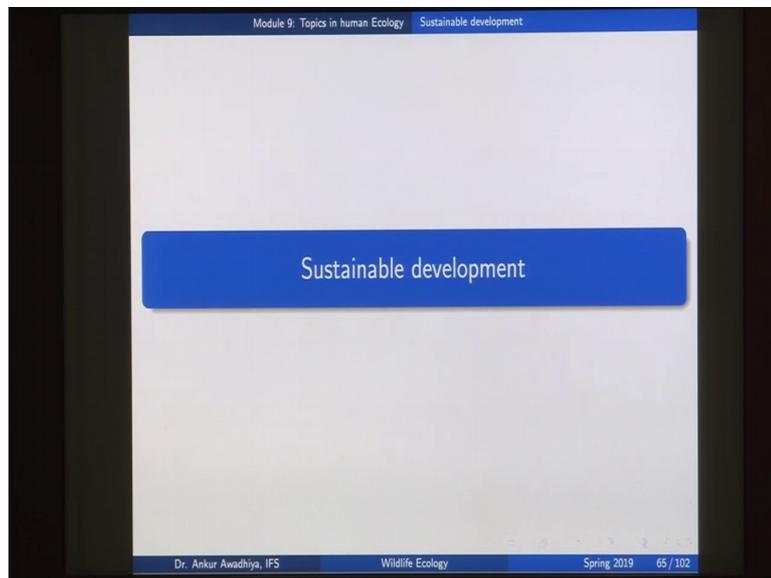


Wildlife Ecology
Dr. Ankur Awadhiya
Department of Biotechnology
Indian Institute of Technology, Kanpur

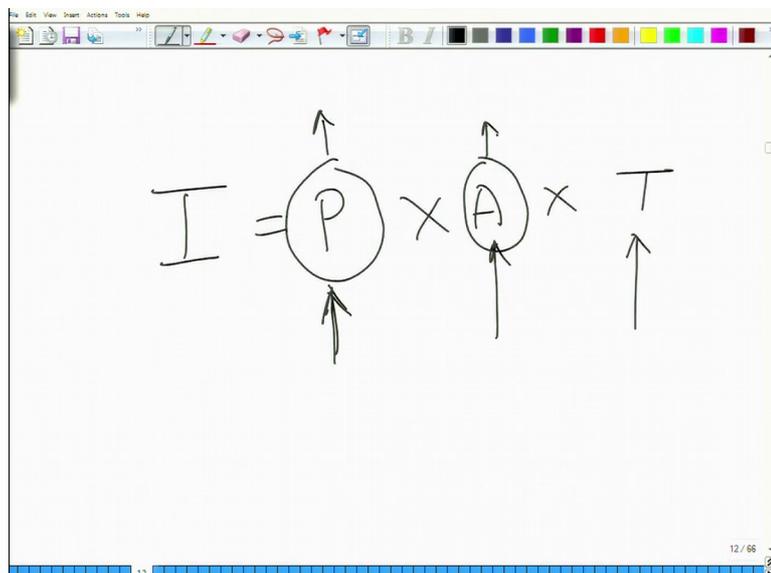
Lecture – 27
Sustainable development

[FL] We move forward with our discussion on Human Ecology and today we will have a look at Sustainable Development.

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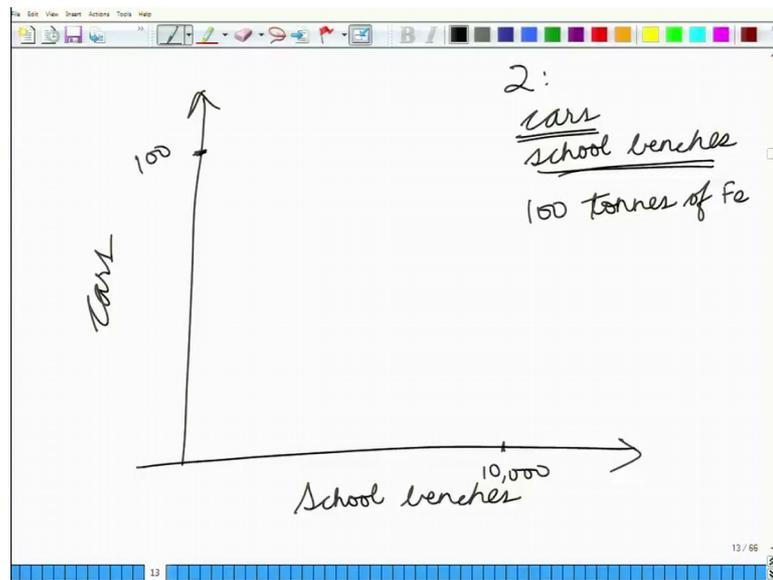
Now, in this module we had begin with our definition of the amount of impact that is caused on the environment. And we said that the impact is a product of P into A into T, where P is the population of human beings, A is the affluence or the amount of resources that they have or the purchasing power that they have typically represented as GDP per capita and T is the technology or the level of technological advance that humanity has at that particular type place or time.

Now, in our previous lecture we saw that the population is increasing and the population has been increasing for quite a while. So, this thing is increasing with time. The level of affluence also is increasing with time because now we have access to much more amount of resources. Now, we have access to much more purchasing power than our ancestors had. Today we use much more modern technologies, we use much more amount of electricity, much more amount of fuels as compared to our ancestors, but then what about T?

Now, T is the technology or the level of technological advance and we cannot reduce the population in a jiffy because it will take quite a quite some time to reduce the population. We saw in the previous lecture that the growth rate of human population has been decreasing it is reaching to a level of decline, but then still the growth rate is positive. So, the population is going to increase for the next few couple of decade, so maybe for maybe one more century.

The level of affluence is not something that we would want to reduce because we want to have people to have access to as much amount of resources, we want people to be rich, people to be prosperous. So, we do not want A to come down, but then T is something that we can play with the technological advance. Now, here in we have a choice that if we are manufacturing something how much of attention should be give to the environment or and how much of attention should we give to the affluence of people?

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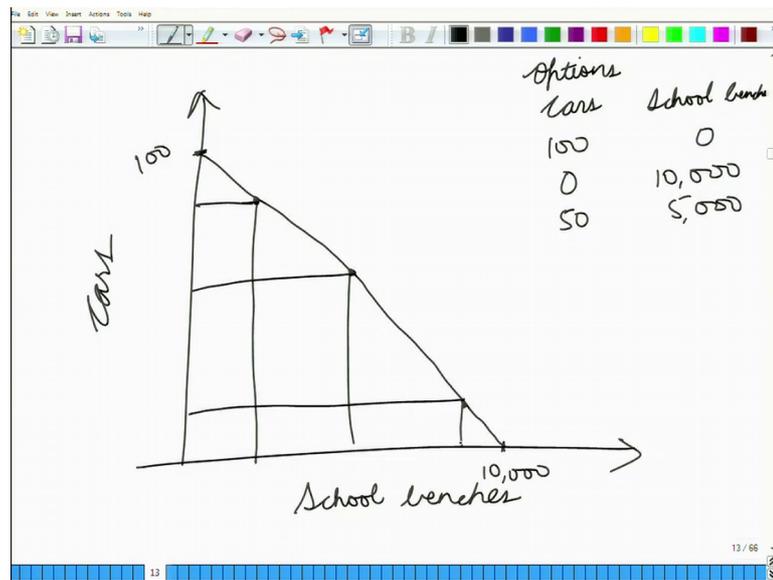
Because we have this choice everywhere, suppose you have a fixed amount of resources and suppose the resources that we are considering is say iron and steel. Now, this iron and steel and to take things in a very simple manner let us say that we can use this iron and steel either to manufacture cars or to manufacture school benches. So, we have two choices, we can either make cars or we can make school benches.

Now, in this example what we are referring to is that if we make more number of cars, so the affluence of general community will increase and if we make more number of school benches, so we are taking the we are trying to make the community more and more educated we are giving much more attention to the children. So, do we give more attention to adults or do we give more attention to the children.

Now, the amount of resources that we have is fixed it is limited. So, suppose we have let us say that in this fictional country we have say 100 tonnes of iron and steel. Now, with that 100 tonnes of iron and steel we can make cars, and if we make if we put all of this 100 tonnes of iron and steel into cars let us say that we are able to make 100 cars.

On the other hand, if we use all of it to make school benches then probably we will be able to make say 10,000 school benches. Now, we have this choice that we can devote all of it to making cars, so we make 100 cars and 0 school benches or we may we devote everything into school benches and we make 10,000 school benches and 0 cars. So, what are the options that we have?

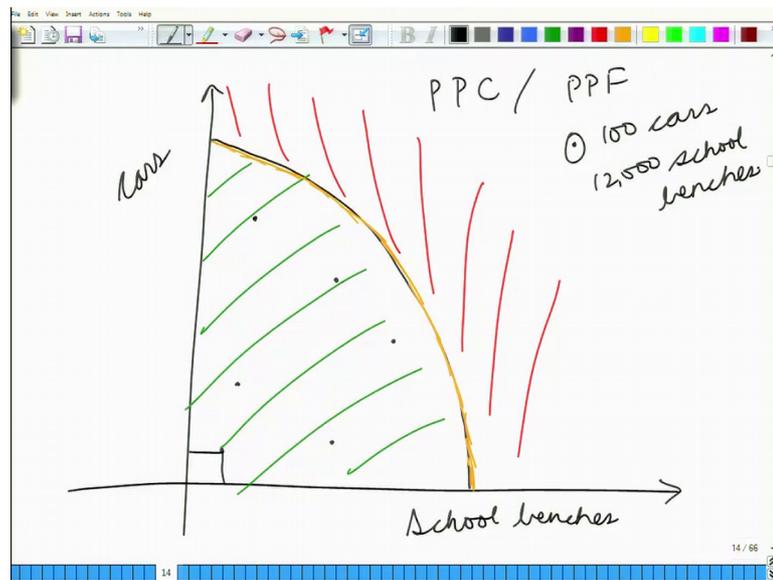
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So, here are the options. So, you have cars and you have the school benches. So, you can make 100 cars and 0 school benches or you can make 0 cars and 10,000 school benches or maybe something in between maybe you can make 50 cars and may make 5000 school benches. So, typically your 50 cars would come somewhere here and your 5000 school benches would come somewhere here.

So, in this case you have this curve that is giving you the option of how many cars and how many school benches you can make. You can say make this much amount of cars and this much amount of school benches, and this case you are making 80 cars and maybe you are making 2000 school benches or you make just 20 cars and you make 8,000 school benches. So, now this is a choice that you have as a society or as a nation. Now, this thing is referred to as a production possibility curve.

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And in general, the shape of the curve is something like this, because typically if you are trying to make suppose you are making this is your cars, this is your school benches. Now, typically we have seen that the rate at which you can make something is very large in the beginning because you are if you are moving from say 0 school benches to say 10 school benches it is much more easy to develop technologies such that you are able to make 10 school benches. But then if we are trying to move from say 9,990 school benches to 10,000 school benches making an increment when you already have a very high level of productivity that becomes much more difficult.

So, in that case this is your curve and this is known as the production possibility curve or the production possibility frontier. And in this case, you can take any point that is inside this. So, as a society you might even decide that you will make only say 1 car and you will make 1 school bench and you will keep all of your remaining iron and steel as such. Now, that is not the most efficient utilization of your resources because as economists we would want to make the fullest utilization of resources.

So, anything that is within this curve, anything that falls in this green area is something that you can choose. Anything that falls on this particular curve or that falls on this yellow line is the most efficient way of utilizing your resources, but then you will have to make a choice between what you want. And anything that is outside or that is in this red region is something that you cannot make because your resources are limited.

So, suppose you said that I am going to make 100 cars and I am going to make 12,000 school benches. So, at this point you have 100 cars and you have 12,000 school benches, but then your amount of iron and steel is such that you cannot go with both of these. So, you will have to restrict yourself somewhere. Now, similarly when we are talking about the environment and if we are making any technology we again have to make a choice.

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Handwritten notes on a whiteboard:

- Cost of pen = Cost of manufacturing (₹10)
- # pens afforded = 10
- $I = P \times (A) \times (T)$
- Cost of pen = Cost of manufacturing (₹10) + Cost of treating wastes (₹10)
- = ₹20
- # pens afforded = 5
- Requirement/Need = 6
- Vertical text on the left: Average person has ₹100

So, in this equation when we talked about I is equal to P into A into T. When we are when we are altering the technologies we have this option of how much of technology to put into affluence of people and how much amount of technology to put into the environment.

Now, say suppose you are making this particular pen. Now, you could choose a technology that makes this pen in the cheapest possible cost. So, maybe you are able to make this pen for say 10 rupees and these 10 rupees is the cheapest you can make this pen. Now, if you are making this pen at a lower cost, so in that case the effluence of the people will be more because say a person has say 100 rupees. So, he will be able to purchase 10 of these pens.

On the other hand, if you are able if you produce this pen at a larger cost say you are able to produce this pen at 20 rupees. So, any person will be able to afford only 5 of these pens, but then when you are making this pen and you are only considering about the cost of this pen only when you are only thinking about the affluence of the society it is

possible that you are releasing quite a lot of pollutants into the atmosphere because you are not treating those pollutants. So, when you are making this pen it will give rise to certain pollutants and you are not treating those pollutants, so that you can reduce the cost of this pen.

Maybe suppose if you treat all of those pollutants if you say that no I am not going to release all any of these pollutants into the air or our water because I am very concerned about the environment. So, in this case let us say that it takes 10 more rupees per pen to take care of all the pollutants. So, you are able to convert all of your pollutants into non harmful substances, but then that takes 10 more rupees.

So, in that case your cost of pen will become the cost of manufacturing plus the cost of treating waste. Now, the cost of manufacturing goes 10 rupees and the cost of treating waste was again 10 rupees. So, it becomes in total 20 rupees. Whereas, earlier when you were only making the pen you were not treating the waste your cost of pen was equal to the cost of manufacturing which was 10 rupees.

Now, in this case and let us say that an average person in your society, so the average person has 100 rupees. Now, in the first case the number of pens that get afforded by the person becomes 10 and in this case the number of pens that are afforded by the person it becomes only 5 because 100 divided by 20 is only 5. So, here what we are discussing is how much amount of resources do we put into affluence and how much amount of resources do we put into the environment.

Now, earlier, so like till the 60s we had this notion that ok, we have a small population on this earth and we have plentiful of resources there is so much amount of ocean, so many lakes where if we can dump our pollutants and we did not know about the ecological impacts of a number of the of a number of pollutants that we were throwing into our water bodies.

And so, in those days it was very easy to say that let us reduce the cost of this pen as much as possible, so we make this pen for 10 rupees and we want to have as much amount of affluence as we can give to the people. But these days now that we know that our resources are limited our waste pools are limited, we cannot dump all of these waste materials into the ocean bodies because ultimately it will come back to us. So, now, we are talking about treating all these days and now we are talking about using a technology

in a way such that you are able to put least amount of impact on the environment. But then when you are putting your or when you are using your technology in a way that you are saving the environment.

So, you are not saving it just for yourself you are saving it for the future generations you are saving it for your children or your children's children and so on. So, if you are doing that in the current generation you will have to make do with certain sacrifices. You will only have 5 pens. So, you will have less resources for yourself if you are saving these resources for the posterity or for the future generations. And here in comes the topic of sustainability.

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Module 9: Topics in human Ecology Sustainable development

Definition

"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts:

- 1 The concept of 'needs', in particular, the essential needs of the world's poor, to which overriding priority should be given; and
- 2 The idea of limitations imposed by the state of technology and social organisation on the environment's ability to meet present and future needs.³⁸"

³⁸ Brundtland, G., 1987. Our common future: Report of the 1987 World Commission on Environment and Development. United Nations, Oslo, 1, p.59.

Dr. Ankur Awadhya, IFS Wildlife Ecology Spring 2019 66 / 102

Now, sustainability is defined as or sustainable development is defined as development that meets the needs of the present without compromising the ability of the future generations to meet their own needs. So, essentially what you want is you want to have a development such that you are able to meet the needs of the present.

Suppose in your current generation you require say 6 pens and if you devote all if you devote 10 rupees into treating of the waste, so in place of get your requirement or your need is say 6 pens. And you are if you devote everything into the future generations you are only able to get 5 pens. So, that is not a good scenario because you are not able to meet your needs.

But then there is a difference between needs and wants, so probably I might need 6 pens, but probably it is also possible that I might want 1,000 pens. So, there is a difference between need and want. So, when we are talking about needs, we are talking about the genuine requirements of every person, we are not talking about what every person wants.

So, in this definition we are saying that it is development that meets the needs of the present, we cannot go away by not meeting the needs of the present because the present generation also requires medicines, the present generation needs to be educated, the present generation requires jobs, the present generation requires some level of comfort. But and in this case, we are not overlooking those needs or those requirements.

But at the same time, we should not be compromising with the ability of the future generations to meet their own needs. So for instance if just because my needs are 6, but I want 10 pens; so if I make 10 pens in this method that I am not treating any of the waste materials so it is possible that I live in an environment for the future generations in which they will not be able to meet their needs. Because the environment will be so polluted or the environment will be having so few number of resources that I am geo paralyzing with their needs.

Probably, I am releasing so much amount of waste materials into the into the landfills that that probably now we have less number of landfills that are available for the future generations. Or probably I am dumping so much amount of pollutants into the atmosphere and into the water bodies that the future generation will not be able to meet their needs for of a proper amount of food. So, that is a choice that we need to make.

So, such in the case of sustainable development we want a development that meets the needs of the present without compromising the ability of the future generations to meet their own needs. So, we are taking not just the current need into picture, but also the future needs. And this concept contains in itself two key concepts, the concept of needs in particular the essential needs of the world's poor to which overriding priority should be given. So, in this case I cannot say that we need to make some cuts. So, let us cut the amount of resources that the poor's have because I do not want to compromise with my level of comfort.

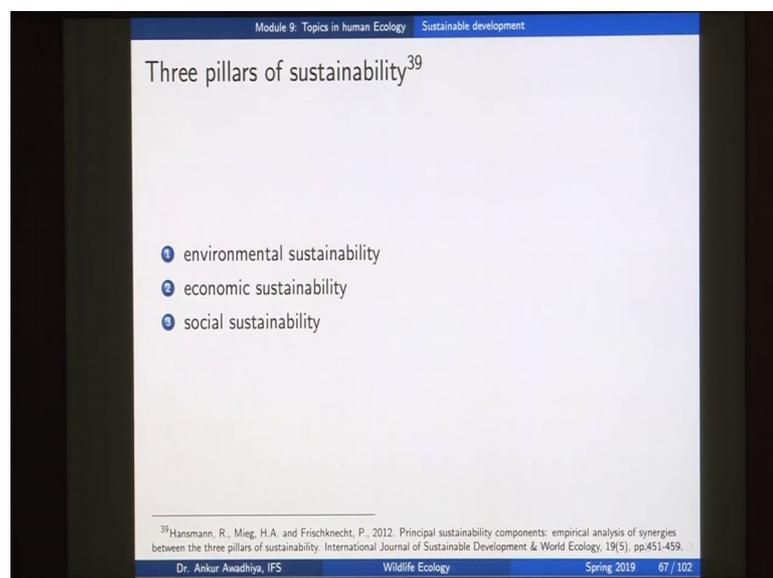
So, that is not something that can be done, because you have to give ample resources to the poor as well because they also have the right to develop themselves. So, here when

we are talking about needs it does not mean to wants. So, the concept of needs is essential needs and especially all the essential needs of the world's poor need to be met.

In the second idea is that of limitations that are imposed by the state of technology and social organization on the environments ability to meet the present and future needs. So, essentially what it is saying is that the environment has a limited ability to serve the needs of the present in the future generations.

If the environment had an unlimited ability, so any amount of pollutants that we dump into the environment it would be fine. But just because the environment is also limited in its ability, so which is why we need to make these choices. And when we are making these choices we need to ensure that all the essential requirements especially of the world's poor also have to be met. Now, this is the definition that was given by the Brundtland Commission and the report is called our common future and this is a very worth reading document.

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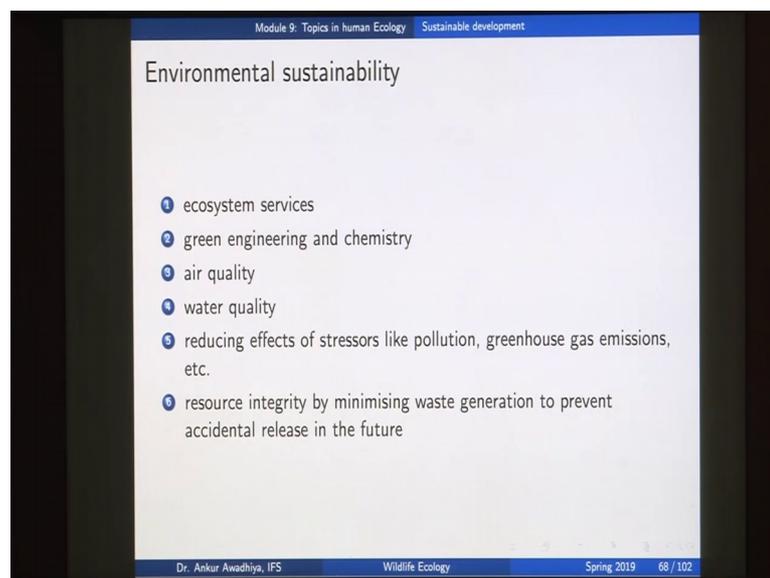


Now, when we are talking about sustainability or when we are talking about sustainable development there are three pillars that we need to take care of. One is environmental sustainability; that is the current usage of environment should be such that we are able to meet our needs, but at the same time we are also able to need meet the needs of the future generations.

Similarly, we have the concepts of economic sustainability. Our economic structures have to be such that they are able to persist, they are able to prevail and even our future generations are able to meet their own needs. And similarly, we have social sustainability; our social structure has to be such that everybody has opportunities to meet their own needs.

If we make a social structure in which we have some people who are extremely deprived and we have some people who are extremely affluent. So, in that case this structure will not be able to persist or prevail for a very long period of time and we will say that this structure or that or this kind of society will not be a sustainable society. So, we will now look at all three of these.

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When we talk about environmental sustainability, we are talking about say things like ecosystem services. What are the services that are being provided by the proper functioning or the bill functioning of an ecosystem? So, things like oxygen. So, oxygen is given by the plants when they are doing photosynthesis. So, when we are talking about environmental sustainability, we need to have ample number of plants that we are able to get ample amount of oxygen or services that are provided by biodiversity such as pollination.

So, pollination is done by insects. So, we need to have ample number of insects that we are able to meet this particular need of pollinating our crops or things like the impacts of

the predators. So, there are certain predators that eat up the insects that cause diseases. So, we need to have ample number of frogs into our system; that is also an ecosystem service that is being provided.

So, in the case of environmental services we talk about ecosystem services, we talk about things like green engineering and chemistry, which is using engineering and chemistry in a way that we are manufacturing such products that are not harmful to the environment. We talk about things like air quality and water quality they also need to be maintained not just for the present generation, but also for the future generation.

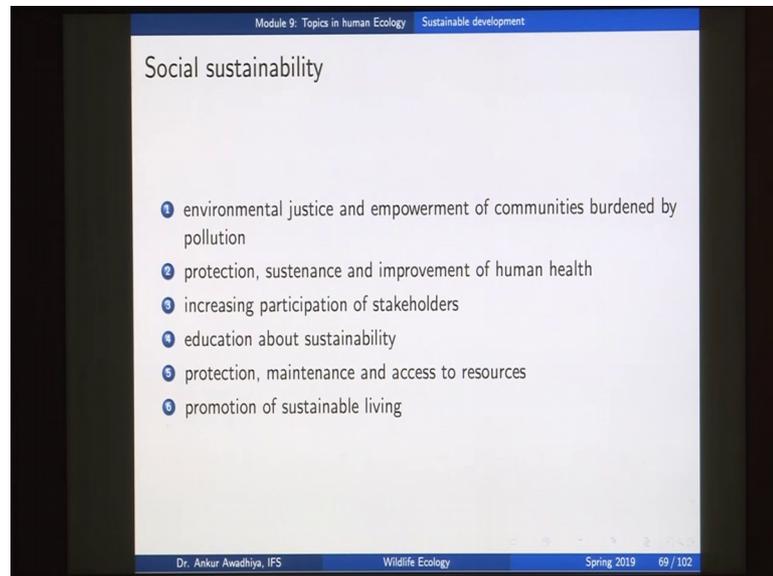
So, the amount of pollutants that we are releasing into the environment needs to be regulated. Or we talk about reducing the effects of stressors like pollution greenhouse gas emissions etcetera. So, in this case what we are saying is even those amount of pollutants that need to be released into the environment to meet the needs of the present generation we should try to reduce their impacts. So, if for instance we are generating electricity by burning coal. So, we will have to release certain amount of greenhouse gas emissions, but then are there ways in which we can reduce these greenhouse emissions.

Is there a way in which we can sequester this carbon especially on site? So, if there is a power plant that is using a coal. So, it is giving out a lot of carbon dioxide into its flue gases. So, is there a way in which we can capture this carbon dioxide? We also talked about things like resource integrity by minimizing waste generation to prevent accidental release in the future. So, in this case what we are talking about is that when we are manufacturing something or when we are doing any process is there a way in which we can minimize the level of waste that is generated. Because if there is a waste that is generated that will have to be stored somewhere and if this waste is stored somewhere then probably in future it might there might be an accidental release of this waste.

For instance, if you are putting all your waste in a large size landfill and this landfill is now all full and it has now converted into a mountain, it is possible that this landfill might topple someday and some people might be killed because they are because this landfill falls on them. Or probably in if you are manufacturing electricity using nuclear reactors and we are generating a huge amount of waste and we are storing this waste somewhere it is possible that in future there might be some leakage from this facility and

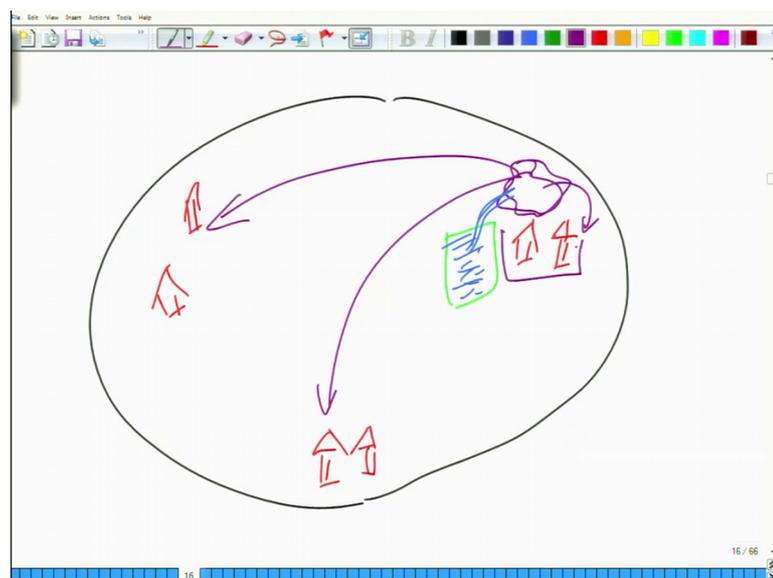
all these radioactive nuclides will come out. So, these are the things that we talked about in environmental sustainability.

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In the case of social sustainability, we talked about things like environmental justice and empowerment of communities that are burned by pollution.

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Let us say that we are doing a mining operation that is near to a village. So, in this case we have this big area and in this big area you have certain villages. So, you have a

village here, maybe a village here and maybe a village that is here and let us say that we are doing some mining operation in this area.

Now, when we are doing this mining operation there will be some amount of waste that are released from these mines. So, probably let us say that we are mining out copper minerals. So, when that happens a lot of copper sulphate will come out. Now, that copper sulphate might then get into the fields of these people. So, this copper sulphate is flowing out and it is getting into the fields of these people, and once that happens when you have all this copper sulphate the plants are unable to grow properly.

Now, do we need to take out these minerals? Yes, but then when we are taking out these minerals, we are providing benefits not just to these people, but also to these people and also to these people because the copper that is being generated will be consumed by everybody. But the negative impacts that will be suffered will be suffered only by this particular community.

So, when we are talking about environmental justice, we are saying that the communities that are burdened by pollution they also need to be empowered. So, there has to be a mechanism in which they are properly compensated so that they are able to lead their lives in a proper manner. Or we talk about things like protection sustenance and improvement of human health or things like increasing the participation of stakeholders. So, probably in this mining company you have these villages that are there as stakeholders and they are not having any empowerment.

So, it is possible that when the when this copper sulphate is coming out, it is possible that the company might set up a small plant where this copper sulphate can be treated maybe it can be crystallized and sold somewhere else. And that would be an operation that will not be cost intensive, in fact, it will be giving you some amount of revenue or it will be giving the company some amount of revenue.

But then probably the people in the company they just do not want to set up this copper sulphate plant because they are not feeling a huge need because in the case of their mining operations they are earning in crores and probably this small facilities will be able to give them say only a few lakhs of rupees. So, they are thinking that we are getting so many crores of rupees what is the benefit of putting so much amount of energy and money into getting something that should be only a few lakh worth. But then in this case

they are only thinking about their own profits. they are not talking about the negative impacts that they are given to this community.

Now, if the people of this community were empowered, if the people of these community were given such powers that they were able to direct the company or maybe influence the decision making of that particular company. Now, if that is the situation these people might prevail on the company and they might say no if you want to carry on mining any further you will have to set up this facility because you are polluting our fields you are polluting our water bodies. So, empowerment can bring about a lot of changes and might lead to a lot of good to the environment as well.

So, we talked about increasing the participation of stakeholders. When the company needs to make a decision does it ask the people who are there in the surroundings, does it ask all the stakeholders what do they want? And if we are able to create a situation or a condition in which the participation of the stakeholders increases, so that will lead to a lot of social sustainability. Or we talk about things like education about sustainability. Maybe a lot of people just do not know about what environmental pollution is or do not know what are what do we mean by ecology and what are the impacts that are being brought about to the ecology to the functioning of the ecosystems because of our different activities.

So, this is where education about sustainability also comes into picture or education about the harms we are going to the environment or education about what can be done to reduce these harms. So, for instance when you are doing this course you are getting an idea about what are the how does an ecosystem function, what are the human influences on that on that ecosystem, how can we reduce those influences, what are the different processes that are going on in ecosystems and so on.

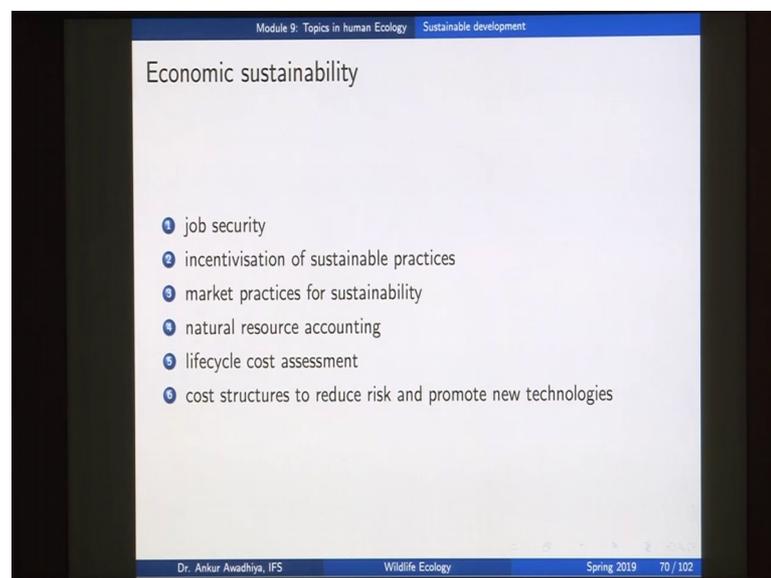
Now, this education empowers you and it puts you in a position where you can ask questions. So, you can write to your local representatives, you can write to your MLAs, you can write to your MPs, if there is something wrong that is going on. You can write to the newspaper, so that you can you are able to bring about a change in the public opinion. If everybody thinks for instance that there is one particular area where you should not have a particular port that is coming up. So, things can be changed, but that is only possible when more and more number of people have this education.

So, when we talk about social sustainability we have to talk about education about sustainability, if is that provided is that being provided to the members of the society or we talk about things like protection, maintenance and access to resources. So, protection of resources things like your forests are a resource, are they being protected enough, are they being maintained properly, do you have an idea about how different populations of different organisms are growing up and down.

If there is a death in a carnivore population do you know what were the reasons, what is being done to maintain them properly. So, these are the things that we ask. Do you have enough access to resources? So, probably you have a resource in the form of a river and or maybe in the form of a pond and there are only a few people in the village that have the access to the resource.

If you are talking about social sustainability you will have to make a situation in which everybody has proper access to the resources. So, that they can also meet their own needs and we talk about promotion of sustainable living which we will come to in a short while.

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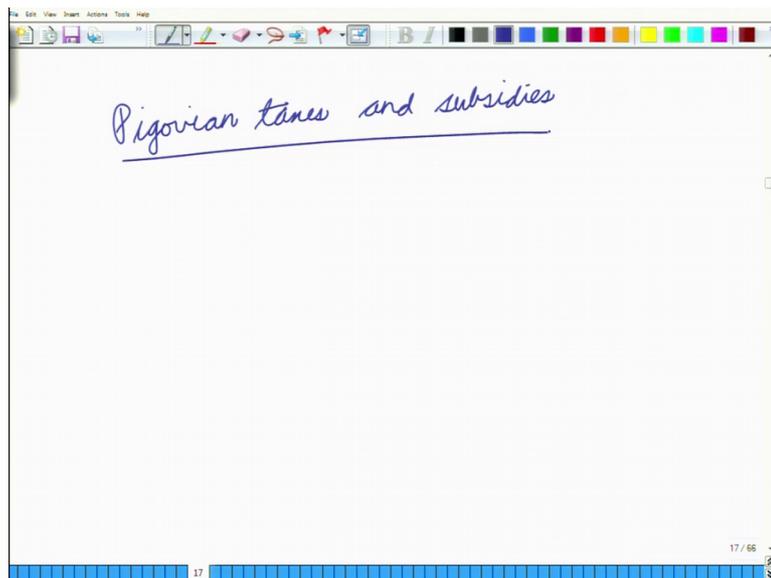


Then the third thing that we need to talk about is the economic sustainability. Do people have job security? If people do not have job security, if they do not have stable jobs then whatever amount of talking we are doing about sustainability nobody will pay a heed. So, you will have to make a situation where people are able to get jobs, where people are

able to maintain their jobs, and this can only be done through economic means other things are things like incentivization of sustainable practices.

So, for instance we talked about the situation of making a pen and if there is a company that is treating the based. So, do, is there a mechanism in which we can incentivize this company or is there a mechanism in which we can penalize this company that was releasing all its ways out into the environment. Are there some kinds of taxations that we can put on people or are there some kinds of penalties that we can put on people who are harming the environment or is there some kind of subsidy that we can give to those people who are protecting the environment or diverting all the steps such that their impact on the environment is lessened. So, these are things that we discuss in the case of economic sustainability.

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And in this case one important concept is that of Pigovian taxes, Pigovian taxes and subsidies. Now, a good example is the taxation that is put by the government on things like cigarettes. Now, cigarettes are something that we as a society want to reduce or we want people to be dissuaded from using cigarettes because they not only harm themselves, but they also hump the surroundings, they also harm the environment. Now, Pigovian taxes are those taxes that are put into some material such that it becomes more and more expensive for people to use that particular resource. So, this is a tax that the

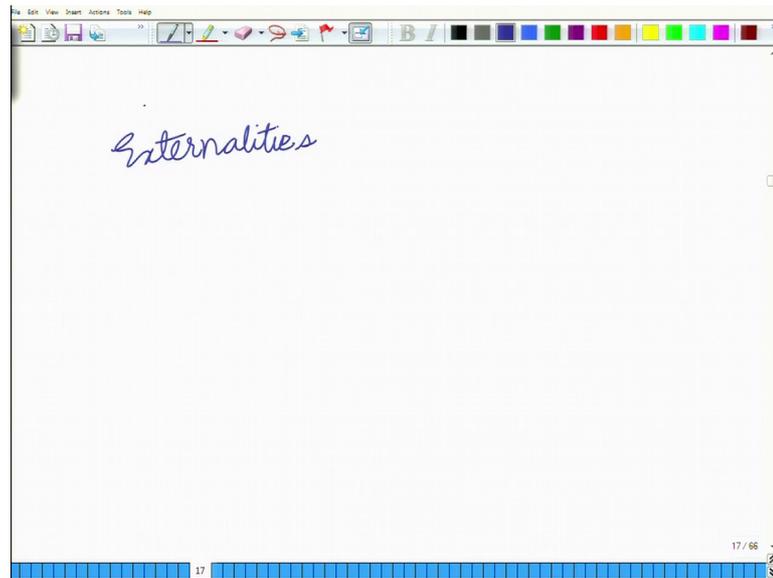
one man puts not because it wants a revenue, but because it wants people not to have access to this resource; so this is a Pigovian tax.

We can also talk about things like Pigovian subsidies. Now, Pigovian subsidy is say a subsidy that we are giving to the manufacturing of pen or a subsidy that we are giving to the manufacturing of textbooks or manufacturing of notebooks. So, these are things that we as a society want to promote. So, in that case the government will give some subsidies to these particular sectors, so that their manufacturing becomes easier and people have more and more access to these things.

Now, these when we talk about topics like these we are talking about economic sustainability by incentivization of sustainable practices or maybe penalization of non-sustainable practices or we can talk about things like market practices for sustainability or things like natural resource accounting. When we are doing an accounting of resources every company does an accounting, but then that accounting is it only limited to the profit and loss or the amount of money that the company is getting is it only confined to the cash flows of the company or does it also take into account the amount of natural resources that are being used by the company.

If there is a mechanism by which we can make this compulsory then we are talking about economic sustainability or things like lifecycle cost assessment. So, for instance, if you are using polythene bags. So, polythene bags are very cheap to manufacture, but then if you consider the whole life of the of the polythene bag once you have used it you have thrown it into a dustbin, then it will go it will kill off some organisms, it will say choke your drains, it will choke certain animals to death and so on. So, the lifecycle cost is very high, it is extremely light in weight so it gets dispersed to a very large area. So, collecting it becomes very cost intensive. Now, are you able to put all of these costs into the cost of the polythene bag? That is the question.

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So, what we are talking about here is externalities. Now, externalities are situations where your action is leading to some positive or negative impact on a bystander who has got nothing to do with what you are doing. So, for instance, if you are smoking a cigarette and you are putting that smoke into the lungs of somebody who is standing nearby.

So, you are giving that person a negative externality, that person is not smoking the that person is not gaining anything out of your smoking, but that person is actually getting the harm. Or for instance, if you are using a vehicle that is extremely polluting and you are polluting all the surroundings. So, the people who are living in that surroundings they are not getting the benefit of using a car only you are getting the benefit, but then you are putting a cost that is external to you that is being paid by the society. So, that is an externality. And externalities can be positive or they can be negative externalities.

So, negative externalities are things like pollution that we just talked about. Positive externalities are things such as if you get educated yourself, if you know more about environment then the society gets a benefit. Why? Because when you are educated you can write to your MPs, MLAs, you can write to the editors of newspapers, you can bring about policy changes and once that happens then the society is also getting a benefit. So, that is a positive externality.

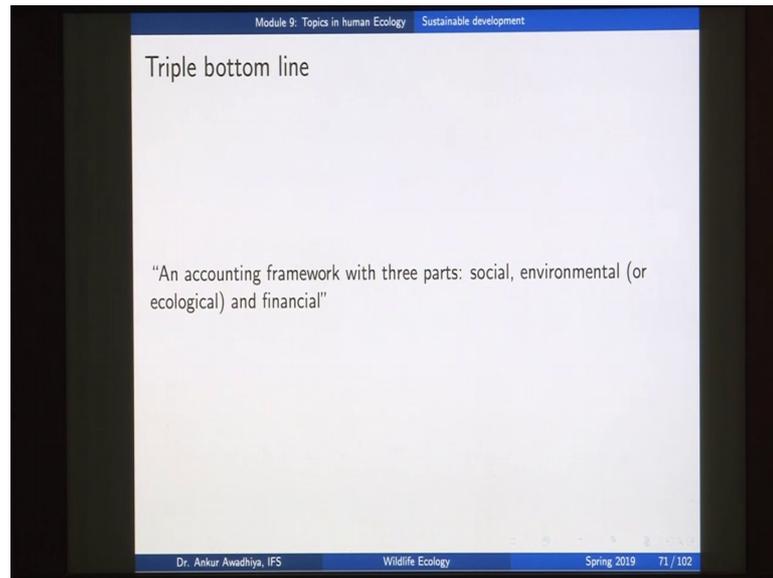
Now, in the case of economic sustainability what we are asking is when we are talking about the cost assessment of anything are we taking the whole lifecycle cost into account, are we putting all the negative externalities that this thing is giving out into the cost of that material.

So, when we are talking about say a polythene bag, do we include the cost of cleaning that polythene bag or picking it up from there from the surroundings into the cost of this particular polythene bag because once we do that the polythene bag will become so expensive and say things like bio plastics will become so cheap that the society will automatically shift from a polythene bag to a bioplastic bag. But till that is done and that is only possible when you are able to put in the lifecycle cost assessment into the cost of different products.

We also talk about cost structures to reduce the risk and promote the new technologies. So, for instance if I want to put up a solar panel on to my house and getting a solar panel it is expensive and probably if I put up the solar panel so I am putting up a lot of cost and I do not know what is the return that I will get in future. So, can I can be either society have a cost structure, such that this becomes easier for people to buy, maybe through subsidies or maybe by an agreement through which government says that if you are putting up this solar panel the electricity that you are producing will buy up this electricity at this particular rate.

Now, if such kinds of cost structures are put in that are able to incentivize these new technologies. So, in that case these new technologies will be used in a much larger way or are there ways to reduce the risk that are associated with the new technology. So, all these things are talked about when we are talking about economic sustainability.

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And when we include all these three kinds of sustainabilities into our accounting framework we talked about the triple bottom line. So, bottom line is a concept that is used in finance and economics which tells us what is the profit or the loss of any particular company.

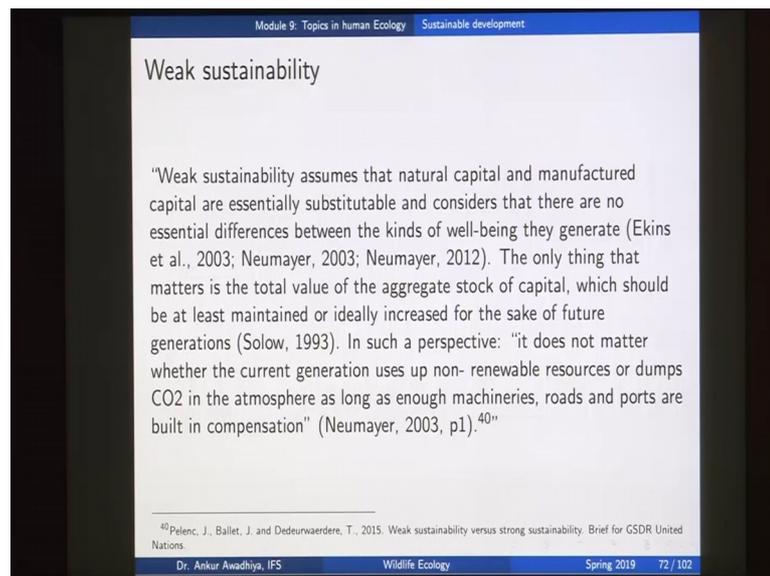
Now, when we talk about the triple bottom line, we are talking about any an accounting framework with three parts. Social bottom line, so in the case of social bottom line will ask this question that whether this activity is leading to a profit to the society or a loss to the society and this profit and loss in is not in the terms of economics a concept that is used in finance and economics which tells us what is the profit or the loss of any particular company.

Now, when we talk about the triple bottom line, we are talking about any an accounting framework with three parts. Social bottom line, so in the case of social bottom line will ask this question that whether this activity is leading to a profit to the society or a loss to the society. And this profit and loss in is not in the terms of economics, but in terms of whether people are getting more and more empowered whether people are able to get justice where the people are able to get jobs and so on.

We will have the environmental or ecological bottom line, which means that are we harming the environment or are we protecting the environment, is the environment getting a profit or a loss, is the environment getting better or is the environment getting

worse. So, if we include that then and if we include the financial bottom line which is already there which talks about the profit and loss in the financial terms. So, along with our normal profit and loss if we talk about the social and the environmental profits and losses or whether our structures are improving or deteriorating in the social aspect and in the environmental aspect is will then we are talking about triple accounting.

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And when you talk about sustainability it is important to differentiate between weak sustainability and strong sustainability. Now, weak sustainability assumes that natural is capital and manufactured capital are essentially substitutable and considers that there are no essential differences between the kinds of well being they generate. The only thing that matters is the total volume of the aggregate stock of capital which should be at least maintained or ideally increased for the sake of future generations.

In such a perspective it does not matter whether the current generation uses up non-renewable resources or dumps carbon dioxide in the atmosphere, so long as machineries roads and ports are built in compensation. So, when we are talking about weak sustainability it says that even if you are dumping the environment, even if you are releasing wastes into the environment, but if you are able to get some products out of it.

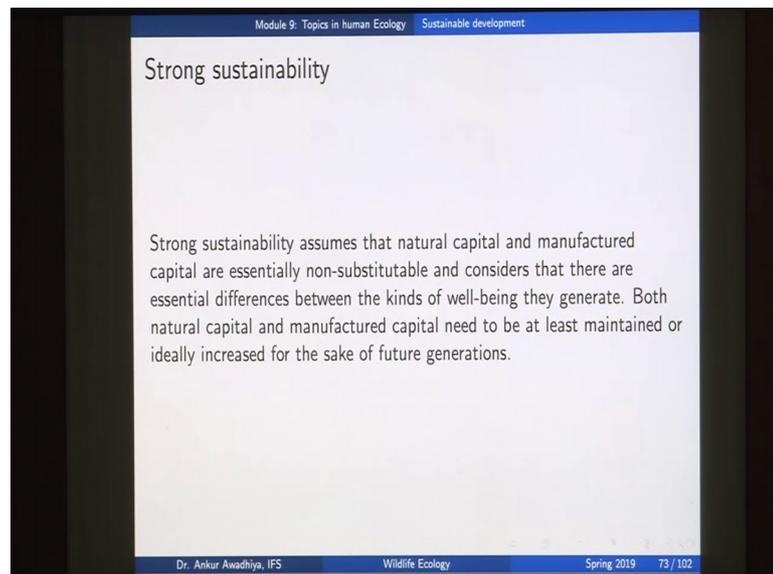
So, you are reducing your natural capital, but you are able to increase your manufactured capital. So, that compensates one another which means that when we were talking about the example of the pen. So, if in the case of this company that was manufacturing the a

pen that was worth 10 rupees and it was releasing the effluent into the environment or whether we talked about this company that is making a pen that is worth 20 rupees because it is putting 10 rupees into the cleanup operations they are one and the same.

Now, we people who are working in the conservation sector we might argue this kind of a logic because we will say that no if you are harming the environment then this is not something that we can make up for by making more number of pens or say if we are trashing the whole of the environment and if we are making a big beautiful house then both of these things cannot be equated together because we need a good house, but at the same time we also need a good environment, we also need pure air, we also need pure water and by trashing the environment we are not getting that. So, these two things are different.

So, you cannot just say that we will trash the environment and will make a good house. And when we bring out arguments, such as these we are talking about the strong sustainability argument, which assumes that natural capital and manufactured capital, a national capitalist things like forests manufactured capitalist things like houses. They are essentially non-substitutable.

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So, if you have a forest and if you do not have a house to live in that is not a good situation. If you have a house to live in, but you do not have a forest to give you pure air that is also not a good situation you need both of these, so these cannot substitute each

other. And, because these are because the natural capital and manufactured capital are essentially non-substitute able because they have essential differences in the kinds of well being that they generate. So, both of these have to be maintained separately and both of these have to be ideally increased for the sake of the future generations. So, for the sake of the future generations we need more number of houses, but at the same time we also require more amount of forests to take care of them.

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Module 9: Topics in human Ecology Sustainable development

Differences: Strong vs. Weak Sustainability⁴¹

PARAMETER	STRONG SUSTAINABILITY	WEAK SUSTAINABILITY
Key idea	The substitutability of natural capital by other types of capital is severely limited	Natural capital and other types of capitals (manufactured etc.) are perfectly substitutable
Consequences	Certain human actions can entail irreversible consequences	Technological innovation and monetary compensation for environmental degradation

⁴¹ Pelenc, J., Ballet, J. and Dedeurwaerdere, T., 2015. Weak sustainability versus strong sustainability. Brief for GSDR United Nations.

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Now, if you look at the differences. So, the first one is that the substitutability that we have already discussed. Now, if you talk about the consequences the strong sustainability which says that things are not substitutable you have to maintain both of these. So, it says that certain human actions can entail irreversible consequences, irreversible consequences on the environment and because you have destroyed your environment. So, you cannot make up for the loss by say building more number of houses or by building a better road.

On the other hand, the weak sustainability would put up an argument the technological innovation and monetary compensation for environmental degradation are good enough. So, which means that it would say that if you are destroying the forest and if you are paying people money or if you are destroying the forest and you are making a good road, so that covers up everything whereas, in the case of strong sustainability it would say that no if you are destroying the forest then you will have to make up for a forest

somewhere else. A forest can only be replaced by a forest, a forest cannot be replaced by money, a forest cannot be replaced by a road, a forest we replaced by houses.

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Module 9: Topics in human Ecology Sustainable development

Differences: Strong vs. Weak Sustainability⁴²

PARAMETER	STRONG SUSTAINABILITY	WEAK SUSTAINABILITY
Sustainability issue	Conserving the irreplaceable stocks of critical natural capital for the sake of future generation	The total value of the aggregate stock of capital should be at least maintained or ideally increased for future generation
Key concept	Critical natural capital	Optimal allocation of scarce resources

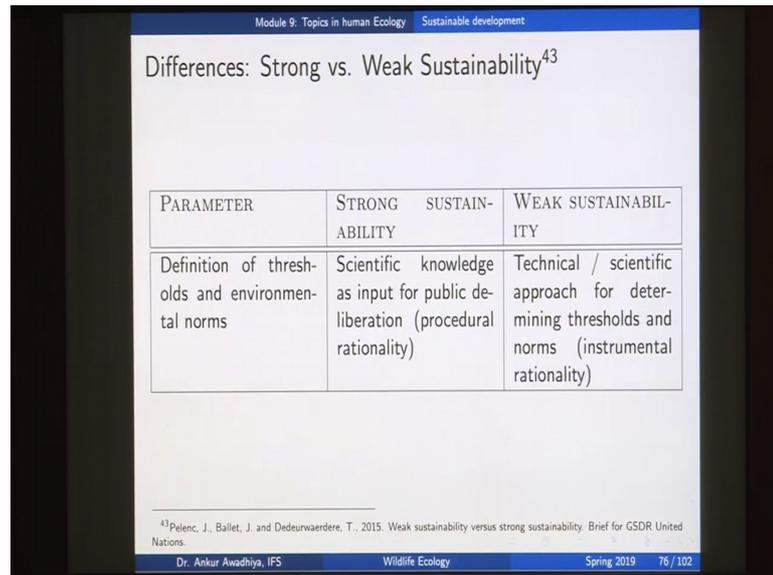
⁴²Pelenc, J., Ballet, J. and Dedeurwaerdere, T., 2015. Weak sustainability versus strong sustainability. Brief for GSDR United Nations.

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Other things are sustainability issues. So, strong sustainability see is that conserving the irreplaceable stocks of critical natural capital for the sake of future generation. So, you have to conserve the irreplaceable stocks of critical natural capital. So, for instance you have to conserve the petroleum that you have, you have to conserve the coal that you have, you have to conserve the forest that you have, you have to conserve the oceans that you have. Whereas, weak sustainability would say that conservation is not important, the total value of the aggregate stock of capital should be at least maintained or increased for the future generation.

So, it is not important to conserve anything. So, long as you are manufacturing something. So, that is the weak sustainability argument. The key concept in the case of strong sustainability is the critical natural capital. It is extremely critical it is not replaceable it has to be conserved. In the case of weak sustainability it only talks about an optimum allocation of these scarce resources. So, as long as you are doing an optimal allocation it is good enough.

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Module 9: Topics in human Ecology Sustainable development

Differences: Strong vs. Weak Sustainability⁴³

PARAMETER	STRONG SUSTAINABILITY	WEAK SUSTAINABILITY
Definition of thresholds and environmental norms	Scientific knowledge as input for public deliberation (procedural rationality)	Technical / scientific approach for determining thresholds and norms (instrumental rationality)

⁴³Pelenc, J., Ballet, J. and Dedeurwaerdere, T., 2015. Weak sustainability versus strong sustainability. Brief for GSDR United Nations.

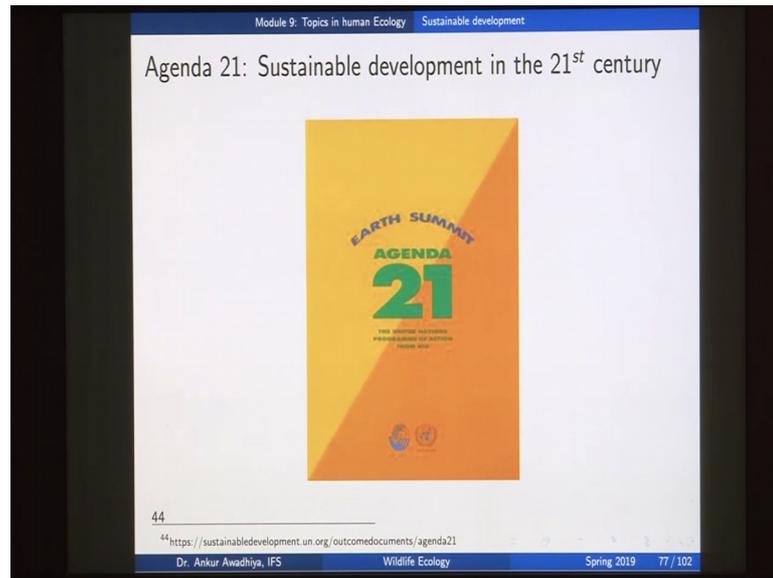
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Then the definitions of thresholds and environmental norms, the strong sustainability says that scientific knowledge is important as an input for public deliberation and for procedural rationality which means the stronger sustainability argument says that we need to study climate change, we need to study different eco systems so that we get more and more knowledge about these things and. So, that we are able to better conserve our environment.

On the other hand, the weak sustainability only talks about technical or scientific approach for determining thresholds and norms that is the weak sustainability would only say, ok, so this is this much is the amount of damage that we can tolerate, so we will have this much amount of damage.

Now, strong and weak sustainability have been a part of the public discourse. So, the policymakers have all have always been discussing whether we should go for a weak sustainability, whether we can degrade our resources to make more capital for the current generation or whether there is a need to go for a strong sustainability in which we need to conserve our resources no matter what.

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And after these deliberations we came up with agenda 21. Now, agenda 21 is an agenda that came up in the RIO summit or the earth summit in 1992 and in this document the world community agreed that that there are certain sectors in which we need to work we need to create situations that we are able to conserve the resources. So, this talks about a strong sustainability in a number of situations and because of this we are now talking about climate change and we are saying that ok, we have to put we need to cap our global greenhouse gas emissions.

So, that the climate change does not cross this threshold of 1.5 degrees Celsius or in the worst case scenario it does not cross the threshold of 2 degree Celsius. Because if we say that ok, we are making more and more roads we are making more and more factories and we are emitting more and more amount of carbon dioxide into the atmosphere and we will be happy that argument does not stand good anymore.

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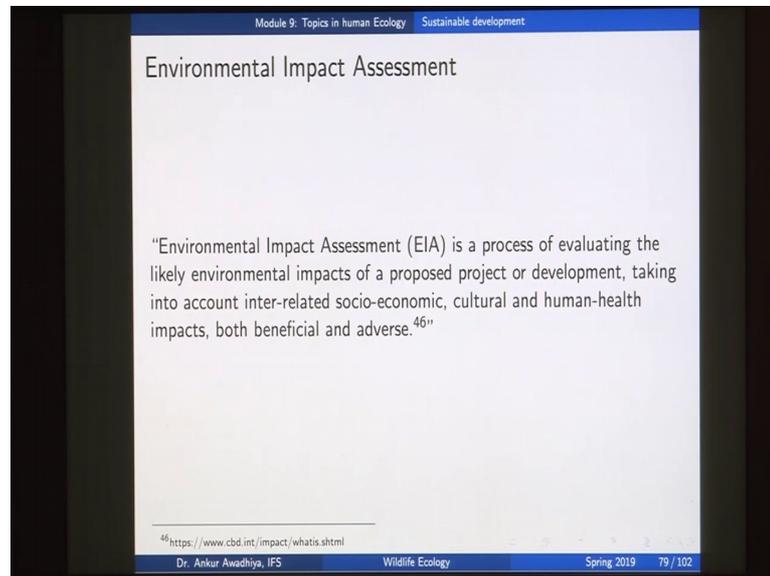
So, after these we have been having a number of cop summits and we have come up with sustainable development goals. So, these are the goals such as we should have no poverty, there has to be 0 hunger, there has to be good health and well-being, quality education, gender equality, clean water and sanitation, affordable and clean energy, decent work and economic growth, industry innovation and infrastructure, reduce inequalities, sustainable cities and communities, responsible consumption and production, climate action, life below water needs to be conserved, life on the land needs to be conserved, we need peace justice and social institutions, we need partnerships for all these goals. So, these are the 17 sustainable development goals that we have come up with as a global community.

Now, once we have set up our goals what do we do, so that we are able to meet these goals. So, there are a number of things that we can do. The first thing is to assess the impact of anything that we are doing. If the environmental impact of something is much greater. So, we will have to reduce our impacts or maybe we will have to go with maybe we will just throw that particular proposal that this proposal is going to put so much negative impacts on the environment that we cannot afford this.

Or probably we will put up some kinds of mitigation measures that if you have to have mining in this area you need also to clean up your operations. You also need to clean up

the air fluids that are coming up in this area, no matter that is going to increase the cost that is going to reduce the profits, but then we have to go with it.

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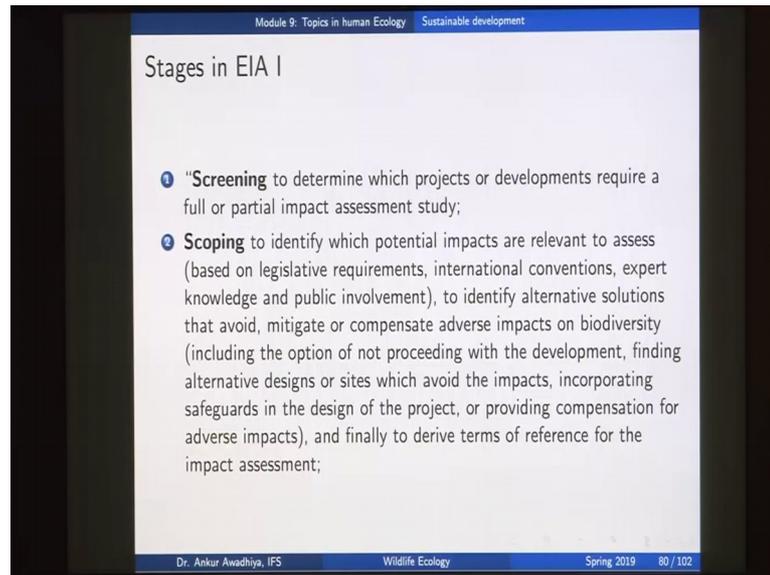


So, the first thing that we need to do is an environmental impact assessment. Environmental impact assessment or EIA is a process of evaluating the likely environmental impacts of a proposed project or development. So, whenever there is any project that has been proposed such as making of a dam.

So, how much area of forest wood will we lose? How much of habitats of different organisms will be lose? How much will be the amount of water logging in that area? All these things have to be assist, before we give a go ahead to that particular project or development and it takes into account the interrelated socio-economic cultural and human health impacts both beneficial and adverse.

So, you need to make a cost benefit analysis. So, we saw this thing in the case of behavioural ecology, every animal makes this cost benefit analysis. Should I go and run after this chital? So, a tiger has to make this decision. Do I go and run after this chital? Expend energy and get this chital or should I just stay here? Now, similarly for each and every of our actions, the human actions we also may need to make this kind of an assessment.

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Now, this assessment is done in various stages the first stage is screening. So, screening determines which projects or developments require a full or partial impact assessment study. So, if there is something that is a very small project then probably, we can let go of the environmental impact assessment, but if there is something that is a bit larger such as a dam or a mining industry that has to go through the EIA process.

The second thing is scoping. So, after screening we go with the scoping stage, scoping identifies which potential impacts are relevant to assess. To identify alternative solutions that avoid mitigate or compensate adverse impacts on biodiversity and finally, to derive terms of reference for the impact assessment. So, for instance if there is a dam that needs to be built up this dam is above a certain size limit or above a certain cost limit.

So, we put it into the next stage which is the scoping stage and the scoping stage will identify what are the impacts that we need to assess. Do we need to assess water logging in this area or not? Probably if there is some area that suffers from n number of earthquakes and because we know that if you have a big dam that will also increase the propensity of getting an earthquake in that area then probably we need to assess that as well.

So, scoping will come up with water impacts need to be assessed. And it will also identify the alternative solutions if there is something that we can put up to mitigate the impacts and it also derives terms of a difference for the impact assessment.

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Module 9: Topics in human Ecology Sustainable development

Stages in EIA II

- 1 **Assessment and evaluation of impacts and development of alternatives**, to predict and identify the likely environmental impacts of a proposed project or development, including the detailed elaboration of alternatives;
- 2 **Reporting** the Environmental Impact Statement (EIS) or EIA report, including an environmental management plan (EMP), and a non-technical summary for the general audience.
- 3 **Review** of the Environmental Impact Statement (EIS), based on the terms of reference (scoping) and public (including authority) participation.
- 4 **Decision-making** on whether to approve the project or not, and under what conditions; and

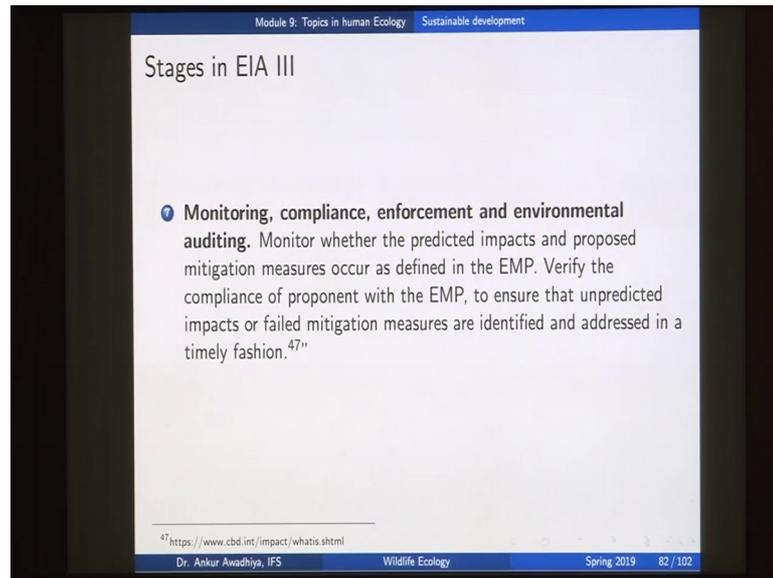
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So, after scoping we move on to the assessment. So, in this stage we do an assessment and evaluation of the impacts and development of the alternatives. So, we have listed all the different topics that we need to study next we study those topics. Once the assessment is done, yet we make up a report that is known as an EIA report or an environmental impact statement.

So, in that case whatever where our findings in the this stage of assessment we put it up in the form of a formal report. Once this report is formed it is put through the review process not. in the review process it is given to the decision makers probably there would be some amount of public hearings.

So, once this report has been made it will be made open to the people who are living there probably they will come up with some other things that have been missed out some other things that need to be incorporated while taking a decision. And on the basis of this review and on the basis of your public hearings and participation, then the decision makers make a decision, do we need to have this project or do we not need to have this project. And if we need to have this project here what are the other conditions that will apply to this project what are the mitigation mechanisms that will incorporate along with this project.

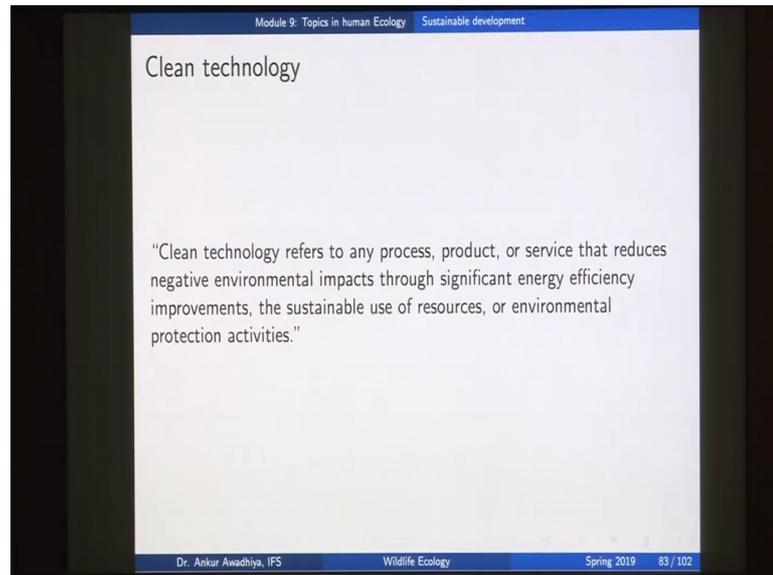
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And after this after making this decision and once, this project is on the last stages monitoring compliance enforcement and environmental auditing. So, for instance in the case of a mining project we said that ok, we will give a go ahead to this mining project, but then they need to treat their effluents. So, this last stage of monitoring compliance enforcement it will ask this question is the company, but doing this effluent treatment in a proper manner or is it just a sham or probably are they leaving out quite a number of effluent, they are only treating say 10 percent of the effluent.

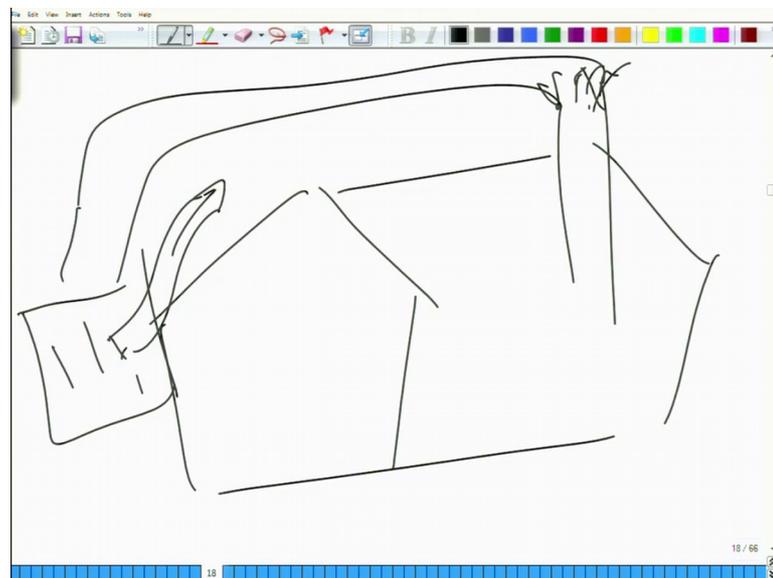
So, the environmental impact assessment does not end at making the report after you have taken the decision, you also need to see whether the recommendations are being followed or not. So, that is one thing.

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The second thing is promotion and development of the clean technologies. Now, clean technology refers to any process, product or service that reduces negative environmental impacts through significant energy efficiency improvements, sustainable use of resources or environmental protection activities.

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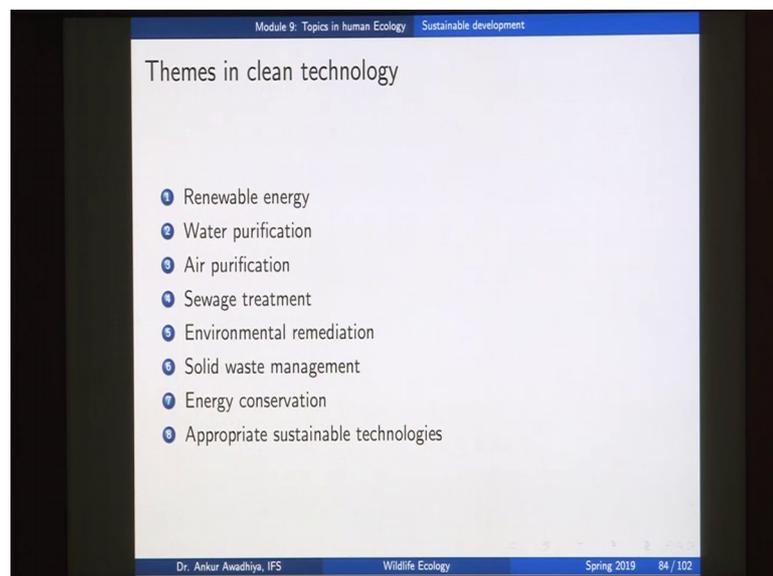
So, for instance a clean technology will be something like you have an industry in an area and this industry is giving out quite a lot of flue gases and probably you as a clean technology you set up a structure in which these flue gases are taken out. And then they

are put through some treatment chamber and then they are released back, so that the amount of discharge into the environment it reduces. So, that would be our clean technology.

Any process, it can be a process, it can be a product, it can be a service that reduces the negative environmental impacts through significant energy efficiency improvements. So, for instance when one mid came up with this program, that you will replace the incandescent bulbs with LED bulbs. So, that is providing us with a lot of with a significant energy efficiency improvement. So, that will be counted as a clean technology or which goes with a sustainable use of resources. So, sustainable use of resources such as if you are having say petroleum and you are using it for making something and you are able to increase the efficiency.

So, from say 1 litre of petroleum you were earlier able to make 300 grams of plastic. Now, in place of 300 grams of plastic you are able to make say 400 grams of plastic. So, that will be a more sustainable use of resources because of an increase in the efficiency or environmental protection services. Environmental protection services such as wastewater treatment or say effluent treatment and so on.

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Now, there are some common themes that are running in the clean technology sector, we talk about renewable energy that needs to be promoted, we talk about water purification and air purification, we talk about sewage treatment environmental

remediation. So, in the case of environmental remediation, there is an environment that has already been polluted and we are trying to remove those pollutants from that environment. Maybe through putting up some particular species of plants that are absorbing those pollutants or maybe by using some chemical processes or some physical processes; so, that is environmental remediation.

Things like if you have a water body in which say oil has been released and this oil needs to be cleaned up. So, that is an environmental remediation operation. Or if there is an area where the mining has released copious amounts of mineral salts and those mineral salts are proving toxic to the plants, so they need to be removed. So, that will be called as environmental remediation.

Then, we talk about solid waste management, we talked about energy conservation or in increasing the efficiency of different gadgets and devices and we also talk about appropriate sustainable technologies. Now, appropriate technology is a technology that might not be having a very large skill that might be a very small scale technology, but that is appropriate for that particular society and that is able to or to provide some amount of social sustainability or environmental sustainability or economic sustainability to the people who are working in that particular area.

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Module 9: Topics in human Ecology Sustainable development

Some clean technologies I

- 1 Environmentally friendly energy and energy storage
 - 1 Power generation with renewable energy
 - 1 Photovoltaics
 - 2 Solar thermals
 - 3 Geothermal
 - 4 Wind
 - 5 Bioenergy
 - 6 Sewage gas
 - 2 Environmentally friendly use of fossil fuels
 - 1 Combined cycle power plant: Assembly of several heat engines to increase efficiency
 - 2 Cogeneration plants: Simultaneous generation of electricity and useful heat
 - 3 High performance power stations

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So, we look have a look at some clean technologies. So, clean technologies such as environmentally friendly, energy and energy storage in the case of power generation

which is renewable energy, we talk about solar cells, we talk about solar thermal energy production, geothermal energy, wind energy, bioenergy, sewage gas energy or we talk about environmental friendly use of fossil fuels in which case we talk about combined cycle power plants.

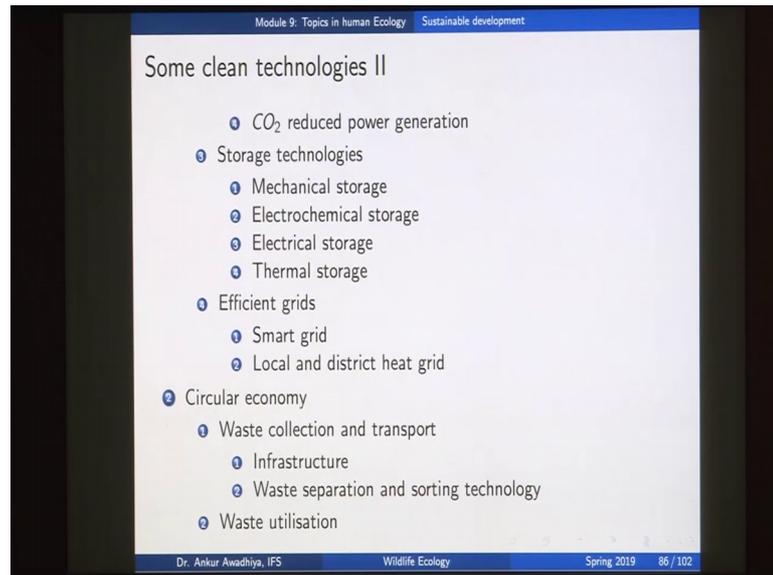
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Now, in the case of a combined cycle power plant what you have is that suppose you have a diesel engine. So, this diesel engine is taking in diesel and then it is producing electricity we are talking about a diesel generator. Now, in this case the gases that are coming out, now these gases are also quite hot gases. Now, in the case of a combined cycle power plant you will put these gases into a tank of say water and so that you are able to convert this water into steam.

Now, this is steam which is coming out at a very high pressure you put it into another turbine which is a steam turbine. So, the energy that was being lost in the form of hot gases through your diesel generator that energy has been taken back it has been used to heat up water and then that heated water is converted to steam and that is used to run another turbine. So, that you are able to make a much better utilization of the fossil fuel or diesel that we are using in this case that is known as a combined cycle power plant. Or we can talk about cogeneration plants, where we are talking about simultaneous generation of electricity and useful heat especially in areas that are very cold.

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So, even that hot water can be supplied to people or high performance power stations or things like reduced carbon dioxide power generation or we talked about storage technologies, mechanical storage, electrochemical storage, electrical storage, thermal storage. Or we talked about efficient grids.

So, these are the grids that are that I able to supply your electricity with reduced losses, smart grids local and district heat grids or we talk about things like circular economy. What about waste collection and transport? Do we have infrastructure? How do we separate the waste? Is there a certain technology that is available? Is there any amount of waste utilization that we can do, either through recycling or we can burn these wastes to generate heat and generate electricity out of it?

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Some clean technologies III

- 1 Recycling
- 2 Thermal waste treatment
- 3 Waste disposal
 - 1 Safeguarding and removal of contaminants and hazardous waste
 - 2 Reduction / utilisation of landfill gas
- 4 Environmental remediation
 - 1 Land rehabilitation
 - 2 Ecological restoration
- 5 Sustainable water management
 - 1 Water procurement and treatment
 - 1 Groundwater monitoring
 - 2 Water purification
 - 2 Water utilisation

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Or we talk about waste disposal technologies that is also a clean technology; safeguarding and removal of contaminants and hazardous waste. If we can remove the hazardous waste then the rest of the waste can be disposed of much easier or reduction or utilization of landfill gas, or we talk about environmental remediation, or sustainable water management, water procurement and treatment, water utilization.

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Some clean technologies IV

- 1 Components of the water distribution system
- 2 Water distribution grid
- 3 Efficiency increases in water utilisation
 - 1 Water efficient technology in the residential sector
 - 2 Water efficient technology in the commercial sector
- 4 Sustainable mobility
 - 1 Alternative fuels
 - 1 Biofuels
 - 2 Natural gas
 - 3 Hybrid drive
 - 4 Electrical drive
 - 5 Fuel cell drive
 - 2 Alternative drive technology
 - 1 Efficient combustion engines

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Or efficiency increases in water utilization. How can you how can you ensure that that the same amount of water is used for much more amount of purposes? Or we talk about

sustainable mobility, alternative fuels can we run our vehicles through say biofuels or through electricity or through fuel cells. Or we talk about alternative drive technologies more efficient engines.

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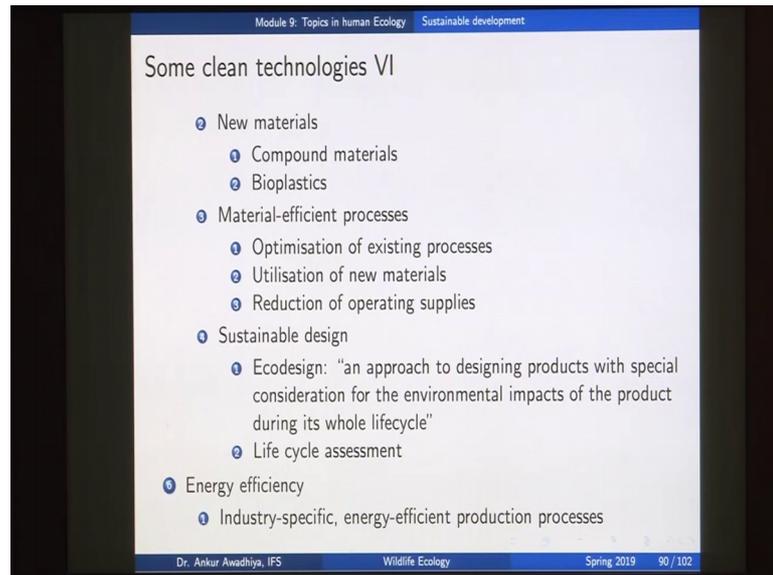
Some clean technologies V

- ② Environmentally friendly vehicle design
- ③ Infrastructure and traffic control
 - ① Intelligent traffic control
 - ② Integrated traffic infrastructure
 - ③ Electric charging stations
 - ④ Natural gas fuelling stations
- ④ Sustainable mobility management
 - ① Carsharing
 - ② Vehicle fleet management
- ⑤ Resource and material efficiency
 - ① Cross-sectional technology
 - ② Biotechnology
 - ③ Nanotechnology
 - ④ Mechanical engineering / process technology

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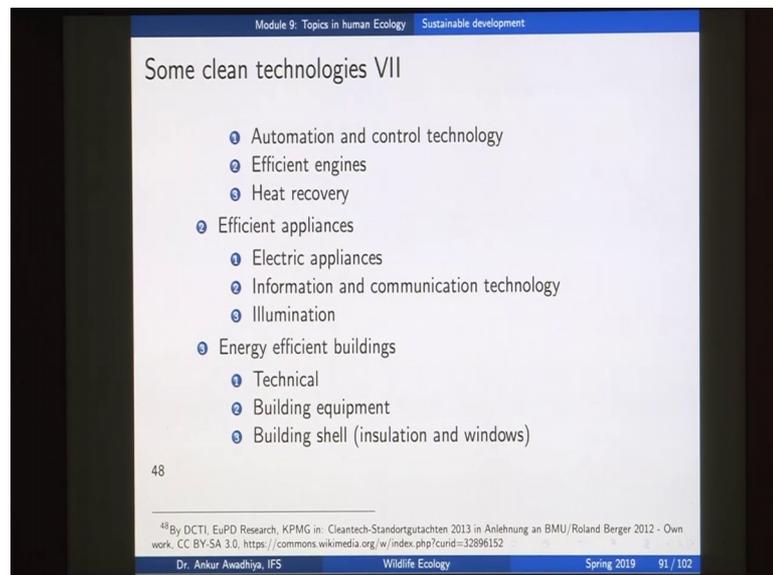
Or environmentally friendly vehicle design there is a reduced amount of drag or we talked about infrastructure and traffic control sustainable mobility management, carpooling, car sharing, vehicle fleet management, or things like resource and material efficiency, cross sectional technology that is being used for different environmental applications.

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Or new materials like compound materials or bio plastics, can they replace something that is already degrading to the environment. Or we talk about material efficient processing sustainable designs, eco designs or lifecycle assessment has an integral part of designing process.

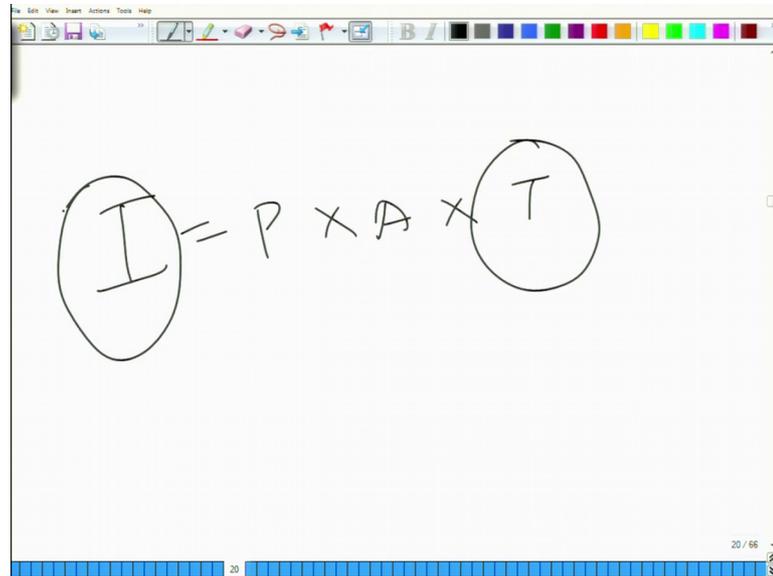
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Or we talk about energy efficiency, industry specific, automation and control technologies, efficient engines, heat recovery or efficient appliances on energy efficient buildings that are now becoming a norm in our country as well. So, all these things all

these different technologies all these things like environmental impact assessment or education are extremely crucial to reduce the impacts that we have on the environment.

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A screenshot of a whiteboard application showing the handwritten equation $I = P \times A \times T$. The letter 'I' is enclosed in a circle, and the letter 'T' is also enclosed in a circle. The whiteboard interface includes a toolbar at the top with various drawing tools and a status bar at the bottom showing the number '20'.

So, when we talk about I is equal to P into A into T, this T can be tinkered in a way that we are able to reduce the impact. And the way in which we can tinker with this technology is what we term as the sustainable technology, clean technology which is essential for sustainable development. So, that is all for today.

Thank you for your attention. [FL].