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Global Warming and Health Hazards

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Introduction

Global warming has captured the centre stage of the worldwide attention and has inspired more debates and action at every level than any other environmental issue in history. Throughout most of the human history, all climate changes were the direct results of natural forces. This has been changed with the start of the industrial revolution, when new industrial and agricultural practices began to alter the global climate and environment. Widespread use of the fossil fuels, deforestation, chemical agriculture and population growth are creating an excess of greenhouse gases in the atmosphere and contributing to global warming.

The fourth assessment report (AR4) of the Intergovernmental Panel on Climate Change (IPCC) of the United Nations, representing the works of 2,500 scientists from more than 130 countries, published on 2nd February 2007, states that global warming is now unstoppable^{1,2} and human activities are to blame³ for the heat-trapping greenhouse gases that have caused global temperature to rise dramatically since 1950. Warming in the last 100 years has caused about a 0.74° C increase in global average temperature. According to their most recent projections, the global mean temperature will increase by 1.1 – 6.4° C (best estimate between 1.8 – 4.0° C) during the 21st century.^{4,5} The climate change and the consequential effects of this are no

longer just a theoretical issue of environment. In fact, it is looming as the biggest human catastrophe, threatening our ultimate survival.

What Causes Global Warming ?

A major part of the solar radiation coming to the earth escapes back into the outer space after being reflected from the earth surface. Many greenhouse gases occur naturally and surround the earth. They trap the heat and reflect back a part of this escaping solar radiation to the earth again. This is called the greenhouse effect, which keeps the earth warm enough to support life.

Scientists have determined that a number of human activities are adding an excessive amount of greenhouse gases to the atmosphere. As the concentration of the heat absorbent greenhouse gases increases, more and more heat becomes trapped in the atmosphere and less heat escapes back into space. This increase in the trapped heat raises the surface temperature of the earth and changes the climate. This is called global warming.

Global warming is taking place since 1950. Rapid industrialisation has accelerated it. Human use of fossil fuels is the main source of excessive greenhouse gases. By using electricity from coal-fired thermal power plants, using coal or coal-gas as the major fuel source of many industries, using

petrol and diesel for driving cars, we release more and more carbon dioxide and other heat-trapping gases into the atmosphere. During the last 150 years of the industrial age, the atmospheric concentration of carbon dioxide has increased by 31%⁶ and the atmospheric methane level has increased by 151%⁶. Deforestation is another significant source of greenhouse gases, because fewer trees means less carbon dioxide is being removed from the atmosphere to be converted to oxygen.

February 2007 report of IPCC opines that the main cause of global warming is excess emission of carbon dioxide and other greenhouse gases, produced by the following human activities:⁷

- Widespread use of fossil fuels (coal, petrol, diesel, natural gas)
- Deforestation
- Chemical agriculture
- Population growth

Major Greenhouse Gases⁸

• Carbon dioxide	83 %
• Methane	9 %
• Nitrous Oxide	6 %
• Ground-level Ozone	} 2 %
• Chloro-fluoro-carbons (CFC)	
• Per-fluoro-carbons (PFC)	
• Sulfur-hexa-fluoride (SF ₆)	

These gases are heat-absorbent & hold heat in the atmosphere.

Sources of the Major Greenhouse Gases

1. Carbon dioxide

- Burning of fossil fuels (coal, petrol, diesel, natural gas).
- Burning of solid waste, wood and wood products.

2. Nitrous oxide

- Burning of fossil fuels and solid waste.
- Various agricultural and industrial processes.

3. Methane

- Production and transport of fossil fuels.
- Decomposition of organic waste.

4. CFC, PFC, SF₆

- Exclusively industrial products.
- CFC is largely used as refrigerant and in aerosols.

Ground-level Ozone vs. Stratospheric Ozone

- Ground-level ozone is a health hazard, as it irritates airways and injures lungs.
- Stratospheric ozone layer is good, as it blocks the entry of carcinogenic UV rays.
- CFC depletes stratospheric ozone layer, causing ozone hole.

Sources of Carbon dioxide and Our Task

A. The main cause of carbon dioxide accumulation is either

- Increased production due to burning of fossil fuels in thermal power plants, industries, transport vehicles or
- Decreased removal due to deforestation.

B. The sources of carbon dioxide production are⁸

• Burning of fossil fuels	97 %
• Everything else	3 %

C. The sectors responsible for carbon dioxide production are⁸

• Electricity generation	40 %
• Transport vehicles	32 %
• Industrial use	17 %
• Residential	7 %
• Commercial	4 %

D. So, for the effective reduction of the accumulation of greenhouse gases in the atmosphere, we must set our practical target to reduce carbon dioxide emission, for which we must stop burning of fossil fuels in at least three major sectors:

1. Thermal power generation
2. Automobile emissions and
3. Industrial sector.

Per Capita Carbon dioxide Emission

USA alone is responsible for more than 24% of total global emission of greenhouse gases⁹ and for about 50% of total global automobile emission.¹⁰ While the world average of per capita emission of carbon dioxide in the year 2002 was 3.9 tonnes,⁹ the figure for USA was 5 times higher, as it produced an awesome 19.7 tonnes⁹ of carbon dioxide per capita. On the contrary, India, a less industrialised country, figured well below and produced only 1.0 tonne⁹ of carbon dioxide per capita, 4 times less than the world average. So, it is quiet clear that the developed countries are the major culprits and naturally these countries will have to share more responsibilities than the under-developed countries, to come out of this grave situation at present.

Effects of Global Warming

Increased global surface temperature due to the effect of trapped heat will result into

- Climate change
 - Rapid water cycle
 - Melting of glaciers and polar ice
 - Ocean expansion
1. Scorching heat and heat waves are the direct results of this climate change.
 2. Breeding of mosquitoes and spread of many infections are enhanced in warm or hot climate.
 3. Droughts which are becoming more common and longer lasting, can lead to starvation and the destruction of entire ways of life, particularly in regions of sub-Saharan Africa, that are least equipped to deal with such catastrophes.¹¹

4. Raised surface water temperature and hot climate increases the evaporation of ocean water, resulting in rapid water cycle, which causes flood in many areas.
5. Melting of glaciers and the polar ice due to raised temperature will increase the quantity of ocean water and at the same time the thermal expansion of the ocean water will cause a significant rise of the sea level. Average rate of sea level rise during the years 1961-2003 was about 1.8 mm/year, which steadily increased to 3.1 mm/year during 1993-2003. Now it is estimated that sea level will rise in the range of 18 – 59 cm^{4,5} at the end of 21st century.
6. As hurricane formation requires warm ocean surface along with hot climate, fiercer storms will occur. In fact, last 10 years has been the most active hurricane season in the history.

So, summarily, the results which can affect the human health are :-

- Killer heat waves
- Spread of vector borne diseases
- Devastating droughts
- Heavy rainfall
- Rising sea level and coastal flood
- Fierce storms.

Effects on Human Health

Global warming not only poses a significant threat to the earth's ecology, but also unleashes an unprecedented health risks due to heat waves, spread of infectious diseases, disasters and malnutrition. As per WHO estimate, global warming currently contributes to more than 1.5 lakh deaths¹¹ and more than 50 lakh illnesses every year.¹¹ 50 million environmental refugees,¹² displaced by floods, droughts and rising sea levels, are expected by 2010. Numbers may double by 2030.¹¹ Experts apprehend that global warming will kill billions in this century!!¹²

The effects of global warming on human health may be summarised below:

1. Direct Effect of Hot Climate

- a. There will be an increased intensity, duration and frequency of heat waves around the world.¹ So, heat related diseases will increase sharply. In August 2003, Europe suffered its worst heat wave in recent memory; the scorching weather claimed as many as 35,000 lives. In France, nearly 15,000 people succumbed as the temperature peaked at about 40°C, completely unprepared for that kind of heat.
- b. The sick and the elderly persons are most vulnerable, for their decreased ability to increase cardiac output and decreased sweat function for cooling of body.
- c. People in temperate countries, like UK, France etc., who are not accustomed to hot weather and people in countries where houses and other infrastructures are not designed to cope with hot climate, are more vulnerable.
- d. Technological adaptations, e.g. installation of air-conditioners and construction of heat-minimising houses will happen quickly among the rich.
- e. So, the heat waves will more affect the populations that are least able to deal with it. In the developed nations it will affect the poor more than the rich and in the developing world it will affect the nations least able to respond to these threats and stresses. Overall, global warming has more and disproportionate effect on the under-developed countries and on the poorer segments of the society.
- f. There is increased risk of bushfire or forest-fire, which can kill people.

2. Indirect Effect of Hot Climate

- a. More than 65% of world population are at increased risk of infection.¹³

- b. As warm climate favors breeding of mosquitoes, there will be a massive spread of the whole range of mosquito-borne diseases^{1,14} e.g. Malaria, Dengue, Chikungunya, Encephalitis and Yellow fever.¹ In successive two years of 2005 and 2006, Dengue and Chikungunya became pandemic. Malaria and Encephalitis are becoming endemic in many countries. Malaria is moving to higher altitudes in Africa, Asia & Latin America.¹
- c. Tick and other insect-borne diseases are spreading to areas once considered too cold for them to survive, e.g. Lyme disease, Rocky mountain spotted fever, West Nile fever & Eastern equine encephalitis.¹
- d. Food-poisoning is increased, as these bacteria best grow in 35 – 37° C temp.

3. Effect of Floods

- a. There are health effects secondary to flooding, such as contaminated water supplies and breakdown in sewerage and garbage services,¹⁴ leading to spread of the whole range of water borne diseases,¹ food borne diseases and other infectious diseases. Cholera thrives in such situation.
- b. Contamination of swimming water also invites some health hazards.
- c. Water logging hampers food distribution with natural consequences on health.

4. Effect of Droughts

- a. There will be a sharp increase in the nutritional diseases caused by starvation¹, as a result of the poor agricultural yield due to severe and prolonged droughts. By 2020, yields from rain-fed agriculture in some African countries could be reduced by 50%.
- b. Water is already in short supply. Under hot climate conditions, precipitation patterns will change, leading to severe water scarcity,¹⁵

with great implications on health. By 2020, 75–250 million people in Africa will be exposed to water scarcity due to climate change.

5. Effect of Increasing Air Pollution

- a. Increasing air pollution from the continued burning of fossil fuels will cause higher rates of respiratory and cardiovascular diseases.¹
- b. With warming, there will be an increase in pollens, mold spores and release of large quantities of particulate matters, aggravating the hazards of asthma.
- c. The concentration of photochemical pollutants, like ozone, increases with increasing temperature. Increased ground-level ozone damages lung tissue, induces and increases asthma¹⁴ and invites many other cardio-respiratory diseases.
- d. Depletion of stratospheric ozone allows more and more UV-rays to enter into the atmosphere and thus increases the incidence of malignancies.

6. Effect of Ocean Expansion

- a. Sea level may rise 18 – 59 cm by 2100⁵.
- b. It may be quite disastrous for people of low-lying islands, e.g. Maldives in Indian ocean and many south Pacific islands.¹⁶ There will be a 50 fold rise of the number of people exposed to coastal flooding per year¹⁶ in the years around 2080.
- c. 13 of the 20 largest cities on earth are located at sea level on coasts.¹⁵ As sea level rises, there go our medical institutions, water treatment plants, emergency response units such as fire departments and ambulances. The bulk of the services designed to keep us healthy are almost all located in our larger cities, which are also located frequently at sea level.

- d. With increasing sea level, there will be coastal erosion, contamination of freshwater supply and degradation of agricultural areas¹⁶ resulting in a massive impact on our eco-system, health and life.

7. Effect of Disasters

- a. There will be a sharp rise in the storms, heavy rainfall, sea-water flood, draughts, forest-fire, earthquakes, tsunami and volcanoes.
- b. Hospitals, health services, ambulances, fire-services, electricity, food & water supply, transport and all sorts of communications become ineffective altogether, after the disaster, with a massive impact on health and life.
- c. These disasters invariably increase the psychological stress, depression, agony and a feeling of isolation among people affected by natural disasters¹⁶.

No country, even USA, will escape these hazards. But, ironically, the poor nations least responsible for greenhouse gases are most affected by global warming.^{1,17} Though it affects everyone on earth, poor people are most vulnerable to the disease and death, as they are least able to cope.¹ Here lies the enormous ethical challenge.

Examples of Some Effects : Super-cyclone in Paradeep claimed 10,000 lives in October 1999. Australia had severe drought in the year of El Niño, 2002. Worst heat wave across Europe claimed 35,000 lives in August 2003. South India faced the worst tsunami in December 2004. USA had massive hurricane Katrina in August 2005. The world suffered the biggest pandemic of Dengue and Chikungunya in 2005 and 2006. Mumbai experienced the heavy rains followed by sea-water flood in 2006 and 2007. California saw the disastrous forest-fire in October 2007.

Salient Observations IPCC Fourth Assessment Report⁵

Changes in the atmosphere

- Carbon dioxide, methane, and nitrous oxide are all long-lived greenhouse gases, but these gases have increased markedly as a result of human activities since 1750 and now far exceed pre-industrial values.
- The amount of carbon dioxide in the atmosphere in 2005 (379 ppm) exceeds by far the natural range of the last 6,50,000 years (180 – 300 ppm). The primary source of this increase is fossil fuel use; but, land-use changes also make a contribution.
- The amount of methane in the atmosphere in 2005 (1774 ppb) exceeds by far the natural range of the last 6,50,000 years (320 – 790 ppb). The primary source of this is very likely to be a combination of human agricultural activities and fossil fuel use.
- Nitrous oxide concentrations have risen from a pre-industrial value of 270 ppb to a 2005 value of 319 ppb. Most of this rise is due to human activity, primarily agriculture.

Warming of the planet

- Eleven of the twelve years in the period 1995 – 2006 rank among the top 12 warmest years in the instrumental record since 1850. Cold days, cold nights and frost events have become less frequent. Hot days, hot nights and heat waves have become more frequent.
- Warming in the last 100 years has caused about a 0.74° C increase in global average temperature. Surface air warming in the 21st century will be in the range of 1.1 – 6.4° C (with the best estimate between 1.8 - 4.0° C)
- Observations since 1961 show that the ocean has been absorbing more than 80% of the heat added to the climate and that ocean temperature has increased to depths of at least 9800 ft. Ocean warming causes seawater to expand, which contributes to sea level rising.
- Sea level rose at an average rate of about 1.8

mm/year during the years 1961-2003. The rise in sea level during 1993-2003 was at an average rate of 3.1 mm/year. It is estimated that sea level rise will be in the range of 18 – 59 cm.

- There will be an increase in frequency of warm spells, heat waves and events of heavy rainfall. There will be an increase in areas affected by droughts, intensity of tropical cyclones (including hurricanes and typhoons) and the occurrence of extreme high tides.

Hurricanes

- There has been an increase in hurricane intensity since 1970s, and this increase correlates with increases in sea surface temperature. It is likely that we will see increases in hurricane intensity during the 21st century. It is more likely that there has been some human contribution to the increases in hurricane intensity.

Coastal System

- It is projected with very high confidence that coasts will be exposed to increasing risks of coastal erosion due to climate change and sea-level rise.
- Many millions more people will be flooded every year due to sea-level rise by the 2080s.

Fresh Water

- It is projected with high confidence that dry regions will get drier, and wet regions will get wetter. Heavy rainfall events are very likely to become more common and will increase the flood risk. At the same time drought affected areas will become larger.
- By mid-century, annual average river runoff and water availability are projected to increase by 10-40% in some wet tropical areas, and decrease by 10-30% over some dry regions.

Food

- It is projected that food production may increase, globally, for temperature rises of 1 – 3° C, but will decrease for higher temperature range.

IPCC

The **Intergovernmental Panel on Climate Change** (IPCC) is a scientific body tasked to evaluate the risk of climate change caused by human activity. The panel was established in 1988 by two organizations of the United Nations – the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP). The IPCC does not carry out research, nor does it monitor climate. One of the main activities of the IPCC is to publish special reports on topics relevant to the harmful effects of climate change. Its first assessment was published in 1990, followed by in 1995 and 2001. The fourth assessment report has been published on 2nd February 2007 and has created a huge repercussion throughout the world. The IPCC chairman of Indian origin, Rajendra Pachauri, who took his office only in May 2002, shared the 2007 Nobel Peace Prize for the excellent works on this field.

Kyoto Protocol

Though the first international response to address the problems of climate change was launched in 1992, at the Earth Summit in Rio de Janeiro, an international agreement was reached by more than 160 nations, in December 1997, in Kyoto, Japan. This is known as Kyoto Protocol, which commits 38 industrialised countries to cut their greenhouse gas emissions¹⁸ and sets a binding target of 5.2% net reduction of worldwide emission of greenhouse gases, mainly carbon dioxide, below 1990 level as benchmark, by the five year period of 2008 to 2012¹⁹.

Most of the industrialised nations have ratified it and have begun efforts to meet their emission target. Notable exception is USA, which accounts for about 24% of the global emission of greenhouse gases. Before election in 2001, George W. Bush promised to decrease the emission, but refused after victory.²⁰ Alternatively, proposed a 4.5% reduction of current emission by 2010. According to US Energy Department, this will result in 30% elevation of emission over 1990 level, instead of

reduction.¹⁹ Australia also declined. In November 2004, Russia accepted it. The protocol becomes a worldwide binding force on February 16, 2005.

Remedies

We can stop global warming, if we immediately opt for

1. Alternative energy use for industrial sector
2. Alternative fuel use for transport vehicles (Biodiesel = Ethanol + vegetable oil.)
3. Efficient use of electricity
4. Widespread use of renewable energy
5. Organic agriculture
6. Reforestation and afforestation

While the first four measures reduce the production of carbon dioxide, organic agriculture and forestation remove carbon dioxide from the air.

Three ‘R’s may be the most useful remedial tools,

- **R**estrictions on biggest polluters
- **R**educed automobile emission
- **R**enewable energy sources
 - Solar energy
 - Wind power
 - Hydroelectric power
 - Geo-thermal energy
 - Bio-energy

Energy Revolution

An ‘Energy revolution’ is essential to counter the ill effects of the ‘Industrial revolution’, as

- 96% of all energy used globally at present, is derived from thermal power.
- Other energy sources are grossly inadequate for the huge demand of the modern civilisation. The need of electricity has tremendously increased nowadays by the use of so many electrical

gadgets at every home, rapid surge in installation of air-conditioners and the widespread use of computers at every level. Civilisation is energy-intensive and we cannot turn it off.

- Only key to our future survival may be the widespread use of 'Nuclear energy' as the clean source of energy.²¹ This becomes further relevant, as we know that the fossil-fuels have a very limited stock for a few more decades only. We are not panicked, unnecessarily, to recommend nuclear energy, as we judiciously use radio-active nuclear materials for the diagnosis and treatment of many diseases in the Dept. of Nuclear Medicine. Above all we use nuclear radiation to treat cancer.
- The more the developed nation, the more rapid should be the change over to clean energy source, compared to the under-developed nations, to halt our approaching devastation.

Conclusion

All sensible global citizens, particularly the physicians should raise their voice today

- To stop burning of fossil fuels, as it is the real driver of the climate change
- To call for clean energy
- To draw attention of our policy makers and
- To make the people aware of this ensuing real threat to our ultimate survival, as energy source is fundamental for the environment of our health and for the health of our environment. Without that, we are going to have a very polluted, sick and disastrous future.

We must, must act now to save our planet, our civilisation and our next generation.

Summary

The global mean temperature has been increasing steadily and significantly since 1950 and has reached an unstoppable state due to some human activities. Main cause is significant elevation of the concentration of atmospheric carbon dioxide

as major greenhouse gas, due to widespread use of the fossil fuels in thermal power plants, industries and transport vehicles. Deforestation and land-use changes also make a contribution. Developed countries are the major culprits. Poor people and the poor nations are the worst sufferers. Global mean temperature will rise by 1.1 - 6.4° C by 2100. This change in climate is looming as the biggest human catastrophe, threatening our ultimate survival. The results affecting our health are killer heat waves, devastating droughts, ocean expansion, heavy rainfall, coastal flood, fierce storms, massive spread of the whole range of mosquito-borne diseases like malaria, dengue, chikungunya, encephalitis and yellow fever, along with the effects of flood, spread of water borne diseases like cholera, effects of droughts, malnutrition, water scarcity, increasing air pollution and disasters. More than 65% of world population are at increased risk of infection. WHO estimates more than 1.5 lakh deaths and 50 lakh illnesses per year now due to global warming. 50 million environmental refugees are expected by 2010. Experts say this will kill billions in this century. Stoppage of burning fossil fuels, use of clean energy, opting for organic agriculture and forestation are the remedies. Widespread use of nuclear energy may be the only key to our future survival.

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