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Perilous Consequences of Global Climatic Change: A Review

Amarpreet K Kalra[1], Namita K Johar[2]
[1]*Department of Chemistry, S. G. T. B. Khalsa College, University of Delhi, India*
[2]*Applied Science Department, Maharaja Agrasen Institute of Technology, India*

Abstract: ***Global warming is the rise in the average temperature of the Earth's atmosphere. Recent decades have seen very high average global surface temperature. This global warming causes the climate to change. Climate change is predicted to have overwhelming effects on the environment and on socio-economic and related sectors, including water resources, agriculture, human health and coastal zones. The global temperatures are likely to rise about 6^0C, if not checked. The cause of global warming is mostly by human interferences like deforestation and increase in the emission of green house gases. CO_2 is a major contributor to the green house effect and global warming. 91% of CO_2 emission enters the atmosphere by burning of fossil fuels (for eg. natural gas, coal, oil and gasoline), gas flaring and cement production. The poles are affected most by the elevated earth's temperature resulting the glaciers, polar ice to melt and sea level to rise. Studies show that the summers in the arctic region may be ice-free by 2040. The climate change is a great threat to human life causing the intensity and frequency of floods, storms, cyclones, droughts to rise. This temperature enhancement will increase the rate of extinction for many habitats and species and it would become difficult for life to sustain on earth. Developing new energy polices and initiatives can help save the planet and health of our earth's inhabitants today.***

Keywords: Global warming, climate change, fossil fuels, CO_2, policies and initiatives.

I. INTRODUCTION

Global warming is defined as the increase of the average temperature on Earth. The average temperature of the earth has risen between 0.4 and 0.8^{0}C over the past 100 years (Masih, 2010). Scientists have recently predicted that average global temperature could increase between 1.4 and 5.8^{0}C and the top 5% cities of the world could see increase in temperatures of about 8^{0}C and larger by 2100. Cities cover only about 1% of Earth's surface, but produce more than 60% of global CO_2 emissions from burning coal, oil and gas for fuel. The average global temperature across land and ocean surface areas for 2016 was 0.94^{0}C above the 20th century average of 13.9^{0}C. As the earth is getting hotter, disasters like hurricanes, droughts and floods are getting more frequent. Global temperatures have continued to rise, making 2016 the hottest year on the historical record. Globally over 1.5 times more extreme weather catastrophes were seen in 2016 than the average over the past 30 years.

1) Some Of The Selected Climate Anomalies For The Year 2016 Are Listed Below

a) Asia observed its 3rd warmest year on record.
b) On May 19th, 2016, Phalodi, India reached a temperature of 51^{0}C, becoming the highest temperature on record for the country.
c) On July 21st, 2016, temperature of 54.0^{0}C was recorded at Mitribah, Kuwait, becoming the highest temperature on record for Asia.
d) Australia observed its 4th warmest year in its 107 year national record.
e) Europe experienced its 3rd warmest year in the 107 year continental record.
f) 2016 was the warmest year for North America since continental record began in 1910.
g) South America recorded 2016 as the 2nd warmest year in its continental record.

2) Few Of The Climate Disasters (In 2016) Are Discussed Here

a) A wildfire damaged large parts of Fort McMurray in early May and became the costliest natural disaster in Canada's history.
b) Tropical Storm Darby (July 11th-26th) caused rainfall flooding in the Hawaiian Islands.
c) Typhoon Lionrock (Aug. 16th-31st) effected the north eastern areas of the Democratic People's Republic of Korea where rainfall of (320mm) for almost four days led to catastrophic flooding and 133 fatalities.
d) Hurrican Mathew (Sept. 28th – Oct. 9th), category 5 hurrican in North Atlantic affected Haiti, Cuba, the Bahamas and parts of South Eastern US. The causalities were in excess of 600.

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The top three perils: flooding, earthquake and severe weather combined for 70 % of all economic losses in 2016.The number of human fatalities caused by natural disasters in 2016 was approximately 8250.

A. *Green House Effect*

The sun radiates large quantities of energy into the space, across a wide spectrum of wavelengths (spectrum of electromagnetic radiation). 43% of the total radiant energy emitted comprises of a narrow band of visible light (400 to 700nm), wavelengths shorter than the visible are high energy ultraviolet (5-7%). The UV light is very energetic causing sunburn, skin cancer and also interferes with photosynthesis in algae and plants.

The remaining 50-52% of the solar energy is spread over wavelength that is longer than visible light (infra-red) (Fig. 1). The earth's atmosphere largely absorbs ultraviolet and infrared solar radiations (only a portion of the UV light arrives at the surface of Earth) and is transparent to visible light. The solar radiation (in visible range) is absorbed by earth's surface and oceans, making it warm. The visible light is transformed into heat and is radiated in the form of invisible infrared radiation.

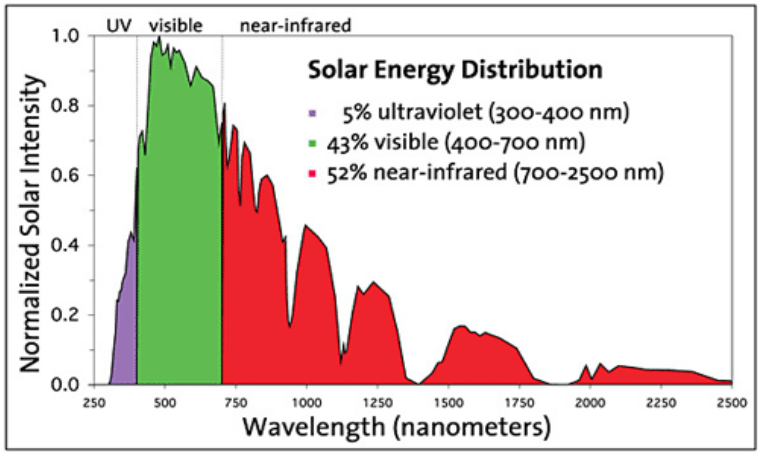

Fig 1: The distribution of solar spectral radiations

The earth's atmosphere contains molecules (CO_2, water vapours etc) that absorb the heat and re-radiate the heat in all directions, warming the atmosphere. This reflecting back of heat energy by the atmosphere is called the "green house effect" and the molecules that absorb heat are called green house gas molecules".

The green house gas hold the heat just like the glass walls of a green house, and make the average surface temperature of earth comfortable and suitable for life to sustain (Latake et al., 2015). If the earth had no atmosphere its average surface temperature would be very low (-18^0C). This is the "natural green house effect".

By their percentage contribution (upto an approximate level) to the green house effect on Earth the four major green houses gases are: water vapour (36-70%), CO_2 (9-26%), methane (4-9%) and ozone (3-7%) (Venkataramanan, 2011). All these are gas molecules where the absorption and emission bands overlap. Other green house gases include nitrous oxide, sulphur dioxide, carbon monoxide, hydro fluorocarbons and chlorofluorocarbons (CFC's). The level of these gases in atmosphere is determined by a balance between sources and sinks. Sources are the process that generate them and sinks that removes the green house gases by converting them to a different chemical compound respectively. Many human activities disturb the green house gas levels by either introducing new sources or by interfering with natural sinks. The increase in the atmospheric concentration of the green house gases will further hinder the escape of terrestrial IR radiation and warm that Earth's surface, this contributes to the "Enhanced Greenhouse effect".

The Earth's climate must change to restore the balance between incoming and outgoing radiation. This climatic change will hence induce "Global Warming".

B. *The Causes of Global Warming*

1) *Depletion of Ozone Layer:* The ozone layer is a belt of ozone around 15 to 30 km above the earth in stratosphere, acting as a shield that absorbs most of the UV radiation emitted by the sun. The ozone layer is reduced when manmade CFC's reach the stratosphere and are broken apart by short wave energy from the sun. The free chlorine atoms then break apart molecules of ozone, creating a hole in ozone layer called *"Ozone holes"*. The ozone layer depletion allows the UV radiation to enter Earth making it warmer and hence leading to global warming.

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2) *Air Pollution:* The harmful vehicles exhaust, gases from factories and green house gases (at very high levels) cause pollution in the air. These gases get captured in the atmosphere. The large amount of smoke up in the atmosphere forms clouds of harmful gases, which then falls as acid rain destroying the aquatic ecosystems, vegetations, buildings and causes cancer, skin burns etc. With the decrease in the number of the plants on earth, the level of CO_2 in atmosphere will increase.
3) *Greenhouse Effect:* Due to burning fuels and cutting of trees, the amount of heat on Earth has increased to very high abnormal levels, making green house effect as one of the major cause of global warming.
4) *Use of Chemical Fertilizers:* Soil microbes convert nitrogen-rich crop fertilizers into nitrous oxide at a faster rate than normal. With an overload of fertilizer on farms, soil microbes are belching unexpectedly high levels of nitrous oxide in atmosphere, with 300 times more heat trapping power as CO_2.
5) *Deforestation, Burning Of Fossil Fuels Mining Activities:* Deforestation releases large amount of carbon, and also reduces the amount of carbon gas capture on the Earth. It's estimated that more than 1.5 billion tons of CO_2 is released to atmosphere due to deforestation every year. Combustion of fossil fuels gives out CO_2, and various other gases like carbon monoxide, methane, causing air pollution and hence triggering global warming. Mining oil, coal allows methane to escape from Earth.

C. Global warming increasingly visible impacts

The major impacts and threats of global warming are widespread and are clearly visible around the world.

1) *Extreme Weather Conditions:* The global warming will increase the frequency and intensity of some of the extreme events (like heat waves, flood producing storm or drought).By 2040, the risk of heat wave could increase 100-fold if there is no continuous monitoring and reduction in the green house gases. Higher temperature speed up evaporation and increase the amount of water vapour in air, leading to heavier downpours. These heavier rainfall increases the risk of flooding. Enhancement in the intensity and frequency of El Nino effect (where the Pacific Ocean releases a huge burst of energy and water vapours into the atmosphere) has also caused intense precipitation in some regions (Cashin et al., 2017). *Droughts* are also expected to be more frequent and severe due to Global warming. Higher temperature speeds up the rate of evaporation, if precipitation doesn't soon replenish the lost moisture, soils grow drier .In these dry soils, less solar energy is used up in evaporating water, thus more available energy to further shoot the temperature of the soil and the overlying air, resulting in a lengthy and severe drought. Warmer temperature promotes the outbreaks of insects that feed on trees, killing majority of them and producing large amount of dry fuels for forest fires. With this combination of heat, drought and pest, *wildfires* have become increasingly destructive. The Boreal forests region stretching across the Northern Hemisphere through Alaska, Canada, Scandinavia and Russia are vulnerable to fires and climate change (Nagano, 2017).
2) *Rise in the Sea level and Coastal Flooding:* Sea level rise is one of the most certain impacts of global warming. Global sea level rose about 8 inches in the last century. The rate in the last 2 decades is almost double than that of the last century. This rise of sea level is attributed to the thermal expansion of ocean water as it warms and also to the addition of water from melting of glaciers and ice sheets both are the consequences of global warming. Over the next several centuries, this would lead to complete, irreversible disappearance of Greenland ice sheet, causing the sea level to further increase by 7m (Vasskog et al., 2015). The increase of sea level rise would submerge large areas of island nations and densely populated coastal areas, displacing millions of people. This will cause land loss and also to erosion by ocean water (because of high salt content).This would aggravate the flooding risk associated with storms during hurricanes.
3) *Retreating Glaciers and Shrinking Snowpack:* Temperature increase is the main culprit for the reduction in the snowpack in various parts of the world (affecting the ski resorts).Ski season in the province of Ontario in Canada is projected to shorten by 16% in 2020 (Rutty et al., 2017). *Glaciers* are retreating in response to a warming climate. Glaciers are slow moving "rivers" of ice formed over many years from snow on sloping land. Their continued disappearance will have a severe impact on water supplies in some regions.Scietists project that all the glaciers in Montana' ns Glacier National Park (USA) could disappear completely by 2030.About 5500 glaciers in the Hindu Kush –Himalayan region could reduce their volume by 70-90% by 2100, with dire consequences for farming and hydropower generation (Ashraf et al., 2017). *Sea ice shrinkage* further amplifies global warming. Light coloured ice reflects a major section of sun radiation back to the space. If the sea ice is not there, the darker water absorbs the solar energy and the climate heats up faster. Due to climate change, the *permafrost soil* is melting very fast. This permafrost is rapidly melting in Arctic of Northern America, Siberia and Himalayan region of Asia (Gadek, 2012). Permafrost is soil (including organic material) that remains at or below 0^0C for at least two consecutive years. These soils are rich in organic carbon. When the soil remains deep-frozen the carbon is mostly inert but when permafrost thaws, the

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decomposition of the organic matter increases and CO_2 and methane are released to the atmosphere. This will exacerbate warming, leading to more permafrost thawing and more warming and so on.

4) *Ecological Impacts:* Climate change is transforming ecosystems at an extraordinary pace. This triggers a cascade of impacts throughout the entire ecosystems. As temperature warm, species may either move to a cooler habitat or die. Species that are particularly vulnerable include endangered species, polar animals and coral reefs. Increasing levels of CO_2 in the water cause damage to the corals. The corals are formed when polyps (the living portion of stony corals) extract calcium from sea water and combine it with CO_2 to construct the elaborate limestone skeletons that form the reef. As the oceans become more acidic, the corals ability to form skeletons through calcification is inhibited, causing their growth to slow. The normally brilliant colours of corals are provided by photosynthetic algae, zooxanthellae, which live inside the corals. Under stressful abnormal conditions such as warmer sea temperatures, the corals expel their tiny photosynthetic algae, draining them of their colour. Prolonged bleaching often leads to death of corals (Kavousi et al., 2015). The 2300 km world heritage listed reef ,The Great Barrier Reef, suffered its most severe bleaching on record last year (2016).The loss of corals ecosystems would have severe economic repercussions in region that depend on reefs for food, tourism income and for the protection of coastal land from destructive waves.
5) *Outbreaks of Vector-Borne Diseases:* Higher temperatures accelerate the maturation of certain disease causing agents and their vectors. Higher annual average temperatures can lengthen the season during which vectors are active. A warmer climate can expand the geographic range of tropical mosquito-borne diseases, such as malaria, dengue, fever and yellow fever, to higher altitude and latitudes.

D. Control Measures of Green House Gases

The evidence that human are causing global warming is strong. Many people and government are already working hard to cut greenhouse gases. Some of the remedial and control measures of global warming include reduction in consumption of fossil fuels (coal and petroleum), use of bio-gas plant, use of nuclear power plants, increasing forest cover etc.

E. Paris Climate Agreement or Accord de Paris

Reduction of green house gases is central to all nations because the brunt of the problem is global and no one country or group of countries can provide its own remedy. In 2016, the Paris Agreement marked a turning point in the battle against climate change. The Paris Agreement entered into force on November 4th, 2016. It is an agreement within United Nations Framework Convention on Climate Change (UNFCCC) dealing with greenhouse gases emissions, mitigation, adaptation and finance starting in the year 2020 (Liobikiene, 2017).It is the global target of keeping global average temperature from rising 2^0C by the end of century and to strengthen the ability of countries to deal with the impacts of climate change. As of June 2017,195 UNFCCC members have signed the agreement, 148 of which have ratified it.

II. CONCLUSIONS

The climate change would increase the number of people suffering from death, injury from heatwaves, floods, storms and droughts. The cost to national economies of coping with extreme weather events, crop failures and other emergencies related to climate is growing steadily higher. Scientific understanding of the causes of climate change has progressed dramatically in the past few years. International agreements to deal with Climate change should invoke the principles of sustainable development proposed in the UNFCCC (Jones, 2016).These include:

1) *Precautionary Approach:* The parties should take precautionary measures to anticipate, prevent or minimize the causes of climate change and mitigate its adverse effects.
2) *Costs and Responsibility:* The parties should protect the climate system for the benefit of present and future generations of humankind on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities. Accordingly, the developed countries should take the lead in combating climate change and the adverse effects thereof.
3) *Equity:* The parties should protect the climate system for the benefit of present and future generations of humankind on the basis of equity.

Adherence to these principles would make a substantial contribution towards the prevention of any further global environmental threat and the reduction of existing ones.

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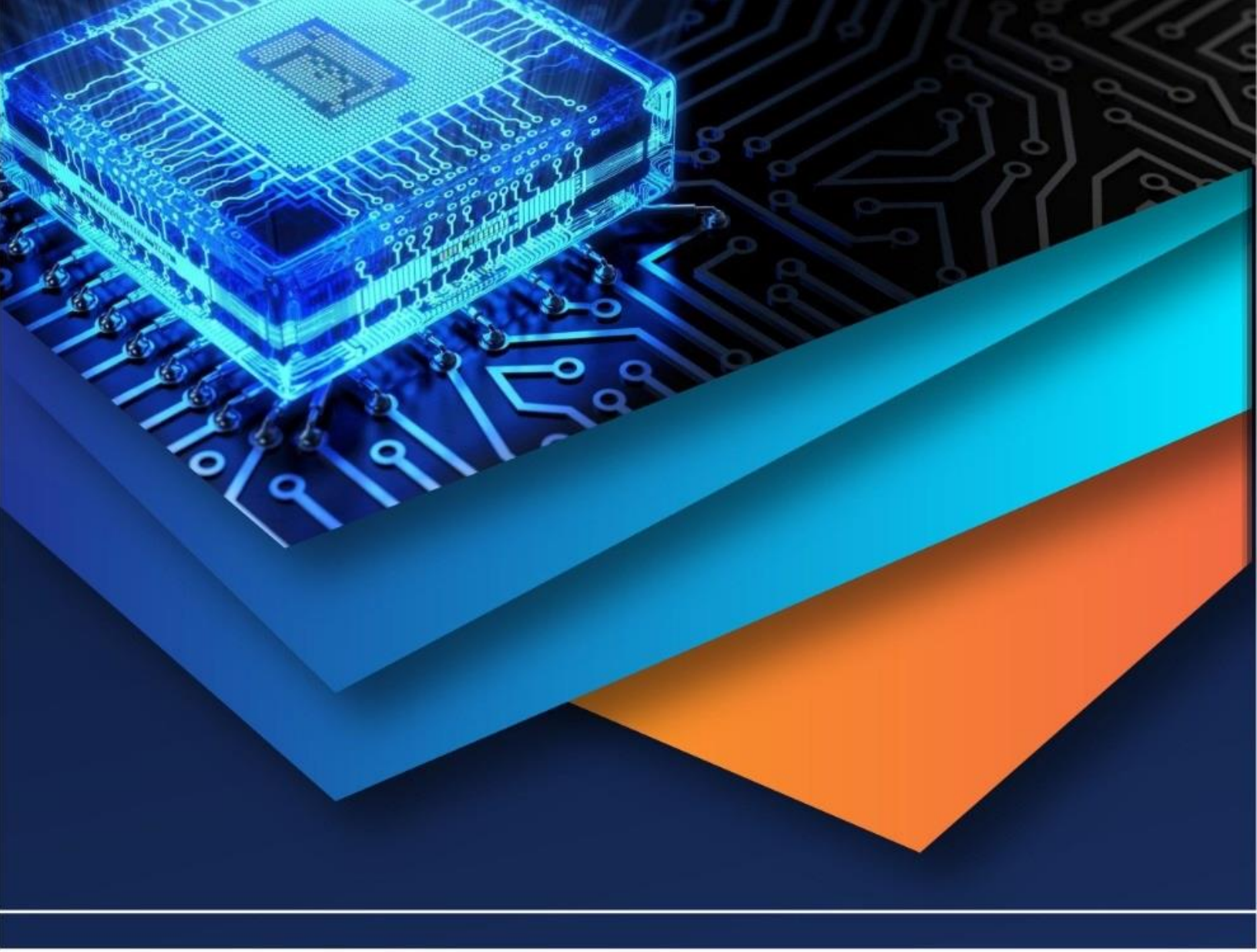

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