UNIT 3 HUMAN DIMENSIONS OF CLIMATE CHANGE

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3.0 INTRODUCTION

The Fourth Assessment Report of IPCC observed that, ‘warming of climate system is now unequivocal, as is now evident from observations of increase in global average air and ocean temperatures, widespread melting of snow and ice, and rising global sea level (Solomon et al., 2007, p. 5). This has a specific impact on different physical and socio-economic systems, namely, agriculture and ecosystem, coastal system, health, infrastructure and tourism etc. On the other hand, in the context of spatio-temporal scale, the developing nations are severely affected by the potential impacts of the climate change now and forever. Moreover, presently some of the developed nations are also facing severe damages due to the climate change, some recent examples include: European heat wave 2003 and Katrina Hurricane 2005 etc. Interestingly, it is also stated that the developing nations are affected due to three main reasons which include: geographical location, high dependence on the sensitive sectors and low adaptive capacity (Stern, 2006). Hence, it seems that the world communities, particularly the poor people living in the developing nations, have faced many risks from the climate change.

In this unit an attempt has been made to understand the nature of climate change risk and its impacts on the society, especially in light of human dimension. Therefore, attempts have been made to discuss issues related to human lives and livelihood. As agriculture is the major source of livelihood in most of the developing countries and simultaneously it is severely affected by climate change, a detailed discussion about agriculture is being made in this unit. Apart from agriculture some of the major issues like food security, human health as well as human conflict have also been discussed in brief.
3.1 OBJECTIVES

After reading this unit you will be able to:

- describe human dimensions of climate change in general;
- explain vulnerability of people and places to climate change;
- analyze the impact of climate change on agriculture in general and India in specific; and
- highlight the impacts of climate change on various aspects of human life i.e. food security, human conflicts and health.

3.2 CLIMATE CHANGE AND VULNERABILITY

Under the backdrop of the existing scientific literature, it asserts that the climate change has a significant impact on the world community, especially on the livelihood of the poor people in the developing nations. Henceforth, it is necessary to understand the vulnerability of the people that address three issues:

- Who is vulnerable (i.e. entity within the specific place);
- Vulnerable to what (i.e. stimulus/stress); and
- Vulnerable with respect to what (i.e. the characteristics of the entity that make them more vulnerable).

The concept of ‘vulnerability’, therefore, has gained momentum from the ongoing climate change research in the recent period that most of the scholars are interested to assess it from different perspectives: region, sector, social groups and ecosystems etc. The Third Assessment Report (AR3) of the IPCC (2001) has given formal definition and methodology to assess it empirically. In the context of the climate change, the notion of the ‘vulnerability’ is defined as the extent to which a natural or social system is susceptible to sustaining damage from climate change. Thus, it is the function of three factors, i.e. the sensitivity, adaptive capacity and the degree of the exposure of the system to climatic hazards. The AR3 of the IPCC has given the formal definition on vulnerability as:

‘the degree to which a system is susceptible to or is unable to cope with adverse effects of climate change including climate variability and extremes, and it is the function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity’ (McCarthy et al., 2001, p. 995).

Here, the exposure is the nature and degree to which a system is exposed to significant climatic variations, the sensitivity is the degree to which a system is affected – either adversely or beneficially – by climate related stimuli (i.e. direct or indirect), and the adaptive capacity is the ability of the system to adjust to climate change to moderate potential damages, to take advantage of opportunities, or to cope with the consequences (McCarthy et al., 2001). Of late, the climate change discourse, in sum, has defined vulnerability from the integrated perspective that combines both bio-physical and socio-economic vulnerability. In fact, the socio-economic vulnerability focuses on the internal state of the system that makes human societies and communities either susceptible to or cope with damage from external hazards. The bio-physical vulnerability, in contrast, is determined
by the nature of the physical hazards to which it is exposed, i.e. the likelihood or frequency of hazard events, the extent of human exposure to hazard and the systems’ sensitivity to the impacts of the hazard.

3.2.1 Climate Change: Vulnerability of People and Places

As per scientific evidences, climate change would have more influential impact in the upcoming years of the 21st century, and importantly, it would be greater than the last 10,000 years. It seems that the term climate change will be a real stress as well as shock to the human being. The impacts, however, are region or location specific that especially depends upon their exogenous (i.e. physical environment) and endogenous (i.e. socio-economic environment) factors. As ‘vulnerability’ is scale dependent, the vulnerability of an entity is different even at household level that depends upon both physical and socio-economic factors. Therefore, it is very important to downscale the vulnerability study rather than estimating it at the global level. In general, the climate change especially affects the regions which are located in the temperate zone (i.e. South Asia, Sub-Saharan Africa and Latin America) and people who are living in the susceptible location and whose livelihood is basically derived from the sensitive sectors like agriculture, fishing, etc.

In the context of Africa, the Fourth Assessment Report (AR4) of the IPCC has mentioned that it is one of the most vulnerable continents to climate change and climate variability. As Africa’s economy mostly depends on the agriculture sector, it is highly vulnerable to current climate sensitivity in addition to the existing development challenges such as endemic poverty, complex governance, institutional dimensions, and limited access to capital, including markets, infrastructure and technology, ecosystem degradation, complex disasters and conflicts. In Africa, human or societal adaptive capacity is very low and hence they are more vulnerable. This is not only true to Africa but also applicable to many developing countries of Latin America and Asia including India.

Small islands are also highly vulnerable to climate change and variability. As per the AR4 of the IPCC, some of the studies suggest that sea-level could lead to reduction in island size, particularly in the Pacific. The small islands situated in the Indian and Pacific Oceans and the Caribbean are highly vulnerable to sea level rise that will exacerbate inundation, erosion and other coastal hazards. Further, the water resources, coral reefs, fisheries, marine-based resources are in high risk in the small islands. Many islands, for example, in the Caribbean are likely to experience increased water stress as a result of the climate change. Further, the tourism that generates higher share of foreign exchange is severely affected by climate change.

As far as Asia is concerned, the AR3 of the IPCC predicted that the area-averaged annual mean warming would be about 3°C in the decade of the 2050s and about 5°C in the decade of the 2080s over the land regions of Asia. The rise in surface air temperature was projected to be most pronounced over boreal Asia in all seasons. Therefore, it would affect different sectors as well as regions of Asia. The water and agriculture sectors are likely to be the most affected because of their sensitivity to climate change. Agricultural productivity is likely to suffer severe losses because of high temperature, severe drought, flood conditions, and soil degradation. Further, the forest ecosystems in boreal Asia would suffer from
floods and increased volume of runoff associated with melting of permafrost regions. In spatial scale, AR4 of the IPCC asserts that the frequency of occurrence of climate-induced diseases and heat stress in Central, East, South and South-East Asia have increased with rising temperatures and rainfall variability. The tropical Asia are likely to have increased exposure to extreme events, including forest die back and increased fire risk, typhoons and tropical storms, floods and landslides, and severe vector-borne diseases. The stresses of climate change are likely to disrupt the ecology of mountain and highland systems in Asia. Glacial melt is also expected to increase under changed climate conditions. Sea-level rise will lead to large-scale inundation along the vast Asian coastline and recession of flat sandy beaches. The ecological stability of mangroves and coral reefs around Asia would be put at increased risk.

In India, a trend of sea level rise due to thermal expansion of seawater in the Indian Ocean is expected to inundate low lying areas, drown coastal marshes and wetlands, erode beaches, exacerbate flooding and increase the salinity of rivers, bays and aquifers. Deltas will be threatened by flooding, erosion and salt intrusion. The major delta area of the Ganga, Brahmaputra, and Indus rivers, which have large populations reliant on riverine resources, will be affected by changes in water regimes, salt-water intrusion and land loss. Many large Indian cities are situated on the coast, flood plains and river deltas. A one-metre sea level rise will displace approximately 7.1 million people in India and about 5764 square kilometres (km) of land area will be lost, along with 4200 km of roads.

The coastal states of Maharashtra, Goa and Gujarat face a grave risk from sea level rise, which could cause flooding of land (including agricultural land). Goa will be the worst hit, losing a large percentage of its total land area, including many of its famous beaches and tourist infrastructure. A one metre rise in sea level will adversely affect 7 per cent of the population in Goa. In the state of Maharashtra, over 13 lakh people are at risk. Beyond actual inundation, rising sea levels will also put millions of people at greater risk of flooding and displace a large number of people. Increased seawater percolation may further reduce freshwater supplies. Coastal erosion will increase substantially. Loss of coastal mangroves will have an impact on fisheries and coastal fishing communities will be severely affected.

The Andaman and Nicobar Islands and the coral reef of the Lakshadweep archipelago are most vulnerable. In the Lakshadweep group of islands, the entire population is at risk. Most of the areas likely to be lost in West Bengal include the Sunderban mangrove swamps and reserved forests. Such a similar situation is also predicted for coastal Orissa. Andhra Pradesh and Tamil Nadu, the two coastal states with long and heavily populated coastlines will also face the risk of coastal erosion and displacement. Mangroves in the Krishna, Godavari and Kaveri deltas will be gravely affected, as well as important bird areas such as Pulicat, Point Calimere and Neelapattu wetlands. Intensive food grain production practiced in these states will be negatively affected by salt water intrusion.

Therefore, climate change has become a major obstacle in the developmental pathways of the developing nations that would create major hindrances in achieving the objectives of the Millennium Development Goals (MDGs). In reality, the developing nations are already in stress due to the different development related problems and hence the climate change has brought
additional problems that again ruined the susceptible position of the developing nations. In South Asia and the Sub-Saharan Africa, up to 145-220 million additional people could fall below US $2 per day and every year an additional 1,65,000 to 2, 50,000 children could die due to the climate change by 2100 (Stern, 2006). Further, there is also prediction that by the middle of the current century 200 million people may become permanently displaced due to rising sea level, heavier flash floods, more intense droughts and high sensitivity of super cyclone (Stern, 2006) and also more than 400 million people could be suffering from chronic hunger in 2015.

Check Your Progress 1

Note: a) Use the space given below for your answer.

   b) Compare your answers with those given at the end of the unit.

1) How is vulnerability defined in climate change? Describe in brief, the three factors that constitute vulnerability definition.

3.2.2 Climate Change: Vulnerability of Agriculture

Among the sensitive sectors, the agriculture sector is severely affected by the potential impacts of the climate change that has significant negative influence on future food security. Though some studies have found that the emission of CO₂ has beneficial effects on crop yields, the change in temperature and precipitation affect the timing and length of the growing yields, and the reduction in availability of water decreases the agricultural production. Further, the extreme climatic shocks such as cyclone and flood have negative implications on agricultural production also. Henceforth, there is a negative correlation between temperature and agricultural productivity. It seems that the rising temperature has some positive impacts on agricultural productivity at the initial period, but it has negative implications while it has reached the threshold level. Therefore, at present the developed nations are enjoying higher productivity due to the slight change in the temperature that has increased the growing period of the crops. On the other hand, the developing nations are losing agricultural productivity as they have already reached the threshold level that a slight change has severe impact on the agriculture.

At present, 40% of the Earth’s land surface is managed for cropland and pasture. In the developing countries, nearly 70% of the people live in rural areas where agriculture is the largest supporter of livelihoods. It seems that the growth in agricultural incomes in the developing countries fuels the demand for non-basic goods and services fundamental to human development. Of late, the United Nations Food and Agriculture Organization (FAO) estimates that the livelihoods of roughly 450 million of the world’s poorest people are entirely dependent on managed eco-system services. Henceforth, the negative implication
on the agriculture sector as a result of the climate change has significant impact on the poor people around the world that affect real purchasing power, standard of living and adaptive capacity of the people to cope with the climatic chaos.

During the early 1990s, Rosenzweig and Parry (1994) and Darwin et al. (1995) estimated the impacts of climate change on agriculture sector, and their results mainly found that there will be minimal impact at the global level due to the modest level of adaptation (c.f. Adger et al., 2007: 725). Focusing on the regional distribution, Rosenzweig and Parry (1994) highlighted that the agricultural production could be improved in the developed nations, and in developing nations, it might be declined. It estimated that, in their global study, a change of −1.2 to −7.6% in worldwide cereal production without adaptation is reduced to 0 to −5% with moderate farm level adaptation. In the context of India, Kumar and Parikh (2001) highlights that even after accounting farm level adaptation, a 2-3.5 degree centigrade rise in mean temperature and 7% increase in mean precipitation will reduce net revenue by 9-25% in India. On the other hand, Rao and Sinha (1994) estimated that the wheat yields decrease between 28 to 68% without considering carbon fertilization effects; and would range between +4 to -34% after considering carbon fertilization effect in India.

Swaminathan (2002) describes two major types of impacts of climate change on agriculture. One is by altering production adversely in the main food producing areas; the climate change could result in increased food scarcities. The location of main food-producing regions could change. The other impact could be on the physiological mechanisms regulating plant and animal productivity with the most coming from changes in precipitation patterns.

i) Ecological Vulnerability of Agriculture

Not all regions of the world contribute equally to food production. The impact of climate change on the major food-producing regions would affect global food security system significantly. The four vulnerable producer groups which may be severely affected by adverse changes in temperature and precipitation have been identified.

- The first is located in the humid tropics, in lowland areas of Asia and in the Pacific and Caribbean. These areas, normally prone to excessive rains and flooding, may be less severely affected by climate change.
- The second group, in the arid and semi-arid areas of the tropics in Africa and South Asia and in the Mediterranean climate of West Asia and North Africa, will be extremely vulnerable.
- A third group that comprises of farmers at high altitudes may experience both favourable and unfavourable effects.
- The fourth group at the cold margins at higher latitudes may also experience diverse effects.

Swaminathan (2002) has suggested that overall levels of production can be maintained through a combination of shifts of agricultural zones and adjustments in technology and management. These, however, require an excellent understanding of the varied effects of climate change on soil, water, biodiversity, and physiology of crop plants. These analyses of Swaminathan (2002) have been greatly substantiated by a few recent publications, such as
those of Altieri and Nicholls (2004), titled “Biodiversity and Pest Management in Agroecosystems”; and Rosenzweig and Hillel, (2008) on “Climate change and the Global Harvest: Potential Impacts of the Greenhouse Effect on Agriculture”. Some of these are:

- Potentially significant impact to small farm production is loss of soil organic matter due to soil warming; if so, small farms must manage soil nutrients by using farm yard manure, ploughing in stem-nodulating Sesbania rostrata, bio-fertilizers etc.

- Higher air temperatures are likely to accelerate the natural decomposition of organic matter, which is good.

- Under drier soil conditions, root growth and decomposition of organic matter are significantly suppressed, and as soil cover diminishes, vulnerability to wind erosion increases, especially if wind intensifies. Therefore, rain water harvesting, storage and its sustainable use are essential.

- Conditions usually become more favourable for the proliferation of insect pests in warmer climates. Warmer winter temperatures may also allow larvae to winter-over in areas where they are normally limited by cold, thus causing greater infestation during the following crop season. Migrant pests are expected to respond more quickly to climate change than plants, and may be able to colonize newly available crops/habitats.

- Models on plant diseases indicate that climate change could alter stages and rates of development of certain pathogens, modify host resistance, and result in changes in the physiology of host-pathogen interactions. The most likely consequences are shifts in the geographical distribution of pathogens and increased crop losses. Literature suggests that the most likely impact of climate change will be felt in three areas: in losses from plant diseases, in the efficacy of disease management strategies, and in the geographical distribution of plant diseases. Climate change could have a positive, negative or no impact on individual plant diseases, but with increased temperatures and humidity many pathogens are predicted to increase in severity.

- The above said scenario could necessitate a steep increase in the use of chemical pesticides and this would enhance production costs and also increase the environmental problems associated with agrochemical use. However, within the realm of ever-green agriculture that involves several cereal, pulse, oilseed, vegetable, fodder crops, it is expected that build up of a particular insect pest species would be greatly retarded. Further, several different crops grown simultaneously enhance the abundance of predators and parasites which provide biological suppression of pest densities.

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**Genetic shields in coastal areas vulnerable to seawater inundation**

Based on the suggestion of Prof. M.S. Swaminathan as early as 1988 in a meeting on climate change at Kyoto, Japan, the scientists at the MSSRF identified several salt-tolerant genes from the mangrove species, *Avicennia marina* (Mehta *et al.*, 2005) and transferred these through the recombinant
DNA technology to rice. It is an important crop in the coastal areas, which are threatened by increasing sea level, and frequent storms and cyclones. The salinity-resistant rice developed with the help of genes transferred from unrelated mangrove species (A. marina) also emphasizes the urgent need to prevent loss of valuable genes through conservation and enhancement of biodiversity in the developing countries. The transgenic rice tolerates salinity up to 150 mM. The development of transgenic salt-tolerant rice (Prashant and Parida, 2005) is scientifically fascinating and socially relevant. MSSRF is currently engaged in transferring drought-resistant genes from Prosopis juliflora, a common desert tree, to water-thirsty rice. Such genetic shielding of crop plants against salinity, submergence and drought would sustain the coastal agriculture and the livelihoods of millions of resource-poor farming families, even if the frequencies and intensities of extreme hydro-meteorological disasters increase. Recombinant DNA technology provides an opportunity to design and develop genetic shields against adverse changes in temperature, precipitation and sea level as a result of global warming.


ii) Physiological Vulnerability of Agriculture

Generally, increased CO2 in the atmosphere can help to increase the rate of photosynthesis if water and nutrients do not become limiting factors. It should be noted that C3 and C4 plants (i.e. those which have a 3-carbon or 4-carbon pathway of photosynthesis) respond differently. The C3 crops like wheat, barley, rice and potatoes could respond positively to CO2 enrichment. However, as has been pointed out by Sinha and Swaminathan (1991), the rise in temperature would nullify the benefit of higher CO2 concentration. They examined the integrated impact of a rise in temperature and in CO2 concentration on the yield of rice and wheat in India. The study showed that for rice, increasing mean daily temperature decreases the period from transplantation to maturity. Such a reduction in duration results in decreasing crop yield. There are, however, genotypic differences in per-day yield potential.

Wheat has shown an adverse impact on yield if the mean temperatures rise by 1 to 2°C. For each 0.5°C increase in temperature, there would be a reduction of crop duration of seven days, which in turn would reduce yield by 0.45 tonnes per hectare. Also, for an increase of 1°C, in mean annual temperature, the thermal limit of cereal cropping in mid-latitude northern hemisphere regions would tend to advance by about 150 to 200 km; the altitudinal limit to arable agriculture would rise by about 150-200m. Several other studies (Warrick, R.A. 1998) also suggest that for the core mid-latitude cereal regions, an average warming of 2°C may decrease potential yields by 3 to 17%.

In general, higher temperatures are found to result in reduced rice yields in all seasons and in most locations. As said earlier, the possible increase in rice yields because of increased CO2 levels is nullified by rise in temperature. Simulations of impact of climate change on wheat yields for several locations in India using a dynamic crop growth model indicated that productivity depended on the magnitude of temperature change. The Indian simulation
studies (Rao and Sinha, 1994) suggested that wheat yields would be smaller than those in the current climate, even with the beneficial effects of CO₂ on crop yields, since yield reductions are associated with a shortening of the wheat-growing season resulting from projected temperature increases. Very little information is available on the physiology and productivity as affected by rise in temperature and CO₂ in the plantation crops like rubber, oil palm, coconut, sugarcane, coffee, and spices etc.

In a recent interview by Prof. Swaminathan given to Times of India on 30th January, 2011 entitled ‘Sly Climate makes farming India’s riskiest profession’ has rightly said that “…people at the grassroots should know how to checkmate climate aberration. We have not utilized our Panchayati raj system effectively. At least one woman and one male member of every panchayat should be trained to become climate risk managers. A biogas plant and a farm pond in every farm are essential to reduce emission and ensure energy and water security. In addition we need to classify our crops into those which are climate resilient and those which are climate sensitive. For example, wheat is a climate sensitive crop while rice shows a wide range of adaptation in terms of growing conditions. A search for new genes conferring climate resilience is an urgent need. For a long term solution, we have to build gene banks for warming India”. (Times of India, p.27)

Check Your Progress 2

Note: a) Use the space given below for your answer.

b) Compare your answers with those given at the end of the unit.

1) Describe any four ecological vulnerability of agriculture in India due to climate change.

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3.3 CLIMATE CHANGE AND ITS IMPACT ON VARIOUS ASPECTS OF HUMAN LIFE

In this section, we will discuss briefly about some of the other aspects of human life i.e. food security, human conflict and human health.

3.3.1 Climate Change and Food Security

Agriculture in the 20th century accomplished the remarkable achievement of increasing food supply at a faster rate than growth in demand, despite rapidly growing populations and per capita incomes. Johnson (1999) and Antle et al. (1999) show that during the second half of the 20th century, real (inflation-adjusted) prices of wheat and feed corn have declined at an average annual rate of 1–3%. Climate change aside, several recent studies anticipate that aggregate food production is likely to keep pace with demand, so that real food prices will be
stable or slowly declining during the first 2 decades of the 21st century. According to the U.S. Department of Agriculture (1999), food security has improved globally, leading to a decline in the total number of people without access to adequate food. The declining real price of food grains has greatly improved the food security of the majority of the world’s poor, who spend a large share of their incomes on these staples. The global number, however, masks variation in food security among regions, countries, and social groups that are vulnerable because of low incomes or a lack of access to food (FAO, 1999). In lower income countries, political instability and inadequate physical and financial resources are the root causes of the food security problem. In higher income developing countries, food insecurity stems from unequal distribution of food, those results from wide disparities in purchasing power.

Relatively few studies have attempted to predict likely paths for food demand and supply beyond 2020. There are reasons for optimism that growth in food supply is likely to continue a pace with demand beyond 2020. For example, population growth rates are projected to decline into the 21st century, and evidences suggest that agricultural productivity potential is likely to continue to increase. Other analysts are less optimistic about long-term world food prospects. For example, there is evidence that the Asian rice monoculture may be reaching productivity limits because of adverse impacts on soils and water. Tweeten (1998) argues that extrapolation of the downward trend in real food prices observed in the latter half of the 20th century could be erroneous because the supply of the best arable land is being exhausted and rates of productivity growth are declining. At the same time, demand is likely to continue to grow at reasonably high rates well into the 21st century. Ruttan (1996) indicates that despite advances in biotechnology, most yield improvements during the first decades of the 21st century are likely to continue to come from conventional plant and animal breeding techniques. These concerns about future productivity growth, if correct, mean that simple extrapolation of yield for impact assessment may be overoptimistic. The implication is that confidence in predictions of the world food demand and supply balance and price trends beyond the early part of the 21st century is low.

In most developing countries with long coastlines like India and developing small island state countries, climate change related degradation of marine resources would ultimately lead to loss of livelihoods, and food insecurity. For instance, with rise in sea surface temperatures, coral decline and death result in loss of fish breeding and harvesting grounds leading to lower fish stocks and catch. The damage to coral reefs and sea grass beds leads to loss of habitat for fish, turtles, and couch. This leads to smaller fish catch and threatens livelihoods based on fisheries.

3.3.2 Climate Change and Human Conflicts

Other than the weather related catastrophes, it causes another effect known as ‘conflict and violence’. The shortages of natural resources due to the climate change will bring vie in between the countries to acquire it. In consequence, it will create conflict and violence between the countries such as the lack of water resources in the Nile River has driven the conflict between the East African countries. The expectation that, it can foster the third world
Climate Change

war in future and is increasing tension across as well as within the nations. Henceforth, it needs an urgent action that the regional cooperation between the countries is required to solve the matter about the distribution of the natural resources between the nations.

3.3.3 Climate Change and Human Health

Health is another major area which has been severely affected due to climate change. Impact on health will ultimately affect the level of poverty through reducing per capita productivity and level of wages of the labour that deteriorate the economic growth rate of the country. Ultimately it affects Human Development Index (HDI) of the nations due to the occurrence of high mortality and decreasing life expectancy.

Since 70’s, climate change demands large number of death increase in worldwide such as malnutrition, heat stress, vector borne disease like malaria and dengue fever, particularly in low and mid latitude regions whereas, decreasing cold related deaths in high latitude region. The Fourth Assessment Report (FAR) of the IPCC cited that, the temperature would be higher in some parts of Africa and European Union as comparison to the other regions of the world (IPCC, 2007). The heat wave in Europe (2003) demands life of the 35 thousand people and loss of agricultural productivity reached $15 billion (Stern, 2006). In 1998, a large number of deaths occurred in Orissa due to heat wave. At the same time, World Health Organization (WHO) claims that climate change since 1970’s demands 1, 50,000 deaths per year and it is the cause of creating refugee in the developing world. About 96 percent of natural disaster related deaths have occurred in the developing nations. In Vietnam rising health expenditures were found to have pushed about 3.5 percent of the people into the absolute poverty in both 1993 to 1998, whereas Malaria is estimated to have reduced economic growth in the most affected countries especially Africa and South Asia by 1.3 percent per year (Sachs and Gallup, 2001).

Global climate change will have a wide range of health impacts. Overall, negative health impacts are anticipated to outweigh positive health impacts. Some health impacts would result from changes in the frequencies and intensities of extremes of heat and cold and of floods and droughts. Other health impacts would result from the impacts of climate change on ecological and social systems and would include changes in infectious disease occurrence, local food production and nutritional adequacy, and concentrations of local air pollutants and aeroallergens, as well as various health consequences of population displacement and economic disruption. There is little published evidence that changes in population health status actually have occurred as yet in response to observed trends in climate over recent decades. Occurring difficulty in identifying such impacts is that the causation of most human health disorders is multi-factorial and the “background” socioeconomic, demographic, and environmental context varies constantly. A further difficulty is foreseeing all of the likely types of future health effects, especially because for many of the anticipated future health impacts it may be inappropriate to extrapolate existing risk-function estimates to climatic-environmental conditions not previously encountered.

Estimation of future health impacts also must take account of differences in vulnerability between populations and within populations over time. Human beings are exposed to climate change through changing weather patterns and indirectly though changes in water, air, food quality and quantity, ecosystems,
agriculture, livelihoods and infrastructure. These direct and indirect exposures can cause death, disability and suffering. Ill-health increases vulnerability and reduces the capacity of individuals and groups to adapt to climate change. Populations with high rates of disease and debility cope less successfully with stresses of all kinds, including those related to climate change.

Communicable diseases are still a serious threat to public health in many parts of the world. Almost 2 million deaths a year, mostly in young children, are caused by diarrheal diseases and other conditions that are attributable to unsafe water and lack of basic sanitation. Malaria, another common disease whose geographical range may be affected by climate change, causes around 1 million child deaths annually. Worldwide, 840 million people were under-nourished in 1998–2000. Progress in overcoming hunger is very uneven. Based on current trends, only Latin America and the Caribbean will achieve the MDG target of halving the proportion of people who are hungry by 2015.

Research since the Second Assessment Report (SAR) mainly has described the effect of climate variability, particularly daily and seasonal extremes, on health outcomes. Studies of health impacts associated with the El Niño-Southern Oscillation (ENSO) have identified inter-annual climate-health relationships for some epidemic diseases. The upward trend in worldwide numbers of people adversely affected by weather disasters has been characterized by peak impacts during El Niño events. Meanwhile, there has been an expanded effort to develop, test, and apply mathematical models for predicting various health outcomes in relation to climate scenarios. This mix of epidemiological studies and predictive modeling leads to the following conclusions.

- An increase in the frequency or intensity of heat waves will increase the risk of mortality and morbidity, principally in older age groups and the urban poor.

- The greatest increases in thermal stress are forecast for higher latitude (temperate) cities, especially in populations that have limited resources, such as access to air conditioning.

- Poor urban populations in developing countries may be particularly vulnerable to the impacts of increased heat waves, but no equivalent predictions are available.

- Warmer winters and fewer cold spells, because of climate change, will decrease cold-related mortality in many temperate countries (high confidence). The reduction in winter deaths will vary between populations. Limited evidence indicates that, in at least some temperate countries, reduced winter deaths would outnumber increased summer deaths.

- Any regional increases in climate extremes associated with climate change would cause physical damage, population displacement, and adverse effects on food production, freshwater availability and quality, and would increase the risks of infectious disease epidemics, particularly in developing countries. Over recent years, several major climate related disasters have had major adverse effects on human health—including floods in China, Mozambique, Bangladesh, and Europe; famine in Sudan; Super Cyclone in Orissa; hurricane Katrina; and Hurricane Mitch, which devastated Central America.

Climate change will cause some deterioration in air quality in many large urban areas, assuming that current emission levels continue. Increases in exposure to ozone and other air pollutants (e.g. radon and forest fire particulates etc.) could increase known morbidity and mortality effects. Vector-borne diseases are maintained in complex transmission cycles involving blood-feeding arthropod vectors (and usually reservoir
hosts) that depend on specific ecological conditions for survival. These diseases are sensitive to climatic conditions, although response patterns vary between diseases. In areas with limited or deteriorating public health infrastructure, and where temperatures now or in the future are permissive of disease transmission, an increase in temperatures (along with adequate rainfall) will cause certain vector-borne diseases (including malaria, dengue, and leishmaniasis) to extend to higher altitudes (medium to high confidence) and higher latitudes. Higher temperatures, in combination with conducive patterns of rainfall and surface water, will prolong transmission seasons in some endemic locations.

Mathematical models indicate that climate change scenarios over the coming century would modestly increase the proportion of world population living in regions of potential transmission of malaria and dengue (medium to high confidence). These models are limited by their reliance on climate factors, without reference to modulating influences of environmental, ecological, demographic, or socioeconomic factors. Although the most recent of several biologically based model studies suggests that the increase in population living in regions of potential malaria transmission would be on the order of an extra 260–320 million people in 2080 (against a baseline expectation of about 8 billion). Changes in climate, including changes in climate variability, would affect many other vector-borne infections (such as various types of mosquito-borne encephalitis, Lyme disease, and tick-borne encephalitis) at the margins of current distributions. For some diseases such as malaria in the Sahel, Western equine encephalitis in North America, and tick-borne encephalitis in Europe a net decrease may occur. Changes in surface water quantity and quality will affect the incidence of diarrheal diseases. Ocean warming will facilitate transmission of cholera in coastal areas.

In some settings, the impacts of climate change may cause social disruption, economic decline, and displacement of populations. The ability of affected communities to adapt to such disruptive events will depend on the social, political, and economic situation of the country and its population. The health impacts associated with such social-economic dislocation and population displacement are substantial. For each anticipated adverse health impact there is a range of social, institutional, technological, and behavioral adaptation options to lessen that impact. There is a basic and general need for public health infrastructure (programs, services, surveillance systems) to be strengthened and maintained.

As far as India is concerned, climate change simulation models suggest that a rise in temperature and change in humidity will adversely affect human health in India. A warmer and wetter India will see a rise in heat-related and infectious diseases. More people will die due to heat waves. Heat stress could result in heat cramps, heat exhaustion, heat stroke, and damage to physiological functions, metabolic processes and immune systems. Increased temperatures can increase the range of vector borne diseases such as malaria, dengue fever, yellow fever and several types of encephalitis, particularly in regions where minimum temperatures currently limit pathogen and vector development. An apt example to prove this point is the summer of 1994, when western India experienced temperatures as high as 50°C, providing favourable conditions for disease-carrying vectors to breed. Not surprisingly, 1994 was also the year that the town of Surat in Gujarat was hit by an epidemic of pneumonic plague, resulting in 59 deaths. In the same year, as summer gave way to the monsoon and western India was flooded with rains for three months, Surat was hit by a malaria epidemic. The cause could be the numerous unattended water puddles (resulting from heavy rainfall), which provides good breeding conditions for mosquitoes.
Water borne diseases, natural disasters, environmental migration, and nutritional deficiency could be other major risk factors. Waterborne diseases including cholera and diarrhoeal diseases will increase as rainfall patterns change, restricting human access to water supplies and sanitation. Global warming will increase the incidence of respiratory and cardiovascular diseases in arid and semi-arid parts of India. Cyclones and floods will also cause rise in illnesses, diseases, injuries and loss of life.

Check Your Progress 3

Note: a) Use the space given below for your answer.

b) Compare your answers with those given at the end of the unit.

1) Explain any two major impacts of climate change on health in India.

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3.4 LET US SUM UP

• Vulnerability in climate change is defined as the degree to which a system is susceptible to or is unable to cope with adverse effects of climate change including climate variability and extremes, and it is the function of the character, magnitude, and rate of climate variation to which a systems is exposed, its sensitivity, and its adaptive capacity.

• Climate change especially affects the regions those are located in the temperate zone i.e. South Asia, Sub-Saharan Africa and Latin America and people those are living in the susceptible location and whose livelihood is basically derived from the sensitive sectors like agriculture, fishing etc.

• Swaminathan (2002) describes two major types of impacts of climate change on agriculture. One is by altering production adversely in the main food producing areas; the climate change could result in increased food scarcities. The location of main food producing regions could change. The other impact could be on the physiological mechanisms regulating plant and animal productivity with the most coming from changes in precipitation patterns.

• In most developing countries with long coastline like India and developing small island state countries, climate change related degradation of marine resources would lead to loss of livelihoods, and food insecurity. Other than the weather related catastrophes, it has another effect known as ‘conflict and violence’. The shortages of the natural resources due to the climate change will bring vie in between the countries to acquire it. In consequence, it can create conflicts and violence between countries.

• Last but not the least; health is another major area which has been severely affected due to climate change. A warmer and wetter India will see a rise in heat-related and infectious diseases. More people will die due to heat waves. Heat stress could result in heat cramps, heat exhaustion, heat stroke, and damage physiological functions, metabolic processes and immune systems. Increased temperatures can increase the range of vector borne diseases such
as malaria, dengue fever, yellow fever and several types of encephalitis, particularly in regions where minimum temperatures currently limit pathogen and vector development.

3.5 KEY WORDS

**Vulnerability**: The degree to which a system is susceptible to or is unable to cope with adverse effects of climate change including climate variability and extremes, and it is the function of the character, magnitude, and rate of climate variation to which a systems is exposed, its sensitivity, and its adaptive capacity.

3.6 REFERENCES AND FURTHER SUGGESTED READINGS


Kesavan, P. C. and Swaminathan, M. S. 2006. From green revolution to evergreen revolution: pathways and terminologies (Guest editorial), Current Science, 90, 145-146.


3.7 KEY TO CHECK YOUR PROGRESS

Check Your Progress 1
1) Your answer must include the following points:

- Vulnerability in climate change is defined as the degree to which a system is susceptible to or is unable to cope with adverse effects of climate change including climate variability and extremes, and it is the function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity.

- Here, the exposure is the nature and degree to which a system is exposed to significant climatic variations, the sensitivity is the degree to which a system is affected by climatic related stimuli, and the adaptive capacity is the ability of the system to adjust to climate change to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.

Check Your Progress 2

1) Your answer must include the following points:

- Ecological vulnerability of agriculture in India due to climate change is: the first is located in the humid tropics, in lowland areas of Asia and in the Pacific and Caribbean. These areas, normally prone to excessive rains and flooding, may be less severely affected by climate change.

- The second group, in the arid and semi-arid areas of the tropics in Africa and South Asia and in the Mediterranean climate of West Asia and North Africa, will be extremely vulnerable.

- The third group comprising farmers at high altitudes may experience both favourable and unfavourable effects.

- The fourth group at the cold margins at higher latitudes may also experience diverse effects.

Check Your Progress 3

1) Your answer must include the following points:

- Climate change simulation models suggest that a rise in temperature and change in humidity will adversely affect human health in India.

- A warmer and wetter India will see a rise in heat-related and infectious diseases.

- More people will die due to heat waves. Heat stress could result in heat cramps, heat exhaustion, heat stroke, and damage physiological functions, metabolic processes and immune systems. Increased temperatures can increase the range of vector borne diseases such as malaria, dengue fever, yellow fever and several types of encephalitis, particularly in regions where minimum temperatures currently limit pathogen and vector development.