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Consequences of climate change on public health: A Review

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ABSTRACT

Climate change has previously been linked to alterations in the distribution of plants and animals, variations in population densities, adjustments to the timing of seasonal activities, rises in disease prevalence and the introduction of invasive species. It is feared that climate change will have negative effects on Earth's ecological systems, including a general loss of biodiversity, disturbances to ecosystem processes, and a decrease in the number of ecological products and services available to human society. Vertebrate, invertebrate, and plant species, as well as their seasonal behaviors and physiological responses in both aquatic and terrestrial habitats, are all impacted by climate change.

Key words : *Climate change, Ecosystem, Ecological system, Terrestrial environments*

Introduction

Increased frequency and intensity of extreme weather events: Climate change is causing more frequent and severe heatwaves, droughts, floods, hurricanes, and other extreme weather events, which can directly affect public health. For example, heat waves can lead to heat exhaustion, dehydration, and even death, while floods can cause waterborne diseases. Changes in air quality: Climate change can lead to increased air pollution due to factors such as higher temperatures, increased wildfires, and more frequent dust storms. This can cause respiratory problems and exacerbate conditions such as asthma and allergies.Spread of infectious diseases: Climate change can alter the distribution and abundance of disease vectors such as mosquitoes and ticks, which can increase the transmission of diseases such as malaria, dengue fever, and Lyme disease.

Food insecurity: Climate change can lead to decreased agricultural productivity and increased food prices, which can result in food insecurity and malnutrition, especially in developing countries.
Mental health impacts: Climate change-related events such as natural disasters and extreme weather can cause psychological distress, anxiety, and depression, especially among vulnerable populations such as children and the elderly.

Outbreaks of numerous diseases including those of humans have been associated with climate in particular the EL-Nino Southern Oscillation (ENSO). EL-Nino means the change in the climatic phase in the Pacific range. EL-Nino affects the whole Southern and Northern parts of India. It has a very bad role in the climatic condition of India. It does not only affect agriculture and public health but also give an impact on the Indian economy. As it is seen in EL-Nino years there are drought years which

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means EL-Nino affects the land and climatic conditions of India.

The amount of solar radiation influences the climate significantly. As solar radiation is an important and fundamental source of light, it also provides vitamin D by UVB rays to human and animal lives. Presence of less UVB cause in a deficiency of vitamin D but the excess of UVB cause in skin cancer and also many skin diseases.Solar radiation also plays important role in environmental temperature factors. Fluctuation in temperature is a major factor of climatic change which also affects the product production of livestock and their reproduction. High temperatures could result in fetal loss during the pregnancy of cattle. Effects of climate change include high temperatures and changes in rainfall patterns which in turn results in the increase in vector-borne diseases and macroparasites. The rise of 2 ^{0}C to 3 ^{0}C in temperature could affect the flora and fauna to a very large extent and could even lead to the extinction of species.

Effects of climate change on human health

It is now well acknowledged that greenhouse gases are building up in the atmosphere as a result of numerous activities including fuel burning, forest loss, and other factors. The greatest health hazard of the twenty-first century is climate change, which has a variety of potential effects on health. For instance: As a result of a rise in the frequency and severity of heat waves, a decrease in the number of deaths caused by the cold, changes in the distribution of vector-borne illnesses, and impacts on the risk of catastrophes and starvation like those caused by floods and droughts. Extreme weather events, poor air quality, shifting patterns of infectious illnesses, ocean acidification, war, and migration, as well as sea level rise, are just a few of the risk factors that climate change has on human health Climate change-related sea level rise is predicted to endanger low-lying coastal people and has an impact on their health. Climate may have a negative impact on health through a number of methods (Haines *et al.,* 2004). Acute or chronic illness may emerge from temperature and rainfall extremes such as heat waves, floods, and drought. For instance: Variations in rainfall and temperature may have an impact on the spread of disease vectors like malaria and dengue, as well as the prevalence of diarrheal disorders. Moreover, biodiversity and the ecosystem products and services that are necessary for human health are expected to be impacted by climate change. There are also worries that the effects of climate change's flooding, droughts, and environmental degradation could result in more environmental refugees and widespread chaos in human life.

For instance: Those who have recently experienced flooding may report prolonged increases in mental illness Air pollution levels may alter as a result of climate change, which could have an impact on human life. Tropospheric ozone pollution may be higher in some regions of Europe than others, although the correlations between the two are still not fully understood (Langner *et al*., 2005). Vector-borne illnesses and other infectious diseases are impacted by climate change. There is proof that European vector species are adapting to climate change (Purse *et al.,* 2005). Throughout the past few decades, changes in the frequency of weather extremes have been noted (McCarthy *et al.,* 2001). Many health consequences are susceptible to singular extreme occurrences, such as intense rains and high temperatures. Climate change and economic conditions have been impacted by the deadliest illness, COVID-19 (Abbass *et al.,* 2022; Pirasteh-Anosheh *et al.,* 2021).As a result, the health industry needs to be prepared as climate change is now considered the biggest global health problem (Smith *et al*., 2014; Watts *et al*., 2015). Cyclone Nargis, which hit Myanmar in 2008; the Port-au-Prince earthquake in Haiti in 2010; the 1983–1985 famine and drought in Ethiopia; the 2004 Indian Ocean earthquake and tsunami; and the current COVID-19 pandemic (Erman *et al.,* 2021). More than 200,000 people died as a result of natural disasters throughout the world as a result of these occurrences, which is more than 0.4% of all fatalities during these years. It is impossible to prevent low-frequency, high-impact disasters like earthquakes and tsunamis, although such significant human casualties do occur. In China, its effects are already being felt, and future forecasts indicate an unacceptably high danger of catastrophic human health effects (Zing *et al*., 2008). Given the complexity of the climate system, it is impossible to predict a rise in hazardous exposures due to climate change (Haines *et al.,* 2014), and the degree of effective adaptation will have a significant impact on the health effects.

Effects of climate Change on the bioclimatology

The shifting GEnS datasets and the categorical present were created to create the bioclimate, which represents the advantages of categorized data but in

level detail the combination of a regular surface We are aware that methanogens play a variety of roles in climate change, which has a minimal impact on the planet and its inhabitants. In the modern world, we believe that the past ten years have seen a steady change in the climate.

It is quite difficult to learn and accept conservation, which is a direct conclusion of the above drastic change in climates, as the average earth temperature is regularly increasing by 1.5 ^{0}C to 3 ^{0}C in certain seenario. (Saxon *et al*., 2005; Veloz *et al.,* 2012). As the majority of energy production in developing nations originates from fossil fuels, energy consumption has increased GHG levels in relation to warmer temperatures (Balsalobre-Lorente *et al.,* 2022; Usman *et al*., 2022b; Abbass *et al.,* 2021a; Ishikawa-Ishiwata and Furuya, 2022). Modeling climate impacts provides a more recent understanding of the possible outcomes of a change in the climate on a global scale. (Schroter *et al.,* 2005; Silh *et al*., 2005; Thriller *et al.,* 2005; Zia *et al*., 2016). The vegetation model and hub to understand the consequences of primary production are impacted by the global carbon balances (Piao *et al*., 2009). In order to access bioclimatology and climate change, the combined modeling methodologies integrate social economic and climatic data (Schroter *et al.,* 2005; Wei *et al*., 2009). As a result, the aforementioned characteristics offer particular potential impacts. Their uses are few in number and limited in complexity. The largest industry contributing to climate change and having a substantial influence on it is global agriculture, which accounts for 30–40% of all greenhouse gas emissions (Mishra *et al*., 2021; Ortiz *et al*., 2021; Thornton and Lipper, 2014). Many climate trajectories make understanding its outcome more difficult (Jones, Visser *et al*., 2000).

Effectof climate change on aquatic life

Climate change has an impact on parasitism and illness in all aquatic ecosystems, including freshwater, coastal estuarine habitats, and marine ecosystems (Parry *et al.,* 2007), which has an impact on the socioeconomic and health effects. As an illustration, a change in relative temperature has an impact on the metabolism and physiology of fish, which has an impact on their growth, fecundity, feeding habits, distribution, migration, and abundance (Ficke *et al.,* 2007; Reist *et al.,* 2006; Roessig *et al*., 2004; Wrona *et al*., 2006). Global warming will directly alter the distribution of parasites and diseases, as well as indirectly through effects on host range and abundance (Marcogliese, 2001). In aquatic ecosystems, the spread of parasites and illness will be significantly impacted by climate change (Harvell *et al*., 2002; Marcogliese, 2001).

The distribution of invertebrate, vertebrate, and plant species as well as the timing of their seasonal activities and physiological reactions in both aquatic and terrestrial habitats have all been impacted by climate change (Root *et al*., 2003; Rosenzweig *et al*., 2007; Stenseth *et al.,* 2002; Walther *et al*., 2002). Fish and marine zooplankton are among these organisms (Beaugrand *et al.,* 2002; Perry *et al.,* 2005). 20% to 30% of plant and animal species are predicted to be in high danger of extinction at a temperature rise of 20 to 30 degrees Celsius above pre-industrial levels, while significant changes to the structure and operation of marine and other aquatic ecosystems are projected (Fischlin *et al.,* 2007). Moreover, hotter temperatures may produce thermal stress in aquatic animals, which can result in stunted growth, unfavorablebehaviors, and a diminished immunological response to antigen exposure (Ficke *et al*., 2007; Harvell *et al.,* 2002; Roessig *et al.,* 2004). Many illnesses, including human ones, have been linked to climatic changes, particularly the EL-Nino Southern Oscillation (ENSO) (Daszak *et al.,* 2000; Harvell *et al.,* 2002).

The impacts of temperature changes on hosts and their eight parasites are only one of the climate change factors; other ones include Changes in water levels and flow patterns, stratification, alterations to ocean currents, eutrophication, weather extremes, greater penetration of UV light, rapid runoff.
All these factors will have consequences for entire ecosystems and their food webs (Marcogliese, 2001).

Coral reef fish performance, recruitment dynamics, trophic linkages, population connectivity, and other ecosystem processes are all significantly impacted by climate change. The coral bleaching caused by this will have the greatest direct effects on fish community composition and diversity loss (Allen, 2007). However, how will coral reefs be impacted by them? There are over 4000 fish species associated with coral reefs and these fish are particularly vulnerable to rapid climate change because corals can become stressed, bleach, and die when exposed to ocean temperatures that are just a few degrees above long-term average temperatures anywhere in the world. Since coral reefs are one of the most diverse ecosystems on Earth, continued coral

cover loss and eroding of the intricate habitat structure linked to healthy coral reefs are expected to have serious repercussions for a wide variety of species that are connected to reefs, and these repercussions are only just beginning to be understood (Munday and Holbrook, 2006; Hoegh Guldberg *et al.,* 2007; Munday *et al.,* 2002). Amazingly little attention has been paid to the current effects of climate change (Roessig *et al.,* 2004; Harley *et al.,* 2006). Temperature changes also have an impact on the reproduction of tropical reef fishes. Depending on whether populations are currently close to their thermal reproductive optimum, increased temperature could have either a favorable or negative impact on reproductive output (Ruttenberg *et al.,* 2005).

Effect on acidification of ocean

As the atmospheric partial pressure of CO_2 rises, more CO_2 gets dissolved in the ocean. More Co2 forms carbonic acid when it combines with water, which causes a sequence of reactions that lower the pH and change the carbonate-bicarbonate ion balance (Feely *et al.,* 2004). In 2007 alone, atmospheric CO_2 concentrations reached 380 ppm, up from 280 ppm in pre-industrial times (IPCC, 2007b). By the end of the 21st century, CO_2 concentration is expected to reach 540 to 979 parts per million (ppm) depending on emission scenarios, which also a role in climate change. As a result, the average ocean pH would decrease by 0.4 to 0.5 points compared to pre-industrial values (Royal Society, 2005). As a result, the ocean would become more acidic than it has ever been in the last 4000000 years (Feely *et al.,* 2004). Aquatic diversity will be significantly impacted by dissolved CO_2 and lowered pH levels.

Climate change-related temperature increases, ocean thermal expansion, and extra water contributions from melting glaciers and continental ice sheets all contribute to sea level rise. By 2100, at least another 30 to 40 cm of sea level increase is anticipated (IPCC, 2007b). If glacier and ice sheet melting increases dramatically, as some studies have suggested, sea level rise will be much larger (Velicogna and Wahr, 2006). These rising water levels will have serious impacts on marine ecosystems. The amount of light reaching offshore plants and algae dependent on photosynthesis could be reduced, while coastal habitats are already being flooded. Rapid sea level rise will likely be the greatest climate change challenge to mangrove ecosystems, which require stable sea levels for long-term survival.

Consequences of El-Nino effect in India

As we know El-Nino effect is a wide term and explained by many authors and researchers. It is on the history of a fisherman called El-Nino, who was a Spanish man (Dijkstra, 2006). An interannual sea saw in tropical sea level pressure between the western and eastern Pacific Oceans is a hallmark of the southern oscillation. According to Bjekens, ENSO involves favorableocean–atmosphere feedback. With a timeframe of between 2 to 8 years, ENSO is acknowledged as the largest mode of yearly variability in the global climatic system.

Sir Gilvert Walker explained year-by-year fluctuation in sea level pressure, surface air temperature, and precipitation which provide a separate global scale interconnection pattern to the southern hemisphere and a large part of the northern hemisphere (Walker 1923, 1924, 1928, Walker and Bliss, 1932, 1937) these are the researchers who described El Nino effects since although all the drought which have been occurred in India, the main cause or it is associated with El Nino (Rajeevan and Pai, 2006). From the last twenty El Nino and thirteen drought years and, all droughts are in non-ElNino years. The teleconnection related toEl Nino results in all over warming in the Indian Ocean (Xie *et al.,* 2009) due to changes in cloud cover and wind system that relate to a change in ascending and descending, parts of walker circulation (Du *et al*., 2009; Venzke *et al.,* 2000) the nino is defined as the strong phytoplankton bloom in the east of India so it suffers as very low productivity in India El Nino is the big terminology because it not only affects the climate change but also to the agriculture and also to the farmers. As we have seen El Ninocaused drought 13 times in India by this fact it not only affects agriculture but also to the Indian economy and also the researchers described how it will behave andshow its effect in the future.

Effect of solar radiation in cancer cause

Solar radiation is essential for human growth and health, but it also contributes to skin aging and skin cancer. In addition, too little sun exposure can lead to vitamin D deficiency, which is primarily produced by UVB. As a result, both types of non-melanoma skin cancer, including basal cell carcinoma (BCC) and squamous all-carcinoma (SCC), are also known as cutaneous malignant.

CMM can be also developed by UVB,but recently

show some data that UVB may play a significant character in its etiology (Wang SQ *et al.,* 2001). The key factor for this difference is that DNA is the main chromophore for BCC and SCC,while melanin in addition to DNA, might act like a chromophore for CMM by the production of independent radicles.In this above by the generation of independent radicles. In this above work, CMM will be initially explained. So it has high death rate than SCC and BCC (www.krefregisteret.no) UV is one of the which actlead roles in cancer development and may urocanic acid (Marrot L and Meunier *et al.*, 2008; Norval *et al.*,2008). Vitamins D interact with the immune system (Cantorna *et al,* 2004; Cantorna, *et al.,* 2006). Yet as the climate changes, scientists are beginning to realize that our future generation will have to contend with a damaging solar radiation phase since the UV rays that reach the planet are responsible for skin conditions like cancer. As a result, considering sunlight is important because it is a very important issue for our future generation.

Effect of climate change on livestock

Around 30% of the earth's land surface is dedicated to livestock, directly sustaining the livelihoods of smallholder farmers in developing nations like India (Thornton, 2010). Hence, raising livestock is a crucial aspect of global agriculture. The global human population depends heavily on livestock for a variety of goods, including meat, fat, milk and other dairy products, eggs, wool, and other items like transportation, draught, and fertilizer supplies. Extremes in climatic conditions, however, have a negative impact on cattle productivity.

Climate change is a long-term movement in a region's average environmental factors, such as temperature, humidity, radiation, wind, and rainfall. Climate change is typically linked to rising global temperatures. It has been predicted that by 2100, the average global temperature may be 1.1 to 6.4 degrees Celsius warmer. Extreme weather conditions are posing challenges for cattle, such as prolonged heat waves, floods, and droughts. Extreme occurrences also cause the mortality of cattle in addition to output losses (Gaughan *et al*., 2015). Animal growth, milk production, wool production, and reproduction are all directly impacted by climate change (Hounghton *et al*., 2001).

Climate change effects might be immediate or delayed. The emergence and spread of new illnesses can be attributed to the direct consequences of climate change, which also include high temperatures and changes in rainfall patterns that enhance the prevalence of existing vector-borne diseases and macroparasites. The changes in feed resources brought on by the lack of feed brought on by the increased demands for food, feed, and fuel production and usage of land are examples of the indirect consequences. Animal reproduction suffers from thermal stress brought on by climate change, both in male and female species (Amundson *et al*., 2006). Via the hypothalamic-hypophyseal-ovarian axis, the high rise in temperature and high intensity of radiated heat would directly impact reproductive rhythm.

GnRH and the gonadotropins, FSH and LH, produced by the anterior pituitary gland, play a major role in the hypothalamus in controlling ovarian activity (Madan *et al.,* 2007). Dairy cow conception rates might decrease by up to 20–27% in the summer. Heat stress-related poor reproductive performance changes ovarian function and embryonic development by lowering the rate of conception and the number of resultant embryos. Buffaloes may have inadequate estrus (silent heat) expression because of low estradiol levels throughout the summer (Upadhyay *et al*., 2009). Because of this, crossbreed cattle and buffaloes have poor summer conception rates and estrus expression.

Pregnancy heat stress inhibits the development of the fetus and may lead to more miscarriages. According to reports, developing follicles are damaged and rendered non-viable when the body temperature surpasses 40 °C. Moreover, it boosts cortisol and adrenocorticotropic hormone (ACTH) release and inhibits estradiol-induced sexual behavior. Equally crucial to cow fertility is bull fertility. Climate is a crucial determinant for healthy spermatozoa production. The testis should be 2–6 °C below core body temperature for fertilisation to result in healthy, viable, and genetically highly potential kids. Increased testicular temperature can cause thermal stress, which negatively impacts seminal and metabolic parameters and impairs a bull's ability to conceive. As a result, heat exhaustion drastically affects male fertility rates per insemination and male fitness.

Animal health and output are also impacted by climatic change. Heat stress is one of the most significant effects of climate change, having a negative impact on mil production and composition, especially in animals with hereditary traits (Wheelock *et*

al., 2010). Dairy cows that are breastfeeding need a temperature of at least 35°C to trigger their stress response systems (Berman, 2005). Dairy cows are under heat stress reduce their feed intake, which results in a negative energy balance and lower milk output (Wheelock *et al.,* 2010). Due to physiological adaptations to heat stress, dairy cows' milk output might decline by up to 50%. This is because they consume less feed and rest more frequently (Baumgard *et al.,* 2013). Thus, it is necessary to use heat mitigation solutions in order to avoid future animal health problems such as reproductive loss in addition to reducing thermal stress.

Conclusion

As it is globally known that climate change is affecting livelihood, people now must be aware of the threats of climate change and its health impacts. The light must be given especially to rural and socially backward areas and awareness must be raised there. This could be done by integrating of climate change into the existing medical education curriculum and combining these with social organizations. This would raise sufficiency and facilitate change preparedness. This awareness can be served as a good initiative for preparing and bringing the medical field to tackle climate change. Outbreaks of numerous water-borne diseases have also been introduced in both humans and aquatic life which are linked to climatic events. Bioclimatology is degrading day by day, the incident of skin disease and skin cancer is increasing among human, and cases of droughts have also been increasing. There is much more evidence to propose that virulence and disease transmission will increase with global warming. Further, the spread of parasitism, vector-borne disease, and raising temperature due to global warming has its own effect on animal and human populations. The production and reproduction of livestock is also being altered due to climatic change. These in turn are disturbing the social and economical status of society. So, first and foremost there is a critical need to control and reduce greenhouse gas emissions to give at least a survival environment to affecting organisms in near future. The introduction of advanced information technologies and more researchneeds to be done in this sector to reduce the climatic change effect on living organisms.

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