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Consequences of Climate Change

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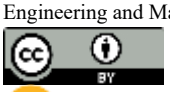

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Abstract:
The Earth's average temperature is sustained at 15°C by the atmosphere, which functions similarly to a sheet of plastic in a greenhouse. Without this condition, the Earth would be in a state of extreme coldness, rendering life impossible. Nevertheless, an intensified greenhouse effect can lead to an elevation in the Earth's temperature, as has been observed in the recent historical period. The global mean temperature of the Earth is increasing. The phenomenon referred to as global warming is having a direct impact on the climate of our planet.
The comparison of the atmosphere to a "glass plastic sheet in the greenhouse" is a simplified analogy. The greenhouse effect is primarily due to certain gases in the Earth's atmosphere, such as carbon dioxide, water vapor, and methane, which trap heat from the sun and warm the planet.
While the greenhouse effect is essential for maintaining a habitable temperature on Earth, an excess of greenhouse gases, mainly from human activities like burning fossil fuels and deforestation, leads to an enhanced greenhouse effect. This results in global warming, causing an overall increase in Earth's average temperature.
Global warming is a long-term trend of increasing temperatures, and it contributes to changes in climate patterns. The impacts of global warming include rising sea levels, more frequent and severe weather events, and disruptions to ecosystems.

Key words: Climate change, Global warming, Methane, Green house, and Aerosols

Introduction:

Weather, climate and climate change

It is not possible for most of us to differentiate between weather and climate. Fluctuations in weather conditions are often considered as climate change, which is not correct because weather is a local and short-term phenomenon while climate is a long-term phenomenon observed over a much larger area. In 1966, the WMO (World Meteorological Organisation) coined the term "climate change" to include all climatic variability both natural and anthropogenic prevailing for more than 10 years. On the other hand, weather fluctuations may happen on day-to-day basis. It is difficult to perceive climate change through casual observations but only long-term records can give some indication of climate change[1].
Climate change is safe to be one of the biggest challenges of mankind. Human activities, especially the combustion of fossil fuels, contribute to the increase of greenhouse gases in the atmosphere and thus to the pace of climate change[2].
A general definition of climate change is a change in the statistical properties (principally the mean and spread) of the climate system when considered over long periods. Fluctuations over periods shorter than a fewdecades, like El Niño, do

not represent climate change. The term is now used to indicate changes caused by human activities vis-à-vis the changes resulting from natural processes on Earth. In environmental policy, climate change is synonymous with global warming caused by human activities, Global warming refers to increase in the Earth's surface temperature while climate change includes everything affected due to increase in levels ofgreenhouse gases (GHG'S) in the atmosphere[3].

Global warming

Earth is surrounded by air (atmosphere) consisting of several layers of gases. At 100 km above the sea level there is an imaginary line. Karman Line, that defines the boundary between the Earth's atmosphere and outer space. Sun's radiations pass through the atmosphere and reach the Earth, which heats up and emits infrared radiation. This emitted radiation travels up towards outer space, but Earth's atmosphere has certain gases called GHG'S, which restrict the passage of heat from Earth to space. The system works like a GHG'S. Greenhouses are enclosures with glass walls and roofs. Now-a-days plastic sheets have replaced glass foreconomy and flexibility. Sunlight enters the greenhouse and warms the inside. When the heat waves try to goout, glass or plastic restricts free passage. That is why the inside of a greenhouse it is warmer than the outside.Greenhouses are used to grow plants at high altitudes and in places where the night temperature drops too low Greenhouses protect plants against chill. The Experience showed that the greenhouse effect in our daily life. When a car or bus is parked in Sun with glass windows shut, the inside becomes hot because of greenhouse effect. Earth's average temperature is 15°C maintained by the atmosphere, which acts like glass/plastic sheet in the greenhouse. If it were not so, the Earth would be frozen, and life would not be possible here. However with stronger greenhouse effect the Earth's temperature can rise, as has happened in recent past. Earth's average temperature is rising. This is called global warming, which is directly affecting Earth's climate[4].

Greenhouse gases (GHG'S)

There are important gases that showed greenhouse effect.

Water vapour : Water vapour is the naturally occurring and most abundant GHG'S present in theatmosphere. Water evaporates from oceans, lakes, rivers, ponds, soil, living organisms, etc., and enters theatmosphere as vapour.

Carbon dioxide (CO_2): This gas is produced naturally when living organisms perform respiration. Most living organisms utilise oxygen and produce CO_2 which enters the atmosphere. But green plants utilise CO_2 and produce oxygen during photosynthesis and acts as a natural sink for the gas. Also, volcanoes emit CO_2 into the atmosphere. Fossil fuel burning, and manufacture of cement are other major contributors.

Methane: This gas is generated in the digestive system of ruminant animals like cattle, sheep, deer, antelopes, and giraffes. It is also generated in wetlands due to decomposition of vegetation and also, generatedin paddy fields. When coal, petroleum and natural gas are used as fuel, methane is generated. Landfills can also generate methane. That is why there is occasional fire in landfills as methane is highly inflammable

Nitrous oxide : Nitrous oxide is produced naturally as well as due to human activities. Oxidation ofatmospheric ammonia is an important natural source. Also, nitrogen in soil forms the gas Nirogenous fertilisersused in agriculture also produce the gas. Some nitrous oxide is generated during the burning of fossil fuels,biomass and on decomposition of animal manure.

Ozone (O_3) : This gas occurs naturally in the atmosphere. O_3 present in the troposphere influences climate change O_3 in the troposphere, extending from the ground up to the height of 7 to 20 km above mean sea level, is formed in the presence of sunlight. Also, hydrocarbons and oxides of nitrogen from automobile emissions react in the presence of sunlight to form O_3 gas at ground level[5].Saveral important natural factors triggering climate change

Volcanoes : Volcanoes are part of the lithosphere (outer part of the Earth), about 100 km in depth.During 1979 to 2010 aerosols released by two large volcanoes (El) Chichon in Mexico and Pinatubo in thePhilippines) influenced the atmospheric temperature. But scientists, including those from US Geological Surveysaid that human activities generate much more (about 100 to 300 times more) CO_2 than volcanoes.

Oceans: Oceans cover about 71% of the Earth's surface and play an important role in deciding the Earth's climate. Ocean currents move water in specific directions and carry vast amounts of heat across theEarth. But the entire Earth is not influenced uniformly. For example, the Humboldt Current affects Peru andadjoining areas in South America, but El Niño, which periodically warms the sea surface in part of the Pacific Ocean, affects the entire Earth, including India, reducing rainfall.

Forest fires: During past few decades, the number of wildfires has increased, and more areas areburning. In future it is expected that wildfires could become more and more. In recent years, there have been big fires in Siberia and many other places around the world where typically large-scale wildfires were notcommon. The affected areas are those which have become drier and hotter, and where spring comes earlier. Drier conditions and higher temperatures also increase the duration and severity of the wildfires. IPCC (2007)observed that during previous two decades, forest fires in Asia increased largely due to rise in temperature anddecline in precipitation along with increased land use[6].

Anthropogenic sources of greenhouse gases (GHG'S)

Fossil fuel engines: Global warming started in 1712 when British inventor, Thomas Newcomen made the first easy-to-use steam engine. That event led to the Industrial Revolution leading to large-scale burning ofcoal. In 1861 an Irish physicist, Karl Benz built the first practical motor car with internal-combustion engine.Since then energy consumption and release of GHG'S into the atmosphere have continuously increased.

By 1927 that carbon dioxide from fossil fuels burning and industrial activities were about one billiontones/year. In 1938 a British (Guy Callender) claimed that Earth's temperature had gone up in 19th century due to CO_2 entering the atmosphere. By 1975 global warming came in focus because a scientific paper written byUS scientist Wallace Broecker explained that humans were disturbing the climate by adding excess of CO_2 into the atmosphere. By 1989 carbon emissions from fossil fuel burning and industries reached six billion tones/year[7].

Aerosols: Aerosols are both natural and anthropogenic, containing a mixture of sulphates, nitrates ammonium, organic carbon, black carbon, sea salt, mineral dust, trace metals and water. Aerosol particlesscatter and absorb solar radiation and modify the properties of clouds. Black carbon causes warming; other particles result in cooling Aerosols are less persistent compared to GHG'S, having mainly regional effects. Infact, aerosol cooling has masked some of the global warming. In the long term, CO_2 is the main driver ofclimate change.

Agricultural activities: Fertiliser industries emit GHG'S. When chemical fertilisers are applied, nitrousoxide is released from soil. Livestock, especially cattle are responsible for almost 1/3 of methane emissionsfrom the agriculture sector. Also, livestock manure adds methane and nitrous oxide to the atmosphere. Rice fields are another source of methane burning of crop residues emits methane, CO_2 and nitrous oxide. Thusagriculture plays important role in causing greenhouse effect.

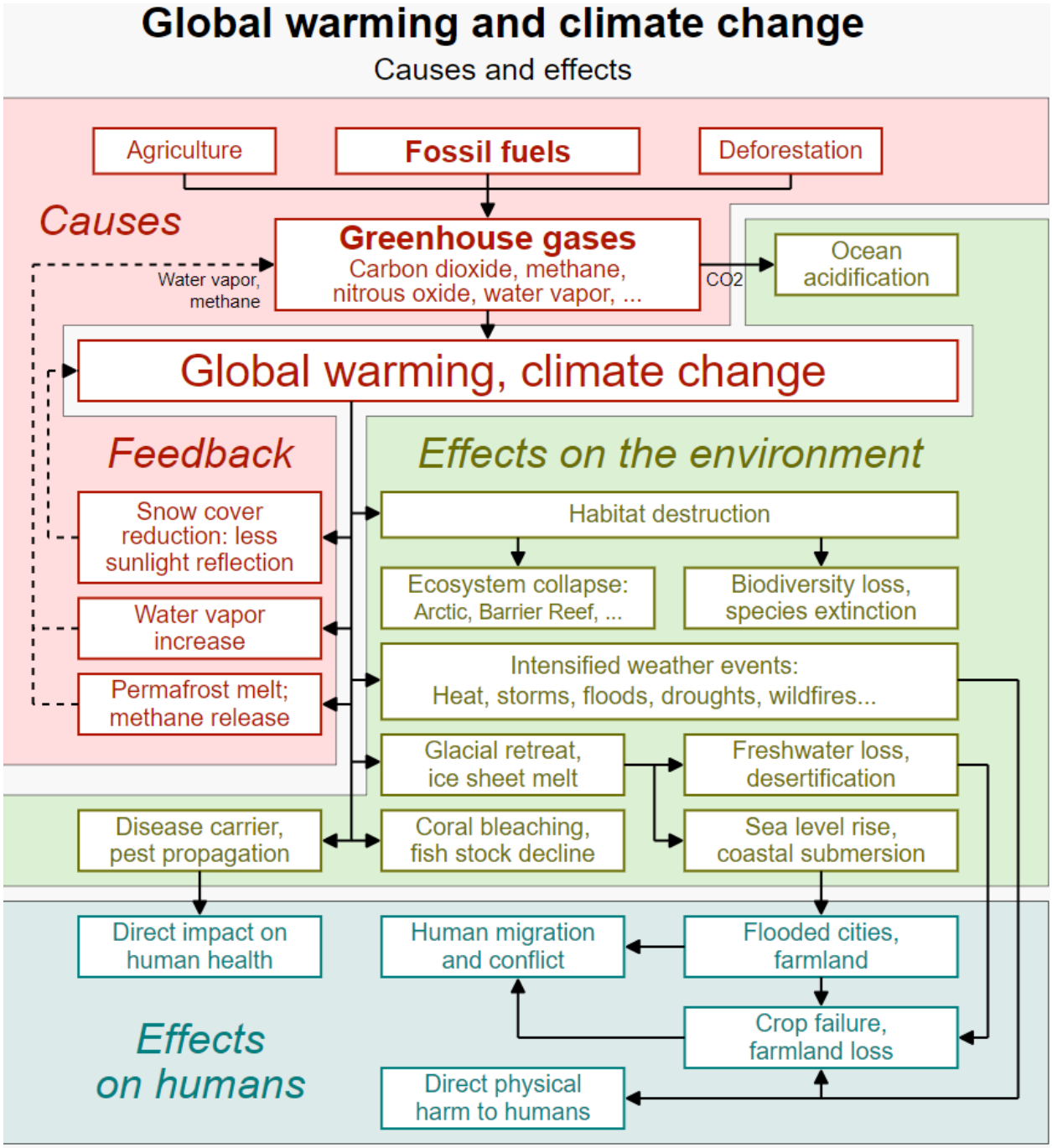
Deforestation: About 25% of the total GHG'S are released on account of deforestation. Forests are amajor storehouse for CO_2. Scientists say that CO_2 stored in the forests is more than double the amount present in the atmosphere. When any area suffers deforestation not only is a large carbon sink destroyed but the CO_2 locked in the vegetation is also released.

In India, deforestation has been going on for centuries. During the colonial rule, exploitation of the forestresources was the maximum. Even after Independence the trend did not reverse. Industrialization, urbanization,infrastructure development, etc., have contributed substantially. In certain areas, slash-and-burn agriculturehas been going on historically. In past the cycles were long to allow regeneration of the forests. With time thecycles shortened resulting in rapid deforestation.

Recently a new issue is there: crop residue burning. Changes in harvesting techniques leave residues which find no use. The farmers burn them in the fields, adding GHG'S and other pollutants to the atmosphere. UP, Punjab and Haryana contribute substantially. The issue comes into focus almost every year. Globally 100,biomass burning contributes several times more GHG'S compared to natural forest fires[8].

Destruction of coral reefs and mangroves: Coral reefs, present in shallow waters of the tropicalareas store about 2.4 kg per m^2/year calcium carbonate on average as the shells of corals are made of calciumcarbonate. The Great Barrier Reef (Australia) collects about 50 million tonnes of calcium carbonate/year. Globally the production of calcium carbonate is about 900 million tonnes/year. Thus, coral reefs act as sink forabout 111 million tonnes of carbon/year. In recent years, coral reefs have been getting destroyed due to humanactivities, e.g., dumping of wastes, acidification of water, navigation and mining of corals for calcium carbonate, etc. Mangrove forests also capture CO_2 through photosynthesis reducing the greenhouse effect. However,

mangroves are being devastated in many areas, especially in poor countries hampering their positive role in mitigating climate change.



Source:https://en.wikipedia.org/wiki/Effects_of_climate_change#/media/File:20200118_Global_warming_and_climate_change_-_vertical_block_diagram_-_causes_effects_feedback.svg

Present consequences of global warming

Melting of glaciers and ice: According to WMO (World Meteorological Organisation), 2016 wasrecorded as the hottest year till now, 1.2°C above the pre- industrial baseline. Global warming is a potential threat for the two Poles. Satellite observations indicate that areas covered with snow and ice in the Northern Hemisphere are decreasing. In the Arctic region the impact of climate change is double than the Earth's average. In February 2019, a Russian town declared an emergency after more than 50 hungry polar bears invaded a town in the archipelago of Novaya Zemlya, which stretches into the Arctic. The bears generally hunt seals in the Arctic. As the Arctic ice is thinning due to climate change, the animals, mad for food, move ashore closer tohuman populations. Models suggest that Arctic sea ice is declining at about 13% /decade. Some environmentalists however, consider melting of snow and glaciers as an opportunity. Agriculture may become possible in areaspresently covered by snow/ice. Places cut-off during the winters will become more accessible. Melting of icemay render navigation easier in Antarctica and the Arctic, and distances will be reduced. Exploration of gas,oil, minerals, etc., in those areas will become easier and economical. But more important issue is that globalwarming will result in multiplicity of problems, which cannot be compensated by such small benefits. Also,people who may benefit will not be those suffering the most[9].

Effect on Himalayas: The Himalayan range is a big resource provider to several countries. Thetemperature in the Himalayas is rising faster than the global average. During the last one century the Earth'saverage temperature has gone up by less than 1°C while certain regions in the Himalayas have experienced arise of 0.6°C in only the last one decade. This will adversely affect life in the region and the economy. There may be shortage of water in the Himalayas and downstream. Floods may be more frequent as the quantity of melt water will fluctuate drastically.

Sea level rise : Global warming will cause sea level rise while some regions will be affected more. Bythe end of 21st century, ocean warming will be about 0.3 to 2.0°C, causing volume expansion and resulting in water level rise. Another factor will be the melting of ice and snow, Ice in Antarctica and Greenland is alreadymelting, and more water is being added leading to swelling of the oceans further. Estimates suggest that in recent times around 159 billion tonnes of ice are being lost every year. By the end of the current century theglobal glacier volume, excluding peripheral glaciers of Antarctica may decrease by 15 to 85%. During 2015the level of Arctic sea ice was the second lowest in history. Some scientists believe that the entire Arctic ice maymelt by 2050. Rapid melting of the Arctic ice has great potential to devastate. There will be rise in sea level, threatening coastal areas and islands. Number of people affected may go to hundreds of millions.

Evidence indicates that the average global sea level rise was 1.7 mm/yr during the period from 1901 to2010. During the period 1971-2010 the rate became 2.0 mm/ yr and between 1993 and 2010 the rate was

3.2 mm/yr. It is expected that there will be greater rise in future. By the beginning of the next century sea levelsmay go up by 20 to 40 cm. If the ice sheet in Greenland melts completely, sea level may rise by as much as 7

m. According to IPCC, the sea level rise will not be uniform all over. But by the end of the 21st century morethan 95% of the oceans may rise. Also, it is projected that 70% of coastlines will experience sea level changes.

Marooning of coastal areas will displace millions: Bangladesh and Netherlands will be worst victims. Sea level rise will also intensify the storms. During 1960 to 1969 less than 20 instances of floods and severe stormswere recorded in Southeast Asia. During 2000 to 2008 the number reached 120, i.e., a six-fold increase.Intrusion of sea water will create further aggravate water scarcity in coastal areas. In this regard it may be mentioned that of the ten largest cities of the world, eight are close to the coasts. Also, world over more people have been settling along lowlying coastal areas. In 1990 the number was 538 million. In 2010 the estimated number was 724 million, i.e., a 34% increase.

Water availability: Many parts of the world suffer from water scarcity. Only climate change can intensify the problem. There will be more rains in some regions while others will get less. Also, the rainfall will be moreerratic, resulting in floods or droughts. It is projected that the runoff will reduce for all the Indian river basins except for Narmada and Tapti. Already a decrease of between 6 to 8% in monsoon rainfall has been observedin the Northeast, parts of Gujarat and Kerala and eastern Madhya Pradesh. Also, the glaciers an importantsource of fresh water-are being adversely affected. Even if the present targets about climate change are achieved,at least 1/3 of the glaciers in the Himalayas will face melting by the end of the 21st century. If the goals are not met, and GHG'S emissions continue as at present, the Himalayas may lose about 2/3 of its glaciers by the end of the current century. Himalayan glacial retreats will impact flows in perennial rivers like Brahmaputra, Gangesand the Indus.

A large part of India shows water- deficient. Rising temperature will aggravate the problem further.Reports suggest that the Indo-Gangetic plain will face severe droughts if conditions do not improve. A group of Indian, Chinese and University of Cambridge scientists have concluded that extreme wet events and droughts may become more frequent. Another study has indicated that in the Indo-Gangetic plain, the probability of adrought was 45%. Cereal production is declining in the area since 2000 due to expansion of drought- affected areas from 20% and 25% to 50% and 60%, respectively before and after 2000, The study included Haryana,Uttar Pradesh. Uttarakhand, Chhattisgarh, Bihar, West Bengal and parts of Madhya Pradesh and Odisha.Obviously, it will have serious implications[10].

Impacts on farming : Most of the global food comes through agriculture. According to scientists allover the world, climate change will make it difficult for plants, animals and even people to survive in their own habitats. Also, changes in weather conditions will adversely affect crops. Wheat and rice grow better in warm environment but maize and sugarcane cannot grow at high temperatures. Also, the crops require differentdegrees of rainfall. Climate change will alter the temperature regimes, and rain patterns resulting in failure of crops. Changes in the rainfall patterns will result in flooding of certain areas while others will face drought. We are already observing that floods and droughts regularly destroy crops in different parts of the world, including India. The problem will become more intense with time.

IARI, New Delhi has confirmed that the impact on agriculture will vary greatly, region to region and onthe crop type. Also, there will be boundary changes for certain crops. But rain-fed agriculture will be affectedmore. It may be mentioned that in

lndia and many other countries rain-fed agriculture accounts for high percentage of production.

In general a temperature rise of about 2°C could reduce grain yields in wheat in most places. Wheat contributes more than 20% of the total food grains globally. More than 80% of the productions are utilised in the developing countries, locally, In India wheat contributes more than 35% of the total grains produced. Ifconditions remain as they are, climate change could seduce production by 6 to 23% by the year 2050 and by10 to 40% by the end of the current century. For the Indo-Gangetic Plains, which is a major producer ofwheat, heat stress will be important. Central and south-central regions of India with warmer climates are likelyto suffer more. Another report says that temperature rise will adversely affect global food production, but India would be the hardest hit. Crop yield in India, the second largest producer of rice and wheat, would fall by upto 30% within a decade or so. According to US based Universal Ecological Fund, higher temperatures willaffect world agricultural output, but India will be worst hit.

Temperature rise will affect rice production as well; with maximum impact in eastern India. With reducedsunlight and higher temperature, the number of grains/plant will reduce and the grains will not be healthy. Rice plants become sterile (without grains) if exposed to 35°C or above for more than an hour during flowering season. Also, the International Rice Research Institute has concluded that there will be about 20% reduction inrice yield for every 1°C rise in temperature. Total yield may drop by as much as 30% within a decade.

Climate change can also affect soil properties. Increased temperature will decompose soil organicmatter faster and more nutrients will become available. Plants may grow faster but with long-term nutrientdeficiency. Faster growth of plants can also exhaust available water, triggering drought conditions. Also,pathogens, weeds, and pests, etc., will proliferate faster at higher temperatures.

Impact on plants and animals: Life on the Earth has been continuously changing with changingenvironment. Minor changes may not make substantial difference, but major changes could finish groups of plants and animals. We find fossils of large numbers of extinct plants and animals caused by environmental changes.

Change in the climate of an area affect temperature and rainfall patterns, important factors for plants andanimals. The prevalent life on Earth took millions of years to adapt. If human-induced climate change is forced upon these organisms, there will be adverse implications. Organisms may disappear partially or completely, or they may change their habitats. If they cannot find suitable alternative habitats, they will be finished. Certain species of plants and animals are already responding to higher temperatures by moving to cooler areas. It is being suggested that climate change can result in extinction of about 25% of birds, animals and plants and alsoalters the life cycles of plants and animals. Changes in bird migration and pattern of flowering in plants, etc.,have been recorded in recent years. For animals, changes in breeding time, migration time, spring appearance,etc., have been observed in case of animals. In certain birds return migration is absent. They continue at theplaces of nesting[11].

Impact on human health: Humans will also be directly affected by climate change. People living incertain regions will face greater risk. Migration of population from coastal areas to inland will cause crowdinginland, impacting all facets of life, including health[12].

Meteorological parameters like humidity, rainfall and temperature effectively influence transmission and intensity of infectious diseases. In 2007 the IPCC had warned that climate change could expand vulnerable areas for infectious diseases such as dengue, diarrhoea, etc. For developing countries, spike in diarrhoeal infections, cholera, dysentery and typhoid will be of great concern. Warmer climate will help many bacteria to survive longer, spreading diarrhoea, cholera, cryptosporidiosis, giardiasis and salmonellosis, etc. Even at presentabout 25% deaths of children in South Asia are caused by diarrhoeal diseases. Floods in Bangladesh. India, etc., are generally linked with outbreaks of diarrhoea and infectious respiratory diseases. Also, leptospirosisand rotavirus have shown links with floods. Flood waters contaminated with municipal waste help spreading of various diseases caused by bacteria and viruses. Scarce clean water and inadequate sanitation facilities areimportant health factors. Increased pressure on water availability due to climate change will lead to greaterproblems[13].

Malaria is a serious problem in many parts of the world, including India. More than one million deaths arereported annually. Changes in temperature, humidity, rainfall and lower immunity levels can increase incidence of the disease due to mosquito population growth and better development of the parasite (Plasmodium). If temperature rise continues, malaria is likely to move towards higher altitudes and latitudes, putting greaternumber of people at risk. There are various other mosquito- related diseases like chikungunya, dengue, filariasis,etc., endemic to South Asia.Also ticks spread diseases. Their intensity may change, and geographical distributions may alter due to Climate Change. Similarly, rickettsial diseases, transmitted by lice or ticks will increase.

Another important issue is the Zika virus, generally spread by mosquitoes. Certain studies suggest that the sudden spread of the virus in past could be linked to climate change. Also, in case of H1N1 virus, commonlycalled Swine Flu, climate change has been linked to faster spread of the disease. The disease has causedserious concerns in India too.

Conclusion:

All things considered, it is evident that socioeconomic factors combined with climate change can make people more vulnerable in both wealthy and developing nations. The sustainability of the ecosystem may be threatened, and nature and wildlife may suffer greatly as a result. Therefore, regardless of money or way of living, it is critical to support initiatives in both of these countries and to take some action. Regardless of where on Earth they reside, everyone is equally affected by the global warming.

In general, there are two basic categories of greenhouse gas emissions related to transition risk: transition risks and mitigation activities. The term "climate protection" refers to actions that can be performed to restrict alterations in the global climate brought about by human activity. Science and research that promote climate protection work to better understand change and the body of information that guides policy related to climate protection. In addition to combating climate change, we also need to address other pressing global issues. We cannot afford to ignore climate change or the larger question of sustainability given the magnitude of these difficulties, which may take months or even years to tackle. The only option to prevent the rising risk of economic and physical hazards that come with this reality is to actively reduce emissions daily life and the economy.

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