**Non-ferrous Extractive Metallurgy**

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**Module No. # 01**

**Lecture No. # 34**

**Energy and Environment Related Issues in Nonferrous Metals Production (Contd.)**

Friends, I will continue my lectures on energy and environment related issues with particular reference to nonferrous metals production. Now, so far I have given definitions of some terms which are often used very loosely. The terms I have defined, include waste pollution, industrial pollution, air pollution. Now, in all these definitions, you would have noted that there is reference to adverse effects to humans, animals, plants, property; even there is reference to discomfort and lack of enjoyment.

In other words, whenever you have pollution, there is something negative. Why I am saying it is, because I am going to gradually quantify this idea that, when you are talking about development, we are talking about setting up industries. There is a negative impact on life and property, and we might be able to quantify that. Then, in one hand, we want to progress; in one hand, these negative impacts bring us down. We have to weigh one against the other if we are serious about (( )). Before I do that, let me analyze little more critically what are the adverse things that happen during processing of raw materials from the mines, and when it goes up to the secondary metals stage. We will look at this table.

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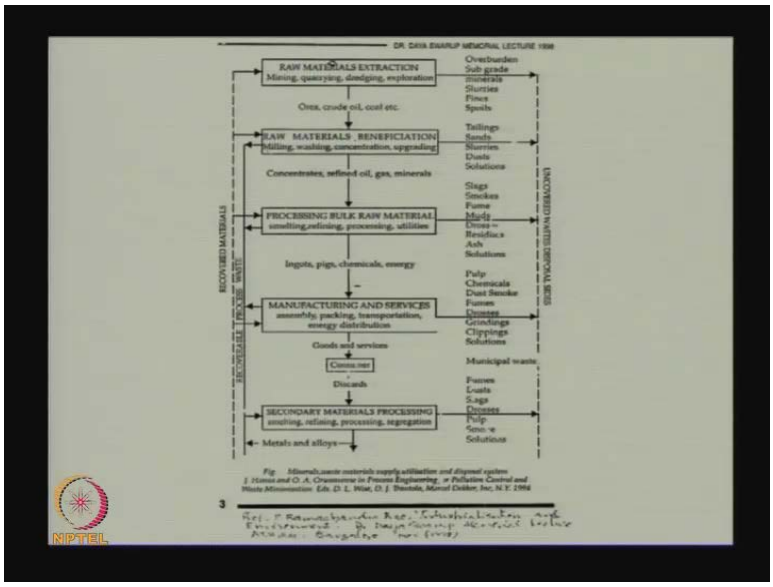


We are starting with Raw material extraction all that is coming from earth's crust. It implies mining, quarrying, dredging, exploration, all kinds of activities on land; all that creates overburden means something that you have taken out from the top so as to reach the inner layers. You reject some ores which are sub grade, sub grade minerals. We create slurries; sometimes we create fine that we do not use. We also have things called spoils. All kinds of things that, you are not going to put in the processing steps.

So, from this step would come all these. I am just talking about what is happening to the land and, and, the most of the land part during all these lot of dust is going into the air. We are not talking about that now. So, with this, we get ores, crude oil, coal, etcetera come from an extraction process. Then, we come to a beneficiation step. After mining, beneficiation will consist of milling, that is, crushing and grinding, washing, concentration, up gradation by various mineral dressing processes.

And during that, we will produce tailings means fractions we do not want; sands that will be rejected; slurries, dusts, solutions that we reject. All these will go to uncovered wastes and disposal sites. Uncovered waste and disposal sites, they would all go to that site. On this side, we are throwing into recoverable process waste. So, whenever you are producing waste, some we do try to bring it to the left side in this category recovery route, where there are recoverable process wastes and we can get some recovered materials.

The more we throw to this side, the more wastes we generate; the more we put to this side, then there is more hope for mankind. Now, after you have gone through this step, we are going to processing bulk raw material. We have got the bulk raw material which will go for steps like smelting, refining, various processes, processing, utilities, all kinds of things, and there we produce slags, smokes, fume, muds, dross, residues, ash, solutions of all kinds. Much of which goes straight out into unrecovered waste disposal site could be land, could be water body, could be just air.

To some extent, it can may go into the recoverable process waste. From which, we get some values. From this, we get ingots pigs, chemicals, energy; sometimes we recover energy, and then, we go into manufacturing and services where there is assembly; there is packing, transportation, energy distribution. There what are the wastes? Pulp, chemicals, dust, smoke, fumes, drosses, grindings, clippings, solutions, all these are can also be rejected; sometimes it goes to the recovery route.

From all this, we get what we call steps towards development, and development means availability of goods and services. That is what development is. The country is more developed when it makes available to the population more goods and services. These go to the consumer. Then eventually consumer will discard a lot of the material he has already used. He does not want to keep anymore.

So, there we go into the secondary materials processing route that I discussed little while ago. We will have smelting, refining, processing, segregation and all that. Again, there we are creating whole lot of waste – municipal, wastes, fumes, dusts, slags. Now, the consumer produces municipal wastes, and from those wastes if you process again during the step, we get fumes, dust, slags, drosses, pulp, smoke, solutions; the same as we had for the processing of bulk raw materials same. Occasionally we may be able to get metals and alloys into recoverable process waste route. The more of this the better, but as of now there is so much of all this going into air water and land that, our process metallurgy industry is making a tremendous adverse impact.

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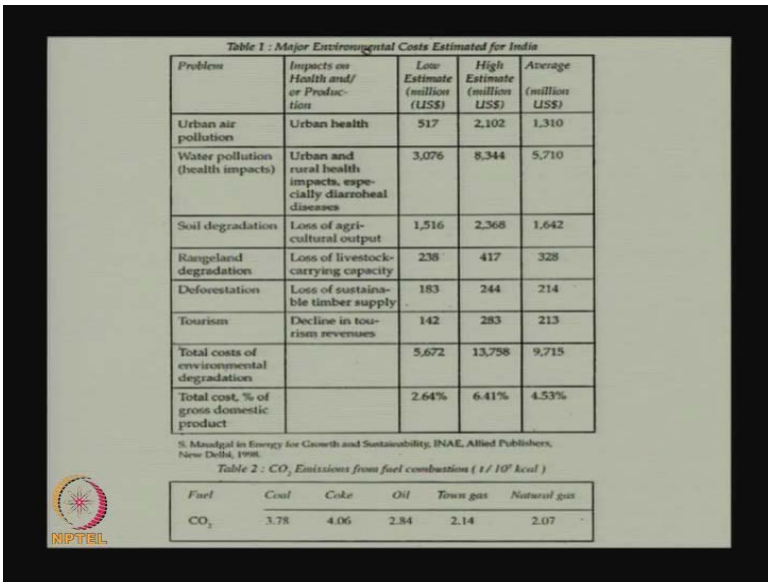

*Table 1 : Major Environmental Costs Estimated for India*

| Problem | Impacts on Health and/ or Production | Low Estimate (million US$) | High Estimate (million US$) | Average (million US$) |
|---|---|---|---|---|
| Urban air pollution | Urban health | 517 | 2,102 | 1,310 |
| Water pollution (health impacts) | Urban and rural health impacts, especially diarrobeal diseases | 3,076 | 8,344 | 5,710 |
| Soil degradation | Loss of agricultural output | 1,516 | 2,368 | 1,642 |
| Rangeland degradation | Loss of livestock-carrying capacity | 238 | 417 | 328 |
| Deforestation | Loss of sustainable timber supply | 183 | 244 | 214 |
| Tourism | Decline in tourism revenues | 142 | 283 | 213 |
| Total costs of environmental degradation | | 5,672 | 13,758 | 9,715 |
| Total cost, % of gross domestic product | | 2.64% | 6.41% | 4.53% |

S. Maudgal in Energy for Growth and Sustainability, INAE, Allied Publishers, New Delhi, 1998.

*Table 2 : $CO_2$ Emissions from fuel combustion ( t / $10^9$ kcal )*

| Fuel | Coal | Coke | Oil | Town gas | Natural gas |
|---|---|---|---|---|---|
| $CO_2$ | 3.78 | 4.06 | 2.84 | 2.14 | 2.07 |

What happens as a result of this adverse impact? There is a cost of this development. How do we find out the cost of this development? There has been lot of debate on this that, suppose in a city you have polluted the air; there is an adverse effect on the population. How do you calculate the adverse effect? One way, not the best way, but apparently that is the simply way; simple way that we can approach the problem. It is this that, you find out how many people have been medically affected because of that pollution; it is not difficult to do.

You can take a reference population in another city similar population, similar age group. See, respiratory diseases there. If you find, if you have polluted air, only I am talking about air pollution, there will be more people with respiratory disease. Then you estimate how much money you will have to spend to restore your health to the original condition means make them as healthy as the other people if it is possible.

Get that means what are all things you have to do. There are two ways of going at it. You find out what all equipment we will require to clean the air and bring it to the condition it was when there was no pollution or you attack the effect part. Find how much of money you have to spend on the affected people to make them healthy. You get an estimate.

Suppose you find something as polluted a river. You will have to find the cost of that by finding out. Two ways you can do it - you find out equipment which will clean up the river. How much is the cost of that equipment from data available? So, you find out how much money you have to spend to clean up the river again. That is the cost of the development which we did to pollute the river, get that. You always find of the financial cost for restoring the damaged system to the original condition. That is how one way of calculating the financial value of the damage.

Now, let us look at it. We will find the impacts on only one health and on production. There is two columns - one is low estimate; one is high estimate; one is the average. Now, there are different ways of estimating. Some are conservative; some are another end. So, some people have collected these data and come up with an average value listed under major environmental costs estimated for India. The word is important. Environmental cost, these are the environmental costs of development and this is for India.

What is been our impact on health and production is, split into different things – urban, air pollution; urban, health, estimated yearly 517 million U S dollars. We need to restore the health. Higher estimate is this; this is the average estimate. Water pollution, we are only talking about health impacts - urban and rural health impacts especially diarrhoeal diseases. To find medical solution to that, this is the average cost.

Soil degradation, there is loss of agricultural output. If your fly ash going everywhere, alkali going into them. All kinds of things, agriculture production has gone down. To bring up the agriculture production, what you need to do to the soil or the fertilizers that you have to put and whatever, that is going to cost a lot of money.

There is deforestation loss of substantial timber supply. We are only talking about the timber that was coming. This case easy to calculate once the vegetation is gone that you want to set up an industry. So, you cut down all the trees. You have got some timber at 1 time, but there is no more timber supply. So, you can find out for next 20 years what the loss in terms of timber supply is.

Now, when you deforest, there are certain other things happen the cost of which is very difficult to estimate. If birds are gone, if animals disappear, and if the trees go away, there are no more fruits and flowers. What is the cost of this loss? How would you estimate the cost of birds not being there or animals not being seen? Flora and fauna, it is very difficult. So, in all this cost calculations, one has to lament and say, we cannot estimate the cost of loss of flora and fauna. That is actually invaluable.

It is not just the disappearance. What it does to human aesthetics to your feelings to the lifestyle of tribal's who live there and this cannot be estimated. So, let us ignore it for the moment and be little more practical. If you destroy a certain area, destroy tourism, tourists are coming to a nice place with forests and rivers and things. Tourists do not come. We can find out decline in tourism revenues that can be estimated. Total cost of environmental degradation this; total cost percentage of gross domestic product 4.53 percent.

So, an estimate actually has been made that, if you take the higher estimates, then the effect percentage effect on gross domestic product is 6.41; lower estimate is 2. Look at this 4.5, which seems to be reasonable. Many people agree with this. So, when we are trying to develop and by the way, this is a publication from 1998 where we at a lower state of development, but that kind of calculation shows that the adverse effects on land, water and air has a cumulative financial impact which is adverse impact, which is equivalent to 4.5 percent of our GDP. So, If you are talking about GDP growth, this has to be taken out of annual GDP growth. Let us look at it in a slightly different manner.

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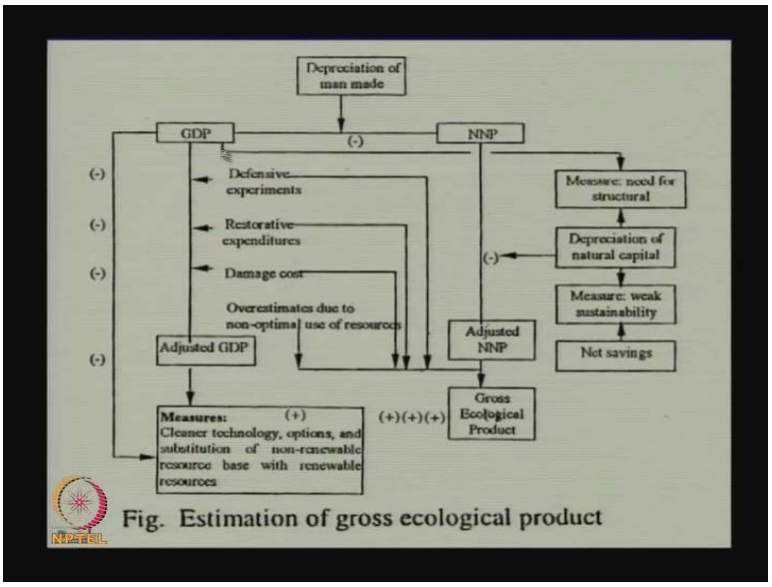


We talk about gross domestic product. This is a kind of index for our progress. How much we are producing in the country taking to count all production steps? But now, in view of what I mentioned just now, that has to be adjusted because that G D P has come at some cost. You must estimate what you have paid for that. So, we have to deduct from here defensive experiments. What all things you have to put in there? To stop the adverse thing, that is happening. You have to have spend some money on restorative expenditure, restore things to the original conditions.

There are some things you have damaged; for that, there is a damage cost. For example, suppose you have taken out minerals and ores from mines. You have damaged the mines forever. That ore will never come back there. It is a kind of depreciation. You have taken out your capital. You have destroyed part of the capital you had with you from which, on which, your thing depends. So, there are methods of calculating the value of the depreciations. This is a damage cost.

So, there is cost of restoration; there is a cost of damage; there is a defensive experiment, expenditure. Now, example of defensive. Suppose one thousand trees are cut to clear some land. Many states the government wants. You have to plant if you cut one thousand trees, two thousand trees somewhere else. May be not there, but you have to compensate putting two thousand trees elsewhere, that costs to the company.

And I have mentioned perhaps earlier; otherwise, let me mention again. If the top part of the soil is taken out somewhere and there are mining activities, and when mines are exhausted, you leave the mines as such. Nothing will grow there again because it takes three hundred years for surface of the earth to have a top soil where vegetation will grow, where microbes will come which is have a full flora and fauna. It will take three hundred years.

Now, since there is this awareness, many companies what they are doing it? Before they start mining, the top layer of the land is taken out kept separately. When the mining activity is over, you have taken out most of the valuables, high value, metallic value things, and you think you do not want to continue mining anymore. You bring in that top layer again, fill up the mines, that will again allow flora and fauna you had in the earlier.

Now, many companies are again putting growing forest there, but to cheat the system or the controlling agencies very often, they put their fast growing species. So, that they grow very fast. It becomes green again, but do not forget, perhaps the trees that were cut were mangoes, neem. There were all kinds of banyan trees, other trees which grow over hundreds of years, and they were the kind of trees where certain kind of birds will come.

If you bring in fast growing trees like you put devdhar or ashoka trees which grow very fast, but there the earlier kinds of animals, flowers, bees or birds will not come. You change the nature of flora and fauna. You can never recreate a forest unless you allow the same kind of trees to come with that. That is not possible once you have finished them.

This is a tragedy that once you have cleared a forest perhaps never ever again you will have the same forest back unless it will take 100 of years; nature will take its own course like the mangroves we have in sundarbans. Now, because of pressure of developments settlements, the mangroves area is declining. All that some amazing species of trees are disappearing. Amazing species of animals, birds and flowers, they are disappearing; they will not come back.

Even if you reclaim, remove all the settlements say this land is left free as such. It will take 10s if not hundreds of years for the mangrove to come back and be again like what it was. So, when we are doing the development, we have going into a lot of trouble. Now, we can certainly think of some measures like we can think of cleaner technologies; we have various options. We can have substitution of non renewable resource base with renewable resources like we can bring recycled materials all that we can do.

But as of now, there are, there is cost of defensive experiments, restorative expenditure, the damage, and there are over estimates due to non optimal use of resources. Sometimes you are wasting lot of resources, not using them as efficient as you should. So, that is also causing a damage you have to estimate. So, all these estimates will have to be deducted from this so called Gross Development Product, so that we get an adjusted N N P which you can clause Gross Ecological Product. So, actually G D P is not a right index of development. We have to talk in terms of gross ecological product, which is calculated by deducting from our GDP value - the cost of development - in terms of restorative measures, in terms of defensive experiments, in terms of cost of damages, not proper use of raw materials, etcetera, etcetera, etcetera.

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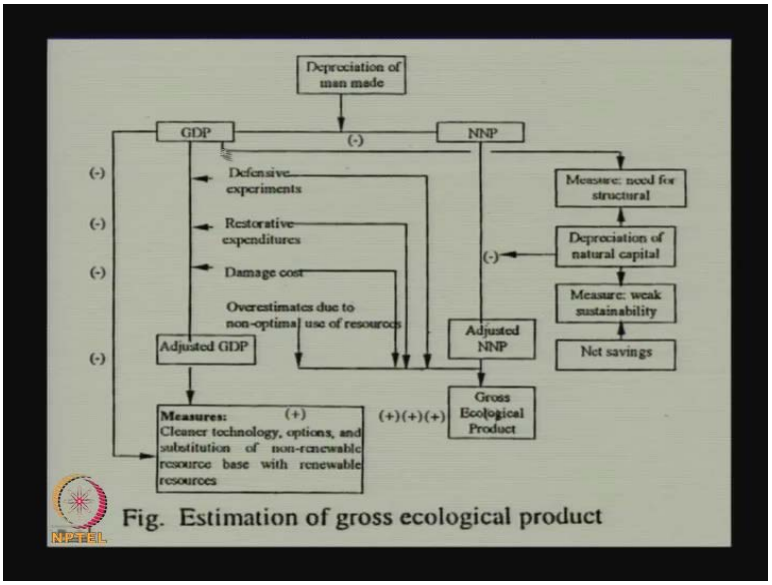

In a minus side, I have added here depreciation of natural capital and some other things. Anyway, I get the idea. So, let us not be always be very happy with a high GDP value. You have to find out what it really means when you keep in mind the cost of development. Let me say and that is how we estimate gross ecological product. Now, let me tell you this that, what I am saying all that is not universally accepted. It is a very debatable topic.

There are others who may have strong arguments against what I am saying, but what I am saying is not my opinion. It is also opinion of many people who are worried about the way development normally occurs, because as we grow older, we see the devastation all around. And in this calculation of Gross Ecological Product, we are leaving aside some other things which are more controversial. Like when you claim land, do deforestation, you remove the population from that place. The population is displaced.

Supposing you find alternate sites for them, they are not equally happy going to the alternate sites, and just giving them a piece of land does not mean you have given them a right substitute for the way they live together. Will they enjoy their life as much as they did earlier? Will they be as comfortable as they were earlier? These were the words we have used when we defined pollution.

You have devastated populations. Now, in places like china, this happens. Recently they, few years ago, they made a dam which supplies large part of their energy requirements. Hundreds and thousands of people if not a million were relocated, but they, that is a dictatorial regime. They can do it and perhaps they do a good job of resettlement also. They just remove the population from here; put them elsewhere. The country has always been there. How many of know how the Great Wall of China was built? Of course, it was built over centuries, but much of it came in a very short period (( )) Chinese army convinced the emperor saying that we need a defensive wall against the Mongols who come and attack us anytime they please.

Now, to build that wall, thousands of Chinese workers were relocated from all over china. They were asked to come and work on the wall for months and years together. A point came when the general and his associate associates realized that it will be a better for the moral of the work force and for his efficiency to bring in families also.

So, 100 and 1000 of families came where the wall was being built and resettled there. Now, china can do it like when the dam is built, many people could be resettled, but see the problems we have. Even during Sardar Sarovar dam, we still have that problem. There is a socio, social cost of this; there is social unrest. I do not know how to estimate the form, and that social unrest leads to political unrest. That political unrest leads to development being stalled as we have happening in many states, rightly or wrongly I am not saying that, but when we talk about calculation of GDP, we should not make it a very dry subject; it is a soft subject because there are human beings and their feelings involved.

Even if you knew all these dry calculations and come up with a Gross Ecological Product, you have left out two very important thing - the cost of flora and fauna. You have now do not have the flowers; you do not have the animals; you do not have the plant life where the industries have come up. There is a cost of that which you may not know. What we will do eventually? We do not know like you know, you cannot say kill all the snakes, because if you kill all the snakes, then rats will multiply; rats will take away your grains.

After china became independent, some of their leaders thought that all the birds eat away their grains. So, the, all the birds should be killed. So, entire population got busy in killing birds; even school children were asked to kill away all the birds, and I have been to china some ten, fifteen years ago and somebody told me count the birds. I actually went along counted the birds. I saw only about fifteen birds in my ten days stay and most of the birds were there near, near, the near the birth place of chairman Mao Zedong, where there, there, were some forests and hill sides. I could see some birds and I was counting them. I believe now the population of birds have gone up. They must have realized that you cannot have a country without birds.

Indecently, they do not have very many wild animals because they had large population; they have eaten away the animals. Only some panda, they value them now because they are there in their in the southern area where there are bamboo groves and bamboo plantations, bamboo jungle, but tigers are gone; many animals are gone. Fortunately, Indians were very lucky. We love nature; we loved animals. Many of us were vegetarians. We were, we were, taught to be kind to animals, flora, fauna and nature.

So, India is a lovely country with tremendous flora and fauna. Now, when you go in the path of development, we can have development without scarifying this. For that, we have to have the awareness and this is what I am trying to give you. That when you blindly go for development and not aware of these issues, you lose out. So, when we are calculating this gross ecological product as I have shown, we have taken out two things - we have taken out the cost of loosing flora and fauna; we have also taken out the possible cost of social unrests. That can be very damaging for development. It can stop development; it can stop industry; it can destroy industries and its beginning to happen.

There is answer to that, and that answer is before starting on a project. All the stake holders have to be brought together. Anybody, who can be affected in terms of every parameter, they have to be sit together. And everybody has to be convinced that the whole thing is for a greater good and there is those who are likely to be affected more. They have to be satisfied more than others with remedial measures. Maybe if the tribals are to be taken to another place, they have to be given plots. To live cultivate, they have to be given alternative site which are even better than what they had; otherwise, why they should move.

So, again I am coming back to the point. It is a very tricky subject and very debatable subject. How do you calculate the Gross Ecological Product, but the principle is this. From GDP, you have to take out the cost of many things and some of them have been listed. Some we have not listed because we do not know how to estimate social cost and loss of flora and fauna. Let us ignore them for now.

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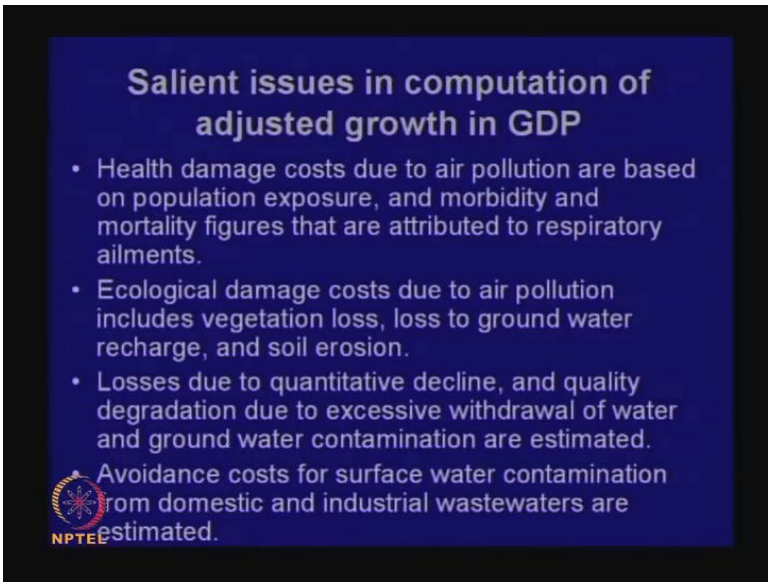


So, to summarize the salient issues in computation of adjusted growth in GDP would be like this; some this is not a total. Health damage cost due to air pollution are based on population explosion, and morbidity and mortality figure that are attributed to respiratory ailments. We calculate from there.

Ecological damage caused due to air pollution includes vegetation loss, loss to ground water, recharge and soil erosion. Losses due to quantitative declaim and quality degradation due to excessive withdrawal of water and ground water contamination are estimated. If you are excessively taking out ground water, first of all you are losing on capital that you have also it has adverse consequences. Then there are avoidance costs for surface water contamination, for domestic and industrial waste waters. They are estimated all kinds of things are estimated.

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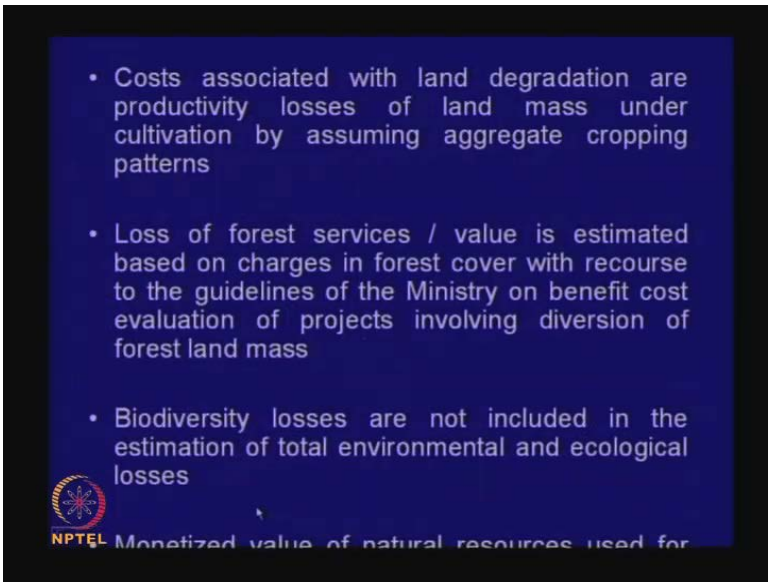


And by estimated, there are some others before I move on. Costs associated with land degradation are productivity losses of land mass under cultivation by assuming aggregate cropping pattern. Loss of forest services, values is estimated based on changes. You know, charges changes in forest cover will (( )) to the guidelines of the Ministry of Benefit Cost Evaluations of projects involving diversion of forest land mass. Bio diversity losses are not included in the estimation of total environment and ecological losses. Not also social costs and monetized value of natural resources used for, used for, also are (( )) estimated.

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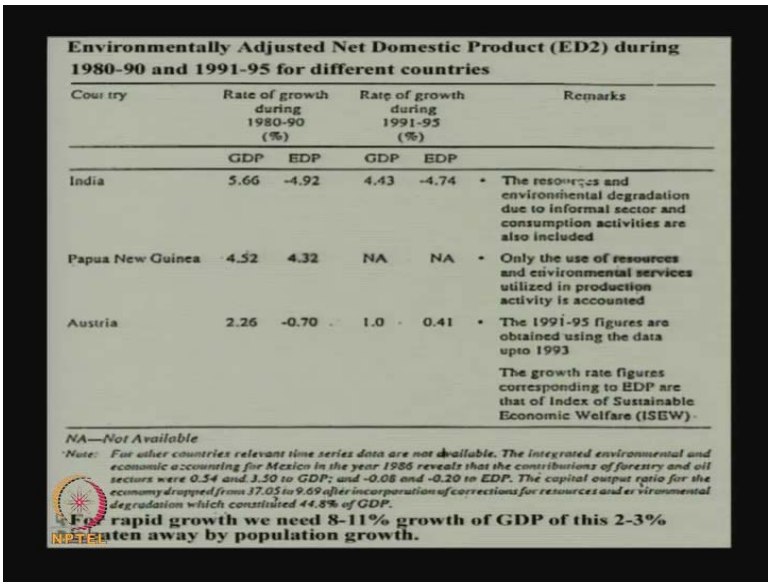


Now, I once found many years ago, somebody, one doctor khanna, who was the director of National Environmental Engineering Research Institute. He did calculations of GDP and EDP. That is the adjusted, estimated adjusted value. And what he found was quite remarkable. He said that during the nineties wherever GDP growth rate was at 5.66, in this period, if you adjusted, if you took into account the costs, this figure actually become minus 4.95.

Means instead of, so, development actually we were, we are falling behind; it was becoming a worst scenario. Similar thing was there in the year ninety one to ninety five. He took data from some other country like Papua, New Guinea. He had the data to show. There also, they were paying for their development, but much less they were still with the plus figures.

In Austria, again which claim 2.26, when you apply, it will become minus 0.7. Later on, it was 1; it was 0.45, but it was very very reveling for India that we were claiming to go ahead at 5 percent, but maybe we are going behind by 5 percent. If you take into account, a cost that was required for the development. Now, here, there are some remarks that the resources and environmental degradation due to informal sector and consumption activities are also included. Only the use of resources in environmental services utilized in production activities accounted. 91 to 95 figures are obtained from using the data up to 1993 etcetera, etcetera, excuse me.

Now, I do not want to put too much emphasis on the figures that are given in the table. I would like to just get the idea. I would not even ask you to except this fact that, when there was 5 percent, it became minus 4.7 percent; I would not even accept, but the idea is sound that you are claiming to go in the path of development. But if you take into account the costs of the development, you are not developing as rapidly as you think. You may actually be not developing at all. If you think the costs elements are important, if you think those are not important, it does not care if people have become sick, if the land is polluted, if the water is polluted, if the flower flora and fauna are gone. That is a different matter.

If you say, we do not care if there is social unrest. In china, as I said, they knew how to control it and nobody knows about there was no hullabaloo about what happened to the dislocation of population when the dam was built, but in our country, the social unrest continues. I should not sound political, but you know how much of unrest is now coming in tribal areas precisely because of this factor. They believe that development has not touched them rather they have been exploited. The land is gone; the livelihood is gone.

So, unless the development ensures that they also share development, our GDP is actually a figure that raises doubts. But again, I will insist after all, this is a technical course. I am bringing in some social things and soft subjects because I believe these are important. It can no longer separate hard topics and soft topics.

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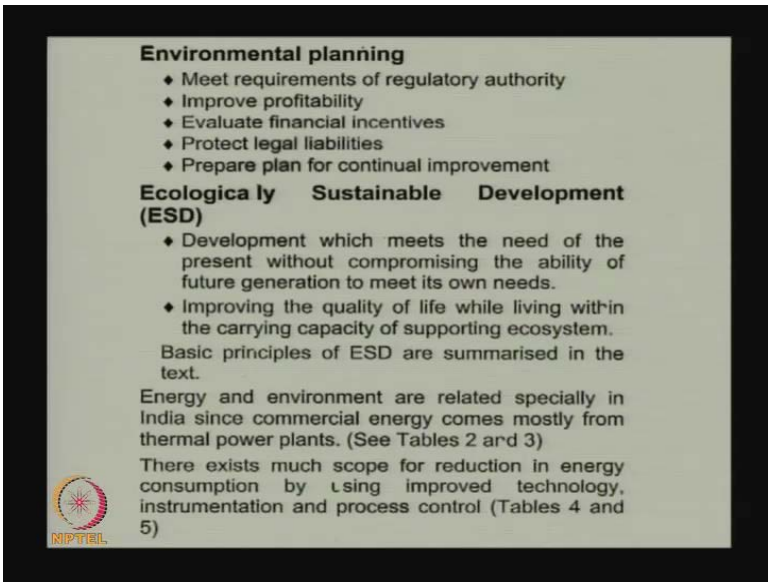

Now, fortunately there are problems that there are solutions to the problems I have discussed. It is not that we only talk about the problems. If we are aware and if we are sincere, we can find solution to this problem. So, the technologies of production need not always have a big gap with technologies of abetment. They can come together. The moment there is a problem; there should be a technology or a policy ready.

Now, here, one way would be to have solid environmental planning. This will meet, meet, requirements of regulatory authority. In our country today, there are strong regulatory bodies who are very wise, who have framed very good policies, which if followed will bring out the damages of development to the minimum. So, we need to meet requirements of regulatory authority. It does not mean one is not aiming at profitability. Proper environmental planning will improve profitability.

We have to find financial incentives for proper implementation of (( )) regulation. We have to protect legal liabilities that can come if there are adverse conditions. We have to prepare plans for continual improvement. Not one time improvement because an industry last for a long time. It must have a long term planning; the subjective horizon must be very long. Now, we come to a word sustainable development, and to be more precise, ecologically sustainable development. It is a very very important word - ecologically sustainable development. You can have development, but that development may not be the kind of development we want.

By sustainable development, we mean development which meets the need of the present without compromising the ability of the future generation to meet its own needs. Like suppose I have some amount of money, if I want my children to enjoy same amount of money, I should not spend the money. I should live on the interest only, so that we do not touch the capital. So, that I can enjoy certain kind of life with the interest from that money and my children can also enjoy that interest and have the same kind of life. This will be a sustainable income, but if I start spending from the capital, I will enjoy for a few years. Then the capital will be gone. My future generation will have nothing to enjoy. So, if you consume all the good things we have, we can have a short term progress, short term life. Then there will be nothing left.

I should tell you the story of a small island called Nauru. It is a small island. Just I think a few square miles, small island which is in the pacific a 100 or 200 miles above Australia. Its very hard to spot called Nauru. There was a time when Nauru had the highest per capita income in the world. How did it happen? In the middle of nineteenth century or may be yes, nineteenth century, one English man while going by the sea route stopped by in that small island which was full of some vegetation and he found there were lot of phosphates in it.

How did the phosphates come there? It is said and maybe true that all the migratory birds which went from north to south, south to north stopped over in that island to rest and their droppings all this full of phosphate. Over centuries made that place, the richest place to find phosphates. The entire island was phosphates although and highly valued.

The population was very small. So, they started a phosphate industry. They had roads built only to dig out the phosphate, bring to the coast and, and, export. Very soon they were so rich. The couple of thousand inhabitants forgot to work. They had all their money; they set up an airline which had some 2 or 3 planes. They simply were for holiday makers to come and go, and the people were happily digging away the phosphates.

By the middle of twentieth century, they found they floated banks, they floated this, floated that. It was totally everybody was supported by the state. Nobody had to work; nobody paid taxes. Now, they find the phosphates are beginning to lower, and very soon that they are no longer that wealthy, their airlines gone; the, the, landscape is devastated. It was no longer the beautiful island with trees, it is not.

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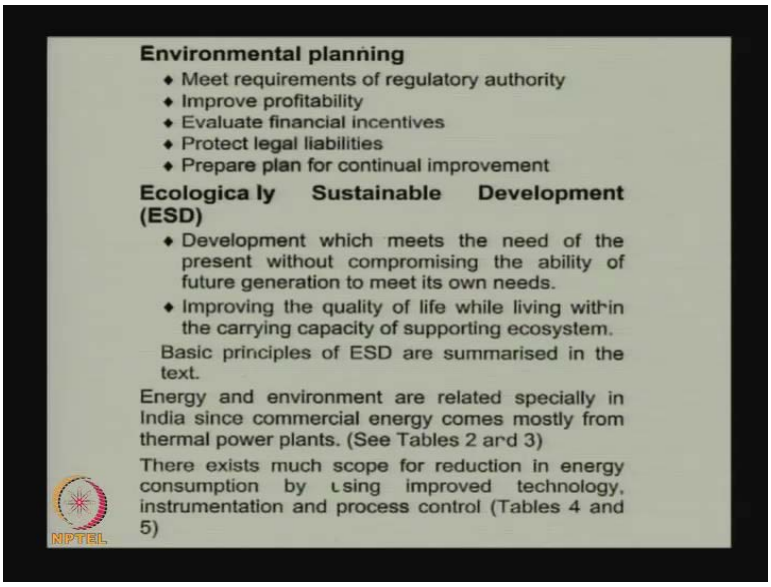


So, they have tried to live for a short while on their capital if only they have planned to live well by exporting only that amount of phosphates, while on which they could have a sustainable lifestyle; they would have been much wiser. So, the sustainable development requires that you develop yourself wisely living on the interest, not on the capital. So, it also means improving the quality of life while living within the carrying capacity of the supporting eco system. What do you mean by carrying capacity? By carrying capacity we mean, you can cause certain amount of damage to the environment, but the environment has a natural restorative power, all kinds of natural processes help them to come back.

See, even twenty or thirty years ago Hindus believed that Ganges water had unnatural power even to counteract poison, and many I have see even some documents. They showed experiments that you put some poison in 1 gnat 300 meters away or 400 meters away, you take out the water; you find no poison. They would say you know this cremations takes place, this and that, but still little down the river if you drink the water, nothing happens.

So, it was, it was restoring itself. To some extent, this is true for any river body. In any river if something happens little down the stream, the river can take care of itself because it has what I have mentioned here - some carrying capacity of the supporting ecosystem, but there is a limit during the last Kumba Mela that took place in Allahabad. Even the

Naga Sadus which are suppose to be the holiest of the holies, they refused to take bath in the Ganges because it was so polluted. It is no longer that holy river. There are many rivers where there is so much of pollution. If you take a dip, you get sores on the body. You get skin diseases because they, pollution has now exceeded the carrying capacity of the river; river cannot carry so much of pollution to restore itself.

At one time, our air atmosphere also had a carrying capacity. We could do something, but the vegetation took care of the C O 2. It absorbed the C O 2, let off oxygen. C O 2 generated in industries, the sea took care of it, but now, we have generated so much of C O 2 that it has gone beyond the carrying capacity of, of, the atmosphere. So, that is the concept of carrying capacity.

Now, the basic principles of ecological, ecologically sustainable development itself are summarized in many texts. I have summarized in my book on energy in materials and metallurgical industries which I have shown to you once. Now, energy and environment are related specially in India since commercial energy comes mostly from thermal power plants. This is a tragedy in our case. You know by now that in France, 80 percent of energy is coming from nuclear power, nuclear reactors.

When that happens, you are not generating C O 2; you are not doing climate change. In Denmark, where in the capital recently that international got together on climate change and global warming took place. The Denmark is very vociferous against C O 2 emission because it is in so situated that high winds blow in the sea shores fifty percent of their energy demand is made by wind mills, wind power.

So, they can claim that they are using a very clean source of energy wind. It is not generating any C O 2, their very happy state of affairs. In India, we do not have that kind of currents. That kind of tradition, we are generating by the way about 8 percent of our energy demand by wind power, but we cannot do without coal. We do not have that in the nuclear power plant. There are some countries where a lot of power is coming from dams, hydroelectricity. Once you have built them, if the water is allowed to flow through the (( )), they will rotate generator generate electricity.

Like if you go to North Vietnam or in that area Mekong River, they have the dams; they have surplus energy. That is why India wants to put up aluminum plants there because we have the skill and technology; they have the power, but in India, unfortunately we have to have this, and that is why our energy and environment issues are related in India because of thermal power plants.

Now, their exist much scope for reduction in energy consumption. Remember, there can be improved technology; there can be improved instrumentation; there can be improved process control. So, we would go to discuss some of the enough scope. So, first of all existing technologies which have adverse effect can be improved. We can think about alternate energy sources, wind nuclear power, solar power. Unfortunately, many of these technologies are not. So, well developed or yet not. So, economic they will come and immediately becomes substitutes, but work has to go on. So, I will continue this discussion after little break. Thank you.