Introduction to Civil Engineering Profession

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Lecture-04
Introduction to Environmental Engineering

Nice to see bright young faces. So, you all know what is a topic of today right you already gone through lectures in other fields of Civil Engineering. Today and tomorrow I will be talking to you about Environmental Engineering right. It is not a new topic to you may be the other topics were new to you it was not you are not expose to it in your school right, but environment is something which is introduced to you right from your kinder garden or first year right.

So, it is nothing new to you, but what I would like to expose you is to the domain of the vast domain of environment. And how as engineers right we can play a role in controlling the way things are happening, and mitigating the damage which human impact is causing the environment and make the environment better for now and for the future generations ok. So, the engineering aspect was what was missing in your school education probably all of your almost expose to environmental environment subject right.

The impacts it is been hammered on to us not only in school, but in social media, print media every I am sure everybody is now quiet aware then the recent trends, recent times lot of awareness is been generator in multiple media ok. So, let me quickly get into the subject.

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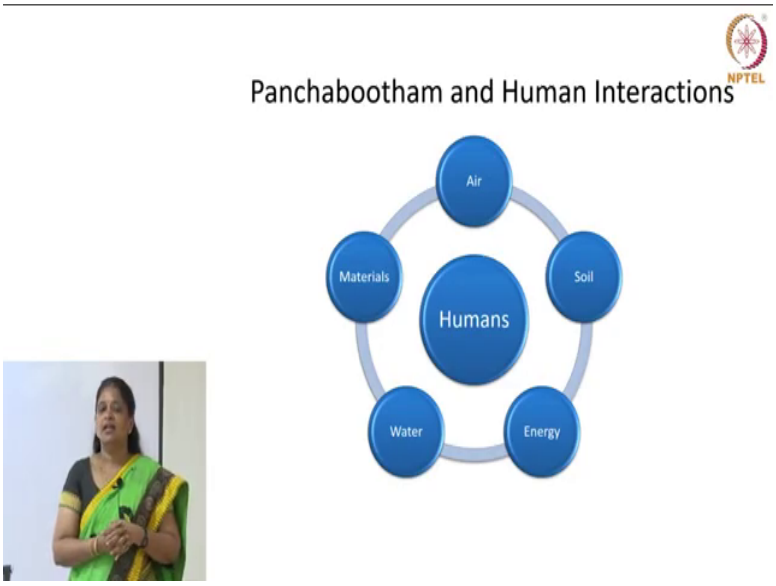

So, environment as you see here is everything including us right. In Sanskrit we call it the panchabootham and you can add other dimensions to the same panchabootham principle right everything around us water, air soil, materials that is the one which I added and energy right everything includes environment including us.

And we are in the center of everything we I mean it should it is not just human I should also included the whole living system which is controlled and which controls all these 5 dimensions. So, it is important to understand the each of these domains separately and also to understand the interactions between the human and the living ecosystem with these 5 different domains ok.

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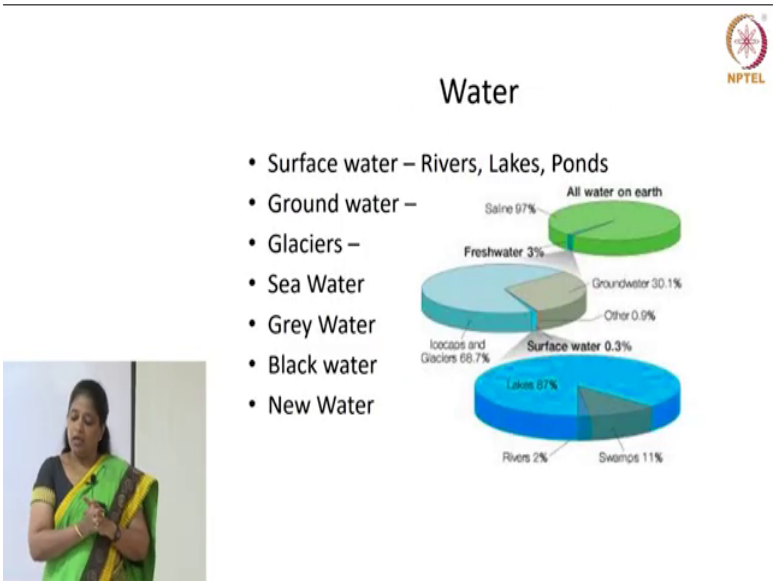

Water I will as we all knows it is very very important right water can be in comes from various sources, comes in various forms right and I think, nowadays this summer everybody has realized even those who did not realize the importance of water has is made to realize by nature right all across the country.

And we are also seeing it across the world in paths of the world where water supply is in kind of not equitable distribution of I would not say it is limited, but it is not equitably distributed across the boundaries and across the annual time frame that is why we face water shortages ok. So, water comes from surface water, ground water we all know this glaciers ok, but I would like to show an sea water.

Predominantly 4 different sources and you can see that what the quantum of water which we have access is very very small. So, although we have lot of water if you look at the globe you

have lot of water, but all the water in earth is about 97 percent of the water is saline, only 3 percent is fresh water right.

So, in that 3 percent we have only about 30 percent accessible to us in term as water the rest of them are all glaciers or ice caps on mountains ok. And in that quantum of surface water and fresh water which is available to us you can see the distribution that most of it ends up the surface water particularly is in the lakes right.

We all have seen lakes, rivers, but we really do not know how much is available where this kind of puts things into perspective and it also helps us to understand which component of the water which we have to value and which we have to protect depending upon the quantum.

So, lakes into be the dominant surface water source whether we know it or not and we all know what is a pathetic state of lakes right in any urban system ok. So, somewhere along the line people did not probably pay attention to all these and some miss management is happened. And we need to put things back into the right spot and in the right condition.

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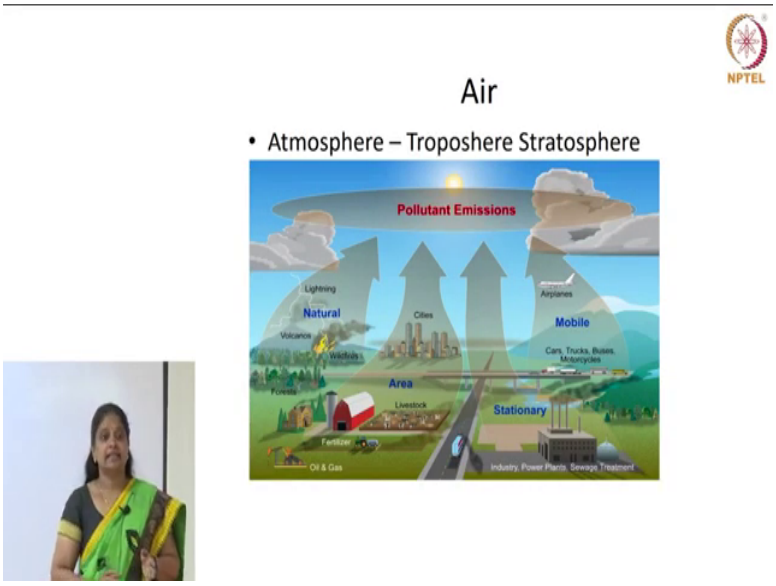

Next thing is air right, air has a we all know different layers I do not want to go into the details, but the most important layer which human interacts or where humans have an impact is troposphere and stratosphere ok. Troposphere very close to where we live and a few kilometers above and what does happen to the troposphere over the last few I would say decades still right not centuries all the damages happened within the last century right. So, what we this kind of gives you an overall perspective of what is happening to the air environment which is very very important right.

If you put a order of priority air comes first to humans or any living system then water, then food, and then shelter ok. So, to the touching upon in environmental engineering we touch upon all these important aspects of human sustenance or in larger perspective the ecosystem

sustenance of the living things in the ecosystem ok. So, air pollution comes from multiple sources right, I wish this was more interactive I could have got the answers from you.

But I am just listed everything with this slide kind of list everything here were it can be manmade, mostly man made impacts to the air coming from transportation the daily travel in vehicles create a lot of pollution. Then we also have industries which contribute a major source of pollution industries emitting all these toxic fumes during their manufacturing process.

And then we have our energy sources. Energy sources are like thermal power plants India still dependent on a large percentage of energy comes from thermal power plants. And I hope you all know they are the biggest and they create the biggest environmental impact not just by using coal or sometimes fuel oil that itself is a big impact. The emissions are a very big impact and also the water.

Do you know how thermal power plants impact the water? Water environment there is always relations I told you right human and these 5 domains and the 5 domains impacting the human not only that there is also a interconnection between these among these 5 domains right. So, how air or energy domain impacts the water domain?.

Students: (Refer Time: 08:25).

Exactly, when we have thermal power plants one impact one big impact is not only the contamination, but also the temperature contamination right, thermal contamination we call them. You cannot just release the hot water from the thermal power plant directly into a water body. It completely damages the ecosystem there right from corals to plants, planktons, the basic life forms, to fishes ok. So, it has a huge impact and not only that it consumes a lot of water in the first place right.

If the largest if you look at rank all the industries and look at their water foot print you will find that thermal power plants are on the top of the list right many of us do not know this thermal power plants consume a huge amount of water in terms of cooling water ok. So, it

impacts air, energy domain impacts air, it also impacts water, and together they all impact the living ecosystem ok.

So, we had a in human related pollution like your transportation, I talked about energy and other industries we also have the most necessity we may think that agriculture is a most benign way of benign industry right. So, agriculture also has a huge impact on the other domains of environment like air and water primarily and soil right because of usage. We become more enter as an agriculture become more intensive we use more water, we use more fertilizes, we use more pesticides ok.

It does as we go move away from nature it has an impact on the nature ok. So, agriculture then also natural right there are natural things which are happening up for which we have no control right this a even the formation of ozone NOx right there would NOx combines with CFCs to create all these impacts which can affect the ozone layer certain things we have control, certain things we do not have control ok,.

But it was an balance when we have a Vulcan hose or wire fires a lot of emissions are happening right, but it was nullified by the natures capacity to heal itself ok. The issues come only when nature when we exceed the capacity of nature to heal itself.

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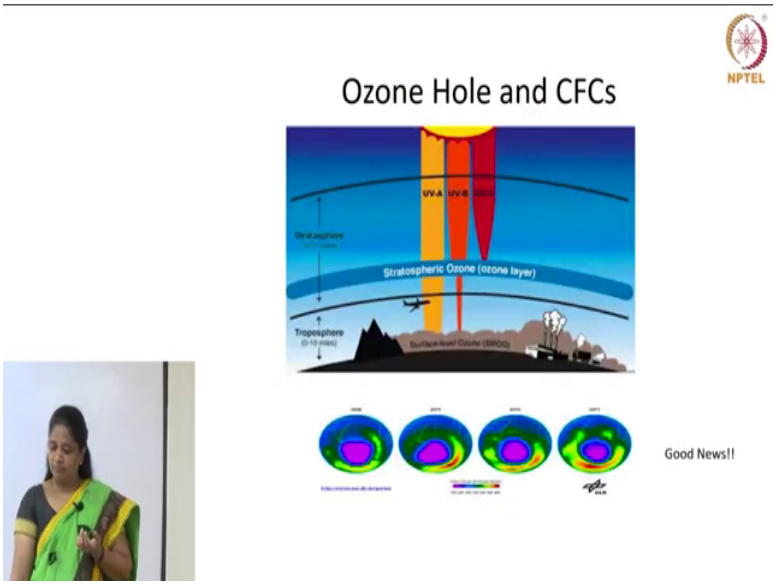

So, troposphere lot of these things what we discussed is only impacting the troposphere then that is the zone where we are closely related in, but we also have this hole ozone layer hole in the ozone layer which is been talked about a lot ok. So, the UV radiations can penetrate if there is a hole and then there is a lot of impacts on skin and other body conditions for humans ok. So, ozone layer has been similarly impacted because of human interventions ok. So, can you name one compound which impacts ozone layer?

Student: CFCs.

CFCs we have heard a lot about this ok, but what is a good news you can see in the picture how the UV radiations are filtered by ozone layer which does not happened when there is a hole right. And the hole as been mostly found in the extremes of our earth arctic Antarctic

and what is happening? Good news what is a good news in recent times there the picture also shows you that ozone hole because ok.

I also want to talk about the positive things which people and community, scientist, environmental engineers have brought about together that was a huge awareness created in the entire you know in the global the scientist have created a huge awareness program and they have worked on alternatives ok.

So, alternatives to CFCs. CFCs are banged over the last decade many countries have now adopted that and they are very serious and. So, what is happening the hole is shrinking ok. So, the positive thing is many times you will only here negative things about environmental damage, environmental pollution, man men development is causing this. So, we cannot shutdown development right we cannot live without energy all of us need energy nice air condition room here right.

So, where does all the energy come from thermal power plants right? So, can we just have it an open environment, natural environment go back to gurukul right no chairs sit under the tree. Is it possible nowadays? We need a lot; we need a lot of gadgets in education in our day to day life ok. So, we need a lot of energy we need a lot of materials right we cannot live without all that now we cannot reverse the time clock and go back right.

So, how do we do it with balancing it with the environment and if we make a mistake its it is very very common that we make a mistake right if you look at stories of environmental degradation it is always been a mistakes some things which were thought were right ok. Few decades later they realize that it is a wrong way to go and then it is right at that point of time our knowledge was limited we learned a lot over the last few decades ok.

So, it me to see if it is possible to reverse it, it is ok, we do not really have to beat our self up saying that we did a really terrible thing it is as long as we can recoup and we do not have permanent damage it is fine. So, ozone hole closure is a one big achievement with collectively mankind and technology have science and engineering put together everything

made that happen ok, government policy, industries everybody came together realized it is a problem. And now what is that is the good news.

So, what is the other problem which humanities facing environment is facing which needs this kind of an intervention or which is already happening. Can you think of something which everybody in the world is talking about?

Student: Global warming.

Global warming right So, that is much more threatening because it threatens everything the existence of everything in this world and its collected again to all these domains water they say drought, and flood and diseases and everything is related to global warming ok. So, it that needs a much more bigger attention and sooner; the attention has to be sooner the clock is sticking that is what the people who are working in climate change in global warming keep telling and putting pressure ok. And many of that damages irreversible that is the worst case ok.

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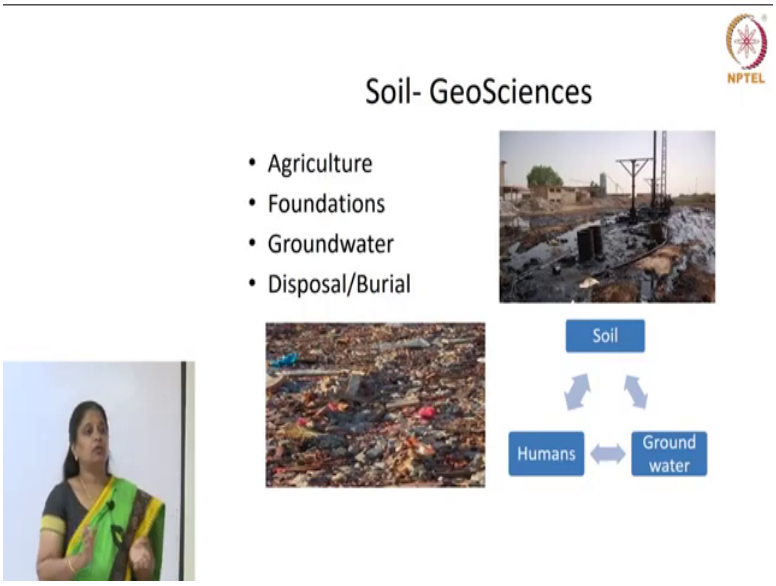

So, coming back the third domain which I want to talk about is the soil domain; you might have heard about soil with the different angle from the geotechnical faculty. Is it already done this class?

Students: (Refer Time: 16:15).

No, you will be hearing soon ok. So, soil has multiple dimensions to civil engineers geotechnical is one dimension where we look at foundations right that is a we look at the building has to have a foundation and you we try to understand. How soil can take the load? Different types of soil. How they are capacity to take the load? How do we engineer structures ok?

So, that they can be anchored into soil certain the engineering comes in because we want, man wants a certain thing, or certain building of certain size, in a certain place right. If the soil is not good what do we do?

Students: (Refer Time: 16:57).

We were engineer the soil right. So, we our technology has improved so much that we could do all that. And make things happen right that is what civil engineers do we do not compromise right? So, engineering has given us this strength to do all that. Again agriculture is one domain where soil is very closely connected to us right we soil is the basis for growing food crops right.

And ground water that is also closely connected to soil right ground water is in the soil right it is not separate it is just the pore spaces of the soil is where the ground water is stored right. And also soil is important to us when we go off to finally, dispose things including ourselves, our own physical self right. And now of lake lot of waste, waste water everything is being disposed in the soil ok. So, that is where problems occur ok.

So, how do we do this disposal practices? And how it is impacted? So, some examples you see here ok. How do we avoid this? how do we do disposal in a safe manner we still can disposed, but it has to be in an engineer land fill right many countries have engineers landfills India is still yet to make even that small step when it comes to waste disposal ok. And there are also in environmental engineering you will learn about not only the contamination problems soil contamination, ground water contamination because of soil contamination you also get ground water contamination.

Because, when waterfalls it percolates through a contaminated soil then your ground water is going to be contaminated, or it can contaminated soil can also contaminated, contaminates surface water because everything runoff ends up in rivers and lakes right. So, we need to understand how soil contamination is has happen. What is a extent? Ok and how to reverse things?

If it is already happened and even before that we should know how to avoid if it is already happen we should know how to reverse it or we how do we safely dispose things even nuclear remains right wastes are worried very deep into the soil right. So, we need to be very careful how we do that? Because some of those are completely irreversible and the impact is going to be long term ok.

So, engineering, environmental engineering you will learn about are the interactions flow of waste, waste water, chemicals with soil and ground water and also remediation practices and also wanted to see just throw some light on again the interactions ok. So, we I told you about soil contamination impacting ground water. Do you know what happens when how can ground water impact soil, soil strength?.

Have you heard of cases where ground water is abstracted extensively large quantum of ground water that is what is happening in Chennai now because, we have we are dried on rivers and lakes. So, we keep abstracting a lot of ground water ok. What is that due to the soil? You might not a heard about this if somebody has heard its fine ok.

Ground water subside drown subsidence happens when there is huge abstraction in one particular area depending on the soil condition sink holes have been formed entire buildings have collapsed because they were abstracting a lot of ground waters So, you learn it is a close interaction between what you learn in your geotech and environmental engineering in these domains.

And also when you talk when I talked about landfill we need it is the whole domain is called geo environmental engineering right. We have a lot of faculty working in that domain that is where geotech and environment come together.

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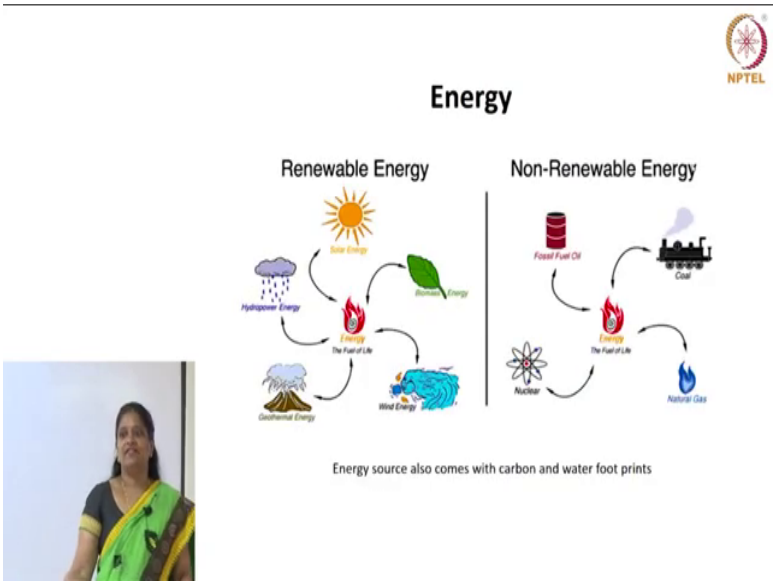

Next energy a very very important topic right we already touched upon energy you were read about all these there are sources of renewable energy, non renewable energy and everybody has been talking about moving from that side to this side or how fast is it happening we keep talking environment is something which everybody talks about have you heard about it? Or seen it? Right. Everybody talks about it you need not be an environmental engineer right even the road side person to politicians.

But and the sad thing is a only talking happens right not much action when it comes to action you see a slow down ok. So, this talk also has been happening for a long time renewable to non renewable; non renewable to renewable and India is making some progress.

But then as young engineers who are going to get into this field you should understand the whole thing holistically right how good is a technology you can just see like solar everybody

is promoting solar right and windmills of course, it is a good instead of oil or coal it is good to have these ok. But what is a environment foot print of these non renewable sources of energy sorry renewable sources of energy ok. Do you see any environmental impact of these?.

Students: (Refer Time: 49:00).

EV. Everybody talks about EV right? It is a trending thing ok. EV is good that is what where people keep promoting ok. Any thoughts you need to reflect on we need to see where these materials come from many times in environmental engineering and even in other fields we have blindly try to copy what people in the west because they started thinking first they found certain things suitable to their country, and their eco, conditions ok, but may not be the same for us ok.

In environmental engineering when you come to your second year you will be learning about different treatment technologies most of the treatment technologies are huge energy guzzlers activated slush process I think you will be visiting part of the class to our switch statement plant in IIT it is one of the best ok, but it is a huge energy guzzler.

Many many places where there is no energy also they have these technology what will happen when you have an energy guzzler and we do not have adequate power what will they do they will not run the plant right they may build the plant, but they may not run the plant ok. Because they may not even have power for operating the industrial processes why would they operate the treatment plant when there are ways to get away with it ok.

So, there are technology you have to look at all the options there are non energy or low energy technology options for doing the same thing right many times we do not look at the options ok. So, similarly when we talk about solar, wind and EV they are good I am not deny ok, but what is the cost to the environment when we are building these ok.

So, particularly if we do not have lithium resource in our country right. What is going to happen? Solar again it is now been completely imported from China right we do not have the basic material to build these solar panels what makes are the what we will become totally

dependent on certain countries in certain other countries will be as we become more and more dependent on these sources we will become more and more controlled by these countries right.

So, it is not just engineering alone you need to think beyond all that ok. And see what is suitable for our country for sustained approach and self reliant approach ok. So, if anybody gives you an option just do not take it is just like marketing, somebody marketing a product to you way all the pros and cons long term, short term ok.

So, that is what I want to tag talk about renewable energy there is something called life cycle assessments which you will learn as you go along ok. So, life cycle assessments gives you a entire holistic picture about any product whether it is a thermal power plant or it is a small cell phone or a pen where the materials come from and where what is a energy input we need to look at things holistically it is a little too much for you now. So, just be aware that everything has pros and cons ok.

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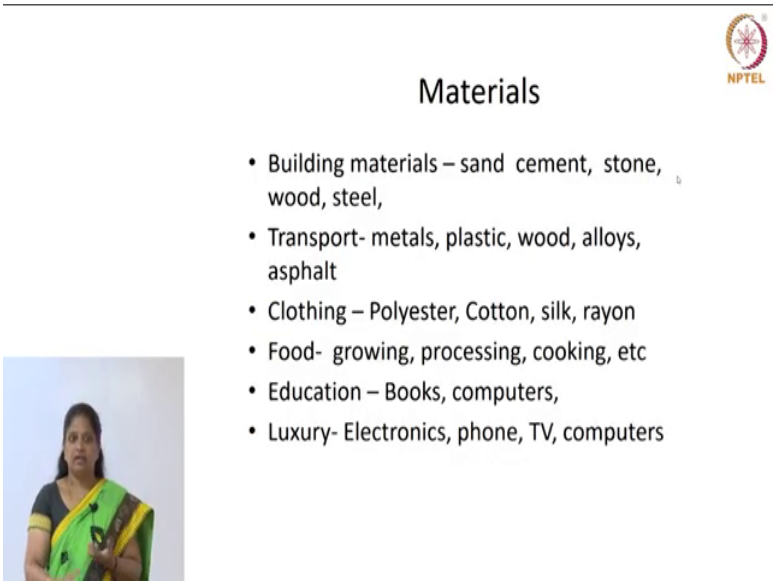

And we need to be always conscious about what is the impact to environment when we do when we make a choice. The more and most important topic as civil engineers or as engineers any engineer should know this is this particular domain materials right. What do you mean by materials? This is again a topic which is common to all engineering fields not just material person or metallurgy materials and metallurgy engineers.

So, as engineer as civil engineers we deal a lot of we deal with a lot of materials cement, concretes, sand, gravel, steel and all these new composite materials including polymers ok. So, we always make we have to make choices as you are embarking into civil engineering right the traditional approaches concretes, steel right mesentery you will be learning the all the conventional materials and you will also be exposed to new materials ok.

And now the whole world is going towards becoming a green world right green buildings it is not just greening the buildings, but looking at choice of materials it is not just making the air conditioning less or water conservation and all that, but fundamentally a civil engineers we should be able to make the right choice of material each material as a carbon foot print as a water foot print right.

So, you can now that with technology has given a. So, much options to choose from right from your wall panel, to your door ok, to the table where you are sitting you have a lot of options we often go with the option of how good it looks right? How fancy it is? What is trending? Even when you are choosing a cell phone have you ever thought how safe it is for the environment when they manufacture this product right. What is the impact of this product? And then made your choice based on that many people are doing it ok.

If you are equipped with the right tools right now you have that green dot for organic food or vegetarian food and all that and now you make a choice few given a year earlier it was not there in India right. So, if you are given a choice and if you are given a data about a product whoever is conscious can make a choice and that is what the life cycle assessment and sustainability classes teach you. You can make conscious decision about the product you choose to use ok.

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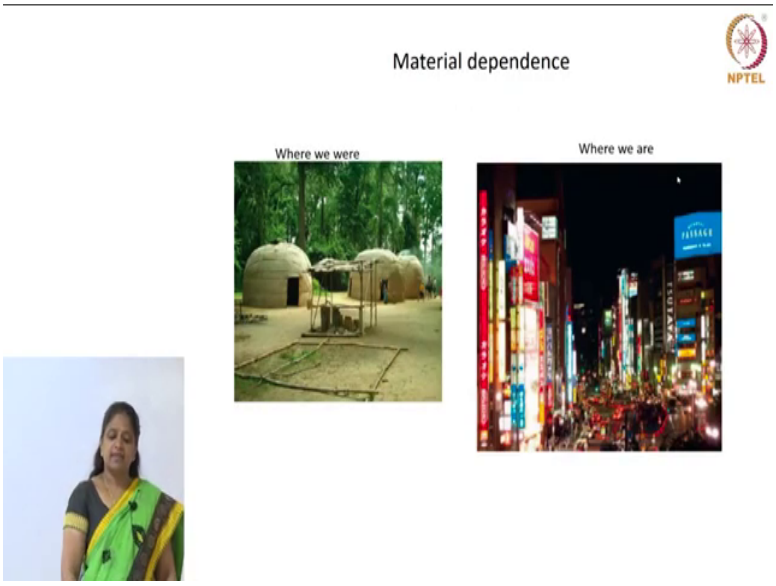

So, I have just listed all the materials which we are working with. And so, this kind of gives you a very large perspective of where we were and where we are in terms of material dependents and material usage from the food we eat, the material which goes into making it food, shelter, clothing basic essentials of life to the luxuries of life right.

That is what I have captured in this from essentials to luxury. So, much of materials different types of the at least I can think of about a 50 different materials which are mind and used for our everyday used even essentials.

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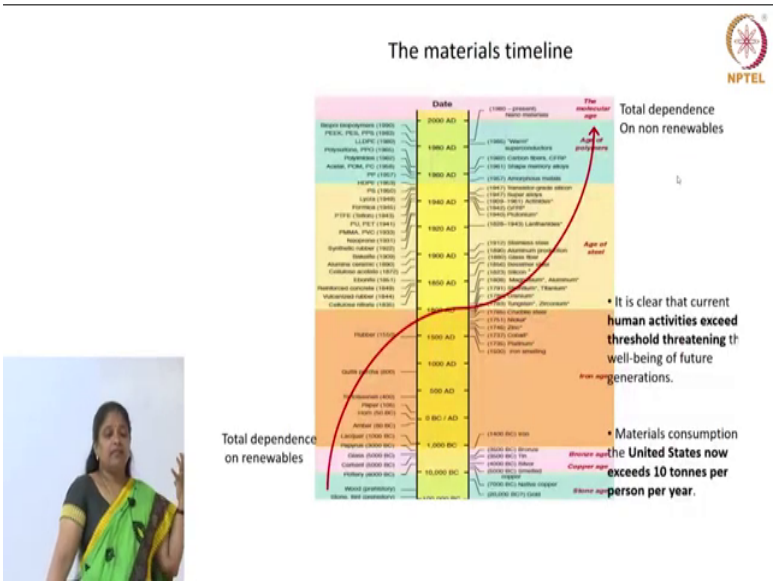

So, this is a very very nice picture you may not be able to see the details of it, but when it share to you can see that it captures all the different materials which human use right starting and its timeline is also given starting from BC 100 1000 years BC to current days when materials started coming into existence in the human domain and how the changes happened over a timeline? It is very important for engineers particularly civil engineers to see that red line ok.

So, earlier we were completely dependent on renewable sources of materials when we were like I said gurukul times ok. Obviously we cannot do that now ok, but this scary part is we did not have a balance right. Where are we now? As the timeline shifted from stone age to copper age, bronze age, ion age, age of steel, age of polymers and now we are in they say molecular age where all these path breaking things are happening the nano or the molecular age.

What is happen now? What is arrow indicate? From total dependence on renewables to total dependence on non renewables ok. That is scary right because non renewables are non renewables right what will happen if we are exhausting it already we have gone in that path ok. So, how do we engineer and build things and build products which can have a balance between the 2 and how do we reverse things ok.

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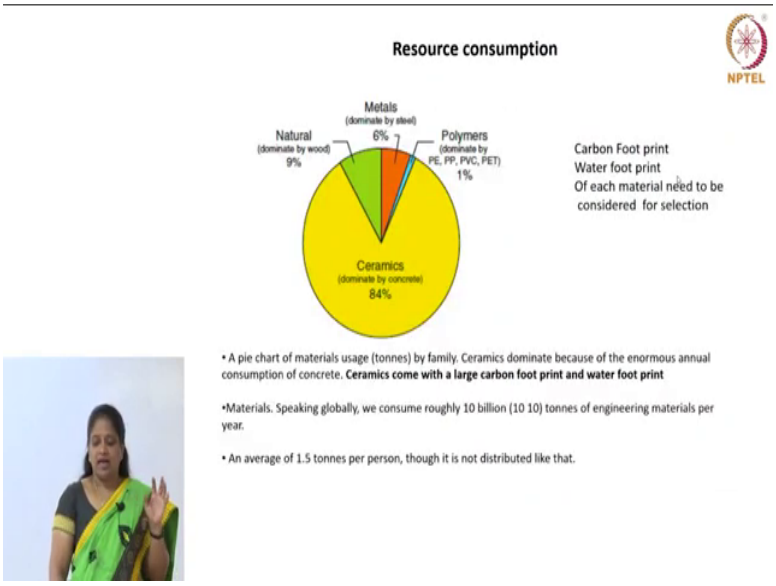

And we know that people have given these carry numbers the earth holding capacity of the earth is like we have exceeded it by 1.5 times every year you will see that there is day when alarm bell rings and say that this day you have exhausted your quota. Everybody has a quota. What is that quota?

Student: (Refer Time: 32:13).

Carrying capacity of the earth other replenishing capacity of the earth it was usually like now it moved from 70s this has been happening We are now using 1.5 times the material in the earth; that means, we are utilizing or we are not we are utilizing more than what the earth can replenish 1.5 times 50 percent existence ok. And that time is shifting I think this year it was august, in august we have utilized what is our quota and all the rest of the months it is we are taking from future generation right.

So, you have to go and see I can send you links these are scary things we need to really worry about and think about and not only worry and think, but how do we reverse it? And it is easy, we just have to consciously do certain things ok. This is a chart which talks about what is a major group of materials which we are all consuming its surprising is not it?.

What you thought might have been different ceramics and often dominated by concrete that is the material which we are using the maximum. And it has the largest carbon foot prints cement manufacturing bricks, they all have the steel, they all have very large carbon foot print and water foot print.

I hope you all understand what is carbon foot print and water foot print right amount of carbon dioxide emitted from mining to processing and when it comes to our final form. Similarly, how much water we have utilized? these have to be made a note of when we are making from choices can we find alternatives which are less which have a less water foot print and carbon foot print ok.

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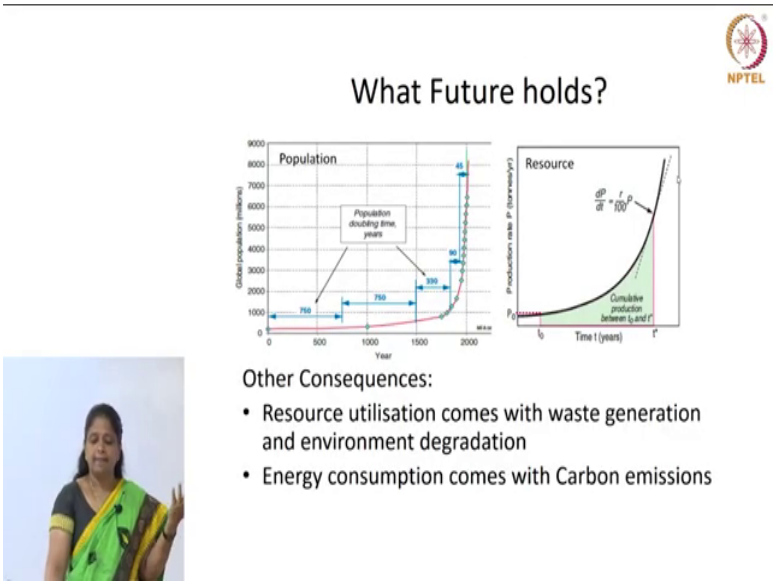

And what future holds? Not the way in which we are going without this conscious decisions is disastrous ok. The resource as you see there is being utilize it an exponential rate and look at the population it is not exponential its even much more it is called explosive growth in population ok. The doubling time has been reduced, doubling time of population ok.

The in terms of years you can see it is become its getting shorter and shorter; that means, we are the populations growing and for all these population we need to have they all have this demand the demand is also growing right per capital demand is growing people are becoming more and more to us luxury items without the consciousness ok, but it is not bad, but we have to do it in a balanced way do we need to think whether we really need what we are what we want?

Students: (Refer Time: 35:18).

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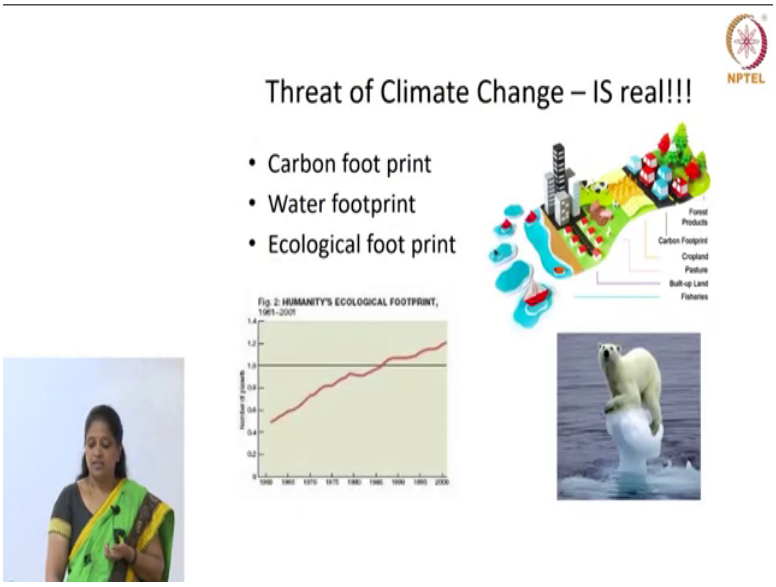

So, we talked about carbon foot print, water foot print, ecological foot print which combines the capacity of the earth to replenish and the thread of climate change is real for a long time people were debating, but then it is real ok. There is no more debate about it even though the top leaders talk still have some doubts in their mind we cannot a effort to have that doubt you people cannot effort to have a doubt you are the future generation ok.

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So, yes just want to put things in perspective although these things are talked about and action has been done by multiple people in other domains as civil engineers you have a big role to play ok. Whatever domain you choose structures, building technology or transportation whatever domain of civil engineering you choose to specialize or you become interested in environment consciousness should be there in the top of your mind.

And; obviously, if you are going to choose environmental engineering or water resources you have even better you will get even closer to the subject and you will be understanding all that nuts and bolts of how to reverse things ok. Primarily that is what you will be learning in your environmental engineering. I have just listed base management is one, but one domain area where we can do a lot because it is in India it is just starting we have not even done anything yet this. So, much to do and there are so much opportunities in that domain.

In this new 6 R I do not know if you are know about 3 Rs many people know reduce, reuse, recycle 6 R is a new concept ok. 6 R starts from rethink and reinvent ok. That is what I have been telling you even before you make a product do not think about at the waste and reusing and recycling, but think when you are developing a product? When you are designing a product what materials to go can we do it differently can the process be different. So, it has a reduced carbon foot print and water foot print.

So, its starts from there reinvent, rethink refuse certain thinks if you do not want if you do not need you can refuse. Something like a people give you when you go to a birthday party they give you some gift right take home gift. What do they call it? Returned gift most of the things are junk in return gift. And it just it goes straight to your dustpan or you just keep it there for the sake of people have given you and then one day you just discard it right.

So, refuse things which you do not want. So, that you do not take generate waste and then all that we already know reduce, refurbish, repair build things to last right from buildings those days the temples lasted for 1000 even now they are there right 1000 of years ok, but we do not build buildings that can last for more than 50 years ok. So, that is the entire waste is just going to be there when you demolish a building and build another one right from buildings to cell phones, to pens.

How many of you refill by a refill and put into in your pen? I am glad there are few hands going up ask for a refill many times even the shops do not carry refills right? Until we find even that refill has not very sustainable ink pen may be the best, but convenience sake we need to have a compromise right.

So, do something at your own personal level there are certain things which we can we can do it a personal level as an engineer as a civil engineer, as an environmental engineer or when you go and take up big positions as administrative officers IAS, IES or politician there are multiple ways in which you can contribute and, but will start doing it. When we have control? Where we have control?.

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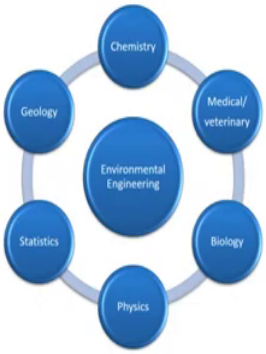

So, I think we are almost there 851. I just want to saw that is where my talk is going to end, but these are some of the things I wanted to tell you that as an environmental engineer you will be working in all domains chemistry, geology, physics whichever to give always have something to learn from other domains.

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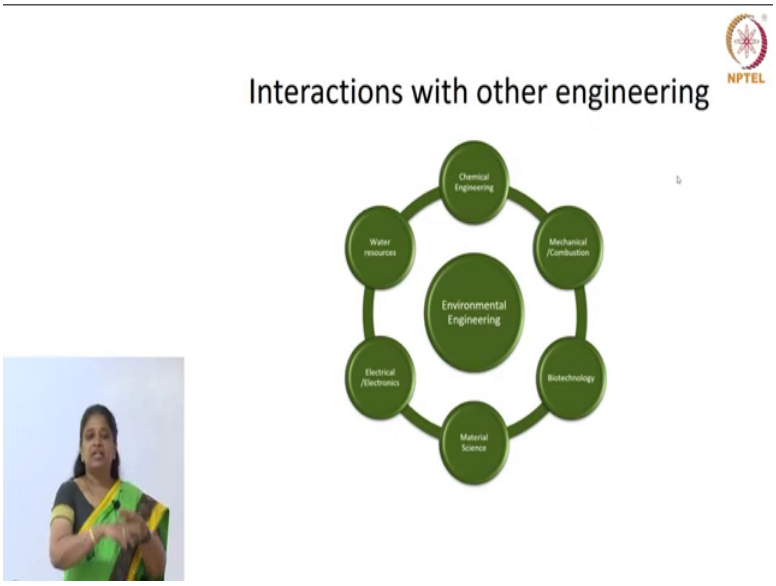

And it is also interactive between different domains of engineering, chemical engineering we work with all these domain areas. So, if you have missed out being a computer science graduate you still can do HI FI modeling when it comes to climate science and other things material, biotech we interact with all these domains ok.

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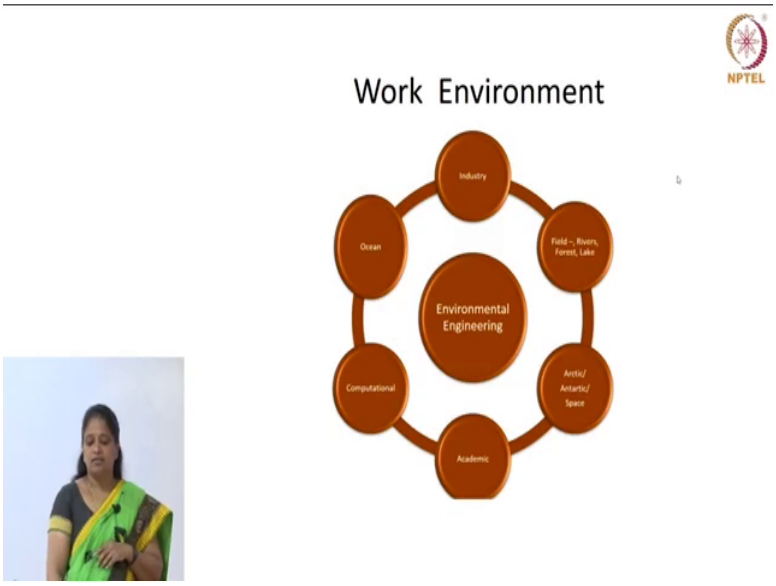

And your work environment can be from a lab, to an office to even arctic environmental engineers go into space machines arctic Antarctic and the whole world is your lab you can go out do a most of our students are always outside working in lakes, rivers, landfill sides, and bring samples, do some drilling ok. So, there are lots of options to explore.

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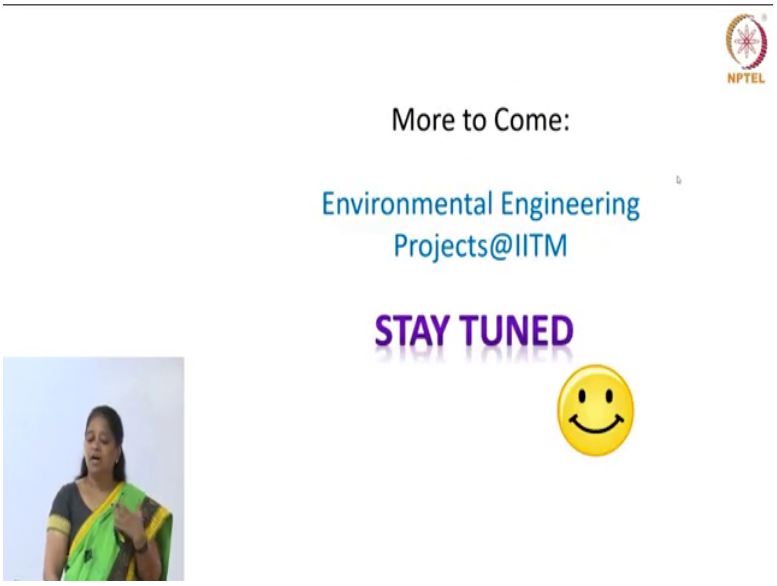

And tomorrows class I will be showing about some of the projects which are environmental engineering group is working on to excite you on what are the things beyond classroom, lectures and calculations. What you do what we do things in the field I want to through show you some of the projects what we are doing, all right.

Thank you.