Sustainable Transportation Systems
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Lecture 03
Concept of Sustainability

Hello friends. So, today, this is the third lecture in the series of Sustainable Transportation Systems and today we will talk about Concept of Suitability. As you know this Sustainable Transportation Systems has this word 'sustainable'. So, what is sustainable? What are the issues which are linked with sustainability? So, those issues, those aspects and various dimensions of sustainability we would discuss in this particular lecture.

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So, these are the contents. Today's lecture will include like what makes a development to be unsustainable? So, that means, we would like to discuss about what is sustainable or what is unsustainable. And then the concept of sustainable development; means conceptual understanding, some definitions, some ideas, thoughts by several experts and goals for the sustainable development.

After all why do we need sustainable development? What is the goal? What is the objective? What is the aim of it? So, sustainable transport, goals and objectives and examples will be there and at last we will conclude it as a summary. So, friends we want to discuss about sustainability issues in terms of what is sustainable and what is not sustainable or what is unsustainable.

You can see like in 18th century when these steam engines were invented and lot of fossil fuel related energy sources were discovered and applied for the use and that was the era when industrialization increased and at the same time because industrialization are based on fossil fuels uses, urbanization also increased because it makes sense that if people live in nearer distances otherwise you will consume lot of fuel to travel from one place to another.

Earlier what was the transportation system, it was like bullock cart or these wind related ships or rivers using boats, etc. So, renewable resources or natural resources were the main sources of energy but as soon as we shifted towards this fossil fuel based energy systems we started to live together in dense populated areas which are known as cities and this is the time when mega cities also were created as human signature or anthropogenic changes. So, like there in 50s there was only one mega city Tokyo, and later on then, now many mega cities came into existence because people started to live in densely packed cities.

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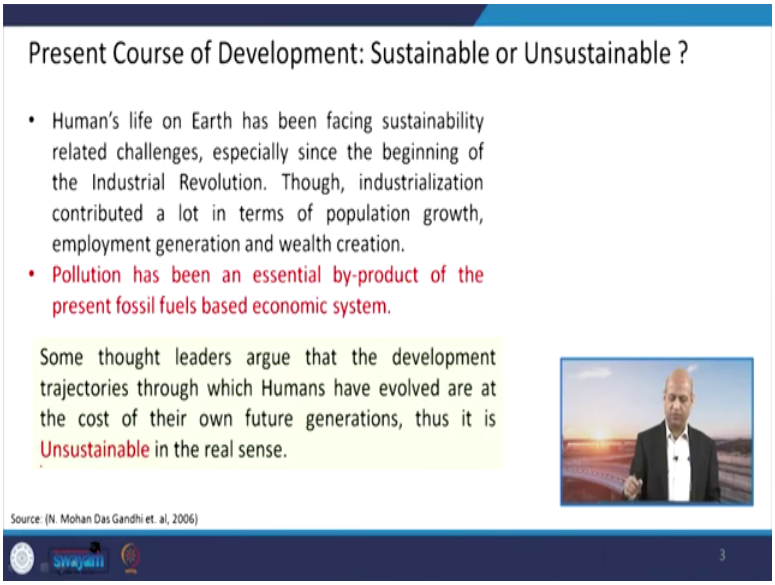

Well, so you can see like the pollution level was also in parallel to the uses of the fossil fuel pollution also was a essential by-product. So, initially when industries were setup, people used to look at the chimneys or stacks as signs of wealth creation or signs of development, but as we increased in terms of industrialization and urbanization, lot of pollution level started to increase and later on we found that this is not the good thing because this is the negative externality of present development trajectory.

So, in that sense we can say that when we are using this fossil fuel related resources, we are in a sense, means some people argue that we are in fact, decreasing the capacity of future

generation or we can say that these are the wealth which future generation also has right on, but we are using it in a huge quantity and that should not be there. But there are other arguments also; people say that the capacity of future generation we do not know right now.

And we do not know what kind of technology they will use in the future, so just because we curtail our uses that may not be good thing, that means we are missing to provide good quality life to our public. So, there are lot of debates in fact, I do not want to give you one particular idea but I want to leave on you to discuss or to think about these issues and come to some sort of conclusion on your own.

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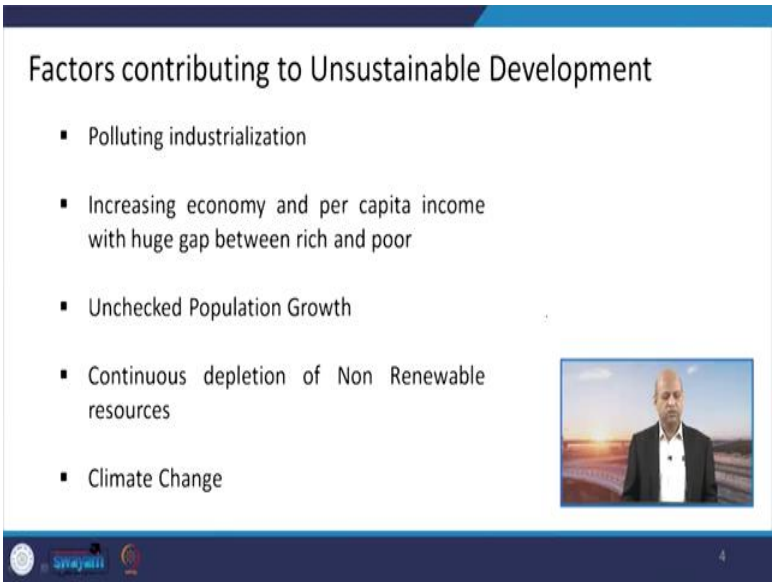

Well, so these are the factors contributing to unsustainable development which are like polluting industrialization. Means, if we are having industries and they are releasing lot of effluents in terms of waste water, and air pollutants or greenhouse gases, so these are the polluting industries and they may be termed as unsustainable because we cannot keep on adding lot of pollution beyond the capacity of urban air sets and water sets, all those kind of things. Then there is like increasing economy that is a good thing.

Increasing economy is a good thing but the per capita income increased in a very parity situation, disparity increased also, means there was, there became huge gap between rich and poor. Earlier poor population was larger but now different kind of segments came into existence in society like middle class and very rich people having big industries or corporates. So, people argue about that this is not a good thing.

Because when society has very huge disparity then the homogeneity may not take place and people may not feel good about that, but again there are different schools of thoughts and these are debatable things. Then unchecked population growth because though it is a good sign that we could have more people because of science and technology, we could have good medical facilities and that way we could have also accessibility to food also and that increased our survival chances.

So, this is a good sign that population increased but the negative impact became because as per the increase of the population the infrastructure did not increase simultaneously and you will find that in cities there are so many poor people living in suburban areas or in slums, it is a pathetic situation there if you look at their quality of life. So, again this is not a sustainable way to grow. Next is like depletion of non-renewable resources, which are the basic backbone of present industrialization.

This fossil fuel or carbon economy, this is non-renewable in the sense although in long term, in thousands of years you can say that all these fossil fuels we are extracting from the Earth are nothing but again the solar energy in terms of like trees and then it got converted into oil and other, like coal, after millions of year's process but because the time span is so huge we call them as non-renewable and this direct energy like solar or wind, these are renewable sources.

And then the climate change issues because of GHG – Greenhouse Gas Emissions, global warming and then the climate change like temperature difference or precipitation, frequency, at some places very more, high and at some other places low and then these storms, all these things have given us that this kind of development is not so good for the human society.

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Well, these are the negative externalities which causes unsustainable development as we have given very briefly idea like air pollution, then noise pollution or accidents because transportation, infrastructure is not so good, then if vehicles are more, congestion is more, then again it is unsustainable because lot of fuel is burned, lot of emissions are released by tail pipe emissions.

And then consumption of land is also high because you need lot of infrastructure for that. Loss of habitat, biodiversity, means because of this infrastructure facilities we need to convert these forest lands into some roads or railway tracks, etc. And this disturbs biodiversity or the natural habitats of many animals and then the release of hazards materials again because of these fossil fuel burning, sometimes heavy metals are there.

And then we have transportation of one meterial to another, so hazardous materials are also transported, although there are protocols to transport them in a particular way, in a safe way but still accidents happen, you might be reading in newspapers that somewhere some oil caught the fire and somewhere some other kind of hazardous materials got spilled over.

Then waste disposal, because when we packed into cities then lot of huge waste is created, solid waste in the cities and you need landfill sites or, to treat them in a proper manner. Lot of water pollution is also there because of industries and if we do not treat them properly. So, all these things add to the negative externalities.

The reason is because this is the human tendency that when we are releasing pollution into air or river, we are not including that cost into the cost of the product and this is kind of free of cost we are using it. But there are of course, guidelines and industries should not release their waste just like that, they should treat them and treatment needs cost because you have to apply some technology, you have to apply some man power.

So, these are known as negative externalities because they are adding into negative part of our or negative dimensions of our quality of life because when we are exposed to pollutant then our health is being damaged or because of, and we want to treat them, then again we have to invest some energies or some economic parameters are there, so that is why we call them negative externalities.

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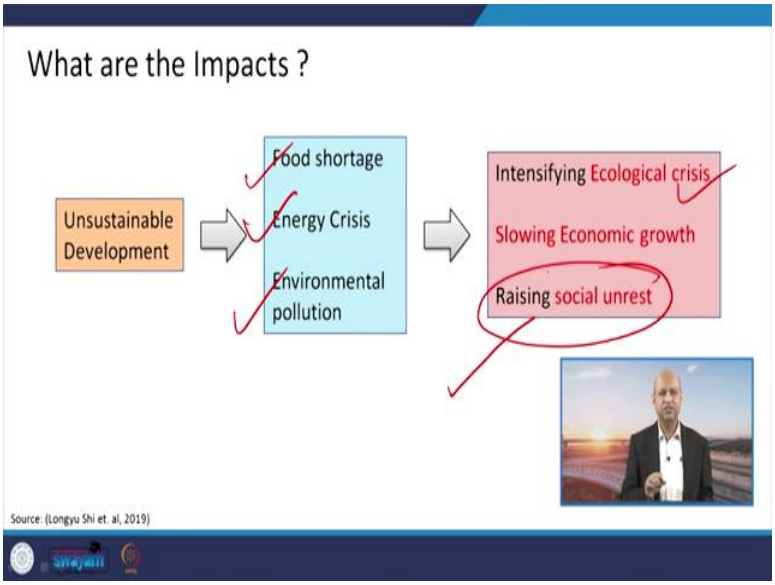

And what are their impacts? So, unsustainable development and they are like if we summarize them into like energy crisis and environmental pollution, energy crisis in the sense because these resources which are non-renewable they are depleting day by day, we are using them hugely and then the cost of extracting them is also increasing and every day you might be reading in newspapers that oil prices now are increasing and people are suffering because of that, then intensifying ecological crisis.

Here on environment day I will like to share with you that our prime minister gave this idea that it is not like there is conflict between economic development or ecological protection or conservation, we can have ecology and economy together because we can invest lot of

resources into these renewable resource uses, solar, wind, and these geo-thermal, etc, so we have to take care of ecology and then we want to achieve economy growth also.

So, we can shift towards these kind of model where less consumption of fossil fuels, more consumption of renewable resources, but that is not again free, we have to invest lot of money to harness the renewable resources. It is not just simply like that, so as we want to walk the top then we need to invest lot of resources. And then because of these ecological issues or environmental issues, there are social unrest. So, these are the negative impacts which call this the present development course as the unsustainable.

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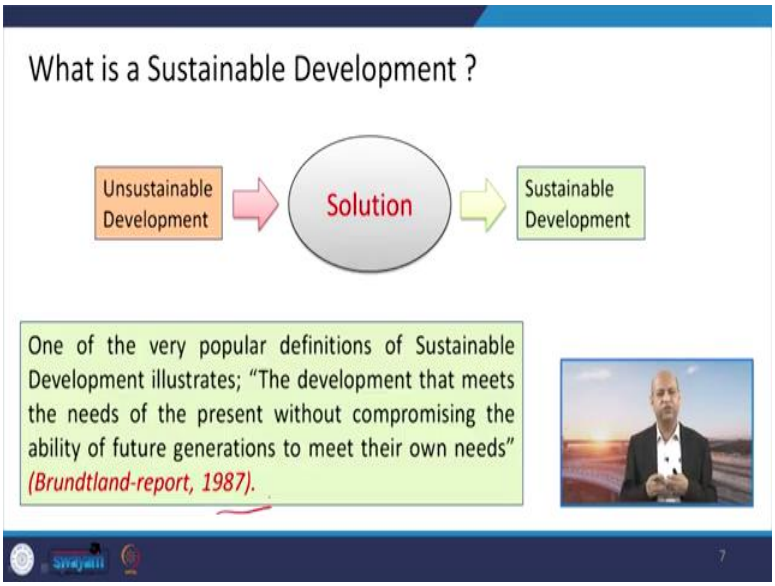

Then what is the sustainable development? So, how to define the sustainable development, very initial definition you can see this Brundtland–report in 1987 and it was given very popular definition which many people use still that the "development that meets the needs of the present without compromising the ability of future generations to meet their own needs", although later on many people debated on this and other definitions came into existence.

And they said that, "We do not know what kind of capabilities will be of future generation," so if we stick to this, it may not be so good idea. So, again, I mean, this is not straight way but of course, this was the good definitions at that time when people started to think about the sustainability issues.

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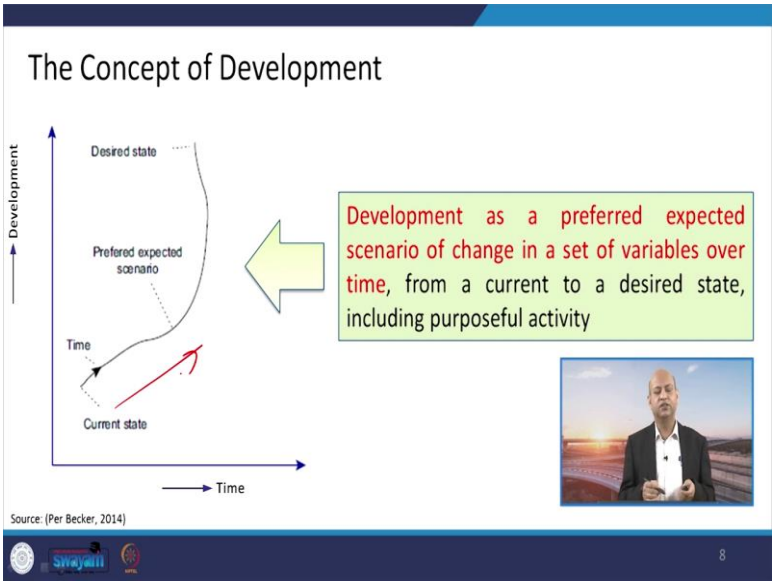

Well, the concept of development as we see that with the time if you want to develop in terms of economic developments or per capita income or quality of life increases, excess to energy, excess to the clean air, clean water, etc. that kind of development if you want to have then that scenario should be in that sense without impacting negatively the environmental components.

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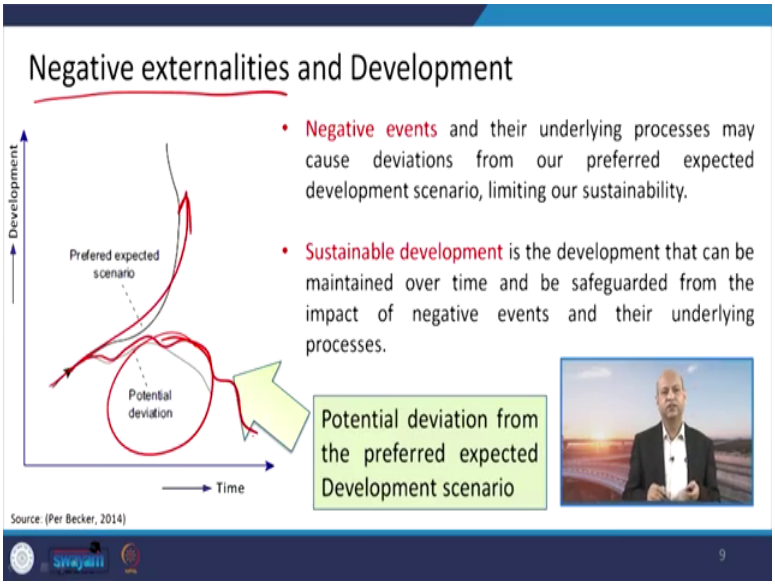

So, the negative externalities should be minimum; it should be minimum. Otherwise we will not be able to achieve the sustainable path of the development. So, the potential deviation because of this negative externalities, means we wanted to go through this route but because

of this negative externalities we may come like this because we have to invest lot of money to keep our self, healthy if we are exposed to hazardous chemicals.

We get several diseases if we get too exposed to severe air pollutants higher than the Ambient Air Quality standards. So these kind of things have increased the negative externalities and deviated from the developmental path. So, because of several negative externalities the deviation is there, so we need to incorporate these things when we decide some model of the development.

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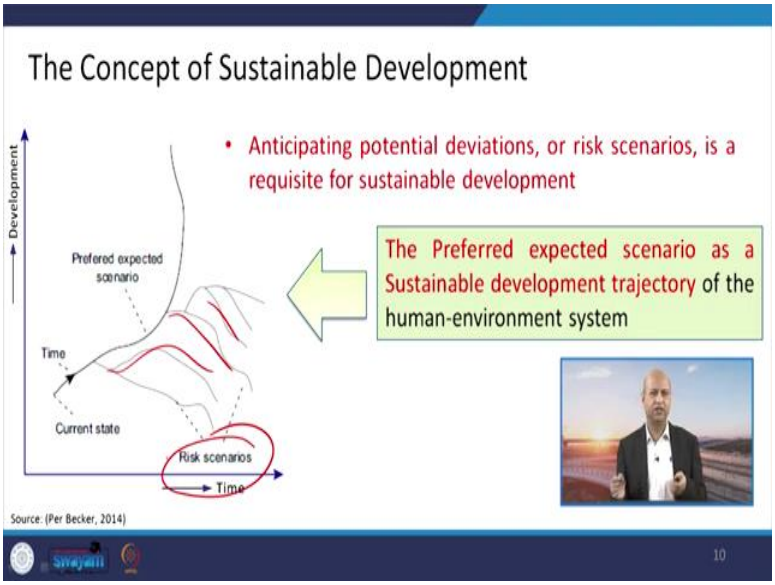

And similarly there are several risk scenarios based on what kind of energy resources we are using then there may be some different perception also like nuclear power plants are known as very less polluting but then because of some large accidents public have great fear about those nuclear power plants and they do not want to be in nearby areas, there is a concept that it should not be in my backyard; that was the concept in US at that time when hazardous facilities those were shifted to country side.

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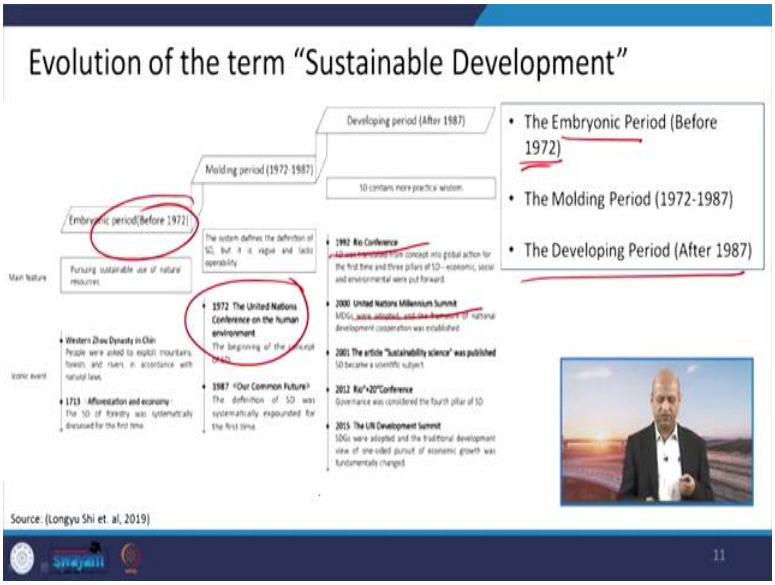

Well, next is like how this evolution took place on the sustainable trajectory. So, this was, Embryonic Period, before 1972, and at that time this was the conference United Nations Conference on the human environment in 1972, when this sustainable development related aspects all countries started to discuss and India took participation in this particular conference and our country India was the first one to have the ministry of environment and forests because of these developments.

And later on then several like Rio Conference and then United Nations Millennium Summit and periodically United Nations having different meetings and different committees and then there is IPCC Intergovernmental Panel on Climate Change. All these efforts are being taken at the international level to combat with negative aspects of the present development scenarios.

So, this developing period after 1987 has been that we are having several policy measures to reduce the greenhouse gas emissions and to shift towards those kind of energy resources which have very-very minimum negative externalities.

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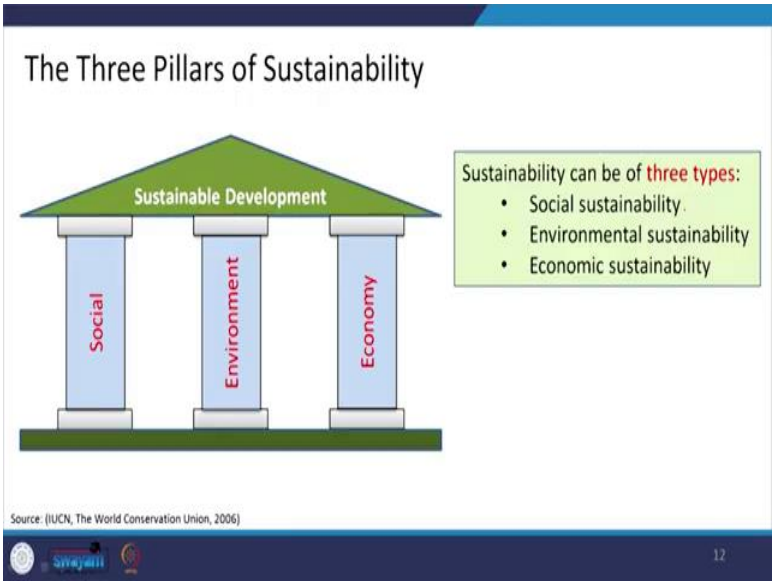

So, these are the three pillars of sustainability, social, environmental and economic. We will discuss about them in detail.

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So, what is the social sustainability? What are the criteria which define the social sustainability? So, it should protect the health of the communities over-burdened by pollution, so these are the negative aspect which should be minimum. Then it should have participation of different communities. It should enhance education, so the social sustainability aspect of any economic model or any developmental model should take care of these things. Means it should not be socially discriminatory or socially harmful.

When it is inclusive, when it emphasize on participation of all the communities and accessibility to all the infrastructure, there is not huge gap into different communities or different groups of the society, everyone has freedom to use those infrastructure facilities, then we can say that it is sustainable, otherwise these criteria on the basis of these criteria we can come to the conclusion that whether something is socially sustainable or unsustainable.

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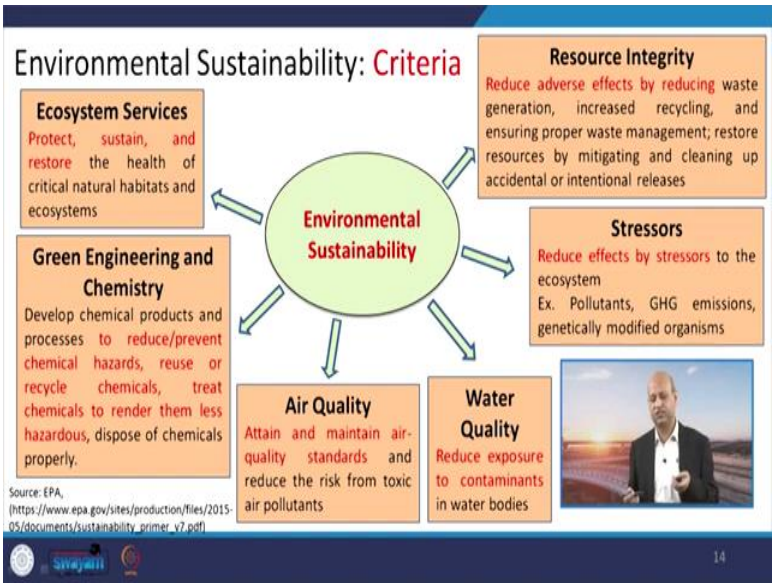

Then environmental sustainability, what are the different criteria? Again like all the components of the environment like air, water or soil, forest, biosphere, everything, they should not be influenced in a very negative manner, means they have some caring capacity, they have some resilience, so only that much pollution can be released which can be naturally treated.

Otherwise if it exceeds the natural cleaning capacity of a river or an eco-system, then there is the harmful movement of different streams. Then we need to do something to restore it, so the restoration like this year's environment day we had this big issue of how to restore our eco-system to the original one, to the quality one.

Then this economic aspects of the sustainability, means people should have more jobs like if suppose some particular locality is highly polluted then people would not like to go there to do something, so that is why these are interrelated whether environmental sustainability, economic sustainability and social sustainability.

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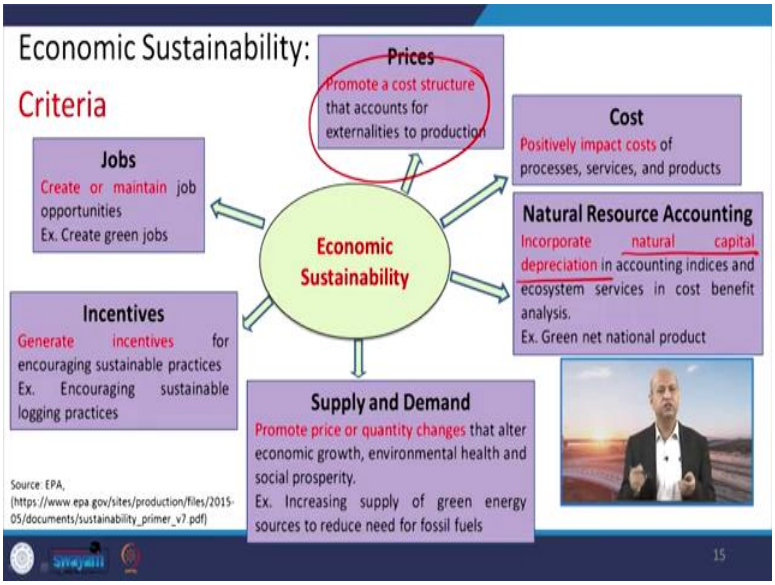

So, any kind of activity which creates job opportunities and which provides incentives to those sustainable practices and also like this natural capital depreciation it is to be accounted, if there is negative impact on the environment then it should be accounted into the price of something as you know there is a policy aspect that polluter should pay, so those kind of policy measures must be there and this prices should reflect all those aspects wherever some economic activity has harmed environment, so we have to restore that environment.

We have to invest lot of efforts and that needs investment of resources, so those thing should be reflected into the price, this is one economic aspect, only then it may be viable otherwise sometimes we feel it is very cheaper, but that economic activity may be very harmful because of its negative impacts, like one very simple example, we have policies of free electricity or free water, because of that farmers do not feel incentive to control the usage, so they can extract as much water as they want.

They do not need to pay for that and that may be the reason that now these water table has gone very down, so these are the negative impacts of those policies when we provide something free without incorporating the cost of that resources which we are using.

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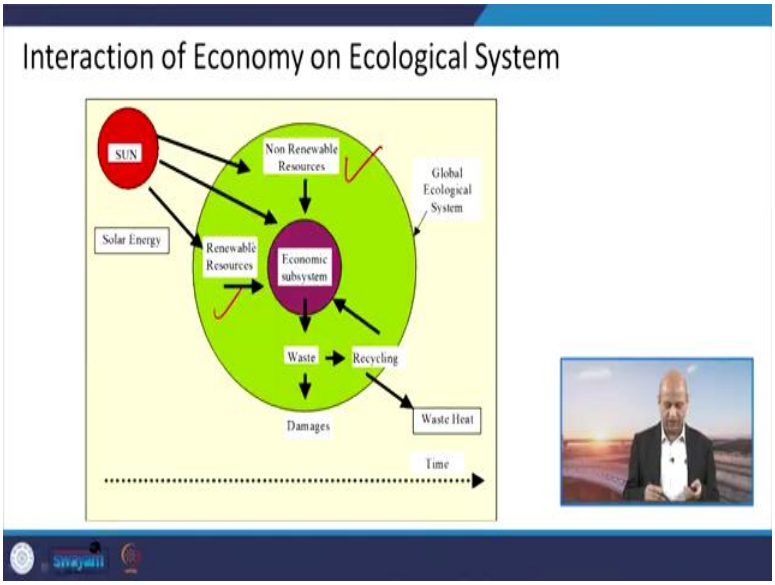

Now, if we want to see how this interaction of economy and ecological system happens, so basically all the energy resources, whether it is non-renewable or renewable, these are because of solar energy. Because when we are talking wind energy that is also because of solar energy because at different places this solar insulation is different.

At some places when it is higher then the air mass becomes lighter, it goes up and the pressure reduces but at some places pressure is more and because of this difference in pressure wind starts to blowing, so wind energy is also you can say solar energy indirectly. So, that way then streams and the water cycle all those things are part of this ecological system.

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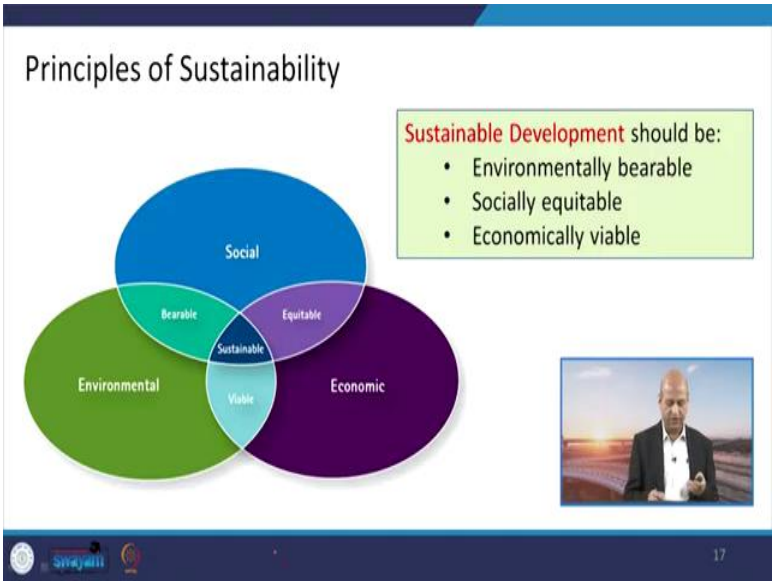

When we talk about principles of sustainability, so those were the three pillars we talked about like environmental, economic and social. So, we can say that anything which is environmentally bearable and socially equitable or acceptable, and economically viable, only then, that activity can be sustainable. So, that, those three basic principles, when they merge together, they integrate together, then we call it as a sustainable activity.

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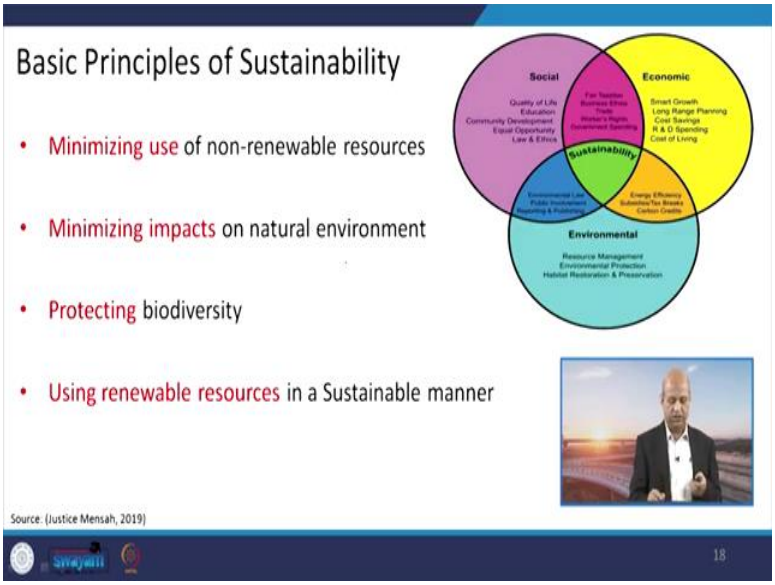

Well, so minimizing the use of non-renewable resources, minimizing impact of the natural environment, then protecting biodiversity, using renewable resources in a sustainable manner, so these are the basic aspects which we have already discussed.

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Then there are goals for sustainable developments, as you know United Nations have given different goals for sustainable developments, these are known as SDGs. So, you can see like we should reduce the poverty, then we should reduce the hunger and, means people should have accessibility to the food, then quality education, gender equality and, so that way you can see different thing, climate action, life under water, life on land, all those things in collective manner we call them sustainable development goals, which should be achieved by each country and we are committed to that.

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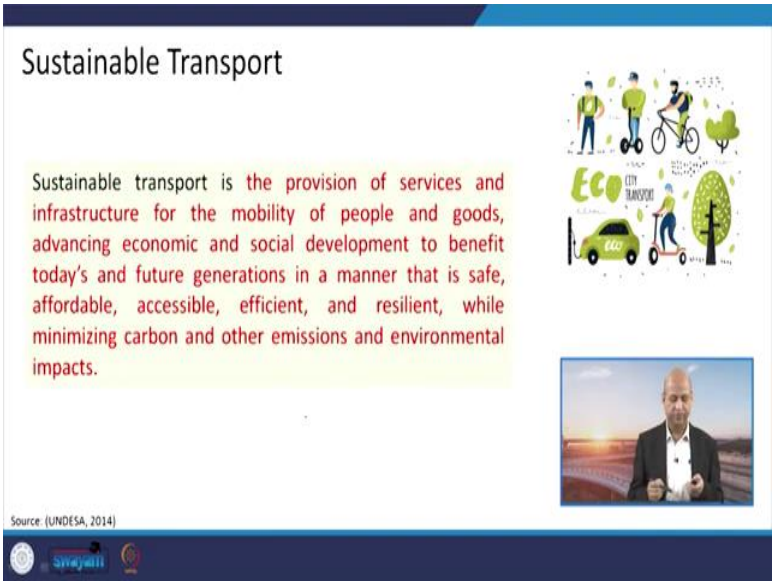

So, sustainable transportation, now new definition you can see that the "provision for services and infrastructure for the mobility of people", means when we talk about sustainable transportation, we were earlier discussing about sustainable development, so within the framework broader perspective of sustainable development, now we talk about sustainable transportation and how it is?

Sustainable transport is the provision of services and infrastructure for the mobility of people and goods and services, you can also say. Advancing economic and social development to benefit today's and future generations, means again future generations concern has to be incorporated in a manner that it is safe, affordable, accessible and efficient and resilient, and while minimizing the impact of emissions and environmental impacts.

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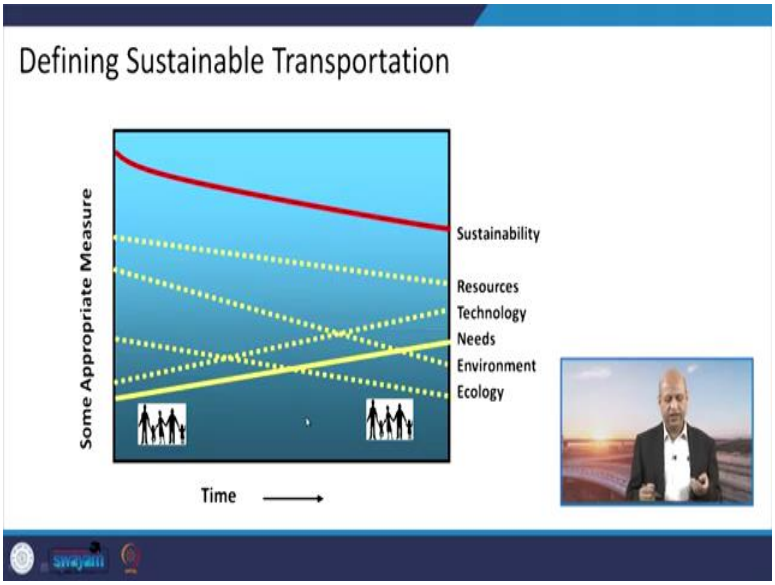

So, in that way the present trajectory when we see about these like the needs which are increasing because population is increasing and technology is also increasing you can see, so many technological developments are there because of those the resources are decreasing, environmental degradation is also happening, so sustainability is decreasing in a way you can say.

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So, sustainable transport goals again, these three aspects economic, social, environmental, all these three aspects must be addressed properly. So, socially means that transportation system should be accessible by everyone, economic means efficient, mobility should be there, local economic development should be taken into account and then operational efficiency should also be there, means it should not be very time consuming and then environmental because it should not pollute air, water, etc.

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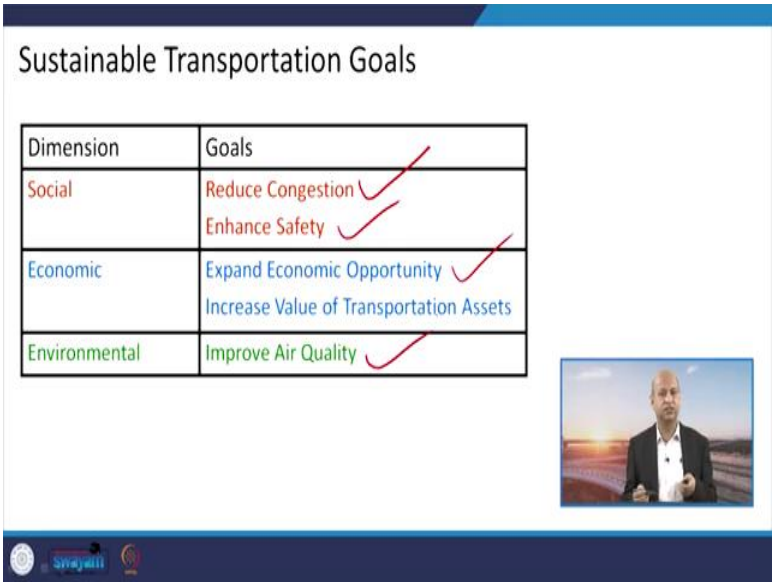

So, again social, economic, environmental, these aspects which we discussed sustainable development, we also want to have these aspects for sustainable transportation system, so

social aspect that it should reduce congestion. If there is a lot of congestion then it is a negative aspect, we should not have congestion.

Then safety measured must be proper, if lot of accidents are there then it is not good, it is not good for the society. Then economic, it should expand the economic opportunities, means people can travel from one place to another for job, etc. And environmental means it should improve the air quality or water quality, etc. It should not degrade those quality parameters of different parameters of the environment.

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Then sustainable transportation goals, there they should be in harmony with the SDGs, sustainable development goals of the United Nations. So, it should be safe, affordable, accessible, efficient, all these parameters also addressing some sort of SDGs, like if it is safe then it is part of good health and well-being, it is SDG 3rd. At the 3rd number this SDG is there.

When it is accessible, so it will reduce the hunger, people can use those transportation means to travel from one place to another, if it is efficient then this 7th number of SDG is met, so different SDGs are addressed by different aspects of the sustainable transportation systems.

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It should be resilient, so sustainable development goal 9 number is met by this, so like climate action related 13 number, because of if we minimize carbon emissions or we do de-carbonization of the transportation system then we are trying to achieve this climate action and sustainable cities related goals of United Nations.

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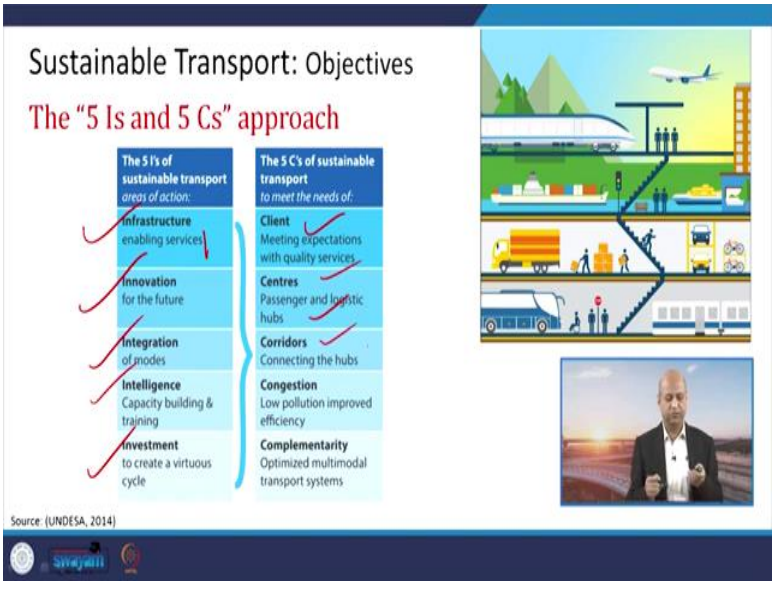

Well, then we talk about what is the sustainable transportation objective? So, to remember properly we can talk about 5 Is and 5 Cs, so 5 Is like infrastructure, innovation, integration, intelligence and investment, these are the 5 Is we should focus on to achieve sustainable transportation system like infrastructure it should be enabling, infrastructure should be like

enabling, people should get enabled, innovation for the future so that it can sustain for longer period.

Similarly, like 5 Cs, so client, meeting the expectation of the clients, means stake holders, then centers, passenger or logistic hubs should be there and then corridors, like connecting different hubs and different multi-modal transportation system it is talking about.

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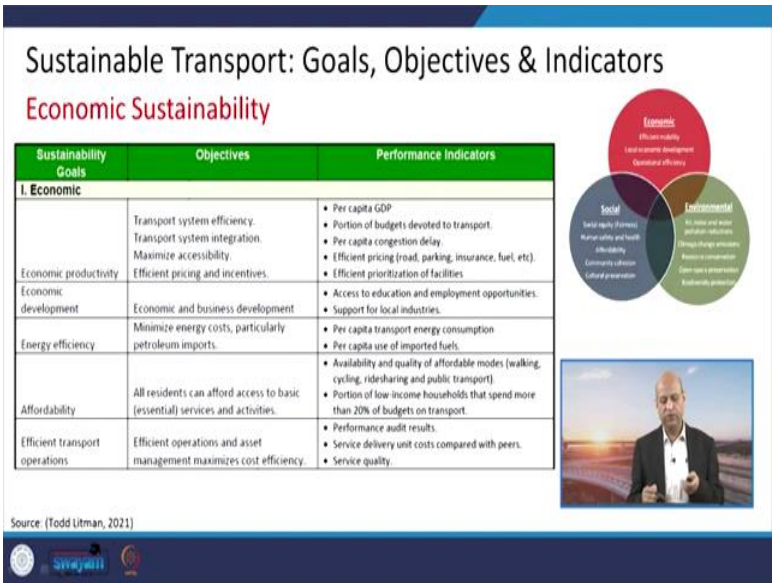

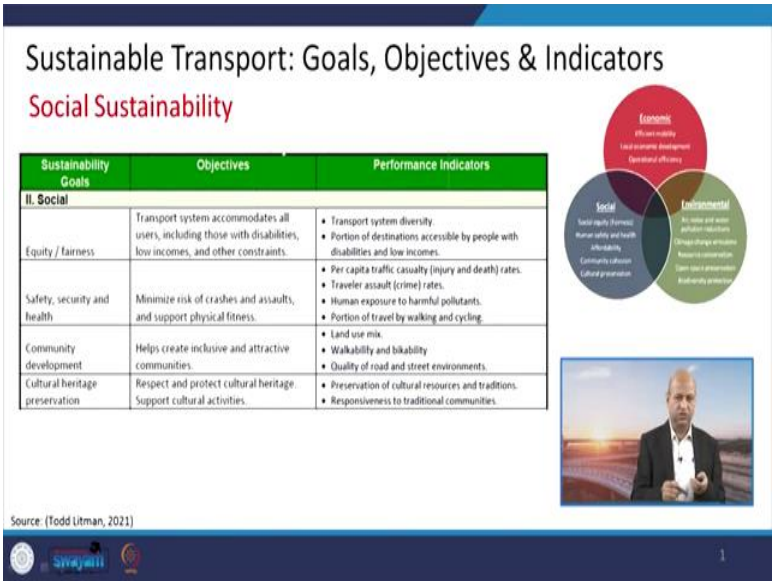

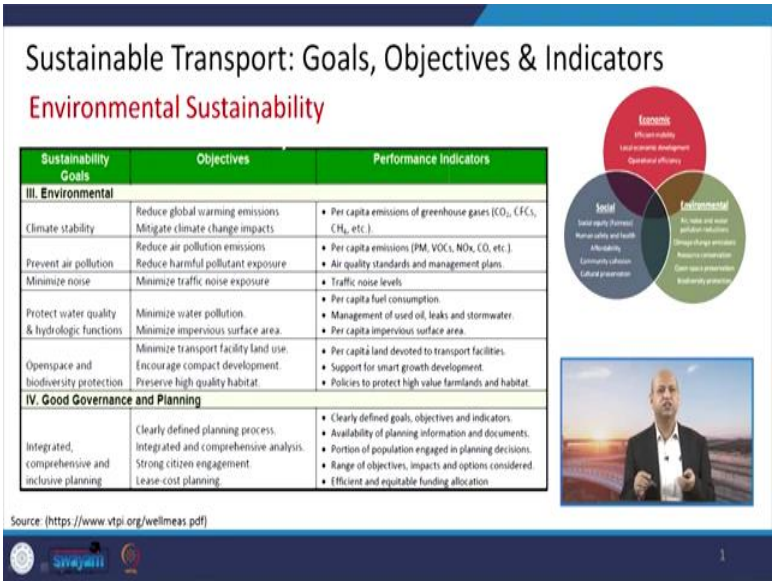

Sustainability Goals	Objectives	Performance Indicators
III. Environmental		
Climate stability	Reduce global warming emissions Mitigate climate change impacts	• Per capita emissions of greenhouse gases (CO_2, CFCs, CH_4, etc.).
Prevent air pollution	Reduce air pollution emissions Reduce harmful pollutant exposure	• Per capita emissions (PM, VOCs, NOx, CO, etc.). • Air quality standards and management plans.
Minimize noise	Minimize traffic noise exposure	• Traffic noise levels
Protect water quality & hydrologic functions	Minimize water pollution. Minimize impervious surface area.	• Per capita fuel consumption. • Management of used oil, leaks and stormwater. • Per capita impervious surface area.
Openspace and biodiversity protection	Minimize transport facility land use. Encourage compact development. Preserve high quality habitat.	• Per capita land devoted to transport facilities. • Support for smart growth development. • Policies to protect high value farmlands and habitat.
IV. Good Governance and Planning		
Integrated, comprehensive and inclusive planning	Clearly defined planning process. Integrated and comprehensive analysis. Strong citizen engagement. Lease-cost planning.	• Clearly defined goals, objectives and indicators. • Availability of planning information and documents. • Portion of population engaged in planning decisions. • Range of objectives, impacts and options considered. • Efficient and equitable funding allocation.

So, again this economic or these social and then environmental, all these aspects of sustainable transportation systems, all these aspects, all these goals and objectives must be addressed timely and properly, that's is very-very important.

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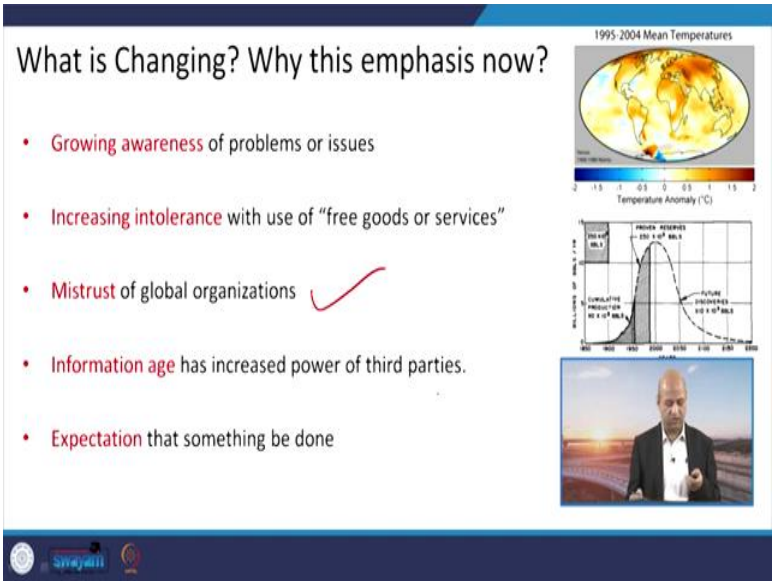

So, now what is changing? Why emphasis is being given to this particular aspect of sustainable transportation? Because awareness is growing, people are demanding that our transportation system should not be unsustainable, and like global organizations, mistrust in the sense that as you have seen because of this Corona also mobility and all these things has been affected very seriously.

So, public is feeling that maybe those global organizations are not doing as effectively as they should do. Information age is there so it has increased the power of third parties, people can know in advance and they can also issue if there is some negative aspect, then expectation is also increasing of the people.

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So, there are several things which are coming out of this, so people are using several means like in Hong Kong there are certain examples like they are using one smart card which is use for public transport of any manner. So many people are using, like 93 percent people are using these public transportation system and then 45 percent they use walking kind of thing. That means they are more health conscious and they are using technology.

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Plus there is one example like reduce, recycle or reuse, so the waste tires, they have been created in a, for utilization as asphalt pavements, so reuse of the waste is there.

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Then you can see like Last Mile Challenge, because connectivity, last mile connectivity should be better, so for that we should have some means from this destination, our home to the hub where we want to have transportation means.

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Then for India there is one wonderful example of Dedicated Freight Corridor, so this will basically save more than 450 million tons of CO2 in first 30 years of operation, so that will reduce the distances and Dedicated Freight Corridor is an ambitious policy implementation of government of India.

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Then we can also have different systems, information systems which can make safe passages for animals, wild life, etc. so these are being used in Canada.

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There is one more example of Bus Rapid Transit System in Johannesburg, so that is a very successful case study, which can be taken as an example of success story.

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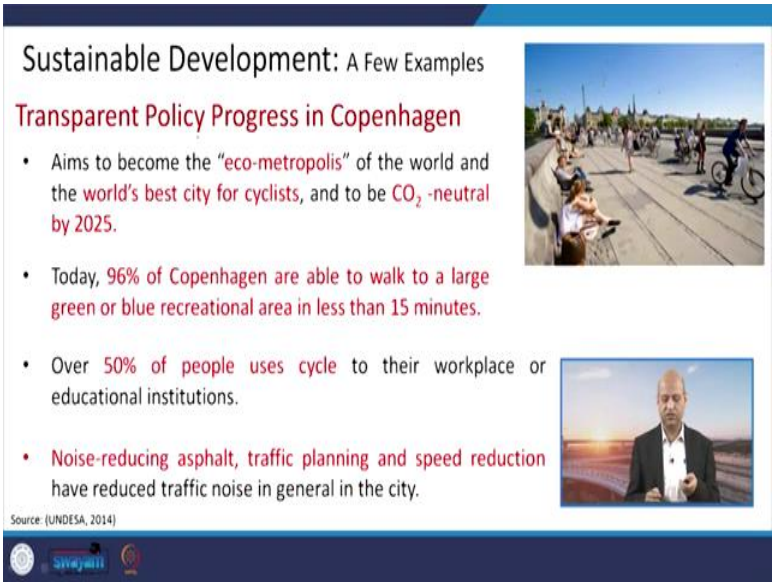

And then these like Copenhagen, this is very much known as the city of eco-metropolis, so CO2-neutral activities are there, because most of the people are using cycle as the means to travel from one place to another. So 96% of Copenhagen people are able to walk to large green or blue recreational area within 15 minutes, so the planning is very good in that sense.

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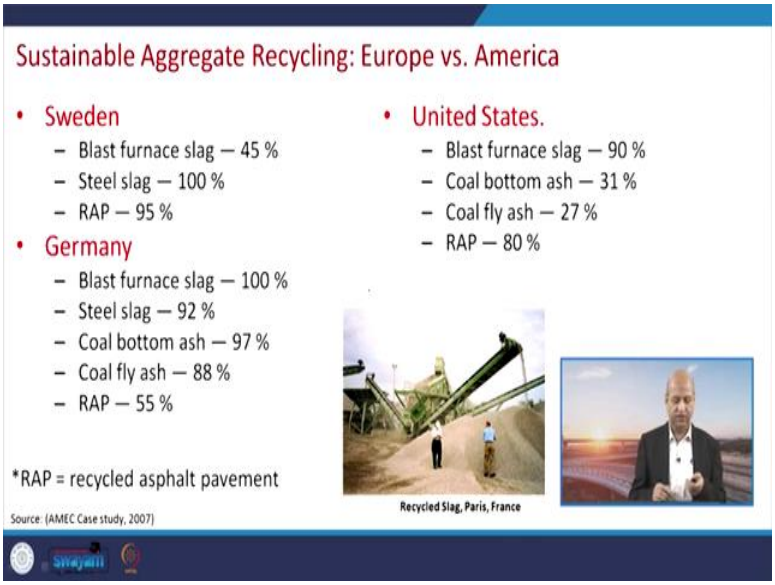

Similarly, different countries are using waste material like blast furnace; Sweden is using only 45%, where is in USA it is being used 90%, but recycled asphalt pavement, 80% in United States, in Germany only 55%, so different countries are using in different ways.

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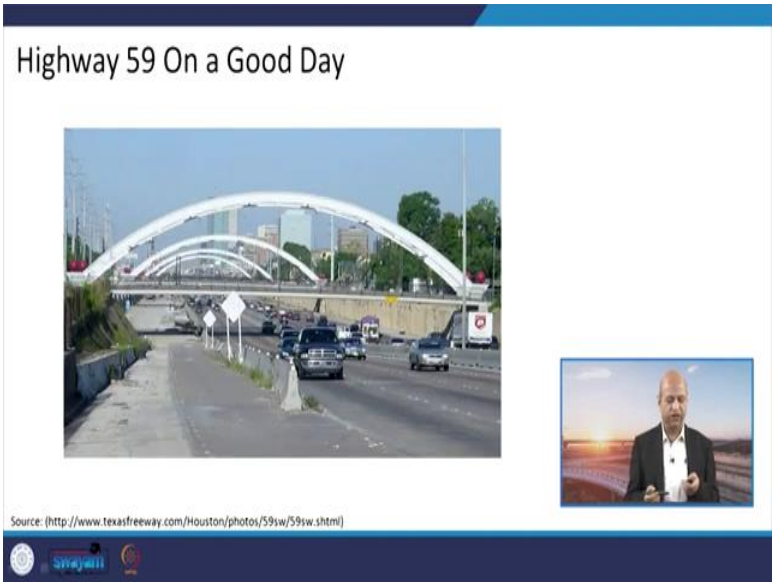

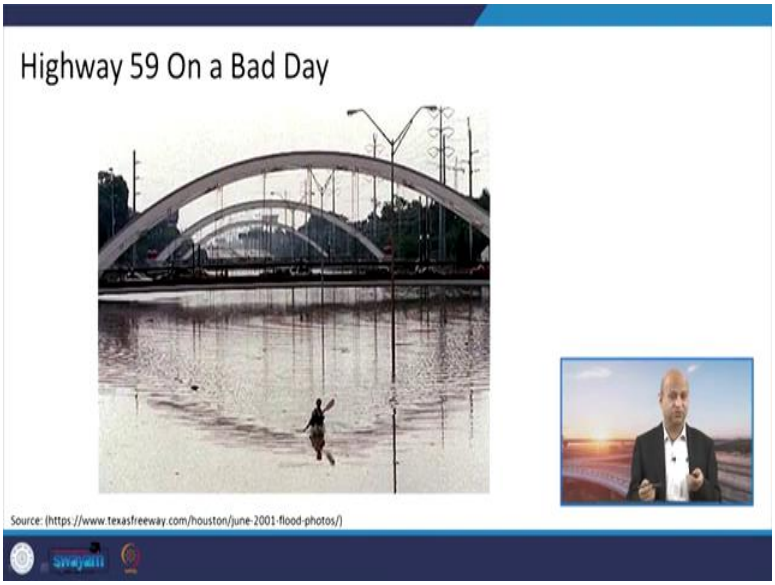

Well, this is a picture of a good day, but if the planning is not good, if it is not on the sustainable parameters then this kind of situation may emerge because of flooding after rain.

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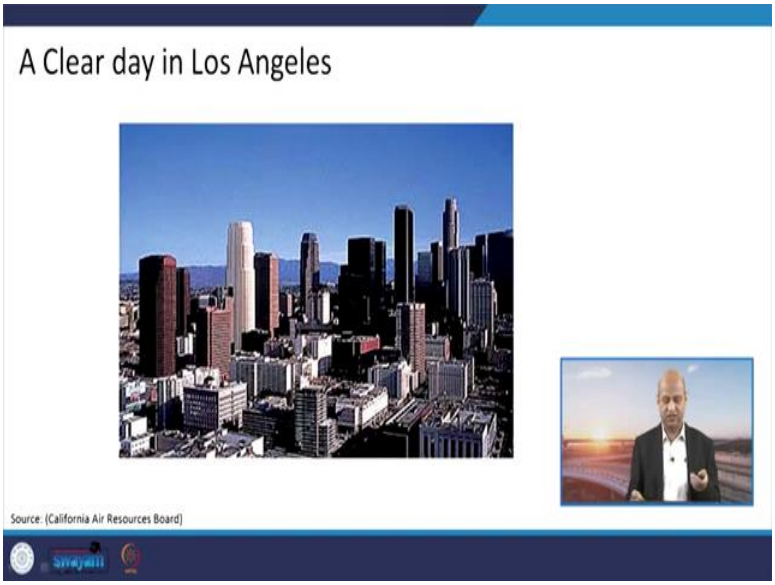

This is smoggy day of Log Angeles before it was properly cleaned or proper policies were implemented, but now it is like, it is as clean as this particular picture. So, these are the benefits of proper policies towards in the direction of sustainable development.

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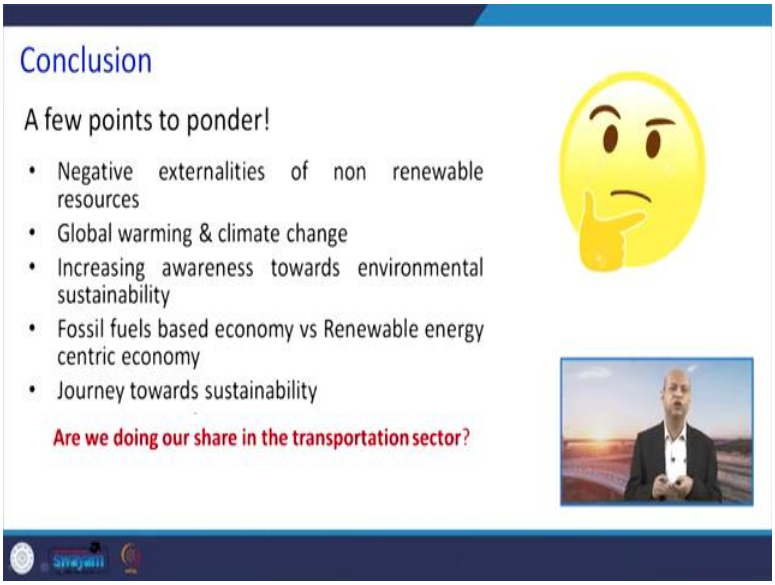

So, in conclusion we can say that the negative externalities of non-renewable resources must be addressed properly and then the global warming, climate change or the increasing awareness of the people and environmental sustainability, fossil fuel based economy should be shifted towards renewable energy, like ecology and economy, in parallel, and journey towards sustainability because of these case studies as we have seen, these kind of case studies should be multiplied and these should be replicated at different places.

New innovations must be also respected by the new generation and that way we can reduce emissions and other negative pollutants or negative externalities from the transportation sector and we can achieve the sustainability in real sense in the transportation sector, so we can achieve the sustainable transportation system.

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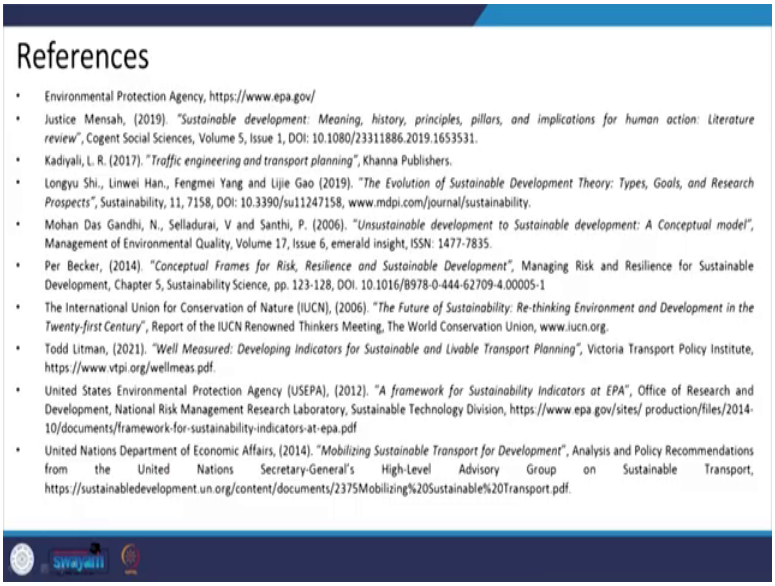

These are the references which you can go through if you want to know more about the sustainability aspects of this transportation system, very good list of these references or resources where lot of information has been borrowed for this presentation and thanks to your kind attention, let us meet in the next lecture, thank you.