Environmental & Resource Economics
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Optimum extraction of renewable resources and Tragedy of Commons Part - 6

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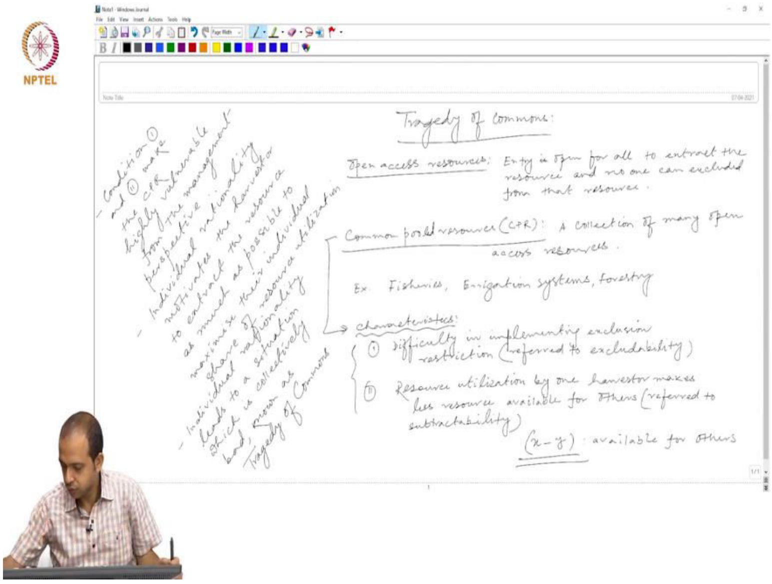

Welcome once again to our discussion on optimal extraction of renewable resources. In our last class, we are talking about open access resources where no one can be excluded from an entry to enjoy the resources. And we discussed that, in open access resources, resource extraction is much faster than the situation when the resources are privately owned. But in both cases in both cases, we can have a price which is resource exhausting.

If sketching becomes too attractive then under both private and open access resource the species may get exhausted. Because the harvester has no information about the x mean or critical amount of species that should always be maintained for the resource to have the regenerating capacity.

So, today, what you will do, we will have another situation wherein, we will prove that how in case of open access resource, the resource the, species may get exhausted. In our last class, we mainly got a proof with simple diagram where we showed that in case of open access resource price equals to average cost of average cost instead of marginal cost, and there were congestion externality in that case of open access resource.

So, today also, we will discuss another interesting case, which in the literature is called as tragedy of commons. So, this is tragedy of commons. So, before we discussed about tragedy of commons, let us introduce another concept which is called common pool resources. So, earlier, we discussed about open access resources, which was defined, as entry is open for all to explore to extract the resource and no one can be excluded from that resource.

This is called open access resource. Now, let us say, we have a pool of such open access resource then that is called common pool resource or in short CPR common pool resource. This is basically a collection of many open access resources this is called common pool resource. So, idea is same. Here in case of open access resource, we talk about only one resource.

Here if we have a collection of such open access resources then that is called common pool resource. For example, we can take that as an example we can take fisheries then we can think about irrigation system or you can think about and you can also think about let us say forestry. So, these are all example of basically common pool resource, which is a collection of many open access resources, common pooled resources.

Now, in this case, what happens actually, this common pool resource it has basically two distinguishing features. What are those? Two features, two important features or characteristics? Number 1, see, apparently it may look like that common pooled resource is like any other public good, but it is a little different from the public goods that we generally aware of. The first condition, which is similar to the public good.

In case of public good, for example, public road, highways, so on and so forth, where we cannot actually exclude anyone from enjoying the resource. So, difficulty in implementing exclusion restriction, which is referred to excludability. So, this feature is similar to public good, but the second feature of this common pool resources, which is different from the public good, this is called subtractibility.

That means, if the resource is used by one that makes less amount of resource available for others. So, that means, the resource utilization by one harvester makes less resource available for others, which was not the case in the context of public good. If I drive along a public highway, then that no way is going to reduce the resource, less amount of road available for you tomorrow when you are actually driving your vehicle along that same road.

So, once use does not make a situation where the less amount of resource available for others that is in the context of public good, but here, if one harvester uses the resource today, it makes a situation where less amount of resources available for other hardware starts tomorrow, so this is referred to subtractability.

Why it is called subtractability? Because if the total amount of resource is let us say x, and a particular harvester extracts y amount of resource today, then x minus y is only available for others. So, that means, we need to subtract an individual harvesters' amount from the total amount of resource, which should be available for tomorrow's utilization.

So, since x minus y we are getting resource availability by subtracting y from x this characteristics is known as subtractability. Now, these two features. First of all these non-excludability, so that means, difficult to implement exclusion and the subtractability condition. This condition one and two make the CPR highly vulnerable from the management perspective. So, individual harvesters, they are actually guided by their own rationality.

And what is the rationality? The rationality is to maximize their individual share. Because if a particular harvester is not extracting the resource today, then someone else will come and harvest it, so less amount of resource would be available tomorrow. So, that is why, individual rationality is to maximize their own share of resource utilization, individual rationality motivates the harvester to extract the resource as much as possible to maximize their individual share, shares of resource utilization.

And this individual rationality leads to a situation, wherein, everyone is actually guided by rationality, but individual rationality leading to a situation which is collectively bad for everyone, resource get exhausted so soon, and that situation is known as tragedy of the commons in the context of common pool resources. Generally individual rationality leads to maximum social welfare.

We have learned in the context of market behavior, wherein, in a perfectly competitive market, wherein, every single participant in the marketplace they are motivated by individual rationality and that individual rationality, which is selfish behavior actually. All the individuals, they try to maximize their own utility or their own profit in a market, and collectively that maximizes social welfare also, that we have proved.

But here is a case when individual rationality of maximizing their own share of resource utilization leads to a situation, which is collectively bad, and that situation is called tragedy of commons. So, individual rationality leads to a situation, which is collectively bad known as tragedy of the commons. Individual rationality in the context of open access resource or common pool resource leads to a situation, which is collectively bad.

So, what we will do now? We will try to understand. We will try to have a formal proof of this tragedy of commons using a simple mathematical model. In our previous class, we understood the situation by a simple diagram. Now today what we will do, we will try to understand the tragedy of the commons in the context of a simple mathematical model, a simple, very simple mathematical model.

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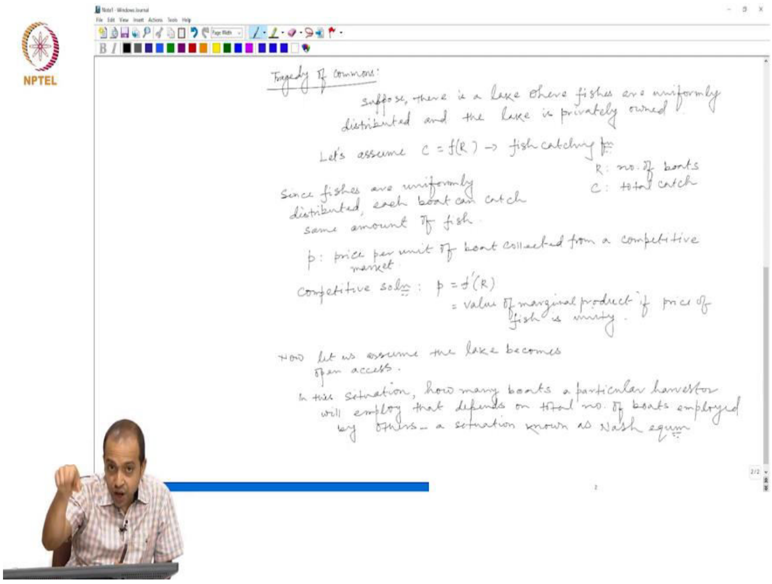

So, this is called tragedy of commons. So, suppose there is a lake where fishes are uniformly distributed, and the lake is privately owned. Let us assume c equals to f of k is basically the fish catch function, fish catching function. Some kind of production function you may think of and wherein k is basically k is total number of boats.

K is actually number of boats, this is let us say, small k to denote, this is also small k, number of boats and sea is basically total catch. So, we assume that fish catching function is like a fish production function which is a single input production function. What is the input? Input is basically both, there is only both is required for free sketching and we assume it is a single input production function.

So, since fishes are uniformly distributed each boat can catch same amount of fish. Let us also assume p is basically price per unit of boat collected from a competitive market. So, what is the competitive solution? The competitive solution is then, competitive solution would be p equals to the marginal product that means, p should be equals to f prime k, this is the competitive solution, f prime k, p equals to f prime k is a competitive solution.

So, that means, if we assume that so p equals to the value of marginal product if price of fish is unity, that is the assumption we make. So, p equals to f prime k. Now, let us assume the lake becomes open access. Now, we assume the lake becomes open access.

So, earlier, it was a privately-owned and in case of private ownership what we learn that price should be equal to the marginal product or previously we saw that price should be equal to marginal cost when we derived the condition of open access extraction and private extraction in the simple diagram. So, let us now assume the lake becomes open access resource.

So, what will happen then? In this situation, how many boats a particular individual a particular harvester will employ, that depends on total number of boats employed by others. Earlier, the resource was being enjoyed only by a single harvester, now there are too many harvesters, the resource becomes now open access.

In this situation, an individual is thinking how many boats to employ. And that the individual’s choice about the number of boat is actually dependent on how many boats are employed by other harvester. If there are too many other harvesters and they are employing too many boat, as a single individual now, it is best for me also to employ too many boats. Otherwise, when the others are extracting at a faster rate by employing too many boards my strategy would be also to employ too many boats to increase my sphere of extraction.

So, it becomes a strategic situation now. So, my best strategy is basically depends on the other’s best response, which in the language of Kim theory is called Nash equilibrium situation. So, that Nash equilibrium situation, so called as a situation a situation known as Nash equilibrium where while deciding my best response, best strategy I first consider others best strategy so that means others, given others based strategy I decide my best strategy.