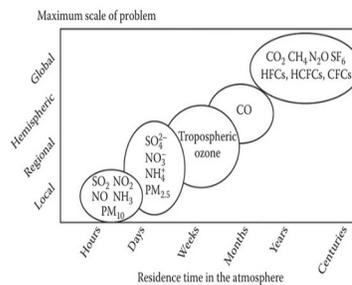


Strategies for Sustainable Design
Professor Doctor Shivaji Ji
Indian Institute of Technology, Hyderabad
Lecture- 16 & 17
Designing Strategically for Preventing Pollution:
Air, Water, Soil, Noise, Light, Radiation etc.

Hello everyone, so, in this lecture we will discuss about designing strategically for preventing pollution such as air, water, noise, light, radiation et cetera.

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Selected pollutants, their average residence times in the atmosphere, and maximum extent of their impact. (After UNEP, 2007. Global Environment Outlook: Environment for Development (GEO-4). United Nations Environment Programme. http://www.unep.org/geo/geo4/report/GEO-4_Report_Full_en.pdf)



Week 4: Impact of Pollutions and Design Processes with Alternative Solutions for Health of Ecosystem
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So, if you see, the kind of selected pollutants over here they are given on this actually slide. So, the maximum scale of problem which is being caused by these pollutants, so we will see the scale of it, on the timescale, on the local tube global scale, how they are impacting? So, how soon they can actually start actually having some impact, on the given location or how long, or till how long they can actually exert, keep exerting during impact and the effect in the long term.

So, if you see here in this first bubble, so, this is SO₂, NO₂, NO, NH₃ and PM₁₀ etcetera. So, these actually compounds, they can immediately actually start affecting within the matter of hours, till days and they immediately start exerting their impact in the on the local actually place. So, if you see these, their average residents actually time in the atmosphere, for how long they actually can stay in that particular place or the atmosphere.

And the other maximum extent of their impact, until how long they can actually last. So, this is what actually being discussed. So, as we saw, SO₂, NO₂ so, these compounds actually from hour till days, they can affect at the local level. And further to this if you see these compound, SO₄, NO₃, NH₄, PM_{2.5}, so, these are the actually compounds, which can actually affect, any local tool regional, the level from days till weeks.

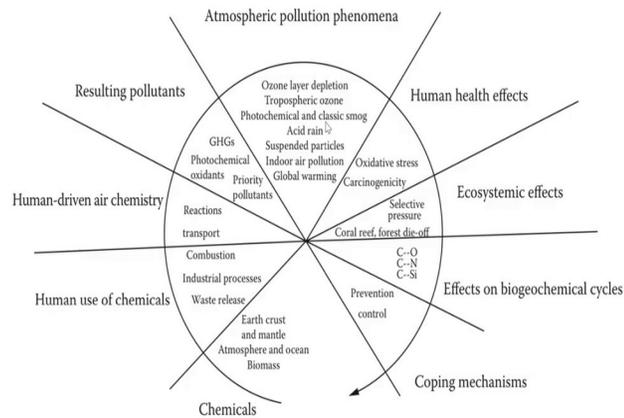
So, if they are any kind of excreted in any place or any atmosphere, they are going to be there for several weeks, they could be there and they can spread to, up to region of region. So, region can extend from in the hundreds of kilometers. So, this is how they can actually, actually create their impact. If you see next to it tropospheric ozone and all, so these can have, their impacts from, ranging from weeks till several months and they can go up to an extent of hemisphere, or level or they can go up to an extent of, maybe half several countries they can catch they can, hover over maybe a continent or two.

So, this is the extent at which they can cause their damages. Even the same is this for CO also, this can have its impacts from ranging from months till several years and this can also spread over several continents, it can cover a major actually portion of the globe. And if you see other compounds CO₂, CH₄, NO₂, SF₆, HFCs and HCFCs and also CFCs etcetera, well we are all aware of the, the causes which these actually these compounds actually do.

So, the kind of harms what they do, so acid rains, the kind of global warming, all of these greenhouse effects etcetera, they are all caused by most of these actually compounds, even the depletion of ozone is because of the CFCs. So, such actually compounds can last in that atmosphere for several centuries and they can actually affect the world at its global scale that that they can affect actually, this entire planet if you see.

So, this is the extent at which these compounds can have their impact. So, we must actually take care of these compounds, to minimize actually the impact on our life on the on this planet. So, this I wanted to actually bring it to your notice at the beginning of this lecture, because these are the some compounds and chemicals which are very very crucial which are very, very critical for actually maintaining the balance on our biosphere.

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So, let us see these how this phenomena actually this whole atmospheric pollution phenomena all of this phenomenon of several kinds of this pollution, so what are the effects and causes, so, we will discuss one by one. So, this if you see this the atmospheric pollution, pollution phenomena, it causes obviously we are all aware of these ozone layer depletion.

So, it works for depleting, actually the ozone which is the safe guarding actually these protective, protective layer in the top of our atmosphere in the higher altitude, which covers the entire globe. It saves us from the ultraviolet radiation from the of space, from the sun and it creates a habitable actually atmosphere on the lower side of our planet on the, on the surface of this planet. And there is photochemical and the classics smog actually related problems, which create actually the sky gets filled with the smoky shooting material.

There are suspended particles in the air, it created creates actually problem for the, the oncoming of the fresh, fresh air and the ventilation and even the light it creates problem for actually aviation industry, so, such kind of effects are there. Then it causes acid drain. So, several actually parts of the world, several parts of the different countries they have experienced it several, several times these acid rain.

So, acid rains are actually because of these chemical compounds which gets accumulated in the sky, they interact with the clouds. And they come along with the rainwater to the ground surface

and while they, they come down at the ground surface, they obviously cause several types of damages to the crop to the agriculture to the animals, microbial life, to the even humans.

So, they actually cause several kind of situations they cause sometimes skin diseases also, a for one receives such water on their bodies. And the suspended particles, well the the fumes generated from the manufacturing units in factories, even though the fumes generated from, other machines, heavy equipment, they get actually very fine dust in the form of fine dust it gets suspended in the air and it creates actually problem.

And then of course, there is the next one is the indoor air pollutions, since there are several actually appliances and equipment, which we are using these days very frequently, so these units are actually responsible for creating pollution in inside the educational spaces inside the buildings. So, there is a need actually for checking these indoor air quality also for actually maintaining its balance.

And on overall sense this atmospheric actually pollution phenomena it causes actually global warming, we are all aware of there is accumulation of GHG gases in the atmosphere and in overall terms the Earth's average temperature is slightly increasing, every few years. And what are the human health effects observed through this oxidative stresses are becoming actually normal.

Carcinogenicity is becoming actually normal because these compounds are highly toxic in nature. And they exert actually such reactive thing on the human skin on the human bodies that it can develop into, a cancerous growth also in the body. And if you see that there are ecosystemic effects, they create actually selective press, they create actually a damages to the coral reefs, they occur they actually cause damage to the forest, it causes several forest run of, huge swaths of green vegetation areas to actually simply die off these situations.

So, there are actually several kinds of efforts what we can see over here from normal human being to the, the life of animal world if we see or the even the vegetation world if you see there is so much of effect happening. And when we see the effects of the, on biochemical lifecycle, so, in the COs, CNs and the CSI is carbon, silicone compounds, carbon nitrogen compounds carbon oxygen compounds.

So, these actually there are several ranges, several series of compounds, which cause actually reactions of biochemical cycles and they actually disturb actually biochemical cycles in the organisms. And if you see here in the coping mechanisms, so, they help in well, there are actually we need to evolve coping mechanisms, where one can actually have some preventing actually measures taken for the actually design of our gadgets and utensils and built environment.

So, resulting pollutants if you see GHG's photochemical oxidants, there are some priority pollutants also which create actually pollutions. And then the human driven air chemistry, if you see reactions and transport, if you see some effluents which are coming out of certain industries, they actually create problems in these areas specifically.

Human use of chemicals if you see here combustion based actually exhaust, industrial process based exhaust, the waste releases to the compound in form of, in the gases to the air, in form of effluent in the water, in form of other solid waste and fluids in the, soil. So, in an overall sense they create problem in these. And in the chemicals if you see earth crust and mantle atmosphere in ocean biomass, so, the overall actually there are, are impact.

So, it starts from here there are these are some chemicals then the use of, how we are using these chemicals, then how the human soul ties society is driving actually these chemicals, then the, the how they are turning into, to pollutants and how this whole pollution is causing these many problems what we just discussed ozone layer depletion, the acid rain and global warming etcetera.

And how the human health is affected, how the ecosystems balance is actually getting a hit, and how it is affecting the overall biochemical cycles of the, of living organisms. So, this is the kind of chain reaction you can see over, it starts from here and goes on till, indefinitely. So, it has actually reverberating and long lasting actually effects on the ecosystem and the well being of living species.

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The logical sequence of atmospheric pollution investigation. This sequence moves away from ex-post facto monitoring to ex-ante atmospheric modeling, experimenting, and trialing (similar to ex-ante toxicity modeling already initiated in green chemistry). Humans use chemicals from the Earth. The resulting pollutants combine into pollution manifestations, which affect humans first as these are closer to the emission points, and subsequently alter survival and competition in the ecosystems. Eventually, several biogeochemical cycles are altered, calling for a combined view on biogeochemical cycles instead of the usual separate approach to them (Schwedt 2001). As this cycle suggests, the further the effects are left to develop, the deeper and more pervasive they become and the harder to tackle: prevention and control become insufficient when pollutants have accumulated beyond the capacity of natural sinks to remediate pollution.



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So, if you see, as, as we saw in the previous slide, so there is actually a sequence of actually how these chemicals, how these compounds actually are traveling actually in this biosphere. So, how they are making their actually way into the different domains where they have not been earlier, so, from one place to another and from next, from that place to the next one, this is how actually they are traveling and they are creating actually effects of certain, several actually kinds, whether it is, whether it is biological, chemical or even atomic.

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Risk Assessment Process

Step	Description	Content
Hazard identification	Identifies the type and nature of adverse health effects	Human studies Animal-based toxicology studies <i>In vitro</i> toxicology studies Structure-activity studies
Hazard characterization	Qualitative or quantitative description of inherent properties of an agent having the potential to cause adverse health effects	Selection of critical data set Modes/mechanisms of action Kinetic variability Dynamic variability Dose-response for critical effect
Exposure assessment	Evaluation of concentration or amount of a particular agent that reaches a target population	Magnitude Frequency Duration Route Extent
Risk characterization	Advice for decision making	Probability of occurrence Severity Given population Attendant uncertainties

Source: World Health Organization (WHO) (2010b), WHO human health risk assessment toolkit: Chemical hazards, IPCS harmonization project document No. 8, Geneva: WHO.



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So, some how to go for risk assessment actually processes. So, we will see the stepwise for the hazard identification. So, it identifies the type and nature of adverse health effects on the human beings and it actually studies our for the human studies it studies animal based actually, toxicological studies, it takes in vitro toxicology studies, structure activity studies to grow by conducting these many several types of studies, we can understand what kind of hazards or, you can be associated with such chemicals and such compounds.

This data is actually released by World Health Organization in the year of 2010. So, and how to characterize the, this hazards. So, qualitative and quantitative are descriptive analysis can be conducted and based on several such analytical methods, we can actually characterize the hazard limits of those actually compounds and chemicals.

How we can do this exposure assessment, so evaluation of concentration or amount of particular agent, that reaches the target population. So, we can assess the magnitude of it, we can assess the frequency of it, we can assess the how long, how, was the duration of this, we can, we can assess the root of it, how well in, which way and or through which actually circuit it is the, following the actually its route, and up to what extent it is causing the damage.

And now, we can go further risk characterization, advice for decision making. So, these actually, this can help into taking decision as far as policymaking and things are concerned. So, that we can create actually cohesive, actually place of sustainable growth and development model. So, it is the simple example you can understand, the chemical based effluent based industries should not be actually placed next to any residential area, obviously, because that is going to create a impact to that particular place.

And any place of habitation should not be exposed to actually such unit. So, such kind of actually policymaking decision can be actually taken care of through studies, probability of, of occurrences how frequently it is going to happen, the severity and the extent of it,, in the given population in that given place,, and several other types of uncertainties are also involved with such chemicals, which are not completely known yet. So, those also can be assessed and a policy decision actually can be taken care of.

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The Sumida River in 1967 (*left*) and now (*right*). Source of *left*: Ministry of the Environment, Summary of Annual Report on the Environment in Japan 1983 (JPY only). http://www.env.go.jp/policy/hakusyo/zu/eav11/eav110000000000.html#2_1. Source of *right*: Tokyo Houseboat Guide (JPY only). http://www.t-yakata.com/tyh_dkship.htm



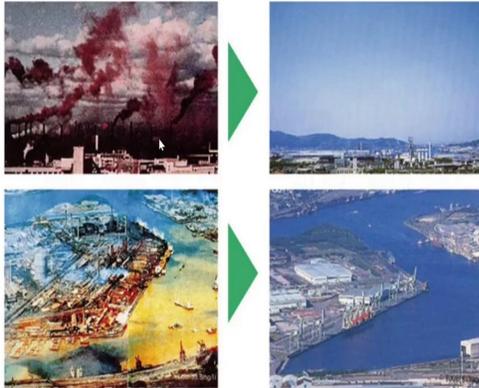
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So, you can see through, these pictures, how the, some places, some rivers have been,, polluted in the first half of this previous century, and how it was transformed by serious effort from the government agencies and governments itself. So, this is the Sumida River in 1967 as you can see is highly polluted and damaged actually, the all of the aquatic life at that time was almost completely gone.

This is a scene from country of Japan in year 1980 and the in the 1983 it got actually reformed and corrected and you can see the view over here in this particular, this second image. So, they are they have actually tried to restored and almost they have, they were actually successful in restoring the actually ecological balance of this river in this particular place, with the conscious effort.

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Kitakyushu in 1960 (left) and now (right). Source: Kitakyushu City. http://www.city.kitakyushu.lg.jp/kankyou/file_0269.html



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Same, some examples from Japan, so this is a first picture is from 1960 now how it got transformed, so you can see the spillover of chemical compounds and hazardous waste into the sea water directly over here and how they took actually corrective measures, how they actually brought actually enforced laws and rules and regulation to bring the checks and measures on such an industrial actually places.

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This problem was highlighted by our National Geographic also, you may have seen actually this, the cover page of this magazine, this is a piece of plastic which is floating inside the, water body, and it is shown as, this planet of plastic, so it looks piece of an iceberg. So, what we can see the extent of pollution these days is very little, but it has the potential that it can damage a much larger exchange.

So, that is actually message what can actually draw from this cover image, which is quite literally, we have all seen the pollution caused by the plastics, in our surrounding areas. So, the one fact which is given right here on this cover page, you can read, 18 billion pounds of plastic ends up in the ocean each year.

And that is just the tip of the iceberg, that is what they mean to actually say over here, the extent of pollution what we are seeing, what we can see is just a little part, that kind of extent it has and it is having on our ecological balance is really immense, that we cannot even measure.

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So, plastic we all know is recent actually industrial adventure, invented actually material, which came actually recently not very long ago, 150 years ago, we actually created this plastic. It is very lightweight, it is strong, and it is very cheaper material compared to other packaging materials, whatever are available in the market today.

And this actually miracle material has helped us also for several requirements for packaging for our carrying liquid based, liquid based substances, and it has plastic as impregnated almost everywhere, even our computers, these desktop, even our mobile phones, all the most of these electronics, most of our household appliances, almost every every article today has at least one or two plastic components, or that entire component or the entire that product is made up of a plastic, it has impregnated so much.

So, as this fact actually estates over here in this National Geographic actually magazine, it talks about more than 40 percent of it is used just once, then it is just thrown and it is, it is gone out of your control and now it is going to end up somewhere in the maybe a water body or maybe on some landfill or somewhere is going to be there somewhere for a very long time depending upon its grade and it cannot be actually, disposed off properly, it is not disposed off properly.

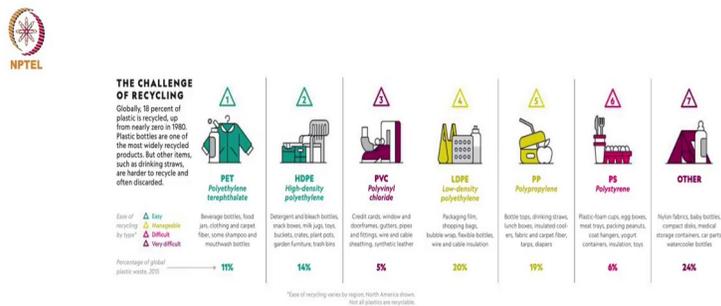
Some 9 million tons of it end up in the ocean each year. That is a huge amount if we see and that is why actually there are some satellite images which are indicating, there is a huge actually volume of these plastic bags actually waste and garbage material, which is just simply floating across the oceans from one place to another.

And it is causing actually severe damages, we have seen in the previous lecture, how the animal life, how the bird life they are eating on these are plastic waste and they are actually dying, they are simply dying out of it. So, if you see working life of one single plastic bag, which we usually get on any shop in the market is just for 15 minutes and for the purpose of, the purpose serving of this 15 minutes this plastic bag is going to last in the ecosystem for several years.

after which it is discarded, in the building industry actually it goes on for, for up to 35 years and then it is discarded. And the total if you see 448 million tons of plastic was produced only in year 2015. So, that is a huge amount of that we, that is the amount we cannot even practically imagine, how it would be but we can see the reflection of it in our planet is kind of drowning in this plastic.

The growth in the Asia if you see, it this is at the time of the recession in the year 2000, there was a slight dip observed but again it, it actually maintained its pace. So, the as the economies in Asia grows, so does the demand for consumer products and plastics. Half the world's plastics are made there, 29 percent in China only. So, you can see, how the Asia is contributing to this waste of plastic. So, the more than half of it is produced only in Asia and almost 30 percent total in China.

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Let us see the grades of the plastics, what are the grades of the common grades, which are available in the market in the commercial usages and percentages of their global waste, what they form. So, as well this is a data from year 2015 taken from National Geographic. So, there is a challenge of recycling, if you are recycling, if it is not properly recycled, how long it is going to be there in the ecosystem and how much bulk of that waste it forms.

So, the grade one actually this is PET, polyethylene terephthalate. So, this forms actually the 11 percent of the total waste which was produced in the year 2015. The second one HDPE, high density polyethylene, 14 percent. The third one PVC polyvinyl chloride. So, this we are all aware of I think we have seen all of these plastics in our conjunction, this forms bulk of 5 percent, LDP low density polyethylene, this constitutes for around 20 percent, very big.

And then we have polypropylene PP, number five to constitute for around 19 percent, then we have PS polystyrene. So, this is also one of the very a hard plastics which, which we usually make with, for our plastic cups, the egg boxes or the meat trays, and the hangers, there are several types of insulating materials, we use of this material.

So this, this actually forms 6 percent of that bulk and then we have other very hard polymer grades, which is represented by seven for example, nylon fabrics and ropes, baby bottles, they are very hard, compact disc like CD discs,, medical storage containers, those are actually very hard, actually plastic materials.

Components from any car or mechanical equipment, water cooler bottles, those are actually the seventh grade, actually plastics and they constitute a 24 percent of the total bulk, which was produced in the year 20, 2015.

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NPTEL

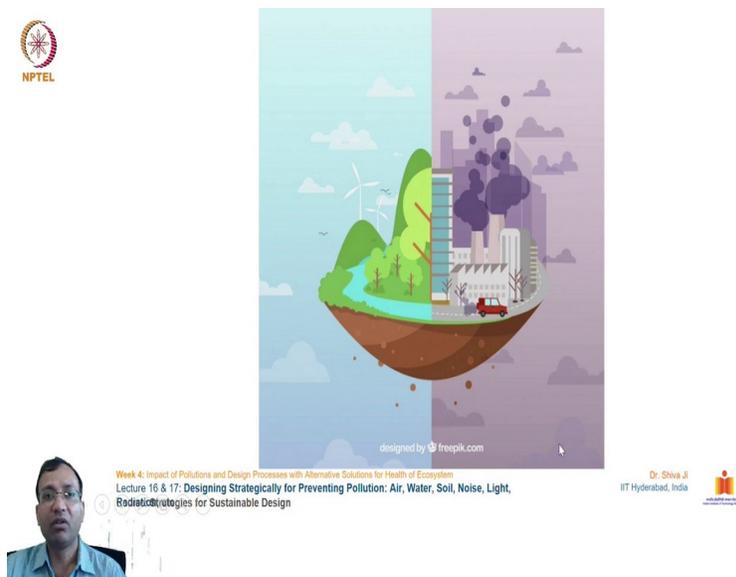
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And this is actually if you can see this image. These are the actually pieces of plastic waste and you can easily identify most of these from everyday objects what we use in our daily life. So, every piece of plastic here was found in the stomach of a single albatross chick. So, these are not some random actually pieces of plastic, plastic collected from some summer dump yard. But these pieces were found inside the stomach of actually Albatross like a bird.

lid beer outside the actually bird it killed, the plastic pieces from the bottle caps in the top row to the tiny fragments along the bottom all the represent actually parts of some product which we generally use in our daily, in our daily life. So, this actually, these pieces were collected from remnants of a bird, and they were actually photograph by this photographer Mandy Barker. So, this is actually the extent of damage one can imagine, this plastic is causing.

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So, if you see, how the world looks, in a polluted world and how it should be. So, it is a kind of a graphic illustration how we should strive for balanced ecosystem based design.

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So, how these an industrial world, the features of the industrial world, the technologies of the industrial world, which were actually very harmful for example, radioactive materials for the heavy discharging actually electrical or manufacturing units, how we can actually replace them with renewable energy resource generations and how we can actually replace them with the much efficient and greener actually solutions from, from the use of the latest technology and we can actually strive for the bringing back earth to a normal state.

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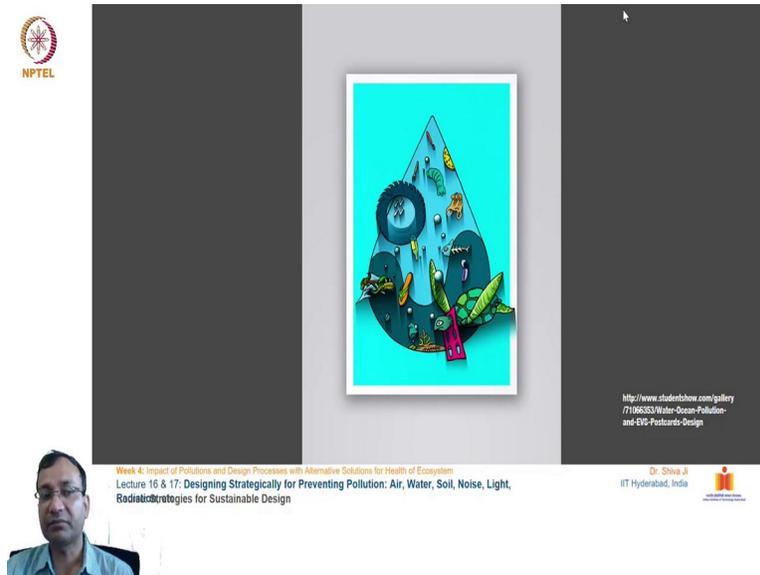


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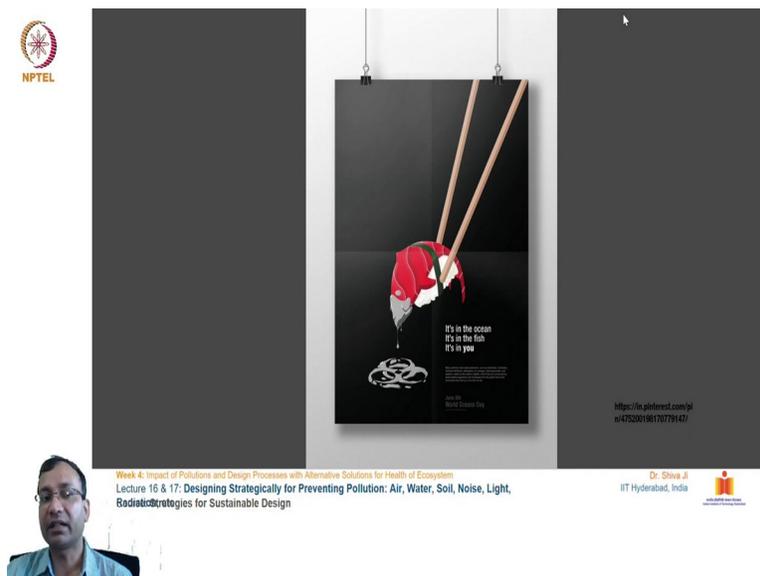
So, this is actually an artist's illustration you can see over here. This girl is actually kind of trapped in actually a suffocating actually environment of a city and there are lot of gases and poisonous actually suspended material in the air and she is simply unable to breathe and open her eyes and there is a ray of hope we can see on top of her head, as a two leaves of a sapling.

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So, these are some illustrations which are actually depict, depicting the, the aquatic life, how the aquatic life is actually plagued with this, the waste generated by these plastic.

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Another depiction like how this, our food material is getting the concentration of actually poisonous substances and chemical compounds, how they, those chemical compounds actually reaching in our food chain and how we are also getting affected out of that.

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So, in this graphic also you can see, how pollution is actually affecting all of the ecosystem. So, it is causing global warming situation, is causing light pollution, it is causing actually littering, it is causing air pollution, radioactive radiation, it is causing noise pollution, it is causing acid rain. So, there are actually various forms of pollution emanating from the same sources of industrialized ways of actually making stuff.

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This is an image taken from Beijing, China it shows actually the, this is stadium, very famous the stadium on two different days when the sky is clear and when there is a sky is not so clear and it is, inundated with the toxic air.

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Again, another a shot of place from Beijing, you can see taken on two different days and how the pollution has actually entirely taken over the skies and nobody is able to even easily breathe in

this air and you see the visibility has gone so bad. It shows the actually the, the level of the concentration of this, these toxic fumes and suspended actually material suspended particles in the air.

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You may be wondering what is it? It looks tasty piece of ice cream, but no. Actually the water what you are seeing over here in the form of an ice cream is taken from different actually places of pollution, from different places. So, whatever these substances you can see in the, is suspended actually matter which are visible either pieces of plastic, the pieces of actually are torn cloth. And some other some living actually organisms, so the dead particles, there are actually an number of things actually available in these, these actually frozen actually ice.

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<http://www.designidea.com/infoc/creative-work/nature-already-has-solution-water-contamination>

Researchers have caught on to a traditional Native American and Mexican water purification method that uses the inner sap of the common cactus plant. The cactus substance presents an environmentally friendly, surprisingly simple solution to contaminated water. The cultivation of this substance and development of the purification method could significantly impact the lives of the one billion people in the world who do not have access to clean, drinkable water. The substance inside the cactus, called mucilage, keeps the plant hydrated. Researchers have found that the sugar particles in the mucilage have the ability to filter contaminants such as various chemicals and arsenic from polluted water. The Mexican water purification method is as simple as boiling the mucilage of a prickly pear cactus in contaminated water. The pollutants rise to the top and are easily scooped out of the liquid.



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So, how actually, these pollution and pollution based actually effects can be actually controlled. So, there are actually natural methods also available in the nature from which actually these, several types of actually pollution for example, water pollution is being talked over here on this slide, can be actually taken care of. So, there are actually some traditional Native American and Mexican actually water purification method that uses the inner sap of the common cactus plant.

The cactus substance presents an environmentally friendly, surprisingly simple solution to contaminated actually water. The cultivation of these substances and development of the purification method could significantly impact the lives of 1 billion people in the world, who do not actually have access to clean drinkable water, the substance inside the cactus called mucilage, keeps the plant hydrated.

You may have actually seen most of us may have seen actually these cactus plants. So, even in the harsh of the harsh like summers, they are always, they maintain their actually hydration level. The researchers have actually found that the sugar particles in the mucilage have the ability to filter contaminants such as the various chemicals and arsenic from polluted water.

The Mexican water purification method is as simple as boiling the mucilage of a prickly actually a prickly pear actually cactus in contaminated water. The pollutants rise to the top and are easily

scooped out of this, the liquid. So, this is how actually they have been traditionally actually filtering the water in the some parts of the America in the Mexican places.

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Another actually example taken over here, as you can see is the, is the garbage actually collector for the lack of water bodies, water bodies. So, this is called as a waterwheel. So, the facts about this is, there are, it has two trash actually containment booms, so which actually collects the debris from the surface of the water.

So, it keeps moving, it is keeping the belt which the conveyor belt here, as you can see in this picture over here and the whatever the trash which is there in front of it, it gets actually deposited in its belly. And it keeps on moving, this is powered on the, the water itself, so it moves freely in the water and it keeps actually collecting the debris.

So, you can see over here that debris racking system helps to remove trash and debris to the front of the commandment. Further the conveyor belt actually lifts trash and debris from the actually water body. The seal actually fabric cover protects the waterwheel from a wind and rain this top portion over here, the part four here, and the fifth one the waterwheel actually harnesses the current of the river to turn the conveyor belt. The dumpster barge actually stores trash and debris and further ones that is collected, one can actually collect the trash from the water body.

can say, and from here actually starts with this waste actually going to the landfills in the US. So, from the ones that actually, the garment is discarded, it reaches to the landfills.

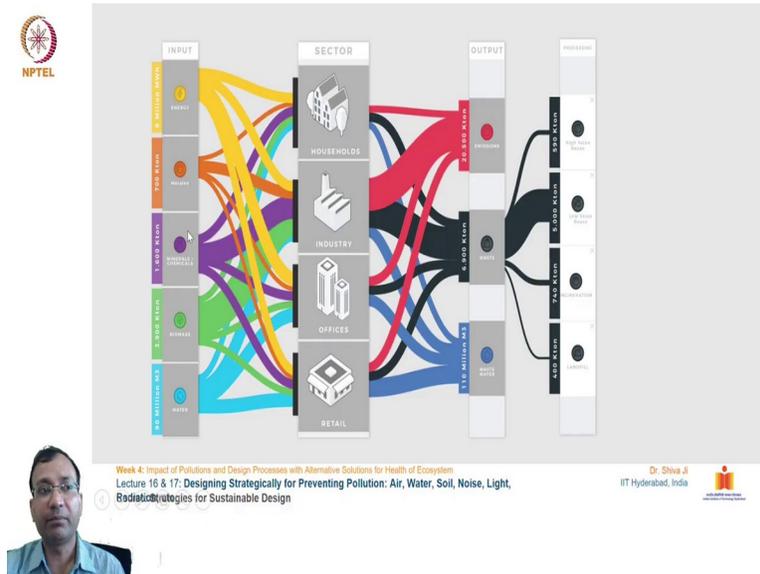
Then, then from these actually garment based selling to the, a major portion of this actually garbage, actually is sold to Bangladesh, you can see over here point 08 million tons of it is sold to the Bangladesh. Again it reaches over here in the Bangladesh and then it starts actually creating certain issues over here, it goes for the landfill is goes for recycling.

So, several types of some treatments, whether it is treated or not, it ends up actually in these like many places you can see over here. And then this is actually a map of actually landfills in the Dhaka Landfills. So, there are several location is talks about where there are landfill created for dumping actually such waste. And it here, it actually comes to the end, well not practical end, but at least it stops here for further moment.

So, this is the actually journey of this material and on the seventh part you can see the textile recycling industry. So, there is a whole full-fledged actually recycling industry in the places, in the countries of Bangladesh and Vietnam and some more countries, from there actually they do the recycling and some again actually some recycled fabric or the yarn out of that they go back again to the EU and U.S.

And that is how actually this whole, you can see a cycle over here. So, this cycle is actually connected at the global ways, at the global level actually these times. So, this is how actually globalization have, has played a role in actually affecting each and every corner of this world, through some way or the other.

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In this slide, we will see the amount of input in the energy input in the metals input in terms of minerals and chemicals in the biomass and water is divided for these, these many sectors for their services. And then it goes into this what kind of emissions and what kind of actually processing are actually done with these.

So, let us see the first one 8 million megawatts of energy goes for the households, industry, offices and retail, almost 700 kilo tons of metal goes to some of these four sectors. Then 1600 kilotons of minerals and chemicals actually go for serving to these actually sectors. And then these, water if you see 19 million actually cubic meter, volume of water goes for serving these for actually sectors of household industry, offices and retail.

And in terms of output, they generate actually, you see in the terms of emissions 20,500 kilotons of emissions are generated out of these, out of these four and 6900 kilotons off waste is generated and 110 million meter cubic meter of waste of water is also generated out of diesel.

These are for actually major, large consuming actually industrial sectors. And out of that, even in the waste, if you see how much of waste is processed, so 590 kilotons of waste is actually processed for high value, like reuse. And then 5000 kilotons of waste is process for low value reuse, 740 kilotons of waste is used for, incineration, facilities for power generation or simply burning the waste.

And a 400 kilo tons of waste is anyways landing into the landfills. So, this is actually life journey on overall scale you can see of resources how they are being utilized and how they are turning into such a waste for the, this planet to handle. With this, I would like to come to an end of this lecture.