

Vulnerability to Climate Change Induced Drought and Sustainable Livelihoods: A study of farm households in three villages of Balangir District, Odisha

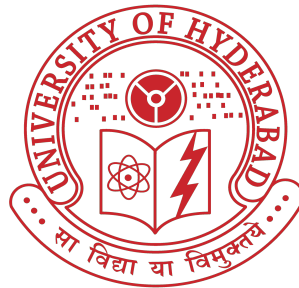
**A thesis submitted to the University of Hyderabad
in partial fulfilment of the requirement for the award of**

**DOCTOR OF PHILOSOPHY
in
SOCIOLOGY**

by

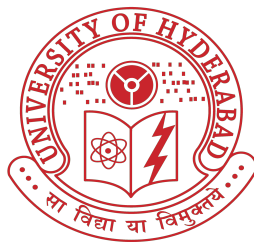
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15SSPH04



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JUNE 2022**

Dedicated to *My Younger Brother Prabhat*



**Department of Sociology
School of Social Sciences,
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Date: / / 2022

DECLARATION

I hereby declare that the research embodied in the present thesis entitled '**Vulnerability to Climate Change Induced Drought and Sustainable Livelihoods: A study of farm households in three villages of Balangir District, Odisha**', submitted by me under the guidance and supervision of **Prof. Satyapriya Rout**, Department of Sociology, School of Social Sciences, University of Hyderabad, is a bonafide research work which is also free from plagiarism. I also declare that it has not been submitted previously in part or in full to this University or any other University or Institution for the award of any degree or diploma. I hereby agree that my thesis can be deposited in Shodganga/INFLIBNET.

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This thesis is free from plagiarism and has not been submitted previously in part or in full to this or any other university or institution for award of any degree or diploma.

Parts of the Thesis have been:

Published in the following Journals:

- Changing climatic conditions and agricultural livelihoods: An impact study in Jagatsinghpur, District, Odisha published in *Journal of Social Change*, Sage Publication, New Delhi. Vol 51, Issue 2, 2021
 - Mapping the role of NGOs in co-opting the cyclone prone areas: with special reference to cyclone Fani, *South India Journal of Social Sciences*, AP Academy of Social Science. Vol. IXX (1), 2021
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Presented Papers in the following conferences and seminars:

- Participated and presented a paper titled: Vulnerability to climate change and agricultural drought: An impact study of Balangir district, Odisha in the two days virtual international conference on "emerging environmental issues and challenges" organised by Shillong law college NSS unit in collaboration with Phuket Rajabhat university, Phuket, Thailand on 11th and 12th February 2022.
- Participated in the two-day National Seminar on ‘Implementation of Right to Education and Mid-Day-Meal Programme: Promises and Challenges’ (25-26 March 2015) and presented a paper entitled ‘Evaluation of Mid-Day-Meal (MDM) Programme in Odisha’ organized by M.P. Institute of Social Science Research (MPISSR), Ujjain, sponsored by ICSSR.

Further, the student has passed the following coursework requirement for Ph.D. / was exempted from doing coursework (recommended by Doctoral Committee) on the basis of the following course passed during his M.Phil. Program and the M.Phil. degree was awarded:

Course Code	Name	Credits	Pass/Fail
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Abstract

The present study examines the impact of climate change induced natural disasters, especially drought on Odisha's agricultural system. The study has selected three objectives based on the research problem: (a) To examine the impact of drought vulnerability on agricultural production and socio-economic conditions of farm households belonging to scheduled and non-scheduled categories. (b) To analyse the rate of migration among the farm household during normal and drought year. (c) To evaluate the essential safety measures adopted by the farm households to combat the adverse impact of drought. The study has collected data from secondary sources (the India water portal, census reports, agricultural statistics, newspaper articles etc.) and conducted a field study in three villages (Bhaludharah, Mundomahul and Manepad) in the Balangir district of Odisha. The study used an interview schedule consisting of 23 open and close-ended questions to understand the impact of drought on the studied villages. The village economy structure is primarily dependent on agricultural production. The most dominant crops grown in the area are rice, cotton, pulses and wheat. The drought condition in the studied village is considered one of the significant threats to the livelihood of the poor farmers. Therefore, to understand people's real problems at the grassroot level, a comparative analysis of normal and drought year has been analysed. The study has discussed the drought situation in the study area based on the availability of water resources and social category. After collecting data from various sources, the study used different statistical methods such as mix design ANOVA, Crosstabulation and regression to analyse the sample data. The study found that people belonging to the scheduled category are more vulnerable to drought than the non-scheduled category. Moreover, based on water accessibility, farmers having inadequate water resources (IWR) are more vulnerable than farmers having adequate water resources (AWR) in the study area. The vulnerable farmers have adopted different safety measures at the farm level to minimise the grave consequences of climate change-induced drought impact.

Keywords: *Climate Change, Vulnerability, Drought, Livelihood, Safety Measures*

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Abbreviation

AWR	Adequate Water Resources
IWR	Inadequate Water Resources
IPCC	Intergovernmental Panel on Climate Change
UNFCCC	United Nations Framework Convention on Climate Change
IMD	India Metrological Department
BPL	Below Poverty Line
UNISDR	United Nations International Strategy for Disaster Reduction
SLF	Sustainable Livelihood Framework
SL	Sustainable Livelihood
SLA	sustainable livelihood approach
ACZ	Agro Climatic Zone
AES	Agro Ecological Situations
WCTL	Western Central Table Land
GHGs	Greenhouse gases
CFC	Chlorofluorocarbon
CO ₂	Carbon dioxide
CIND	Climate Induced Natural Disaster
IOM	International Organization for Migration
NATCOM	National Communication
WWI	World watch Institute
RPG	Refugee Policy Group
UNDP	United Nations Development Programme
HYV	high yielding varieties
PRA	Participatory Rural Appraisal
GSVA	Gross State Value Added
GDP	Gross domestic product
KMF	Karnataka Milk Federation
NFS	non-farm Sector
SSI	Small Scale Industries
MSME	Micro, Small & Medium Enterprises
SEZ	Special Economic Zones
HH	Household
GP	Gram Panchayats
SC	Scheduled Castes
ST	Scheduled Tribes
OBC	Other Backward Classes
ANOVA	Analysis of variance
SD	Standard Deviation
PAR	Pressure and Release Model
OC	Other Caste

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CHAPTER I

Introduction

1.1 Background of the study

The problem to be addressed by this study comprises the multifaceted aftermath of climate-induced drought vulnerability on agricultural livelihood and socio-economic conditions of the rural farm households. Drought is a climate induced natural disaster that poses complex challenges for humankind in the present-day technology-driven society (FAO, 2019). The rural agricultural community faces the worst impact of drought vulnerability due to livelihood loss (Udmale, 2015). Consequently, it leads to various effects on the rural community. Its manifestations and effects vary from people to people, from community to community, region to region, and country to country. In addition to this issue, it is essential to focus on the adaptation, safety strategy and preferences to lower the vulnerability. The assessment of ground-level vulnerability requires affordable and effective planning to bridge the gap between the community level and the higher level (Mohanty and Wadhawan, 2021). The higher-level authority dealing with policy and planning is accountable to the needs and priorities of the community level to reduce the vulnerability caused by natural disasters. The policy at the micro-level will help the government form effective policies for the state and national levels (Burton & Smith, 2006). Many researchers have analysed the issues of aggregate level for the state or a region. Still, micro-level analysis of vulnerability at the household level helps in framing effective plans since the household is the primary unit where the decision about the adaptation is taken. To understand the complete picture of drought vulnerability, it is necessary to understand the climatic factors that lead to frequent disasters and are responsible for several vulnerabilities in the human world.

This chapter consists of eight sections (section 1: introduction, section 2: Sociological understanding of environmental problem, section 3: climate change context, section 4: vulnerability context, section 5: Approaches to social vulnerability, section 6: sustainable livelihood context, section 7: Methodology and rationale of the study, section 8: chapter scheme of the Thesis).

The significance of climate change in contemporary society generally comes with a vital question, why are we compelled to hassle this much? In the end, climate induced natural disasters have been associated with us for as long as recorded in history and presumptively even longer. Generations of people have had to face several disasters and recover from them, and life keeps moving like normal. Phenomenon like drought, cyclone, earthquake, volcanic eruption, tsunami, wildfire, flood, landslide etc., have been seen for ages. These climate disasters have severe impacts such as social, economic, human casualty, injury and many more to the human and natural world (Alexandar, 2018; Cannon, 1994). Consequently, the vulnerable population learned to address these issues comprehensively. However, we have neither removed nor entirely restricted them; we have been able to transform their impacts in diverse ways. The effect still corresponds to intolerable difficulties for people marked by comprehensive sustenance of life. According to the World Bank (n.d.), climate disasters are inevitable as fatalities. They can be reflected in three-dimensional results in many sectors such as personal, social, and economic. Of all nations, developing nations experience the worst impact of climate-induced natural disasters. In the context of a developing nation, India is placed among the most vulnerable country to climate-induced natural disasters due to its geo-climatic, topographic, industrialisation, urbanisation, and overpopulation settings.

Of all India states, Odisha is considered the poorest state in terms of growth and development. According to the Directorate of Horticulture, government of Odisha about 70 % of the total population in the state depends on the agricultural sector; however, the sector is highly exposed to climate induced natural disasters such as drought, floods and cyclones almost every year (Das, 2016). Agriculture is one of the climate-sensitive sectors because of its higher dependence on monsoon rainfall (Howden and Soussana, 2007). The variability in the monsoon pattern is one of the major threats to agriculture in the state. The irregular rainfall pattern in the state causes severe drought in the hilly areas and floods in coastal areas. Hence, Odisha is a workplace of various natural disasters. Floods and drought are the state's regular features among all natural hazards. Most coastal regions face flood impact, which triggers massive loss of lives, property, livelihood, displacement (Hossain and Ryakitimbo, 2020). Similarly, droughts in the hilly region poses considerable impact on human life in terms of low agricultural production, malnutrition, migration, unemployment etc. Therefore, this research aims to integrate both secondary and primary data to examine the impact of drought vulnerability on farmers belonging to different social categories in the study area. The study examines the migration rate of these vulnerable farmers during drought years for alternative

and additional livelihood. The study also examines the safety measures adopted by farm households to mitigate the drought vulnerability. Due to the magnitude of the issues witnessed due to the climate-induced drought, people tend to alienate themselves from their traditional agricultural occupation and constantly search for alternative livelihood. Consequently, the study area is exposed to various problems such as Low crop output, shortage of agricultural labour, indebtedness of poor farmers, and forced migration. To understand the research problem, it is necessary to discuss on sociological understanding of environmental problems. The discussion will illustrate a holistic approach to understanding the environmental problem and people's vulnerability.

1.2 Sociological understanding of environmental problem

In the 21st century, the environmental problem is considered the foremost issue of numerous social impacts on human society. To understand these social problems, sociologists play a significant role in mitigating vulnerability. Environmental study as an interdisciplinary subject has much more importance across the social science subject, exclusively in sociology to deal with humans and the study of ecology. The study of environmental issues across the social science discipline is recognised increasingly among the young and dynamic sociologists (Brewer and Stern, 2005). The ecological concern increased with the consciousness that environmental problems are one of the social problems that need to be checked at the earliest to save humanity. By societal effort and conscience, the issue can be mitigated. Environmental degradation is an ultimate consequence of modern industrial societies, observed in climate change vulnerability (Brewer and Stern, 2005). Climate change is one of the significant issues contracting modern civilisation. Mapping the vulnerability level is more important as it impacts the human and animal world. It is very interesting that social scientists also focus on environmental issues like climate change and its impact on human society. Therefore, environmental sociology is essential to analyse the effects of climate change on the natural environment, thereby bringing the mitigation strategy among the people.

Moreover, environmental sociologists scrutinise and theorise the complex and multifaceted relationship between human beings and their natural environment. Mainly, it creates social awareness of environmental problems and reactions toward the emerging issues (Nagel et al., 2008). The conflict over nature is based on two important aspects of socio-economic conflicts (a) Conflict over the distribution of land between landlord and agricultural labour and (b) Conflict in the factory between the capitalist class and working class (Guha,

1997). Agricultural and industrial conflicts are prime concerns for many scholars; however, sociological research or study on the conflict over natural resources came up as a debate very late (Guha, 1997). Baviskar explains that sociology is the youngest discipline/ branch in all social sciences. She also points out that within the study of sociology, the study of ecology and development is still younger. The study of ecology is also popularly known as 'Ecological Anthropology', 'Social Ecology' (Guha, 1994), and 'Environmental Sociology' (Baviskar, 1996). Many works have been done on 'Ecology and Development'; still, the discourse on the specific topic within the discipline of sociology is inadequate (Patel, 1997). So that it requires more attention to reduce the confusion in the further study; she also admits that there is confusion regarding the specific boundaries of social ecology and environmental sociology. Even though many books on ecology and the environment have an adequate flow that discovers its correlation to social processes, the subject remains mysterious. She suggests that to know the correlation at first, it is necessary to examine the Sociology of Environmental movements and their relationship with society and relate them to the state's response. Chipko and Narmada have been the two most basic movements studied by Indian sociologists. Baviskar (1995) analysed the participation of tribals in the Narmada Bachao Andolan. It was the struggle of those people who were to be displaced due to the giant Sardar Sarover Dam project in central India. Guha (1989) analysed India's most popular environmental movement, i.e., the "Chipko movement" (hug the trees) in 1973, where a thousand numbers of hilly people in the northern State of UP came to resist the commercial logging throughout the establishment of the Himalayan Region. These two significant movements insisted many sociologists work on the issues related to natural resources management.

Baviskar pointed out that Indian scholars had not discussed the international debate on the environment. Mostly, Indian environmental sociologists ignored the macro-level analysis of the impact of industrialisation and urbanisation. Still, they have given attention to the micro-level analysis of the effects of various developmental projects (Pradhan, 1998). On the contrary, Giddens (1991) mentioned that modern society, with its technological advancements, tends to incur newer forms of insecurities and anxieties, which Beck (1992) calls the 'Risk Society'. 'Calculativeness', as Giddens terms it, thereby becomes the order of the traditional post society. Giddens further says that living in an age of modernity means living in an environment of risk and chances. Modernity reduces risks in certain areas and modes of life and introduces new risks in other areas. For instance, developments in medicine have reduced the risk of dying from various illnesses. Still, at the same time, there are increased health

hazards due to pollution caused due to the increasing number of cars and factories. However, certain risks that modernity has produced are apocalyptic, for example, the threat of a nuclear war. The emergence of various risks has also led to an obsession with fortune or fate, believing that some cosmic forces lead to certain events. Though risk calculation can be done, it is never possible to fully calculate the risk as there are always some unforeseen outcomes. Some forms of threats are inevitable (for example- risks that come from being a part of the economic system). In contrast, some are voluntarily taken for experience or thrills (for example, smoking). There are 'high consequential risks' which has a decisive impact on the life of individuals, and there are also 'cultivated risks' that are undertaken to produce greater possibilities (Giddens, 1991).

The rapid growth of an industry or the industrial estate leads to a nightmare of human civilisation. Climate change is one of human society's vital issues due to an uncontrolled polluted environment. The primary source of pollution in the contemporary era is the growth of industries. The increasing level of pollution leads to the increase of greenhouse gases in the atmosphere, which has resulted in an extreme rise in the earth's temperature. The increase in the earth's temperature ultimately leads to climate change. Global warming is one of the major problems human civilisation faces due to the rising temperature in the modern era. Many political leaders are now aware of the hazards created by climate change, and also, they are preparing for the response. Global warming, climate change, and extreme natural events are risks and dangerous to human civilisation in the contemporary era. The issues of risk and uncertainty are posed by climate change. The politics of climate change is all about the risks/dangers posed by climate change and the coping strategy to mitigate the negative impacts of climate change (Giddens, 2009).

Beck makes a systematic distinction between three logics of global risks and explores their interrelations (1) environmental crises, (2) global financial risks (3) terrorist threats. Among these three, we can analyse one logic, environmental and risk, in the context of Odisha. Beck aims to develop the existing theory and sociology of risk at least three steps further: globalisation perspective, staging perspective, and comparative perspective. Risk is everywhere in society. It may happen knowingly and sometime unknowingly. This will affect the whole society. Natural/ environmental risk varies according to geographical and social settings in which they are located. It includes earthquakes, floods, landslides, droughts, cyclones, etc. Human-made risk or disaster tends to occur more frequently and often with great intensity, like communal and caste riots, ethnic conflict and refugees (Beck, 2012).

1.3 Climate change context

The existence of human society has always been at the mercy of nature. The rapid growth of modern industrial society has changed the shape of the natural and social world. The superfluous experiment on the natural environment is solely responsible for forming a new catastrophic world that leads to climate change risk. In recent decades, drastic climate change has threatened the whole world and human civilisation. Earth's climate is made from the interaction between five types of the climate system components, i.e., atmosphere (air), Hydrosphere (water), Lithosphere (rocky surface), Cryosphere (ice) and biosphere (living things) respectively (Planton, 2013). The small changes in these components could lead to extreme climatic variability. The composition of the climate system develops the weather conditions of the earth, which makes the living organism suitable for the planet. Climate is the statistically-average behaviour of the weather condition of a region, and change in the average weather condition of an area leads to climate change in that particular region (Moharaj & Rout, 2021). Similarly, the composition of all changing regional weather conditions is called global climate change. It is calculated by observing a more extended period. Both natural and human-induced factors are responsible for the climate change severity. Natural factors can be categorised as volcanic eruption, ocean current, solar variation, and earth's orbital change. Similarly, human-induced factors are deforestation, cities and roads, greenhouse gas emissions, industrial power, coal mining, fossil fuels, and agricultural activities (Stern and Robert, 2013; Trenberth, 2018).

1.3.1 Factors Influencing Climate Change

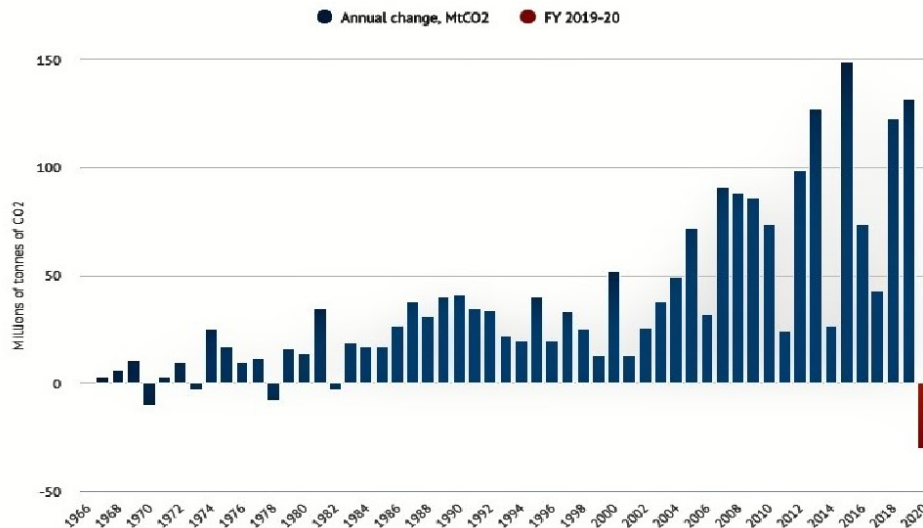
Public consciousness about various forms of environmental degradation has seen remarkable growth in India and worldwide. The awareness is gradually being translated into substantial media coverage and official initiatives such as creating new government departments concerned exclusively with different aspects of environmental management. A decade ago, studies on the environment were considered a western trend, irrelevant to the third world. However, in the contemporary era, the scenario is different. The natural environment has emerged as one of the most hotly debated themes in public life. Climate change can be observed in terms of natural disasters in Indian society in everyday life. The chronic shortage of natural resources adds a more complex situation for well-being. The reason and consequences of climate change have always been a matter of discussion among the social science community and policymakers. However, the environmental crisis seems to have caught the social science

community unaware in India. Despite several contributions of the natural scientist, journalist, environmentalist and social activist regarding the social implication of climate change and environmental discourse, there has been a minimal contribution by the social scientist to the environment debate in India (Guha, 1994). In the developed nations, too, the social scientists are not showing much interest in the environmental problems of their respective societies. In India, much importance has been given to establishing a new modern India in massive development. This has resulted in excessive exploitation of the natural resources and further marginalisation of the millions of Indians who solely depend on nature for their sustenance and survival. Four-fifths of India's rural people live entirely in the natural environment, many leading a miserable lifestyle. Ironically, the remaining sixths of India's population are the actual beneficiaries of economic development. Gadgil and Guha (1995) have rightly defined it "as the artificial growth at the cost of the natural". The beneficiaries of such a development process are invariably the big landowners who have access to irrigation, the modern entrepreneurs, or the urban professionals who have been rapidly gaining in wealth and prestige. They have the purchasing power to buy cars, fly in aeroplanes, and feast on flesh, fruit, and fish brought to them from the four corners of the end. These people enjoy the produce of the entire biosphere. In the context of India, the emissions of CO₂ in the atmosphere have increased substantially over the last two decades. The statistics show that the CO₂ level in 2000 was 50 million tonnes which significantly increased to 150 million tonnes in 2015 and 130 million tonnes in 2019. However, in 2020, the level goes significantly low to -30 million tonnes in India's history of CO₂ emission because of the Covid-19 pandemic. During the pandemic, the government initiated the lockdown, and all the factories, industries, transportation and energy sectors were utterly inactive. Consequently, the lockdown situation helped reduce the CO₂ emission; however, millions of poor people lost their livelihood because of the covid problem in India.

The rapid growth of industries and the industrial estate is one of the primary causes of environmental pollution. The increasing pollution level leads to greenhouse gasses in the atmosphere and causes a drastic increase in the earth's temperature. Consequently, the rise in the earth's temperature ultimately leads to global climate change. Figure 1 reveals the global temperature statistics from 1850 to 2020. Both natural and human-induced factors have been calculated to understand the primary factors responsible for global temperature rise. It is evident from the statistics that the human-induced factor is showing a drastic increasing trend

toward 1.5° Celsius of global warming from the 1950s onward compared to the natural factor, which is showing a decreasing trend of less than 0.0° Celsius.

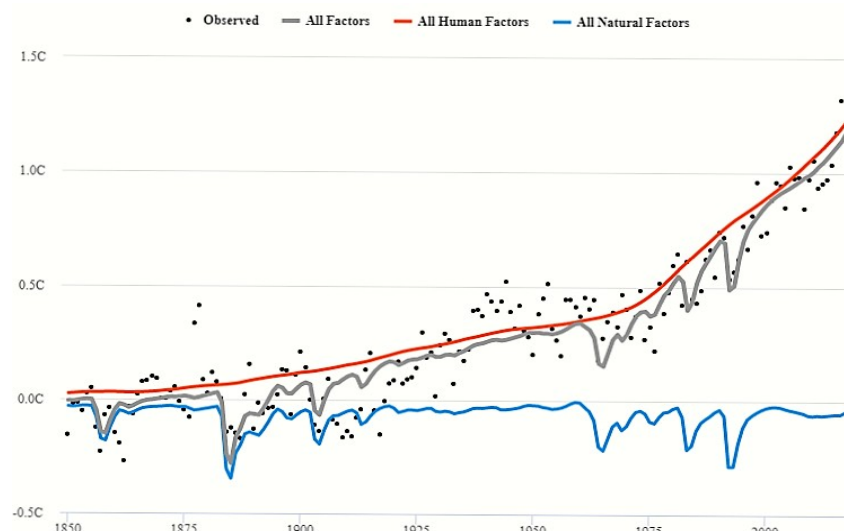
Figure 1.1 CO₂ emissions in India from 1966 – to 2020 (in million tonnes)



Source: World Economic Forum (2020), India's CO₂ emissions fall for the first time in four decades amid coronavirus

The scientific community has projected the global warming level of 1.5° Celsius could lead to a severe impact on the human world, such as health problems, water scarcity, livelihood loss, economic crisis etc.

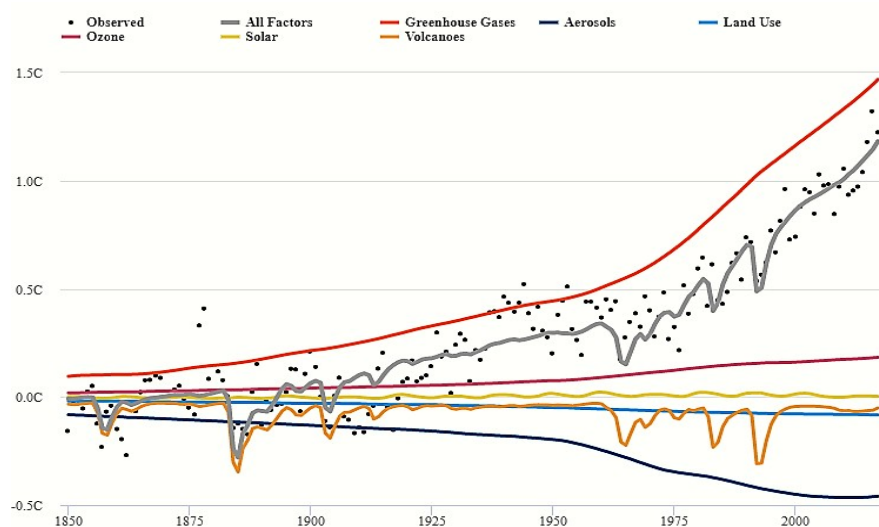
Figure1.2 Temperature rise and global warming level by human and natural factors from 1850 to 2020



Source: Carbon Brief (2017), Analysis: Why scientists think 100% of global warming is due to humans

The human and natural aspects of global warming have been categorised under the various component of the emission. Figure 1.3 has identified six significant elements responsible for global warming and climate severity, i.e., greenhouse gases, aerosol, land use, ozone, and solar volcanoes. The concentration of Greenhouse Gases is highest compared to other components such as ozone, solar, land use, volcanoes and aerosol from 1850 to 2020. The primary greenhouse gasses are carbon dioxide (CO₂), water vapour (H₂O), Methane (CH₄), Nitrous Oxide (N₂O) and Ozon (O₂). Figure 1.2 shows that since 1850 the greenhouse gas concentration was increasing slowly up to 1950, and it started growing towards the dangerous landmark of 1.5° Celsius projected by scientists. Although other components, i.e., volcanoes, solar, land use, aerosol and solar, don't have a substantial emission like greenhouse gasses, it altogether plays a vital role in accumulating a considerable share of emissions in the atmosphere.

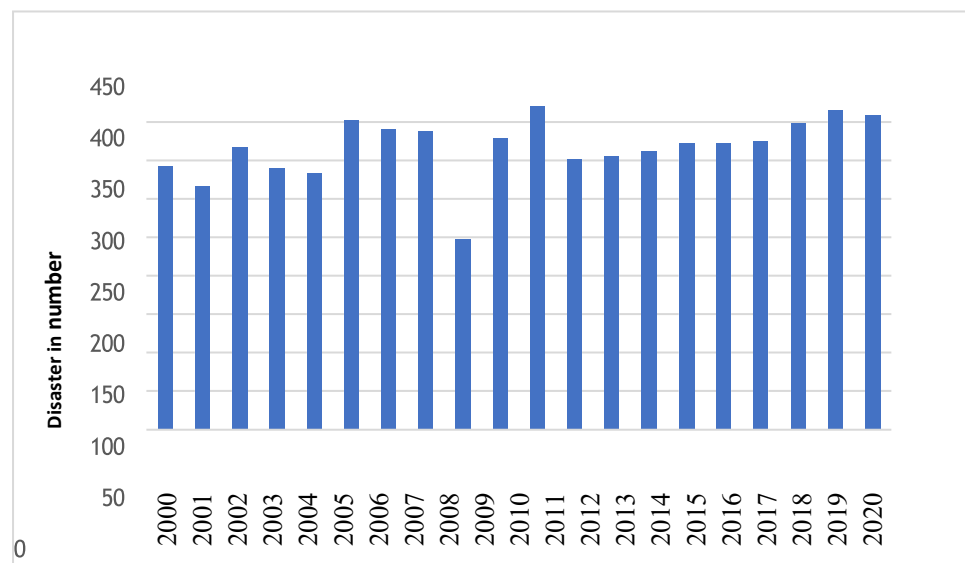
Figure 1.3 Global emissions by factors since 1850 – 2020 (a sub-category of human & natural factors)



Source: Carbon Brief (2017), Analysis: Why scientists think 100% of global warming is due to humans

Global warming and atmosphere emissions have resulted in many natural catastrophes over the last two decades. Figure 1.4 elucidates an increasing trend of natural disasters world-wile. The occurrence of natural disaster events in 2000 was 343 while it increased by 403 in the year 2005. The year 2008 has seen a curve of only 248 natural events while it again started moving towards the maximum track of 420. Consequently, it has been observed more than 350 natural events each year from 2009 to 2019 that make human life challenging to survive.

Figure 1.4 Annual number of natural disaster events globally (2000-2019)



Source: T. Wang (2020), Global number of natural disasters events 2000-2019

1.4 Vulnerability Context

The concept of vulnerability is used in multiple contexts such as social, cultural, environmental, institutional, economic structures, public health, ecology, livelihoods, development, climate change, adaptation and many more. Therefore, it will be unfair only to use the concept in an environmental context (Few, 2003; Fusel, 2007). According to United Nations International Strategy for Disaster Reduction (UNISDR, 2004), vulnerability is the condition determined by physical, environmental, social and economic processes that increase the susceptibility of a community to the impact of risks. The general use of the term ‘Vulnerability’ is referred to the capability of a system to be harmed, i.e., the level to which a system is susceptible to and unable to cope with the risk. So, it indicates being prone or susceptible to harm or injury. Our study elucidates the vulnerability Pattern in relation to natural hazards by placing people’s vulnerability as its core analysis. In terms of natural events or processes, people’s vulnerability means the characteristics of an individual or group and their condition that impact their capability to anticipate, resist, cope with, and recover from any natural hazards. The process generally affects people’s livelihood, health, property and other valuable assets differently based on the diverse socio-economic conditions of the people. The socio-economic conditions are influenced by many vital variables such as class, caste, gender, age, health, occupation etc. Most physical and natural sciences studies have focused on the physical vulnerability, especially natural hazards, while social scientists have focused on the social vulnerability, i.e.,

adaptive capacity, coping mechanisms, policy measures, resources management, migration, etc. Most interestingly, social vulnerability has become one of the vital parts of vulnerability study, intending to focus on the most vulnerable section of society (Brooks, 2003).

Based on various definitions by researchers, Mugadur (2009) analysed some vulnerability characteristics such as, Population group location, overpopulation, women, disabled, aged person and accessibility to economic, material and other resources. In addition to this, it has some regular elements which are responsible for the development of vulnerability, such as in rural areas (Ecological damage, degradation, decline of natural or essential local resources, forced migration, no access to credit facilities, inability to produce a surplus, absence of alternative sources of income, Unequal access to land in rural area) and in urban areas (low-income level, subsistence income level, Inadequate personal, social, infrastructural, or transport service, population in-migration, compressing risks).

1.4.1 Development of vulnerability and its uses in a different discipline

As far as the evolution of the concept is concerned, the buzzword ‘Vulnerability’ was most prevalent among scholars of natural hazards in the 1990s. The scholars used this concept to know environmental impacts, especially climate change analysis. Therefore, vulnerability is initially associated with Geography. Over time, some scholars from the mathematics background also used the concept while studying resilience and vulnerability by using mathematical models. But most importantly, the concept gained more attention when it came across various case studies and comparative analyses (Editorial, 2006). Similarly, the study by human ecology and geography theorised the concept of vulnerability to environmental variation. However, both studies contribute to understanding the social- ecological system, i.e., social change and decision making. More precisely, these two fields of study, the vulnerability study as lack of privileges and the study of vulnerability to natural disasters, led to the study of social and physical vulnerability in an integrated manner (Adger, 2006). According to (Beck, 2009), vulnerability and risks are closely associated with each other in terms of social impact. Social vulnerability assessment is essential to understand the numerous ways to deal with several known or unknown social threats that could hamper people’s lives. Thus, the ‘social vulnerability cannot be precisely restricted either in space or in time but rather a methodological implication of the cosmopolitan outlooks (Beck, 2009). At the start, there is the choice of the threatened unit, the unit of analysis of social vulnerability: Who or what is exposed to what danger (Beck, 2009)? The answer to the specific question has importance in

the real world, i.e., who is vulnerable and responsible for the environmental hazards. The evidence shows that the local inhabitants are always more susceptible to multiple disasters.

1.4.2 Hazards and Vulnerability

All types of natural hazards have different impacts on human beings and society as a whole. The impacts generally vary from people to people, group to group and community to community, based on their capacity to resist. Again, the effect can be visible when the people or groups cannot resist or recover from stresses. So, it indicates that vulnerability can't be mapped without impending people or groups to resist, absorb and recover from the grave consequences of natural calamities (O'Keefe et al., 1976). The vulnerability of people to natural hazards generally depends on the place where they reside, the types of natural resources they use and most importantly, the management of appropriate natural resources during a particular hazard event. Hence, natural hazards are mediated by the institutional structure of society, and it doesn't necessarily imply that increased economic activities will reduce the vulnerability (Burton et al., 1993). However, Adger (2003) has a somewhat distinctive opinion; vulnerability is not only mediated by the institutional structure but rather by the constraint over the availability and accessibility of resources. Researchers, scientists, and academicians are more concerned about the natural hazards and their impact on the human world in the contemporary era. Hence, it gained huge attention in vulnerability research (Hogan, 2002). This also raised some vital questions, such as how a particular population or groups are vulnerable to a particular hazard, to what extent they are vulnerable, and how to reduce such vulnerability effectively? Adger (2006) explained the dominant role of resilience and various government policies in effectively decreasing vulnerability to answer these questions.

1.4.3 Drought Vulnerability

Depending on precipitation and water availability, drought is categorised into meteorological, hydrological, and agricultural (Nam et. Al., 2012). Meteorological drought is where the rainfall deviates more than 25 per cent from the normal precipitation. Similarly, the prolonged meteorological drought over an area resulted in hydrological drought. Finally, agricultural drought is a situation where soil moisture and rainfall are inadequate for the growth of crops over an area. According to the India Metrological Department (IMD), drought has three dimensions over a region, i.e., marginal drought, moderate drought and severe drought. The marginal drought occurs when the deviation of precipitation is 25 per cent from average

rainfall. The deviation of rain between 25 to 50 per cent from the normal is called moderate drought, and more than 50 per cent of deviation from normal is called severe drought over an area (Rao, 2018). Drought is one of the most frequently occurring national disasters in India (Mishra and Desai, 2005). With its increased frequency and expanded coverage in recent years, about one-third of the country is drought-prone or under desert areas. These areas are lagging in agriculture and also in overall economic growth. They experience wide year-to-year fluctuations in agricultural production and incomes and have a relatively high incidence of poverty. The poor in these regions are highly vulnerable to various risks due to their low and fluctuating incomes, high indebtedness and low human development. Drought generally has multiple native impacts on human society.

The National Commission of Agriculture, Ministry of agriculture, categorised drought into three types, i.e., agricultural drought, hydrological drought and meteorological drought. The primary reason for agricultural drought is less precipitation and lack of soil moisture, leading to low crop output during the maturity period. Meteorological drought is usually defined based on the dryness of a region compared to the normal. It varies from region to region based on their atmospheric conditions with lesser precipitation than normal. Similarly, Hydrological drought is defined as a result of long-term meteorological and agricultural drought that results in water deficiency in river basins, reservoirs, lakes, streams and groundwater. The agricultural occupations in backward drought-prone regions are constantly overcrowded due to increasing smallholdings (Size 1 to 2 hectares), the absence of irrigation, and other socio-cultural determinants. Sharing knowledge and information on updated technology for higher production has been limited among their relatives and neighbors (Mahapatra, 1978). The other significant feature is the multi-cropping pattern in the rain-fed areas, which reduces risk in a particular crop pattern. The size of the operational holdings does play a major deciding factor for crop types to be cultivated (Mohanti and Padhi, 1995; Pathy, 2003). In rural societies, risk-aversion is negatively correlated with the wealth of crop produce generated in agricultural land (Arrow, 1970). Therefore, the diversity of crop production could be negatively related to the farm size. Multi-cropping or diversity in crop cultivation has been prevalent among its inhabitants in drought-prone regions. This helps develop a cropping pattern rather than specialising in a single variety of crop production (Mohanti and Padhi, 1995; Pathy, 2003). The multiple cropping patterns enable the development of strategies for crop protection from pests and reduce any kind of risk (Pionetti and Reddy, 2002). The crop diversity practised in drought-prone areas erects a vital pillar of support for agriculture in semi-arid regions. The

crop diversification strategy could also be practised in rainfed/dryland areas. Still, the size of the operational land holding (Parthy, 2003) and wealth of resources (Arrow, 1990) plays a significant role in determining strategic effectiveness. In drought-prone regions, due to poor irrigation facilities, there has been an increase in the fragmentation of agricultural land. As a result, the poor peasants meagerly gain produce from their agricultural cultivations (Pathy, 2003). Even if the farmers have obtained all the necessary implements such as bullocks, seeds, ploughs etc. are somehow prone to poor skill, especially among the small size land-holdings. The impediment of lacking the contextual knowledge and the adaptable experience in acquiring skills related to arid/semi-arid region cultivations both as an owner-cultivator has caused a significant setback to them in earning their income and subsistence (Kshirsagar, Pandey and Bellon, 2002). The other household or cottage industries services in which both men and women primarily, more non-agricultural workers serve livelihood services such as rope-making with Sabai grass, and tasar cocoon rearing and weaving. The farming communities in the dryland areas prefer the traditional varieties of crop cultivation rather than the modern ones. The cultivation of traditional varieties is a lesser risk than the modern varieties.

On the other hand, the traditional crop varieties generate lesser profits when compared to the modern crop varieties, leading to an increase in inequality among the coastal regions and the dry land regions (Kshirsagar and Bellon, 2002). The small size of the operational holdings and the absence of irrigation facilities hindered the modernisation of agriculture (Singh, 1982). The shift of the workers from the farm to the non-farm sector was identified to be different in pattern in the backward regions compared to the developed areas (Jha, 2005). In the backwards areas, the shift from the farm to non-farm activities is mainly driven by distress-led factors rather than development-oriented ones. Further, the share of the workers in the farm sector was also found to be higher in these regions. The very high percentage of agricultural labour is also an index of the non-availability of alternative non-agricultural employment (Mahapatra, 1978).

1.4.4 Entitlement, Human ecology and vulnerability

Entitlement based vulnerability approach focuses on the social domain of class structure, social institution, human well-being, gender, social status, social role, social relationship etc. These are called social capital made by the human being and the society itself (Adger, 2006). Similarly, vulnerability is also associated with human ecology or political ecology, which generally implies human adjustment to nature in environmental hazards (Cutter, 1996; Hufschmidt, 2011). People from different back-ground, i.e., poor, marginalised, middle class

and rich class, react differently to similar events. Most studies found that poor and marginal classes are more vulnerable to hazard events than middle and rich classes. This approach is associated with neo-Marxist and structuralism approaches (Liverman, 1994). Patel (1997) argued that, though a large number of works have been done on 'Ecology and Development', still the discourse on the specific topic within the discipline of sociology is insufficient. So, it requires more attention to reduce the confusion in further study. She also admits that there is confusion regarding the specific boundaries of social ecology and environmental sociology. Even though there is an adequate flow of many books on ecology and or environment that discover its correlation to social processes, the subject remains mysterious. She suggests, at first, that to know the correlation, it is necessary to examine the Sociology of Environmental movements and their relationship with society and relate them to the state's response to it.

1.4.5 Vulnerability as a socially formed phenomenon

The condition of vulnerability is socially distinguished within the hazards and environmental change literature. It has its original concept in the work of Gilbert White, who mentioned the significance of shifting population, mobility and types of housing and their contributions to a nation's vulnerability to hazards (White and Haas, 1975). The vital portion of the initial work in this area concentrated on independent social elements and their impact on vulnerability. The importance of age and occupation was studied by Bolin (1982), and housing, family structure and built ecosystem by Bolin and Bolton (1986). Hewitt (1983), Susman et al. (1983) and Alexander (1991) questioned the predominant beginning at a more conceptual or theoretical standard, and this led the way to contemporary work by O'Brien and Lienchenko (2000), Watts and Bohle (1993), Bohle et al. (1994), Blaikie et al. (1994), Adger and Kelly (1999, 2001) and Lienchenko and O'Brien (2002). The social construction of vulnerability study focuses on the system's ability to react to the stimulus, identifying that the system is not entirely prone to natural disasters but rather to the social condition. People surviving under various social, economic, constitutional, developmental and institutional environments or settings have distinct levels of vulnerability. Biophysically susceptible places do not always intersect with vulnerable populations. For instance, in places of high biophysical risks, the financial loss might be extensive. Still, likewise, the population might have substantial security measures like insurance to recover from such losses quickly. Moderate issues could have a distinctive effect on socially vulnerable populations with a long-time interval for recovery.

Amongst other nations, Bangladesh and Florida are the nations which are vulnerable biophysically, for instance, sea-level rise and tropical storms. The effect of these occurrences varies in both nations distinctively. Florida incurred more financial loss or was affected economically, whereas Bangladesh incurred the loss of life and livelihood. Hurricane Andrew hit Florida in 1992, which caused an economic loss of more than US\$16 bn but perished less than 20 people (Morrow, 1997). Before the year, a similar cyclone hit the southeast coast of Bangladesh, killing around 140,000 people and devastating millions of livelihoods. All were not similarly affected. Vulnerability varies in accordance with gender, health, livelihood, and age, and this unlikeness cannot be described only in the condition of the nature of the stimulus. Therefore, with reference to policy, the social vulnerability composition indicates the need to concentrate on the attributes of the system determining the capability of humans and the society to respond to, cope with and adapt to a stimulus.

1.5 Approaches to social vulnerability

1.5.1 Political economy approach

Preet & Thrift (1989) considered that political economy describes the socio-economic and governmental framework that affects vulnerability and highlights the major role played by the distinctive constitutional and economic power in determining the vulnerability of people and groups. As part of structuralism, Santos and Harvey introduced this perspective during the 1970s on economic dependency and third world underdevelopment. Apart from this, some other notable theorists who developed the theoretical basis of this work are Bohle et al. (1994) concerning climate change, Sen (1981) and Watts assessed the natural threats environmental change literature, natural disasters by Blaikie et al. (1994), famine by Bohle (1993) and agriculture, climate change and coastal vulnerability by Adger and Kelly (1999, 2000). According to Blaikie et al. (1994), “vulnerability is the capacity to anticipate, cope with, respond to and recover from an external stimulus”. Vulnerability is enlightened in terms of human dimensions, whereas biophysical and social aspects are differentiated in this structure. The Pressure and Release Model (PAR) also examines that vulnerability is a part of the risk. Moreover, it found that a series of social factors are the sole cause of vulnerability. These aspects are the primary causes and vigorous pressures, with the crucial point on political, social and cultural systems that give birth to the precarious conditions (e.g., vulnerable community/groups). The structure has a different range of components. The original purpose concerned remote impacts and the economy, demography, and political techniques within the periphery

of society and the world economy that replicate the division of power. Twigg (2001) argued that Dynamic pressures simultaneously transmit the original causes into specific forms of hazards by lowering the accessibility to resources. Blaikie et al. (1994) added factors such as training, local savings, institutional scarcity, freedom of the press, appropriate skills, moral standards in the public sphere and macro points like urbanisation, debt repayment, expenditure on arm force, population growth and deforestation process etc. in their analysis of dynamic pressures. The specific forms of vulnerability expressed in time and space are an outcome of the unsafe condition. It forces people to live in dangerous places with unsafe livelihood, lack of disaster preparedness, poor health, etc.

The tripartite model proposed by Bohle et al. (1994) and Watts and Bohle (1993) is quite similar to that of the PAR model of Blaikie et al. to trace. To identify the movement of vulnerability from larger structural components to particular types of vulnerability. Compared to Blaikie et al., which aims only at capability, Watts and Bohle explained vulnerability in potentiality, exposure and capacity. It can be recognised based on people's institutional, economic, and political capacity based on specific locations and times. Whereas the social space of vulnerability arises in three interrelated parts

- Vulnerability as an entitlement problem - follows from the work of Amartya Sen (1981) on access to resources or endowments during periods of crisis.
- Vulnerability as powerlessness, a lack of empowerment
- Vulnerability through appropriation and exploitation – a political economy structural/historical class-based forms of social reproduction

many authors like Adger (1996), Adger and Kelly (1999), Reilly and Schimmelpfening (1999), Hammer et al. (1999), Adger (2000), Kelly & Adger (2000), O'Brien & Liechenko (2000) Liechenko, Adger et al. (2001), O'Brien (2002) have stated that vulnerability is a continuous development process. Similarly, Adger and Kelly (1999) argued that vulnerability is dynamic. Later, Liechenko and O'Brien (2002) developed this approach to dynamic vulnerability. It integrated environmental and economic changes that can 'affect the capacity of ecosystems, social groups, regions, sectors to react to various biophysical and socio-economic shocks. Although some studies found that the dynamic vulnerability approach follows a traditional method of vulnerability (Watts and Bohle, 1993), It also found that the approach is quite flexible towards rapid changing contexts in terms of calculating how macro changes are regular in regional and local scales (Blaikie et al., 1994). Similarly, authors like

Kelly and Adger (1999), Adger and Kelly (1999), and Adger et al. (2000) also focused on the dynamic nature of the vulnerability. They argued that the prime focus of this study should be 'capacity,' i.e., the capacity to adapt, cope and respond to the dynamic vulnerable condition. This 'capacity' approach generally plays a significant role in terms of entitlement of social group or individual, and ultimately it leads to resource management and accessibility (Adger, 2000). Adger et al. (2001) analysed the dynamic nature of vulnerability in terms of individual and collective perspectives. The individual aspects of vulnerability generally deal with the management and accessibility of resources at the local/ micro level, i.e., household income, income source, expenditure, total dependents, saving, social status etc.

In contrast, the collective aspect of vulnerability deals with the macro-level, i.e., infrastructure development, policy response, and institutional preparedness. Inequality can be the best example to understand these two aspects of vulnerability. In the context of individuals, inequality leads to poverty at the local/ community level. In the context of the collective, inequality leads to the reduction of communal allocation of resources at the macro level. Dynamic vulnerability is used by Aandahl and O'Brien (2001) to survey how climatic variability is affected by the economic change to constitute vulnerability among Indian farmers. Variables such as liberalisation of agricultural trade, removal of domestic support for agriculture and changing climatic conditions result in 'double exposure' of increased vulnerability emerging from climate and socio-economic variation.

1.5.2 Social-cultural constructivist approaches

The social/ cultural constructivist approach argues that vulnerability is highly induced by the role of political, social and economic structure. Factors such as gender, ethnicity, and religion are ignored at the initial stage in terms of complex and dynamic social relations. For example, women are most vulnerable to hazards because of their poorness and exposure (Enarson, 2000). However, Bhole (2001) argued that these factors are the individual determinant of vulnerability which was neglected regarding external or structural determinants of vulnerability, i.e., collective aspect. Some remarkable works on this theme, such as Cutter (1995), focused on the differential vulnerability impact on women and children in terms of environmental change. Denton (2002) focused on gender and climate change vulnerability and concluded that the theme has a dearth flow of literature. Wisner (1998) focused on the role of religious belief in reducing vulnerability. Enarson (2000) studied the relationship between gender and vulnerability and found that women are comparatively more vulnerable than men in natural

disasters. The Vulnerability evaluation underlines the system which defines vulnerability as a social event, and it is not new to the hazards of climate change literature. The social construct literature on vulnerability is a radical alternative to the hazard-specific literature. Several kinds of literature on the social aspect of vulnerability focus on institutional (local, regional, national and global) capacity to deal with various forms of vulnerability in terms of resource accessibility and management.

1.5.3 Capability approach

The study has adopted Amartya Sen's entitlement approach to carry out the research work. According to Sen's approach, a lack of entitlements leads to the social construction of vulnerability. The social construction of vulnerability study focuses on the system's ability to react to the stimulus, identifying that the system is not entirely prone to natural disasters but rather to the social condition. Nobel laureate Amartya Sen. articulated the capability approach. He mentioned that it must be deeply rooted in not just utilitarianism of well-being but also the kind of division of various resources within the nation and to distinctive individuals, specifically the diverse and marginalised groups. Therefore, from the point of view of people's liberties and choices, well-being must be understood.

Most importantly, how people utilise their resources to ensure that they can evolve into a proper standard of living and ensure that they come out of poverty. Sen's capability approach, therefore, recognise the fact that people have different capacity. This is significant in his theory because he highlights that every human being is not the same. Every human being has a different capacity to perform even though they may have resources. An individual can have different abilities to change similar resources into valuable functioning. Broadly, in terms of poverty and famine, Amartya Sen's entitlement approach has precisely categorised the legal sources of food into four categories (Devereux, 2001).

- (1) own-labour based entitlement (working for food)
- (2) inheritance and transfer-based entitlement (food given by others)
- (3) production-based entitlement (growing food) and
- (4) employment-based entitlement (buying food).

People surviving under various social, economic, constitutional, developmental and institutional environments or settings have distinct levels of vulnerability. Biophysically

susceptible places do not always intersect with vulnerable populations. For instance, areas of high biophysical risks, financial loss etc., might be extensive, but likewise, the population might have substantial security measures like insurance to recover from such losses quickly. Moderate issues could have distinctive effects on social vulnerability. Therefore, it is necessary to focus on vulnerability assessment to understand both physical and social vulnerability caused by climate change. Vulnerability assessment is one of the important aspects of impact analysis in terms of specific location, people, g, etc.

The appropriate assessment can consider ecological and socio-economic characteristics at the local level (Hinkel & Klein 2007). Therefore, it can be said that vulnerability is dependent on many essential factors, and ultimately these factors administer various levels of exposure and sensitivity to various communities and regions (TERI 2013). The numerous factors that lead to the vulnerability of a system can be categorised as socio-economic conditions, population dynamics, climate, topography, land use pattern etc. The climate change approach directly deals with the current climatic conditions (Carter et al., 2007). Hence, it helps detect risk and mitigation processes, and it can work as a development framework in contemporary settings (O'Brien et al., 2004). Therefore, the study has constructed a vulnerability index to measure the complete picture of vulnerability. The vulnerability index is constructed by using social vulnerability and biophysical vulnerability indices. Again, the social vulnerability index is framed by taking the following indicators: social category, migration, indebtedness, percentage of farmers engaged in agriculture, percentage of the agricultural workforce, literacy rate etc. The biophysical vulnerability index is constructed by taking the land distribution, water availability, precipitation, etc.

After constructing the vulnerability picture, the study will focus on sustainable livelihood strategy through Sen's capability approach, i.e., resources/ capital management in the study area. Capital has been categorised as Human capital, social capital, financial capital, Physical capital and Natural capital. People generally have limited or no control over their livelihood and the wider accessibility of resources. Therefore, the Sustainable Livelihood Framework (SLF) is one of the essential methods to identify various vulnerable factors that affect people's livelihood and subsequently, it provides a better solution. People's livelihood and assets are affected by three vital aspects of vulnerability, i.e., trends, shocks and seasonality. In vulnerability, trends are predictable, but they may not produce positive results for livelihood strategies. It includes population, economics, resources, governance, technologies etc. Consequently, shocks can directly influence human life in terms of loss of resources/ assets,

forced migration, economic imbalance etc. It includes natural shocks, health shocks, economic shocks, livestock health shocks, crop health shocks, conflicts etc. Similarly, seasonality also has some negative impacts on developing countries regarding food availability, employment generation, economic insecurity, etc. Therefore, it includes health, price, employment opportunity, production etc. These three aspects (trend, shock, seasonality) of vulnerability are important because they directly impact people's assets/ resources status and enhance methods to manage the assets.

1.6 Sustainable Livelihood context

The trends in the changes in income generation, which are mainly on the negative side, in recent years among the arid and rural communities, have been a serious concern for both the government and the public of late. However, the livelihoods at the individual, household and community levels need attention not just in terms of earnings alone but also are to be looked into with regard to the human capability, aspirations and empowerment, which require a holistic and participatory approach. This approach should be embodied with the cooperation and coordination across all relevant sectors and the stakeholder communities engaged in fisheries, agriculture and related livelihoods to ensure sustainable livelihoods overall. Further, it is also pivotal that the sustainable livelihood development and management be in tune with the Ecosystem Approach to Management which aims at ecological and human well-being through appropriate governance and meaningful participation by the relevant stakeholders. The present study on the livelihoods of Balangir district, Odisha, seeks to perform a complete assessment of the current and potential livelihoods options, mainly with regard to Agriculture. This livelihood assessment is scoped to address three aspects: enhancement of the resources, the inclusion of additional livelihood opportunities during lean and off seasons, and recommendation of alternative livelihood options to sustain the resources that support the dependent communities. For the aspects mentioned above of studies, appraisals of the current nature and status of livelihoods, available from secondary sources of information, will be analysed for Balangir. The sustainable livelihood approach (SLA) has been adopted to explore the issues affecting the rural livelihoods in the Balangir district. The SLA provides several options to improve rural livelihoods, and it begins with the people as the central focal point and how they manage their resources. The sustainable strategy solely depends on accessibility, usage, ownership, and development of different assets at the household level. The assets are

generally composed of various types of capital, which directly or indirectly help people generate different livelihood opportunities.

1.7 Methodology and rationale of the study

Drought has always been a challenge for millions of those depending upon agricultural livelihood. In recent decades, climate change has added extra pressure in intensifying the impact and frequency of the occurrence. In India, drought can be best observed in terms of low crop output, long term dryness of land and extreme heatwave in one-third of the country. The erratic rainfall in the Indian climate has caused desertification in most of the agricultural land in India. The year to year fluctuation in crop output followed by extreme poverty and hunger is an outcome of drought vulnerability. The impact generally varies people to person and community to community-based on their level of adaptation and resources. Most of the vulnerable population are the small and marginal farmers belonging to SCs, STs and economically backward districts in rural India. Therefore, it is necessary to focus on the rural populations to understand the accurate picture of vulnerability. The micro-level study (household level) of drought impact could lead to the study of macro-level threshold in terms of a long-term perspective. Most importantly, the study identifies the various level of drought impact on rural farm household and their strategies to cope with the extreme situations. As a result, the safety measures adopted by the farm households can be improved through effective steps and channels at a later stage. The assessment of ground-level vulnerability fosters affordable and effective drought mitigation planning to bridge the gap between the community level and the higher level. The higher-level authority dealing with policy and planning is accountable to the needs and priorities of the community level to reduce the vulnerability caused by drought. The safety measures at the micro-level will help the government form effective policies for the state and national levels (Burton & Smith, 2006). Many researchers have analysed the issues of aggregate level for the state or a region; however, micro-level analysis of vulnerability at the household level helps in framing effective plans since the household is the primary unit where the decision about the adaptation is taken.

1.7.1 Research question

- What is the impact of drought vulnerability on agricultural livelihood?
- How far is a drought-prone condition responsible for migration?
- What are the strategies adopted by the households to mitigate drought vulnerability?

1.7.2 Objectives of the Study

- To examine the impact of drought vulnerability on agricultural production and socio-economic conditions of farm households belonging to scheduled and non-scheduled categories.
- To analyse the rate of migration among the farm household during normal and drought year
- To evaluate the essential safety measures adopted by the farm households to combat the adverse impact of drought.

1.7.3 Plan and design

The study is conducted in two phases- phase I and phase II. In phase I, the secondary data is collected using a statistical survey schedule to assess the drought vulnerability and pattern of agriculture production in Odisha and the study area, i.e., the Balangir district. The secondary data were collected from various sources such as ‘District Statistical Handbook of Balangir district’, ‘Census report- 2011’, ‘India water portal’, ‘Odisha agricultural statistics’, agricultural office in Patnagarh etc.

In phase II, primary data were collected from the rural farm household of the study area by using a survey method and interview method. The survey method is based on a $2 \times 2 \times 2$ mixed factorial design, where the first two factors were the subject factor and the last one is the within-subject factor. The first two factors consist of 2 different levels, and the last factor is considered a repeated factor consisting of 2 levels. Therefore, the method is used as $2(\text{Adequate Water Resources-AWR and Inadequate Water Resources-IWR}) \times 2 (\text{scheduled category and non-scheduled category}) \times 2 (\text{normal period and drought period})$ repeated

1.7.4 Data Sources, Sampling and Methodology

Odisha is being chosen as the universe of the study, whereas the study of rainfall variation and natural disasters is significant in the context of climate change. The Southwest monsoon, which arrives at the state, continues to impact for three months (July to September) and provides 80 per cent of total precipitation. Based on the agro-climatic zone, the distribution of rainfall is unequal. While the coastal region receives adequate rainfall, the hilly area receives scant rainfall. The study has selected the Balangir district of Odisha out of 30 districts to understand

the climate-induced drought vulnerability on rural farm households' livelihood and socio-economic life. The rationale behind choosing the Balangir district as our study site is that it is one of the rainfed areas under the Western Central Table Land (WCTL) Agro Climatic Zone, characterised by hot and sub-humid climate with hot summer and erratic rainfall of south-west monsoon. It is one of the drought-prone districts of western Odisha. Between 1970 to 2020, the district has experienced 25 drought years, three flood years and four floods and drought year, respectively. Almost all the year, the districts can be seen as dry. As a result, the most significant crop season, such as Kharif and Rabi, are primarily vulnerable to the drought impact. Thus, the selection of the district to understand the climate-induced drought vulnerability in the study area is justified. After selecting the district, the study has chosen the Patnagarh block for the proposed research. The total population of the block is 168,325. Out of which, 147,301 (87.50%) population reside in rural areas whereas only 21,024 (12.50%) population in urban. After selecting the block, the study has chosen Mundomahul Panchayat of Patnagarh Block out of the 26 GPs. There are seven villages in Mundomahul panchayat-Bada Jhankarpalli, Bhaludarah, Chitadungri, Golimara, Manepad, Mundomahul, Ranidharah. Out of these villages, the study has chosen Bhaludharah, Mundomahul and Manepad villages based on the availability of water resources and vulnerable social groups. After selecting the district, block and villages, the study has prepared a survey schedule to collect the primary data from the household level. The interviews during the period of the household survey were aimed to capture the effects of drought on the studied community and strategies adopted by the local farmers to cope with the chronic drought situation in the study area. Thus, the collection of primary data is carried out using a multistage sampling method that consists of selecting the study district in the first step, taluka in the second step, study village in the third step, and households in the final step. The study used an interview schedule consisting of 23 open and close-ended questions to understand the impact of drought on the studied area regarding livelihood vulnerability and safety measures adopted by the farm household to reduce the vulnerability. The village economy structure is primarily dependent on agricultural production. The most dominant crops grown in the area are rice, cotton, pulses and wheat. The drought condition in the studied village has been seen as one of the significant threats to the livelihood of the poor farmers.

1.8 Chapter Scheme of the Thesis

The thesis has been divided into five chapters. Chapter 1 deals with the introduction, background, theoretical perspectives, research problem, significance, objectives, methodology, and rationale. Chapter 2 presents the literature review on climate change and agricultural drought, migration issues, and sustainable livelihood strategies to mitigate drought vulnerability. Chapter 3 focuses on secondary data analysis. It examines the climatic factors such as rainfall, natural disasters influencing agriculture, and vulnerability assessment on significant crops such as paddy and cotton in Odisha and Balangir district using secondary data sources. The study has also analysed migration statistics in the state and district based on secondary data. Chapter 4 examine the primary data based on vulnerability assessment on major crops such as paddy and cotton during normal and drought year in the study area. Moreover, it focuses on migration statistics in the area and discusses various safety measures adopted by farm households to mitigate drought vulnerability. The empirical results at the household level address the livelihood income vulnerability and human capital vulnerability in the study area. Chapter 5 focuses on the climate induced drought scenario in India and Odisha. It also examines the rate of migration among the sample farm households in the study area. Chapter 6 delineates significant findings and discussions of the study based on literature and empirical evidence.

CHAPTER II

Review of Literatures

2.1 Introduction

Climate change poses multiple threats to human society. The threat can be best observed in terms of increasing earth's temperature (Bhattacharya, 2019). The major greenhouse gasses (GHGs) consist of carbon dioxide, methane and nitrous oxide primarily responsible for temperature rise. The significant increase of greenhouse gases (GHGs) is resulted in the melting of the glacier, shifting of seasons and extreme weather conditions (Manabe, 2019). The extreme environmental impacts have directly affected agricultural livelihood across the globe (Black, 2011). The agricultural sector is primarily one of the climate-sensitive sectors. The changes in climate patterns ultimately leads to the change in agricultural productivity. The agriculture sector is now fully vulnerable to climate change for the last few decades. Consequently, agriculture production of primary crops such as rice, pulses, oilseeds, maize, millet, jute, sugarcane, coconut and turmeric etc. and cash crops such as sugarcane, jute, tobacco etc. has been declined drastically. The livestock sector has also been significantly impacted because of the unavailability of fodder, grass and other cereal grains. The number of livestock has decreased, resulting in declining incomes from livestock and related activities. The ever-changing climate has a tremendous bearing on the crops as well. Owing to the magnitude of the problems witnessed due to climate change, people tend to alienate themselves from their traditional occupations and constantly search for alternative livelihoods (Campbell, 2006). Consequently, the vulnerable people forced to migrate to urban region for their livelihood. Majority of them are engaged in labour intensive work due to lack of educational qualification. During this distress period, sustainable livelihood strategy plays a key role to mitigate drought vulnerability.

This chapter consists of five section (section 1: introduction, section 2: Agricultural studies in the context of climate change vulnerability, section 3: migration, section 4: Sustainable livelihood and safety measures and section 5: summary).

2.2 Agricultural studies in the context of climate change vulnerability

The impact of climate change in the modern era is mostly shattering in nature. The global liquidity into the local and the industrialisation process ultimately changed the face of risk in modernity because of man-made induced environmental risk. The uncertainty and insecurity are the ultimate consequences of modernity in environmental risk (Giddens, 2009; Giddens, 1991). Understanding the environmental issue is not always based on the surrounding world but on multi-causal effects in the inner world society, such as economic, social, human, cultural etc. In the Stone Age, the people didn't have the capacity for nuclear energy, which is the primary cause of environmental degradation; however, human beings are involved in explosive inventions and experimentation with nature in the modern era. Therefore, human-made activities in the contemporary era have a lion share in climate change vulnerability. The world is now spending a lot of money on climate protection to minimise the climate change vulnerability. Many national and international level policies have been introduced for climate protection (Beck, 2009).

Climate change is one of the major threats to agriculture, food security and rural livelihoods for billions of people. The agricultural sector is the most vulnerable because of its dependence on various climatic factors such as rainfall and temperature. More than 70 % of the population is directly or indirectly involved in agriculture in the pacific region of Asia. The agricultural sector in Asia faces a sustainability problem, and climate change adds another pressure on it. The livelihoods of rural poor people are badly affected due to climate change. It is already evident in several ways, such as consistent warming trends and more frequent and intense extreme weather events such as droughts, cyclones, floods, and hailstorms have been observed across Asia and the Pacific in recent decades. In South Asia, climate change leads to a 14 % decline in rice production, which shows the most negligible impact of climate change on rice. A 44 to 49 % decline in wheat shows the highest impact, followed by 12.2 to 19.6 % declines in Sorghum and 9 to 19 % declines in Maise (Dev, 2011).

A village-level study in Tanzania revealed that the farmers in the rural areas are experiencing the negative impact of climate change in crop failure. Both primary and secondary data has been taken to examine the effects of climate change on small-scale farmer. Participatory Rural Appraisal (PRA) techniques were also used to know the in-depth impact of climate change on small scale farmers. Tanzania is more prone to drought; all the Sub-Saharan African countries, including Rwanda, Somalia, Malawi, Kenya, Nigeria, Burkina Faso,

Somalia, Sudan and Mozambique, are the workplace of drought for years. Since 1960, Tanzania has observed an annually increasing of 1 degree Celsius in temperature and a decrease in precipitation at an average rate of 2.8 mm per month. Therefore, climate change-induced natural disaster is a major problem for all the developing nations in Africa. Over the year, the erratic rainfall causes crop failure, livelihood loss, forced migration, etc. The impact also can be seen in the socio-economic status of the poor farmers, such as changes in family and gender roles. Water scarcity and firewood have been seen as primary concerns for the rural people, which enable male members to fetch water by using cycles and carts from a long distance (Mbilinyi A. et al., 2013).

The physical effects of climate change on agriculture can be best observed in terms of changes in crop and livestock yields and the economic consequences of these potential yield changes. Moreover, the effects could influence agricultural production by changing cropping patterns and food supplies due to uncertain climatic predictions. The climate fails to fulfil the essential requirement of soil fertilisation for different crops. The impacts on the livestock can be observed in terms of disease in the animal husbandry etc. (Aydinalp and Malcolm, 2008). Climate change affects agricultural productivity in two ways: directly through temperature changes, rainfall and CO₂ implantation effect (Erda *et al.* 2005), and indirectly through changes in soil moisture and pest infestation (Rosenzweig *et al.* 2001).

Similarly, Hulme (2011) points out how climate change affects agricultural productivity. Firstly, variations in rainfall and temperature may change the existing spatial allocation of agro-ecological zones, thereby impacting the timing and duration of crop growing seasons. Secondly, with other things remaining constant, increased CO₂ concentrations may affect crop productivity through increased photosynthesis rate and increased efficiency of water used by plants. Thirdly, climate change may impact agricultural productivity positively or negatively through the availability of water resources. Fourthly, it may affect agricultural productivity through the increased occurrence of climate-induced natural events such as droughts and floods. Rosenzweig and Parry (1994) attempted to examine the potential impact of climate change on food supply at a global level. The study found that a doubling of atmospheric CO₂ concentration has little effect on crop production. The analysis also finds that climate change creates a disparity in the production of cereals between developing and developed countries. Food production in the developed world has benefited from climate change, whereas it has declined in the developing world. On the other hand, farm-level

adaptation does little to disparities and aggravates them in the face of increasing cereal prices, thus increasing hunger and malnutrition in the developing countries.

Aggarwal and Sinha (1993) discussed the effect of increasing CO₂ concentration and temperature on wheat production in India. Using dynamic crop growth simulation, the study revealed that wheat yield had risen significantly with CO₂ at 425 ppm without any change in temperature for all production levels. Moreover, a 1^o Celsius temperature rise has shown an insignificant impact on wheat yield, but production depending on irrigation and rainfall has increased in most places. For two-degree Celsius temperature, wheat yields have decreased in most areas. Lal *et al.* (1998) examined "the risky situation of rice and wheat in northwest India and found that rice and wheat yields have significantly increased by about 28 % and about 15 %, respectively, with a doubling of CO₂. However, the impact of two or three degree Celsius on wheat and rice yields have neutralised the positive impact of increased CO₂. Moreover, the combined impact of increased CO₂ and water stress due to enhanced temperature has increased rice and wheat yields by about 4 % and about 21 % respectively for the irrigated schedule currently followed in the region".

Lal *et al.* (1999) used the "CROPGRO-soybean model" and estimated a 50 % improved soybean production for a doubled CO₂ concentration in central India. However, a three-degree Celsius temperature rise has neutralised the positive impacts of enhanced CO₂ by reducing the total duration of crop and bringing about premature blossoming and minimising the grain fill period and hence, productivity. The study also found that severe water stress on account of inadequate water supply during the poor monsoon period has affected soybean productivity even under optimistic impacts of enhanced CO₂ in the future.

Kumar and Parikh (2001) examined the functional relationship between climate variables and net farm revenue by introducing linear, quadratic and interaction terms. The study revealed that a climatic scenario (i.e., a 2-degree temperature rise and a 7 % precipitation rise) has negative impacts, nearly a loss of about 8.4 % of total net farm revenue for India. The reason for this is the negative effect resulting from temperature rise, which outweighs the small positive impact resulting from precipitation rise. The study also revealed an important finding that the "temperature response function" is inverted 'U' shaped, i.e., the loss of net farm revenue will be higher with higher temperature. Moreover, as far as the spatial distribution of climatic impacts is concerned, states like Western Uttar Pradesh, Haryana, Punjab, Andhra Pradesh,

Orissa, Rajasthan, Tamil Nadu, Madhya Pradesh and Gujarat are the worst affected due to climate change.

In contrast, states like West Bengal, Bihar and Maharashtra are expected to be benefited from the changing climate. Mishra *et al.* (2016) attempted to study the climate change impact on agricultural production in Odisha by using the "Ricardian approach". The study found that the optimum combination of rainfall and temperature is required to increase the net farm revenue in Odisha. The climatic settings (a 5 % increase in rainfall and a 3 to 4⁰ temperature rise) enhanced the net farm revenue. All other climatic scenarios (a 15 % increase in rainfall and 2-4 degree Celsius temperature rise or a 5 % increase in rainfall and 2 degree Celsius temperature rise) negatively impact the net farm revenue.

Ravindranath *et al.* (2011) endeavoured to develop the vulnerability profiles under current and projected climate change settings for agriculture, water and forest sectors at the district level of the North-eastern region of India. Applying the vulnerability index, principal component analysis, and PRECIS model revealed that agriculture in Tirap, West Siang, Nalbari, Changlang, and Dibrugarh districts is the most vulnerable to current climate change. Whereas, Kolasib, N.C.Hills, Cochar, Ukhrul, and Morigaon are the districts with the least vulnerability. Palanisami *et al.* (2014) examined the climate change vulnerability in different districts falling in the Godavari, Krishna and Cauvery River basins (GRB, KRB, and CRB). The study analysed the vulnerability by using an index approach. It was found that Adilabad of GRB, Anantapur of KRB, and Salem and Coimbatore of CRB are the most vulnerable districts to climate variability. In contrast, the less vulnerable districts are East and West Godavari of GRB, Guntur and Krishna of KRB, and Thiruvavarur and Perambalur of CRB.

Adger (1999) undertook a study on social vulnerability to climate change in Xuan Thuy, a district of coastal Vietnam. The study used a survey of 81 households and 11 government officials and indicator-based individual and social vulnerability analysis. The analysis revealed that poorer families with fewer resources are more vulnerable to climate change. The study showed that the institution and economic factors could enhance social vulnerability. Shewmake (2008) estimated the potential impacts of droughts on rural South African households in the Limpopo River Basin in South Africa. The study adopted the household survey of 800 farmers in 20 districts and used econometric analysis and propensity score matching. The analysis suggested no statistically significant impacts of droughts on income. However, household who

doesn't have access to livestock and rely upon rainfed agriculture are more vulnerable than others.

Deressa and Durham (2010) analysed farmers' vulnerability to climate extremes such as droughts, floods, and hailstorms in the Dega, Weynadega, and Kola districts of the Nile Basin of Ethiopia. The study used a survey of 1000 households and probability estimation of vulnerability as expected poverty. The study revealed that increasing incomes would enable farmers to meet their daily minimum requirements, which will reduce their vulnerability to climate extremes. Aulong *et al.* (2012) assessed the "rank adaptive capacities" of the farmers among 153 households in Gajwel, Veeranagar, and Ranganpet villages of Medak district in Andhra Pradesh. The study adopted the "sustainable livelihoods approach", "indicator-based approach", "analytic hierarchy process", and compromise programming. The results revealed that at the basin scale, the geographic positioning of farmers is an essential feature in adaptation performance, and the proximity of an administrative centre facilitates a rise in their "adaptive capacity". Small and marginal farmers' "adaptive capacities" are limited by their small farming land, while large farmers are affected by economic factors such as large loans.

2.2.1 Impact of climate change on agriculture in the context of Odisha

Pattanayak (2002) explained the nature and trends of cropping patterns in Odisha. The study has taken thirteen districts and eighteen crop types to analyse their nature and tendencies. The study has calculated the area, yield and production of crops from 1985 to 2000. There are two main crop seasons in Odisha – (a) Kharif, or the season of summer crops and Rabi or winter crops. Kharif is dependent upon the Southwest monsoon in mid-June, and the Rabi season starts at the beginning of cold weather, i.e., at the end of October or early November. The food crops grown in the Kharif season are Maise, Paddy, Bajra, Jowar, Maize, Pigeon Pea, Green Gram, Black Gram, Groundnut and Sugarcane, which depend on high temperature and sufficient water. The food crops of the Rabi season are potatoes, Lentils, Wheat, Bengal Grams and Peas which depends on cold water and a moderate supply of water. The harvesting periods of Kharif crops start from September to October, and the Rabi crops are generally harvested from March to April. The study has taken thirteen districts of Odisha with eighteen crops to investigate the changes in cropping patterns during the three periods (1985-1990, 1990-1995 and 1995-2000). The crops selected in this study are Paddy, Wheat, Maise, Jawar, Ragi (cereals), Biri, Mung, Kulthi, Arhar, Gram (pulses), Jute and Cotton (cash crops), Groundnut (oil seeds), Til, Mustard, Onion, Potato, Sugarcane. From the inter-District analysis of the

Cropping Pattern, the study found that paddy is the only most important crop in every district. During the first period (a), Mayurbhanj, Balasore, Sambalpur, Keonjhar, Sundargarh, Koraput, Balangir, and Puri districts have more than 50 % of Gross Coverage Area (GCA) under Paddy. Apart from Balasore and Puri, these districts are all non-coastal hilly regions. Cuttack, Kalahandi and Ganjam comprise less than 50% (i.e., 40 to 50%) of GCA under Paddy. And Dhenkanal and Phulbani include less than 40% (i.e., 30 to 40%) of GCA under paddy during the first period. During the second period, the similar eight districts have more than 50% of GCA under Paddy, although the relative position of the last three districts has been changed. Phulbani's share under paddy increased in the second period and joined the less than 50% group. Dhenkanala is the only district with less than 40% of GCA under paddy in the second period. Cuttack and Ganjam obtained more than 50% of GCA under Paddy during the final period and the existing districts. Dhenkanala's area share under Paddy has increased and joined the less than 50% area, share group. From the above, it is clear that the eight districts mentioned above have maintained more than 50% of the area under Paddy, and during the last period, two new districts, Cuttack and Ganjam, have entered the group. But there is variation in area coverage under each crop among districts, which changes over time. According to the report, in 2001, the area coverage under coarse cereals and yield level are going down over the years in the district where the frequency of poverty is very high.

Roy et al. (2002) investigated that most people are dependent on agricultural productivity, so it plays a vital role in the country's development and makes people self-reliant. Climate-Induced Natural Disaster (CIND) is one of the crucial issues in the coastal belt, which includes floods, droughts and cyclones. Climate change has badly impacted the agricultural sector. It leads to low productivity, poverty, unemployment, malnutrition, starvation, death, etc. Due to the huge loss in agriculture, the people of the coastal region face financial problems. The study has selected the Kendrapara district of Odisha to analyse the impact perspective because it is one of the high-risk coastal areas. The district Kendrapara forms a part of coastal Odisha and is characterised by a fragile environment, prone to cyclones and floods and low variable rainfall. The study has taken a purposive random sampling method as per the methodology concerned. Hence, it used household surveys to know the impact of the climate change-induced disaster and the response from the local affected people. Four sample villages (Gupti and Sanwara from Rajnagar block and Jambu and Mangalpur from Mahakalpara block) were selected randomly. The two blocks, Rajnagar and Mahakalpara, were chosen because of their proximity to the sea and high degree of vulnerability to CINDs. The farmers, fishers,

landless labourers, persons involved in marketing, and field-level development and extension officials were interviewed for the study. The study found that between 1961 and 2000, floods increased in Orissa. During 1834 and 1926, the state experienced a flood once in four years, which grew to once in two years after 1926. The state experienced nine short periods of flood within just 15 days in 2001, an all-time high, damaging 2.12 million hectares of standing crops. Recurring drought, floods, and cyclones have made the rural population highly vulnerable in the study area.

Pande and Akermann (2009) have reported that the farmers of the tribal belt, Rayagada district of Odisha, adopted some essential coping strategies to tackle the negative impact of climate change in the concerned area. The adaptation strategies are included: crop diversification, where the farmers of the Rayagada use short term and long-term paddy and a high yielding variety of paddy. Apart from paddy, they also use pulses like black gram, pigeon pea and many minor types of millets. Another strategy adopted by the farmer is land management. They can deal with soil erosion by tree plantation in major regions and proper planning by canal facilities using rainwater in the upland. Like soil conservation, farmers also adapted forest conservation as one of the strategies. They use the forest for their livelihood purpose. Therefore, they are aware of its protection like proper use of wood, distribution of wood, reduction of unnecessary trees, etc. The farmer also engages in non-farm activities like rope making, processing minor forest produce, basket making, honey collection from the forest and selling it in the market. The small-scale tribal farmers in the concerned region also engage in various rural employment schemes provided by the government at the grassroots level. Another strategy adopted by the farmer is horticulture which includes the production of litchi, mango, jackfruit and guava etc. The paper focuses on the coping measures taken by the farmer. Still, it is also essential to study the government policies related to climate change and its implementation in vulnerable areas. The small farmers should get an awareness programme that deals with climate change issues and their remedies.

2.3 Migration

The nature of migration varies from region to region, community to community, based on socio-economic status. People with access to all the resources are less vulnerable to migration situations than people with limited access. A study was conducted in three villages in Northern Tanzania to understand the impact of climate change on people's movements. The study found that 80 % of the economies were severely impacted by the rainfall variability, which caused

frequent droughts in the region. To get rid of drought situations in the area, people were forced to migrate to other places, searching for better livelihood. Moreover, the migration rate differed for all the studied villages (Afifi, Tamer, Emma Liwenga, and Lukas Kwezi, 2014).

Similarly, in the context of Nigeria, most of the regions in Nigeria have been facing drought vulnerability for years. People in these regions are dependent on agriculture, and the long-term dry spell causes drought, and people are forcefully displaced to the other areas. Apart from agriculture, people in Niger are also dependent on other economic activities such as animal rearing, fishing, business etc. Due to natural hazards such as soil erosion, drought, deforestation, water scarcity etc., causes a massive impact on people's livelihood and lead to climate-induced migration among the vulnerable community. Although it is reported that the primary cause of migration was an economic loss, the stimulating force was environmental degradation (Afifi, Tamer, 2011).

The long term drought situation in Brazil has caused a massive migration among the rural population due to the loss of agricultural livelihood. Agriculture and forest are the backbones of the economy of Brazil. However, a larger portion of the population has migrated to the United States because of multiple natural events, especially drought. The farmer needs an integrated irrigation facility to cope with the drought situation in the country. The amazon deforestation rate is currently 15 years high, which invites weather variations such as erratic rainfall, heatwave, drought etc. Despite the current political situation, the government should focus on environmental protection policy to bring an equilibrium in the climate health (Cohen, Ignacio Sánchez, et al., 2013). De Sherbinin, A., K. Warner, and C. Ehrhart (2011) conducted a study in Vietnam, Mozambique and Mexico and Central America, which found that migration is one of the reactive measures adopted by most people to reduce the climate-induced vulnerability. In Mozambique, Mexico, and Central America, drought has been observed most frequently, causing massive damage to agricultural production. In Vietnam, flood causes many problems for people living near the coastal area. However, it has been observed that the irrigation facilities have been incorporated in many areas due to the flood. Nevertheless, it is projected that the rise in the sea level could displace millions of people residing near the coastal area. All these three regions are prone to natural disasters, and these vulnerable people have been migrating to the USA over the year.

Drought and flood are observed as a regular feature in most countries in the world. Allan M. (2011) found that the disaster situation causes massive migration among the rural

population. Interestingly, most vulnerable people choose Europe as their primary destination hub to settle down. The study concluded that there is a need for policy and adaptive measures to understand the vulnerable climate and migrant's behaviour. Understanding the migrant's destination and the reason behind choosing a particular destination is necessary instead of migration statistics. Most the study reveals that drought is one of the primary climate-induced factors for the migrant people. A study was conducted in rural Ethiopia using a household survey of 1500 sample households to understand the relationship between climate change and migration. The study found that drought vulnerability has caused a higher migration rate, i.e., almost double among the adult labour over the year due to the loss of agricultural livelihood. The labour section uses migration as a coping strategy to get rid of drought vulnerability in the region. Another critical aspect of the agricultural failure is the cultivation process in the lowland area in Ethiopia which hampers the production rate (Gray, C., & Mueller, V. 2012a).

Similarly, a study by Hassani-Mahmooei, Behrooz, and Brett W. Parris (2012) revealed that extreme events such as flood is more common in Bangladesh, which has displaced a larger population internally over the year. Based on the socio-economic and environmental variables, the study integrates Push factors (poverty, unemployment, climate change, standard of living etc.) and pull factors (employment opportunities in new destination, favourable environmental conditions, favourable socio-economic conditions etc.) of migration in several districts. The study found that severe floods over the year cause North and Eastern district migration and severe cyclones cause southern district migration. The pull factor is not significant in respect of migration in the study area. Based on the climatic factors, it will not be an injustice to say that Bangladesh is a workplace of various natural disasters. The government should react proactively to the climatic situation. Many Bangladeshi climate refugees can also be traced to India despite internal migration. The neighbour country should be sensible to the migrants in terms of job opportunities and livelihood generation.

In Mexico, the rainfall deficit is one major challenge for rural farmers. Therefore a larger portion of the population has been displaced to the US each year. Nawrotzki, Raphael J., Fernando Riosmena, and Lori M. Hunter (2013) took the Mexico census report, 2000, using an econometric regression model combining various socio-economic indicators to understand the relationship between rainfall deficit and migration. The study found a significant correlation between rainfall deficiency and migration in rural Mexico. The rainfall deficiency resulted in severe drought in Mexico that drove the rural population to migrate to the US. The study

suggested that the Mexican government adopt various safety measures such as climate policy, crop insurance, climate-resilient crop, and irrigation facility for the rural people to lower the drought vulnerability and check the migration.

The impact of drought can also be observed in the fertile crescent of Syria, which caused huge internal migration among the farming community. Kelley, Colin P., Shahrzad Mohtadi, Mark A. Cane, Richard Seager, and Yochanan Kushnir (2015) have examined the impact of drought in Syria by using a time series analysis model study of drought-induced migration from 2007 to 2010 due to rainfall deficiency. The study revealed that a huge migration has occurred due to climate variability, low precipitation, prolonged spell rainfall deficit etc. Moreover, the failure of government policies, mainly agricultural and environmental policies, are found to be more responsible for the migration situation in the region. The farmers in rural Mexico are forced to move to some urban areas due to the massive agricultural failure. Consequently, the higher migration rate from the rural to urban has caused numerous problems in the urban setting, such as crowds, illegal settlement, unemployment, crime, an unclean environment etc. Despite all the challenges faced by the migrant community, internal and international migration is considered one of the vital adaptive measures to get rid of climate change. The primary driving forces of these kinds of migration are mostly drought, followed by floods, storms, heatwaves and disputes over natural resources (Martin S., 2013). The concerned government should adopt effective climate change policy, agricultural policy, and additional and alternative livelihood programs to lower climate-induced vulnerability.

McLeman, Robert A. (2014) have projected, based on the various academic literature, that by the end of 2080, around 6 million people in Europe would migrate due to the grave consequences of drought and flood. The author suggested that academicians, research scholars, and policymakers should be more concerned with real-life events related to academic literature. In the context of India, Chand et al. (1998) have examined the major factors that accelerate the pace of migration in Punjab. The study conducted a primary survey among the labour in four different sugar mills. It found that people working in various mills are migrated driven by the blend of push and pull factors or migration. The push factors have been categorised as flood, drought, agricultural failure, low crop output, landless poor, joint family pressure etc. In contrast, the pull factor was categorised as a better job, urban lifestyle, additional livelihood etc. Based on these criteria, the study revealed that out of 160 sample labour, only 19 % of the labourer are influenced by the pull factor, whereas the push factor affects 81 % of the labourer.

In India, most migration cases are identified as seasonal and cyclical. A study in Mahbubnagar district in Andhra Pradesh by Vijay Korra (2010) revealed that the drought situation caused by severe rainfall deficiency leads to temporary migration among the small and marginal farmers in the study area. The drought condition in the study district resulted in low crop output, followed by agricultural unemployment, indebtedness, etc. This forced the rural poor to migrate to the nearby city and other states in India in search of livelihood.

Similarly, in another study in Andhra Pradesh's Srikakulam district, Rao et al. (2004) found that most rural people practice the out-migration process. The district is one of the drought-prone districts of Andhra Pradesh because of erratic rainfall and climate variability. The prolonged spell of rainfall deficiency resulted in drought and caused crop failure in the district. Therefore, the rural people, especially the adult agriculturalists, prefer to move to the city to seek jobs and additional livelihood opportunities. Surprisingly, the study revealed that most of these vulnerable communities are also attracted to the city/ urban culture and lifestyle. The young migrant in the urban setting changes their traditional occupation to a different occupation based on their choices. The study suggested that rural out-migration can be checked through various developmental approaches by the government, such as policy intervention, small scale industry, advanced technology in agriculture, training programme etc.

Rao and Reddy (2004) have explored the migration pattern in the Warangal district in Telangana. The study conducted a household survey and interviewed 145 respondents and found that drought is the primary reason for migration among the rural farmers. In the early 1970s, the vulnerable farming community temporarily migrated to the urban area; however, in the current scenario, people are permanently migrating to the urban areas for better livelihood and urban lifestyle. Many driving factors that change the pattern of migration in the district can be broadly categorised as urban culture, small landholding in the village, social prestige, changing characteristics of rural areas, etc.

In the context of the Indian state of Odisha, several kinds of the literature suggest that Western Odisha has been highly prone to drought vulnerability for years. A household-level survey conducted by Jülich and Sebastian (2011) revealed that most of the population depends on agricultural livelihood. The long term rainfall deficit causes drought in the district, which results in people's migration. The district population is dominated by the Scheduled Tribes (STs) and Scheduled Castes (STs). These deprived section is primarily dependent on agricultural livelihood. Although the district has a river (Tel river), it is insufficient for all the

villages in terms of irrigation. Moreover, the river gets dry during the summer, resulting in a drought situation in the district. Most people are practising temporary migration as an adaptive capacity because of limited access to natural resources, credit facility, agricultural land etc.

Similarly, a study by Suchismita Mishra (2007) was conducted in the Sundargarh district in western Odisha. The study found a correlation between drought vulnerability and migration. A combination of the qualitative and quantitative methods was used to understand various safety measures adopted in the studied area to get rid of the grave consequences of drought. A majority of the population in the district is tribal. During the drought, the young farmer practised temporary migration as a primary safety strategy to lower the vulnerability. Moreover, some farmers used other safety measures such as alternative livelihood options, additional livelihood, credit, change in food consumption patterns etc., to get rid of drought in the study area.

2.4 Sustainable livelihood and safety measures

The sustainable livelihood plan focuses exclusively on the people at the focal point rather than on institutions or resources. Its holistic approach covers a wide range of options and the involvement of different sectors.

2.4.1 Livelihood Diversification

Despite bringing a commitment to GDP, agriculture and the rural economy remain the spine of India's general development story. With two of three residents living in towns, their earnings and utilisation designs are essential to expanding interest in the industry. As per the advance estimates of growth in gross value added for 2018-19, farm output declined to 2.9% compared with 6.3% the previous year. (Economic Survey of India, 2018-19). It is, appropriately, the purpose behind the current examination has been rotated around to investigate the strategy for setting up the case of improvement and the rising situation of work, nature of help of different budgetary get-togethers of rural nuclear families and different underprivileged social groups. Generally, agribusiness is the prime fragment of common economy and nation business. The adjustment in the structure of yield and occupation from cultivation to progressively beneficial non-farm portions is considered a fundamental wellspring of money related advancement and change in the nation and complete economy. Rural development can't be avoided as it is the spine of any country's budgetary improvement and employment generation of millions. Rural

progression is the centre point of the economy, including the work ethics influencing business capacity in a gigantic manner. A large section of India's population depends upon agriculture. There has been a vigorous study on various aspects of contributions from the rural economy. The study has been undertaken primarily on the shift from agriculture to the non-farm sector in the rural economy. It is also attributed to how the rural economy continues to contribute a significant chunk of the National GDP. Since independence, a large part of our GDP still relies on village industries (Singh, A., Sanchita Roy, 2013).

2.4.2 Agricultural sector

Farming has contributed 48% and 60% in the initial two decades of the post-freedom period towards India's economy. Later the share was diminished to around 30% in 2002. Rural improvement should benefit needy people such as landless poor, women, Scheduled Castes and Scheduled Tribes community etc. The sharp rising in the food grain age amid India's Green Revolution during the 1970s engaged the country to accomplish autonomy in sustenance grains and fend off the risk of starvation. In the context of Odisha, agriculture and the allied sector together contribute a significant share of 19.9% to the state's Gross State Value Added (GSVA) in the year 2019-20. The sector is considered the prime source of livelihood for the majority of the people. According to the 2017-19 economy report, 48.8% of the population is directly engaged in agriculture. There are two types of cropping seasons available in the state, i.e., Kharif and Rabi. The primary cropping season in the state is inclined to Kharif crop. Rice is one of the principal Kharif crops and covers about 67 % of the cultivated area. However, the rabi season is primarily restricted to irrigation tracks. During the last part of December, the rainfall helps the cultivated land with moisture content to grow rabi crops. The other major crops grown during the Rabi season are maise, ragi, pulses (arhar, green gram, black gram), oilseeds (mustard, sesame, groundnut), fibre (cotton, mesta, jute), vegetables, sugarcane, spices, fruit crops etc. Paddy is appeared to be the dominant crop with a total area of 4180 thousand ha and 11,535 thousand million tons of production in 2114-15. However, in 2018-19, the statistics show an increasing trend in the production of 11,718 thousand million tons with decreasing trend of the area of 3859 thousand ha. As far as the cash crop is concerned, the state has witnessed a substantial increase in cotton production from 299 thousand million tons to 455 thousand million tons in 2018-19.

2.4.3 Livestock Sector

Around 41% of the GDP originates from the commitment to domesticated animals. In 2004, the market estimation of this industry was evaluated to be about USD 35 million. Animals have a significant job in improving individuals' social and practical existence in India. Domesticated animals comprise meat, eggs, milk, and fish which shape a basic segment of our eating regimen. They contain rich nutrients and supplements fundamental for appropriate sustenance. Along these lines, these items are of enormous interest in the market. The animal enumeration was last determined in 1991 when it recorded approximately 204 million cattle, 400 million chickens, 12 million pigs, 51 million sheep, 83 million bison, and 116 million goats in India. This sector has massive potential as it gives countless work after the horticultural part and contributes to the rural poor's financial improvement through its commitment to the nourishment preparing division. The tamed creatures provide sustenance for human consumption and livelihood, such as milk, eggs, and meat. India is place number one in terms of milk producers in the world. It produces around 165.4 million tons of milk per year (2016-17). Moreover, it has around 88.14 billion eggs and 8.89 million tons of meat in a year. At current expenses, the yield of the tamed creatures' region was Rs 8,11,847 crores in 2015-16. The trained animals similarly add to the age of downy hair, conceals, and pelts. Bullocks are the establishment of Indian agribusiness. Despite bundle types of progress in using mechanical force in Indian green errands, the Indian farmer, especially in rural domains, uses bullocks for various agrarian exercises. The bullocks are saving a ton of fuel which is a basic commitment for using mechanical forces like tractors, united authorities, etc. Pack animals like camels, steeds, asses, ponies, donkeys etc., are generally extensively used to move stock in different parts of the country despite bullocks. Moreover, it is used as fuel (biogas, fertiliser cakes) and for advancement as poor man's solid (compost). Creatures are considered "moving banks" because of their likelihood to mastermind off amid emergencies. They fill in as capital and, in cases of landless agricultural labourers, often as a principal capital resource.

The trained animals expect an indispensable occupation in the economy of farmers. The animals serve the farmers in different manners. Tamed creatures are a wellspring of reinforcement pay for certain families in India. Being less capable and incompetent, many people in India depend on agribusiness for their employment. Mostly, among the landless and marginal sections of rural areas, people depend on trained creatures to utilise their work amid the lean provincial season.

2.4.4 Dairy Production

India is one of the principal milk delivering nations globally, with around 20% worldwide commitment. It had 150 million tons of milk in 2014-15, with an expansion of 10 million tons compared to the earlier year. This shows a huge rise in the development of around 6.26 % (Economic Survey of India, 2015-2016). Milk is an essential part of the diet for most people, especially children. There are various dairy items which are made and sold across the nation.

- The fluid milk is blended with different sugar mixtures and packed to prepare milk with fluctuating fat substances.
- Indian customers are more interested in protein-rich milk items like butter, cheese, ghee, curd, lassi, chhas etc.
- India is a nourishment adoring nation with its hunger for Indian desserts. The vast majority of these desserts are produced using milk like Rabdi, Kheer, Kulfi, Burfi, Peda, Kalakand, etc.
- Milk is additionally matured by utilising different acids to create Paneer, Sandesh, Rasgulla, Milk sugar, Protein, etc.

The primary credit for this advancement in the dairy industry is the small farmers owning 2-3 buffalo or cows as their early foundations. Later the small farmers started investing in various milk societies. Afterwards, the National Dairy Development Board was additionally shaped to direct the working of these milk societies. Therefore, the Indian dairy division provides a lion share of the Gross Domestic Product (GDP). Around 46 % of the milk is used as liquid milk, 47 % as ordinary dairy products and 7 per penny as a western dairy product. The milk products such as ghee, margarine, yoghurt, paneer, cheddar, liquid cheddar, etc., make the sector a good livelihood. More than 550 plants in India, comprising around 175 in north India, 120 in the south, 50 in the east and more than 200 in west India. The primary dairy plant in India is the Amul brand under Gujarat Cooperative Nandini brand under Karnataka Milk Federation (KMF). Similarly, in Odisha, Milk Manta and Utkal Feed etc., are popular. The demand for tea in Odisha is also one of the better livelihood options for the rural people to run dairy business.

2.4.5 Poultry Production

The poultry business may be considered one of the additional and alternative livelihoods of the rural people during the lean season of agriculture. Poultry production in India has developed substantially since post-1960. The annual growth of egg production is 9%, and meat production

is 14%. With around 40 billion eggs, India is ranked the 5th most giant egg delivering nation worldwide. The poultry industry offers work to around 2 million people. In the 20th century, India produced 200 billion eggs and 4 billion kilos of meat. The production of eggs and broilers has increased by 8-10 % per year. Today India is the world's fifth-greatest egg producer and the eighteenth most significant producer of barbecues globally. The egg consumption has been significantly increased than the poultry meat over the year for many health benefits advised by the fitness industries. Based on the demand, the poultry production has a better opportunity for the rural people to engage in the business.

2.4.6 Fisheries

Inside and around the nation, roughly 6 million new water region which incorporates lakes, rivers and waterways are reasonable for developing fisheries. India produces about 5.65 million tons of fish and their results (inside land-2.72 million tons and off the coast - 2.73 million tons). It is evaluated that India can produce about 8.4 million tons (inside land 4.60 and off coast 3.80 million tons). On the off chance that increasingly present-day advances and logical components are utilised, at that point, there is a huge unfamiliar potential that can be mishandled. With more than 300 million potential buyers, the Indian populace has a greater interest in fish items. The responsibility of fishery to our GDP is about 1.3%. India sends out almost \$ 1.3 billion of marine items. Indian marine items are sent out to more than 64 nations. These fare of fisheries items over the following five years could be extended to US\$ 3 to 4 billion with escalated endeavours (Abhinav Singh, 2013). Indian fisheries and aquaculture are fundamental to sustenance which gives better security, other than business support and productive work, to millions of poor.

2.4.7 Non-Farmer sector

The Indian non-farm Sector (NFS) is considered a primary sector for the farmers during the agricultural failure. Works like stoneware, bamboo-creates, carpentry, insignificant exchanging, metal forger, fixing, mining and so forth fall under the non-farm sector. The provincial pay is excessive, subject to farming and the domesticated animal segment. So, the NFS empowers the rural poor to choose different business and livelihood methods. As indicated by a Government study in 1998, more than 82 % of common endeavours were non-provincial, joining a broad assortment of activities.

Table 2.2 The Classifications of Non-farm activities in rural India

Non-Farm Activities	Means	Ranking
Small Trading	0.78	1
Blacksmiths	0.16	9
Craft Worker	0.06	14
Carpenters	0.11	11
Pottery	0	17
Shoe works	0.03	16
Barber	0.11	11
Motorcycle repairing	0.06	14
Tailoring	0.18	8
Medicine selling	0.15	10
Teaching	0.4	4
Health	0.11	13
Party agent	0.19	7
Rental service	0.32	6
Labour	0.55	2
Transportation	0.36	5
Construction	0.53	3

Source: Jawaharlal Nehru Agriculture University (MP)

A planned system of non-farm improvement may shield various provincial people from migrating to urban areas or business centres. Commonplace compensation appointment is impressively less inconsistent in domains where a wide arrangement of non-farm streets of business exists; the lower strata of provincial social requests take an intrigue essentially more emphatically in non-farm works, and their affiliation is generously less gainful as differentiated and that of the upper strata. Now uncultivated territory transforms into a handy trade choice to address people's concerns. It can improve the compensation of everybody in provincial locales, thereby diminishing migration to urban districts and making country zones increasingly vigorous. The institutional credit flow is available through various channels. The courses of action are going for fast development of the natural non-farm zone. Moreover, the 73rd amendment has a pivotal role in updating the open entryways in NFS.

2.4.8 Small Scale Cottage Industries

Small Scale Industries (SSIs) are comprised of small business visionaries who take part in limited scale level establishment and manufacturing. The mechanism functions as an imperative wellspring of work in the country and contributes to the GDP. The National Manufacturing Policy has an objective to contribute around 25% of GDP. So, this objective must be accomplished by building up the Micro, Small & Medium Enterprises (MSMEs). SSIs are important for upgrading local markets. It is a customary industry highly influenced by Mahatma Gandhi's visionary society. The Gandhian Principle focuses basically on building up these house enterprises as it makes the nation independent and self-reliable. The administration should shield these enterprises from outside products by making Special Economic Zones (SEZs) and levy obstructions.

The significance of SSIs

- **Delivering Employment Opportunities:** Many individuals in provincial India can include exercises like weaving, turning, earthenware, detailed work, bamboo work and so forth and offer these items to secure their livelihood. Subsequently, it additionally lessens pay imbalance.
- **Upgrading Skills:** The purpose of accomplishing the Skill India Mission has been the improvement of SSIs. It tackles the abilities of the rural poor. These talented individuals can be additionally enlisted in enormous enterprises too.
- **Advance Exports:** The industry promotes indigenous products in the national and international markets. Consequently, it leads to diminishing the usage of imported products. The nation can send out this local surplus merchandise and procure outside trade. Before the market, an incentive for SSI items was around 400 crores. However, it has reached Rs 72,000 crores currently. Likewise, SSI items are engaged with 34% of the complete fares of India.
- **Upgrade Industrial Relation:** The connection between boss and representatives improves over the year. The workers have freedom in these smaller units and help the business concentrate on advancing and selling those items.

2.5 Summary

Chapter- 2 delineates a review of literature based on climate change, agricultural livelihood, migration and sustainable livelihood strategy. The climate-induced drought has been a bigger challenge for the farmers globally. In the context of India and Odisha, climate change has caused huge loss of cropped land and livelihood of millions of farmers. Major Kharif crops like paddy is more vulnerable to climatic shock than other crop. The agricultural loss in a drought year is significantly higher than the normal year. The crop failure in drought prone area have caused migration among the farm household to reduce the impact. Based on the availability of water resources, people having access to water resources are less migrated than people with inadequate access. Similarly, in the social category, the scheduled category population is more prone to migration than the non-scheduled category due to unequal distribution of various resources and social-economic positions in society. The study has also examined various safety measures adopted by the farm household to mitigate drought vulnerability in the study area. After reviewing the literature, chapter 3 has looked at the impact of natural disasters on crop production through secondary data sources.

CHAPTER III

Climate Change, Natural Disasters and Livelihood

3.1 Introduction

Climate change is one of the emerging global threats to the human and animal world. In the new industrial setup, the Greenhouse gases are increasing rapidly due to the massive pollution generated by the factories and industries. Therefore, human activities, like industrialisation, transportation, use of CFC uses in cold stores, refrigerators, air conditioners, etc., contribute to the formation of GHGs in the atmosphere (Selvaraj, 2021). The temperature is increasing rapidly in a dynamic manner over the year. The increasing temperature directly impacts the environment, biodiversity and other aspects of life. India is prone to the grave consequences of climate change due to its huge industrial setup and geophysical features. For the last few years, Delhi, the capital city of India, has been facing air pollution, water pollution, and a lack of oxygen in the air (Tripathi, 2019). The rural communities in India are experiencing some special waves (drought, floods, cyclones, heatwave, erratic rainfall etc.) of climate change. Due to climate change-induced weather variability, the world is experiencing extremely hot and cold days. Water scarcity is one of the vital issues faced by the rural communities due to the changing climatic pattern, intensity and amount of rainfall etc. Due to the water shortage, most agricultural land is arid and semi-arid. This chapter primarily focuses on the secondary sources of data collected from multiple sources such as census report, India water portal, Balangir district portal, Odisha economic survey, India economic survey etc. The chapter deals with the climate, rainfall and production relationship in the state (Odisha) and study district as well.

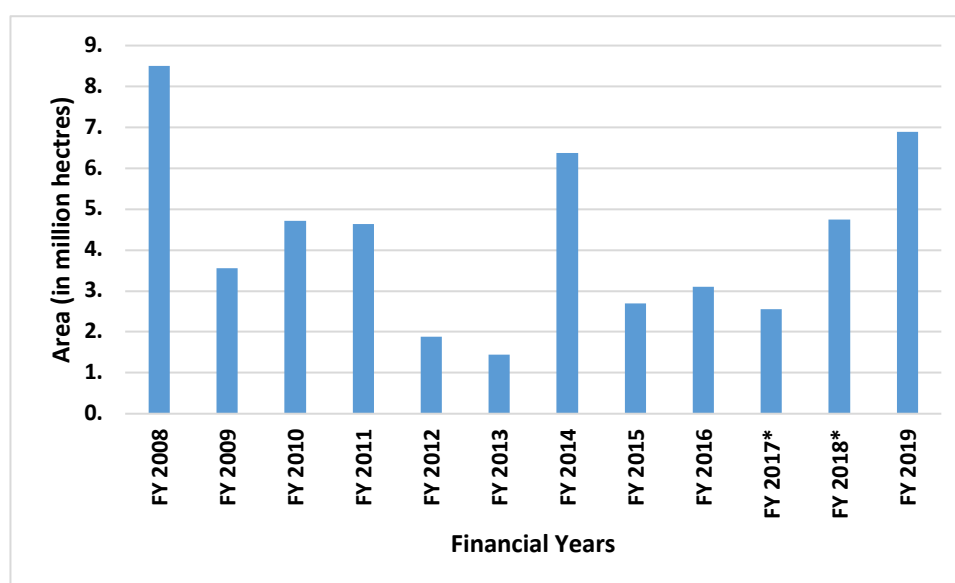
This chapter consists of 5 different sections (section 1- introduction, section 2: Impact of natural disasters on agriculture in India, section 3: overview of Odisha, section 4: socio-economic and general profile of the study district, Balangir and section 5: summary)

3.2 Impact of natural disasters on agriculture in India

Hectares of cropped land in India are under threat to various disasters each year. Disasters such as flood, drought and cyclone primarily have significant effect of agriculture. The natural disasters have caused huge loss in terms of India's rural economy system. The estimations of

those loss could illustrate a new dynamic between production and agricultural investment. Figure 3.1 revealed twelve years (2008-2019) of time series data on damaged crop areas in India due to natural disasters and found that the financial year 2008 was the worst affected due to natural disasters, with a total of 8.61 million hectares. The substantial amount of damaged area can be estimated from the financial years 2010, 2011, 2014, 2018 and 2019, respectively.

Figure 3.1 Total crop area damage in India due to natural disasters during the financial year (2008-19)



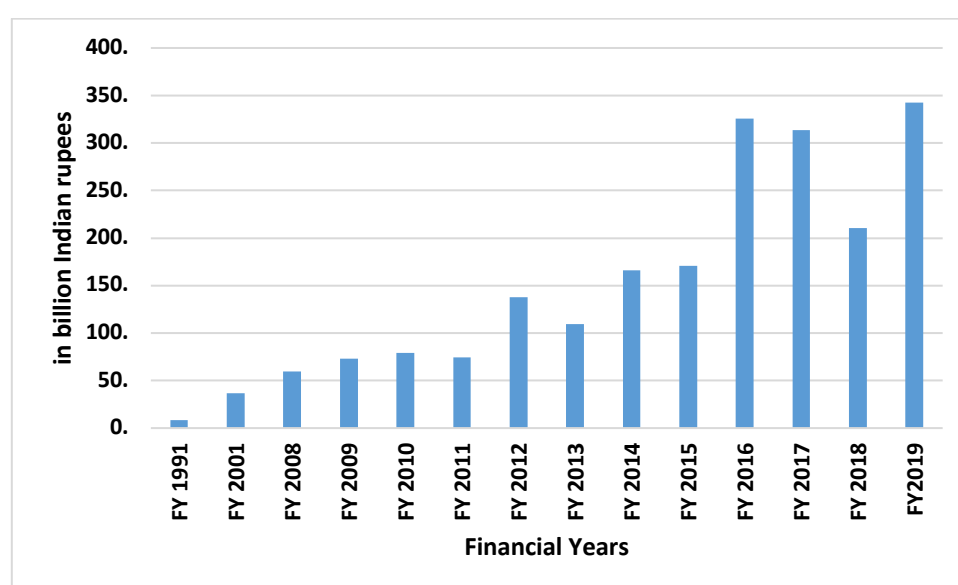
Source: J, Madhumitha (2019), Damaged crop area due to natural disasters across India 2007-2018.

3.2.1 Revenue expenditure on natural disaster relief in different financial years

The government spends a huge amount of money to reduce the vulnerability posed by natural disasters in India. The expenditure on the disasters can be best visible during ex-ante (precautionary action) and ex-post (relief during post even scenario) of natural disasters. The ex-ante measures may include rehabilitation of poor vulnerable people to safety places during flood or cyclone event, announcement/ alert regarding the disasters, provision of food and drinking water, climate resilient crop for drought prone area and different training program etc. Similarly, the ex-post measures is a safety measure adopted by the government and non-governmental organisations (NGOs) after the occurrence of any kind of natural disasters. It is based on various ground level work such as relief program, basic health facilities, food, clothes, shelter, special care for child, women, aging population and most vulnerable community etc.

The objective of these adoptive strategy is to facilitate basic facilities among the vulnerable people prone to natural disasters. Therefore, it costs a huge amount of investment during ex-ante and ex-post scenario of natural disasters. Figure 3.2 shows the revenue expenditure from the financial year 1991 to 2019 on account of various natural disasters in India. The expenditure on various natural disasters is showing an increasing trend from 8.6 billion Indian rupees in the FY-1991 to 342.48 billion rupees in the FY-2019. Moreover, the FY- 2018, 2017, 2016 and 2019 have been estimated to be a much higher revenue expenditure on natural disasters than other years, i.e. 210.67, 313.87, 325.38 and 342.48 billion rupees, respectively.

Figure 3.2 Revenue expenditure on natural disaster relief in India during 1991-2019



Source: K, Sandhya (2020), Natural disaster relief revenue expenditure of India's Government 1990-2018

3.3 Overview of Odisha

The state Odisha is an eastern part of India located in the globe between 17° 31' N to 20° 31' N latitude and 81° 31' E to 87° 30' E longitude. It is bounded on the East by the Bay of Bengal, on the West by Chhattisgarh, on the North by Jharkhand and West Bengal, and on the South by Andhra Pradesh state. In terms of area, it is the ninth-largest state in the Indian union, with an area of 1,55,707 sq. km, forming India's 4.7 % of the total population (Census, 2011). It has a coastal line of 480 Km long. The coastal line traverses six coastal districts of Odisha vis-a-vis Bhadrak (50 Km), Balasore (80 Km), Jagatsinghpur (67 Km), Puri (155 Km), Kendrapara (68 Km) and Ganjam (67 Km). There are 6234 Gram Panchayats under 314 CD Blocks and also

51,313 villages. The state's geographical area is confined to 155.71 lakh hectares, and it is broadly divided into two regions, i.e., the coastal and plateau regions. The coastal region comprises 23 % of the total geographical area, while the rest, 77 % of the geographical location, is covered by the plateau region. The state of Odisha is characterised by ten agro-climatic zones, out of which the entire coastal area is divided into three agro-climatic zones. In contrast, the Plateau region is divided into seven agro-climatic zones, with a central drought-prone region. The land in the state can be classified as low land (25.5 %), medium land (33.5 %) and upland (41 %) with a variety of soil such as black, red, red-loamy, yellow, laterite, alluvial and coastal alluvial etc. with low & medium texture.

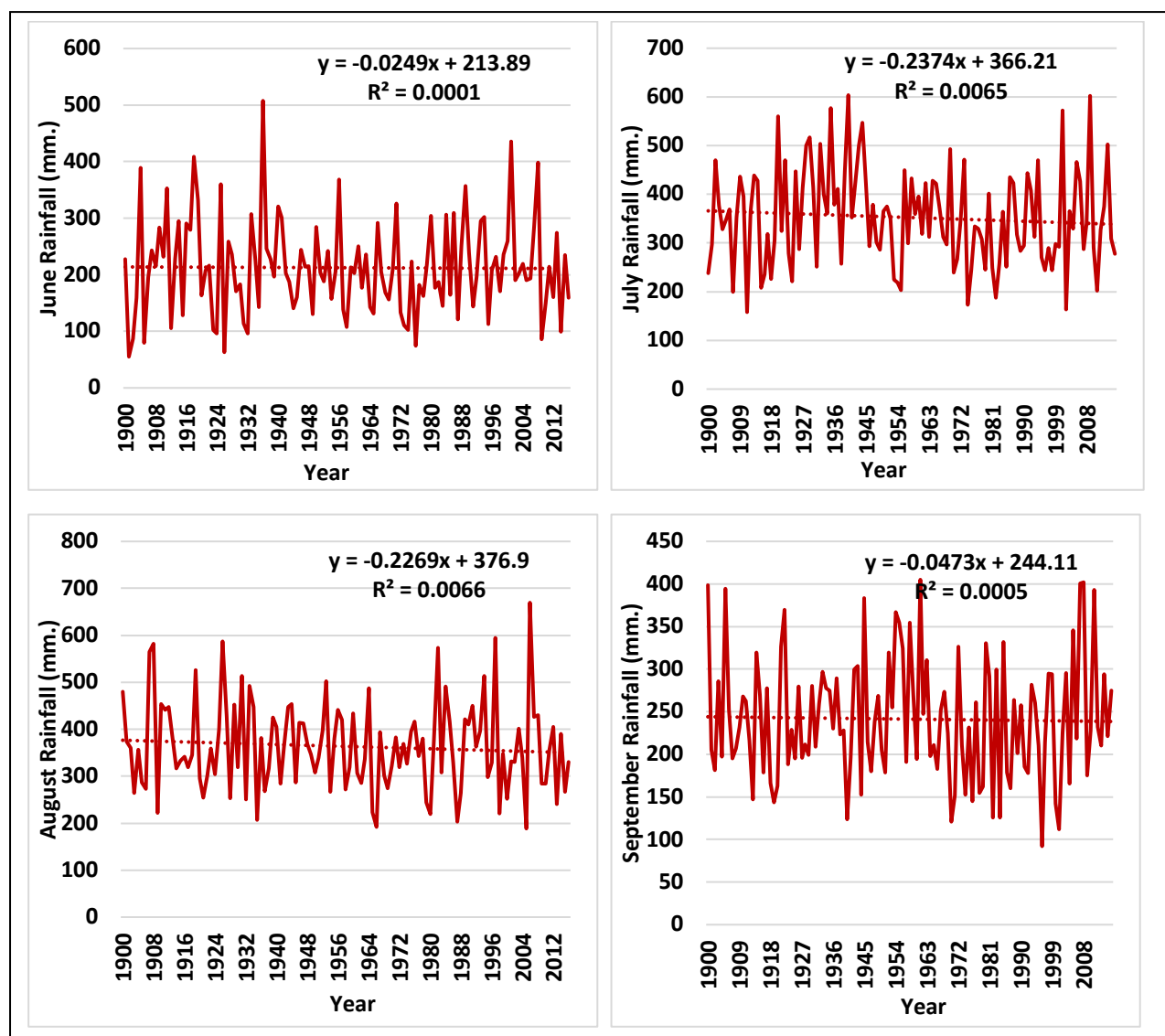
3.3.1 Climate and Rainfall in Odisha

Rainfall plays a significant role in agricultural production and provides livelihood to millions of rural populations. The state's average rainfall is about 1451.12 mm (Odisha Economic Survey, 2019). During the Kharif season, the state receives about 70-80 % of rainfall between mid-June and end-September.

3.3.2 Month-wise total rainfall in Odisha

Figure 3.3 represents month wise rainfall (June to September) in the state from 1900 to 2016. The month of June shows a declining rainfall trend along with July, August and September. The low precipitation in the state is one of the prime reasons for low agricultural crop output. The unpredictable rainfall pattern in the state generally leads to floods in coastal areas and drought in hilly areas.

Figure 3.3 Month-wise total rainfall (June-Sep) in Odisha during the period of 1900- 2016



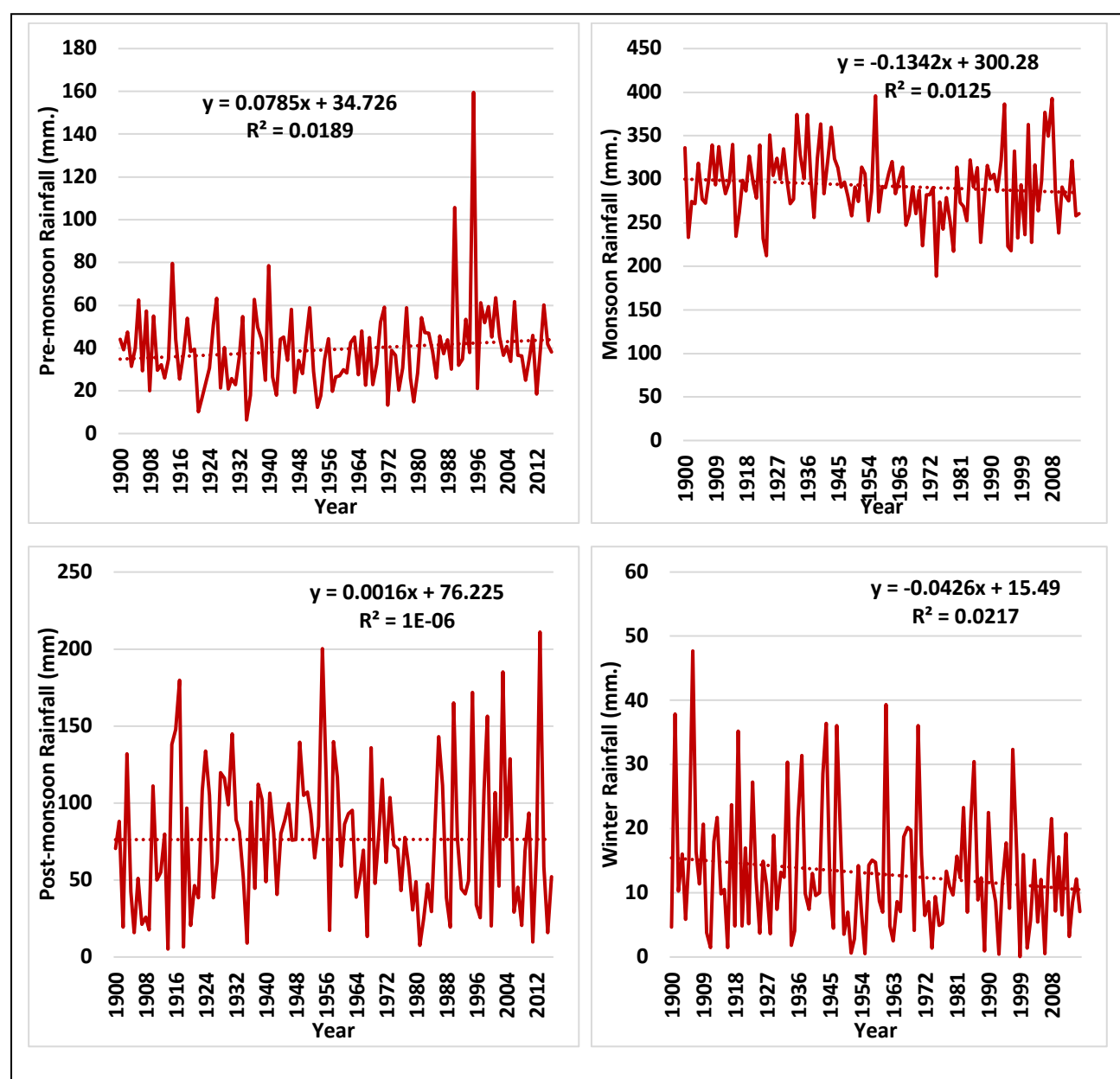
Source: India water portal

3.3.3 Season-wise average monsoon rainfall in Odisha

Agriculture is one of the climate sensitive sectors because of its dependent on the monsoon pattern. The variability in the monsoon pattern is one of the major threats to agriculture. According to the government report, the normal rainfall in the State is 1452 mm, of which about 80 percent is confined to monsoon months (June-September). The unpredictable rainfall pattern in Odisha causes extreme flood in coastal areas as well as drought in other hilly areas. The State has approximately 64.09 lakh hectares of cultivable area out of total physical area of 155.711 lakh hectares, which constitute 41.16 percent. Total cultivated area is around 61.50 lakh hectares. Approximately 40.17 lakh hectares of cultivable area has acidic soil and near

4.00 lakh hectares suffers from salinity and about 3.00 lakh hectares of cultivable area suffers from water logging. Agriculture contributes about 26 percent in the State Gross Domestic Product (SGDP). Kharif is the main cropping season in Odisha and rice is the principal crop which occupies 67 percent of cultivated land. But, cropping pattern during the Rabi season is confined to the irrigated tracks and land with moisture in the soil, which mostly depends on the occurrence of rainfall during the last part of September.

Figure 3.4 Season-wise Average Rainfall in Odisha during the period 1900-2016



Source: India water portal

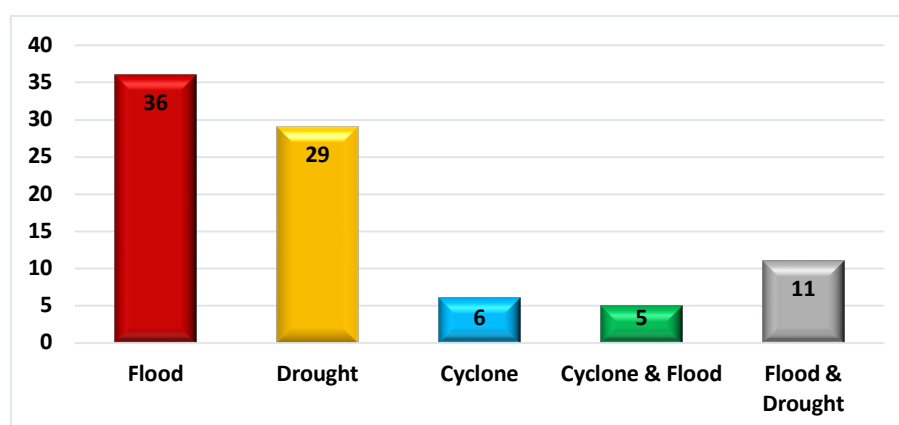
The other major crops grown are maize, ragi, pulses (arher, green gram, black gram), oilseeds (groundnut, til, mustard, Niger), fiber (jute, Mesta, cotton), sugarcane, vegetables, spices, and

fruit crops (mango, coconut, cashew nut). Figure 3.4 shows season-wise (pre-monsoon, monsoon, post-monsoon and winter) average rainfall in the state from 1900-to 2016. During the pre-monsoon season, the graph shows a positive trend in the rainfall that helps in the plantation of various Kharif crops and harvesting of Rabi crops as well. But during the monsoon season, the graph shows a declining trend because of rainfall variability. This trend generally constrains the growth of Kharif crops, whereas the season is supposed to get a healthy amount of rainfall for the Kharif crop output. The post-monsoon season in the graph shows a positive trend of rainfall which helps both Kharif and Rabi crops simultaneously. The Kharif crop is harvested during the post-monsoon season, and at the same time, the farmers start with their plantation of Rabi crops. The winter season in the graph shows a negative trend in rainfall patterns. The uncertainty during this period generally hampers the growing Rabi crops in the state.

3.3.4 History of natural calamities in Odisha

The disaster statistics show that Odisha has been a workplace of several natural disasters. The major disasters can be categorised as floods, droughts, and cyclones. The extreme natural events in the state cause massive damage to the state's economy. It also causes several casualties, loss of property and many more. While floods and cyclones are experienced in the districts of Eastern Odisha, regular and frequent droughts are mainly seen in different districts of Western Odisha. Figure 3.5 shows the temporal distribution of natural calamities in Odisha from 1955-to 2020. Between 1955-2014, Odisha confronted 35 flood years, 29 drought years, six cyclone years, five cyclone and flood years and 11 flood and drought years. These recurrent natural disasters have affected the agricultural production and income of the farmers.

Figure 3.5 Natural Calamities in Odisha during 1955 to 2020 (in number)



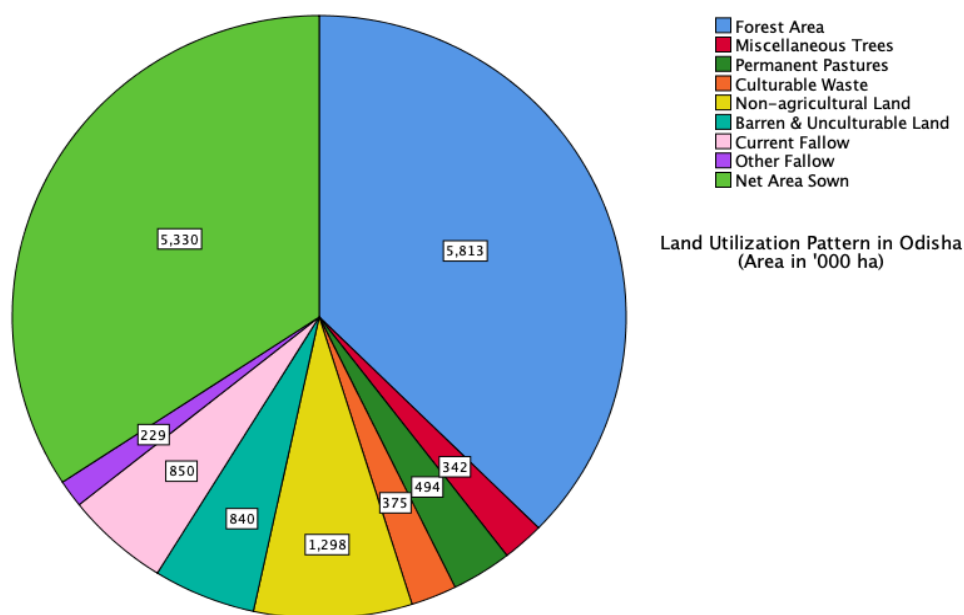
Source: Odisha state disaster management authority

3.3.5 Land utilization pattern in Odisha

From Figure 3.6, it is observed that the geographical area of the state is confined to 15,571 thousand hectares of land, of which 5,813 is covered by forest, 5,350 are net sown area, 1,298 are non-agricultural lands, 850 are current fallow, 840 are barren and unculturable land, 494 are permanent pastures, 375 are culturable waste, 342 are miscellaneous trees, and 229 are other fallows respectively. The figure revealed that the land utilisation pattern is dominated by the forest area and net sown area together.

Agriculture plays a vital role in the state's economy and provides a decent livelihood to the majority of its population. Moreover, the total cultivated land of the state is 64.09 lakh hectares, out of which 29.14 lakh hectares (47 %) are high land, 17.55 lakh hectares (28 %) medium land and 15.11 lakh hectares (25 %) low land. About 35 % of cultivated land is irrigated, and the rest, 65 % of the land, is rain-fed in nature, which is exposed to the vagaries of monsoon rainfall in the state.

Figure 3.6 Land Utilization Pattern in Odisha (Area in '000 ha) during 2019-20



Source: Author's calculation from secondary sources

3.3.6 Agriculture and allied sector Status in Odisha

Agriculture and allied sector contribute a significant share of 19.9% to the state's Gross State Value Added (GSVA) in 2019-20. The sector is considered the prime source of livelihood for

the majority of the people. 48.8% of the population is directly engaged in the agricultural sector (Economic report, 2017-19).

Table 3.1 The growth rates in the agriculture sector in Odisha (in %)

Economic Activity	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Agriculture, Forestry & Fishing Sector	15.8	-4.1	8	-12.7	20	-8.1	8.5	7.5
Crops sector	23.5	-9.1	10	-22.2	23	-17.5	9.11	3
Livestock sector	2.10	9.5	-3.6	4.8	3	7.4	14.3	20.7
Forestry Sector	-3.45	9.34	5.69	5.75	21.79	0.49	1.34	7.64
Fishing & Aquaculture sector	12.5	-1.7	13.5	10.5	22	17	8.7	12

Source: Odisha Economic Survey, 2019-20, Directorate of Statistics and Economics, Bhubaneswar, Odisha

The growth rate of crops has been seen as more unpredictable due to the cyclone Phailin in 2013-2014, the drought in 2015-2016 and the pest attack in 2017-2018, which have affected the crop production in Odisha. During 2012-2013 and 2016-2017, production growth was higher at 23.4 % and 23.1 %. The crop sector growth during 2012-2013 and 2019-2020 was only recorded at an average rate of 2.5 %. There are two types of cropping seasons available in the state, i.e., Kharif and Rabi. The primary cropping season in the state is inclined to Kharif crop. Rice is one of the principal Kharif crops and covers about 67 % of the cultivated area. However, the rabi season is primarily restricted to irrigation tracks. During the last part of December, the rainfall helps the cultivated land with moisture content to grow rabi crops. The other major crops grown during the Rabi season are maise, ragi, pulses (arhar, green gram, black gram), oilseeds (mustard, sesame, groundnut), fibre (cotton, mesta, jute), vegetables, sugarcane, spices, fruit crops etc. Paddy is appeared to be the dominant crop with a total area of 4180 thousand ha and 11,535 thousand million tons of production in 2114-15. However, in 2018-19, the statistics show an increasing trend in the production of 11,718 million tons with a decreasing trend of 3859 thousand ha. As far as the cash crop is concerned, the state has witnessed a substantial increase in cotton production from 299 thousand million tons to 455 thousand million tons in 2018-19.

Table 3.2 Area and Production of different crops (Area in '000 ha and Prod- '000 MT)

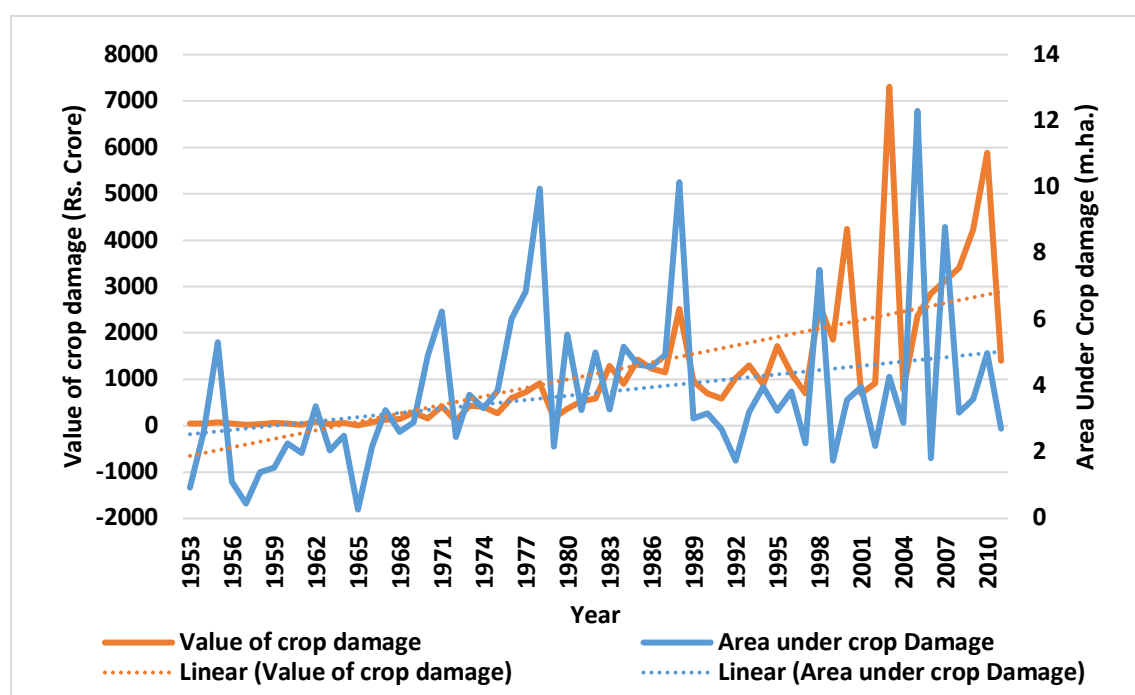
Crops	2014-15		2018-19		Change (%)	
	Area	Production	Area	Production	Area	Production
Paddy	4180	11535	3859	11718	-7.7	1.6
Maise	279	778	251	752	-10	-3.3
Mung	857	407	837	412	-2.3	1.2
Arhar	139	124	144	147	3.6	18.5
Biri	598	272	260	132	-56.5	-51.5
Sesamum	212	85	203	82	-4.2	-3.5
Groundnut	267	478	192	345	-28.1	-27.8
Potato	15	250	25	290	66.7	16
Sweet Potato	42	396	40	378	-4.8	-4.5
Onion	36	432	33	373	-8.3	-13.7
Cotton	124	299	158	455	27.4	52.2
Small millets	19	9	33	17	73.7	88.9

Source: Source: Odisha Economic Survey, 2019-20, Directorate of Statistics and Economics, Bhubaneswar, Odisha

3.3.7 Estimation of costs of crop damage under the cultivated area in Odisha

Figure 3.7 depicts a clear picture of the area under crop damage and the value of that crop damage from 1950 to 2013 in Indian agriculture. It indicates that the value increases with the increase of area under crop damage. The statistics revealed that the value of the crop damage since 1953 to 1989 was lower from area under crop. However, since 1989 to 2010, the value of crop damage significantly increased. It indicates that the number of natural disasters have been increased substantially and consequently it affects the production process.

Figure 3.7 Area under crop damage from 1950 to 2013 in Odisha



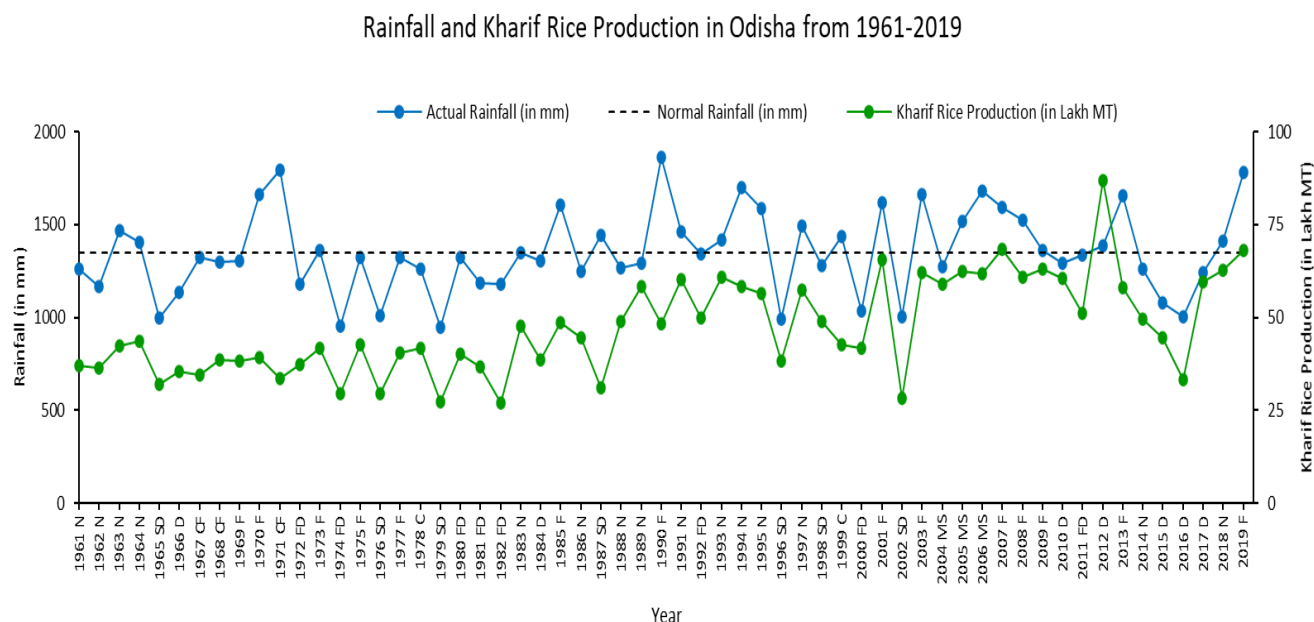
Sources: Odisha agriculture statistics, 2012-13

3.3.8 Impact of rainfall deviation and natural calamities on rice production in Odisha

Figure 3.8 depicts a clear understanding of rainfall deviations, climate-induced natural disasters and Kharif rice production in the state of Odisha. The rainfall variation directly hampers the production rate in terms of low crop output and drought due to the state's erratic and scant precipitation. The actual rainfall deviation from the normal (< 1000 mm) causes prolonged drought in the region, while the flood situation leads to healthy rice production. The analysis of time series data from 1961 to 2019 based on rainfall and rice production shows that from 1961 to 1973, rice production was around 35 lakhs million tonnes per annum which later decreased to an average of about 25 lakhs million tonnes from 1974 to 1987. From 1988 to 1995, rice production significantly increased due to adequate rainfall (> 1400 mm) and flood years in the state. However, from 1996 to 2002, rice production was low due to rainfall deficiency and drought situations. Similarly, from 2003 to 2015, rice production significantly increased due to the adequate rainfall of more than 1500 mm and flood situations. Again during 2016 and 2017, the production rate followed a decreasing trend because of inadequate water and from 2018 to 2019, the production rate of rice turned out to be much higher due to adequate rainfall and flood situation. Therefore, it is evident from the time series data analysis that

rainfall variation directly leads to various natural calamities in the state and significantly affects rice production.

Figure 3.8 Rainfall and rice production in Odisha from 1961-to 2019



Sources: Author's calculation from different sources

Note. N= Normal, D= Drought, F= Flood, C= Cyclone, MS= Moisture Stress, SD= Severe Drought

3.4 Socio-economic and general Profile of Balangir district

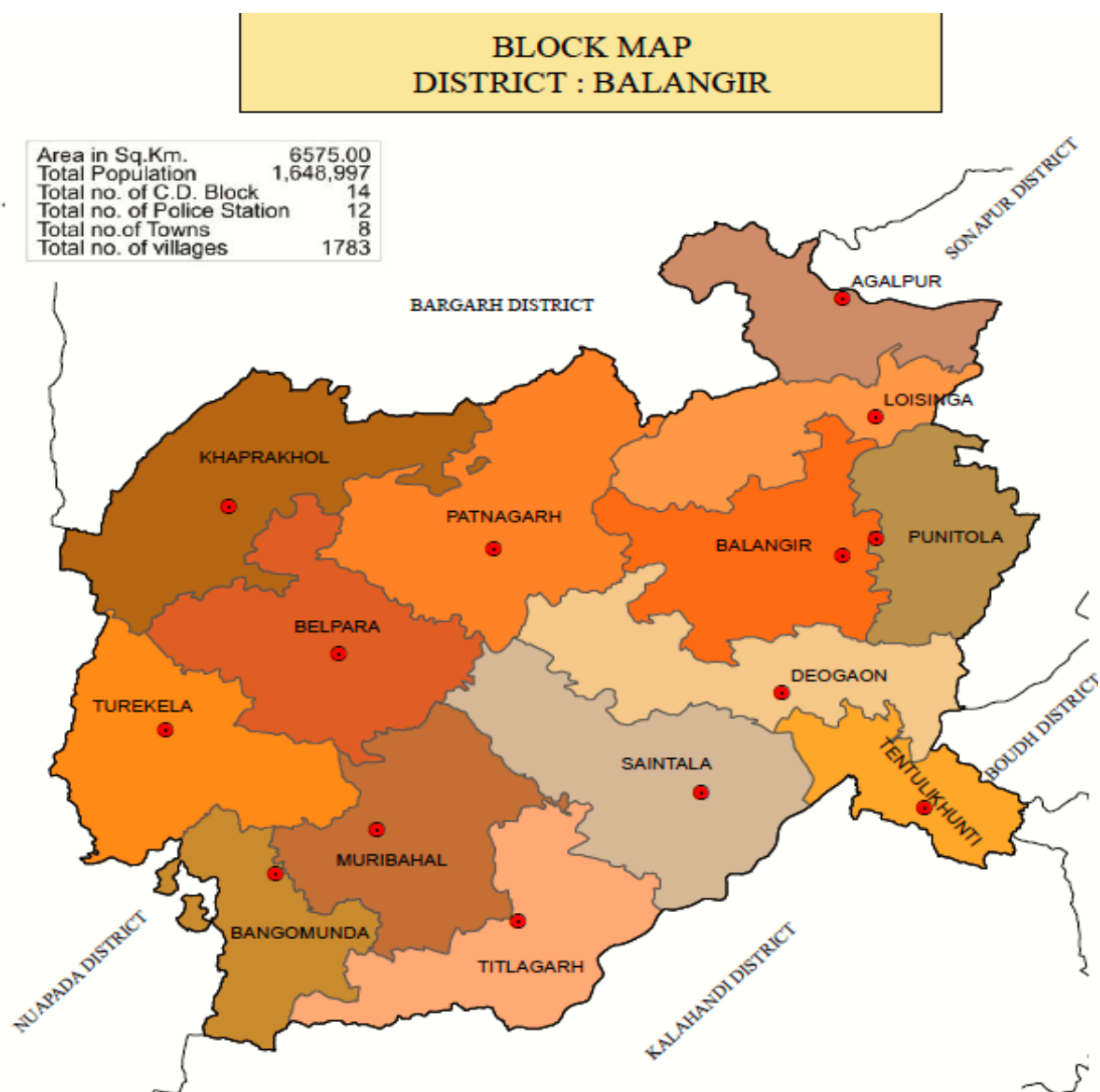
There are a total of 10 districts in the western part of Odisha. Almost all the areas receive precipitation scantily because of their geographical and climatic setup. Balangir is one of the western parts of Odisha districts that receive the least rainfall each year. The district is among the most economically backward districts in western Odisha in terms of development. The district is confined to a total area of 6569 sq. Km.

3.4.1 Demographic Features

According to the 2011 census report, the area's total population is 16, 48,997 out of which 8, 30,097 are male and 8 18,900 are female, with a sex ratio of 987. The decadal growth of the population has increased by 23.32 % from the last 2001 census year. It indicates a high growth rate of population in comparison to all the districts. As far as the Scheduled Caste and Scheduled Tribe population are concerned, 294,777 are from the SC community and 347,164 from ST. The district's literacy rate is only 64.72 %, which is relatively low compared to other districts. A significant number of populations, i.e., 14, 51,616, reside in rural setups, out of

which 7, 28,770 are male and 7, 22,846 females. Whereas the least numbers of people, i.e., 197,381, reside in urban setups, 101,327 are male and 96,054 females. The district is surrounded on the East and west by Sonepur and Nuapara districts while on the north and south by Bargarh and Kalahandi districts.

Figure 3.9 Block-wise Map of Balangir District, Odisha



Source: District portal, Balangir, Odisha

3.4.2 Administrative Setup

The district consists of 14 CD Block, three subdivisions, 285 Gram Panchayats (GPs) and 1789 villages, as the 2011 district census report. Patnagarh block has the highest number of GPs (26)

and highest number of villages (164), whereas, Gudvella block has the lowest number of a panchayat (12) with the lowest number of the village (94).

Table 3.3 Total Number of CD Blocks with gram panchayat and village details

Sl. No.	Name of CD Block	No. Gram Panchayats	No. of Villages
1	Agalpur	18	107
2	Loisinga	18	108
3	Patnagarh	26	164
4	Khaprakhol	18	133
5	Belpara	22	120
6	Turekela	19	104
7	Bangomunda	22	133
8	Muribahal	18	161
9	Titlagarh	22	133
10	Saintala	20	142
11	Deogaon	23	129
12	Balangir	23	125
13	Puintala	24	136
14	Gudvella	12	94
Total		285	1789

Source: Directorate of census operations, Odisha, 2011

3.4.3 Roadway and Railway connectivity

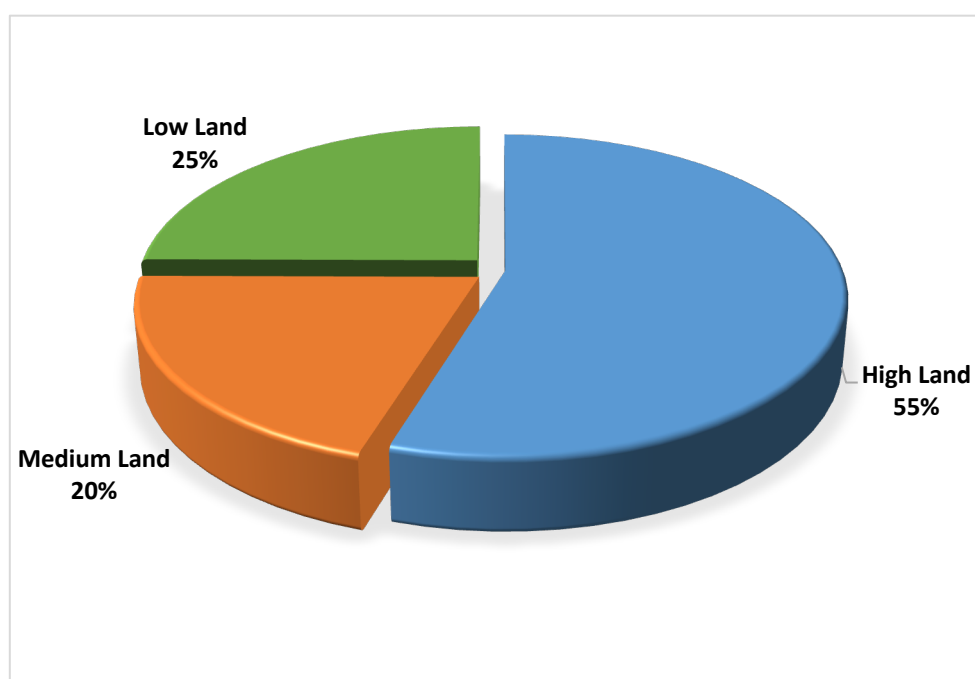
It has both Railway and National Highway connectivity. Balangir Railway station is the central railway station of the district, which connects nearby districts such as Sambalpur, Bargarh, Kalahandi, Jharsuguda etc. Moreover, two National Highways (NH-57 & NH-26) pass through the district. This indicates that the district is entirely developed in transportation and communication.

3.4.4 Agriculture and Allied Sector

People's livelihood is skewed toward agriculture since most of the population residing in rural areas depends on the agriculture sector. Therefore, the sector is the principal source of

livelihood majority of the population in the district. Nevertheless, many factors such as climate, precipitation, temperature, soil quality, irrigation, etc., that play a vital role in agricultural production. The district has a total of 345475 ha of geographical area. Of these, 55 % of the area is high land, followed by 25 % of low land and 20% of medium land, respectively (refer to Figure 3.10).

Figure 3.10 Types of cultivated area in Balangir (in ha)



Source: District portal, Balangir, Odisha

3.4.5 Climate and Rainfall

The South-West monsoon is the principal source of rainfall which the district usually receives from June to August. The irregularity and variability of the rainfall cause severe droughts in the area. Moreover, this situation triggers maximum drought years in the region. The agricultural practice in the area is rainfed in nature. Rainfed agriculture is defined as the farming practices which mostly rely on rainfall for water. In India, about 70 % of the population is dependent directly or indirectly on rainfed agriculture. The rainfall deficit is more acute in a region like the Patnagarh subdivision of the district. Patnagarh is located in the west and west-central part of the district (Central Ground Water Board, 2013). The normal annual rainfall of the district during (1991-2000) was 1212.23 mm, which was later substantially increased and recorded as 1417.32 during (2001-10). Surprisingly, from (2010-to 2019) the district observed a sharp decrease in the normal rainfall to 1186.4 despite the heavy flood year in 2019.

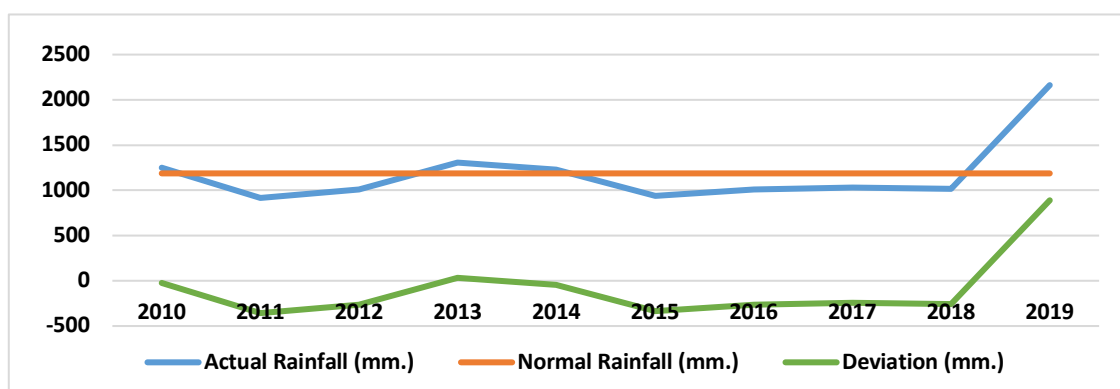
Table 3.4 Year-wise Rainfall Behaviour in Balangir (2010 to 2019)

Year	Actual rainfall (mm.)	Normal rainfall (mm.)	Deviation (mm.)	Deviation (%)
2010	1251.2	1186.85	-21.6	-1.73
2011	915.6	1186.85	-357.2	-39.01
2012	1007	1186.85	-265.8	-26.40
2013	1307	1186.85	34.2	2.62
2014	1227	1186.85	-45.8	-3.73
2015	941	1186.85	-331.8	-35.26
2016	1008	1186.85	-264.8	-26.27
2017	1030.9	1186.85	-241.9	-23.46
2018	1018.4	1186.85	-254.4	-24.98
2019	2162.4	1186.85	889.6	41.14

Source: Odisha Agricultural Statistics, various issues

The higher negative deviation suggests a drought year based on the inadequacy of water, whereas the higher positive deviation indicates a flood-like situation in the district. The intermediate between the positive and negative variation suggests a normal year. The healthy monsoon rainfall has always been a challenge for the district over the year. Therefore, rain plays a significant role in the production process.

Figure 3.11 Year-wise Rainfall Behavior in Balangir during 2010 to 2019



Source: Balangir district portal

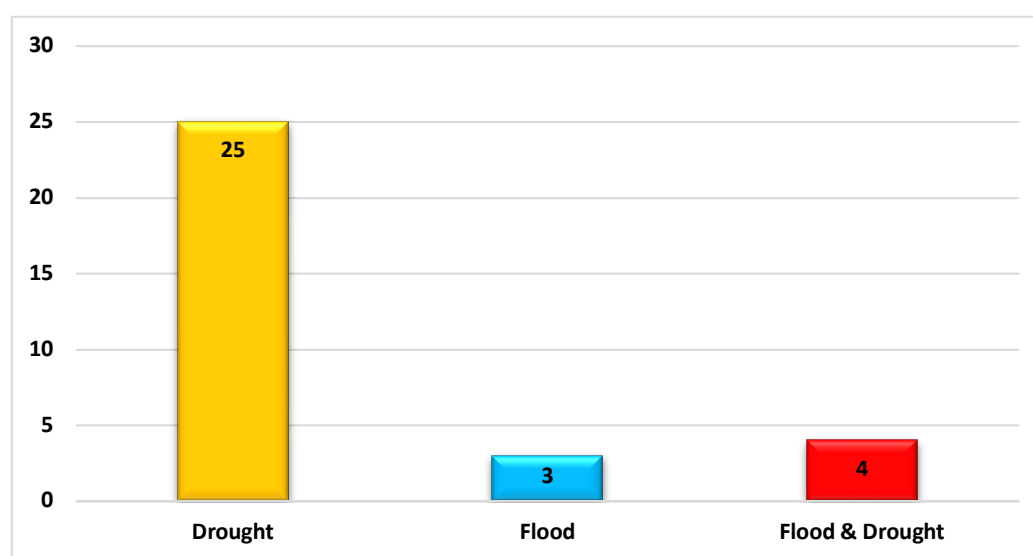
Due to the irregular rainfall, the district has been going through dramatic changes in the production pattern following drought almost all the year. The statistics show a continuous

scarcity of rain over the year, which indicates a drought situation in the region. However, the year 2019 is recorded as a flood year in the district because of heavy rainfall of around 2122.4 mm.

3.4.6 Disaster history of Balangir district

The district is one of the drought-prone districts in western Odisha due to scanty rainfall. The agriculture in the district is rainfed in nature. Better irrigation facility is the only solution to the drought situation. There is various irrigation project in the district are pending since years. The implementation of those project could help lakhs of farmers to mitigate the drought vulnerability in the grassroot level. It has so far experienced 25 drought years, 3 flood years and 4 flood & drought years from 1970 to 2020. The frequent drought situation in the district has caused a severe impact on people's lives in terms of vulnerable agricultural livelihood over the year.

Figure 3.12 Natural Calamities in Balangir During 1970 to 2020



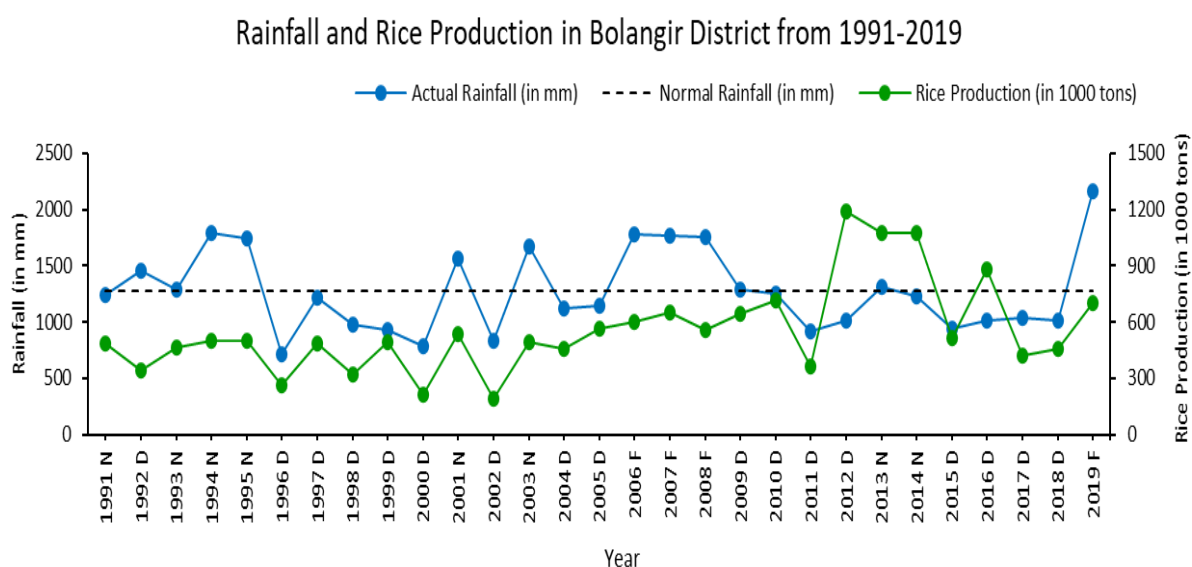
Source: District portal Balangir

3.4.7 Impact of rainfall deviation and natural calamities on rice production in Balangir

Rice is one of the dominant crop in Balangir district cultivated by majority of the farmer. It is consumed as a staple food in Odisha and in the study district. The deficit of monsoon rainfall and lack of water sources causes drought situation in the district. The drought conditions in the region primarily responsible for the agricultural failure in the district. due to Figure 3.13 depicts a clear understanding of rainfall behaviour, climate-induced natural disasters and rice

production from 1991 to 2019 in the Balangir district. The rainfall variation directly affects rice production in crop failure and drought situations due to erratic and scanty rainfall in the district. The actual rain from the normal rainfall of less than 1000 mm causes a prolonged drought period in the region, while flood and normal period lead to production growth. The time-series statistics (1991-2019) show that from 1991 to 1995, rice production was around 6 lakhs tonnes due to the actual rainfall of more than 1400 mm. However, the production significantly declined from 1996 to 2002 due to less than 1000 mm average rainfall. From 2003 to 2010, the production of rice increased more than due to the adequate rainfall (> 1500 mm), while in 2011, the production declined (less than 4 lakhs tonnes) due to rainfall shortage and drought conditions in the district. Similarly, from 2012 to 2014, the production increased to more than 7 lakhs tonnes per annum because of adequate rainfall in the district. Again, the production from 2015 to 2018 declined due to the rainfall deficiency and frequent droughts over the year and increased in the 2019 flood year in the district. The district has experienced 17 drought years, 4 flood years, and 8 normal years between 1991 and 2019. The impact of a higher frequency of drought years has resulted in low crop output and agricultural failure in the district. Therefore, rainfall is a primary determinant of a healthy rice production in the district.

Figure 3.13 Rainfall and rice production in Balangir from 1991-to 2019



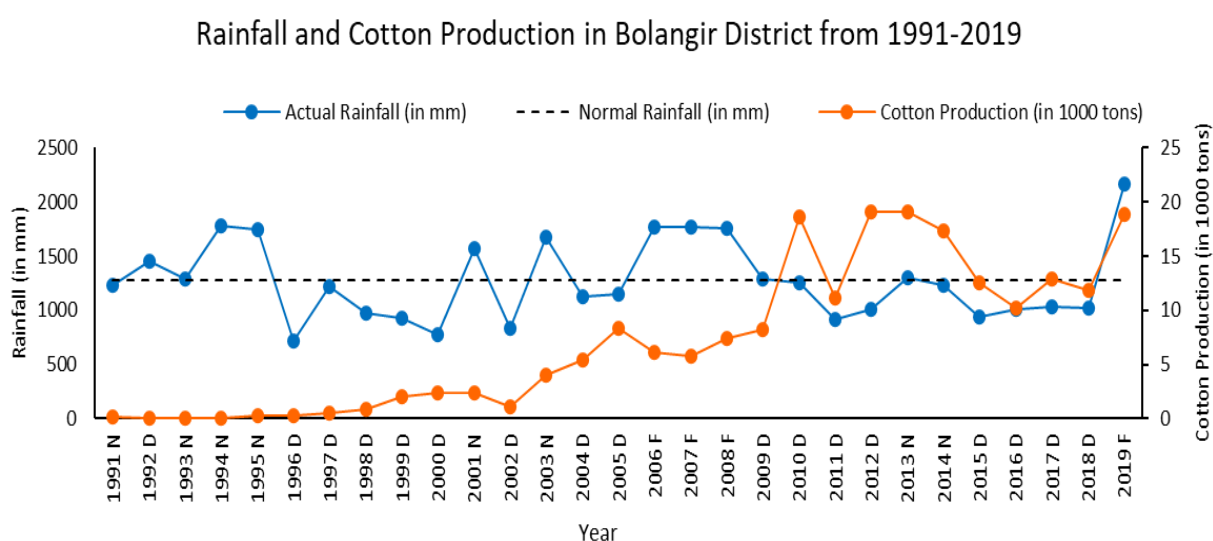
Source: Author's calculation from different sources

Note. N: Normal year, D = Drought year, F = Flood year

3.4.8 Impact of rainfall deviation and natural calamities on cotton production in Balangir

A large share of cotton in Odisha is produced from the western part of Odisha districts such as Balangir, Kalahandi and Rayagada. Although Balangir is a rainfed area, the demand for cotton production is almost equal to traditional rice cultivation. Figure 4.9 presents a clear understanding of rainfall variability and natural calamities on cotton production in Balangir. The rainfall variation directly affects rice production in crop failure and drought situations due to erratic and scanty rainfall in the district. The actual rain from the normal rainfall of less than 1000 mm causes a prolonged drought period in the region, while flood and normal period lead to production growth. The time-series statistics (1991-2019) show that from 1991 to 1998, the production of cotton was less than 2 thousand tonnes per annum, even though adequate rainfall (> 1500 mm.) was observed during the period except 1996. The cotton production in the district from 1999 to 2009 showed an average production compared to the rainfall behaviour. However, from 2010 to 2019, cotton production showed an all-time high compared to the previous year's production. The rainfall behaviour in these periods was consistent with an average annual rainfall of around 1200 mm. to 1700 mm. Moreover, the deviation from normal was comparatively low during the 21st century. Therefore, the production of cotton increased to around 20,000 tonnes in 2019. The district has experienced 17 droughts, 4 flood years, and 8 normal years between 1991 and 2019. The impact of the higher frequency of drought years has resulted in low cotton production and agricultural failure in the district.

Figure 3.14 Rainfall and cotton production in Balangir district from 1991-to 2019



Source: Author's calculation from different sources. Note. N: Normal year, D = Drought year, F = Flood year

3.4.9 Category of Workers in Balangir

The statistics revealed that the agricultural sector has the leading sector in the district with around 45.3 % of the workforce, followed by other sectors (27.61 %), cultivators (23.11 %) and households (3.98 %). The agriculture and allied sectors together consist of around 68.49 % of the total workforce in the district.

Table 3.5 Category of Workers engaged in different sectors

Sector	Classification	Total Number	Percentage
Cultivators	Persons	1,66,565	23.11
	Males	1,40,282	29.85
	Females	26,283	10.49
Agricultural Labourers	Persons	3,26,416	45.3
	Males	1,60,697	34.19
	Females	1,65,719	66.12
Workers in the household industry	Persons	28,650	3.98
	Males	17,798	3.79
	Females	10,852	4.33
Other Workers	Persons	1,98,970	27.61
	Males	1,51,179	32.17
	Females	47,791	19.07

Source: Directorate of census operations, Odisha, 2011

3.4.10 Water resources and Irrigation Status

As far as the district's water resources are concerned, it has one major river that flows in the district called "The Tel", which generally flows from West to East. Apart from this river, some tributaries of "The Tel", such as Suktel, Indra, Lant and Ong-a, tributaries of The Mahanadi, also flows in the region, which generates its primary drainage system. The flows of the river "The Tel" and other tributaries are inadequate for the irrigation facilities in the region. Therefore, most of the area is rainfed in nature. The district has 657500 hectares of land; however, only 27705 hectares are under irrigation from different sources such as rivers, canals, groundwater, etc. It has two medium irrigation projects, two ongoing medium projects, and three major irrigation projects to facilitate sustainable agriculture. Apart from these projects, the district also has 30,532 hectares under irrigation facilities from groundwater sources for Kharif and Rabi crops. The statistics show that around 1,02,171 ha of land is irrigated from different sources under the Kharif crop, whereas only 34,144 ha of land is irrigated under the Rabi crop.

3.4.11 Irrigation system during Kharif and Rabi Season in the District

The district has a total of 1,02,171 ha of land coming under different sources of irrigation projects for agricultural purposes. The Doug well irrigation project covers the highest Kharif crop area in terms of irrigation, followed by Lift irrigation, Minor irrigation, Tube well, Others and all, respectively. Similarly, for the Rabi crop, a total of 34,144 ha of land are covered by different irrigation projects. Based on the cropped area covered under different irrigation projects, it is evident that the Kharif crop is one of the dominant crops that cover the highest irrigated area compared to the Rabi crop (Table 3.6).

Table 3.6 Irrigation system in the district

Sl. No.	Sources	Kharif (area in ha)	Rabi (area in ha)
1	Major Irrigation Project	667 ha	350 ha
2	Medium Irrigation Project	8243 ha	100 ha
3	Minor Irrigation Project	17656 ha	472 ha
4	Lift Irrigation Project	20310 ha	10656 ha
5	Major Lift Irrigation Project	750 ha	0
6	Doug well Irrigation Project	23206 ha	4734 ha
7	Tube well Irrigation Project	17557 ha	13455 ha
8	Micro Lift Irrigation Project	715 ha	70 ha
9	River Lift Irrigation Project	2987 ha	1539 ha
10	Others Irrigation Project	10070 ha	2768 ha
Total		102171	34144

Source: District Portal, Balangir, Odisha. Note. ha- hectare

3.5 Summary

The study found that in the context of India the government has been spending a huge amount of money each year to reduce the vulnerability posed by natural disasters. The expenditure on the disasters can be best visible during ex-ante (precautionary action) and ex-post (relief during post even scenario) of natural disasters. Hectares of cropped land in India are under threat to various disasters each year. Disasters such as flood, drought and cyclone primarily have significant effect of agriculture. The natural disasters have caused huge loss in terms of India's rural economy system. The estimations of those loss could illustrate a new dynamic between

production and agricultural investment. In the context of Odisha, it is observed that between 1955-2014, Odisha confronted 35 flood years, 29 drought years, six cyclone years, five cyclone and flood years and 11 flood and drought years. These recurrent natural disasters have affected the agricultural production and income of the farmers. Therefore, the rainfall variation directly hampers the production rate in terms of low crop output and drought due to the state's erratic and scant precipitation. The actual rainfall deviation from the normal (< 1000 mm) causes prolonged drought in the region, while the flood situation leads to healthy rice production. Similarly, in the context of the study district Balangir, the study observed that both rice and cotton production has correlation with the natural disasters. The state and the district consequently have experienced maximum drought years over the year. In addition to the drought condition, people having access to different resources are less vulnerable. However, the lack of entitlement among the poor marginal people are the most vulnerable to the drought situation. According to Amartya Sen drought is not just because of lack of food, rather lack of entitlement (Sen, A., Ed., 1981).

CHAPTER IV

Drought Vulnerability in the Context of Social Groups and Water Resources

4.1 Introduction

Drought is one of the most frequently occurring national disasters in India (Mishra and Desai, 2005). With its increased frequency and expanded coverage in recent years, about one-third of the country is drought-prone or under desert areas. These areas are lagging in agriculture and also in overall economic growth. They experience wide year-to-year fluctuations in agricultural production and incomes and have a relatively high incidence of poverty. The poor in these regions are highly vulnerable to various risks due to their low and fluctuating incomes, high indebtedness and low human development. Drought generally has multiple native impacts on human society especially social vulnerability. The present chapter illustrates a clear picture of drought vulnerability based on empirical evidence collected from the study area and based on review of relevant literatures. The study has used statistical methods such as descriptive statistics and a mixed designed ANOVA model to evaluate the socio-economic conditions and impact of drought vulnerability on the farming population. The drought vulnerability is exclusively examined in human capital, social capital, livelihood conditions and agricultural production in the study area. Therefore, a 2 x 2 x 2 Mixed-design ANOVA the last factor repeated and descriptive statistics are computed to understand the dynamics of drought vulnerability in social groups (scheduled category and non-scheduled category) and accessibility to water resources (adequate water resources -AWR and inadequate water resources -IWR) in the study area.

This chapter is consisting of seven sections (section 1: introduction, section 2: Profile of the sample respondents, section 3: Drought vulnerability, section 4: Conditions of vulnerability in the context of Social category and Water Resources, section 5: Conditions of human capital in the context of Social Category and Water Resources, section 6: Impact of climate change vulnerability on agriculture in the study area, and section 7: Summary and observation).

4.2 Profile of the sample respondents

The profile of the sample respondent includes the demographic features of sample villages, sample respondents, gender, social category (scheduled category and non-scheduled category), Water availability (based on adequate and inadequate), and size during normal and drought years and irrigated and unirrigated land size during normal and drought year etc.

4.2.1 Demographic features of the study village

The sample villages' total population is 2775 (Bhaludharha- 1341, Mundomahul- 906 and Maneipad- 528). The male and female population in these three villages are more or less equal (Bhaludharha: male- 50.5 %, female- 49.5 %); (Mundomahul: male- 48.5%, female- 51.5%); (Maneipad: male 50.5%, female- 49.5%). The Scheduled Castes (SCs) population in Bhaludarha village is 300 (male- 52%, female- 48%). The SCs population in Mundomahul village is 212 (male- 50.5, female- 49.5). Similarly, the SCs population in Maneipad village is 119 (male- 50.5%, female- 49.5%). The Scheduled Tribes (STs) population in Bhaludarha village is 289 (male- 46.7%, female-53.3%). The STs population in Mundomahul village is 477 (male- 48.6%, female- 51.7%). Similarly, the STs population in Maneipad village is 298 (male- 51.3%, female- 49.7 %). As far as the literacy rate is concerned, Bhaludarha has the highest literacy rate compared to Mundomahul and Maneipad. The literacy rate in Bhaludarha village is around 47 %, of which 58 % are male, and 42 % are female. The literacy rate in Mundomahul is 50 %, of which 56.5 % are male, and 43.5 % are female. Similarly, the literacy rate in Maneipad is 57 %, of which 59.5 % are male, and 40.5 % are female (Census, 2011).

4.2.2 Demographic features of the sample respondents

The study has interviewed 288 sample farm households in three villages out of 350 total households in the Patnagarh block of Balangir district. Of the total sample households, about 95.5 % are male, and only 4.5 % are female. The sample respondents have been classified into four types of social category, i.e., SCs: 16.6 % (male- 91.66 %, female- 8.33%); STs: 54.86 % (male 94.93%, female- 5.06%); OBCs: 7.3% (male-95.2, female- 4.8); General: 21.2 % (male- 100, female- 0). The area is mainly dominated by the Scheduled Tribes population, followed by Scheduled Castes, Generals and OBCs.

Table 4.1 Composition of sample respondents based on gender and social category

<i>Social category</i>	Male		Female		Total	
	<i>f</i>	%	<i>f</i>	%	<i>F</i>	%
SC	44	91.66	4	8.33	48	16.66
ST	150	94.93	8	5.06	158	54.86
OBC	20	95.24	1	4.76	21	7.29
General	61	100.00	0	0.00	61	21.18
Total	275	95.48	13	4.52	288	100

Source: Field Work, Balangir District, Odisha, 2019

4.2.3 Age composition of the sample respondent

The maximum number of the sample population (45 to 54 years), irrespective of their social category, are engaged in agriculture and allied activities in the study area. The second dominating age group involved in agricultural livelihood is 35 to 44 years, followed by other age categories such as 25 to 34, 55 to 64 and 65 to 74 years. The age group between 45 to 54 are much more experience in agricultural activities than other groups. The adult population in the study area are primarily engaged in small business and other household activities.

Table 4.2 Age group of the sample based on social category

Social Category	Age Group (in years)					Total
	25-34	35-44	45-54	55-64	65-74	
SC	1 (1.85 %)	11 (20.37 %)	32 (66.6 %)	3 (5.56 %)	1 (1.85 %)	48
ST	8 (5.26 %)	57 (37.50 %)	86 (54.4 %)	5 (3.2 %)	2 (1.32 %)	158
OBC	1 (4.76 %)	1 (4.76 %)	19 (90.48 %)	0 (0.00)	0 (0.00)	21
General	1 (1.64 %)	3 (4.92 %)	55 (90.16 %)	0 (0.00)	2 (3.28 %)	61

Source: Field Work, Balangir District, Odisha, 2019

4.2.4 Literacy rate of the sample population in the study area

As the area is mainly dominated by the Scheduled Tribes and Scheduled Castes population, the educational background of most of these farm households is confined to primary to middle-class education due to their poor socio-economic conditions. The majority of the school-aged children help their parents during the agricultural season. The maximum number of children

are enrolled in a government school to avail of mid-day meal benefits in the study area. However, after a certain period, children's attendance goes significantly low compared to private schools. Parents' educational backgrounds also directly impact children's education. The maximum numbers of sample respondents (67 %) have only middle-class qualifications, followed by 27.5 % primary, 7.3 % matriculation, only 2.1 % intermediate, only 1 % of the sample population can only read and sign documents, and 5.2 % of the sample population are illiterate in the study area (Table 4.3). Being a pivotal human capital, education plays a crucial role in sustainable agriculture and advancing agriculture techniques in tribal-dominated regions like the Balangir. However, the statistics reveal that very few sample respondents possessed higher qualifications in the study region.

Table 4.3 Literacy rate of the sample population

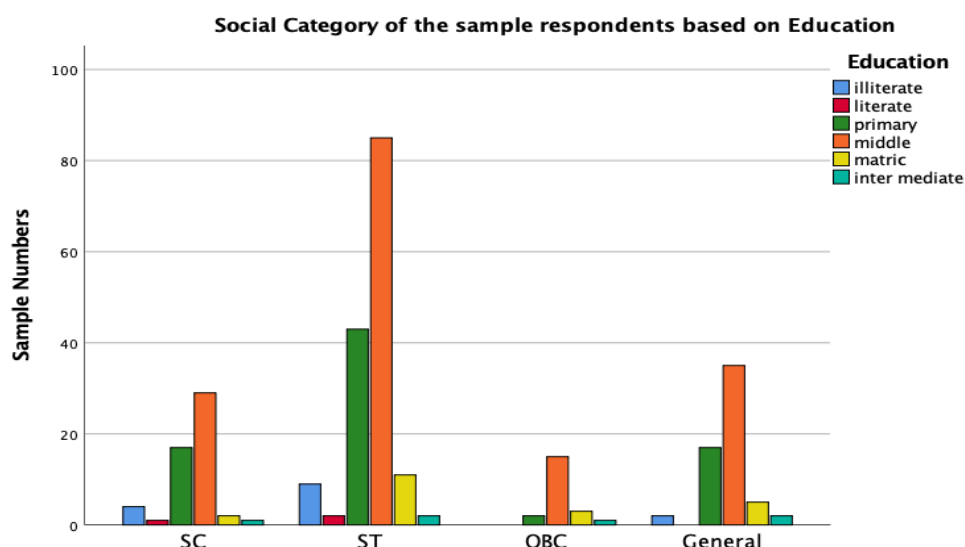
Education	Frequency	%
illiterate	15	5.2
literate	3	1
primary	79	27.4
middle	164	56.9
matric	21	7.3
inter mediate	6	2.1
Total	288	100

Source: Field Work, Balangir District, Odisha, 2019

4.2.5 Education of sample respondents based on social groups

As the STs population mainly dominates the area, most sample respondents belong to middle-class education in the study area. Figure 4.1 revealed that the maximum numbers of STs population have middle-class qualifications based on the social category, followed by general, SCs and OBCs. Similarly, in the case of primary, matric and intermediate qualifications, STs populations are significant in number.

Figure 4.1 Education of sample respondents based on social category



Source: Authors' calculation from Field data

4.2.6 Key variables in this research

The study has considered some significant variables to conduct this research. These variables may include normal year and drought year; adequate water resources (AWR) and inadequate water resources (IWR); scheduled category and non-scheduled category

Normal and drought year

The normal year is defined as the period having adequate rainfall or an average rainfall for healthy crop production. However, the drought year is the opposite of a normal year. The rainfall deficit and erratic rainfall during a period cause a massive problem for the agricultural sector. Lack of soil moisture for extended periods resulted in a dry spell and drought situation in the study area. In normal year, the sample respondent has experienced marginal vulnerability due to the non-drought condition and easy accessibility to various resources. In contrast, people have lost their primary agricultural livelihood in drought years and are forced to practice migration. The study has

Adequate water resources (AWR) and inadequate water resources (IWR)

Water plays a significant role in terms of healthy agricultural production. Excessive water causes floods in coastal areas, while less water causes drought in the hilly area. In the context of Odisha, monsoon rainfall plays a key role in providing adequate water for agricultural

purposes. In the study area, access to AWR is defined as people's access to several water resources for agricultural purposes without any barriers. The sample respondent has possessed multiple water sources such as well irrigation, private borewell, government irrigation scheme, pond, canals, monsoon rainfall etc. During the drought period, people use these sources to lower their vulnerability.

Similarly, IWR represents a picture of difficulty in accessing water for agricultural needs. In the study area, the drought year has witnessed a dry spell of water bodies in the SukTel (a tributary of the Tel river) river, which is around 15 to 20 km distance from the study area. Apart from the natural sources of water, well, pond, borewell, tube well etc., gets short of water during the drought year. The groundwater level goes below 25 to 30 feet, which results in severe water shortage in agriculture. Consequently, the failure of agriculture in the region has a massive impact on the rural farming community.

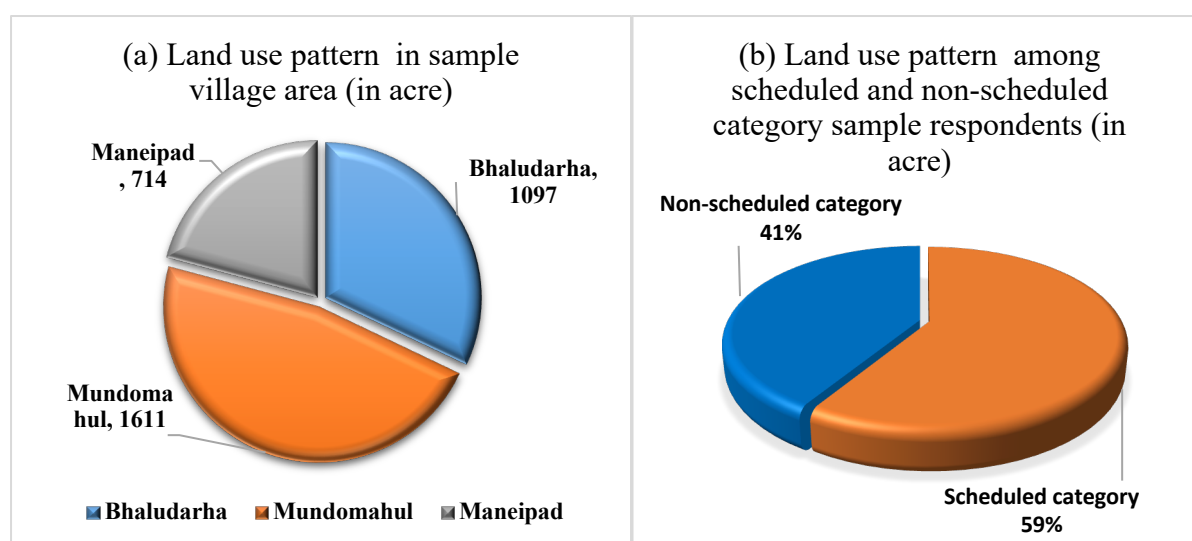
Scheduled and non-scheduled category

In this study, the social category of the sample respondents has been categorised as the scheduled and non-scheduled categories. The scheduled category consists of Scheduled Castes (SCs) and Scheduled Tribes (STs) clubbed together as both categories share some similar socio-economic status. Similarly, the non-scheduled category consists of Other Backward Classes (OBCs) and General or Other Castes (OCs) are also clubbed together and have some similar characteristics in common in terms of social position and socio-economic conditions in the study area.

4.2.7 Land distribution in normal and drought years in the study area

The land use pattern in the sample village revealed that the village Mundomahul has the highest land of around 1611 acres, followed by 1097 acres in Bhaludarha and 714 acres in Maneipad village, respectively (Figure 42-a). The agricultural land in Bhaludarha village is nearby the Patnagarh block itself. Therefore, the communication facilities in the village are rich compared to Mundamahul and Manepad village. The sample household in the study area has possessed 1109 acres of agricultural land. The scheduled category household holds 653 acres (59 %) of land, and the non-scheduled category owns 456 (41 %) of land. The study area revealed that scheduled areas are significantly higher than the non-scheduled category (Figure 4.2-b).

Figure 4.2 Land use pattern in sample village and distribution among the social category

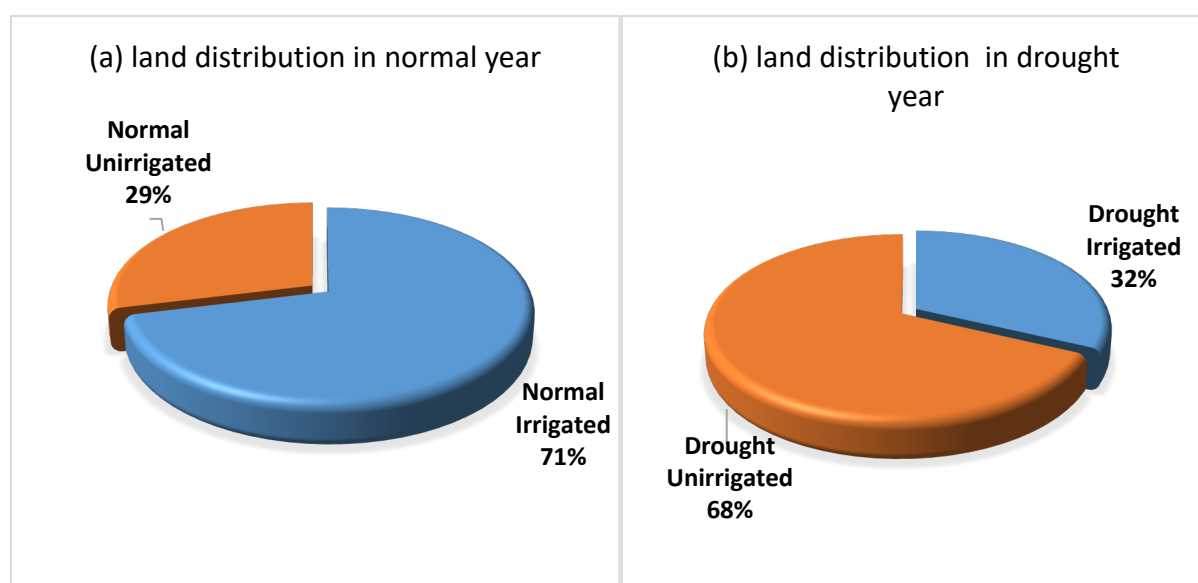


Source: Field Work, Balangir District, Odisha, 2019

Moreover, the Bhaludarha water project also helps many farmers in their farming process. However, the case of Mundamahul village, which is also a panchayat, faces the worst irrigation facility due to the under constructed water dam placed nearby a water body. Similarly, in the case of Manepad village, farmers have no choice of any irrigation facilities except the government schemes such as Jeevan Dhara, Borewell, Tube well etc.

Around 71 % of land out of 1109 acres is allocated under irrigated land in the normal year, whereas only 29 % is allocated under unirrigated land (Figure 4.3-a). The sources of irrigation in the sample village are canal water, minor irrigation projects, dug well, government borewells, tube wells etc. The agricultural land nearby the canal used to get adequate water, whereas land located distance from the canal water source faces a shortage of water due to the lower pressure from the motor pump. However, in the drought year, the land allocated under irrigation goes down significantly due to the shortage of water in the canal and other major water sources. Only 32 % of agricultural land is allocated under irrigation during the drought year, whereas 68 % is allocated under unirrigated land (Figure 4.3-b). A larger portion of the agricultural land in Bhaludarha village is irrigated. The primary source of irrigation in the village is mainly confined to canal irrigation.

Figure 4.3 Distribution of agricultural land during normal and drought years



Source: Field Work, Balangir District, Odisha, 2019

4.3 Drought vulnerability

In terms of rainfall and water availability, drought is categorised as meteorological, hydrological and agricultural. Meteorological drought is where the precipitation deviates more than 25 % from the normal rainfall. Similarly, the prolonged meteorological drought over an area resulted in hydrological drought. Finally, agricultural drought is a situation where soil moisture and rainfall are inadequate for the growth of crops over an area. According to the India Metrological Department (IMD), drought has three dimensions over a region, i.e., marginal drought, moderate drought, and severe drought. The marginal drought occurs when the deviation of precipitation is 25 % from normal rainfall. The variation of rainfall between 25 to 50 % from the normal is called moderate drought, and more than 50 % of deviation from normal is called severe drought over an area (Sudarsan Rao A., 2018). The drought vulnerability assessment has been carried out in the study area based on the livelihood of vulnerable farm households to understand the impact of drought on the sample respondent in terms of social category and availability of water resources in the study area.

4.3.1 Total Land distribution among the social category

The 2 x 2 x 2 Mixed-design ANOVA results are presented in Table 4.4. The study found an unequal distribution of cultivable land in the study area based on social category and accessibility to water resources. From the statistics, it is observed that there is no significant difference in the total area observed between the two categories of availability of water resources, $F(1,284) = 1.92, p > .05$. This indicates that the total area is more or less equal for the farmers having access to AWR ($M = 4.34, SD = 3.06$) and farmers having no access to AWR ($M = 3.67, SD = 3.90$). There is a significant difference in the total area between the two social categories, $F(1,284) = 22.32, p < .001$. This suggests that the total area is significantly higher in non-scheduled category ($M = 6.00, SD = 5.32$) compared to scheduled category ($M = 3.08, SD = 2.50$). However, the interaction between the availability of water resources X Social category is found to be significant in respect of the total area, $F(1,284) = 21.44, p < .001$

Table 4.4 Summary of 2 x 2 x 2 ANOVA done on the land distribution among the social category

<i>Between-subjects</i>	SS	df	MS	F	P
Water resource (WR)	21.762	1	21.762	1.927	0.166
Social category (SC)	252.153	1	252.153	22.324	<.001
WR X SC	242.186	1	242.186	21.441	<.001
Error	3207.881	284	11.295	-	-

Source: Author's calculation from primary survey

From Figure 4.4, it is observed that the farming areas of the scheduled and non-scheduled categories under AWR are almost equal. Moreover, the farmers of the non-scheduled category have a significantly higher amount of farming areas under IWR than the scheduled category. The comparison between AWR and IWR access category revealed that the Scheduled category with AWR has a larger share of total land than the IWR access category. However, the non-scheduled category having IWR has a more significant share of total land than the AWR category.

4.3.2 Total Irrigated Area in Normal Year based on Social Category and Water Resources

From Table 4.5, it is observed that there is a significant difference in total irrigated area between the two categories of availability of water resources, $F(1,284) = 4.44$, $p = .036$. This indicates that the total irrigated area in normal year is more or less equal for the farmers having access to AWR ($M = 2.64$, $SD = 1.98$) and farmers having no access to AWR ($M = 2.75$, $SD = 2.29$). In the case of the social category, there is no significant difference in the total irrigated area observed between the two social categories during normal year, $F(1,284) = 2.13$, $p = 0.145$. The total irrigated area in the normal year is significantly higher in the non-scheduled category ($M = 3.26$, $SD = 2.85$) than the scheduled category ($M = 2.53$, $SD = 1.9$). Similarly, the interaction between the availability of water resources X Social category is also significant in respect of the total irrigated area in normal year, $F(1,284) = 15.38$, $p < .001$.

Table 4.5 Summary of 2 x 2 x 2 ANOVA done on the irrigated area in normal year

<i>Between-subjects</i>	SS	df	MS	F	P
Water resource (WR)	20.288	1	20.288	4.444	0.036
Social category (SC)	9.742	1	9.742	2.134	0.145
WR X SC	70.196	1	70.196	15.376	<.001
Error	1296.57	284	4.565	-	-

Source: Author's calculation from primary survey

From Figure 4.5, it is observed that during a normal year, the irrigated farming areas of the scheduled and non-scheduled categories under AWR are insignificantly higher for the scheduled category than the non-scheduled. Moreover, the farmers of the non-scheduled category have a significantly higher amount of farming areas under IWR than the scheduled category.

4.3.3 Total Irrigated Area in Drought Year based on Social Category and Water Resources

From table 4.6, it is observed that there is no significant difference in total irrigated area between the two categories of availability of water resources, $F(1,284) = 3.05$, $p > .05$. This indicates that the total irrigated area in drought year is more or less equal for the farmers having access to AWR ($M = 1.25$, $SD = 1.18$) and farmers having no access to AWR ($M = 1.20$, $SD = 1.45$). A significant difference in total irrigated area in drought year is observed between two

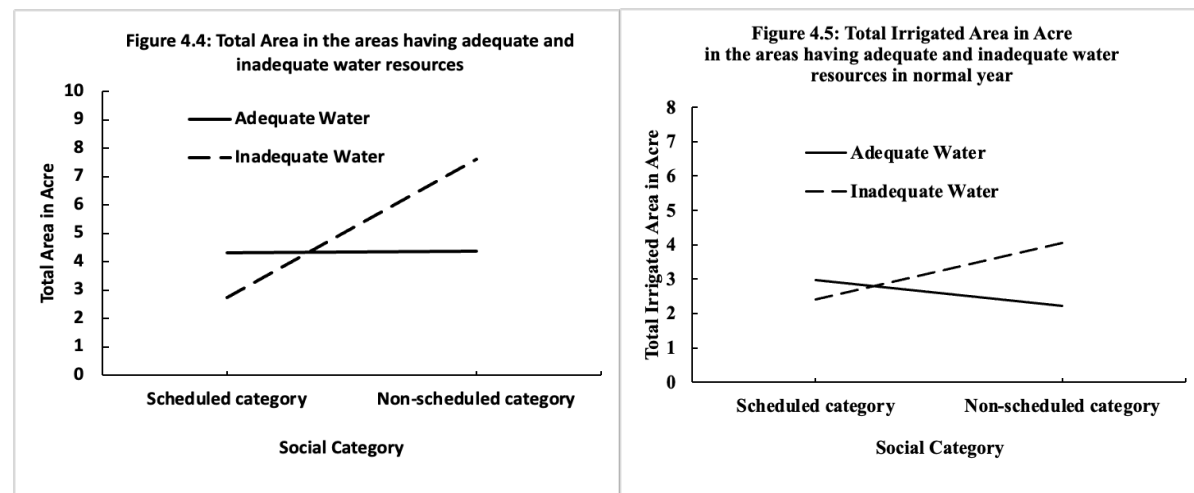
social categories, $F(1,284) = 7.50, p < .001$. This suggests that the total irrigated area in drought year is significantly higher in the non-scheduled category ($M = 1.72, SD = 1.93$) than in the scheduled category ($M = 1.02, SD = 1.06$). However, The interaction between the availability of water resources X Social category is also found to be significant in respect of total irrigated area in drought year, $F(1,284) = 14.15, p < .001$ (Table 4.6).

Table 4.6 Summary of 2 x 2 x 2 ANOVA done on Irrigated areas in the drought year

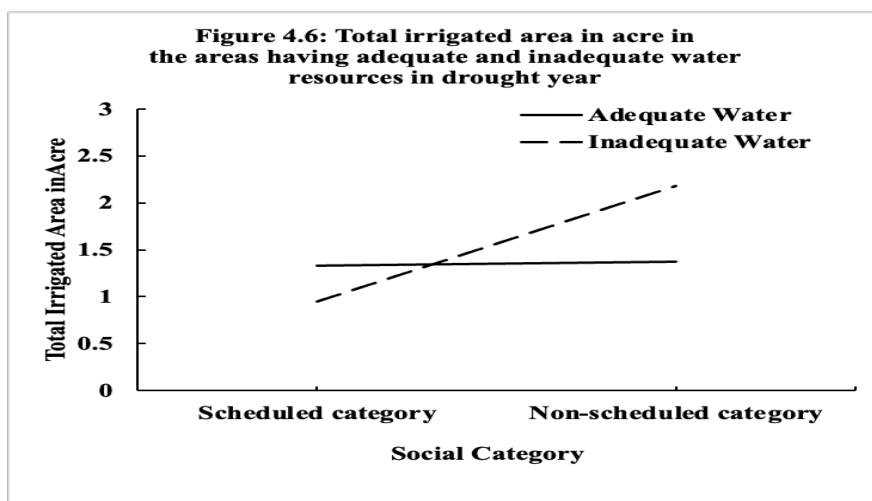
<i>Between-subjects</i>	SS	df	MS	F	P
Water resource (WR)	5.291	1	5.291	3.049	0.082
Social category (SC)	13.02	1	13.02	7.502	0.007
WR X SC	24.558	1	24.558	14.151	<.001
Error	492.864	284	1.735	-	-

Source: Author's calculation from primary survey

From Figure 4.6, it is observed that during a normal year, the farming areas of the scheduled and non-scheduled categories under AWR are almost equal. Moreover, the farmers of the non-scheduled category have a significantly higher amount of farming areas under IWR than the scheduled category.



Source: Author's calculation from primary survey



Source: Author's calculation from primary survey

4.4 Conditions of vulnerability in the context of Social category and Water Resources

The socio-economic conditions of vulnerability have been analysed in terms of social category and availability of water resources. Therefore, attributes such as livelihood, human capital, social capital etc., have been examined precisely by using mixed designed ANOVA to understand the dynamics of vulnerability in normal and drought years. People's socio-economic conditions vary from household to household depending upon the level of adaptation and availability of various resources.

4.4.1 Conditions of livestock Income

Livestock income is considered as one of the vital secondary sources of income for millions of rural poor in India. Livestock includes all the domesticated animals raised in agricultural settings for livelihood purposes. According to the World Bank report, around 4.11% of the GDP originates from the commitment to the domestic animal sector. Moreover, it holds 8.8 % of employment in India. Livestock sectors can be included cows, goats, sheep, poultry, fishery etc. The present study found that people in the studied area mostly engaged in livestock activities such as cows, goats, poultry etc. To understand the livestock income conditions of the sample respondent, the study classified the livestock income into two categories, i.e., income from livestock-based on social category and availability of water resources. From Table 4.7, it is observed that there is a significant difference in livestock income between the two categories of availability of water resources, $F(1,284) = 4.30$, $p = .039$. This indicates that the livestock income is significantly higher for farmers with access to AWR ($M = 19428.57$, $SD =$

28880.62) than farmers with IWR access ($M = 11701.42$, $SD = 19391.48$). The study found significant difference in livestock income between the two social categories, $F(1,284) = 0.45$, $p > .05$. This suggests that the livestock income is significantly higher in non-scheduled category ($M = 16881.58$, $SD = 19253.37$) compared to scheduled category ($M = 12650.94$, $SD = 23540.04$). However, the interaction between the availability of water resources X Social category is insignificant regarding livestock income, $F(1,284) = 0.26$, $p > .05$.

Table 4.7 Summary of 2 x 2 x 2 ANOVA done on conditions of livestock income

Between-subjects	SS	df	MS	F	P
Water resource (WR)	2150816167	1	2150816167	4.306	0.039
Social category (SC)	223359493	1	223359493	0.447	0.504
WR X SC	127681605	1	127681605	0.256	0.614
Error	1.4187E+11	284	499531881	-	-

Source: Author's calculation from primary survey

From Figure 4.7, it is observed that the annual livestock income of the scheduled and non-scheduled categories under AWR are almost equal. Moreover, the farmers of the non-scheduled category have significantly higher yearly livestock income under IWR than in the scheduled category.

4.4.2 Conditions of non-farm business income

Non-farm business plays a pivotal role in household economies in rural India. The income flow generally comes from the non-farm business sector, such as wage-paying activity, manufacturing and service units, and self-employment in commerce. The vulnerability in the non-farm business has been mapped in terms of social category, i.e., scheduled and non-scheduled category income and income based on water availability. From table 4.8, it is observed that there is no significant difference in income from non-farm businesses observed between the two categories of availability of water resources, $F(1,284) = 0.008$, $p > .05$. This indicates that the income from the non-farm business is not significantly higher for the farmers having access to AWR ($M = 3149.35$, $SD = 9353.11$) and farmers having no access to AWR ($M = 5182.46$, $SD = 38648.30$). In the case of the social category, there is no significant difference in income from the non-farm business between the two social categories, $F(1,284)$

= 0.40, $p > .05$. This suggests that income from non-farm business is not significantly higher in non-scheduled category ($M = 1644.74$, $SD = 5420.83$) compared to scheduled category ($M = 5712.26$, $SD = 38786.53$). The interaction between the availability of water resources X Social category is found to be insignificant in respect of income from the non-farm business, $F(1,284) = 0.27$, $p > .05$ (Table 4.8).

Table 4.8 Summary of 2 x 2 x 2 ANOVA done on conditions of non-farm business income

<i>Between-subjects</i>	SS	df	MS	F	P
Water resource (WR)	8463668.35	1	8463668.35	0.008	0.931
Social category (SC)	458701771	1	458701771	0.408	0.523
WR X SC	308367570	1	308367570	0.274	0.601
Error	3.1925E+11	284	1124114727	-	-

Source: Author's calculation from primary survey

From Figure 4.8, it is observed that the non-farm business annual income of scheduled and non-scheduled categories under AWR are more or less equal. Moreover, the farmers of the scheduled category have significantly higher non-farm business income under IWR than the non-scheduled category.

4.4.3 Conditions of Salary Income

The status of annual salary income revealed that very few sample respondents engaged in government departments such as schools, post offices, government engineers etc. From table 4.9, it is observed that there is no significant difference in income from salary between the two categories of availability of water resources, $F(1,284) = 1.48$, $p > .05$. This indicates that the income from salary is not significantly higher for the farmers having access to AWR ($M = 7012.99$, $SD = 45626.20$) and farmers having no access to AWR ($M = 10891.00$, $SD = 64775.45$). In the case of the social category, there is no significant difference in income from salary observed between the two social categories, $F(1,284) = 0.17$, $p > .05$. This suggests that income from salary is not significantly higher in non-scheduled category ($M = 14881.58$, $SD = 62650.56$) compared to scheduled category ($M = 8051.89$, $SD = 59348.77$). The interaction between the availability of water resources X Social category is found to be insignificant in respect of income from the non-farm business, $F(1,284) = 3.37$, $p > .05$ (Table 4.9).

From Figure 4.9, it is observed that the annual salary income of the scheduled category has significantly higher under AWR than in the non-scheduled category. Moreover, the farmers of the non-scheduled category have significantly higher salary income under IWR than in the scheduled category.

Table 4.9 Summary of 2 x 2 x 2 ANOVA done on conditions of salary income

<i>Between-subjects</i>	SS	df	MS	F	p
Water resource (WR)	5350215711	1	5350215711	1.484	0.224
Social category (SC)	610070646	1	610070646	0.169	0.681
WR X SC	1.2164E+10	1	1.2164E+10	3.375	0.067
Error	1.0237E+12	284	3604494067		

Source: Author's calculation from primary survey

4.4.4 Conditions of farm wage income

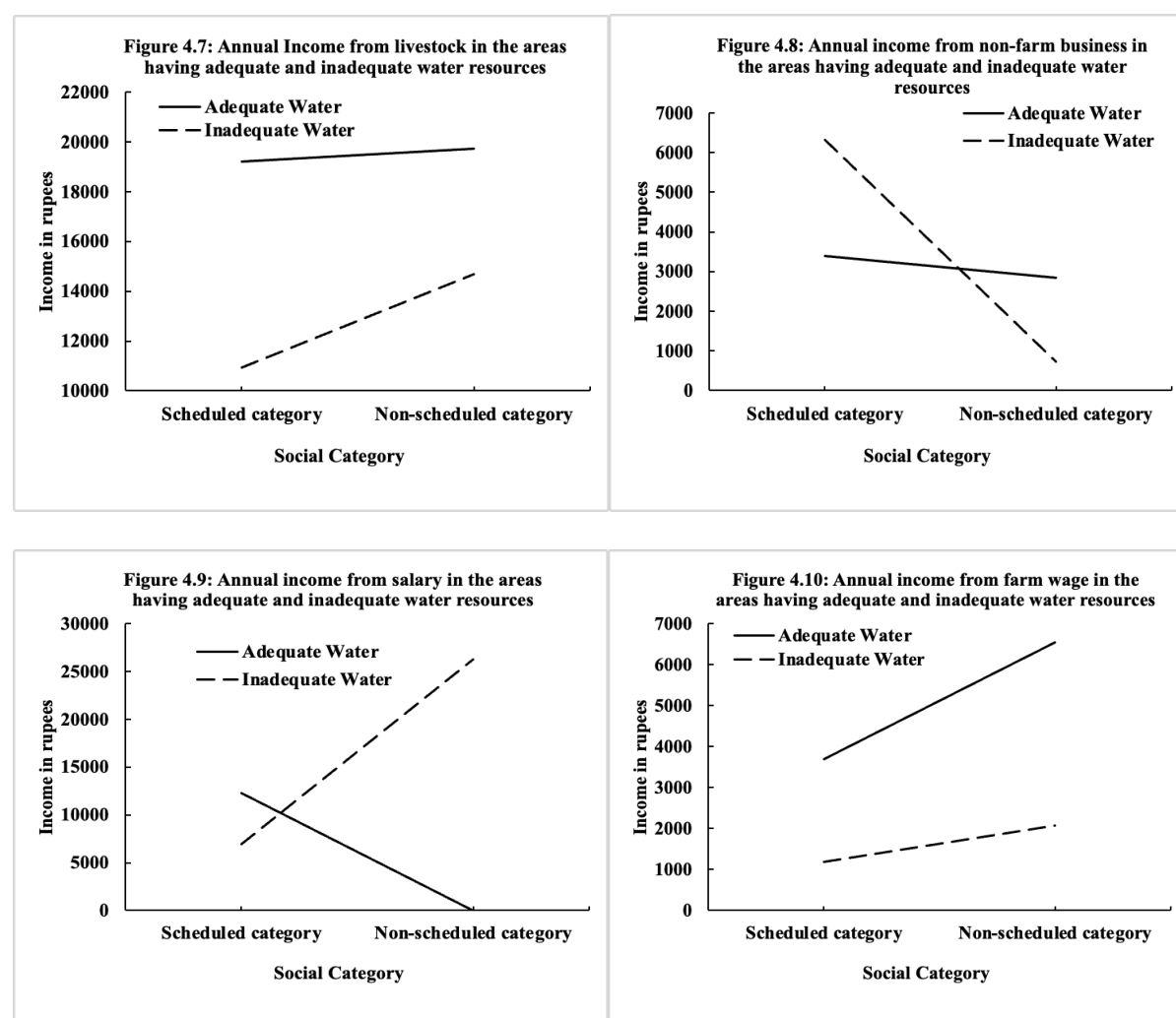
Farm wage income is an important aspect of livelihood for the small, marginal, landless poor and tenant farmers in rural India. In the context of our studied area, more than 50 % of the sample respondent are engaged in cotton and paddy fields, from sowing to harvesting crops. The study has mapped the vulnerability of farm wages in terms of income generated from the activities based on social category and availability of water resources. From Table 4.10, it is observed that there is a significant difference in farm wage observed between the two categories of availability of water resources, $F(1,284) = 53.56$, $p < .001$. This indicates that farm wage is significantly higher for farmers with access to AWR ($M = 4922.08$, $SD = 4906.40$) and farmers with no access to AWR ($M = 1364.93$, $SD = 2676.97$). In the case of social category, there is a significant difference in farm wage observed between two social categories, $F(1,284) = 15.19$, $p < .001$. This suggests that farm wage is significantly higher in non-scheduled category ($M = 4013.16$, $SD = 5087.22$) compared to scheduled category ($M = 1707.55$, $SD = 2928.75$). The interaction between the availability of water resources X Social category is significant regarding farm wage, $F(1,284) = 4.19$, $p = .042$.

Table 4.10 Summary of 2 x 2 x 2 ANOVA done on conditions of farm wage income

<i>Between-subjects</i>	SS	Df	MS	F	P
Water resource (WR)	595097699	1	595097699	53.561	<.001
Social category (SC)	168828644	1	168828644	15.195	<.001
WR X SC	46506532.6	1	46506532.6	4.186	0.042
Error	3155411369	284	11110603.4	-	-

Source: Author's calculation from primary survey

From Figure 4.10, it is observed that the annual farm wage income of the non-scheduled category has significantly higher under AWR than in the scheduled category. Moreover, the scheduled category farmers also have lower farm wage income under IWR than the non-scheduled category.



Source: Author's calculation from primary survey

4.4.5 Conditions of non-farm wage

Although non-farm wages in rural areas have declined drastically, people from lower socio-economic strata have no choice but to engage in non-farm wage activities. These activities can be included wage paid labour in house construction, road construction, MGNREGA work, sanitation work etc. based on their income, the vulnerability level has been defined. From table 4.11, it is observed that there is no significant difference in non-farm wage between the two categories of availability of water resources, $F(1,284) = 0.09, p > .05$. This indicates that the income from the non-farm business is not significantly higher for the farmers having access to AWR ($M = 376.62, SD = 1026.47$) and farmers having no access to AWR ($M = 369.67, SD = 1021.59$). In the case of social category, the study found no significant difference in non-farm wages between the two social categories, $F(1,284) = 0.73, p > .05$. This suggests that non-farm wage is not significantly higher in non-scheduled category ($M = 328.95, SD = 998.51$) compared to scheduled category ($M = 386.79, SD = 1030.99$). The interaction between the availability of water resources X Social category is insignificant with respect to income from the non-farm business, $F(1,284) = 2.16, p > .05$.

Table 4.11 Summary of 2 x 2 x 2 ANOVA done on conditions of non-farm wage income

<i>Between-subjects</i>	SS	df	MS	F	p
Water resource (WR)	95250.052	1	95250.052	0.091	0.763
Social category (SC)	761439.104	1	761439.104	0.729	0.394
WR X SC	2264882.1	1	2264882.1	2.167	0.142
Error	296770777	284	1044967.52	-	-

Source: Author's calculation from primary survey

From Figure 4.11, it is observed that the annual non-farm wage income of the scheduled category has significantly higher under AWR than in the non-scheduled category. Moreover, the expected category farmers also have relatively lower non-farm wage income under IWR than the non-scheduled category.

4.4.6 Conditions of agricultural income

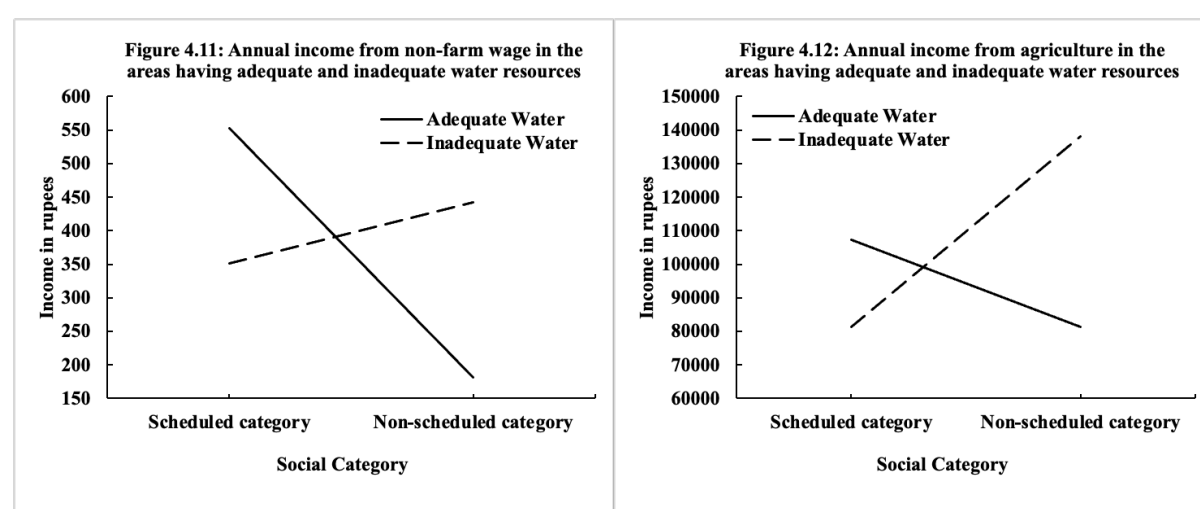
Paddy and cotton are the dominant crops in western Odisha districts, especially Balangir. The revenue generated from agriculture generally varies from farmer to farmer based on their

accessibility and availability of different capitals. From table 4.12, it is observed that there is no significant difference in agricultural income between the two categories of availability of water resources, $F(1,284) = 2.98, p > .05$. This indicates that income from agriculture is more or less equal for the farmers having access to AWR ($M = 99579.22, SD = 56555.07$) and farmers having no access to AWR ($M = 95028.27, SD = 75041.86$). In the case of social category, the study revealed a significant difference in agricultural income between two social categories, $F(1,284) = 6.42, p = .012$. This suggests that farm wage is significantly higher in non-scheduled category ($M = 122542.76, SD = 94012.18$) compared to scheduled category ($M = 86817.52, SD = 57290.70$). The interaction between the availability of water resources X Social category is found to be significant in respect of income from agriculture, $F(1,284) = 19.62, p < .001$ (Table 4.12).

Table 4.12 Summary of 2 x 2 x 2 ANOVA done on conditions of agricultural income

<i>Between-subjects</i>	SS	df	MS	F	p
Water resource (WR)	13243308779	1	1.3243E+10	2.968	0.086
Social category (SC)	28642603974	1	2.8643E+10	6.419	0.012
WR X SC	87545287272	1	8.7545E+10	19.621	<.001
Error	1.26716E+12	284	4461814304	-	-

Source: Author's calculation from primary survey



Source: Author's calculation from primary survey

From Figure 4.12, it is observed that the annual agricultural income of the scheduled category has significantly higher under AWR than in the non-scheduled category. Moreover, the farmers of the scheduled category have significantly lower agricultural income under IWR than the non-scheduled category.

4.5 Conditions of human capital in the context of Social Category and Water Resources

In Human Development Index (HDI), human capital plays a significant role in eradicating poverty. It consists of knowledge, idea, skill and capability to enhance people's livelihood. Human capital development depends on the standard of living based on food, health, education, living conditions, etc. The present status of gender-based education, health and ability to work is appraised to pursue different livelihood patterns and achieve their objectives. The levels of health, education and skills and knowledge play prominent roles in determining the choice of livelihoods and improving the drawability of benefits. The current focus of the analysis suggests that the sample respondents possessed different forms of human capital such as food, cooking fuel, and clothing.

4.5.1 Conditions of food consumption pattern

Food is an essential aspect of human capital in terms of nutritional support for humans. People living under different socio-economic conditions have different kinds of food patterns. The present study has elucidated the nature of food patterns based on social category and availability of water resources. The present study revealed the impact of drought vulnerability on food consumption patterns during normal and drought years. The impact has enhanced multiple food adjustment practices among the farm households in the studied area. It is evident from Table 4.13 that there is a significant difference in expenditure on food between the normal and drought year, $F(1,284) = 2136.98, p < .001$. This indicates that the expenditure on food is significantly higher in the normal year ($M = 16542.96, SD = 239.52$) compared to the drought year ($M = 13512.36, SD = 202.60$). The interaction between Period X Social category is significant in respect of expenditure on food, $F(1,284) = 15.47, p < .001$.

From Figure 4.13, it is observed that the annual food expenditure in the normal year under the scheduled category is significantly higher than drought year. Moreover, the food expenditure in the normal year under the non-scheduled category is also considerably higher than in the

drought year. The interaction between Period X Availability of water resources is significant in respect of the expenditure on food, $F(1,284) = 15.22, p < .001$.

Table 4.13 Summary of 2 x 2 x 2 ANOVA done on conditions of food consumption pattern

Source	SS	Df	MS	F	P
<i>Between-subjects</i>					
Water resource (WR)	22215399.5	1	22215399.5	1.186	0.277
Social category (SC)	20513938.2	1	20513938.2	1.095	0.296
WR X SC	13469964.5	1	13469964.5	0.719	0.397
Error	5319399157	284	18730278.7		
<i>Within-subjects</i>					
Period	893452541	1	893452541	2136.981	<.001
Period X WR	6364487.62	1	6364487.62	15.223	<.001
Period X SC	6468110.67	1	6468110.67	15.471	<.001
Period X WR X SC	6962748.83	1	6962748.83	16.654	<.001
Error	118737832	284	418090.956	-	-

Source: Author's calculation from primary survey

From Figure 4.14, it is observed that the annual food expenditure in a normal year under AWR is significantly higher than drought year. Moreover, the food expenditure in a normal year under IWR is also significantly higher than drought year. The interaction between Period X Availability of water resources X Social category is also significant in respect of the expenditure on food, $F(1,284) = 16.65, p < .001$. However, the difference in expenditure on food between the two social categories was insignificant, $F(1,284) = 1.09, p = .29$. This suggests that the expenditure on food is significantly higher in non-scheduled category ($M = 15257.27, SD = 354.11$) compared to scheduled category ($M = 14798.05, SD = 259.12$). There is no significant difference in the expenditure on food between the two categories of availability of water resources. This indicates that the expenditure on food is more or less equal for the farmers having access to AWR ($M = 14788.72, SD = 352.36$) and farmers having no access to AWR ($M = 15266.60, SD = 261.50$). However, the interaction between the availability of water

resources X Social category is insignificant in respect of expenditure on food, $F(1,284) = .719$, $p > .397$.

From Figure 4.15, it is observed that the annual food expenditure in the area having adequate and IWR under the scheduled category are more or less equal. Moreover, the food expenditure in the area having IWR under the non-scheduled category is significantly higher compared to the scheduled category

4.5.2 Conditions of cooking fuel uses

Under the Pradhan Mantri Ujjwala Yojana (PMUY), India has witnessed a massive chain of LPG connections among the Below Poverty Line (BPL) category population. In Odisha, also lakhs of BPL families are the beneficiary of the scheme. The studied area is estimated to be the maximum number of beneficiaries from Ujjwala Yojana from the BPL category. The uses of LPG connections mainly vary from household to household during normal and drought years. During normal years, most of the household was found to be using LPG connection, whereas, during drought years, the sample household has reduced its uses and is partially dependent on the jungle wood. Therefore Table 4.14 revealed a significant difference in expenditure on cooking fuel between the normal year and drought year, $F(1,284) = 2455.24$, $p < .001$. This indicates that the expenditure on cooking fuel is significantly higher in the normal year ($M = 3492.09$, $SD = 90.21$) than in the drought year ($M = 2104.68$, $SD = 103.33$). The interaction between Period X Availability of water resources is significant in respect of expenditure on cooking fuel, $F(1,284) = 15.41$, $p < .001$.

From Figure 4.16, it is observed that the annual cooking fuel expenditure in the normal year under the scheduled category is significantly higher than in the drought year. Moreover, the cooking fuel expenditure in the normal year under the non-scheduled category is also significantly higher than in the drought year. The interaction between Period X Social category is significant in respect to the expenditure on cooking fuel, $F(1,284) = 15.41$, $p < .001$.

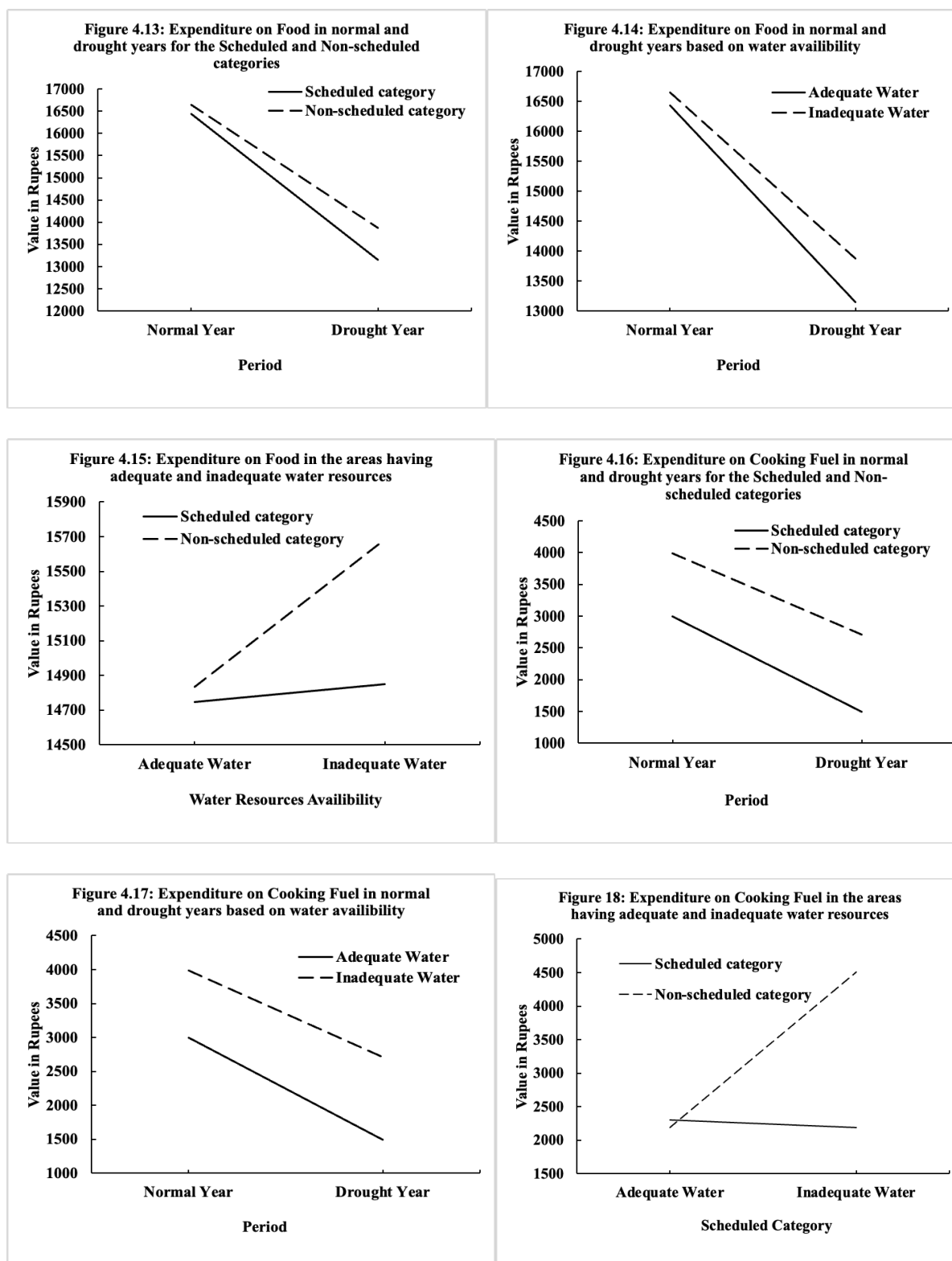
From Figure 4.17, it is observed that the annual cooking fuel expenditure in a normal year under AWR is significantly higher than drought year. Moreover, cooking fuel expenditure in the normal year under IWR is also considerably higher than in drought.

Table 4.14 Summary of 2 x 2 x 2 ANOVA done on conditions of cooking fuel uses

Source	SS	df	MS	F	P
<i>Between-subjects</i>					
Water resource (WR)	118733900	1	118733900	33.123	<.001
Social category (SC)	118733900	1	118733900	33.123	<.001
WR X SC	144025162	1	144025162	40.178	<.001
Error	1018044365	284	3584663.26		
<i>Within-subjects</i>					
Period	187252423	1	187252423	2455.241	<.001
Period X WR	1175241.04	1	1175241.04	15.41	<.001
Period X SC	1175241.04	1	1175241.04	15.41	<.001
Period X WR X SC	512520.569	1	512520.569	6.72	0.01
Error	21659659.9	284	76266.408	-	-

Source: Author's calculation from primary survey

On the contrary, the interaction between Period X Availability of water resources X Social category is insignificant with respect to the expenditure on cooking fuel, $F(1,284) = 6.72, p \geq .010$. Moreover, a significant difference in expenditure on cooking fuel between two social categories, $F(1,284) = 33.12, p < .001$. This suggests that the expenditure on cooking fuel is significantly higher in scheduled category ($M = 5.20, SD = .33$) compared to non-scheduled category ($M = 2.95, SD = .46$). There is also a significant difference in expenditure on cooking fuel between the two categories of availability of water resources. This indicates that the expenditure on cooking fuel is more for both the categories, i.e., farmers having no access to AWR ($M = 3350.78, SD = 114.40$) and farmers having access to AWR ($M = 2256, SD = 154.14$). Moreover, the interaction between the availability of water resources X Social category is significant in respect of expenditure on cooking fuel, $F(1,284) = 40.17, p < .001$.



Source: Author's calculation from primary survey

From Figure 4.18, it is observed that the annual cooking fuel expenditure in the area having adequate and IWR under the scheduled category are more or less equal. Moreover, the cooking

fuel expenditure in the area having IWR under the non-scheduled category is significantly higher than in the area having AWR.

4.5.3 Conditions of clothing expenditure

Clothing is considered one of the basic needs of the human being. Wearing new dresses and attire is a cultural practice among the Indians. It is a saying in the Odia language, "*Bara masa re tera parba*" It means there are 13 festivals in 12 months in Odisha. Due to its rich cultural practice, people used to wear new dresses in all the festive seasons.

Moreover, there are different types of festivals within the state among diverse communities residing in different geographical settings. In Balngir, festivals such as Nuakhai, Bhai Jintia, Pua Jintia, and Laxmi Puja are famous. It attracts lakhs of people to participate in the cultural events with new attires. However, it is interesting to explore how the drought situation in the region has impacted their cultural practice of wearing new dresses during festivals. Table 4.15 revealed a significant difference in expenditure on clothing between the normal year and drought year, $F(1,284) = 2357.90, p < .001$. This indicates that the expenditure on clothing is significantly higher in the normal year ($M = 2719.39, SD = 39.37$) than in the drought year ($M = 1717.79, SD = 29.16$). The interaction between Period X Availability of water resources is significant in respect of annual expenditure on clothing, $F(1,284) = 14.61, p < .001$.

From Figure 4.19, it is observed that the annual expenditure on clothing in the normal year under the scheduled category is significantly higher than in the drought year. Moreover, expenditure on clothing in the normal year under the non-scheduled category is also significantly higher than in the drought year. The interaction between Period X Social category is significant in respect to the expenditure on clothing, $F(1,284) = 14.87, p < .001$.

From Figure 4.20, it is observed that the annual expenditure on clothing in the normal year under AWR is significantly higher than in the drought year. Moreover, expenditure on clothing in the normal year under IWR is also significantly higher than in drought year. The interaction between Period X Availability of water resources X Social category is significant in respect of the annual expenditure on clothing, $F(1,284) = 16.08, p \leq .001$. On contrary, insignificant difference of annual expenditure on clothing between two social categories, $F(1,284) = 2.90, p \geq .090$ suggesting that the annual expenditure on clothing somewhat low in scheduled category ($M = 2162.27, SD = 39.06$) compared to non-scheduled category ($M = 2274.91, SD = 53.38$). A similar pattern of annual expenditure on clothing between the two categories of availability

of water resources. This indicates that the annual expenditure on clothing is more or less equal for the farmers having access to AWR ($M = 2160.90$, $SD = 53.12$) and farmers having no access to AWR ($M = 2276.27$, $SD = 39.42$). However, the interaction between the availability of water resources X Social category is insignificant with respect to annual expenditure on clothing, $F(1,284) = 2.28$, $p \geq .132$.

From Figure 4.21, it is observed that the annual expenditure on clothing in the area having adequate and IWR under the scheduled category are more or less equal. Moreover, the expenditure on clothing in the area having IWR under the non-scheduled category is significantly higher than in the area having AWR.

Table 4.15 Summary of 2 x 2 x 2 ANOVA done on conditions of clothing expenditure

Source	SS	df	MS	F	P
<i>Between-subjects</i>					
Water resource (WR)	1294793.3	1	1294793.3	3.042	0.082
Social category (SC)	1234300.68	1	1234300.68	2.9	0.09
WR X SC	971135.814	1	971135.814	2.281	0.132
Error	120892328	284	425677.212		
<i>Within-subjects</i>					
Period	97588323.5	1	97588323.5	2357.905	<.001
Period X WR	604977.618	1	604977.618	14.617	<.001
Period X SC	615483.899	1	615483.899	14.871	<.001
Period X WR X SC	665709.086	1	665709.086	16.085	<.001
Error	11754113.5	284	41387.724	-	-

Source: Author's calculation from primary survey

4.5.4 Conditions of health expenditure

Health is one of the essential aspects of human capital. Generally, the expenditure on health has become a burden for the rural poor due to poor socio-economic conditions. The study found that the expenditure on health has increased substantially during the prolonged drought years compared to a normal year. The drought vulnerability has intensified various chronic diseases among the ageing population in the studied area. Moreover, it causes multiple health-related issues such as malnutrition, hypertension, sugar, blood pressure etc., among the rural poor. Therefore, the expenditure costs for health have increased during drought years and post-

drought situations. It is evident from Table 4.16 that there is an insignificant difference in annual expenditure on health between the normal year and drought year, $F(1,284) = 1.91, p \geq .168$. This indicates that the annual expenditure on health is somewhat lower in the normal year ($M = 1875.74, SD = 45.37$) than in the drought year ($M = 1889.70, SD = 46.93$). The interaction between Period X Availability of water resources is insignificant in respect of annual expenditure on health, $F(1,284) = 1.91, p \geq .168$.

From Figure 4.22, it is observed that the annual expenditure on health in the normal year under the scheduled category is more or less equal. Moreover, expenditure on health in the normal year under the non-scheduled category is higher in drought than in a normal year. The interaction between Period X Social category is insignificant with respect to the annual expenditure on health, $F(1,284) = 1.91, p \geq .168$.

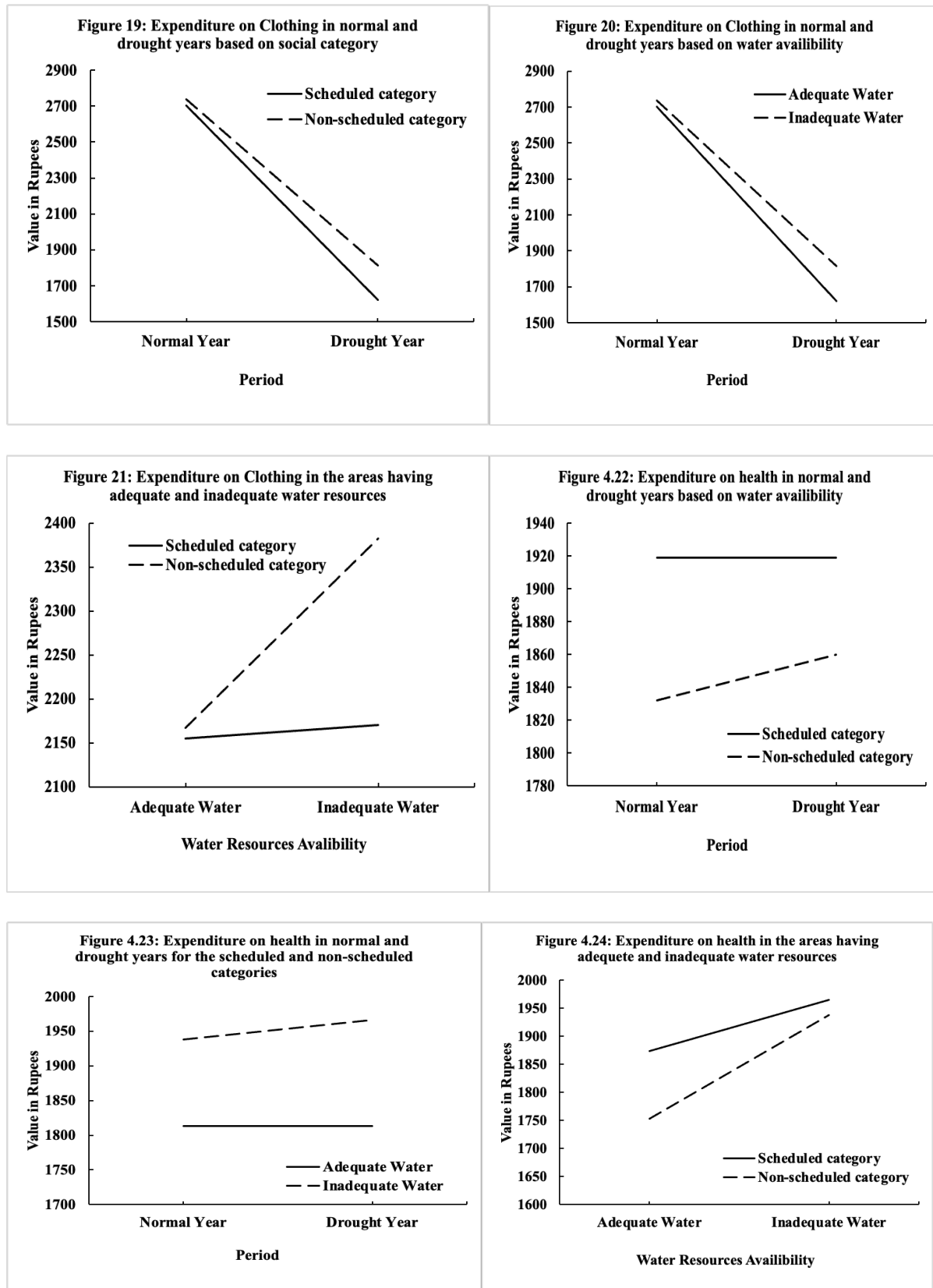
Table 4.16 Summary of 2 x 2 x 2 ANOVA done on conditions of health expenditure

Source	SS	df	MS	F	P
<i>Between-subjects</i>					
Water resource (WR)	1881825.3	1	1881825.3	2.297	0.131
Social category (SC)	521055.444	1	521055.444	0.636	0.426
WR X SC	221539.851	1	221539.851	0.27	0.603
Error	232690927	284	819334.249		
<i>Within-subjects</i>					
Period	18940.019	1	18940.019	1.912	0.168
Period X WR	18940.019	1	18940.019	1.912	0.168
Period X SC	18940.019	1	18940.019	1.912	0.168
Period X WR X SC	18940.019	1	18940.019	1.912	0.168
Error	2813023.26	284	9905.011	-	-

Source: Author's calculation from primary survey

From Figure 4.23, it is observed that the annual expenditure on health in normal and drought year under AWR is equal. Moreover, expenditure on health in drought year under IWR is higher than in the normal year. On the contrary, the interaction between Period X Availability

of water resources X Social category is insignificant in respect of the annual expenditure on health, $F(1,284) = 11.91, p \geq .168$.



Source: Author's calculation from primary survey

Moreover, there is an insignificant difference in annual expenditure on health between the two social categories, $F(1,284) = .63, p \geq .426$. This suggests that the annual expenditure on health is somewhat higher in scheduled category ($M = 1919.31, SD = 54.19$) compared to non-scheduled category ($M = 1846.13, SD = 74.06$). There is also an insignificant difference in annual expenditure on health between the two categories of availability of water resources. This indicates that the annual expenditure on health is slightly lower for the farmers having access to AWR ($M = 1813.18, SD = 73.69$) and farmers having no access to AWR ($M = 1952.26, SD = 54.69$). Moreover, the interaction between the availability of water resources X Social category is found to be insignificant in respect of annual expenditure on health, $F(1,284) = .27, p \geq .603$.

From Figure 4.24, it is observed that the annual expenditure on health in the area having IWR under the scheduled category is significantly higher than in the area having AWR. Moreover, the expenditure on health in the area having IWR under the non-scheduled category is also considerably higher than in the area having AWR.

4.5.5 Conditions of education expenditure

Education is also one of the human capital in terms of skill and human development index. The drought vulnerability has significantly impacted education at the primary level. The study found that the expenditure on the education segment has been substantially decreased due to the poor economic conditions of the sample respondents. People having poor socio-economic conditions have forced their children to engage in different household activities to sustain their livelihood. Therefore, the school drop-out rate has increased among these sections. Table 4.17 revealed a significant difference in annual expenditure on education between the normal year and drought year, $F(1,284) = 58.74, p < .001$. This indicates that the annual expenditure on education is significantly higher in the normal year ($M = 1394.93, SD = 164.06$) than in the drought year ($M = 774.21, SD = 87.39$). The interaction between Period X Availability of water resources is found to be insignificant in respect of annual expenditure on education, $F(1,284) = .76, p \geq .383$.

From Figure 4.25, it is observed that the annual expenditure on education in the normal year under the scheduled category is significantly higher than in the drought year. Moreover, the expenditure on education in the normal year under the non-scheduled category is also higher

than the normal year in the drought year. However, the comparison between the two social categories revealed that scheduled category people are more vulnerable than non-scheduled category. The interaction between Period X Social category is found to be significant in respect of the annual expenditure on education, $F(1,284) = 8.03, p \leq .005$

From Figure 4.26, it is observed that the annual expenditure on education in the normal year under AWR is significantly higher than in the drought year. Moreover, the expenditure on education in the normal year under IWR is higher than in the drought year. On the contrary, the interaction between Period X Availability of water resources X Social category is insignificant in respect of the annual expenditure on education, $F(1,284) = .28, p \geq .594$.

Moreover, a significant difference in annual expenditure on education is observed between two social categories, $F(1,284) = 2.33, p \geq .128$. This suggests that the annual expenditure on education is significantly higher in scheduled category ($M = 1275.48, SD = 147.69$) compared to non-scheduled category ($M = 893.65, SD = 201.83$). There is also a significant difference in annual expenditure on education between the two categories of availability of water resources. This indicates that the annual expenditure on education is more or less equal for the farmers having access to AWR ($M = 825, SD = 200.83$) and farmers having no access to AWR ($M = 1344.14, SD = 149.04$). However, the interaction between the availability of water resources X Social category is insignificant regarding annual expenditure on education, $F(1,284) = .50, p \leq .479$.

Table 4.17 Summary of 2 x 2 x 2 ANOVA done on conditions of education expenditure

Source	SS	df	MS	F	P
<i>Between-subjects</i>					
Water resource (WR)	26217505.2	1	26217505.2	4.309	0.039
Social category (SC)	14182532.7	1	14182532.7	2.331	0.128
WR X SC	3056632.13	1	3056632.13	0.502	0.479
Error	1728046835	284	6084671.95		
<i>Within-subjects</i>					
Period	37480892.3	1	37480892.3	58.74	<.001
Period X WR	486554.113	1	486554.113	0.763	0.383
Period X SC	5128217.88	1	5128217.88	8.037	0.005
Period X WR X SC	181867.461	1	181867.461	0.285	0.594
Error	181214506	284	638079.247	-	-

Source: Author's calculation from primary survey

From Figure 4.27, it is observed that the annual expenditure on education in the area having IWR under the scheduled category is higher than in the area having AWR. Moreover, the expenditure on education in the area having IWR under the non-scheduled category is significantly higher than in the area having AWR.

4.5.6 Conditions of total Human Capital Estimation

The human capital in the present study has precisely focused on food consumption, cooking fuel, health, education, clothing etc. To understand the level of vulnerability in human capital, the study has estimated the exposure in terms of social category and availability of water resources in the study area. After analysing specific human capital, the study has assessed the overall vulnerability picture in human capital. The study found that there is a significant difference in expenditure on human capital between the normal year and drought year (Table 4.18), $F(1,284) = 1529.71, p < .001$. This indicates that the expenditure on human capital is significantly higher in the normal year ($M = 26025.13, SD = 450.25$) compared to the drought year ($M = 19998.75, SD = 376.65$). The interaction between Period X Availability of water resources is insignificant with respect to the expenditure on human capital, $F(1,284) = 6.33, p \geq .012$.

From Figure 4.28, it is observed that the annual expenditure on total human capital in the normal year under the scheduled category is significantly higher than drought year. Moreover, the expenditure on human capital in the normal year under the non-scheduled category is also higher than the normal year in the drought year. The interaction between Period X Social category is significant in respect of the expenditure on human capital, $F(1,284) = 20.14, p < .001$.

From Figure 4.29, it is observed that the annual expenditure on total human capital in a normal year under AWR is significantly higher than drought year. Moreover, the expenditure on total human capital in the normal year under IWR is significantly higher than in the drought year. The interaction between Period X Availability of water resources X Social category is also significant in respect of expenditure on human capital, $F(1,284) = 9.70, p < .002$. Moreover, there is no significant difference in expenditure on human capital between the two social categories, $F(1,284) = 2.24, p \geq .135$. This suggests that the expenditure on human capital is significantly higher in non-scheduled category ($M = 23672.75, SD = 658.31$) compared to scheduled category ($M = 22401.12, SD = 481.73$). There is also a significant difference in

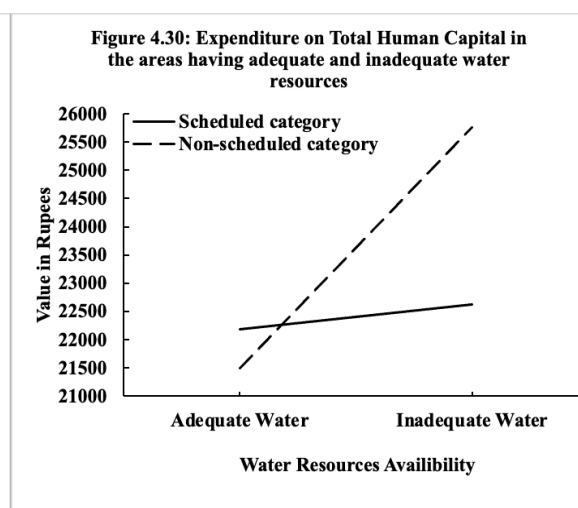
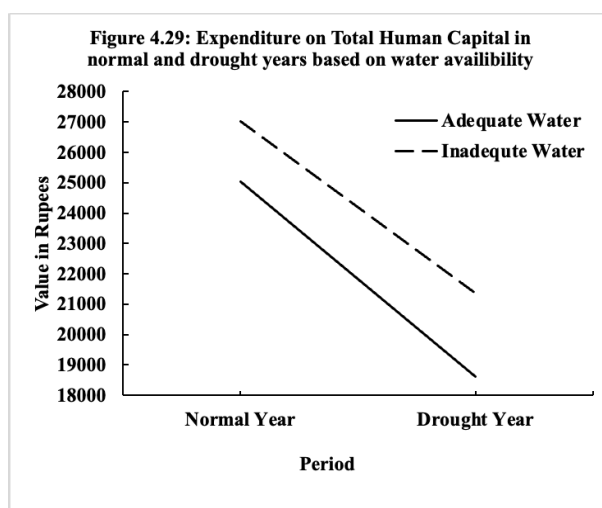
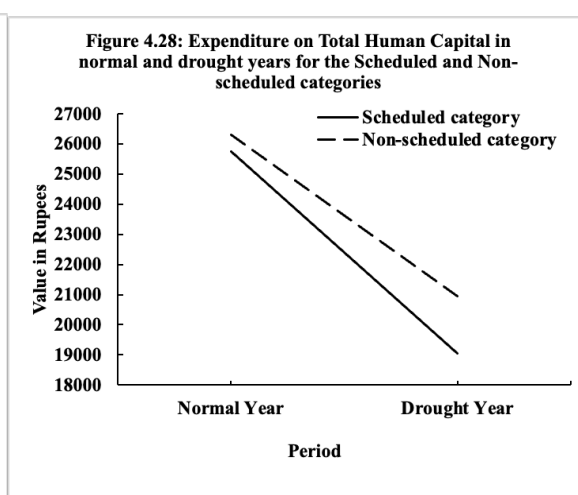
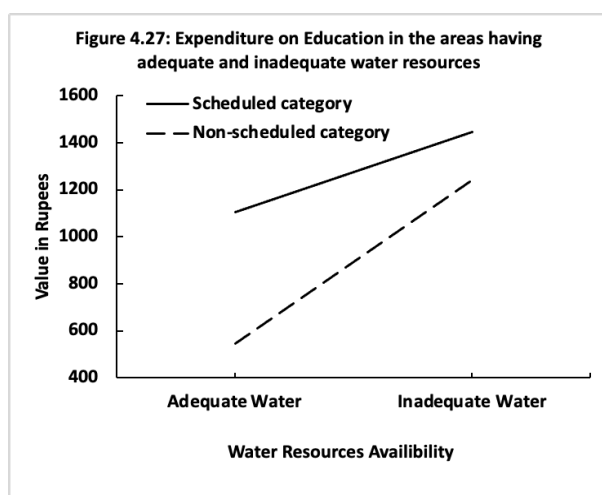
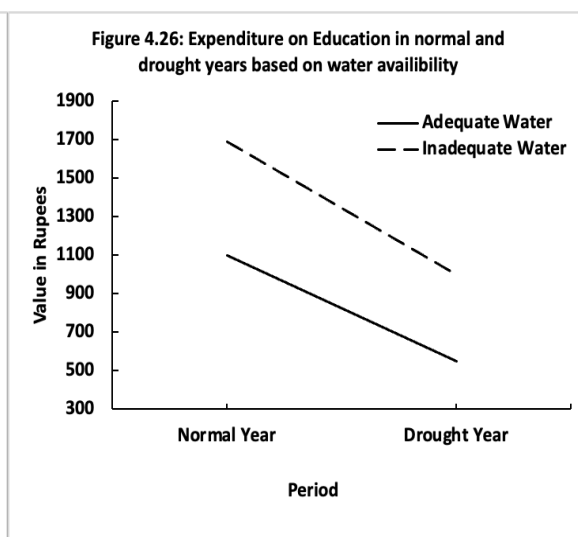
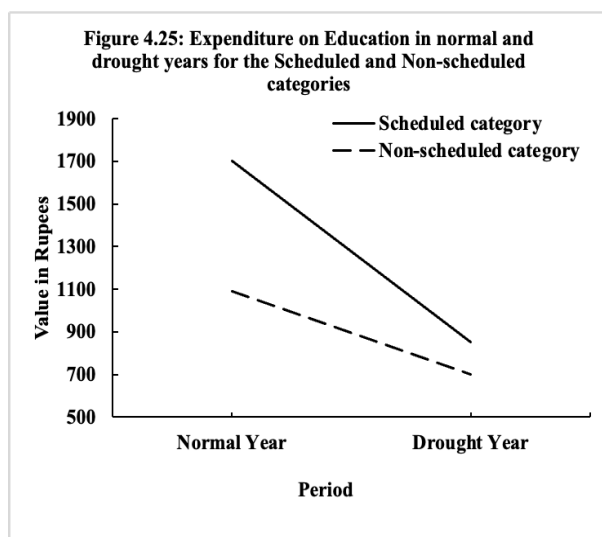
expenditure on human capital between the two categories of availability of water resources. This indicates that the expenditure on human capital is significantly higher for the farmers having no access to AWR ($M = 24190.07$, $SD = 486.15$) and farmers having access to AWR ($M = 21933.80$, $SD = 655.06$). However, the interaction between the availability of water resources X Social category is insignificant in respect of expenditure on human capital, $F(1,284) = 5.50$, $p \geq .020$.

From Figure 4.30, it is observed that the annual expenditure on total human capital in the area having IWR under the scheduled category is more or less equal. Moreover, the expenditure on total human capital in the area having IWR under the non-scheduled category is significantly higher than in the area having AWR.

Table 4.18 Summary of 2 x 2 x 2 ANOVA done on conditions of total human capital estimation

Source	SS	df	MS	F	P
<i>Between-subjects</i>					
Water resource (WR)	540089212.1	1	540089212	8.343	0.004
Social category (SC)	145176447.2	1	145176447	2.243	0.135
WR X SC	356290483.9	1	356290484	5.504	0.02
Error	18384291770	284	64733421.7		
<i>Within-subjects</i>					
Period	3532866185	1	3532866185	1529.715	<.001
Period X WR	14628869.11	1	14628869.1	6.334	0.012
Period X SC	46431152.67	1	46431152.7	20.104	<.001
Period X WR X SC	22416432.03	1	22416432	9.706	0.002
Error	655896191.4	284	2309493.63		

Source: Author's calculation from primary survey



Source: Author's calculation from primary survey

4.6 Impact of climate change vulnerability on agriculture in the study area

Agriculture is the primary source of income for most of the sample population in the study area. Paddy and cotton are the dominant crops, followed by pulses, other cereals, vegetables etc. The farm households in the study area have experienced the impact of climate change-induced drought on significant crop production such as paddy and cotton. The production of paddy and cotton shows a declining trend during the drought year compared to a normal year. The impact also varies based on the availability of water resources and social category. A 2 x 2 Mixed-design ANOVA last factor repeated statistics are computed to examine the pattern of agricultural production during the normal and drought year in the study area.

4.6.1 Paddy production in the study area in respect of social category and water availability

Paddy is one of the principal crops in Odisha in terms of production and consumption. There are three types of rice seasons seen in Odisha, i.e., winter rice, autumn rice and summer rice. It takes 90 to 150 days to harvest the paddy crops, depending on the types of rice and climatic factors. In Balangir, too, people used to cultivate rice and consume it as a staple food. Moreover, tribal people in Balangir prepared local alcohol out of the water rice called 'Handia'. The paddy cultivation has been highly impacted due to the grave consequences of climate change-induced drought in the study area. The vulnerability has been clearly defined in terms of social category and availability of water resources. The study found that there is a significant difference in the production of paddy between the normal year and drought year (Table 4.19), $F(1,284) = 268.92, p < .001$. This indicates that the production of paddy is significantly higher in the normal year ($M = 40.82, SD = 2.13$) compared to the drought year ($M = 16.67, SD = 1.03$). The interaction between Period X Availability of water resources is significant with respect to paddy production, $F(1,284) = 54.18, p < .001$.

From Figure 31, it is evident that in a normal year, the production of paddy is significantly higher in the areas having IWR compared to the areas having AWR. In a drought year, however, an opposite trend was noticed, where paddy production was significantly lower in the areas with IWR than in the areas with AWR. The interaction between Period X Social category is significant in respect to the production of paddy, $F(1,284) = 29.67, p < .001$.

From Figure 32, it is observed that in normal year, the production of paddy is significantly higher in the case of the farmers belonging to the non-scheduled category than farmers belonging to the scheduled category. In a drought year, however, paddy production was

significantly lower in a similar form for the farmers belonging to the non-scheduled and scheduled categories.

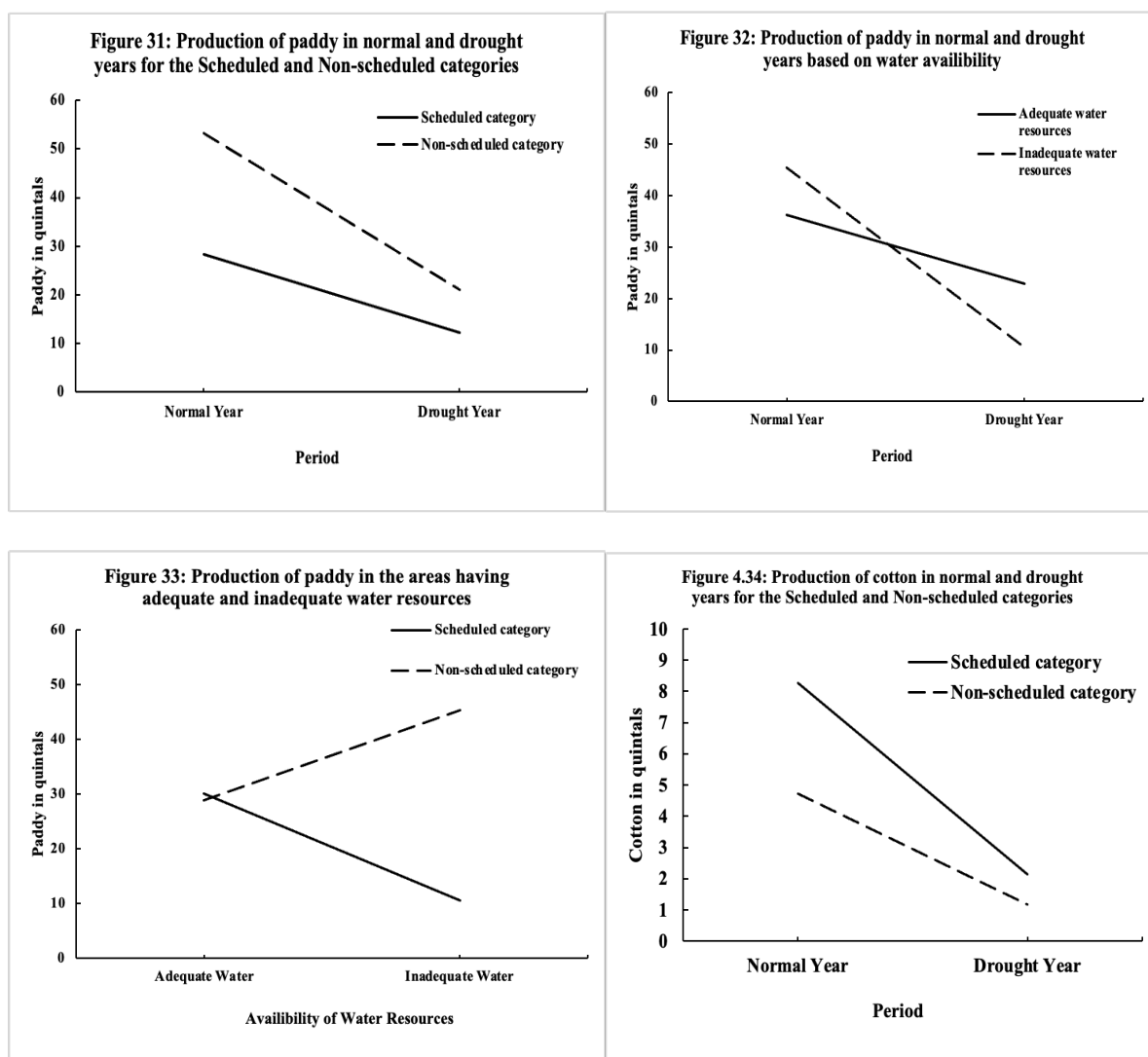
Moreover, a significant difference in the production of paddy is observed between two social categories, $F(1,284) = 31.28, p < .001$. This suggests that the production of paddy is significantly higher in non-scheduled category ($M = 37.14, SD = 2.42$) compared to scheduled category ($M = 20.35, SD = 1.77$). There is no significant difference in paddy production between the two categories of availability of water resources. This indicates that paddy production is more or less equal for the farmers having access to AWR ($M = 29.51, SD = 2.41$) and farmers having no access to AWR ($M = 27.97, SD = 1.78$). However, the interaction between the availability of water resources X Social category is significant with respect to paddy production, $F(1,284) = 35.51, p < .001$.

From Figure 33, it is observed that in areas with AWR, paddy production is equal for the farmers belonging to the scheduled and non-scheduled categories. In the areas with IWR, however, paddy production was significantly higher in the case of the farmers belonging to the non-scheduled category than farmers belonging to the scheduled category.

Table 4.19 Summary of 2 x 2 x 2 ANOVA done on paddy production based on water resources and social category

Source	SS	df	MS	F	P
<i>Between-subjects</i>					
Water resource (WR)	232.205	1	232.205	0.265	0.607
Social category (SC)	27425.594	1	27425.594	31.283	<.001
WR X SC	31131.448	1	31131.448	35.51	<.001
Error	248984.027	284	876.704		
<i>Within-subjects</i>					
Period	56739.984	1	56739.984	268.918	<.001
Period X WR	11431.789	1	11431.789	54.181	<.001
Period X SC	6261.017	1	6261.017	29.674	
Period X WR X SC	3431.47	1	3431.47	16.263	<.001
Error	59922.182	284	210.994	-	-

Source: Author's calculation from primary survey



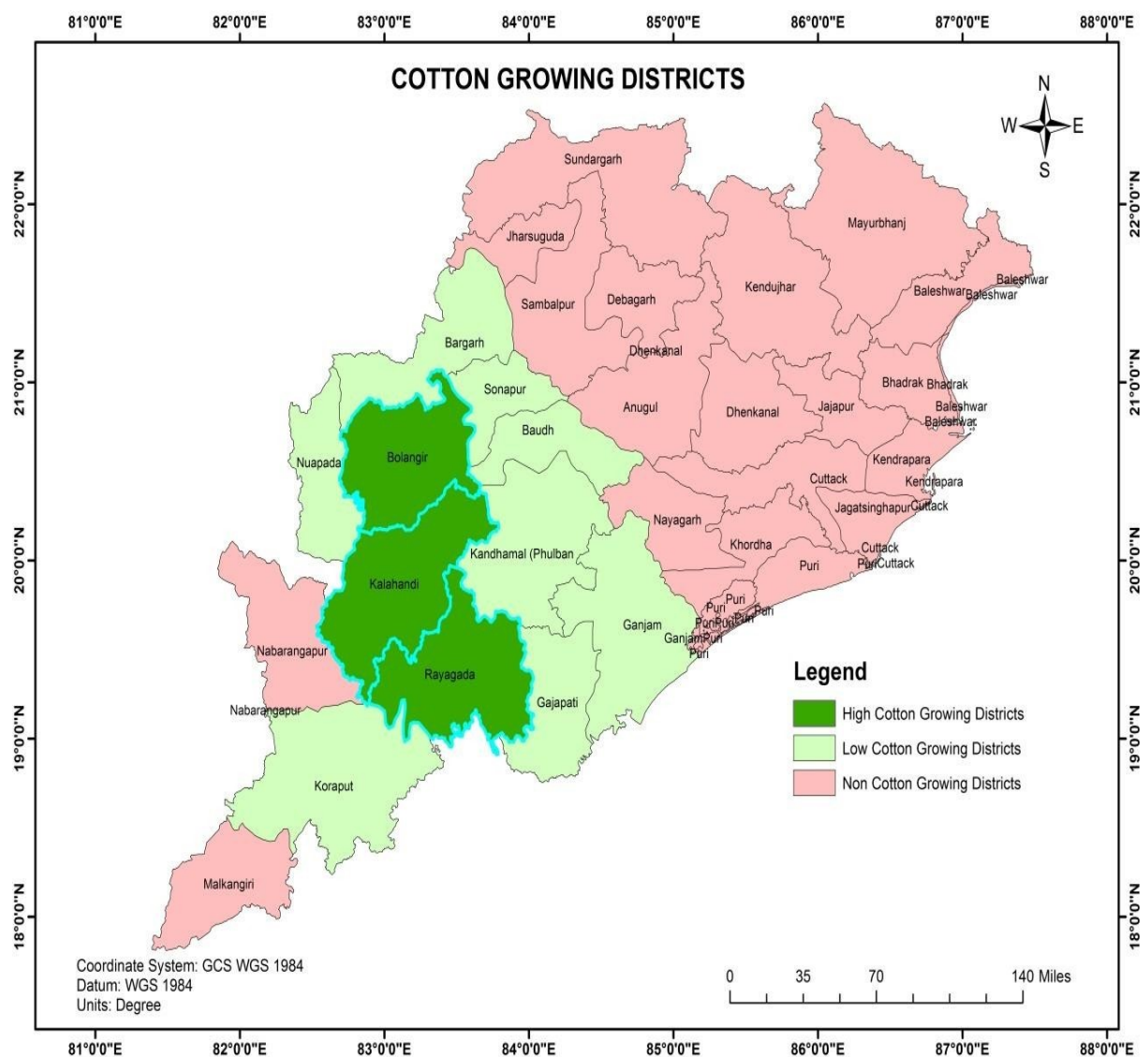
Source: Author's calculation from primary survey

4.6.2 Cotton production in the study area in respect of social category and water availability

India is placed among the topmost producer of cotton in the world. The crop covers around 8.7 % of India's nets sown areas. The maximum cotton producer state in India is Maharashtra, Gujarat and Telangana. Other states such as Odisha, Andhra Pradesh, Tamil Nadu, Karnataka, Rajasthan and Haryana also produce a huge quantity of cotton terms. In Odisha, around 1.7 lakh hectares of cultivated land are allocated under the cotton crop, which is around 2.75 % of the total cultivated area in the state. In terms of upland cultivation, it covers around 5.8 % of cropped land. In Western Odisha, districts such as Balangir, Kalahandi and Rayagada produce the highest quantity of cotton among all the districts.

Despite drought vulnerability, cotton or white gold is one of the most popular crops grown in undivided KBK regions, such as Kalahandi, Balangir and Koraput districts. These

regions are rainfed in nature; however, only 10 % of the cultivated land is irrigated. Districts such as Nuapada, Bargarh, Sonapur, Boudh, Kandhamal, Ganjam, Gajapati and Koraput are the lowest cotton production state in Odisha compared to Balangir, Kalahandi and Rayagada. Being a cash crop, cotton growers have potential risks of crop failure as it consumes maximum water. Monsoon precipitation plays a significant role in cotton production. The variation in rainfall patterns directly affects the production of cotton. Despite various risks associated with the production process, most sample respondents are engaged in cotton production in the study area. The seed costs rupees 1200 to 1600 per 900 grams, covering one acre of the cotton-growing land. The application of pesticides, fertiliser and fertilisers is expensive in terms of expenditure.



Source: Agriculture Map of Odisha

In the sample area, cotton is one of the principal crops grown by the majority of the farm household. Due to the drought situation in the region, the production rate goes significantly down over the year. Therefore, the study has collected the production data for cotton during the normal and drought year to understand the impact. The study found that there is a significant difference in the production of cotton between the normal year and drought year (Table 4.20), $F(1,284) = 122.06, p < .001$. This indicates that the production of cotton is significantly higher in the normal year ($M = 6.49, SD = .48$) compared to the drought year ($M = 1.65, SD = .16$). The interaction between Period X Availability of water resources is significant with respect to cotton production, $F(1,284) = 10.98, p < .001$.

From Figure 4.34, it is observed that the annual cotton production in the normal year under the scheduled category is significantly higher than in the drought year. Moreover, the cotton production in the normal year under the non-scheduled category is also higher than the normal year than in the drought year.

The interaction between Period X Social category is insignificant with respect to cotton production, $F(1,284) = 8.74, p \leq .003$.

From Figure 4.35, it is observed that the annual cotton production in the normal year under AWR is significantly higher than in the drought year. Moreover, the annual cotton production in the normal year under IWR is considerably higher than in the drought year. On the contrary, the interaction between Period X Availability of water resources X Social category is insignificant with respect to paddy production, $F(1,284) = 1.94, p \geq .165$.

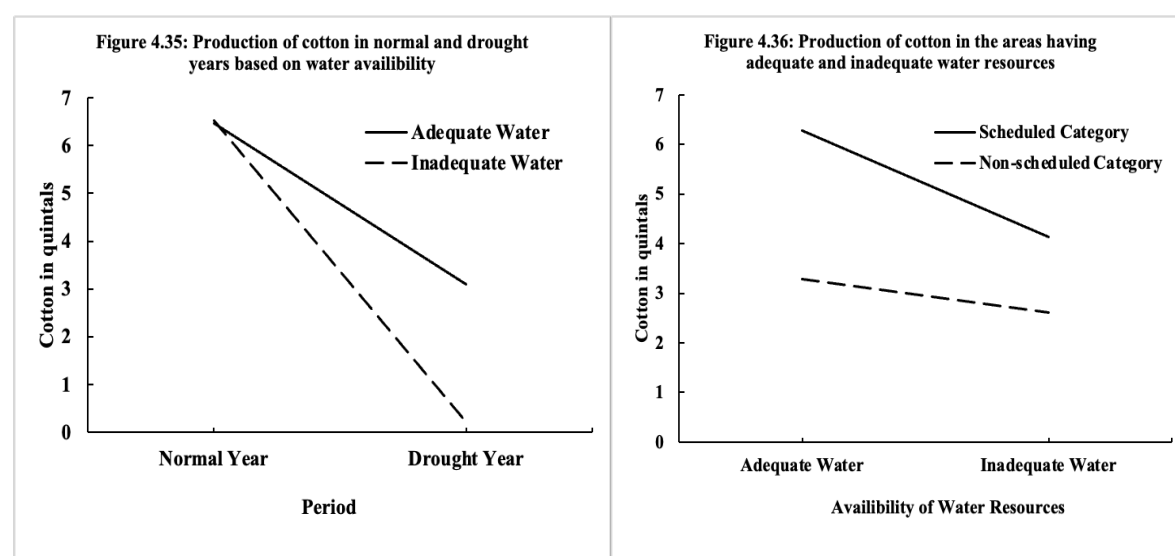
Moreover, a significant difference in the production of cotton is observed between two social categories, $F(1,284) = 15.60, p < .001$. This suggests that the production of cotton is significantly higher in scheduled category ($M = 5.20, SD = .33$) compared to non-scheduled category ($M = 2.95, SD = .46$). There is also a significant difference in cotton production between the two categories of availability of water resources. This indicates that cotton production is more or less equal for the farmers having access to AWR ($M = 4.78, SD = .45$) and farmers having no access to AWR ($M = 3.37, SD = .34$). However, the interaction between the availability of water resources X Social category is insignificant with respect to paddy production, $F(1,284) = 1.69, p \geq .193$.

Table 4.20 Summary of 2 x 2 x 2 ANOVA done on cotton production based on water resources and social category

Source	SS	Df	MS	F	p
<i>Between-subjects</i>					
Water resource (WR)	192.574	1	192.574	6.079	0.014
Social category (SC)	494.154	1	494.154	15.6	<.001
WR X SC	53.83	1	53.83	1.699	0.193
Error	8995.996	284	31.676		
<i>Within-subjects</i>					
Period	2273.487	1	2273.487	122.059	<.001
Period X WR	204.603	1	204.603	10.985	0.001
Period X SC	162.8	1	162.8	8.74	0.003
Period X WR X SC	36.146	1	36.146	1.941	0.165
Error	5289.801	284	18.626	-	-

Source: Author's calculation from primary survey

From Figure 4.36, it is observed that the annual cotton production in the area having AWR under the scheduled category is significantly higher than in the area having IWR. Moreover, the annual cotton production in the area having IWR under the non-scheduled category is more or less equal.



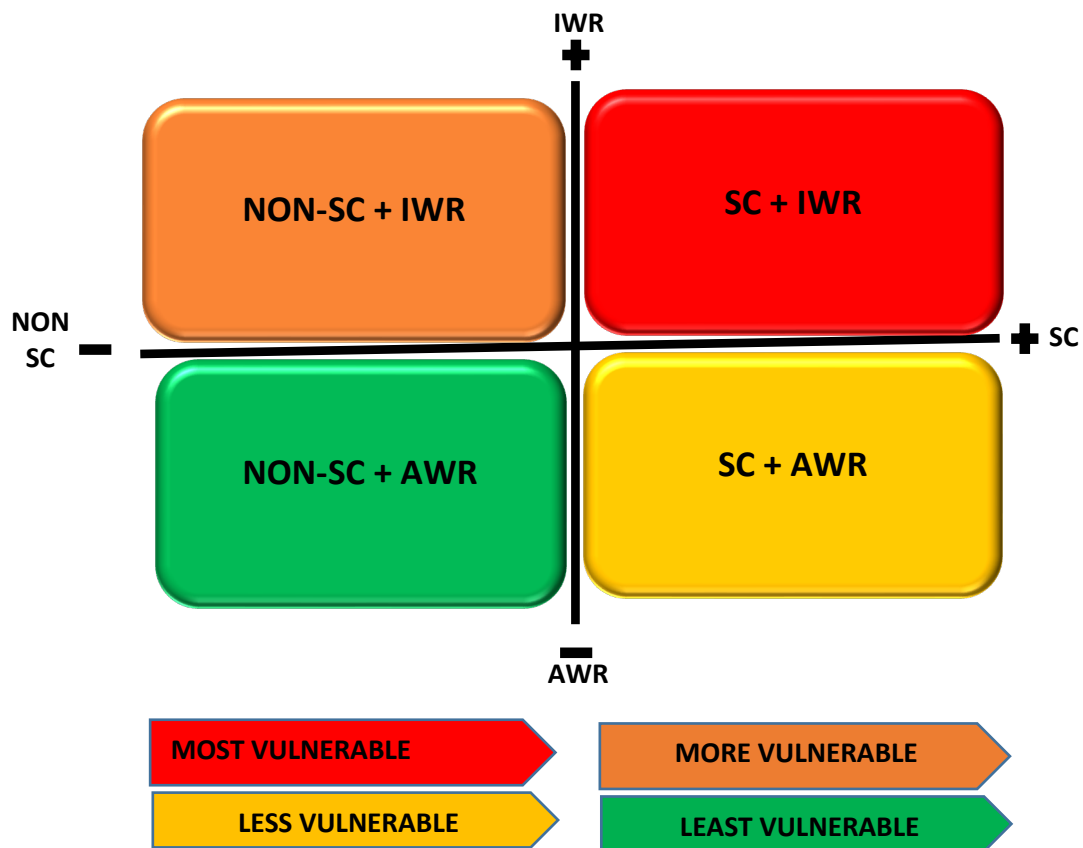
Source: Author's calculation from primary survey

4.7 Summary and observation

The study has examined the drought vulnerability in terms of availability of water resources and social groups during normal and drought periods. Empirical results at the household level addressed the livelihood vulnerability and human capital vulnerability posed by drought conditions. The study found that even if the non-scheduled category sample size is comparatively low, the mean area for the cultivation purposes among the non-scheduled category is significantly high compared to the significant numbers of the scheduled category population. Similarly, based on the availability of water resources and accessibility, the land size for cultivation purposes is higher among the farmers with IWR than those with AWR accessibility. So, the maximum land area is under inadequate water and unirrigated, consequently affecting the study area's production.

The drought vulnerability framework has measured significant factors such as social category, water resources and degree of vulnerability to evaluate a clear picture of household-level vulnerability. The framework has taken two important parameters (least vulnerable and high vulnerable) to evaluate the level of vulnerability among different social groups. From figure 4.37, it is observed that there are four types of vulnerable in the context of socio-economic conditions, accessibility of resources, i.e., (a) least vulnerable, (b) less vulnerable, (c) more vulnerable and (d) most vulnerable in the study area. It is evident from the statistical analysis that the scheduled category with IWR is most vulnerable because both the scheduled category and IWR are disadvantageous groups. On the contrary, the non-scheduled category with AWR is less vulnerable as both are under the advantageous category. The rest, more vulnerable and less vulnerable, are advantageous and disadvantageous components, i.e., the scheduled category with AWR is the less vulnerable, and the non-scheduled category with IWR is more vulnerable.

Figure 4.37 Framework to understand drought vulnerability



Note- NON-SC: Non-scheduled Category

SC: Scheduled Category

AWR: Adequate Water Resources

IWR: Inadequate Water Resources

(-): Least Vulnerable

(+): High Vulnerable

Problem of irrigation

Based on the field-based observation, it is evident that water resources play a significant role in agricultural growth. The main problem in the recent decade is the shortage of water resources (D'Souzaa, 2003; Vijay Shankar, 2016; D'D'Souzat and AlID'Souzast0144). It is observed from various studies that there is a huge gap between the supply and demand of water resources (Saleth and Dinar, 2004). The scarcity of water resources ultimately poses multiple challenges to the sustainable development agenda. Consequently, it causes a huge problem for the agricultural community to produce

sufficient grains to satisfy the demand of India's huge population (Molden 2007, 2010). The use of water for infrastructure development and daily uses puts intense pressure on water resources. The overpopulation of India also adds extra pressure while dealing with water scarcity (Garg and Hassan, 2007). The decadal growth of world population statistics revealed a three-fold increase in world population (Rose, 2013). The population growth leads to the demand for water.

Moreover, water use for different purposes has exceeded more than six times. It is evident from various studies that water plays a significant role in the agricultural sector. The prolonged period of water scarcity ultimately resulted in a chronic drought situation in many regions and consequently led to severe crop failure. In hilly areas, the frequency of drought has increased (Sharma, 2017). The drought scenario caused by inadequate water resources is primarily responsible for crop failure in India. The irrigation facility for agriculture purposes has been substantially decreased over the year (Saleth, 1996). Therefore, the efficient use of water resources is significant in bridging the gap between agriculture and sustainable development.

The expansion of irrigated land is crucial in nation-building and agricultural growth (Kreutzmann, 2015). In western Odisha, the geographical settings and irregular rainfall cause a huge problem for the farming community. The majority of the rural population is dependent on the agricultural sector. The development of the agricultural sector will foster rural prosperity in the state. In recent decades, prime importance has been given to irrigation systems due to the insufficient monsoon rainfall (Jairath and Ballabh, 2008; Kar and Swain, 2000). The inadequate monsoon rainfall in western Odisha is primarily responsible for the loss of dominant crops such as paddy and cotton. Based on the drought situation in western Odisha, farmers usually produce only one crop per year, even during the regular seasons. It is evident from various district statistics reports that the average precipitation in western Odisha is relatively lower due to monsoon failure. The monsoons arrive in the state in late June and continue to impact until mid-August or early September each year.

The deficit of rainfall during the monsoon months ultimately leads to crop failure. The irrigated area produces healthy crops compared to un-irrigated land (Panda, 1985). The irrigated area produces 2.3 times higher production than the rainfed agriculture area (FAO, 2007). The World Bank (1999) study revealed that crop production under irrigated areas is seven times higher than the area utterly dependent on rainfall. According to Rajvanshi (1991), the irrigated area contributes 66 % of food grain compared to the rainfed area. The government of India is also spending millions of dollars through the national budget and different funding agencies such as World Bank and Asian Development Bank to enhance the rural economy and sustainable livelihood of million (Herath, 2002). Although there is no evidence of complete immunity to drought situations in India, partial immunity is observed against drought vulnerability in several states through irrigation facilities. During the drought year in 1989-80, the food grain output of India declined by 6 % of its average level of production in an irrigated track.

The statistics also revealed a significant fall in food grain in the rainfed area at 22 % (Dhawan, 1988). The most vulnerable population belonging to the scheduled category (SCs and STs) are more prone to migration in search of job opportunities. The majority of them are engaged in labour-intensive work due to a lack of education and skill. Therefore, it is evident from various literature and the study report that farmers belonging to the scheduled category with no irrigation facilities are the most vulnerable in terms of low production and poor socio-economic conditions. Consequently, these vulnerable communities are more prone to migration each year irrespective of normal or drought years to ensure their livelihood. The impact of drought conditions generally varies based on farmers' level of adaptation, human capital and socio-economic conditions. People with access to different resources are less vulnerable than those with inadequate access. The development and proper implementation of different irrigation schemes can solve the agricultural livelihood at the earliest. The lack of an adequate irrigation scheme poses multiple threats to the poor and marginalised section and leaves them with no choice and to believe in their fate.

On the contrary, excessive rainfall also potentially impacts crop production in terms of drought vulnerability. The study area Balangir district has also experienced two recent flood years, immediate after drought in 2020 and 2021 due to excessive rainfall. Therefore, the farmers are always at the double-edged swords in which the lack of rainfall resulting in drought will spoil the crops, and the excessive rain resulting in the flood will also damage the crops. Irrigation serves as a lifeline for the people of western Odisha, where most people depend upon agriculture as their primary source of livelihood.

The primary water sources in the study region are confined to the canal, pond, government-supported large well and borewell in the study area. People with private and public water access can save their crops during the drought. However, in the scheduled category, the vulnerability impact is completely different. Even if they have access to AWR, people from these communities engage in alternative livelihoods and practice migration. The effect of drought on crop production remains unchanged; however, in the case of the scheduled category population, the socio-economic conditions get more miserable due to the lack of access and availability of various capital than in the non-scheduled category. Due to the poor financial and socio-economic conditions, the scheduled category population have lower level of adaptation to drought vulnerability (Sam, A.S., 2017). The drought condition of these populations directly replicates Amartya Sen's entitlement approach. Hence the move is spelt out from being at the mercy of the rainfalls to a move to the practice of the irrigation systems, which would ensure them a guaranteed crop output. The lack of irrigation facilities in western Odisha, especially in the Balangir district, has caused an upside-down for farmers in the district. Moreover, the irrigation project in the SukTel river has been under construction for more than ten years in the

district. Therefore, expansion of the irrigation infrastructures has to be given prime importance for developing agriculture in the region. After assessing vulnerability in the study area, the next chapter (chapter- 5) will discuss the relationship between climate change and migration, more precisely, climate change-induced drought and migration rate in the study area.

CHAPTER V

Climate Change-induced Migration

5.1 Introduction

Since the beginning of civilisation, humanity has been on the move. In general, the movement of people from one place in the world to another for a temporary or permanent period is called human migration (Crawford, 2012). Migration is one of the significant contributors to social change throughout the history of human civilisation. Based on the socio-economic and environmental variables, two crucial factors influence migration, i.e., the push and pull factor. The Push factors (poverty, unemployment, climate change, the standard of living etc. and pull factors (employment opportunities in new destinations, favourable environmental conditions, favourable socio-economic conditions etc.) are vital to grasp the nature of migration. Migration can be broadly classified into two types (a) ‘internal migration’, which takes place within a country and (b) ‘international migration takes place across the international periphery (Bhende and Kanitkar, 2006). Apart from these major migration typologies, a third type is identified by Jay Weinstein and Vijayan Pillai (2001) as forced migration (Hill, 2016) or force-displacement (World Bank, 2017). Forced migration occurs when people migrate to other places against their will. Such migration is influenced by external factors like climate change, natural disasters, civil war etc. The present study primarily focuses on the third type of migration, i.e., forced migration.

This present chapter consists of 7 sections (section 1: Introduction, section 2: Climate change and migration, section 3: Migration scenario in the study area during normal and drought year out of total sample, section 4: Sustainable livelihood strategies, section 5: Status of Debt among the sample based on the social category in the study area, section 6: Socio-political adaptation and section 7: Summary).

5.2 Climate change and migration

Climate change doesn't directly lead to human migration; instead, it generates a changing environmental condition which forces the vulnerable community to migrate (Podesta, 2019). The changing environmental condition generally composes precarious livelihood, low

adaptation strategy, lack of access to various resources, proper training and techniques, etc. These factors result from multiple stressors such as extreme weather conditions like hotter atmosphere, more intensive rainfall, thunderstorm, flood, drought, volcanic eruptions etc. It makes it difficult for vulnerable communities to survive in challenging conditions. In 2010, around 11 million people were internally displaced in Pakistan due to the extreme flood situation in the Indus river caused a massive loss of agricultural production and human life (IDMC and NRC, 2012).

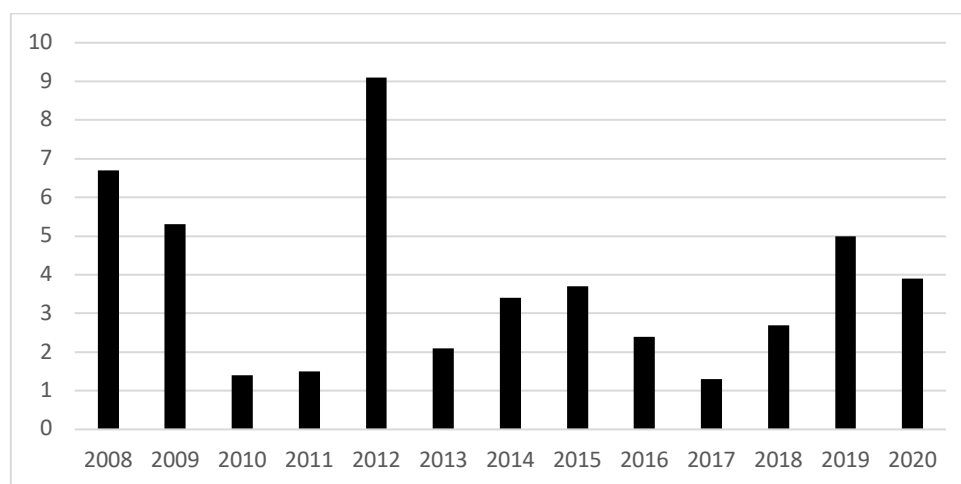
Similarly, in China, many people are internally migrating almost all the year due to the grave consequences of the flood. Places such as Kebbi, Niger, Sokoto, Lago and Kwara in Nigeria are prone to forced migration due to massive floods. Climate change has diverse impacts on many countries globally in terms of loss of livelihood, human life, and many more. Along with underdeveloped nations, developing nations are more vulnerable than developed ones (Wijaya, 2014). Because most of these vulnerable countries are highly dependent on climate-sensitive sectors such as agriculture. On the contrary, the adaptive capacity is very low for developing and underdeveloped nations compared to developed nations (Patt, 2010).

Based on various literature, it is clear that there is a strong correlation between climate-induced natural disasters and the decision to migrate (Berlemann, 2017). However, it is questionable and debatable among the research scholar, academicians and policymakers to conceptualise the climatic factors as the primary force for migration or forced displacement (Black, 2001). The combination of both push and pull factors of migration always tends to direct the nature of migration as multi-causal (De Hass, 2021). Therefore, it is quite challenging to establish a causal link with a specific factor such as social, economic, political, environmental, climate etc. The major challenge is tracing and understanding whether the Climate-induced migration is forced or voluntary. Based on the nature of the climate change impact, the nature of migration varies people to a people, community to community. During a natural disaster, people are left with no choice and are forced to migrate to survive in a different suitable location. However, in case of slow migration pressure like drought, people voluntarily migrate to other safe places to find better livelihood and healthy life. On the contrary, other factors such as socio-economic conditions and political and distribution of natural resources could influence the potentially vulnerable population to migrate. Finally, it is difficult to define a particular movement as voluntary or forced.

5.2.1 Climate change-induced migration in India

The mobility of people or human migration due to the environmental impact is not a new phenomenon. Since long ago, it has been seen that people are moving from one place to another place according to the changing environmental conditions. As far as the Nomadic and Pastoralist people are concerned, such mobility was people's part of livelihood. In early 1990, the IPCC (IPCC, 1990) addressed that "the greatest single impact of climate change could be on the human migration"- with millions of people displaced by coastal flooding, shoreline erosion and severe drought. Supplementary, in 1992 International Organisation for Migration (IOM) and the Refugee Policy Group (RPG) together published a report on "migration and environment", which stated that- "Large numbers of people are moving as a result of environmental degradation that has increased dramatically in recent years. The number of such migrants could rise substantially as larger areas of the earth become uninhabitable due to climate change" (IOM, 1992). The migration statistics from 2008 to 2020 (in Figure 5.1) revealed that India had witnessed an average of 3.7 million people displaced each year due to climate change (Panda, 2020). Natural disasters such as drought, heatwaves, cyclones, floods, thunderstorms etc., are the major forces that accelerate the pace of human movement in India. In 2012, 9.1 million were displaced due to climate-induced factors, followed by 6.7 million in 2008, 5.3 million in 2009, 5 million in 2019 and 3.9 million in 2020, respectively. People generally leave their native place and migrate to different convenient locations based on their capability in search of additional and alternative livelihood opportunities.

Figure 5.1 Climate induced internal displacement in India (in Million)



Source: Internal Displacement Monitoring Centre

5.2.2 The plight of the migrant community

The majority of the migrant population possessed a nuclear family during their migration time. The nuclear family system generally forces many families across India, especially the migrant community, to search for some job opportunities in town or city. As most of the migrant community holds primary level education, they have to compromise their salary and wages. A majority of the migrant worker does not know the factory and companies as they have been engaged in agricultural activities for years. The field observation shows a binary view of opting for migration during the drought situations in the study area, i.e., forced migration or environmentally motivated migration and alternative coping strategies to get rid of drought vulnerability. Factors such as crop failure, indebtedness, lack of awareness, lack of proper credit facilities etc., forced many people to practice forced migration. In contrast, factors such as payment of the old loan, compensation for crops loss, more opportunities, additional livelihood etc., enhance people to adopt migration as an adaptive strategy to climate change-induced drought vulnerability. The structure of traditional Indian society is characterised by the spirit of social inequality. While interacting with the fellow migrant community, it is noticed that the migrant community have faced many difficulties during the re-settlement process in different migration destination. The difficulties in the respective destination can be broadly categorised as a language problem, cultural problem, shelter problem, financial insecurity due to lower wage, higher cost of living, unemployment problem, timely house rent payment problem, water scarcity etc. Moreover, the migrants narrate incidents of their constant mistreatment and harassment by their employers, especially the middle-class shopkeepers, residents, and local police.

5.2.3 Development implications: migration as adaptation

The shortage of rainfall causes huge damage agricultural sector in terms of livelihood loss. Millions of farmers have been going through the impact of climate change on crop output. The long term dry spell of agricultural land resulted in a drought situation all over the world. Although the physical impact of drought is identical for all the agricultural land, the vulnerable farmers from the developed nation can lower their vulnerability through access to different capitals. The worst impact can be best observed in developing nations compared to the developed ones. The livelihood loss forces many farmers from the poor and marginal communities in a country like India to migrate to seek better livelihood opportunities in the

migrant destination. The vulnerable population uses migration as one of the safety measures to eliminate the worst impact of climate change and natural disasters.

However, many studies suggest that migration is an outcome of environmental induced natural disasters rather than an enhancement to the adaptation process to combat the impact. As we discussed earlier, in the case of Bangladesh, each year, people from the different vulnerable groups to drought and flood choose migration as the best safety net to cope with the grave consequences of natural disasters. The International Organisation for Migration, Colombia, has offered job opportunities for migrant labour practising temporary and circular migration abroad (IOM, 2009). During the Copenhagen Conference on Climate Change and beyond, “adaptation” was popularised in climate change discourse. Within the discourse, migration played a significant role in the best suitable adaptation strategy to combat the climate change vulnerability. (ref. Martin chapter in IOM 2007, 2008; UNDP 2009; World Bank 2010). Planned and voluntary migration can always be recognised as one of the adopted safety nets to reduce environmental disasters. By adopting the migration strategy, the vulnerable community could lower its vulnerability. In short, migration could help provide multiple opportunities regarding migrants’ occupational choices in other places. Therefore, the holistic approach to the issues of migration, climate change, development, policy and strategy together is quite challenging for the researcher and policymakers. These challenges could be addressed by the implication of a sustainable livelihood strategy to make migration an essential safety measure.

5.2.4 Migration scenario in Odisha

The agrarian crisis during the decade 1990 has caused huge internal migration all over India in search of livelihood opportunities, and it was found to be an alternative livelihood strategy for millions of those depending upon agriculture and allied sector (Rao, 2018). Being a poor state, Odisha emerged as one of India’s key labour sending markets (Odisha Economic Survey, 2020). The sole purpose of the migration was confined to additional and alternative livelihood for the rural poor. However, the urban setup has emerged to be troublesome for the rural people in terms of inequity. On the other hand, it can’t be denied the contribution of migration in sustaining millions of rural poor in terms of livelihood. The lower income from the traditional agricultural occupation is primarily responsible for the internal migration in Odisha. Table 5.1 illustrates that as per the Census report from 1961 to 2011, the total inter-state migrant population in Odisha has increased from 332078 to 855096 over the decade. However, the decadal growth of the migrants has been inconsistent and significantly low. The migration rate

was considerably higher from 1961 to 71 at 48.36 % of the change in the growth rate, followed by 39.71 % from 1971 to 1981, -13.95 % from 1981 to 1991, and 11.9 % from 1991 to 2001 and 29.01 from 2001 to 2011 respectively. Since 1971, the migration trend has decreased till 2011. More surprisingly, from 1981 to 1991, the decadal change of the migrants' percentage shows a negative trend.

Moreover, the gender perspective of the migrant population shows that the number of female migrants has been significantly increased than the male population over the decade. Female migration has always been ignored and termed secondary migration. Moreover, it is assumed that female migration is mainly dependent on male migration. However, the statistical evidence depicts a different scenario for female inter-state migration in Odisha. Most of them are involved in household activities in urban area, hotel industries, and construction work in various migration destinations. Due to the patriarchal value, female family members, especially unmarried women, were denied to migrate in the early days of society. The stigma has vanished, and females are practising migration along with men to different cities for their livelihood. The latest Census report 2021 is delayed due to the ongoing Covid-19 pandemic. The new report may reveal a dynamic growth in the inter-state migration statistics in Odisha. According to the Census report, 2011, it is observed that the western Odisha region consisting of Balangir, Kalahandi and Nuapada together has the highest percentage of estimated numbers of migrants (67.25 %) than the total inter-state migration in Odisha.

Table 5.1 Inter-state migration statistics in Odisha as per Census report, 1961 to 2011

Census Year	Total Migrants	Male		Female		% Change of migrants
		<i>F</i>	%	<i>f</i>	%	
1961	332078	150992	45.47	191086	54.53	-
1971	492661	229674	46.62	262987	53.38	48.36
1981	688300	303403	44.08	384897	55.92	39.71
1991	592292	227953	38.49	364339	61.51	-13.95
2001	662800	265120	40	397680	60	11.9
2011	855096	335575	39.24	519521	60.76	29.01

Source: Census of India, various year

5.2.5 Climate induced rural migration in Odisha

Rural migration has been increased over the decade due to various reasons such as employment, business, marriage, climate change, education, better life etc. The issue of climate induced migration in recent year have attracted many academicians, research scholars and policy makers to explore the emerging factor. Climate change doesn't directly lead to migration rather, it creates such a condition that force the vulnerable community to practice migration (Black et al., 2011).

Table 5.2 District-wise climate induced rural migration (as per Census, 2011)

Districts	Total Migration	Environmental induced rural migration					
		Person	%	Males	%	Females	%
Bargarh	365321	42106	11.5	22467	53.4	19639	46.6
Jharsuguda	175797	41079	23.4	28124	68.5	12955	31.5
Sambalpur	288023	59380	20.6	38509	64.9	20871	35.1
Debagarh	96165	15519	16.1	9359	60.3	6160	39.7
Sundargarh	597459	153341	25.7	107806	70.3	45535	29.7
Kendujhar	493210	72547	14.7	45030	62.1	27517	37.9
Mayurbhanj	699497	96366	13.8	48313	50.1	48053	49.9
Baleswar	607569	62624	10.3	30391	48.5	32233	51.5
Bhadrak	376892	35460	9.4	16494	46.5	18966	53.5
Kendrapara	391265	33806	8.6	13894	41.1	19912	58.9
Jagatsinghapur	335276	44541	13.3	25879	58.1	18662	41.9
Cuttack	685763	107973	15.7	65341	60.5	42632	39.5
Jajapur	495597	58674	11.8	27108	46.2	31566	53.8
Dhenkanal	319603	42440	13.3	21405	50.4	21035	49.6
Anugul	375188	68054	18.1	41707	61.3	26347	38.7
Nayagarh	275559	31132	11.3	15261	49.0	15871	51.0
Khordha	719509	194233	27.0	134976	69.5	59257	30.5
Puri	446431	47499	10.6	23789	50.1	23710	49.9
Ganjam	921516	159021	17.3	85873	54.0	73148	46.0
Gajapati	133064	34441	25.9	17455	50.7	16986	49.3
Kandhamal	223915	44244	19.8	22911	51.8	21333	48.2
Baudh	118785	15699	13.2	7954	50.7	7745	49.3
Subarnapur	158173	19600	12.4	9020	46.0	10580	54.0
Balangir	414872	56416	13.6	25174	44.6	31242	55.4
Nuapada	165830	21215	12.8	9602	45.3	11613	54.7
Kalahandi	417409	53255	12.8	27402	51.5	25853	48.5
Rayagada	226136	57211	25.3	32424	56.7	24787	43.3
Nabarangapur	321191	58845	18.3	29377	49.9	29468	50.1
Koraput	345435	79415	23.0	44757	56.4	34658	43.6
Malkangiri	177054	43055	24.3	24221	56.3	18834	43.7
Total	11367504	1849191	16.3	1052023	56.9	797168	43.1

Source: Census of India, 2011, Registrar General and Census Commissioner of India.

The Table 5.12 illustrates district wise climate induced rural migration scenario in Odisha. The failure of agrarian economy structure in Odisha is an outcome of frequent disasters such as flood, drought, cyclone etc. Consequently, the extreme climatic events lead to rural people's migration to urban areas. Flood vulnerability causes migration in coastal area whereas drought vulnerability causes migration in hilly areas. The percentage of migration in western Odisha district is higher than the coastal district. Therefore, the western Odisha is more prone to climate induced migration especially due to drought.

5.2.6 Migration statistics in western Odisha

As per the census 2011 report (in Table 5.3), it is evident that there are three top migration prone districts in western Odisha such as Kalahandi, Balangir and Nuapada. Balangir has registered 2nd highest percentage of migrants after Kalahandi, and the least migrant estimated district is Nuapada (Balangir: 28.8 %, Kalahandi: 29.3 % and Nuapada: 16.6 %). The estimated migrant population in Balangir district is skewed towards Balangir districts, followed by Kalahandi and Nuapada. Moreover, as per the panchayat directory report, it is evident that Balangir has the highest average number of migrants per panchayat, followed by Nuapada and Kalahandi. Balangir, due to its higher dependency on agriculture and allied activities, is placed among the most vulnerable districts to climate change-related disasters, especially drought. Table 5.3 Migration statistics in western Odisha as per Census report, 2011 and Panchayat directory

District	Total no. of hh Surveyed	Migrant hh	Total no. of rural hh*	Estimated no. of migrant hh	Estimated no. of migrants
Balangir	9783	2821 (28.8%)	368542	106272	154786.7
Kalahandi	23675	6930 (29.3%)	372518	109041	99827
Nuapada	11841	1971 (16.6%)	143887	23951	47882.1
Western Region	45299	11722 (25.9%)	1795003	464492	575053

Source: Centre for Migration and Labour Solutions, Aajeevika Bureau

Note: hh- household

During the distress situation, poor farmers are left with no options practices migrate to the nearby district or other states to minimise their vulnerability. Therefore, migration is popular among the people in terms of alternative and additional livelihood. The real problem arises

during the post-migration scenario. Migrants find it challenging to survive in a new environment like big cities in India. The rural lifestyle is entirely different from the urban or metropolitan cities (Pateman, 2011). The migrant community from western Odisha also battle for their survival in the urban setup (Biswal, 2019).

5.3 Migration scenario in the study area during normal and drought year out of total sample

The migration caused by distressing situations is usually called forced migration. On the contrary, many vulnerable people used migration as one of the safety measures to lower the vulnerability caused by multiple stressors such as natural calamities, socio-economic conditions etc. In the present study, climate change-induced drought is a significant determinant of migration in the Balangir district of Odisha. The district Balangir has been experiencing drought for years. The region has witnessed severe crop failure due to chronic drought and forced the rural farming community to engage in the migration process and alternative livelihood opportunities. Therefore, it is necessary to understand people's socio-economic status during normal and drought year in the district.

Table 5.4 Migration Status during normal and drought year out of the total sample

Gender, Social Category & Education of migrants	Normal year				Drought year			
	Migration		No migration		Migration		No migration	
	<i>f</i>	%	<i>F</i>	%	<i>F</i>	%	<i>F</i>	%
Gender								
Male	26	9.5	249	90.5	45	16.4	230	83.6
Female	3	23.1	10	76.9	4	30.8	9	69.2
Social Cat.								
Scheduled	25	11.8	187	88.2	35	16.5	177	83.5
Non-scheduled	4	5.3	72	94.7	14	18.4	62	81.6
AWR								
Adequate	4	5.2	73	94.8	16	20.8	61	79.2
Inadequate	25	11.8	186	88.2	33	15.6	178	84.4
Education								
Illiterate	0	0	15	100	3	20	12	80
Literate	0	0	3	100	1	33.3	2	66.7
Primary	4	5.1	75	94.9	17	21.5	62	78.5
Middle	20	12.2	144	87.8	26	15.9	138	84.1
Matric	5	23.8	16	76.2	0	0	21	100
Intermediate	0	0	6	100	2	33.3	4	66.7

Source: Field Work, Balangir District, Odisha, 2019

Note: AWR- Availability of Water Resources

The migration statistics (in Table 5.4) area revealed that in normal year, 29 people have migrated out of the sample population of 288. Of which 26 are male, and 3 are female migrants. However, in drought year, the total number of migrants has increased to 49 from the same sample size. Out of which 45 are male, and 4 are female migrants. The statistics revealed that people are more prone to migration during drought than in a normal year. The scheduled category population is found to be 212 from the collected sample. In the normal year 11.8, per cent of the scheduled category population has migrated compared to 5.3 per cent of the non-scheduled category. However, in the drought year, 16.5 per cent of the scheduled category population migrated compared to 18.4 per cent in the non-scheduled category. As far as the water availability in the area is concerned, in a normal year, around 5.2 per cent of people have migrated despite having AWR, whereas 11.8 per cent migrant population have IWR.

However, in the drought year, out of the total population having AWR (77 samples) available, 20.8 per cent of migrants have migrated, whereas from the total population having IWR (211 samples), 15.6 per cent have migrated. As far as the educational status is concerned, out of 79 primary school qualified samples, only 5.1 per cent have migrated in the normal year.

Similarly, out of 164 middle school qualified samples, 12.2 per cent have migrated, and out of 21 matriculations qualified samples, 23.8 per cent have migrated. However, out of 15 illiterate samples in the drought year, 20 per cent have migrated. Out of 3 literate samples, 33.33 per cent have migrated. Out of 79 primary school qualified samples, 21.5 per cent have migrated. Similarly, out of 164 middle schools qualified samples, 15.9 per cent have migrated. Finally, out of 6 qualified intermediate samples, 33.3 per cent have migrated.

5.3.1 Migration status during normal and drought year out of sample migrant

The rate of migration of people regarding their gender, social category, education, and availability of water resources in both normal year and drought year is highlighted in Table 5.5. Firstly, with reference to gender, both male and female members of a household have migrated in large numbers in drought year compared to a normal year. However, comparing the change in migration between two genders and two time periods, it is evident that the rate of migration of male members is significantly more than female members. This happens due to the supremacy of the male in Indian traditional society in which the male is responsible for the livelihood of a household. At the same time, female is assigned the role of household chores.

Secondly, with reference to the social category, people belonging to the scheduled category have migrated more in both normal and drought year than scheduled category people. But, the percentage change in migration of non-scheduled category people in a drought year is significantly more significant than the percentage change in migration of scheduled category people in a drought year because people belonging to the non-scheduled category do not cope with sudden shock caused by drought. So, they migrate to other states or cities to earn a better livelihood.

Thirdly, with respect to the availability of water resources, the statistics illustrate that more people migrate to other states or cities when they don't have adequate water resources. However, the interesting point is that the percentage change in migration in a drought year is significantly more significant in the case of adequate water resources than inadequate water resources because of major crop failure. As people largely depend on agriculture for their livelihood, water scarcity due to drought acts as a major setback in the production of crops like rice and cotton. Therefore, although people have a water resource that is not adequate for crop production, they are forced to migrate.

Fourthly, with regards to the educational qualifications of the migrants, most of them have possessed middle-class qualifications. The maximum number of migrants has middle-class qualifications during a normal year, followed by matriculation and primary. However, during a drought year, the number of migrants having primary education and middle-class education has significantly increased by 325% and 30%, respectively, while there are no migrants having matriculation qualifications. The migrant population has the least scope in skilled jobs with basic educational qualifications. Therefore, most of them prefer to migrate and engage in multiple labour-intensive jobs such as the Bricklin industry, construction work, and cotton industries in southern and western parts of India. Moreover, some of them are also working in the hotel industry.

Table 5.5 Migration status during normal and drought year out of sample migrant

Gender, Social Category & Education of migrants	Normal year		Drought year		Change %
	Migration		Migration		
	F	%	F	%	
Gender					
Male	26	36.62	45	63.38	73.08
Female	3	42.86	4	57.14	33.33
Social Cat.					
Scheduled	25	41.67	35	58.33	40
Non-scheduled	4	22.22	14	77.78	250
AWR					
Adequate	4	20.00	16	80.00	300
Inadequate	25	43.10	33	56.90	32
Education					
Illiterate	0	0	3	100	N/A
Literate	0	0	1	100	N/A
Primary	4	19.05	17	80.95	325
Middle	20	43.47	26	56.52	30
Matric	5	100	0	0.00	-100
Intermediate	0	0	2	100	N/A

Source: Field Work, Balangir District, Odisha, 2019

5.3.2 Reason, Place, Type and Income of the migrant in the study area

In India, forced migration is associated with underdeveloped and underprivileged states such as Bihar, Madhya Pradesh, Rajasthan, Uttar Pradesh etc., in terms of poor economic conditions and high population explosion. In the context of Odisha also, migration has been seen mainly in the KBK region (undivided Kalahandi, Balangir and Koraput) in the western part of Odisha. The migration history of Odisha shows that the maximum number of migrants move towards the southern state of India, such as Andhra Pradesh, Telangana, Tamil Nadu etc. and engage mainly in bricks kiln. Besides these states, some migrants also move towards developed cities such as Chennai, Bengaluru, Mumbai, Ahmedabad etc., to work in different construction sites and hotel industries. Poverty and unemployment problems in Odisha are primarily responsible for the distress situations. The majority of the population in the state is engaged in agricultural and allied activities, and the agrarian system mainly relies on the monsoon pattern. The erratic rainfall in the state causes drought in western Odisha and floods in coastal Odisha, accelerating the pace of migration among the vulnerable population in search of additional and alternative livelihood. In 2008, the statistics show that more than 80,000 seasonal migrations was

observed, which later increased to 1.05 lakhs in 2012, 1.2 lakhs in 2013, 1.35 lakhs in 2014 and 1.46 lakhs in 2015 (Praharaj, 2017).

The migrant population has several reasons to practice migration in the study area, such as low crop output, free from indebtedness, additional livelihood, drought, flood and other reasons. Table 5.6 highlights the migration destination, influencing factors, types and income of the migrant in the study area.

Table 5.6 Reason, Place, Type and Income of the migrant in the study area

Place, Type, Reason & Income	Normal year		Drought year		Change %
	<i>f</i>	%	<i>F</i>	%	
Reason					
Low crop output	15	44.11	19	55.88	26.67
Free from indebtedness	11	33.33	22	66.67	100.00
Additional Livelihood	1	100	0	0	-100.00
Drought	0	0	7	100	N/A
Flood	0	0	1	100	N/A
Others	2	100	0	0	-100.00
Place					
Own town/ village	0	0	0	0	0.00
Nearby town	0	0	5	100	N/A
Other State	29	39.72	44	60.27	51.72
Type					
Seasonal	10	16.95	49	83.05	390.00
Temporary	19	100	0	0	-100.00
Income					
Less than 10k	4	14.29	24	85.71	500.00
10-20k	10	41.67	14	58.33	40.00
20-30k	8	44.44	10	55.56	25.00
30-40k	7	87.50	1	12.50	-85.71

Source: Field Work, Balangir District, Odisha, 2019

During a normal year, migration occurs due to low crop output, indebtedness and additional livelihood. However, most people migrated to different places during a drought year to get rid of old debt or new loans, followed by low crop production, drought, and flood. Therefore, the percentage change in migration due to indebtedness is significantly more significant than other causes of migration. Secondly, with reference to places of destination, all people prefer to migrate to other states during a normal year. However, some people prefer to migrate to nearby towns during a drought year. The percentage change in migration to other states is significantly more than in other places. No migration took place within the sample respondent's city or village. Thirdly, with respect to the type of migration, temporary migration dominates over seasonal migration during a normal year. However, during a drought year, the situation is

completely reversed. This indicates that only seasonal migration takes place during a drought year. Therefore, a massive surge in seasonal migration occurs during a drought year. Fourthly, with regards to the monthly income of the migrants, during a normal year, the people having monthly income of 10-20K have migrated in large numbers, followed by the people having monthly income of 20-30K, 30-40K, and less than 10K respectively. However, during a drought year, the migrants having an income of less than 10K per month have increased very significantly by 500%, followed by the migrants having monthly income of 10-20K and 20-30K, respectively, while the number of migrants having income 30-40K has declined in a drought year. This happens because of low education, lack of required skill set, and nature of work, hence forced to migrate to earn an additional livelihood.

5.4 Sustainable livelihood strategies

A livelihood consists of assets, capabilities, and activities that help a person avail of different income sources to survive. A livelihood can be sustainable with a better coping strategy and defence against multiple shocks and stress. Furthermore, it sustains or enhances its capabilities and capital in the present and the future scenario without damaging the natural resources. (chambers and Conway, 1992, Carney, 1998).

5.4.1 Livelihood strategies

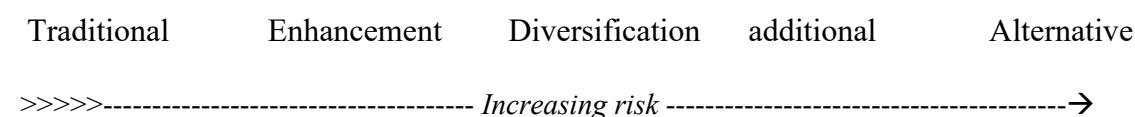
In the context of rural society, livelihood activities are most diverse. They include on-farm, off-farm and non-farm activities (Ellis 2000). Due to the divergence between household livelihood assets and strategy, the households select a complex portfolio of livelihood activities. They may include diversification, intensification and migration (Ellis, 2000, Scoones, 1998). In the households, the activities of the respective household combine to avail several needs at different times. People become more secure when there are more choices and flexibility in opting particular choice/s in livelihood strategies. They can cope with shocks and risks in the pursuit of their livelihoods. The basic opportunities for sustaining rural income sources exist in short term measures to meet the immediate requirements and long term strategies of developing supportive policies and legal processes and building up capacity through institutional and participatory mechanisms. The adoption of sustainable livelihood strategies helps the people maintain or improve their standard of living, reduce the vulnerability impacts, and ensure their activities conform to sustainability principles. The SLA relies on collating adequate information from secondary and primary sources, listing out all the

stakeholders' issues and concerns, and designing appropriate policies and management interventions.

Vulnerability context

The more successful income-generating activities are built on traditional skills and knowledge.

The level of risk in livelihood strategy



5.4.2 The merit of the SLP framework

For the sustainable livelihoods (SL) approach, some tools facilitate the analysis and decision-making for implementing development programmes and help prioritise entry point activities (Pasteur, 2001). The study of present livelihoods status is essential to outline the requirements and strengths of the local communities and to identify the development interventions that would be appropriate to implement with the cooperation of all the stakeholders. The issues, constraints, and gaps in aspects like infrastructure in practising the existing livelihoods are to be identified in consultation with the stakeholders and understanding their aspirations and capacity to adopt the interventions. The SL approach intends to be holistic and dynamic, people-centred and participatory, built on strengths and linked between macro-and micro-aspects, ensuring sustainability overall. Instead of focussing directly on problems & gaps, It takes the existing assets, and livelihood approaches as starting points. The needs and constraints are addressed based on the strengths of the community. The SL framework facilitates the analysis and planning by focussing on a range of factors influencing the people's livelihoods and the complexity of their diverse livelihood approaches in a specific location or context. The framework guides the collection and analysis of data on SL and the interpretation of the existing strengths and gaps that can provide direction to the proposed interventions (refer to Table 5.7).

Table 5.7 Support of SL framework in development planning

Livelihood strategy	It helps to identify vulnerable groups as per their primary sources of livelihood. Identify that households may adopt different livelihood strategies during a panic situation.
Livelihood assets	It helps to categorise the critical assets needed to support diverse livelihoods. Focus much more on economic assets (employment/job opportunities) and social assets (social relationships, membership in organisations)
Vulnerability context	It helps to recognise the prime sources of vulnerability linked with specific livelihood plans.
Policies, institutions and processes	It helps to understand the impact of policy interventions on vulnerable people's livelihoods. Understand the necessity of poor people's access to different resources.
Livelihood outcomes	It helps establish an effective linkage between the structure and process to enhance diverse income sources for millions of poor.

Source: Pasteur (2001)

SL study may provide numerous ideas and enable vulnerable people to adopt any of them but selecting a suitable livelihood opportunity for secure livelihood is pivotal. It may be prudent to prioritise the entry point actions and sequence them with appropriate time lags. The framework should have inbuilt flexibility, and it should be possible to make changes in the approach with periodical monitoring and evaluation of the progress of developmental interventions. The SLP framework chosen facilitates to structure of the information on the key linkages among the different assets and accessibility, identifying the significant issues and gaps in livelihood and determining the strategies for making short and long term interventions to improve the livelihoods. The sustainable livelihood framework and its principles provide tools to understand the micro-and macro-factors shaping the livelihood options and strategies and plan and implement development activities. Scoping is done to recognise the key factors influencing livelihood characteristics. The interventions focus on livelihood enhancement and creating additional and alternative livelihoods. The links at macro-and at micro-levels are identified,

and the policy development and planning of the strategies revolve around the people's needs and priorities mainly based on their aspirations and capacities. Enhancing the access of the rural poor population to the opportunities and resources is aimed at securing sustainable livelihoods for the rural population of the studied district.

5.4.3 Safety Measures Adopted by the Farm household based on water availability

Based on the availability of water resources, the safety measures have been categorised among the sample respondents as having adequate IWR in the study area. People having access to AWR are less vulnerable compared to people having IWR. The drought caused by below-average annual precipitation in the studied district caused a massive loss of agricultural production, especially paddy and cotton. During this period, people used to seek alternative water resources to lower their vulnerability. This section will elucidate various safety measures adopted by the farmers to reduce drought vulnerability in the region. The safety measures can be categorised as crop insurance, crop intensity change, irrigation & fertiliser, livestock rearing, credits or loans, household savings, mortgage, distress sale, migration, reducing food consumption and other expenditures, etc. Table 5.8 revealed that in the case of crop insurance measures, 36 per cent of samples have AWR, whereas 64 per cent have IWR.

Similarly, in case of change in crop intensity measure, only 8 per cent of samples have AWR, whereas 92 per cent of samples have IWR. In case of change in irrigation and fertiliser application measures, only 18 per cent of samples have AWR, whereas 82 per cent of samples have IWR. In the case of livestock rearing, only 37 per cent of samples have AWR, whereas 63 per cent of samples have IWR. In the case of credits or loans measure, only 31 per cent of samples have AWR, whereas 69 per cent of samples have IWR. In the case of using household savings measure, only 35 per cent of samples have AWR, whereas 65 per cent of samples have IWR. In the case of mortgage measures, only 42 per cent of samples have AWR, whereas 58 per cent of samples have IWR. In the case of distress sale measure, only 11 per cent of samples have AWR, whereas 89 per cent of samples have IWR.

In the case of migration measures, only 32.5 per cent of samples have AWR, whereas 67.5 per cent of samples have IWR. In the case of reducing food consumption measures, only 22 per cent of samples have AWR, whereas 78 per cent of samples have IWR. In the case of lowering non-food expenditure measures, only 27.5 per cent of samples have AWR, whereas 72.5 per cent of samples have IWR. In the case of adopting the barter system measure, only 29 per cent of samples have AWR, whereas 71 per cent of samples have IWR. In the case of

rainwater harvesting, only 18 per cent of samples have AWR, whereas 82 per cent of samples have IWR. In the case of diversified livelihood measures, 65.5 per cent of samples have AWR, whereas 34.5 per cent of samples have IWR. In the case of avoiding commercial crops measure, only 22.5 per cent of samples have AWR, whereas 77.5 per cent of samples have IWR.

Table 5.8 Safety measures adopted by the farm household based on the availability of water resources

Safety Measures	Availability of Water Resources				Total Adopted
	Adequate		Inadequate		
	<i>F</i>	%	<i>f</i>	%	
Crop insurance	18	36.00	32	64.00	50
Change in crop intensity	7	8.24	78	91.76	85
Change in irrigation & fertiliser	31	17.82	143	82.18	174
Livestock rearing	41	37.27	69	62.73	110
Credits or loans	20	30.77	45	69.23	65
Using HH saving	64	35.16	118	64.84	182
Mortgage	47	42.34	64	57.66	111
Distress sale	12	11.11	96	88.89	108
Migration	16	32.65	33	67.35	49
Reduce food consumption	18	21.95	64	78.05	82
Reduce non-food expenditure	73	27.44	193	72.56	266
Adopting barter system	26	28.89	64	71.11	90
Rainwater harvesting	2	18.18	9	81.82	11
Diversification of livelihood	19	65.52	10	34.48	29
Avoid commercial crops	21	22.58	72	77.42	93
Seek non-agricultural employment	16	28.57	40	71.43	56

Source: Field Work, Balangir District, Odisha, 2019

Finally, in the case of seeking non-farm employment measures, only 28.5 per cent of samples have AWR, whereas 71.5 per cent of samples have IWR. It is evident from the analysis that farm households having IWR are more vulnerable to drought as compared to people having AWR.

5.4.4 Safety Measures Adopted by the Farm HH based on the social category

Similarly, based on the social category, the safety measures have been categorised among the sample respondents belonging to the scheduled and non-scheduled categories in the study area.

Adopting various farm-level safety measures is unequal among the different social categories. The maximum number of scheduled category farm households belonging to SCs and STs have adopted various safety measures compared to the non-scheduled category, i.e., General and OBCs. Table 5.9 revealed that in the case of crop insurance measures, 72 per cent of samples belong to the scheduled category, whereas only 28 per cent belong to the non-scheduled category. Similarly, in case of change in crop intensity measure, about 85 per cent of samples belong to the scheduled category. In contrast, only 15 per cent of samples belong to the non-scheduled category. In case of change in irrigation and fertiliser application measures, about 82 per cent of samples belong to the scheduled category. In contrast, only 18 per cent of samples belong to the non-scheduled category. In the case of livestock rearing, about 59 per cent of samples belong to the scheduled category, whereas 41 per cent of samples belong to the non-scheduled category. In the case of credits or loans measure, about 78.5 per cent of samples belong to the scheduled category, whereas only 21.5 per cent of samples belong to the non-scheduled category. In the case of using household savings measure, about 61.5 per cent of samples belong to the scheduled category, whereas only 38.5 per cent of samples belong to the non-scheduled category. In the case of mortgage measures, about 58.5 per cent of samples belong to the scheduled category, whereas about 41.5 per cent of samples belong to the non-scheduled category. In the case of distress sale measure, about 86 per cent of samples belong to the scheduled category, whereas only 14 per cent of samples belong to the non-scheduled category. In the case of migration measures, about 71.5 per cent of samples belong to the scheduled category, whereas only 28.5 per cent of samples belong to the non-scheduled category. In the case of reducing food consumption measures, about 77 per cent of samples belong to the scheduled category, whereas only 23 per cent of samples belong to the non-scheduled category. In the case of reducing non-food expenditure measures, about 76 per cent of samples belong to the scheduled category. In contrast, only 24 per cent of samples belong to the non-scheduled category.

In the case of adopting the barter system measure, about 76.5 per cent of samples belong to the scheduled category. In contrast, only 23.5 per cent of samples belong to the non-scheduled category. In the case of rainwater harvesting, only 18 per cent of samples belong to the scheduled category, whereas 82 per cent of samples belong to the non-scheduled category. In the case of diversified livelihood measures, about 55 per cent of samples belong to the scheduled category, whereas 45 per cent of samples belong to the non-scheduled category. In the case of avoiding commercial crops measure, about 76 per cent of samples belong to the

scheduled category, whereas only 24 per cent of samples belong to the non-scheduled category. Finally, in the case of seeking non-farm employment measures, about 78.5 per cent of samples belong to the scheduled category.

Table 5.9 Safety Measures adopted by the farm household based on the social category

Safety Measures	Social Category				Total Adopted
	Scheduled Category		Non-scheduled Category		
	<i>F</i>	%	<i>f</i>	%	
Crop insurance	36	72.00	14	28.00	50
Change in crop intensity	72	84.71	13	15.29	85
Change in irrigation & fertiliser	143	82.18	31	17.82	174
Livestock rearing	65	59.09	45	40.91	110
Credits or loans	51	78.46	14	21.54	65
Using hh. saving	112	61.54	70	38.46	182
Mortgage	65	58.56	46	41.44	111
Distress sale	93	86.11	15	13.89	108
Migration	35	71.43	14	28.57	49
Reduce food consumption	63	76.83	19	23.17	82
Reduce Non-food consumption	203	76.32	63	23.68	266
Adopting barter system	69	76.67	21	23.33	90
Rainwater harvesting	2	18.18	9	81.82	11
Diversification of livelihood	16	55.17	13	44.83	29
Avoid commercial crops	71	76.34	22	23.66	93
Non-agricultural Employment	44	78.57	12	21.43	56

Source: Field Work, Balangir District, Odisha, 2019

In contrast, only 21.5 per cent of samples belong to the non-scheduled category. The study revealed that based on the higher frequency of scheduled category sample population of 212, most of the sample respondents avail significant safety measures compared to the non-scheduled category population of 76 in the study area. People belonging to the scheduled categories are more vulnerable to drought than the non-scheduled category.

5.5 Status of debt among the sample based on the social category in the study area

The drought situation in western Odisha causes severe damage to agriculture almost every year. The Balangir district has been facing drought vulnerability for decades. Farmers have less access to various resources such as economic, social, natural, human etc., considered to be the most vulnerable in terms of livelihood. The majority of those farming communities used to seek financial assistance through different sources. The statistics represent the status, sources and purposes of indebtedness of the vulnerable farm households based on the social category in the study area. The social category has been defined as the scheduled and non-scheduled categories. Furthermore, the planned category combines SCs and STs, whereas the non-scheduled category is the combination of OBCs and General. The statistics revealed that out of 288 sample respondents, 65 farm households had availed financial assistance from different sources.

Table 5.10 revealed that based on the social category, around 78.46 per cent of farm households had availed financial assistance from different sources compared to the non-scheduled category of 21.53 per cent out of the total respondent borrowed. As far as the sources of debt are concerned, around 61.54 per cent of SCs farmers have chosen institutional credit facilities because of their low-interest rates. In contrast, only 4.93 per cent of them have chosen non-institutional sources of indebtedness. However, in the non-scheduled category, only 18.46 per cent of farmers have availed financial assistance from institutional sources and 1 per cent from non-institutional sources in the study area. The purpose of the debt is identified as agriculture, business, household consumption, construction of houses, marriage and other social functions and repaying old loans. In the scheduled category, the majority of the respondent (64.71 per cent) have taken loans for agricultural purposes, followed by 21.5 per cent for business, 8 per cent for household consumption, 4 per cent for repaying the old loan and only 2 per cent for marriage and other social functions purpose. However, in the case of the non-scheduled category, 43 per cent of respondents have availed financial assistance for agriculture, 43 per cent for household consumption and 14 per cent for farm households for construction of house purposes in the study area.

Table 5.10 Status of debt based on social category in the study area

Debt Status	Scheduled Category		Non-scheduled Category		Total
	<i>f</i>	%	<i>f</i>	%	
Debt					
Indebtedness	51	78.46	14	21.53	65
Non-indebtedness	161	72.19	62	32.28	223
Source					
Institutional	40	61.54	12	18.46	52
Non-institutional	11	4.93	2	0.90	13
Purpose					
Agriculture	33	64.71	6	42.86	39
Business	11	21.57	0	0.00	11
HH consumption	4	7.84	6	42.86	10
Construction of House	0	0.00	2	14.29	2
Marriage/ Social Function	1	1.96	0	0.00	1
Repaying Old Loans	2	3.92	0	0.00	2

Source: Field Work, Balangir District, Odisha, 2019

5.5.1 Status of debt among sample based on the availability of water resources in the study area

The agricultural system in the study area is rainfed in nature due to the acute and erratic rainfall for years. The erratic rainfall causes a huge loss in the agricultural sector and hampers the allied sector. The vulnerable farmers' communities tend to get financial assistance from different sources to avoid crop failure shock. The following table discusses the Status, Sources and Purpose of indebtedness based on the availability of water resources in the study area. Table 5.11 revealed that 65 farm households had availed the financial assistance from different sources based on the availability of water resources. The statistics showed that based on the AWR, only 31 per cent of farm households had availed of loans from different sources, whereas 69 per cent of farm households have availed the loan in the area having IWR. As far as the sources of indebtedness are concerned, 26 per cent of respondents have chosen intuitional sources of financial assistance, whereas only 1.5 per cent of respondents have chosen non-institutional. However, in the case of the area having IWR, 54 per cent of farm households have availed financial assistance from intuitional sources, and only 4.5 per cent of respondents benefited from non-institutional sources. People with AWR are the minor victim of indebtedness compared to people with IWR. In the case of AWR, the purpose of the debts is inclined towards agriculture (45 per cent), followed by 30 per cent for household consumption, 10 per cent for construction of the house and 5 per cent for business, marriage or social function

and repaying of old loans. Whereas, in the case area having IWR, the purpose of indebtedness is significantly higher (67 per cent) for agriculture, followed by 22 per cent for business, 9 per cent for household consumption and 2 per cent for repaying old loans.

Table 5.11 Status of debt based on availability of water resources in the study area

Debt Status	Adequate Water		Inadequate Water		Total
	<i>f</i>	%	<i>f</i>	%	
Debt					
Indebtedness	20	30.76	45	69.23	65
Non-indebtedness	57	25.56	166	74.43	223
Source					
Institutional	17	26.15	35	53.85	52
Non-institutional	3	1.35	10	4.48	13
Purpose					
Agriculture	9	45	30	66.67	39
Business	1	5	10	22.22	11
HH consumption	6	30	4	8.89	10
Construction of House	2	10	0	0.00	2
Marriage/ Social Function	1	5	0	0.00	1
Repaying Old Loans	1	5	1	2.22	2

Source: Field Work, Balangir District, Odisha, 2019

Note. HH- Household

5.6 Socio-political adaptation

Social capital refers to the social relationship among individuals in society. It allows people to work together effectively to achieve goals. The possession of social capital includes participation in different decision-making bodies, membership in social groups, the beneficiary of varying development schemes etc. The study has categorised the possession of social capital into two broader types, i.e., social capital based on social category and availability of water resources. The social capital status of the sample farm household (in Table 5.12) revealed that about 98.9 per cent of the sample populations are under the BPL category, out of which 50.5 per cent are the beneficiary of different state and central government schemes the study area. About 21.5 per cent of the sample respondents are active members of other social groups in the study area. Based on the social category classification, it is evident that about 77 per cent of the scheduled category sample respondents are under the BPL category. In contrast, only 23 per cent of the non-scheduled category are under BPL, out of which 77 per cent of the scheduled

category sample respondent are beneficiaries of different development schemes. In contrast, only 23 per cent of non-scheduled category sample respondents are from BPL.

Table 5.12 Socio-political status of the sample respondent in the study area

Socio-political	Membership	Percentage	Total Sample	
Membership in Social Groups	59	21.5	288	
BPL Category	272	98.9	288	
the beneficiary of the Development Scheme	139	50.5	288	
Socio-political	Scheduled Category		Non-scheduled Category	
	F	%	f	%
Membership in Social Groups	48	81.4	11	18.6
BPL Category	210	77.2	62	22.8
the beneficiary of the Development Scheme	107	77	32	23
Socio-political	AWR		IWR	
	f	%	f	%
Membership in Social Groups	11	18.6	48	81.4
BPL Category	76	27.94	196	72.1
the beneficiary of the Development Scheme	39	28.1	100	71.9

Source: Field Work, Balangir District, Odisha, 2019

The study also revealed that only 48.5 per cent of the scheduled category sample respondents are active participants in different social groups. However, only 18.5 per cent of the non-scheduled category are members of other social groups in the study area. Based on the availability of water resources, the study revealed that only 28 per cent of the sample respondent having adequate water access are under the BPL category, whereas 72 per cent sample having inadequate access to water resources are under BPL, out of which 28 per cent sample respondent having adequate water access are beneficiary of different government development schemes whereas, 72 per cent sample respondent having inadequate water access are beneficiary in the various government development scheme. As far as the membership status is concerned, 18.5 per cent of sample respondents having adequate water access are active members in different social groups, whereas 81.5 per cent of the sample respondent having inadequate water access are active participants in other social groups in the study area.

5.7 Summary

Climate change doesn't directly lead to human migration; instead, it generates a changing environmental condition which forces the vulnerable community to migrate (Podesta, 2019). The changing environmental condition generally composes precarious livelihood, low adaptation strategy, lack of access to various resources, proper training and techniques, etc. These factors result from multiple stressors such as extreme weather conditions like hotter atmosphere, more intensive rainfall, thunderstorm, flood, drought, volcanic eruptions etc. It makes it difficult for vulnerable communities to survive in challenging conditions. Due to the loss of livelihood, the vulnerable people migrated to different places, searching for alternative livelihoods. People with access to adequate water resources are less migrated than people with inadequate access based on water resource availability. Similarly, in the social category, scheduled category populations are more prone to migration than the non-scheduled category in the study area. Moreover, the development dimensions of migration cannot be ignored completely. It helps millions of poor rural communities, especially the scheduled castes and scheduled tribe community, to enhance their livelihood. Migration is one of the safety measures farmers adopt in the study area to minimise drought vulnerability. Apart from migration, the second phase of the chapter has analysed other safety measures adopted by the farm household to minimise the grave consequences of drought in the study area. The safety measures have examined the vulnerability of social categories based on the access to water resources. The study found that farmers with access to water from various sources such as canals, borewells, government schemes, well etc. are less vulnerable than farmers with inadequate access. After the analysis of migration and safety measures, the final chapter deals with the conclusion and discussion of the study.

CHAPTER VI

Summary and Conclusion

The concept of vulnerability is used in multiple contexts such as social, cultural, environmental, institutional, economic structures, public health, ecology, livelihoods, development, climate change, adaptation and many more. Therefore, it will be unfair only to use the concept in an environmental context (Few, 2003; Fusel, 2007). According to United Nations International Strategy for Disaster Reduction (UNISDR, 2004), vulnerability is the condition determined by physical, environmental, social and economic processes that increase the susceptibility of a community to the impact of risks. The general use of the term 'Vulnerability' is referred to the capability of a system to be harmed, i.e., the level to which a system is susceptible to and unable to cope with the risk. So, it indicates being prone or susceptible to harm or injury.

Our study elucidates the vulnerability Pattern in relation to natural hazards by placing people's vulnerability as its core analysis. In terms of natural events or processes, people's vulnerability means the characteristics of an individual or group and their condition that impact their capability to anticipate, resist, cope with, and recover from any natural hazards. The process generally affects people's livelihood, health, property and other valuable assets differently based on the diverse socio-economic conditions of the people. The socio-economic conditions are influenced by many vital variables such as class, caste, gender, age, health, occupation etc. Most physical and natural sciences studies have focused on the physical vulnerability, especially natural hazards, while social scientists have focused on the social vulnerability, i.e., adaptive capacity, coping mechanisms, policy measures, resources management, migration, etc. Most interestingly, social vulnerability has become one of the vital parts of vulnerability study, intending to focus on the most vulnerable section of society (Brooks, 2003).

Based on various definitions by researchers, Mugadur (2009) analysed some vulnerability characteristics such as, Population group location, overpopulation, women, disabled, aged person and accessibility to economic, material and other resources. In addition to this, it has some regular elements which are responsible for the development of vulnerability, such as in rural areas (Ecological damage, degradation, decline of natural or essential local resources, forced migration, no access to credit facilities, inability to produce a surplus, absence

of alternative sources of income, Unequal access to land in rural area) and in urban areas (low-income level, subsistence income level, Inadequate personal, social, infrastructural, or transport service, population in-migration, compressing risks). The vulnerability study in the present context has been defined in terms of natural hazards vulnerability and social vulnerability to examine the study's objectives.

6.1 Natural disasters-induced vulnerability

All types of natural hazards have different impacts on human beings and society as a whole. The impacts generally vary from people to people, group to group and community to community, based on their capacity to resist. Again, the effect can be visible when the people or groups cannot resist or recover from stresses. So, it indicates that vulnerability can't be mapped without impending people or groups to resist, absorb and recover from the grave consequences of natural calamities (O'Keefe et al., 1976). The vulnerability of people to natural hazards generally depends on the place where they reside, the types of natural resources they use and most importantly, the management of appropriate natural resources during a particular hazard event. Hence, natural hazards are mediated by the institutional structure of society, and it doesn't necessarily imply that increased economic activities will reduce the vulnerability (Burton et al., 1993). However, Adger (2003) has a somewhat distinctive opinion; vulnerability is not only mediated by the institutional structure but rather by the constraint over the availability and accessibility of resources.

6.2 Social Vulnerability

The condition of vulnerability is socially distinguished within the hazards and environmental change literature. It has its original concept in the work of Gilbert White, who mentioned the significance of shifting population, mobility and types of housing and their contributions to a nation's vulnerability to hazards (White and Haas, 1975). The vital portion of the initial work in this area concentrated on independent social elements and their impact on vulnerability. The importance of age and occupation was studied by Bolin (1982), and housing, family structure and built ecosystem by Bolin and Bolton (1986). Hewitt (1983), Susman et al. (1983) and Alexander (1991) questioned the predominant beginning at a more conceptual or theoretical standard, and this led the way to contemporary work by O'Brien and Lienchenko (2000), Watts and Bohle (1993), Bohle et al. (1994), Blaikie et al. (1994), Adger and Kelly (1999, 2001) and Lienchenko and O'Brien (2002).

The social construction of vulnerability study focuses on the system's ability to react to the stimulus, identifying that the system is not entirely prone to natural disasters but rather to the social condition. People surviving under various social, economic, constitutional, developmental and institutional environments or settings have distinct levels of vulnerability. Biophysically susceptible places do not always intersect with vulnerable populations. For instance, in places of high biophysical risks, the financial loss might be extensive. Still, likewise, the population might have substantial security measures like insurance to recover from such losses quickly. Moderate issues could have a distinctive effect on socially vulnerable populations with a long time interval for recovery.

Amongst other nations, Bangladesh and Florida are the nations which are vulnerable biophysically, for instance, sea-level rise and tropical storms. The effect of these occurrences varies in both nations distinctively. Florida incurred more financial loss or was affected economically, whereas Bangladesh incurred the loss of life and livelihood. Hurricane Andrew hit Florida in 1992, which caused an economic loss of more than US\$16 bn but perished less than 20 people (Morrow, 1997). Before the year, a similar cyclone hit the southeast coast of Bangladesh, killing around 140,000 people and devastating millions of livelihoods. All were not similarly affected. Vulnerability varies in accordance with gender, health, livelihood, and age, and this unlikeness cannot be described only in the condition of the nature of the stimulus. Therefore, with reference to policy, the social vulnerability composition indicates the need to concentrate on the attributes of the system determining the capability of humans and the society to respond to, cope with and adapt to a stimulus.

6.3 Significance of vulnerability assessment

The significance of climate change in contemporary society generally comes with a vital question, why are we compelled to hassle this much? in the end, climate-induced natural disasters have been associated with us for as long as recorded in history and presumptively even longer. Generations of people have had to face several disasters and recover from them, and life keeps moving like normal. Phenomenon like drought, cyclone, earthquake, volcanic eruption, tsunami, wildfire, flood, landslides etc., have been seen for ages. These climate disasters have severe impacts such as social, economic, human casualty, injury and many more to the human and natural world. Consequently, the vulnerable population learned to address these issues comprehensively. However, we have neither removed nor entirely restricted them; we have been able to transform their impacts in diverse ways. The effect still corresponds to

intolerable difficulties for people marked by comprehensive sustenance of life. According to the World Bank (n.d.), climate disasters are inevitable as fatalities. They can be reflected in three-dimensional results in many sectors such as personal, social, and economic.

Of all nations, developing nations experience the worst impact of climate-induced natural disasters. In the context of a developing nation, India is placed among the most vulnerable country to climate-induced natural disasters due to its geo-climatic, topographic, industrialisation, urbanisation, and overpopulation settings. The country comprises 28 states and nine union territories. Of all the Indian states, Odisha is one of the poorest states in terms of growth and development. About 70 % of the total population in the state depends on the agricultural sector. However, agriculture in the state is severely vulnerable due to the negative impact of natural hazards, especially drought and flood. Agriculture is one of the climate-sensitive sectors because of its higher dependence on monsoon rainfall. The variability in the monsoon pattern is one of the major threats to agriculture in the state. The irregular rainfall pattern in the state causes severe drought in the hilly areas and floods in the coastal area. Therefore, Odisha is a workplace of various natural hazards like cyclones, floods, drought etc. Floods and drought are the state's regular features among the entire natural hazards.

6.4 Objectives of the Study

- To examine the impact of drought vulnerability on agricultural production and socio-economic conditions of farm households belonging to scheduled and non-scheduled categories.
- To analyse the rate of migration among the farm household during normal and drought year
- To evaluate the essential safety measures adopted by the farm households to combat the adverse impact of drought.

6.5 Plan and design

The study was conducted in two phases- phase I and phase II. In phase I, the secondary data was collected using a statistical survey schedule to assess the drought vulnerability and pattern of agriculture production in Odisha and the study area, i.e., the Balangir district. The secondary data were collected from various sources such as 'District Statistical Handbook of Balangir

district', 'Census report- 2011', 'India water portal', 'Odisha agricultural statistics', agricultural office in Patnagarh etc.

In phase II, primary data were collected from the rural farm household of the study area by using a survey method and interview method. The survey method was based on a $2 \times 2 \times 2$ mixed factorial design, where the first two factors were the subject factor and the last one was the within-subject factor. The first two factors consist of 2 different levels, and the last factor is considered a repeated factor consisting of 2 levels. Therefore, the method is used as $2(\text{Adequate Water Resources-AWR and Inadequate Water Resources-IWR}) \times 2 (\text{scheduled category and non-scheduled category}) \times 2 (\text{normal period and drought period})$ repeated

6.6 Data Sources, Sampling and Methodology

Odisha is being chosen as the universe of the study, whereas the study of rainfall variation and natural disasters is significant in the context of climate change. The Southwest monsoon, which arrives at the state, continues to impact for three months (July to September) and provides 80 per cent of total precipitation. Based on the agro-climatic zone, the distribution of rainfall is unequal. While the coastal region receives adequate rainfall, the hilly area receives scant rainfall. The study has selected the Balangir district of Odisha out of 30 districts to understand the climate-induced drought vulnerability on rural farm households' livelihood and socio-economic life. The rationale behind choosing the Balangir district as our study site is that it is one of the rainfed areas under the Western Central Table Land (WCTL) Agro Climatic Zone, characterised by hot and sub-humid climate with hot summer and erratic rainfall of south-west monsoon. It is one of the drought-prone districts of western Odisha. Between 1970 to 2020, the district has experienced 25 drought years, three flood years and four floods and drought years, respectively. Almost all the year, the districts can be seen as dry. As a result, the most significant crop season, such as Kharif and Rabi, are primarily vulnerable to the drought impact. Thus, the selection of the district to understand the climate-induced drought vulnerability in the study area is justified. After selecting the district, the study has chosen the Patnagarh block for the proposed research. The total population of the block is 168,325. Out of which, 147,301 (87.50%) population reside in rural areas whereas only 21,024 (12.50%) population in urban. After selecting the block, the study has chosen Mundomahul Panchayat of Patnagarh Block out of the 26 GPs.

There are seven villages in Mundomahul panchayat- Bada Jhankarpalli, Bhaludarah, Chitadungri, Golimara, Manepad, Mundomahul, Ranidharah. Out of these villages, the study

has chosen Bhaludharah, Mundomahul and Manepad villages based on the availability of water resources and vulnerable social groups. After selecting the district, block and villages, the study has prepared a survey schedule to collect the primary data from the household level. The interviews during the period of the household survey were aimed to capture the effects of drought on the studied community and strategies adopted by the local farmers to cope with the chronic drought situation in the study area. Thus, the collection of primary data was carried out using a multistage sampling method that consists of selecting the study district in the first step, taluka in the second step, study village in the third step, and households in the final step. The study used an interview schedule consisting of 23 open and close-ended questions to understand the impact of drought on the studied area regarding livelihood vulnerability and safety measures adopted by the farm household to reduce the vulnerability. The village economy structure is primarily dependent on agricultural production. The most dominant crops grown in the area are rice, cotton, pulses and wheat. The drought condition in the studied village has been seen as one of the significant threats to the livelihood of the poor farmers.

6.7 Major Findings

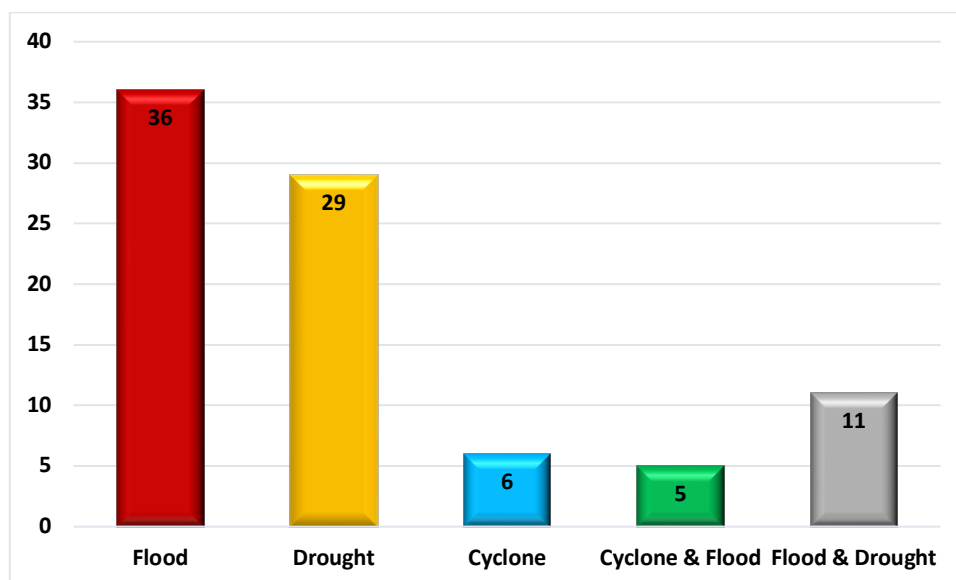
The research findings have been analysed based on objectives and empirical research conducted in the study area. Subsequently, the finding is accompanied by the issues of livelihood, agriculture, migration and safety measures in terms of social category and water resources. The study has assessed the drought vulnerability in two phases (a) state and district level vulnerability based on secondary sources of data collected from the India water portal, census and other sources (b) household-level vulnerability based on primary/ empirical sources of data collected from the field location.

(a) The state and district level vulnerability based on secondary sources of data revealed the vulnerability scenario as follows:

The disaster statistics show that Odisha has been a workplace of several natural disasters. The major disasters can be categorised as floods, droughts, and cyclones. The extreme natural events in the state cause massive damage to the state's economy. It also causes several casualties, loss of property and many more. While floods and cyclones are experienced in the districts of Eastern Odisha, regular and frequent droughts are mainly seen in different districts of Western Odisha. Figure 6.1 shows the temporal distribution of natural calamities in Odisha from 1955-to 2020. Between 1955-2014, Odisha confronted 35 flood years, 29 drought years,

six cyclone years, five cyclone and flood years and 11 flood and drought years. These recurrent natural disasters have affected the agricultural production and income of the farmers.

Figure 6.1 Natural Calamities in Odisha during 1955 to 2020 (in number)



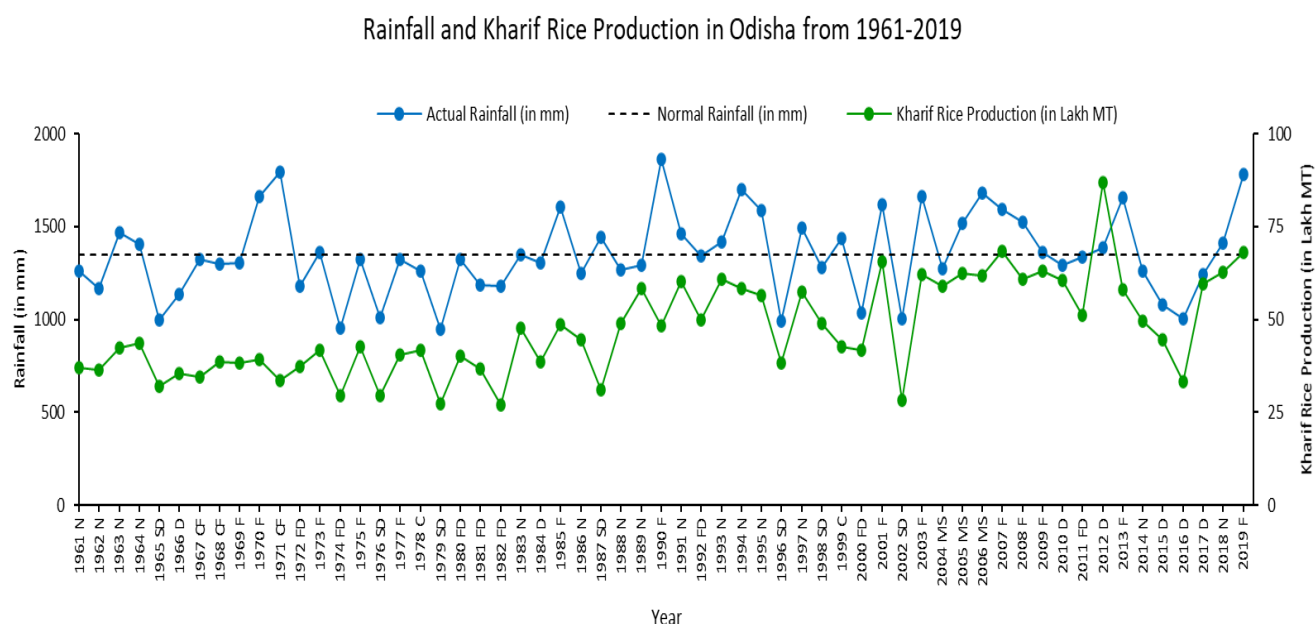
Source: Odisha state disaster management authority, OSDMA

6.7.1 Impact of rainfall deviation and natural calamities on rice production in Odisha

Figure 6.2 depicts a clear understanding of rainfall deviations, climate-induced natural disasters and Kharif rice production in the state of Odisha. The rainfall variation directly hampers the production rate in terms of low crop output and drought due to the state's erratic and scant precipitation. The actual rainfall deviation from the normal (< 1000 mm) causes prolonged drought in the region, while the flood situation leads to healthy rice production. The analysis of time series data from 1961 to 2019 based on rainfall and rice production shows that from 1961 to 1973, rice production was around 35 lakhs million tonnes per annum which later decreased to an average of about 25 lakhs million tonnes from 1974 to 1987. From 1988 to 1995, rice production significantly increased due to adequate rainfall (> 1400 mm) and flood years in the state. However, from 1996 to 2002, rice production was low due to rainfall deficiency and drought situations. Similarly, from 2003 to 2015, rice production significantly increased due to the adequate rainfall of more than 1500 mm and flood situations. Again during 2016 and 2017, the production rate followed a decreasing trend because of inadequate water and from 2018 to 2019, the production rate of rice turned out to be much higher due to adequate rainfall and flood situation. Therefore, it is evident from the time series data analysis that

rainfall variation directly leads to various natural calamities in the state and significantly affects rice production.

Figure 6.2 Rainfall and rice production in Odisha from 1961-to 2019



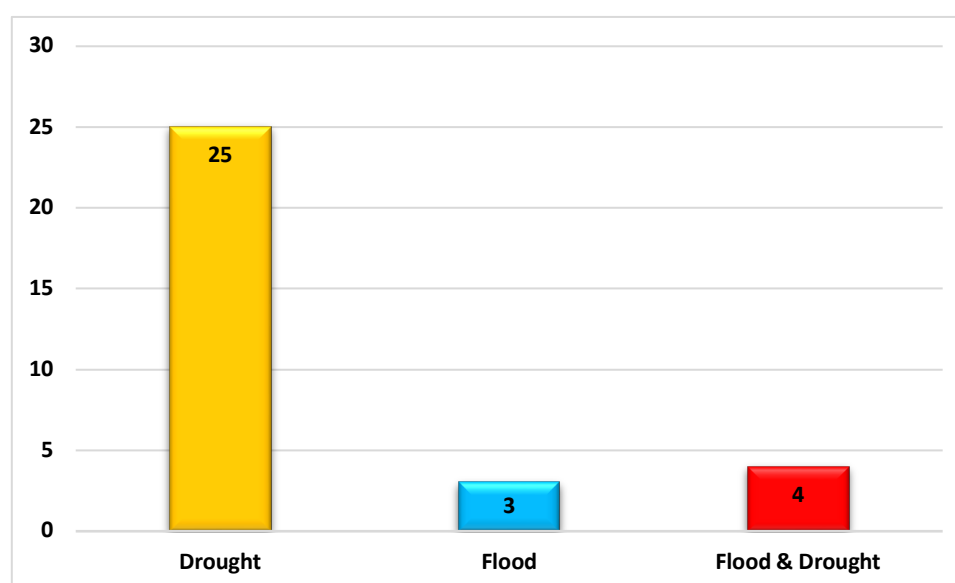
Sources: Author's calculation from different sources

Note. N= Normal, D= Drought, F= Flood, C= Cyclone, MS= Moisture Stress, SD= Severe Drought

6.7.2 Disaster history of Balangir district

The district is one of the drought-prone districts in western Odisha due to scanty rainfall. The agriculture in the district is rainfed in nature. It has so far experienced 25 drought years, 3 flood years and 4 flood & drought years from 1970 to 2020. The frequent drought situation in the district has caused a severe impact on people's lives in terms of vulnerable agricultural livelihood over the year (Figure 6.3).

Figure 6.3 Natural Calamities in Balangir During 1970 to 2020

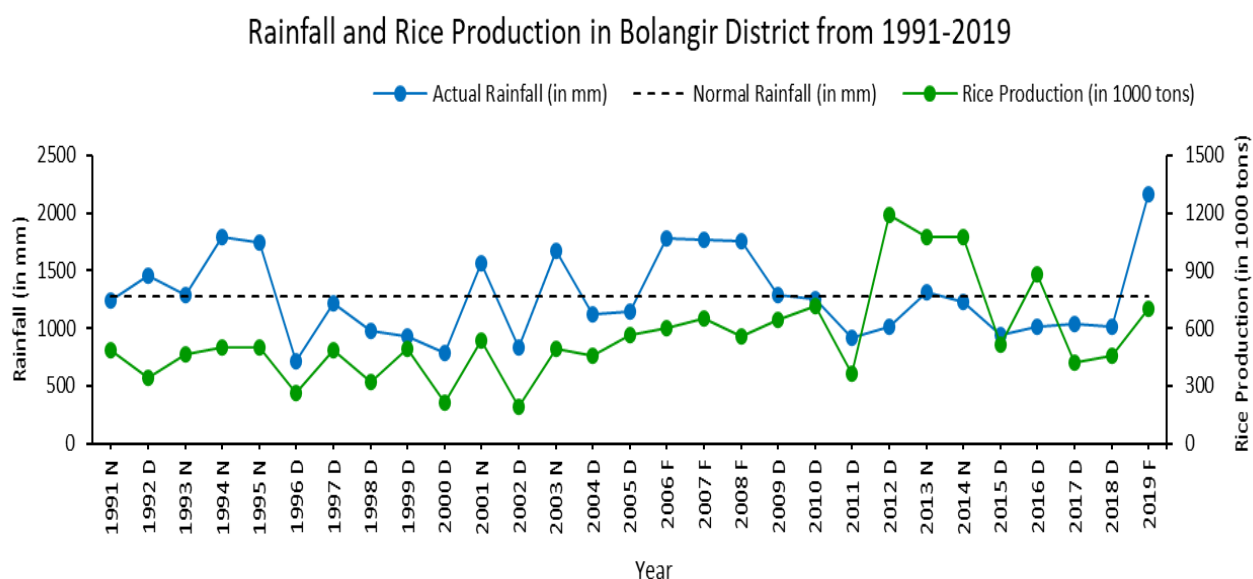


Source: Balangir district portal

6.7.3 Impact of rainfall deviation and natural calamities on rice production in Balangir

Figure 6.4 depicts a clear understanding of rainfall behaviour, climate-induced natural disasters and rice production from 1991 to 2019 in the Balangir district. The rainfall variation directly affects rice production in crop failure and drought situations due to erratic and scanty rainfall in the district. The actual rain from the normal rainfall of less than 1000 mm causes a prolonged drought period in the region, while flood and normal period lead to production growth. The time-series statistics (1991-2019) show that from 1991 to 1995, rice production was around 6 lakhs tonnes due to the actual rainfall of more than 1400 mm. However, the production significantly declined from 1996 to 2002 due to less than 1000 mm average rainfall. From 2003 to 2010, the production of rice increased more than due to the adequate rainfall (> 1500 mm), while in 2011, the production declined (less than 4 lakhs tonnes) due to rainfall shortage and drought conditions in the district. Similarly, from 2012 to 2014, the production increased to more than 7 lakhs tonnes per annum because of adequate rainfall in the district. Again, the production from 2015 to 2018 declined due to the rainfall deficiency and frequent droughts over the year and increased in the 2019 flood year in the district. The district has experienced 17 drought years, 4 flood years, and 8 normal years between 1991 and 2019. The impact of a higher frequency of drought years has resulted in low crop output and agricultural failure in the district.

Figure 6.4 Rainfall and rice production in Balangir from 1991-to 2019



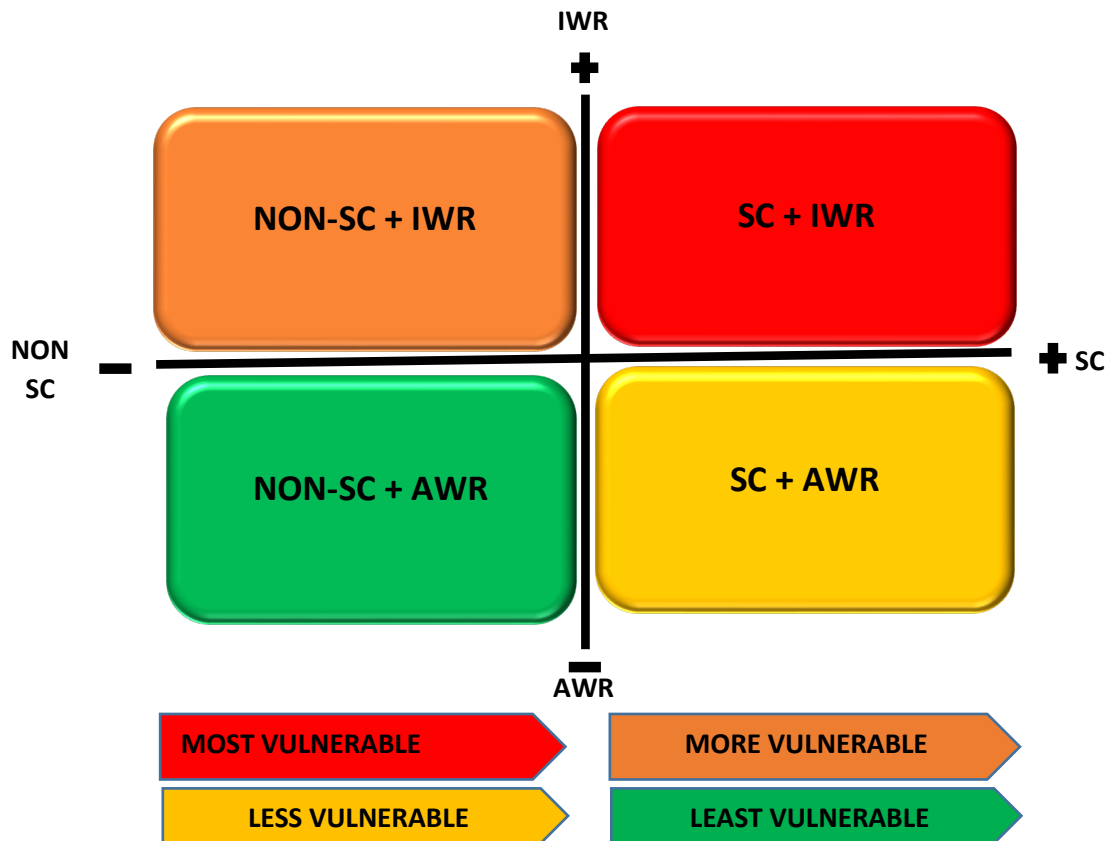
Source: Author's calculation from different sources

Note. N: Normal year, D = Drought year, F = Flood year

(b) Similarly, the household level vulnerability based on primary/ empirical sources of data collected from the field location revealed the drought vulnerability as follows:

The drought vulnerability framework has measured significant factors such as social category, water resources and degree of vulnerability to evaluate a clear picture of household-level vulnerability. The framework has taken two important parameters (least vulnerable and high vulnerable) to evaluate the level of vulnerability among different social groups. From figure 6.5, it is observed that there are four types of vulnerable in the context of socio-economic conditions, accessibility of resources, i.e., (a) least vulnerable, (b) less vulnerable, (c) more vulnerable and (d) most vulnerable in the study area. It is evident from the statistical analysis that the scheduled category with IWR is most vulnerable because both the scheduled category and IWR are disadvantageous groups. On the contrary, the non-scheduled category with AWR is less vulnerable as both are under the advantageous category. The rest, more vulnerable and less vulnerable, are advantageous and disadvantageous components, i.e., the scheduled category with AWR is the less vulnerable, and the non-scheduled category with IWR is more vulnerable.

Figure 6.5 Framework to understand drought vulnerability



Note- NON-SC: Non-scheduled Category
 SC: Scheduled Category
 AWR: Adequate Water Resources
 IWR: Inadequate Water Resources
 (-): Least Vulnerable
 (+): High Vulnerable

6.7.4 Problem of irrigation

Based on the field-based observation, it is evident that water resources play a significant role in agricultural growth. The main problem in the recent decade is the shortage of water resources (D'Souzaa, 2003; Vijay Shankar, 2016; D'D'Souzat and AlID'Souzast0144). It is observed from various studies that there is a huge gap between the supply and demand of water resources (Saleth and Dinar, 2004). The scarcity of water resources ultimately poses multiple challenges to the sustainable development agenda. Consequently, it causes a huge problem for the agricultural community to produce sufficient grains to satisfy the demand of India's huge population (Molden 2007, 2010). The use of water for infrastructure development and daily uses puts intense pressure on water resources. The overpopulation of India also adds extra pressure while dealing with water scarcity (Garg and Hassan,

2007). The decadal growth of world population statistics revealed a three-fold increase in world population (Rose, 2013). The population growth leads to the demand for water.

Moreover, water use for different purposes has exceeded more than six times. It is evident from various studies that water plays a significant role in the agricultural sector. The prolonged period of water scarcity ultimately resulted in a chronic drought situation in many regions and consequently led to severe crop failure. In hilly areas, the frequency of drought has increased (Sharma, 2017). The drought scenario caused by inadequate water resources is primarily responsible for crop failure in India. The irrigation facility for agriculture purposes has been substantially decreased over the year (Saleth, 1996). Therefore, the efficient use of water resources is significant in bridging the gap between agriculture and sustainable development.

The expansion of irrigated land is crucial in nation-building and agricultural growth (Kreutzmann, 2015). In western Odisha, the geographical settings and irregular rainfall cause a huge problem for the farming community. The majority of the rural population is dependent on the agricultural sector. The development of the agricultural sector will foster rural prosperity in the state. In recent decades, prime importance has been given to irrigation systems due to the insufficient monsoon rainfall (Jairath and Ballabh, 2008; Kar and Swain, 2000). The inadequate monsoon rainfall in western Odisha is primarily responsible for the loss of dominant crops such as paddy and cotton. Based on the drought situation in western Odisha, farmers usually produce only one crop per year, even during the regular seasons. It is evident from various district statistics reports that the average precipitation in western Odisha is relatively lower due to monsoon failure. The monsoons arrive in the state in late June and continue to impact until mid-August or early September each year.

The deficit of rainfall during the monsoon months ultimately leads to crop failure. The irrigated area produces healthy crops compared to un-irrigated land (Panda, 1985). The irrigated area produces 2.3 times higher production than the rainfed agriculture area (FAO, 2007). The World Bank (1999) study revealed that crop production under irrigated areas is seven times higher than the area utterly dependent on rainfall. According to Rajvanshi (1991), the irrigated area contributes 66 % of food grain compared to the rainfed area. The government of India is also spending millions of dollars through the national budget and different funding agencies such as World Bank and Asian Development Bank to enhance the rural economy and sustainable livelihood of million (Herath, 2002). Although there is no evidence of complete immunity to drought situations in India, partial immunity is observed against drought vulnerability in several states through irrigation facilities. During the drought year in 1989-80, the food grain output of India declined by 6 % of its average level of production in an irrigated track.

The statistics also revealed a significant fall in food grain in the rainfed area at 22 % (Dhawan, 1988). The most vulnerable population belonging to the scheduled category (SCs and STs) are more prone to migration in search of job opportunities. The majority of them are engaged in labour-intensive

work due to a lack of education and skill. Therefore, it is evident from various literature and the study report that farmers belonging to the scheduled category with no irrigation facilities are the most vulnerable in terms of low production and poor socio-economic conditions. Consequently, these vulnerable communities are more prone to migration each year irrespective of normal or drought years to ensure their livelihood. The impact of drought conditions generally varies based on farmers' level of adaptation, human capital and socio-economic conditions. People with access to different resources are less vulnerable than those with inadequate access. The development and proper implementation of different irrigation schemes can solve the agricultural livelihood at the earliest. The lack of an adequate irrigation scheme poses multiple threats to the poor and marginalised section and leaves them with no choice and to believe in their fate.

On the contrary, excessive rainfall also potentially impacts crop production in terms of drought vulnerability. The study area Balangir district has also experienced two recent flood years, immediate after drought in 2020 and 2021 due to excessive rainfall. Therefore, the farmers are always at the double-edged swords in which the lack of rainfall resulting in drought will spoil the crops, and the excessive rain resulting in the flood will also damage the crops. Irrigation serves as a lifeline for the people of western Odisha, where most people depend upon agriculture as their primary source of livelihood.

The primary water sources in the study region are confined to the canal, pond, government-supported large well and borewell in the study area. People with private and public water access can save their crops during the drought. However, in the scheduled category, the vulnerability impact is entirely different. Even if they have access to AWR, people from these communities engage in alternative livelihoods and practice migration. The effect of drought on crop production remains unchanged; however, in the case of the scheduled category population, the socio-economic conditions get more miserable due to the lack of access and availability of various capital than in the non-scheduled category. Due to the poor financial and socio-economic conditions, the scheduled category population has a lower adaptation level to drought vulnerability (Sam, A.S., 2017). The drought condition of these populations directly replicates Amartya Sen's entitlement approach. Hence the move is spelt out from being at the mercy of the rainfalls to a move to the practice of the irrigation systems, which would ensure them a guaranteed crop output. The lack of irrigation facilities in western Odisha, especially in the Balangir district, has caused an upside-down for farmers in the district.

Moreover, the irrigation project in the SukTel river has been under construction for more than ten years in the district. Therefore, expansion of the irrigation infrastructures has to be given prime importance for developing agriculture in the region. After assessing vulnerability in the study area, the next chapter (chapter- 5) will discuss the relationship between climate change

and migration, specifically, climate change-induced drought and migration rate in the study area.

6.8 Limitations of the study

The present study looked into different aspects of climate-induced vulnerability, such as drought, agricultural failure, migration etc. and safety measures adopted by the farmers at the household level to cope with the extreme impacts. However, the study has some limitations and scope for future research.

- The time and resources involved in the research were not enough to conduct a repeated survey to understand the dynamism of the sample respondents.
- The sample size may be considered to be a limiting factor. The conclusive statement could have been done more effectively based on district-level data. However, the sample drawn from the study location represents the consideration.
- In terms of safety measures adopted by the farm households, the study is confined to the studied sample with the similar socio-economic background. It could be different people having dissimilar socio-economic settings.
- The vulnerability assessment in a comparative study could have enlightened more research scholars, academicians and policymakers to enhance and strengthen better strategies to mitigate vulnerability for the nation-state.

To sum up, the study postulates a holistic approach to climate change vulnerability in the context of a developing nation. The household data collected from the vulnerable population is crucial to understanding the micro-level vulnerability and adopting coping mechanisms to mitigate the vulnerability. Many researchers have analysed the issues of aggregate level for the state or a region. Still, micro-level analysis of vulnerability at the household level helps in framing effective plans since the household is the primary unit where the decision about the adaptation is taken. Therefore, the researchers and policymakers need to enhance and strengthen people's livelihood strategy at the grass-root level and provide alternative and additional livelihood opportunities for the vulnerable population.

References

- Aandahl, G. and Karen, O'Brien. (2001). Vulnerability to climate changes and economic changes in Indian agriculture. Paper presented at *Waters of Hope. The Role of Water in South Asian Development, Biannual Conference of the Nordic Association for South Asian Studies*, 20–22 September 2001.
- Adger, W. N. (1996). Approaches to vulnerability to climate change. Norwich, England. *Centre for Social and Economic Research on the Global Environment*, pp1-63.
- Adger, W. N. (1999). Social vulnerability to climate change and extremes in coastal Vietnam. *World Development*, 27(2), pp 249-269.
- Adger, W. N. (2000). Institutional adaptation to environmental risk under the transition in Vietnam. *Annals of the Association of American Geographers*, 90(4), pp 738-758.
- Adger, W. N. (2003). Social capital, collective action and adaptation to climate change. *Economic Geography*, 79(4), pp 387–404.
- Adger, W. N. (2006). Vulnerability. *Global Environmental Change*, 16(3), pp 68–281.
- Adger, W. N. and Kelly, P. M. (1999). Social vulnerability to climate change and the architecture of entitlements. *Mitigation and Adaptation Strategies for Global Change*, 4(3) pp 253-266.
- Adger, W. N. and Winkels, A. (2006). *Vulnerability, poverty, and sustaining well-being*. In: Atkinson, G., Dietz, S., Neumayer, E. (Eds.), *Handbook of Sustainable Development*, Elgar, Cheltenham.
- Adger, W. N., Kelly, P. M. and Ninh, N. H. (2001). *Living with Environmental Change: Social resilience, adaptation, and vulnerability in Vietnam*. Routledge, London.
- Aggarwal, P. K. and Sinha, S. K. (1993). Effect of probable increase in carbon dioxide and temperature on productivity of wheat in India. *International Journal Agricultural and Forest Meteorology*, 48(5), pp 811–814.
- Alexander, D. (1991). Natural disasters: A framework for research and teaching. *Disasters* 15(3), pp 209-226.
- Alexander, D. (2018). *Natural disasters*. Routledge.
- Aulong, S. (2012). Are South Indian farmers adaptable to global change? A case in an Andhra Pradesh catchment basin. *Regional Environmental Change*, 12(3), 423- 436.
- Berlemann, M., & Steinhardt, M. F. (2017). Climate change, natural disasters, and migration—a survey of the empirical evidence. *CESifo Economic Studies*, 63(4), 353-385.

- Bhattacharya, A. (2019). Global climate change and its impact on agriculture. Changing climate and resource use efficiency in plants, 1-50.
- Bhende, A., & Kanitkar, T. (2006). Principles of Population Studies. New Delhi: Himalaya Publishing House.
- Biswal, M. Crisis of Seasonal Migrants in Odisha during Covid-19 Pandemic, *Research gate*.
- Black, R. (2001). Environmental refugees: myth or reality? *UNHCR working paper 34*, UNHCR, Geneva.
- Black, R., Adger, W. N., Arnell, N. W., Dercon, S., Geddes, A., & Thomas, D. (2011). The effect of environmental change on human migration. *Global environmental change*, 21, S3-S11.
- Blaikie, P., et al. (1994). *At risk: Natural hazards, people's vulnerability and disasters*. Routledge, New York.
- Bohle, H. C. (2001). Vulnerability and criticality, *Newsletter of the International Human Dimensions Programme on Global Environmental Change*.
- Bohle, H. C., Downing, T. E. and Watts, M. J. (1994). Climate change and social vulnerability. *Global Environmental Change*, 4(1), 37-48.
- Bolin, R. (1982). Long term family recovery from disaster. *Monograph 36 Boulder Institute for Behavioural Science*, 42.
- Bolin, R. and Bolton, P. (1986). Race, religion and ethnicity in disaster recovery, Program on Environment and Behaviour, Monograph 42.
- Brooks, N. (2003). Vulnerability, risk and adaptation: A conceptual framework. *Tyndall Centre for climate change research working paper*, 38(38), pp. 1-16.
- Burton, I. (1993). *The environment as hazard*. Guildford Press, London.
- Carbon Brief (2017). Analysis: Why scientists think 100% of global warming is due to humans. Retrieved 5 June 2020, from <https://www.carbonbrief.org/analysis-why-scientists-think-100-of-global-warming-is-due-to-humans>
- Cannon, T. (1994). Vulnerability analysis and the explanation of 'natural' disasters. *Disasters, development and environment*, 1, 13-30.
- Campbell, J., Whittingham, E., & Townsley, P. (2006). Responding to coastal poverty: should we be doing things differently or doing different things. *Environment and livelihoods in tropical coastal zones*. CABI, Wallingford, UK. Retrieved 8 January 2020 from <http://dx.doi.org/10.1079/9781845931070.0274>, 274-292.

- Carney, D. (1998). Implementing the sustainable rural livelihoods approach. *Sustainable Rural Livelihoods*. What contribution can we make, 3(27).
- Carter, TR. et al. (2007). *New assessment methods and the characterization of future conditions*. Cambridge University Press, Cambridge, UK, pp. 133-171.
- Castles, S. (2002). Environmental change and forced migration: making sense of the debate, working paper no. 70. *UNHCR*, Refugee Study Centre, Oxford University, Oxford.
- Census of India (2011), Registrar General and Census Commissioner of India, New Delhi.
- Chambers, R. and G. R. Conway. (1992). Sustainable rural livelihoods: practical concepts for the 21st century. *IDS Discussion Paper*, Sussex; IDS www.ids.ac.uk/files/Dp296.pdf
- Crawford, M. H., & Campbell, B. C. (Eds.). (2012). *Causes and consequences of human migration: An evolutionary perspective*. Cambridge University Press.
- Cutter, S. (1995). The forgotten casualties: Women, children and environmental change. *Global Environmental Change*, 5(1), pp.181-194.
- Cutter, S. L. (1996). Vulnerability to environmental hazards. *Progress in Human Geography*, 20(4), pp. 529-539.
- Das S (2016) Economics of Natural disasters in Odisha. In: The Economy of Odisha: A Profile. Nayak PB, Panda SC and Pattanaik PK (Eds). Oxford University Press, Delhi. Pp.266–301
- Devereux, S. (2001). Sen's Entitlement Approach: Critiques and Counter-critiques. *Oxford Development Studies*, 29 (3), pp 246-263. Accessed on 22th June 2019 retrieved from <http://www.sas.upenn.edu/~dludden/FamineMortality.pdf>
- De Haas, H. (2021). A theory of migration: the aspirations-capabilities framework. *Comparative Migration Studies*, 9(1), 1-35.
- Denton, F. (2002). Climate change vulnerability, impacts, and adaptation: why does gender matter? *Gender and Development*, 10(2), pp. 10-21.
- D' Souza, R. (2003). Supply Side Hydrology in India: The Last Gasp. *Economic and Political Weekly*, 38(36), 3785-3790.
- Deressa, T., et al. (2010). Analysing the determinants of farmers' choice of adaptation methods and perceptions of climate change in the Nile Basin of Ethiopia. *International Food Policy Research Institute*. Discussion Paper 00798. <http://www.ifpri.org/sites/default/files/publications/ifpridp00798.pdf>. Accessed 30 August.

- DFID (2000). Sustainable livelihoods guidance sheets. *Department for International Development*. Retrieved from http://www.livelihoods.org/info/info_guidancesheets.html.
- Ellis, F. (2000). *Rural livelihoods and diversity in developing countries*. Oxford University Press.
- Enarson, E. (2000). Gender issues in natural disasters: talking points and research needs. ILO Infocus programme on crisis response and reconstruction, *Workshop*, Geneva, May 3-5 2000.
- Erda, L, et al. (2005). Erda, L., Wei, X., Hui, J., Yinlong, X., Yue, L., Liping, B., & Liyong, X. (2005). Climate change impacts on crop yield and quality with CO₂ fertilization in China. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 360(1463), 2149-2154. doi:10.1098/rstb.2005.1743
- FAO. (2015). Climate change and food security: risks and responses. Food and agriculture organization of the united nations Retrieved on 7 June 2020 from <https://www.fao.org/3/i5188e/15188E.pdf>.
- Few, R. (2003). Flooding, vulnerability and coping strategies: local responses to a global threat, *Progress in Development Studies*, 3, pp. 43-58.
- Ford, J. (2002). Vulnerability: Concepts and issues, Ph.D. scholarly field paper, University of Guelph, Canada.
- Fusel, HM. (2007). Vulnerability: A generally applicable conceptual framework for climate change research. *Global Environmental Change*, 17, pp. 155-167.
- Garg, N.K. & Q. Hassan (2007). Alarming Scarcity of Water in India'. *Current Science*, 93(7), 32-41.
- Government of Odisha (2020) Odisha Economic Survey Report 2019-20. Planning & Convergence Department, Bhubaneswar.
- Hammar-Klose, E. S., & Thieler, E. R. (2001). *Coastal vulnerability to sea-level rise: a preliminary database for the US Atlantic, Pacific, and Gulf of Mexico coasts (No. 68)*. US Geological Survey.
- Hewitt, K. (1983). The idea of calamity in a technocratic age. In: Hewitt, K. (Ed.), *Interpretations of Calamity from the Viewpoint of Human Ecology*. Allen and Unwin, Boston, pp. 3-32.
- Hewitt, K. (1983). The idea of calamity in a technocratic age. *Interpretations of Calamity from the Viewpoint of Human Ecology*. K. Hewitt, Allen and Unwin, pp. 3-32.

- Hill, A. G. (2016). Jay Weinstein and Vijayan K. Pillai: Demography—The Science of Population. *European Journal of Population*, 32(4), 623-625.
- Hinkel, J., & Klein, R. J. (2007). Integrating knowledge for assessing coastal vulnerability to climate change. McFadden et al.(eds). *Elsevier Science*, Amsterdam, the Netherlands
- Hogan, D. J. (2002). Movilidad poblacional, sustentabilidad ambiental y vulnerabilidad social: una perspectiva latino-americana. LEFF, Enrique; EZCURRA, Exequiel; PISANTY, Irene and LANKAO, Patricia R. (comp.) *La transición hacia el desarrollo sustentable. Perspectivas de América Latina y el Caribe*. Mexico: INE-SEMARNAT, 161-185.
- Hossain, B., Sohel, M. S., & Ryakitimbo, C. M. (2020). Climate change induced extreme flood disaster in Bangladesh: Implications on people's livelihoods in the Char Village and their coping mechanisms. *Progress in Disaster Science*, 6, 100079.
- Howden, S. M., Soussana, J. F., Tubiello, F. N., Chhetri, N., Dunlop, M., & Meinke, H. (2007). Adapting agriculture to climate change. *Proceedings of the national academy of sciences*, 104(50), 19691-19696.
- Hufschmidt, G. (2011). A comparative analysis of several vulnerability concepts. *Natural hazards*, 58(2), pp. 621-643.
- Hugo, G. (1996). Environmental concerns and international migration. *International Migration Review*, 30(1), pp. 105–131.
- Hulme, M., S. J. O'Neill, and Dessai. S., (2011). Is weather event attribution necessary for adaptation funding? *Science*, 334 (6057), pp. 764 -765. doi:10.1126/science.1211740.
- IDMC and NRC. (2012). Displacement caused by conflict and natural disasters, achievements and challenges. *Reliefweb*. Available at <https://reliefweb.int/report/pakistan/displacement-caused-conflict-and-natural-disasters-achievements-and-challenges>. Accessed on 2nd January 2018.
- Intergovernmental Panel on Climate Change (IPCC). (1990). *First assessment report*, Cambridge University Press, Cambridge.
- International Organization for Migration (IOM). (1992). Migration and the environment, IOM and the Refugee Policy Group (RPG), Geneva.
- International Organization for Migration (IOM). (2008). Migration and Climate Change, Geneva, March.
- IOM. (2007). Migration and the Environment, International Dialogue on Migration, No. 10m Geneva.

- IOM. (2007). Discussion Note: Migration and the Environment (MC/INF/288– 1 November 2007, 94th Session), International Organization for Migration (IOM), Geneva.
- IOM. (2008). Speech by IOM Director General, Brunson McKinley, at the Institute for Public Policy Research Conference on Climate Change and Forced Migration. Available at: <http://www.iom.int/jahia/Jahia/cache/offonce/pid/1336?entryId=17096>
- IOM. (2009). *Commonly used migration terms*. Available at: [http://www.iom.int/jahia/Jahia/about-migration/migrationmanagement-foundations/terminology/commonly-used migration-terms](http://www.iom.int/jahia/Jahia/about-migration/migrationmanagement-foundations/terminology/commonly-used-migration-terms)
- IOM, (2007). Discussion Note: Migration and the Environment, MC/INF/288, International Organization for Migration. Available at http://www.iom.int/jahia/webdav/site/myjahiasite/shared/shared/mainsite/microsites/IDM/workshops/evolving_global_economy_2728112007/MC_INF_288_EN.pdf
- IOM. (2007). Expert Seminar: Migration and the Environment, International Dialogue on Migration no. 10, IOM, Geneva.
- IOM. (2007). Discussion Note: Migration and the Environment, MC/INF/288, International Organization for Migration (IOM). Available at: http://www.iom.int/jahia/webdav/site/myjahiasite/shared/shared/mainsite/microsites/IDM/workshops/evolving_global_economy_2728112007/MC_INF_288_EN.pdf
- Jain, M., et al. (2021). Groundwater depletion will reduce cropping intensity in India, *Science Advances*, *US National Library of Medicine National Institutes of Health*, 7(9), DOI: [10.1126/sciadv.abd2849](https://doi.org/10.1126/sciadv.abd2849)
- J, Madhumitha. (2019). Damaged crop area due to natural disasters across India 2007-2018. Retrieved on 7 June 2020 from <https://www.statista.com/statistics/1007093/india-damaged-crop-area-due-to-natural-disasters/>
- Janssen, M. & Ostrom, E. (2006). Resilience, vulnerability, and adaptation: A crosscutting theme of the International Human Dimensions Programme on Global Environmental Change. *Global Environmental Change*, 16(3), pp. 237–239. <https://doi.org/10.1016/j.gloenvcha.2006.04.003>.
- K, Sandhya. (2020). Natural disaster relief revenue expenditure of India's Government 1990-2018. Retrieved on 7 June 2020 from <https://www.statista.com/statistics/626176/natural-disaster-relief-expenditure-india/>
- Kelly, P. M. and Adger, W. N. (2000). Theory and practice in assessing vulnerability to climate change and facilitating adaptation. *Climate Change*, 47, pp. 325-352.

- Kshirsagar, K., G.S. Pandey and M.R. Bellon (2002), 'Farmer Perception, Varietal Characteristics and Technology Adaptation: A Rainfed Rice Village in Orissa', *Economic and Political Weekly*, Vol. 37, No. 13, pp. 1239-1246
- Kumar, K. K., & Parikh, J. (2001). Indian agriculture and climate sensitivity. *Global environmental change*, 11(2), pp. 147-154.
- Kumar, K.K., & Parikh, J. (2001). Socio-economic impacts of climate change on Indian agriculture. *International Review for Environmental Strategies*, 2 (2), pp. 277-293.
- Lal, M., et al. (1998). Vulnerability of rice and wheat yields in NW-India to future change in climate. *Agric. Forest Meteorology*, 89(2), pp. 101–114.
- Lal, M., et al. (1999). Growth and yield response of soybean in Madhya Pradesh, India to climate variability and change. *Agriculture and Forest Meteorology*, 93(1), pp. 53–70.
- Leichenko, R. M. and O'Brien, K. L. (2002). The dynamics of rural vulnerability to global change: the case of southern Africa. *Mitigation and Adaptation Strategies for Global Change*, 7, pp. 1-18.
- Liverman, D. M. (1994). Vulnerability to global environmental change. In *Environmental Risks and Hazards*, ed. Cutter, S. L. Englewood Cliffs, NJ: Prentice Hall, pp. 326–42.
- Mahapatra, S. (1978) Modernization of Tribal Agriculture, Technological and Cultural Constraints', *Economy and Political Weekly*, Vol. 13, No. 13.
- Maisonnette, N. (2014). Assessment of Additional and Alternative Livelihood Options in five Marine Protected Areas. *Caribbean Aqua-Terrestrial Solution*, caribbeancats.org.
- Manabe, S. (2019). Role of greenhouse gas in climate change. *Tellus A: Dynamic Meteorology and Oceanography*, 71(1), 1620078.
- Martin, P. & Zucheher, G. (2008). Managing migration, the global challenge. *Pop Bulletin* 63(1), pp. 1-3.
- Mishra, D., et al. (2016). Impact of climate change on agricultural production of Odisha (India). A Ricardian Analysis. *Regional Environmental Change*, 16(2), pp. 575-584.
- Mohanti, K.K. and Sakti Padhi (1995) 'Employment Situation of Tribal Population in Orissa: 1981 Census Data', *Economic and Political Weekly*, Vol. 30, No. 29, pp. 1879-1882.
- Mohanty, A and Wadhawan, S. (2021). Assessment, A. D. L. Mapping India's Climate Vulnerability.
- Moharaj, P., and Rout, S. (2021). Changing Climatic Conditions and Agricultural Livelihoods: An Impact Study in Jagatsinghpur District, Odisha. *Social Change*, 51(2), pp. 160–179. Available at <https://doi.org/10.1177/0049085720924362>
- Molden, D. (2007). Water for Food, Water for Life: A Comprehensive assessment of Water Management in Agriculture. USA/UK: Earthscan, IWMI. Colombo

- Morrow, B. H. (1997). *Disaster in the first person. hurricane Andrew: Ethnicity, gender, and the sociology of disasters*. Routledge, W. G. Peacock. London.
- Mishra, A. K., & Desai, V. R. (2005). Spatial and temporal drought analysis in the Kansabati river basin, India. *International Journal of River Basin Management*, 3(1), 31-41.
- Mugadur, Nagappa S. (2009). Vulnerability and coping up strategies of the poor a case study of Haveri district, Karnataka University, India. Retrieved on 12 Feb 2020 from <http://hdl.handle.net/10603/95363>.
- Nam, W. H., Choi, J. Y., Yoo, S. H., & Jang, M. W. (2012). A decision support system for agricultural drought management using risk assessment. *Paddy and Water Environment*, 10(3), 197-207.
- O'Brien, K. L. and Leichenko, R. M. (2000). Double exposure: assessing the impacts of climate change within the context of economic globalization. *Global Environmental Change* 10(3), pp. 221-232.
- O'KEEFE, P. et al. (1976). Taking the naturalness out of natural disasters. *Nature*, 260, pp. 566-567.
- O'Brien, K.L., et al. (2004). Mapping vulnerability to multiple stressors: climate change and globalization in India. *Global Environmental Change*, 14(4), pp. 303–313.
- Palanisami, K., et al. (2014). *Climate change and agriculture in India: Studies from selected river basins*. Routledge, India.
- Pasteur, K. (2001). Tools for sustainable livelihoods: project and programme planning. *Institute of Development Studies*, 510, Brighton, pp. 1-15.
- Patel, S. (1997). Ecology and development. *Economic and Political Weekly*, 32(38), pp. 2388-91.
- Pateman, T. (2011). Rural and urban areas: comparing lives using rural/urban classifications. *Regional trends*, 43(1), 11-86.
- Patt, A. G., Tadross, M., Nussbaumer, P., Asante, K., Metzger, M., Rafael, J., ... & Brundrit, G. (2010). Estimating least-developed countries' vulnerability to climate-related extreme events over the next 50 years. *Proceedings of the National Academy of Sciences*, 107(4), 1333-1337.
- Pathy, S. (2003) 'Destitution, Deprivation and Tribal Development', *Economic and Political Weekly*, Vol. 38, No. 27, pp. 2832-2836.

- Panda, A. (2020). Climate Change, Displacement, and Managed Retreat in Coastal India. Feature, Migration Policy Institute. May, 22, 2020.
- Paul, S.K. (2013). Vulnerability concepts and its application in various fields: A review on geographical perspective. *Journal of Life and Earth Science*, 8, pp. 63-81. Retrieved on 17 April, 2020 from <http://banglajol.info/index.php/JLES>
- Peet, R. and Thrift, N. (1989). *New Models in Geography*. Unwin Hyman, London.
- Podesta, J. (2019). The climate crisis, migration, and refugees, Brookings report. Available at <https://www.brookings.edu/research/the-climate-crisis-migration-and-refugees/>. Accessed on 4th May 2019
- Poinetti, C. and Suresh Reddy (2002) 'Farmers' Perceptions of Crop Diversity in the Deccan Plateau', SEEDLING, Quarterly Newsletter of Genetic Resources Action International, Spain
- Praharaj, S., Han, J. H., & Hawken, S. (2018). Urban innovation through policy integration: Critical perspectives from 100 smart cities mission in India. *City, culture and society*, 12, 35-43.
- Ravindranath, N. H. (2011). Climate change vulnerability profiles for North East India. *Current Science*, pp. 384-394.
- Rao, S., & Vakulabharanam, V. (2018). Migration, crises and social transformation in India since the 1990s. *Handbook of Migration Crises*.
- Reilly, J. M. and Schimmelpfening. (1999). Agricultural impact assessment, vulnerability, and the scope for adaptation. *Climate Change*, 43(4), pp. 745-788.
- Rezadoost, B. & Allahyari, M.S. (2014). Farmers opinion's regarding effective factors on optimum agricultural waste management. *Journal of Saudi Society of Agricultural Sciences*. 13, 15-21.
- Rosenzweig, C. (2001). Climate change and extreme weather events; implications for food production, plant diseases, and pests. *Global change and human health*, 2(2), pp. 90-104.
- Sam, A. S., Kumar, R., Kächele, H., & Müller, K. (2017). Quantifying household vulnerability triggered by drought: evidence from rural India. *Climate and Development*, 9(7), pp. 618-633.
- Scoones, I. (1998). Sustainable rural livelihoods: A framework for analysis. *Working Paper* 72, Brighton, UK, Institute of Development Studies, University of Sussex. Retrieved on 17 April, 2020 from www.ids.ac.uk/files/dmfile/Wp72.pdf.
- Saleth, R.M. & Dinar, A. (2004). *Institutional Economics of Water: A Cross Country Analysis of Institutions and Governance*. Cheltenham: Edward Elgar Publishing Limited.

- Sen, A., Ed. (1981). *Poverty and famines: an essay on entitlement and deprivation*. Clarendon Press, Oxford.
- Shewmake, S. (2008). Vulnerability and the impact of climate change in South Africa's Limpopo River Basin. *International Food Policy Research Institute*, 804.
- Singh. A, and Roy, S. (2013). Contribution of rural economy in national development. Bhubaneshwar, St. Xavier's College.
- Smith, T.F., et al. (2013). Cumulative pressures on sustainable livelihoods: coastal adaptation in Makong delta. *Sustainability*, 5, pp. 228-241.
- Sudarsan Rao A., et al. (2018). Assessment of drought in Balangir district of Odisha, India using drought indices. *Water Science and Technology Library, Springer*, 82, pp. 273-291, Singapore. https://doi.org/10.1007/978-981-10-5714-4_21
- Susman, P. (1983). Global disasters: a radical interpretation. *Interpretations of Calamity from the Viewpoint of Human Ecology*, K. Hewitt. Boston, Allen and Unwin, pp. 263-283.
- T. Wang. (2020). Global number of natural disasters events 2000-2019. Retrieved on 6 June 2020 from <https://www.statista.com/statistics/510959/number-of-natural-disasters-events-globally/>
- TERI. (2013). Climate proofing Guwahati, Assam: city resilience strategy and mainstreaming plan, *Synthesis Report*, TERI, New Delhi.
- Selvaraj, D. A., & Victor, K. (2021). Vapour absorption refrigeration system for rural cold storage: a comparative study. *Environmental Science and Pollution Research*, 28(26), 34248-34258.
- Social Dimensions of Climate Change (n.d). The World Bank, IBRD, IDA, Retrieved on 4 January 2020 from <https://www.worldbank.org/en/topic/social-dimensions-of-climate-change#1>
- Tripathi, C. B., Baredar, P., & Tripathi, L. (2019). Air pollution in Delhi: biomass energy and suitable environmental policies are sustainable pathways for health safety. *Curr Sci*, 117(7), 1153.
- Twigg, J. (2001). Sustainable livelihoods and vulnerability to disasters. *Benfield Greig Hazards Research Centre*.
- Udmale, P. D., Ichikawa, Y., Manandhar, S., Ishidaira, H., Kiem, A. S., Shaowei, N., & Panda, S. N. (2015). How did the 2012 drought affect rural livelihoods in vulnerable areas?

- Empirical evidence from India. *International Journal of Disaster Risk Reduction*, 13, 454-469.
- UNISDR. (2004). *Living with risk. United Nations Secretariat for the International Strategy for Disaster Risk Reduction*, Geneva, Switzerland.
- UNISDR (2009). Terminology on disaster risk reduction. Retrieved on 09 February 2019, from www.unisdr.org.
- Vijayshankar, P.S. (2016). All is not Lost but Water Sector reforms must go Ahead. *Economic and Political Weekly*, 51 (52), 19-20.
- Watts, M. (1983). On the poverty of theory: natural hazards research in context. In: Hewitt, K. (Ed.), *Interpretations of Calamity for the Viewpoint of Human Ecology*, Allen and Unwin, Boston, pp. 231–262.
- Watts, M. J. and Bohle, H. G. (1993). The space of vulnerability: the causal structure of hunger and famine. *Progress in Human Geography*, 17(1), pp. 43-67.
- White, G. and Haas, J. E. (1975). *Assessment of research on natural hazards*. Cambridge, MIT Press.
- Wijaya, A. S. (2014). Climate change, global warming and global inequity in developed and developing countries (Analytical perspective, Issue, Problem and Solution). In IOP Conference Series: Earth and Environmental Science (Vol. 19, No. 1, p. 012008). IOP Publishing.
- Wisner, B. (1998). World views, belief systems, and disasters: implications for preparedness, mitigation and recovery. Retrieved on 6 June 2020 from http://www.anglia.ac.uk/geography/radix/resources_papers.htm
- World Bank. (2017). *Forcibly displaced: Toward a development approach supporting refugees, the internally displaced, and their hosts*.
- World Economic Forum. (2020). India's CO2 emissions fall for first time in four decades amid coronavirus. Retrieved on 5 June 2020 from <https://www.weforum.org/agenda/2020/05/india-emissions-environment-air-pollution-coronavirus-covid19/>.

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Changing Climatic Conditions and Agricultural Livelihoods: An Impact Study in Jagatsinghpur District, Odisha

Social Change
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Prasanta Moharaj¹ and Satyapriya Rout¹

This article attempts to examine the negative impact of climate change on agricultural livelihood and human social life. Natural climatic variations have always been a challenge for human sustenance as they are predicated on a host of factors that include natural, human-made and unbalanced environmental conditions. India too, with its geographic zones such as mountains, small islands, wetlands, coastal areas, deserts, semi-arid lands and plains, is exposed to challenges of climatic change. The impact of climate is particularly severe on the livelihoods of the rural poor. For instance, people living near coastal regions are constantly prone to severe floods. This study specifically focusses on coastal Odisha and the impact of floods which have been triggered by climate change. The study, looking at the effect on crop production and socio-economic conditions, has followed a two-pronged approach, conducting a field survey and collecting data from secondary sources.

Keywords

Climate change, impact, vulnerability, adaptation

Introduction

According to the United Nation's Framework Convention on Climate Change (UNFCCC), climate change is the change of climate attributed directly or indirectly to human activity that alters the composition of the global atmosphere. This is in addition to natural climate variability observed over comparable

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MAPPING THE ROLE OF NGOS IN CO-OPTING THE CYCLONE PRONE AREAS : WITH SPECIAL REFERENCE TO CYCLONE FANI

Prasanta Moharaj * Devi Prasad **

Introduction

Natural calamities are indeed alarming as well as growing issues in the state of Odisha since a long time. The poor and marginalized sections of the state are the most vulnerable population to various disasters. The state has witnessed many natural calamities such as drought, flood, cyclone etc. since decades. Recently, nine districts of Odisha namely Baragarh, Bolangir, Deogarh, Jharsuguda, Kalahandi, Nabarangpur, Nuapada, Sambalpur, Sundargarh have been declared drought-affected.¹ These areas lack not only irrigation facilities but also receive inadequate rainfall. There is at least one severe drought in a year in every decade, thus underlying a high degree of vulnerability of the state to drought, Odisha has confronted the drought situation in most of the years in the latter half of the 1990s. Thus, Bolangir and Boudh are the most drought affected districts of Odisha. More than 50 per cent of villages in these two districts are affected by drought. Similarly, floods are also a major natural calamity for the state of Odisha. The heavy rains in the upper catchment areas, as well as unusual rainfall in different districts, cause flood in all major rivers of the state. All the coastal regions of Odisha are usually affected by flood. Odisha has faced many floods during 1950-1965 and 1992- 2001 and still the flood situation is not entirely under controlled.

Besides these natural disasters, Odisha is also affected by various man-made disasters, and it ultimately aggravated some ecological imbalances which lead to natural disasters. The role of government with the cooperation of NGOs in development as well as disaster preparedness is crucially inevitable today. The crucial and critical part of the NGOs in disaster reduction and the response has been widely accepted. In South Asia, many NGOs are dedicated their valuable time in disaster-related activities; however, networking and collaboration among them have been weak because of the lack of resources and organizational limitations.

Yet, the networking and enhancing the capabilities of NGOs are considered to be the

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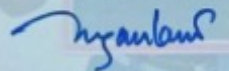
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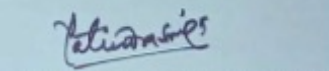
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This is to certify that **Mr. Prasanta Moharaj** of **School of Social Science, University of Hyderabad** has participated in the two day National Seminar on '**Implementation of Right to Education and Mid-Day-Meal Programme: Promises and Challenges**' (25-26 March 2015) and presented a paper entitled **Evaluation of Mid-Day-Meal (MDM) Programme in Odisha**.

The Seminar is organised by M.P. Institute of Social Science Research, Ujjain and sponsored by Indian Council of Social Science Research, New Delhi.


Prof. Sandeep Joshi
Seminar Convener


Dr. Manu Gautam
Seminar Coordinator


Prof. Yatindra Singh Sisodia
Director

Field Study Photos at Balangir District











Interview Schedule

Vulnerability to Climate Change Induced Drought and Sustainable Livelihoods: A study of farm households in three villages of Balangir District, Odisha (Data collected are meant for preparation of Ph.D. Thesis to be submitted at University of Hyderabad)

1. Details of the Field Survey

State		District		Block	
Gram Panchayat		Village		Date of Survey	

2. Household Particulars

Caste (SC=1, ST=2, OBC=3, Gen=4, Specify sub-caste for all)	Type of Household (Nucleus=1, Joint=2)	Number of Household Members (>14 yrs)		Number of Family Members, Children (<14 years)	
		Male	Female	Male	Female

3. Composition of Household (Begin with Respondents) and their economic activity

Name	Relation with HH	Male-1 / Female-2	Age*	Marital Status	Educational Qualification	Farming experience	Usual Activity	Main Occupation	Subsidiary Occupation	Type of Worker

* Enter the completed age (for less than one year age = 00, 98 years and above =98) or Date of birth after verifying records

Codes used: Relationship with HH (Column 3): Self-HoHH-1/Spouse-2/Father-3/Mother-4/Father-in-law-5/Mother-in-law-6/Uncle-7/Aunt-8/Brother/Brother-in-law-9/Sister/Sister-in-law-10/Son/Son-in-law-11/Daughter/Daughter-in-law-12/Nephew-13/Niece-14/Own grandchildren-15/Sibling's grandchildren-16/Cousin (brother)-17/Cousin (sister)-18/Live-in domestic help-19/Others (specify)-20

Marital Status (Column 6): Married (1), Unmarried (2), Divorcee (3), Widow/Widower (4), Separated/Deserted (5)

Educational Qualification (Column 7): Illiterate (1); Literate (2); Primary (3); Middle (4); Matriculate (5); Intermediate (6); Graduate and above (7); Professional qualification (Specify)(8); other (Specify)(9)

Usual Activity (Column 9): Worker (1); Unemployed (2); House wife (3); Student (4); Old/Retired (5); School age children not going to school (6); Non-school age children (< 6 years) (7); Handicapped (8); Others (Specify)(9)

Occupation (Column 10 & 11): Cultivation-1/Dairy-2/Fishery-3/Goatery & other animal rearing-4/Daily Wages-Agricultural Labourer-5/Skilled Wage Labourer-6/Semi or Unskilled Wage Labourer-7/Service-Private Sector-8/Service-Government-9/Trade/Business-from fixed premises-10/Owner of SSI/Cottage Industry-11/Other Self-employed-12/Professionals-13/Household Industry-14/Artisan-15/Vendor(Cycle/Pheri wala)-16/Others (Specify)-17

Type of Worker (Column 13): Main worker-1/Marginal worker-2 (Main worker>180 days engagement/year; Marginal worker<180 days engagement/year)

4. Land profile of Households during Normal and abnormal years (in Acres)

Details	Normal Year				Abnormal Year			
	Irrigated**	Un Irrigated	Total	Source of Irrigation*	Irrigated**	Un Irrigated	Total	Source of Irrigation*
1) Owned land								
2) Leased-in land								
3) Leased-out land								
Operated land(1+2-3)								

*Source of irrigation: Well -1/ Tank or Pond- 2 /Canal -3/Stream-4/River-5/Others (Specify) - 6

** Irrigation: From own source (Specify) – 1 / From Purchased Source (Specify) – 2

5. Ownership of Livestock during Normal and Abnormal years

Livestock	Normal Year (No.)	Expenses incurred	Abnormal Year (No.)	Expenses incurred	Expenses incurred (N+A)
Cow					
Buffalo					
Ox					
Goat					
Sheep					
Poultry birds					
Others (Specify)					

6. Household/Movable Assets Possessed during Normal and abnormal period

Assets	Normal (No.)	Expenses incurred	Abnormal (No.)	Expenses incurred	Expenses incurred (N+A)
Tractor					
Power Tiller					
Thresher					
Winnower					
Sprayer					
Diesel Pump					
Bullock Cart					
Cell Phone					

7. Source wise Annual Household Income in Normal and abnormal Period

Source of Income	Normal	Abnormal	Reason's for change	Source of Income	Abnormal	Abnormal	Reason's for change
Income from farming				Income from farm wage employment			
Income from Livestock				Income from Non-farm wage employment			
Income from Non-farm business*				Income from Salary			
				Income from Interest/Pension/Dividend			

*Petty business, cottage industries. Manufacturing, hotels & restaurant, construction, mining and quarrying, repairing and others

8. Human Capital: Source-wise Annual Household Expenditure Normal and abnormal Period

Sources of Expenditure	Normal	Abnormal	Sources of Expenditure	Normal	Abnormal
Food expenditure			Health		
Cooking Fuel			Education		
Clothing			Total		

9. Financial Status

1. Do you save money	
Yes	
No	
2. The way of saving money	
Home	
Bank	
Cooperate Society	

Others					
Sources of Indebtedness*	Name	Purpose of Loan**	Amount (Rs.)	Rate of Interest	Amount unpaid

*Institutional: Co-operative, RRBs, Commercial Banks, Post Office, SHG, others (Specify); Non-institutional: Private Money lender, Neighbours/Friends, Relatives Shopkeeper, Trader, other (specify)

**Agriculture, Business, Household Consumption, Construction of House, Purchase of land, Marriage & other social function, Repaying old loans, others (specify)

10. Social Capital: Membership/ Participation in different organisations

Sl.No.	Membership	Roles and Purposes
1	Membership in SHGs	
2	Participation in Community-level decision-making	
3	Membership in Farmers-based organisation	
4	Membership in political organisation	
5	If any other	

Beneficiary of Development Programmes: Do you have BPL Card?

Are you or any member of your household a beneficiary of any development programmes? (Put 'Y' for Yes & 'N' for NO)

Specify Programme	Normal Year	Abnormal Year	Specify Programme	Normal Period	Abnormal Year

Programme: PDS/Annapurna Yojana/Antodaya Yojana/Old Age Pension/Widow Pension/Disability Pension/National Family Benefit Scheme/Mid-Day-Meal Programme/Land for landless families/Homestead for homesteadless/IAY/NREGA/GGY/SGSY/SJRY/PMRY/JRY/IRDP/TRYSEM/SITRA/MWS/Madhu Babu Pension Yojana for Leprosy and AIDS Patient/Pregnant Women Scheme/Balika Samridhi Yojana/Pre-matric scholarship for students belonging to the Minority Communities/Total Sanitation Campaign/Biju Kutir Jyoti yojana, etc.

Do you have any difficulty to receive these supports?

Yes

2. No

1.

If yes, state difficulties?

11. Migration (Out migration in Normal and Abnormal Period)

Name	Sex	Type of migration (Seasonal/Permanent)	Reasons for Migration	Place where migrated	Type of engagement (Pvt. Jobs/Govt job, Business)	Income/month at Migration place	Amount Remitted/month
Normal Year							
Abnormal Year							

12. Recording responses on happening of climate change and its causes

Statements	Strongly disagree	Disagree	Uncertain	Agree	Strongly Agree
Climate Change is taking place, due to natural factors					
Climate change is taking place, due to both anthropogenic and natural factors					
Climate change is taking place, due to only anthropogenic factors.					
Climate change is not taking place.					
I am uncertain about change in the climate					

13. Statements on perceived effects of climate change

Statements	Strongly disagree	Disagree	Uncertain	Agree	Strongly Agree
Increase in Summer temperature					
Increase in Winter temperature					
Increase in Rainy temperature					
Increase in Autumn temperature					
Pattern of Rainfall is changing					
Number of hot days (/ length of warm period) are increasing					
Number of cold days are decreasing.					
Change in soil salinity/ soil moisture					
Reduction in soil fertility					
Increase in pests and insecticides					
Decline in Ground water					
Happening of Drought					
Persistent Drought					

Note: Perception based on the previous 10 years.

14. Drought

Type of drought	
Seasonal	
Over the year	
4. Duration of drought	
..... to (month)	
5. Type of crop production during drought	
Rice	
Jute	
Vegetables	
Others (define).....	
6. Impact of drought	
Reduce production	
Delay to crop harvest	
Disease attack	
Unable to agriculture	

15. Cropping pattern

Season: Kharif (June – October) and Rabi (Nov-April)

Item	Kharif Crop				Rabi Crop			
	Crop 1		Crop 2		Crop 1		Crop 2	
	Nor mal	Abnor mal	Nor mal	Abnor mal	Nor mal	Abnor mal	Nor mal	Abnor mal
Crop Name								
Variety used (HYV/ Traditional/								

Tolerant)								
Area (in Acres)								
Seed own (quantity) Kg								
Seed purchased (value) Rs/ kg								
Organic manure own (quantity) Kg								
Organic manure purchased: (value) Rs/ kg								
Fertilizers own (quantity) Kg								
Fertilizers purchased (value) Rs/ kg								
Pesticides purchased: (value) Rs/ litre								
Transport cost of output from field to sale point (Rs)								
Sources of Irrigation								
Expenditure on water								
Production: Number of bags								
Production: Size of bags (Kg)								
Production: Value (Rs) Per Quintal								

1. Urea, DAP, Superphosphate etc 2. Tubewell, tank, canal, river etc.

16. Measures resorted to cope strategies by Farmers

Strategies used to cope during drought years	Select options	Reasons
Changes in cropping pattern (Change in crops, tolerant varieties, planting schedule)		1) Indigenous knowledge 2) Easy accessibility of seeds 3) Highly subsidised 4) Market factors 5) Access to information 6) Variability in rainfall and temperature 7) Poor soil conditions 8) Low procurement prices 9) Lack of markets in vicinity 10) New crops need less labour 11) New crops have shorter life cycle
Changes in cropping Intensity (single crop/ double crop/ No crop)		1) Variability in rainfall 2) Impact on soil moisture
Changes in Irrigation, fertiliser application		1) Variability in rainfall 2) Reduced soil moisture
Farm employment (Numbers employed)		1) Reduced cropping intensity 2) For Savings
Insurance		1) Easy availability 2) Covers risks related to Drought 3) Subsidised
Credits/ Loans	1. Bank Repayment schedule a. Is it extended during Drought b. Remains the same (half yearly basis, yearly basis and any other criteria) 2. Micro-credit/ SHGs 3. Others, please specify	1) Immediate assistance 2) Covers risk instantly 3) Easy procedural measures 4) Easy repayment methods 5) Low Interest rates
Using up household savings – cash/ food stocks		1) Measures resorted at their own level

Loans from relatives/ friends		2) Easier way of coping Others, please specify
Distress Sale/ mortgage	1. Jewellery/ other valuables 2. Land/ property rate 3. Cattle rate 4. Others	
Migration		(1) Inadequate Income from farming (2) Indebtedness
Reducing Food consumption expenditure		
Reduction in non-food expenditures		
Adopting Barter System		
Pull children out of school (5 to 15 years of age)		1) Non-availability of School (s) 2) Poverty 3) Engaged in child care 4) Helping hand in family's profession 5) Earning opportunity 6) Social exclusion 7) Lack of awareness 8) Lack of interest 9) Child labor 10) If any other
Sale/eat own harvested grain		
Sale of land		
If anything, specify		

17. Coping Strategies Adopted By Government

Coping strategies	Dichotomous Response	Reasons
Governance	1 = Yes, 2 = No	
Afforestation	1 = Yes, 2 = No	
New policy development and law enforcement	1 = Yes, 2 = No	
Awareness campaign and training	1 = Yes, 2 = No	
Availing of resources	1 = Yes, 2 = No	
Electric fence	1 = Yes, 2 = No	
Employment	1 = Yes, 2 = No	
Supplying of seedlings	1 = Yes, 2 = No	
Order of cutting trees along river bank	1 = Yes, 2 = No	
Energy saving	1 = Yes, 2 = No	
Research	1 = Yes, 2 = No	
Water harvesting	1 = Yes, 2 = No	
Water rationing	1 = Yes, 2 = No	
Control population	1 = Yes, 2 = No	
Recycling materials	1 = Yes, 2 = No	
Seeds	1 = Yes, 2 = No	
Fertilizer/pesticide	1 = Yes, 2 = No	
Credit	1 = Yes, 2 = No	
Compensation	1 = Yes, 2 = No	
Training	1 = Yes, 2 = No	
Marketing facilities	1 = Yes, 2 = No	
If any others	1 = Yes, 2 = No	

18. List of local level on-farm Agricultural adaptation of farmers

On farm Adaptation strategies	Are they effective in enhancing farm productivity?	Ways	Reasons
Crop Diversification			
Using Agro-forestry Systems			
Heat/Drought tolerant Crops			
Using Irrigation			
Crop rotation			
If any other,			

19. List of local level off-farm Agricultural adaptation of farmers

Off Farm Adaptation Strategies	Are they effective in enhancing farm productivity?	Ways	Reasons
Livelihood diversification			
Forced Migration			
Applying Indigenous Knowledge			
Changing diets			
Reducing food consumption			
If any other,			

20. List of Farmers' mitigative actions for agriculture

Supply-side Mitigative Actions	Tick	Demand-side Mitigative Action	Tick
Increased use of organic manure		Change in dietary pattern	
Reduce synthetic manure			
Non-conversion of forest land for agricultural purpose			
Practice of Agro-forestry			
Sustainable Agri. Intensification			

21. List of Adaptation Barriers to Climate Change

Adaptation Barriers	Reasons
Lack of information	
Lack of seed	
Lack of resources	
No access to credit	
No access to technology	
Lack of market access	
Insecure land tenure	
Shortage of labour	
Access to irrigation system	
Lack of awareness	
Social and cultural constraints	
Governance and Institutional constraints	
Cognitive constraints	

(Signature of Invigilator)