

# Climate Change and Myriad Ways Its Impacting the World

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**Abstract-** Antarctica's first documented heat wave, Greenland's ice summit receiving its first on record rainfall, Tennessee's unprecedented downpour leading to flash floods, an increasing number of wild fires across the world, periodical cicadas making an appearance 4 years ahead of their scheduled emergence, a pizzly or grolar bear spotted in the wild - are just few of the vital signs ascertaining that climate change is for real and its becoming visible at an alarming pace, globally. The Cassandra syndrome related to this issue has turned a past now as the global audience has become more receptive and has started paying heed to climate scientists. The climate change is not just restricted to extreme weather conditions, melting glaciers or rising sea levels, its consequences are far reaching and deep rooted. Climate change driven, altered temperature and rainfall patterns are reducing global agriculture yield of the staples for a major proportion of world's population. Reduced crop production is directly associated with food insecurity of an ever growing population. Climate change would exacerbate water scarcity owing to more water consumption by agricultural sector. Food insecurity and water crisis, together will boost the existing socio-economic divide and conflicts. Climate change is hitting biodiversity hard with several species of plants and animals shifting their home range and those lacking tolerance towards altered habitat conditions are on their way to extinction. Biodiversity and ecosystem share an intangible bond and with the loss of biodiversity, diverse tipping points may come into action, making the ecosystem extremely fragile and vulnerable, culminating in a complete collapse of the system. Today, the appalling state of climate demands an immediate attention from all the stakeholders and transforming into action in an unprecedented manner before the increasingly narrowing safety window vanishes.

**Index Terms-** Agriculture, Biodiversity, Climate change, Food insecurity, water

## INTRODUCTION

The year 2021 has been quite an eventful one for the world already grappling with a pandemic, as a series of extreme weather events drubbed it. A historic snowfall blanketed parts of Spain after the country was hit by the storm Filomena, the cyclone Ana battered the island nation Fiji, torrential rains ravaged the western Europe followed by devastating floods, the heat dome led

to soaring mercury levels and seared Canada and north-western United States. These events represent a minuscule fraction of the extreme weather events that severely impacted the world and left people in dismay and disbelief.

Its irrefutable that humans today, are witnessing the catastrophic effects of "Climate change", the defining crisis of Anthropocene. The various anthropogenic activities and their corresponding imprints have been instrumental in modifying and impacting the Earth's climate, adversely, increasing global surface temperature (13,14,15). Increasingly shrinking glaciers, rising sea-levels with an innate potential to engulf coastal cities in many parts of the world, unprecedented rains, flooding, droughts, increased frequency of wildfires, hurricanes and other indicators of climate-associated changes have their roots embedded in global warming.

The Cassandra syndrome related to the issue, is past now as the global audience has turned more receptive and attentive to climate scientists. Climate scientists have been warning about the serious and potentially irreversible consequences of climate change and how it will impact the earth and humankind. For 60 long years the alarm bells were ringing but ignored (1). In 2017, the world was 1°C warmer (Fig.1) than pre-industrial times (1850–1900) due to greenhouse gases emissions originating from anthropogenic activities (14). Today, we are already at mark 1.2°C and the latest IPCC report, 2021 confirms the earlier predictions of inevitable 1.5°C rise in average surface temperature of the Earth, around 2040 if the current global trend of greenhouse gases emissions continues.

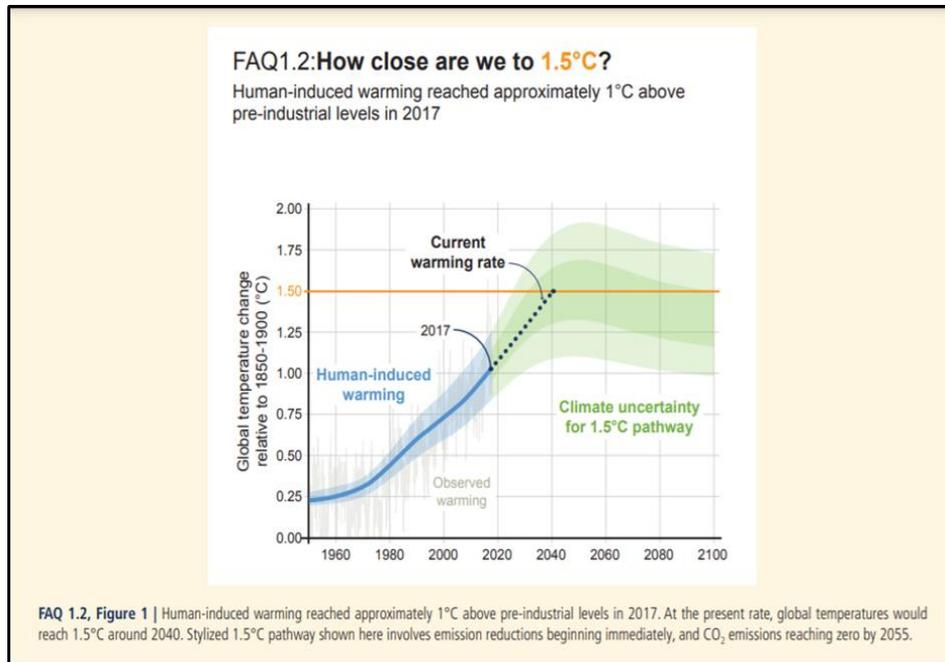


Fig.1. Source: IPCC Report Special Report on Global Warming of 1.5°C

**Climate change and changing weather pattern:**

Human activities driven climate change is unequivocally visible and increasing at relentless pace, so is the frequency and intensity of extreme weather and climate events, world-wide (4,15,32). The frequency and magnitude of heatwaves, droughts, wildfires, cyclones and floods have remarkably gone up in an unprecedented

way. The persistent warming trend is reflected in global mean temperatures recorded. The decade 2011-2020 have been the warmest decade of human history so far and the last seven years have been the warmest seven years with 2016, 2019 and 2020 being top three, with discerning differences in average global temperatures between the three warmest years on record (32).

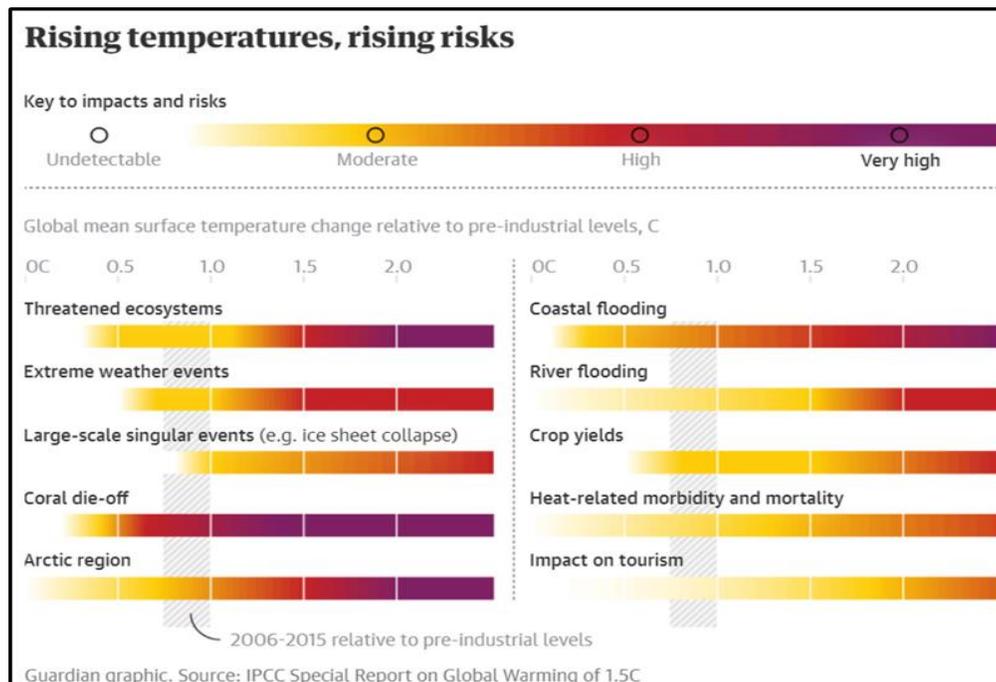


Fig.2. Rising temperatures and associated rising risks

The global average temperature recorded for 2020 was 1.2 °C above the pre-industrial baseline despite a La Niña event, rendering a temporary cooling effect. La Niña, along with El Niño constitute the Earth's two natural climatic phenomena that occur across the tropical Pacific Ocean and are part of a recurring weather pattern called the El Niño Southern Oscillation (ENSO). The El Niño is a phase of unusual warming of surface waters in the eastern equatorial Pacific Ocean, while La Niña is the cooling phase and characterized by water in the eastern Pacific Ocean colder than average. Studies have suggested the correlation between unremitting climate change and extreme and measurably frequent El Niño and La Niña events. The altered ENSO's dynamics will have far reaching social and economic consequences owing to global scale effects on atmospheric and

drier. Climate models (Fig.3) have predicted that together these factors can turn periods with reduced precipitation drier than they would be in cooler conditions and change moderate droughts to severe and more frequent in future (2).

On the other hand, the severity of cyclones, hurricanes and typhoons, that are considered as planet's one of the most destructive weather phenomena is expected to amplify. Studies have indicated that the intensity of these violent storms has increased due to global warming (12,16) and can further go up substantially, if the warming trend continues. The correlation between the two is simple as the warmer water temperatures translate into increased heat energy availability, fueling the intensity of tropical cyclones.

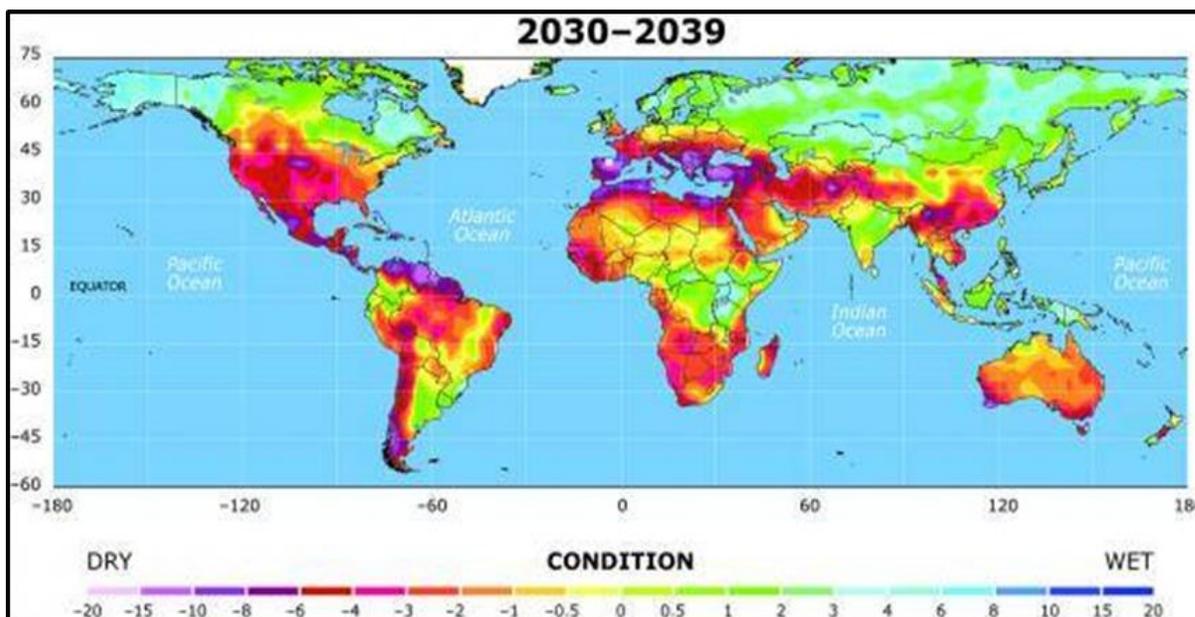


Fig. 3. Source: Courtesy Wiley Interdisciplinary Reviews, redrawn by UCAR

The map showing potential for drought by 2039, based on current projections of future greenhouse gas emissions. The map uses the Palmer Drought Severity Index, which assigns positive numbers when conditions are unusually wet, and negative numbers when conditions are unusually dry.

oceanic circulation, terrestrial and aquatic ecosystems and other natural systems (5). Apart from that, rising temperatures are also projected to be associated with a multitude of issues ranging from heat-related morbidity, threatened ecosystems, droughts, crop production, food security, coastal floods to impact on tourism (Fig.2).

The increasingly warmer planet has been forecast to experience altered precipitation patterns resulting in increasingly drier conditions in some parts of the world while others receiving more than usual rainfall. Reduced precipitation, in a warmer region may amplify the severity of drought as warmer temperatures intensify evaporation, which further reduces surface water and dries out soils and vegetation. In the absence of soil moisture and vegetation, dried soil absorbs ore solar radiation and heats up, promoting the formation of high pressure systems that further suppress rainfall, leading an already dry area to become even

Globally, the occurrence of intense tropical cyclones has accelerated since 1979, and the proportion of category 4-5 storms is projected to increase substantially under a warming climate (16). This observed shift towards an increased number of intense storms has garnered much attention as tropical cyclones with greater intensity lead to more damage as compared to weaker ones.

Further, an upward trend is also spotted in intensification rates of the tropical cyclones and associated rainfall rates. The inexorable increase in global temperature is also causing global mean sea-level rise due to melting of glaciers and ice caps and oceanic volume expansion due to warm water (32). Decades of greenhouse gases emissions have rendered rising sea levels inevitable that is expected to lead to increase in coastal flooding and/or erosion, even under 1.5 °C of warming (27). Also, with warmer atmosphere increase the chances of storms producing extreme rainfalls, as warm air holds about 7 percent more moisture per 1°C of warming

(13). The prevalent unusual rainfalls witnessed in certain parts of the global, associated with tropical cyclones are consistent with the studies projecting the influence of warming on extreme rainfall events (29) as air on average is warmer and moister than levels prior to 1970. Rising sea levels will contribute to storm surge inundation, greater tropical cyclones associated rainfall and flooding. Together these factors will enhance the magnitude of damage inflicted by tropical cyclones and lead to serious and significant societal impacts.

#### **Impact of climate change on Agriculture and food security:**

Agriculture, ironically is both a culprit and victim when it comes to anthropogenic global warming. It is estimated to generate 20% of the total greenhouse gas (GHG) emissions (8). The vulnerability of crops to temperature, precipitation and other climate related fluctuations (25,31) put agricultural production at high risk, making agriculture and climate change closely interlinked. Climate change is emerging as a huge challenge for agriculture as rising temperatures, precipitation pattern variation, increased frequency and intensity of extreme weather events together can lead to reduced crop production or even complete failure, exacerbating the mammoth challenge of feeding an ever increasing human population. Agriculture is a water intensive sector and it alone accounts for almost 70% of freshwater withdrawals, globally (6). The rainfed agriculture represents 80% of the total cultivated land and contributes 60% of the total global food production. In future, irrigated agriculture land is expected to expand and contribute more in global crop production (6), to meet the growing food demand, as on an average it is almost twice as productive as rainfed agriculture per unit of land, allowing more room for increasing crop production and crop diversification. Climate induced temperature rises will intensify the water scarcity owing to increased water demand for crop production. The pervasive water scarcity due to dwindling water resources and erratic precipitation patterns stemming out of climate change, will impact both artificially irrigated and rainfed agriculture (7) while by 2050, the global water demand of agriculture is further estimated to increase by 19% due to irrigation needs, pressing the already water challenged ecosystems. Together these factors will intensify the water crisis, exacerbate the disputes among water users and inequality in access to water, widen the socio-economic divide and adversely affect food security (9).

#### **Climate change affecting Biodiversity and ecosystems:**

Biodiversity and ecosystems are intricately interwoven and share an intangible bond. The health of an ecosystem is reflected by the rich biodiversity it supports, on the other hand this diversity itself is governed by the health of ecosystem. However, the geographical distribution range of species is influenced by a complex of factors, climate being an integral and pivotal part of it (17). The various biological aspects of organisms are closely linked to abiotic factors of the environment, consequently, climate change driven global warming is bound to affect organisms. Organisms are struggling hard and employing different strategies to cope up with the changing climatic scenario. There is a growing body of evidence in favour of climate change triggered ecological and life history alterations exhibited by organisms (17,23,24). The spectrum of responses witnessed include (but not limited to) shifting home ranges (19,22), phenological shifts (20,22),

changing body size (10), shape-shifting (20,26,28) and even extinction (23) in few cases, depending on the species ability to mold with respect to corresponding changes in its environment. The global extinction rate is likely to accelerate in future if the mercury keeps soaring up owing to global warming (18,30) and many species of plants and animals are predicted go extinct in future due to their inability to disperse or shifting the niche (24). The warming climate can affect not only individual species but probably can alter their ecological relationships as well, resulting in altered ecosystems and the services they provide (3,11,21).

#### **CONCLUSION**

We are at the crossroads of climate change crisis where the events all around us are indicating that the global warming has touched every part of the globe in every possible way. Climate change impacts are multifarious, some of them are irreversible and already visible while others are in action and inevitable. It's a race against time as the window of opportunity to avoid the worst is increasingly becoming narrower. Immediate, bold and collective efforts are demanded from all the stakeholders to deal with the climate emergency we are facing, if we want to win this race. This will require basic yet dramatic transformations in all aspects of society including lifestyle, infrastructure, food production methods, transport and how we fuel our economies, keeping decarbonization as central goal. Policymakers need to support research and development of zero-emission technologies. At the same time, we need to adopt already existing, readily – available technological solutions in order to reduce net emissions. Nature based solutions provide the cheapest ways to mitigate a significant share of our collective carbon foot-print. Ecosystem based adaptations - restoring the distressed ecosystems, ecosystem protection and rewilding are great strategies to tackle the issue. The various ecosystems not only act like buffer against extreme events but forests and wetlands also serve to recharge groundwater. Today, world has reached a stage where some changes are inevitable, even under zero-emissions scenario, therefore, along with mitigation we need to be prepared for climate adaptation as well.

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