



## EFFECT OF CLIMATE CHANGE ON HUMAN HEALTH AND SOME ADAPTIVE STRATEGIES – A REVIEW

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### ABSTRACT

*The impact of human-induced climate change and ozone depletion are now observed to compromise the sustainability of human development as it threatens the ecological support system on which life depends. Evidences abound to show that there is climate change and ozone layer depletion in the last 2-4 decades. The Earth is warming, the warming is accelerating, and human actions are responsible. If the current climate change and warming trends remain uncontrolled, humanity will face more injury, disease and death related to natural disasters and heat waves; higher rates of food-borne, water-borne and vector-borne illnesses; and death that is more premature and disease related to air pollution. Moreover, in many parts of the world, large populations will be displaced by rising sea level, and many others will be affected by drought and famine. As glaciers melt, the hydrological cycle shifts and the productivity of arable land will change. That is the bad news. Nevertheless, the good news is that through increased interdisciplinary and intersectoral collaboration, and rapid deployment of mitigation strategies to stabilize climate change as well as development of proactive adaptation programmes to minimize health impact of climate change, the global community will be better prepared to cope with the challenges of protecting health from the impact of climate change.*

**Key Words:** Climate Change, Human Health, Adaptive Strategies

### INTRODUCTION

Climate is the product of interactions between the atmosphere, ocean, land surface and ice cover. Shift in global climate occurs because of external factors, such as changes in the balance at the outer edge of the Earth's atmosphere between incoming short wave solar radiation and the outgoing terrestrial long wave radiation. Climatic factors vary naturally around the world without obvious notice, and at the same time comfortably maintaining the various natural and ecological systems. In the last 2-4 decades, however, this variation has gone beyond natural levels that climatologists are now in general agreement that the world has begun to experience the process of global "climate change". The assessment report of the Intergovernmental Panel on Climate Change (IPCC) confirmed that human activities, principally the burning of fossil fuel, have increased the atmospheric concentration of important green house gases, which may result in a warming of the earth's surface (IPCC, 1996). In his work on "planetary overload", McMichael (1993) stated, "climate change is now compromising the sustainability of human development on the planet because it threatens the ecological support systems on which life depends".

It is generally accepted that global socioeconomic development and health interventions have improved the general standard of living in the recent times but the resulting deteriorating global

environmental conditions or factors are now affecting human health. The major global environmental changes significantly affecting health according to WHO (1996) and McMichael (1996) include climate change and ozone depletion.

Ozone in the stratosphere is produced by photolytic destruction of oxygen. It is a protective shield to life on earth, preventing much of the sun's ultraviolet (UV) radiation; especially UV radiation with shorter wavelength from reaching the Earth. As a result, any change in atmospheric concentration of ozone causes changes in the radioactive levels. Since the industrial revolution, human activities have increased the atmospheric concentration of what is known today as greenhouse gases (GHGs). These are carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O) and chlorofluorocarbons (CFCs) (WHO, 1996).

The photochemical reactions of these greenhouse gases with the ozone, "the green house effect", have now led to serious depletion of the protective or ozone layer. The effects of this depletion have far-reaching effect on man and life on Earth.

### Health effects of ozone depletion and climate change

#### Health impact of Ozone depletion

- Increased levels of ultra violet (UV) radiation due to ozone depletion may have serious consequences for living organisms:

- b. Adverse impact of ultra violet-Beta (UV-B) rays has been reported on terrestrial plant growth and photosynthesis.
- c. Increased UV-B has also been shown to have a negative influence on aquatic organisms, especially small ones such as phytoplanktons, larval crabs, shrimps, and juvenile fish.
- d. Since many of these organisms are at the base of the marine food chain, increased UV-B may seriously affect aquatic ecosystem.
- e. Furthermore, increased UV-B radiation affects tropospheric air quality and may cause damage to materials such as wood, plastic and rubber.

#### **Health impact of climate change**

Climate change is likely to be associated with multitude of effects:

- a. Climate change has been associated with shift in the composition and geographical distribution of many ecosystems (e.g. forests, deserts, coastal systems) as individual species respond to changed climatic conditions, with likely reduction in species diversity and agricultural yield.
- b. Climate change will lead to an intensification of the global hydrological cycle and may affect regional water resources.
- c. Additionally, climate change and the resulting sea-level rise can have a number of negative effects on energy, industry and transportation infrastructure, human settlements and tourism (IPCC, 1996).

Problems associated with climate change and ozone depletion are numerous and interrelated. For instance, the depletion of ozone layer in the stratosphere because of greenhouse effect causes global warming (World Metrological Organization (WMO), 1987). Such changes in the concentration of greenhouse gases are projected to lead to regional and global changes in climate and climate-related parameters: temperature, humidity precipitation etc. This is to the extent that IPCC (1996) has projected an increase of global mean surface temperature of more than 1°C by the year 2100.

In man, the health impact of ozone depletion and climate change cannot be separated because the effects are very likely to be synergistic. For instance, with increased UV-B radiation on earth, the human immune system is likely to be affected; and this will reduce the affected population's resistance to infectious and parasitic diseases. Broadly speaking, the various potential health effects of global climate change upon human health can be divided into DIRECT AND INDIRECT EFFECTS, according to whether they occur predominantly via the impacts of climate variable upon human biology, or are mediated by climate-induced changes in other biological and biogeochemical systems.

In healthy individuals, an efficient regulatory heat system enables the body to cope effectively with thermal stress. Temperature exceeding comfortable limits, both in the warm and cold range, substantially increases the risk of (predominantly cardiopulmonary) illness and death.

DIRECTLY, an increase in mean summer and winter temperatures would mean a shift of these thermal-related diseases and deaths. An increased frequency or severity of heat waves will also have a strong impact on these diseases. If extreme weather events (droughts, flood, storms etc) were to occur more frequently, increases in rates of deaths, injury, infectious diseases and psychological disorder would result.

INDIRECT: One of the major indirect impacts of global climate change upon human health could occur via effects upon cereal crop production. Cereal grains account for around 66% of all foodstuffs consumed by humans (McMichael, 1996). These impacts would occur via the effects of variations in temperature and moisture upon germination, growth, and photosynthesis, as well as via indirect effects upon plant diseases, predators-pest relationship, and supplies of irrigation water. A further important indirect effect on human health may well prove to be a change in the transmission of vector-borne diseases. Temperature and precipitation changes might influence the behaviour and geographical distribution of vectors, and thus change the incidence of vector-borne diseases, which are major causes of mortality and morbidity in most tropical countries. Increase in non-vector-borne infectious diseases such as cholera, salmonellosis, and other food- and water-related infectious diseases could occur, particularly in tropical and sub-tropical regions, due to climatic impact on water distribution, temperature and proliferation of microorganisms.

#### **Other main categories of health risk associated with climate change include:**

- (a) Higher temperatures enhance production of various secondary air pollutants (e.g. ozone and particulates). Consequently, there is increase in the frequency of allergic and cardio-respiratory disorders and deaths caused by these air pollutants.
- (b) Increased production of aeroallergens (spores, pollens), thus exacerbating asthma and other allergic diseases (Bunyavanich et al; 2003).
- (c) Mental health consequences of social, economic and demographic dislocations resulting from environmental deterioration such as flooding, rising sea levels, shortage of water, forest fire- leading to population mobility and settlement.
- (d) Emotional stresses and mental health problems in response to perceptions/fear of climate change may also constitute health problem to affected communities (Horton and McMichael, 2008).

**Table 1: Summary of health impact of climate change and ozone layer depletion (Horton and McMichael, 2008).**

<b>Health effect</b>	<b>Known effects</b>
Thermal stress	<ul style="list-style-type: none"> <li>• Mortality (especially cardiopulmonary) increases with cold and warm temperatures</li> <li>• Older age group and people with underlying organic diseases are particularly vulnerable</li> </ul>
Vector-borne diseases	<ul style="list-style-type: none"> <li>• Mortality increases sharply during heat wave</li> <li>• Climate conditions (particularly temperature) necessary for some vectors to thrive and for the microorganisms to multiply within the vectors are relatively well known</li> </ul>
Water/food-borne diseases	<ul style="list-style-type: none"> <li>• Survival of disease organisms (and insects which may spread them) is related to temperature</li> <li>• Water-borne diseases most likely to occur in communities with poor water supply and sanitation</li> <li>• Climate condition affect water availability</li> <li>• Contamination of portable water, particularly following extreme rainfall; seepage of contaminants from illegal dumping of solid waste and other waste into underground aquifers</li> </ul>
Food production	<ul style="list-style-type: none"> <li>• Temperature, precipitation, solar radiation and carbon dioxide are important for crop production</li> <li>• The potential indirect effect of increased UV-B level reaching the Earth lead to impairment of photosynthesis on land (food crops) and in the sea (phytoplankton), reducing the world's food production</li> <li>• Crop failure may lead to malnutrition</li> <li>• Undernourishment may increase susceptibility to infectious diseases</li> </ul>
Skin cancer	<ul style="list-style-type: none"> <li>• Skin cancer is related to UV exposure (both melanoma skin cancer and non-melanoma skin cancer), people with lightly pigmented skin being most susceptible</li> <li>• Aging increases the risk of skin cancer</li> </ul>
Cataracts	<ul style="list-style-type: none"> <li>• UV radiation damages the eye, more particularly the lens</li> <li>• Different types of cataracts will react differently to changes to UV radiation</li> <li>• Aetiology of cataracts is assisted with age, diabetes, malnutrition, heavy smoking, hypertension, renal failure, high alcohol consumption, and excessive heat</li> </ul>
Immune suppression	<ul style="list-style-type: none"> <li>• UV suppresses immune system in animal models, and may adversely affect various infections</li> <li>• In man, serial UV radiation may cause proper immunization to fail</li> <li>• UV-induced immuno-suppression appear to be a risk factor for skin carcinomas</li> </ul>

**Protecting Health from Climate Change**

Scientists agree that more extreme weather patterns are on the horizon. A range of forecasts predict increased drought in some parts of Africa and flooding in others. Rising sea levels and tropical cyclones threaten small island States. Nothing can stop the march of climate change, but there is still time to temper its effects (Horton. and McMichael, 2008).

**(a) Mitigation**

Global socioeconomic development and health interventions have improved the general standard of living in recent times but the resulting deteriorating global environmental conditions or factors are now affecting human health. The major global environmental changes significantly affecting health include climate change and ozone depletion. Mitigation against socioeconomic and technological development efforts that deteriorate the global environmental conditions/factors must be the first step towards protecting health from climate change.

Since the industrial revolution, human activities have increased the atmospheric concentration of what is known today as greenhouse gases (GHGs). These are carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O) and chlorofluorocarbons (CFCs). Global mitigation of stratospheric ozone depletion by the green house gases will go a long way towards protecting health from climate change. For instance, mitigation to reduce depletion of the stratospheric ozone by chlorofluorocarbons (CFCs) can be achieved by national and international restrictions on their production and use. Since CFCs are the primary refrigerants used in air conditioners, the international community should spend time and energy to finding replacement for them.

Mitigation measures should be taken to ameliorate human-induced global environmental processes that provoke climate change such as deforestation, desertification, depletion of freshwater resources, and loss of biodiversity as well as use of fossil fuel.

For instance, if our communities depend heavily on activities, which require burning of fossil fuel, not only would these increase greenhouse gas production but also would increase pollution. Reduction in energy consumption must be a key part of the strategy of protecting health from climate change. In addition to mitigation, another important aspect of the solution is increased public awareness.

Some of the international efforts to address the issue of climate change and human health as presented by *La Documentation française* (CTA Spore, 2008) include:

- (i) In 1967, the first publication on global warming was presented
- (ii) 1987: adoption of the Montreal Protocol relating to substances which reduce the ozone layer
- (iii) 1988: Creation of the Intergovernmental Panel on Climate Change (IPCC) charged with scientific monitoring of climate change
- (iv) 1992: The Earth Summit in Rio (Brazil) adopts a Framework Convention on Climate Change, ratified by 50 countries and entering into force in 1994.
- (v) 1997: Adoption of the Kyoto (Japan) Protocol which commits industrialized countries to cutting green house gas emissions by an average of 5.2% by 2012, compared to 1990 levels; flexible mechanisms are created to enable polluting countries to avoid targets by funding reduction in other countries.
- (vi) 2007: The 13<sup>th</sup> United Nations Climate Change Conference in Bali (Indonesia) reached an agreement on a "road-map" aimed at producing a new treaty in 2009, in Copenhagen (Denmark). This treaty will replace the Kyoto Protocol in 2012.

#### **(b). Health Care in a changing climate to protect health**

In this changing climate, we need a health care system that addresses the health impact of climate change. When we consider the wide range of the health impact of climate change, it becomes very evident that our health care will need to be:

- i. Responsive to a broad range of emerging threats of health,
- ii. Collaborative with other sectors of the community; and
- iii. Informed by the strategic imperative of reducing greenhouse gas emission and limiting the impact of climate change

Responsive health care: To protect health from the impact of climate change in the years ahead, patients and doctors as well as other health promotion professionals will need to be on the lookout for the early signs and symptoms of serious health consequences of climate change such as heat related illness. Community and family physicians will be particularly well placed to counsel those at higher risk such as the elderly who live alone, about what to do in the event of extreme temperatures. Such recommendations might include dressing coolly, drinking enough fluid, limiting physical activity during the hottest part of the day and working/resting in the cooler part of the house.

The response of doctors and other health promotion professionals will need to be flexible and adaptive in order to meet the wide range and evolving nature of health impacts of climate change, whether allergies, respiratory illness, or the traumatic injuries relating to storms, floods and bushfire.

Collaborative health care: To protect health from the impact of climate change, doctors and other health professionals will need to collaborate with communities and organizations in areas such as disaster preparedness, diseases surveillance and advocacy.

On infectious disease transmission, it is important to note that community collaboration to protect health from climate change is needed so that outbreaks of climate-related infectious diseases are detected at the earliest possible stage. General practitioners will be required to assist with public health strategies for monitoring the spread of diseases which are transmitted by vectors such as insects.

#### **Major Adaptive Strategies to Lessen Health Risks associated with Climate Change ( Horton and McMichael, 2008)**

##### **a. Activities in which the doctors and other health promotion professionals should lead or participate**

- i). Public education, including in health-care settings such as clinics, hospitals
- ii). Preventive programmes: E.g. vaccines, mosquito control, food hygiene and inspection, and nutritional supplementation
- iii). Provision of health care (especially mental health promotion and primary care) for communities affected by environmental adversity, for example drying conditions in rural communities
- iv). Surveillance of disease, especially infectious disease and its key environmental, social and biological risk factors for those diseases
- v). Forecasting future health risks from projected climate change
- vi). Health sector workforce training (primary and in-carer) to attune to climate-related health risks

##### **b. Strategies that extend beyond the former health sector**

- i). Education and mass media campaigns strong enough to spark commitment and action among governments, international organizations, donors, civil society, business and communities, especially among the young people to anchor health at the heart of the climate change agenda.
- ii). Creation of awareness and public understanding of the global and locally relevant health consequences of climate change.
- iii). Advocacy for interdisciplinary and intersectoral partnerships from the local to international level that seek to improve health through rapid deployment of mitigation strategies to stabilize climate change and development of proactive adaptation programmes to minimize health impact.

- iv). Early-warning system for impending weather extremes such as heat-waves, storms, etc.
- v). Neighbourhood support/watch schemes, to protect those who are most vulnerable.
- vi). Enhanced urban planning: green space, green city, etc.
- vii). Climate-proof housing design (shade, insulation, ventilation).
- viii). Improved water catchments in water-deprived regions.
- ix). Disaster preparedness across sectors.

## CONCLUSION

It is clear from this work that if our generation must protect health from climate change, we must begin to design and adopt ecologically acceptable strategies in all our activities, which ensures sustainability. In other words, sustainability of our socioeconomic efforts should ensure that the biosphere and its component ecosystems remain intact and productive, so that life on earth is able to continue drawing sustenance from them.

Climate change is already a threat to community well-being. It is not only an economic issue; it is a threat to our support systems. In the coming decades, doctors who are interested in the long-term health of their patients and communities will have a central role in the mitigation of climate change and in preparing for and managing its adverse health impacts. Interdisciplinary and intersectoral partnerships from the local to international level that seek to improve health through rapid deployment of mitigation strategies to stabilize climate change and

## REFERENCES

- Bunyavanich, S; Landngan, C; McMichael, A and Epstein, P. (2003). The impact of climate change on child health. *Ambulatory Pediatrics*, 3: 44-52.
- CTA (2008). Special Edition on Climate Change. 5. <http://spore.cta.int>
- Horton, G. and McMichael, T (2008). Climate change, health check 2020. A Report by Climate Institute of Australia. [www.climateinstitute.org.au](http://www.climateinstitute.org.au)
- IPCC. (1996). (Intergovernmental Panel on Climate Change). Climate change 1995. *The science of climate change. Contribution of Working Group to the second assessment report of IPCC*. Houghton, J. T. et al. (Eds.). Cambridge University Press.

development of proactive adaptation programmes to minimize health impact of climate change are fundamental. We must act now because the rate at which the human environment is changing is alarming and the impact of climate change on human health is getting worrisome. All tiers of government, health professionals and other stakeholders should be able to marry the socioeconomic development of our generation and the global ecosystems. Protecting Health from Climate Change depends on how we address the challenges posed by climate change and ozone layer depletion.

## RECOMMENDATIONS

It is recommended that working groups should be constituted on protecting health from climate change. This group should include specialists in such fields as: infectious diseases, food security, food-borne diseases, disaster management, water-borne diseases, vector-borne diseases, chronic respiratory diseases, mental health and health-system strengthening.

Research and policy priorities in protecting health from climate change should be established for addressing and mitigating the public health hazard. The research and policy areas should include:

- a. Improving monitoring of early indicators of changes in the incidence of health outcomes in humans, with particular attention paid to biological indicators or biomarker precursors for skin cancer and eye disorder.
- b. Adopting preventive measures which have short-term ancillary health benefits and enhance long-term environmental sustainability.

- McMichael, A. J. (1993). *Planetary Overload: Global Environmental Change and the Health of Human Species*. Cambridge: Cambridge University Press.
- McMichael, A. J. (1996). Human population health. In: *Climate Change 1995: Impacts, Adaptation and Mitigation of Climate change. Scientific Technical Analysis* Watson, R. T. et al. (Eds.) Cambridge: Cambridge University Press.
- WHO (1996). *Climate Change and Human Health*. A. J. McMichael; A. Haines; R. Slooff and S. Kovoits (Eds.). Geneva: WHO, (WHO/EGH/96.7).
- World Metrological Organization (WMO) (1987). Climate and human health. *Proceedings of WMO/WHO/UNDP Symposium*, Sept. 1986. Geneva.