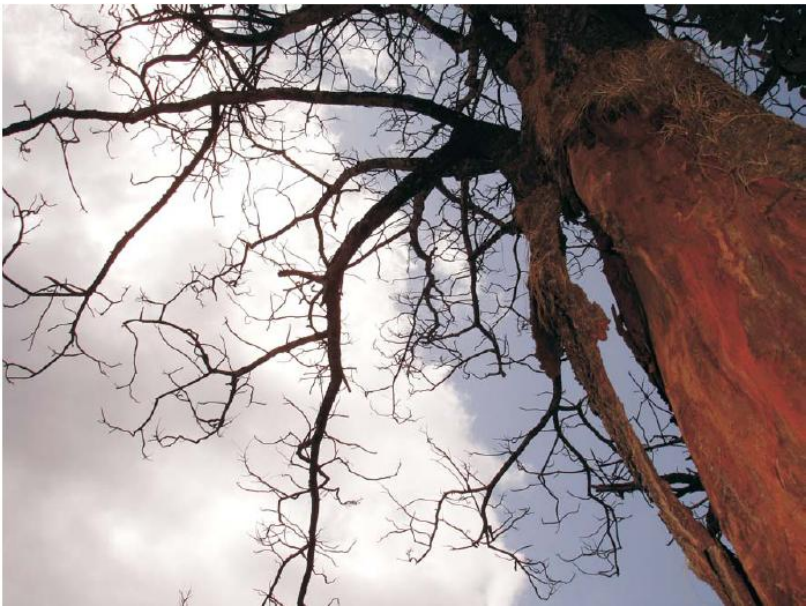


I

Basics of Climate Change

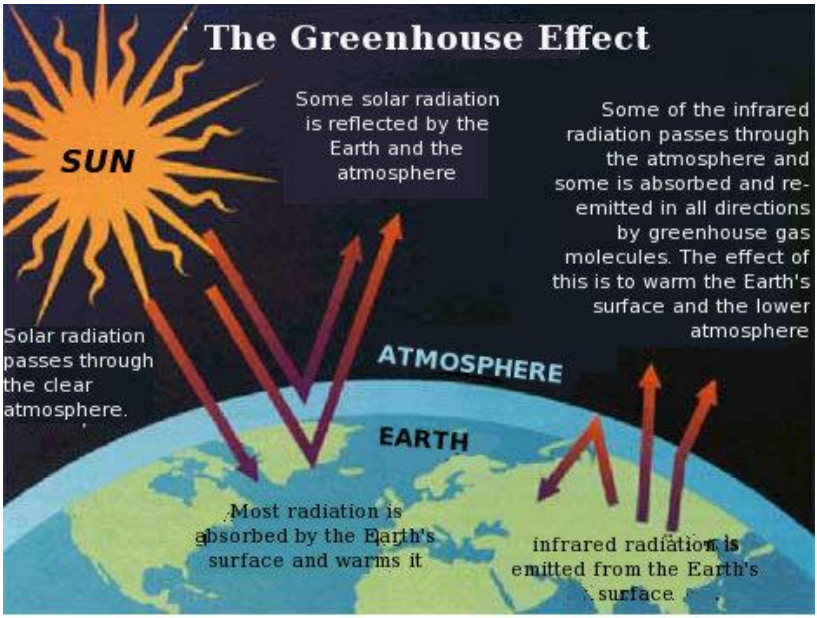
What is Climate Change ?

Climate Change refers to long term changes in global and regional climates. It is about changes in the climate system as a whole which affect the average pattern and intensity of climate phenomenon. It does not refer to day to day changes in the weather.

These days however whenever we talk about climate change, we are referring to one type of climate change namely Global Warming.

Global Warming

Global Warming refers to climate change where there is an increase in temperature, over and above the normal temperature cycles. It specifically refers to increases in earth temperature caused by the increase in Green House Gases(GHGs) in the atmosphere. This increase is largely due to human activities, particularly after the industrial revolution..



Green House Effect

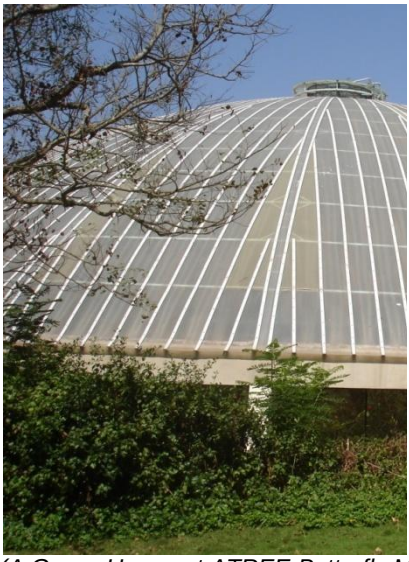
The Sun and the intensity of its light and heat is the most important driver of climate. The heat of the sun which comes to the earth is in the form of short wave energy while the heat that goes back from the earth is in the form of longer wave energy. The energy retained in the earth's atmosphere is dependent on the composition of gases in the atmosphere. Two elements - Nitrogen (N_2) and Oxygen (O_2), make up almost 99% of the volume of clean, dry air in the atmosphere. The other gases make up the remaining one percent. Some of these gases, namely CO_2, CH_4, N_2O etc contribute to the warming of our planet. They are referred to as Greenhouse Gases (GHG).

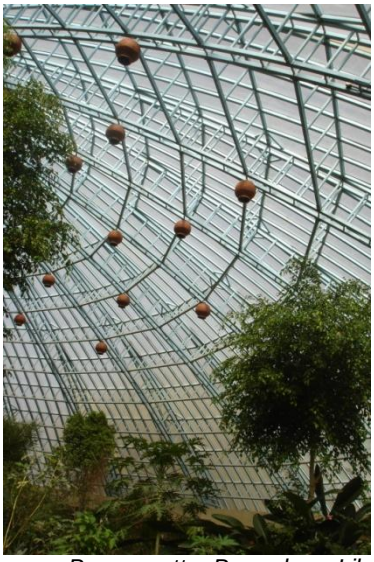
These GHGs act like a giant net around the earth, which allows short wave energy to pass through it, but stops the returning long wave energy. If the amount of these gases in the atmosphere increases, the net is thicker – It allows less heat to escape the earth compared to that which enters the earth. Therefore the earth becomes hotter. Actually, in proper proportions these gases enable the earth to maintain a temperature which supports life, as we know it. If these gases were totally absent in the atmosphere, the earth would have been around 30°C colder (which means ice like temperatures).

Major GHGs are carbon dioxide, methane, nitrous oxide, sulphur hexafluoride), and two groups of gases -hydrofluorocarbons and perfluorocarbons.

All gases do not have the same "netting" or "blocking power". For example methane is 21 times more problematic than CO2.

CFCs, a gas used for refrigeration and air-conditioning is another important GHG. The CFC issue came into prominence when scientists showed how the ozone layer which filtered the UV rays from the Sun, started getting holes. Technology came up with a solution: hyper CFCs, which may be neutral to the ozone layer, but is still a GHG.

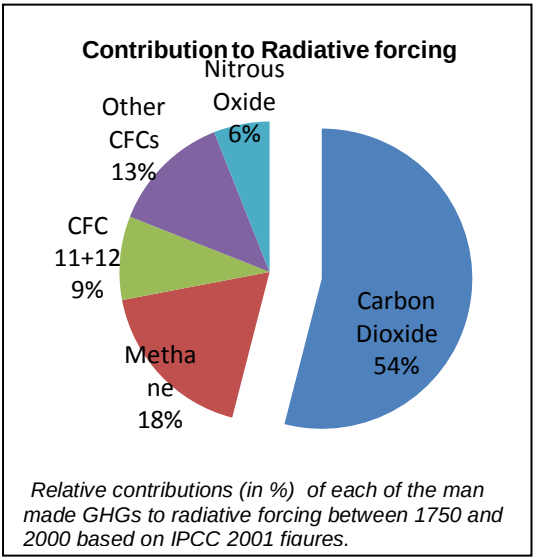




(A Green House at ATREE Butterfly Museum, Bannergatta, Bangalore. Like in all Green Houses, the principle of trapping CO2 is used to increase foliage, and the balance of oxygen is maintained through photosynthesis)

Why Global warming?

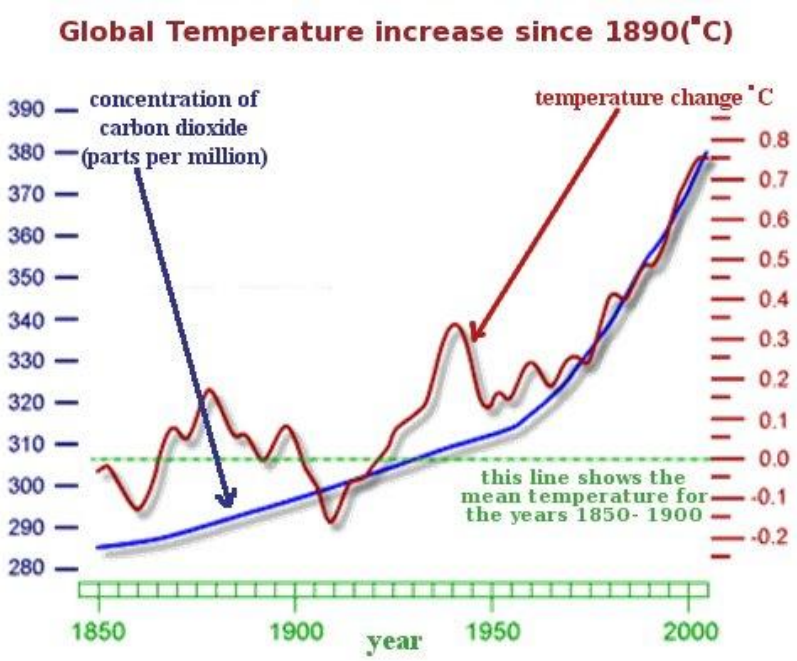
The most important greenhouse gas is water vapour (making up for about 60% of the greenhouse effect). We assume that global water vapour content did not change a lot during the last few centuries. And therefore even though largest in quantity, water vapour is not



Relative contributions (in %) of each of the man made GHGs to radiative forcing between 1750 and 2000 based on IPCC 2001 figures.

considered responsible for the additional warming (radiative forcing) that we experience today.

The concentration of carbon dioxide, the second important greenhouse gas, however, has increased about 30 percent, from a pre-industrial level of about 270 parts per million to a current level of 384 parts per million.



Burning of oil & coal produces CO_2 which is released into the atmosphere. This takes place in all our factories, cars, planes etc. When we use electricity, we don't see the emission of CO_2, but CO_2 is produced in the power plants creating this electricity.

Since 1901, the Earth has warmed over 0.7°C. An average temperature increase of 0.1°C per decade is already underway. This increase in temperature will start a vicious circle of less availability of water, increased water salinity, more soil salination, less cultivable land and less crop productivity,

resulting in increase in concentration of atmospheric CO_2, and in turn further increase in atmospheric temperature. If the consumption of fossil fuels such as coal and oil continues into the next century at projected rates, the carbon dioxide concentrations in the atmosphere would reach the 600-700 parts per million by 2100. The average global temperatures are likely to increase further by 1 to 6.40 ^{o}C by 2100.

Impacts of Climate Change

The latest high resolution modeling of the scenarios of and projections for climate change in India shows that there will be:

- An annual mean surface temperature rise by the end of century, ranging from 3 to 5°C to 2.5 to 4°C, with warming more pronounced in the northern parts of India.
- A 20% rise in all India summer monsoon rainfall and further rise in rainfall is projected over all states except Punjab, Rajasthan and Tamil Nadu, which show a slight decrease.

Climate Change has a chain of impacts on this planet. Jeffrey Sachs of the Earth Institute warns that four types of geographies will share the largest burden of climate change crisis. They are

a) the low-lying coastal settlements,
b) farm regions dependent on river water from glacier and snow melt,
c) sub-humid and arid regions that suffer from drought, and
d) regions of Southeast Asia facing changes in monsoon patterns.

Most of India falls into one of these four zones:

- We have a coastline of over 8118 km and touches eight states and two island territories. It is about 5700 kms. on mainland and about 1800 kms. in the two groups of islands which are most vulnerable
- We have the entire indo-gangetic plains, which rely of the river-waters fed by the himalayan glaciers,

- We have a large arid regions in the deccan plateau, and Rajasthan and finally
- Most of peninsula India is covered by either the south-west or the north east monsoon, and therefore vulnerable to changes in the monsoon patterns.

Extreme weather

Most of the potentially damaging consequences relating to climate change are being associated with extremes - heat waves, floods, or severe storms. Extremes in maximum and minimum temperatures are also expected to increase and similarly extreme precipitation also shows substantial increases, particularly over the west coast of India and west central India.

As a result of global warming; oceans have become warmer, and humidity and water vapor have increased 4% since 1970. This has increased tropical storm activity.

As the planet gets warmer, more evaporation could take place leading to heavy rain and increase in frequency and intensity of floods.

This could have a catastrophic impact at several places especially in countries such as Bangladesh where more than 17 million people live at an elevation of less than 3 ft. above sea level, and millions more inhabit the flat banks of the Ganges and Brahmaputra Rivers.

However evaporation and precipitation occur at different places, and if the planet warms, while wet regions could receive even more rainfall, evaporation may be accelerated in drier regions and they could face acute water shortages. This, in turn, will accelerate desertification and give rise to acute water supply shortages.

Shrinking water resources

Warming accelerates the rate of land surface drying, leaving less water moving in near-surface layers of soil. Less soil moisture leads to reduced downward movement of water and so, less replenishment of groundwater supplies.

Areas in mid-latitudes and mountainous regions depend upon glacial runoff to replenish river systems and groundwater supplies. These areas will become increasingly susceptible to water shortages with time, because increased temperatures will initially result in a rapid rise in glacial melt water during the summer months that will be followed by a decrease in melt as the size of the glacier continues to shrink.

This reduction in glacial runoff water is projected to affect approximately 1/6 of the world's population by the IPCC.

Water quality degradation will be a major cause of water scarcity. Sea-level rise will not only extend areas of salinity, but will also decrease freshwater availability in coastal areas.
Many islands are gradually facing the loss of their fresh water supply due to salt-water intrusion.

Rise in sea-level

At least 300 million people live in low-lying coastal areas and deltas and they are particularly threatened by sea level rise. It could accelerate coastal erosion and force the relocation of communities and infrastructures.

The average sea level rose by 10 to 20 cm during the 20th century, and an additional increase of 18 to 59 cm is expected by the year 2100. Higher temperatures can cause the ocean volume to expand and glaciers to melt thereby causing the water to overflow onto the heavily populated coastlines of countries like Bangladesh and drown islands like Maldives.

Simulation models show an increase in frequencies of tropical cyclones in the Bay of Bengal; particularly intense events are projected during the post-monsoon period. Sea level rise is projected to displace populations in coastal zones, increase flooding in low-lying coastal areas, result in loss of crop yields from inundation and salination.

Ecosystem changes

Ecosystems provide fundamental life-support services. Human civilization depends directly or indirectly on the products of the eco-system such as livestock, fish, wood, clean water as well as ecosystem services like pollination, erosion prevention, re-cycling of nutrients, climate moderation and detoxification of natural substances.

Climate change has the potential to alter ecosystems so as to impact the resources and services they provide to each other and to society. It could benefit certain plant or insect species by increasing their ranges. The resulting impacts on ecosystems and humans, however,

could be positive or negative depending on whether these species were invasive (e.g. weeds or mosquitoes) or if they were valuable to humans (e.g. food crops or pollinating insects). Most of the world's endangered species (some 25 per cent of mammals and 12 per cent of birds) may become extinct over the next few decades.

Forests: -Climate impact assessments for the year 2085 show 77% and 68% of the forested grids in India are likely to experience shift in forest types under A2 and B2 scenario[i] .

Indications show a shift towards wetter forest types in the northeastern region and drier forest types in the northwestern region in the absence of human influence. Increasing atmospheric CO_2 concentration and climate warming could also result in a doubling of net primary productivity under the A2 scenario and nearly 70% increase under the B2 scenario.

Health

Climate change can have both direct and indirect human health impacts. WHO has estimated that the increase of temperature by *10F* in the quarter of the 20th century, was responsible for the annual loss

of about 160,000 lives and the loss of 5.5 million years of healthy life by 2000. The toll is expected to double to about 300,000 lives and 11 million years of healthy life by 2020. The exacerbated air pollution levels, and heat waves directly contribute to deaths from cardiovascular and respiratory diseases, especially among the elderly people.

Vector-borne diseases such as Schistosomiasis, Chagas disease, Sleeping sickness, River blindness, and various strains of encephalitis all could change their ranges and patterns of infection in the course of climate change.

Malaria is likely to persist in many Indian states and new regions may become malaria-prone and the duration of the malaria transmission windows is likely to widen in northern and western states and shorten in southern states.

The impact of climate change on water availability is likely to be one of the most significant for the health of populations. Other indirect health impacts arise from changes in temperature patterns,

which may disturb natural ecosystems and cause large-scale reorganization of plant and animal communities. Rising temperatures, changing patterns of rainfall, and more frequent droughts and floods are projected to decrease crop yields in many developing countries causing shortages of food supplies. This could result in severe malnutrition, especially among children, in countries where large populations depend on rain-fed farming at subsistence level.

Agriculture and food security

Temperature-induced range changes may push populations into new areas for which they are otherwise poorly adapted. It may render local cultures, economies, and infrastructure (that had been uniquely shaped around specific food resources), obsolete. The range, migration habits, and life cycles of pollinators and plants, pests and their prey, and wild food stocks and their predators, will all be affected.

In general agricultural producers will face less stress from extreme cold events and freezes but higher stress from more frequent and more intense heat waves. Such events can damage crops, kill or

stress livestock, and disrupt or destroy both natural resources and necessary infrastructure. Parasites, diseases, fungi and other pests will thrive and spread faster in warmer and more humid climates. Due to sea level rise, agricultural areas, such as low-lying river deltas and brackish estuaries will be increasingly susceptible to saltwater intrusion.

The oceans are absorbing excess amounts of carbon dioxide making the environment acidic which is unsuitable for sea life. Higher concentrations of atmospheric carbon dioxide allow plants to grow faster and larger. Farmers may have to use more herbicides. Due to CO_2, sometimes plants may speed through the growth phase in which they generate their harvestable grains, fruits or vegetable matter. As a result the harvest may be diminished and less nutritious.

The simulation studies based on experimental work, which predict that increase in CO_2 concentration to 550 ppm would increase the yield of rice, wheat, legumes and oil seeds by 10-20 per cent. While 10^oC increase in temperature may reduce the yield of wheat, soybean, mustard, groundnut and potato by 3-10 per cent. Initially, the productivity of most crops will decrease marginally by 2010. However, if the trend of climatic changes continued at the same pace, the losses will be 10-40 per cent by 2100[ii]. (Dr Pathak at Indian Science Congress)

Shelter

Human-induced climate change threatens to create an unmanageable environmental refugee crisis during this century. Most in danger are people in the developing world who have the least ability to adapt to climatic variability. Many scholars and activists working on this issue are pushing for international legal recognition of environmental refugees.

The Intergovernmental Panel on Climate Change (IPCC) estimates that there will be 150 million environmental refugees by 2050. The Institute for Environment and Human Security, affiliated with United Nations University, estimated the number of environmental refugees at 20 million in 2005 and predicted the number could be 50 million as early as 2010.

More Reading

http://climatedigitallibrary.org/
http://climateasiapacific.org/
http://inecc.net

---

[i] These refer to the different scenarios, for which climate models have been developed in order to study climate change in those scenarios. They include:

A1 scenario of very rapid economic growth, a peak in global population by the mid-21st century, rapid development of more efficient technology, with conversions between developed and developing regions. The A1 scenario is further subdivided into fossil-intensive (A1F1), non-fossil energy sources (A1T) or a balance across sources (A1B).

A2 scenario envisages a very heterogeneous world, with preservation of local identities. Economic development is locally focused, resulting in slower development but continuous population increases.

B1 scenario: A convergent world economy, similar to scenario A1, though with a heavy focus on clean and resources-efficient technologies, with an emphasis on global solutions to economic, social and environmental sustainability.

B2 scenario: Again a heterogeneous world similar to A2 though with an emphasis on local solutions to economic development social and environmental sustainability

[ii] Dr H Pathak, Environmental Scientist from the Indian Agricultural Research Institute, New Delhi while delivering the 'Professor S K Mukherjee Commemoration Lecture' at the 98th Indian Science Congress.