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Global Warming-The Parley of The Century

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Abstract- *The IV assessment report of IPCC on global warming (2007) is significant - the award of Nobel Peace Peace Prize for the work of the panel (2007)is likely to set at rest all the controversies in respect of global warming. Global warming is an environmental issue of deep concern all over the word .it is centered around greenhouse gases mainly carbon di oxide .It has the potential to rival nuclear wars in terms of irreversible damage to the environment .The greenhouse gases can be arranged in a sequence in terms of global warming potential (GWP) -CFC >N2O>CH4>CO2.The United Nations is seized with the issue - the various agencies -UNDP ,IPCC, etc. have recommended several measures for curtailment of greenhouse gas emissions.*

Introduction- Carbon dioxide and water vapour in the atmosphere play important roles in changing the earth's surface temperature. The earth absorbs about 66% of all solar flux incident on it (19.5 kcal/m1) while it reflect and scatters back into space about 34% (albedo) of the solar flux. Energy transport plays a crucial role in earth's radiation balance. This proceeds through the mechanisms of (a) radiation of energy in the IR region from the earth, (b) conduction of energy through the interaction of atoms or molecules and (c) convection of energy through massive air circulation. The latter two mechanisms are responsible for loss of heat from the earth's surface through transport to clouds and consequent radiation from the clouds.

Greenhouse effect- Among the constituents of the atmosphere, both water vapour and carbon dioxide strongly absorb outgoing IR radiation from the earth's surface in the regions 40008000 nm and 1400018000 nm respectively. The radiation thus absorbed by H2O vapour and CO2 is partly reemitted or transferred to the earth's surface. the net result is that the earth's surface gets heated up by a phenomenon called the Greenhouse effect.

The average surface temperature of the earth is maintained at 15 0C varying from 0 0C in arctic zone to more than 25 0C in the tropical zone.

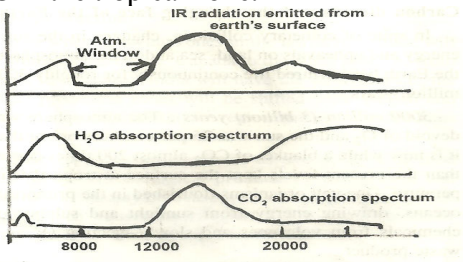

Fig. 1. Absorption of terrestrial radiation by H_2O vapour and CO_2.

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Carbon dioxide- Without CO2, the earth would have been as cold as the moon whereas with excessive CO2, the earth will be lifeless as the neighbouring planet, Venus with surface temperature of 450 0C. The concentration of CO2 has increased from 283 ppm in 1880 (pre-Industrial Revolution period) to 379 ppm at Present. However, it constitutes a fraction of the atmospheric gases, 0.03 per cent of the total but plays a big role in changing the global climate. By trapping the heat radiating from the earth's surface, CO2 regulates global temperature to life-sustaining 15 ^{0}C.

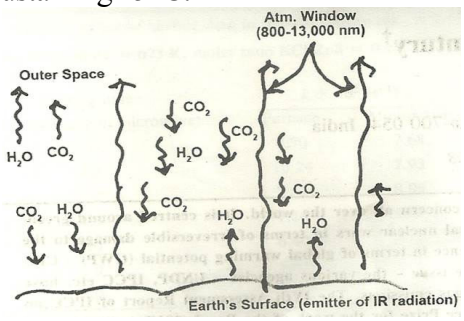

Fig 2.The Green house effect

Carbon dioxide and the changing face of the Earth- 3000 million (3 billion years : The atmosphere was devoid of O2 and the sun was 25 per cent less bright than it is now while a blanket of CO2 almost 200 times denser than the present levels kept the surface at tropical denser than the present levels kept the surface at tropical temperature. One-cell organisms flourished in the primordial oceans, drawing energy from sunlight and sulphurous chemicals from volcanoes and slowly enacting O2 as a waste product.

100 million years ago : The Earth was a hot house, 3-6 oC warmer than today. CO2 level was 4-10 times higher than today. There were no icecaps at the poles and dinosaurs wandered as far north as Greenland. The giant landmass (super continent) broke up into smaller continents opening up volcanoes and sea vents that filled air with CO2 intensifying the Greenhouse effect.

18000 years ago (Ice age) : Much of the Earth was covered by glaciers whose cycles of growing and receding seem to be initiated by fluctuations in the Earth's orbit and tilt. The Earth was about 3 0C cooler than today's and CO2 was about 60 per cent of modern level.

In a cycle that takes millions of years, carbon is shifted through a series of elaborate feedback loops to oppose force of change that may arise on the planet. Thus an increase of CO2 in the atmosphere from an outburst of volcaic activity or the burning of fossil fuel will start a series of compensating change throughout the cycle, eventually triggering an increase of CO2 uptake by plants from air and by the oceans where it is turned to minerals on the atmosphere, the reverse process sets in. There is less evaporation of sea water and less rainfall and carbon in the mineral rock at the ocean's bottom ultimately makes its way back into atmosphere through volcanoes and sea vents. The climate record based on the studies of ice cores, taken from Greenland and Antrctica suggests that CO2 may serve as a king of global thermostat which resets the Earth's temperature as the CO2 level rises and falls.

Sources and sinks of carbon dioxide-The major sink is the ocean which contains the bulk of dissolved CO2 as bicarbonate which finally reacts with the dissolved minerals and settles at the oceans bottom as bicarbonate minerals.Another important sink is the biomass i.e. living green plants which take up CO2 by photosynthesis. The latter in turn gets accelerated with increase in CO2 level in the atmosphere.

CO2 fertilization flux is an important parameter in balancing CO2 in the atmosphere. An overview of the fluxes of CO2 per year is given :

(a) Emission by fossil fuels - 20 X 109 (billion) tons (+)

(b) Emission by deforestation, mining quarrying and construction activities- 5.5 X 109 tons (+)

(c) Uptake by the oceans- 5.5 X 109 tons (-)

(d) Uptake by biomass-7.3 X 109 tones (-)

Net increase- 11 X 109 tons

The balance sheet shows a net increase of CO2 in the atmosphere of 11 X 109 (is the resultant of exchange fluxes between very large reservoirs viz. the atmosphere (2700 billion tons), biosphere (6600 billion tons) and oceans (136000 billion tons). The major source of CO2 is combustion of fossil fuel. However, this has little effect on the O2 stock of the atmosphere which is relatively large but it has considerable impact on the CO2 content (379 ppm). the rate of increase of CO2 is only about 50% of the expected magnitude due to the removal mechanisms by sinks of CO2.billion) tons per year. It may be noted that CO2 concentration in the atmosphere

Other Greenhouse gases Other greenhouse gases are- methane, chlorofluorocarbon, ozone, nitrous oxide and water vapour. The relative contributions to temperature rise are : CO2, 5%; CH4, 19%; CFC, 17%; O3, 8%; N2O, 4%; H2O, 2%.

The main influence is by CO2 but the contributions of other greenhouse gases, particularly CH4 cannot be neglected. 360 million hectares of rice fields and 1.2 billion cattle discharge CH4.

On a molecule for molecule basis CH4 is 20-30 times more effective than CO2 in trapping heat. The potential of a Greenhouse gas to cause warming is expressed by "Global warming Potential", (GWP) originally defined by United Nations Intergovernmental Panel on climate change (IPCC), which is function of both the IR sorption characteristics and the life time of the gas. The Green house gases can be arranged in GWP sequence :

$$CFC \xrightarrow{1000\ X} N_2O \xrightarrow{150\ X} CH_4 \xrightarrow{25\ X} CO_2$$

In other words, CFC is 38 millions times stronger, N2O 3800 times and CH4 25 times stronger than CO2 in terms of GWP.

Measurement of Global Warming- The scientists in general agree with the theory of greenhouse warming, debate continues as to whether the increase in these greenhouse gases is responsible for warming the global climate at present. They hope to settle the question by measurements of the speed of sound by sending pulses of underwater sound around the world through all five ocean basins. The experiment is conducted by an international team of

scientists from eight nations under the direction of Scripps Institute of Oceanography, California, USA. It is based on the principle that the speed of sound in water (1609 km s-1) depends on the temperature of water - the warmer the water, the faster sound propagates through it.

In the experiment a small ship is anchored near Heard Island, a remote Australian Island in the Southern Indian Ocean. An underwater loudspeaker is lowered to a depth of 250 meters and for nine consecutive days the speaker broadcasts signals of low notes at high volumes. Underwater microphones are installed in Australia (Heard Island), New Zealand, India, South Africa, Antrctica near Bermuda, San Francisco and Canada - five ocean basins are directly connected in this route, 17920 km (Heard Island to San Francisco). With rise in ocean surface temperature, sound will travel faster by about 0.25 seconds each year. This has indeed been confirmed. Hence global warming is not a myth but hard reality.

Impact on Global climate, Agriculture and World map

Even a slight increase, say 1 0C, in surface temperature can adversely affect food production, world map and global climate. The temperature effects of CO2 and H2O vapour are synergic enough to have long range impact on the global climate. As the Earth's surface temperature rises with the increase in CO2 level, the evaporation of surface water increases, thereby raising the temperature further. It about a 3 oC rise in surface temperature for a doubling of CO2 concentration, which is likely to occur around, the end of this century.

Food production- The wheat growing zones in the northern latitude will be shifted from USSR, Canada to the north pole i.e. from fertile to poor soil. India will have the same fate i.e. the wheat producing zones will be shifted from Punjab and Haryana to the Himalayan region (infertile soil) Thus wheat production will decline.

The seas and oceans provide us with about 40% food (sea food). The biological productivity of the seas and oceans will sharply decrease with warming of the surface layer, which reduces the transport of nutrients from deeper layer to the surface by vertical circulation.

World map- Greenland, Antarctica and expansion of the sea water due to warming will cause rise in sea levels by as much as 2 meters. The rise of sea levels will threaten coastal countries - some 60 odd is lands which face deep inroads by the sea such as Maldives, Bangladesh may to under the sea. In India coastal cities such as Chennai and Goa may meet similar fate.

Warming can have drastic effect on climate. The IPCC (entrusted with the task of assessing concern about global warming) in their 1st Assessment Report concluded that the Earth's lower level temperature without suitable in-tervention would increase on an average between 2 0C and 40C by the end of this century with disastrous con-sequences.

The 1990s were the hottest years since the middle ages (1990, 1994, 1997 and 1998) . 1994 witnessed coldest winter in Europe and USA, Japan, Korea, Thailand followed by worst summers, floods, killer cyclones, super-typhoons etc. these are symptoms that the world's weather is in turmoil.

Collapse of ice shelves in Antarctica and Greenland and shrinking of Himalayan glaciers (India) are all signals of global warming.

The checks and balances

Particle loading: Industry, agriculture and mining activities release large quantities of dust and fumes into the atmosphere. The effects of these man-made practices are small compared to the natural forces- wind, sea spray, volcanoes- which contribute to a large extent to the particle loading of the atmosphere.

Table 1. Worldwide addition of particulate matter to the atmosphere Annual addition (million tons)

Material	Natural	Man-made
Total particle	800-2500	200-500
Forest fires	500-1200	-
Sulphate particles	150-200	130-200
Nitrates	30-50	150-200
Hydrocarbons	15-20	75-200
Dust, smoke, soil, volcanic ash, sea spray	700-800	-

These atmospheric particles have a cooling effect on the Earth's surface due to increased scattering of the sun's rays. It is estimated that if the particle loading in the atmosphere increases by 50%, the average temperature of the Earth will drop by 0.5 0C. The same order of temperature drop will result from particle-induced cloud formation. This serves as a check and balance for global warming which is below the anticipated mark. Violent volcanic eruptions from time to time have counterbalanced the global warming for the period is some region. Thus the eruption of Mount Pinatubo in Philippines in 1991 increased the dust load (fly ash, sulphate particles) of the atmosphere to 60 times more than its normal level with the result that summer was missing for two successive years from South East Asia.

In 1980, Asian Brown Cloud, resulting from forest fires, fossil fuel combustion etc. hovered over South Asia spreading from Afghanistan to Sri Lanka and Indonesia. It was 3 in thick, cutting down sunlight by 10-15 percent which led to less rainfall, drought, acid rain and risks of flash floods, unusual heat waves etc.

IPCC IV Assessment Report (April 2007)

After assessing over 1,00,000 scientific papers in 5 years on the subject of global warming and numerous review meeting, the UN based IPCC published its IV assessment Report on global warming. A group of 560 scientists and representatives of 114 nations out of 192 UN member nations reached consensus after intensive consultations and brought out their Final Report in Brussels on 6th April, 2007.

The highlights of the Report are:

• Atmospheric concentrations of greenhouse gases-CO2, CH4, NOx-exceeded their usual range in the last 6,50,000 years. CO2 reached it highest level at 379 ppm.

• Average surface temperature rise by 0.74 0C in the past century- expected rise by 3-4 0C by the end of 21 st century.

- 11 hottest years witnessed between mid 80s and mind 90s.
- Arctic zone warming up twice as rapidly as the rest of the world.
- Greenland ice shelf collapsing altogether and pushing up sea levels by several metres.
- Antarctica warmed up by 0.5-0.7 0C per decade last 30 years.

• In India torrential rains will pout in north-west during monsoon while the number of rainy days will decline along the east coast. Mumbai had a record rainfall about 94 cm in 2005 with loss of 1000 lives and propertyworth Rs. 1000 crores. On the other hand, Orrissa was affected by severe drought in 2000-02 which endangered more than 11 million people.

• Himalayan glaciers are melting at an alarming rate and may vanish by 2050. This will damage Himalayan ecology and people living in the Gangetic Valley (over) 40% of total population) will suffer. The lifelines of India-the Ganga and Yamuna will lose their perennial water resource and dry up. Water tables will go down and over 500 million people will face water crisis. Much of the Gangetic plain will turn into a vast dust bowl.

- Food grain production will decline by 30% in the next 30 years.

• Sea level rise will be about 40 cm by 2100, flooding residence of millions of people in low lying areas. About 50 million people will become homeless.

• Desertification is likely to increase as grassland cover drops.

• Warmer ocean temperatures would lead to bleaching and destruction to coral reefs.

• Ocean acidification resulting in from increased CO2 level would lead to shell dissolution at sea be and affect marine life and ecosystem.

• About 50% of the country's biodiversity would be at risk while 25% of the plant and animal species would face extinction if the temperature exceeds 1.5-2.50C

• Disease like dengue and diarrhoea would rapidly spread across India.

In recognition of the work of the IPCC Panel, headed by Dr. r.K. Pachauri, Nobel Peace Prize (2007) was awarded to the Panel jointly with AI gorge, Ex-Vice President, USA who carried sustained campaign for environment conservation.

R.K. Pachauri's Novel Lecture: ".....The Indian philosophy of "Vasudaiva Kutumbakam" which means the

whole universe is one family must dominate global efforts to protect the global commons.....Climate change is expected to exacerbate current stresses on water resources- Widespread mass losses from glaciers and reductions in snow cover projected to accelerate throughout the 21st century reducing water availability in regions supplied by melt water from mountain range....."

Al Gore's Nobel Lecture : ".....the Earth has a fever and experts have said it is not a passing affliction that will heal by itself.....the very web of life on which we depend is being ripped and frayed....."

Kyto Protocol (1986)/ Bali summit (2008)- Kyto Protocol (1986) stipulated curtailment of CO2 and other greenhouse gas emissions by 55 below 1990 level within 2012. Most of the industrial nations except, USA, Australia signed this protocol. The UN climate conference was convened in 2008 at Bali to evolve a new International Treaty as a successor of Kyto Protocol which expires in 2012, it was attended by 190 countries. Under pressure from European Union countries and Asian developing countries, USA yielded and accepted the consensus date 2013 for implementing the new Treaty for quantum of emission reduction by all countries including China and India.

Conclusion- Global warming is no longer a myth but a hard reality. We have to face it or we perish joining the ranks of threatened species of plants and animals on the brink of extinction. there is experimental proof from international teams of scientists which has sounded note of caution for us. The latest IPCC IV Assessment Report on Global Warming, recognised by Nobel Committee through award of Nobel Peace Prize (2007), is indeed more than a wake up call for all. It is high time for all to remain on high alert and act accordingly.

"Arise, Awake, Onward- Vivekananda".

Plan for remedial measures based on recommendation of various relevant UN Agencies, is out lines below:

(a) Use of alternative energy resources (renewable) such as solar, hydroelectric, wind, ocean energy and nuclear power-this will reduce greenhouse gas emissions.

(b) use of clean and less carbon-intensive fuels like compressed natural gas (CNG), liquefied petroleum gas (LPG) and bio fuel for public transport systems.

(c) Emphasis on forest conservation, less deforestation, and reforestation on large scale to compensate deforestation.

(d) Shifting to environment friendly and green technologies in industries, agricultural practices and water management.

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