

Impact of Climate Change on Public Health

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Abstract - Climate change has been recognized as the foremost environmental problem of the twenty-first century and has become a subject of considerable debate. It is predicted to lead to adverse, irreversible impacts on earth and the ecosystem as a whole. Although it is difficult to connect specific weather events to global warming, increases in global temperatures have been predicted to cause broader changes, including glacial retreat, arctic shrinkage, and worldwide sea level rise. Climate change has been implicated in mass mortalities of many aquatic species, including plants, fish, corals, and mammals. Climate change is an emerging threat to global public health and is predicted to affect human health in many ways including heat stress (stroke), air pollution, food scarcity, spread of infectious diseases and intensity of disease outbreaks. Thus, 'Global Climate Change' has been a major issue that has created global concern, and this has been highlighted by awarding the 2007 Nobel Peace Prize for this cause, on the Intergovernmental Panel on Climate Change (IPCC) and Albert Arnold (M) Gore Jr., the former American Vice-President, jointly. The present paper focuses on different aspects of 'global climate change'; the causes, predicted impacts, probable steps for mitigation and the need for greater understanding of climate change and bringing global awareness on the issue.

Index Terms - Global Temperatures, Ecosystem, Arctic Shrinkage, Global Awareness.

1. INTRODUCTION

Not in 100 years, not in 10 years, right now. We're feeling the health effects of climate change right now. What really surprises most people is how well interconnected all of these systems are. Rising CO₂ levels isn't just making our temperatures high. It's also making our crops less nutritious. And higher temperatures don't just raise our sea levels. Higher sea levels add salt to our water supplies. So less nutritious food, poor quality water, you know that's going to impact all of our health. Air quality, nutrition, infectious disease, human migration are some big

effects. The impact of climate change on health, particularly in vulnerable populations.

With so much at stake for health, now and into the future, honestly it can feel overwhelming and what people are doing around the world, things you can do to reduce the impact of climate change on health.

2. WHAT IS CLIMATE CHANGE?

You might know what weather is. Weather is that the changes we see and feel outside from day to day. It'd rain at some point and be sunny subsequent. Sometimes it's cold. Sometimes it's hot. Weather also changes from place to place. Whereas climate is that the usual weather of an area. Climates are often different for various seasons. An area could be mostly warm and dry within the summer. An equivalent place could also be cool and wet within the winter. Different places can have different climates.

Climate change may be a change within the usual weather found during a place. This might be a change in what proportion of rain an area usually gets during a year, or it might be a change during a place's usual temperature for a month or season. Global climate change is additionally a change in Earth's climate. This might be a change in Earth's usual temperature, or it might be a change in where rain and snow usually fall on Earth. Weather can change in only a couple of hours. Climate takes hundreds or maybe many years to vary.

2.1. What Causes Climate Change?

There are many factors that contribute to Earth's climate. However, scientists agree that Earth has been getting warmer within the past 50 to 100 years thanks to human activities. Certain gases in Earth's atmosphere block heat from escaping. This is called the Greenhouse Effect. These gases keep Earth warm just like the glass a greenhouse keeps plants warm. Human activities like burning fuel to power factories, cars and buses are changing the natural greenhouse.

These changes cause the atmosphere to trap more heat than it used to, leading to a warmer Earth.

As Earth becomes warmer, some regions may welcome warmer temperatures, but others may not. Warmer conditions will probably cause more evaporation and precipitation overall, but individual regions will vary, some becoming wetter. A stronger greenhouse effect will warm the ocean and partially melt glaciers and ice sheets, increasing sea level. Ocean water also will expand if it warms, contributing further to water level rise. Due to greenhouse effect, higher atmospheric CO₂ (CO₂) levels can have both positive and negative effects on crop yields. Some laboratory experiments suggest that elevated CO₂ levels can increase plant growth. However, other factors, like changing temperatures, ozone, and water and nutrient constraints, may quite counteract any potential increase in yield. If optimal temperature ranges for some crops are exceeded, earlier possible gains in yield may be reduced or reversed altogether.

2.2. How Does Climate Change Affect Health?

The influences of weather and climate on human health are significant and varied. They range from the clear threats of temperature extremes and severe storms to connections that may seem less obvious. For example, weather and climate affect the survival, distribution, and behavior of mosquitoes, ticks, and rodents that carry diseases like West Nile virus or Lyme disease. Climate and weather can also affect water and food quality in particular areas, with implications for human health. In addition, the effects of global climate change on mental health and well-being are integral parts of the overall climate-related human health impact.

A useful approach to understand how climate change affects health is to consider specific exposure pathways and how they can lead to human disease. The concept of exposure pathways is adapted from its use in chemical risk assessment, and in this context describes the main routes by which climate change affects health.

Exposure pathways differ over time and in different locations, and climate change related exposures can affect different people and different communities to different degrees. While often assessed individually, exposure to multiple climate change threats can occur simultaneously, resulting in compounding or cascading health impacts. Climate change threats may

also accumulate over time, leading to longer-term changes in resilience and health.

Whether or not a person is exposed to a health threat or suffers illness or other adverse health outcomes from that exposure depends on a complex set of vulnerability factors. Vulnerability is the tendency or predisposition to be adversely affected by climate-related health effects, and encompasses three elements: exposure, sensitivity or susceptibility to harm, and the capacity to adapt or to cope.

Because multiple disciplines use these terms differently and multiple definitions exist in the literature, the distinctions between them are not always clear.

All three of these elements can change over time and are place- and system-specific.

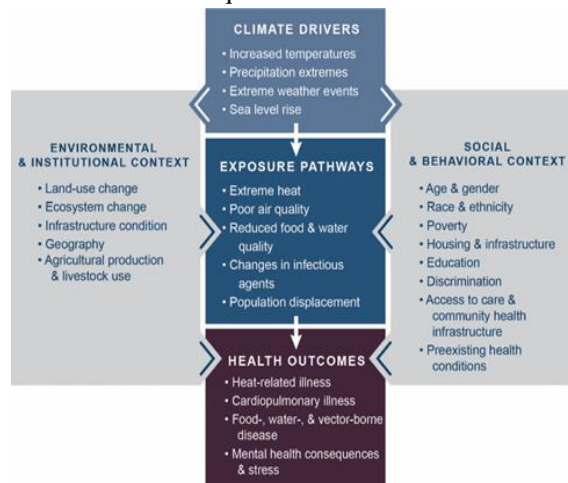
In the context of this report, we define the three elements of vulnerability as follows:

- Exposure is contact between a person and one or more biological, psychosocial, chemical, or physical stressors, including stressors affected by climate change. Contact may occur in a single instance or repeatedly over time and may occur in one location or over a wider geographic area.
- Sensitivity is the degree to which people or communities are affected, either adversely or beneficially, by climate variability or change.
- Adaptive capacity is the ability of communities, institutions, or people to adjust to potential hazards, to take advantage of opportunities, or to respond to consequences. A related term, resilience, is the ability to prepare and plan for, absorb, recover from, and more successfully adapt to adverse events.

For example, water resource, public health, and environmental agencies in the United States provide many public health safeguards, such as monitoring water quality and issuing advisories to reduce risk of exposure and illness if water becomes contaminated. Some aspects of climate change health impacts in the United States may therefore be mediated by factors like strong social capital, fully functional governance/management, and institutions that maintain the Nation's generally high level of adaptive capacity. On the other hand, the evidence base regarding the effectiveness of public health interventions in a climate change context is still relatively weak. Current levels of adaptive capacity

may not be sufficient to address multiple impacts that occur simultaneously or in close succession or impacts of climate change that result in unprecedented damages.

The three components of vulnerability (exposure, sensitivity, and adaptive capacity) are associated with social and demographic factors, including level of wealth and education, as well as other characteristics of people and places, such as the condition of infrastructure and extent of ecosystem degradation. For example, poverty can leave people more exposed to climate and weather threats, increase sensitivity because of associations with higher rates of illness and nutritional deficits, and limit people’s adaptive capacity. As another example, people living in a city with degraded coastal ecosystems and inadequate water and wastewater infrastructure may be at greater risk of health consequences from severe storms.



Conceptual diagram illustrating the exposure pathways by which climate change affects human health. Exposure pathways exist within the context of other factors that positively or negatively influence health outcomes (gray side boxes). Key factors that influence vulnerability for individuals are shown in the right box and include social determinants of health and behavioral choices. Key factors that influence vulnerability at larger scales, such as natural and built environments, governance and management, and institutions, are shown in the left box. All of these influencing factors can affect an individual’s or a community’s vulnerability through changes in exposure, sensitivity, and adaptive capacity and may also be affected by climate change.

3. IMPACTS OF CLIMATE CHANGE ON PUBLIC HEALTH IN INDIA: FUTURE RESEARCH DIRECTIONS

3.1. Climate Change and Human Health

Although low- and middle-income countries are responsible for only a small percentage of global greenhouse gas emissions, the adverse health effects associated with climate change will likely fall disproportionately on their populations. High-risk areas include those already experiencing a scarcity of resources, environmental degradation, high rates of infectious disease, weak infrastructure, and overpopulation. In particular, tropical regions will experience significant changes in human–pathogen relationships because of climate change. Changing temperatures and precipitation patterns linked to climate change will further affect health by changing the ecology of various vector-borne diseases, such as malaria, dengue, chikungunya, Japanese encephalitis, kala-azar, and filariasis

The goals of this report are to briefly summarize relevant literature and highlight the enormous challenges and opportunities for innovative research, with a particular focus on India. Such research is needed to pave the way for unique and pioneering solutions that can improve public health in the face of increasing climate variability. Therefore, we review the current state of the science relevant to the 2009 Joint Indo–U.S. Workshop on Climate Change and Health that was held in Goa, India, and then discuss the observed relationships between climate variability and human health, specifically in relation to the Indian subcontinent, highlighting future research directions. Potential health impacts discussed at the Goa workshop fell into three categories: heat stress and air pollution, waterborne disease, and vector-borne disease focusing on malaria. Additional crosscutting sessions covered climate modeling and predictions for India, adaptation and vulnerability, surveillance and early warning systems, integration of spatial analysis, and bridging policy and science. We acknowledge that the potential physical and social impacts of climate change in India will likely be diverse, and that many additional important factors were not covered in our workshop, such as food yields, malnutrition, child growth, river flow, monsoon rain patterns, and freshwater availability. Nevertheless, we believe the Goa workshop served to target many of the major

public health concerns associated with climate change and began the process of conceptualizing research needs and approaches that are integrative and achievable in low- and middle-income countries.

3.2. Impacts in India

The 2009 Joint Indo-U.S. Workshop on Climate Change and Health

The workshop was held in Goa, India, on 30 August through 2 September 2009; it was cosponsored by the University of Michigan's Center for Global Health, the U.S. Centers for Disease Control and Prevention's National Center for Environmental Health, and the Indian Council of Medical Research. Scientists from the cosponsoring institutions, along with other partners from academia, government, and nongovernmental organizations, met under the auspices of the existing Indo-U.S. Collaboration in Environmental and Occupational Health to discuss the current state of the science, identify gaps in understanding, and outline future research directions related to the human health effects of climate change in India. The focus was prediction and prevention in India, and discussions touched on the tremendous opportunities and significant challenges associated with designing, initiating, and conducting research, as well as pursuing related public health programming to improve public health infrastructure in the face of climate change.

3.2.1. Natural Disaster

Earthquakes, storms, flooding or drought are the number of recorded loss events due to natural catastrophe is very high. Developing and emerging countries are particularly vulnerable, for example those exposed to floods and heatwaves. The most devastating earthquakes in recent years hit Haiti and Chile for example, where very severe tremors were felt in 2010. The damage caused by a particular earthquake greatly depends on the properties of the affected buildings, as well as on local subsoil conditions and the parameters of the earthquake itself, i.e. magnitude, distance and duration. Developing countries are poorly equipped to deal with weather extremes. Hence the number of people killed, injured or made homeless by natural disasters has been increasing rapidly. This reflects global trends in population vulnerability more than an increased frequency of extreme climatic events

3.2.2. Air Quality

Changes in climate can result in impacts to local air quality. Atmospheric warming associated with climate change has the potential to increase ground-level ozone in many regions, which may present challenges for compliance with the ozone standards in the future. Climate change might also affect human health by making our air less healthy to breathe. Higher temperatures lead to an increase in allergens and harmful air pollutants. For instance, longer warm seasons can mean longer pollen seasons which can increase allergic sensitizations and asthma episodes and diminish productive work and school days. Higher temperatures associated with climate change can also lead to an increase in ozone, a harmful air pollutant.

3.2.3. Agriculture and Food Availability

Agriculture has always been at the mercy of unpredictable weather, but a rapidly changing climate is making agriculture an even more vulnerable enterprise. In some regions, warmer temperatures may increase crop yields. The overall impact of climate change on agriculture, however, is expected to be negative which is reducing food supplies and raising food prices. Many regions are suffering from high rates of hunger and food insecurity.

With changes in rainfall patterns, farmers face dual threats from flooding and drought. Both extremes can destroy crops. Flooding washes away fertile topsoil that farmers depend on for productivity, while droughts dry it out, making it more easily blown or washed away. Higher temperatures increases the water intake by the crops, making them even more vulnerable during dry periods.

3.2.4. Water Quality and Availability

Climate change leads to the increase in the frequency and intensity of droughts as well as floods and extreme precipitation. Climate change is increasing the levels of water vapour in the atmosphere and is making water availability less predictable. This can lead to more intense rain storms in some areas, while other regions may face more severe drought conditions, especially during the summer months.

The climate change determinants affecting water quality are mainly the ambient (air) temperature and the increase of extreme hydrological events. This phenomenon globally leads to the concentration increase of dissolved substances in water but also to the concentration decrease of dissolved gases.

3.2.5. Waterborne infectious disease

The burden of waterborne disease in India is enormous. However, estimates vary widely because of a lack of reporting, poor surveillance, and minimal data infrastructure. A report from the Ministry of Health and Family Welfare estimates that nearly 40 million people are affected by waterborne disease every year that places a large burden on both the health sector and the economic sector. As a consequence, approximately 73 million workdays or US\$600 million are lost each year. Although the World Health Organization (WHO) estimates that 900,000 Indians die each year from drinking contaminated water and breathing polluted air (WHO and UNICEF 2000), the Indian Ministry of Health estimates 1.5 million deaths annually among 0- to 5-year-old children. Cholera provides another example, with approximately 5 million cases reported by WHO each year; however, this estimate is thought to be a gross underestimation of the true burden of cholera because of a lack of surveillance and underreporting on the Indian subcontinent. Approximately 73% of the rural population in India does not have proper water disinfection, and 74% do not have sanitary toilets.

3.2.6. Heat stress and air pollution

The summer of 2010 was the hottest summer on record in India, with temperatures approaching 50°C (122°F); the effects were far-reaching, including hospitalization because of heatstroke, suffering of livestock, and severe drought in some regions that affected health as well as agriculture. Research linking temperature and health effects in India is sparse. However, in a study of 12 international urban areas that included Delhi, found a 3.94% [95% confidence interval (CI), 2.80–5.08%] increase in mortality for each 1°C increase above 29°C. Individuals in the 0- to 14-year-old age group had greater vulnerability to temperature increases in Delhi than did those in the 15- to 64-year-old age group or in the ≥ 65-year-old age group. These findings are in direct contrast with results from cities in Europe and the United States that consistently identify the elderly as the more vulnerable age group.

3.2.7. Vector-borne disease

India has approximately 2 million confirmed cases of malaria per year. Like most infectious diseases, prevalence varies by region. Although WHO concludes that approximately 15,000 individuals die

from malaria each year in India, a recent study by Dhingra et al. estimates approximately 200,000 malaria deaths per year in India before 70 years of age and 55,000 in early childhood. As Dhingra et al. suggest, accurate estimation of malaria mortality in India is difficult because correctly diagnosed episodes are successfully treated and do not result in death; in fatal cases without medical intervention, malaria is easily mistaken for some other life-threatening fever; and in most rural areas where death from malaria is common, proper medical attention at the time of death is uncommon. These challenges, which hold true in many developing countries, make it difficult to use hospital-based data to assess the association between climate variability and malaria, because disease burden may be vastly underestimated.

Examples of Vector-borne diseases

Malaria

Malaria is transmitted through the bites of female *Anopheles* mosquitoes, which lay eggs in the water and thrive during rainy seasons of tropical countries. Rainfall patterns, humidity and temperature greatly affect the transmission rate of malaria. Furthermore, other non-environmental factors, such as cheap airfares and the rise of tourism in tropical cities, allow for almost 2,000 people to return from overseas with malaria annually. Climate change will allow malaria to spread into new areas. Climate change is expected to cause additional 60,000 deaths per year due to malaria.

Zika Virus

Zika virus is a tropical disease spread by *Aedes* mosquitoes, which also carry West Nile virus, as well as yellow and dengue fever. The *Aedes* vectors breed in containers where fresh water is collected, and their eggs can survive for long periods in a dormant state. But temperatures play a vital role in the vector's survival, viral replication and infective periods.

Higher temperatures from climate change could expand the geographic range, decrease the incubation period of the pathogen, and increase the biting rate of the mosquitoes. More precipitation could provide additional habitat for larvae, and changes in human behavior, such as deforestation, dam construction, the extinction of natural predators, and changes in biodiversity, can also accelerate the spread of Zika.

Dengue

Climate change is likely to expand the geographical distribution of several vector-borne human infectious diseases. The risk of dengue transmission is increased by warming climates, as the growth and development of mosquitoes are significantly influenced by temperature and humidity.

The effect of climate change on the rates of dengue transmission is complex. Rates of dengue transmission may actually increase in regions that are projected to become more prone to drought, because the *Aedes* mosquitoes which carry dengue breeds in containers used for household water storage.

3.2.8.Risks for Wildlife

Climate change is happening so fast that many plants and animal species are struggling to cope. Many terrestrial, freshwater and marine species have already moved to new locations. Some plant and animal species will be at increased risk of extinction if global average temperatures continue to rise unchecked.

Forest wildfires are one of the most common happenings due to climate change. The term “wildfire” refers to large-scale fires, generally occurring in forests and jungles. The areas affected by the wildfire may be sparsely populated or nearby the city boundaries. Wildfires could become quite frequent with climate change. Addressing such phenomena on a global scale will prove challenging. It is also difficult to predict how populations will react once the anthropogenic role of this type of event takes hold.

3.2.9.Costs for society and economy

Damage to property and infrastructure and to human health imposes heavy costs on society and the economy. Sectors that rely strongly on certain temperatures and precipitation levels such as agriculture, forestry, energy and tourism are particularly affected.

Economic difficulties that last over time or in conjunction with other factors, lead to a physical, cognitive, psychological, and social malfunction with a decrease in well-being and health. Economic crises can occur and lead to an increase in stress and other mental and behavioral disturbances especially working men.

4.WHAT WE CAN DO TO FIGHT CLIMATE CHANGE

Planting Trees and Plants

Nature plays a major role in regulating the climate by storing carbon dioxide. By conserving forests and wetlands, adding regenerative practices to agriculture and planting trees, we're unleashing nature's full potential to stabilize the climate.

Promoting Smart Clean Energy Policies

As global energy demands continue to rise, renewable energy can grow economies while reducing carbon emissions.

Building Resilience

By helping the most vulnerable communities adapt to climate change by restoring habitats, such as mangroves that reduce the impact of severe storms.

Inspiring Productive Conversations

By encouraging people to talk more frequently and constructively about global warming so we can build a stronger common ground to halt climate change.

5.CONCLUSION

Most people think of climate change as just an environmental issue. But the World Health Organization has declared it the biggest threat to health in the 21st century. Climate change is an urgent problem that affects our health in many ways, now and in the future. Already, we have seen a rise in extreme events like heat waves, floods and bushfires. These events affect our health, threaten our food and drinking water supplies, and pollute the air we breathe. All of these issues affect our physical and mental health. But it's not all doom and gloom. There are simple things we can all do to protect ourselves and our loved ones from the impacts of climate change. And the best part is, they help us to stay healthy and save money at the same time! For example, things like walking or cycling instead of driving; eating a diet full of fruit, veggies and whole grains; reducing the amount of processed and packaged foods you eat; and choosing tap water over bottled water and sugary drinks, not only help to reduce your impact on the environment, but also improve your mental and physical wellbeing. It's also important to look out for those who are most at risk to the immediate impacts of climate change, like the elderly, children, pregnant women and people with chronic diseases. To adapt to our changing climate,

and make sure we're reducing the risks of further problems, we all need to work together. From government to industry to communities, right down to individuals. We all play a part. Climate change and health act today for a healthier tomorrow.

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