International Journal of Academic Research
ISSN: 2348-7666 Vol.1 Issue.2, August, 2014

Human Health Perspective on Climate Variations

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Abstract:

Health equity and climate change have a major impact on human health and quality of life, and are interlinked in a number of ways. Climate change can lead to dramatic increases in prevalence of a variety of infectious diseases. Weather and climate play a significant role in people's health. Changes in climate affect the average weather conditions that we are accustomed to. Increases in the frequency or severity of extreme weather events such as storms could increase the risk of dangerous flooding, high winds, and other direct threats to people and property. This paper presents human health perspective on climate variations

Key words: *Health, Climate, temperature, global carbon, sustainable development*

Law in its very character has been reactive and not proactive. For law to have its significance, in this society which is always in a state of flex, law needs to keep pace with societal advancements including the changing technology. Weather and climate play a significant role in people's health. Changes in climate affect the average weather conditions that we are accustomed to. Increases in the frequency or severity of extreme weather events such as storms could increase the risk of dangerous flooding, high winds, and other direct threats to people and property.

Warmer temperatures could increase the concentrations of unhealthy pollutants and combined with increased climatic variability would alter the pattern of exposure to thermal extremes and resultant health impacts, in both summer and winter. By contrast, the public health consequences of the disturbance of natural and managed food-producing ecosystems, rising sea-levels and population displacement for reasons of physical hazard, land loss, economic disruption and civil strife, may not become evident for up to several decades.

In 2009, the World Health Assembly endorsed a new WHO work plan on climate change and health. This includes: Advocacy: to raise awareness that climate change is a fundamental threat to human health. Science and evidence: to coordinate reviews of the scientific evidence on the links between climate change and health, and develop a global research agenda. Health system strengthening: to assist countries to assess their health vulnerabilities and build capacity to reduce health vulnerability to climate change. This paper deals with all the intricacies of human health affected by climate health and coordinate with various other agencies in order to reduce this human vulnerability to climate health.

Human Health perspective on Climate variations

In a world of myriad "what if" scenarios surrounding climate change, it becomes very complicated to create wise health policies for the future because of the uncertainty of predicting environmental change and human decisions. The need for sound science on which to base such policies becomes more critical than ever.[1]

There is abundant evidence that human activities are altering the earth's climate and that climate change will have significant health impacts both domestically and globally. While all of the changes associated with this process are not predetermined, the actions we take today will certainly help to shape our environment in the decades to come. Some degree of climate change is unavoidable, and we must adapt to its associated health effects; however, aggressive mitigation actions can significantly blunt the worst of the expected exposures. Still, there will be effects on the health of people in

India, some of which are already underway. As great as the domestic risks to the Indian public health are, the global risks are even greater.

Climate change and health issues transcend national borders, and climate change health impacts in other countries are likely to affect health in the United States as well. Famine, drought, extreme weather events, and regional conflicts—all likely consequences of climate change—are some of the factors that increase the incidence and severity of disease, as well as contributing to other adverse health impacts, making it imperative to address climate change-related decision making at local, regional, national, and global levels. The complicated interplay of these and other factors must be considered in determining the scope and focus of both basic and applied research on climate change and health.

India is one of the most important countries in the world with regard to climate change sources and impacts. With a large and growing population, India's emission of green house gases is increasing. At the same time potential climate impacts in India are severe, they include sea level rise, changes in monsoon, increased severe storms and flooding and more drought.

Climate change, interacting with changes in land use and demographics, affect important human dimensions in India, especially those related to human health, settlements and welfare. The challenges presented by population growth, an aging population, migration patterns, and urban and coastal development compounded by changes in temperature, precipitation, and extreme climate-related events are devastating. Climate change will affect where people choose to live, work, and play. Among likely climate changes are changes in the intensity and frequency of precipitation, more frequent heat waves, less frequent cold waves, more persistent and extreme drought conditions and associated water shortages, changes in minimum and maximum temperatures, potential increases in the intensity and frequency of extreme tropical storms, measurable sea-level rise and increases in the occurrence of coastal and riverine flooding. Further the Indian economy is intrinsically linked with the annual monsoon cycle due to India's dependency on agriculture.[2]

This paper aims to examine what makes the population vulnerable to the effects of climate change and to recommend steps to reduce the vulnerability.

The changes in global climate that have been forecast by the IPCC[3] may affect human health both directly and indirectly The direct effects include injury and illness due to the more frequent heat waves and floods — expected as a result of higher temperatures, extremes of rainfall and thermal expansion of the oceans. The indirect effects are more difficult to specify, but will probably be more important in terms of the magnitude of the disease burden they cause. Indirect effects are mediated via the influence of climate on biological systems (such as disease-carrying vectors or productive agro-ecosystems) or other aspects of the physical environment (for example, photochemical oxidants). The vulnerability of societies to climate change will therefore depend, to some extent, on the ways in which critical ecosystems adapt to climatic change.

The potential effects of global climate change have been reviewed by the Intergovernmental Panel on Climate Change [4] and reported in greater detail in a recent WHO/WMO/UNEP publication[5]. There is no reason to believe that the Asia Pacific region will be spared; indeed, in many respects the region is particularly susceptible to climate-related injury and illness. Most obviously, Pacific island states and the low-lying coastal countries of Asia are more liable than most countries to damage from rising sea levels. Health problems due to heat waves and photochemical air pollution will be most severe in large cities with high traffic volumes and poor housing. The Asia Pacific region already contains 13 of the 25 largest cities of the world. By 2015, nearly 1 billion people in Asia are expected to be living in cities[6]. Within urban areas there is potential for some vector-borne infections, such as dengue fever, to spread to large non-immune populations as temperatures rise and rainfall patterns alter.[7]

Both gains and losses in agriculture are expected as a consequence of global warming. Worldwide, the gains and losses may almost cancel out if the most optimistic scenarios are followed[8]. However, the overall picture masks pronounced differences between countries. In general terms, developed countries are expected to do well, while developing countries do poorly. In the Asia Pacific region, food demand is expected to increase by about 50% by 2015 and about 100% by 2050.[9]

Factors contributing to Climate Change – GHG Emissions

The global carbon cycle involves interaction among the atmosphere, oceans, soils and vegetation and fossil fuel deposits. The oceans contain 39,000 giga tonnes of carbon (GtC), fossil fuel deposits about 16,000 GtC, soils and vegetation about 2500 GtC, and the atmosphere about 760 GtC[10]. Since 1850, land-use change is estimated to have released about 136 GtC and fossil fuel combustion, about 270 GtC. Of this, 180 GtC has ended up in the atmosphere, while 110 GtC has been absorbed by grow-ing vegetation and the remainder by the oceans. It is the increasing concentration of atmospheric CO2 that is the cause for concern about global climate change. The combustion of fossil fuels and other human activities are the primary reasons for increased concentrations of CO2 and other greenhouse gases. Between 1990 and 1999, an estimated 6.3 GtC/year was released due to the combustion of fossil fuels, and another 1.6 GtC/year was released due to the burning of forest vegetation. This was offset by the absorption of 2.3 GtC/year each by growing vegetation and the oceans. This left a balance of 3.3 GtC/ year in the atmosphere[11]. Controlling the release of green-house gases from fossil fuel combustion, land-use change and the burning of vegetation are therefore obvious opportunities for reducing greenhouse gas emissions. Reducing greenhouse gas emissions can lessen the projected rate and magnitude of warming and sea level rise. The greater the reductions in emissions and the earlier they are introduced, the smaller and slower the projected warming and the rise in sea levels. Future climate change is thus determined by historic, current and future emissions. Of the six aforementioned GHGs, CO2 accounted for 63%, methane 24%, nitrous oxide 10%, and the other gases the remaining 3% of the carbon equivalent emissions in 2000. Thus in addition to CO2, global mitigation effort needs to focus on the two largest and rapidly increasing GHGs.

Contribution of Industrialized and Developing Countries

Historically, the industrialized countries have been the primary contributors to emissions of CO2. According to one estimate, industrialized countries are responsible for about 83% of the rise in cumulative fossil fuel related CO2 emissions4 since 1800. In the 1990s, they accounted for about 53% of the 6.3 GtC/year, which was released as CO2 from fossil fuel combustion. These countries have contributed little to the release of CO2 from the burning of vegetation, which is largely due to tropical deforestation during this period. According to another estimate, devel-oping countries accounted for only 37% of cumulative CO2 emissions from industrial sources and land-use change during the period 1900 to 1999, whereas industrialized countries accounted[12] for 63%, but because of their higher population and economic growth rates, the fossil-fuel CO2 emissions from developing countries are likely to soon match or exceed those from the industrialized countries. Large countries, such as China and India, could match the USA's year 2000 greenhouse gas emissions within two to three decades. Figure 2 shows that when fossil fuel CO2 emissions alone are considered, due to population and economic growth in the coming decades, the contribution of developing countries as a group will soon overtake the industrialized countries. Historically, the responsibility for emissions increase lies largely with the industrialized world, though the developing countries are likely to be the source of an increasing proportion of future increases.

Impacts of Climate Change: Implications for Developing Countries.

Developing countries are faced with immediate concerns that relate to forest and land degradation, freshwater shortage, food security and air and water pollution. Climate change will exacerbate the impacts of deforestation and other economic pressures, leading to further water shortages, land degradation and desertification. Increasing global temperatures will result in rising sea levels. Populations that inhabit small islands and/or low-lying coastal areas are at particular risk of severe social and economic disruptions from sea-level rise and storm surges that could destroy cities and disrupt large coastal livelihoods.

The widespread retreat of glaciers and icecaps in the 21st century will also lead to higher surface temperatures on land and increasing water stress. By 2025, as much as two-thirds of the world population, much of it in the developing world, may be subjected to moderate to high water stress. Estimates of the effects of climate change on crop yields are predominantly negative for the tropics, even when adaptation and direct effects of CO2 on plant processes are taken into consideration. Ecological productivity and biodiversity will be altered by climate change and sea-level rise, with an increased risk of extinction of some vulnerable species.

Even though the ability to project regional differences in impact is still emerging, the consequences of climate change are projected to be more drastic in the tropical regions. This is true for all sectors that are likely to bear the brunt of climate change, sea level, water resources, eco-systems, crop production, fisheries, and human health. The populations of the developing world are more vulnerable as their infrastructure is not strong and extensive enough to withstand a deleterious impact.

Role of Developing and Industrialized Countries in addressing Climate Change: Mitigation and Adaptation

In the global climate change debate, the issue of largest importance to developing countries is reducing the vulnerability of their natural and socio-economic systems to projected climate change. Over time, there has been a visible shift in the global climate change discussions towards adaptation. Adaptation can complement mitigation as a cost-effective strategy to reduce climate change risks. The impact of climate change is projected to have different effects within and between countries. Mitigation and adaptation actions can, if appropriately designed, advance sustainable development and equity both within and across countries and between generations.

One approach to balancing the attention on adaptation and mitigation strategies is to compare the costs and benefits of both the strategies. If adaptation of climate change could be carried out at negligible cost then it may be less expensive, at least in the short-term, than any alternate strategy. Of course, there are complications in establishing the benefits of adaptation policies and consequent avoided damages[13]. Further, there are significant co-benefits of many mitigation and adaptation measures, which need to be estimated. The co-benefits could play a critical role in making decisions regarding the adoption of any mitigation or adaptation strategy.

The impact of mitigation will only be felt in the long run by the future generations. However, the impacts or benefits of adaptation measures are immediate and felt by the implementers of the measures. The regions implementing the mitigation measures could be different from the regions experiencing its impacts. The current generation of industrialized countries may invest in mitigation measures and the main beneficiaries may be the next generation largely in the developing countries. The choice between mitigation and adaptation strategies has spatial (geographic) and temporal (different generations) dimensions. An optimal mix of mitigation and adaptation strategies may elude the climate negotiations due to the spatial and temporal dimensions, as well as the differing perceptions of industrialized and developing countries. Under the Kyoto Protocol and UNFCCC, developing countries have insisted that Annex-I countries demonstrate commitment by promoting mitigation measures domestically and provide resources for adaptation measures in developing countries [14]. However, over emphasis on adaptation might inhibit concerted mitigation actions by the Annex I governments, as adaptation measures are implemented and rewarded locally. Consequently, there is no incentive to participate in international negotiations, if a country considers itself to be able to fully adapt to climate change[15].

India's need to be concerned about Climate Change

India is a large developing country with nearly 700 million rural population directly depending on climate-sensitive sectors (agriculture, forests and fisheries) and natural re-sources (such as water, biodiversity, mangroves, coastal zones, grasslands) for their subsistence and livelihoods. Further, the adaptive capacity of dry land farmers, forest dwellers, fisher folk, and nomadic shepherds is very low[16]. Climate change is likely to impact all the natural ecosystems as well as socio-economic systems as shown by the National Communications Report of India to the UNFCCC[17].

The latest high resolution climate change scenarios and projections for India based on Regional Climate Modelling (RCM) system, known as PRECIS developed by Hadley Center and applied for India using IPCC scenarios. A 20% rise in all

India summer monsoon rainfall and further rise in rainfall is projected over all states except Punjab, Rajasthan and Tamil Nadu, which show a slight decrease. Extremes in maximum and minimum temperatures are also expected to increase and similarly extreme precipitation also shows substantial increases, particularly over the west coast of India and west central India.

Some of the projected impacts of climate change in India are as follows:

Water Resources

The hydrological cycle is likely to be altered and the severity of droughts and intensity of floods in various parts of India is likely to increase. Further, a general reduction in the quantity of available run-off is predicted.

Agriculture

Simulations using dynamic crop models indicate a decrease in yield of crops as temperature increases in different parts of India. However, this is offset by an increase in CO_2 at moderate rise in temperature and at higher warming; negative impact on crop productivity is projected due to reduced crop durations.

Forests

Climate change is expected to exert an additional pressure on India's stressed forest ecosystems. In a recent study conducted using Regional Climate Model (RCM) and BIOME model (BIOME4), it was observed that more than 50% of the vegetation in India would be less than optimally adapted to its existing location by 2085, making it more vulnerable to adverse climatic conditions as well as to increased biotic stresses.[18] For instance, the study predicts an increase in the area under tropical evergreen forests at the expense of tropical semi- deciduous forests and tropical deciduous forests due to an increase in rainfall and a moderate increase in temperature. On the other hand, tropical xerophytic shrubland will undergo large-scale reduction in area, possibly, due to increase in rainfall, with a large chunk of the area changing to tropical deciduous forests and tropical savanna. The study also points to higher vulnerability of cold and temperate forests compared to tropical forests, with a vast majority of cold and temperate forests giving way to warm mixed forests.

On the positive side, enhanced levels of CO2 are projected to result in two-fold or more increase in the net primary productivity (NPP). These projections are, however, fraught with uncertainty due to the lack of reliable data on climate projections at the regional level. Nevertheless, studies indicate that climate change could impact the composition of species and the availability of forest goods and services, affecting, in turn, the livelihoods of forest-dependent communities. For instance, a study conducted by Deshingkar, Bradley, Chadwick, (1996) in Himachal Pradesh indicates that the predicted diminution in alpine grasslands would have an impact on the livelihoods of the transhumant grazier communities in the region. Similarly, an exploratory study conducted by TERI in the Uttarkashi Forest Division of Uttarakhand indicates that climate change has had an impact on the phenology of some of the species in the study area. However, in this case, the phenological changes like early fowering, early sprouting of leaves in spring, and extended growing season would benefit local communities, at least in the short run [19]

Coastal Zone

Simulation models show an increase in frequencies of tropical cyclones in the Bay of Bengal; particularly intense events are projected during the post-monsoon period. Sea level rise is projected to displace populations in coastal zones, increase flooding in low-lying coastal areas, loss of crop yields from inundation and salinization.

Human Health

Climate change poses a wide range of risks to population health - risks that will increase in future decades, often to critical levels, if global climate change continues on its current trajectory.[20] The three main categories of health risks include: (i) direct-acting effects (e.g. due to heat waves, amplified air pollution, and physical weather disasters), (ii) impacts mediated via climate-related changes in ecological systems and relationships (e.g. crop yields, mosquito ecology, marine productivity), and (iii) the more diffuse (indirect) consequences relating to impoverishment, displacement, resource conflicts (e.g. water), and post-disaster mental health problems.

Climate change thus threatens to slow, halt or reverse international progress towards reducing child under-nutrition, deaths from diarrheal diseases and the spread of other infectious diseases. Climate change acts predominantly by exacerbating the existing, often enormous, health problems, especially in the poorer parts of the world. Current variations in weather conditions already have many adverse impacts on the health of poor people in developing nations,[21] and these too are likely to be 'multiplied' by the added stresses of climate change.

A changing climate thus affects the prerequisites of population health: clean air and water, sufficient food, natural constraints on infectious disease agents, and the adequacy and security of shelter. A warmer and more variable climate leads to higher levels of some air pollutants and more frequent extreme weather events. It increases the rates and ranges of transmission of infectious diseases through unclean water and contaminated food, and by affecting vector organisms (such as mosquitoes) and intermediate or reservoir host species that harbour the infectious agent (such as cattle, bats and rodents). Changes in temperature, rainfall and seasonality compromise agricultural production in many regions, including some of the least developed countries, thus jeopardising child health and growth and the overall health and functional capacity of adults. As warming proceeds, the severity (and perhaps frequency) of weather-related disasters will increase - and appears to have done so in a number of regions of the world over the past several decades. Therefore, in summary, global warming, together with resultant changes in food and water supplies, can indirectly cause increases in a range of adverse health outcomes, including malnutrition, diarrhea, injuries, cardiovascular and respiratory diseases, and water-borne and insect-transmitted diseases.

Health equity and climate change have a major impact on human health and quality of life, and are interlinked in a number of ways. The report of the WHO Commission on Social Determinants of Health points out that disadvantaged communities are likely to shoulder a disproportionate share of the burden of climate change because of their increased exposure and vulnerability to health threats. Over 90 percent of malaria and diarrhea deaths are borne by children aged 5 years or younger, mostly in developing countries.[22] Other severely affected population groups include women, the elderly and people living in small island-developing states and other coastal regions, mega-cities or mountainous areas.[23]

Climate change can lead to dramatic increases in prevalence of a variety of infectious diseases. Beginning in the mid-70s, there has been an "emergence, resurgence and redistribution of infectious diseases".[24] Reasons for this are likely multicausal, dependent on a variety of social, environmental and climatic factors, however, many argue that the "volatility of infectious disease may be one of the earliest biological expressions of climate instability". Though many infectious diseases are affected by changes in climate, vector-borne diseases, such as malaria, dengue fever and leishmaniasis, present the strongest causal relationship. Malaria in particular, which kills approximately 300,000 children annually, poses the most imminent threat.[25]

Malaria

Malaria is especially susceptible to changes in the environment as both the pathogen (Plasmodium) and its vector (mosquitoes) lack the mechanisms necessary to regulate internal temperature and fluid levels. This implies that there is a limited range of climatic conditions within which the pathogen and vector can survive, reproduce and infect hosts.[26] Vector-borne diseases, such as malaria, have distinctive characteristics that determine pathogenicity. These include: the survival and reproduction rate of the vector, the level of vector activity (i.e. the biting or feeding rate), and the development and reproduction rate of the pathogen within the vector or host. These depend on climatic conditions such as temperature, precipitation and humidity.

Temperature

The ideal temperature range for malaria-carrying mosquitoes is 15–30 °C. Temperature exerts varied effects on survival and reproduction rate of mosquitoes. If initial temperature is high, then an increase in average temperature, associated with global warming, can decrease the survival and reproduction rate of mosquitoes.

Precipitation and Humidity

Increased precipitation can increase mosquito population indirectly by expanding larval habitat and food supply. They are highly sensitive to changes in precipitation and humidity. Mosquitoes are, however, highly dependent on humidity, surviving only within a limited humidity range of 55-80%.

Extreme Weather Events

Infectious disease often accompanies extreme weather events, such as floods, earthquakes and drought. These local epidemics occur due to loss of infrastructure, such as hospitals and sanitation services, but also because of changes in local ecology and environment. For example, malaria outbreaks have been strongly associated with the El Nino cycles of a number of countries (India and Venezuela, for example). El Nino can lead to drastic, though temporary, changes in the environment such as temperature fluctuations and flash floods.[27] In addition, with global warming, there has been a marked trend towards more variable and anomalous weather. This has led to an increase in the number and severity of extreme weather events. This trend towards more variability and fluctuation is perhaps more important, in terms of its impact on human health, than that of a gradual and long-term trend towards higher average temperature.

Desertification

Globally, about 1900 millions of hectare meters (Mha) of land are affected by land degradation, of which 500 Mha each are in Africa and the Asia-Pacific and 300 Mha in Latin America. Climate change leading to warming and water stress could further exacerbate land degradation, leading to desertification.

The United Nations Convention to Combat Desertification (UNCCD) aims to address the problem of land degradation, which is linked to climate change. It is important to note that the climate-sensitive sectors (forests, agriculture, coastal zones) and the natural resources (groundwater, soil, biodiversity, etc.) are already under stress due to socio-economic pressures. Climate change is likely to exacerbate the degradation of resources and socio-economic pressures. Thus, countries such as India with a large population dependent on climate sensitive sectors and low adaptive capacity have to develop and implement adaptation strategies.

Social effects of extreme Weather

As the World Meteorological Organization explains, "recent increase in societal impact from tropical cyclones has largely been caused by rising concentrations of population and infrastructure in coastal regions." [28] Normalized mainland U.S. hurricane damage from 1900 to 2005 to 2005 values and found no remaining trend of increasing absolute damage. The 1970s and 1980s were notable because of the extremely low amounts of damage compared to other decades. The decade 1996–2005 has the second most damage among the past 11 decades, with only the decade 1926–1935 surpassing its costs. The most damaging single storm is the 1926 Miami hurricane, with $157 billion of normalized damage.[29]

The American Insurance Journal predicted that "catastrophe losses should be expected to double roughly every 10 years because of increases in construction costs, increases in the number of structures and changes in their characteristics." [30] The Association of British Insurers has stated that limiting carbon emissions would avoid 80% of the projected additional annual cost of tropical cyclones by the 2080s. The cost is also increasing partly because of building in exposed areas such as coasts and floodplains. The ABI claims that reduction of the vulnerability to some inevitable effects of climate change, for example through more resilient buildings and improved flood defences, could also result in considerable cost-savings in the long-term.[31]

Indian Government and Preventive measures

National Action Plan On Climate Change (NAPCC) has been set up by the Government of India. Recognizing that climate change is a global challenge, India will engage actively in multilateral negotiations in the UN Framework Convention on Climate Change, in a positive, constructive and forward-looking manner. Our objective will be to establish an effective, cooperative and equitable global approach based on the principle of common but differentiated responsibilities and respective capabilities, enshrined in the United Nations Framework Convention on Climate Change (UNFCCC).

In order to achieve a sustainable development path that simultaneously advances economic and environmental objectives, the National Action Plan for Climate Change (NAPCC) will be guided by the following principles:

- Protecting the poor and vulnerable sections of society through an inclusive and sustainable development strategy, sensitive to climate change.

- Achieving national growth objectives through a qualitative change in direction that enhances ecological sustainability, leading to further mitigation of greenhouse gas emissions.
- Devising efficient and cost-effective strategies for end use Demand Side Management.
- Deploying appropriate technologies for both adaptation and mitigation of greenhouse gases emissions extensively as well as at an accelerated pace.
- Engineering new and innovative forms of market, regulatory and voluntary mechanisms to promote sustainable development
- Effecting implementation of programmes through unique linkages, including with civil society and local government institutions and through public private partnership.
- Welcoming international cooperation for research, development, sharing and transfer of technologies enabled by additional funding and a global IPR regime that facilitates technology transfer to developing countries under the UNFCCC.

To conclude, it can be said that we as human beings should undertake the responsibility of doing as much as we can in order to prevent climate change as this shall adversely affect us in the future. Every individual must take the responsibility of maintaining the environment around them and to help the government in their efforts to restore and prevent any further drastic climatic changes.

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