UNIT 15 LIVELIHOOD

Structure

15.1 Introduction

15.2 Objectives

15.3 Interrelationship between Climate Change and Livelihood

15.4 Adverse Impact of Climate Change on Primary Sectors Related to Livelihood

- 15.4.1 Impact of Climate Change on Agriculture
- 15.4.2 Impact of Climate Change on Forests and Biodiversity
- 15.4.3 Impact of Climate Change on Fisheries

15.5 Climate Change, Forced Migration and Changing Livelihood Pattern

15.6 Let Us Sum Up

15.7 Keywords

15.8 Suggested Further Readings/References

15.9 Answers to Check Your Progress

15.1 INTRODUCTION

Various studies including the studies reported by IPCC has clearly demonstrated that climate change has differential impacts on places and people now and forever (McCarthy *et al.*, 2001; Mendelsohn *et al.*, 2006; and Parry *et al.*, 2007). Importantly, the Fourth Assessment Report (AR4) of the IPCC has asserted that that "*Warming of the climate system is unequivocal, as is now evident of observations of increases in global average air and ocean temperatures, widespread melting of sea and ice and rising global average sea level"* (Solomon *et al.*, 2007). In particular, the developing nations are disproportionately highly vulnerable in comparison to the developed nations (Mendelsohn *et al.*, 2006; and Stern, 2006). It is due to three reasons: (i) geographical region, (ii) high dependency on natural resources and agriculture, and (iii) availability of fewer resources for adaptation (Stern, 2006). For instance, during the period 2000-04 on an average annual basis, one in 19 people living in developing world was affected by climate related disasters (HDR, 2007). It has further been observed that flooding affected the lives of 68 million people in East Asia and 40 million people in South Asia. In addition, monsoon floods and storms in South Asia during the 2007 season displaced more than 14 million people in India and 7 million people in Bangladesh, and more than 1000 people lost their lives across South Asia (HDR, 2007: 76). These climatic disasters make the livelihood of the people more susceptible, especially in South Asia as they are already vulnerable to the conventional problems, e.g. poverty and food security, etc. It is argued that South Asia is particularly vulnerable to predicted climate change impacts because of its high population density, low adaptive capacity, several unique and valuable ecosystem (coral reef, large deltaic region with rich biodiversity), and vast low-altitude agricultural activities (Roy, 2007). In some areas, people are forced

to migrate and change their livelihood due to extreme events like flooding, drought, famine, etc. in their respective places for a quite longer time. In this unit, an attempt is being made to analyse the impacts of climate change on various climate sensitive sectors related to livelihoods like agriculture, water, forestry, biodiversity and fisheries. An effort has also been made to analyse the impacts of climate change on human life i.e. food security, income, employment and migration.

15.2 OBJECTIVES

After studying this unit, you should be able to:

- explain the interrelationship between climate change and livelihood particularly in developing countries;
- describe the impact of climate change on primary sectors of economy like agriculture, forestry, biodiversity and fisheries in developing countries with a special reference to India; and
- analyse the impacts of climate change on human life i.e. food security, income, employment and migration.

15.3 INTERRELATIONSHIP BETWEEN CLIMATE CHANGE AND LIVELIHOOD

One of the most widely accepted definition of livelihoods is: "A livelihood comprises the capabilities, assets (including both material and social resources) and activities required for a means of living. A livelihood is sustainable, when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base" (Carney 1998: 4). It is the means of production available to a given individual, household or group that can be used in their livelihood activities. There are five forms of livelihood assets namely:

i) **Natural capital**: The natural resource stock from which resource flows useful to livelihoods are derived. The actual resources available to an individual household reflects the characteristics of the local resource base and the extent to which the household is able to gain access to these resources, which in turn reflects issues of ownership and entitlements as well as the availability of technologies that make it possible to use the resource potentials.

ii) **Social capital**: The set of social relationships upon which people draw in pursuit of their livelihood. This includes the range of contact networks, membership of groups and organizations, relationships of trust and access to wider institutions of society that are important in the actual operation of livelihood activities and that can be determining in terms of access to markets, credit, government services and many other factors of production.

iii) **Human capital:** The skills, knowledge and good health important to the ability to pursue livelihood activities. For individual households, this includes

both the quantity (number of productive individuals) and the quality (what these individuals know and how hard they are able to work) of human resources. It includes knowledge and skills learned from formal education and through experience and non-formal learning.

iv) **Physical capital**: The basic infrastructure for transport, buildings, water management, energy, and communications and productive capital (tools, machines, etc.) which enables people to pursue the livelihoods. It includes both those that people own and those that they have access to (roads, irrigation systems, telephone networks, etc.) whether provided by government or the private sector (either free or paid for).

v) **Financial capital**: The financial resources which are available to people (whether savings, supplies of credit, regular remittances and pensions, social security payments or insurance) and which provide them with different livelihood options. This includes finances (including credit) for investments in new productive assets, for inputs into production and for responding to the effects of different vulnerabilities, including recovering and reconstructing livelihoods after disasters.

Taken together, these livelihood assets determine much about how livelihoods work, and in particular are the basis for understanding how people will respond to climate-induced vulnerabilities. This in turn means they are (or at least should be) the basis for the development of adaptation strategies. All of these assets are important, but for the poorest and most vulnerable of the world (especially the rural poor), natural resources are of particular significance. This poverty-environment link has been recognized for some time: "predominantly the poor of the world depend directly on natural resources, through cultivation, herding, collecting or hunting for their livelihoods. Therefore, for sustainable livelihoods, there is a need for sustenance= natural resources" (Rennie and Singh, 1996: 16). This recognition is now reflected in international summit that "poor people tend to be most dependent upon the environment and the direct use of natural resources, and therefore most severely affected when the environment is degraded or their access to natural resources is otherwise limited or denied". With environmental resources playing such a crucial role for a large proportion of the world's population, threats to ecosystem functioning and integrity undermine livelihood security. All the evidences suggest that environmental vulnerabilities are going to significantly increase in the future, in part due to climate change but also because of other forms of resource and livelihoods pressures, unless effective and substantial measures are taken to ameliorate them through adaptation and other strategies.

The range of vulnerabilities that poor people face in different parts of the world encompasses all aspects of life, with most not directly related to climate change (though many are affected in some way by it). Here we relate the likely changes to vulnerabilities identified in the report to the dynamics of the livelihoods of poor people in different major types of agro-ecological zones of the developing world. In doing so, it strongly agree that: people are highly variable in their endowments and it will be high in developed world, particularly least developed nations; it led to more vulnerable to the climate change, and more extreme among the poor people.

For example, sea level rise will displace millions of the poor, with the areas least likely to be protected those where people are poorest. Small island states and low coastal areas and deltas such as southern Bangladesh, Eastern Coast of India is most at risk. In many cases, those displaced will have few opportunities to re-establish their lives except in urban areas, where livelihood opportunities are limited without the skills, capital and contacts needed to cope with urban life. Even where people are not physically displaced, rising seas will reduce the natural capital in ecosystems such as coastal fisheries, mangroves and wetlands that are essential to the current livelihood patterns of many poor communities, while the dangers of salinization of water supplies will affect these and other coastal communities.

In addition, changes in temperature and rainfall patterns (both to averages and to the variability of rainfall) are widely predicted, with many semi-arid parts of the developing world likely becoming even hotter and drier with even less predictable rainfall. These changes will both directly affect crop yields and will produce changes to ecosystem distributions and species ranges. This will dramatically affect the livelihoods of many poor people, particularly through declining food security and problems with the viability of many livelihood activities, including livestock raising, fishing and the use of forest products as well as agricultural production. Further, the secondary impacts will likely include increases in urban food prices and greater problems with services such as water supply and sanitation (exacerbating pressures that rapid urbanization will bring) that affect the urban poor.

The changing climate patterns, and especially the increased frequency and/or severity of extreme events, will increase vulnerability to natural disasters, both slower-onset ones such as droughts and rapid-onset disasters such as floods and cyclones. These will affect many areas, but semi-arid areas (droughts) and coastal and deltaic regions (floods and storms) are particularly vulnerable. Dangers of erosion, landslides and flash floods will also increase, particularly in many hilly and mountainous areas. Changing climate patterns and more extreme events will have impacts on new livelihood activities such as from tourism, that will limit diversification of opportunities which, combined with damage to infrastructure and other types of physical capital, will affect the wider range of vulnerabilities (such as limited access to markets) the poor face. The poor social and political capital, along with extremely limited access to financial capital, mean that these communities are least likely to be protected by investments in infrastructure or disaster mitigation and relief systems. Predicted adverse health risks will affect the poor in particular throughout the developing world. These risks are in particular those associated with water-borne (such as dysentery or cholera) vector-borne (such as malaria) diseases as well as heat stress morbidity and mortality. These health impacts pose a double jeopardy for poor people's livelihoods: the contribution of key productive members of the household is lost and the cost of health care is expensive and time consuming. Such risks will be widespread, but the dearth of medical care systems in many more remote, poorer areas of Africa and Asia in particular mean that the poor in these areas are the most vulnerable to these risks.

The deterioration of the availability or quality of water supplies in many areas (again due to wider resource stresses that climate change will exacerbate) will significantly increase many of these health risks, while poorer nutritional states caused by declining food security will make many poor people more vulnerable

to the effects of diseases when they do strike. The increased danger of damage to crops, livestock and gathered plants and animals from pests will be similar in distribution and impact to those of increased health risks, but will be exacerbated by the risks of physical damage caused by floods, droughts and storms. Although the development of more pest-resistant or drought-tolerant crop strains may limit these risks, many poor rural communities are far less able to gain access to such new varieties (which in any case make them more dependent upon external inputs that can be unreliable in their availability), placing them at an even greater disadvantage in agricultural markets.

This has been highlighted by Human Development Report 2007/08 and World Development Report 2010. According to Human Development Report 2007/ 08 titled '*Fighting Climate Change: Human Solidarity in a Divided World"* stated that "Climate change is the defining human development issue of our generation. All development is ultimately about expanding human potential and enlarging human freedom. It is about people developing the capabilities that empower them to make choices and to lead lives that they value. Climate change threatens to erode human freedoms and limit choice. It calls into question the Enlightenment principle that human progress will make the future look better than the past." (p.1)

Climate change has potential to erode the international efforts in the areas of health, nutrition, poverty, education, etc. In particular, climate change can undercut the developments in the areas of "Agricultural production and food security"; "Water stress and water insecurity"; "Rising sea levels and exposure to climate disasters"; "Ecosystems and biodiversity"; and "Human health".

In the context of India, using climate scenarios predicted from RCM and SWAT model (Gosain and Rao 2003; Gosain, Rao, and Basuray 2006), BIOME 4 (Ravindranath, Joshi, Sukumar, et al. 2006), simulations for mean sea level (Unnikrishnan, Kumar, Fernandes, et al. 2006), malaria transmission window analysis (Bhattacharya, Sharma, Dhiman, et al. 2006), and simulations based on dynamic crop models (GoI, 2004) show the following findings (see Roy, 2007).

- Hydrological cycle is likely to be altered. Drought and flood intensity will increase. Overall runoff will decline.
- Crop yield will decrease with temperature.
- The overall effect will be crop productivity decline induced by decline in crop duration.
- Under the A2 and B2 scenarios, there will be shifts towards wetter forest types. Due to CO_2 increase and warming, NPP will grow to double under the A2 and 70% under the B2 scenario for the forestry sector.
- Frequencies and intensities of tropical cyclones in the Bay of Bengal will increase, particularly in the post-monsoon period and there will be increased flooding in low-lying coastal areas. Sea-level rise of less than 1 mm/year has been predicted for Mumbai, Visakhapatnam, and Kochi (much evidence); but there is probability of a decrease in sea level around Chennai.
- Malaria-prone states will continue to be so (Odisha, West Bengal, and southern parts of Assam bordering West Bengal). This may later shift from the central Indian region to the south-western coastal states of

Maharashtra, Karnataka, and Kerala. New regions (states like Himachal Pradesh, Arunachal Pradesh, Nagaland, Manipur, and Mizoram) may become malaria-prone and the transmission duration window may widen in northern and western states and shorten in the southern states.

In the following sections we will analyse in details three primary sectors i.e. agriculture, forestry and fishery, which are strongly related to livelihoods of nearly 7 billion people of the world and adversely affecting billions of people in the developing world including India.

15.4 ADVERSE IMPACT OF CLIMATE CHANGE ON PRIMARY SECTORS RELATED TO LIVELIHOOD

15.4.1 Impact of Climate Change on Agriculture

Growing population in India challenges the sustainability of agricultural system. The growing demand for food grain production, and nutritive food products demand transformation of agricultural system. Further, the undernourished and malnourished population in India is emerging as a critical issue. At the same time, agriculture is being affected negatively by a series of biotic and abiotic stresses including climate change. To a great extent, Indian agriculture is rainfed and it is dependent on the groundwater as well. Other characteristic of agriculture in India is the resource poor farmers' who are highly vulnerable to climate change. Under such circumstances, increasing agricultural production is indeed a huge task.

Agriculture and allied activities constitute an important component of India's economy. However, given that 62% of the cropped area is still dependent on rainfall, Indian agriculture continues to be fundamentally dependent on the weather. The impacts of climate change on agriculture are critical in India. As some 75% of the population live in rural areas, agricultural performance is closely related to poverty levels. The focus is on the two main cereal crops – rice and wheat – in terms of the effects of climate change on crop yields, overall food production, and welfare.

Acute water shortage conditions, combined with thermal stress, could adversely affect wheat and, more severely, rice productivity in India even under the positive effects of elevated CO_2 in the future. The simulations of four different sites (Kalra, Aggarwal, Chander, et al. 2003; GoI 2004) under various climate change scenarios for each crop reveal the following:

- The yields of both crops – rice and wheat – would decrease with a rise in temperature levels and increase with a rise in precipitation.
- Higher CO_2 concentrations in the atmosphere would have beneficial effects for both crops by increasing the rate of photosynthesis, radiation use efficiency, and water use efficiency.
- Increased CO_2 levels would be more favourable for wheat than for rice.

Overall, the simulation suggests that temperature rise is going to have the following effects.

- Larger negative impacts are expected to neutralize positive impacts, if any, of CO_2 fertilization.
- Net yield losses in rice under irrigation could be some 13%–22%, compared with losses of 16%–34% for wheat.
- Quality of products such as cotton, fruits, vegetables, tea, coffee, aromatic and medicinal plants, and the nutritional quality of cereals and pulses may be moderately affected.
- Decline in grain protein content in cereals could partly be related to increasing CO_2 concentrations. Wheat yields in central India are likely to suffer by up to 2% in the pessimistic scenario, but there is also a possibility that these might improve by 6% if the global change is optimistic.
- Changes in soil water induced by global climate change may affect all soil processes and, ultimately, crop growth.
- An increase in temperature would also lead to increased evapotranspiration, which may result in the lowering of the groundwater table at some places.
- Increased temperature, coupled with reduced rainfall, may lead to upward water movement, leading to accumulation of salts in upper soil layers.
- A rise in sea level associated with increased temperatures may lead to salt-water ingression in the coastal lands, making them unsuitable for conventional agriculture.
- An increase of 1ºC in soil temperature may lead to higher mineralization.

15.4.2 Impact of Climate Change on Forests and Biodiversity

Climate is probably the most important determinant of vegetation patterns globally and has significant influence on the distribution, structure and ecology of forests. Several climate–vegetation studies have shown that certain climatic regimes are associated with particular plant communities or functional types. It is therefore logical to assume that changes in climate would alter the configuration of forest ecosystems. Recent modelling studies indicate that forest ecosystems could be seriously impacted by future climate change. Even with global warming of 1–2°C, much less than the most recent projections of warming during this century, most ecosystems and landscapes will be impacted through changes in species composition, productivity and biodiversity. These have implications for the livelihoods of people who depend on forest resources for their livelihoods.

India is a mega-biodiversity country where forests account for about 20% (64 million ha) of the geographical area. With nearly 200,000 villages classified as forest villages, there is obviously large dependence of communities on forest resources. Thus, it is important to assess the likely impacts of projected climate change on forests and develop and implement adaptation strategies for both biodiversity conservation and the livelihoods of forest dependent people. Preliminary qualitative assessments of potential climate change impacts on forests in India were based on earlier GCM (General

Circulation Model) outputs of climate change that have undergone considerable refinement. Following this, there were two regional studies, the first pertaining to potential climate change impacts on forests in the northern state of Himachal Pradesh, and the second in the Western Ghats. These studies indicated moderate to large-scale shifts in vegetation types, with implications for forest dieback and biodiversity. The studies conducted in India so far have had several limitations, e.g. coarse resolution of the input data and model outputs due to the use of GCM scale grids, the use of earlier versions of the BIOME model that had limited capability in categorizing plant functional types, and the absence of any national level model-based assessment of climate impacts. A recent study using the BIOME3 model and climate change scenarios of HadCM2 projected large-scale shifts in areas under different vegetation types and an increase in NPP.

Climate is an important determinant of the geographical distribution, composition, and productivity of forests. Therefore, changes in climate could alter the configuration and productivity of forest ecosystems. NTFPs (non-timber forest products) provide about 40% of total official forest revenues and 55% of forest-based employment. In India, about 200 million people depend on forests directly or indirectly for their livelihoods. Indian forests support more than 5150 plant species, 16 214 insects, 44 mammals, 42 birds, 164 reptiles, 121 amphibians, and 435 fish species. Forests meet nearly 40% of India's energy and 30% of fodder needs. In India, out of 15000 plant species, 3000 species yield NTFPs such as fruits, nuts, edible flowers, medicinal plants, rattan and bamboo, honey, and gum.

The aggregate quantity of potentially extractable NTFPs is projected to lead to the following.

- Increase in expanding evergreen and moist deciduous forest types.
- Decline in the dry deciduous, dry thorn, and montane forest areas.

As a result, there will be an increase in income from potentially extractable NTFPs with the income per hectare likely to increase by about 22%. However, there is uncertainty regarding the transient response of vegetation to climate change and this could lead to forest dieback and loss of vegetation. Conversely, fuel wood and timber production may increase due to increased productivity as a result of increased CO_2 fertilization and nitrogen deposition. Under moderate climate projections, the total area under tree cover in all biomes except the tundra and xerophytic woods in Himachal Pradesh is projected to increase by 11%. The tundra forests show a uniform downward trend with sharp reduction in area by early 2020. By 2080, more than 70% of the area under tundra forests is projected to decline under the moderate scenario.

GCM (Global Climate Model) projections (for example, the Hadley Centre Model, HADCM2) for India indicate an increase in precipitation by up to 30% for the north-eastern region, in addition to a relatively moderate increase in temperature of about 2ºC by the period 2041–60. This could increase the incidence of flooding in the Brahmaputra basin and thus favour the maintenance of moist grasslands in the region. For the rest of the country (southern, central, and north-western) a steep increase in temperature by 3ºC in the southern (except along the coast) to over 4ºC in the north-western, and a decrease in precipitation of over 30% in the north-western regions would

cause major changes in the composition of present-day vegetation in these regions, with an overall shift to a more arid type. Increased atmospheric CO_2 levels and temperatures, resulting in lowered incidence of frost, would favour exotic weeds such as wattle, which could invade the montane grasslands of the Western Ghats. The cool, temperate grasslands of the Himalayas could also be impacted by rising temperatures, which would promote the upward migration of woody plants from lower elevations.

The recent study (Ravindranath *et al.* 2006) concludes that 77% and 68% of the forested grids in India are likely to experience shift in forest types for climate change under A2 and B2 scenarios, respectively. In addition there have been two regional studies, the first focusing on potential climate change impacts on forests in the northern state of Himachal Pradesh (Deshingkar 1997) and the second in the Western Ghats (Ravindranath *et al.* 1997). These studies indicated moderate to large-scale shifts in vegetation types with implications for forest dieback and biodiversity. Impacts of climate change on forests have severe implications for the people who depend on forest resources for their livelihoods. India is a mega-biodiversity country where forests account for more than one fifth of the geographical area. With nearly 173,000 villages classified as forest villages, there is a large dependence of communities on forest resources in India (Kishwan *et al.* 2009). India has a large afforestation programme of over 1.32 Mha per annum (Ravindranath *et al.* 2008), and more area is likely to be afforested under programmes such as 'Green India mission' and 'Compensatory Afforestation Fund Management and Planning Authority' (CAMPA). Thus it is necessary to assess the likely impacts of projected climate change on existing forests and afforested areas, and develop and implement adaptation strategies to enhance the resilience of forests to climate change.

It is very timely that Government of India under NAPCC (National Action Plan on Climate Change), has brought a proposal to afforest more than 6 mha of degraded forested lands (Government of India 2008). Most of the studies have recommended that care should be taken to plant mixed species and planting should also be executed in such a way as to link the existing fragmented forests. Efforts should also be made to convert open forests to dense forests. Chaturvedi *et al.* (2011) have suggested that Western Ghats, though a biodiversity hotspot, has fragmented forests in its northern parts. This makes these forests additionally vulnerable to climate change as well as to increased risk of fire and pest attack. Similarly, forests in parts of western as well as central India are fragmented and are having low biodiversity. At the same time these are the regions which are likely to witness a high increase in temperature and either decline or marginal increase in rainfall. They notice that most of the mountainous forests (sub-alpine and alpine forest, the Himalayan dry temperate forest and the Himalayan moist temperate forests) are susceptible to the adverse effects of climate change. This is because climate change is predicted to be larger for regions that have higher elevations. There is a need to explore win-win adaptation practices in such regions such as anticipatory plantations, sanitary harvest, and pest and fire management.

Forests are likely to benefit to a large extent (in terms of NPP) in the northern parts of Western Ghats and the eastern parts of India, while they are relatively adversely affected in western and central India. This means that afforestation, reforestation and forest management in northern Western Ghats and eastern India may experience carbon sequestration benefits. Hence, in these regions, a species-

mix that maximizes carbon sequestration should be planted. On the other hand, in the forests of western and central India, hardy species which are resilient to increased temperature and drought risk should be planted and care should be taken to further increase forest resilience. This may be achieved by planting mixed species, linking up forest fragmentations, devising effective pest and fire management strategies and carrying out anticipatory plantation activities.

15.4.3 Impact of Climate Change on Fisheries

Even without climate change, between 25 and 30 percent of marine fish stocks are overexploited, depleted, or recovering from depletion—and are thus yielding less than their maximum poten-tial. About 50 percent of stocks are fully exploited and producing catches at or close to their maximum sustainable limits, with no room for further expansion (WDR, 2010, p. 157).

Climate change driven "rising ocean temperature", and "ocean acidification" are reported to affect the aquatic ecosystem including the distribution and productivity of fish species. Eventually, climate change affects the sustainability of fisheries and livelihood of fishing community. Also, climate change affects the carbon sequestration potential of marine ecosystem. Ocean acidification affects the marine organisms such as oysters, corals, and shrimps. Impacts on fish distribution, and productivity have cascading effect on marine food web.

Countries and communities dependent on fishing would be vulnerable to climate change as it affects the fish production and productivity. The countries such as Maldives, and Tuvalu, which are low-lying are highly vulnerable to climate change, and also the vulnerability and impact may lead to climate refugees. In countries like Bangladesh, the fishing community experience the problem of climate change which is manifested both in terms of rise in sea level and flooding due to cyclones and other extreme events. It is reported that the fishing communities in Mekong River system produce more than 1million tons of Basa fish per annum. Due to climate change and sea water intrusion, the Basa fish production would be drastically affected. Further, decline in fish production due to climate change and other drivers, may greatly influence the nutritional security and livelihood as it is reported that "*fish provides essential nutrition for 3 billion people and at least 50% of animal protein and minerals to 400 million people from the poorest countries. And over 500 million people in developing countries depend, directly or indirectly, on fisheries and aquaculture for their livelihoods*".

As far as India is concerned, mainland India has about 6100 km long coastline and total Indian coastline would be of about 7517 km if we add to this the coastline of Andaman and Nicobar Island in the Bay of Bengal and Lakshadweep Islands in Arabian Sea. Conservative estimate suggests that about 3.5 millions of people derive their livelihood from marine capture fisheries in the over 4000 fishing villages situated along the Indian coastline, though other estimates put the number of people dependent on marine fisheries as much higher. Hundreds of thousands are also supported indirectly, through the marketing and trade of marine produce. The sector is dominated by small-scale and artisanal fish workers, making a livelihood from fishing and small-scale trading activities. Climate change is also affecting fresh water aquaculture. This is due to sea level rise and intrusion of saline water in the fresh water. Apart from this, fishing communities living along the coast are more vulnerable to extreme weather events like cyclones and tsunamis in terms loss of life and livelihoods.

Check Your Progress 1

Note: 1) Use the space given below for your answers.
2) Check your answers with those given at the end of this unit.

1. Define Livelihood. Discuss briefly, how climate change is affecting livelihood of poor people?

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2. Describe any four effects of increase in temperature on agriculture of India.

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15.5 CLIMATE CHANGE, FORCED MIGRATION AND CHANGING LIVELIHOOD PATTERN

Climate change has potential to cause migration which includes migration within the country and migration from outside the country. The migration within the India may occur due to climate change induced effects like drought, low agricultural productivity, desertification, etc. Migration may occur from other countries where the effects of climate change are more marked. However, studies are not providing categorical evidence in this regard. Increased occurrence of drought induces migration. It is reported that about 3 lakh labourers migrate every year from drought prone Bolangir district, Western Odisha (Deshingkar 2003). It is reported that the rivers like Mahi, Tapi, and Sabarmati are vulnerable to water shortage (NATCOM 2004). Studies report that the semi-arid regions of Indian Peninsula and Western region of India are vulnerable to climate change impacts and the drought occurrence in these regions would induce migration to urban centres (Revi 2007). Further, migration from coastal regions may occur due to climate change induced impact on livelihood. The effects of climate change in the coastal region include salt water intrusion, and occurrence of cyclones. Reports show that the sea level since the 1950s has risen at the rate of 2.5 mm per year along the Indian coast. It is projected that sea level would rise by 46-59cm by the end of 21st century. It is projected that 1m of sea level rise has potential to displace about 7 million people in India (NATCOM 2004). Further, it is observed that submergence of a small island called Lohachara Island has forced people to migrate to Sagar Island in the Sundarbans. The major metropolitan cities in coastal region like Mumbai, Kolkata due to increased occurrence of storms may witness migration (Dasgupta et al 2009).

Migration from neighbouring countries may be induced by climate change. For instance, the vulnerability of Bangladesh to climate change is one of the prime reason for out-migration. Myers (2002) argues that "climate refugees from Bangladesh alone might outnumber all current refugees worldwide. He projected that 26 million refugees will come from Bangladesh". Studies show that the

climate change may cause large scale migration from Bangladesh leading to tremendous pressure on resource, livelihood, etc.

Check Your Progress 2

Note: 1) Use the space given below for your answers.
2) Check your answers with those given at the end of this unit.

1. How climate change leads to forced migration in India? Explain any two situations with examples.

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2. Why is it being predicted that climate change would lead to a large number of migration from Bangladesh to India?

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15.6 LET US SUM UP

- Developing nations are disproportionately highly vulnerable in comparison to the developed nations. It is due to three reasons: (i) geographical region, (ii) high dependency on natural resources such as agriculture, and (iii) availability of less resource for adaptation.
- A livelihood comprises the capabilities, assets and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base. There are five forms of livelihood assets namely as natural, socio-political, human, physical and financial capital.
- Due to climate change, rising ocean temperatures and ocean acidification are radically altering aquatic ecosystems. This is modifying fish distribution and the productivity of marine and freshwater species. This has impacts not only on the sustainability of fisheries and aquaculture, but also on the livelihoods of the communities that depend on fisheries.
- Even with global warming of 1–2°C, much less than the most recent projections of warming during this century, most ecosystems and landscapes will be impacted through changes in species composition, productivity and biodiversity. These have implications for the livelihoods of people who depend on forest resources for their livelihoods.
- Climate change might result in two types of displacement and migration in India. First, increased migration is likely within India due to the effects of climate change such as drought, desertification, sea level rise, water scarcity and low food productivity, and melting glaciers. Second, climate

change might lead to increased flow of migrants from neighbouring countries due to the accelerated effects of climate change.

15.7 KEYWORDS

Financial Capital : The financial resources which are available to people (whether savings, supplies of credit, regular remittances and pensions, social security payments or insurance) and which provide them with different livelihood options.

Human Capital : The skills, knowledge, and good health important to the ability to pursue livelihood activities.

Livelihood : A livelihood comprises the capabilities, assets (including both material and social resources) and activities required for a means of living.

Natural Capital : The natural resource stock from which resource flows useful to livelihoods are derived.

Physical Capital : The basic infrastructure for transport, buildings, water management, energy, and communications and productive capital (tools, machines, etc.) which enables people to pursue the livelihoods.

Social-political Capital : The set of social relationships upon which people draw in pursuit of their livelihood.

Sustainable Livelihood : A livelihood is sustainable, when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base.

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15.9 ANSWERS TO CHECK YOUR PROGRESS

Check Your Progress 1

1. A livelihood comprises the capabilities, assets and activities required for a means of living. Poor people tend to be most dependent upon the environment and the direct use of natural resources, and therefore most severely affected when the environment is degraded or their access to natural resources is otherwise limited or denied.

2. Temperature rise is going to have the following effects: (i) Larger negative impacts are expected to neutralize positive impacts, if any, of CO_2 fertilization; (ii) Net yield losses in rice under irrigation could be 13%–22%, compared with losses of 16%–34% for wheat; (iii) Quality of products such as cotton, fruits, vegetables, tea, coffee, aromatic and medicinal plants, and the nutritional quality of cereals and pulses may be moderately affected; (iv) Decline in grain protein content in cereals could partly be related to increasing CO_2 concentrations; (v) Changes in soil water induced by global climate change may affect all soil processes and, ultimately, crop growth; (v) An increase in temperature would also lead to increased evapo-transpiration, which may result in the lowering of the groundwater table at some places; and (vi) Increased temperature, coupled with reduced rainfall, may lead to upward water movement, leading to accumulation of salts in upper soil layers. (Any four).

Check Your Progress 2

1. Migration is likely to increase within India due to the effects of climate change. This is due to increase in intensity of extreme weather events like drought, flood, and cyclone. This will lead to desertification, sea level rise, flooding in the coastal and low lying urban areas, water scarcity and low food productivity, etc. which would force poor, marginal and vulnerable sections of population to migrate.

2. Various studies find that Bangladesh is currently faced with severe crisis of land and water, caused by population growth, environmental change and recurring natural disasters. This might increase the flow of migration from Bangladesh to India at a faster rate.