Environmental & Resource Economics
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Lecture 54
Economic Valuation of Environmental Goods and Services – Different Valuation Approaches Part -14

Welcome once again to our discussion on economic evaluation of the environment and we said that there are three different approaches for valuing the environment stated preference approach, reveal preference approach and production function approach. In our previous sessions we have already completed our discussion on stated preference and reveal preference approach, today we are going to briefly talk about the production function approach of valuing the environment.

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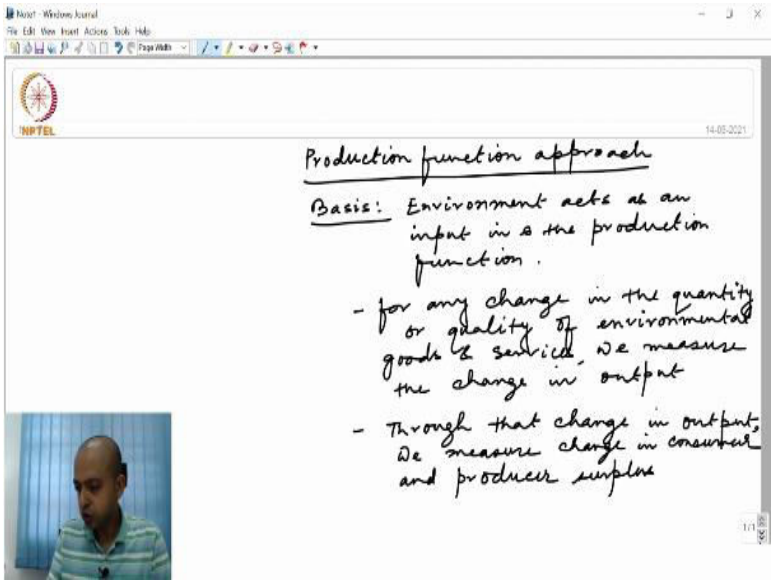

So, this is production function approach that we are going to discuss today production function approach. Now, the basic assumption in this particular approach what we assume or the basis of this approach is what is the basis of this production function approach? The basis is environment acts as an input in the production function, this is the basis, we assume environment acts as an input in the production function. If you recall initially when we discussed three or four major types of services that we derive from the environment, one such, one such service was environment can act as a supplier of material and energy, environment can also acts as a supplier of absorptive capacity and environment can also act as a supplier of the global life support system.

So, in all these activities we can assume that for our well-being, for our satisfaction, for social well-being social welfare or whatever you may think about, we always need environmental goods and services either as a form of supplier of energy or in the form of supplier of absorptive capacity or in the form of supplier of maintaining a global life support system in the form of maintaining atmospheric and climatic a proper atmospheric and climatic condition for our very existence.

So, in this approach we will try always to hypothesize a production function and then we will include environmental goods or services as one of the inputs and then for any change in the quantity or quality of environment we will try to estimate the change in output through which we will try to estimate the change in consumer or producer surplus and that change in consumer and producer surplus is basically the value of environment for that amount of change.

So, that means what we do here step by step, first of all environment acts as an input in the production function, then what we do for any change in the quantity or quality of environment or I will say environmental goods and services, we measure the change in output and then through that change in output, through that change in output we measure change in consumer and producer surplus.

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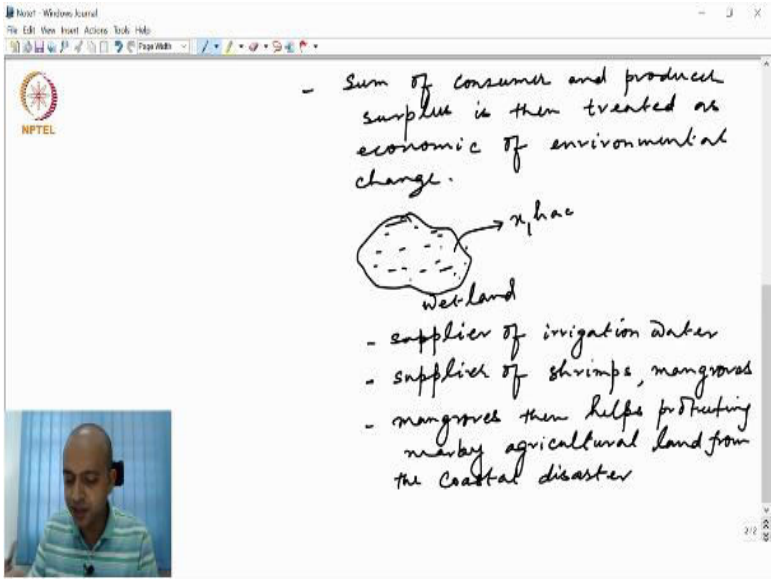

So, the summation, sum of consumer and producer surplus is then treated as economic value of environmental change. So, the idea is very simple if I give an example it would be more clearer to you. Let us say that we are trying to estimate the value of a wetland through this production function approach, so this is a wetland, this is a wetland and let us assume that the size of the wetland is x hectare, so this is a wetland.

So, in production function approach we will try to assume that what are the different services that we derive from the wetland so that we can conceptualize different types of production function in which the services derived from the wetland enters as input. For example, firstly we can think of that wetland is a supplier of irrigation water, so this is service number one, supplier of irrigation water.

Wetland can act as a resource wherein we get different type of flora and fauna for example, let us say uh in wetland we have mangrove, so wetland is a supplier of mangrove which helps producing, let us say shrimps or the mangrove protects the nearby land from let us say any type of coastal disaster so and so forth. So, let us say wetland acts as a supplier of shrimps, mangroves and these mangroves then helps protecting nearby agricultural land from the coastal disaster.

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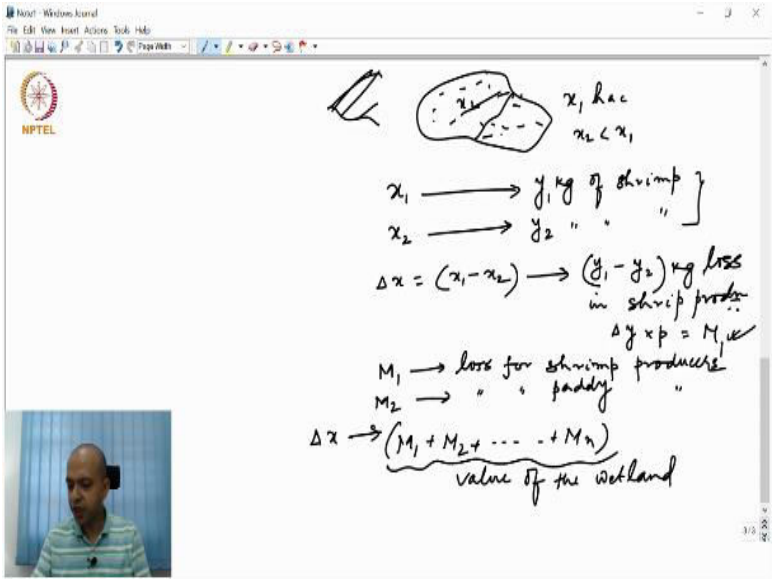

Let us say that initially the size of the wetland is x, so initially initial size of the wetland is, this is the wetland and initial size is x1 hectare so when size is x1 hectare, then we produce y kg of

shrimp or y1, when size is x2 when size got reduced to x2, let us say this is x2, why this has been reduced because maybe we have used the wetland for some other purposes, wetlands might be converted for any other developmental activities, here x2 is we assume x2 is less than x1 and we produce y2 kg of shrimp, so that means for a change in wetland by delta x which is equals to x1 minus x2, it results in y1 minus y2 kg loss in shrimp production and we can convert this into monetary units if we know the price of the shrimp.

So, that means we can say that this is delta y amount let us say, so we can we can then say that this delta y amount if you multiply this by p, that is M amount of money, which is loss for the shrimp producers profit. So, shrimp producers profit goes down by M amount due to a change in delta x for the wetland size then we can say that, that means the wetlands value in monetary units is M for this delta x amount. So, this is how we can conceptualize wetland as an input in the production function.

In the same way we can say that when the wetland size is x1 hectare we get certain amount of water from the wetland, for which we can say that y1 amount of paddy is produced and when the size got reduced to x2 then we get y2 amount of paddy production, so that means for delta x amount of change in the wetland size we get delta y amount of change in paddy production. Again, if you multiply that with the paddy price per unit or per kg or whatever then we will get some monetary units let's say again M, then we will say that that M is then a value of environment for delta x amount of change.

Now, what we need to do, we need to identify all the services, let us say that this is M1, for loss in profit for the shrimp producer. Similarly, so let us say for delta x amount of change in wetland M1 is the loss for shrimp producers, M2 is loss for paddy producers. So, we need to identify different types of services that we derive from a coastal ecosystem like wetland, then we need to add up M1 plus M2 plus we derive n number of such services from the wetland and that is the value of the wetland for this delta x amount of change.

So, when environmental quantity in the form of reduction in size of a particular wetland happens this is the total amount of loss that we incur and that is the value, so this is the value of the wetland. Now, this is like the production function approach what we discussed here, this is like a valuing coastal ecosystem following a stated and reveal preference approach but only difference

is that, in stated preference approach when we value wetland we can capture the use value as well as non-use value of the wetland, but in this production function approach what happens we can capture only the use value because environment acts as an input and goes into the production function and this is how we are evaluating.

So, we are capturing only the use value but the amenity value of the wetland that is not captured in this production function approach. Similarly, the bequest value, existence value, option value all those values again is not captured in this production function approach because here we are trying to capture the use value of the wetland, different type of services that we derive from the wetland and that goes into the different type of production function. So, though this approach is simple to estimate, again it can capture only the use value that we have to keep in mind, so this is how we can value the environmental goods or services through production function approach.

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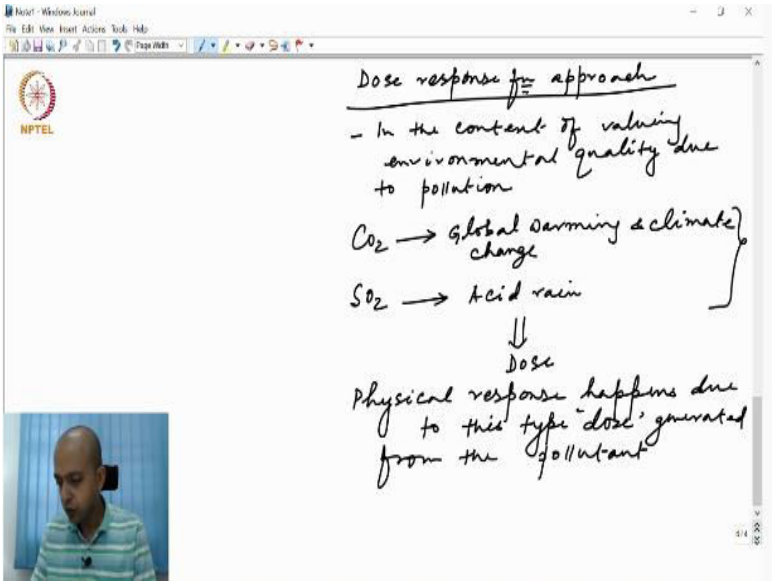

There is one more approach which is called Dose response function approach, Dose response function approach, so basically applied in the context of valuing environmental quality due to pollution. For an example, when economic activities take place in the process of producing many goods and services, we all know that production of goods and services automatically generates different type of undesirable by-product with detrimental impact on the environment.

Let us say that in the process of production we generate mainly two type of pollutant, one is Co2 and another one is So2, so this Co2 it gets accumulated in the atmosphere as a result of which global temperature increases and we know the consequence of that is climate change. So, it leads to global warming and climate change. Similarly, when we generate So2, that So2 also travels from one country to another it does not get restricted only to that country where it is produced but it also travels to another countries and then it comes down as acid rain.

So, this global warming and climate change to Co2 emission, acid rain related to So2 emission these are called, they are called dose and physical response happens due to this dose, that is why this is called dose response, so physical response happens due to this type of dose generated from the pollutant.

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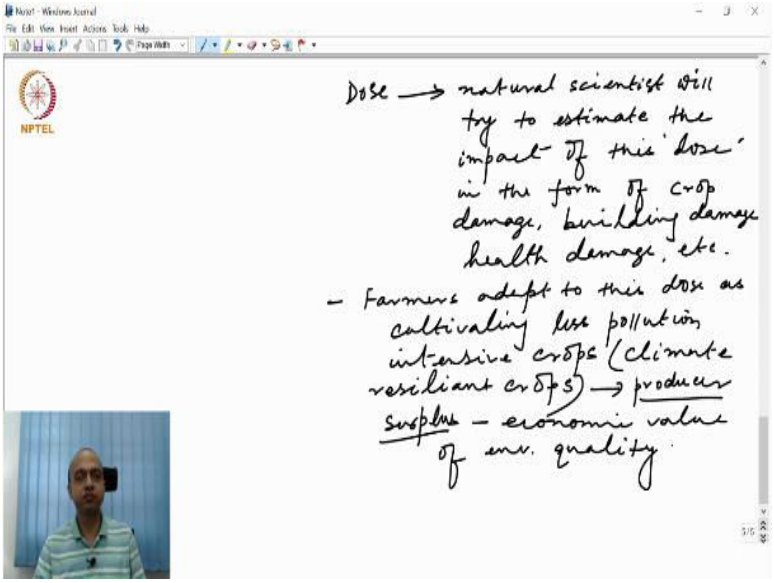

Now, once we get the dose these dose responses, that means once we get the dose what the natural scientists will do, natural scientists will try to estimate the impact of this dose in the form of let us say crop damage, building damage, health damage etcetera. Now, let us say that the farmers adapt to this dose by cultivating less pollution intensive crops, so what the farmers do? Farmers adapt to these dose as cultivating less pollution intensive crops or climate resilient crops, so what will happen, there will be a change in farmers profit, we do not know whether it is negative or positive, that may lead to some in some cases a positive impact as well, so whatever happens negative or positive there will be some change in producer surplus.

Producer surplus and that producer surplus would be treated as economic value of environmental quality, this producer surplus would be treated as economic value of environmental quality. Similarly, when buildings get damaged due to this acid rain we need to spend some amount of money to rectify that, if our health get damaged due to this pollution we need to spend money to correct our health that is called health expenditure, so all these expenditures are actually the response towards that dose and monetary value of these responses, monetary value of these responses are called as the value of environment which is generated due to this type of doses, that is why these are called dose response function.

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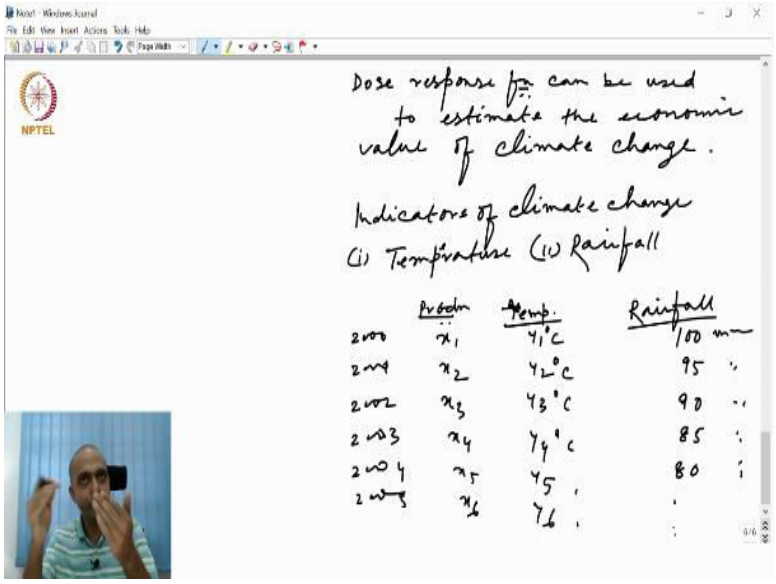

Now, recently these dose response functions are also used to estimate the economic value of climate change, so dose response function can be used to estimate the economic value of climate change. So, what economist they do, they use some kind of indicators for climate change, what are those? Indicators of climate change, mainly they use temperature and secondly rainfall, temperature and rainfall these are the two major indicators of climate change.

Now, the economist what they do, they collect time series data, let us say we have time series data on temperature and climate change, this is let us say degree centigrade climate change and this is rainfall, let us say rainfall or we have time series data starting from 2000, 2001, 2002, 2003 and 2004, 2005 like that we have temperature and we have rainfall data.

And we also have production, that is production of wheat this is x1, x2, x3, x4, x5, x6 and this temperature is mean temperature in a particular area, let us say this is y1, y2, y3, y4, y5 and y6 this is degree centigrade, this rainfall is 100 millimeter, then 95, then 90, then 85, 80 like that we have rainfall data, so what we need to collect production of wheat over a period of time, temperature and rainfall.

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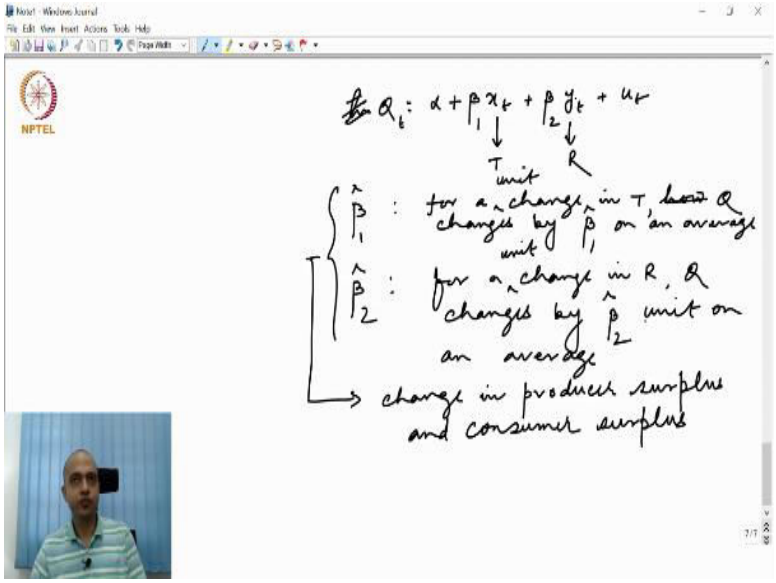

Then the economist what they do they try to estimate some kind of again production function like log of Q equals to alpha this is Qt production of t th period of time, alpha plus beta 1 xt plus beta 2 yt plus ut, this xt is for temperature and this yt is for rainfall. So, once we estimate this model, that means after estimating this model we will get beta1 hat and beta 2 hat, this beta 1 hat will tell you for a change in temperature, how temperature Q or output changes by beta 1.

Similarly, beta 1 hat for a change in rainfall Q changes by beta 2 hat, let us say I am not using log, I am using simple production function, so for a unit change I will say that for a unit change in t, for one-unit change, one degree change in temperature or one millimeter change in rainfall, for a unit change in rainfall Q changes by beta 2 unit on an average. So, from this change, from this change in production due to change in rainfall and temperature due to the global warming we can again calculate, what we can calculate? Change in producer surplus and consumer surplus.

Why producer and consumer surplus both change? Because as production changes it will have some impact on price level, so that will lead to either more profit to the producer or less profit to the producer, that is why producer surplus will change, consumer will also pay either high price or low price depending on what type of production change happen, if there is more changes that means if there is more production then consumer will be able to pay less, generally the impact of climate change and crop production is negative, so it will negatively impact both producer and consumer surplus and that will be treated as economic value of environmental quality, so this is the production function approach in short.

Basically we need to conceptualize a production function in which environmental goods or services will enter as an input along with several other inputs, here when we write this production function it is not only the temperature or rainfall but also several other inputs like fertilizer so on and so forth, will also enter into the production function and then we will try to estimate this equation using proper econometric methods and then estimated coefficient will be treated as a response function, that means when environmental quality changes, how it impacts on output and that will get reflected in consumer and producer surplus and that summation of consumer and producer surplus will then be treated as a economic value of the environment.

So, with this we are closing our discussion on economic valuation of the environment, so the entire discussion, all the approaches we have discussed, we started with stated preference approach, wherein we asked the respondent to state their preference for environment, in absence of any market we created hypothetical market, then we want to move on to the reveal preference approach wherein the respondents or individuals preference already reflected or revealed through related market, we discussed about hedonic pricing, taking housing market we discussed travel cost method and then lastly we discussed about production function approach for valuing the environment.

Different approaches they have different merits and demerits, some approach can capture both use value, non-usable, some approaches can use only use value not the non-use value. Some approach may suffer from hypothetical bias, some approaches may not suffer from hypothetical bias, so we need to understand clearly in our mind what are the pros and cons of different approaches and then we need to apply suitable model depending on the context, thank you.