

Conservation Economics
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Module 5
How can Economics help?
Lecture 1
Need to understand controls

Namaste!

So, far we have looked at why we need conservation, what are the threats to widening. Now, the question is how can we use the knowledge of economics for the aid of conservation? Now in this module, we will look at how economics can help in achieving our objectives of conservation. And this module will have 3 lectures, the first one is the Need to Understand Controls, second is thinking as an economist, and the third is interdependence and gains from trade.

Let us begin with the need to understand the controls. And we begin with a thought experiment. Consider that there is a 747 aircraft and in this aircraft there are two pilots and these two pilots are in disagreement. The question is this plane facing an imminent danger, can this plane go and crash, is there something that is going wrong.

Now, both of these pilots are extremely experienced pilots, but they are looking at different controls and they are looking at these controls correctly. They are reading these controls very correctly. So, both pilots are correctly reading the instrument dials. The pilot 1 is only looking at the altimeter, the on-board radar, and the position of the wing flaps. And the pilot 2 only looks at the fuel gauge, the air speed indicator, and the cabin pressure dial.

Now, the question is it ok to see only certain readings and ignore the rest? Because, if both these pilots do not come to an agreement and they cannot come to an agreement till they talk or they look at each other's readings. Now, if they do not come to an agreement it is possible that both of them will spend their time in disagreement and the plane might go and crash. For instance pilot 2 is looking at the fuel gauge, but pilot 1 is not looking at the fuel gauge.

Pilot 2 looks at the fuel gauge, but pilot 1 does not look at the fuel gauge. For suppose the fuel gauge shows that the amount of fuel in the aircraft is extremely low because of which the plane might not work so, it is possible that this plane that is flying the engines will stop and it will crash. Now, pilot 2 is seeing this gauge and he is currently correctly reading that this plane is an imminent danger of crashing.

But pilot 1 has turned his eyes off this gauge, he says that I am not going to look at this gauge whatever happens. Now, what will happen? This thought experiment tells us that whenever we are working for a common good we need to be on the same page and we need to look at things in a more coherent manner.

Now, similarly when we talk about economies or when we talk about conservation. Why do we do economics? The aim of economics is to maximize the availability of resources to maximize the benefit of resources to mankind and why do we do conservation? We do conservation for precisely the same purpose. Why do we need plants and animals? We need plants and animals for ourselves.

Because, if we do not have these ecosystems that are working properly then, that will lead to a harm to us as a species of homo sapiens as well. When both of us, the economists and the conservationists, are working towards the same goal, it is extremely crucial that both of them read all the dials together.

Now, currently the situation is that the conservationist concentrates upon the loss of habitats, loss of biodiversity, coral bleaching, soil erosion, pollution, global warming, and all these things and the conservationist says that the world is going towards the doom.

Similar to the second pilot: the second pilot says that oh the fuel has gone, this fuel tank has gone empty, we are out of fuel and so, this plane is going to crash. Similarly, the conservationist is looking at all these different aspects, he is looking at the biodiversity and he sees that biodiversity is declining at a very fast pace and so, he says oh the earth is going towards the doom.

But then, we have the economist who concentrates upon increasing GDP, increasing per capita wealth, and resource efficiency. And the economy says oh all over the world the GDP is rising, the per capita GDP is rising, we are using resources with exceedingly greater efficiency. So, there is no cause for concern, because we are doing everything in a much better manner than we were doing previously. Why is there a cause of concern? There is nothing wrong.

Similar to the first pilot who was ignoring the readings of the fuel tank, and was saying that this plane is flying ok. Now, the question is it ok to see only certain readings and ignore the rest? Because if that happens, if we do not take all the readings into account, it is possible that the plane may crash or the earth will doom.

So, we need to get the full picture to make an informed decision. Now, here it is also important to highlight the differences between the economic thought process and the ecological thought process, as we have seen recently. Now, this is something that needs to be changed. Currently, the economists and the ecologists are having a different thought process. They are looking at different dials and they are coming to different conclusions.

We need to bring both of them to the same page but before bringing them to the same page it is important to realize what are the differences between both of these. The first one is the time horizon. The economist looks at a much smaller time horizon than the ecologist. The time horizon in the case of economics is say the next year, the next decade or probably the next century, but not beyond that. Whereas, when the ecologist looks at things he looks at things at an ecological time scale and also at the evolutionary time scale.

The ecologist might say that we should plan for say the next hundreds of years, or probably we should plan for the next millions of years because a number of these processes in ecology they happen at such a slow pace that whatever harm we do to the environment will come to the results or we will face the consequences after a time being.

The ecologist says that whenever we are setting up any new industry, the ecologist would say oh hang on. First let us see, if we can carry on with this level of pollution, why do not you go and install say a catalytic converter to reduce the amount of smoke that is coming down.

Now, the economist would say oh if I install this machine or if I install this equipment probably I will be able to recuperate the cost in say the next 30 years. So, this is not good from an economic point of view but the ecologist might say that no this is extremely crucial otherwise; we might have a situation of acid rain. Now, this time horizon needs to be kept in mind.

Secondly, the differences between sustainability and utility. Now, sustainable development means a development that meets the needs of the present without compromising the ability of the future generations to meet their own needs. So, when we talk about sustainability we are keeping a long term time horizon.

Sustainability says that we need to meet the requirements of this generation while ensuring that the next generations and the generations after that will also be in a position to meet their own requirements, so we are taking a long time span. Whereas, in the case of utility, utility is a measure of happiness or satisfaction. And this measure of happiness or satisfaction is used for current status, for the current population, we do not calculate utility for the next generation, we calculate the utility for us.

Now, in the case of economics we are more concentrated with the current generation. So, we concentrate on utility. In the case of ecological thought processes, we look at sustainable development. We look at in the case of sustainable development as well. We are emphasizing that we need to meet the requirements of the present generation but then sustainable development says that ok we should meet the requirements of this generation, but we also need to ensure that the next generation is also not harmed, in the longer time span.

This is again another difference between the ecological and the economic thought process at present. Now, the concept of utility has brought us to a thought process that is known as utilitarianism. Now, utilitarianism is "the political philosophy according to which the government should choose policies to maximize the total utility of everyone in the society".

Now, utility as we have seen is the measure of happiness or satisfaction. Now, utilitarianism says that we need to maximize this satisfaction of all the people in the current society. So, it is the political philosophy according to which the government should choose policies to maximize the total utility of everyone in the society.

Now, the important thing to keep in mind in the case of utilitarianism or its definition is that nowhere it says that we need to maximize the utility for the current society as well as of the future generations, it does not say that. Just says that we need to maximize utility, and such a thought process in which we want to maximize the utility of the current society can at times run counter to the thought of sustainability.

This is a major difference between the ecological and the economic thought process. Another difference is whether we are ok with externalities or whether we need to internalize the externalities. Now, externalities are the impacts of one person's actions on the well being of a bystander. "The impact of the actions of one person on the well being of a bystander" and it and there are two kinds of externalities, a negative externality and a positive externality.

Now, negative externality means that the actions of one person create a negative impact on the well being of the bystander. Then, we call it a negative externality such as exhaust from industries, or exhaust from automobiles. Now, the industrialist who set up the industry is getting all the benefits from the profits that the industry is bringing. But the pollution that is caused by the industry is causing harm to the society as a whole. It could even be at the global level in the case of certain chemicals that are being released.

Now, the negative consequences are faced by everyone in the society, the positive consequences are retained by the industrialists. This is an example of a negative externality because, the industrialist when he or she is taking this decision on whether or not I should set up this industry and what sort of pollution containing measures should I be putting up. Then, he only takes these decisions on the basis of maximizing his or her own utility, maximizing his or her own profits.

And these could even be at the cost of the local surroundings. Because the local surroundings will suffer because of the pollution it is not just the industrialist himself or herself alone who will suffer. So, this is an example of a negative externality. Positive externality is when the action of one person has a positive impact on the well being of others or on the well being of a bystander, good examples are education.

If you educate yourself, if you make yourself a more learned person, then the decisions that you would make in your lifetime are going to help not just yourself, but also your society and also your country and also the world. So, by educating yourself you are not only bringing a positive impact on yourself, but you are also bringing a positive impact on everybody else.

Similarly, if you keep yourself healthy, if you vaccinate yourself, you play a role in stopping the movement of diseases or stopping the spread of diseases. So, vaccination or health or exercising daily these are all actions that have a positive impact on the well being of others, or on the well being of the society or the country as a whole. So, these are positive externalities.

Now, the economic thought process states that we mostly concentrate on the well being of ourselves. Because, economics as we have seen before, economics considers that everybody is a rational person. Now, rationally if I am an industrialist I am setting up an industry and whether or not I should put up equipment to contain pollution is the question before me.

Now, rationally if I do not suffer from the consequences, there is nobody to force me to install this equipment and if I install the equipment my profits will go down, because there is an investment that is involved not only in the installation of the equipment, but also in its running cost. So, rationally I might take the decision that I should not install the pollution containing device because I am taking this decision rationally.

This is the economic thought process. The ecological thought process would say not all the externalities get internalized. In that case, what is the decision that a rational person should make is the correct decision, which means that an ecologist might say that ok, if such and such amount of pollution is released, and it causes so and so amount of health impacts on the surrounding people and if all of those people were to go to a hospital for their treatment.

What is the total cost of that treatment that everybody would have to pay? If you sum that up and if the industrialist were to pay that cost because it is the action of the industrialist that has brought harm to those people. So, the industry should pay for the cost, the polluter pays

principle. Now, if that were the situation, then what is the decision that a rational industrialist would make, is the correct decision.

In other words, what we are saying here is that suppose the cost of installing the pollution controlling device is rupees 10 lakhs and the cost of health care of people in the vicinity, if the device is not installed is say 30 lakhs, and if the industrialist had to pay this cost. So, in that case if the industrialist does not pay the cost of treatment, then he would have to pay rupees 0.

But, if the industrialist has to pay the cost of treatment then, we would have to pay rupees 30 lakhs. Now, if this is the situation before the industrialist and the industrialist has got two options. Option one is that he or she should get the pollution controlling device installed in which case, the cost to the industrialist would be 10 lakh rupees.

The second option is that ok, you do not want to install this pollution containing device, fine go ahead, but any harm that you do to the surroundings you will have to pay for that. That is you will have to pay for the health treatments for all the people in the surroundings that you have harmed because you have not installed this pollution containing device and that cost is 30 lakhs. Now, what would a rational industrialist prefer, would he prefer paying 10 lakhs or would you prefer paying 30 lakhs?

The answer is very simple, he would prefer paying 10 lakh rupees only and he would install this machine or this equipment into this factory. But, this is only possible when the externalities get internalized, when we have a mechanism to force the industrialist to pay the cost of treatment. If we do not have such a mechanism, if we do not have a way of internalizing the externality, the options before the industrialist are very different.

He has the option of not installing the pollution controlling device which is 0 rupees and the cost of installing the pollution controlling device which is 10 lakhs of rupees. If the externalities are not internalized the two options are whether to pay 0 rupees or whether to pay 10 lakhs of rupees. And of course, a rational industrialist would prefer not to pay any amount, he would prefer to pay 0 rupees and he would not install the pollution controlling device.

So, internalizing the externalities is a very powerful concept to help people make the right decisions. Now, the ecological thought process emphasizes that all the externalities need to be internalized before we take a decision on the correct course of action. Here again remember that the decision is a rational decision, but it says that before taking any decision let us first internalize all the externalities.

This is a major thought difference between the ecological thought process and the economic thought process. Now, what are the mechanisms or what are the methods of internalizing these externalities? Now, the first option is a command and control policy, in which case the government has a big role. So, in the command and control policy such as regulation the government would say ok.

No matter what happens, we are only going to permit an industry to be set up, if the industrialist gets this pollution controlling device installed otherwise, there is no permission at all. So, you cannot set up an industry till you agree to install the pollution controlling device.

This is one way of internalizing externality. Or another way of regulation is that if anything goes wrong the polluter will have to pay, the industrialist would have to pay and we will make use of

the government machinery, we will make use of the law and order machinery to ensure that if the surrounding people are harmed then the industrialists would have to pay. That is another way of regulating things.

In a command and control economy or in a command and control government this is one way of ensuring that the externalities get internalized. But not just the government's role we also have certain market based policies, market based policies include things like Pigouvian taxes and subsidies.

Now, in the case of Pigouvian taxes and subsidies, the government says that we are going to impose a tax or we are going to provide a subsidy not because we want to increase our resources through taxation and not because we want to support a particular person through subsidizing, but we are going to use it to ensure or to incentivize people to do something or to refrain from doing something.

Now, in that case it will be called a Pigouvian taxation or a subsidy. Now, how would a Pigouvian taxation or subsidy work in this case? The government might say that ok the cost of installing this pollution controlling device is 10 lakhs of rupees and we are going to subsidize 9 lakhs of it. So, if any person has to install this machine, he or she only has to pay 1 lakh of rupees.

Now, in this way the government is turning the table, the government is saying that you do not have to now make a choice between paying 0 rupees and paying 10 lakhs of rupees, you have you only have to make a choice between paying 0 rupees and paying 1 lakh of rupees, and paying 1 lakh it should be an easy matter for an industrialist.

The government might in some cases even bring the subsidies to a level that it becomes 0, or the government might even say that ok, if somebody installs this device we are going to pay that person 11 lakhs. So, in that case the government is paying 1 lakh of rupees to incentivize the person and also covering up all the costs of installing this device. Now, this is an example of a Pigouvian subsidy.

An example of a Pigouvian taxation or would be say if anything go if there is a person who is not installing this pollution controlling device, then there would be a higher level of taxation to ensure that the government has sufficient funds to cover up if there is something, if there is a negative impact to the health of the vicinity.

In that case the government would say, "Ok you do not have to pay, we are going to take care of all the citizens but to take care of the citizens we also require money, we also require taxation. So, if you do, if you make this choice that you are not going to install this pollution controlling device. So, in that case you will have to pay 5 lakhs of rupees as taxes every year."

And then the industrialist would think that ok, if I install this machine I only have to pay 10 lakhs of rupees, if I do not install this machine I will have to pay 5 lakhs of rupees every year. And so, in a span of like 2 years, I would have already paid the cost of the machine and from the 3rd year onwards, I will be paying more than 10 lakhs of rupees.

Then the choice becomes much simpler. The industries would say ok, if I can get a tax break by installing this machine let me go for the tax break, let me install this machine. So, Pigouvian taxes and subsidies are also a mechanism through which we can ensure that the externalities get

internalized and people take those decisions in which others are not harmed.

Another example is a tradable pollution permit. In the case of tradable pollution permits, the government might say that every industry can release only 100 units of noxious fumes or pollutants. And if any industry releases more than 100 units, then the industry will be completely shut down. Or you have another option, the government might say that in place of say polluting 100 units, you are only polluting say 20 units.

In that case you have 80 units left with you and you can sell these units to some other industry, who is unable to reduce their levels of pollution. So, what we are saying here is that you have an industry that has a quota of 100 units; and if the industry only uses 20 units of quota, then they can sell off 80 units.

Now, who is going to buy these 80 units, there are certain industries for which it is easier to bring down the levels of pollution. Such as our industry in question in which we have a device that is available to reduce the levels of pollution. On the other hand, there could be certain industries that have such processes in which it is very difficult to reduce pollution.

Now, the aim of the government here is to ensure that the total level of pollution is down and it does not cross a threshold. So, in the case of these tradable pollution permits, what would happen is that our industrialist might think that ok, if I install this device I will have to pay 10 lakhs of rupees. But by installing this device, I will be able to save so much on my quota; and I can sell off this quota to my neighbor who is unable to install such a machine and he is going to pay me say 5 lakhs of rupees every year.

And if such a situation arises, then in 2 years I will be able to recuperate the cost of installing this device and from the third year onwards I will be earning a profit on it. Now, in such a scenario the industries would go for installing this device. Now, the benefit to the industrialist in this case is that he or she is able to earn the profit. The benefit to the society is that the level of pollution has been contained and the benefit to the other industry is that it is able to pollute more than 100 units by purchasing this from somewhere else.

So, the total level of pollution is already down, but this has brought in a market mechanism through which one industry can sell off part of its quota to someone else. And a big benefit in such scenarios to the society is that those industries for which it is easier and it is cheaper to reduce the levels of pollution become the first ones to reduce the level of pollution.

So, essentially the society is able to reduce the pollution at a lower cost. So, this is another mechanism that is available to internalize the externalities. Then, we also have certain private solutions; private solutions include things like social norms and mores. Now, in the case of social norms and mores, there could be a social norm in a society that we should not give respect to those people who are polluting the environment.

In that case, the level of pollution is brought down by social action. So, people might boycott those industrialists who are doing a lot of pollution and people might start to honor those industrialists who have taken exemplary steps to reduce the levels of pollution. So, through social norms and mores also we can internalize, we can bring in a mechanism to internalize the externalities.

Other examples are charities to social causes. So, there could be say an NGO, who is able to

procure these pollution controlling devices and this NGO goes and fits this device to through to different industries say free of cost, but then how does this NGO get money to run this operation, through donations.

Now, in this case the private solution is charity to this NGO. So, the people who are there in the vicinity, they might pay to this NGO as a charity. So, the total level of pollution that they have to tolerate goes down. So, through charities and through NGOs and other social causes as well there is a mechanism to internalize the externalities and bring these negative consequences down.

This is another economic way, in which somebody pays so that the level of pollution goes down. Another private solution is integrating different businesses and this normally occurs in the case of positive externalities. Integrating different businesses it means that, if somebody has an apple orchard and some and this person also starts an apiary to raise honey bees.

Now, in such a scenario what happens is that the person is able to produce honey and sell off the honey and at the same time this person also has the honey bees to pollinate his apple orchard. So, because both of these businesses help each other aid each other. So then, it also makes economic sense to integrate both of these businesses together.

This is also another way, in which internal in which externalities are internalized and especially the positive externalities. Another private solution is through bargaining and contracts such as the Coase theorem. Now in the case of bargaining it is possible that the residents of this area, who are there in the surroundings, might come to the industrialist and they might try to bargain. They might say that ok, you are releasing so much pollutants and that is harming us.

Why do not we come up with an arrangement that can suit you as well as it can suit us because, remember if there is no way in which the residents can force the government to take an action, then the residents might take this action by themselves. So, in this case the industrialist wants to reduce the cost of installing this device and the residents want to save their health.

Essentially the industry does not want to put in 10 lakhs of rupees but if the industrialist does not put in 10 lakhs of rupees, the residents would have to pay 30 lakhs of rupees for their own health. So, the residents might say ok why do not we do this thing, why do not we procure this machine and we install it into your industry.

In that case, the residents are benefited because in place of paying 30 lakhs of rupees, they will only have to pay 10 lakhs of rupees. And the industrialist is also happy because he does not have to pay; or in certain situations and something other than then this can also occur.

It is also possible that the industrialist might say that ok I it is not possible for me to install this device, but why do not I pay you something. So, I will pay you. I will compensate you for the health damages that you have and if the industrialist can come up with a figure that is less than 10 lakhs of rupees, that is also an arrangement between the society and the industrialist.

These are different options that are available for internalization of the externalities. Now, we will look at the Coase theorem in more detail here. So, Coase theorem says that "if private parties can bargain without cost over the allocation of resources, they can solve the problem of externalities on their own".

It only talks about the private party. So, there is hardly any role of the government here. If private parties can bargain without cost, that is it should not cost both these parties to come

together in terms of time or in terms of money, that is the transaction costs are reduced. If the private parties can bargain without cost over the allocation of resources, they can solve the problem of externalities on their own.

Now, let us look at one example of this Coase theorem, that we normally see in the case of the tiger reserves. Now, in tiger reserves there are only a set number of vehicles that can get inside on any particular day. Why? Because the national tiger conservation authority looks at this matter and tries to ensure that there is no excessive level of pollution in the tiger reserves.

And at the same time, the animals are not excessively disturbed and so it regulates the number of vehicles that can get inside. Now, there might be some players who have a greater interest in getting inside. A common example is that there are certain Gypsy operators or there are certain guides who are so good at their job, that they receive quite a lot of money in terms of gifts or in terms of honorariums from the people who get inside.

That is what normally happens when this Gypsy driver is taking you to the park. He tells you about all different kinds of birds, he tells you about all the stories that are associated with this park and because of that you are so much entertained that you pay him say 100 rupees extra because he not only took you inside the park, but he also entertained you.

In that case, the benefit that this Gypsy owner will get is much greater than the benefit of some other Gypsy owner who is not good at telling these stories or telling you about the birds and animals. So, in the normal course of operation, one Gypsy owner only gets the amount of money that he or she can charge for taking you inside, but the other Gypsy owner is also getting something extra.

Another difference is that there are some gypsies that are so old, that the cost of running them is higher than say a new Gypsy. So, a person who has a new Gypsy will probably be running at a much greater profit than a person who is having an old Gypsy. Now, if it so happens, that a person who does not get a lot of money from getting inside has been chosen to get inside, because of a roster system and there is another person who thinks that if in place of this person if I were to go I can earn much more.

Now, how can the Coase theorem bring us to a solution that is beneficial to everybody. So, let us look at this, what we are saying here is that there is this Gypsy and if this Gypsy goes inside the profit is 2,000 rupees. If it does not go inside it gets a profit of 0 rupees, because it is not plying inside. And different other Gypsies have different levels of profits, if they go inside.

There are certain gypsies that will earn more than 2,000 rupees and there are certain gypsies that will earn less than 2,000 rupees. So, suppose these are the Gypsies that have been selected as part of the roster system, that is when the NTCA is that 9 gypsies can get inside. So, these are the 9 gypsies that were chosen and this Gypsy was not chosen.

Now, the NTCA is concerned that only 9 gypsies should get inside, the NTCA is not concerned which gypsy should get inside. Now, how can the Coase theorem bring us to a much better solution? Now, suppose this person whose Gypsy was not selected bargains with this person, who if he gets inside will only earn 900 rupees and this person says that ok in place of you getting inside let me go inside and I will pay you.

This person is saying that, I will earn much more profit if I get inside and so in place so it is your

turn to get inside, but you give that turn to me. And to compensate you I will pay you some money, for this jumping right so to speak. Now, how much money will be paid, anything that is between the profit of this Gypsy that is 900 rupees and the profit of this Gypsy that is 2000 rupees.

Let us say that both of these bargain and they agree on 1200 rupees 1200 rupees and so, this Gypsy owner says that ok you pay me 1200 rupees and I will keep my Gypsy outside and you can go in my place. Now, what happens? This person who would have earned 900 rupees, has now earned 1200 rupees and so this person is happy because, in place of earning 900 he is earning 1200. What about this person? Now, if this person did not get inside because, it was not selected in today's roster.

So, he would have earned 0 rupees. But, now that he has earned this, he has paid for these jumping rights and he now has the chance to get inside he will be earning 2000 rupees, now out of these 2000 rupees he will be paying 1200 rupees to do this Gypsy owner. And now, he will be left with 800 rupees.

So, for this Gypsy owner the choice was either 0 rupees or 800 rupees and this Gypsy owner is now earning 800 rupees, so he is also happy. So, this Gypsy owner is happy because he earned 300 rupees more. This Gypsy owner is happy because he earned 800 rupees more. And NTCA, of course is happy because only 9 gypsies got inside and there is no other issue with this.

So, by bargaining themselves, by doing this bargain both of these parties have come up with a solution that is beneficial to both of them. So, this is an example of the Coase theorem and we normally apply the Coase theorem in the case of conservation these days. For example, through payment of ecosystem services and a good example of this is the Catskill watershed.

What is this story? In New York, the water that is supplied comes from these mountains that are known as Catskill Mountains. Now, the city of New York has got two options, option one is which is the default option that most of us use is that whatever water comes to the city has to be treated. So, you set up a water treatment facility and you run this facility and you pay for its installation you pay for its running, and this is the amount of money that you will have to spend to get good quality water.

The second option, that these people thought was that why do not we do something so that the water that comes to the city does not have to be treated at all. So, they started looking at what causes pollution in this water? And they saw that the people in the Catskill Mountains were also doing agriculture and when these people do agriculture they will be using fertilizers, they will be using pesticides, and these chemicals are coming into the water.

So, the people of New York said ok why do not we do one thing, if we set up our water treatment facility and say we have to pay say 1 million dollars. In place of doing or spending this 1 million every year, if we pay say 500000 dollars to the people who live on top there on the Catskill Mountains and we will say we will tell them that, that you guys refrain from using the fertilizers, you guys refrain from using the pesticides.

And of course, if the fertilizers and pesticides are not used then your crop yields will go down and we are going to compensate you for that. So, we are paying you these 500000 dollars, to compensate you for the lower productivity. Now, the farmers might think that ok, if I do not use

fertilizers and pesticides my crop yields surely go down, but what is the extent to which they go down? It is not that we will be able to produce no crops.

We will be able to produce crops, but probably of a lesser quantity. So, if they calculate and they come to this conclusion that ok, if we go for organic agriculture, we will only be earning 300000 dollars in place of say 400000 dollars that we are earning every year. So, there is a loss of 100000 dollars every year, but now these guys are paying us 500000 dollars to go for organic cultivation.

So, what is the harm? In this way the farmers who are out there in the Catskill Mountains are able to earn much more than what they would have earned through traditional agriculture, so they are benefited. And the people of New York they would in place of failing out say 1 million dollars every year, they can make go with 500000 dollars. So, there is a cost cutting, there is a saving for the people of New York as well.

Now, this is an example of the Coase theorem in which there are two parties that are bargaining at their own private levels and they are coming up with a solution that is beneficial to both of them. The farmers are happy, the people of New York are happy. And of course, the water quality because it is now so good that it can be directly used for drinking.

So, it also helps the environment because you do not have to pay a cost of installation, you do not have to release greenhouse gases because you would have required electricity to run your plants. So, it helps the environment as well. It also helps the biodiversity because those fertilizers and pesticides that were polluting the waters are now not there and so the biodiversity also is much better.

Another difference between the economic and the ecological thought process is the kinds of goods that we are concerned with. And we can divide goods and services into four different categories, based on two concepts: whether they are excludable and whether they are rivals in consumption. Now, what does this mean? Excludability means that "the property of a good whereby a person can be prevented from using it".

Now, what does that mean? It means that if I have this pen, I can say that this is my pen and I will not allow you to use this pen. In that case this pen is an item that is an excludable item. So, I can exclude others from using this pen. Rivalry in consumption means "the property of a good whereby one person's use diminishes another person's use".

It means that, if there is a tree and this tree is all full of mangoes and if I go there and if I take these mangoes and if I eat these mangoes there are less mangoes that are available for you to take out. So, your consumption and my consumption are rivals of each other. The more I consume the less you consume, the more you consume the less I consume so, this is known as rivalry in consumption.

Now, on the basis of excludability and rivalry in consumption, we have four different kinds of goods. There are certain goods that are both excludable and rivals in consumption which are known as private goods such as clothing. Now, clothing is excludable because, I can always say that this is my cloth and I will not permit you to use it.

At the same time it is a rival in consumption because, if I purchase one piece of cloth from a shop, then it is not available for you to purchase. So, there is a rivalry in consumption, either I

can have this plot or you can have this plot. When there are other goods that are excludable, but they are not rivals in consumption, such as fire protection.

In the case of fire protection we can say that we are only going to provide fire protection to these people who are paying for it. So, we can always say that if there is a society that pays for fire protection we will provide them with fire services. If a society does not pay for it we will not provide it with fire services. But this is not a rival in consumption, because if you pay for this for fire services and you are able to get the fire services it does not mean that I will not get the fire services.

It is not a rival in consumption. So, these goods are known as club goods. Then there are certain other goods that are rival in consumption but they are non excludable such as the environment. Now, why are these non excludable because a thing such as the air now, if I am breathing air I cannot prevent you from breathing the air. It is non excludable, but it is a rival in consumption because if I add pollutants to my air, then because it is a non excludable thing and the air is there everywhere.

These pollutants will also reach you. The more I harm this resource or the more I consume this resource the less is available for you. So, this is a non excludable, but rival in consumption so, this is a common resource. And the fourth kind of good is known as a public good, such as the national defense.

It is neither excludable nor a rival in consumption, because if my country is protected, your country is also protected. So, it is non excludable and if I protect my country it is not that your country is not protected. So, it is not a rival in consumption. Now, the difference between the economic thought process and ecological thought process is that a lot of ecological thought processes occur around the common resources of the environment.

Whereas, the majority of economic thought processes occur around private goods. So, there is this major difference between the thinking of economists who are more concerned about private goods and the thinking of the ecologists who are more concerned about the common resources.

Now, we will look at an example to see that it is not that both of these thought processes are very different. We can bring the economist and the ecologists on the same page, we can bring them to a common solution that can benefit both of them and this example is one of the linear infrastructure. Now, linear infrastructure refers to those basic physical and organizational structures and facilities that are needed for the operation of a society or enterprise.

This much portion is the definition of an infrastructure, those basic physical and organizational structures and facilities that are needed for the operation of a society or an enterprise. But, linear infrastructure means that they can be represented as straight or curved lines. And examples are roads, railways, power lines, canals, pipelines and so on. So, a road is an infrastructure that you can represent either as a straight line between two points or as a curved line between two points.

So, this is a linear infrastructure. So, good examples are roads, railways, pipelines, and so on. Now, it is known that linear infrastructure through the wildlife areas leads to conflicts. So, this is something that the ecologist wants to avoid. The ecology says that if you build a road in the forest area it harms the biodiversity. How does it harm biodiversity? Because animals use roads, we normally see animals on all different kinds of roads.

And if there are vehicles that are flying, then there are also accidents and animals die on getting collided with different vehicles. So, roads are a method of killing. Roads also cause pollution in terms of air pollution, sound pollution, and light pollution. So, if there is a road then you are also harming the forest, you are harming the biodiversity. You are providing a means through which people can throw waste products into the forest, which is another harm.

Roads are barriers to wildlife movement because this wildlife area is very different from this paved structure of the road. And so, a number of times the animals who want to move from this side to this side will avoid going on top of the road. They act as barriers, they act as physical barriers, they act as psychological barriers.

And a lot of this has also got to do with the amount of or the number of vehicles that are plying per unit time. If you have a very small number of vehicles, then probably the animals are able to cross the road. If you have a very large number of vehicles then probably the animals see a wall of vehicles that is plying through these roads and they just do not cross.

But, in these central areas where the vehicle density is in between, the animal sees that ok vehicles are coming but they are not coming at such a huge density that I might be unable to cross. So, the animal thinks ok let me take a chance and cross this road, and as it tries to cross there is a vehicle that comes and hits this animal and the animal dies. So, in this middle region we have the highest number of deaths as shown in this rate curve.

And when we look at this barrier effect it also depends on a number of other factors such as traffic intensity if there is more traffic intensity there will be a wall of vehicles, the speed of vehicles, the sensitivity of the drivers whether they are using headlights or horns and so on, the presence and location of animal crossings.

If there is a road with a very heavy traffic, but then there is also a bridge and the animal can cross under the bridge so; in that case it is not very big of a barrier. Movement patterns of this species so, especially in the rainy seasons when a number of species are on the move, the barrier effect is much more pronounced.

Species specific preference of road use, there are some species that are more comfortable in using a road, there are some species that completely avoid the road. The edge features, what is the height of the embankment? If the embankment is too high the animals will be unable to get to the road.

So, that will be a very great barrier. Time of the day, time of the year and species diversity in the surroundings. Another harm, with these linear infrastructures like roads is that roads fragment the habitats. So, here you have one habitat: you were having a big habitat and now it has fragmented it into these three sections.

There was this beautiful forest but now the animals cannot cross from this side to this side. So, it has created a fragmentation. Construction of roads causes loss and destruction of habitat because to construct roads or railway lines you will have to cut off trees.

You will have to perform earth work. So, even during construction it creates a problem for biodiversity. It can lead so, this is an example of earthwork in which a big sized hole has been dug, construction causes loss and destruction of habitat. Roads also facilitate the destruction of habitat. Why? Because roads permit accessibility to different areas. So, if people can reach an

area they can also come there and cut trees, they can also poach animals.

Roads also facilitate the destruction of habitat. Roads also increase interaction with humans. So, this is an example in which a Nilgai hit a vehicle, the Nilgai died on the spot but both the people that were traveling in the vehicle, were also critically injured. Roads change animal behavior. Langurs normally do not interact with humans, but because people have been feeding these Langurs, now it has changed their behavior. They always come up to beg for food. This is another example, these people are feeding these animals, they are feeding the monkeys, they are feeding the langurs, they are feeding the wild pig, they are feeding the peacock, and this is not a behavior that would be seen in an actual environment.

Normally, if you step out of your vehicle all the animals will just run away they are so afraid of humans. But in this case, the behavior has completely changed. In a number of situations there are also incidents in which the animals attack the vehicles. This is also an issue for people because one option that the ecologist might suggest is that we should reduce the speed limit.

So, if the vehicles are plying at a lower speed then there is a chance that the animals will be saved because the animals will have much greater time to cross and avoid the vehicle, avoiding the collision. But then, if we try to reduce the speed of the road then that is also having an impact on development because we normally want to go from point a to point b as soon as possible and this will hamper that.

Linear infrastructures lead to a number of human wildlife conflict situations. A human wildlife conflict occurs when the wildlife requirements encroach on those of human populations, with costs to both the residents and the wild animals. Examples include things like crop depredation, spreading of diseases, predation of humans and livestock, road accidents, poaching, habitat degradation, loss, road kills and so on.

So, what is the option that is left with us? The option to avoid these conflict situations is to keep humans and wildlife separate from each other. The option is education and awareness, the option is mitigation measures, underpasses, overpasses, canopy bridges, culverts and so on. Now, what do we mean by these mitigation measures?

Remember we said a short while back that if there is a road and this road is acting as a big barrier but there is also a bridge. So, the animals may use the bridge to cross and in that case the interaction between the animals and the humans goes down. So, the animal is saved because it avoids a collision, the humans are saved because there is no vehicle, there is no animal to harm their vehicles and they can also move at a much faster speed.

This is a mitigation option that is available, but the question is how do we ensure the implementation of this mitigation option and do we need to have this mitigation option at all places? Even for smaller animals, the answer is yes, the ecologists would say yes. These smaller animals play a very big role as scavengers and if these animals were not there then, we will have a very big problem of dead animals that are not being disposed of.

Now, either the economist and the ecologist might go on disputing these facts or the other option is to bring them both to the same page and to make the economist realize that these mitigation measures not only protect the animals, but they also increase surplus. They enhance the surplus of the society. Why? Because they lead, they reduce the chances of human deaths and accidents.

Vehicles ply at higher speeds which leads to economic prosperity. It also aids in the conservation of biodiversity which has its own benefits for enhancing the surplus of the society. Now, the point to emphasize here is that the mitigation measure is not just a tool of conservation, it is also a tool of good economics, and this is why it is important to understand economics.

So that you can make the economist understand things in his or her language. So, if you were to portray a bridge or a mitigation measure as a way of protecting wild animals, then probably the economist might not agree. But if you portray a bridge or a mitigation measure as a means of enhancing surplus by protecting the lives of human beings, by protecting the property of human beings, by ensuring that they are able to move at faster speeds, and by giving them the benefits of biodiversity, then probably it will be a very different matter.

The economists may completely agree with your point of view. Now, similarly it is important for the ecologist also to understand that we cannot go on saying that ok this thing is important for animals so, this has to be done. Because, that is not a persuasive argument. You also have to know about economics so that you can make use of the language of economics, you can make use of the thought process of economics to portray your case in a much better manner.

So, the implementation of these tools such as the mitigation measures can be ensured through an understanding of economic decision making and incorporation of a thorough economic analysis, not just a superficial one. So, in other words we can say that economics is a good tool for good conservation. If you did not have economics you would not be able to perform conservation because nobody is going to listen to you.

And at the same time conservation is a tool for good economics, because by using the tools of conservation we are able to enhance the total surplus of the society. Now, it is important to remember here that both the economist and the ecologist are working for the same goal of enhancing the total surplus of the society, but both of us need to understand each other's controls, each other's devices.

So that we do not fall prey to the situation in which there are 2 pilots and they are not understanding each other's controls, they are looking at completely different readings. And it is important to remember here, that the solution to the issues that have been generated by "Economic" decisions.

In certain circles, it is very fashionable to say that all the harm to the environment has been done due to economic decisions that were made. Whether we talk about pollution, whether we talk about global warming, whether we talk about loss of biodiversity, there are certain ecologists who always put the blame on the economist and say that it is because of the economist that all these harms have come to Mother Nature.

But it is important for them to realize that the solution to these issues that were generated by "Economic" decisions is more Economics, and not less. It is their duty to ensure that the economists also get the point of view that these tools of conservation are also the tools of better economics and of enhancing the surface of the society.

That is all for today. Thank you for your attention. Good day. Jai Hind!