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Impact of Climate on Diseases–A Case Study of North Bengal

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Annotation: Climate change is inducing uncertainty in decision making system through sudden onset of unprecedented temperature rise or intense precipitation within a very short duration, recurrent drought and flood and many such weather extremities. Northern eight districts of West Bengal forms North Bengal. It has a vibrant departure from rest of West Bengal in respect of its geographical position. The region is enriched with high mountain ranges, dense forests and a large number of rivers. The climatic condition of the region is quite different from the southern part of West Bengal. The soil of North Bengal is stony or sandy, somewhere dry or wet. In the spring and the autumn seasons, the weather conditions became unhealthy and gave rise to several diseases like fever, malaria, dysentery, chest and respiratory affections, rheumatism and some other diseases in a severe form. As temperature increases these diseases also speeds. The main objective of the paper is to find out how the change of climate effects on these diseases in this region. Both primary and secondary data are used to fulfil the objectives. Afforestation and pollution control can check the climate change as well as spreading these diseases. Human consciousness is also imperative for the prevention and protection from these diseases.

Keywords: Climate Change, Global Warming, Flora & Fauna, Diseases.

Introduction

The climatic change is the variations and shift in weather conditions over space and time of different scales and magnitude resulting into change of climatic types (Singh, 2010). Climate changes both gradually and rapidly, partly and drastically. It is essential to design the adaptation plan in intellectual manner to make various manmade infrastructures, agriculture, health care and also natural reserves resilient to climate change (Govt. of W.B., 2017-18). North Bengal has a clear departure from rest of West Bengal in respect of its geographical position, climate, soil, forests even density of population also. Climate change is emerging as the biggest threat to the health and well-being of the human race. It increases the risk of occurrences of extreme heat events, floods, droughts and heavy storms, consequently leading to the multiplication of the risks of asthma attacks, obstructive lung diseases, and cardiovascular diseases. Climate change is also causing a change in the pattern of the spread of certain diseases carried by ticks and mosquitoes. Globally, there is increased evidence indicating these health impacts due to climate change (Govt. of W.B., 2022-27). Several times, the rivers' paths were altered, causing flooding, droughts and disease outbreaks. It was basically necessary for the subsurface air and water to be pure. When one or both of them were toxic, the environment became unhealthy. Water vapor and carbon dioxide were still present in high concentrations in the subsurface air. Infectious vapor, organic debris, marsh gas, hydrogen salphaide (H_2S) and subsurface hazardous substances were occasionally also common in subsurface air. Typhoid, malaria, cholera, diphtheria, fever, infectious dysentery and other diseases were brought on by those toxic substances (Grunning, 2008). As the soil's temperature increased, the subsurface air rose. The atmosphere grew contagious as a result of this rise. Diseases were born in the infectious air. Alluvium soil that was sandy, slightly muddy, or included organic waste was unsanitary. During the winter months of December through February, the Duars was bracing and healthy. However, the weather became bad in the fall, causing a number of illnesses, including rheumatism, fever, dysentery, chest and lung ailments and other illnesses in more severe forms. Because they spread fever, the strong winds from the east were bad for both the native population and the Europeans (Bose PK, 2006). Large amounts of dust were also carried by the winds, rendering the area unfit for human habitation. In the months of June and July, there were a lot of flies and mosquitoes, which caused a lot of disturbance on the plains during the day. Until the end of October, insects were a problem at night and occasionally during the day. From June to September the weather was too hot. In the following season cholera broke out in April and May (Dutta, 2009). Our main three (3) objectives of this paper: 1) to know the main causes of climate change, 2) to assess the impact of climate change, 3) to find out the diseases spreads due to the climate change in North Bengal.

Methodology

The present study is mainly based on both primary and secondary sources of data. The primary data has been collected through an extensive field visit in different places of North Bengal. As the climatic change is the long-term processes so the study mainly depends on the secondary source of data from internet, different books, journals, articles and newspapers. Different data collected and processes as per use. The map of North Bengal was created using GIS platform, specifically version 3.2 (QGIS 3.2), which is a free, open-source software for mapping and analysis tool.

Map of the study area:

North Bengal, comprising eight districts, exhibits a diverse climate with variations in temperature, rainfall, humidity and soil types. The region generally experiences hot, humid and heavy rainfall, with cooler temperatures in the northern hilly areas. The eight districts are Cooch Behar, Darjeeling, Kalimpong, Jalpaiguri, Alipurduar, Uttar Dinajpur, Dakshin Dinajpur and Malda. The region's climate is influenced by its proximity to the Himalayas and the Bay of Bengal. North Bengal extends approximately from 24°45' N to 27°20' N latitude and from 87°45' E to 89°50' E longitude, according to the International Journal of Scientific Development and Research (IJSDR).

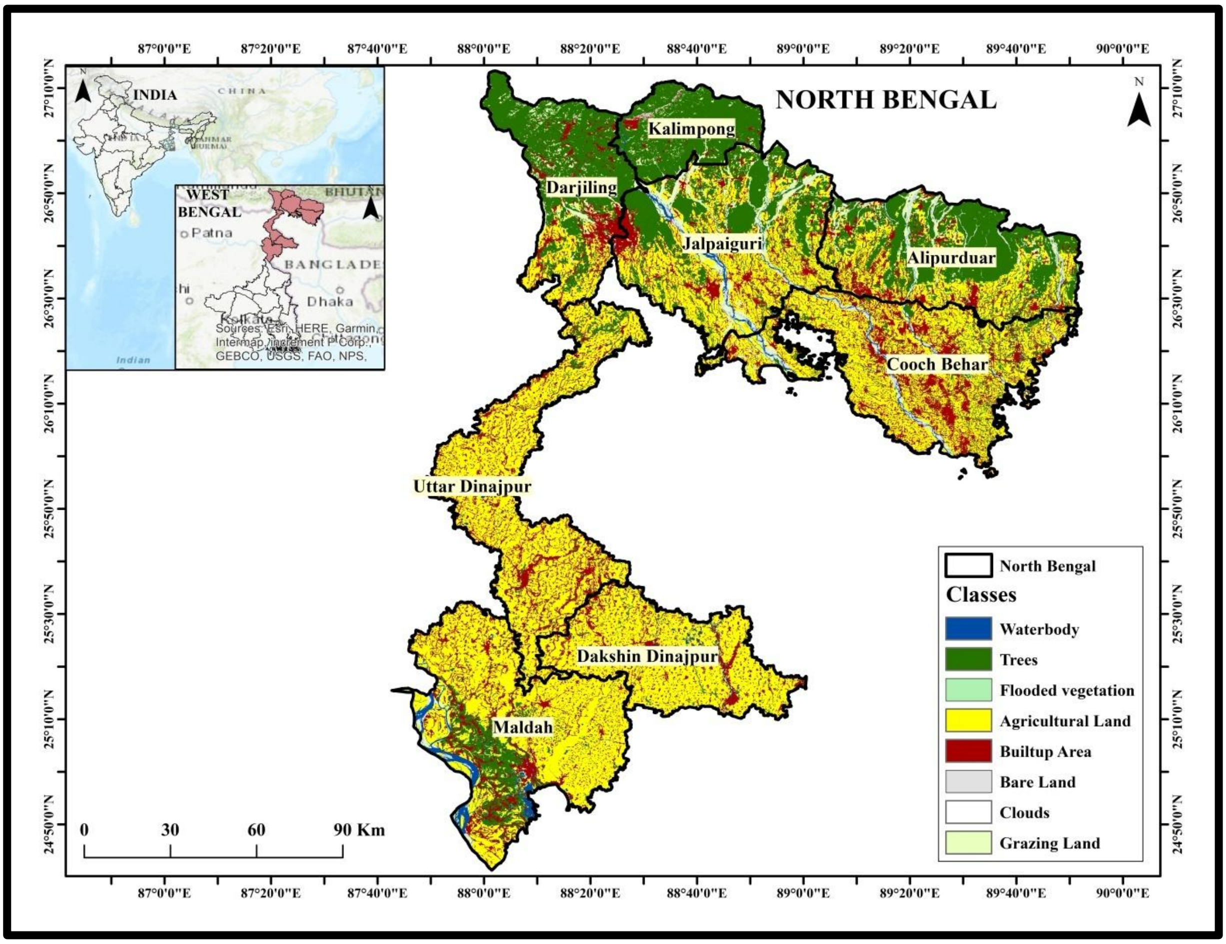

Fig.1 Map of North Bengal, West Bengal, India showing the study sites.

Reason for climate Change

The main reasons for the climate change are natural and impact of human activities.

Natural reasons are -

1. Volcanic activities
2. Changes of Earth's orbit or rotation
3. Variation of Sun rays

4. Changes of Earth's reflectivity
5. Deforestation
6. El Nino oscillations

Impact of human activities-

7. Burning of fossil fuel
8. Production of greenhouse gasses
9. Deforestation
10. Industrialization and urbanisation
11. Transports and vehicles
12. Waste disposal

Effects of climate change

More recurrently and intensely drought, forest fire, melting of polar ice cap and mountainous glaciers, storms, heat waves, increase of temperature of atmosphere and ocean, change of ecosystem and change of rainfall pattern upsurge numerous diseases. The aggregate effects of possible climate change by agroclimatic zone are displayed in **Table 1**.

Climate change and diseases

Darjeeling Himalaya and the Terai region of North Bengal are prone to Cholera, Malaria, Dengue fever, Chikunguniya and diverse respiratory diseases. As there are several wet lands and climate is moist throughout the year due to heavy rainfall. This climate is apposite for mosquitoes. Climate change fetches more apt environments for mosquitoes and generates more prone to diseases. According to WHO due to climate change hot climatic infectious diseases like malaria is found in the cold places of Nepal, Bhutan also and 200 to 400 million more people will be infected by the malaria and nearly one million people will die (Saha *et al.*, 2022). During the months of June and July, flies and mosquitoes were abundant and very disturbing on the plains during the daytime and mosquitoes were troublesome at night and sometime even in the day, up to the end of October. From June to September the weather was too hot. Cholera broke out in April and May.

Climate sensitive diseases prevalent in North Bengal

In accordance with the disease burden in the state, the changing epidemiological and/or entomological scenario as well as the threats of individual diseases/public health problems, the following disease conditions were tentatively short-listed for primary focus:

(1.) Dengue:

a) Urban disease extending its limit to affect peri-urban and rural areas due to continuing unplanned/ less planned urbanization.

b) Disease pathology changing characteristics; more of organ involvement warranting critical care.

c) Change in serotype pattern.

d) Change in vector predominance: *Aedes albopictus* gaining importance (Govt. of W.B., 2022-27).

The biology of mosquitoes, the viruses they spread and the cycles of dengue transmission more generally are all significantly influenced by climatic variables. Higher temperatures speed up the growth of larvae, shorten the time it takes for adult mosquitoes to emerge, enhance the rate at which mosquitoes bite and shorten the time needed for viral replication inside the mosquito. The beneficial impact on mosquito abundance may be countered by extremely high temperatures that shorten the mosquito's survival period (Watts *et al.*, 1987). Dengue incidence is greatly influenced by weather, although these correlations are all quite nonlinear. Dengue is most affected by minimum temperature (T_{min}), which is nearly zero below 5°C, slightly elevated above this temperature, and rapidly increasing when average T_{min} rises above 18°C. The significant seasonality seen in tropical areas when seasonal temperature differences are not more than a few degrees can be partially explained by the sharp increase in dengue prevalence at T_{min} beyond 18°C (Focks *et al.,* 2000). Because rising temperatures shorten the virus's extrinsic incubation period (EIP), as well as the mosquito's development time and gonotrophic cycle, increasing the likelihood of dengue transmission, these effects are consistent with the biology of both the dengue vector and the dengue virus (Watts *et al.*, 1987). T_{min} is not the only factor that affects maximum temperature (T_{max}). As T_{max} climbs above roughly 20°C to a peak of 32°C (Focks *et al.,* 2000; Jansen & Beebe, 2010; Watts *et al.*,1987), the risk of dengue increases; thereafter, the risk decreases. The maximum transmission effectiveness of *Aedes aegypti* is reached above 32°C, while adult mosquitoes gradually die at temperatures above 36°C, which may account for the decline in dengue's responsiveness to high T_{max} levels (Focks *et al.*, 2000). Additionally, the risk increases when precipitation increases to almost 550 mm, after which it decreases. While the deterioration seen at high precipitation levels may be the result of such breeding facilities being washed out, the gradual rise in dengue prevalence at low precipitation levels supports the establishment of rain-filled (outside) breeding sites (Gage *et al.*, 2008). The noteworthy correlation between the percentage of the population with access to piped water and dengue incidence is also noteworthy. People without access to a piped water supply were more at risk for dengue because they had to store water, which mosquitoes may use to spawn. Ironically, though, they demonstrated that those who used rainwater collection had the lowest adjusted risk—and it stands to reason that they would save the most water. Water availability and dengue risk have a complex relationship that might vary from place to place (Schmidt *et al.*, 2018). Another important element that affects the life cycle of mosquitoes at various stages is relative humidity. The quantity of blood meals is greatly influenced by the combined effects of temperature and humidity, which can also have an impact on the vector's survival rate and likelihood of contracting dengue and spreading the disease (McMichael *et al.*, 1996). According to the literature, the two most significant factors that could affect dengue transmission are temperature and relative humidity. A combination of temperature and rainfall affects vapor pressure, or relative humidity, which in turn affects mosquito lifetime and, consequently, the virus's potential to spread. According to Hales *et al.*, (2002), the most significant climatic predictor of dengue occurrence worldwide was yearly average vapor pressure. As a result, the geographic boundaries within which dengue transmission is likely to persist are significantly influenced by temperature, precipitation, and relative humidity.

***(2) Malaria*:**

a) Parasite is likely to develop drug resistance with time.

b) New species may emerge.

c) New endemic foci may appear.

d) Vector may become resistant to insecticides.

e) Challenge of forest malaria – very difficult to prevent.

f) Asymptomatic malaria (Govt. of W.B., 2022-27).

The type of soil degraded in many ways because a lot of plant matter remained there, causing a small amount of water to evaporate and becoming damp and cold. Malaria may have spread under those circumstances. Wet soil was unsanitary, and lowlands covered with vegetation were excessively soaked. There were many dead organic plants in this type of chilly soil. This type of dirt was found in several areas of Rangpur and Dinajpur. However, there was little sunlight and improper air circulation in the half-dry, plant-rich soil at the base of the hills (Rennie, 2005). The Terai soil was one of these types. It was said that ironic soil was the source of malaria. Depending on how dry or humid the soil is, the health status may improve or deteriorate. The moist soil may swiftly give rise to several diseases. Because water vapor could not escape the body in damp soil, the amount of water vapor rose and tainted blood started to flow through the body. North Bengal had a lot of this type of soil. However, the relatively low-lying area between the two hills was the most unsanitary. Although the hill's pick was clean, the valley was rife with many illnesses (Dasgupta, 2004). This kind of soil rapidly lost its water content, leaving the top surface parched. There was little air, and the potable water was still pure. Alluvium soil that was sandy, light muddy, and combined with sand and organic materials was unsanitary. When that type of soil absorbed a small amount of water, it became cold and damp. Malaria breakout was a real risk if a shallow pond with a lot of plants persisted on that soil (Das, 1993). Some physicians believed that damp fields were the source of malaria's toxin. The poison originated from areas that were kept fallow and devoid of crops. Because water could not be adequately drained from wet ground, there was more stagnant water, which made the area ideal for malaria production. Malaria poisoning can also enter the body through the air or water. In the past, the rainy season lasted a long time and even encouraged flooding. Beginning in early October, the heavy rains stopped falling. The warm weather at the period occasionally caused fever. However, the climate was very different on the highlands. At an elevation of 2500 feet, the humid, moist heat of the Terai used to subside, and the tropical zone of fever vanished above that point. When the Europeans arrived in Darjeeling, they discovered that the climate was similar to that of their own country in many aspects (Lambourn, 2003). Malaria accounted for more than 80 percent of all deaths in the Terai, where it was most prevalent. In 1905, the average fatality rate was 51 per mile. The fever was identified by several names and characteristics, such as quotidian, double quotidian, tertian and intermittent fever with splenic enlargement. Additionally, the most severe fevers—the deadly Kala-azar and black-water fevers—were discovered. There were tertian cases of fever that lasted 48 hours and quartan cases that lasted 72 hours in the Terai, which was notorious for having fever. Black-water fever was one of several malignant fevers that had a 24-hour cycle (Bhattacharya, 2011). Although they were present throughout the year, they were most prominent during and after the rainy season. Certain places, like Sukna, Garidhura, Matigara and Naksalbari, were particularly prone to the malignant type of fever because of their marshy conditions, as well as the fact that they were congested and confined with no space for growth (Devand Manguin, 2021). The Jalpaiguri area was divided into two malarial domains by the Tista River: the eastern, or extremely malarious zone and the western, or moderately malarious zone. The latter, referred to as the western Duars, suffered greatly from black-water disease and malaria. Due to the region's abundance of rivers and streams and abnormally high rainfall, which provided ideal conditions for anopheles mosquito multiplication, malaria predominated in the Duars (Sharma *et al.,* 2019). The town of Jalpaiguri, which symbolized the western area, was a zone of mild malariousness. However, the other Duars region was a malarial hotspot, and the index quickly increased until it peaked at Nagrakata. The degradation of the rank vegetation, which spread widely throughout the district, was the source of those deadly fevers. They were typically discovered in March and April, in September and October, and at the start and finish of the rainy season (Islam *et al.,* 2024).

(3) Cholera

Although cholera was endemic in North Bengal all year round, it only became an epidemic twice a year, from November to January and April to June. Although it was rarely high, the fatality rate was one per mile in the decade ending in 1902 and 1.2 per mile in the decade ending in 1908. It was common practice to wash, bathe, and drink with the same water. There was no pollution protection for tanks, wells, or watering ghats (landing stages on river or pond banks) (Sur *et al.,* 2000). When cholera cases arose in the neighborhood, no precautions were made to keep flies away, and bodies were frequently dumped into the waterways. As a result, numerous local residents were often infected by a single case. The cholera outbreak in Cooch Behar was caused by unclean water, contaminated food, inadequate clothing, subpar lodging, a malfunctioning drainage system, and general unwellness (Phukan *et al.,* 2004). The rivers and the many tanks where people bathed themselves, their animals, their clothing, and their cooking utensils were the main sources of the drinking water supply. They also used those to get rid of dead bodies, a lot of which had been cholera victims. The spread of the disease was further aided by poor cuisine, particularly the dried fish, which was a favorite of the locals and produced diarrhea, which made people more susceptible to contracting cholera. According to Dr. Briscoe, the civil surgeon for the state of Cooch Behar, cholera typically manifests between November and the end of March, when there is a lack of precipitation (Bouma *et al.,* 2001). In March or April, cholera always followed a too dry cold season. The water supply system was extremely subpar in many areas of the state, particularly in the winter. Because the police learned about the cholera outbreak mostly after the deaths of the afflicted individuals, the disease also spread widely. Compared to other districts, the district saw a less severe outbreak of cholera. Dinajpur's citizens collected their drinking water from wells in their homes because they were highly concerned about hygiene. Compared to public water sources like tanks and rivers, the wells were less contagious. However, those wells were rarely deeper than 12 to 15 feet, and during dry spells, they ran empty, forcing families to use river or tank water. It had disastrous effects. However, the district's cholera death rate was so low in comparison to the fever death rate that it hardly seemed worth comparing one year to the next. However, 1891 was a very gloomy year. Because there were 6,491 fatalities in that year, or 4.17 per thousand. Despite being high for Dinajpur, the death rate was low when compared to many other districts in the province (Shackleton *et al.,* 2023).

(4) *Heat Stress and Related Impacts:*

a) As heat related events are being reported almost regularly during the summer months, thus it is an impending problem.

b) In last few years drastic increase in temperatures has been noted which is causing significant impact on public life (Govt. of W.B., 2022-27).

***(5) Influenza*:**

a) Notifiable disease.

b) Previously it was seen that upsurge in cases was only during rainy season (July –October) but currently two trends have been noted one during rainy season and the other during late winters.

c) Round the year cases are been noted.

d) High risk disease.

e) Often a zoonotic entity (Govt. of W.B., 2022-27).

(6) Japanese Encephalitis:

a) Japanese Encephalitis (JE) has long been recognized as a disease of paramount importance related to climate changes due to its high case fatality rate (20-30%) and ability to cause considerably prolonged morbidity as well as disability.

b) But off late, the burden of the disease has decreased to a great extent in our state due to routine vaccination drive for the children and the special drives for the adolescents/adults in different pre-identified hotspots.

c) On the other hand, scrub typhus, a mite borne disease has emerged as a public health problem in the state during last few years (Govt. of W.B., 2022-27).

The precise time sequence with correction for pertinent elements has never been addressed, despite the fact that the previous study showed the association between climate factors like temperature and precipitation and JE. Using a generalized autoregressive model that accounts for seasonal factors, time trend, pig density, vaccination rate and region, the current study has shown the considerable impact of the delayed climate variables on the occurrence of JE in humans.

Similar to the findings of Bi *et al.*, (2023) this data implies that the occurrence of JE in the current month is connected to temperature and precipitation from 1-2 months prior. Precipitation may be considered a booster for mosquito population growth, while temperature may be considered a catalyst for the development of viraemia in pigs and for the facilitation of mosquito multiplication. During the dry hot season, non-immune sentinel pigs were not vulnerable to infection until a few weeks following the onset of the weather season's first rains (Gingrich *et al.*, 1992). Shorter duration may be explained by the high density of mosquitoes and pig breeders in these places, as both may help the mosquito population achieve the threshold density. Indeed, the evolution of mosquito density may be reflected in the shift of two climate parameters. The relevance for JE surveillance is that one can predict if a JE outbreak would occur in advance by including temperature and precipitation changes into known data on seasonal factors and pig population (Hsu *et al.*, 2008).

(7) Fungal infection

Although the precise effects of climate change on fungal diseases are unclear and can be difficult to isolate from other influences, fungi are environmental creatures that are impacted over time. While some fungus, like Coccidioides, has been investigated for the possible consequences of climate change, it is unclear how other mycoses would be affected. Although there is little evidence now available, fungi that usually occur in tropical or subtropical climes, like chromoblastomycosis, paracoccidioidomycosis and eumycetoma, may see a comparable expansion in global distribution. Similarly, since talaromycosis has been demonstrated to peak during wet seasons, more frequent rainfall may result in a higher frequency of the disease (Chariyalertsak *et al.*, 1996; Le *et al.*, 2011). Significantly, the interplay between social determinants of health and climate change may increase the risk of fungal infection for specific populations. Those most affected by environmental dangers, especially those brought on by climate change, are frequently individuals who are more prone to suffer from poor health outcomes due to underlying social and economic issues. These populations may be more susceptible to chronic illnesses, food insecurity and subsequent malnutrition, and substandard living conditions due to displacement, all of which can be risk factors for fungal infections. They are also less able to recover from the increasing frequency of natural disasters and extreme weather events (Jenks *et al*., 2023). To better understand the possible impacts of climate change on the spatiotemporal trends of mycotic illnesses and provide insights into the genesis of novel fungal pathogens, increased surveillance, environmental sampling and molecular analysis are essential. The significance of acknowledging the potential direct and indirect effects of climate change on fungal diseases is highlighted by the close interconnectedness of fungus and the ecosystems that surround them. To raise awareness and guide public health action, more research is needed to evaluate the possible changes to fungal infections and their effects on human disease brought on by environmental changes. The spread and acquisition of fungal illnesses, the introduction of new fungal infections, and the increased dispersion of fungi have all been significantly impacted by the changing environment. As a result of fungi's increasing thermo-tolerance, new human-pathogenic species including *Candida auris* and *Candida deuterogattii* are emerging. Fungi and other infections adapt to the planet's ongoing warming and increase their virulence and range. Once restricted to particular localities, a number of funguses have become serious health risks in places where infections of this kind are uncommon. Due to its detrimental effects on crop yields and agricultural productivity, climate change has also been linked to food and water shortages. A critical One Health issue that poses a serious threat to both agricultural and public health is the growing reliance on fungicides to protect crops in response to these shortages, which may also be a factor in the emergence of antifungal resistance in fungal diseases. A pressing worldwide concern that impacts high-, low-, and middle-income nations alike is the effect of climate change on fungal infections and illnesses, which are made worse by natural disasters and population relocation brought on by climate change. Improved prevention, detection and treatment efforts could be facilitated by systematic and cooperative international efforts to lessen the negative effects of climate change and a better knowledge of the connections between fungal diseases, natural disasters, and climate change (Seidel *et al.*, 2024).

(8) Inflammatory bowel disease (IBD)

Crohn's disease (CD) and ulcerative colitis (UC) are two chronic inflammatory gastrointestinal disorders that are part of the group known as inflammatory bowel diseases (IBD). Environmental variables and normal intestinal commensal bacteria are thought to interact in genetically vulnerable individuals to cause an incorrect immune response that result in chronic inflammation. Inappropriate immune responses later in life are caused by better cleanliness and less exposure to intestinal pathogens during childhood (Gent *et al.*, 1994). Having several siblings raises a child's exposure to intestinal microbes, which may lower the chance of developing IBD later in life (Gent *et al.*, 1994, Baron *et al.*, 2005). Having younger siblings is linked to a lower chance of CD, but having older siblings is linked to an increased risk of UC (Montgomery *et al.*, 2002). Consuming unpasteurized milk, living in more crowded households, and growing up on a farm are all linked to a lower risk of IBD, however, this reduction is more prevalent in CD than UC (Bernstein *et al.*, 2006; Amre *et al.*, 2006; Lashner *et al.*, 2006). A lower incidence of IBD may be linked to the colonization of parasitic worms, or helminths. The gut flora's helminths have a significant immune-regulatory function (Koloski *et al.*, 2008; Korzenik *et al.*, 2005). Both UC and CD may benefit from helminth treatment, according to open-label clinical trials. This is probably because the parasite can increase immune-regulatory and anti-inflammatory cytokines (such as interleukin-10 and interleukin-4) (Hunter *et al.*, 2004, Summers *et al.*, 2005). The clinical manifestation of IBD is similar to that of other animal diseases. One notable instance is Johne's disease in cattle, which resembles CD in both histology and clinical manifestation (Loftus, 2004). Because *Mycobacterium avium* subspecies paratuberculosis (MAP) has a similar clinical effect to Johne's disease in cattle, it has been suggested as a possible cause of CD in humans (Loftus, 2004). Acute gastroenteritis and pathogenic microorganisms like *Salmonella* and *Campylobacter* have been linked to the pathophysiology of IBD. The CD ideal phenotype was linked to adherent-invasive *Escherichia coli* (García et al., 2006; Gradel *et al.*, 2009). Alternatively, psychotropic intracellular bacteria like *Yersinia enterocolitica* and *Listeria monocytogenes* have flourished in contemporary civilizations due to greater refrigeration use. IBD risk may rise as a result of exposure to certain harmful organisms (Koloski *et al.*, 2008; Korzenik*et al.*, 2005). CD is linked to dysbiosis, a disorder characterized by microbial imbalances in the intestine (Marteau, 2009). The faecal microbiota of CD patients, their unaffected relatives, and unrelated controls was the subject of recent case-control research (Joossens *et al.*, 2011), and identified five bacterial species that characterized dysbiosis: a decrease in *Dialister invisus*, *Faecalibacterium prausnitzii* and *Bifidobacterium adolescentis*; and an increase in *Ruminococcus gnavus*. UC was more likely to develop in children and young people who lived in areas with high quantities of sulphur dioxide (SO_2), an industrial-based pollution (Kaplan *et al.*, 2010). Additionally, children and young people were more likely to develop CD if they lived in locations with high concentrations of nitrogen dioxide (NO_2), a known pollutant linked to traffic (Kaplan *et al.*, 2010). Ironically, middle-aged adults' development of CD was adversely correlated with nitrogen dioxide (Kaplan *et al.*, 2010). This result emphasizes the possibility of age-specific impacts from environmental exposures. Hospitalizations for IBD flares were more common in regions with greater levels of ambient air pollution, according to another study (Ananthakrishnan *et al*, 2011). Air pollution has also been implicated in triggering appendicitis (Kaplan *et al.*, 2009) and nonspecific abdominal pain (Kaplan *et al.*, 2012). Although stress may contribute to the pathophysiology of IBD, it is more likely to modify than to cause disease activity (Danese *et al.*, 2004). Both chronic and acute stress can alter immune function and, in turn, may influence the natural course of IBD (Mawdsley *et al.*, 2005).

(9) Cough, sneezing and VRI (viral respiratory infections)

Seasonal fluctuations in meteorological conditions are typically thought to be linked to seasonal epidemics of VRIs. Numerous research has looked at the connection between VRIs and these variables; the most prominent ones that have been suggested as possible determinants of the frequency of seasonal epidemics of VRIs are temperature, humidity, precipitation, sun radiation and wind speed. Seasonal epidemics in northern hemisphere winters are typically linked to low temperatures, low humidity and low sun radiation, but tropical and subtropical VRI peaks are linked to higher precipitation (Ianevski *et al.,* 2019; Gamba *et al.,* 2016). Because of their high infection rates and very sophisticated surveillance systems, RSV (Respiratory Syncytial Virus) and influenza has been the subject of a significant amount of study examining the connection between climatic conditions and VRIs (Gamba *et al.,* 2016). The two most important meteorological factors influencing the seasonal epidemics of VRIs are temperature and humidity (Lowen *et al.,* 2014). Previous laboratory research has demonstrated that low humidity and temperature increase the survival and transmission of viruses, particularly influenza, and can weaken the host's airway antiviral defences (Ren *et al.,* 2020; Gustin *et al.,* 2015; Foxman *et al.,* 2015). The combined effects of temperature and humidity on VRIs have been the subject of recent epidemiological research. These studies have revealed nonlinear relationships with or without thresholds under various temperature-humidity combinations, indicating that seasonal epidemics of VRIs are probably influenced by a combination of several meteorological conditions rather than just one (Shobugawa *et al*., 2017; Xu *et al.,* 2021). In addition to massive wildfires in Siberia and the Eastern Mediterranean, East Asia is experiencing flooding and strong rainfall. Sadly, these catastrophes are merely a preview of what can happen in the future, since many areas are seeing an increase in the probability of simultaneous extreme events like heat waves and wildfires or more intense flooding brought on by sea level rise and heavy precipitation. These occurrences may alter disease exposure, increase susceptibility, and eventually raise the risk of infections and outbreaks by having a cascading influence on hydrological conditions, air quality, and health determinants (McMichael, 2015; Suk *et al.,* 2020). Heat waves and wildfires are examples of extreme weather phenomena that are linked to a number of detrimental effects on respiratory health, many of which are linked to an increase in air pollution (Zhang *et al.,* 2019; Grigorieva *et al.,* 2021; Joshi *et al.,* 2020). During heat waves, sunlight, low wind speeds and high atmospheric pressure all contribute to elevated air pollution levels. The spread of wildfires is accelerated by heat waves and droughts, which raise particulate matter (PM) levels widely. This can worsen lung damage and/or pre-existing respiratory conditions like asthma and chronic obstructive pulmonary disease (COPD) (Allouche *et al.,* 2022; Guarnieri *et al.,* 2014). Heavy rainfall is more likely to be linked to VRI peaks in resource-constrained tropical low- and middle-income countries (LMICs), which have been shown to be more susceptible to the effects of climate change (Gomez *et al.,* 2017; Umuhoza *et al.,* 2021; Lim *et al.,* 2022). According to earlier research, excessive rainfall raises the number of hospital admissions and emergency visits for acute respiratory infections (Murray *et al.,* 2012; Phung *et al.,* 2014; Smith *et al.,* 2017). Haynes *et al.,* (2013) have documented higher RSV incidences peaking in tropical/subtropical countries with high precipitation during wet months (including Bangladesh, Guatemala, and Thailand). Variations in temperature and humidity, in particular, control the antiviral function of the airways and impact the host's innate and adaptive response to VRIs. Dry air that is inhaled damages the airway tract's tissue healing, mucociliary clearance, and epithelial integrity. Furthermore, new study has shown that breathing cold air dampens an innate defence response in nasal tissues that was previously unknown and protects against viruses that cause upper respiratory infections (Kudo *et al.,* 2019; Adivitiya *et al.,* 2019; Huang *et al.,* 2013; Sacks *et al.,* 2018). Additionally, it is possible that seasonal variations in host immunity and the seasonal epidemic of VRIs are related, with seasonal weather factors (like sunlight) playing a significant role in controlling host immunity (like vitamin D levels, which are linked to immune clearance against respiratory infections) (Damoiseaux *et al.,* 2018). The high incidence of VRI in the winter at high latitudes may be explained by these immune mechanisms, but outbreaks during summer heat waves do not seem to be explained by them.

(10) Diarrhoea

The ailment known as "hill diarrhoea" was common in the Darjeeling hills. However, the cause of its onset was unknown. As a result, opinions of its outbreak varied. Some individuals thought that drinking water containing mica was the cause of the outbreak of hill diarrhea. When the Europeans arrived from the plains, they worked hard and exercised a lot. As a result, they became extremely thirsty and drank a lot of water (Majumder *et al.,* 2024). Since mica was dissolved in water, it also got inside their bodies and caused diarrhea. However, as hill diarrhea was also reported in other hill locations with non-micaceous soil, the argument was not as compelling. In actuality, however, the Darjeeling hill people who shared the same water were essentially resistant to it. Another set of individuals believe that the presence of organic particles in the drinking water that was drawn from springs on the border of the Senchal range is what caused hill diarrhea. The water was contaminated by the decaying vegetation when the springs were running through a thick forest. Diarrhea is also a common occurrence in Jalpaiguri Duars, particularly in the early winter months (Pazhani *et al.,* 2014). Its rise was ascribed to both the consumption of bad food and the climate's tendency toward moisture and fluctuation. Other illnesses that used to manifest during the rainy season were rheumatism and lung ailments (Das *et al.*, 2007). They were brought on by the atmosphere's high levels of humidity. The hill people also had phthisis because of their lack of clothes and propensity to be exposed to heat, moisture, and cold all the time. Those who lived in corrugated iron or solid brick homes were more likely to have it than those who lived in timber huts. In addition to being overcrowded, those homes lacked adequate ventilation. Other than that, though, the homes were clean and spacious (Khan *et al.*, 2023).

Table 1. Agro-climatic Zone wise Summary Impacts of Potential Climate Change

Sl. No	**Agro climatic zone**	**Districts**	**Main crops**	**Potential climate change impacts**
1	Hill Zone	1. Darjeeling (except Siliguri Subdivision) **2.** Northern part of Jalpaiguri.	Maize, rice, different vegetables, potato, soybean, cardamom, ginger, medicinal plants, tea, orange etc.	• Decline in size and quality of citrus such as mandarin orange due to rising minimum temperature during flowering of citrus trees. • Increase in runoff from enhanced intensity of rainfall leading to erosion and landslides. • Reduced productivity of Darjeeling tea due to increase in extended drought periods. • Increase in winter temperature effecting potato and wheat. • Degradation of seed quality.
2	Terai Zone	1. Darjeeling (only Siliguri Subdivision), 2. Jalpaiguri, 3. Alipurduar, 4. Cooch Behar, **5.** Uttar Dinajpur (only Islampur Subdivision)	Rice, jute, tea, pineapple, potato, pulses, oilseeds etc.	• Long winter periods conducive to wheat production in this region, but increase in winter temperatures reducing wheat yields. • Degradation of quality seeds. • Nutrient loss by enhanced leaching. • Long span of winter is an advantageous which can be exploited.

Conclusion

Climate change is a continuous process. Climate is changing from the past to present and it will change in future also. We cannot stop these changes. But we can check the intensity and bad effects of climate change by the adoption of some measures, increase our capabilities, and by the adaptation. To reduce the effects of climate change, afforestation should be taken as a regular practice. Use of fossil fuels should be reduced. Use of non-conventional energy like wind and solar power should be increased. New hospitals and rural health centres have to establish and improvement of present health centres and hospitals with modern health instruments in North Bengal. Rural education and employment facilities also have to improve by using bio-informatics, geo-informatics as well as artificial intelligence.

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Contribution of the Authors

Authors have given equally.

Possible Conflicts of Interest

When the authors speak out, they are free from conflicts of interest.

Acronyms:

CD: Crohn's Disease

COPD: Chronic Obstructive Pulmonary Disease

EIP: Extrinsic Incubation Period

H_2S: Hydrogen Salphaide

IBD: Inflammatory Bowel Disease

IJSDR: International Journal of Scientific Development and Research

JE: Japanese Encephalitis

LMICs: Low- and Middle-Income Countries

MAP: *Mycobacterium avium* subspecies Paratuberculosis

NO_2: Nitrogen dioxide

PM: Particulate Matter

QGIS: Quantum Geographic Information System

RSV: Respiratory Syncytial Virus

SO_2: Sulphur dioxide

T_{min}: Minimum temperature

T_{max}: Maximum temperature

UC: Ulcerative Colitis

VRI: Viral Respiratory Infection

WHO: World Health Organization

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