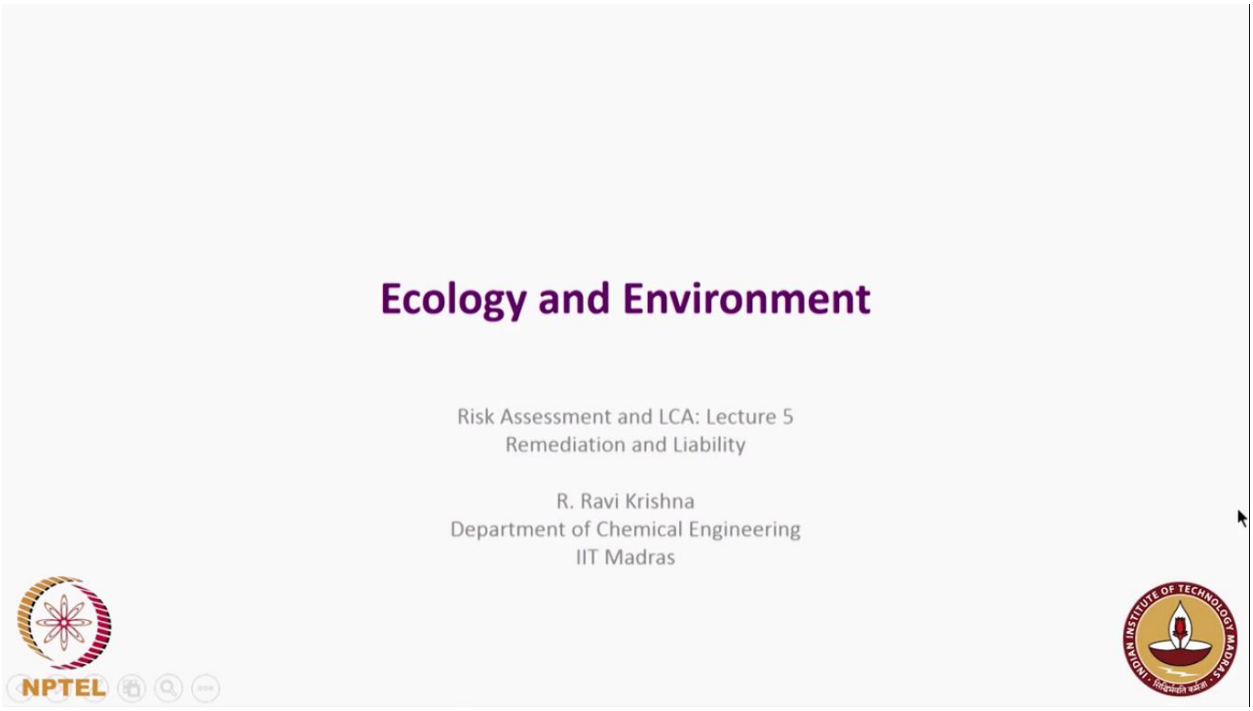
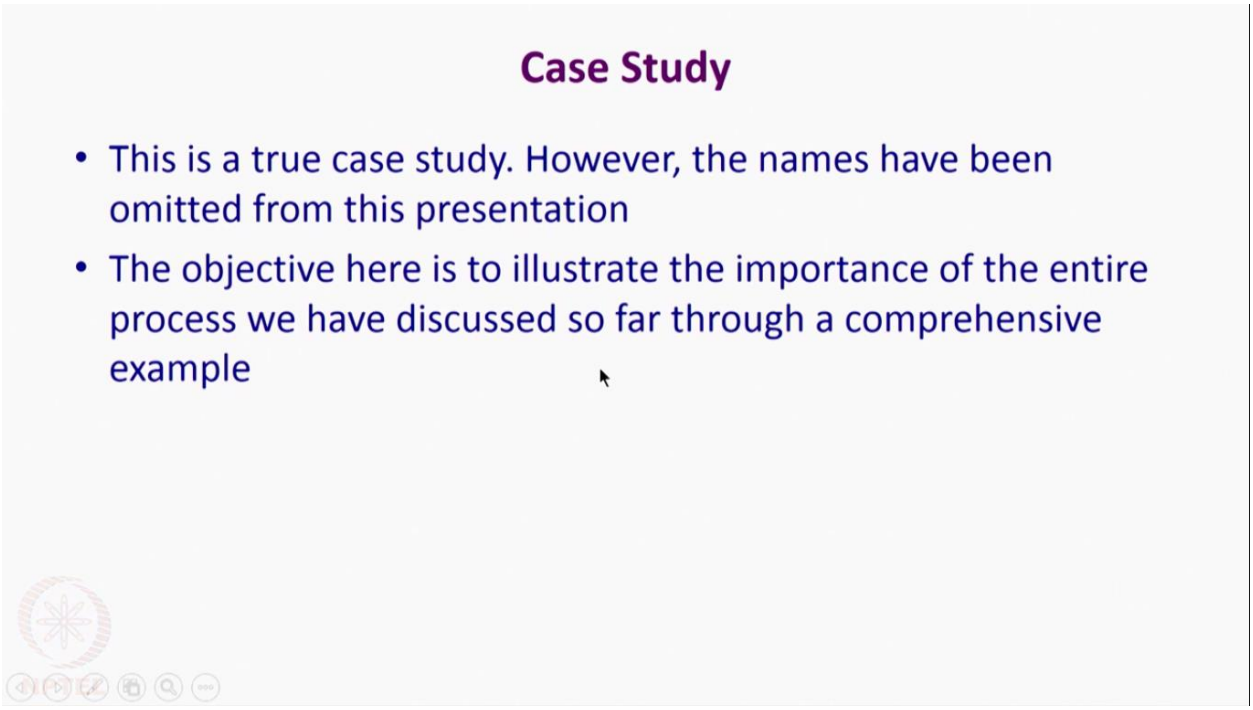
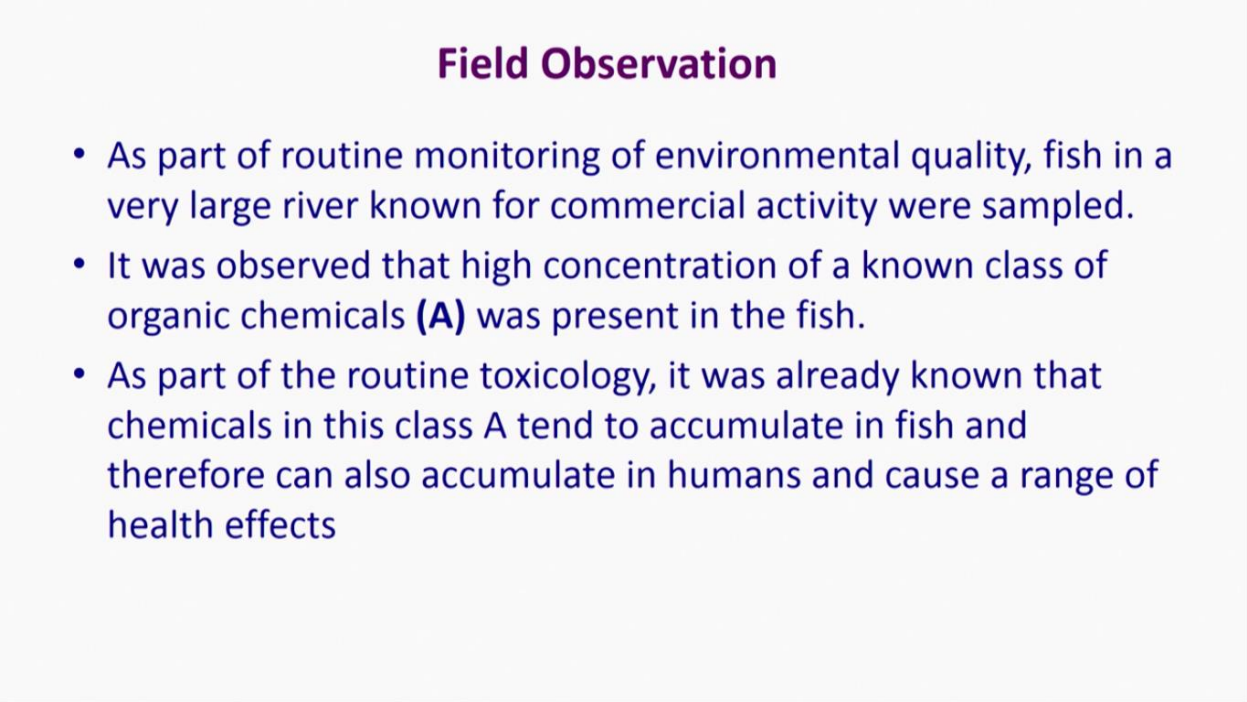


Hello. Welcome to lecture five in the series of lectures for risk assessment and lifecycle analysis as part of ecology and environment course. In this lecture, we are looking at a case study for remediation. We will try to cover all the aspects that we have discussed in this series of lectures.

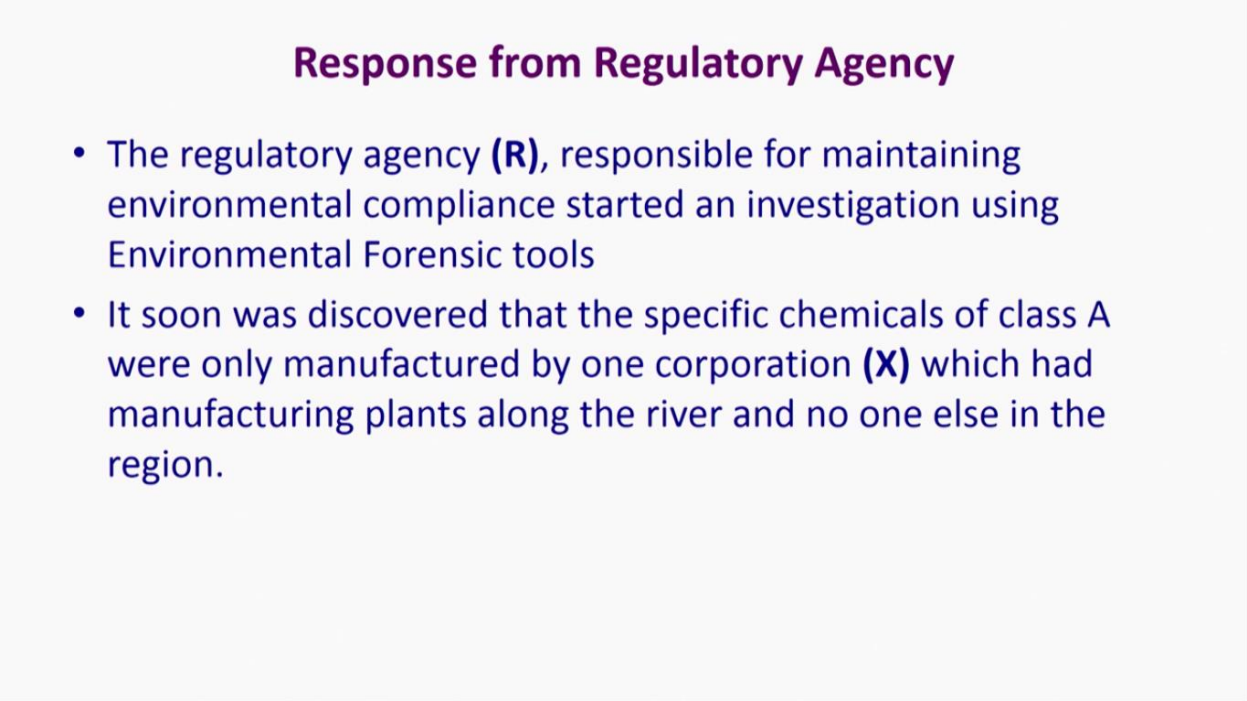


This is based on a true case study. However, the names have been omitted. The names of the corporation, the chemical and the agencies have been omitted but it is based on true data that is available, and the objective here is to illustrate the importance of the entire process that we have discussed so far through this very comprehensive example and there are a large number of examples of this nature but this is one example that covers the a very wide spectrum of whatever we have discussed in the class and it can be quite illustrative.



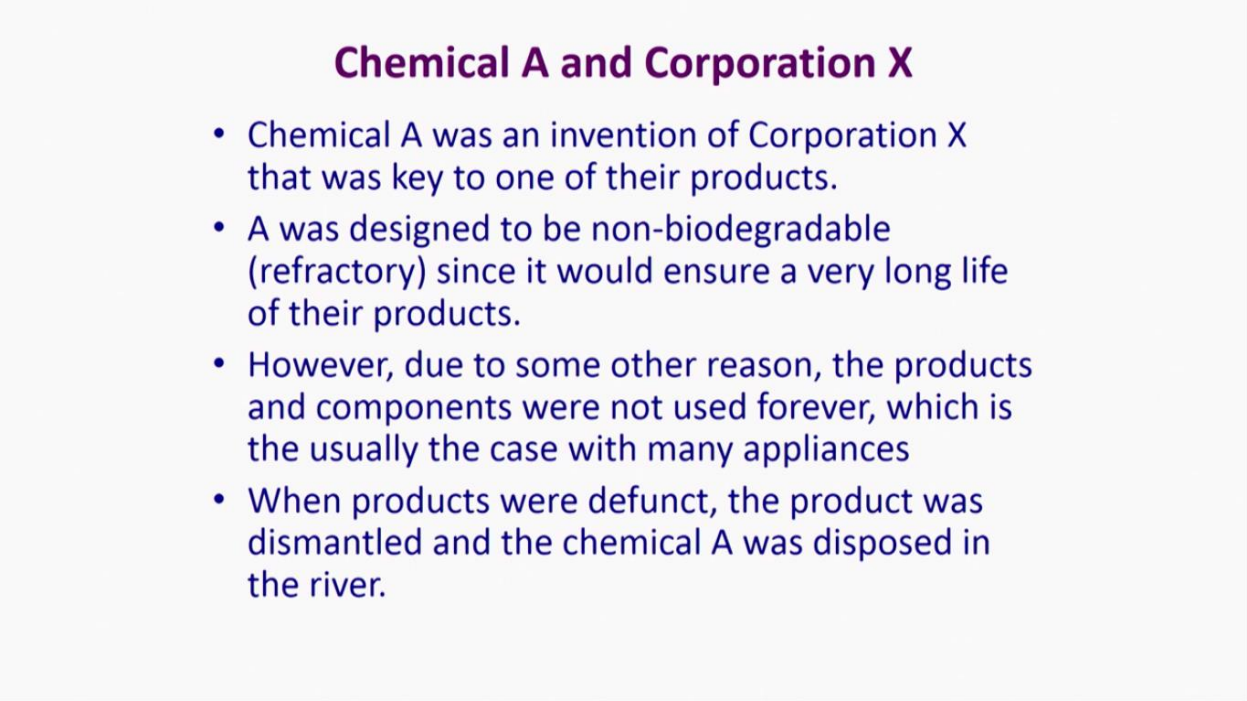
So, it is a story that begins with a field observation and as part of routine monitoring of environmental quality of a river. Fish in this particular river, this river is a very well-known river and for commercial activity. The fish were sampled routinely and found that a very high concentration of a known class of organic chemicals was present in the fish and this high concentration that was present in the fish this chemical A is part of routine toxicology. It was already known that the chemicals of this class tend to accumulate in the fish and therefore can also accumulate in human beings and causing a range of health effects. So, chemical A was already known to have, as part of the process of toxicology. It was well known all properties of A were known, and it was found that this was present in concentrations that were unacceptable for quality.

So, as part of a routine activity of monitoring so this stresses the importance of routine monitoring of natural. In the presence of anthropogenic sources, it is always possible that a particular chemical can enter the environment. So, this is an illustration of why routine monitoring is important. Monitoring and sensing of pollutants is important. So, there was a response from a regulatory agency.



So, regulatory agencies are – a regulatory agency is like the Central Pollution Control Board in India or any environmental protection agency in any other country. All countries have one, and they are responsible for maintaining environmental quality, and this regulatory agency let us call it as R responsible for maintaining environmental compliance started an investigation using environmental forensic tools.

So, environmental forensic tools are things like what we have already discussed in this class and so if a chemical is found downstream in a river the source must be upstream somewhere. And also, you have signatures, you have a particular – in this particular case the chemical A is what is responsible, and you soon discovered that specific class of chemicals was only manufactured by one corporation X which had manufacturing branch along the river, and nobody else in the region. And therefore, it was very easy.

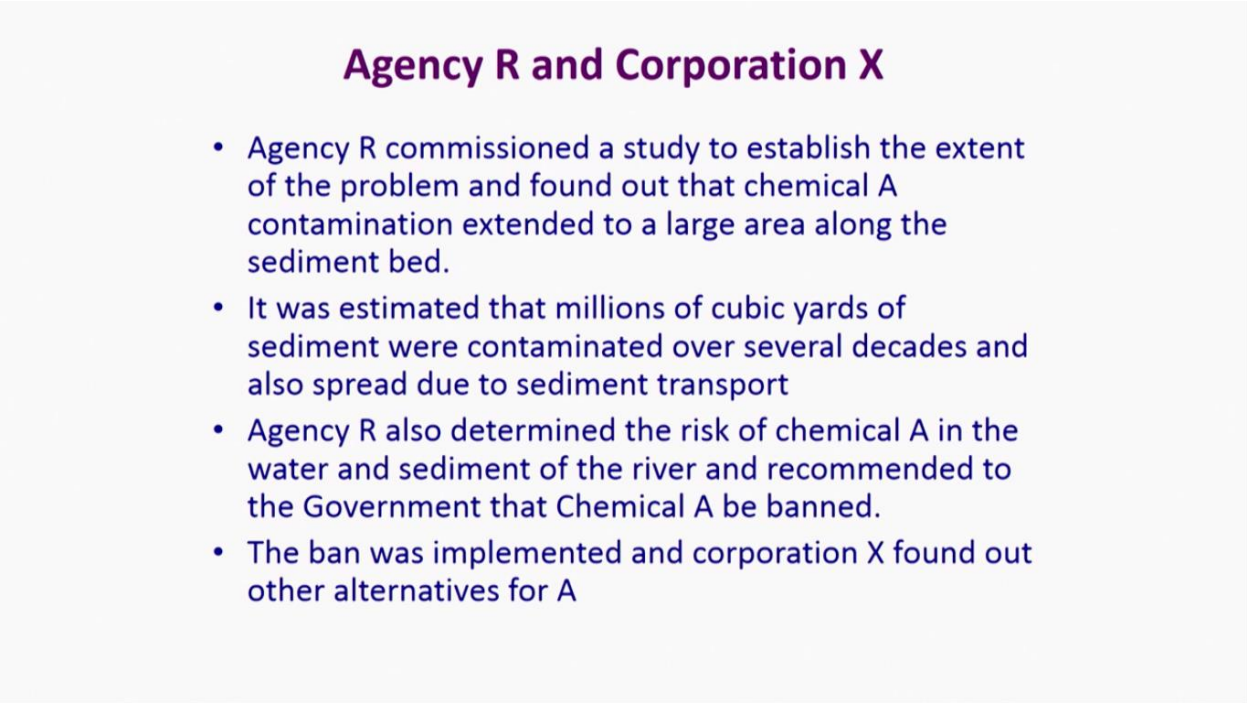


So, we go to a little bit of this thing on this chemical A was an invention of corporation X. So, it is not a– there are a very wide class of chemicals, organic chemicals. So, some of them are found in nature, and those manipulated slightly in order to give specific properties for a specific application. This was the same, but it was an invention based on other known compounds and a very large number of chemicals like this are invented by chemists all around the world and properties of these chemicals are measured for various applications. And people also measure environmental properties, properties of environmental relevance of fate and transport and toxicology and all that. So, it was a key invention of their products. This chemical A was invented by corporation X because it served a very specific purpose in one of their products and one of their key products. And the idea was it was designed to be non-biodegradable since it would ensure a very long life of their products and it had specific properties, but in the process of doing so, it also was very difficult to degrade; biodegrade. When we say non-biodegradable, it is not non-biodegradable, it has very small low biodegradability, and it would ensure a very long life of the product. So, this is often the case and this is the case with say something like plastics for example. Plastics are very good -- they have very good applications in our daily life, but we also know that there is a lot of plastic which are not biodegradable and it just stays in the environment. And there every day we see some case or the other of a problem that is arisen because of the plastics and their durability in the environment, and they do not go and volume of plastic itself the management of that is a sheer big problem.

So anyway coming back to this problem. This product, however, no product is used indefinitely and we know that from our experience that we have telephones, or we have mobile phones or television sets. They have hundreds of components made of different materials, and they do not last forever. They have a finite lifetime because something or the other -- some other component breaks down and you cannot use it anymore. And so, this is the same thing happened, and these components were not used forever and then when the products were defunct, the products were

dismantled, and the chemical A was disposed in the river. So, this is the – this, of course, there is no proof that the chemical was disposed in the river, but because it was found in the river, then the assumption is that it was disposed in the river or it somehow ended up in the river. So, this is the usual assumption, and sometimes it may just be that people just might have thrown the used product into the river and all that.

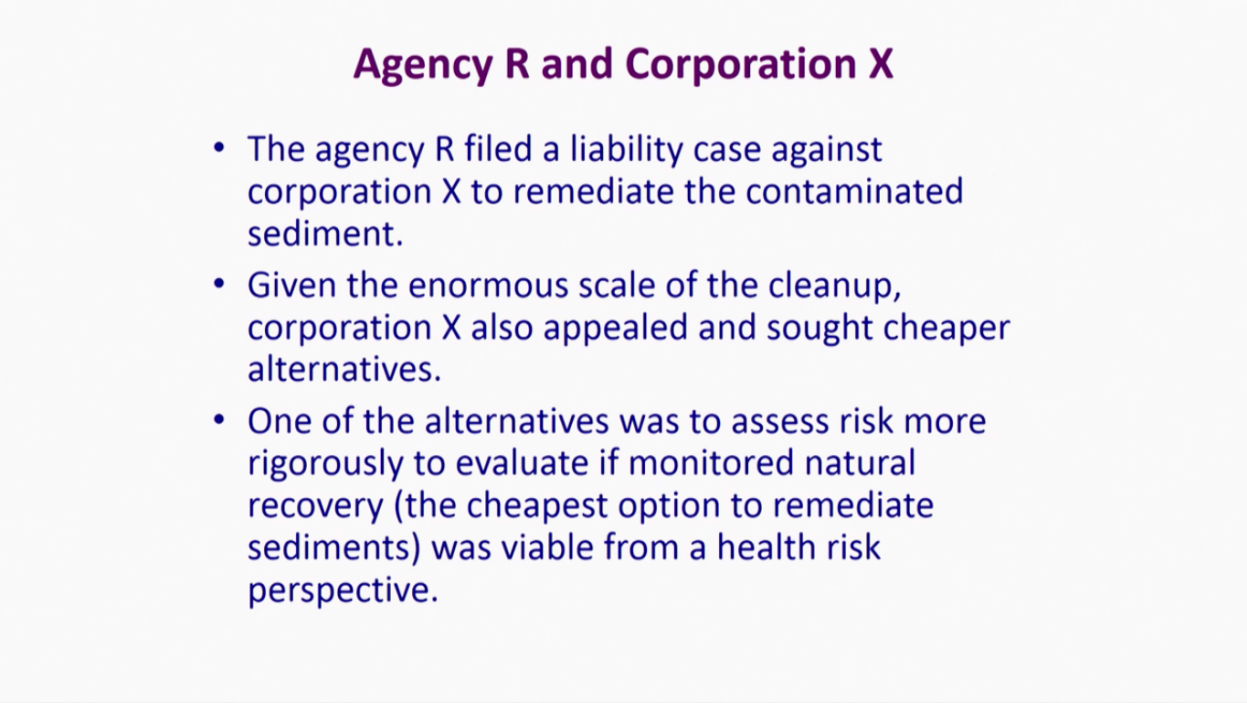
So, there is a lot of speculation about that, but since it has happened over a long period of time, there is really no case to that.



So, then the agency R commissioned a study to establish the extent of the problem and found out that chemical A contaminated a very large area along sediment bed in the river. So, this extends to a long region downstream of the factories manufacturing facilities of corporation X along the river and then as we discussed earlier you have sediment contamination, sediment transport occurs, and this can result in the spreading of the contamination from its original location and extends the problem. And it was estimated that millions of cubic yards of sediment were contaminated. Measurement of this extent of contamination itself is a very challenging task and it is not easy, it is expensive, and one has to make use of very smart tools in order to optimize or reduce the cost of doing it and economics is invariably linked to any of these kinds of issues. So, you see all these at play here in this, and it takes a long time to do it, and once they discovered that this was so widespread. And they also determined the risk of the chemical A in the water, so it is so much of chemical in the water, millions of cubic yards of sediment, and then they estimated the amount of material that is present and given that the estimate that the risk is is quite significant and therefore recommended to the government that the chemical A be banned. So, which means that in the hope that banning this chemical would then further you know will prevent the aggravation of the problem any further and taking the advice of the regulatory

agency the government banned this chemical and so this chemical anyway was made by only one company so banned and then they found other alternatives. As is the case usually.

So, the other point that is being made here is that there are alternatives as was the case with CFCs, chlorofluorocarbons which might not be as convenient as this one but there are alternatives and this is always the challenge and the opportunity that is presented to scientists and engineers to do the other alternative which can lead to a lesser risk.

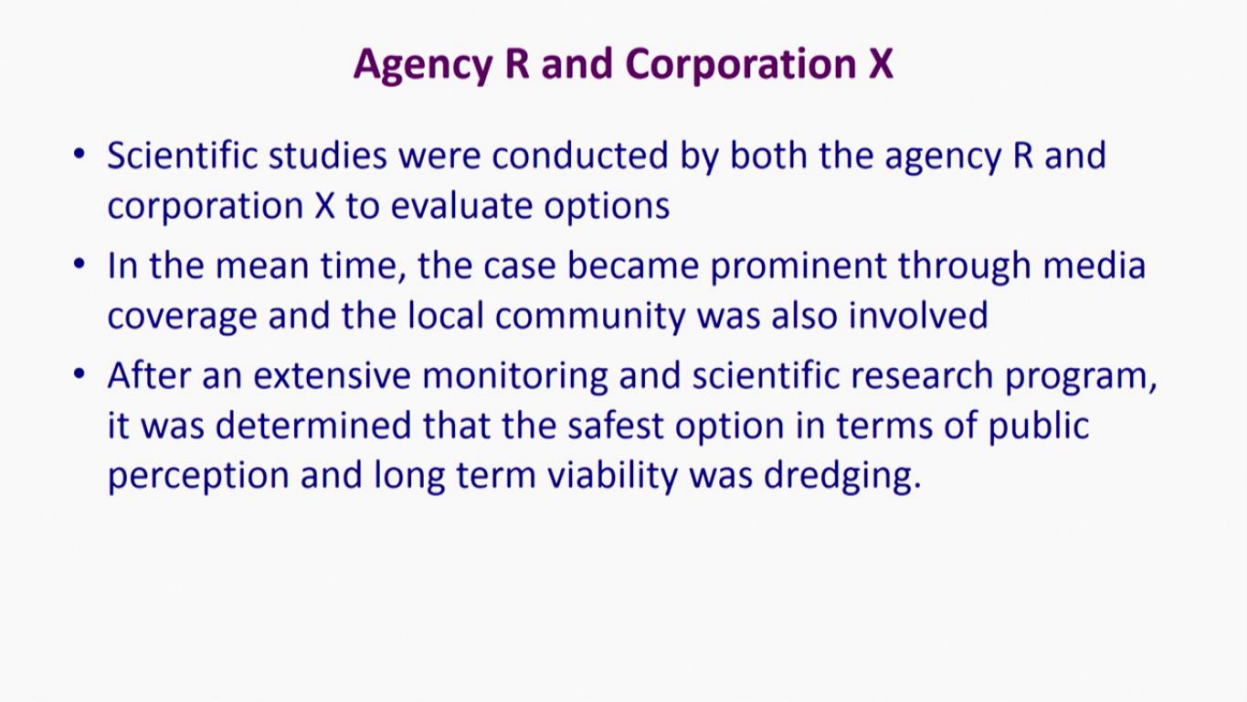


So, continuing on this, the agency R filed a liability case against a corporation X. So, it is a case of remediation of the contaminated sediment and therefore, as we as we thought we know who is most likely the polluter, the arguments can be made against it, but it was very clear in this case since A was produced only by X no other corporation had the rights to it. So, it was very clear case. Sometimes in some cases, it is not so clear, and so one has to really use the environmental forensic tools very smartly in order to arrive at a very unequivocal decision whether the particular chemical is coming from a particular source or not. So otherwise, it can always be argued that somebody else is doing the pollution.

So, this is often the case when you have air pollution, where you clearly do not have a very specific direction to wind, sometimes it changes, and therefore it is very difficult, but it is not impossible. And people have found tools, mathematical, statistical tools and even physical tools in order to and chemical tools by which you can pinpoint a signature of a pollutant coming from a particular source, and this is done routinely.

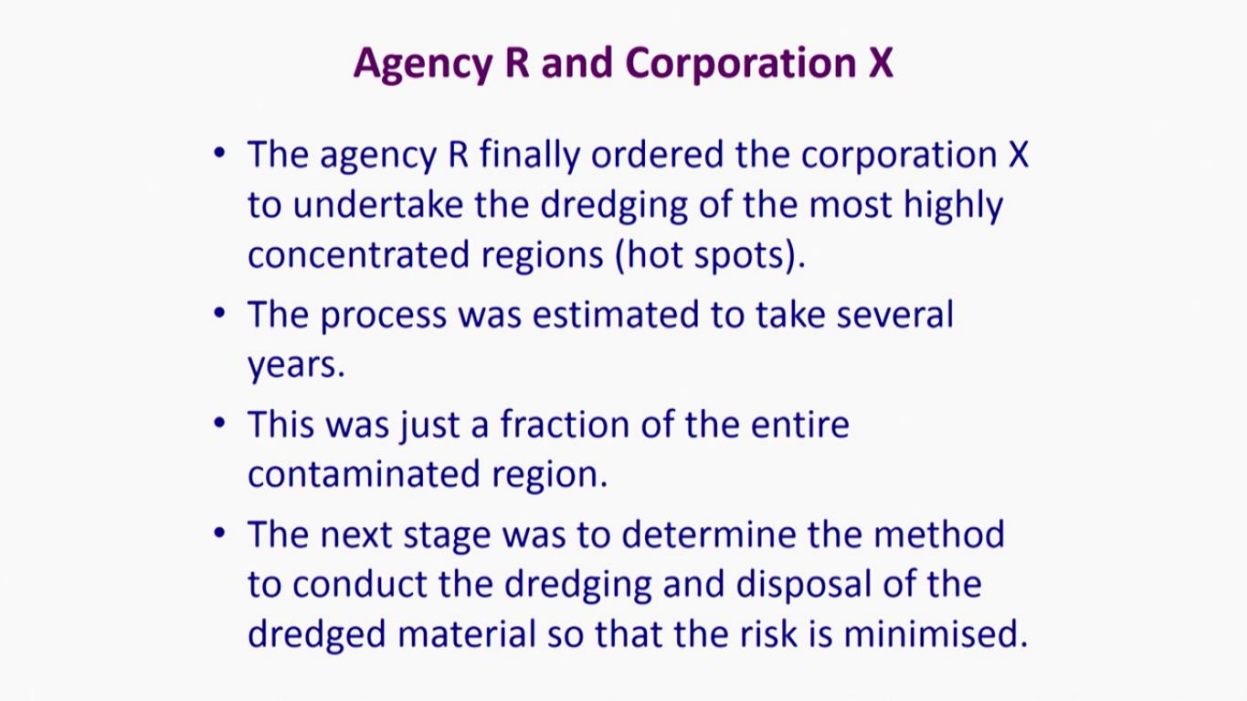
Given the enormous scale of the cleanup, corporation X also appealed and sort cheaper alternatives, and this is natural, and this again is in line with the sustainability issue that such a large task of cleanup should not break the company. So, the company sought to find out other

alternatives for various reasons, but it is a very large, it was a very prestigious company it had its own group of scientists who are very capable of finding alternatives as they had demonstrated in previous cases of research in their corporation. And one of the alternatives was to assess risk more rigorously to evaluate if monitored natural recovery would work which is the cheapest option as we saw in our previous lecture. It was viable from a health risk perspective and they found some evidence that it could be but then again as the case would be.



A lot of scientific studies were conducted by both the agency and the corporation to evaluate options, and they were done in good spirit. I think they were done in with the goal of solving a community problem.

In the meantime, the case became very prominent through media and local community was also involved. And public meetings were held in order to decide to provide the options by from both sides; from the regulatory agency as well as the corporation. And after more extensive monitoring and research scientific programs it was determined that the safest, in the long-term viability of safety, the safest option was decided, determined to be dredging and we saw that dredging is not clear from any effects.

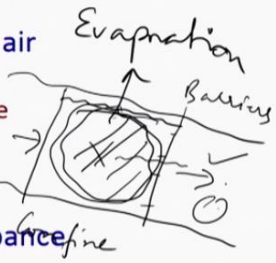


Therefore, there was some concern about it and therefore but -- so the agency ordered dredging of some very highly concentrated regions called as hot spots and the process was estimated to take several years just to do this hot spot. It was a fraction of the entire contaminated region, but it was still assumed that these hot spots would reduce the problem largely. So as the first step, they had mapped the entire region and said they had identified certain places where they would remove it, and therefore hope that it would reduce the problem a little bit. And therefore you know, not do it with a brute force method of trying to dredge the entire thing and then it may not be economically viable. So, this was one of the decisions that was made by a mutual agreement.

So, the next stage was to determine the method to conduct dredging and disposal of dredging material. So, as we saw in our previous case, there was you know just by saying dredging it is not enough and one has to figure out that the dredging process and the disposal itself can release the chemical into the air and so on and so people were worried about that. So along with it, there is also this thing that there might be other chemicals along with it. This is one of the complex complexities of this issue of liability because when you are focusing on one particular chemical, there could also be other chemicals while you are doing the dredging which may cause more problems, secondary of a secondary nature than the chemical A that you are initially worried about.

Concerns during Remediation

- Since it was a river, dredging was expected to cause resuspension
- Resuspension would result in increased pollution in the water
- Increased pollution in water can also lead to potential air pollution
  - This was addressed by providing silt curtains to confine the dredging related resuspension to a small region.
  - This minimised the extent of water pollution, but slightly increased the air pollution risk
- The dredging also was expected to cause some disturbance to the ecology of the system

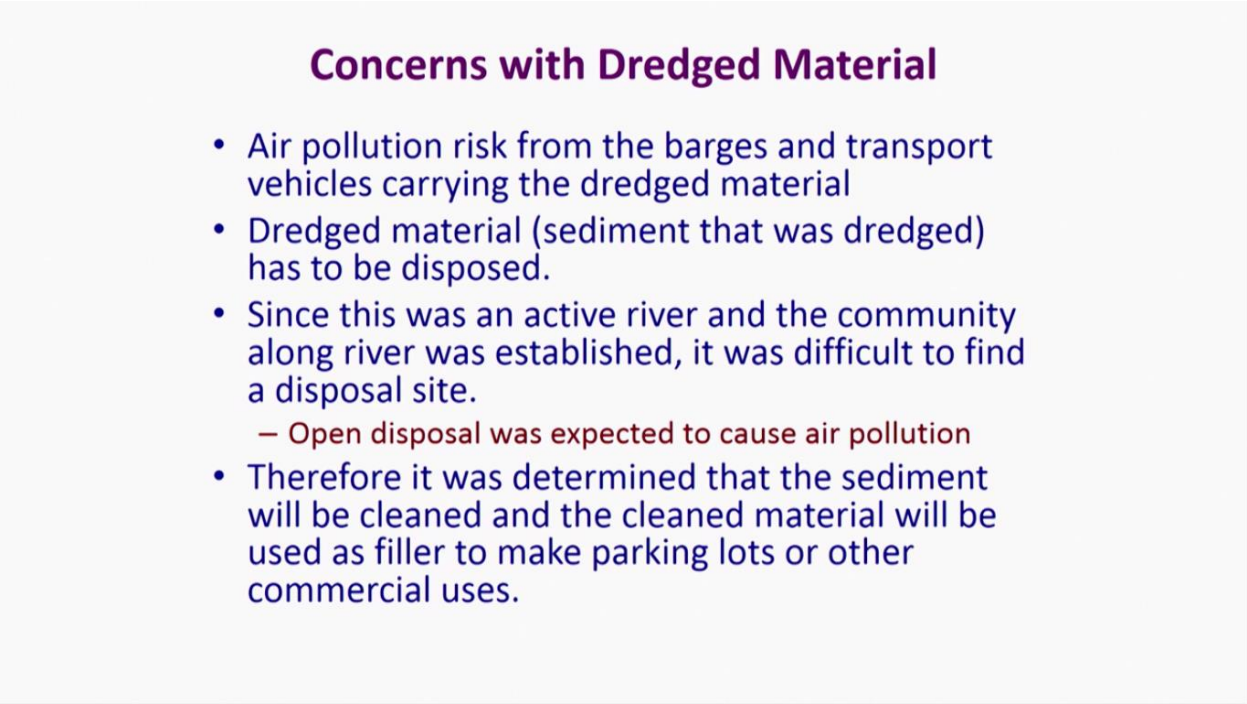


So, concerns during remediation, since it was a river dredging was expected to cause resuspension and resuspension would result in increased pollution of the water and increased pollution of water can lead to potential air pollution and so on. So this was addressed by providing silt curtains. So, what they would do is, let me just illustrate it here by drawing on the side of this thing here, that there is a river, and the river is flowing here, this is the surface of the river and if dredging is done in this portion and river is flowing in this direction. So, in order to prevent this mass to move here, they would put barriers both in this side and this side, these were barriers as we will call it, silt curtain they are called silt curtains. They are curtains literally with very small openings, very small openings to allow the water to flow through. So essentially this entire region would become very highly contaminated but the rest of the region this will be relatively clean. So, this region here downstream will be relatively clean, and only this region will be contaminated.

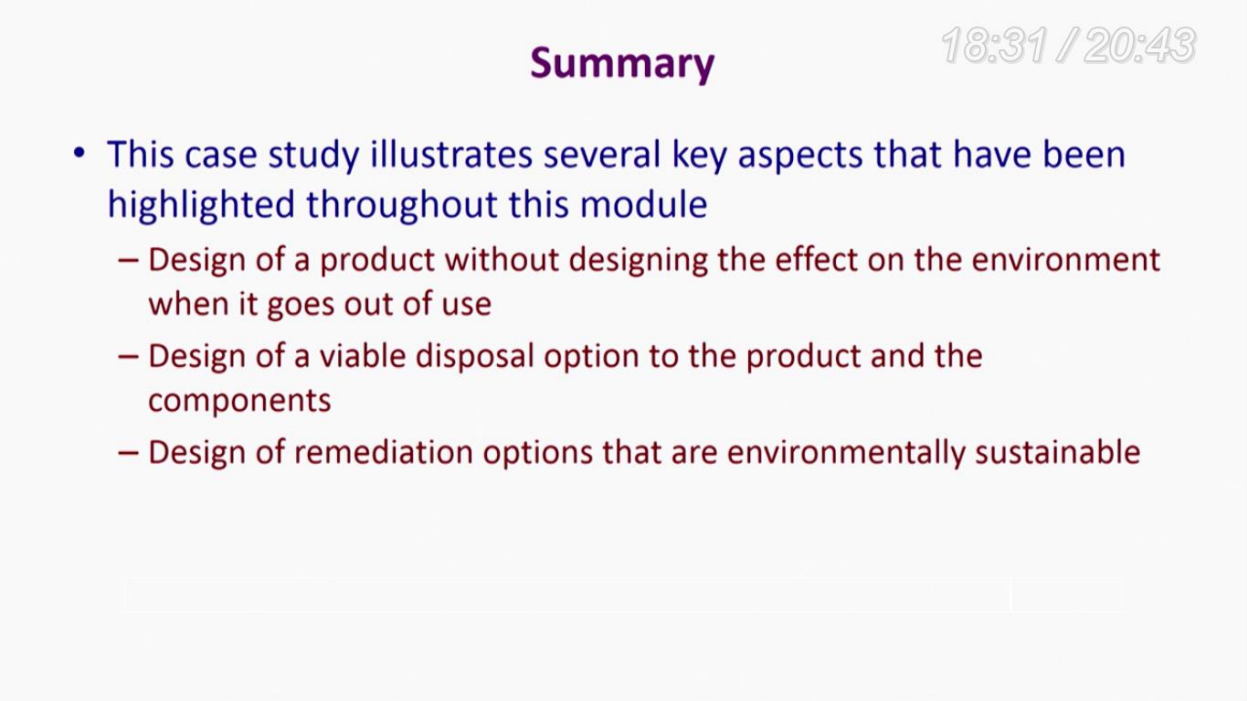
So, what it ends up doing is confined, this will confine the contamination to a relatively small region during this. So, they will dredge this one area then they will move to the next area and so on. The problem, however, is that the concentration of chemical becomes so high here that it can result in a very high evaporation. It can result in very high evaporation from this particular site. So, therefore, this causes some amount of air pollution risk, but it is better than providing this thing. So, the other you have to look for other methods in which maybe you can put a barrier here and all that, but it is inevitable. So, this kind of problems do occur and that was something that one could not work at. Dredging was also expected to cause some disturbance to the ecology of the system and what we mean by that is there is obviously in the marine environment sediment there are other plants and animals that live and this is an enormous disturbance. So, bringing a large mechanical excavator which is inside a river which means that you have to get into the river and I encourage you to go and look at images of dredging equipment. They are very large. They are big. You could see it in many places where people do land reclamation.

They go in and dredge the bottom, and they put it somewhere else. So, it is a very heavy-duty operation. It is not a simple thing. It causes enormous disturbance to the entire region, and that is one, and the second it was also – there is quite a bit of noise from the mechanical this thing. So, people were, care was taken to keep noise below acceptable levels, and there was a decibel range in which they had to do all this. So, so you can see that this is a linkage of several other chain of events that needs to happen. So, there must be equipment that will reduce the amount of resuspension that will occur. So mechanical dredging devices that were used were such that it would minimize the amount of resuspension and resuspension was further minimized by silt curtains and so on.

So, there is a long chain of other technological improvements that need to be done in order to do this.

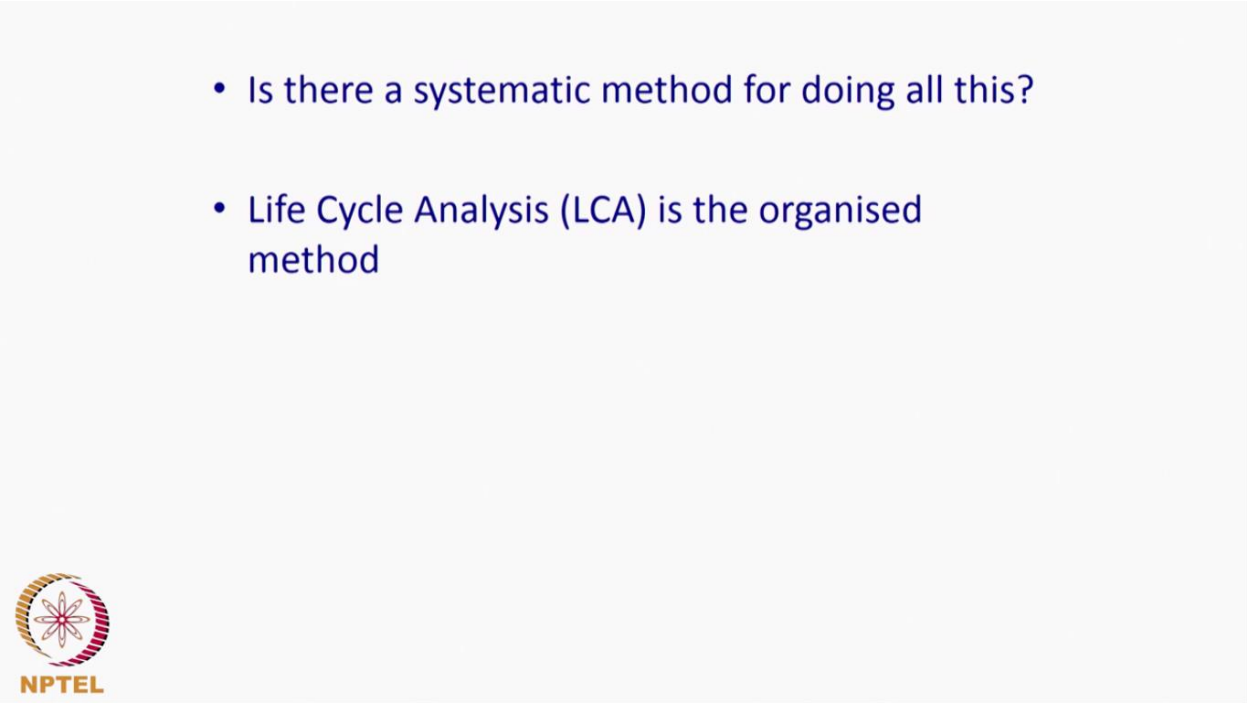


So, with the dredge material as we had discussed earlier air pollution risk from the barges and transport vehicles carrying the dredge material as material has to be transported somewhere else. So, and it has to be disposed and as we discussed earlier not in my backyard principle applies here. So since it was an active river, which means that there are a lot of activity going on along the river. There was a lot of residential areas, towns, and cities that were along this river. It was very difficult to establish a disposal site and so what they eventually did is found a site where open disposal was not possible, but it was determined that the sediment would be cleaned and the clean material would be used as a commercial filler for parking lots or other, other uses. And the solvent, the waste material that is extracted would be disposed of in the ways that we had discussed earlier with any other like a wastewater or a waste solvent treatment either by incineration or some other method.



So, this case study illustrates several key aspects that have been highlighted throughout this module. One of the first main things is that design of a product without designing the effect on the environment when it goes out of use this what is called as end of life. Well, end of life is a term that is used in product management where we see several examples of that we have end of life of mobile phones. We do not know where it goes. We say we recycle it, but we do not know exactly where it go. So its effect on the environment whether it is incinerated or whether it is dumped in a landfill is something that needs to be taken care of because in certain countries where land is available, you know very large amount of lands available you can dispose it somewhere, and it may not affect you much. But in countries where population density is very high such as in India or in countries like Japan where you cannot find land. Land is very high premium. It is imperative that we find other options. And one of the biggest option is to design it at the source, that if you anticipate that a product is going to be of a certain problem you do not know – you do not have a road-map of how you are going to deal with it at the end of its life, then I think it is, you will run into problems as in this case because the focus was more on one particular aspect of the product and a commercial and utilitarian aspect of it.

So, as with this, this philosophy of this course is to sensitize engineers in order to think about at the end of life aspects of any process or product, and we see lots of cases as you can look around. I encourage you to go and look at the aspect of any product that you use and see what happens to it when you when you do not use it when you throw it away where does it go and so you can try to trace its lifecycle. And the design of a viable option, disposal disposal option must be presented when it is formed. So, it is the responsibility of whoever is doing the process in order to do this and design of remediation options that are environmentally sustainable.



So, is there a systematic method for doing all of this and this is the method called lifecycle analysis or LCA which is the organized method for doing this. And in the next lecture, we will discuss some of the formal aspects of and some examples of what lifecycle analysis means.

Thank you.