Global Warming & Climate Change

Science of Climate Change

Greenhouse Gases

During the last decade, two important events occurred which have had far-reaching consequences for life on our planet. These events are the appearance of ozone hole over Antarctica and compelling scientific evidence of global warming leading to climate change. The ozone layer acts as a shield to the harmful ultraviolet-B (UV-B) radiation (280-320 nanometre wavelength). This helped in the evolution of life on earth. Depletion of the ozone layer increases the earth's exposure to UV-B. This may cause serious damage to health, for example, skin cancer, cataract and blindness; lower agricultural yields, forests die-back, loss of biodiversity, and adverse effects on aquatic life and materials.

Increased emissions of greenhouse gases (GHGs) have induced global warming which causes climate change, shifts rainfall distribution and hydrologic regimes, affects agriculture, human health and habitat, causes sea level rise, inundation and has many socio-economic implications. Recent studies have shown conclusive evidence that both the appearance of ozone hole and global warming are caused mainly by human activities resulting in augmented emissions of carbon dioxide, methane, nitrous oxide and chloroflurocarbons.

Greenhouse Effect

Short-wave solar radiation can pass through the clear atmosphere relatively unimpeded. But long-wave radiation emitted by the warm surface of the earth is partially absorbed and then re-emitted by a number of trace gases also known as greenhouse gases (GHGs) in the lower atmosphere. The main natural atmospheric GHGs are water vapour, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_20) and ozone.

The natural greenhouse effect keeps the earth warmer by 33^0C (from minus 18^0C to plus 15^0C) than it would otherwise be, thus making it warm enough to be habitable. For a thousand years prior to the industrial revolution, concentration of the GHGs in the atmosphere was relatively constant. However, as the world's population increased, agriculture developed and with the spread of industry, the abundance of GHGs increased markedly.

Anthropogenic activities that increase the atmospheric concentrations of the GHGs is projected to lead to a rise in the global-average annual-mean surface air temperature and cause global warming. Such human activities include :

- Energy production from fossil fuels
- Industries
- Transport
- Construction
- Agriculture
- Landuse Change and Forestry

Inter Governmental Panel on Climate Change (IPCC), 1990 & 1995

Scientific Assessments on Climate Change , Salient Findings of the IPCC are :

- Emissions resulting from human activities are substantially increasing the atmospheric concentrations of the greenhouse gases : carbon dioxide, methane, chlorofluorocarbons or CFCs and nitrous oxide. These increases will enhance the greenhouse effect, resulting, on average, in an additional warming of the earth's surface.
- An increase in the global mean surface air temperature by 1^0 to 3.5^0C, with a mid-range value of 2^0C relative to 1990 and with a rate of increase of 0.2^0C per decade or 0.02^0C per year by 2100. In all cases the average

rate of warming would probably be greater than any seen in the last 10,000 years.

- Regional climate changes differ from the global mean.
- Predicted sea level rise due to climate change will lie between 15 cm and 95 cm with the best estimate of 50 cm from the present to 2100.
- Sea level would continue to rise at a similar rate in future centuries beyond 21,00, even if concentrations of GHGs were stabilized by that time. Regional sea level changes may differ from the global mean value owing to land movement and ocean current changes.

In all these projections the direct and indirect effects of anthropogenic aerosols like SO_2 from burning of coal have an important effect (cooling effect).

United Nations Framework Convention on Climate Change (UNFCCC)

During June 1992 Earth Summit at Rio de Janeiro, representatives of 154 countries signed the UN Framework Convention on Climate Change (UNFCCC). They recognized climate change as a common concern of humankind, and pledged to forge a global strategy to protect the climate system for the present and future generation.

The Convention provides a 'framework' within which Governments can work together to carry out new policies and programmes that will have broad implications for the way people live and work.

The Convention emphasizes that developed countries are mainly responsible for historic and current emissions and ought to take the lead in combating climate change.

Objectives of the FCCC

(1) To achieve stabilization of GHG concentration in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow the ecosystem to adapt naturally to climate change.

(2) To ensure that food production is not threatened and to enable **economic development to proceed in a sustainable manner**.

(3) By becoming Parties to the Convention, both developed and developing countries accept a number of commitments. These include:

- submitting for review information about the quantities of GHGs they emit, by source, and their natural sinks (processes and activities that remove GHGs from the atmosphere, notably forests and oceans).
- carrying out national programmes for mitigating climate change and adapting to its effects.
- strengthening scientific and technical research and systematic observation related to climate system, and promoting the development and diffusion of relevant technologies.
- promoting education programmes and public awareness about climate change and its likely effects.

Developed country Parties accepted a number of additional commitments specific only to themselves. Some of the most important are :

Adopting policies designed to limit their greenhouse gas emissions and to protect and enhance their GHG 'sinks' and 'reservoirs', with the aim of returning individually or jointly to their 1990 levels of carbon dioxide and other greenhouse gases not controlled by the Montreal Protocol. These developed country Parties may implement such policies and measures jointly with other Parties and may assist other Parties in contributing to the achievement of the objective of the convention.

They were also required to submit detailed information on their progress. The Conference of the Parties (CoP) would review the overall implementation and adequacy of this commitment in the CoP-1 by taking into account the best available scientific information and assessments on climate change and its impacts, as well as relevant technical, social and economic information.

- Transferring to developing countries financial and technological resources above and beyond what is already available through existing development assistance, and supporting efforts by these countries to fulfill their commitments under the Convention.
- Helping developing countries that are particularly vulnerable to the adverse effects of climate change to meet the costs of adaptation.

First Conference of the Parties and AIJ

The first Conference of the Parties (CoP-1), convened pursuant to Article 7.4 of the UNFCCC, was held at the International Congress Centre, Berlin, 28 March to 9 April 1995.

CoP-1 recognized that **climate protection was one of the most important challenges to environment policy today and would continue to be so in the future**. Radical changes were needed in patterns of behavior, consumption and production and in lifestyles, and **those were as much a part of the quest for sustainable development as innovation and technological development**. The spirit of international cooperation and global partnership was essential to achieve effective and sustainable progress towards meeting the Convention's objectives. Professor Klaus Topfer, Chairman of the UN Commission on Sustainable Development, said that sustainability was the essence of the global environment strategy adopted at Rio in 1992 and that promoting economic growth at the expense of the environment was as serious a threat to world peace as political and military conflicts.

The CoP-1 established Activities Implemented Jointly (AIJ) as a pilot phase activity to bring developed and developing countries priorities together.

In terms of environmental protection the world is moving towards a situation in which different countries have different environmental preferences. Developing Countries preferences are in the field of socio-economic development and domestic environmental problems whereas developed countries main environmental problem is their present life-style leading to high emission of GHGs with adverse consequences globally. The developed countries need cooperation with other countries in the world for reduction of the emissions of GHGs to stabilize their concentrations in the atmosphere.

So, what is needed now are instruments and concepts that can bring these different priorities together.

The Kyoto Protocol to the Convention on Climate Change

The commitment made by the industrialized countries in the Convention to bring down their greenhouse gases emissions to 1990 levels by 2000 was considered inadequate for meeting the objective of the Convention (viz.; stabilization of the atmospheric concentration of greenhouse gases at a level that would prevent dangerous human interference with the Climate System).

In the third Conference of the Parties (Parties here refers to countries who have signed and ratified the UNFCCC) or popularly referred to as CoP-3 held in Kyoto, Japan during November - December 1997, the industrialized countries accepted quantified emission limitation and reduction commitment (QELRC) and on an aggregate to bring down their emissions by 5.2 per cent from their 1990 levels during their first commitment period 2008 - 2012. The Protocol also established three flexible mechanisms as a supplemental means of fulfilling their commitment in a cost effective manner, and introduced the concept of trade in carbon between nations.

India's greenhouse gas emissions

Though per capita emission of CO_2 as carbon in India is still low only 0.21 metric tonne per head per year against United States per capita CO_2 emissions of more than 5 metric tonnes per head per year. As India is trying to build up its economy to eradicate poverty and to provide basic facilities of life to the people, India's greenhouse gas emissions is bound to rise - using the present day technologies. Figure 1 depicts the contribution of the greenhouse

gases to the total increase in Climate forcing during the 1980s. Figures 2 and 3 depict total and per capita emissions of some the developed and developing countries. Figures 4 and 5 depict CO_2 emissions from India fuel wise over the years.

Impacts of Climate Change and Global Warming

The projected temperature rise due to human induced greenhouse gases (1^0 to 3.5^0C) by 2100 will have considerable adverse impacts on natural ecosystems as well as on agriculture, water resources, human habitat with possibility of sea level rise (SLR). Indian agriculture is highly dependent on monsoon rainfall and its distribution over India. On many occasions in the past, when India faced droughts on continental scale, it caused loss of agricultural food production, human lives and cattle and migration of people from one part to another. Similarly adverse impacts on rainfall and distribution over India (both as snow and rain) will cause adverse impact on water resources and its management. Global warming due to thermal expansion of sea water as well as melting of land glacier will result in sea level rise inundating vast coastal areas (India has about 7000 km coastline as well as islands). This will result in loss of fragile ecosystems like mangroves, as well as the wet lands and will have adverse impacts on the coastal economy and on fisheries and other aquatic life, which provide livelihoods to the coastal people.

About 60 per cent of the CO_2 emission is from burning of fossil fuels (coal, gas and petroleum product). For addressing to these issues of our country has to formulate policies to abate Climate Change. We would need transfer of clean technologies and additional funds (in additional to normal ODA flows) for replacing the highly polluting technologies by clean technologies as well as policies to recycle industrial wastes, improvement in energy efficiency and better management through institutional design and capacity building, both at the village, district, state and national levels.

Though country like India has no commitment under the Climate Change Convention and Kyoto Protocol for reduction of greenhouse gas emissions but yet India has initiated various programmes on alternate energy sources (wind energy, solar energy, tidal energy, biomass energy etc.) as well as improvement in the distribution and generation of electricity and in effecting better energy efficiency in other economic sectors. India's prime objective at this moment is rapid economic growth and development to address to the agenda of poverty alleviation and providing basic facilities of life, like clean water supply, primary health facilities, education to children and women and providing sustainable livelihoods to its millions. India has initiated various technological and policy measures to address to our main agenda which directly or indirectly also address to Climate Change.

The Global Climate Change can only be addressed by global action through the cooperation of all the nations and particularly by those who are mainly responsible for historical as well as very high current emissions of the greenhouse gases (industrialized countries or Annex 1 countries). Since the adverse impacts of Climate Change can be substantially reduced or minimized by carefully designing policy actions and measures, each country should initiate research in the areas of Climate Change and Global Warming to integrate such findings in country's developmental and environmental plans and strategies to minimize the impacts of Climate Change.