
UNIT 10 CLIMATE CHANGE*

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10.0 OBJECTIVES

After reading this Unit, you should be able to:

- Understand the concepts of Weather and Climate;
- Explain Climate Change; and
- Describe Climate Change Adaptation.

10.1 INTRODUCTION

Climate change is a major global environmental and developmental problem. Though all the possible consequence of climate change are yet to be understood, it is now established that adverse impacts are likely from an increased frequency of extreme weather, floods and droughts, submergence of coastal areas due to sea level rise and extreme climate variability. The poor, women, the aged and the very young, especially in underdeveloped or developing area contexts, are relatively more vulnerable due to their greater dependence on climate-sensitive sectors such as agriculture, fisheries and forestry for their livelihoods or their limited adaptive capacity. The poor status of infrastructure and essential services in most of the poverty-affected areas also limits their ability to cope with adverse impacts of climate change. According to the IPCC 5th Assessment Report (2014), human influence has been detected in warming of the atmosphere and the ocean, in changes in global water cycle, in reductions in snow and ice, in global mean sea level rise and in changes in some climate extremes.

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The atmospheric concentrations of the greenhouse gases carbon dioxide (CO_2), Methane (CH_4) and nitrous oxide (N_2O) have all increased since 1750 due to human activity. The deep interconnection between the vulnerability of natural and human systems to climate change calls for expeditious coping strategies and response measures. Climate proofing of vulnerable sectors, programmes, natural systems and interventions are increasingly becoming an integral part of the development/environment lexicon and action worldwide (IPCC, 2015).

10.2 UNDERSTANDING WEATHER AND CLIMATE

10.2.1 Weather

Weather is the day-to-day state of the atmosphere and is a chaotic non-linear dynamical system. Fundamentally, weather is caused by the sun, which heats the air at the planet's bulging equatorial regions more than at either pole. Combine the heat of the sun rotation of a planet covered mostly in water, and the product is what we call weather. Weather means the day-to-day change in the quality of atmosphere near the surface of the earth. Because hotter air rises and cooler air falls, the difference in temperature across the planet causes masses of air to begin to move. It is felt that the movement of the air becomes even more dynamic because of earth's rotation, while the steady evaporation of surface water leads to the formation of clouds and eventually precipitation.

10.2.2 Climate

The term 'climate' has a very wide variety of meanings. To many of us, 'climate' often first suggests temperature, although rainfall and humidity may also come to mind. When we think of climatic change, it is often in the time frame of glacial periods. More recently, however, there has been considerable public concern over the possible shorter-term impact upon the climate of increasing atmospheric carbon dioxide and other greenhouse gases. Climate includes the average temperature, amount of precipitation, days of sunlight, and other variables that might be measured at any given site. However, there are also changes within the earth's environment that can affect the climate.

Climate is determined by large scale pattern and force, beginning with the position with the position of the earth 93 million miles from the sun close enough to receive a life-sustaining amount of solar radiation. Since earth tilts on its axis, much of the sun's heat falls on the tropical areas around the equator. The resulting uneven distribution of sun light –and of temperature in the atmosphere and throughout the world's oceans- establishes underlying sea current and wind patterns that, in turn, influence climate.

10.3 UNDERSTANDING CLIMATE CHANGE

10.3.1 Climate Change

Climate change refers to a change in the state of the climate that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcing such as modulations of the solar cycles, volcanic eruptions, and persistent anthropogenic changes in the composition of the atmosphere or in land use. UN Framework Convention on Climate Change (UNFCCC) defines climate change as: 'a change of climate which is attributed

directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time periods (IPCC, 2007).

Climate change refers to change conditions such as weather pattern of temperature that can be observed for a long period of time. In the usage of the Intergovernmental Panel on Climate Change (IPCC), climate change refers to any change in climate over time, whether due to natural variability or as a result of human activity.

10.3.2 Climate Change Impact on the Globe

Over the last 50 years, human activities – particularly the burning of fossil fuels – have released sufficient quantities of carbon dioxide and other greenhouse gases that are trapping additional heat in the lower atmosphere and affect the global climate (UNDP, 2006; IPCC, 2013). In the last 130 years, the world has warmed by approximately 0.85°C. Each of the last 3 decades has been successively warmer than any preceding decade since 1850 (IPCC, 2014). Sea levels are rising, glaciers are melting, precipitation patterns are changing, and extreme weather events are becoming more intense and frequent. Human health has always been influenced by climate and weather (IPCC, 2014; WHO, 2005 and 2014). Changes in climate and climate variability, particularly changes in weather extremes, affect the environment that provides us with clean air, food, water, shelter, and security. Climate change, together with other natural and human-made health stressors, threatens human health and well-being in numerous ways (Balbus et al., 2016). Some of these health impacts are already being experienced in all parts of the world including the Himalayan Mountains (WHO, 2005; ICIMOD, 2007). Given that the impacts of climate change are projected to increase over the next century, certain existing health threats will intensify and new health threats may emerge (IPCC, 2013 and 2014). These are the global major impacts on the earth planet.

10.3.2.1 Global Warming

About 75% of the solar energy reaching the earth is absorbed by the earth's surface, which increases its temperature. The rest of the heat radiates back to the atmosphere. Some of the heat is trapped by greenhouse gases (GHGS), mostly carbon dioxide is released by various human activities, it is rapidly increasing. This is causing global warming (Cline, 2008).

A human activity during the last few decades of industrialisation and population growth have polluted the atmosphere to the extent that it has begun to seriously affect the climate. The carbon dioxide in the atmosphere has increased by 31% since pre-industrial times, causing more heat to be trapped in the lower atmosphere. There is evidence to show that carbon dioxide levels are still increasing. Many countries have signed a convention to reduce GHGS under the United Nations framework convention on climate change (UNFCCC). However, the current international agreement is not still effective enough to prevent the significant changes in climate and in sea levels (www.unfccc.int).

10.3.2.2 Acid Rain

On burning fossil fuel such as coal, oil and natural gas; chemicals, sulfur dioxide and nitrogen oxides are produced. These chemicals react with water and other chemicals in the air to form sulfuric acid, nitric acid and other harmful pollutants like sulfates and nitrates. These acid pollutants spread upwards into the atmosphere, and are carried by air currents, to finally return to the ground in the form of acid

rain, fog or snow. The corrosive nature of acid rain cause many forms of environmental damage. Acid pollutants also occur as dry particles and gases, when washed from the ground by rain, add to the acid in the rain to form an even more corrosive solution. This is called acid depositions.

10.3.2.3 Ozone Layer Depletion

Ozone is formed by the action of sunlight on oxygen. It forms a layer 20 to 50 km above the surface of the earth. This action takes place naturally in the atmosphere, but is very slow. Ozone is a highly poisonous gas with a strong odor. It is a form of oxygen that has three atoms in each molecule. It is considered pollution at ground level and constitutes a health hazard by causing respiratory ailments like asthma and bronchitis. It also causes harm to vegetation and lands to deteriorate further. Ozone in the upper atmosphere, however, is vital to all forms of life as it protects the earth from the sun's harmful UV radiation. This ozone layer in the upper atmosphere absorbs the sun's UV radiation, preventing it from reaching the earth's surface.

10.3.2.4 Nuclear Accidents and Nuclear Holocaust

Nuclear energy was researched and developed as an alternate source of clean cheap energy compound to fossil fuels. Although this did happen, along with the benefits of nuclear energy came its downfalls. In the short history of nuclear energy, there have been a number of accidents that have surpassed any natural calamities or other energy sources extractions in their impacts. A single nuclear accident causes loss of life, long-term illness and destruction of property on a large scale and for a long period of time. Radioactivity and its fallout lead to cancer, genetic disorders and death in the affected area for decades after, thus affecting all forms of life generations to come.

Check Your Progress 1

Note: i) Use the space given below for your answers.

ii) Check your answers with those given at the end of the Unit.

1) Discuss about Weather and Climate.

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2) What is Climate Change?

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3) Explain the impacts on Climate Change.

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10.4 CLIMATE CHANGE VULNERABILITY

Climate change is a major issue in the current perspective, and the impact of climate is affecting both natural eco-system and society directly as well as indirectly. Water being the most fundamental and critical natural resource is highly sensitive to climate change. It has been observed that rapid changes in climatic phenomena has modified global hydrological cycle; and has profound impact on the quantity as well as on the quality of both surface and groundwater across the planet. These changes are affecting the availability of water resources for drinking, food production, manufacturing and sanitation; and increasing the vulnerability of large population particularly in developing and low income countries to water, food, and livelihood and health insecurity.

Vulnerability

IPCC Fifth Assessment Report (2007) has defined “vulnerability to climate change broadly as the propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt”. Thus, vulnerability in regard to climate change refers to the inability to cope with changes in climate conditions. As changes become more extreme, people might not have the capacity to adapt to them. It is these people who are considered as vulnerable to climate change. According to the IPCC’ Vulnerability is “the degree, to which a system is susceptible to and unable to cope with, adverse effects of climate change, including climate variability and extremes.... Vulnerability is a function of the character, Magnitude, and rate of climate change and carination to which a system is exposed, the sensitivity and adaptive capacity of that system” (IPCC, 2007). The climate change is not a speculative concern, but is based on the works of hundreds of scientists under the aegis of IPCC. The UNEP and the WMO established IPCC which was endorsed by the United Nation General Assembly in 1988. Climate change is recognized by IPCC as a significant man made global environmental challenge. International efforts to address climate change began with the adoption of the united now the IPCC has published fifth rounds of assessment reports and the sixth will be submitted in 2019.

The National Context

Climate change is expected to manifest quite significantly in India. India is much affected by climate change, not only because of high physical exposure to climate-related disasters (65% of India is drought-prone, 12% food-prone and 8 % susceptible to cyclones), but also because of the dependency of its economy and majority of population on climate-sensitive sectors (for example, agriculture, forest, tourism, animal husbandry and fisheries). India is one of the most vulnerable countries to climate change (Beernaert & Malone 2005). The Government of India is serious

on this issue as evident from the statement of the Ministry of Environment and Forests that no country in the world is as vulnerable, on so many dimensions to climate as India. Whether it is our long coast line of 7000 km; our Himalayas with their vast glaciers; our almost 70 million hectares of forest which incidentally house almost all of our key minerals reserve; we are exposed to climate on multiple fronts. Rigorous science based assessment are therefore critical in designing our adaptation strategies (INCCA, 2012).

Climate Change Vulnerability: Hotspots

The identification of hotspots of climate change vulnerability depends upon exiting knowledge on the subject, which is having growth in recent years (Anthony-Smith, 2009) According to the Asian Development Bank (2009), low-lying coastal area, deltaic regions and semi-arid areas are the hotspots vulnerable to climate change. Hotspots are defined as specific areas or regions that may be at relatively high risk of adverse impact of one or more natural hazards as a result of climate change. The west coast, the Ganga- Brahmaputra Delta, the delta of Mahanadi, Krishna and Godavari in the east coast and arid area of Rajasthan are the hotspots. On the other hand, INCCA (2012) considered only four regions namely, coastal areas, Western Ghats, north-east and the Himalayas as hotspots of climate change vulnerability based on biodiversity, and left the western dry land which is an important biophysical entity of India. Foresight Group (2011) identified dry lands, mountainous region and low elevation coastal zones as areas of hotspots. It is worthwhile to note that the climate change models are still ratchet imperfect representations of reality, and differ considerably in identifying the zone of vulnerability and hotspots (Ericksen et al., 2011).

The Indian Himalayan Region (IHR)

It stretches across states in the western and eastern Himalaya and provides critical ecosystem services for communities in mountains and downstream planes. The IHR covers vast areas, with about 17% of the region being under permanent snow cover and glaciers and about 30-40 % under seasonal snow cover, forming a unique water reservoir. This feeds important perennial rivers that provide water for drinking, irrigation and hydropower. Every year about 1, 00,000 million m³ of water flows from Himalayan rivers. The IHR is home to nearly 4 % of the country's population and provides directly or indirectly for livelihoods. The average land holdings are very small and less than a hectare per family. Most agriculture is of subsistence type and depends on suitable weather for good yields. Economically vulnerable groups including the scheduled tribes and castes have high dependence on the forest resources' including collection of fodder, medicinal plants and firewood these ecosystem services are highly sensitive and the regional economy vulnerable (Government of Uttarakhand, 2012).

Himalaya constituting headwaters of major rivers of south Asia is highly vulnerable to climate change (ICIMOD, 2007). Owing to constraints of terrain, subsistence agriculture constitutes main source of food and livelihood even though the availability of arable land is severely limited and agricultural productivity is low (Tiwari & Joshi 2012). During recent past, a variety of changes have emerged in traditional resource use structure mainly in response to population growth, improved access, growing market economy, rapid urbanisation, growth of tourism and resultant exploitation of natural resources in Himalaya. These changes have exerted sharply accentuated pressures on primary ecosystem services through disrupting hydrological

regimes of headwaters, eroding biodiversity and undermining livelihood and food security both in mountains and adjoining lowlands. Moreover, climate change has stressed traditional agricultural system through higher mean annual temperature, fast melting of snow and glaciers, erratic rainfall and increased frequency and severity of extreme weather events (ICIMOD, 2007). During recent years, Indian monsoon has shown sweeping changes over the region resulting into decreased annual rainfall and reduced number of rainy-days affecting adversely the availability of and access to water resources (Bandyopadhyay et al., 2002). These changes are exacerbating region's limited capacity to cope with projected decrease in availability of water for drinking and food production. Consequently, agricultural productivity is declining thereby increasing vulnerability of local population to food insecurity and a variety of health risks (IPCC, 2014). It is, therefore, highly imperative to analyse micro-regional variability in precipitation pattern, and assess its impacts on key sectors, such as agriculture, food and community health, and evolve an effective adaptation framework to strengthen traditional adaptation mechanism and coping strategies.

10.5 CLIMATE CHANGE ADAPTATION

Adaptation is defined by IPCC (2014) as “in human system, the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities” In natural systems, it is the process of adjustment to actual climate and its effects; human Intervention may facilitate adjustment to expected climate”. In human system, adaptation seeks to moderate harm or exploit beneficial opportunities. In natural systems, human intervention may facilitate adjustment to expected climate and its effects. According to UNFCCC, adaptation is defined as *practical steps to protect countries and communities from the likely disruption and damage that will result from effects of climate change.*

Stages of Adaptation Process

The basics towards adaptation, as mentioned below, will remain same when adaptation is planned at national, state, district, block or panchayat level.

- Identifying adaptation needs
- Identifying adaptation options
- Appraising adaptation options
- Planning and implementing
- Monitoring and evaluation

Adaptation to Climate Change in IHR

IHR is highly vulnerable to climate change and there is an urgent need to respond to the current and future risks by enhancing the preparedness of the communities and natural systems. Current scientific evidence suggests instability in the Himalayan ecosystems result of climate change in composition and distribution of natural resources such as water, Forest and agro bio diversity. Thus, adaptation is imperative for responding to current and future climate change risks in IHR and enhancing preparedness (Government of India, 2010). According to IPCC (2014), adaptation needs arise when the anticipated risks or experienced impacts of climate change require action to ensure safety of population and security of assets including ecosystem and their services.

Check Your Progress 2

Note: i) Use the space given below for your answers.

ii) Check your answers with those given at the end of the Unit.

1) Write a note on climate change vulnerability.

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2) Describe Climate Change Adaptation.

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10.6 CONCLUSION

Global Warming is perhaps the biggest challenge that the humankind is facing presently. Man has the onus of protecting not only himself but also other life forms on this planet. Globally, all nations are working on their strategies to combat climate change.

India has engaged actively in multilateral negotiations in the United Nations Framework Convention on climate change (UNFCCC). India's immense geographic diversity adds to the complexity of developing and implementing sectors, locations and populations, there can be no 'one size-fits-all' climate change strategy. Approaches will need to be fit specific sub-national context and conditions. India's National Action Plan on Climate Change, 2008 (NAPCC), with its eight national missions, is designed to achieve sustainable development as a co-benefit of addressing climate change. These 8 missions are: National Solar Mission; National Mission for Enhanced Energy Efficiency; National Mission on Sustainable Habitat; National Water Mission; National Mission for Sustaining the Himalayan Ecosystem; National Mission for Green India; National Mission for Sustainable Agriculture; and National Mission for Strategic Knowledge for Climate Change.

The climate change is the biggest environmental emergency that the earth faces today. This inevitable disaster has a multitude of serious implications for both environment and human society. In accordance with it, the Unit discusses various aspects of climatic change.

- Climate Change** : Climate change refers to a change in the state of the climate that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcing such as modulations of the solar cycles, volcanic eruptions, and persistent anthropogenic changes in the composition of the atmosphere or in land use. UN Framework Convention on Climate Change (UNFCCC), defines climate change as: ‘a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods.
- Impacts** : Effects on natural and human systems of extreme weather and climate events and of climate change. Impacts generally refer to effects on lives, livelihoods, health, ecosystems, economies, societies, cultures, services, and infrastructure due to the interaction of climate changes or hazardous climate events occurring within a specific time period and the vulnerability of an exposed society or system. Impacts are also referred to as *consequences* and *outcomes*. The impacts of climate change on geophysical systems, including floods, droughts, and sea-level rise, are a subset of impacts called physical impacts.
- Adaptation** : The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects.
- Resilience** : The capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation.
- Transformation** : A change in the fundamental attributes of natural and human systems. Within this summary, transformation could reflect strengthened, altered, or aligned paradigms, goals, or values towards promoting adaptation for sustainable development, including poverty reduction.

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10.9 ANSWERS TO CHECK YOUR PROGRESS EXERCISES

Check Your Progress 1

- 1) Your answer should include the following points:
 - Weather is the day-to-day state of the atmosphere and is a chaotic non-linear dynamical system.
 - Humidity, atmospheric pressure, clouds and rain storm.
 - Climate is determined by large scale pattern and force, beginning with the position of the earth 93 million miles from the sun close enough to receive a life –sustaining amount of solar radiation
- 2) Your answer should include the following points:
 - Change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere.
 - Change conditions such as weather pattern of temperature that can be observed for a long period of time.
- 3) Your answer should include the following points:
 - Global Warming
 - Acid Rain
 - Ozone Layer Depletion
 - Nuclear accidents and nuclear holocaust

Check Your Progress 2

- 1) Your answer should include the following points:
 - Vulnerability in Indian Context.
 - Climate Change Hotspots.
- 2) Your answer should include the following points:
 - The process of adjustment to actual or expected climate and its effects.
 - Adaptation seeks to moderate harm or exploit beneficial opportunities.