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Climate Change and Health Effects

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1. Introduction

The United Nations Framework Convention (UNFC) on climate change defines climate change as, “a change of climate which is attributed directly or indirectly to the human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods” (UNFCCC, 1992). The EU has defined dangerous climate change as an increase in 2 degrees celsius of average global temperatures. Since 1900, global temperatures have risen by 0.7 degrees celsius and are continuing to rise at an estimated rate of 0.2 degrees per decade. If left unchecked, this implies global warming of at least 1.4 degrees celsius (IPCC, 2001).

The United Nations Framework Convention on Climate Change (UNFCCC) was convened in 1992 with an overarching framework to address the challenges of climate change through inter governmental efforts. The objectives of the UNFCCC are: 1. To stabilize greenhouse gas concentrations to levels that prevent dangerous interference with the global climate system; and 2. To achieve these reductions within a time frame that allows ecosystems to adapt naturally to climate change, to ensure that food production is not threatened, and to enable economic development to proceed in a sustainable manner. The Kyoto protocol was developed in 1997 to reinforce the emissions reduction commitments of the UNFCCC. The protocol came into legal force in 2005 when it was ratified by 30 industrialized nations, creating legally binding targets for a 5 percent reduction in emissions below 1990 levels by 2012.

The World Metrological Organization and United Nations Environment Programme (UNEP), in an effort to combat the worsening situation, set up the Intergovernmental Panel on Climate Change (IPCC) in 1988. In recognition of the strong body of evidence that this panel has painstakingly collated, it was honored with the Nobel Peace Prize in 2007. The panel recently released their fourth assessment report which categorically states that the “warming of the climate system is unequivocal, as is now evident from observation of increases in global average air and ocean temperature, widespread melting of snow and ice and rising global average sea level”. The fourth assessment report has already identified three areas in which human health has already been affected by climate change. These are: (I) alteration of distribution of some infectious disease vectors, (ii) seasonal distribution of some allergenic pollen species, and (iii) increased heat wave related deaths (Confaloneieri et al 2007).

That climate change impacts health in many ways was highlighted by the World Health Organization (WHO) when it chose to mark World Health Day on April 7 with the theme

“Protecting health from climate change”... The relationship between climate change and human health is multidimensional. The emerging evidence of climate change effects on human health (IPCC 2007) shows that climate change has: altered the distribution of some infectious disease vectors; altered the seasonal distribution of some allergenic pollen species; and increased heat wave-related deaths.

Health effects due to climate change is not a new phenomenon; literate, scholarly systems of medicine dating back more than 3,000 years are available for many parts of the world. Pathological signs in bones, fossil excreta and other items can be studied in archaeological material. Molecular techniques can yield additional information from such remains. In Europe, parish records, the diaries and publications of physicians and other archival material are a rich source of information. Thus, as with climatology, we can turn to a variety of sources for evidence of diseases in past climates (Reiter, 2007). Root cause analysis show that, social and economic developments [driving forces] exert pressure on the environment and, as a consequence, the state of the environment changes. This leads to impacts on e.g. human health, ecosystems and materials that may elicit a societal response that feeds back on the driving forces, on the pressures or on the state or impacts directly, through adaptation or curative action (Griffith, n.d)

The Intergovernmental Panel on Climate Change (IPCC) projected that changes in temperature, precipitation, and other weather variables due to climate change “are likely to affect the health status of millions of people, particularly those with low adaptive capacity” and stated that they had “very high confidence” that climate change is “currently contributing to the global burden of disease and premature deaths” (Paul et al, 2009).

The World Health Organization has concluded that the climatic changes that have occurred since the mid 1970s could already be causing annually over 150,000 deaths and five million disability-adjusted life-years (DALY), mainly in developing countries. The less developed countries are, ironically, those least responsible for causing global warming. Many health outcomes and diseases are sensitive to climate, including: heat-related mortality or morbidity; air pollution-related illnesses; infectious diseases, particularly those transmitted, indirectly, via water or by insect or rodent vectors; and refugee health issues linked to forced population migration. Yet, changing landscapes can significantly affect local weather more acutely than long-term climate change (Partz & Olson, 2006).

2. Health consequences of climate change

Impacts of Climate Change on health are manifested directly due to heat, cold, and injuries or indirectly through changes in environment, agriculture, human behavior and migrations.

2.1 Direct & acute effects

Direct effects on health due to heat, cold, and injuries are some of the acute manifestations resulting due to climate change. These effects can easily be witnessed as a consequence of climate change either in the form of heat and cold waves or direct injuries resulting from heavy rains and wind speeds as witnessed in hurricanes.

2.1.1 Direct effects of extreme events

An increase in the frequency and intensity of extremes of temperature, precipitation and wind speed have clear implications for mortality and morbidity. Flooding and storms

increase the risk of deaths and non-fatal injuries. Climate change is expected to increase average temperatures as well as the number and intensity of heat waves. Heat waves are associated with increases in morbidity and mortality in the short term, especially in populations who are not adapted to extremely hot weather. Hot working environments also have non-fatal implications. Heat exposure increases the risk of having accidents. Hot working environments may decrease the ability to carry out physical tasks as well as have implications for mental task ability. Prolonged heat exposure may lead to heat exhaustion or heatstroke. In addition to the implications for health and well-being, climate change may through exposure of workers to heat stress have important direct effects on productivity (Nerlander, 2009).

The Indian metropolitan city of Mumbai was besieged with India's heaviest downpour of the century in July 2005, killing nearly 600 people. According to the Indian Meteorological department, this was the heaviest rainfall ever received in a single day, anywhere in India, recording 94.4 cm in the last 100 years. It broke the record of the previous highest rainfall at one place in India, at Cherrapunjee in Meghalaya (83.82 cm recorded on July 12, 1910). Cherrapunjee in the Northeastern state of Meghalaya is a generally well-known for being the wettest place in the world. Extreme weather changes surpassing their usual statistical ranges and tumbling records in India could be an early warning bell of global warming. Extreme weather events like the recent record setting in the western Indian city of Mumbai, or the all time high fatalities due to the heat wave in southern Indian states, or increasing vulnerability of eastern Indian states to floods could all be a manifestation of climate change in the Asian subcontinent (Patil & Deepa, 2007).

Acute variation in temperature and precipitation, can lead to various Patho-Physiological (Hypo-Hyper thermia, heart stroke, burns, frost bites etc). Extreme weather events such as severe storms, floods and drought can have obvious results such as physical injuries and drowning. Rising sea-levels will also give rise to flooding leading to drowning and population displacement.

2.2 Indirect and chronic effects

There are many indirect effects as: communicable diseases e.g.: vector borne disease, diarrheal diseases; ecological disturbances impacting on agent- host-environment relationships; malnutrition resulting due to agricultural impacts leading to food security issues; environmental health related to air and water quality issues, and human behavior issues such as migrations, and mental health.

2.2.1 Vector borne disease

Climate change is also expected to affect animal, human and plant health via indirect pathways. It is likely that the geography of infectious diseases and pests will be altered, including the distribution of vector-borne diseases, which are highly sensitive to climatic conditions. Extreme weather events might then create the necessary conditions for vector borne disease to expand its geographical range. Strengthening global, regional and national early warning systems is crucial, as are co-ordinated research programs and subsequent prevention and intervention measures (Martin et al, date??). As the ambient temperature of a region rises, the ecology changes and therefore populations of disease carrying animals or insects may increase as well. The rate of replication of the vector itself, or the pathogen (virus, bacteria) within those vectors can be sensitive to temperature. Changes in

precipitation patterns can alter the number of breeding sites available leading to explosive epidemics of the following varieties of vector Borne diseases: **Mosquitoes Borne Diseases** e.g., Malaria, Dengue, Chikungunia, Yellow fever, Filaria are some of most climate sensitive diseases in which there is a direct correlation with temperature and rainfall which can be demonstrated. **Rodent-borne diseases** e.g. leptospirosis, are commonly reported in the after-math of flooding. In some areas, drought may reduce the transmission of some mosquito borne diseases, leading to reduction in the proportion of immune persons and therefore a larger amount of susceptible people once the drought breaks. **Pests borne disease:** Pests could become even more important disease vectors as a result of climate change. The spread of Plague, West Nile and Lyme disease are indicative of impact of pests on public health.

2.2.2 Malaria

Climate factors, particularly rainfall, temperature and humidity, interact to greatly affect the development, behavior and survival of mosquitoes transmitting malaria. However, as the Intergovernmental Panel on Climate Change (IPCC) reports, despite known causal links between climate, malaria and transmission dynamics, there is still much uncertainty about the potential impact of climate change on malaria at local and global scales. This is in part due to the complexity and local specificities of malaria transmission. Different mosquito vector species and parasites react differently to various climate conditions. For example, a change in temperature can affect the growth of the parasite within the mosquito and a change in local climate may make it less suitable for one vector. This particularly applies to water habitats for mosquito breeding environmental and institutional factors). However, while there is substantial knowledge on mosquito vectors, there is uncertainty about how climate change may change and influence malaria transmission. Two impacts of climate change at least have to be considered as major factors: temperature and rainfall patterns. The less important, but easiest to model, is the direct effect of temperature. This has effects both on mosquito range and survival, and the period of time it takes for mosquitoes to become infectious following biting an infected individual; the shorter the period, the greater the vectoral capacity. For both reasons, higher temperatures are likely to lead to more malaria, but the effects of this should not be exaggerated, and changes in temperature are unlikely to occur with all other environmental factors remaining constant (DEFID, 2010).

Vector Borne Zoonotic Disease[s] [VBZDs: Climate change may affect the incidence of VBZDs through its effect on four principal characteristics of host and vector populations that relate to pathogen transmission to humans: geographic distribution, population density, prevalence of infection by zoonotic pathogens, and the pathogen load in individual hosts and vectors. These mechanisms may interact with each other and with other factors such as anthropogenic disturbance to produce varying effects on pathogen transmission within host and vector populations and to humans. Because climate change effects on most VBZDs act through wildlife hosts and vectors, understanding these effects will require multidisciplinary teams to conduct and interpret ecosystem-based studies of VBZD pathogens in host and vector populations and to identify the hosts, vectors, and pathogens with the greatest potential to affect human populations under climate change scenarios (Mills et al, 2010). Most vector-borne diseases exhibit a distinct seasonal pattern, which clearly suggests that they are weather sensitive. Rainfall, temperature, and other weather variables affect in many ways both the vectors and the pathogens they transmit. For

example, high temperatures can increase or reduce survival rate, depending on the vector, its behavior, ecology, and many other factors. Thus, the probability of transmission may or may not be increased by higher temperatures. The tremendous growth in international travel increases the risk of importation of vector-borne diseases, some of which can be transmitted locally under suitable circumstances at the right time of the year. But demographic and sociologic factors also play a critical role in determining disease incidence, and it is unlikely that these diseases will cause major epidemics in the United States if the public health infrastructure is maintained and improved (Gubler, 2001).

Climate is a major factor in determining: (1) the geographic and temporal distribution of arthropods; (2) characteristics of arthropod life cycles; (3) dispersal patterns of associated arboviruses; (4) the evolution of arboviruses; and (5) the efficiency with which they are transmitted from arthropods to vertebrate hosts. Thus, under the influence of increasing temperatures and rainfall through warming of the oceans, and alteration of the natural cycles that stabilize climate, one is inevitably drawn to the conclusion that arboviruses will continue to emerge in new regions. For example, we cannot ignore the unexpected but successful establishment of chikungunya fever in northern Italy, the sudden appearance of West Nile virus in North America, the increasing frequency of Rift Valley fever epidemics in the Arabian Peninsula, and very recently, the emergence of Bluetongue virus in northern Europe (Gould, 2009)

2.2.3 Chikungunya

Chikungunya is a viral disease that is spread by mosquitoes. It causes fever and severe joint pain. Other symptoms include muscle pain, headache, nausea, fatigue and rash. The disease shares some clinical signs with dengue, and can be misdiagnosed in areas where dengue is common. There is no cure for the disease. Treatment is focused on relieving the symptoms. The proximity of mosquito breeding sites to human habitation is a significant risk factor for Chikungunya.

The Indian capital city of Delhi reported its first ever case of Chikungunya in June 2007. Any new disease in any new region where it was previously not known to occur is certainly a cause of concern, as it is an emergence of a new infectious agent in a hitherto 'virgin' region. It could be a manifestation of disturbed equilibrium in the ecology of a given region. New epidemics in the new regions are a definite signs of an ecological ill health. Hence, if the ongoing climate change can lead to ecological disturbances, it is likely to bring in changes in distribution of vector borne disease like Chikungunya and other vector borne diseases (Patil, 2011)

2.2.4 Lyme disease

Lyme disease, or Lyme borreliosis, is an emerging infectious disease caused by at least three species of bacteria belonging to the genus *Borrelia*. The disease is named after the town of Lyme, Connecticut, USA, where a number of cases were identified in 1975. Lyme disease is the most common tick-borne disease in the hemisphere. Early symptoms may include fever, headache, fatigue, depression, and a characteristic circular skin rash called erythema migrans. Left untreated, later symptoms may involve the joints, heart, and central nervous system (Ryan, 2004)

Climate change will increase the geographical distribution of Lyme disease. Lyme disease is spread by blacklegged tick bites. A survey conducted from 1992 to 2006 indicates that the

incidence of Lyme disease is increasing and rates are highest among children age 5–14 years. The number of reported cases of Lyme disease more than doubled during this time period.¹⁹ Children are especially vulnerable to tick bites because they tend to play outside and close to the ground (EPA, u.d) Effect of Climate change on other vector borne diseases

West Nile virus is spread by infected mosquitoes, and can cause serious, life-altering and even fatal disease. The main route of human infection is through the bite of an infected mosquito. Approximately 90% of West Nile Virus infections in humans are either without any symptoms or very vague symptoms with fever and generalized body pain. The temperature thresholds for WNV survival are not documented, but laboratory studies indicate that the ability of competent vectors to transmit the virus is favored by higher temperatures and the vector's temperature-dependent survival pattern. Climate change may lengthen survival periods of WNV-competent *Anopheles* mosquitoes (Table 8) and possibly allow infected hosts (birds) to change their geographic range. These could result in changes in virus prevalence rates and distribution. Therefore, climate change may increase WNV transmission risk. Leishmaniasis. The current environment is conducive to *Phlebotomus* sandfly survival for several months. Climate change might decrease the number of days suitable for *Phlebotomus ariasi*. The risk of contracting leishmaniasis may become high.

Mediterranean spotted fever. The abundant and widespread distribution of the tick as well as the high prevalence of dogs infected with *Rickettsia conorii*. Because *R. sanguineus* has a remarkable ability to adapt to its environment, and disease transmission is highest during warmer months, even in harsher arid climatic zones where ambient temperatures exceed 35°C and soil temperatures exceed 45°C In fact, it is possible that climate change may prolong the peak season of MSF cases because of higher temperatures in spring and autumn. **Schistosomiasis:** Environmental conditions can be conducive to *Schistosoma* transmission, the competent snail population may be infected, and the risk of transmission could be high. Assuming ambient air temperatures as approximations of shallow water temperatures (which affect parasite and vector survival), it is clear that climate change might lengthen parasite survival periods and vector survival. Focal introduction of the parasite from infected imported human cases to the currently non infected snail population is also possible. If a focal parasite-infected snail population were to occur, if a warmer climate scenario is assumed and that the infected vector population may with time widen its geographic distribution as the favorable temperature period for survival increases significantly, then disease transmission risk may increase toward a medium level (Casimiro, 2006).

3. Food security

Climate change together with other factors can have serious implication on food security consequently resulting in Malnutrition due to following reasons:

Decreased Agricultural Yield: Agricultural production and food security are also linked directly to precipitation patterns – this impacts the nutritional status of the population. Excess or Scarcity of Water resulting from draught, floods, heavy rains can adversely affect agricultural output. Salinization of fertile land : **Rising sea levels** increase the risk of coastal flooding of agricultural land due to sea levels rise leading to decreased yield of crops resulting in malnutrition. **Population Migrations:** Population displacement and also rural to urban migration carries its own health risks e.g., malnutrition and increased risks of communicable diseases. Increased rates of malnutrition as they become more susceptible to

other diseases through influx or outpouring of infected population e.g. malaria parasitemia may alter the host and herd immunity leading to increased susceptibility. The vicious cycle between malnutrition and life threatening infectious disease is well demonstrated

3.1 Effect of climate change on malnutrition

About Climate change affects food and nutrition security and further undermines current efforts to reduce hunger and protect and promote nutrition. Additionally, under nutrition in turn undermines the resilience to shocks and the coping mechanisms of vulnerable populations, lessening their capacities to resist and adapt to the consequences of climate change. Climate change further exacerbates the already unacceptably high levels of hunger and under nutrition. Climate change will increase the risk of hunger and under nutrition over the next few decades and challenges the realization of the human rights for health and adequate food. Climate change will affect nutrition through different causal pathways that impact food security, sanitation, water and food safety, health, maternal and child health care practices and many socioeconomic factors. Climate change negatively affects food availability, conservation, access and utilization and exacerbates socioeconomic risks and vulnerabilities. According to the IPCC if current trends continue, it is estimated that 200–600 million more people will suffer from hunger by 2080. Calorie availability in 2050 is likely to decline throughout the developing world resulting in an additional million undernourished children, 21% more relative to a world with no climate change, almost half of which would be living in sub-Saharan Africa. Climate change negatively affects nutrition through its impacts on health and vice versa. Climate change has an impact on water availability and quality, sanitation systems, food safety and on waterborne, food borne, vector-borne and other infectious diseases which eventually both increase nutritional needs and reduce the absorption of nutrients and their utilization by the body. Mitigation is critical to limit impact of climate change on food security and nutrition in low and middle income countries in the future. However, mitigation strategies should not increase food and nutrition insecurity. For example, bio fuel production can have a negative impact on food production and nutrition. Bio fuel production requires large amounts of natural resources (arable land, water, labor, etc.) that might thus be diverted from the cultivation of food crops¹⁰ (UNSCN, 2010).

About 46% of the DALYs attributable to climate change were estimated to have occurred in the WHO South-East Asia Region, 23% in countries in the Africa region with high child mortality and very high adult male mortality, and 14% in countries in the Eastern Mediterranean region with high child and adult male mortality. The relative risk estimates for malnutrition, diarrheal diseases, and malaria, respectively, projected for 2030 under the alternative exposure scenarios. The relative risks of malnutrition is directly proportional to underweight; this applies to all diseases affected by underweight (including diarrhea and malaria) (McMichael, 2004).

3.2 Effect of climate change on food security

With “high” or “very high confidence” the IPCC predicts the following, by 2020, in some countries, yields from rain-fed agriculture could be reduced by up to 50%. Agricultural production, including access to food, in many countries is projected to be severely compromised. This would further adversely affect food security and exacerbate malnutrition. According to the IPCC, GCC threatens the health, happiness and even survival of literally hundreds of millions of people, through increased risk of malnutrition

and starvation, and increased frequency of deadly weather events (Philos, 2010). In the socio-economics literature on rural livelihoods, it is widely accepted that farming households face three main sources of vulnerability : shocks (unexpected extreme events, for example the sudden death of a family member, or an extreme weather event), seasonal variations (including variations in periodicity and amount of rainfall) and long term trends (such as increases in input prices, or long term changes in mean temperature and rainfall). The problems from all three are likely to increase in intensity, particularly for farmers relying on rain-fed production. Small-scale farming provides most of the food production, as well as employment for 70% of working people. These small-scale producers already face the challenges of climate variability in current climates. For example, intra-seasonal distribution of rainfall affects the timing and duration of the possible cropping season, and periods of drought stress during crop growth. Cropping practices that are often used to mitigate the effects of variable rainfall (Challinor et al, 2007).

Looking at individual sectors, the equity implications of climate change are most pronounced for food security. Low-emission countries are, in general, more adversely impacted (in terms of projected future yield changes of staple crops), more exposed (in terms of the share of agriculture in gross domestic product and labor force), and less able to cope with adverse impacts (in terms of the current level of under nutrition). The analysis for human health also implies that those least responsible for climate change will be most affected by its adverse impacts. Countries with low emissions levels have, on average, a lower current health status (measured by infant mortality and life expectancy), higher socio-economic vulnerability to extreme weather events, and already experience stronger adverse climate impacts on human health (Fussler, 2009).

3.3 Pests

The reproductive success of predators depends, food abundance and population density and their interactions may respond to changes in climatic conditions. Timing of reproduction may increase, during a period of temperature increase. Few studies have investigated how climate change affects predator-prey and parasite-host interactions, although such effects are widely predicted to be key for understanding community level effects of climate change. Theoretical studies suggest that predators and parasites may be particularly susceptible to the effects of climate change due to the direct effects of climate on the distribution and the abundance of prey and host populations, respectively. However, there are only few empirical studies indicating that the ability of hosts to defend themselves against parasites is strongly influenced by environmental conditions. The North Atlantic Oscillation has been shown to affect predator-prey cycles in the Canadian arctic. Studies of the great tit *Parus major* and its caterpillar prey have shown increasing mal-adaptation of timing of breeding to maximum availability of prey, providing a cause for concern (Nielsen & Møller, 2006).

3.4 Effects of agricultural chemicals and pathogens on human health

Humans may be exposed to agriculturally derived chemicals and pathogens in the environment (i.e., air, soil, water, sediment) by a number of routes, including the consumption of crops that have been treated with pesticides or have taken up contaminants from soils; livestock that have accumulated contaminants through the food chain; fish exposed to contaminants in the aquatic environment; and groundwater and surface waters used for

drinking water. Exposure may also occur via the inhalation of particulates or volatiles, or from direct contact with water bodies or agricultural soils (e.g., during recreation). The importance of each exposure pathway will depend on the pathogen or chemical type. The main environmental pathways from the farm to the wider population will be from consumption of contaminated drinking waters and food (Alistair et al, 2009).

3.5 Migration/shift in occupation

At a basic level, for many farmers the challenge will be whether they can continue to farm. Already rural livelihoods at household level are highly diverse, with farming accounting for a lower proportion of disposable income and food security for farming households than 20 years ago. For example, concludes that “diversification out of agriculture has become the norm among African rural populations.” There is evidence that households moving out of poverty are those moving either completely or partially out of farming. It is likely that many households will respond to the challenge of climate change by seeking further to diversify into non-farm livelihood activities either in situ or by moving (or sending more family members) to urban centers. For these households, farming may remain as (or revert to) a semi-subsistence activity while cash is generated elsewhere. This would be simply a continuation of a well-established trend towards pluriactive, multi-locational families and the transfer of resources through urban-rural remittances. However, given the acute population and development related challenges faced by most African nations, many households will be forced to remain in the farming sector for livelihood and security for some time to come as the population in Africa undergoes a three-fold increase this century. This will lead to considerable demand for expansion of area under small-farm cultivation for staple crops. Farming for profit, particularly production for international markets, may therefore become more concentrated on fewer farms, as is already happening in the fresh vegetable export market from eastern and southern Africa. Companies with the capital to invest in controlling their production environment through irrigation, netting and crop protection in order to meet stringent quality and bio-safety requirements of European supermarkets are increasing their market share at the expense of smallholders. This should lead to further irrigation development, and contribute to a recommended doubling of irrigated land by 2015.

4. Water borne diseases

4.1 Climate change and water borne disease

High temperatures, water scarcity and water abundance resulting from flooding or heavy precipitation have been shown to be related to diarrheal diseases. Heavy rainfall, even without flooding, may increase rates of diarrheal disease as sewage systems overflow. Increases in soil run-off may contaminate water sources

A lack of availability of water for personal hygiene and washing of food may lead to an increase in diarrheal disease and other diseases associated with poor hygiene. It is important to note that high temperatures in itself an independent risk factor for increased rates of diarrheal diseases, including salmonella and cholera.

Clearly, the health implications of changes to water supply are far-reaching. Currently, more than 3 million people die each year from avoidable water-related disease, most of whom are in developing countries. The effects of climate change on water will exacerbate the existing implications of water shortages on human health (Water Aid u.d), as follows:

Water-borne diseases: result from the contamination of water by human/ animal faeces, or by urine infected with pathogenic viruses/ bacteria, both of which are more likely to occur during periods of flood.

- Water-washed diseases: those resulting from inadequate personal hygiene as a result of scarcity or inaccessibility of water (including many water-borne diseases and typhus).
- Water-based diseases: those caused by parasites that use intermediate hosts living in/near water (e.g. guinea worm).
- Water-related diseases: borne by insect vectors that has habitats in/near water (such as malaria)
- Water-dispersed diseases: infections for which the agents proliferate in fresh water and enter the human body through the respiratory tract (e.g. legionella). Climate change and water resources

Climate change may affect the growth and survival of disease-causing organism's related to water- and food-borne illness. The incidence of water- and food-borne illnesses, such as gastroenteritis and infectious diarrhea, is known to increase when outdoor temperature increases, or immediately following storms or floods. Extreme weather can result in the breakdown of sanitation and sewer systems, a loss of power for refrigeration, or inadequate means to thoroughly cook food, increasing the likelihood of water- and food-borne illness. Children are especially susceptible to water- and food-borne illness due to their developing immune systems. In fact, infectious diarrhea is responsible for approximately 1.5 million child deaths per year globally, disproportionately affecting children of developing nations (EPA u.d).

Knowledge about transport processes and the fate of microbial pollutants associated with rainfall and snowmelt is key to predicting risks from a change in weather variability. Although recent studies identified links between climate variability and occurrence of microbial agents in water, the relationships need further quantification in the context of other stresses. In the marine environment as well, there are few studies that adequately address the potential health effects of climate variability in combination with other stresses such as overfishing, introduced species, and rise in sea level. Advances in monitoring are necessary to enhance early-warning and prevention capabilities. Application of existing technologies, such as molecular fingerprinting to track contaminant sources or satellite remote sensing to detect coastal algal blooms, could be expanded. This assessment recommends incorporating a range of future scenarios of improvement plans for current deficiencies in the public health infrastructure to achieve more realistic risk assessments (Bose et al, 2001).

4.2 Harmful algae bloom

A worldwide increase in cyanobacterial (blue-green algae) sources has been observed in both coastal and freshwaters. These harmful algae blooms (HABs), which produce nerve and liver toxins, are longer in duration, of greater intensity, and are suspected of being tied both to increased temperatures due to climate change and nutrient runoff. Exposure to marine toxins has resulted in death and poisonings of California sea lions and Florida alligators. Human exposure is of concern through both drinking water contamination and recreational exposure (English et al, 2009).

4.3 El Niño and severe rainfall/flooding and potential health effects

El Niño is a phenomenon results in the namesake oscillation of wind and ocean currents, usually occurring every three to seven years, there is concern that climate change will increase its frequency or the severity of its consequences. These, in turn, change regional temperatures and precipitation patterns and lead to significantly increased rainfall. Several researchers have established a link between heavy rainfall and flooding – whether resulting from El Niño-associated events or from other meteorological impacts – and subsequent outbreaks of infectious diseases. Extreme meteorological events can easily disrupt water purification and storm water and sewage systems, as well as contaminate uncovered wells and surface water, leading to an increased risk of illness. These risks are even higher when a population lives in a low-lying area, where the land's hydrology causes draining tributaries to meet. Conversely, heavy rains and coastal events can also flush microorganisms into watersheds, affecting those up-coast as well. Nonsustainable development, such as that which contributes to deforestation and soil erosion, influences water contamination by destroying the land's natural ability to absorb runoff, resulting in water-contaminating mudslides(Reiter, 2007).

4.4 Cholera and diarrheal diseases

Climate change can result in increased temperatures in both ocean water and ambient air. Increased sea temperatures have a direct effect on the proliferation of plankton and algae in sea water. *Vibrio* species organisms, including *V. cholera*, thrive in particular sea conditions. Among these are warm water, moderate salinity, and number of aquatic invertebrates, all conditions influenced by climate change. In particular, the quantity of *vibrio* species may increase or the range of the bacteria may extend. Many causative agents of diarrheal disease have a seasonal variability, with peaks in the warmer months. Increased temperatures or higher temperatures for longer times can result in higher than expected diarrhea incidence. Finally, rises in sea level due to increased temperatures can lead to coastal flooding, which can force the use of contaminated water, overwhelm sanitation systems, or prompt migration into areas with insecure water and sanitation availability (Fricas & Tylor, 2007).

Climate change has begun to negatively affect human health, with larger burdens projected in the future as weather patterns continue to change. The climate change-related health consequences like diarrheal diseases (Kristie, 2008). Recent studies examining the potential impacts of climate variability and change on the risks and incidence of water- and food borne illnesses conclude that that the risk of water- and food-borne illness will likely increase with climate change. Studies suggest that extreme precipitation events increase the loading of contaminants to waterways, climate change could increase the risk of illness associated with *Cryptosporidium parvum*, association between increases in the lagged monthly mean temperature and increases in the number of notifications of salmonellosis infections (Ebi et al, 2006).

5. Air quality and health

5.1 Effect of climate change on air quality

Climate Change also change patterns of air movement and pollution, causing expanded or changed patterns of human exposure and resulting health effects. The formation of many

air-pollutants is determined in part by climate factors such as temperature and humidity. In addition the transport and dispersion of air pollutants away from source regions are strongly affected by weather factors. Climate change therefore influence pollutant concentrations, which in turn may affect health as air pollution is related to cardio-respiratory health

Climate and air quality are closely coupled. Conventional pollutants, such as ozone and particle pollution, not only affect public health but also contribute to climate change. Ozone is a significant greenhouse gas (GHG) and particles can influence the climate by scattering, reflecting, and/or absorbing incoming solar radiation and interacting with various cloud processes. Due to climate change, the IPCC predicted “declining air quality in cities.” In summarizing the impact of climate change on ozone and particle pollution, the IPCC concluded that “future climate change may cause significant air quality degradation by changing the dispersion rate of pollutants; the Chemical environment for ozone and particle pollution generation; and the strength of emissions from the biosphere, fires, and dust.” Though a great deal of uncertainty remains regarding the expected future impacts of climate change on air quality, recent research suggests that such effects may be very significant, particularly on a local or regional scale (EPA, 2010)

Health effects of air quality the formation of many air-pollutants is determined in part by climate factors such as temperature and humidity. In addition the transport and dispersion of air pollutants away from source regions are strongly affected by weather factors. Climate change may therefore influence pollutant concentrations, which in turn may affect health as air pollution is related to cardio-respiratory health. Exposure to high levels of ground-level ozone, for example, which is formed from the exhaust of transport vehicles, increases the risk of exacerbations of respiratory diseases such as chronic obstructive airways disease and asthma, leading to hospital admissions or increased mortality. The number of forest and bush fires may increase as certain regions face longer periods of extreme dry conditions and such fires can contribute to air-pollution. The direction and magnitude of the effects of climate change on air pollution levels are however highly uncertain and there will be regional variations. National energy policies and transport policies should take into account the health effects of air-pollution⁴⁰ and early warning systems for levels of air pollution can be implemented. Reducing emission from transport vehicles is a win-win solution contributing both improve health as well as reduce greenhouse gas emissions (Nerlander, 2009).

5.2 Ozone

Because ozone formation increases with greater sunlight and higher temperatures, it reaches unhealthy levels primarily during the warm half of the year. Daily peaks occur near midday in urban areas, and in the afternoon or early evening in downwind areas. It has been firmly established that breathing ozone can cause inflammation in the deep lung as well as short-term, reversible decreases in lung function. In addition, epidemiologic studies of people living in polluted areas have suggested that ozone can increase the risk of asthma-related hospital visits and premature mortality. Vulnerability to ozone effects on the lungs is greater for people who spend time outdoors during ozone periods, especially those who engage in physical exertion, which results in a higher cumulative dose to the lungs. Thus, children, outdoor laborers, and athletes all may be at greater risk than people who spend more time

indoors and who are less active. Asthmatics are also a potentially vulnerable subgroup (Ebi, u.d).

6. Climate change and allergies

Pollen allergy currently affects significant proportion of the population. A warmer climate will lead to a longer pollen season and more days with high pollen counts. In addition, a warmer climate increases the risk of proliferation of new plants with well-known allergenic pollens like ragweed, plane tree and wall pellitory. The consequences will be more people with hay fever and pollen asthma, longer allergy seasons and an increase in the severity of symptoms, disease-related costs and demands on health care for diagnosis and treatment of more complex allergies. It is clearly identified that climate change can exert a range of effects on pollen, which might have consequences for pollen-allergic patients. The pollen season might become longer thereby extending the period in which patients suffer from allergy symptoms. This extension of the pollen season could be due to a prolonged flowering period of certain species, e.g. grasses, or the appearance of new species that flower in late summer, e.g. common ragweed. Climate change could cause an increase in heavy thunderstorms on summer days in the grass pollen season, which are known to increase the chance of asthma exacerbations (sommer et al, 2009).

Climate change alters the concentration and distribution of air pollutants and interferes with the seasonal presence of allergenic pollens in the atmosphere by prolonging these periods. The link between climate change and respiratory allergies is most importantly explained by the worsening ambient air pollution and altered local and regional pollen production. Laboratory studies confirm epidemiologic evidence that air pollution adversely affects lung function in asthmatics. Damage to airway mucous membranes and impaired mucociliary clearance caused by air pollution may facilitate access of inhaled allergens to the cells of the immune system, thus promoting sensitization of the airway. Consequently, a more severe immunoglobulin (Ig) E-mediated response to aeroallergens and airway inflammation could account for increasing prevalence of allergic respiratory diseases in polluted urban areas (D'Amato et al, 2010).

6.1 Molds

Aeroallergens that may respond to climate change include outdoor pollens generated by trees, grasses, and weeds, and spores released by outdoor or indoor molds. Because climatologic influences differ for these different classes of aeroallergens, they are discussed separately here. As compared with pollens, molds have been much less studied. This may reflect in part the relative paucity of routine mold monitoring data from which trends might be analyzed, as well as the complex relationships among climate factors, mold growth, spore release, and airborne measurements.⁶³ In addition to potential effects on outdoor mold growth and allergen release related to changing climate variables, there is also concern about indoor mold growth in association with rising air moisture and especially after extreme storms, which can cause widespread indoor moisture problems from flooding and leaks in the building envelope. Molds need high levels of surface moisture to become established and flourish (Kinney, 2008).

The urban heat island effect, a combination of anthropogenic and climatologic heat, can increase urban temperatures as much as 5°C compared with rural locations and further drive the formation of ozone.

Air pollution can interact with pollen grains, leading to an increased release of antigens characterized by modified allergenicity.
Air pollution can interact with allergen-carrying paucimicronic particles derived from plants. The paucimicronic particles, pollen-originated or not, are able to reach peripheral airways with inhaled air, inducing asthma in sensitized subjects.
Air pollution—in particular ozone, PM, and sulfur dioxide—have been shown to have an inflammatory effect on the airways of susceptible subjects, causing increased permeability, easier penetration of pollen allergens in the mucus membranes, and easier interaction with cells of the immune system.
There is also evidence that predisposed subjects have increased airway reactivity induced by air pollution and increased bronchial responsiveness to inhaled pollen allergens.
Some components of air pollution seem to have an adjuvant immunologic effect on IgE synthesis in atopic subjects—in particular, DEPs, which can interact in atmosphere with pollens or paucimicronic particles.

Table 1. The rationale for the interrelationship between agents of air pollution and pollen allergens in inducing respiratory allergy (Shea et al, 2008).

7. Non communicable disease

IPCC expects all parts of the planet to experience more heat exposure in the future (IPCC 2007), while the local extent of heating will vary. Increased heat and climate variability will also influence other exposure routes which are moderated by socio-economic status and other variables. Dehydration increases the concentration of calcium and other compounds in the urine, which facilitates the formation of kidney stones (Cramer and Forrest 2006). In addition to kidney stone disease, there is evidence that during heat waves there is an increase in hospitalizations for acute renal failure and other kidney diseases (Kjellstrom et al, u.d)

7.1 Effect of climate change on non communicable disease

Cardiovascular Disease and Stroke: Association between air quality, especially ozone and particulate burdens, and cardiovascular disease appear to be modified by weather and climate. Ozone is also associated with acute myocardial infarction. Particulate matter is associated with a variety of patho-physiological changes including systemic inflammation, deranged coagulation and thrombosis, blood vessel dysfunction and atherosclerotic disease, compromised heart function, deep venous thromboses,95.Increased burden of PM2.5 is associated with increased hospital admissions and mortality from cardiovascular disease, as well as ischemic heart disease. **Neurological:** climate change on ocean health, resulting in increased risks to neurological health from ingestion of or exposure to neurotoxins in seafood and fresh and marine waters. Neurotoxins produced by harmful algal blooms and other marine microorganisms can cause serious illness and death in humans. The most frequent human exposures are via consumption of seafood containing algal toxins, although some toxins may be present in freshwater sources of drinking water, and others may be aerosolized by surf breaking on beaches and then transported by winds to where they can cause respiratory distress in susceptible individuals who breathe them. Because cooking or other means of food preparation do not kill seafood biotoxins, it is essential to identify contaminated seafood before it reaches consumers. **Human Developmental Effects:** climate change could alter normal human development both in the womb and later in life. Food

borne illness and food insecurity, both likely outcomes of climate change, may lead to malnutrition. While adult humans exposed to mild famine usually recover quite well when food again becomes plentiful, nutritional reductions to a fetus in the womb appear to have lasting effects throughout life. Climate change effects on food availability and nutritional content could have a marked, multigenerational effect on human development. Certain commercial chemicals present in storage sites or hazardous waste sites can alter human development. Flooding from extreme weather events and sea-level rise are likely to result in the release of some of these chemicals and heavy metals, most likely affecting drinking and recreational waters. Some of these, including mercury and lead, have known negative developmental effects (IWGCCH, u.d).

8. Cancer

Since last 30 years there has been concern that anthropogenic damage to the earth's stratospheric ozone layer will lead to an increase of solar ultraviolet (UV) radiation reaching the earth's surface, with a consequent adverse impact on human health, especially to the skin. More recently, there has been an increased awareness of the interactions between ozone depletion and climate change (global warming), which could also impact on human exposure to terrestrial UV. The most serious effect of changing UV exposure of human skin is the potential rise in incidence of skin cancers. Climate change, which is predicted to lead to an increased frequency of extreme temperature events and high summer temperatures. This could impact on human UV exposure by encouraging people to spend more time in the sun. While future social trends remain uncertain, it is likely that over this century behavior associated with climate change, rather than ozone depletion, will be the largest determinant of sun exposure, and consequent impact on skin cancer (Diffey, 2004).

9. Mental health

Climate change has potential to influence mental health and behavior. It is observed that those with lower socioeconomic standing are more likely to choose to relocate permanently following a devastating event, often due to limited resources to rebuild property and restore livelihood. In addition, people will continue to experience place-based distress caused by the effects of climate change due to involuntary migration or the loss of connection to one's home environment, a phenomenon called "Solastalgia". (IWGCCH)

Climatic changes may have a significant impact on various dimensions of mental health and well-being. India has been witnessing high incidence of for cotton farmers' deaths/suicides since 1998. The socioeconomic-political factors emerge as very strong determinants of deaths, given the occupational work environment. Also there is decreasing yield of cotton over the years resulting in loss of revenue for the farmers leading them to mental distress. (Patil, 2002)

Violent crime may be exacerbated during heat waves because more stress hormones are released when people are exposed to excessive heat (Simister & Cooper, 2004). More alcohol and drugs may be consumed during heat waves, and more people may seek help for their psychiatric problems during these periods (Bulbena et al, 2006). Drought appears to contribute to a variety of mental health effects, including more stress, grief, and hopelessness as well a sense of solastalgia, which describes a palpable sense of dislocation and loss people feel when they perceive changes to their local environment are pervasively harmful (Sartore et al, 2007). Conflict among people may be one of the hallmarks of climate

change's severe weather, which can displace thousands or millions and lead to those people competing with others for scarce resources (Abbott, 2008). While many people have short-term reactions to extreme natural disasters—including grief, anger, anxiety, and depression—persistent post-traumatic stress may be the hallmark of climate change, as was demonstrated after Hurricane Katrina (Galea et al, 2007). One study showed that mental illness doubled after Hurricane Katrina (Kessler et al, 2006). One year after Hurricane Katrina, exposed children were four times more likely than before the storm to be depressed or anxious and twice as likely to have behavioral problems (Abramson et al, 2007). Other psychological problems, including family dysfunction, difficulties at work, increased child misbehavior, a sense of lost identity, and more may result from experiences of the extreme disasters that climate change is likely to bring (Bourque et al, 2006). Emotional distress and anxiety will be among the hallmarks of climate change and its effects, and disadvantaged communities are among those to be most harmed (Fritze et al, 2008).

The association between acute psychosis and climatic variation is known, especially in tropical countries. Studies from tropical countries like India suggest an increased prevalence of acute psychosis following viral fever, especially in winter. The hospital admission rates for schizophrenia and "schizoaffective" patients are clearly increased in summer and fall respectively, as reported in an 11-year study from Israel. Schizophrenia patients' mean monthly admission rates correlated with the mean maximal monthly environmental temperature, indicating that a persistently high environmental temperature may be a contributing factor for psychotic exacerbation in schizophrenia patients and their consequent admission to mental hospitals. Around half the children and adolescents exposed to the 'supercyclone' in the state of Orissa in India reported symptoms of the post-traumatic stress disorder (PTSD) syndrome of different severity even after one year. Drought affects family relationships. Stress, worry and the rate of suicide increase. The phenomenon of farmers' suicides in India is a typical example of the consequences of climatic vagaries in poor, predominantly agrarian economies (Chand, 2008)

10. Ethics

Anthropogenic climate change entails important consequences for international equity because both the causes of climate change and its impacts are unequally distributed across (and within) nations. The equity implications of climate change are attracting increasing attention because a comprehensive international agreement on climate change will only be agreed upon if it is considered fair by all parties to the UNFCCC. Therefore, the distribution of mitigation and adaptation costs across countries needs to consider their responsibility for climate change as well as their capacity to act, and the allocation of funds for adaptation need to consider, among others, their vulnerability to climate change. Looking at individual sectors, the equity implications of climate change are most pronounced for food security. Low-emission countries are, in general, more adversely impacted (in terms of projected future yield changes of staple crops), more exposed (in terms of the share of agriculture in gross domestic product and labor force), and less able to cope with adverse impacts (in terms of the current level of under nutrition)... The analysis for human health also implies that those least responsible for climate change will be most affected by its adverse impacts. Thus, countries with low (fossil) emissions are not only least responsible for climate change, but they generally have lower socio-economic capacity to cope with adverse impacts of climate change (Fussel, 2009).

Ironically, the most serious victims of climate change are also the ones who do not have a voice in the mitigation of the problem. Therefore, the implementation of policy becomes deeply ethical. Human activity has already resulted in the loss of many thousands of species and the trend will only continue. Going back to the economic arguments, placing an economic value on the existence of a species or an ecosystem is not viable and as such economic arguments fail to be effective. Trying to fix an ethical problem with an economic solution is simply deficient (Helix, 2011). Ethics of global warming emphasizes the need to address concerns about climate change in a responsible way that improves conditions for the poor. The Kyoto climate treaty could cost the world community \$1 trillion a year –five times the estimated price of providing sanitation and clean drinking water to poor developing countries, thereby preventing millions of deaths each year (Spencer et al, 2005).

10.1 Mitigation, adaptation, and intergenerational equity

There are three aspects of fairness vis-à-vis climate change: what is a fair cost allocation to prevent further global warming; what is a fair cost allocation to cope with the social consequences of the global warming that will not, in fact, be avoided; and; what is a fair allocation of greenhouse gases emissions over the long term and during the transition to long-term allocation? Helm lists five aspects of equity in climate change ethics: international equity in coping with the impacts of climate change and associated risks; international equity in efforts to limit climate change; equity and social considerations within countries; equity in international processes; and, equity among generations

Bio fuels have been defined as any type of liquid or gaseous fuel that can be produced from biomass and used as a substitute for fossil fuels (Giampietro et al.1997). There have been increasing efforts substitute gasoline and diesel by renewable transport bio-fuels that come in the form of ethanol and bio diesel (Davidson, 2003). However in sudden increasing reliance on biofuel in itself can have implication on climate change as follows.

- Emissions may be reduced, but added crop production may affect the ability of the world's poor to feed themselves through increased demand.
- Environmentalists often value low-intensity crop production as it causes less environmental degradation and uses fewer fertilizers and fossil fuels. Higher intensity crop production would allow for greater output and less land transformation.
- Though climate change affects biodiversity, the land use associated with large-scale bio fuel production has the potential to devastate ecosystems, especially in poor countries.
- Finally, a shift to bio fuels will result in rural economic development. This may have implications for the urban economy.
- Should we develop bio fuels if their production could be detrimental to the poor?
- Should we really be developing low intensity energy if it results in the destruction of more natural areas than high intensity energy?
- Should we only be focusing on the ecological after effects of climate change rather than the land impacts created by potential energy systems?
- Should we consider potential effects on rural and urban economies?

10.2 Moral angle to climate change

Philosophers should take the lead in exposing the fallacy that economic growth is any longer the key to human flourishing in wealthy industrial democracies. We should emphasize the need to pursue intellectual/spiritual/personal/relationship growth rather than increased

wealth, if we hope to live better lives. Environmental philosophers should also deal honestly with population issues, something we have rarely done in the recent past. At a minimum, we should acknowledge the role population growth plays in environmental destruction, rather than continuing to sweep this unpleasant fact under the rug. We also need to begin to bring “growth is bad” into politics, as well. It is difficult to see how this might be accomplished, however, at least from an American vantage point. For Americans, economic growth is not one goal among many, or a by-product of some more fundamental goal. It is the primary goal of our society, organizing much of our activity, individually and collectively.

Studies have repeatedly shown that while increasing wealth in poor countries does augment happiness, once a society becomes sufficiently prosperous, further increases in wealth no longer boost subjective wellbeing. Throughout the world, the cutoff line seems to be around \$10,000, far below the average American income. Meanwhile, psychological studies show that a materialistic outlook is actually an impediment to individuals achieving happiness (Lane 1998, Kasser 2002, Kasser 2006). This is partly because such an outlook interferes with highly valuing people, and good relationships with spouses, friends and co-workers turn out to be very important in securing happiness. All in all, there is little evidence that doubling our wealth will increase Americans’ happiness or flourishing. Values and ethics have a strong influence upon the behavioral outcomes that are manifest as the driving forces behind environmental pressures. Although this perspective underplays the structural constraints upon behavior, the influence of beliefs and values can be seen to operate via the configuration of goals, wants, needs, intent and choices. There needs to be consideration of human welfare as the key objective of both the human economy. The misguided nature of existing consumer culture beliefs about what will bring welfare probably represents the core issue in this analysis. Maximum consumption via material good accumulation, and derived services, drives economic and lifestyle choices and is the natural economic (if not the social) outcome of a belief system based on the principle that the external world is the ultimate source of happiness. The accumulation frenzy has required, and resulted in, prodigious natural resource extraction and global labor force exploitation powered largely by the capabilities endowed by fossil fuel energy. The extensive biophysical intervention associated with fossil carbon has led to the looming problems of climate change. (Philos, 2010).

The Middle Way describes the best approach to life as the “golden mean” – a concept shared in various philosophical strands (Marinoff 2007). This is a balanced approach in which basic needs and wants, that genuinely enhance welfare, can and should be satisfied (for all people). This would naturally cover food, clothing, warmth, shelter, and most ecological services as well as psychological security from social and community based needs. Alternately, extremes are avoided and excessive attachment and accumulation is inimical to the three spheres, and individual wellbeing and spiritual progress. The key process is to break and close the endless wants satisfaction circular gap by realization of the heedless nature of clinging to 'tamha' (desire) as a source of wellbeing (Griffith u.d).

11. Conclusion

Climate and weather are two of the most important factors in the emergence of infectious disease in humans. Extreme climate events are expected to become more frequent in the coming years with climate change. The natural history of disease transmission, particularly transmission by arthropods, involves the interplay of a multitude of interacting factors that defy simplistic analysis. The principal determinants are politics, economics, human ecology

and human behavior all of which have direct relation to climate change. To detect and respond to the changes in the infectious disease epidemiology caused by the climate change will require strengthening of the public health infrastructure and ensuring increased surveillance for diseases most likely to be influenced by climate with particular attention to those with potentially large public health impacts. Climate change together with other factors can have serious implication on food security consequently resulting in Malnutrition. Agriculture is currently seen by many development experts including economists and policy makers as a sector that can make a significant contribution to the alleviation and mitigation of poverty in the medium term alongside the growth in non-agricultural sectors. The greatest challenges of the climate change in the coming years will be to cater to needs of growing demands to global food in the milieu of climate change.

The risk of non communicable diseases (NCDs) are seen to increase following climate change through number of mechanisms by which increasing population heat exposure and other environmental changes related to global climate change may affect NCDs causing acute or chronic health impacts. Cardiovascular, renal and respiratory diseases may be particularly affected, and people in low and middle income countries are at particular risk due to limited resources for prevention. It follows that in the climate change and health evaluations and action plans a greater focus on NCDs is warranted. The burden of mental health consequences need to be studied from several dimensions: psychological distress per se; consequences of psychological distress including proneness to physical diseases as well as suicide; and psychological resilience and its role in dealing effectively with the aftermath of disasters. When these events happen, people with pre-established mental illnesses often have more extreme difficulty coping than the rest of the population.

Climate change throws larger ethical and moral dilemmas on us as human beings since we have larger responsibility towards our other fellow co-habitants of this lone planet that can support life in the entire universe. While climate changes throws up difficult moral and ethical questions it is important to develop a normative framework of justice for the international-level funding of adaptation to climate change within the United Nations Framework Convention on Climate Change (UNFCCC) architecture. The distribution of power should assure that every party is able to make its interest count in every negotiating stage. According to this principle, the voice of weaker countries in the international regime on adaptation funding must be assured the same weight as that of the developed world. There needs to be guidelines providing for consumption, and hence production, imperatives and choices driving the environmental pressures behind climate change. Climate change may affect our natural resource supplies in terms of quality, quantity and availability. Study after study points to something many people don't want to acknowledge: that we can't continue our present path, and new technologies alone cannot prevent uncontrollable global warming. New thinking and behavior are essential. Without fundamental shifts in our assumptions, beliefs and practices, it is clear we are on a collision course with the planet.

Recognition of the existence of the problem is the first step towards solution, rather than dismissing global climate change as conspiracy theory or hype created by environmentalists. It is important that we have these extreme events on our surveillance radar and verify them for being potential pieces of evidence from India for global climate change. Mitigation measure for reducing health effects due to climate change present phenomenal operational challenges. Unlike in infectious diseases, where there is genuine desire for disease eradication by the affected countries, commitment to efforts to international agreements to reduce green house gas effect give rise to dynamics that are entirely different. There are corporate forces that are

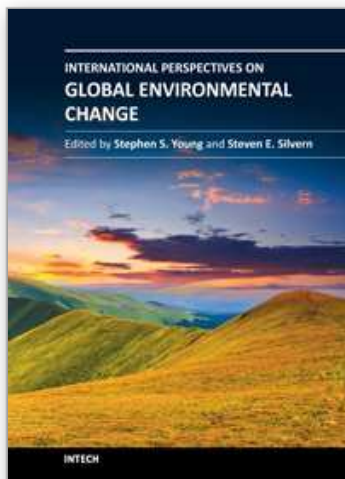
working hard to maintain status quo. There are dimensions of economic dependence, politics, fear, suspicion, pressure tactics, intense lobbying, etc, that make commitment to reduction of greenhouse gases very difficult. It's not that the countries that are most likely to be affected due to climate change are not concerned about their health, but their participation in global climate change negotiations is very tentative in nature since their country development and economics is at stake. Therefore it is important that developing countries should strive to strike a balance between economic growth and environmental sustainability.

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