



Resource Handbook on **CLIMATE LITERACY**



Compiled by
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Reforestation

Planting of forests on lands that have previously contained forests but that have been converted to some other use.

Sea Level Rise

The increase in ocean water levels at a specific location, taking into account both global sea level rise and local factors, such as local subsidence and uplift.

Renewable Energy

Energy resources that are naturally replenishing such as biomass, hydro, geothermal, solar, wind, ocean thermal, wave action, and tidal action.

Resilience

A capability to anticipate, prepare for, respond to, and recover from significant multi-hazard threats with minimum damage to social well-being, economy, and the environment.

Sea Surface Temperature

The temperature in the top several feet of the ocean.

Soil Carbon

A major component of the terrestrial biosphere pool in the carbon cycle. The amount of carbon in the soil is a function of the historical vegetative cover and productivity, which in turn is dependent in part upon climatic variables.

Solar Radiation

Radiation emitted by the Sun. It is also referred to as short-wave radiation. Solar radiation has a distinctive range of wavelengths (spectrum) determined by the temperature of the Sun.

United Nations Framework Convention on Climate Change (UNFCCC)

The Convention on Climate Change sets an overall framework for intergovernmental efforts to tackle the challenge posed by climate change. It recognizes that the climate system is a shared resource whose stability can be affected by industrial and other emissions of carbon dioxide and other greenhouse gases.

Vulnerability

The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes.

Water Vapor

The most abundant greenhouse gas, it is the water present in the atmosphere in gaseous form. Water vapor is an important part of the natural greenhouse effect.

Weather

Atmospheric condition at any given time or place. It is measured in terms of such things as wind, temperature, humidity, atmospheric pressure, cloudiness, and precipitation. In most places, weather can change from hour-to-hour, day-to-day, and season-to-season.

Resource Handbook on CLIMATE LITERACY

Contents

Acronyms	i
List of Figures	ii
Preface	iii
Acknowledgments	v
About the Hand Book	vi
Chapter 1 : Introduction to Climate and Climate Change	1-15
1.1	Understanding Weather and Climate
1.2	Weather
1.3	Climate
1.4	Why do We study the Climate?
1.5	Climate Variability
1.6	Climate Change
1.7	Why is the Atmosphere Important?
1.8	What is Greenhouse Effect
1.9	Why is Greenhouse Effect Important?
1.10	Greenhouse Effect and Global Warming
1.10.i	Rising Sea Level
1.10.ii	Disruption of Water Cycle
1.10.iii	Worsening Health Effect
1.10.iv	Changing Forest and Natural Ecosystem
1.10.v	Challenges to Agriculture and food Security
1.11	Drivers of Climate Change
1.11.A	Natural Causes
1.11.A.i	Continental Drift
1.11.A.ii	Volcanic Eruption
1.11.A.iii	The earth Tilt
1.11.B	Human Causes
1.12	Impacts of Climate Change
1.12.i	Agriculture
1.12.ii	Forests
1.12.iii	Water Supply
1.12.iv	Health
1.12.v	Bio-diversity and Ecosystem
1.12.vi	Recreation
1.13	Climate Change, Disasters and Development
1.14	What is Climate Change, Adaptation and Disaster Risk Reduction?
1.15	Why Integration of DRR and CCA Essential ?
1.16	DRR, CCA and Development Connect
1.17	Global Initiatives
1.17.i	United Nations Framework Convention on Climate Change (UNFCCC)
1.17.ii	First World Conference on Natural Disaster in Yokohama,1994
1.17.iii	Hyogo Framework for Action 2005-2015
1.17.iv	Sendai Frame work for Disaster Risk Reduction, 2015-2030
1.18	Regional Initiatives
1.18.i	National Action Plan on Climate Change, Government of India, June 2008
1.18.ii	National Mission
1.18.iii	Chhattisgarh state Action Plan for Climate Change
	Frequently Asked Questions

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Chapter 2 : Risk and Vulnerability

16-22

- 2.1 What is Risk?
 - 2.2 Climate Risk
 - 2.3 Risk to Climate Change
 - 2.4 Risk and Hazards
 - 2.5 Type of Risks
 - 2.5.i Livelihood based Risks
 - 2.5.ii Environmental Risks
 - 2.5.iii Socio-economic Risks
 - 2.5.iv Health Risks
 - 2.6 What is Vulnerability?
 - 2.7 What is Climate Vulnerability?
 - 2.8 Vulnerability and Climate Change
 - 2.9 Types of Vulnerability
 - 2.9.i Physical Vulnerability
 - 2.9.ii Economic Vulnerability
 - 2.9.iii Social Vulnerability
 - 2.9.iv Attitudinal Vulnerability
 - 2.10 Factors that Impact Vulnerability
 - 2.10.i The poverty
 - 2.10.ii Population Growth
 - 2.10.iii Rapid Urbanization
 - 2.10.iv Transport and Culture
 - 2.10.v Environmental Degradation
 - 2.10.vi Lack of Awareness
 - 2.11 Approaches to Hazard Assessment
 - 2.12 Assessment of Vulnerability
 - 2.13 Methodology for Vulnerability Assessment
 - 2.13.i First Step : Assessment of Current Vulnerability
 - 2.13.ii Second Step : Estimate Future Conditions
 - 2.13.iii Third Step : Estimate Future Vulnerability
- [Frequently Asked Questions](#)

Chapter 3 : Understanding Mitigation, Adaptation, Resilience and Disaster Risk Reduction 23-27

- 3.1 What is Mitigation?
 - 3.2 What is Adaptation?
 - 3.3 What is Disaster Risk Reduction?
 - 3.4 Examples of DRR Measures
 - 3.4.i Agriculture and Food Security
 - 3.4.ii Water Sector
 - 3.4.iii Health Sector
 - 3.5 Awareness Raising and Education
 - 3.6 Environmental Management
 - 3.7 Early Warning Systems
 - 3.8 Development Planning and Practices
 - 3.9 Disaster Risk Reduction and the UNFCCC Initiatives
 - 3.10 What is the Resilience?
 - 3.11 Climate Change Resilience Frame work (CRF)
 - 3.12 Characteristics of Resilience
 - 3.13 Assessment of Disaster Resilience
 - 3.13.i Robustness
 - 3.13.ii Redundancy
 - 3.13.iii Resourcefulness
 - 3.13.iv Rapidity
- [Frequently Asked Questions](#)

Chapter 4 : Understanding Livelihood System

28-33

- 4.1 Primary Sector
 - 4.2 Secondary Sector
 - 4.3 Tertiary Sector
 - 4.4 Major Economic System for Livelihood
 - 4.5 Impacts of Climate Change on Livelihood
 - 4.5.i Farm Based Livelihood System
 - 4.5.ii Forest Based Livelihood System
 - 4.5.iii Non-Farm Livelihood System
 - 4.6 Sustainable and Alternative Livelihood Options
 - 4.7 Sustainable Livelihoods Frame work (DFID)
 - 4.7.i Natural Capital
 - 4.7.ii Human Capital
 - 4.7.iii Financial Capital
 - 4.7.iv Social Capital
 - 4.7.v Physical Capital
- [Frequently Asked Questions](#)

Chapter 5 : Impacts of Climate Change on Livelihood System

34-38

- 5.1 Impacts of Climate Change on Agriculture
 - 5.2 Impacts of Climate Change on Land use
 - 5.3 Impacts of Climate Change on Agricultural Productivity
 - 5.4 Impacts of Climate Change on Food Security
 - 5.5 Impacts of Climate Change on Pest, Diseases and Weeds
 - 5.6 Impacts of Climate Change on Livestock
 - 5.7 Impacts of Climate Change on Soil Erosion and Fertility
 - 5.8 Impacts of Climate Change on Forest
 - 5.9 Climate Change Impact on Forest growth and productivity
 - 5.10 Impacts of Climate Change on Natural Disturbances
 - 5.11 Impacts of Climate Change on Non- farm activities.
 - 5.12 Migration
 - 5.12i Industries
 - 5.12ii Tertiary Activities
 - 5.12iii Climate Effects on Conflict
- [Frequently Asked Questions](#)

Chapter 6 : Women as Primary Producer and Climate Change Impacts

39-44

- 6.1 Gender and Women
 - 6.2 Identity and Recognition
 - 6.3 Contribution of Women
 - 6.4 Women as Primary producer
 - 6.5 Access and Control over Resources vis-a vis male Migration
 - 6.6 Impact of Climate Change on Women
 - 6.7 Health Impacts
 - 6.8 Climate Change, Natural Disaster and Gender
 - 6.9 Gender and Access to Information, Organization and Markets
 - 6.10 Women and Market Access
 - 6.11 Women add Value to the Climate Efforts
- [Frequently Asked Questions](#)

Chapter 7 : Resilient Livelihood

45-48

- 7.1 Knowledge empowers people
- 7.2 Village Resource Centre (VRC)
- 7.3 Integrated Farming System for Climate Change

- 7.4. Time Management Through Alteration in Cropping Cycle
 - 7.4.i Space Management
 - 7.4.ii Climate Resilient Agriculture (CRA)
 - 7.4.iii Vegetable Farming strengthens livelihood in flood/drought affected areas
 - 7.4.iv Climate Smart Agriculture (CSA)
 - 7.4.v Promoting Climate services
 - 7.5 Farmer to Farmer Extension System
 - 7.6 Farmer's Field School (FFS)
 - 7.7 Master Trainers (MT)
 - 7.8 Self Help Group/ Community Collectives (SHG)
 - 7.9 Synergy of Science and Indigenous Traditional Knowledge
- [Frequently Asked Questions](#)

Chapter 8 : Relevant Policies and Programmes

49-52

- 8.1 Structural and Non-structureal Activities
 - 8.2 Agriculture (RKVY and NFSM)
 - 8.3 Forest and Bio-diversity
 - 8.4 Animal Husbandry
 - 8.5 Rural Development (MANREGA)
 - 8.6 Integrated Water Shed Management Programme (IWMP)
 - 8.7 National Agricultural Insurance Scheme
 - 8.8 Disaster Management Act
- [Frequently Asked Questions](#)

[References](#)
[Glossary](#)

53
55

Acronyms

CASM	Communities and Small-Scale Mining
CCA	Climate Change Adaptation
CRA	Climate Resilient Agriculture
CRF	Climate Resilience Framework
CSA	Climate Smart Agriculture
DRR	Disaster Risk Reduction
FFS	Farmer Field School
GHG	Green House Gas
HFA	Hyogo Framework for Action
IARI	Indian Agricultural Research Institute
IDNDR	International Decade of Natural Disaster Reduction
IEWP	International Early Warning Programme
IFAD	International Fund for Agriculture Development
IFS	Integrated Farming System
IMD	Indian Metrological Department
IPCC	Inter-governmental Panel on Climate Change
ISSET	Institute for Social and Environmental Transition
IWRM	Integrated Water Resource Management
JE	Japanese Encephalitis
MCEER	Multidisciplinary Centre for Earthquake Engineering Research
MNREGA	Mahatma Gandhi National Rural Employment Guarantee Act
MT	Master Trainer
NAIS	National Agriculture Insurance Scheme
NAPCC	National Action Plan on Climate Change
NGO	Non Governmental Organization
OECD	Organization for Economic Co-operation and development
PIP	Policies, Institution and Processes
SAPCC	State Action Plan for Climate Change
SL	Sustainable Livelihood
SLA	Sustainable Livelihood Approach
SLED	Sustainable Livelihoods Enhancement and Diversification
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
VRC	Village Resource Centre
WMO	World Metrological Organization

List of Figures

1.1.	Various Weather and Condition
1.2.	Climate Regions of the World
1.3.	Rainfall Variability in Jashpur, C.S. India
1.4.	Green House
1.5.	Green House Effects
1.6.	Composition of Green House in the atmosphere
1.7.	Impact of Global Warming
1.8.	Drift of Continents
1.9.	Volcanic Eruption
1.10.	Earth Tilt
1.11.	Ocean Currents
1.12.	Human causes of Climate Change
1.13.	Impacts of Climate Change
1.14.	CCA, DRR and Development Connect
2.1.	Risk & Vulnerability
2.2.	Types of Vulnerability
2.3.	Key steps of Vulnerability Assessment
3.1.	Climate Resilience Frame work
4.1.	Rural and Urban Livelihood
4.2.	Types of Capital
4.3.	Sustainable Livelihood
5.1.	Impact of Climate Change on Agriculture
5.2.	Impact of Climate Change on Animal Husbandry
6.1.	Women's Contribution
6.2.	Impacts of Climatic Change on Women
7.1.	Synergy of Indigenous Knowledge and Science
7.2.	Integrated Farming System

Preface

Weather and climate are the dynamic features of our physical environment. They effects a wide range of human activities to a greater or lesser degrees. It is fact that weather and climate are important factors in determining our day-to-day and longer term activities and modes of life. These are no more fundamental environmental components than the air we breathe and the sunshine and rainfall that nourish our crops. Man is affected by the weather and climate and also reacts to them through his ability for his livelihood and to make decisions for other socio-economic activities. Different world climate not only influence human affairs on the long term but they may be change as a result of our activities which are causing the various problems. A grave concern is being expressed with the problems posed by shrinking natural resources, increasing population and degradation of the environment. To quote J.E Hobbs, "to these can be added the role of man himself as a climate factor of growing interest and concern, particularly with regard to his role as a cause of environmental degradation, Perhaps leading to climate change".

Moreover, human society has developed its activities unintentionally produced weather and climate modification on a large scale. There are two long term effects of climate modification that are causing grave concern. One is said to be the observed increased of CO₂ gas in the atmosphere and the resultant increase in global temperature. The other is the changes in the ozone shield which may give rise to the penetration of more and more of harmful ultra violet rays of sun.

Climate as the key to regional difference

If we analyze the interaction between man and his physical environment, we arrive at the conclusions that each and every human society, its present form, economic and cultural level has shaped by its environmental influence whereas climate is the most fundamental or far reaching of the natural elements that control the human life. The mode of life and economy of the people in Chhotanagar plateau are altogether, different from what they are in Gangetic plain. Thus the climate undoubtedly holds the key to regional diversity.

Climate and Human affairs:

Of all the factors of our natural environment which influence the life of the human on earth, the most important and most fundamental is the climate. The clothes we wear, the houses we build for our shelter, the food we eat, the occupation we follow, migrations from one part of the earth to the other and even the very mode of living, every aspects of human life is affected and more or less controlled by climatic conditions in which we live.

Climate and Civilization:

The climate has be assigned a very high place, most dominant and essential factor in the development of civilization. It is historical fact that many advanced civilizations in the past have grown up and nourished in different regions of the world but as and when the climate conditions changed to become adverse like in Nile valley, Tigris and Euphrates valley, those civilizations decayed and ultimately perished.

Climate and culture:

The culture of various groups of mankind are the result of a number of factors and among the physical factors involved, none is more powerful than climate. The main factor that determine the health, food, other resources and parasite disease and people's cultural level is climate. Climate is undoubtedly one of the principal determinants at a people's culture through its effects. Climate has been the most dominant factor in causing migration, racial mixture and natural selection. Hence, In other worlds, climate may be said to be a determining factor in spatial distribution of human progress. Climate conditions have complex bearing on soil, crops, commerce, plant disease and above all human health. Even the surface of the land is modified to large extent by the action of climatic elements. Natural vegetation and the pattern of land use are controlled by the type of climate. Even a large part of the commerce of the world is mainly due to climatic difference.

Climate and political organization:

Climate is such an important factor that effects the political organization of the country. An example may be cited from India where there is still an agrarian economy, the recurrence of the floods and drought not only causes immense hardship to the cultivators, but also tell upon of health of the government. The Indian agriculture is still 'a gamble in Monsoon' whose failure or pulsating character has serious repercussion on our national economy and political stability.

Thus the climate is an important component of the physical environment which affects the socio-economic development of human of a particular region and on the other hand man modify the climate according to his mental ability and resource availability. With this view the awareness about the climate and its changing pattern is very essential for the socio-economic activities and transformation of the society. The objective of the present document is to make familiar with the concept of climate and its impacts on livelihood with the process of mitigation and adaptation for making the livelihood sustainable and resilient.

Acknowledgements

We are thankful to the residents of Karkata and Chandagarh, (Patalgaon Block) and Gohapani and Jampani (Bagicha Block) villages of Pathalgaon Tahsil of Jashpur District for their time and providing the information during the initial visit in the month of March, 2016 and during the visit of validation in April, 2016 about the changing pattern of weather conditions of the area and their impacts on their livelihood and other activities.

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We are grateful to CARE India for financial support and technical assistance for completion of the handbook. In the last not the lost we thanks to all the scholars whose works have been consulted and referred here that help in completion of the handbook.

About the Hand Book

vi

Resource Handbook on Climate, Climatic Change, its impacts on community and its livelihood is a learning material for the master trainers and resource persons who are working with the project 'Where the Rain Falls (WtRF)' implemented by CARE India in Jashpur District of Chhattigarh. It is a community which is mostly Adivasi in rural areas and climate change is presenting the stresses around water in Jaspur district. This is the area where climate poses a huge threat to sustainability, availability and productivity of natural resource like land, water and livestock to all but especially pushes critical and adverse implications on economic development of the community. The climate changes affect the productivity of land and forest resources which are abundantly available in the region but provide inadequate return and present serious implications for food, fuel, fodder and other livelihood which increase the pressure on community to meet their own food and nutrition requirements.

The women of the area are more sufferer because they have less capability to cope with the climate change. Women have lesser or no say in deciding the land uses, cropping choice, reach to market and financial matter. Women's lackness of skills provides less scope high return economic activities and face social restriction to their mobility. Women of rural areas have to transverse longer distances to fetch water, fuel and other necessities. In such socio-economic conditions, the focus on women for enhancing their resilience to climate induced risks and vulnerabilities for which a massive program for enhancing capacity and capabilities of the local women and girls to mitigated, adopt and cope with the environmental and economic risks and to reduce the existing and future vulnerability of the Adivasi woman and their household and to make the resilience through strengthening the system, agents and institutions of the area should be initiated. To achieve these goal a clear understanding of the weather and climate, its global changing pattern with their natural and man-made causes and its impacts on lives of the people and their livelihood is very necessary for mitigation, adaptation and making the community resilient to the climate change that need a wide training and capability building of the community.

The present resource handbook is a document to provide the understanding the basic concept on climate, how its differs from weather, pattern of global, national and region changes of climate and how the climate change is impacting the lives of the community especially Adivasi farming communities as they are dependent on agriculture and forest for their livelihood and food security. It will also help to make aware them about the ways of mitigation and adaptation in such physical conditions of less availability water for drinking, domestic and irrigation uses which worsen the solution for them.

Objective: The objectives of this resource handbook are to make aware all trainers and learners about the concept of climatic, possible impacts of climate change and to strengthen their capacity for the mitigation and adaptation activities. It will also provide background of livelihood pattern in the rural area which are being adversely effected by climate change. The book focuses on the vulnerability and adaptation to climate. It also includes general aspects related to mitigation of climate change and their link to sustainable

development. The impacts of climate change on the women are especially dealt in the book along with some measures of the mitigation and adaptation method to the climate change.

Process of documentation: At the out set a preliminary survey of the area was conducted in the month of March, 2016 to make acquainted with the physio-cultural setting of the area, the experiences and responses of the community for changing climate scenario of the region. For this two villages of each block of Pathalgaon and Bagicha were visited by the team where the focus group discussions (FGD) with community were conducted and their outcomes were recorded. On the basis of this FGD. The contents of Climate Literacy Module and Climate Resource Handbook were finalized and shared with CARE India, Team. After the inclusion of the feedbacks the draft of both the document made prepared.

For validation of draft, again a visit was conducted to share contents, language, way of presentation and to know the acceptability and understanding the contents. This validation process was organized at two levels:

1. **CARE Team Level:** It was conduction separately in three sessions- one with core team of CARE India and CARE France Team members and CARE India Pathagao Team the draft of both the documents where discuss and their feed backs and suggestions for making the documents more presentable and understandable were noted and finally, they were included in the documents. Next day both the documents were presented before the CARE team of Pathalgao and some village animators. In the beginning a forma was distributed to provide their feed backs. After the completion presentation and the discussion the feed backs were provided by each participants which was compiled and incorporation in final draft.

In the third session, the same process was adopted in village Mahuadaraha in which animators, facilitators, member of village development committee, SHG members and community members with CARE Team participated. The community member categorically accepted that the climate has changed which is impacting their day to day activities. After presentation and discussion of science of climate, causes of its change and impacts at global, national and local levels, there feed backs were invited. They suggested that the facts are truthful but it should be presented in a easy way so that it should be explicable to common people. The impacts of climate change on women were also assessed to validate the facts included in th documents.

Structure of the Handbook: The book has been organized into 8 chapters along with introduction in beginning and references and glossary in the last. In the first chapter 'Introduction to Climate and Climate Change', the general concept of climate, climate variability and change, the major drivers of Climate Change including Green House Impacts and its impacts on the physio-cultural human phenomenon, natural disasters and socio-economic development of human kind have been dealt. The concept of Disaster Risk Reduction and Climate Change Adaptation along with the global and national initiations for DRR and CCA have been explained. The risk and vulnerability are the main theme of the second chapter in which risk and hazards, risks and vulnerability caused by climate change have described. The third chapter is devoted to the understanding mitigation, adaptation, Disaster Risk Reduction and Resilience

vii

in which their conceptual background and various measures have been suggested. In the fourth chapter, the major economic system for livelihood has been illustrated along with the sustainable livelihood frame work proposed by different organizations. The impacts of climate change on livelihood system especially on land use, agriculture productivity, and food security, livestock, forest and non-farm activities are discussed in the fifth chapter. The women of the rural folk who are major primary producers have adversely affected by the climate change which has been argued in sixth chapter.

The measures to make the community resilient to climate change in respect to livelihood such as knowledge, empowerment, village resource centre, integrated form of agriculture with space and time planning for climate resilient agriculture with integration of animal husbandry, agro-forestry and other primary activities have been suggested in seventh chapter. The relevant policies and programmes of Central and state government of Chattishgarh to make the rural community resilient in terms of livelihood even during the stress period have been described in the last eighth chapter. Thus an attempt has been made to present a comprehensive background of the climate change and its impact on the community, the measures have also been suggested to make them resilient to risk of climate change.

In the last a wide range of reference have been giver for further reading and a list of keywords with their scientific meaning and definition where made available for ready references.

CHAPTER : 1

Introduction to Climate and Climate Change

1.1 Understanding Weather and Climate

In climatology the terms 'weather' and 'climate' are closely related, but have different connotations when it comes to defining them.

1.2 Weather

Weather is the state of atmospheric conditions of any place at any given time, in terms of temperature, rainfall, air pressure, wind, humidity, cloudiness and visibility. *Example: When we stand outside, we can tell how hot it is by taking a temperature reading or just by our own general experience. We can see if it is raining, windy, sunny or cloudy. All these factors are integral to what we think of as weather. Besides this, weather is highly variable, and in most places, changes from minute-to-minute, hour-to-hour, day-to-day, and also season-to-season.*

Figure 1.1 | Various Weather Conditions



1.3 Climate

Climate is the sum total of a variety of general weather conditions of any place or any area. Thus climate is the average of all statistical weather information of a particular area for a long period, usually several decades (at least 30 years). The **World Meteorological Organization** (WMO) suggests a standard

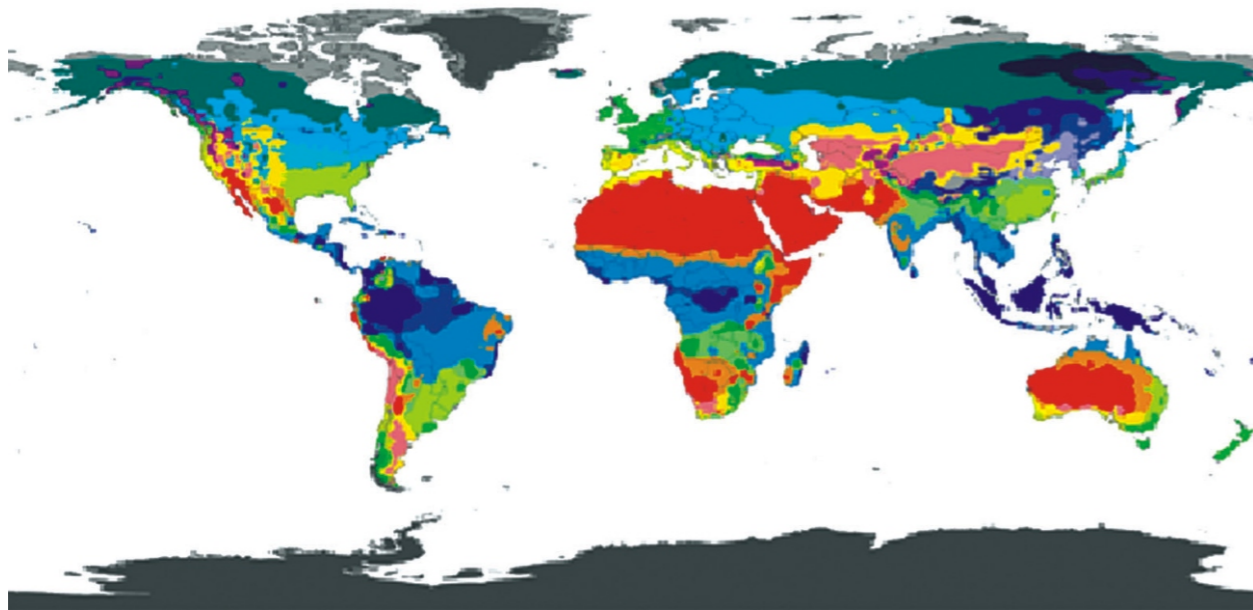
Weather is the state of the atmospheric conditions of any place at any given time, in terms of temperature, rainfall, pressure, wind, humidity, cloudiness and visibility; while climate is the average behavior of weather, over an extended period of time.

period of 30 years for calculating the climate average of different weather elements. The Indian Meteorological Department (IMD) also averages weather data over the course of 30 years (or longer) to determine an area's climate. Thus, climate is the description of the long-term pattern of the weather of a particular area that includes the averages of sunshine/ temperature, precipitation, humidity, wind direction & velocity, and other phenomena such as fog, frost and hail storms.

1.4 Why do we Study Climate?

The reason for studying climate, especially climate change is important, as it affects millions of people living around the world. Rising global temperatures are expected to change not only the temperature, but also precipitation and other local climatic conditions that could alter forests, crop yields, water supplies, increase frequency & severity of natural hazards like floods, droughts and also raise sea levels. This could have a devastating impact on human health, animal habitats and the planet's many diverse ecosystems. For example, the existing Gangetic alluvial plain may be transformed into a vast

Figure 1.2 | Climate Regions of the World



2

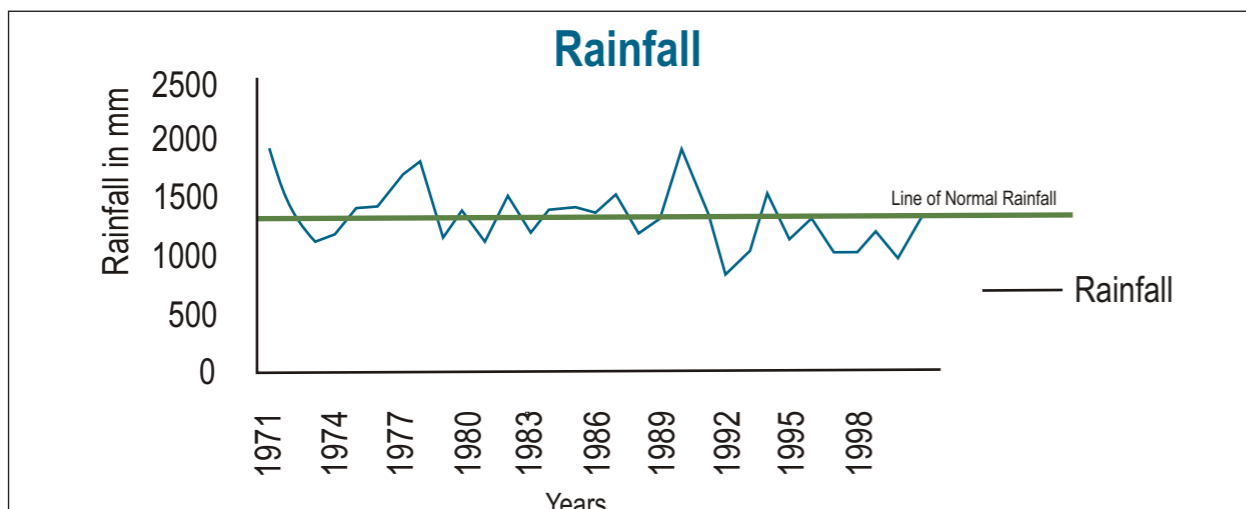
desert, and the existing features of some of our National Parks and National Forests may be permanently altered.

1.5 Climate Variability

Weather conditions vary in a particular season and are not regularly repeated. For example, there are variations in precipitation during monsoons every year. Climate variability refers to the climatic parameters of a region varying from its long-term average. Every year in a specific time period, the weather of a location is different. For example, over the Indian subcontinent El Nino during winter results in development of warm conditions, while in

The average annual rainfall of Jaspur, Chhattisgarh is 1349.2 mm. This is not an assured amount of rainfall every year. The actual rainfall may vary due to drought & flood conditions. Fig. 1.3 displays the year-to-year variability of Jaspur rainfall for the period from 1971 to 2000, in terms of the percent departure from the mean.

Figure 1.3 | Rainfall variability in Jaspur district, Chhattisgarh, India



summer it leads to dry conditions and deficient monsoon. Some years have below average rainfall, some have average or above average rainfall.

1.6 Climate Change

Climate change is a shift in weather conditions, which occur and persist for an extended period, typically decades or longer. It is a slow process, whose impact is visible only after an extended period of time. For example, the winters today are not as cold & severe as they used to be earlier. A change in one weather element can produce changes in the regional climate. For example, if the average regional temperature increases significantly, it can affect the amount of cloudiness, as well as the type and amount of precipitation that occurs. If these changes occur over long periods, the average climate values for these elements are also affected.

1.7 Why is the Atmosphere Important?

The earth's atmosphere is a blanket of gases and suspended liquids & solids particles collectively called aerosols. At sea level, the dry air comprises mainly of nitrogen, oxygen, argon, carbon-di- oxide, neon, helium, krypton, xenon and methane gases, in different ratios. Two gases nitrogen and oxygen make up about 99% of the clean and dry air, while the remaining gases are mostly inert and constitute about 1% of the atmosphere.

These gases and aerosols are of great climatic significance. Without atmosphere, life would be impossible on earth and there would be no cloud, wind or storm, or simply, no weather. It also acts as a great canopy to protect the earth surface from solar effect by day, and prevents excessive loss of heat by night.

Composition of Atmosphere

Gases	Percentage
Nitrogen	78.08
Oxygen	20.94
Organ	0.93
CO ₂	0.038
Hydrogen	0.01
Neon	0.0018
Helium	0.0005
Krypton	0.0001
Xenon	0.000009
Ozone	0.000001

1.8 What is Greenhouse Effect?

A greenhouse is basically a glass house, constructed for protection and survival of plants, usually in colder countries where insolation (sun radiations) received, especially during winters is not sufficient to support or nurture the plants (Figure 1.4). The transparent glass sheets of the greenhouse allow sunlight to enter, heat up the soil and warm the plants. The warm soils emit radiation in longer wavelength which is prevented by the glass covering from escaping. This mechanism

3

Figure 1.4 | Green House



traps the heat and keeps the greenhouse warmer than the environment outside. Likewise in the atmosphere, the greenhouse gases (GHG) such as carbon-dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), halocarbons (Chloro fluoro carbon), ozone (O₃) and water-vapor, allow direct sunlight through the atmosphere to reach the earth's surface unimpeded. This heats up the surface and energy (heat) is reradiated back to the atmosphere, which is easily absorbed by these greenhouse gases present in the earth's

Figure 1.5 | Green House Effect

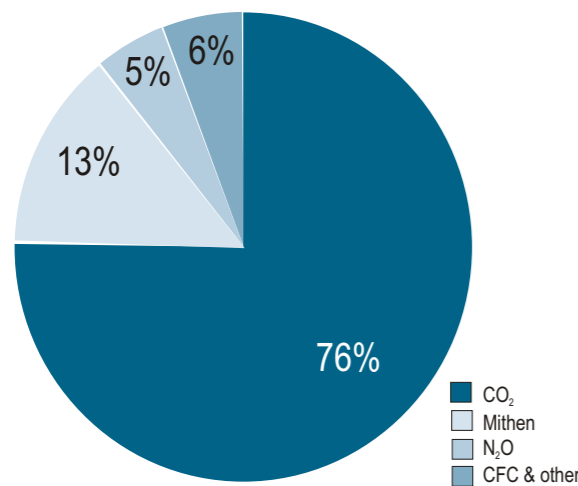


atmosphere, thereby allowing less heat to escape back to space, and 'trapping' it in the lower atmosphere (troposphere), keeping it warmer (33°C) than it would otherwise be. This natural greenhouse effect (Fig.1.5) similar to the action of a greenhouse where the atmospheric greenhouse gases act like the glass panels of a green house is vital to life on earth.

However when atmospheric GHG concentrations increase, the earth temporarily traps infrared radiation more efficiently, and its natural radiative balance is disturbed, until the surface temperature rises to restore equilibrium between incoming and outgoing radiation. It takes many decades for the full effect of greenhouse gases to be realized in terms of higher surface temperatures, because oceans have a huge capacity to store heat. These water bodies gradually warm up due to the excess infrared radiation from the atmosphere, and even a slight increase in their temperature is thus significant. Figure 1.6 illustrates the relative contributions from man-made emissions of various GHGs to climate change.

Figure 1.6 | GHG Composition

Composition of GHG in Atmosphere



1.9 Why is Greenhouse Effect Important?

Here one may ask about the importance of greenhouse effect. Greenhouse gases occur in small amounts in the earth's atmosphere, yet they have an important role to play in keeping the earth's surface warm and conducive to sustain life. Without the natural greenhouse effect, the earth's average temperature would be - 18°C instead of the current average temperature 15°C, and life as we know today, would not be possible. Thus, these GHG are

essential to keep the earth's average temperature to a more hospitable 15°C. The problem arises when the atmospheric concentration of GHGs increases significantly.

1.10 Greenhouse Effect and Global Warming

Since the beginning of industrial revolution (1750 AD), atmospheric concentration of CO₂ has increased nearly 30%, methane concentration has more than doubled and nitrous oxide concentration has risen by nearly 15%. Energy utilized to run transport vehicles, industries, power plants, heating homes and businesses are responsible for the emission of GHG. Increased agriculture, deforestation, landfill construction, industrial production and mining have also contributed significantly to this state.

The United Nation Environmental Programme (UNEP) established the Inter-governmental Panel on Climate Change (IPCC) with a remit to search for an authoritative inter-nation consensus of scientific opinion on climate change, its impacts and possible responses. IPCC in its report concluded that the continued accumulation of GHGs in the atmosphere would lead to climate change and was likely to have important impacts on natural and human systems. IPCC has estimated the globally average surface temperature and this change may lead to a number of serious consequences.

Global warming means that the earth's surface temperature has increased anywhere between 0.6 to 1.2°C since the 19th century. The 10 warmest years in 20th century have all occurred in the last 15 years of the 20th century. It is expected that the global average surface temperature will increase by another 1.0-3.5°C, by year 2100, if emissions continue at the same pace. Thus, global warming as a consequence of greenhouse effect, may lead to serious consequences such as:

1.10. i Rising sea level

It can aggravate the melting rate of snow cover of Polar Regions and mountain peaks, which may ultimately increase sea levels. Globally, the sea level has risen by 4-6 inches over the past century and by 2050 the ocean may rise 8 inches, which will inundate coastal areas. The low lying countries with large coastal population such as Bangladesh, Indonesia, Pakistan, Thailand, Maldives, Mozambique, Senegal, Surinam and Peninsular India are the most vulnerable.

1.10.ii Disruption of water cycle

As global warming occurs, evaporation increases which further enhance average global precipitation, and intense rain storms tend to become more frequent. This change in climate may lead to flooding which can contaminate the water supplies with pollutants washed from the disrupted treatment systems, raising the spread of infectious diseases. Global warming can also decline soil moisture in many regions, leading to drought situations.

1.10.iii Worsening health effects

Climate change is likely to have a wide range and an adverse impact on human health. The projected increase in duration and frequency of heat waves is expected to increase mortality rates due to heat strokes. Heart attacks and other health issues too are aggravated by heat. In some regions, the heat may become unbearable, forcing people to migrate. Hot, stagnant conditions could cause chemical reactions in the atmosphere, increasing risks of respiratory diseases like bronchitis and asthma. Likewise, climate change is also expected to cause a surge in potential transmission of many infectious diseases including malaria, dengue, yellow fever etc.

1.10.iv Changing Forest and Natural Ecosystem

A rapid and large scale climate change could severely harm the earth's existing ecosystems. A change could lead to a loss of species, with their habitats lost or transformed. The animals would be forced to migrate or even become extinct.

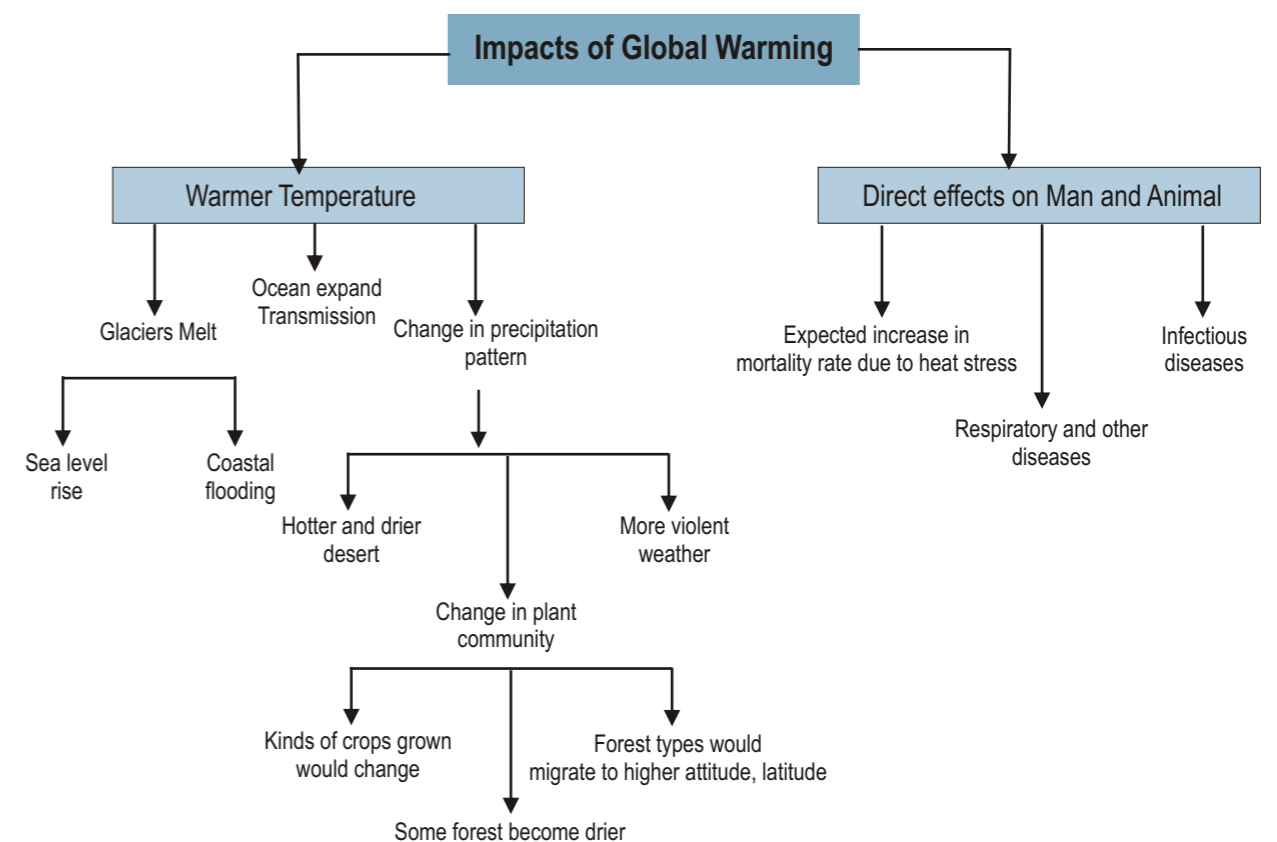
1.10.v Challenges to Agriculture and Food Security

Decrease in crop yield and productivity is expected to occur in response to climate change. Hence, it may not be possible for global agricultural production to keep pace with increasing demand. This raises the risk of famines, particularly in sub-tropical and tropical semiarid and arid regions of the world.

1.11 Drivers of Climate Change

Before explaining the drivers of climate change, from a global and local perspective, it is important for us to understand the difference between global warming and climate change. Global warming is the term used to describe the current increase in the earth's average temperature, while climate change refers not only to global changes in temperature but also in wind, precipitation, season's length, as well

Figure 1.7 | Impacts of Global Warming



Causes of Climate Change	
Natural Causes 1. Continental drift 2. Volcanic eruption 3. Earth's tilt 4. Ocean currents	Man Made Causes 1. Industries 2. Transport 3. Consumption of fossils fuels 4. Deforestation 5. Change in land use 6. Population explosion 7. Mass consumption

as the strength and frequency of extreme weather events like droughts and floods. The earth's climate is dynamic and is constantly changing through a natural cycle. Causes of climate change can be divided into two categories - natural and manmade.

1.11.A Natural causes

A number of natural factors are responsible for past climate changes and these are still very active. Some of the more prominent ones are

Figure 1.8 | **Drift of Continents**



continental drift, volcanoes, ocean currents, the earth's tilt, comets and meteorites. Let's look at them in a little detail:

1.11. A.i Continental Drift

Nearly 250 million years ago, all the continents were merged in one large land mass known as Pangea. They gradually began to drift apart and formed separate continents, those that we are familiar with today (figure 1.9). This drift had an impact on the climate as it changed the physical features of the landmass, their position and that of the water bodies. The separation of the landmasses changed the flow of ocean currents and winds, which affected the climate.

This drift of the continents continues even today; the Himalayan range is rising by about 1 mm (millimeter) every year because the Indian land mass is moving towards the Asian land mass, slowly but steadily. There are evidences of the North America continent drifting in the west. These incidents have an effect on the change of climate of that particular region.

1.11.A.ii Volcanic Eruption

When a volcano erupts it throws out large volumes of sulphur dioxide (SO₂), water vapor, dust, and ash into the atmosphere which influence climatic patterns of the area. The gases and dust particles partially block the incoming rays of the sun, leading to cooling. Sulphur dioxide combines with water to form tiny droplets of sulphuric acid, leading to acid rain on the earth during rainy season.

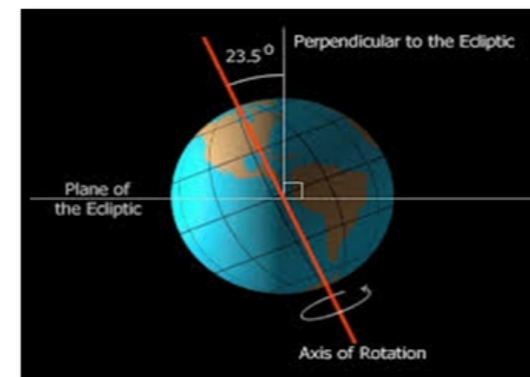
Figure 1.9 | **A Volcanic eruption**



1.11.A.iii The Earth's Tilt

The earth makes one full orbit around the sun each year. It is tilted at an angle of 23.5° to the perpendicular plane of its orbital path (figure 1.11). For one half of the year when it is summer, the northern hemisphere tilts towards the sun. In the other half when it is winter, the earth is tilted away from the sun. The Earth's orbit is somewhat elliptical, which means that

Figure 1.10 | **The Earth's tilt**

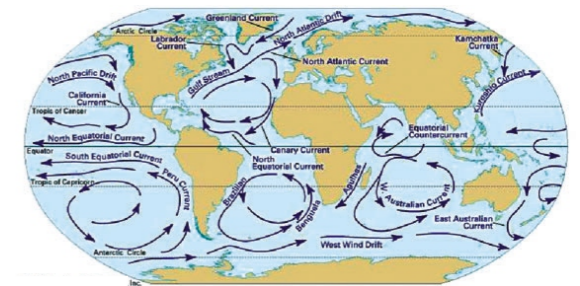


the distance between the earth and the Sun varies over the course of a year. The earth's axis does move, at the rate of a little more than a half-degree each century. This gradual change in the direction of the earth's axis, called precession is responsible for changes in the climate.

Ocean Currents : Ocean currents move vast amounts of water across the planet (figure

1.11). But the oceans are surrounded by land masses. The travelling warm current increase the temperature of the area by warming the sea breeze that blows over them, making them warmer. Similarly the cold current too influences the temperature of the regions along which they flow.

Figure 1.11 | **Ocean Currents**



1.11.B Human Causes

The industrial and transport revolution of the 19th century provoked a large scale use of fossil fuels. These industries created jobs and over the years, people moved from rural areas to the cities, and this trend continues to this day. More and more land covered with vegetation has been cleared to make way for houses, and natural resources are being used extensively for construction, industries, transport, and consumption. Consumerism (our increasing want for material things) has increased by leaps

Figure 1.12 | **Human Causes of Climate Change**



and bounds, creating a huge amount of waste. Added to this, is the rapid and dramatic rise in human population.

All these above mentioned factors have contributed to raise the concentration of greenhouse gases in the atmosphere. Fossil fuels such as oil, coal and natural gas supply most of our energy needs. The energy sector in turn is responsible for the emission of carbon dioxide, methane and a large quantity of nitrous

How we all contribute every day towards CC?

All of us in our daily lives contribute our bit to climate change in the following manner:

- Electricity is the main source of power. All our gadgets run on electricity generated mainly from thermal power plants. These thermal power plants are run on fossil fuels (mostly coal) and are responsible for the emission of huge amounts of greenhouse gases and other pollutants.
- Goods and people are transported by vehicles, which are run mainly on fossil fuels- petrol, diesel and natural gases
- We generate large quantities of waste in the form of plastic that remains in the environment for many years causing great damage
- We cut trees for timber, construction, to make paper, fuel and fodder; all of which are good sources to soak GHG
- A growing population means more and more mouths to feed. High-yielding varieties of crop are grown to increase the agricultural output on limited agricultural land, which require large quantities of fertilizers that emit more nitrous oxide, both from the field into which it is put and the fertilizer industry that makes it
- Fast pace of urbanization led to the construction of huge number of houses for the growing population, industries and other activities causing urban heat island syndrome.

oxide gases. Excess use of fertilizers and pesticides also adds to this problem. The industrial and energy sector also produce nitrogen dioxide (NO₂) and carbon monoxide (CO). Though these are not greenhouse gases, they do influence the chemical cycle in the atmosphere that produce or destroy greenhouse gases.

1.12 Impacts of Climate Change

Increasing global temperature is the greatest challenge of the 21st century. Temperatures have exceeded global annual averages for 38 consecutive years. Its impact is being felt all around the world with extreme weather events becoming more frequent and also more severe. Heat waves and drought in many countries, destroying agriculture, increasing risk of wildfires and endangering lives. Rising sea level threatens coastal communities and infrastructure by amplifying flooding and storm surges. Some of the major impacts of climate change on different sectors are as follows:

1.12.i Agriculture

Our food crops need specific conditions to thrive, which include the right temperature and sufficient water. Global climate variability/change will affect agriculture and food supply in many other ways. A changing climate could have both positive and negative effects on crops. It could make it too hot to grow certain crops and droughts could reduce the amount of water available for irrigation. Climate change is also likely to cause stronger storms and more floods, which could damage crops. Sudden downpour creates the havoc of floods and water logging causes a massive loss of human, animal, agriculture, assets, property and infrastructure. Higher temperatures and changing rainfall patterns could encourage weeds and pests to spread to new areas. An additional half degree rise in global temperature could result in a 17% wheat yield decrease and 30% drop in general food grain production in India, by 2035.

1.12.ii Forests

Forests are sensitive to climate change, including shifting weather patterns, drought, wildfires, and the spread of pests like the mountain pine beetle. Wildfires are already very common in the forests and grasslands of the tropical and temperate zones. As the Earth gets warmer and droughts increase, wildfires are expected to occur more often and be more destructive. Wildfires do occur naturally, but

Global Impacts of Climate Change

1. Economic Impacts

- Deterioration of infrastructure
- Agricultural production
- Timber production
- Industrial process
- Employment

2. Impacts on Ecosystem

- Loss of soil productivity
- Shortage of potable water, food & fuel
- Increase in evaporation & rainfall
- More landslides; land and soil erosion
- More flooding and water logging
- More severe drought

3. Social Impacts

- Diseases
- Mortality
- Reduced labor productivity
- Conflicts over limited resources
- Migration
- Changes in social network

the extremely dry conditions resulting from droughts allow fires to start more easily, spread faster, and burn longer. In fact, if the Earth gets just 1.0°C warmer, we can expect wildfires in

Climate change impacts are always local. The impacts felt in the socio-economic conditions and ecosystems in Chhatisgarh are as follows:

1. Impacts on agriculture

- Most of the area, which is single paddy cropped & monsoon dependent, faces a decrease in number of rainy days
- Crop production will decrease due to flood & drought
- Deficient water for irrigation
- Decreased paddy crop yield
- Decreased soil humidity and productivity
- Milk production and breeding capacity of animal has been affected badly
- Animal diseases are increasing

2. Impacts on resources

- Wildfire incidences will increase
- Due to change of land use, pasture area will decrease
- Availability of products specially *Mahua*, *Chirangi*, *Tendu* and *Plash* leave will reduce
- Many plants and wild animals will become extinct
- Limited water resources to face the population pressure
- Ground water level depletion
- Eco-systems disturbed due to over exploitation of finite resources

India to burn even more land than they do now. Human society and global economy are inextricably linked to forests. More than 1 billion people depend on forests for their livelihoods. Forest ecosystems play a critical role in stabilizing the climate; providing food, water, wood products, vital medicines, fruits, fuel, and fodder as well as supporting much of the world's biodiversity. Due to decreased deforestation rates in some regions, forest ecosystems are already under great threat.

1.12.iii Water Supply

Climate change is already affecting where, when, and how much water is available for us to use. Many parts of the world have very little water, and climate change could worsen this problem. Rising temperatures, changing precipitation patterns and increasing droughts will affect the amount of water in lakes, rivers, and streams, as well as the amount of water that seeps into the ground to replenish groundwater. We all know that clean, reliable water supplies are vital for drinking, domestic, industry, agriculture and energy production. Every community and ecosystem on Earth depends on water for sanitation, hygiene, and daily survival. Yet the world's water systems face formidable threats. More than a billion people currently live in water scarce regions, and as many as 3.5 billion could experience water scarcity by 2025. Increasing pollution will degrade freshwater and coastal aquatic ecosystems. Climate change is poised to shift precipitation patterns and speed of glacial melt, altering water supplies and also intensifying floods and drought cycles.

1.12.iv Health

Heat waves, severe storms, air pollution, and diseases linked to climate, already threaten people's health in many areas of the world. Global climate change will amplify these threats. The poor, very young or elderly, disabled and those who live in coastal areas or big cities will be particularly at risk. Heat waves are uncomfortable for everyone, but for infants and young children, the elderly, and sick, they can be especially dangerous. Extreme heat can cause illnesses such as heat cramps, heat stroke, and even death. The 2003 heat wave in Europe caused about 50,000 deaths. Such phenomenon is also manifested in northern India every year.

1.12.v Bio-diversity and Ecosystems

Most plants and animals thrive in very specific climatic conditions, such as temperature and rainfall patterns. Any change in the climate of an area can affect the flora and fauna intrinsic to that particular area, as well as the makeup of the entire ecosystem. Some species have already

begun to respond to a warmer climate by moving to cooler locations or higher altitudes. For example, some south Himalayan animals and plants are moving further north or to higher elevations, in the face of a warming planet. Climate change can also alter the life cycle of living things. For example, as temperature rises, many plants have started to grow and bloom earlier in the spring and survive longer. Some animals are waking from hibernation sooner or migrating at different times, too. Even cows and buffaloes are underproductive and dry much earlier due to climate change.

1.12.vi Recreation

In addition to causing physical problems, such as heat waves, droughts, and coastline damage, warmer temperatures could also affect people's jobs, recreational activities and hobbies. For example, in areas that usually experience cold winters, warmer temperatures could reduce opportunities for skiing, ice fishing and other winter sports. Rising sea level may wash away beaches and loss to a worldly leisure activities.

1.13 Climate Change, Disasters and Development

Natural hazards by themselves do not cause disasters; it is the combination of an exposed, vulnerable and ill-prepared population or community along with a hazard event that results in a disaster. Climate change therefore, affects disaster risks in two ways- (i) through likely increase in weather & climate hazards (ii) through increase in vulnerability of communities which are impacted by these natural hazards, particularly through ecosystem degradation, reduction in water and food availability, and changes in livelihood patterns.

Climate change has added a new dimension of stress to those of environmental degradation and rapid unplanned urban growth, which further reduces community's abilities to cope with even the existing levels of weather/climate hazards. It is impossible to be absolutely certain about all the disaster related effects of climate change, owing to the intrinsic uncertainty in climate projection, the diverse and rapidly changing nature of community vulnerability and the random nature of individual extreme events. However, there is plenty of information on the serious impacts of events that occurred in past decades, and on this basis alone, there is much to be concerned about.

1.14 What is Climate Change Adaptation and Disaster Risk Reduction?

Climate Change Adaptation (CCA) and Disaster Risk Reduction (DRR) are closely linked. "CCA is adjustment in natural or human systems in response to actual or expected climate stimuli or their effects, which moderate harm or exploits beneficial opportunity."

CCA is adjustment in natural or human systems in response to actual or expected climatic changes or their effects.

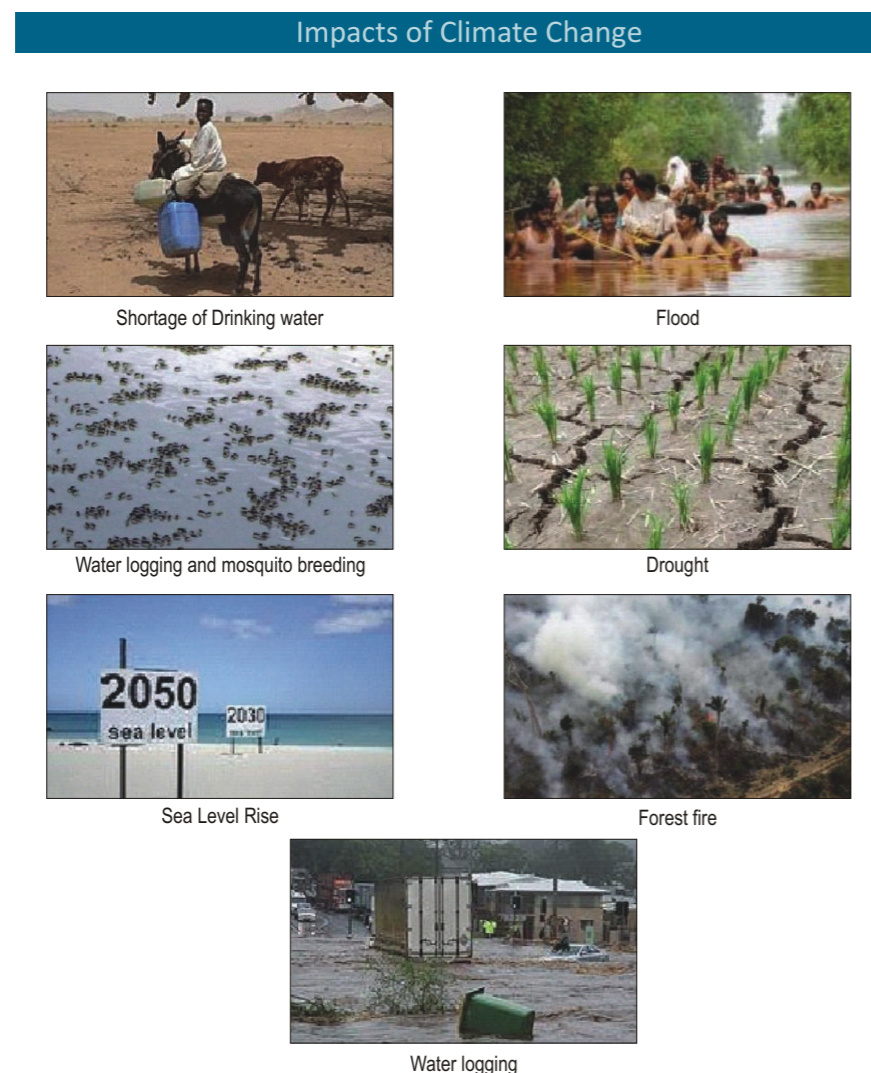
"DRR is a set of activities carried out to minimize vulnerabilities and disaster risks in a society." Experiences have shown that adaptation and risk reduction almost have the same purpose. More extreme weather events expected in the future are likely to increase the number and scale of disasters, while at the same time, the existing methods and tools of DRR provide powerful capacities for adaptation to climate change. The expressions 'disaster risk reduction' and 'climate change adaptation' represent policy goals, one concerned with an ongoing problem (disasters) and the other with an emerging issue (climate change). While these concerns have different origins, they overlap a great deal through the common factor of weather and climate and use similar tools to monitor, analyse and address adverse consequences. It makes sense, therefore, to consider them and implement them in a systematic and integrated manner.

CCA and DRR share another common feature; they are not sectors in themselves but must be implemented through the policies of other sectors, in particular, those of agriculture, water resources, health, land use, environment, finance and planning. They also have linkages with other policies, most notably, poverty eradication, planning for sustainable development and education.

1.15 Why is Intergration of DRR and CCA essential?

The Hyogo Framework for Action provides the foundation for the implementation of disaster risk reduction. It specifically identifies the need to "promote the integration of risk reduction

Figure 1.13 | Climate Change Impacts



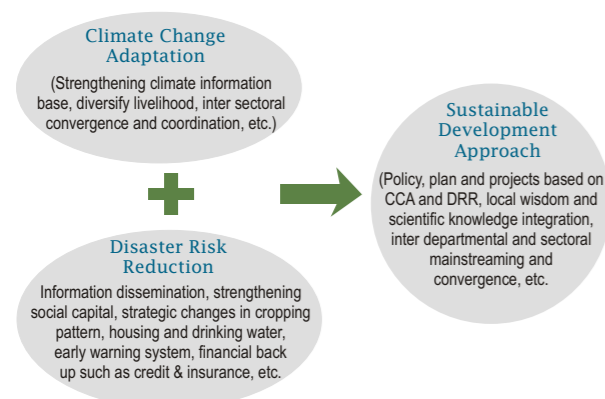
associated with existing climate variability and future climate change into strategies for the reduction of disaster risk and adaptation to climate change”(HFA 2005-15).

In India, DRR and CCA approaches were integrated at national level under India's commitment to Hyogo Framework for Action (HFA 2005-15) which made it mandatory to mainstream climate change component in all developmental themes, plans and departmental policies. Since DRR plan needs collaboration and coordination of all departments in preparedness, timely response and effective post disaster activities, central and state governments have started mainstreaming DRR in all concerned departments. But integration of climate change is still not considered due to lack of knowledge, awareness and capacity of government officials on climate change. It has been widely accepted that the traditional backward looking approach of DRR where plan is developed on the basis of historical information and trends, should also consider future climate projections and anticipated change for better preparedness to cope up with hazard impacts.

1.16 DRR, CCA and Development Connect

Scientific evidence indicates that the current changes in climate will not only increase the number of extreme events, but these will also become more frequent and intense. The anticipated catastrophic impact of climate change may occur in the form of repeated climate disasters of growing intensities that result in higher risks and vulnerability of the poor. Repeated exposure to weather related disasters leaves a long lasting impact on the lives and livelihoods of the poor and marginalized, and is often one of the most common causes of poverty (Snover et.al.2007).

Figure 1.14| CCA, DRR and Development Connect



With frequent climatic changes being felt increasingly, a large population is exposed to the risks of multiple and recurrent natural disasters that reverse decades of development work. This results in slowing down the pace of progress towards poverty reduction. Poverty and vulnerability to disasters are closely linked, as low income groups, the poor & disadvantaged groups are typically more vulnerable to, and also disproportionately affected by disasters. Thus, climate change, sustainable development and DRR closely interlinked.

Some disasters occur as a result of a change in the climate, and even if natural hazards cannot be fully avoided, disasters to a large extent can be avoided by reducing the exposure of communities to the hazard, increasing their capacities to withstand it and/or by reducing their vulnerability (Mehdi, et.al.2006). Developmental plan and policies are now shaped, considering climate change and disasters of that particular region.

1.17 Global Initiatives

The **World Conferences on Disaster Risk Reduction** are a series of United Nations conferences focusing on disaster and climate risk management in the context of sustainable development. The World Conferences were initiated with United Nation Framework Convention on Climate Change (UNFCCC) in 1992 and after that these World Conferences on Natural Disasters have been convened three times hosted by Japan: in Yokohama in 1994, in Kobe in 2005 and in Sendai in 2015. As requested by the UN General Assembly, the United Nations Office for Disaster Risk Reduction (UNISDR) served as the coordinating body for the Second and Third UN World Conference on Disaster Reduction in 2005 and 2015.

1.17. i United Nations Framework Convention on Climate Change (UNFCCC)
The United Nations Framework Convention on Climate Change (UNFCCC) is an international environmental treaty negotiated at the Earth Summit in Rio de Janeiro in June 1992, then entered into force on 21 March 1994. Initially an Intergovernmental Negotiating Committee produced the text of the UNFCCC during its meeting in New York, which was opened for signature on 4 June 1992 at the United Nations Conference on Environment and Development(UNCED) in Rio de Janeiro (known by its popular title, the Earth Summit). On 12 June 1992, 154 nations signed the UNFCCC, to

reduce atmospheric concentrations of greenhouse gases with the goal of "preventing dangerous anthropogenic interference with Earth's climate system". Initially, the framework set no binding limits on greenhouse gas emissions for individual countries and contained no enforcement mechanisms. Instead, the framework outlined how specific international treaties (called "protocols" or "Agreements") may be negotiated to set binding limits on greenhouse gases. One of the first tasks set by the UNFCCC was for signatory nations to establish national greenhouse gas inventories of GHG emissions and removals, which were used to create the 1990 benchmark levels (https://en.wikipedia.org/wiki/United_Nations_Framework_Convention_on_Climate_Change)

Parties to the convention have met annually from 1995, in Conferences of the Parties (COP), to assess the progress in dealing with climate change. In 1997, the Kyoto Protocol was concluded and established legally binding obligations for developed countries to reduce their greenhouse gas emissions during the period 2008-2012. The 2010 Cancun agreements states that future global warming should be limited to below 2.0 °C (3.6 °F) relative to the pre-industrial level. The Protocol was amended in 2012 to encompass the period 2013-2015 in the Doha Amendment, which, as of December 2015, was not entered into force. In December 2015, 197 parties adopted the Paris Agreement which governed emission reductions. The convention enjoys a broad legitimacy, largely due to its nearly universal membership.

The conferences bring together government officials and other stakeholders, such as NGOs, civil society organizations, local government and private sector representatives from around the world to discuss how to strengthen the sustainable development by managing disaster and climate risks. The Third UN World Conference adopted the Sendai Framework for Disaster Risk Reduction 2015-2030, (<http://www.wcdrr.org/preparatory/post2015>). Previous conference outcomes include the Hyogo Framework for Action 2005 2015 (<http://unisdr.org/we/coordinate/hfa>), building the Resilience of Nations and Communities to Disasters in 2005 and the Yokohama Strategy and Plan of Action for a Safer World in 1994.

1.17.ii First World Conference on Natural Disasters in Yokohama:1994
The First World Conference on Natural Disasters in Yokohama, Japan in May 1994 adopted the Yokohama Strategy for a Safer World. It was the main outcome of the mid-term review of the International Decade of Natural Disaster Reduction (IDNDR) and establishes 10 principles for its strategy, a plan of action and a follow-up. Furthermore, it provides guidelines for natural disaster prevention, preparedness and mitigation. Each country bears the primary responsibility for protecting its people, infrastructure, and other national assets from the impact of natural disasters. The international community demonstrated strong political determination required to mobilize adequate and make efficient use of existing resources in the field of natural disaster reduction, bearing in mind the needs of the developing countries, particularly the least developed countries.

The Second World Conference on Disaster Reduction conference was held in Kobe, Japan in January 2005. This conference took on particular poignancy, as it came almost 10 years to the day after the Great Hanshin earthquake in Kobe and less than a month after the 2004 Indian Ocean tsunami. Japan's Emperor Akihito opened the conference and welcomed 4,000 participants from around the world. The World Conference adopted plans to put in place an International Early Warning Programme (IEWP). The goal of the World Conference was to find ways to reduce the toll of disasters through preparation, and ultimately to reduce human casualties.

1.17.iii Hyogo Framework for Action:2005-15
The Hyogo Framework (HFA) was the first plan to explain, describe and detail the work required from all different sectors and actors to reduce disaster losses. It was developed and agreed on with the many partners needed to reduce disaster risk; governments, international agencies, disaster experts and many others, bringing all of them into a common system of coordination. The aim of the frame work is to make disaster risk reduction a priority, to build a culture of safety and resilience and to improve risk information and early warning systems ([http:// unisdr . org/ we/ coordinate/hfa](http://unisdr.org/we/coordinate/hfa)).

1.18.iv Sendai Framework for Disaster Risk Reduction: 2015-2030
The Sendai Framework is a 15-year non-binding agreement which recognizes that the State has the primary role to reduce disaster risk, but this responsibility should be shared with other

stakeholders including local government and the private sector. Its aim is a substantial reduction of disaster risk and losses in lives, livelihoods and health, as also in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries.

This is an improved version of the Hyogo Framework, with a set of common standards, a comprehensive framework with achievable targets, and a legally-based instrument for disaster risk reduction. Member states also emphasized the need to tackle disaster risk reduction and climate change adaptation when setting the Sustainable Development Goals, particularly in light of an insufficient focus on risk reduction and resilience in the original Millennium Development Goals. It emphasized the need to enhance international cooperation to developing countries through adequate and sustainable support, to complement their national actions for implementation of the framework by 2030, and to increase the availability and access to multi-hazard early warning systems to people.

1.18 Regional Initiatives

Following are the national and Chhattisgarh state initiatives :

1.18.i National Action Plan on Climate Change Government of India, June 2008

On June 30, 2008, the then Prime Minister Manmohan Singh released India's first National Action Plan on Climate Change (NAPCC), outlining existing and future policies & programs that address climate mitigation and adaptation. The plan identifies eight core "national missions" running through 2007 and directs ministries to submit detailed implementation plans to the Prime Minister's Council on Climate Change by December 2008.

Emphasizing the overriding priority of maintaining high economic growth rates to raise living standards, the plan "identifies measures that promote our development objectives while also yielding co-benefits for addressing climate change effectively." It says these national measures would be more successful with assistance from developed countries, and pledges that India's per capita greenhouse gas emissions "will at no point exceed that of developed countries even as we pursue our development objectives."

1.18.ii National Missions

The NAPCC aims to promote the development and use of solar energy for power generation and other uses, with the ultimate objective of making solar competitive with fossil-based energy options. Current initiatives are expected to yield savings of 10,000 MW by 2012, through extending the existing Energy Conservation Building Code, urban waste management and recycling, including power production from waste. In the National Mission for a "Green India", goals include the afforestation of 6 million hectares of degraded forest lands and expanding forest cover from 23% to 33%. The plan aims to support climate adaptation in agriculture through the development of climate-resilient crops, expansion of weather insurance mechanisms, and agricultural practices. Likewise, various emphasis and incentives are initiated in the plan to make the country more resilient to climate change.

1.18.iii. Chhattisgarh State Action Plan for Climate Change (CSAPCC)

India's economy and a majority of its population are highly dependent on climate sensitive sectors such as agriculture, animal husbandry, fisheries, tourism, etc. Since climate change is expected to impact natural and human systems adversely by inducing changes in these systems, India can be considered highly vulnerable. Climate change is only likely to exacerbate India's already high physical exposure to climate-related disasters (65% of India is drought prone, 12% flood prone and 8% susceptible to cyclones). As a consequence, climate change is highly likely to impact livelihoods by disrupting social, cultural, economic, ecological systems, physical infrastructure and human assets, accentuating health risks, and as such, posing severe risks to the development of the country.

The Approach paper to the 12th FYP (Five Year Plan) for Chhattisgarh explicitly articulates the need to mainstream climate change concerns into development. It acknowledges that rural areas are the most vulnerable to impacts of disasters and climate change. With a significant population dependent on rain-fed agriculture, animal husbandry, fisheries, and forest-based livelihoods, any change in precipitation and temperature patterns could significantly impact lives of the vulnerable. With variations in recent years manifesting as droughts and floods, the State needs advance preparation to counter such threats and minimize its impact on people and bio/ natural resources. In line with the NAPCC,

the potential climatic change impacts on the state have been assessed for developing a SAPCC.

Based on these threat assessments, in the 12th Plan period, most vulnerable sectors such as agriculture, forestry, mining and energy have to mainstream these climate change concerns in planning and implementation, taking into account their impact on the most vulnerable groups, especially women. Local mechanisms like climate change adaptive planning would also be put in place to help adaptation at the local level. The Chhattisgarh state is adopting the motto "Inclusive Growth for Improved Resilience" for the CSAPCC, to highlight the State's commitment to building resilient human development while maintaining a high economic growth.

Frequently Asked Questions

1. What do you mean by 'weather' and 'climate'?
2. What do we study in climate?
3. What is climate variability?
4. What do you mean by Climate Change?
5. What is 'Green House Effect'? Which are the green house gases?
6. What is Global Warming?
7. What are the impacts of Global Warming?
8. What are the Physical and human causes of climate change?
9. What are the consequences of climate change at global, national and local level of Jashpur District, C.S.
10. What are the major initiatives adopted for Climate change adaptation and Disaster risk reduction?
11. What are the measures have been adapted in our National Action Plan for Climate Change?
12. What do you know about Chhattisgarh State Action Plan for Climate Change?

CHAPTER : 2

Risk and Vulnerability

16

2.1 What is Risk?

It is a probability or threat of damage, injury, liability, loss, or any other negative occurrence that is caused by external or internal hazards, and that may be avoided through preventive action.

Figure 2.1 | Risk of Vulnerability



In the course of increasing global temperature, variability in precipitation and extreme weather phenomena, the Intergovernmental Panel on Climate Change (IPCC) has been founded by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) for a better understanding of climate change and for meeting concerns of these observations. Its main aim is evaluating climate risks and exploring strategies for the prevention of these risks.

2.2 Climate Risk

Climate risk means a risk resulting from climate change and affecting natural and human systems and regions.

2.3 Risks to Climate Change

Climate change is being experienced at global and regional levels. The frequency and severity of extreme events are increasing. In future the impact of climate change will create various climatic hazards which will affect the poor and other vulnerable groups of society disproportionately. Direct risks of climate change are expected especially for those areas that strongly depend on natural resources like agriculture, fishing, forestry, healthcare, real estate and tourism. For example, storms and flooding damage buildings and infrastructure, whereas hot summers with less precipitation cause crop failure. Beside these direct physical climate risks, there are also many indirect derived ones. However, as per current projections of IPCC, the following future risks of climate change are to be expected:

- ◆ Continuous increase in temperature
- ◆ Accumulation of extreme weather phenomena
- ◆ Decreased crops production or crop failure
- ◆ Polar cap and mountain glacier melting
- ◆ Changes in the planet's ecology
- ◆ Loss of biodiversity
- ◆ Spread of diseases

2.4 Risks and Hazards

Risk and hazards are closely related. Risk is an element caused by climate change whereas hazard is its consequence, one which threatens both life and property.

2.5 Types of Risks

2.5.i Livelihood based risk

Due to climate change, natural disasters like flood, droughts are increasing and there is also an upsurge in their severances and frequency.

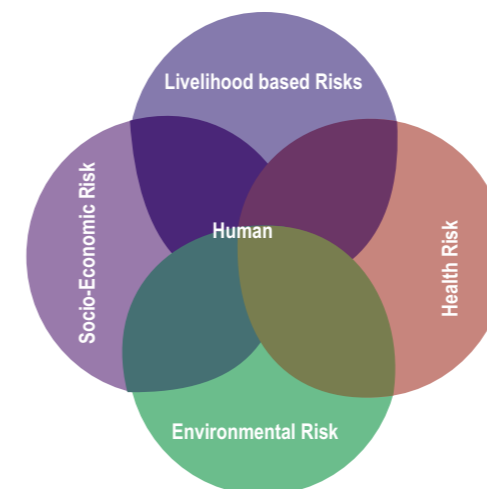
Hence climate hazards are changing their place and time. So areas that were prone to floods and water logging, now face drought due to deficiency of rain. Hence the inhabitants of that area face different problems associated with their livelihood.

- ◆ Flood, drought, storm, excessive rain, cold and hot waves like natural incidents have become prevalent as a result of the climate change. As consequence, farming practices are becoming more erratic and also communities that depended upon forests for their livelihood face similar livelihood problems.
- ◆ Due to climate change, the intensity of hazards is increasing and their impacts on the marginalized people of the society is much larger. With reduced sources of income, they then tend to migrate from rural to urban areas in search of better livelihood.

2.5.ii Environmental risks

- ◆ The environmental risk, especially of temperature rise, due to greenhouse gas emission is exponentially increasing. Humans are making various attempts to cope with variance, even as this increased temperature again boosts the amount of GHG emission, adding to a vicious cycle.
- ◆ Erratic rainfall forces farmers to use more groundwater for irrigation. This further leads to the depletion of surface and groundwater reserves.
- ◆ Change in weather conditions has influenced most of the agricultural activities. Ploughing, transplanting, harvesting and threshing are all mechanized, carried out by fossil fuel dependent machines, which again leads to environmental degradation.

Figure 2.2 | Types of Vulnerability



Example: In case of flood prone areas, small and marginal farmers are considered to be the most vulnerable section, due to direct exposure of floods on their crops. They are not able to migrate as easily as other communities, for better livelihood options. In this situation, vulnerability can be assessed at local level in present and future context through available past information and anticipated future climate information.

- ◆ Different types of diseases, pests and insects are affecting crops and trees in different ways. As a response to it, farmers use more and more chemical fertilizers and pesticides which are also sources of environmental degradation. To meet the needs of a growing population, more forest areas are being converted into agricultural land, which too alters the existing natural ecosystem, and becomes an added factor for environmental hazards.

2.5.iii Socio-economic Risks

Climate change and hazards also have a correlation with cultural risk. The repletion of hazards and diminishing land productivity, coupled with the competition for finite resources, especially land, is increasing. This is a major cause of social conflict and poverty. As a consequence, the youth migrate to other areas and cities in search of basic livelihood. Thus their traditional ways of earning for living are disappearing very fast. These migrants then become totally cut off from their villages, both in society and tradition.

2.5.iv Health Risks

The continuous recurrence of climatic hazards and their increasing severeness badly affects both animal and human health. Their impact on the marginalized people in the community, especially women, poor or those at a social disadvantage, is much higher. Likewise crops and trees suffer from various diseases that further reduce product yield. Drought conditions are a source of increased dust particle in the atmosphere, which become the cause of various respiratory diseases like asthma and TB.

17

2.6 What is Vulnerability?

Vulnerability describes the characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard.

2.7 What is Climate Vulnerability?

It is defined as “the degree to which a system is susceptible to, and unable to cope with, the adverse effects of climate change, including climate variability and extremes.” Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity (IPCC, 2007).

Exposure could include geographical location, especially related to high exposure to risks (i.e., people living in the areas of natural disasters such as droughts, or coastal areas and river basins affected by floods). There are many aspects of vulnerability, arising from various physical, social, economic, and environmental factors. A few examples include:

- ◆ Poor design and construction of buildings
- ◆ Inadequate protection of assets
- ◆ Lack of public information and awareness
- ◆ Limited official recognition of risks and preparedness measures
- ◆ Disregard for wise environmental management

As per IPCC (IPCC, 2007) definition, the components of vulnerabilities are:

- ◆ Exposure
- ◆ Sensitivity
- ◆ Adaptive capacity

Vulnerability can also be generally described as the potential for loss. In the past, vulnerability has led to physical susceptibility. However understanding of this concept is now more comprehensive and includes susceptibility, exposure, coping capacity, adaptive capacity, social inequality and physical, institutional & economic weakness.

2.8 Vulnerabilities and Climate Change

Vulnerability is caused mainly by the exposure of hazard and the socio-economic conditions of the affected community. It is important that the vulnerability of the area and the most vulnerable groups are understood before starting the DRR interventions. The limitation of resources and also demands that the most vulnerable communities are addressed on a priority basis. In virtually all situations,

different groups face different levels of risk, in relation to specific hazards. A tangible example is the tendency of poor populations to cluster in high-risk areas such as urban and rural flood plains. As a result, they have a far higher level of vulnerability to flooding than groups living in less hazard prone areas.

Interventions to mitigate flooding can be designed that meet the needs of such groups. However, in many cases interventions that might “benefit” the larger society as a whole actually increase the risk some other groups face. The fact that interventions often have differential effects, or may not reach specific groups, is common across most hazards and contexts. In many situations, the factors causing vulnerability are not as direct or immediately evident as in the flooding. Instead, vulnerability may be related to culturally based gender differences (women can be more vulnerable to floods due to cultural inhibitions on swimming or clothing styles), differential access to basic services (you cannot call for help as effectively if you do not own a phone), and a host of other factors. As a result, clear understanding of patterns of vulnerability is essential to identify effective risk reduction strategies.

This understanding needs to move beyond the immediately evident exposure to specific hazards and address deeper systemic factors that shape risk for different groups. Furthermore, it is important for approaches to vulnerability analysis to be based on common metrics like indices, maps and disaggregated data, in order to provide an effective basis for planning and decision making to address the specific vulnerability. At present, most approaches to vulnerability analysis are narrative based. Because of this, they are difficult to map in ways that illustrate the concentration or diffusion of vulnerable groups. They are also difficult to aggregate and disaggregate in ways that assist in identifying common factors contributing to vulnerability across large areas or multiple groups.

2.9 Types of Vulnerability

2.9.i Physical vulnerability

The physical vulnerability of an area depends on its geographic proximity to the source and origin of the disaster. For instance, if an area lies near a river, coast line, fault line, unstable hill slope etc. the effect will be more pronounced as the area is more vulnerable in comparison to a location far away from the origin of the disaster. Physical

vulnerability includes the difficulty in access to water resources, means of communication, hospitals, police stations, fire brigades, roads, bridges and exits of a building in case of disasters. Furthermore, the lack of proper planning and implementation in construction of residential and commercial buildings results the buildings that are weaker and more vulnerable in earthquakes, floods, landslides and other hazards.

2.9.ii Economic vulnerability

Economic vulnerability of a community can be assessed by determining how varied its sources of income are, the ease of access and control over means of production (e.g. farmland, livestock, irrigation, capital etc.), adequacy of economic fall back mechanisms and the availability of natural resources in the area.

2.9.iii Social vulnerability

A socially vulnerable community has weak family structures, lack of leadership for decision making and conflict resolution, unequal participation in decision making, weak or no community organizations, and also where people are discriminated on the basis of race, ethnicity, language or region. Other social factors such as culture, tradition, religion, local norms and values, economic standards and political accountability also play a vital role in determining the social vulnerability of a community.

Social vulnerability to natural phenomena is greatest among the poorest people in developing countries, owing to a lack of information and resources with which to take appropriate measures. Within this group, children, women and the elderly are considered to be the most vulnerable. To reduce this, all of the above factors must be addressed. But this requires knowledge and understanding of the local conditions, which can, in most cases, only be provided by local actors.

2.9.iv Attitudinal vulnerability

A community which has a negative attitude towards change and lacks initiative in life, resultantly become more and more dependent on external support, unable to act independently. Their sources of livelihood are limited and without variety, lack of entrepreneurship and they do not possess the concept of collectivism. This brings about a disunity and individualism in the society and they become victims of conflict, hopelessness and pessimism, which further reduce their capacity of coping with a disaster.

2.10 Factors that Impact Vulnerability

The magnitude of each hazard is measured in terms of human and animal deaths and loss of assets. Factors that determine vulnerability are as follows:

2.10.i Poverty: Wealthier people either remain unaffected or survive even after the disaster, and are able to recover quickly, while poverty generally makes people more vulnerable to all impacts of the hazard.

2.10.ii Population growth: If disaster strikes in a more populated region, the impact will be greater. More number of poor people will be forced to live and work in unsafe areas and compete for limited resources, which may result in crisis induced social unrest and migration.

2.10.iii Rapid urbanization: People from rural hinterlands are forced to migrate to urban areas and settle in disadvantageous areas, as they find fewer options for safe places available to build their homes. Here again competition for scarce resources can lead to human made hazards.

2.10.iv Transition and culture: Societies are constantly changing and are in a continuous state of transition. These are often extremely disruptive and unequal, and face gaps in social coping mechanism and technology.

2.10.v Environmental degradation: Hazards are either caused or exacerbated by climate change and environmental degradation, such as deforestation, that lead to soil erosion during heavy rain. Drought conditions may be exacerbated by deforestation, over grazing, stripping of top soil, poor conservation techniques and depletion of both the surface and subsurface water supply.

2.10.vi Lack of awareness: Hazards also happen due to low awareness levels among people about the coping measures to deal with disasters.

2.11 Approaches to Hazards Assessment

◆ Geographical

This method is widely used and emphasis is given to assess the spatio-temporal distribution of hazard impacts and vulnerability.

◆ Anthropological

This approach is focused on the role of disaster in guiding the socio-economic

condition of population. This has forced the anthropologists to search for threshold points through which a community can provide basic requirements for survival of their members.

- ◆ **Sociological**
In this vulnerability an impacts are considered in terms of human behavior pattern and the effects of disaster on human community.
- ◆ **Developmental**
This considers problems of providing aid and relief, health care and avoidance of starvation. The prevailing poverty of the region increases human vulnerability to natural hazards.
- ◆ **Disaster epidemiology**
It focuses on the management of mass causalities, treatment of physical trauma and the epidemiology of communicable diseases whose incidence rate may increase during destruction of public health facilities.
- ◆ **Technical Approach**
Natural and physical scientists emphasize on this approach in which emphasis is give

on the technological, especially the geomorphological and geological approach to disaster.

2.12 Assessment of Vulnerability

Recognizing or assessing risk and vulnerability to climate change is the first step towards CCA and DRR actions. Methods of vulnerability assessment have been developed in context of different natural hazards. Vulnerability varies according to hazards, human ecology and social changes. Each hazard possess different risks to communities at different levels, hence it is not possible to propose a single vulnerability assessment methodology.

Assessing vulnerability to climate change is important for defining the risks posed by climate change, and it provides information for identifying measures to adapt to climate change impacts. It enables practitioners and decision-makers to identify the most vulnerable areas, sectors and social groups. In turn, this means CCA options targeted at specified contexts, can be developed and implemented.

Over the past decades, methods of vulnerability assessment have been developed in a wide range of development related fields, ranging from natural hazards research, food security research and poverty analysis, to sustainable livelihoods research and related fields. Several conceptual models have been developed to give environmental managers a framework for understanding vulnerability to natural disasters (for example, Anderson & Woodrow, 1998; Blaikie, et al., 1994; Twigg, 2001). Experiences with these frameworks suggest that vulnerability is a complex subject that has many dimensions (economic, social, political and geographic), which may often have overlapping effects, which make it difficult to tease out the precise cause-effect relationship.

The impacts and the vulnerabilities to climate change can vary across regions (e.g. global, national, sub-national and local level), economic sectors (e.g. agriculture, industry and services) social groups (e.g. urban populations, forest dwellers, coastal communities) or types of system considered (e.g. natural, social, economic, socio-ecological). Given these circumstances, the development of any one-size-fits-all solution for assessing vulnerability to climate change is problematic (Hinkel, 2011).

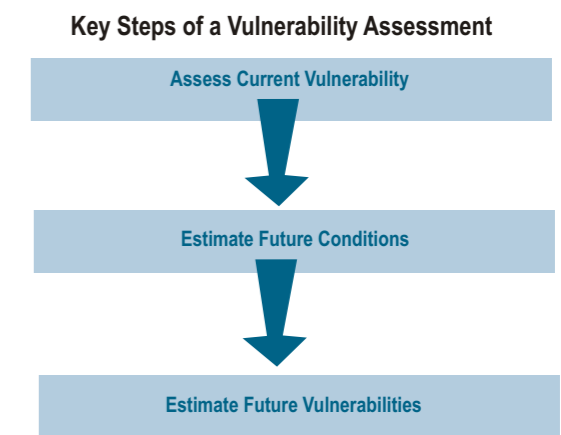
2.13 Methodology for Vulnerability Assessment

In general, a vulnerability assessment has been categorized into 3 steps by the Canadian Climate Impacts and Adaptation Research Network (C-CIARN) as illustrated in figure 2.3 (Snover et.al.2007).

2.13.i First Step: Assessment of Current Vulnerability

This step identifies the system's vulnerabilities to existing stressors, which include relevant climate conditions that currently affect the system. This includes the variation in temperature, precipitation and humidity. The current vulnerabilities are apt to be affected by a complex number of factors including environmental (extreme weather), social (policy changes) and economic (market changes) factors (Mehdi et al., 2006). This step may draw heavily from historical data, experience, and past climate events to provide further insight into the potential responses and vulnerabilities of the system (Mehdi et al., 2006).

Figure 2.3| Key Steps



2.13.ii Second step: Estimate Future Conditions

The future climate change effects within the assessment area are projected for a particular time period to determine the potential changes in relevant climate variables and climate variability and their expected impacts.

2.13.iii Third step: Estimate Future Vulnerabilities

The vulnerability of a system to climate change can be determined on the basis of estimating sensitivity of the system to climate change. This step will draw from the findings of step two which describes how the projected climate effects scenario the current and newly introduced system stressors, and then uses this information to identify system vulnerabilities and their priority, which will enable decision makers to prioritize future impacts.

In addition, estimates of vulnerability will include the system's adaptive capacity (i.e., how can the system sustain climate effects with minimum disruption or cost). Once future vulnerabilities are assessed, adaptive approaches can be developed in response to the increased vulnerabilities or new opportunities. The CCA and DRR strategies can then be identified and implemented to make the region resilient to climate change.

It is obvious that climate change impacts both human life and the natural ecosystems, for which CCA and DRR strategies need to be adopted to mitigate their adverse effects.

Jashpur Vulnerability : A Case Study

Agriculture is the mainstay of the economy of Jashpur district of Chhattisgarh state. A major proportion of population of the region is poor and involved in agricultural production. This is typically supplemented by other activities, such as seasonal migration, handicrafts & mat making, animal husbandry, goat and sheep rearing, collection of forest produces from nearby forests and small scale trading.

Drought and increase in temperature has received the most attention here. Paddy is the main crop of sustenance but due to recurrent droughts, production has been impacted. This also exacerbated the vulnerability of the population, as alternative sources of income could not cover the reduction in agricultural production. So drought led to widespread famines and periods of hunger and nutritional stress.

In addition to drought; hail, lightning and storm during monsoon are pervasive threats to agricultural productivity and livelihoods not only in Jashpur but throughout the state. People are able to cope better when they use terraces to control soil erosion and small-scale water collection systems; or diversify their income sources, perhaps by purchasing tools for a specific job, like construction. Such investments also help reduce vulnerability and improve overall livelihood security. Finally, in terms of actual sensitivity and extent of vulnerability, substantial differences exist among the poor as a population; and more differences appear when comparing farming systems, urban and rural livelihoods, gender, households or household members.

Frequently Asked Questions

1. What are the risks caused by climate change?
2. Mention types of risks caused by climate change?
3. What do you mean by vulnerability caused by climate change?
4. What are the various types of vulnerability caused by climate change?
5. Name the factors impacting the vulnerability?
6. What are the steps for assessment of vulnerability of any region or society?

CHAPTER : 3

Understanding Mitigation, Adaptation, Resilience and Disaster Risk Reduction

3.1 What is Mitigation?

Mitigation is defined by the IPCC as “an anthropogenic intervention to reduce the anthropogenic forcing of the climate system; it includes strategies to reduce greenhouse gas sources and emissions and enhancing greenhouse gas sinks” (IPCC, 2007). Examples of mitigation actions include:

- More efficient furnace systems
- Developing new low energy technologies for industry and transport
- Reducing consumption of energy-intensive products
- Switching to renewable forms of energy (green energy), such as solar & wind power
- Managing natural carbon sinks, such as forests, vegetation and soils, to absorb carbon dioxide
- Developing technologies to capture carbon dioxide at industrial sources and injecting it into permanent storage deep underground

Countries are actively discussing and negotiating ways to deal with climate change problem, within the UNFCCC (https://en.wikipedia.org/wiki/United_Nations_Framework_Convention_on_Climate_Change). The first task is to address the root cause by reducing greenhouse gas emissions due to human activity. The means to achieve this are very contentious, as it will require radical changes in the way many societies are organized, especially in respect to fossil fuel use, industry operations, urban development and land use. Within the climate change arena, the reduction of greenhouse gas emissions is called “mitigation” (IPCC, 2007).

3.2. What is `Adaptation?

“Taking steps to cope with the changed climate conditions is called adaptation”. Adaptation is defined by the IPCC as “the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities” (IPCC, 2007). Examples of adaptation include:

- Preparing risk assessments
- Protecting ecosystems
- Improving agricultural methods
- Managing water resources
- Building settlements in safe zones and instituting better building designs
- Developing early warning systems
- Improving insurance coverage
- Developing social safety nets

These measures are intrinsically linked to sustainable development, as they reduce the risk to lives & livelihoods and increase the resilience of communities towards all hazards. Ideally, adaptation and mitigation should be considered jointly, as some adaptation measures can contribute to reducing greenhouse gas emissions, while conversely mitigation measures can be planned to help reduce, and not inadvertently exacerbate disaster risks.

3.3 What is `Disaster Risk Reduction'?

'Disaster risk reduction' can be defined as “action taken to reduce the risk of disasters and the adverse impacts of natural hazards, through systematic efforts to analyse and manage the causes of disasters, including through avoidance of hazards, reduced social and economic vulnerability to hazards, and improved preparedness for adverse events”. Reducing risk

disaster is closely associated to the adaptation process. The disaster preparation cycle is a part of a continuous cycle of activities which moves from disasters events through recovery (damage mitigation) and risk reduction preparation. There are many of elements that reduce the vulnerability of the society, such as:

- Land use and other planning
- Insurance
- Development of early warning systems
- Strengthening of resilience activities
- Proper planning for disaster preparation
- Strengthening physical structure, infrastructure, assets and capacities of society
- To focus on reducing fragility, and enabling societies to adopt variables & changing conditions due to climate change

3.4 Examples for DRR Measures

3.4.i Agriculture and food security: In the agricultural sector, well-known measures include:

- Alternating crop pattern to enhance resistance to drought conditions and pest assault
- Changing planting times, altering land topography to improve water uptake
- Reducing wind erosion
- Some countries are researching new drought resistant millet for decreased rainfall regimes
- Diversifying and multilayer cropping
- Integrating of food crops, livestock and agro-forestry.
- Introduction of insurance schemes to help people cope with crop losses

3.4.ii Water sector

In this sector the measures include actions on both water supply and water risks, which are:

- Protecting water supply infrastructure
- Improving of traditional water supply sources
- Developing water ponds
- Water harvesting
- Improving irrigation system(Drip or trickle & sprinkle)
- Desalination
- Non-water-based sanitation
- Improved watershed and trans-boundary water resource management
- Integrated water resource management (IWRM)

3.4.iii Health sector: Measures to protect the population from adverse impacts of climate change on health include:

- Early warning systems
- Weather proof dress system to address extreme weather events
- Systematic action on water and vector-borne diseases
- Raise public awareness for safe water and food-handling
- Vector control campaign
- Enforcement of relevant regulations and support for education, research and development on climate-related health risks

As an example, in Ahmadabad (Gujarat) a study was carried out about response to the heat related deaths and other consequences of excessive heat during the summer of 2013. The public were made aware about a response programme to reduce the number of fatalities that could be caused by future heat waves.

3.5 Awareness Raising and Education

Measures include curriculum development for schools, supply of information to community groups and women's networks, radio and television programmes, public poster campaigns, and leadership by national figures and celebrities. Raising awareness for strategic intermediaries such as teachers, journalists and politicians, as well as support to technical experts and groups is also important.

3.6 Environmental Management

Healthy ecosystems provide significant benefits for resilience, livelihoods, risk reduction and adaptive capacity. Measures include strengthening of environmental management in areas of greatest risk from weather hazards; protecting ecosystems, such as water channels and storage; forest cover supporting transitions of livelihoods away from those that degrade environments and aggravate risk; and enforcing regulations concerning these practices.

3.7 Early Warning Systems

Measures include improving existing systems to cover the changed hazard circumstances, instituting specific means to disseminate warnings to affected people in a timely, useful and understandable way, and providing advice on appropriate actions to take upon receiving warnings. Epidemic or disease outbreak early warning systems, for instance, have been developed in Surat (Gujarat) for warning and grievance redressal in health, hygiene and disease areas.

3.8 Development Planning and Practices

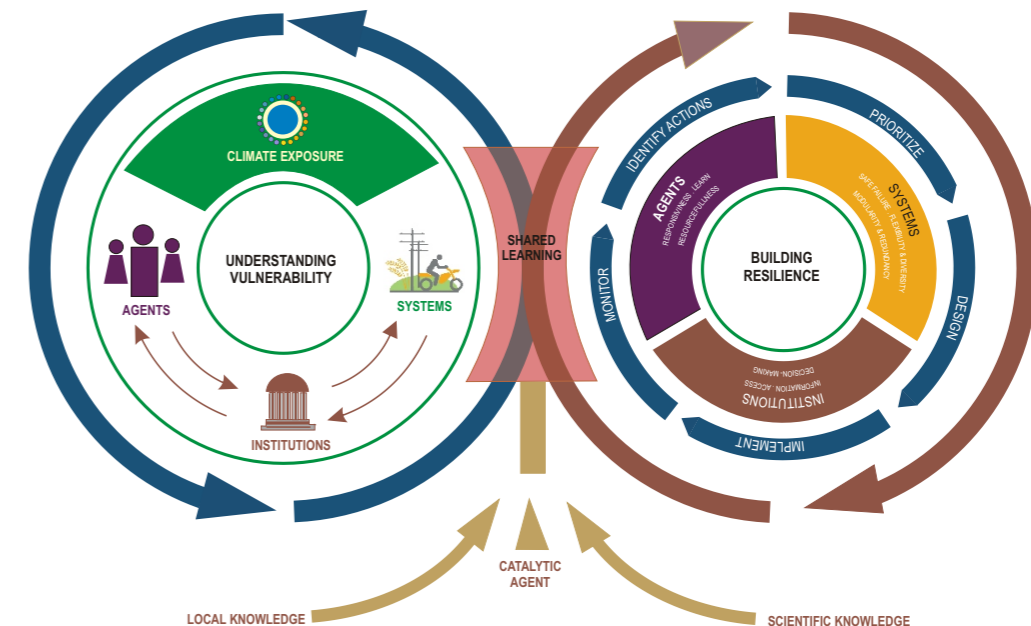
Adaptation and disaster risk reduction measures can be made a formal part of development processes & budgets, and programmed into relevant sector projects. For example in the design of settlements, infrastructure, agricultural development, forest use, etc., all these factors must be considered, in order to achieve sustainable land management, avoid hazardous areas, and build safe schools, hospitals and other public facilities.

Based on a review of past successes and failures in reducing disaster risks, the Hyogo Framework sets out five priorities for action, each elaborated into a number of specific areas of attention. Risk reduction strategies, including risk sharing and transfer mechanisms. These offer a strong basis for developing concrete risk-reducing and adaptation measures.

3.9 Disaster Risk Reduction and the UNFCCC Initiatives

The UNFCCC Parties have recognized that existing knowledge and capacities for coping with extreme weather events must be harnessed to adapt to climate change (https://en.wikipedia.org/wiki/United_Nations_Framework_Convention_on_Climate_Change). Bali Action Plan's directions for adaptation calls for the consideration of disaster reduction strategies and means to address loss and damage associated with climate change impacts in developing countries that are particularly vulnerable to the adverse effects of climate change (www.iisd.ca/climate/cop13/).

Figure 3.1 | Climate Resilience Framework (CRF)



Also, many of the general principles and requirements for adaptation that are listed in the Bali Action Plan are highly relevant to reducing disaster risk, particularly vulnerability assessments, capacity-building and response strategies, as well as integration of actions into sectoral and national planning.

3.10 What is 'Resilience'?

The term resilience means 'bounce back'. In term of climate change, the term resilience is the capacity of an individual, community, or institution to dynamically and effectively respond to shifting climate impact circumstances. It includes the ability to understand potential impacts and to take appropriate action before, during, and after a particular consequence to minimize negative effects and maintain the ability to respond to changing climate conditions. In the context of hazards, the concept of resilience overlaps other concepts such as hazard mitigation and disaster resistance.

3.11 Climate Change Resilience Framework (CRF)

The Climate Resilience Framework (CRF) is a conceptual planning approach to building resilience to climate change. It is designed for practical application by Institute for Social and Environmental Transition (ISET). The Framework addresses the need for an approach that clarifies complex sources of vulnerability and addresses the complexities of climate adaptation (i-s-e-t.org/projects/crf.html). The CRF is structured to build a broad understanding

of resilience by describing the characteristics of **systems, the agents** (people and organisations) **institutions** (laws, policies and cultural norms). It operationalizes these concepts through structured and iterative shared learning approaches that allow local planners to define these factors in their own context, in order to develop practical strategies for local action.

The CRF is composed of 4 main elements, as shown in Figure 3.1, inputs to the process are at the bottom of the figure; a detailed assessment of vulnerability; and, a resilience building component - all facilitated through a shared learning process.

The entry point into the resilience building process is at the bottom of the diagram, where arrows indicate inputs of local knowledge, scientific knowledge, and a catalytic agent who initiates the process. The 'catalytic agent' is intended to be a broad, high capacity organization that can provide training and methodological support to local NGOs or organizations that will directly engage local communities in the local language.

The **left-hand loop** of the CRF guides users through an assessment of who and what is vulnerable, why they are vulnerable, and what factors hold that vulnerability in place. This assessment is structured through assessment of four key elements: systems (both infrastructure and ecosystems), social agents, and institutions (laws, policies and social norms), and, for each, the degree to which they are exposed to climate change hazards.

The **right-hand loop** of the Framework guides users through developing possible adaptation or resilience building actions to address the vulnerabilities identified in the left-hand loop. Actions are prioritized and implemented, and development of resilience indicators and follow-up monitoring is used to learn from the implementation. Institutions could address the constrain effective responses to system fragility, or undermine the ability to build agent capacity.

3.12 Characteristic of Resilience

The attributes of the resilience of a system, agent and institution are explained in the box :

Flexibility

The ability to change, evolve and adopt alternative strategies (in either short or longer term) in response to changing conditions. Flexibility implies recognizing when it is not possible to return to the previous way things worked and finding new solutions and strategies (evolution). This favors 'soft' rather than 'hard' solutions.

Redundancy

Spare capacity to accommodate increasing demand or extreme pressures. Redundancy is about diversity and the ability to adopt alternative strategies through the provision of multiple pathways and a variety of options. Some components of the urban system serve similar functions and can provide substitute services when another component is disrupted.

Resourcefulness

The capacity to visualize and act, to identify problems, to establish priorities and mobilize resources when conditions exist that threaten to disrupt an element of the system. This capacity is related to the ability to mobilize assets (financial, physical, social, environmental, technology, information) and human resources to meet established priorities and achieve goals.

Safe failure

Resilient network infrastructure is designed for safe failure. This is related to its ability to absorb shocks and the cumulative effects of slow-onset challenges in ways that avoid catastrophic failure if thresholds are exceeded. When a part of the system fails it does so progressively rather than suddenly, with minimal impact to other systems. Failure itself is accepted.

Responsiveness

The ability to re-organize, to re-establish function and sense of order following a failure. Rapidity is a key part of responsiveness in order to contain losses and avoid further disruption. However, such rapidity of response should not impair the capacity to learn, and therefore a balance between learning and rapidity should be achieved.

Learn

Direct experience and failure plays a key role in triggering learning processes. Individuals and institutions should have the ability to internalize past experience and failures, and use such experience to avoid repeating past mistakes and exercise caution in future decisions.

3.13 Assessment of Disaster Resilience

Resilience has gained prominence as a framework for measuring the capacity of systems, including centre and regions, to bounce back from shocks of many kinds, from long-term economic events such as de-industrialization or the foreclosure crisis to immediate shocks such as natural disasters. Multidisciplinary Center for Earthquake Engineering Research (MCEER) at the University of Buffalo developed the metrics for assessing disaster resilience, which they defined as "the ability of social units (e.g., organizations, communities) to mitigate hazards, contain the effects of disasters when they occur, and carry out recovery activities in ways that minimize social disruption and mitigate the effects of future disasters." ISET has also developed in its resilience framework, 'R4', which postulates that resilience is determined by four attributes:

3.13.i Robustness, "the ability...to withstand disaster forces without significant degradation or loss of performance"

3.13.ii Redundancy, "the extent to which systems are substitutable, that is, capable of satisfying functional requirements, if significant degradation or loss of functionality occurs"

3.13.iii Resourcefulness, "the ability to diagnose and prioritize problems and to initiate solutions by identifying and mobilizing resources"

3.13.iv Rapidity, "the capacity to restore functionality in a timely way, containing losses and avoiding disruptions."

The R4 resilience framework and other similar efforts to categorize disaster resilience are the focus of many academics and practitioners, particularly planners, who are developing best practice guidelines for hazard mitigation strategies that improve resilience.

Frequently Asked Questions

1. What is climate change impact mitigation?
2. What do you mean by 'Climate Change Adaptation' and 'Disaster risk Reduction'?
3. What are the measures for climate change adaptation?
4. What are the measures to be adapted for disaster risk reduction?
5. What do you know about the climate resilience?

CHAPTER : 4

Understanding Livelihood System

Livelihood is defined as a set of activities, involving securing water, food, fodder, medicine, shelter, clothing and the capacity to acquire above necessities working either individually or as a group by using endowments (both human and material) for meeting the requirements of the self and his/her household on a sustainable basis. Hence a person's **livelihood** refers to their "means of securing the basic necessities- food, water, shelter and clothing of life". Such activities are usually carried out repeatedly. For instance, a farmer's livelihood depends on the availability of cultivable land and accessibility of other requirements for farming.

Livelihood varies from place to place on the basis of physical environment & resources and the socio-cultural & technical capability of the society. Most of the livelihood depends upon the geographical conditions especially geological structure and physiography, climatic conditions, availability of natural resources like water, soil, mineral and bio resources- flora and fauna which differ from region to region resulting in different types of livelihood. The change in a place or environment, livelihood pattern, its priorities, the selection and the dependency of the society; thus all gets changed accordingly.

Figure 4.1 | Rural and Urban Livelihood



The major sources of livelihood are:

- Rural Livelihood: Farming; gardening and plantation agriculture; animal husbandry; cattle, goat, sheep and pig rearing; poultry farming; sericulture; apiculture; marine fisheries; off shore and deep sea fisheries; inland fisheries; pearl fisheries; forestry and forest gathering; hunting and mining.
- Urban Livelihood: Industries, service providing, commerce, retail & wholesale and many more.

A rural household which owns a small amount of land and has household members with skills in traditional farming, but who has no education, no savings, and poor access to markets, will probably be limited to making a living from subsistence rain-fed agriculture alone. However, a household with more extensive land, access to water resources, additional skills in food processing and some savings to risk investing in a business opportunity, could develop a range of agricultural and non-agricultural livelihood options. They will always have alternatives to fall back on in times of need or crisis. However, there are a certain basic components or assets required to make a living.

There is a change in livelihood pattern of urban and rural areas too. In rural areas, the primary activities are the main source of livelihood with minor share of industries and tertiary activities; while in urban areas, the livelihood is influenced by the secondary and tertiary activities which are industries, commerce and services. Some of the families based on their socio-economic condition have more than one option for their livelihood, but poor and vulnerable groups of households have a very limited option, which is usually farming, working as farm labor or a laborer in other economic activities.

Spatial patterns of livelihood systems are determined by the production, distribution, and consumption of goods and services. The patterns of livelihood reflect differing physical potentials and cultural development, including technological levels, political decisions, and other societal variables. Livelihood may be classified by way of production or service marked by the use of physical environmental bases. The livelihood of a region depends upon its economy which can be divided into various sectors to define the proportion of the population engaged in the activity sector. This categorization is seen as a continuum of distance from the natural environment which is as follows:

4.1 Primary Sector

The primary sector of the economy extracts or harvests products from the earth. The primary sector includes the production of raw material

and basic foods. Activities associated with the primary sector include agriculture (both subsistence and commercial), mining, forestry, farming, grazing, hunting and gathering, fishing, and quarrying. In developing countries, a decreasing proportion of workers are involved in the primary sector, while in developed countries its share is the least.

4.2 Secondary Sector

All of the manufacturing, processing, and construction lies within the secondary sector. Activities associated with the secondary sector include metal working and smelting, automobile production, textile production, chemical and engineering industries, aerospace manufacturing, energy utilities, engineering, breweries and bottlers, construction and shipbuilding.

4.3 Tertiary Sector

The tertiary sector of the economy is the commercial and service industry. This sector provides services to the general population and to businesses. Activities associated with this sector include retail and wholesale sales, transportation and distribution, entertainment (movies, television, radio, music, theater, etc.), restaurants, clerical services, media, tourism, insurance, banking, healthcare, law and cultural activities, education and research. Some consider there to be a branch of the tertiary sector called quaternary and the quinary sector. Activities associated with this sector include government, culture, libraries, scientific research, education, and information technology while quinary sector includes the highest levels of decision making in a society or economy. This sector would include the top executives or officials in such fields as government, science, universities, nonprofit, healthcare, culture, and the media. In most developed and developing countries, a growing proportion of workers are devoted to the tertiary sector.

4.4 Major Economic Systems for Livelihood

Three major types of economic systems may be recognized:

1. Subsistence: Where goods and services produced are consumed by the family of the producer
2. Commercial: Where production is for the competitive market
3. Planned: Where production amounts and prices are administratively controlled.

Some of the major livelihood systems are as follows:

Agriculture

Crop production and livestock rearing is the most widespread primary activity, occurring wherever environmental conditions permit. Nomadic herding and shifting cultivation are extensive subsistence agriculture variants, the former involving large land and low capital & labour inputs, while the latter needs relatively high labour inputs in rotating small plot cultivation. Intensive subsistence farming features very large labour and fertilizer inputs on permanent small plots. The population pressures have caused the extension of agriculture onto marginal areas, with often serious environmental deterioration.

Forestry, fishing, mining and quarrying

These are other forms of primary economic activities. Their development depends on the occurrence of perceived resources and the technology to exploit them.

Manufacturing and service sectors

They are the secondary and tertiary sectors of activities that provide livelihood.

4.5 Impact of Climate Change on Livelihood

As it has been described in the above sections, climate change includes changes in average temperatures, rainfall, and climate extremes (e.g., heat waves, Cold wave); changes in pests and diseases; changes in GHGs. All these changes have profound impacts on the livelihood system. In the following paragraphs we will assess the impact of climate change on different livelihood systems.

4.5.i Farm based livelihood system

Agriculture is an important sector of the world economy. As this system of livelihood is highly susceptible to variation of climatic condition, so it also affects wide proportion of population in any region. Though increases in temperature and carbon dioxide (CO₂) can be beneficial for some crops in some places, but to realize these benefits, nutrient levels, soil moisture, water availability, and other conditions must also be met. Changes in the frequency and severity of droughts and floods could pose challenges for farmers and ranchers.

Overall, climate change could make it more difficult to grow crops, raise animals, grow food and catch fish. Simultaneously, it also brings

about a change in farming practices and technology. Also, the frequency and intensity of extreme weather could have significant impacts on crop yields. Warmer temperatures may make some crops mature faster, but it could also reduce the crop yield.

4.5.ii Forest based livelihood system

Forests also provide livelihood means for millions of people. Apart from the direct visible effects of drought, storms, fire and insect infestation induced by climate change, it also hurts the productivity of managed forests. It is assessed from several studies that climate change will affect both the supply and demand for forests products. Climate change could lead to a massive destruction of forests and the extinction of countless species. Global warming is likely to impact the habitat of trees, alter the composition of species, and increase the extent of forest fires. In some regions, increased CO₂ levels and other factors have led to forest growth.

4.5.iii Non- farm livelihood system

Climate change, especially extreme weather events like heavy rain, drought, cold and heat waves will affect other activities for livelihood like mining, industries and tertiary activities, as adverse weather conditions impact human ability & performance, and finally lessen the output and quality of products. To counter this some measures will have to be adopted to minimize the impacts, which include air conditioning and heating devices that in turn will consume more energy and cause greater emission of CO₂, adding to global warming.

4.6 Sustainable and Alternative Livelihood Options

Rapidly changing environmental, social and economic drivers, such as climate change, are threatening ecosystems, the services they provide and the livelihoods of those dependent on these services. Enhanced socio-economic sustainability will ensure that livelihood options are available in a changing environment, and can support dependent communities. The key to understand this is

- (i) Ecosystem services that underpin livelihoods
- (ii) Relationships between climate and livelihood activities

This understanding can help identify socio-economic conditions likely to influence the capacity of communities to take advantage of alternative livelihood activities like aquaculture

or animal husbandry. Ultimately, enhanced and diversified income opportunities are needed that can be maintained under a changing climate.

4.7 Sustainable Livelihoods Framework (DFID)

In 1992 Robert Chambers and Gordon Conway (*Chambers, Robert and Gordon Conway. IDS Discussion Paper 296, February 1992*) proposed the definition of a sustainable livelihood, which is applied most commonly at the household level that *"A livelihood comprises the capabilities, assets (stores, resources, claims and access) and activities required for a means of living; a livelihood is sustainable which can cope with and recover from stress and shocks, maintain or enhance its capabilities and assets, and provide sustainable livelihood opportunities for the next generation; and which contributes net benefits to other livelihoods at the local and global levels and in the short and long term (www.ids.ac.uk/livelihoods.html)."*

It is now recognized that more attention must be paid to the various factors and processes which either constrain or enhance poor people's ability to make a living in an economically, ecologically, and socially sound and sustainable manner. The Sustainable Livelihood concept offers a more coherent and integrated approach to poverty. The sustainable livelihoods idea was first introduced by the Brundtland Commission on Environment and Development, and the 1992 United Nations Conference on Environment and Development which expanded the concept, advocating for the achievement of sustainable livelihoods as a broad goal for poverty eradication (UNDP. Promote Sustainable Livelihood; a brief note, June, 1997).

For sustainable livelihood, CARIBSAVE (Caribbean Sectoral Approach to Vulnerability and Resilience) works to support and enhance livelihoods, economies and environments around the world, in an era of global climatic and environmental change. One of their core thematic study areas is "Society and Livelihoods for reducing poverty, building capacity and enhancing livelihoods, through participatory engagement of communities, governments and the private sector". Likewise The Sustainable Livelihoods Enhancement and Diversification (SLED) approach was also developed by the UK based consultancy IMM Ltd. The SLED approach builds on the lessons of past livelihoods research projects and worldwide experience in livelihood improvement and participatory

development practice. The approach aims to provide a set of guidance for managers who wish to assist people in diversifying their livelihood options.

The International Fund for Agricultural Development (IFAD) is a specialized agency of the United Nations that has also developed a "Sustainable Livelihoods Approach (SLA)" as a way to improve understanding of the livelihoods of poor people. The SLA has many guiding principles including; be holistic, be dynamic and build on strengths. SLA begins by analysing people's livelihoods and how they change over time. The people themselves actively participate throughout the project cycle.

These models of sustainable livelihood advocate that many factors affect people's ability to pursue a sustainable choice of livelihood. Policies, institutions and legislation operating at various levels from the local to international, can either support or hinder people in making a living. Institutions such as schools, health services, or agricultural extension agencies, can significantly enhance people's human assets, if they are functioning properly. The existence of an "enabling environment" is an important element contributing to the sustainability and resilience of the livelihoods of the poor. But poor people usually have least influence over policies or access to institutions; they lack a voice in decision making too.

The uncertainties and risks created by hazards and stresses influence people to manage and to use their available resources, and the choices for selection of livelihood. In the event of disasters, when the impact of a hazard or shock overwhelms the ability to cope, the poor and their livelihoods are the hardest hit. The small and cottage industries often suffer substantial losses, both in terms of damaged property and missed opportunities. The livelihoods of marginal and small farmers, artisans and fishermen are most affected in hazard through the loss of assets, and loss of employment opportunities.

Post-disaster humanitarian assistance often does not prioritize the rehabilitation of people's means of earning a living. Recovery is difficult when livelihoods have been disrupted or destroyed. This increases their vulnerability to future hazards. Thus a succession of small events can often drive the poor from a state of vulnerability to one of total destitution.

Figure 4.2 | Five Livelihood Asset Categories



To cope with all these circumstances, a model was developed by an international and interdisciplinary team of researchers under the auspices of CASM in 2003. It includes a research philosophy, and instruments based on the sustainable livelihoods approach. It considers individuals and households as operating within a livelihoods pentagon, which is made up of five livelihood asset categories: natural capital, physical capital, human capital, social capital and financial capital. The Sustainable Livelihoods Approach is particularly concerned with how (or lack of) access to these capital types, shapes vulnerability to shocks and trends, as well as the ability of individuals, households, and communities to cope with them, as is given in figure 4.2.

4.7.i Natural Capital

It represents the natural resources base, including the forest, flora and fauna, sources of fresh water, and mineral resources. It includes both public goods such as clean air and biodiversity and assets that people use for production, such as arable land and fruit trees.

4.7.ii Human Capital

Human capital encompasses the skills, knowledge, ability to work and good health that enable people to pursue different livelihood strategies and achieve their livelihood objectives.

4.7.iii Financial Capital

Financial capital refers to issues such as employment, savings, and household income, climate for credit, investment, and so forth

4.7.iv Social Capital

Social capital is created by connections among individuals, social networks and the norms of reciprocity and trustworthiness that arise from them. These social resources support people in pursuit of their livelihood objectives. Data on social capital cover organizational and institutional structures, conflicts, migratory networks, and formal and informal social safety nets.

4.7.v Physical Capital

Physical capital represents mainly physical infrastructure such as roads, railways, markets, clinics, schools and physical assets in mines

such as equipment & machinery. A specific livelihoods framework (Figure 4.3) has been developed to assist with implementation of sustainable livelihood methodologies. The livelihoods framework is a tool to improve our understanding of livelihoods, particularly livelihoods of the poor. It presents the main factors that affect people's livelihoods, and the typical relationships between these. It can be used in both planning new development activities, and for assessing the contribution to livelihood sustainability made by existing activities.

The framework:

- Provides a checklist of important issues, and sketches out the way these link to each other
- Draws attention to core influences and processes
- Emphasizes the multiple interactions between various factors which affect livelihoods.

It shows how, in different contexts, sustainable livelihoods are achieved through access to a range of livelihood resources (natural, economic, human, physical and social capitals) which are combined in the pursuit of different livelihood strategies (agricultural intensification or intensification, livelihood diversification and migration).

People and their access to assets are at the heart of livelihoods approaches which are shown in the figure 4.3. These assets can be destroyed or created as a result of the trends, shocks and seasonal changes in the vulnerability context within which people live. Policies, institutions and processes can have a great influence on access to assets, creating them, determining access, and influencing rates of asset accumulation. Those with more assets are more likely to have greater livelihood options with which to pursue their goals and reduce poverty. The vulnerability context within which people pursue their livelihoods includes shocks, trends and seasonality. Livelihood strategies are the combination of activities that people choose to undertake in order to achieve their livelihood goals. They include productive activities, investment strategies and reproductive choices. The Policies, Institutions and Processes (PIPs) elements of the livelihood framework covers the complex social, economic and political context within which people pursue their livelihoods strategies. The livelihoods approach will not be effective unless operationalised in a

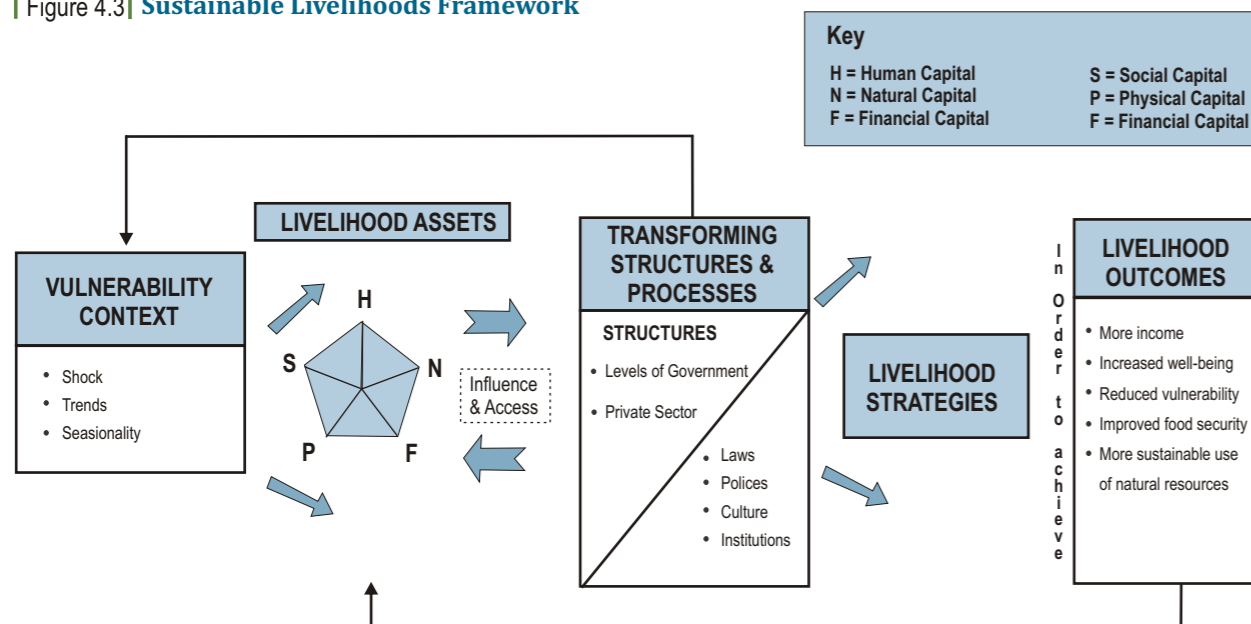
participatory manner by people who are skilled in social analysis, and who share an overall commitment to poverty elimination. The approach incorporates and builds upon existing participatory methodologies.

Future climate change will alter the process and pattern of livelihood, especially the primary activities, which are agriculture, animal husbandry and other allied activities which will impact the social and institutional organization, which in turn shall be a threat to humans, animals and the plant world.

Frequently Asked Questions

1. What do you mean by livelihood?
2. What are the major source of livelihood in urban and rural areas?
3. What are the primary, secondary and tertiary sectors of livelihood?
4. What are the major impacts of climate change on farm based livelihood?
5. What do you know about the sustainable livelihood frame work?

Figure 4.3 | Sustainable Livelihoods Framework



CHAPTER : 5

Impact of Climate Change on Livelihood System

In this chapter the impact of climate change on the following livelihood systems has been assessed

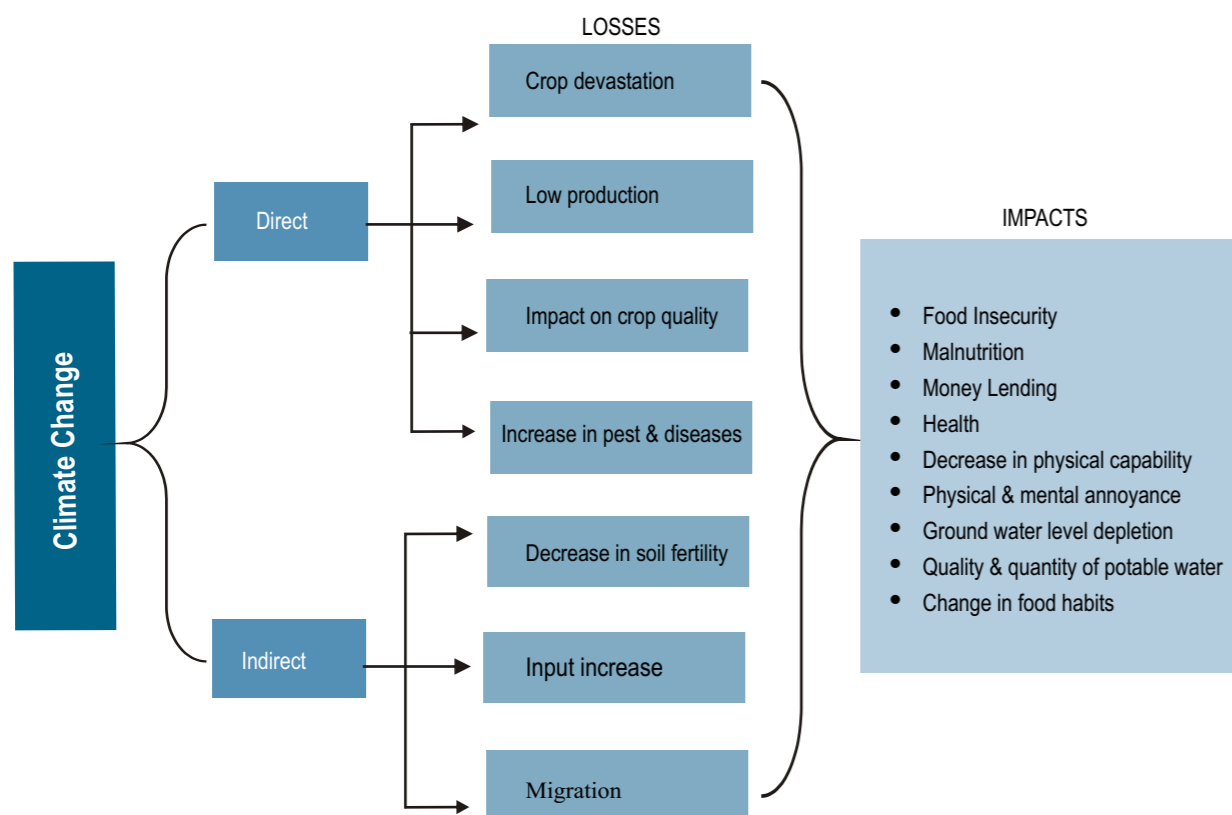
- Agriculture and allied activities
- Forest based activities
- Non-farm activities

5.1 Impact of Climate Change on Agriculture

Agriculture is one of the most important primary activities across the globe. It is the most basic economic activity which provides food grains, fruits, vegetables, nuts, other nutrients,

natural fiber for clothing, fodder for livestock which provide milk, meat and various other ingredients, materials for the construction of houses, bio-fuel & medicinal products, and industrial raw material used to sustain and enhance human life. It is the most important sector for providing livelihood and employment opportunities to humans. Hence, it is also the most important sector for social transformation and socio-economic development of the society. Amongst the various physical conditions on how climate and its various components can affect agriculture; the major factors are the types,

Figure 5.1 | Impacts of Climate Change on Agriculture



pattern, intensity and productivity of agriculture. **Climate change and agriculture** are interrelated processes, both of which take place on a global scale. Climate change affects agriculture in a number of ways, which include changes in average temperatures, rainfall and climate extremes (e.g., heat, cold waves and storms). Climate change is already affecting agriculture across the world, but the future impacts of climate change are prognosticated to cause changes in temperatures and rainfall which will likely affect the pattern and production of food crops negatively. Climate change will impact agriculture in the following ways:

5.2 Impact of Climate Change on Land Use

The fast pace of population growth needs more food grains and other farm produces to feed the growing populace, and to meet the requirement of other sectors of economy. Horizontal (increase in net sown area) and vertical (increase in cropping intensity) development are two ways to increase agricultural production. For horizontal growth of agriculture, more and more open spaces, barren and forest land are being converted into agricultural lands resulting in a major change in the land use pattern, a cause of global warming and climate change. Climate change will influence soil water balance, agriculture and distribution of land use. Drought conditions will need more watering of crops, as global warming will increase soil water deficits i.e. dry soils will become drier.

5.3 Impact of Climate Change on Agriculture Productivity

Climate directly impacts the gross crop production by increasing the mean seasonal temperature and reducing the final yield. Today,

Climatic Element	Impacts Changes by 2050's	Effects on Agriculture
CO ₂	Increase from 360 ppm to 450 ppm	Good for crop: increased photosynthesis, reduced water use
Sea level rise	Rise by 10-15 cm	Loss of land, coastal erosion, flooding, salt intrusion
Temperature	Rise by 1-2°C	Faster, shorter, earlier growing heat stress risk, increased evapo-transpiration
Precipitation	Seasonal change by ± 10%	Impact on drought risk, soil workability, water logging, irrigation supply, transpiration
Storminess	Increased wind speeds and more intense rainfall events	Lodging, soil erosion, reduced infiltration of rainfall
Variability	Increases across most climatic variables, predictions uncertain	Hot wave, frost, droughts and flood which effect crops and turning of farm operations

In Jaspur district of Chhattisgarh the community residing close to the forest, depend upon the collection of fuel, fodder & along with it the leaves of *Tendu*, *Chiraunji* and *Mahua*, for their livelihood. These are the main source of their livelihood, but due to climate change since the last two decades, they are experiencing a decreased number of trees, hence the product collected is being badly impacted and their livelihood adversely affected

the agriculture sector is facing a serious threat due to global warming. India's agriculture is more dependent on the monsoon, and any changes in the monsoon trend, drastically affects Indian agriculture. The increasing temperature is already affecting wheat and rice crops in the Gangetic plain. In the states of Jharkhand, Odisha and Chhattisgarh, rice production, oil seeds and potatoes yield has declined due to recurrent droughts.

The impact is more prominent in those crops which are totally rain-fed or those that require repetitive irrigation. It is estimated that a temperature rise of 0.5°C in winter will reduce rain-fed wheat yield by 0.45 tons per hectare in India.

5.4 Impact of Climate Change on Food Security

Food security is both, directly and indirectly, linked with climate change. Any alteration in climatic parameters such as temperature and humidity, which govern crop growth, will have a direct impact on the quantity of food

production. Indirect linkage pertains to catastrophic events such as floods & droughts, which are projected to multiply as a consequence of climate change, leading to huge crop losses and leaving large patches of arable land unfit for cultivation, thereby threatening food security.

The net impact of food security will also depend on the exposure to global climate change and the capacity to cope with and recover from this global environmental change. The climate change pattern will cause reduction of agricultural production, initiating higher food prices which will lead to food insecurity in the society.

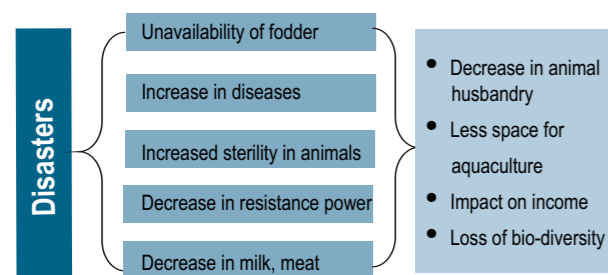
5.5 Impact of Climate Change on Pest, Diseases and Weeds

The change in climate promotes an environment conducive for developing different types of insects and disease vectors. Likewise, the increased temperature also promotes growth of various types of weeds.

5.6 Impact of Climate Change on Livestock

Livestock also would be affected by an increase in temperature. It will affect their reproductive capability and also production of milk, meat and wool, as fodder availability will decrease, due to diminishing pasture lands and deforestation.

Figure 5.2 | Impacts of Climate Change on Animal Husbandry



5.7 Impact of Climate Change on Soil Erosion and Fertility

Climate change will lead to a more vigorous hydrological cycle including more extreme rainfall which will cause land & soil erosion and degradation. Soil fertility would also be affected by global warming.

In a nutshell, the following impacts of climate change would be experienced in agriculture:

- Major changes in land use, especially decrease of open, barren, pasture and forest land

- Agriculture productivity in terms of quality and quantity of crops
- Agricultural practices through change of water use (irrigation) and agricultural inputs such as fertilizers and pesticides
- Environmental effect, in particular in relation of frequency and intensity of soil productivity, soil erosion and reduction of cropping intensity
- Livestock effects in respect to their number and quality, due to less availability of fodder and nutrition

5.8 Impact of Climate Change on Forest

Forests provide many benefits and services to society, which includes a variety of forest

Impact of Forests on Livelihood

In Jampur district of Chhattisgarh state, the community living close to the forest collects fuel, fodder and other forest product to use for their household or sell as a source of income. Most of them collect *Mhauwa*, *Bair*, *Chiraugi*, *Tedu* leaf and other herbs to sell in the market. With diminishing land and tree cover in the forests, during the last two decades, their collection of forest products has reduced, thus impacting their livelihood.

products like timber, fodder, herbs, clean water & air, recreation, wildlife habitat and carbon storage. Climate influences the structure and function of forest ecosystems and plays an essential role in forest health. A changing climate may worsen many threats to forests, such as pest outbreaks, fires, human development and drought.

Climate changes affect, directly and indirectly, the growth and productivity of forests: directly due to changes in atmospheric carbon dioxide & climate and indirectly through complex interactions in forest ecosystems. Climate also affects the frequency and severity of many forest disturbances.

5.9 Climate Change Impact on Forest Growth and Productivity

Climate change will likely affect forest growth

and productivity. Three examples are described below:

- Carbon dioxide is required for photosynthesis, the process by which green plants use sunlight to grow. Given sufficient water and nutrients, increases in atmospheric CO₂ may enable trees to be more productive. Higher future CO₂ levels could benefit forests with fertile soils. However, increased CO₂ may not be as effective in promoting growth of forest and trees, especially where water is limited.
- Warming temperatures could increase the length of the growing season. However, warming could also shift the geographic ranges of some tree species. Habitats of some types of trees are likely to move to higher altitudes. Other species may be at risk locally or regionally, if conditions in their current geographic range are no longer suitable.
- Climate change will likely increase the risk of drought in some areas and the risk of extreme precipitation and flooding in others. Increased temperatures would alter the timing of snowmelt, affecting the seasonal availability of water. Although many trees are resilient to some degree of drought, increase in temperature could make future droughts more damaging than those experienced in the past. In addition, drought increases wildfire risk, since dry trees and shrubs provide fuel to fires. Drought also reduces a tree's ability to produce latex, which protects them from destructive insects.

5.10 Impact of Climate Change on Natural Disturbances

Climate change could alter the frequency and intensity of forest disturbances such as insect outbreaks, invasive species, wildfires and storms. These disturbances can reduce forest productivity and change the distribution of tree species. In some cases, forests can recover from a disturbance, while in others; existing species may shift their range or die out. Climate change could contribute to an increase in the severity of future insect outbreaks, which often weakens and kills trees. Rising temperatures may enable some insect species to develop and spread out faster.

Warm temperatures and drought conditions during early summer contribute to forest fires. Climate change is projected to increase the extent, intensity, and frequency of wildfires in

certain areas of the country. Warmer spring and summer temperatures coupled with decrease in water availability, dry out woody materials in forests and increase the risk of wildfire. Fires can also contribute to climate change, since they cause rapid, large releases of carbon dioxide into the atmosphere.

The cyclonic storms and wind storms can cause damage to forests. Disturbances can interact with one another, or with changes in temperature and precipitation, to increase risks to forests. For example, drought can weaken trees and make a forest more susceptible to wildfire or insect outbreaks. Similarly, wildfire can make a forest more vulnerable to pests.

5.11 Impacts of Climate Change on Non-farm Activities

Climate change will not only affect agriculture, animal husbandry, forestry and other primary activities but also impact secondary and tertiary activities especially mining, commercial and industries. In rural areas, the impact of climate change manifests in the form of unemployment or reduced employment opportunities. This forces rural people to migrate from rural to urban or other regions, in search of jobs and livelihood.

5.12 Migration

People migrate for various reasons that may be economic, political, social or environmental. But economic incentives are a more powerful driver for migration. An economic migrant leaves his/her place of residence in search of job or in order to improve their standard of living and quality of life. This type of migration is pertinent enough in the region where agriculture is badly affected by climate risk. People also migrate if they perceive that in the near future their livelihood will be affected. A large proportion of people in developing countries are dependent on the agriculture and other primary sector for their livelihood, and this agriculture sector is expected to be most affected by climate change. Hence as a result, income in developing countries is likely to be affected by climate change impact on agricultural productivity.

5.12.i Industries

Though it is believed that industry is the least affected by climate change, but the climate phenomena impacts various infrastructure facilities like consumption of power resources to make residences and industry warm/cool, a comparable to the earlier climatic conditions.

The working capability of workers, who are bound to perform their duties in such acute climatic stress conditions, will also get affected.

5.12.ii Tertiary activities

Tertiary activities like commerce, construction, banking, transport and other services are somehow impacted by the heat stroke/cold waves, excessive rain or drought conditions. These adverse climatic conditions may also reduce labor productivity. The heat decreases the physical and cognitive ability of the labor, which reduces income, and also the food intake which has a long lasting effect on the labor productivity in all sectors of economy.

5.12.iii Climate effects on Conflict

The effect of climate on conflict is highly dependent on the socio-economic, institutional and political characteristics of the region. Developing countries are relatively dependent on agriculture and their political institutions often have limited ability to cope with climatic shocks. Due to their dependence on agriculture they are likely to be affected by climate shocks, which can give rise to conflicts among society, where as a consequence, people may be displaced or migrate to better environments.

Frequently Asked Questions

1. What are the impacts of climate change on agriculture?
2. Describe the impacts of climate change on livestock?
3. How the climate change can effect the migration of population?

CHAPTER : 6

Women as Primary Producers and Climate Change Impact

6.1 Gender and Women

The term “gender” refers to socially ascribed roles, responsibilities and opportunities associated with women and men, as well as the hidden power structures that govern the relationships between them.

In this sense, gender includes to the cultural, social, economic and political conditions that are the basis of certain standards, values and behavioral patterns related to genders and their relationship” (Riquer, 1993). Despite recent advances, in most societies there are significant differences between the rights and opportunities of women and men. These include, among others, differences in relation to land and resource rights, possibilities for advancement at work, salaries and opportunities to participate in and influence decision-making processes. The reality is that inequality between men and women is ingrained in social norms and values around the world. In this chapter, we will discuss different issues related with the gender vis a vis climate change.

6.2 Identity and Recognition

Inequality is one of the principal focus issue related with gender. The gender-based analysis seeks to highlight inequalities and promote revision of law and policy, and most importantly of the process of their development.

In India, there is dominance of women workers in agriculture, animal husbandry and forestry. Women are typically responsible for providing their household with water, food, fodder and firewood, and have lesser education, opportunities, authority and resources. Socio-cultural barriers and women's

Gender Disparities/Gaps

- According to the best available data approximately 70% of those who live on less than a dollar each day are women.
- Women work two-thirds of the world's working hours yet receive only 10% of the world's income
- Women own only 1% of the world's property
- Women members of parliament globally average only 17% of all seats
- Only 8% of the world's cabinet ministers are women
- 75% of the world's 876 million illiterate adults are women
- Worldwide women received 78% of the wages received by men for the same work, although in some regions, they have a better educational background. In some parts of the world, the wage gap between women and men is close to 40%
- Of the 550 million low-paid workers in the world, 330 million or 60% are women
- In a sample of 141 countries over the period 1981-2002, it was found that natural disasters (and their subsequent impact) on average kill more women than men or kill women at an earlier age than men

Sources: Social Watch, 2007 and 2008; Oxfam, 2007; Neumayer and Plümpert, 2007; and ILO, 2008.

traditional role as caretakers of their households means they have little time for taking part in community discussions. So their perspectives and needs are often not heard in decision making processes. They collect water, gather cooking fuel from forests, village commons and fields and participate in agriculture, gardening and animal husbandry activities. But their time and labour is unaccounted for in the national gross income.

40

6.3 Contribution of Women

Their roles vary across the regions but, everywhere, women face gender-specific constraints that reduce their productivity and limit their contributions to agricultural production, economic growth and the well-being of their families, communities and countries.

6.4 Women as 'Primary Producer'

Women make crucial contributions in agriculture and rural enterprises across the country, as farmers, workers and entrepreneurs. They contribute to agricultural production, economic growth and the well-being of their families, communities and

Women in agriculture and rural areas have one thing in common across the country: they have less access than men to productive resources and opportunities. The gender gap is found for many assets, inputs and services: land, livestock, labour, education, extension and financial services and technology. This imposes costs on the agriculture sector, the broader economy and society as well as on women themselves.

countries. Women work in agriculture as farmers on their own account, as unpaid workers on family farms and as paid or unpaid labourers on other farms. They are involved in both, crop and livestock production and fish farming at subsistence and commercial levels.

Women are heavily involved in seed selection, sowing, planting, harvesting and other aspects of farm management. In fact, there is hardly any activity in agricultural production, except ploughing in which they are not actively involved. They are contributing considerably

to their families' livelihoods but they have little power in the decision making processes that concern their households.

6.5 Access and Control over Resources vis-a-vis Male Migration

Women face a serious gender gap in accessing productive resources. Women's control over the land property is less than that of men. Women farmers are less likely than men to use modern inputs such as improved seeds, fertilizers, pest control measures and mechanical tools. They also use less credit, and often do not even control the credit they obtain. Finally, women have less education and less access to extension services, which makes it more difficult for them to gain access to, and use some of the other resources, such as land, credit and fertilizer.

6.6 Impacts of Climate Change on Women

Women have been recognized as a vulnerable group. The Intergovernmental Panel on Climate Change (IPCC) also notes that gender differences affect the vulnerability and adaptive capacity of women and men (Adger, W.N. et al 2007) in a changing climatic scenario. For the first time, in December 2010, the International climate negotiations recognized gender as an integral part of action on both mitigation and adaptation in the UNFCCC text. Women are not a homogeneous category, their vulnerability usually being directly proportional to class/ caste/ethnic hierarchies in the society and within their village community.

The successful adaptation to climate change will require recognition of women as critical partners in both driving and delivering solutions needed to increase resilience of communities, especially those living in disaster prone areas across India. This will also require a close collaboration between adaptation research, agriculture-related government services and women farmers. Poor and marginalized rural women are the worst sufferers of climate change impacts, but they are also critical change agents in implementing climate solutions. Their traditional knowledge and skills are often a resource to adapt to climatic vagaries and they have a valuable influence over their households' consumption patterns and lifestyle choices, both critical in the wake of climate change. Women suffer climate impacts more than men, but they are also integral to the solutions.

The impacts of higher temperatures, erratic rainfall, more extreme weather events, and sea level rise are already being felt in India and will continue to intensify. Some of the impacts of climatic changes and changes in extreme weather events as well as projected climate conditions in India are being observed on agriculture, water, forests, and human health.

India's agriculture is sensitive to rainfall variability and temperature changes. Studies by the Indian Agricultural Research Institute (IARI) and others indicates reduced *rabi* (winter wheat) crop, and changes in the quality of fruits, vegetables, tea, coffee, aromatic medicinal plants and basmati rice. Changes in temperature and humidity will also impact pathogens and insect populations. Other impacts include lower yields from dairy cattle, their regeneration, and also decline in fish breeding, migration and reduced harvests, as a reaction to climatic stresses in different parts of the country. Further, up to 77% of the forest areas are expected to shift, affecting both the associated biodiversity and livelihoods based on these forests. Vulnerability to extreme climate events is also expected to increase with heavy populations living in coastal, flood and drought-prone areas.

All of the above mentioned situations will impact women as they are more closely

engaged in growing vegetables, tea, and coffee, paddy, in livestock rearing, fish processing and gathering medicinal herbs, fodder and fuel wood. In Chhattisgarh, tribal women, for example, use almost 300 forest species for medicinal purposes. The shifts in forest vegetation are going to affect their livelihoods and their health. It is also now accepted that women are affected more than men in any natural calamity. Adaptation measures should be done to mitigate these impacts by addressing vulnerabilities of women's livelihood

6.7 Health Impacts

Climate change will also place an additional burden on women's health. First, they are affected because of certain physical vulnerabilities, second because of their caring roles in families, and third because the additional work which is required due to depletion of environmental conditions that may lead to health damage. In the following paragraphs, other factors which impose negative impacts on women's health are described:

- Waterborne and vector-borne diseases will increase in a warmer world. Pregnant women are more susceptible to infection and also have increased risks to illness and secondary diseases, too. In India there are several cases of anaemia with malaria infection, which are responsible for maternal mortality.

41

Climate Change	Impact of Women
Low food production	Less to eat, sleep on an empty stomach, need to take on additional work as wage labour, feminization of agriculture labour
Cyclone ,Floods, Water logging, Droughts	Longer walk to get water and fuel wood, loss of fodder and livestock, woman's primary livelihood, drought/ infrequent spell of rain makes ground harder to work on
Higher summer temperature	Low milk production among animals, more tiring work in fields, longer working hours
Effect on regeneration of species	Medical herbs and fodder unavailability in forest
Heavy rainfall	More weeding, water, fodder, fuel difficult to access during rain/low rainfall, women opportunity for wage employment declines
Untimely rainfall	Lower farm production and consequences of male distress migration, work overload on own farm or as wage labour
Social impact: Higher debt	Women go to take loans and have the responsibility of paying them back
Social impact: Male migration	Women and child trafficking/HIV-AIDS
Social impact: Domestic violence	Increase in domestic violence

Gender-based Vulnerability to Climate Change : Facts

- Women are not well represented in decision-making processes, which constrains their ability to meaningfully participate in decisions on adaptation and mitigation.
- Globally, only 17% of cabinet and 19% of parliament members are women; out of eleven Pacific island developing economies that were studied, five had no women members in parliament at all.
- A global gender gap in earnings and productivity persists across all forms of economic activity; women make between 30-80% of male annual income. Restricting job opportunities for women has been costing the region approximately \$44 billion a year.
- A study by the Organisation for Economic Co-operation and Development (OECD) classified women's access to land as "very limited" in a number of countries within the Asia-Pacific region.
- For those developing countries globally for which data was available, only between 10 - 20 % of all landholders are women
- Burning biomass fuel indoors leads to 2 million deaths per year (mainly women and children).
- In 2007, the estimated number of women and girl children who were "missing"; the number of excess female death's, was 484,000 in Asia (excluding central Asia). Globally, 3.9 million women and girls go "missing" each year.
- During the past decade in the Asia-pacific region, an annual average of more than 200 million people were affected and more than 70,000 people were killed by natural disasters (90% & 65% respectively of global totals for natural disasters). Women and children make up the majority of deaths resulting from water-related disasters

- Decreased agricultural productivity increases malnutrition and hunger. Women are responsible for household food production and because they are usually involved in a very labour-intensive, low-emission subsistence agriculture, they are disproportionately affected by climate change.
- In acute conditions of livelihood loss, male members migrate in search of employment and come back with an infection of some dangerous communicable diseases like HIV/ AID, TB, etc. which affects their women subsequently.

6.8 Climate Change, Natural Disaster and Gender

Natural disasters like floods, droughts, hurricanes or heavy rains, are already impacting livelihoods across the world. There are clear gender differences in the prevention of disasters (e.g. early warning systems don't get through to women), in emergency response (e.g. different risk reduction strategies and different needs), and in the reconstruction phase (e.g. gender differences in migration). It is often reported that women's workloads increase in the aftermath of disasters, while their income generating conditions deteriorate. The following are few examples which explain the nexus of climate change, natural disaster and women:

- Because of gender differences in property rights, access to information, and differences in cultural, social and economic roles, natural disasters are likely to affect men and women differently: Following the cyclone and flood of 1991 in Bangladesh, the death rate was almost five times as high for women as for men. Warning information was transmitted to men, by men in public spaces, but rarely communicated to the rest of the family. As many women were not allowed to leave the house without a male relative, they perished while waiting for their relatives to return home and take them to a safer place.
- Women are at risk mostly during the disaster and often in post disaster situations, when they find themselves thrown into situations where they are unable to decide whether to stay or leave. Men on the contrary are most at risk in the search for survivors and cleanup after disasters and are more likely to be able to decide for themselves how to act.

- Men and women also have different needs and priorities following a hazard. Men tend to focus almost exclusively on productive activity, including agriculture and waged income, while women tend to prioritize physical and psychological health, economic opportunities, and their children and family welfare.
- In post-disaster-situations the shortfall of resources like water, food and fuel wood or the role of care-giver may increase women's workloads. Due to increased burdens, a negative cycle starts. Girls have to take on more tasks in the household and don't have time to attend schools. Poor education of girls results in high number of children and marginal participation in community planning, and the the poverty-cycle starts all over again.
- As greater numbers of men migrate to cities in search of jobs as consequence of a hazard, women are left behind to manage farms and households. The woman farmer therefore contributes significantly not only to the food and economic security of her own family, but to the agricultural productivity of the country as a whole.

6.9 Gender and Access to Information, Organizations and Markets

Information, appropriate information, given and received on a timely basis, is critical to development and use of technical innovations, improvements and disaster. Yet women frequently cannot obtain such information. Agricultural research and development, including extension services, have been dominated by men and have largely ignored women's role in crop production, and not focused on women's needs for technology and information. Social norms and cultural practices prevent women from participating in development interventions, DRR and CCA.

Using more appropriate information channels is one way to address this situation. The strategy is to provide more relevant information by specifically addressing gender aspects of climate resilient crop production. Over the last two centuries, societies have invested considerably in complex institutional arrangements to advance technological innovation in agriculture in climatic stress conditions. Many of these institutions have overlooked women and have marginalized women farmers in terms of technology

Women as Positive agents of Change

Women's activities in food production, community management, natural-resource and biodiversity management, education of children and family care, place them at the centre of development. They are the collectors of fuel and water for their families, and users of energy to prepare food and care for the sick. In developing countries, they engage substantially in agricultural production, both paid and unpaid. Thus, recognizing and supporting the activities and needs of women is essential for socio-economic development.

Source: *United Nations Conference on Trade and Development, 'Applying a Gender Lens to Science, Technology and Innovation', Current Studies on Science, Technology and Innovation, 5th ed., Geneva, 2011*

adoption, but in developing countries they are the main agent for adaptation of those techniques. Gender responsive actions should enable women farmers to take greater advantage of extension systems, and increase the accessibility of new agricultural technologies and innovations to cope with natural hazards.

Organizational innovations, such as participatory research, farmer-extension linkages, and strengthening linkages between formal and local extreme weather tolerant varieties of seed, can improve women's livelihood outcomes by ensuring that technologies meet their needs.

6.10 Women and Market Access

Markets influence the choice of crop species and varieties. Markets can offer opportunities for women as well as men. The situation of women regarding access to market is still very pathetic. In general, women make up half of the agricultural labour force in the developing countries, but it is an irony that they own only 10-20% of the land. Apart from this, the cumulative effects of poverty and social, economic and political barriers further deteriorate the condition of women and their capacity in coping with the adverse impacts of changing climate.

Compared to men, women face huge challenges in accessing all levels of policy and decision-making processes. This renders them less able to influence policies, programmes and decisions that impact their lives.

The socio-cultural norms limit women from acquiring the information and skills necessary to escape or avoid hazards (e.g. swimming and climbing trees to escape rising water levels). Similarly, dress codes imposed on women restricts their mobility in times of disaster. Such social influences render women disproportionately vulnerable to disasters and related negative effects of climate change.

6.11 Women add Value to the Climate Change Effort

Women play a pivotal role in natural resources management and in other productive and reproductive activities at the household and community levels. This puts them in a position to contribute to livelihood strategies adapted to changing environmental realities. Their extensive knowledge and expertise, that can also be used in climate change mitigation, disaster reduction and adaptation strategies, makes them effective actors and agents of change.

Numerous examples demonstrate that communities fare better during natural disasters when women play a leadership role in early warning systems and reconstruction. Women tend to share information related to community well-being, choose less polluting energy sources and adapt more easily to environmental changes when their family's survival is at stake. Women in India displayed enormous strength and capacity throughout the entire disaster cycle: preparing for hazards, managing after a disaster and rebuilding damaged livelihoods. Activities included ensuring food and water for the family, securing seed and other productive material and taking care of the sick and elderly.

Research has also revealed the importance of gender equality and women's empowerment to environmental sustainability and achievement of the development goals. Greater female participation in economic development will lead to productivity gains. Women's greater participation is also likely to enhance the effectiveness and sustainability of climate change projects and policies. Women tend to be very effective at mobilizing communities in the event of disasters and disaster risk

management and reduction, and have a clear understanding of what strategies are needed at the local level. Hence the international recognition of the importance of supporting women and gender equality is increasing.

Frequently Asked Questions

1. What are the contributions of women in household activities?
2. What are the causes for male migration due to climate change?
3. What are the major impacts of climate change on women?
4. What is the impact of natural disasters caused by climate change on women?

CHAPTER : 7

Resilient Livelihood

Over the past six decades, the pattern of livelihood system has become considerably more efficient. Improvements in production systems, crop and livestock breeding programmes have enhanced food production. But the impact of climate change has added a new dimension of threat on different sectors and exacerbated the existing challenges faced by agriculture. Apart from this, it also threatens the stability and productivity in agricultural, forest, livestock and other allied productions.

In many parts of the world where agricultural and other allied productivity is already low and the means of coping with adverse events are limited, climate change has reduced productivity to even lower levels, making production more erratic. Long term changes in the patterns of temperature and precipitation, have also shifted the production seasons, pest & disease patterns, and modified the set of feasible crops affecting production, prices, incomes and ultimately, lives and livelihoods.

In order to stabilize output and income, the production systems must become more resilient, i.e. more capable of performing well in the face of disruptive events. It requires transformation in the management of natural resources (e.g. land, water, forest, soil, nutrients, forest, animal and genetic resources) and higher efficiency in the use of these resources and inputs for production. Hence the change in climatic conditions has brought untold misery to the lives and livelihoods of people.

7.1 Knowledge Empowers People

Knowledge and information are essential for people to respond efficiently and successfully to the opportunities and challenges that the climate change throws at them. But to be useful, knowledge and information must be effectively and timely communicated to the people. In order to facilitate useful and timely information to rural people related to farming practices, the Village Resource Centres (VRC) in clusters of villages can be set-up. These VRCs are steadily becoming single-window delivery mechanisms for information, agricultural

inputs, and agro- weather advisories. The VRCs are playing a significant role in capacity building of the community, enhancing their awareness and knowledge levels.

7.2 Village Resource Centre

As stated above, the Village Resource Centre is a unique centre that is established and managed by the community at the village level, to cater to agriculture related information and resource needs of small & marginal and woman farmers. The centre also acts as a platform for knowledge sharing among the farming communities. The VRC is instrumental in dealing with climate change patterns, as apart from information dissemination and knowledge sharing, it also provides easy and cheaper access to climate-resilient varieties of crop seeds, bio-fertilizers, bio-pesticides, agricultural equipments like irrigation pipe, winnowing fan, spray machine, etc. These inputs and resources are easily availed by the farming community as per their needs and requirements.

In this mechanism of coordination and support, the VRC committees and village level institutions work in synergy and provide meaning & strength to one another's functions and responsibilities in dealing with climate change patterns. For instance, the income generation activities done by SHGs are done in coordination with the VRC committees. These committees decide the income generation activities that can be promoted among the SHGs, which will fetch maximum benefits with lesser risk factors and in turn, ensure the availability of required inputs at the VRC. In a nutshell, the functioning of VRC is well coordinated with other institutions at the village level.

7.3 Integrated Farming System (IFS) for Climate Change

The Integrated Farming (IF) system is a whole farm management system which aims to deliver more sustainable agriculture. It is a

dynamic approach that can be applied to any farming system around the world. It involves attention to detail and continuous improvement in all areas of a farming business, through informed management processes. Integrated Farming combines the best of modern tools and technologies with traditional practices, according to a given site and situation. In simple words, it means using many ways of cultivation, in a small space or land.

In areas like Chhattisgarh, the integrated farming system is a viable model for small and marginal farmers to deal with changing flood/drought patterns. This model, besides producing all the required domestic food and feed items including cereals, pulses, oilseeds, vegetables, fruits, meat and milk etc. for daily consumption, also produces green and dry fodders for their animals in sufficient quantities. Not only this, all the farm-wastes, crop residues, animal urine and dung etc. are properly collected, composted and recycled in production of various types of organic manure such as compost, vermicompost, *matka khaad*, NADEP, etc.

7.4 Time Management through Alteration in Cropping Cycle

The manipulation in the timings of cropping cycle through preponement or postponement of crops was a successful strategy adopted by farmers. Sowing varieties which can sustain water inundation was also helpful in saving crops from flood effects. This strategy was particularly helpful in a climate change situation where the rainfall (and hence flood patterns) are un-predictable (early or late). This practice has been tested in flood and drought prone areas and proved very successful. In this process, appropriate crops and crop varieties are identified with the help of local farmers.

7.4.i Space management

Multi-tier cropping is very effective in low land, where water logging is a major problem. In flood prone areas where farmers grow vegetables, the entire crop gets washed away during floods. Sowing of new crops is also hindered due to water stagnation in the fields. In such situations, experimentation of multi-layered cropping has proven to be quite effective. The layers of crops are able to deal with various water levels in case of flooding in the area. It will be worth mentioning here that the whole annual crop cycle is planned for which appropriate varieties are identified. The choice of the adopted crops also varies

according to family size, available resources and priorities of farmers. In this method two or three cropping is practiced with the highest crops being at a height of 5-6 ft. The higher crops get saved even if lower crops are fully or partially damaged due to flood and water logging.

7.4.ii Climate Resilient Agriculture (CRA)

The frequency and intensity of natural hazards like floods and droughts are increasing due to CC, leading to damage, destruction and disruption of agriculture, as well as animal and human lives. The small and marginal farmers, who are the majority lot of the farming community in Jashpur, are unable to cope with these climatic hazards because of their limited resources. They require financial as well as technical support to contend with climate change. CRA strategies include a range of activities such as diversity of crops, cropping patterns, integrated farming with other primary activities and production systems, etc. The techniques of climate resilient agriculture (CRA) are crop rotation, cropping pattern, multi-layer cropping according to the depth of soil, loft farming, climber farming, selection of extreme weather tolerant variety of crops/seeds, permanent raised seed bed, low poly houses for nursery raising in water logged/flood prone areas.

7.4.iii Vegetable farming strengthens livelihood in flood/ drought affected areas

In Jashpur region of Chhattisgarh, farming communities comprise of small and marginal farmers in majority, who are directly and drastically affected by the drought menace. Drought is a disaster which affects the development process to a great extent, and also worsens the situations of vulnerable and marginalized people in the society. Drought affects agriculture, the main source of livelihood of people in this region. It disrupts life and devastates property on a large scale and it is the small and marginal farmers who mainly undertake subsistence farming, who are the worst affected. In order to deal better with drought and its changing character, the farmers need to be more resilient towards these types of disasters. Farmers can move from traditional cropping systems to adapted cropping patterns, which are much more resilient to disasters like drought. Such adaptive capacities are extremely important when dealing with problems related to climate change.

Vegetable farming can show a ray of hope in agriculture to these small & marginal and woman farmers. Jashpur area was dominated

by paddy cultivation. With changing climate patterns, erratic rainfalls have led to drought problems, resulting in frustration for these small and marginal farmers. Paddy is still grown by farmers but now mainly for domestic consumption only. Farmers can begin undertaking vegetable farming on a large scale, which is more profitable and also ensures food and nutritional security. The gradual shift from a paddy-based farming system to vegetable based farming system will clearly be an adaptation mechanism to sustain the effects the climate change happening in this area.

7.4.iv Climate Smart Agriculture (CSA)

CSA technologies address gaps in farming systems, and minimise the adverse effects of climate change on farm production. CSA technologies also harness untapped potential within farming systems and hence raise farm production. Common technologies for building CSA include:

- Meteorological information, forecasts and climate modelling can inform farming decisions, such as what & when to plant, and how best to manage farming systems. Yet such information will only help farmers if they are familiar with, and can access technologies that are effective under the anticipated conditions.
- Hybrid seed varieties designed to cope with heat stress, drought or floods can deliver dramatic results, but small-scale farmers may struggle to access and/or afford them.
- Agro-ecological farming practices such as soil and water conservation or agro forestry offer 'no regrets' options, effective across a range of alternative climate futures. They tend to be readily accessible to farmers since they require few purchased inputs, and can also diversify production. Yet a tricky question is, why do they often fail to spread?
- Weather-indexed crop insurance has attracted interest in many countries. Yet the questions remain about its wider relevance, such as its affordability to poor farmers and its viability for insurers in areas where climate shocks are frequent.

7.4.v Promoting climate services

Weather and climate are some of the biggest risk factors that impact farming performance and management. Extreme weather and climate events such as severe droughts, floods, or temperature often shock the farming community leading to a decline in agricultural production. Factors such as excessive rainfall variability and large change in temperatures,

contribute to the vulnerability of individual farms, as well as the whole rural communities. In addition, farmers are expected to manage the more insidious effects of long term climate change that may now be occurring at an unprecedented rate. These existing pressures will demand the development and implementation of appropriate methods to address issues of vulnerability to weather and climate. There is a need to assist farmers to further develop their adaptive capacity with improved planning and better management decisions. More effective approaches to delivery of climate and weather information to farmers through participatory, cross disciplinary approach is being carried out by enhancing awareness of information user groups.

7.4.v. a Broad Spectrum of Agro-met Advisories

- Sowing/ transplanting of *kharif* crops based on onset of monsoon
- Sowing of *rabi* crops using residual soil moisture
- Fertilizer application based on wind condition
- Delay in fertilizer application based on intensity of rain
- Prediction of occurrence of pest and disease, based on weather
- Proper active measures, at appropriate time, to eradicate pests & diseases
- Weeding/thinning at regular intervals for better growth & development of crop
- Irrigation at critical stages of the crop
- Quantum & timing of irrigation, using meteorological threshold
- Advisories for timely harvest of crops

7.5 Farmer to Farmer Extension System

Farmer to farmer extension system is an effective means to replicate the innovation being adopted or implemented by the farmer himself in his field. This system can help in building effective, farmer-centred extension systems and empowering farmers as change agents for improving livelihoods in their communities. The linkage of relevant government schemes and departments has been also helpful in this regard. In developing appropriate extension systems, using locally available knowledge has been seriously considered. In fact, for all extension measures a synergy of traditional knowledge available to the local experienced farmer and the new technical and scientific know-how has been vital.

7.6 Farmer's Field Schools (FFS)

Farmer Field Schools (FFS) consist of groups of farmers who get together to study a particular topic. It is a farmer led and owned institution, for sharing information and innovations amongst farmers, learning new knowledge as well as linkages with resource organizations. The topics covered vary from conservation agriculture, organic agriculture, animal & soil husbandry, to income generating activities. FFS provide opportunities for learning by doing. It teaches basic agricultural and management skills that make farmers experts in their own farms. FFS is a forum where farmers and trainers debate, share observations & experiences, present new information from outside the community and confer to solve their problems.

7.7 Master Trainers (MT)

MT are the local farmers trained on flood/drought resilient farming, able to help their fellow farmers with relevant techniques, knowledge and solutions to existing problems.

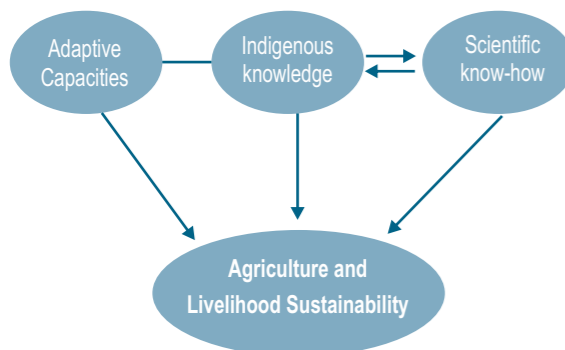
7.8 Self-Help Groups

SHGs are groups of the farmers that practice dissemination of information, organize community for collective actions, linkage with credit providing institutions and markets etc.

7.9 Synergy of Science and Indigenous Traditional Knowledge

Sustainability of livelihood systems depends on strengthening human capital in ways that support the management of the natural capital. Traditional knowledge, the knowledge and insights acquired through extensive use or observation of an area or species, can play an important but often undervalued role, enabling local communities to manage vulnerability, uncertainties, shocks and stresses. New innovations based on modern science can be developed building on it, clearing some of the

Figure 7.1 | Synergy of Indigenous Knowledge and Science



knowledge and technological bottlenecks that limit its applicability and effectiveness. Local community institutions and individuals within a community can be strengthened to identify, conserve, manage, and add value to local diversity and other renewable land resources when traditional knowledge is improved by modern science and technology. New innovations based on traditional knowledge or improvements of traditional resource use and management practices can strengthen rural livelihood systems. Resource use and management practices developed elsewhere based on traditional knowledge also need to be tested in new situations. Both can be achieved through research. Examples of how synergy can be created between traditional knowledge and modern science include, but are not restricted to the following:

- Understanding the role of traditional knowledge in poverty alleviation, biodiversity conservation, & food security through documentation of cases.
- Identifying synergy between traditional knowledge and modern farming practices, for better soil management and food security of poor small-holder farmers.
- Understanding of nutritional values, and new ways to propagate, multiply, process and market traditional foods to create new opportunities for a wider variety of income-generating enterprises, and hence create a ripple effect that multiplies the benefits broadly through the rural communities.
- Assisting farmers to reserve traditional land use practices to achieve poverty alleviation, while ensuring sustainable management of the environment.
- Understanding impacts of agricultural intensification and monocultures (e.g. impacts of pesticides) which can help drive development of more environmentally-friendly agricultural inputs.
- Providing policy recommendations to local people and the international community to strengthen the use of traditional knowledge to build resilience of livelihood systems.

Frequently Asked Questions

1. What are the main measures to make resilient livelihood?
2. What do you know about integrated farming system?
3. What is time and space managements in farming?
4. What is climate resilient farming? Is it different from climate smart farming?
5. What do you know about agro-mat advisory system?

CHAPTER : 8

Relevant Policies and Programmes

Climate change is already devastating lives of many poor and underprivileged people in India on a very large scale. About two thirds of Indians derive their livelihoods from climate-sensitive sectors such as farming, fisheries and forestry, and the changing climate is adversely affecting their livelihood base, especially in rain fed and flood prone areas. It therefore becomes a paramount priority to understand these climate risks in different climatic zones and evolve a comprehensive policy framework on adaption.

For the development of the agriculture, forestry, social forestry, livestock, pisciculture and allied primary activities, various National and State policies acts, plan and programs are formulated time to time for the improvement, enhancement and conservation of these resources for the socio-economic development of the State and Nation, and to create job and livelihood opportunities. It is the duty of the State and Central government to implement this program for the welfare of society and common people. Climate change is adversely impacting the quality and quantity of these resources. Hence governments are purposing the various programs to mitigate its impact as well as for better adaption.

policies are meant for the reduction and adaptation of the impacts of climate change and are being implemented in various fields of activities. Some of the policies and programs are as follows:

- National Action Plan for Climate Change.
- State Action plan for Climate Change.
- Five year plan
- MGNREGA
- Disaster Management Plan
- National Agriculture Development Plan
- National Forest Development Act
- National Livelihood Mission
- National Horticulture Mission
- Crop Insurance

These programs and policies when implemented in the respective region and state can reduce the variability and risk of the community due to climate change. For risk reduction, the following two types of activities are implemented by different departments:

Eight National Missions

- National Solar Mission
- National Mission on Enhanced Energy Efficiency
- National Mission on Sustainable Habitat
- National Water Mission
- National Mission for sustaining the Himalayan Eco-system
- National Mission for Green India
- National Mission for Sustainable Agriculture
- National Mission for Strategic Knowledge for Climate Change

Success of any activities is dependent on the respective policies and programs. Various policies and programs are launched by Central and State governments to highlight climate change issues and to mitigate its impact on agriculture, livestock, forestry and other allied activities. Some of the

8.1 Structural and Non-structural Activities

For example: Following measures can be adopted by different departments to minimize the impact of droughts.

Department	Structural Measures	Non-structural
Irrigation	To install tube-wells, bore wells or construct canals	Rain water harvesting
Rural Development, MGNREGA	Conservation and maintenance of old ponds. Construction of new ponds	Awareness among people about government subsidy and grants

For mitigating climatic hazards and minimizing the impacts of hydro-meteorological disasters, and for improving livelihoods and overall wellbeing of the people, central and state governments have implemented a number of schemes, whose activities are facilitated further by the involvement of PRIs, NGOs and other non-profit organizations. Some of the important national level programmes are listed herein:

8.2 Agriculture (RKVY and NFSM)

In this programme the emphasis has been laid not just on crop improvement through development of climate resistant variety of seeds, but also on preservation of soil fertility and pest control, storage of agricultural produce, extension services and education, among many others. Likewise the department implements various programs for DRR and CCA which are as follows:

- To develop and popularize water-tolerant variety of crops for flood & water logging areas
- To make an attempt to establish seed and grains bank, at community level by different societies
- Organization of agriculture and animal fairs, agricultural exhibition, seminar and discussion etc.
- To provide weather forecast information to farmers so that their risk is minimized
- To encourage drought tolerant variety of crop in drought prone areas
- To develop capability and capacity of farmers through some experienced farmers who can be selected at block level, to propagate integrated farming, which is a combination of

agriculture, animal husbandry, agro-forestry, poultry, goatry, and other allied activities

- To promote crop diversity in the same field, so that if any crop is affected by adverse climatic conditions, the others can survive and provide food security to farmers
- To make agriculture more profitable for which various new techniques and inputs like seed, cropping pattern, and agricultural equipment are developed and provided to the farmers to implement them in their farm practices
- To make arrangement for availability of seeds and other agricultural inputs and resources especially for disaster prone area.
- For better productivity, and to make agriculture more profitable through better time and space management implementation, for which multi-layered crop and loft farming practices can be applied
- To organize training workshops to increase awareness amongst farmers about new technologies
- To minimize use of water in irrigation, and popularize sprinkler and drip irrigation methods
- To enhance bio-farming through use of bio manure and bio- pesticides

Likewise, other departments such as forest and animal husbandry have also implemented various schemes and programs for the benefit of the community.

8.4 Forest and Biodiversity

The forestry and biodiversity sector includes schemes pertaining to the conservation and management of existing forests, afforestation programmes and biodiversity conservation, including conservation of certain keystone wildlife species which are crucial for viability of ecosystems. Additionally, schemes pertaining to conservation of rivers and wetlands, production and dissemination of knowledge and linkages with forestry and livelihood have been included. These include:

1. Increase awareness of the people about environment
2. Mass plantation
3. Under social forestry, plantation in open and ideal land of the *gram sabha*, public institution, schools, organizations, municipal board and open land along roads, canals and railway lines.

8.5 Animal Husbandry

Animal husbandry is another source of income for the community. The department of animal husbandry is making various attempts to enhance the quality of the livestock and their production, which are follows:

1. Development of new variety of livestock for better production of milk, meat and wool
2. To make available veterinary, health services and artificial conception services
3. To make arrangement for green and other fodder for the livestock
4. Arrangement of vaccination for various animal diseases

8.6 Rural Development : MGNREGA

The Mahatma Gandhi National Rural Employment Act (MGNREA) aims to enhance community capacity, through various development works that have been initiated. For this it is necessary to implement the programme effectively and also community participation, with participatory enthusiasm and awareness, is essential. For this, the following major activities have been adopted:

- Making arrangement for draining water in flood prone area
- *Merbandi* : *Bund* making for conservation of humidity in drought prone areas
- Plantation of trees
- Construction of approach road or high raising in hazard prone areas
- To ensure small scale irrigation, especially for schedule caste, schedule tribes and people below the poverty line.
- Construction and renovation of tanks
- Compost making

There are many more programme, schemes and acts to make agriculture sustainable and climate resilient. These include crop rotation, integrated pest management, soil conservation, water conservation, use of organic manure and pesticides, making linkages with market facility and availability of various external outputs.

8.7 Water Resource (Integrated Watershed Management Programme)

Conservation and sustainable use of water resources is crucial for the sustenance of human life and livelihood. The schemes included in this thematic sector consist of initiatives for preventing pollution of water bodies, major and medium irrigation systems, groundwater management and recharging water bodies, amongst others.

8.8 National Agriculture Insurance Scheme

Taking into consideration the diverse agro-climatic region of India, crop insurance is one of the instruments for protecting farmers from crop production related risks, caused by adverse weather conditions. Among notable schemes or programmes in this regard since 1999-2000, are the National Agricultural Insurance Scheme (NAIS), which provides insurance coverage and financial support to farmers in the event of failure of any notified crop due to natural calamities, pests or diseases. The scheme also encourages farmers to adopt progressive farming practices, high value inputs and higher technology in agriculture, and helps stabilize farm incomes, particularly in the disaster years. Likewise, the Weather Based Crop Insurance scheme is being implemented on a pilot basis, since Union Budget 2007-08 made an outlay for the scheme to safeguard farmers against the likelihood of financial loss on account of anticipated crop loss resulting from the incidence of adverse weather conditions like rainfall, temperature, frost, humidity etc.

8.9 Disaster Management Act

As envisaged in the DM Act, 2005, the ongoing schemes and programmes can be used as access points for mainstreaming Climate Change Adaptation (CCA) and Disaster Risk Reduction (DRR) measures into development planning. An approach to mainstream CCA & DRR measures into the ongoing developmental programme may be delineated as following :

- Classification of key programmes/projects at ministerial level along with the area of implementation.
- Integration of structural and non-structural measures in the programme objectives. Guidelines shall be prepared for identifying structural and non-structural measures in programmes/schemes. For example, all the programmes with objectives to construct physical infrastructures such as roads, houses, schools and sanitation & water facilities, must confirm to the structural measures required to ensure disaster resilient construction. Similarly, social projects shall have objectives to mainstream non-structural measures viz. awareness generation, capacity building and preparedness activities as a part of their schemes/projects.

- The state/national authority shall coordinate at ministerial and state level for promoting CCA & DRR measures through developmental programmes. In fact, the new programmes shall be sanctioned only if they meet the clause for ensuring disaster resilient construction activities.

Frequently Asked Questions

52

1. What are the main measures to make resilient livelihood?
2. What do you know about integrated farming system?
3. What is time and space management in farming?
4. What is climate resilient farming? Is it different from climate smart farming?
5. What do you know about agro-mat advisory system?

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53

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Glossary

Adaptation

Adjustment or preparation of natural or human systems to a new or changing environment which moderates harm or exploits beneficial opportunities.

Adaptive Capacity

The ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.

Afforestation

Planting of new forests on lands that historically have not contained forests.

Alternative Energy

Energy derived from nontraditional sources (e.g., compressed natural gas, solar, hydroelectric, wind).

Atmosphere

The gaseous envelope surrounding the Earth. The dry atmosphere consists almost entirely of nitrogen and oxygen together with a number of trace gases, such as argon, helium, active greenhouse gases such as carbon dioxide and ozone. In addition the atmosphere contains water vapor, clouds and aerosols.

Bio-fuels

Gas or liquid fuel made from plant material (biomass). Includes wood, wood waste, wood liquors, peat, railroad ties, wood sludge, spent sulfite liquors, agricultural waste, straw, tires, fish oils, tall oil, sludge waste, waste alcohol, municipal solid waste, landfill gases, other waste, and ethanol blended into motor gasoline.

Biomass

Materials that are biological in origin, including organic material (both living and dead)

Biosphere

The part of the Earth system comprising all ecosystems and living organisms, in the atmosphere, on land or in the oceans including derived dead organic matters.

Carbon Dioxide

A naturally occurring gas, and also a by-product of burning fossil fuels and biomass, as well as land-use changes and other industrial processes.

Chlorofluorocarbons

Gases used for refrigeration, air conditioning, packaging, insulation, solvents, or aerosol propellants.

Climate

Climate is usually defined as the "average weather," The classical period is 3 decades, as defined by the World Meteorological Organization (WMO). These quantities are most often surface variables such as temperature, precipitation, and wind. Climate in a wider sense is the state, including a statistical description, of the climate system.

Climate Change

Climate change refers to any significant change in the measures of climate lasting for an extended period of time. Climate change includes major changes in temperature, precipitation, or wind patterns, among others, that occur over several decades or longer.

Deforestation

Those practices or processes that result in the conversion of forested lands for non-forest uses. Deforestation contributes to increasing carbon dioxide concentrations for two reasons: 1) the burning or decomposition of the wood releases carbon dioxide; and 2) trees that once removed carbon dioxide from the atmosphere in the process of photosynthesis are no longer present.

Desertification

Land degradation in arid, semi-arid, and dry sub-humid areas resulting from various factors, including climatic variations and human activities

Dryland Farming

A technique that uses soil moisture conservation and seed selection to optimize production under dry conditions.

Ecosystem

Any natural unit or entity including living and non-living parts that interact to produce a stable system through cyclic exchange of materials.

Emissions

The release of a substance (usually a gas when referring to the subject of climate change) into the atmosphere.

Energy Efficiency

Using less energy to provide the same service.

Enhanced Greenhouse Effect

The concept that the natural greenhouse effect has been enhanced by increased atmospheric concentrations of greenhouse gases (such as CO₂ and methane) emitted as a result of human activities. These added greenhouse gases cause the earth to warm.

Evaporation

The process by which water changes from a liquid to a gas or vapor.

Fossil Fuel

A general term for organic materials formed from decayed plants and animals that have been converted to crude oil, coal, natural gas, or heavy oils by exposure to heat and pressure in the earth's crust over hundreds of millions of years.

Global Average Temperature

An estimate of Earth's mean surface air temperature averaged over the entire planet.

Global Warming

The recent and ongoing global average increase in temperature near the Earth's surface.

Greenhouse Effect

Trapping and build-up of heat in the atmosphere (troposphere) near the Earth's surface. Some of the heat flowing back toward space from the Earth's surface is absorbed by water vapor, carbon dioxide, ozone, and several other gases in the atmosphere and then reradiated back toward the Earth's surface. If the atmospheric concentrations of these greenhouse gases rise, the average temperature of the lower atmosphere will gradually increase.

Greenhouse Gas (GHG)

Any gas that absorbs infrared radiation in the atmosphere. Greenhouse gases include carbon dioxide, methane, nitrous oxide, ozone, cfc, hfc and perfluorocarbons and sulphur dioxide. Greenhouse gases include, carbon dioxide, methane, nitrous oxide, ozone, chlorofluorocarbons, hydrochlorofluorocarbons, hydrofluorocarbons, perfluorocarbons, sulfur hexafluoride.

Halocarbons

Compounds containing either chlorine, bromine or fluorine and carbon. Such compounds can act as powerful greenhouse gases in the atmosphere. The chlorine and bromine containing halocarbons are also involved in the depletion of the ozone layer.

Heat Waves

A prolonged period of excessive heat, often combined with excessive humidity.

Hydrocarbons

Substances containing only hydrogen and carbon. Fossil fuels are made up of hydrocarbons.

Hydrosphere

The component of the climate system comprising liquid surface and subterranean water, such as: oceans, seas, rivers, fresh water lakes, underground water etc.

Industrial Revolution

A period of rapid industrial growth with far-reaching social and economic consequences, beginning in England during the second half of the 18th century.

Infrared Radiation

Infrared radiation consists of light whose wavelength is longer than the red color in the visible part of the spectrum.

Intergovernmental Panel on climate Change (IPCC)

The IPCC was established jointly by the United Nations Environment Programme and the World Meteorological Organization in 1988.

Mitigation

A human intervention to reduce human impact on the climate system; it includes strategies to reduce greenhouse gas sources and emissions and enhancing greenhouse gas sinks.

Natural Gas

Underground deposits of gases consisting of methane (CH₄) and small amounts of heavier gaseous hydrocarbon compounds such as propane (C₃H₈) and butane (C₄H₁₀).

Natural Variability

Variations in the mean state and other statistics of the climate on all time and space scales beyond that of individual weather events.

Ozone Layer

The layer of ozone that begins approximately 15 km above Earth and thins to an almost negligible amount at about 50 km, shields the Earth from harmful ultraviolet radiation from the sun.

Photosynthesis

The process by which plants take CO₂ from the air (or bicarbonate in water) to build carbohydrates, releasing O₂ in the process.

Radiation

Energy transfer in the form of electromagnetic waves or particles that release energy when absorbed by an object.

Recycling

Collecting and reprocessing a resource so it can be used again.