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ANTHROPOGENIC EMISSIONS AND THE CLIMATE THREAT: A REVIEW OF RISKS AND READINESS

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RESEARCH ARTICLE

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Abstract

Greenhouse Gases in atmosphere have increased substantially especially after the Industrial Revolution. Studies revealed that the increased anthropogenic activities are responsible for that. Many studies revealed that abundance of greenhouse gases in atmosphere has been instrumental in raising average temperature of earth and ocean surface resulting frequent occurrences of climate-related hazards all over the world. If the situation continues unabated, human civilization will suffer enormous. This paper highlights the present scenario of climate-related changes that we have been facing and its impact on the society. It also tries to assess the preparedness of the disaster management associated with that.

Keywords: *Greenhouse Gasses, Climate change, Global warming, Climate risk Index, Disaster management.*

Introduction

Since the beginning of the human civilization the relationship between human and nature has been deep in nature. People used to get everything necessary for their survival from the nature in the form of food, cloth, habitation etc. In this process whatever was lost from the nature was automatically fulfilled. The question of conflict between the nature and human beings was absent. Till the Industrial Revolution the pressure on the environment was under control. The problem has started only after the Industrial revolution and it is getting severe day by day. Since the Industrial Revolution total population has increased manifold compared to that of Pre-Industrial Revolution.

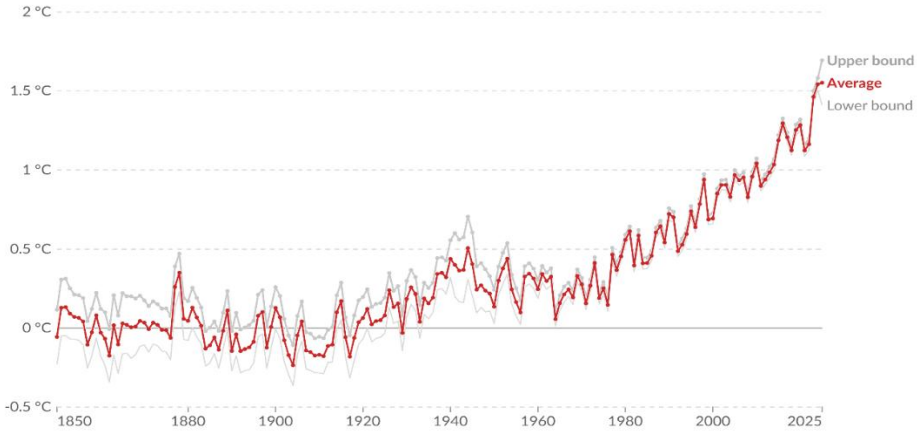
Table 1: World Population (billions)

Year	Population
AD 1	250 million
1750	728 million
1950	2.49
2000	6.17
2010	7.02
2020	7.89
2023	8.09

Source: Todaro & Smith 2014; UN, World Population Prospects 2024

During the period of 1 AD to 1750 AD total population increased by (728-250 =) 478 million. But during the next 200 years it rose by (2490-728=) 1762 million. By 2000 AD it increased to 6.17 billion i.e., increased by3680 million within the next 50 years. To accommodate this burgeoning population more extraction of natural resources is required. Mass consumption of goods led to the depletion of non-renewable natural resources at a faster rate resulting shrinking of forest areas and mineral resources. On the other hand, mass consumption also leads to various types of pollutions like air, water, sound, soil etc. The nature has threshold limit to assimilate all those pollutants. It started to react in a befitting manner once it crosses the threshold limit.

The amount of greenhouse gases (GHGs) in the atmosphere is increasing day by day. As the air has no political boundaries, the effects of this (presence of GHGs at higher amount) have been realizing throughout the different parts of the world. Higher concentration of GHGs in the atmosphere has profound effects on the climate changes (Filonchyk et al., 2024). The emission of Carbon di-oxide, the most important greenhouse gas is correlated with the rise in global temperature (Dilmore & Zhang, 2018).



Source: Met Office Hadley Centre – HadCRUT5 (2025) – with major processing by Our World in Data[1]

In the chart average global temperature compared to the pre-industrialization period suggest that temperature has already crossed 1.5^0 C threshold limit.

Objective of the Study

This paper intends to evaluate the present status of the concentration of Greenhouse Gases (CHGs) in the atmosphere and an attempt has been made to assess the impact of the greenhouse-induced climate changes on human civilization and the readiness of our disaster management.

Database and Methodology

This paper is based on the secondary sources of data collected from Intergovernmental panel on climate change (IPCC), Centre for Research on the Epidemiology of Disaster (CRED), Germanwatch, United Nations International Strategy for Disaster Reduction (UNISDR), World Meteorological Organisation (WMO), World Bank, Arctic Regional Climate Centre. This study is based on descriptive analysis.

Greenhouse Gases (GHGs)

The examples of GHGs are carbon dioxide (CO_2), carbon monoxide (CO), methane (CH_4), water vapour, nitrous oxide (N_2O) etc. The unique feature of these gases is that these gases trap the heat energy emitted from the surface of the Earth. This leads to rise in average temperature of the Earth surface. The concentration of CHGs is measured in parts per million (ppm), parts per billion (ppb) or parts per trillion (ppt).

Table 2: Amount of GHGs in atmosphere

	CO_2	CH_4	N_2O
Global abundance in 2023	420.0 ± 0.1ppm	1934 ± 2ppb	336.9 ± 0.1ppm
2023 abundance relative to year 1750*	151%	265%	125%

Source: World Meteorological Organisation

The threshold limit of atmospheric CO_2 concentration has been set by the scientists as 450 ppm to limit the average Global temperature within 2^0C at 1850-1900 levels. The latest data[2] on the concentration of GHGs by the World Meteorological Organisation revealed that presence of CO_2 in the atmosphere reached 420 ppm in 2023, which is 151% higher than that of pre-industrial level. In case of methane (CH_4), the concentration of this gas reached 1934 ppb in 2023 which is 265 % of the pre-industrial level. The concentration of nitrous oxide (NO_2) reached 336.9 ppb in 2023, which is 125% higher than that of pre-industrial level.

The abundance of GHGs in the atmosphere plays havoc on the climate changes. The signs of the climate changes have been realizing on many fronts like the following incidents.

1) **Global Temperature**
   Intergovernmental Panel on Climate Change (IPCC) released special report on global warming of 1.5^0C above the pre-industrial level (2018) [3]. It shows that during the period of 2006-2015, global mean temperature was 0.87^0C above the

pre-industrial level and average global temperature is heading towards 1^0C above the pre-industrial level. The report on the state of Global Climate in 2018 by the World Meteorological Organisation revealed that the global mean temperature for the first ten months (January-October 2018) was 0.98±0.12^{0}C above the pre-industrial baseline (1850-1900). The year 2024 was the warmest year on record at about 1.55^{0}C above the pre-industrial revolution (World Meteorological Organization, 2025).

2) **Sea-ice and Glacier meltdown**
Both the Arctic region and Antarctic regions have important roles for the entire Earth system. Ice extent at both poles, which is counted as how much is covered by sea-ice, was recorded at 14.48 million Km^2 in March 2017, the second lowest on record since 1979 [4]. Antarctic sea ice witnessed a rapid decline during the period 2014-2017 and it was estimated to be equalled to 30-years of Artic sea-ice decrease (Parkinson & DiGirolamo, 2021). Decrease in sea-ice extent will lead to increase in sea level.

3) **Sea level rise**
Sea level rise is a clear response to high concentration of atmospheric GHGs resulting more warmer earth. IPCC (5th Assessment Report, 2014) found that sea level rose by an average of 12 to 22 cm in the 20th century and it predicted that sea level could increase worldwide by 52-98 cm by the year 2100. It further states that even if all aggressive emission measures are taken it could rise by 28-61 cm. This will endanger the survival of the coastal cities and all island countries of the world.

4) **Ocean heat and acidification**
High concentration of CO_2 in atmosphere has a direct effect on PH value of the sea water. Increase in CO_2 leads to the decrease in the PH value of the water resulting acidification of sea water. As per the IPCC Assessment Report (AR) 2013, the upper 75m of the ocean has been warmed on an average by 0.11^{0}C per decade over the period 1971to 2000.

All these changes have been playing a greater impact on the human civilisation. Frequencies of occurrences of natural hazards have been increasing compared to that of previous years. The question of linkage between the climate change and climate related disaster is a matter of scientific research. But many studies over the years have concluded that the observed frequency, intensity, and duration of some extreme weather events have been changing as the climate system has warmed (NASEM 2016; IPCC 2023).

As per the definition of United Nations Framework Convention on Climate Change (UNFCCC, 1994), climate change is the change that can be attributed "directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods".[5]

The IPCC fourth Assessment Report (2007) defines climate change as a change in the state of the climate that persists for an extended period, typically decades or longer.[6] The climate-related disasters have been rising over the years. During the period 2004-2023, the annual average occurrences of climate-related disasters have been higher than that of geophysical disasters. Centre for Research on the Epidemiology of Disaster (CRED), Brussels, defines geophysical disaster as the events originating from solid earth e.g. earthquake, volcano eruptions, tsunami and dry mass movement. On the other hand, climate-related natural disasters are of two types. These are hydro-meteorological events (e.g. storms, floods, wet mass movements) and climatological events (e.g. extreme temperature, drought, wildfire).

Table 3: Annual average of occurrence by disaster types (2004-2023) [7]

Climate Related	No. of Events	Geophysical Related	No. of Events
Drought	16	Earthquake	26
Extreme temperature	21	Volcanic activity	5
Flood	168	Mass movement (dry)	1
Storm	106	Mass movement (wet)	18
Wildfire	11		
Total	307		48

Source: www.cred.be

Table 3 reveals that among the climate related disasters, occurrence of floods is highest. During the period 2017-2024, proportion of disasters occurred by continent is shown in the table 4. It shows that Asia has the highest number of occurrences followed by America, Africa, Europe and Oceania.

Table 4: Percentage share of disasters by continents (2017-2024)[8]

Continent	Share of Disasters
Asia	40.8
Africa	16.9

America	26.5
Europe	12.4
Oceania	3.2

Source: www.cred.be

Combined data of both climate-related and geophysical disasters shown in table 5 reveals that in terms of occurrence of disasters, upper middle income, lower middle-income and high-income countries have been hit most. But in terms of economic losses high income countries suffered most (65%). This may be because that high income countries have more public and private establishments than that of poor countries.

Table 5: Climate related & Geophysical Disasters (%) (1998-2017) [9]

Country	Occurrence	Death	Affected	Economic Losses
High Income	27	9	3	65
Upper Middle Income	30	22	54	26
Lower Middle Income	29	46	37	8
Lower Income	14	22	6	1

Source: www.cred.be

Middle income and lower income countries bear larger share of death. Despite higher occurrences of disasters, number of death (9%) is comparatively lower in higher income countries than that of other country-groups. This may indicate poor preparedness of those countries to tackle the disaster like situations. As per the classifications of the world economies based on estimates of GNI per capita for 2017 by the World Bank, high income countries are those whose income is US$12056 or more. Countries with per capita income of US$3896 to US$12055 fall in the upper middle-income group. Lower middle income consists of countries whose income is between US $996 to US$3895 and for lower income it is US$995 or less. Climate Risks Index (CRI) developed by Germanwatch, a non-profit, non-governmental organization, Germany indicates level of exposure and vulnerability to extreme events. The Global Climate Risk Index for 1998-2017 analysed the impact of weather-related loss events (storms, floods, heat waves etc) of the different countries and regions of the World.

Table 6: Climate Risk Index (CRI) for 1998-2017 [10]

Country	CRI Rank	Death/Year	Losses/year US $ million PPP	Losses per unit GDP (%) (Annual Average)
Puerto Rico	1	150.05	5033.16	4.204
Honduras	2	302.45	556.56	1.846
Myanmar	3	7048.85	1275.96	0.661
Haiti	4	281.3	418.21	2.642
Philippines	5	867.4	2932.15	0.576
Nicaragua	6	163.6	223.25	1.009
Bangladesh	7	635.5	2403.84	0.64
Pakistan	8	512.4	3826.03	0.567
Vietnam	9	296.4	2064.74	0.516
Dominica	10	3.35	132.59	21.205

Source: www.germanwatch.org

The table 6 represents bottom 10 most affected countries during the period of 1998-2017 based on the indicators shown above. It shows that poor countries are the most sufferers. Out of the ten most affected countries, eight were from low-income or lower-middle income countries group, one from upper-middle income countries (Dominica) and one from high income group (Puerto Rico). Absolute monetary losses may be higher in rich countries; but poorer developing countries are hit much harder in terms of personal hardship, loss of life. Human Development Index-corrected CRI ranking for 1993-2022 found that there were nine developing countries among the ten most affected countries, theses were namely, Dominica, Honduras, China, Myanmar, India, Vanuatu, Philippines, Haiti and Mauritania. Italy was the only developed country among the top ten worst affected countries.

In terms of fatality rates and economic losses developing countries bear higher burden. These losses amounted to 1% of GDP for middle income countries whereas less than 0.1% of GDP accounts for losses in high income countries (IPCC 2012). Recent studies found that 1^0 C increase in average global temperature will cost 12% world GDP reduction. (Bilal & Känzig, 2024)

Disaster Management

The common understanding of the disaster management is that it is related with post disaster management only. But important thing is that disaster risks management includes post disaster as well as pre-disaster also.

To address the problems of climate-change, the first task is to reduce the GHGs. Collective endeavour has been started at the international level but the progress of negotiation among the participating member countries has been dismal. Emerging countries like China and India need more economic growth which enlarges the possibility of releasing more GHGs into the atmosphere. On the other hand, developed countries do not want to limit their consumption patter.

The second task is to manage the impact of climate change both at pre-disaster level with the necessary preparedness and post-disaster level. Pre-disaster level management consists of host of programmes like making maps of risk-prone area, developing early warning system, enhancing public awareness and education, innovating better building designs, improving insurance coverage etc. On the other hand, post-disaster management aims at speedy recovery and rehabilitation of the affected victims and communities. The success of Bangladesh in case of pre-disaster management can be cited as an example. The cyclone Bhola having wind speed of 200km/hr in 1970 killed over 500000 people in Bangladesh. Later on, Bangladesh invested $10 billion on cyclone readiness like developing early warning systems, embankment protection and disaster-resilient shelters. In 2007 when cyclone Sidr came with wind speed of 250 km/hr made the death toll at much lower of 10000 (Thorlund and Potutan 2015).

Conclusion

The foregoing discussion clearly reveals that higher concentration of atmospheric GHGs posed a serious threat to the existence of human civilization. Anthropogenic activity-led GHGs emission has been the mastermind for the climate-related change worldwide. If the present trend of climate related disaster continues unabated, doomsday is not far ahead. Concrete effort should therefore be made both at international level (currently going on) as well as at local level. Effects of disaster put heavy pressure on the poorer developing countries. Government should pay attention to provide more resources for the provision of pre-disaster management. But the poorer countries have little resources to fight against the climate change. In this direction Paris Agreement (2015) agreed to mobilise US $100 billion for the developing nations every year from 2020. It was the Katowice Conference held in Poland negotiators from 196 countries finalised a rule book for 2015 Paris Agreement. The rule book will guide regarding the modalities how the finance will be made for the developing countries to help them deal with climate change. It also specifies what steps should be taken to fight against climate change. But recently withdrawal of USA from the Paris Agreement on Climate change mitigation has put a big uncertainty about the global initiatives to fight climate-related issues unitedly. Apart from this international commitment each country should chalk out their own planning taking into consideration of the regional specifications of the respective country. Area specific action plan needs to be taken based on their exposure and vulnerability to environmental hazards.

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