Implications of Climate Change for Indian Society

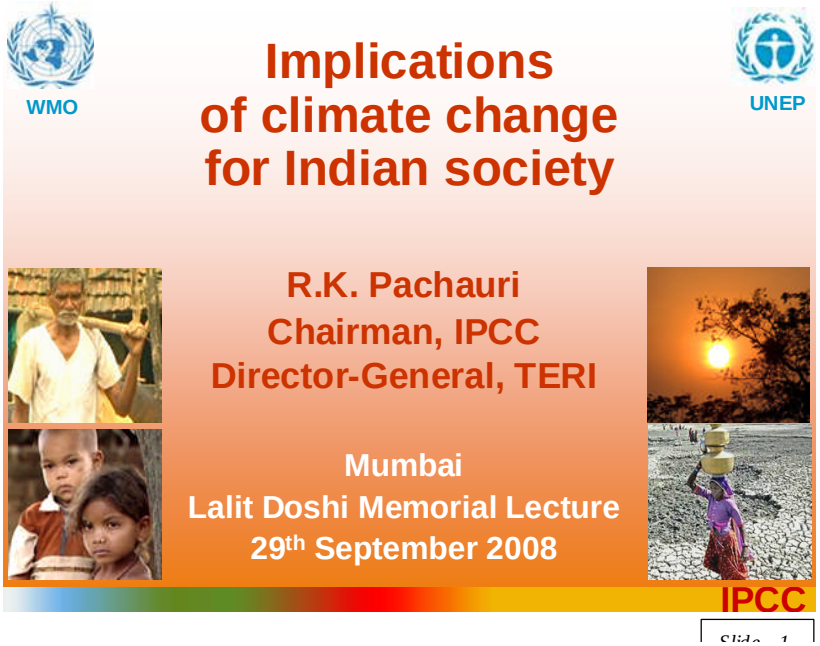
By
Dr. Rajendra K. Pachauri

Smt. Pratima Doshi, Mr. Arun Bongirwar, Mr. Bharat Doshi, Mr. J.S. Sahni, Mr. Keshub Mahindra, other distinguished participants and guests at this lecture.

I am deeply honoured to be given this opportunity and I am really touched that you waited for me till I could make it to Mumbai. As you rightly said, unfortunately my fate seems to be just sitting on an airplane all the time and these days when people ask me where I am based, I normally tell them, ask me my seat number and I might be able to tell you.

I was also very touched by your very generous introduction which if I might boast was deficient in one regard and that's with respect to cricket. Because I still play cricket and I might tell you that I flew in from New York on Saturday morning, I had barely two hours of sleep and we had to play a cricket match that afternoon as part of a tournament, which incidentally I started in the memory of my Guru and my coach, a person by the name of Dattu Phadkar (Dattatraya Gajanan "Dattu" Phadkar), who in his time was the best all-rounder we had. Anyway, I had not played for five months because I had developed a slight back problem, which is, of course, much better now, but I managed to get a modest three wickets, the first three wickets in the opposing side and that I was also happy to see that I could swing the ball in both the directions even now.

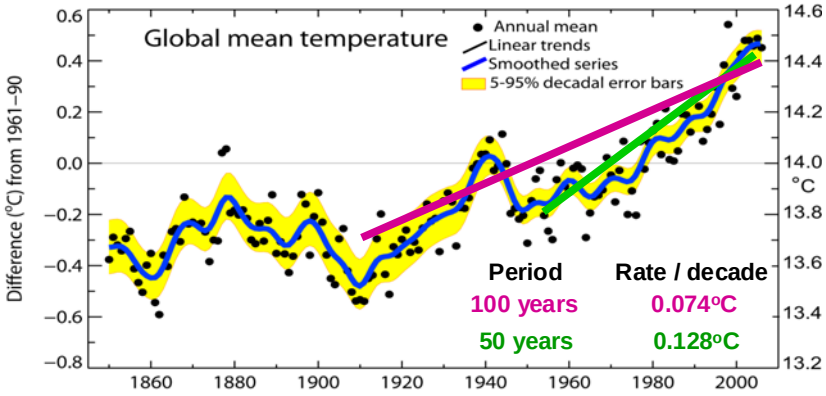
Thank you very much, this is indeed a great privilege and may I say that I find this an extremely significant event, because I believe the Spirit, the Soul, the Memory of great people never fades away and this is something that accords very closely with my own beliefs and therefore I think it is appropriate and certainly a great privilege for me to be part of this lecture and this function, because the least we can do for those who have done so much for the world is to remember them, remember their great deeds, remember their strength of character which clearly was a case in point in the memory of Mr. Lalit Doshi, a person who I had heard a lot about but never had the privilege of meeting. But I feel I am very close to him now and this is indeed a very touching moment for me.



Annual (Fourteenth) Lalit Doshi Memorial Lecture, arranged by Lalit Doshi Memorial Foundation at Mumbai on 29th September 2008, delivered by Dr. Rajendra K. Pachauri on the subject title.

I am going to talk about climate change and what it implies for Indian society and in talking about it I am essentially going to deal with the findings of the Fourth Assessment Report of the IPCC. Let me start with one very important finding that we came up with, which was the fact that the climate system of the earth is warming and this fact is unequivocal. Now there are still, of course, some skeptics who will tell you that whatever is happening to the earth's climate is the result of natural changes, but we now have so much evidence based on observations, we also have a great deal of scientific support and proof to indicate that we as the human race are affecting the climate of this earth.

Changes in global average surface temperature



Eleven of the last twelve years rank among the twelve warmest years in the instrumental record of global surface temperature

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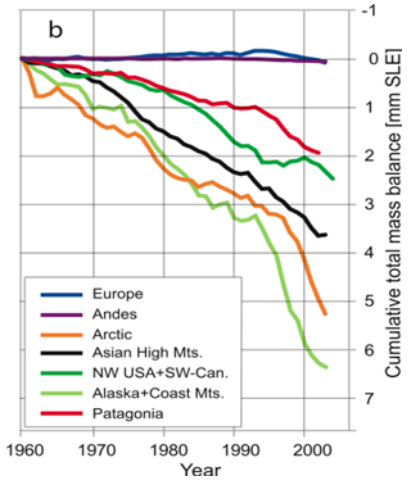
If you look at observations going back to the beginning of industrialization, this is the manner in which these would get plotted and you would observe that there is obviously a variation that takes place over a period of time, there are ups and downs in this curve, but you would observe that in recent decades the slope of this set of changes has been quite steep. If I look at the slope over the last hundred years, you would find there has been a total increase in average temperature of 0.74° degrees Celsius. On the other hand if you look at the slope over the last fifty years, that's clearly much steeper and almost twice the rate at what you observe over the last hundred years. More important is the fact that if you look at the last twelve years, eleven of these rank among the twelve warmest years in the instrumental record of global surface temperature. So the point I would like to make is that the earth is warming and it is warming at a much faster rate as time goes on. But that is not all; there are several impacts of climate change, which I would like to explain to you.

Cumulative balance of glacier mass

Decreases in glaciers have contributed about 28% of sea level rise since 1993

(thermal expansion oceans: 57%; losses from polar ice sheets: 15%)

Water supplies stored in glaciers are projected to decline in the course of the century



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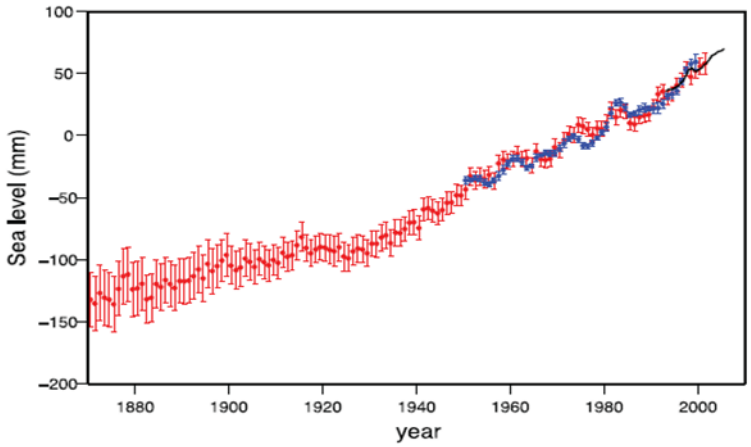
Being located, as we are, in South Asia it is a matter of considerable concern for us that our glaciers are melting very rapidly and this is a plot of the reduction and change in glacier mass in different parts of the world; each of these represents a glacier range and the dark line that you see is the one that refers to the Himalayan high mountains. We know that essentially this glacier system feeds the river systems in the northern parts of the sub-continent and, of course, some rivers in China as well. These decreases have serious problems; firstly you would find a great deal of water flow in the initial period on account of the rapid rate of melting, that causes serious complications in the mountain ecology, wherever they are located, but over a period of time as that mass reduces, the flow of water in river systems, like we find in the northern part of the sub-continent reduces and that can cause serious problems of shortage and scarcity of water. In fact as far as the northern part of this sub-continent is concerned, something like 500 million people are likely to be affected with reduced water availability over a period of time.

Let me also clarify that it is not just the flow in the rivers that would be affected, but what would also be affected is the recharge of ground water. Rivers perform a very vital function, not only in giving you water in terms of what you see flowing, but also what percolates down below and therefore recharges the ground water aquifers.

The other implication of this is the fact that all the ice that melts basically flows into the oceans and that adds to the increase in sea level. As it is stated over here, decreases in glaciers have contributed to about 28% of the sea level rise since 1993. It is also, as I mentioned, a fact that water supplies stored in the glaciers are projected to decline in the course of the coming years.

Changes in global average sea level



Global average sea level has risen since 1961 at an average rate of 1.8mm/yr and since 1993 at 3.1mm/yr

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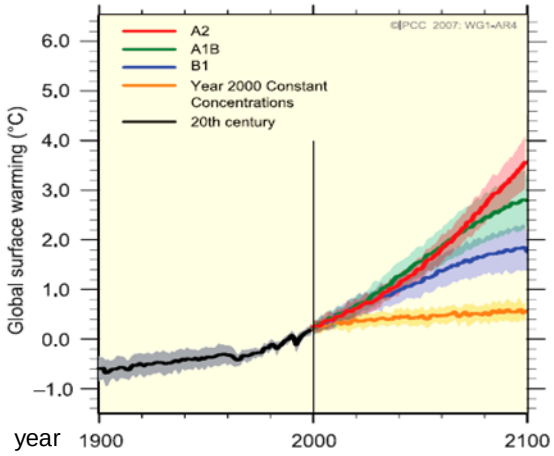
This is the manner in which sea level has changed over a period of time. During the twentieth century there has been an increase of about 17 centimeters in the level of the seas. This may appear like very minor, but if you are living in the Maldive Islands and these islands are barely a meter high, seventeen centimeters, which is close to a foot, is a pretty serious problem for those living in these low lying areas.

I recall, I was elected as Vice Chairman of the IPCC in 1997 and at that stage our plenary session was held in the Maldives, on one of the resort islands of the Maldives, and President Gayoom (Maldives President Maumoon Abdul Gayoom) of that Nation stood before us and said "ladies and gentlemen the place where you are holding this meeting today, ten years ago I had a foot and half of water". Therefore, the threat some of these low lying areas including the small island states, lies not merely in the ultimate threat of complete submergence by increasing sea levels, but even before that, storm surges, cyclones and any of these events cause enormous damage. Here also may I point out that the sea level is rising faster, because if you look at the rate since 1961 it was about 1.8 millimeters per year, but since 1993 it has increased to about 3.1 millimeters per year. So, therefore, may I say that the problems that we find associated with climate change are only increasing at a far more rapid pace than we could have anticipated earlier.

Ranges for predicted surface warming



Continued emissions would lead to further warming of 1.1ºC to 6.4ºC over the 21st century

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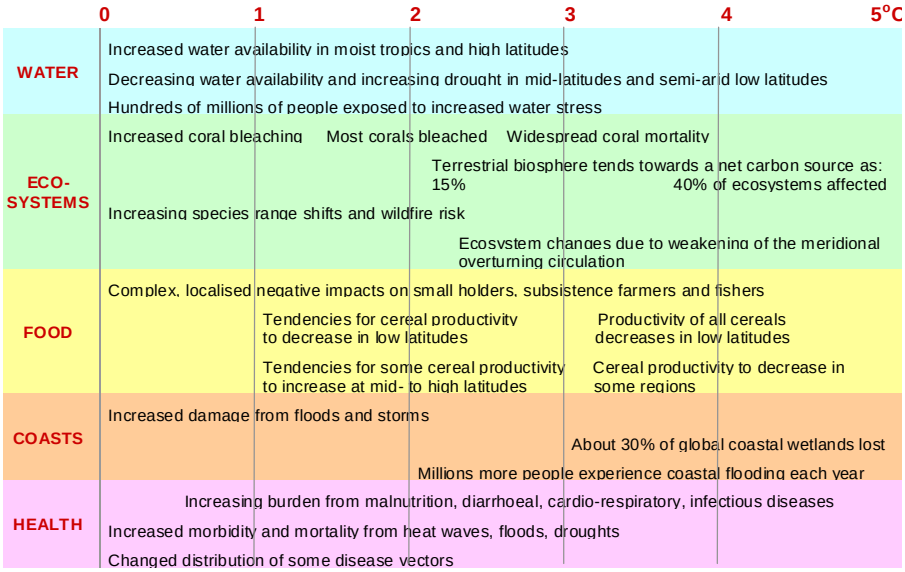
Now if we look at projections for the future we find, based on a number of scenarios that we have examined in the IPCC and these scenarios are, of course, based on changes in economic growth rates, changes in technology, and other social changes and also global markets, on how they might develop. We have taken a whole range of these possibilities and come up with a set of scenarios which give us a range of emissions of greenhouse gases to which correspond increases in temperatures that would take place.

So, the range that we have assessed till the end of this century is anywhere from 1.1 degrees Celsius to about 6.4 degrees Celsius. Even at the lower range there is reason for us to be concerned because this 1.1 degree Celsius increase, when added to the 0.74 degrees, which has already taken place in the twentieth century, is a pretty severe rate of increase of temperature. May I also explain that this increase is not something that is smooth and linear.

Examples of impacts associated with warming



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The impacts of climate change take place in a variety of ways. For the first time in the IPCC we have been able to clearly indicate the kind of impacts that would take place with different levels of average temperature increase that we can project in the future. These impacts are in respect of water, ecosystems across the world, food and food scarcity, coastal areas and human health. You would observe that as far as the water is concerned we would start running into problems even with a one degree increase in temperature. In other cases also, the moment you go to higher levels of temperature increase the impacts become more and more severe.

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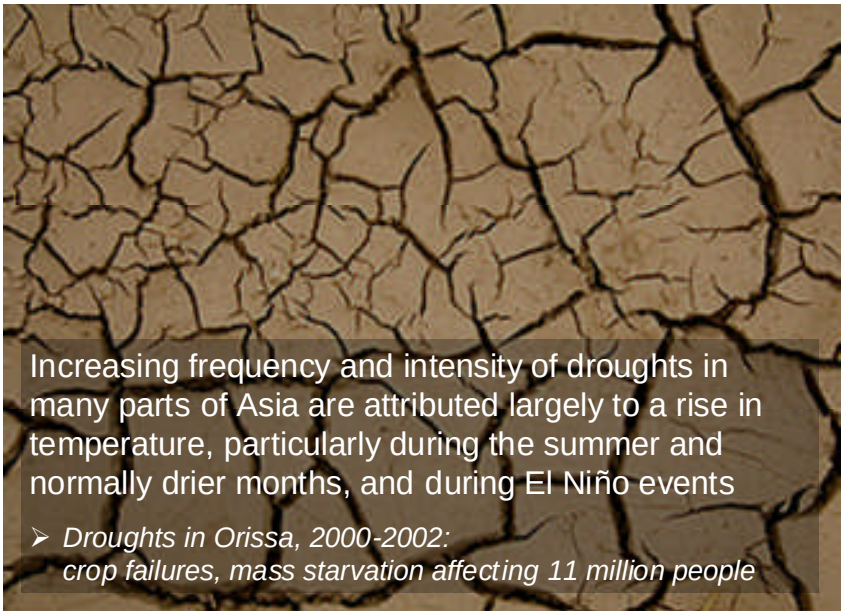
Just to give you an indication of the kinds of changes that would take place, in the case of eco systems a number of species are likely to be threatened with the danger of extinction the moment we cross a range of 1.5 to 2.5 degrees Celsius. In the case of water, by 2020 something like 75 to 250 million people in Africa will be suffering from water stress largely as a result of climate change. Food scarcity is also something that we have to be deeply concerned about, because as you are aware even today we do have a food crisis across the world. This year with an increase in food prices there are some societies which have witnessed demonstrations and all kinds of disturbances and protests largely because there are some societies where people earn very small incomes of which 80 to 90 per cent gets diverted to buying food and once prices escalate to even fifty percent higher than what they were earlier, this imposes a major hardship on those communities.

Therefore, in the future when the temperature increases we would have serious problems, largely because the impact of climate change on a number of crops is in the form of a decline in productivity. This is particularly true of wheat and maize. In the case of wheat even a two degree increase in temperature during a particular period in the growth cycle of this crop can cause a substantial drop in productivity.

Human health would be affected largely because of increased droughts and floods, as well as heatwaves, which are going to become more severe and more frequent in the future, but also because vector borne diseases will increase under the revised climate conditions that we will see in the future.

If you look at changes in extreme events in Asia and India, we have significantly longer heatwave durations and in several cases of severe heatwaves, we have observed them in many countries in Asia.



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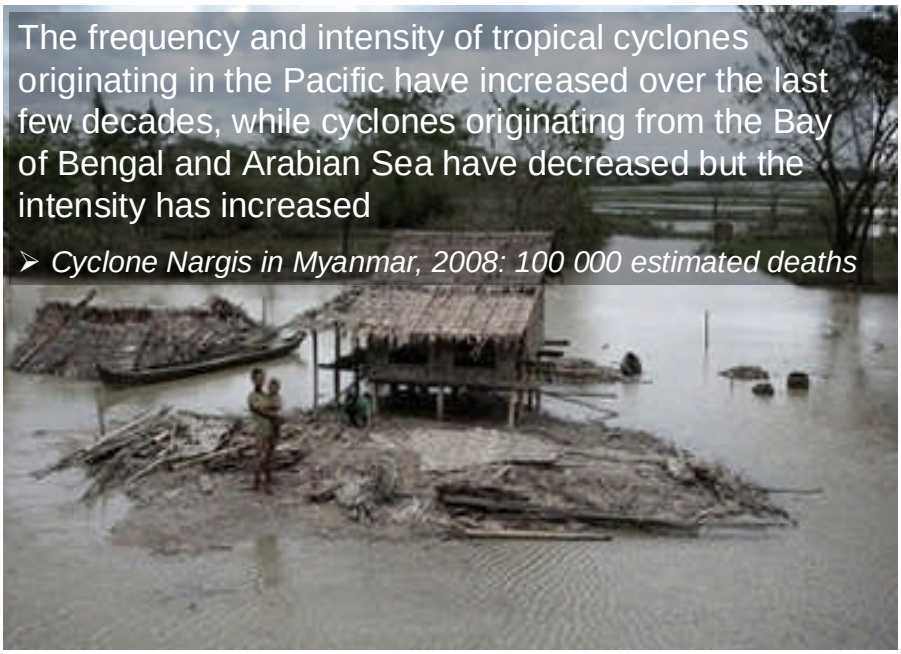
For instance, there were eighteen heatwaves reported in India between the period 1980 to 1998 and the heatwave in Andhra Pradesh in 2003 resulted in something like 3,364 recorded deaths, the number in actual fact would have been much higher. These are likely to increase and these are also getting more and more widespread across the globe. If you go to Europe you will hear several anecdotal accounts of how climate change is becoming manifest in the

form of heatwaves in places and periods when you least expected them. What seemed particularly ironic last year was a major flood in a part of Greece with heavy precipitation and high temperatures in another location, not very far away, of 46 to 47 degrees Celsius. If you talk to people there they will tell you that they have never seen anything like this in living memory.

Now the frequency and intensity of tropical cyclones, particularly those originating in the Pacific have increased over the last few decades, while cyclones originating from the Bay of Bengal and Arabian Sea have decreased but the intensity has increased. So, the extent of damage that you get from these is going to be much more severe.



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An example could be cyclone Nargis, which killed over 100,000 people in Myanmar.

May I also explain how some of these impacts of climate change combine together to create a much worse scenario than would have been the case otherwise. For instance in the case of Myanmar, typically whenever a cyclone hits an area like this, which has a large continental shelf, all the water that's sitting on that continental shelf gets picked up and hurled onshore. In the case of Myanmar, given the fact that sea level rise has taken place during the last century and is continuing to take place, there is a much larger quantity of water available on that continental shelf and therefore the force with which it was hurled would be much higher.

So, one could conclude that if a similar cyclone had taken place a hundred years ago, perhaps it would not have caused the same level of damage. As a matter of fact one can arrive at that conclusion even in respect of the tsunami that hit Asia four years ago. If the sea level was a little lower then perhaps the damage would have been much less. So the impacts of climate change basically exacerbate impacts that would take place naturally in any case otherwise, for a variety of reasons.

The increase in frequency and intensity of droughts in many parts of Asia can be attributed largely to rise in temperature, particularly during the summer and normally drier months and during El-Nino events, which of course are now quite predictable. And droughts in Orissa in

the years 2000 and 2002 led to crop failures, mass starvation affecting eleven million people. One could conclude that droughts in other parts of the world have also played havoc into several societies.

In fact, to an extent, you could say the elections in Australia, in which the government of Mr. John Howard was thrown out and Mr. Kevin Rudd's party won the elections, to a large extent was because of the denial of climate change by the previous Prime Minister. This in a country where they have had six years of prolonged drought. That's why I think when Mr. Kevin Rudd took office as Prime Minister, within a week he decided to ratify the Kyoto Protocol, which his predecessor had rejected along with another great leader in North America.

The frequency of occurrence of more intensive rainfall events in many parts of Asia has also increased and this is causing severe floods, landslides, debris and mud flows.

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The example that one could give; though I am not necessarily ascribing that to human induced climate change, was the rainfall in Mumbai. But, here, I think we must arrive at an important conclusion. If these events are going to become more frequent, and they are going to become more severe, then we will have to adapt to them and that adaptation may take various forms; certainly much better early warning systems, much better provision of facilities by which you can evacuate people and even more importantly, if let's say, rainfall of the type that you got in 2005, earlier it used to take place once in fifty years, as an example, but now it is likely to take once in five years, then I think it would be prudent to revamp the entire drainage infrastructure in the city, because you can't possibly afford the kind of loss of life and property that took place in 2005. So, it is particularly important that when we project these impacts of climate change in the future that we come up with a very clear perception of how we are going to adapt to some of these impacts as they occur.

Impacts on human health

Endemic morbidity and mortality due to **diarrhoeal disease** primarily associated with floods and droughts

Exacerbation of the abundance and toxicity of **cholera** due to increase in coastal water temperature

Increased **deaths, disease and injury** due to heat waves, floods, storms, fires and droughts

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Let me look at the impacts on human health. There would be endemic morbidity and mortality due to diarrheal disease and this is particularly associated with floods and droughts. We know that the biggest problem every time a flood occurs is for the officials to somehow contain the widespread occurrence of all kinds of epidemics and diseases. Exacerbation of the abundance and toxicity of cholera would take place due to increase in coastal water temperature and increased deaths, disease and injury due to heatwaves, floods, storms, fires and droughts. So, human health would be affected by climate change.

Impacts on food production

Crop yields could increase up to 20% in East and Southeast Asia while they could decrease up to 30% in Central and South Asia by 2050

In India, wheat yields could decrease by **5-10%** per one-degree rise in temperature

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I have already talked about crop yields. These could increase upto 20 percent in East and South-East Asia and that is largely because of the fertilization effect of carbon dioxide; carbon dioxide, after all, promotes growth of crops and plants. It is likely that it would decrease upto thirty per cent in central and south Asia by 2050, because the conditions that we project in these parts of Asia are going to be very different over a period of time. In India we know that wheat yields could decrease by five to ten per cent per one degree rise in temperature and that is pretty serious.

Impacts on water resources

Glacier melt projected to increase flooding, rock avalanches and to affect water resources within the next 2 to 3 decades

Salinity of groundwater especially along the coast, due to increases in sea level and over-exploitation

In India, gross per capita water availability will decline from 1820 m^3/yr in 2001 to **1140 m^3/yr** in 2050

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There would be serious impacts on water resources. Glacier melt I have already talked about. Salinity of ground water, especially along the coast due to increases in sea level and over exploitation, will increase.

Impacts on coastal areas

Coastal erosion and inundation of coastal lowland as sea level continues to rise, flooding the homes of millions of people living in low lying areas

In India, 1 m sea-level rise would include inundation of **5,763 km^2** (Gujarat, Maharashtra, West Bengal amongst vulnerable states)

Significant losses of coastal ecosystems, affecting the aquaculture industry

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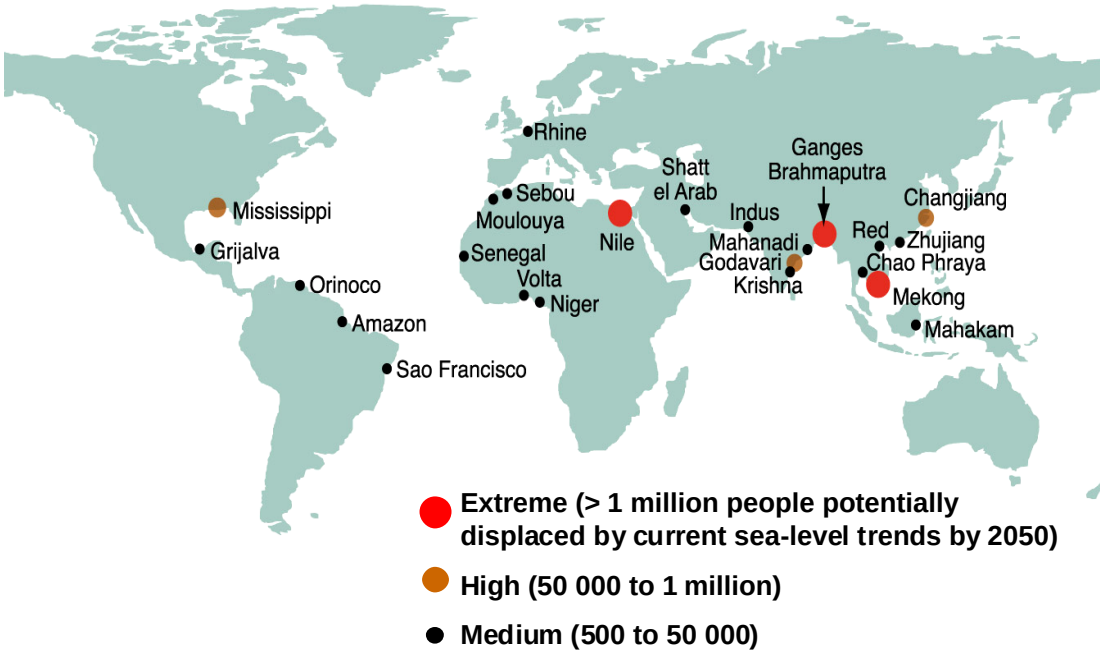
Vulnerability of coastal deltas



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If you look at the small island states they are facing a very difficult future. Because typically in these island states there is something what you might call a water lens, which means a very small quantity of clean drinkable water in a small area within the centre of the islands. But with sea level rise there would be much greater intrusion of sea water and therefore salinity. Our projection is that by the end of this century each of these island states will get water only by desalination for human consumption. Now, that is a pretty serious state of affairs. In India as far as water availability per capita is concerned we are likely to see a decline to about two thirds of what we had, let's say at the start of the century. This clearly means that one form of adaptation that we must ensure is to manage our water resources much more efficiently. Over eighty per cent of our water is actually used in the agricultural sector so we need to bring about major changes over there and certainly some rational form of pricing by which people realize the value of water as a scarce resource.

Impacts on development

Without appropriate measures, climate change will likely exacerbate the **poverty** situation and continue to slow down **economic growth**

- Reductions in **agricultural productivity** could especially dampen economic growth

Climate change adds to the list of stressors that challenge our ability to achieve the ecologic, economic and social objectives that define **sustainable development**

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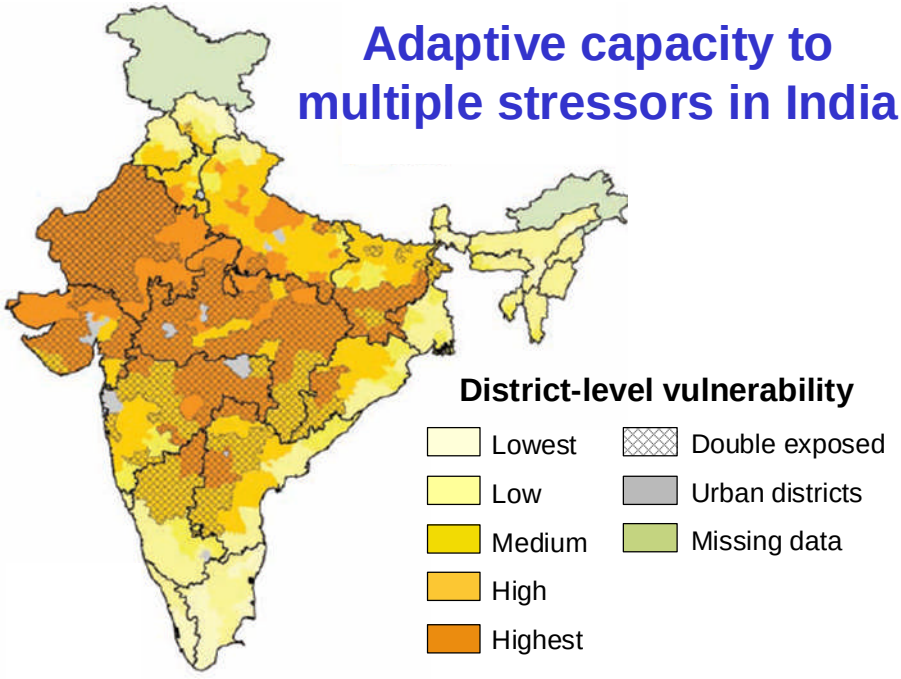
Impacts on Development – without appropriate measures, climate change as you can see, with all these impacts, would exacerbate poverty. Because the worst affected will be the poorest, in any part of the world. Not just in poor countries, but also in rich countries. If one could give you the example of hurricane Katrina, which hit Louisiana, and particularly the city of New Orleans, the people who suffered the worst impact of this particular occurrence were the poorest of the poor. They were left behind and several of them actually died. This time around we had these two recent hurricanes – Ike and Gustav – and fortunately this time the government rose to the occasion and was able to evacuate a very large number of people from the areas that were to be affected and that certainly saved them.

The reductions in agricultural productivity would be particularly bad for economic growth and in this country like in many other poor countries in the world we have a large number of farmers who are dependent on rain-fed agriculture. With changes in rainfall and, let's say, a decline in productivity the fate of these marginal farmers would get much worse.

Climate change, therefore, adds to the list of stresses that challenge our ability to achieve the ecological, economic and social objectives that define sustainable development. Because sustainable development essentially requires protection of all the natural resources around it,

it also requires attention to the disparity in incomes, because clearly in a society where you have very large disparities, you do not have a sustainable situation at all. So the poor, if I can revert to the example of this increase in food prices that has taken place in recent months, it has really wiped out almost a decade or more of the achievements that we had in wiping out poverty earlier on. So people have actually been sliding back as a result.

What are the adaptation challenges that we have in India?



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Well, firstly, we have carried out in my institute (TERI) a very detailed exercise to look at the impacts of multiple stresses. One of them, of course, is certainly globalization. For some farmers it is a stress, because now they have to compete with imports of food. All of which may be very good overall, but there is a period of adjustment that is involved. I remember in 2002 when the World Summit on Sustainable Development was held in Johannesburg, there was a major protest by African farmers, who burnt huge quantities of sugar which were imported from the European Union. Their contention was that with susidised prices in Europe "we as farmers in Africa can't possibly compete with these imports". So, there is a whole range of stresses that exist as far as farming activity is concerned in a country like India. On top of that if you look at the impacts of climate change that adds another stress. What we have been able to do with a very robust climate model is to map out for different sub-regions of the country the extent of vulnerability that exists.

Now may I submit that this kind of exercise is critical for every state in this country. If you take a state like Maharashtra you have a wide variety of eco-systems and agro-climatic regions. It is absolutely essential for us to understand what is going to happen to the fate of farmers in different parts of this state. If we know that ahead of time, then perhaps we take some adaptive measures, which would help them and help the state as a whole. I must say, I have been trying to promote this with several state chief ministers. We are doing a major project for West Bengal, because I was deeply impressed with a fifteen minute discussion

with the Chief Minister, he realised the importance of understanding the impacts of climate change in his state. We are doing this exercise; in fact we did not even get fully funded for it, but we said that it was a responsibility that we should carry out and we are doing it. We have talked to other chief ministers; I have been in a dialogue with the Chief Minister of Maharashtra and I hope at some stage this state will also carry out this kind of exercise. Because I think when it comes to adaptation the response has to be local, unlike mitigation, which I will talk about in a little while. This gives you the wide variation that exists throughout the country in terms of vulnerability of the local population in each place.

Main constraints to adaptation

Insufficient information and knowledge on the impacts of climate change

Lack of co-ordination in the formulation of responses

Poverty (identified as the largest barrier to developing the capacity to cope and adapt)

- The poor have a very low adaptive capacity due to their limited access to information and technology
- The adaptive capacity of poor subsistence farming/herding communities is particularly low
- Rapid population growth, urbanisation and weak land-use planning often drive poor people to high-risk areas

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The main constraints to adaptation, of course, are insufficient information and knowledge. In 2003 when there was this terrible heatwave in Andhra Pradesh, unfortunately people had no warning at all. They did not even know that they are to carry out oral re-hydration therapy if they are hit by heat stress. Several of them continued to get exposed to very high temperatures and that is why there was such a large loss of life. There was also a lack of coordination in the formulation of responses and poverty, of course, is a major barrier in developing their capacity to cope and adapt. The poor have very low adaptive capacity, we know that and the adaptive capacity of poor subsisting on farming and herding as communities is particularly low. They are by far the most unfortunate in this regard. The rapid population growth, urbanization and weak land use planning often drive poor people to high risk areas. Because, where else can they go?

I suppose one reason why the Norwegian Nobel Committee gave the IPCC and Mr. Al Gore the Peace Prize 2007 was because they realised the possibility, in fact the high probability, of conflict as a result of the impacts of climate change. Because when you have large communities not getting enough water even to keep body and soul together, they would obviously move to other locations and there would be conflict. Similarly in the case of

malnutrition and hunger. But, what is perhaps even more dangerous is the movement of people in low lying areas.

I would not like to make this as a categorical statement, but the fact that we have such a large number of people coming across the international border from Bangladesh to India is largely the result of these frequent disasters that take place and with a higher sea level these disasters are certainly much more severe than would have been the case otherwise. If something really bad was to take place in terms of inundation of low lying areas in our neighbourhood we certainly would have a very serious problem on our hands.

The estimate is that if sea level rise is not checked through mitigation measures and the earth's climate is not stabilised, then we will have hundreds of millions of environmental refugees all over the world.

What are the key adaptation strategies?

Key adaptation strategies

Developing **knowledge** on impacts and vulnerabilities

Integrating adaptation in wider policies
(Ex. Integrated Coastal Zone Management, urban planning)

Improving **disaster preparedness** and management

Improving **health care** systems

Promoting **good governance** including responsible decision making and communities empowerment

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You need knowledge to begin with; you have to understand the impacts as I tried to explain through a detailed modeling exercise. We integrate adaptation with wider policies, in other words it has to become part of development plans. We improve disaster preparedness. We improve health care systems, because health would be affected in the event of some of these impacts and these extreme events and certainly last but not least, good governance because a community has to be resilient, it has to be unified, it has to work together in a coordinated manner and for that you certainly need good governance.

The role and limits of adaptation?

Role and limits of adaptation

Societies have a **long record** of adapting to the impacts of weather and climate

- But climate change poses **new risks** that will require new investments in adaptive responses

Adaptation is **necessary** to address impacts resulting from the warming which is already unavoidable due to past emissions

- **But adaptation alone is not expected to cope with all the projected effects of climate change**

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Societies historically have a long record of adapting to the impacts of weather and climate. Because there have been changes in weather and climate throughout history. But climate change certainly poses new risks which will require investments in new adaptive responses. The adaptation is necessary to address impacts resulting from warming, which is already unavoidable due to past emissions. May I clarify that even if we were to stabilize the earth's atmosphere at levels that we have today, the inertia in the system will give us impacts of climate change for the next two to three decades and perhaps even longer. That means we have to adapt in any case. But we know that adaptation alone is not enough, because we need to make sure that we have to mitigate the emissions of greenhouse gases. Otherwise you would have runaway climate change which will have disastrous impacts. There is, therefore, an urgent need for mitigation and sustainable development.

Stabilisation scenarios

Global mean temp. increase (ºC)	Stabilization level (ppm CO_2-eq)	Year CO_2 needs to peak
2.0 – 2.4	445 – 490	2000 – 2015
2.4 – 2.8	490 – 535	2000 – 2020
2.8 – 3.2	535 – 590	2010 – 2030
3.2 – 4.0	590 – 710	2020 – 2060

IPCC

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The IPCC has assessed several scenarios for limiting the emissions of greenhouse gases. Let's say if we were to limit temperature increase to 2 to 2.4 degrees Celsius in the future, then we would have to stabilize the concentration of these gases at the figures that are indicated in the first row. If we were to do that, we have a very short window of opportunity.

We will have to make sure that global emissions peak no later than 2015 and start declining thereafter. That is a daunting challenge. This is what leaders and people everywhere in the world need to understand. We cannot possibly accept complacency.

Mitigation targets

Under most equity interpretations and for a stabilization target of 450ppm CO_2-eq, **developed countries** need to significantly reduce their emissions below 1990 levels:

- 25-40% by 2020
- 80-95% by 2050

Developing country emissions need to deviate below their projected baseline within the next few decades

- This requires urgent action in order to avoid lock-in of carbon-intensive technologies and patterns

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May I also distinguish between adaptation and mitigation. Adaptation is something that you do locally. Because it hits people on a local basis and we have to be prepared for that. But mitigation will work only if we do it at a global level, because these gases mix freely in the atmosphere. The only way you can make a dent on the problem is by mitigating on a global basis. What would be required? Under most equity interpretations and for a stabilization target of around 450 parts per million (ppm) of CO_2 equivalent, which is what will give us the limit that temperatures increase to about two degrees Celsius, we need a cut of 25 to 40 per cent by the developed countries by 2020 and 80 – 95 per cent by 2050. That is something that will take an effort. Unfortunately one doesn't find signs of an adequate effort at this point of time. We also know that developing country emissions will need to deviate below the projected base line. And for our own good, we certainly should not follow the path of development that has been pursued by the developed world.

Gandhi was once asked if he expected India to attain the same standard of living as Britain. He replied:

It took Britain half the resources of the planet to achieve this prosperity. How many planets will a country like India require!

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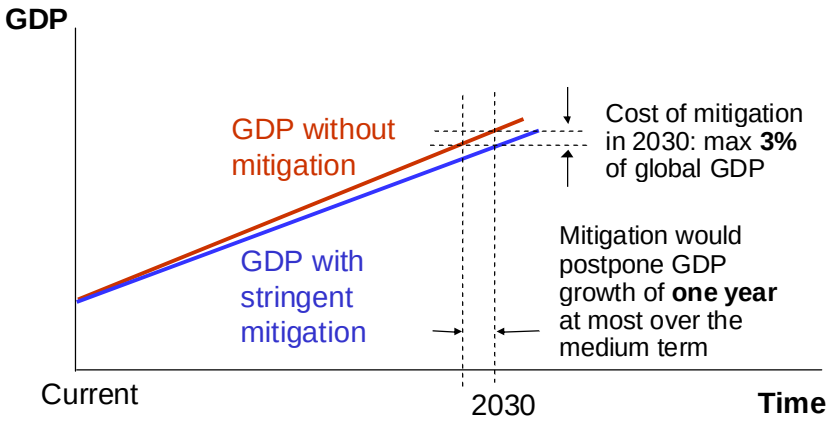
In this respect, Gandhiji, whose wisdom preceded that of the human race by several decades, was once asked whether he would want India to be as prosperous as Britain. His response was that it took Britain to use half the resources of this planet, how many planets would India require?

If we see, for instance, proliferation of cars and ownership and usage at the same rate as, say, North America, we really will run out of space. I know Mr. Anand Mahindra will be very unhappy with me for making this statement. But you make good cars, so that is alright. What I am saying is that we need to invest in public transport. The love affair that the human race has with the automobile is something that you cannot change. But what we can bring about some change in is the availability of public transport. Then, people will have choices. Therefore, you would, perhaps, not have to use cars to the extent that you find we are having to do right now, purely because we have no choices. Overall, we in the developing world have to pursue a path of sustainable development, because anything else would be extremely harmful, will possibly even lead to social tensions that we cannot afford.

Impacts of mitigation on GDP growth



Schematic graph IPCC

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The cost of mitigation is not very high at all. If you look at GDP without mitigation, let's say if it was taking place smoothly and steadily, it would give you this kind of a picture. If you carry out stringent mitigation then the GDP line just rotates a little bit below that and by 2030, we would see that this is the difference you would get in GDP, which amounts to less than 3 per cent of the global GDP in 2030. What does that mean? What this implies is that the level of prosperity that the world would have reached in 2030 without mitigation would at best be postponed by a few months or a year at the most if you carried out mitigation. That is clearly not a very high price to pay.

Also, because there are huge co-benefits of mitigation.

Co-benefits of mitigation

Common drivers lie behind mitigation policies and policies addressing economic development, poverty, health, employment, energy security, and local environmental protection

Linking policies provide the opportunity for no-regrets policies reducing greenhouse gases mitigation costs

- CO_2 mitigation potential for 2010 without net cost in India: between 13 and 23% of business as usual scenario

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Because there are common drivers that lie behind mitigation policies and policies that address economic development, poverty, health, employment, etc. In very concrete terms, let's say, if we were to reduce emissions of greenhouse gases, we would also concurrently be reducing pollutants that are causing problems at the local level. So you would get a lower level of local pollution and therefore health benefits associated with that. You would also get a high level of energy security. Because today we know that the energy supply situation is clearly reaching a level where security could be threatened and even more, if let's say, we were to use decentralized forms of energy production in rural areas of this country and other parts of the world we would be able to generate employment at an unprecedented level.

All those co-benefits if you were to estimate them and add them to the cost of mitigation you might even end up with a negative cost. In the case of India the CO_2 mitigation potential by 2010 without net cost to India would be between 13 and 23 per cent of business as usual. In other words you can use the American expression that these are dollar bills lying on the side-walk. The reason why we do not bring about mitigation over here is because of distortions of various kinds, institutional distortions and distortions in pricing.

A good case in point is kerosene. If kerosene was not subsidized, then clearly it would not be used for adulteration which currently is anywhere from 40 to 50 per cent of the total quantity. So to that extent the consumption of kerosene would go down. But, yes, there would be corresponding increase in the consumption of diesel and other products that are adulterated by adding kerosene. If we had rational pricing, certainly you see signs of that in Europe, Europe has been very proactive in adding taxes to petroleum products. Of course, all of this will work if you invest in public transport as well.

Energy prospects in India

70% of electricity output from coal

70% of crude-oil requirements imported

Under-recoveries for kerosene subsidies projected at **Rs. 62,283 crores** at $125/barrel for oil

3.6% of expected average annual increase in energy demand in 2005-2030

$1.7 trillion worth expected investment needs in energy infrastructure in 2006-2030

Source: IEA, World Energy Outlook 2007 IPCC

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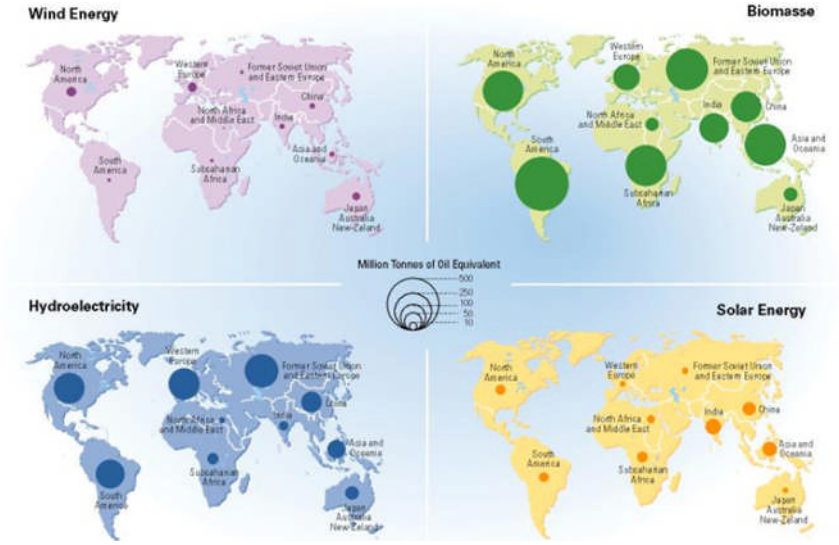
If you look at the energy prospects in India, because that really is the sector in which we have to make major interventions, seventy per cent of our electricity comes from coal, seventy per cent of our crude oil requirements are imported. Under-recoveries of kerosene, if we take 125 US dollars per barrel of oil as the prevailing global price, this would amount to Rs.62,000 crores in this particular year itself and 3.6 per cent of the expected average annual increase in

energy demand would be accounted for by kerosene. We also know that if we use energy efficiently the kind of investments that we would have to make in the energy sector would be reduced substantially, which otherwise would be $1.7 trillion during the period 2006-2030.

World potential renewable energy



Thanks to its location and geography, India enjoys abundant potential to all of the renewable energies

Source: Global Energy Network Institute, 2006 IPCC

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There is enormous scope for using renewable energy and I only want to mention that if you look at our prospects we are extremely well endowed with renewable energy, because thanks to its location and geography India enjoys abundant potential for using all these forms of renewable energy.

I am very happy to say that the Government of India and the Prime Minister in particular, have released the National Action Plan on Climate Change where there is a major emphasis on promoting solar energy and, of course, also improving energy efficiency across the board.

Development challenges in India

Promoting **equity** in spreading the benefits that will arise from economic growth

- 42% of Indians estimated to be below the poverty line in 2005*

Implementing appropriate regulatory intervention to ensure **adequate food supply** in the context of increasing value of land

Finding **new development pathways** wherein GHG emissions and the use of natural resources are minimised

*Source: World Bank, 2008

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For our own good we have to move in that direction because otherwise we would really be staying on the path of unsustainable supply and consumption of energy. We also need to ensure promoting equity and spreading the benefits that will arise from economic growth. Today we know that a large number of Indians are below the poverty line; there are different estimates and you can come up with a range.

National Action Plan on Climate Change

Establishment of **National missions** for:

- Solar Energy
- Enhanced Energy Efficiency
- Sustainable Habitat
- Water
- Sustaining the Himalayan Ecosystem
- Green India
- Sustainable Agriculture
- Strategic Knowledge for Climate Change

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Implementing appropriate regulatory interventions would ensure adequate food supply in the context of increasing value of land. Also, may I say that if we were to globally reduce emissions of greenhouse gases it would also help the food security situation because we will

not see the same decline in the yields of several crops. We, therefore, have to find new development pathways. This National Action Plan on Climate Change which I mentioned consists of national missions which have been identified, solar energy is one of them, enhanced energy efficiency, sustainable habitat and this would be in buildings, the whole structure of urban locations and in buildings you can bring about an enormous reduction in energy.

My institute (TERI) has been at the forefront of this movement. One of our training complexes uses no power from the grid. That is because the design itself has reduced the demand for energy to about one-third of what a conventional building would require. That one-third is met by a solar photovoltaic built into the structure of the building and bio-mass gasification for power generation and even more interesting, we create space comfort in the living spaces inside by using something called an "earth air tunnel". If you go four meters below the surface of the earth, the temperature is literally uniform throughout the year. So what we have designed is a set of four tunnels of certain dimensions, through which air is blown and the only energy used is for a blower, which incidentally is provided by renewable energy and that air picks up heat or discharges heat depending on the season and gives you cooling in the summer and heating in the winter in the spaces inside. These are things that we knew existed with our old buildings and ancient monuments, but we have forgotten all that and we need to rediscover that.

Water is going to be a problem, so that is going to be one mission. Sustaining the Himalayan eco-system, which is threatened. Green India essentially refers to afforestation. Sustainable agriculture, because agriculture will be impacted by climate change and strategic knowledge on climate change, which means creating awareness throughout the country and perhaps even globally.

Lighting a Billion Lives Campaign

We have launched something called "Lighting a Billion Lives". This is a campaign, which essentially addresses the reality that 1.6 billion people lack access to electricity globally. And 25 per cent, that is 400 million, live in India. We have developed solar lanterns and solar torches using photovoltaic technology and these if even a portion of the subsidy on kerosene could be diverted to these particular devices we would be able light up all the unlit homes in this country in a very short period of time.

1.6 billion people lack access to electricity
25% live in India

We commit to enable a billion lives to access
light from solar technologies

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Gobindarampur:
a village benefiting from the campaign

Bani and her friends run and
maintain the charging station

Solar lanterns have helped
families in their daily activities

Solar lanterns are used in livelihood
activities such as betel leaf cultivation,
coaching centres, and shops

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Solar lantern

Each solar lantern:

- Saves about 40-60 litres of kerosene per year
- Mitigates 145 kg CO_2 emissions per year

Alternately:

- Saves about 182.5 kWhr of electricity per year
- Mitigates 157 kg CO2 emissions per year

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The only purpose of my bringing this to the attention of this august audience is to emphasise the fact that we need to think out of the box. We do not have to repeat and pursue the same things that have been done in the developed world. We are endowed differently; our socio-economic conditions are very different. Therefore, if we use ingenuity there is no reason why we cannot meet the needs of all our people and why we cannot wipe out poverty if we did things the right way. If we really made the best use of technology and employed it for the benefit of people clearly keeping in mind the environmental implications then not only would we be able to provide a direction which will take us to world sustainability, but we would also be able to meet the climate change challenge.

Thank you very much.