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Global warming and its impact on ecosystem, agriculture and human health

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Abstract

Human demand on earth ecosystem has increased many folds resulting in erratic climatic changes which may affect millions of people through water crises. On the other hand floods may lead to displacement of millions due to rising sea levels. Rise of sea levels will devastate agricultural and fishing activities. Increase in pests or vectors are major threat to human health with increasing environmental temperature. By 2050, crops yield could decrease by 30% in developing countries, health status will receive major setback because of increased deaths; due to heat waves, floods, drought etc. flood and drought will increase endemic morbidity and mortality due to diarrheas and spread of cholera. Global warming is not only causing trouble to the human beings but also to animals and plants. To embark upon these problems, some remedial steps must be timely taken which include but are not limited to the use of renewable sources of energy and stopping deforestation. Innovative solutions must be brought forward to end this hazard once and forever.

Keywords: Global warming, green house effect, environment, health.

Introduction

Due to increasing pollution, the level of greenhouse gases particularly CO₂ had increased on global basis causing considerable heating of earth leading to global warming. During the past century, more so during the last three decades, the temperature of the earth had an average increase of 0.6 °C. The effect of global warming brings about odd climate changes in the environment and one of these is 'El-Nino Effect' that disturbs the pattern of rainfall every 5-8 years due to warming up of the sea. Global warming begins when sunlight reaches the Earth. The clouds, atmospheric particles, reflective ground surfaces and surface of oceans then send back about 30 % of sunlight back into the space, whilst the remaining is absorbed by oceans, air and land. This consequently heats up the surface of the planet and atmosphere, making life feasible.

As the Earth warms up, this solar energy is radiated by thermal radiation and infrared rays, propagating directly out to space thereby cooling the Earth. However, some of the outgoing radiation is re-absorbed by carbon dioxide, water vapours, ozone, methane and other gases in the atmosphere and is radiated back to the surface of Earth. These gases are commonly known as greenhouse gases due to their heat-trapping capacity. It must be noted that this reabsorption process is actually good as the Earth's average surface temperature would be very cold if there was no existence of greenhouse gases.

The dilemma began when the concentration of greenhouse gases in the atmosphere was artificially increased by humankind at an alarming rate since the past two centuries. Millions of pounds of methane gas are generated in landfills and agricultural decomposition of biomass and animal manure. Nitrous oxide is released into the atmosphere by various nitrogen-based fertilizers including urea and diammonium phosphate and other soil management utilizations. Once released, these greenhouse gases stay in the atmosphere for decades or even longer. According to Intergovernmental Panel on Climate Change (IPCC), carbon dioxide and methane levels have increased by 35 % and 148 % since the industrial revolution of 1750. Between 1906 and 2006, the Earth's average surface temperature

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augmented between 0.6-0.9 °C. Rise in atmospheric temperature has been confirmed by Intergovernmental Panel on Climatic Change (IPCC). It is feared that by the year 2100, the average temperature of earth may rise by 1.5-5.6 °C over 1990 level. The rise in temperature may be greatest in Polar Regions followed by middle latitudes and then tropics as reported by World Climate Programme (WCP). In tundra regions, the temperature had already increased considerably. Recent observations regarding global warming have substantiated the theory that it is indeed a human enhanced greenhouse effect that is causing the planet to heat up. The planet has experienced the largest increase in surface temperature over the last 100 years.

Greenhouse Effect

Most of the climate scientists and researchers agree that humans have changed the Earth's atmosphere in dramatic ways over the past two centuries, resulting in global warming. To understand global warming, it is first necessary to become familiar with the greenhouse effect. Warming of atmosphere due to increased concentration of some gases like carbon dioxide (CO₂), methane (CH₄), chlorofluorocarbons (CFCs) and nitrous oxide (N₂O) is called greenhouse effect and these gases are called greenhouse gases. Naturally occurring Green House Gases (GHGs) *i.e.* CO₂, CH₄, O₃ and water vapours are responsible for slow increase in earth's temperature, which is necessary. But now, human activities have caused a significant and continuing increase in the levels of greenhouse gases in the atmosphere. More greenhouse gases means the atmosphere traps more heat which leads to global warming. This is due to burning of fossil fuels which increase the amount of greenhouse gases (carbon dioxide, methane and oxides of nitrogen) present in the atmosphere. Carbon dioxide and other greenhouse gases act like a mantle, absorbing infrared radiation and preventing it from escaping into the outer space. The net effect is the regular heating of the Earth's atmosphere and surface. Livestock and landfills generate methane (CH₄), a potent greenhouse gas. Vast amounts of greenhouse gases are also released every day by volcanic eruptions and forest fires. Greenhouse gases from all sources mix in the atmosphere and affect the entire Earth.

In 1896, the Nobel Laureate Svante Arrhenius calculated that doubling of CO₂ concentrations in the atmosphere would raise the Earth's temperatures 2-6 °C (Swaminathan and Keshavan, 2012) ^[17]. Intergovernmental Panel on Climate Change (IPCC) estimated that the Earth will warm by 1.4-5.8 °C during the current century (IPCC, 2001) ^[9].

Causes of Global warming

The major cause of global warming is the greenhouse gases. They include carbon dioxide, methane, nitrous oxides and in some cases chlorine and bromine containing compounds. The increase in concentration of these gases in the atmosphere, radiative equilibrium in the atmosphere will be changed. Their overall effect is to warm the Earth's surface and the lower atmosphere because greenhouse gases absorb some of the outgoing radiation of Earth and re-radiate it back towards the surface. The net warming from 1850 to the end of the 20th century was equivalent to nearly 2.5 W/m² with carbon dioxide contribution about 60 % to this figure, methane about 25 per cent, with nitrous oxides and halocarbons providing the remainder. In 1985, Joe Farman, of the British Antarctic Survey, published an article showing

the decrease in ozone levels over Antarctica during the early 1980s. The response was striking: large scale international scientific programmes were mounted to prove that CFCs (used as aerosol propellants in industrial cleaning fluids and in refrigeration tools) were the cause of the problem. Even more important was abrupt international action to curb the emissions of CFCs. The second major cause of global warming is the depletion of ozone layer. This happens mainly due to the presence of chlorine-containing source gases. When ultraviolet light is present, these gases dissociate releasing chlorine atoms which then catalyses ozone destruction. Aerosols present in the atmosphere are also causing global warming by changing the climate in two different ways. Firstly, they scatter and absorb solar and infrared radiation and secondly, they may alter the microphysical and chemical properties of clouds and perhaps affect their lifetime and extent. The scattering of solar radiation acts to cool the planet, while absorption of solar radiation by aerosols warms the air directly instead of permitting sunlight to be absorbed by the surface of the Earth. The human contribution to the amount of aerosols in the atmosphere is of various forms. For instance, dust is a by-product of agriculture. Biomass burning generates a mixture of organic droplets and soot particles. Many industrial processes produce a wide diversity of aerosols depending on what is being burned or generated in the manufacturing process. Moreover, exhaust emissions from various sorts of transport produce a rich mixture of pollutants that are either aerosols from the outset or are transformed by chemical reactions in the atmosphere to form aerosols.

Impact of Global warming

Predicting the consequences of global warming is one of the most difficult tasks faced by the climate researchers. This is due to the fact that natural processes that cause rain, snowfall, hailstorms, rise in sea levels is reliant on many diverse factors.

As Earth warms and temperatures rise, regional climates are affected in different ways. Some areas of South and Southeast Asia are experiencing heavier monsoons and rising sea levels, while other areas, such as southern Africa and the American Southwest, are experiencing more severe droughts and crop failures.

Warmer temperatures also produce increased evaporation, which leads to heavier rainfall and snowfall. But the increased precipitation is unevenly distributed, leading to heavier rainfall in some locations and droughts in others. Heavier snowstorms, stronger hurricanes, more intense heat waves, and extreme rainstorms and resulting flash floods are occurring more frequently around the globe (IFAW, 2013) ^[8]. Warmer air temperatures also lead to higher ocean temperatures, and warmer oceans affect global ocean currents and associated weather patterns. The Gulf Stream a strong ocean current that brings warm water from the equator up the east coast of North America and across the North Atlantic to northern Europe keeps winters in the United Kingdom as much as 9 °F (5 °C) warmer than they might otherwise be (IFAW, 2013) ^[8].

International naturalists suggest that the Gulf Stream will likely slow down as a result of climate change, reducing its warming effect. While due to global warming, global average temperatures continue to rise, the cooling effect due to the slowing of the Gulf Stream means that northern Europe may not experience as much warming as other

regions (IFAW, 2013) ^[8].

Global warming effects have already started showing up with increasing intensity, namely changes in species habitats and habits, acidification of oceans, loss of wetlands, bleaching of coral reefs and increases in allergy including pollen, among others (Borenstein, 2007) ^[2].

Impact on Environment

Acidification of Ocean: Human activities are responsible for dropping the pH of oceans because they absorb nearly a third of the carbon released into the atmosphere. This acidification renders some crustaceans and coral unable produce their protective shells and skeletons. Coral reefs, which serve as habitat for thousands of marine species, are being destroyed by bleaching due to ocean acidification. This destruction of marine life is a threat to the entire ecosystem humans included.

Hot weather: The continue increase in temperature is responsible for drought which alters the habitats of that area because plants and forests suffer from the lack of water. Increased wildfire activity due to hot, dry conditions poses a risk for safety of wildlife. It destroys important wildlife habitats. Stronger and more frequent storms affect the distribution and concentration of the low links on the marine food chain plankton and krill thus having a domino effect on many ocean species.

Melting of Sea Ice: Due to increase in environmental temperature, sea ice is melting at an alarming rate which exert the pressure on iconic species like polar bears, ringed seals, penguins, and whales etc, because melting of ice disrupts the food chain, hunting habits, reproduction, protection from predators, and the ability to travel long distances.

Rises in Sea-Level: Rising sea level presents extreme threat to marine ecosystems which can lead to disturbance in habitat and patterns of survival of marine species. Coastal wetlands are one of the most productive natural ecosystems (Day *et al.*, 1989) ^[3]. Wetlands and coastal ecosystems are at a huge risk due to increasing sea levels. Many communities have already become climate refugees to evade rising sea level (Anonymous, 2007) ^[1]. The IPCC predicts that in the next century, average sea level will rise by 0.18–0.59 m compared to the 1980–1999 levels (Parry *et al.*, 2007) ^[14]. Other climate models go even further, with estimates of 0.5–1.4 m a rise that would inundate many low-lying areas. Human population and development pressure is in many cases likely to prevent coastal habitats from moving inland, thus leading to net habitat loss. Such changes will have immediate impacts on many wildlife species (Michener *et al.*, 1997) ^[12]. Sea turtle populations are likely to be hit as their nesting beaches are inundated. It is predicted that a rise in sea level of 0.5 m will result in the loss of 32 percent of sea turtle nesting grounds (Parry *et al.*, 2007) ^[14]. Mangrove forests would seem to be pre adapted to inundation, as they thrive in coastal locations below the high tide where their stilt roots are submerged in saline water on a daily basis. They cannot, however, survive permanent submersion due to rising sea levels, and mangrove die-off has been reported from several locations (Ellison, 1993) ^[4].

Indian coastal areas vulnerable to climate change are Sunderbans, Maharashtra, Goa and Gujarat (Rann of Kutch).

Species composition and distribution will surely be affected by such changes (Rathore and Jasrai, 2013) ^[15]. The Sundarbans is the largest natural low-lying mangrove ecosystem in the world. The sea level rise recorded over the past 40 years is responsible for the loss of 28 percent of the mangrove ecosystem. Modelling suggests that up to 96 percent of suitable tiger habitat in the Sundarbans could be lost in the next 50–90 years (Loucks *et al.*, 2010) ^[10].

Shifting of Species

Plant and animal species of hills are shifting as the planet warms. Some species are able to adapt and move while others cannot, and these will disappear with their disappearing habitat. In the Mandakini Valley of northern India, scientists report that the oak forests have been invaded by pine trees (between 1 000 and 1 600 m), particularly on south-facing slopes. This phenomenon can also be observed in many other valleys of the region. Many sources of water, such as springs, have dried up because of the disappearing oak trees and invading pines (FAO, 2012) ^[5]. Due to shifting of species, unacquainted species comes into contact with each other. This result in competition for resources and changes in the way predators interact with their prey. For example, red foxes have moved northward toward a warming tundra and compete for prey with native Arctic foxes.

Impact on Agriculture

Agriculture and fisheries are highly dependent on the climate. Increases in temperature and carbon dioxide (CO₂) can increase some crop yields in some places. But to realize these benefits, nutrient levels, soil moisture, water availability, and other conditions must also be met. Changes in the frequency and severity of droughts and floods could pose challenges for farmers and ranchers and threaten food safety. Meanwhile, warmer water temperatures are likely to cause the habitat ranges of many fish and shellfish species to shift, which could disrupt ecosystems. Overall, climate change could make it more difficult to grow crops, raise animals, and catch fish in the same ways and same places as we have done in the past. The effects of climate change also need to be considered along with other evolving factors that affect agricultural production, such as changes in farming practices and technology.

Indian agriculture normally referred to as a “gamble with monsoon” would become even more to weather behaviour vulnerable. With lesser precipitation and increased evaporation, transpiration, survival and productivity of agricultural crops would become a serious problem. The coastal soil and aquifers would become salinized and staple food crops like paddy would come under severe stress. With every 1 °C rise in temperature, yield of rice and wheat will decrease. A rise in sea water temperature will affect mortality of fish and their geographical distribution (Swaminatha and Keshvan, 2012) ^[17].

Thus, there is a need for climate resilient farming systems. Climate literacy should be spread and a cadre of Community Climate Risk Managers should be formed in villages. The calamity of climate change should be converted into an opportunity for developing and spreading climate resilient farming techniques and systems (Swaminathan and Keshvan, 2012) ^[17].

Impact on Animals

Global warming can severely affect the health of living

beings. Excess heat can cause stress which may lead to blood pressure and heart diseases. Crop failures and famines, which are a direct consequence of heating up of earth, can cause a decline in human body resistance to viruses and infections. Global warming may also transfer various diseases to other regions as people will shift from regions of higher temperatures to regions of comparatively lower temperatures. Warmer oceans and other surface waters may lead to severe cholera outbreaks and harmful infections in some types of sea food. Moreover, it is an established fact that warmer temperatures lead to dehydration which is a major cause of kidney stones.

Animal species survive within certain temperature ranges and are able to tolerate variations in weather. The effects of climate change may push some species to the edge of extinction, while other species may flourish. Warmer spring temperatures may cause birds to begin their seasonal migrations or nesting and cause bears to emerge from hibernation earlier than usual. When bears emerge before their regular food sources are available 80% of bears' diets are plants they may starve or wander into towns in search of food. For those animals that rely on late summer plants to survive through the winter, warmer, drier summers may affect their ability to find enough food. The annual flooding of the Brahmaputra River in the northwest corner of India has always been important to the health of Kaziranga National Park and the protected animals that live there, including elephants, rhinoceroses, and tigers. The increasing intensity of Asian monsoons in recent years has caused greater floods, displacing people and killing animals. Also, a 2012 study found that climate change could have a greater impact on Asian elephants dwindling numbers than previously thought. Researchers concluded that young elephants are particularly threatened by increasing temperatures, which can double their mortality risk. Elephants, like humans, reproduce later in life, so if calves die before they can mate, then the species will be unable to survive. Animals that require cooler temperatures are shifting their ranges to higher elevations or towards the poles as the temperatures in their home ranges rise. The American pika, a small mammal related to rabbits and hares, is adapted to life in the alpine environment. They are extremely sensitive to temperature and can die when temperatures reach only 78 °F to 85 °F (25.6-29.5 °C) (IFAW, 2013) [8].

Not only does climate change affect disease in human populations, it also alters the disease behavior in animals as well. The devastating amphibian disease chytrid fungus, likely exacerbated by warmer temperatures, has left many amphibian populations dwindling or extinct. Seasonal pests, like bark beetles in the US, breed longer in warmer weather and thirsty, drought affected trees are more susceptible to infestation. Temperatures in the Himalayan ecosystem are increasing at a rate of 0.9 °C annually, which is considerably higher than the global average of 0.7 °C per decade. Changes in the For example, mosquito nets are now needed in Lhasa, the administrative capital of the Tibet Autonomous Region of China. Residents of the city, located 3 490 meters above sea level, have reported seeing mosquitoes for the first time ever. There are similar reports of flies at Mount Everest base camp in Nepal. The presence of these insects suggests the possible spread of vector borne diseases, such as malaria and dengue fever, to areas where cooler temperatures previously protected people from these threats (FAO, 2012) [5].

Impact on Public health: Impact of global warming on public health will be extensive, ruthless and affect all sectors of the public health system. It will stir up the plague, malaria, dengue fever, kidney stone, Hantavirus and vector-borne diseases (Murugappan and Subbarayan, 2010) [13]. Climate variables are able to affect the prevalence, intensity and geographical distribution of helminthes, directly influencing free-living larval stages and indirectly influencing mainly invertebrates, but also vertebrates, hosts. Impact of climate change appears to be more pronounced in trematodes, and is mainly shown by increased cercarial production and emergence associated with global warming (Singh *et al.*, 2011) [16]. Nematodes diseases including heterakiasis, different trichostrongyliases and protostrongyliases, ancylostomiasis and dirofiliariases, are the helminth diseases most intensively analysed with regard to climate change (Mas-Coma *et al.*, 2008) [11]. Indian public health system is very weak and fragile e.g. more than 1500 people die of gastro-intestinal infection every day, tuberculosis kills more than 1000 per day, about 20,000 people die by rabies per year and about 20,000 people die of poisonous animal bite (Singh *et al.*, 2011) [16]. Vector borne diseases such as malaria, dengue, JE, Chikungunya, Kalaazar are panic problems in our country. H1N1, a swine flu virus is a new strain of influenza virus and WHO declared as pandemic on 11 June, 2009 (Hati, 2009) [7]. It was first reported April 2009 in Mexico and affected 168 countries including India. Dengue as an important public health concern globally about 100 million person affected annually from the tropical and subtropical countries (Gubler, 1998) [6].

Thus it can be concluded that global warming is a big hazard and appropriate measures must be taken to tackle this serious problem. This problem is not only causing trouble to the human beings but also to animals and plants. Melting of polar ice caps will lead to floods which can cause mayhem everywhere. Rise of sea levels will devastate agricultural and fishing activities. To embark upon these problems, some remedial steps must be timely taken which include but are not limited to the use of renewable sources of energy and stopping deforestation. The solution to global warming requires that countries should reduce greenhouse gas emission to the level that the world's sinks-forests, soils and oceans can absorb.

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