Geomorphic Processes: Landforms and Landscapes
Prof. Javed N. Malik
Department of Earth Sciences
Indian Institute of Technology – Kanpur

Lecture - 5
Earth Energy Budget
(Part – II)

Welcome back. So, today we are going to talk a little bit more in detail about the energy part. However, in this part, we will also discuss something related to the greenhouse. So let us go ahead and see.

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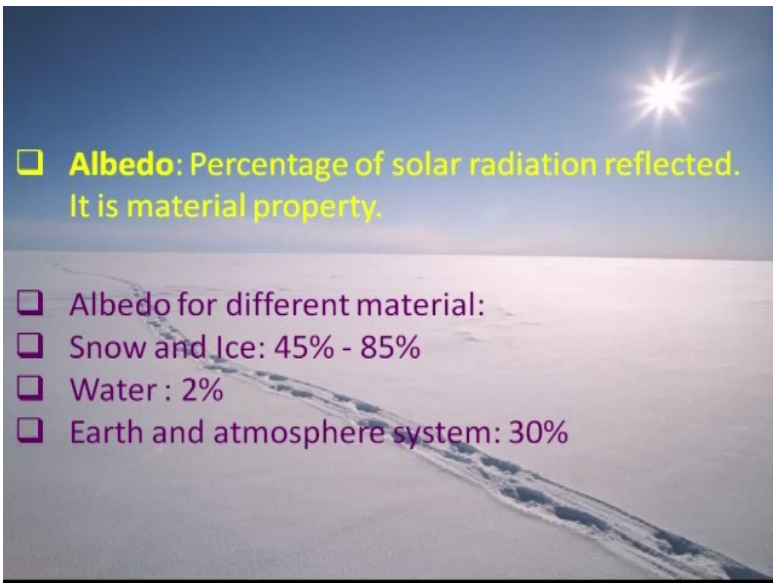

So first we left here. This slide shows where we were talking about the reflectivity from the different objects and the surface of the earth. So, albedo, albedo is basically the percentage of solar radiation reflected. It is a material property, so different materials will have different albedo. For example, snow is having the albedo which is around 45 to 85%. So, if you say 85%, then most of the light which is coming from sun is reflected back to the atmosphere and this is very important when we are talking about the energy balance.

Water only albedo is hardly 2%, that means the radiation which is coming from the sun is mostly absorbed and hardly 2% has been reflected back to the atmosphere. Earth and atmosphere system in total is only 30%.

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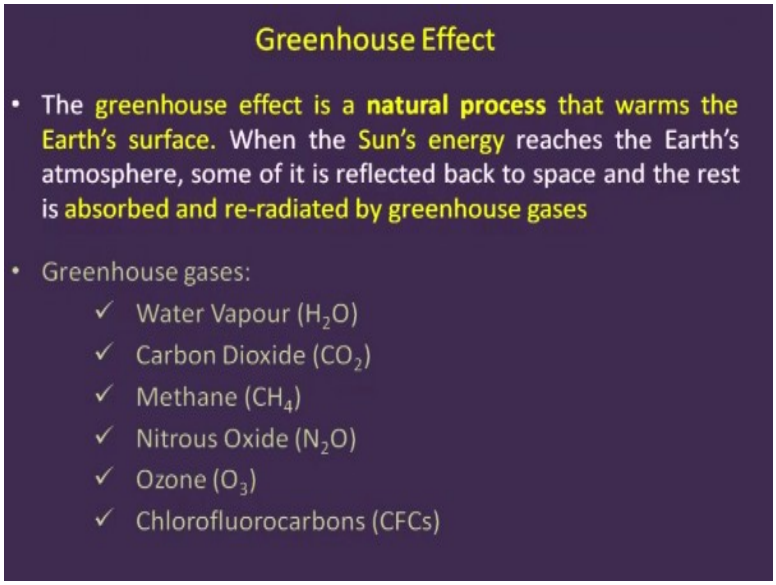

So, further greenhouse effect, of course, depends upon the reflectivity. So, the greenhouse effect is a natural process that warms the earth's surface. So, not all energy as we have talked in the previous couple of slides, that not all energy which is coming from the sun reaches the earth's surface, some is absorbed by the atmosphere, reflected back by the atmosphere, and some is reradiated by the greenhouse gases. So, we have a cover of greenhouse gases, something like this.

So, greenhouse gases if you take, we have water vapor, we have carbon dioxide, we have methane gas, we have nitrous oxide, ozone, chlorofluorocarbon. So, these are all greenhouse gases which does not allow the complete radiation which is coming out of the earth's surface or the heat which has been reflected back into the atmosphere, but it reflect and reradiate back to the earth again.

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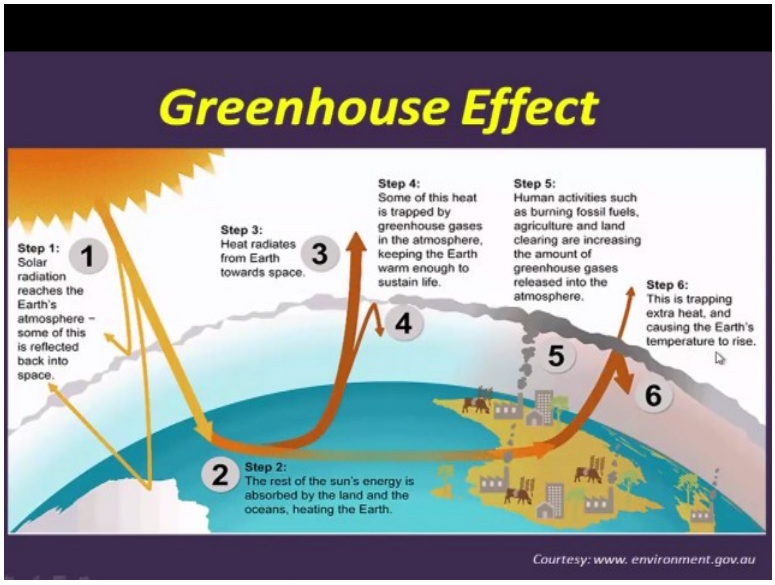

Now, this diagram will explain the things in more detail. So, the first greenhouse effect in total we take, the first step is that the solar radiation reaches the earth's atmosphere, some of this is reflected back into the space, so not all is coming to the earth's surface and whatever has come to the earth's surface, the sun's energy is absorbed by the land and oceans, so this process will heat the earth. Then, heat radiates from earth towards the space. Again, not all goes to this space, some of this heat is trapped by the greenhouse gases in the atmosphere keeping the earth warm enough to sustain life.

So it is reflected back here from the greenhouse gases, and further we humans induce some heat component which is reflected back and that is true human activities such as burning fossil fuels, burning agricultural land, clearing land surfaces, deforestation mainly are increasing amount of greenhouse gases. So this will increase the greenhouse gases into the atmosphere. Then finally, the sixth step is that this is trapping extra heat.

Because of this anthropogenic activity what we have, we are having the extra heat on our planet and causing the earth's temperature to rise. This is in basically the greenhouse effect. In total if you take, the greenhouse up to this of course is good, because it sustain life, but this is adding through the anthropogenic activity, which is increasing the temperatures of the earth, which will result into the melting of the ice and all that.

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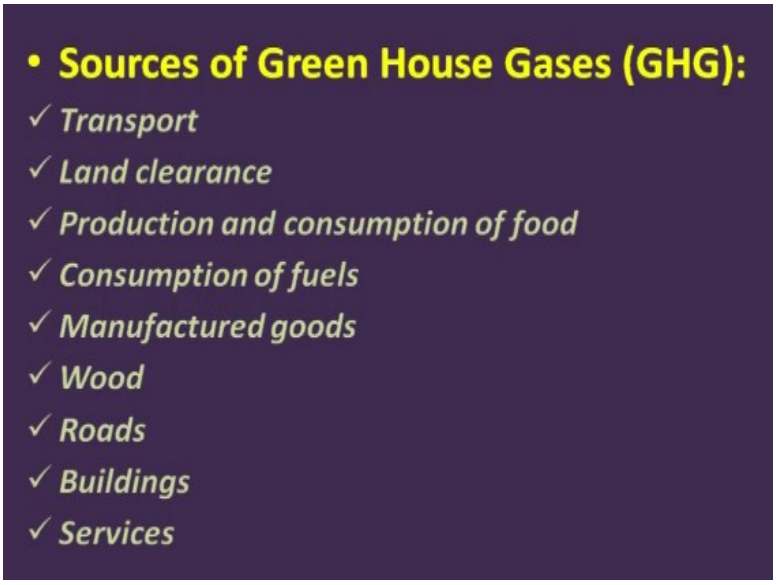

Sources of greenhouse gases mainly, if you look at, we have transportation, we have land clearance, production and consumption of food, consumption of fuel, manufactured goods, wood, roads, buildings, and services. So, these are the sources of the greenhouse gases, which we are putting into the atmosphere.

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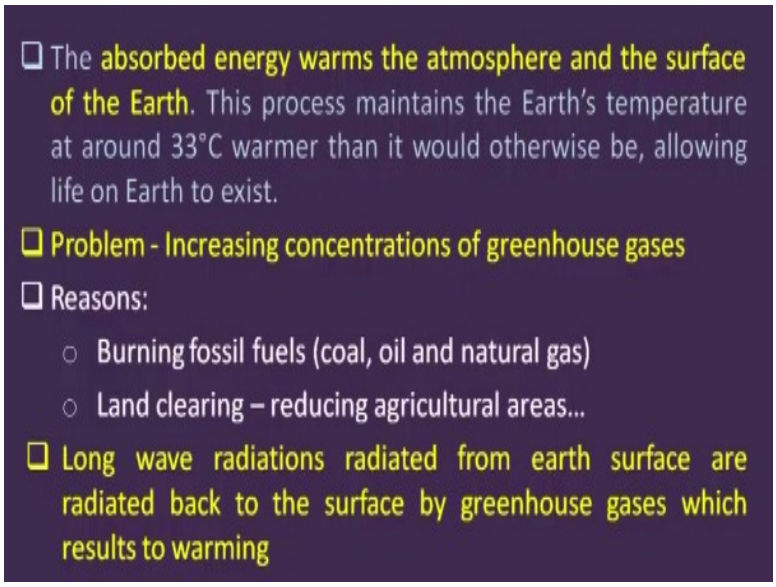

The absorbed energy warms the atmosphere and the surface of the earth. This process maintains the earth's temperature up to somewhere around 33 degrees centigrade and this is important for the existence of life on the earth. The problem increasing is because of the greenhouse gases, for example, reasons are burning of fossil fuels, land clearance, reduction of agricultural areas, etc. The long wave radiation from the earth's surface are radiated back to the surface by greenhouse gases which results to the warming of the earth.

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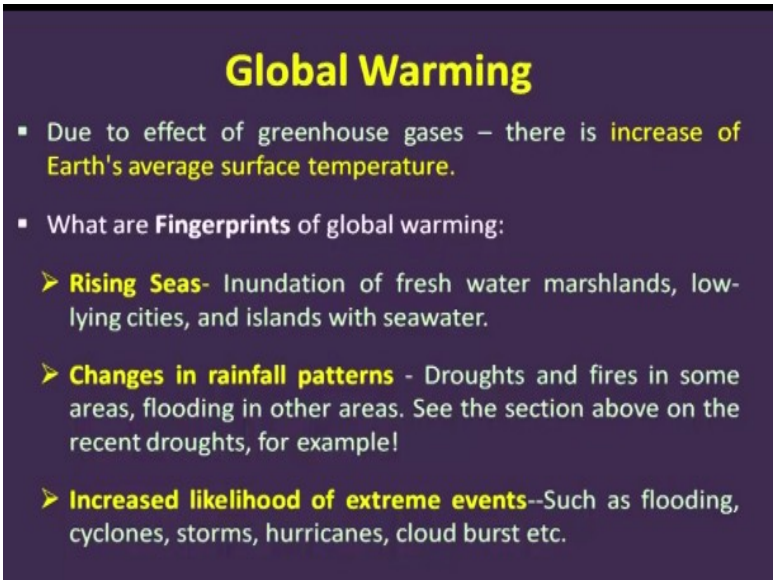

Global warming, in total we take, due to effect of greenhouse gases, there is increase of earth's average surface temperature. What are the fingerprints of the global warming, that means the indications of the global warming. There is the rising of sea level. So, the rising of sea level basically will result into the inundation of many areas close to the coastal regions, so the inundation of the fresh water marshland, low lying cities along the coastal areas, and the islands with the sea water.

Further, global warming has caused change in the rainfall pattern, droughts and fires, as I was talking the best example right now is the Amazon fire in Brazil. So drought and fires in some areas, flooding in other areas. So this is one of the reasons why we are getting what we call the extreme events. So increased likelihood of extreme events, we have experienced in a couple of years, last couple of years such as flooding, cyclones, storms, hurricanes, and cloud burst.

So, these are becoming more common and more and more people are exposed or vulnerable to this events actually. So, global warming in total, if we take again, increasing in the greenhouse gases is affecting the increase in temperature of the earth's surface and in total what we are getting is the global warming and extreme events.

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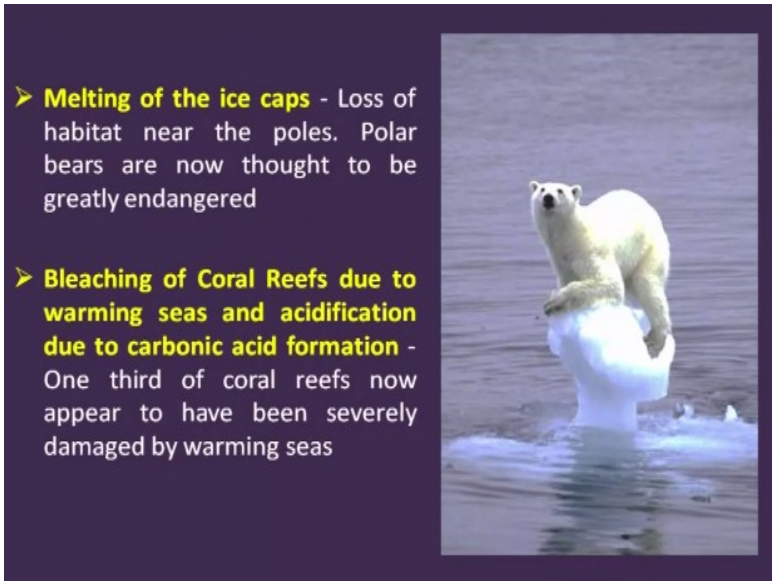

This is another example of melting of ice caps. Bleaching of coral reefs due to warming of seas and acidification due to carbonic acid formation. So, corals are dying because of this and the ice caps are reducing because of the increase in temperature.

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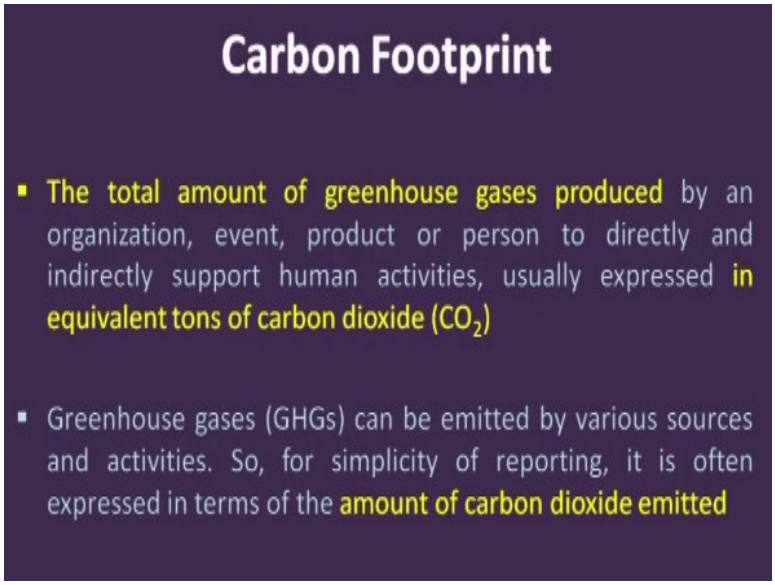

Carbon footprints, basically the total amount of greenhouse gases produced by an organization are mainly through the events, product or person to directly and indirectly support human activities and this is usually expressed in equivalent tons of carbon dioxide. The greenhouse gases can be emitted by various sources and activities. So, for simplicity of reporting, it is often expressed in terms of amount of carbon dioxide emitted.

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So, carbon footprints, a measure of total carbon dioxide, that is amount of carbon dioxide and methane emission. So, there are different sources through which we can generate the greenhouse gases. So, they have been calculated as carbon dioxide equivalent using the relevant 100 year global warming potential. From a defined population system or activity, considering all relevant sources, sinks and storage within the spatial and temporal boundaries. So on the right hand side, this will show that these are the sources of greenhouse mainly.

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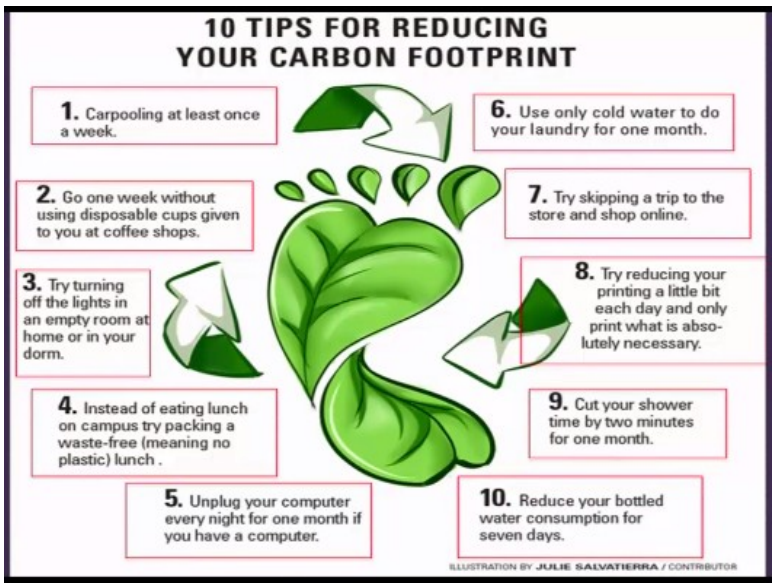

Now, to reduce the carbon production, there are many ways which have been given here. There are 10 tips for reducing the carbon footprints, because mostly what we are worried about the carbon which has been produced. So what it says is first is that you can reduce because we are burning more fossil fuel, so we can say that, please do the carpooling at least once in a week, that will reduce the number of cars on the surface or the traffic will be less and less emission that will reduce the carbon footprints.

Then go one week without using disposable cups given to you at a coffee shop. So, you use your mugs instead of using the disposable cups, so that is another issue which will help in reducing the environmental impact. Try turning off the lights in an empty room at home in your room. So, this is again what we were looking at the reflectivity or the emission of heat, because if you keep putting on lights in your rooms without utilizing it, then unnecessary heat is generated which is again transmitted to the atmosphere.

Fourth is instead of eating lunch on campus, try packing a waste free, means no plastic lunch. Unplug your computer every night and one month if you have a computer, at least once in a

month you should unplug your computer. Then use only cold water to do your laundry for one month. Try skipping a trip to stores and shop online because that will increase the gathering and even the gathering can radiate or generate more heat in the shopping malls. Try reducing your printing a little bit each day and only print what is absolutely necessary.

So you are reducing the usage of paper and eventually that papers are generated, it is coming from the forest by cutting trees and all that. So cut your shower time by 2 minutes for one month. Reduce your bottled water consumption for 7 days. So, these are a few tips which can reduce the carbon footprints in total.

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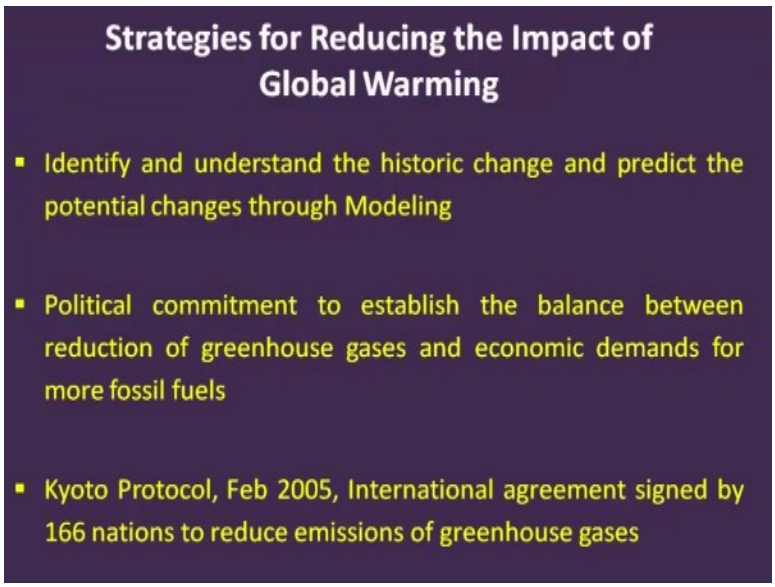

Strategies for reducing the impact of global warming. So strategies are identify and understand the historical change and predict potential changes through modeling. So you take up the historical data, and through modeling, try to identify and understand the issues. Political commitments to establish the balance between reduction of greenhouse gases and economic depends or demands for more fossil fuels.

So, for this type of commitments, there was one meeting which took place in 9, 2005 which is called as Kyoto Protocol, international agreement signed by 166 nations to reduce emissions of greenhouse gases. This was basically commitments which government made to establish the balance between the reduction of greenhouse gases and economic demands, because economic demand will be that more fossil fuel will be burn because the growth of the country is very important.

So, developing countries will have more demand of fossil fuel, but at the same time, you are committing to reduce the greenhouse gases. So, how you will do that, that was very important.

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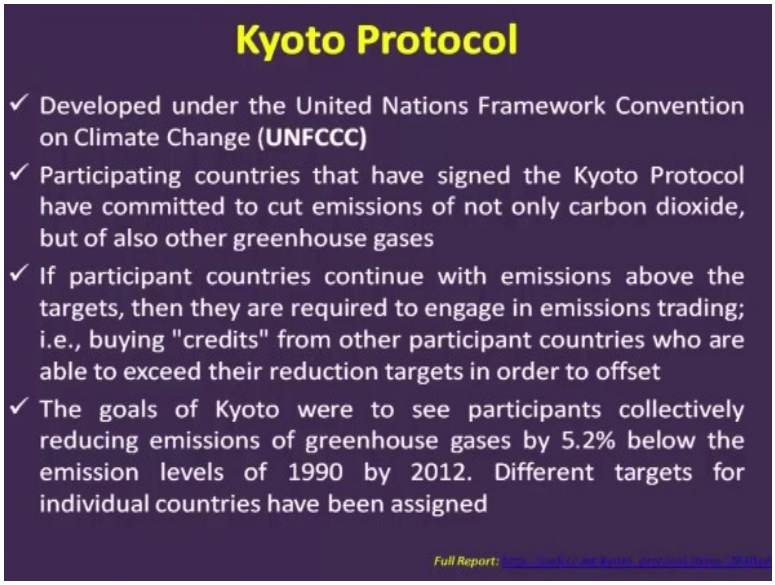

Several commitments were made in Kyoto Protocol. So, Kyoto Protocol developed under United States Framework Convention on Climate Change. So, this was in 2005. So, as I told 166 countries participated. The participating country have signed the Kyoto Protocol have committed to cut emission of not only the carbon dioxide but also other greenhouse gases. So, this was the commitment which has been given by different countries depending on their amount of emission of carbon dioxide, but mostly worried part is the carbon dioxide.

If participant country continues with the emission above the target, then they have required to engage in emission trading. Now, this is something very unusual emission trading is that is the buying the credits from other participating countries who are able to exceed their reduction target in order to offset. So if you have increased, some countries will spill over the committed emission, whereas some country will be under the committed amount of emission.

So one can buy the credits that we will burn the same we have burned more amount of fossil fuel and the emitted carbon dioxide and next time we will reduce and give back your credits, something like that can be done, then that is basically to enable the countries who have exceeded their targets. The goal of the Kyoto Protocol were to see participants collectively reducing emissions of greenhouse gases by5.2% below the emission level of 1990 by 2012.

So, of course, most of the countries must have achieved this. So, different targets for individual countries have been assigned.

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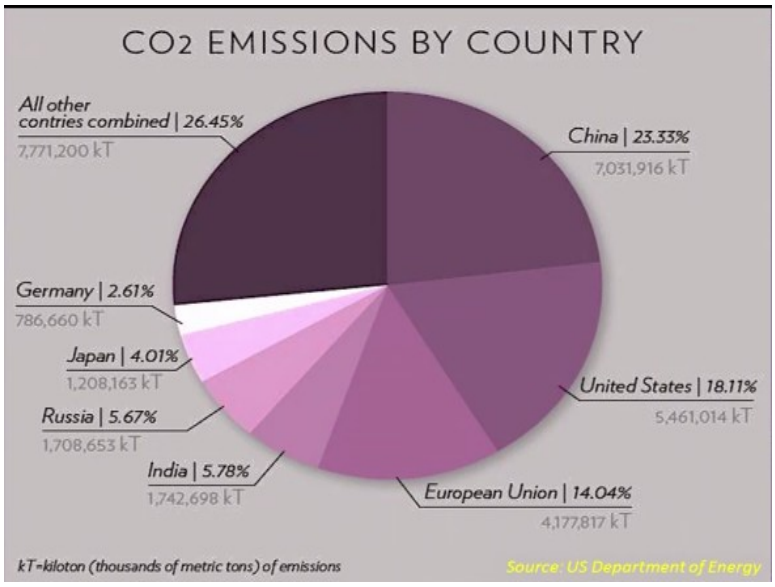

So, if you look at the carbon dioxide emissions by different countries, and this is what you see. China is emitting around 23.33%, United States is 18%, European Union 14%, India is 5.78% and so on. All of the countries other than the major like Russia, Japan and Germany, they are emitting almost a 26%. China is the highest, and China what we have been learning through news and all that is that a lot of development is going on.

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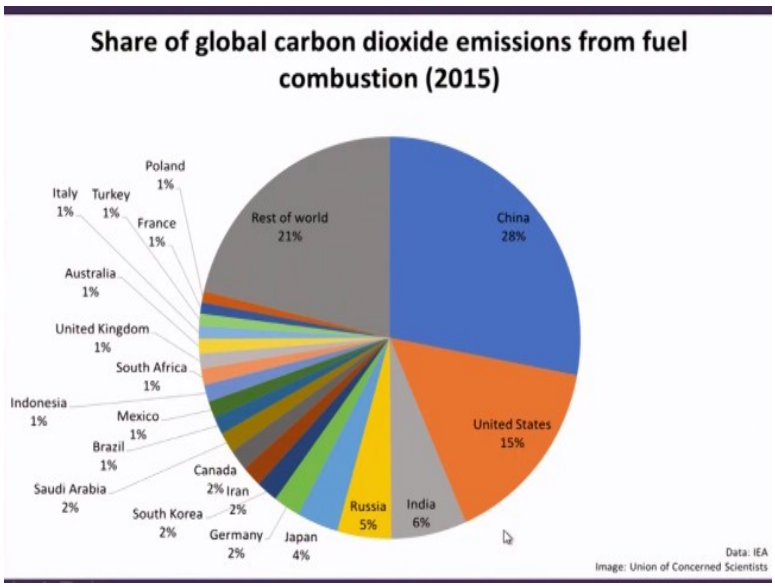

Similarly, this is the global share of global carbon dioxide emissions from fuel consumption only. So, again 28% is China through fuel consumption. India is hardly 6%. So, I will stop here and we will continue in the next lecture. Thank you so much.