Energy Resources, Economics, and Sustainability

Prof. Pratham Arora

Hydro and Renewable Energy Department

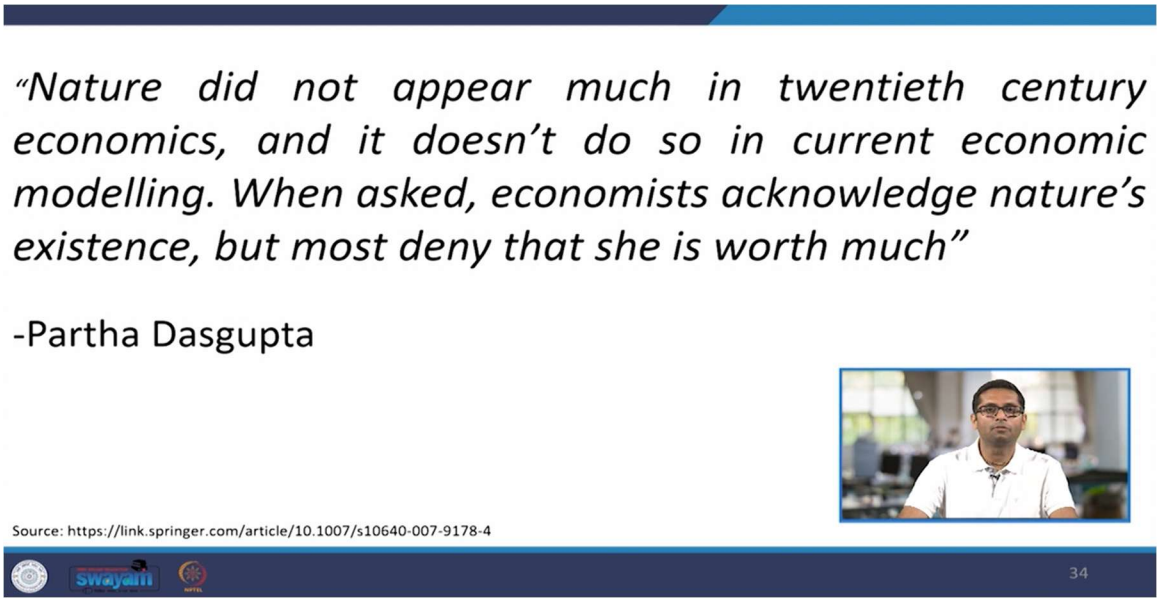
Indian Institute of Technology Roorkee, Roorkee, India

Week – 04

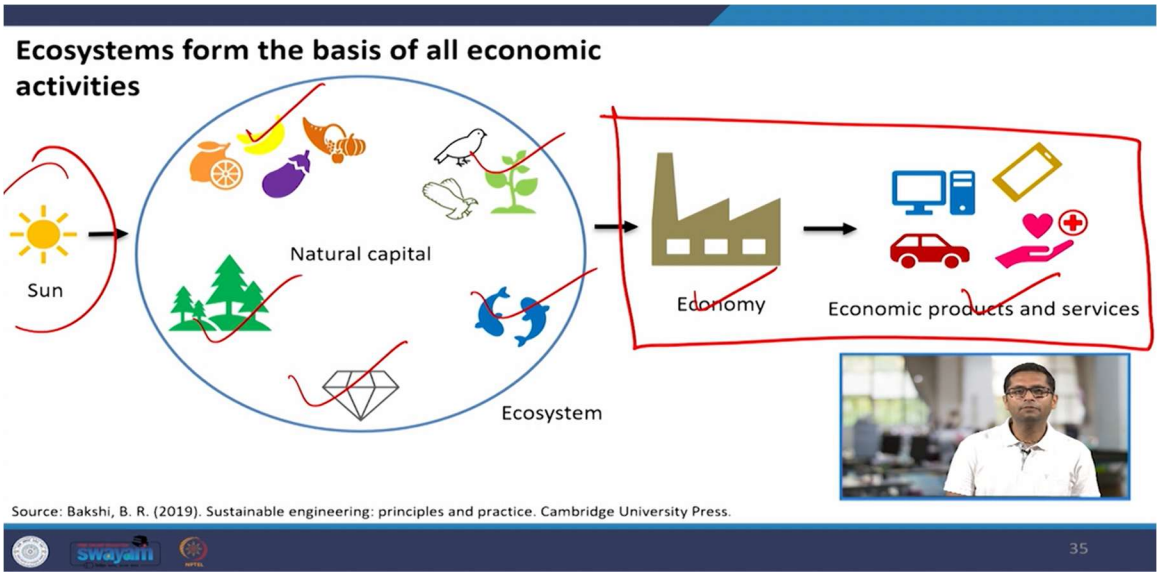
Lecture – 03

Lecture 19 - Economic and Environment

Hello everyone, welcome back to the course Energy Resources, Economics and Sustainability. Till in the past few classes we have been studying different aspects of economics that become applicable to the different energy related projects. We have tried to understand like the different ways in which you could estimate profitability, come up with innovative business models, how the project financing would take place. But we have tried to keep after the ambit of this calculation one very important fact which is the environment. So in today's class we will try to understand the interventions between economics and the environment and how that becomes permanent in some of the energy related projects. So with this let us go further.

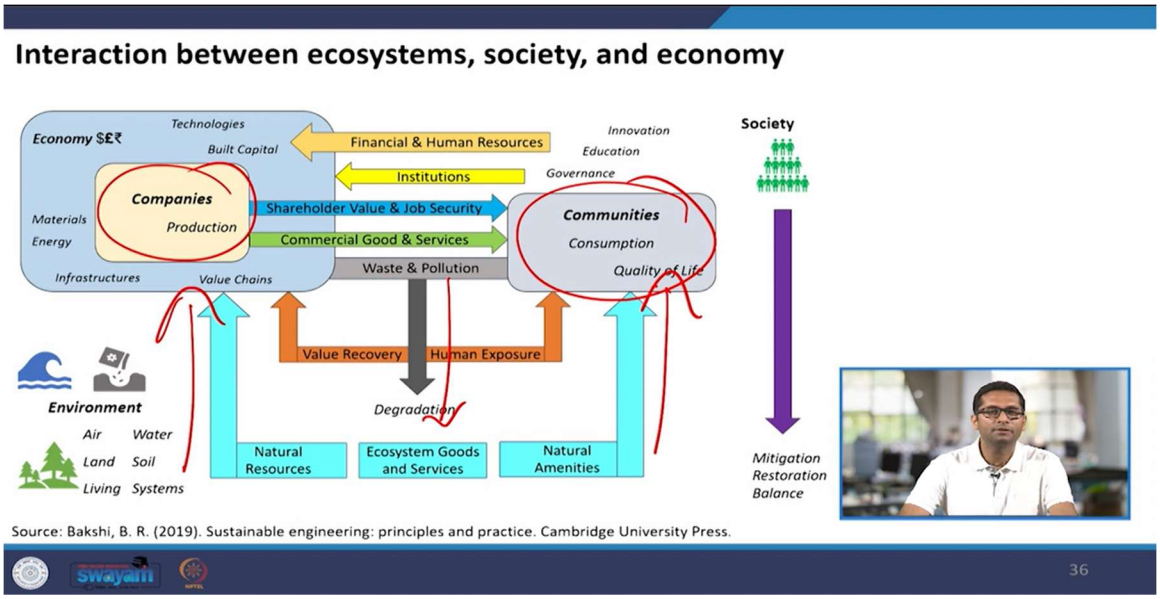


We would like to start with a famous quotation which says that nature did not appear much in the 20th century economics and does not do so in the current economic modelling. Then asked economists acknowledge nature's existence but most deny that she is worth much. And this is the point that we will try to discuss that most of the models that we have discussed in the past hardly had any elements of the ecosystem services that the nature provides us. There are ecosystem services in the form of the raw materials for the different kind of energy products. Even for renewable energy there would be different kinds of metals or non-metals that would be extracted from the earth's crust to make the different kinds of energies possible. A typical case could be that of silicon used in the solar PV modules or the lithium used in the lithium ion batteries. So although we take or we try to incentivize the mining operation, the transportation operations but we tend to keep nature out of such calculations.



So if you see a generic view of the systems, we are mainly concerned about the economy and the economic products and services. We most of the time try or tend to ignore the natural capital that goes into the major inputs to the economy which could include the trees, the different kinds of raw materials, the avian life, the aquatic life as well as the different kinds of products which the nature gives for our survival. And most of these products are powered by the solar energy. Most of the business models or the analysis that we tend to focus have a system boundary which does not take into account the natural capital into account. And today's class we will try to understand if this is

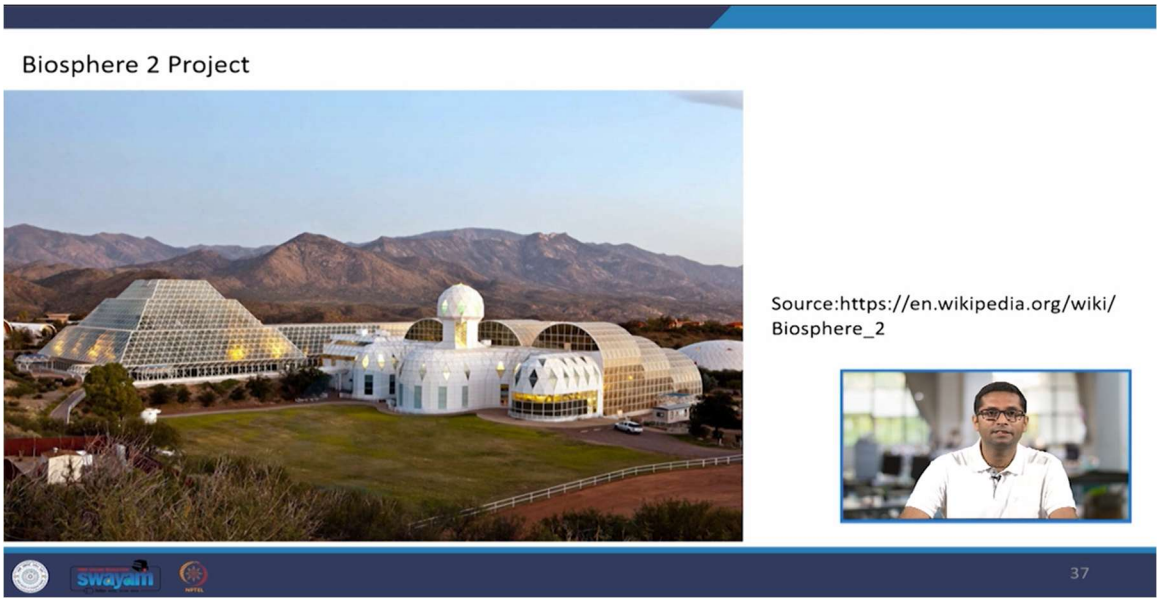
important or not. Also going further we should also understand that the systems are quite complex.



If you see the interaction that happens on the different levels where we would have the communities, we would have the companies, we would have the society, there are different kinds of interaction that happen and many of it will be using the natural resources which can go as raw materials to the companies, the amenities like water or air which feeds the communities.

Further the waste that are generated are going back to the ecosystems and this leads to the ecosystem degradation. It also includes the social capital which is based upon the different ecosystems and then many interactions which we cannot like which we should not ignore for the long term. We have been doing so for the past few centuries. The basic economic models that we have been focusing on does not have any element of ecosystems. But that cannot be the way to think in the future as well.

Let us try to proceed with the help of few examples. So question might be raised that we are a very technologically advanced society. Why should we worry about the nature? If the nature gets spoiled so be it, we are technologically advanced, we will come up with some kind of alternative as we have been doing so in the past 100 years or so. We have done a major degradation to the environment in different ways. But every time we have been able to come up with an alternative.



Well, one of the ways to understand to this kind of question could be a typical project which is called the Biosphere Project. And this project basically came into being in two different trenches. One was the Biosphere 1 and the Biosphere 2 which came up in the Arizona region in the US. So what they tried, the scientists tried to make in an artificial ecosystem which consisted of oceans, deserts, rainforests, farming which had zero interaction with the outside world. So you can see the domes in here.

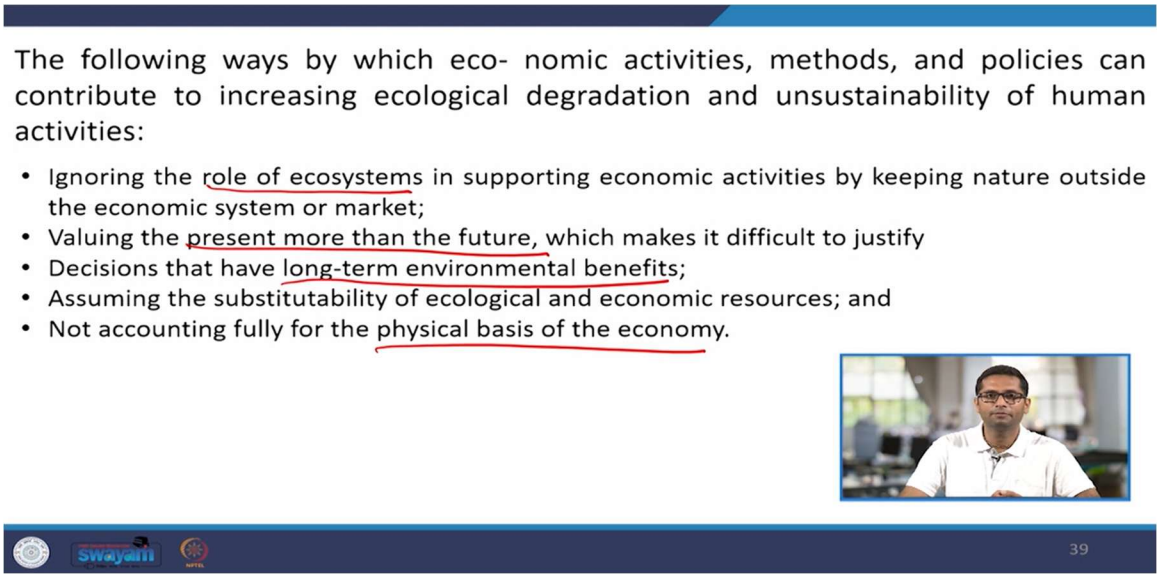
They had, it would have the different kinds of rainforests, different kinds of lakes, oceans and the interaction with the outside world was nil. The only interaction was the coming in of sunlight and that is the only thing. And they tried to understand if they could make an artificial ecosystem of in itself and which could help us or help them understand the ecosystem interactions for the future. So no doubt the project came out with major findings and that helped in advancing the scientific knowledge. But one of the major aims was to see if the system can be self-sustaining.

And the project in itself was not able to reach that particular objective. So what happened that the CO2 levels in this biosphere kept on rising continuously even after the fact that there was no fossil fuels used in the system like this. So although they tried to replicate the natural systems, they were not able to do so 100% such that the model was not able to survive alone without much interactions from the future. So one major learning that came in that the human race cannot take the natural ecosystems or the natural biogenic cycles

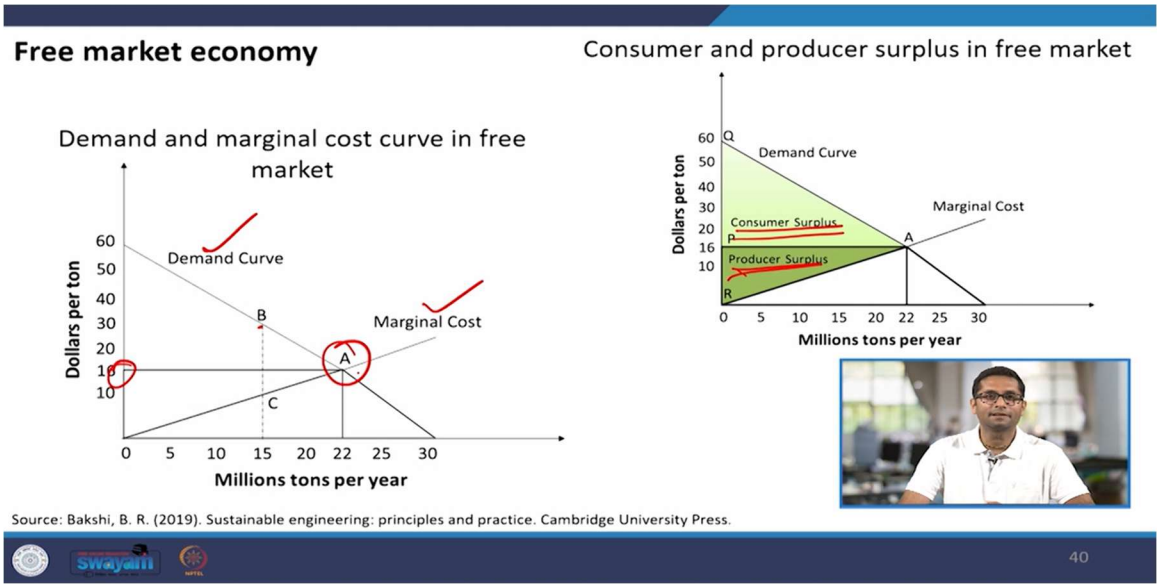
for different kinds of nutrients like the nitrogen, oxygen, carbon to be for granted because it is very difficult to replicate these kinds of cycles even in a controlled environment.

The second kind of example that we can look for is the example of the Easter Islands. So Easter Islands are one of the most remotely habitated islands in the Pacific oceans. So it is believed that settlers first reached these islands around in the 5th century and it had a dormant volcano and near the volcano there was a freshwater source which provided for their water needs. So it is expected that around 30 or more inhabitants were the first one to land on an island like this and since this had a nice climatic zone they made it their homes and they started cultivation. The soil was good enough for cultivating a few things and they had their own livestock brought with them which helped them make up for some of their food requirements. The ocean had a good source of fish and slowly it is expected that the community grew into 7000 strong community and this also led to their developing their own culture and they build up statues like this which are quite famous and one of the mascots of the Easter Islands. It is believed that they build almost 600 statues like this which had which were from head to torso and installed that at different places in the island. But it so happened that in doing so and they have been deteriorating the natural capital at a very fast rate. They had been cutting down trees and the trees were used for basically rolling the stones for making statues like this. The trees were also cleared up for more and more farming and the result of clearing of the trees was the soil

started to erode. With the erosion of the soil less and less foodstuff was growing. After the disappearance of trees started and disappearance of trees also meant that less wood was available for more of the boats to be constructed and this also put a barrier on like the fishing and that they could carry it out with the help of boats. And finally when the last expedition was made to this particular island it included a very like a very old society that had almost like resorted to cannibalism from a very advanced civilization that built beautiful statues like this it had become a very primitive society. So this example was undertaken to highlight that we cannot just neglect the natural resources. Natural resources play a big role in the development of the society as well as the long term sustenance. Now coming back to the different kinds of economic models.



So the economic models that we have been discussing by a large discuss the role of ecosystems in it. Also they are known to value the present more than the future. Anything that is there in the present is expected to be more valuable than the future and the typical case is that of the discount rate. Further the discussions are made without the long term environmental benefits or degradation and we do not really account for the physical basis of the economy which means most of the resources that are which lead to economic development are coming from the nature and we fail to give the due acknowledgement to the nature. So let us try to understand the basic model for a free market economy and this kind of model came into being almost like a few centuries back.



So in this case we have two different types of curves. One is called the demand curve which is basically means that the higher the price of a particular commodity the lesser is going to be the demand for it. So as the price of the commodity decreases you would have more and more of it used in the market or being consumed. Further we also have the marginal curve or the supply curve. This means that basically reflects the additional cost that need to be put in for additional production of any particular commodity.

So you can see a smaller production of a particular commodity might cost less but as we keep on increasing the amount of production of that commodity the price tends to increase. The intersection of the demand and this marginal or cost curve or the supply code basically gives the equilibrium which is marked by A in this particular graph and this is where which basically decides the market price. It is basically the intersection of the demand curve and the marginal curve that basically decides the price of a commodity in the market. Let us for example take the case of iron ore which is used as a raw material in many of the industries. So what we can see is that like if there are people who would be willing for buying the iron ore from around 60 rupees to around 22 rupees.

So this is the range in which the buyers are willing to pay for a ton of iron ore maybe. And further we can also see that from the seller's perspective we would have the production rate of iron ore varying from all the way 0 to around 22 rupees or so. So within this we can say that anyone who wants to buy the iron ore would be willing to pay

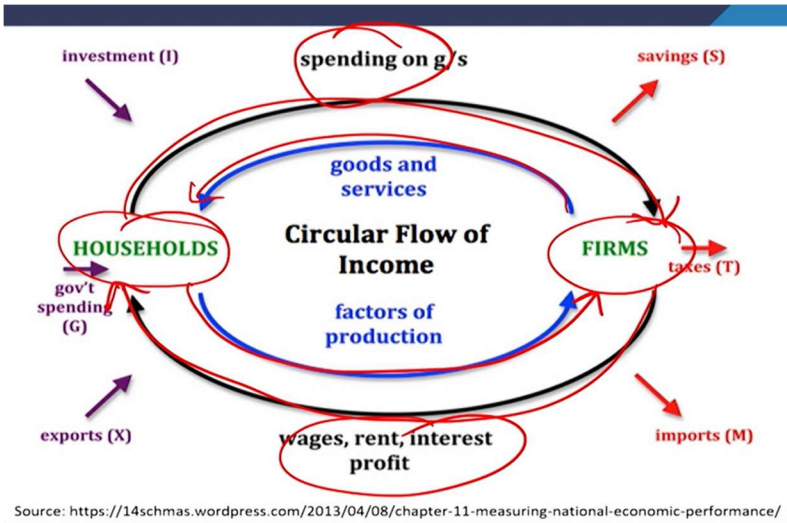
a much greater price and the iron ore is available at a lesser rate and this is also called the consumer surplus space where the consumers are ready to pay more than what is the market price and the commodities available. Further it is also called as the producer surplus place because the producers are paying a much less price for the production of particular commodity than the market is ready to pay. So in this case the market is ready to pay around 16 rupees of price for that particular commodity.

And also these kinds of mechanisms are also responsible for bringing the cost back to the equilibrium in case there is a fluctuation in the price due to some events. Say due to some event the price of the iron ore now goes to the point B where it has now increased so the sellers or the buyer are willing to pay a price of around 30 dollars a ton whereas the sellers are only having a cost of around 10 dollars a ton for the production of this iron ore. So what is going to happen is more and more sellers are going to jump in the market to make up from the profit and slowly it is going to come to the equilibrium point A back again. Something similar happens if we go beyond the point A on the right hand side if we see that the sellers are not willing to pay much and the buyers are incurring a much more amount for putting up a specific commodity again the market would come into play and this would again bring the price of that particular commodity back to around 22 dollars a ton and bring the equilibrium back. And this is the advantage or this is one of the key win-win features of free market economy where the markets on their own are able to decide what is the best price for the consumers as well as the sellers and thus reaching a very nice situation for the market as a whole. And this is what very nice the basic of a capitalist economy. And further this ability of the market to self regulate itself is also something that like the economist Adam Swift calls the invisible hand. So far so good but these kinds of assumptions for a free market economy also are based upon the key assumptions which are some of them are follows it takes into account that all the industries are equally competitive.

Assumptions: For the free market to result in an optimally efficient solution, the following conditions need to be satisfied:

1. All industries are competitive;
2. Consumers and producers have economic knowledge about the costs and benefits of their actions;
3. Everyone in the market is driven by the desire for maximum financial gain;
4. There is no benefit of increasing the scale of an activity, that is, there are no economies of scale; and
5. There are no external or ignored social costs such as damage to society, employees, or the environment.

The consumers and the producers have economic knowledge about the cost of benefits of their actions I mean all the cost and the benefits. Everyone in the market is driven by the desire for the maximum financial gain. There is no benefit of increasing the scale of activity so which means there is no economies of scale coming into being. And finally there are no external or ignored social cost in the form of damage to the society, the employees or the environment. And it would come to us intuitively that many of these assumptions are violated by the corporates that we have in today's world. These basic assumptions form the basis of the free market models that we have discussed in the previous slide and we can see that many of them gets violated in today's world. Let us try to understand something.

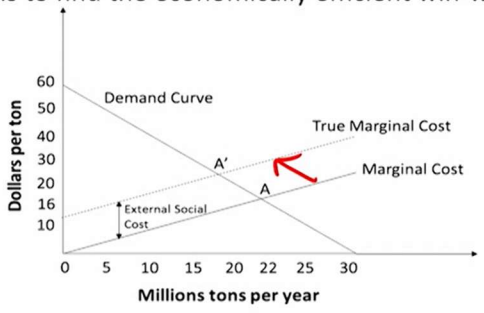


Source: https://14schmas.wordpress.com/2013/04/08/chapter-11-measuring-national-economic-performance/

So the basic model is basically can also be shown with the help of this diagram where an the whole society is divided into the households or the firms and this is also the basis of the neoclassical economics. The households basically buy the goods and services from the firms and they pay for these goods and services to the firms back. Further the households also provide the labour as well as the capital for the operation of these firms for which the firms pay back to the households. And this is a sort of loop that forms the basics or basis of the neoclassical economics wherein you would have the spending and expenditures that is occurring between households and firms and either of the total spending or the wages, rents or the interest and the profit you can calculate to calculate the GDP of a particular country or the entity and the aim of the society as a whole would be to increase the GDP as much as possible because GDP is linked to the economic well-being. It could be either you are spending a lot or you are earning a lot so you total up either of the two entities and you come up with the total GDP.

Environment externalities

- If the price of an economic activity does not include its impact on all the relevant resources, then the market will be blind to the impact of this activity on the ignored resources. For such resources or services that are not included in the market are called externalities.
- The market is unable to balance trade-offs between economic activities and externalities and fails to find the economically efficient win-win solution.



Effect of negative externalities in a free market

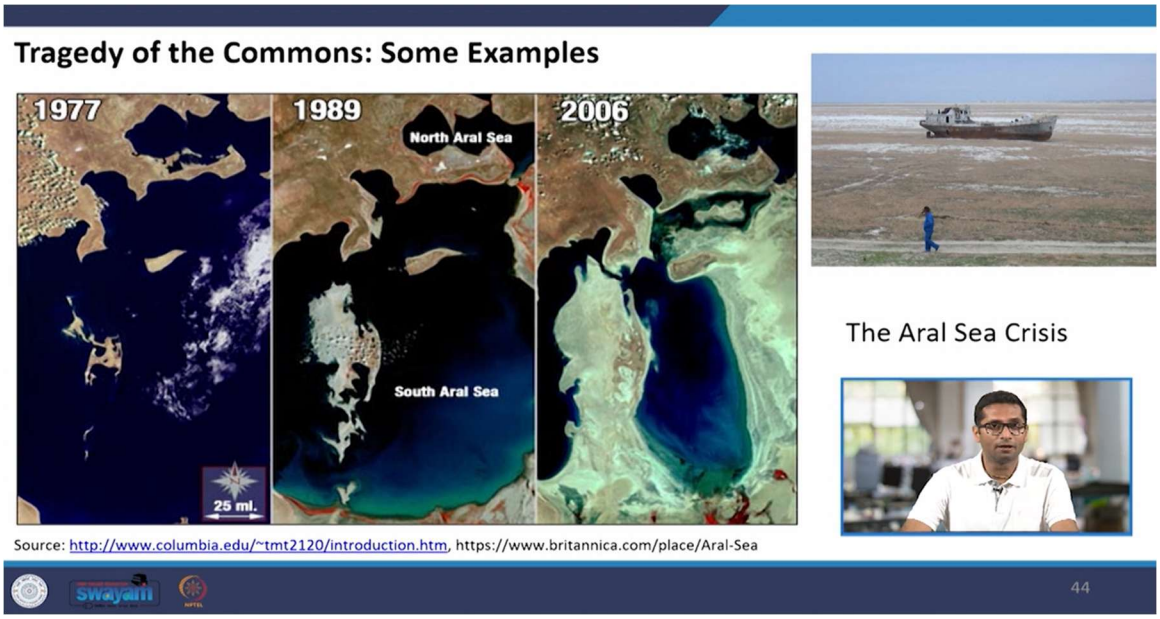
Source: Bakshi, B. R. (2019). Sustainable engineering: principles and practice. Cambridge University Press.

But as we also discussed in one of the classes previously that these kinds of activities often neglect the externalities. By externalities I mean the effect that can happen on the environment. There could be both positive and negative externalities. Take for the example say if I am digging out coal for a power plant and this coal has to be transported from the mines to the power plant. Now the transportation is important fact.

Now the transportation or the road network is something that I do not take into account while calculating the economic model for a coal based power plant. And this is a sort of externality that I am neglecting. So if I am not taking about the cost that goes into the construction and the maintenance of road what is going to happen is slowly the road network or the transportation network is going to degrade. Its effect is not going to be felt much till we have totally disturbed road network which can spoil the whole supply chain. There could be positive externalities as well and there could be nature based solutions in terms of wetlands or gardens that could be created that helps give us a positive environment.

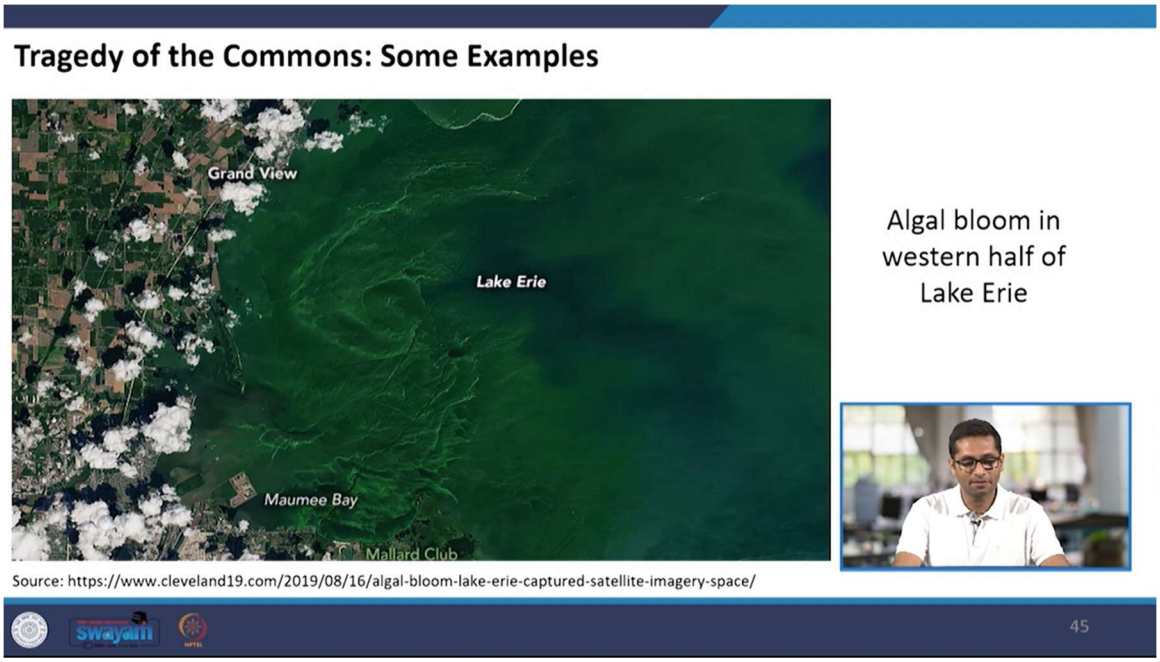
People who would want to buy a house where they have clean atmosphere where there would this clean air so although you are putting buying a house by the same rate if such kind of facilities comes into your neighborhood the price of house naturally increases and this sort of positive externality. In the energy related field we have a lot of negative externalities in the form of environment there are a lot effects that these kinds of plants or these kinds of energy related plants cost to the environment they have a negative effect on the environment but that is not taken into account in the economic or financial model anywhere. if that effect was also taken into account what is going to happen is that the marginal cost curve is going to shift towards the left hand side. So earlier when the point of intersection was A it is now going to be A' because of the extra cost which is input because of the or for the renewal of or for the renewal of the problems that we have caused to the environment or the different kinds of emissions that have been brought to the environment and the sequestration of this emissions calls for further cost. So if you would have to take in the true cost which also includes the externalities in terms of the environment, we might have to shift the marginal cost curve towards the left and this is what we see in here. So in reality the true marginal cost would be somewhere having an interaction at A dash and what happens when we have an equilibrium of A, it basically leads to an over consumption of a particular resource because the resource is having an equilibrium at a lower price, people would want to use much more of the resource which leads to over exploitation and over exploitation also leads to the degradation of the environment. Further if we were to consider the true marginal cost, one thing is that the quantity used would be lesser and further we are also putting in a cost that might be used

to put a hold on the different kinds of environmental degradation that is happening to the environment. So let us try to understand some of these problems, few particular examples. So when we do not take these two marginal cost into the calculations, there is a term that has been coined by Hardin which goes as the tragedy of the commons. So the tragedy of the commons means is basically there is a select few who will be making the benefit because of the technology but which also means that the emissions that are caused because of that particular technology are beared by the society as a whole. So what is happening here is there is the concentration of the incentives but the socialization of the effects. Take for example if you are driving an IC engine vehicle, so you tend to get the benefit of the riding speed as well as the transportation whereas the emissions that are caused because of the burning of the fuel in an IC engine, everyone around the society has to take care of that. So similar could be said by different energy related activities as well.



So let us try to understand this concept with the help of few major case studies. So first let us have a look at the Aral Sea. The Aral Sea was a sea between Uzbekistan and Kazakhstan and this was the part of the erstwhile USSR. It was one of the largest inland lakes or seas that were existing at that time and this was fed by two major rivers which was the Syrdaria and the Amudaria which were carrying the water into this inland sea. But at that time the USSR government felt that the water in these two rivers could be

better used for some of their irrigation requirements in other parts of the country. So they diverted a majority of the part of the river for this irrigation practices. As a result what happened was the area for the sea kept on decreasing, the salinity kept on increasing and if we see today the Aral Sea occupies around 10% of the land that it occupied in the earlier cases or that it were occupied traditionally. So in this case the advantage was reaped by a few irrigated areas in the USSR whereas who paid for the environment degradation it was the people who were living or were dependent on this particular sea for their livelihood and because the sea no longer exists in the original condition and the water quality has degraded a lot.



Another common example that is often cited is that of a lake Ayre that is one of the large five lakes of the US. So this kind of lake is this particular lake is known for a lot of algal blooms which is the green sky that grows and because of these algal blooms there is a huge amount of degradation in the water quality as well as the marine life.

One of the reasons for the coming of this algal blooms is the vast quantity of the fertilizers and the pesticides that seep through the incoming rivers into this lake. So people have been using the pesticides and the fertilizers quite indiscriminately in the past which has led to the flow of these kinds of chemicals into this particular lake and because of the increased nutrients there has been an increased algal production which has led to

the water quality degradement. So whereas we can see the farmers in the nearby areas had the benefit of the use of fertilizers and the pesticides in the terms of the higher productivity of the crops. The problems were faced by the community that was staying near the lake in terms of the lifestyle hazards and unavailability of the ecosystem services that was provided by the lake. Another typical example that is coming now into the focus is the huge amount of plastic pollution.

So plastic pollution has become a major source of concern throughout the world. We have been using plastics, different kinds of plastics indiscriminately and one of the major uses has been for packaging. So as packaging material plastic provides a very stable medium and a very easy to use medium but once it has been used the supply chain is almost a straight chain. There is no recycling done for the packaging material and one of the major places that it ends up is the oceans. The oceans have become a big dumb place for the plastics like this.

As per one estimate if the amount of plastics that is being accumulated in the oceans is to grow at the present rate possibly by the year 2050 the oceans would have more plastics than the current marine life and so that in itself is a worrying situation.

Further I would like to show this is a photo that I myself took at the depth of the ocean and you can see the huge amount of plastic waste that can be seen lying on the ocean floor. So again like the benefit here is derived by a few packaging companies whereas like the result of these kinds of intervention would be like a loss of marine life and also a loss of the to the ecosystems in the long term. Many of the beaches throughout the world are flooded with plastic waste throughout the day because the oceans when they become like the excess plastic waste has to come somewhere. Now let us try to understand like if we were to include this kind of analysis into a cost benefit analysis.

Discounting and Benefit-Cost Analysis

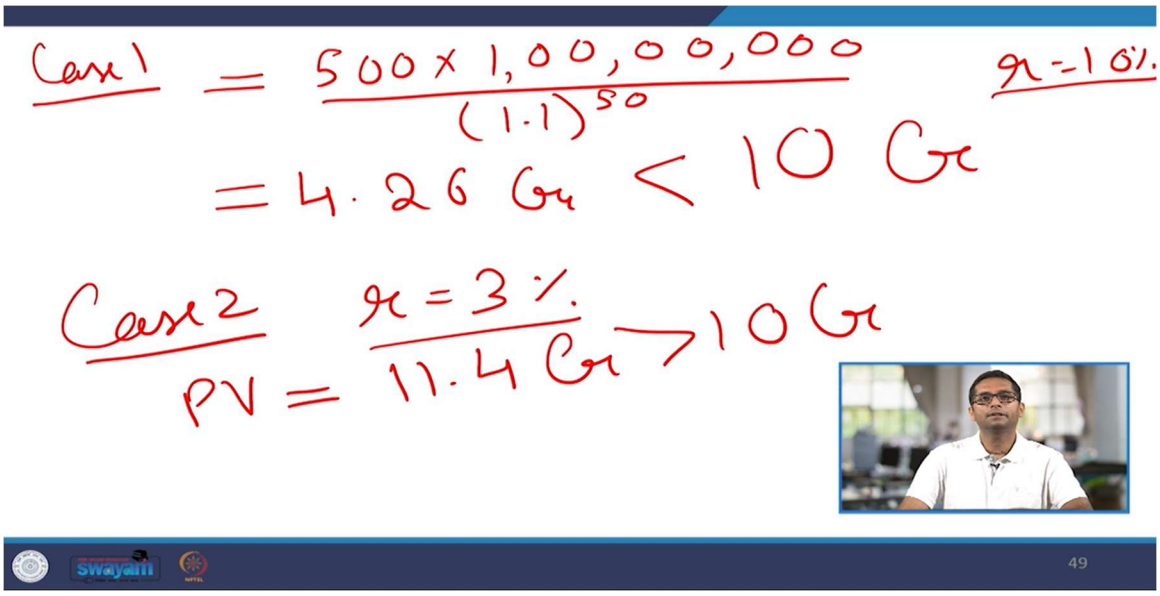
$$P = \frac{F}{(1+r)^n}$$

Where, P = Present Value, F = Future Value,
r = interest or discount rate, and n = number of years

Example: Consider a scenario in which a significant catastrophe of Rs 500 Cr is predicted 50 years from now as a result of greenhouse gas emissions. This could be avoided by spending Rs 10 Cr today. Does it make sense to spend the money today? You may consider discount rates of 10 percent and 3 percent.

Source: Bakshi, B. R. (2019). Sustainable engineering: principles and practice. Cambridge University Press.

So we have already understood the concept of discounting that the present value can be calculated for a future cost by dividing it through the discount rate and let us try to understand with the help of the simple equation. Let us consider simple scenario where in a significant catastrophe is supposed to occur in the future based upon the different kinds of greenhouse gases that we are emitting and it is estimated and this cost of that particular catastrophe would be around 500 CR and that is expected to occur from 50 years 50 years down the line. However if we keep on spending around 10 crores per year today from today onwards we might be able to avoid it. Now let us try to understand does it make sense to put in 10 crores per year from today onwards or would it be okay let us do not do anything and let us see whenever it comes we will be happy to pay around 500 crores whenever there is a catastrophe around 50 years down the back. Now this kind of calculation would again depend upon the type of discount rate which we choose. So for this calculation let us choose two different discount rates one is 10% and 3% and let us try to calculate the present value of these two kinds of investments.



So in the first case I would have 500 crores being invested at the end of 50 years so this would be 500 into 1 crore and I have a factor or discounted of 10% and this is 50 years. So this would roughly come around to around 4.26 crore. So this cost comes out to be quite less than 10 crores if I were to invest that today. So if I am having or I put a discount rate of 10% for my calculation I would say I would rather pay 500 crores at the end of 50 years rather than pay 10 crores today because based upon the discounting

principle the time value of money I am quite well off being 4 point like the present value of that future cost would be around 4.26 crores which is less than the 10 crores which I am assuming today. Now in case 2 wherein I would have a discount rate of 3% in the earlier case it was 10% because equation remains the same and the present value of the future cost would come around to be 11.4 crores which is greater than the initial figure of 10 crores. So it might be worth it to spend 10 crores today rather than around 500 crores 50 years down the line and what important factor that changes the result is the discount factor. But what range do you change or do you value present in comparison to the future. If you go with the perspective of different environmentalists they would want the future to be equally valued as the present whereas the economists have a very different view they would value present more than the future and this is where the debate is. If you value future and the present aspects equally possibly you would want to invest today rather than in the future whereas if you value the present more than the future you would want to delay the catastrophe as far as possible because you would value living a good life today spending less today then you are not considering spending something in the future. We can take another example because these kinds of costs are normally also in that form of annuities or the annual payments in this case the formula would be slightly changed we have already derived a form of this formula in the past.

$$P = \frac{[1-(1+r)^{-n}] \times A}{r}$$

Where, A is the annual cost

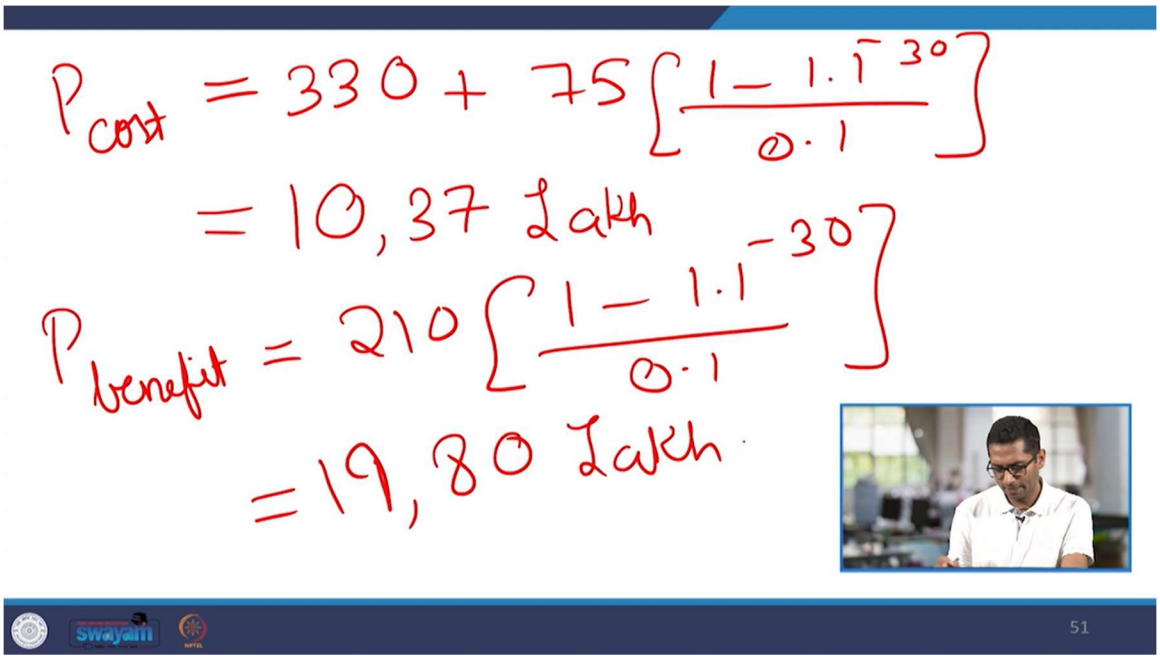
Example: National Parks attract thousands of visitors from all over the world for their views and recreation opportunities. However, visibility in many parks is often poor. One reason for the loss of visibility is identified to be the presence of a local coal-burning power plant. National Park Service analyzed the cost of reducing visibility- impairing pollution from the power plant and the benefit of improved visibility in the park.

- Costs of pollution control at power plant:
  - capital cost of sulfur removal equipment: Rs 330 Lakh at beginning of project;
  - operation and maintenance cost of equipment: Rs 75 lakh per year
- Benefits of better visibility:
  - visitors' willingness to pay for better visibility: Rs 210 lakh per year

Does it make economic sense to implement this project?

Source: Bakshi, B. R. (2019). Sustainable engineering: principles and practice. Cambridge University Press.

So this is the present value of an annuity. So let us take an example of a national park we are expecting the national park attracts a lot of visitors this is specifically true for the developed part of the world and however because of the nearby coal power plants the visibility in the particular national park is not very good and so the leadership would want to understand the trade of that exist between the cost of controlling the emissions from a power plant and the benefits that could be derived in the increase influx of the visitors that can occur. So the pollution that is occurring from a power plant could be basically reduced by adding in a sulphur removal equipment which might cost around 330 lakhs as a capex and then there could be an O&M cost around 75 lakhs per year and because of this increase visibility and bring down the environmental emissions you can the leadership can raise the fees for the national park and there could be an increase influx of the people who are coming and this could be valued at around around 210 lakhs per year. So the question is does it make economical sense to put in the cost right now and does it will it be a profitable thing for the future let us try to estimate that.



So if I was to estimate the present cost of all the cost that was incurred this would include the capex of around 330 lakhs plus 75 lakhs per year of operation and that is an annuity so I will put that is 1.1 minus 30 and 0.1 is the discount rate and this would come around to be roughly 10 crores 37 lakh. If I talk about the present cost of the benefits that I can

derive in terms of the increase influx of people this would again be an annuity with the basic being 210 lakhs increase then 1.1-30 and 0.1 and this would come around to be around 19 crores 80 lakhs. So people can say that like it might be worth investing for a control equipment because the benefit that we can derive is much more than the cost that is incurred but again this is depends a lot on the discount rate that you choose and this discussion about the discount rate also goes back in the history when we had a famous debate between Lord Nicholas Tinn of the London School of Economics and Professor William Nordhaus of the Yale University wherein and they were debating that should the government as such be putting in environmental regulations and limiting the growth of fossil fuel based industries.

So whereas Lord Nicholas was of the view that the environmental tax should be put in Professor Nordhaus was against it they were using their own different models which had the same basics. It later came into understanding that the major difference for their different results was basically the discount rate they were choosing whereas the Lord Nicholas chose a discount rate of 1.6% Lord William or Professor William chose it to be around 6% like Lord Stern was of the opinion that when it comes to emissions people would value the future as well as present equally there is not going to be much of a degradation whereas Professor William was of the opinion that people would always value the present more than the future and his assumption was based on the fact that the future salaries of the people are expected to rise in the future people are expected to be much more wealthier as they are compared to now and spending something in the future might be easier for them. Again if we consider in the future we have catastrophic events like the global warming or the sea level rise these kinds of assumption might be a bit shaky but this also brings to light how the choosing of an interest rate could have a drastic effect on the policy interventions which are proposed by the leaders of the society. Further another economic term that we need to understand is the substitutability which basically means that the different elements of the society are interchangeable or substitutable.

Substitutability

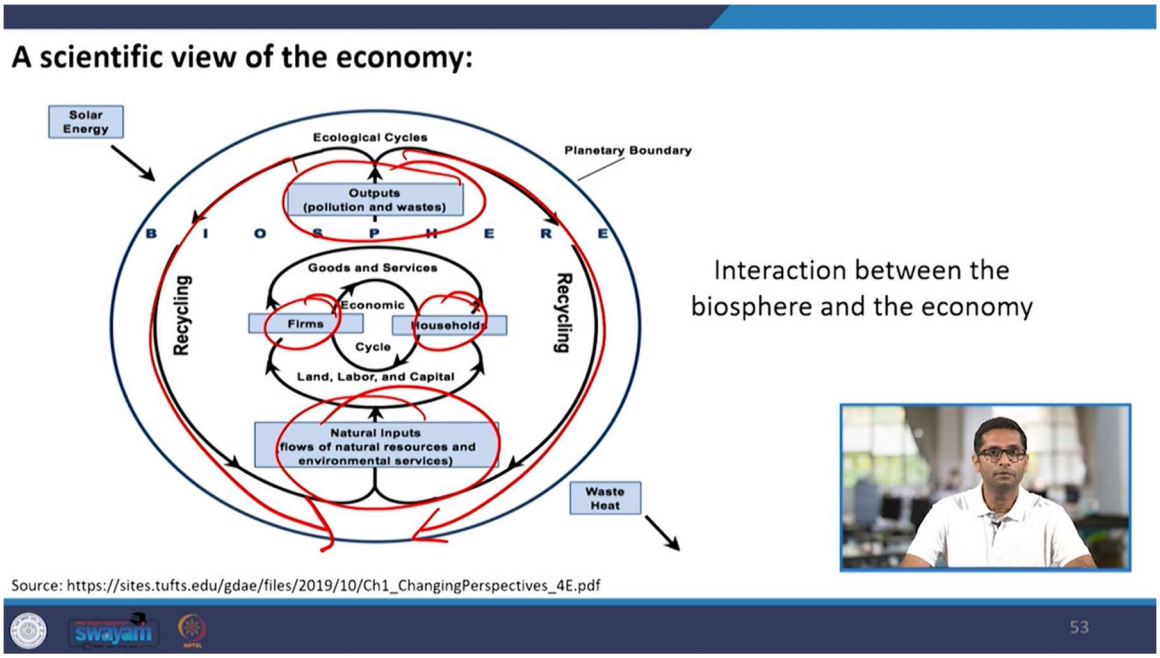
$$Y = F(K, L)$$

Here, K represents capital, and L stands for labor. This equation implies that many combinations of K and L can result in the same value of Y, that is, capital and labor are assumed to be substitutable.

If it is very easy to substitute other factors for natural resources, then there is, in principle, no problem. The world can, in effect, get along without natural resources, so exhaustion is just an event, not a catastrophe

A simple example could be a function in the form of labour and capital so it assumes that the capital that is generated or the total capital can be generated or that is generated would be a function of the capital input as well as the labour either you could increase the labour and reduce the capital in the form of the capital equipment or you can make a highly incentivized or highly computerized framework which has very less labour to take in. Both of them would create some kind of value for the future and the result is that you can substitute the capital with the labour and vice versa and same kind of substitutability has been proposed for the natural ecosystems as well but it has not gone very well because nature as such or the ecosystems or the natural resources cannot be substituted very easily. Even if they can be substituted it takes a lot of time for the nature to regenerate itself. It is not that you can destroy the nature and it will regenerate itself in a very small amount of time and this is one of the major drawbacks of the neoclassical economics which have been of the viewpoint that they can keep on spoiling the nature for as long as they want and because of the substitutability features in the coming future we are all going to find some kind of replacement for that natural activity and the world will go on forever. Probably these kind of thinking was right three centuries back when these kind of economic policies were being formed because at that time the population of the world was quite less further they were new and new discoveries were being made for the uninhabited places of the world.

So, the depletion of resources at one place could easily be made up by the discovery of other resources in different parts of the world but given the today's world it is expected to be much more full and it is not expected that the degradation of the nature that can happen from the different activities that we undertake could be easily be replaced.



So, more scientific view of the economy as has been propagated by many leading scientists would be something like this where we would have the firms and the households interacting in a similar fashion as before but we are also not neglecting the important role that is being played by the natural ecosystems in the form of the natural resources and the ecosystem services that it provides. Further these ecosystem services also play a major role in terms of the control of the pollution and the different amounts of waste that it takes into being. Further it is imperative that many of these waste need to be recycled back to form these natural flows. So, this is a type of interaction between the biosphere and the economy that is being proposed for the future for a better understanding of the world economy where we have the economic systems and the natural ecosystem services working in together both are valued and both exist in harmony.

So, with this we end today's lecture and we will carry on the same discussion in the next class. Thank you.