

Global Climate Change and its Impact on Environment and PublicHealth: Risks and Responses

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Abstract

One of the major challenges to the human population is global climate change. The average surface temperature of the Earth has been rising over the past century as a result of global warming. Rising sea levels, hotter weather, heat stress, poorer air quality, population movement, and extreme weather events like floods, earthquakes, droughts, volcanic eruptions, tsunamis, etc. all have an influence on human health either directly or indirectly. Due to their high degree of exposure, the government's faulty management of the public health system, their poverty, etc., certain people are more susceptible to this shift than others. Age, gender, geography, malnutrition, and other variables may have a significant influence on public health. The spread of infectious diseases, such as those that are vector-borne, water-borne, etc., may be facilitated if we don't take action to regulate the already worsening global climate. Indirect consequences like population movement that cause stress, economic instability, house losses, etc. are also a major cause for worry. This essay examines the effects of global climate change on the environment, including the increased risk of death from extreme weather events, strategies for addressing these changes, perspectives on climate change from various nations, the vulnerability of low-income countries' populations, the economic instability brought on by climate change, and its effects on some nations, as well as the necessity of using sustainable and energy-efficient technology to safeguard the environment.

Key words: climatechange, globalwarming, health and environment.

Introduction

Increased average air temperature, ocean temperature, the melting of glaciers and sea ice, increasing sea levels, and other extensive components of climate change are only a few. Effects on cardiorespiratory health can result from exposing people to particulate matter (PM), as well as numerous other allergens and secondary pollutants. Additionally, the human population is vulnerable to climate change due to a number of issues brought on by it, including issues with mental health, starvation, water-borne sickness, and vector-borne illness. Extreme health effects from climate change are inevitable. Infectious diseases spread through vectors (e.g., Cholera, malaria, etc.), water (e.g., diarrhoea), food, etc. are examples of direct effects of climate change, as are deaths from thermal stress, injuries and fatalities from hurricanes, cyclones, and storms,

drowning in floods, etc. Indirect effects include infectious diseases transmitted through vectors (e.g., malaria, cholera, etc.). The population's livelihood, food security, access to water, agricultural production, etc. are all impacted by these direct and indirect effects. Therefore, one of the greatest ways to combat climate change may be to reduce greenhouse gas emissions, which are a major contributor to global warming. Additionally, synthetic chemicals like chlorofluorocarbon have been eroding the stratosphere and creating holes in it. Let's say that the ozone layer's deterioration is not stopped. In such scenario, the amount of UV light emitted by the earth's surface would rise, increasing the risk of skin cancer and other health issues. In order to minimise energy consumption and avoid pollution, this article will help readers better comprehend climate change and encourage them to use more environmentally friendly and energy-efficient technology.

Global Climate change and its impact on the environment

In order to minimise energy consumption and avoid pollution, this article will help readers better comprehend climate change and encourage them to use more environmentally friendly and energy-efficient technology. One of the main contributors to global warming and the subsequent global climate change that affects public health directly or indirectly is greenhouse gas emissions from human activity. Since CO₂ makes up roughly 63% of the greenhouse gases, tracking its levels can give us an estimate of global warming (GHG). These greenhouse gases have been rising, already raising the Earth's surface temperature by 0.80°C and predicted to raise the atmosphere's temperature by 0.20°C every decade [1]. Currently, CO₂ levels are at 419 ppm (fig. 1).

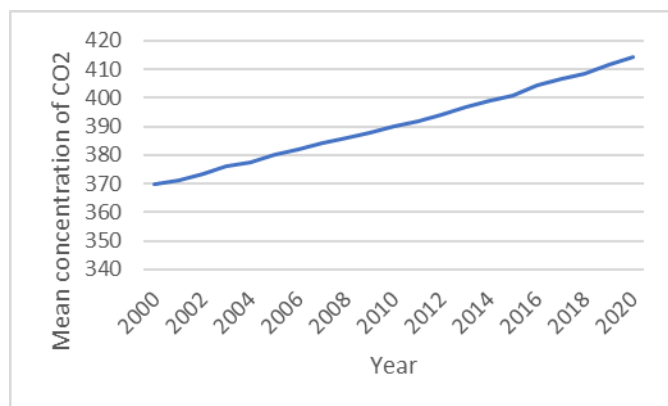


Fig 1. Tendency in atmospheric CO₂

Heat Waves

One of the earliest effects of global warming will be heat stress. This will raise the temperature both during the day and at night, which will increase mortality, particularly among the elderly. There are two primary characteristics of heat waves. The first characteristic, excessively warm circumstances suggest abnormally high temperatures, which implies that equal temperatures might have different impacts at various places or different times of the year, and sustained exposure. The second, sustained exposure, distinguishes heat waves from hot days that take place at different times. The functioning of infrastructure, public health, and other factors can all be negatively impacted by prolonged exposure to heat waves [3].

Changes in precipitation pattern

Global warming may have a significant impact on the environment if no measures are taken. It has the potential to change snowfall and rainfall patterns. From recent researches, it is clear that there are about 90% chances that around 3 billion people worldwide will have to choose either to migrate to areas with milder climates or to go hungry as a result of global crop agricultural failure due to climate change which will be the consequence of shortage in the amount of precipitation.

Melting of glaciers, sea ice and its impact on Biodiversity

Due to the arctic twice as rapid temperature increase as the rest of the world glaciers sea ice etc are melting at an alarming rate warmer temperatures are predicted to cause 1540 of the biodiversity to become extinct emperor penguins ringed seals polar bears and beluga whales are just a few of the iconic arctic animals that are under threat from disappearing sea ice the water level is rising as a result of the greenland ice sheet melting the water level might rise by 23 feet if the ice sheet entirely melts scientists predict that if the region heats only a few degrees further the ice sheets would melt uncontrollably and floods will occur.

Global Climate Change, Air Pollution, and Global Warming

Global climate change will be significantly impacted by global warming this shift will harm healthy lungs because it will affect the air's temperature particle matter pm levels acoustic allergens and ozone levels 6 given the strong connection between emissions and both air quality and climate change it is obvious that lowering ghg level the main cause of global warming could enhance air quality and lower air pollutants protecting people from the potential negative effects of climate change 7 ozone can be created in the lower atmosphere by the combination of nitrogen oxides NO_x methane CH₄ and several other volatile organic molecules ozone is a dangerous toxin that is found in the lower atmosphere.

Climate Change, Indian Perspective

Approximately 917 gm³ of pm were present in India's air over the whole of 2019 the concentrations were greater in the north of India than they were in the south and the country's overall mortality rate from ambient particulate matter pollution was 104 the total disability-adjusted life-years deaths for the year 2019 were 115 of which were attributable to ambient air pollution alone 8 4530-67 of the deaths were caused by home air pollution 6753-80 by ambient particulate matter pollution and 0703-10 by ambient ozone pollution air pollution therefore had an impact on 10856 million individuals 2019 had a 55-fold variation in ambient particulate matter levels between states with the northern states being the most affected the northern and northeastern states had the highest Daly rates for home air pollution in 2019 which differed between states by 1323 times in India the death rate caused by ambient ozone pollution varied 112 times between states in 2019 in a variety of ways depending on geographic location 9 out of the total number of persons in India who experienced a death as a result of air pollution one of the main causes and effects of global climate change in 2019 395 suffered from lung diseases including copd 227 lower respiratory infections 155 and lung cancer 13 the remaining death was accounted for by ischemic heart disease 294 stroke 137 diabetes 55 neonatal disorders 145 and cataract 15 copd ischemic heart disease and lower respiratory illnesses accounted for the majority of air pollution-related fatalities India faced deaths of 1.67 million people only due to air pollution, which is responsible for 17.8% of the total deaths. Ambient particulate matter resulted in death of 0.98 million (0.77-1.19) people, 0.61 million (0.39-0.86) deaths due to household air pollution and 0.17 million (0.08-0.26) died due to ambient ozone pollution (Table 1) [8].

Table1

Deathsand DALYscausedduetoairpollutioninIndiain2019 [8]				
	Numberofdeaths,millions*	Percentage of totaldeaths	NumberofDALYs,millions	PercentageoftotalDALYs
Airpollution	1.67(1.42-1.92)	17.8%(15.8-19.5)	53.5(46.6-60.9)	11.5%(10.2-12.8)
Ambientparticulate matterpollution	0.98(0.77-1.19)	10.4%(8.4-12.3)	31.1(24.6-37.5)	6.7%(5.3-8.0)
Household airpollution	0.61(0.39-0.86)	6.5%(4.3-9.0)	20.9(14.1-28.7)	4.5%(3.0-6.1)
Ambient ozonepollution	0.17(0.08-0.26)	1.8%(0.9-2.7)	3.06(1.51-4.83)	0.7%(0.3-1.0)

Climatechange,AustralianPerspective

The entire earth is currently facing some type of impact from global climate change climate regimes with considerable variability are found all throughout the Australian continent including tropical temperate desert and alpine as per the recent studies there has been a significant rise in global warming which has resulted in greater tropical rainfall and diminished temperate rainfall the infrastructure agriculture and biodiversity of that area may all be negatively impacted by these changes 15 from 1910 to 2011 the air temperature of the Australian continent increased by 09c or 02c greater than the world average temperature for the same period 17 the majority of the warming has been happening since 1950 and each decade since has seen temperatures rise above the previous average 18 the driest continent where people still live is Australia it can be harmed by very little variations in rainfall since 1900 and far more notably in 1950 there’s been major changes in precipitation in northwest Australia southwest western Australia southeast Australia and northeast Australia 19 a long-term rise in yearly rainfall in northwest Australia’s summer months has been linked to higher concentrations in the atmosphere of chemicals from the Asia region that promote cloud formation 20212223 in southwest Australia less rain has been falling recently from the middle of the 1970s to 2007 20 a 15 reduction in winter rainfall has been seen 2009 saw significant forest fire in the greater Melbourne metropolitan region as a result of Australia’s record-breaking heatwaves.

Climatechange,EuropeanPerspective

The entire public’s respiratory health was effected by the rising temperatures and heat waves that happened throughout Europe it is evident from the figures for august 2003 when more than 20000 persons passed away in England,France,Spain,Italy and Portugal 10 intense heat and forest fires lead to more fatalities in Moscow in 2010 in the southern part of Europe there have been more forest fires during the past several decades as a result of climate change which has boosted the amount of particulate matter pm in the air during the dry season flooding is being

forced on by climate change in practically all of Europe the flood from the donau caused almost 8 billion in damages in 2013.

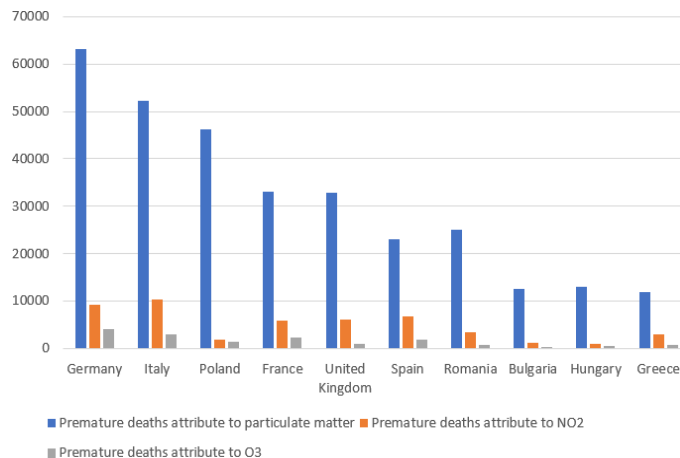


Fig -2: Premature deaths attribute to air pollution in2018[14]

Increased temperatures can cause ozone emission near boreal woods the temperature-dependent biogenic emission will rapidly rise across land proposes the Danisheulerian hemispheric model dehm12 the propagation of free hydroxide radicals oh will be exacerbated as a result of higher ozone emission and rising water vapour which will inevitably cause a rise in respiratory morbidity a longer pollen season may lead to a larger volume of pollen concentration according to a Swiss research from 1979 to 1999 pollen concentration may increase by 2 to 6 times which would lead to an increase in allergy symptoms in the afflicted population 13

The research makes it quite evident that PM was the leading cause of fatalities. According to the research, there were a total of 4,17,000 premature deaths in 2018 throughout the 41 European nations and the EU-28, 55,000 fatalities from NO2 and 20,600 deaths from O₃.

Given that Germany has the largest population among the EU nations, it had the greatest number of fatalities, including 63,100 premature deaths brought on just by excessive PM exposure [14].

GlobalClimatechange,anditsimpactonPublicHealth

The threat posed by global climate change to human health can take numerous forms anticipated concerns have materialised into actual repercussions despite just an increase in average temperature of 085c there are two different sorts of these effects there are two types of effects on the ecosystem first the direct effects such as heatwaves storms forest fires droughts and floods and second the indirect effects which result from the changing patterns of illness economy and social structures such as migration conflict etc due to cultural traditions socioeconomic disparities poor public health system management and a number of other variables certain areas populations are more sensitive to climate change than others 25

Impactofheatwaveson publichealth

As heatwaves become more common, the climate shifts [26]. Hot weather directly affects mortality, especially in elderly persons. Vascular, cardiovascular, and pulmonary issues can all contribute to death during prolonged heat waves. Because of an effect known as the urban heat island effect, there are more premature deaths in metropolitan areas. The temperature is greater here than in the nearby sub-urban-rural areas [27].

Air pollution from heat waves contributes to a rise in mortality. Europe is the finest illustration of how even high-income nations may have negative impacts, which, in the absence of an integrated and coordinated response, can result in a significant number of fatalities [27].

TacklingHeatWaves

Emergency measures, such as treatable condition, access to wind venues, etc., should be deployed to counter heat waves. Using air conditioners is not a wise move because it will just increase the amount of heat transferred by humans and is also unsustainable. Instead, we may use better measures like insulation of buildings, exterior shading, and cool paints. These are far more practical because they require little to no energy to perform once installed [28].

Impact of Storms, Floods and Droughts onpublichealth

Extreme precipitation can emerge from global warming since even a 1°C increase in atmospheric temperature can expand the proportions of saturation concentrations of humid air, which is the source of rain. Extreme precipitation will make floods more frequent, which will lead to financial loss, adverse effects on land and aquatic ecosystems, and impacts on human communities [29].

These natural hazards brought on by climate change will also have a variety of negative repercussions on people's health, including death, bodily harm, various disorders, and long-lasting affects on mental health. A torrent of water and dirt that blanketed a camper next to a channelized river in Biescas, Spain, in 1996 caused a flood that killed 86 civilians [30].

Almost a hundred individuals were murdered and at least 2,000 more were made homeless by river floods in central Europe. Pesticides and perhaps other chemicals, such as those from corporations, can be mobilised in the environment as a result of flooding. After the inundation, heavy metal soil pollution in the Meuse river was discovered. As the polluted water rinsed the floodplain soils with high quantities of lead and cadmium, it may put riverbank residents' health at danger [31].

In every nation, floods raise the danger of respiratory and diarrhoeal illnesses. In industrialised nations, a detrimental effect on the local economy is a key reason for concern because it may result in depression, population mental problems, famine, etc.

At least 1300 people were killed by Hurricane Katrina, which is regarded as the most expensive natural catastrophe in US history. Over a million people were also left homeless [CDC web sites <http://www.cdc.gov/>].

When there is little to no precipitation in an area, a drought occurs. They have a significant impact on people's health. Droughts may affect people's health in a number of ways, including by creating air pollution from forest fires, infectious infections, and nutritional issues. The El Nio cycle has a significant impact on the number of people impacted by droughts [33].

Tacklingtheseextreme events

In order to confront with extreme situations like storms and floods, we should work to boost early warning systems (EWS), act effectively and successfully before such catastrophes occur, and identify and monitor populations that are more exposed and susceptible [40]. Weather predictions, possible health effects on vulnerable groups, the planning and execution of effective and efficient tactics, and communication avoidance responses are a few examples of these EWS [25].

To prepare its residents for every probable circumstance, both emotionally and physically, the nation's health authorities should run emergency programming or disaster management activities as well as various exercise programmes [25].

Impact of Infectious Diseases

One of the finest instances of this sort of sickness is vector-borne illnesses, which are spread by infectious organisms that are sensitive to climate. In response to temperature and precipitation, they display a seasonal pattern. A vector-borne disease like malaria is an illustration of a condition that, in certain areas, varies virtually yearly as a result of climatic conditions [34]. The transmission of vector-borne illnesses is influenced by a number of variables, including temperature, changing rainfall, soil moisture, sea level rise, and humidity. These pathogens that cause disease must be present simultaneously with a host, a reliable vector, and a sufficient quantity of these pathogens. In some areas, the duration of the transmission season may lengthen as the climate changes globally. These infectious illnesses are probably going to afflict many low-income countries more. The industrialised nations, which had previously managed to control a lethal disease like malaria, etc., are thought to be able to manage other diseases as well. Only highland and dry regions in developing nations are free of malaria due to climate factors. Malaria's reach is anticipated to increase in India when it reaches higher elevations. The transmission of malaria would be restricted in certain places as the temperature rose, which would lead to more populations losing their immunity and, eventually, outbreaks in the following years [35]. Various climate change-sensitive vectors and the illnesses they transmit are shown in Table 2 as well.

Table 2

Examples of vector-borne diseases likely to be sensitive to climate change [26].	
Vector	Major Diseases
Mosquitoes	Malaria, filariasis, dengue fever, yellow fever and West Nile fever
Sandflies	Leishmaniasis
Triatomines	Chagas disease
Ixodesticks	Lyme disease and tick-borne encephalitis
Tsetse flies	African trypanosomiasis
Blackflies	Onchocerciasis
Snails (intermediate host)	Schistosomiasis

If global warming persists, the atmosphere will warm and the environment will get warmer, increasing the frequency of water-borne illnesses. The diarrheal illnesses giardiasis, salmonellosis, and cryptosporidiosis are among them [36]. In South Asia, diarrheal morbidity affects around one-fourth of the children. The prevalence of this disease continues to expand as a result of rising ambient temperatures, proliferation, and a number of other causes [37]. Cholera is an illustration of a well-known diarrheal sickness. The following nations have seen cholera outbreaks: India, Bangladesh, Latin America, and Africa [38]. Recent studies have demonstrated that cholera epidemics begin when sea surface temperatures rise, with outbreaks following the seasonal rise and fall of sea surface height and temperatures [38].

Tackling infectious diseases

When we discuss climate change, one of the main worries is infectious illnesses. It would be difficult to combat a widespread sickness that occurred during any catastrophic event since it may spread like wildfire and result in a large number of fatalities. The government has to start

funding public health in order to combat these contagious illnesses. Education, healthcare, and public health prevention all directly affect the population's health. The vulnerability and resilience of the population can be significantly influenced by infrastructure [41]. The UN Framework Convention on Climate Change (UNFCCC) estimates that the overall costs of adapting the health sector in poor nations will be between US\$4 to 12 BN by 2030.0The cost of the repercussions if the public health sector does not invest in public health will be much higher. Additionally, coping with the effects of climate change will boost population immunity [42].

One health method, which is also the most logical one, is another way to combat the prevalence of infectious illnesses. This strategy calls for collaboration across many academic fields and geographical regions to safeguard the environment and human health. Pathogens are responsible for more than 70% of these illnesses, and poverty is also a factor [43]. An efficient response to a growing infectious illness combines a stable long-term finance structure, a well-functioning national human health system, and accurate diagnostics. These diseases' outbreaks have a significant impact on the economy.

The World Bank offers no regrettable alternatives because the investments will contribute to a decrease in future climate vulnerability. By establishing a connection between civil society and the government and providing early warning of numerous illness hazards, it also increases strength [25].

The West African Ebola epidemic served as a stark reminder of how crucial it is for nations to improve their ability to track and address disease outbreaks. In order to combat infectious illnesses, surveillance and monitoring constitute the third strategy. Public health services can gather the data and information, which can then be tracked by monitoring systems. This data can then be used to understand the pattern of the illness, identify susceptible communities, and therefore prepare a response plan to tackle the situation [44].

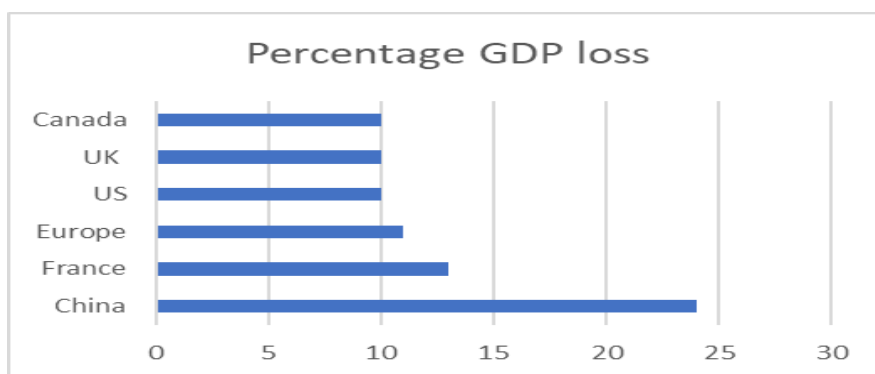


Fig-3:Percentage loss of GDP in various countries if their average temperature increase by 3.2°C [39]

and react to the outbreaks of illness is crucial. In order to combat infectious illnesses, surveillance and monitoring constitute the third strategy. Public health services may gather the data and information, which can then be tracked by monitoring systems. This information can then be used to analyse the pattern of the disease, identify susceptible communities, and create a response plan to deal with the problem [44].

Economic Aspect

In addition to harming people's lives, global climate change also poses a threat to the world economy. There is a chance that heat waves will make people less productive. Storms such as typhoons, hurricanes, cyclones, and others have rendered countless people homeless and

impoverished. According to the United Nations Organization's World Population Prospects 2019, droughts lead to poor harvests and, as a result, a tiny amount of food to feed the population, which is growing swiftly and is anticipated to reach 10 billion by the year 2050. The World Bank says that if quick action is not taken, by 2030, 100 million additional people may live in poverty as a result of climate change. To address this issue and promote sustainable economic growth, we must increase cooperation between the commercial and governmental sectors.

By the middle of the century, China may have lost 24% of its GDP, Greece or France could have lost 13%, Europe could have lost around 11% of its GDP, and the US, Canada, and UK could have lost approximately 10% [38]. Figure 3 displays the percentage GDP loss for several nations if their average temperature rises just 3.2°C.

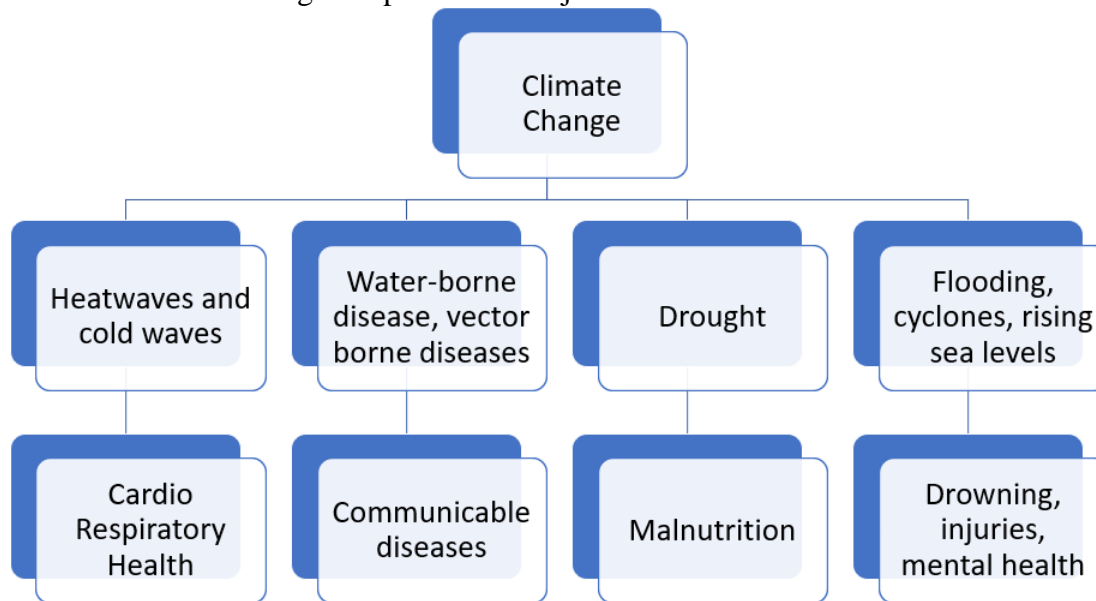


Fig-4: Impact of climate change on Environment and its effects on human health

A research by the Swiss Re Institute found that if nothing is done to address climate change, the world might lose up to 18% of its GDP. Since prior experiences have shown that climate change makes weather-related natural disasters worse, it follows that it will also have a significant influence on countries' incomes and productivity. Let's use the increasing sea levels as an illustration. The sea level would eventually rise as a result of the melting of glaciers and other land and marine ice due to increased temperatures brought on by global warming. We will lose territory that might have been used effectively as the water level rises.

CONCLUSIONS

We, the citizens of the twenty first century, must work to improve our environmental conditions in order to protect our precious environment and make the world a better place to live in the future. There are still a great number of undiscovered aspects of potential health threats caused by climate change. In contrast to the current way of development, which is unsustainable and fails to meet its population's fundamental requirements, we need a new model of human development that is effective and sustainable.

Environmental processes in general will contribute to the anticipated health implications. Changes in agriculture, natural resources (such as fresh water, insects, or vectors), or both may have a variety of effects. Heat waves, altered precipitation patterns, glacier and sea ice melting, and other natural effects of climate change will endanger the lives of the Earth's people. Figure 4 illustrates how climate change affects the environment and how those changes will affect people's health. Since climatic data is obtained from both computer and disease models to provide both field and lab data, numerous scenarios-based mathematical modelling may be utilised to give us an idea of the disease activity in advance.

Ozone gas in the stratosphere is being depleted as a result of global warming. Additionally, it has a negative influence on growth and has several environmental repercussions, including heat stress, vector-borne illnesses, respiratory problems, allergy disorders, etc. Therefore, in terms of research and policy, we require a much more global perspective. We need to investigate these occurrences and develop workable, sustainable solutions, such as using less hot water, relying more on public transportation, planting trees, and ceasing to use CFC-containing air conditioners.

It will be challenging to adjust to a changing environment with a population that is always growing. Given the limited resources we have on Earth, human civilization must work together with wealthy and developing nations—which frequently lack the means even for the most basic needs—to achieve sustainability. The negative effects of global climate change on the economy also need us to be ready for any challenges they may bring. As a result, we ought to employ more sustainable resources and alter how we produce items in order to make it more practical and sustainable. Progress will undoubtedly be made by a human civilization that appreciates the environment as well as current as well as future generations' demands.

REFERENCES

- [1] Rom WN. Environmental Policy and Public Health: Air Pollution, Global Climate Change, and Wilderness. San Francisco, CA: John Wiley & Sons, Inc.; 2012.
- [2] Dr. Pieter Tans, NOAA/GML (gml.noaa.gov/ccgg/trends/) and Dr. Ralph Keeling, Scripps Institution of Oceanography (scrippsco2.ucsd.edu/).
- [3] S.J. Macaulay, K.J. Hageman, J.J. Piggott, et al., Time-cumulative effects of neonicotinoid exposure, heat waves and food limitation on stream mayfly nymphs: A multiple-stressor experiment, *Science of the Total Environment* (2020), <https://doi.org/10.1016/j.scitotenv.2020.141941>
- [4] Eneji, Chris-Valentine. (2017) THE ENVIRONMENTAL STUDIES A Review of Global Warming/Climate Change A Review of Global Warming/Climate Change, Causes, Effects and Mitigations. THE ENVIRONMENTAL STUDIES. 1. 44-71.
- [5] Sharat Kumar Palita, "CLIMATE CHANGE AND ITS IMPACT ON BIODIVERSITY"
- [6] Paul J Beggs 2021 *Environ. Res. Lett.* 16(2021)035006, <https://doi.org/10.1088/1748-9326/abda6f>
- [7] Erickson, LE, Newmark, GL, Higgins, MJ, Wang, Z. Nitrogen oxides and ozone in urban air: A review of 50 plus years of progress. *Environ Prog Sustainable Energy*. 2020; 39:e13484. <https://doi.org/10.1002/ep.13484>
- [8] Indian Council of Medical Research, Public Health Foundation of India, Institute for Health Metrics and Evaluation. GBD India Compare Data Visualization. New Delhi: ICMR, PHFI, and IHME, 2019, <http://vizhub.healthdata.org/gbd-compare/india> (accessed Dec 11, 2020).
- [9] *Lancet Planet Health* 2021; 5: e25–38 "Health and economic impact of air pollution in the

- states of India: the Global Burden of Disease Study 2019”, Dec 22, 2020
[https://doi.org/10.1016/S2542-5196\(20\)30298-9](https://doi.org/10.1016/S2542-5196(20)30298-9)
- [10] Sardon JP. The 2003 heatwave. *Euro Surveill* 2007;12:226.
- [11] Bruno Merz, Florian Elmer, Michael Kunz, Bernhard Mühr, Kai Schröter, Steffi Uhlemann-Elmer, “The extreme flood in June 2013 in Germany” DOI:10.1051/lhb/2014001
- [12] Hedegaard GB, Brandt J, Christensen JH, et al. Impacts of climate change on air pollution levels in the Northern Hemisphere with special focus on Europe and the Arctic. *Atmos Chem Phys* 2008;8:337-67.
- [13] Bernard Clot, “An overview of 21 years of data in Neuchâtel (Switzerland)”. *Aerobiologia* 2003;19:227-34.
- [14] EEA Report No 9/2020 <https://www.eea.europa.eu/publications/air-quality-in-europe-2020-report>
- [15] Lesley Head, Michael Adams, Helen V. McGregor and Stephanie Toole, *WIREs Clim Change* 2014, 5:175–197. doi: 10.1002/wcc.255
- [16] CSIRO, Bureau of Meteorology. State of the climate 2012;2012.
- [17] Cleugh H, Smith MS, Battaglia M, Graham P, eds. *Climate Change: Science and Solutions for Australia*. Collingwood: CSIRO Publishing; 2011.
- [18] Gallant AJE, Karoly DJ. A combined climate extremes index for the Australian region. *J Climate* 2010;23:6153–6165.
- [19] Keenan TD, Cleugh HA. “Climate Science Update: A Report to the 2011 Garnaut Review”. The Centre for Australian Weather and Climate Research, CSIRO and the Bureau of Meteorology; 2011, 99.
- [20] Cleugh H, Smith MS, Battaglia M, Graham P, eds. *Climate Change: Science and Solutions for Australia*. Collingwood: CSIRO Publishing; 2011.
- [21] Taschetto AS, England MH. An analysis of late twentieth century trends in Australian rainfall. *Int J Climatol* 2009;29:791–807
- [22] Wardle R, Smith I. Modelled response of the Australian monsoon to changes in land surface temperatures. *Geophys Res Lett* 2004, 31:L16205. doi:10.1029/2004GL020157.
- [23] Rotstayn LD, Cai WJ, Dix MR, Farquhar GD, Feng Y, Ginoux P, Herzog M, Ito A, Penner JE, Roderick ML, et al. Have Australian rainfall and cloudiness increased due to the remote effects of Asian anthropogenic aerosols? *J Geophys Res* 2007, 112:D09202. doi:10.1029/2006JD007712.
- [24] National Climate Centre. The exceptional January- February 2009 heatwave in southeastern Australia, Bureau of Meteorology, Special Climate Statement 17; 2009
- [25] Watts N, Adger WN, Agnolucci P, Blackstock J, Byass P, Cai W, Chaytor S, Colbourn T, Collins M, Cooper A, Cox PM, Depledge J, Drummond P, Ekins P, Galaz V, Grace D, Graham H, Grubb M, Haines A, Hamilton I, Hunter A, Jiang X, Li M, Kelman I, Liang L, Lott M, Lowe R, Luo Y, Mace G, Maslin M, Nilsson M, Oreszczyn T, Pye S, Quinn T, Svendsdotter M, Venevsky S, Warner K, Xu B, Yang J, Yin Y, Yu C, Zhang Q, Gong P, Montgomery H, Costello A. Health and climate change: policy responses to protect public health. *Lancet*. 2015 Nov 7;386(10006):1861-914. doi: 10.1016/S0140-6736(15)60854-6. Epub 2015 Jun 25. PMID: 26111439.
- [26] Hulme M, Jenkins GJ, Lu X, et al. *Climate change scenarios for the United Kingdom: the UKCIP02 scientific report*. Norwich: Tyndall Centre for Climate Change Research, School of Environmental Sciences, University of East Anglia; 2002.
- [27] Knowles, C. L. (2020). Planning Strategies for Improving Resilience of Cities in Developing Countries to the Urban Heat Island. Retrieved from http://purl.flvc.org/fsu/fd/FSU_libsubv1_scholarship_submission_1587751988_3a8f934a
- [28] Zheng, Z., Zhao, L. & Oleson, K.W. Large model structural uncertainty in global

- projections of urban heat waves. *Nat Commun* 12, 3736 (2021). <https://doi.org/10.1038/s41467-021-24113-9>
- [29] Moustakis, Y., Papalexiou, S.M., Onof, C.J., & Paschalis, A. (2021). Seasonality, intensity, and duration of rainfall extremes change in a warmer climate. *Earth's Future*, 9, e2020EF001824. <https://doi.org/10.1029/2020EF001824>
- [30] Estrela T, Menendez M, Dimas M et al. Sustainable water use in Europe – Part 3 extreme hydrological events: floods and draughts. Copenhagen: European Environment Agency, 2001
- [31] Albering HJ, van Leusen SM, Moonen EJC, Hoogewerff JA, Kleinjans JCS. Human health risk assessment: a case study involving heavy metal soil contamination after the flooding of the river Meuse during the winter of 1993–1994. *Environ Health Perspect* 1999;107:37–43
- [32] Bigger, Patrick & Dempsey, Jessica & Christiansen, Jens & Rojas-Marchini, Fernanda & Irvine-Broque, Audrey & Nelson, Sara & Disilvestro, Adriana & Schuldt, Andrew & Shapiro-Garza, Elizabeth. (2021). Beyond The Gap: Placing Biodiversity Finance in the Global Economy. 10.13140/RG.2.2.10618.21449.
- [33] Meynecke, J.-O., Grubert, M., Arthur, J. M., Boston, R., & Lee, S. Y. (2012). The influence of the La Niña-El Niño cycle on giant mud crab (*Scyllaserrata*) catches in Northern Australia. *Estuarine, Coastal and Shelf Science*, 100, 93–101. <https://doi.org/10.1016/j.ECSS.2012.01.001>
- [34] Kovats RS, Bouma MJ, Hajat S, Worrall E, Haines A. El Niño and health. *Lancet*. 2003 Nov 1;362(9394):1481-9. doi: 10.1016/S0140- 6736(03)14695-8. PMID: 14602445.
- [35] Rodó, X., Martínez, P.P., Siraj, A. et al. Malaria trends in Ethiopian highlands track the 2000 ‘slowdown’ in global warming. *Nat Commun* 12, 1555 (2021). <https://doi.org/10.1038/s41467-021-21815-y>
- [36] Indhumathi K, Sathesh Kumar K. A review on prediction of seasonal diseases based on climate change using big data. *Mater Today Proc*. 2021;37:2648-2652. doi:10.1016/j.matpr.2020.08.517
- [37] Wang, H., Chen, X., Kong, N. et al. TRIM21 inhibits porcine epidemic diarrhea virus proliferation by proteasomal degradation of the nucleocapsid protein. *Arch Virol* 166, 1903–1911 (2021). <https://doi.org/10.1007/s00705-021-05080-4>
- [38] Lipp E, Huq A, Colwell R. Effects of global climate on infectious disease: the cholera model. *Clin Microbiol Rev*. 2002;15:757–70
- [39] Swiss Re Institute, “World Economy set to lose up to 18% GDP from climate change if no action taken, reveals Swiss Re Institute’s stress-test analysis” <https://www.swissre.com/media/news-releases/nr-20210422-economics-of-climate-change-risks.html;2021>
- [40] Sukmara, R.B.; Wu, R.S. Utilization of Mosque as A Part of Early Warning Systems to Reduce Flood Damage in Samarinda City, Indonesia. Preprints 2021, 2021030278 (doi: 10.20944/preprints202103.0278.v1).
- [41] Bhopal, A., Medhin, H., Bærøe, K., & Norheim, O.F. (2021). Climate change and health in Ethiopia: To what extent have the health dimensions of climate change been integrated into the Climate Resilient Green Economy? *World Medical & Health Policy*. 13, 293–312. <https://doi.org/10.1002/wmh3.447>
- [42] Catania, F., Baedke, J., Fábregas-Tejeda, A., Nieves Delgado, A., Vitali, V., & Nguyen Long, L. (2021). Global climate change, diet and the complex relationship between human host and microbiome: Towards an integrated picture. *BioEssays*, 43, e2100049. <https://doi.org/10.1002/bies.202100049>
- [42] Rahman, M.T.; Sobur, M.A.; Islam, M.S.; Ievy, S.; Hossain, M.J.; El Zowalaty, M.E.; Rahman, A.T.; Ashour, H.M. Zoonotic Diseases: Etiology, Impact, and Control.

Microorganisms 2020, 8, 1405.<https://doi.org/10.3390/microorganisms8091405>
[43]Jalloh MF, Kinsman J, Conteh J, et al Barriers and facilitators to reporting deaths following Ebola surveillance in Sierra Leone: implications for sustainable mortality surveillance based on an exploratory qualitative assessment BMJ Open 2021;