ECONOMIC IMPACTS OF DROUGHTS AND DROUGHT RISK MANAGEMENT PRACTICES: A STUDY OF MADHYA PRADESH

Ph.D. THESIS

by

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INDIAN INSTITUTE OF TECHNOLOGY ROORKEE
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STUDENT'S DECLARATION

I hereby certify that the work presented in the thesis entitled "**ECONOMIC IMPACTS OF DROUGHTS AND DROUGHT RISK MANAGEMENT PRACTICES: A STUDY OF MADHYA PRADESH**" is my own work carried out during a period from July, 2015 to June, 2021 under the supervision of Dr. Subir Sen, Associate Professor, Department of Humanities and Social Sciences, Indian Institute of Technology Roorkee, Roorkee.

The matter presented in the thesis has not been submitted for the award of any other degree of this or any other Institute.

A. Sharma

Dated: 23/06/2021 **(ASHISH SHARMA)**

SUPERVISOR'S DECLARATION

This is to certify that the above mentioned work is carried out under my supervision.

Subir Sen

Dated: 23/06/2021 **(Dr. SUBIR SEN)**

ABSTRACT

Disasters have always caused significant economic losses, which are likely to increase in future particularly for developing countries. Droughts and floods are two natural hazards faced most frequently in India. The present thesis considers only drought as flood induced losses have been extensively studied. Droughts are the slow onset, complex, and least understood disaster having multiple definitions and types. Around 50 percent gross cropped area is dependent on the South-West monsoon in absence of adequate irrigation infrastructure in India. As a result, drought affects the aggregate economy and in particular the agricultural sector. It may not cause any direct property damages, but may adversely affect individuals, communities and the overall economic growth of the affected region. Rather than long-term mitigation, response driven approaches such as post-drought financial relief is the primary mechanism to deal with such disasters in India.

Droughts may result in diversion of financial resources towards relief and consumption smoothing causing adverse impact on the other sectors of the economy. Moreover, managing droughts are more challenging for governments and policy-makers because they could be avoided either by coping and adaptation strategies at the individual level or mitigated at the institutional level. The risk management strategies and adaptive capacity to deal with droughts also vary according to economic and social factors associated with individuals, communities and nations among others. It is also noticed that individuals often exhibit irrational decision choices driven by behavioural biases, which are the building blocks of decision making to deal with uncertain disaster events. Often, individuals either simply do not know the risk or do not understand the actionable after knowing the probable disaster risk. In literature pertaining to disasters, the three most prevalent behavioural biases are overconfidence, over-optimism and herding.

With this backdrop, this thesis examines three important facets of drought disaster in the Indian context. First, it analyses the empirical relationship between droughts, drought-relief and growth parameter of the selected state economy in general and agricultural sector in particular. Previous studies have established statistical relationship between natural disasters (including droughts) and the economy, showing varying impact across economies and economic sectors. Therefore, drawing conclusion regarding the direction of impact on the locale economy is difficult, and an analysis at sub-national may

generate further evidences to draw plausible inferences. The present study provides a statistical evidence for India and contributes to the existing literature on drought impact in developing economies. The second aspect of this thesis is to explore the behavioural issues, determinates of preparedness, and individual risk management practices (coping and adaptation strategies) to reduce losses against droughts with particular reference to Madhya Pradesh.

The selected state is vulnerable to droughts and water scarcity owning to its geo-climatic features. In the last 30 years, 7 districts of the state have been highly affected by the droughts, and many districts faced recurrent drought events. In 2015-16 alone, total of 46 districts (90 percent) have been declared drought affected. Furthermore, 72 percent population resides in villages whose main occupation is agriculture. The proposed study in selected district of Madhya Pradesh may provide a first-hand information of existing practices at the individual level to deal with drought disasters. The insights may also be useful for policy-makers and state government to set the priorities for state run programs and further strengthening the social safety nets. Before such field level examination, the study empirically analysed the drought and financial relief impacts at the district level in Madhya Pradesh. Finally, there is an examination and evaluation of the government intervention through policies, particularly the pre and post-disaster budgetary policies for disaster risk management.

The first research objective is accomplished by estimating the impact of droughts and financial relief on the aggregate and agricultural growth rates of 28 Indian states (full sample) and the three sub-groups (Irrigated, moderately irrigated and least irrigated states) for the period 1990-91 to 2015-16, employing panel fixed effects model. Drought shows negative relationship with State Agriculture Gross Domestic Product (SAGDP) in three cases (all states, moderately irrigated and least irrigated states) except for highly irrigated states. It clearly shows that along with overall agricultural growth, the least irrigated and the moderately irrigated states are vulnerable to droughts whereas the states with irrigation facilities could adapt to short-term drought shock efficiently.

Droughts also adversely affected the State Gross Domestic Product (SGDP) growth rates. The financial relief, on the other hand, showed a negative and statistically significant effect on SAGDP for moderate and least irrigated states. These findings suggest that the policymakers should include drought mitigation as an integral part of the rural development strategy at sub-national and national level in India. There must be an enhanced expenditure on the agricultural research, drought and climate change related effect on economic growth.

In addition, the state government must also ensure that the drought-relief funds are effectively utilized.

The study also empirically estimates the drought and financial relief impacts on aggregate and sector wise (agriculture, secondary and tertiary) through a two-step System-GMM approach on the balanced panel data of 45 selected districts for 2005 to 2012 in Madhya Pradesh. The results show that the agricultural growth rate falls by 28%, whereas the aggregate growth rate reduces by 6% due to drought incidence. Post-drought financial relief shows a positive and statistically significant effect on the industrial as well as on the aggregate district growth rates. Therefore, there is an immediate need to look at drought management in the context of the economics of development.

The second objective is fulfilled by analysing the data collected through primary survey. The study employs the descriptive and logistic regression approach to explore the individuals' risk management strategies and determinates of preparedness against droughts in Sagar and Vidisha districts of Madhya Pradesh, India. The respondents' proportion, who received an early warning, financial relief against crop losses, not incurred livestock loss and earn an income of INR 5000 and above, were more among those, prepared to deal with droughts and water scarcity situations. To mitigate the drought risk, many respondents diversified the income and employment sources, accessed more social safety schemes offered by State and Central governments, migrated for livelihoods, and arranged for different irrigation sources for water availability. The results of binary logistic regression analysis showed that the main variables associated with an increase in the odds of drought-preparedness were Gender, Income, and Migration (for full sample). The important predictor variables towards drought-preparedness were Income, Social group, Gender, Migration and Financial relief for sub-sample (farmers).

These findings suggest that, there is a need for strong government intervention to strengthen the social safety net (schemes such as crop and livestock insurance), and providing more access to government schemes to individuals. The State Government must also ensure that the farmers timely receive financial relief towards crop losses due to droughts. Also, the financial relief reimbursement amount should be significantly increased from the current level. The findings and recommendations of the study may be equally applicable to other drought-affected regions with similar socio-economic characteristics of respondents. Further, a descriptive analysis is employed to examine the selected behavioural biases of respondents to mitigate drought risks. The respondents showed over-confidence, over-optimism and herding biases while dealing with uncertain drought events.

Therefore, it is suggested that policy-makers should also incorporate behavioural issues in traditional decision-making models.

The third objective of the thesis is achieved by examining the existing drought management policy framework, pre and post budgetary policies, various programmes and the role of institutions for effective disaster risk management. The outcomes indicate that India lacked a practical and effective drought management policy at the national and the sub-national (state) level of administration. The ambiguity arises due to difference in defining and declaring the drought and the variations in the drought assessment and subsequent management at the state level among others. The study further notices that in the revised drought management guidelines (2016), the new criteria to prove the drought occurrence is rigid as well as impractical and does not fit to all the states climatic conditions.

An analysis of the state budgetary policy show that in short-term, relief oriented works are preferred to reduce drought risks. In addition, Drought-Prone Area Programmes (DPAP), Integrated Watershed Development Programmes (IWDP), Integrated Watershed Management Programmes (IWMP), irrigation projects and crop insurance are the major heads where funds were allocated for long-term in the state. There was an upward trend of budget allocation for DPAP (2001-2007), IWDP (1995-2009), and IWMP (2009-2013), with a few fluctuations in-between. The state also witnessed a consistent rise in the funds towards irrigation infrastructure from 2010 to 2015. Similarly, there was a regular increase in budgetary allocations by state government (2011 to 2015) towards the crop insurance premium. The data suggest that the state witnessed a declining trend in budget allocation towards financial relief to districts (from the SDRF) from 2005 to 2017, with some fluctuations in-between. It is recommended that state should further increase the budgeting to expand the irrigation infrastructure to withstand the drought shock.

Keywords: Drought; Financial relief; Irrigation infrastructure; Economic growth; State Agriculture Gross domestic product; State Gross Domestic Product; Behavioural biases; Disaster risk management; Panel fixed effects; Logistic regression, System-GMM; Budgetary Policy

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Dated: 23rd June 2021 Ashish Sharma

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LIST OF ABBREVIATIONS

CCIS	Comprehensive Crop Insurance Scheme
CGE	Computable General Equilibrium
CWWG	Crop Weather Watch Group
DAC&FW	Department of Agriculture, Cooperation and Farmers' Welfare
DDMA	District Disaster Management Authority
DDP	Desert Development Programme
DMC	Drought Monitoring Cell
DPAP	Drought Prone Area Programme
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
EMDAT	Emergency Events Database
FGP	Food Grain Production
GDP	Gross Domestic Product
GIS	Geographic Information System
GMM	Generalized Method of Moments
HFA	Hyogo Framework for Action
ICDS	Integrated Child Development Services
IDNDR	International Decade for Natural Disaster Reduction
IMD	Indian Meteorological Department
IPCC	Intergovernmental Panel on Climate Change
IWDP	Integrated Wastelands Development Programme
IWMP	Integrated Watershed Management Programme
KCC	Kisan Credit Card
LSDV	Least Square Dummy Variable
MGNREGA	Mahatma Gandhi National Rural Employment Guarantee Act
MNAIS	Modified Agriculture Insurance Scheme
MP	Madhya Pradesh
MSME	Micro Small and Medium Enterprises
NADAMS	National Agricultural Drought Assessment and Monitoring System
NAIS	National Agriculture Insurance Scheme
NDMA	National Disaster Management Authority
NDMI	National Disaster Management Institute

NDRF	National Disaster Response Fund
NGO	Non-Governmental Organization
NWDPRA	National Watershed Development Project for Rainfed Area
PMFBY	Pradhan Mantri Fasal Bima Yojana
PDS	Public Distribution System
OECD	Organisation for Economic Co-operation and Development
RGMWM	Rajiv Gandhi Mission for Watershed Development
RBI	Reserve Bank of India
SFDRR	Sendai Framework for Disaster Risk Reduction
SDMA	State Disaster Management Authority
SDRF	State Disaster Response Fund
SAPCC	State Action Plan on Climate Change
UNDP	United Nations Development Programme
UNDRR	United Nations Office for Disaster Risk Reduction
UNFCCC	United Nations Framework Convention on Climate Change
UNISDR	United Nations International Strategy for Disaster Reduction
WBCIS	Weather Based Crop Insurance Scheme

CHAPTER ONE

INTRODUCTION

1.1 Introduction

Natural hazards have caused significant economic and human losses. According to United Nations, disasters are the consequences of events triggered by natural hazards[1] that often jeopardize local response capacity and thereby affecting the social and economic development of a region (IASC, 2006). From 1970 until 2018, there have been about 11,918 disaster events worldwide, affecting more than 7.4 billion people and causing over the USD 3.2 trillion in estimated economic damages (EM-DAT[2], 2018). The global economic loss due to natural hazards is likely to increase in future and particularly a concern for the developing countries (IPCC, 2014). India is also vulnerable to natural hazards because of its varying geographical characteristics, the size of the population exposed to risks, unplanned development, budgetary constraints and limited adaptive capacities, especially of the individuals for developing the necessary resilience to disaster shocks.

Droughts and floods are two disasters repeatedly faced by the country. An estimated 622 such events have affected 2.31 billion individuals in India. These events caused 2 lakh deaths and incurred about 99 billion USD losses over the period 1970-2018 (EM-DAT, 2018). Noteworthy, floods are a fast onset disaster that occurs rapidly but persists for a relatively shorter period. Floods damage properties and cause loss of human lives and livelihood. On the other hand, droughts are slow onset disaster types. Their ability to harm the individuals and economy is complex to determine in comparison to that of the floods (and other fast onset disasters). Droughts may not cause any direct property damages (Wilhite, 2000), but may adversely affect individuals, communities, key sectors and the hamper economic growth of the affected region. Post-disaster assistance such as financial relief is a major mechanism to deal with such disasters. Rather that planning for structured mitigation policies, response driven approaches are common in India and many developing economies. The present study considers droughts as the disaster of interest assuming that

[1] Natural process or phenomenon that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruptions, or environmental damages (The United Nation Office for Disaster Risk Reduction, 2007).
[2] D. Guha-Sapir, R. Below, Ph. Hoyois (2018) - EM-DAT: The CRED/OFDA International Disaster Database – www.emdat.be – Université Catholique de Louvain – Brussels – Belgium.

flood induced losses have been extensively studied and the losses may be minimized by building adequate infrastructure. The review of literature chapter highlights few important studies focussed on floods and its management. On the contrary, the limited literature available on the slow onset disasters suggests that managing droughts is more challenging for individuals, governments and policy-makers. Unlike floods, as studies have highlighted, droughts are primarily dealt by coping and adaptation strategies at the individual and institutional level. This is elaborated in the later chapter.

With this backdrop, this study examines three important facets of drought disaster in the Indian context. First aspect is to analyse the impact of drought on the economy. This may provide a statistical evidence for India and thus contribute to the existing literature for the developing economies. The study also empirically examines the impact of post-drought financial relief on the growth parameters of selected Indian states. Further, the macroeconomic impacts such as if it leads to negative microeconomic effects and that it may cause reduction in consumption, income, savings and limiting employment opportunities among other negative outcomes. As a result, individuals may have to make considerable reduction in their current expenditures (in particular those towards immediate consumption) to cope from the distress effects of natural disasters.

Despite growing risks of disasters occurring frequently, individuals often avoid rational mitigation measures due to economic and behavioural constraints (Gifford, 2011). Optimistic biases, exposure to limited information, judgmental discounting, social comparisons and norms, inadequate capacity to make correct decisions and even shortcomings in self-learning experiences are identified as few prevalent behavioural biases among individuals. Therefore, the second aspect of this study is to identify behavioural biases, determinants of individuals' preparedness and to explore their risk management strategies (coping and adaptation) to reduce losses from drought. For this, the focus is on selected individuals affected by droughts in the Indian state of Madhya Pradesh. An understanding of the behavioural biases along with the available coping and adaptation practices through extensive field survey may be useful in suggesting the suitable risk management strategies, setting the priorities for state run programs and further strengthening the existing social safety nets. Before such field level examination, the study empirically analyses the impact of droughts and the role of financial relief at the district level in Madhya Pradesh. Finally, this study examines and evaluate the government intervention through policies, particularly pre and post-disaster budgetary policies for drought risk management. This is the third and last aspect of the study aimed at strengthening the empirical results and provide a deeper insight at the state level practices to deal with droughts. The linkage between risk management and risk financing is expected to be broadened and may contribute to growing climate change adaptation (CCA)3 literature.

The remaining chapter is arranged as follows. Section 1.2 presents the background of the thesis. Theoretical standpoints especially microeconomics and behavioural finance approaches relevant for risk management framework are discussed in Section 1.3. The following section presents an overview of the existing literature pertaining to the three aspects highlighted earlier. Based on the literature review the existing gaps, scope of research and research issues have been identified. The research questions and the objectives of the study are presented in Section 1.6. The major contributions of the present study are briefly discussed under Section 1.7. The finally, section elaborates the structure of the thesis.

1.2 Background of the study

An estimate by United Nations Office for Disaster Risk Reduction (UNDRR), in India around 300 disaster events caused USD 79.5 billion direct economic losses in the last two decades. These disasters affected over 1 billion populations, causing 76000 deaths. Among all disasters, droughts occur frequently in the country, as around 50 percent cropped area depends on the South-West Monsoon. As a result, the aggregate economy as well as the agricultural sector is affected by drought, a climate-induced slow-onset disaster. It often led to the diversion of financial resources towards relief and consumption smoothing, causing an adverse impact on the other sectors in the economy. IPCC (2014) forecasts that a warmer climate with increasing climate variability is further expected to increase the risk of climate extremes altering the magnitude, frequency, duration and spatial extension of natural hazards such as floods and droughts.

Natural events such as drought, are just hazards but when they hit areas with vulnerable population become disaster (UNISDR, 2009). Many earlier studies have established a clear relationship between natural disasters (including droughts) and the economy. Such studies are either multi country analysis or single country and sector

[3] Climate change adaptation (CCA) refers to adjustments in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects or impacts. It refers to changes in processes, practices, and structures to moderate potential damages or to benefit from opportunities associated with climate change (United Nations Framework Convention on Climate Change, 2009).

specific studies. The outcomes of these empirical studies were not unidirectional either displaying positive[4] or negative[5] and even neutral[6] impact on the economy. Therefore, drawing conclusion regarding direction of impact on the locale economy is difficult and still lacks a clear consensus among academicians and researchers on the above issue. More empirical studies at country level may generate further evidences to draw appropriate inferences. India being a developing country and a rising trend of negative impact of drought disasters on lives, livelihoods and the economy, it is timely to establish an empirical relationship between drought disaster and the micro-economy in particular.

The macroeconomic impacts of natural disasters trigger the microeconomic impacts. Due to limited resources, poor (especially those in the agriculture sector) and marginalized rural people remain more vulnerable and hence easily become the main victim of natural disasters. Zeller and Sharma (2000) shows that lower income households spend 91 percent of their consumption budget on food, so any drop in income due to disasters may have serious consequences like reduced consumption, savings and income for them. In response to natural disasters, individuals adapt various short-term and long- term measures, which vary according to economic, social and cultural differences of individuals, communities and nations.

Theories in behavioural finance help to understand how individuals prepare to face the uncertain natural disasters. Often, individual's irrational behaviour and decision making, under uncertainty and risk determines their coping and adaptation choices. Optimistic biases, exposure to limited information, judgmental discounting, social comparisons and norms, inadequate capacity to make correct decisions and even shortcomings in self-learning experiences are identified as few prevalent behavioural biases among individuals.

For analysing the individual's behavioural biases, coping and adaption measures, this research studies Madhya Pradesh, which is vulnerable to droughts owning to its geo-climatic features. In the last 30 years, 7 districts of Madhya Pradesh have been highly affected by the droughts (State Disaster Management Plan, 2012), and many districts faced recurrent drought events. In 2015-16 alone, total of 46 districts (90 percent) have been declared drought affected. Furthermore, 72 percent population resides in villages whose

[4] Albala-Bertrand (1993); Skidmore and Toya, 2002; Leiter et al., (2009); Noy and Vu (2010); Cunado and Ferreira (2011).
[5] Noy (2009); Raddatz (2009); Vu and Hammes (2011); Loayza et al., 2012; Felbermayr and Groschl (2014); Kilimani et al., 2018; Panwar and Sen, 2019.
[6] Caselli and Malhotra, 2004; Raddatz, 2007.

main occupation is agriculture. The per capita income of Madhya Pradesh was INR[7] 59770 in 2015-16, which is far less than the national average. This proposed study in selected district of Madhya Pradesh may provide a first-hand information of existing practices at the individual level to deal with drought disasters. Based on the outcomes, we may suggest appropriate programmes for the state to reduce losses from recurrent droughts, fostering sustainable and inclusive development in state. Examining the Madhya Pradesh government intervention through public policy for disaster management (especially budgetary policies), may help the decision makers to design suitable policies, ensuring right balance between investments to reduce risk, transfer risk and effectively prepare for and manage drought impacts.

In the next section, we discuss the behavioural finance theory for decision making under uncertainty and risk along with theoretical background and approaches towards analysing the impact of natural disasters on economy and risk management framework. Traditionally individuals' coping and adaption decisions are based on their own experiences, learnings and trust in others (Eiser et al., 2012). Despite growing risk of droughts they avoid rational mitigation measures due to economic and behavioural driven constraints (Gifford, 2011). Moreover, inadequate capacity to process available information, lack of guidance, different risk perceptions also contribute to incorrect decision outcomes under risk and uncertain conditions. Often, these decision choices may not decrease the risk of losses, if not based on rational rules and ability to process the available relevant information and neglecting other irrelevant information.

Therefore, microeconomic theories like utility maximization theory, prospect theory and the concepts of behavioural finance may be helpful to understand, how individuals frame choices in risk and uncertainty of climatic disasters like droughts. It may contribute to formulate the suitable risk management strategies for coping and adaption at individual level. Therefore, utility maximization theory, prospect theory and three behavioural finance concept i.e. overconfidence, over/under optimism and herding are discussed next, which are most relevant founding stone of decision making theories and to achieve the second objective of this proposed research plan.

[7] INR denotes the Indian Rupee, the currency of India.

1.3 Theoretical perspective

Natural disasters trigger economic losses by causing direct and indirect damages. Direct damages include infrastructure damages (home, household contents, buildings, productive capital, bridges, roads etc.). Indirect damages include business interruption cost because of the direct damages to their suppliers, workers and power breakdown etc. Since it is difficult to measure the indirect damages, calculating exact loss becomes difficult. Hence, instead of attempting to estimate direct or indirect damages, the impact of natural disasters on economic growth are assessed using macroeconomic variables (proxy) like Gross Domestic Product (Cavallo and Noy, 2011).

At the individuals' level, decision making is the act of choosing an option from a set of alternatives. They have to first decide that a decision has to be made then have to identify a set of feasible alternatives before they select one. Decision making under certain conditions is relatively easy. A condition of certainty exists when the decision-maker knows with reasonable certainty what the alternatives are, what conditions are associated with each alternative and able to rank them consistently knowing the outcome of each alternative. Under conditions of certainty, accurate, measurable, and reliable information remains available. Under above assumptions the choices made are generally rational. However, decision making under certainty is rare. It is very difficult to find complete certainty in most of the important decision conditions. In practice the assumptions of certainty like complete and reliable information, known probabilities of possible events and outcomes gets violated.

Most, decision problems fall between the categories of risk and uncertainty. Risk condition means, there are more than one possible events that can take place. However, the decision maker has adequate information to assign probability to the happening or non-happening of each possible event. Such information is generally based on the past experience. In an early attempt, to describe decision making under risk conditions, Jeremy Bentham (1738) rooted the concept of utility that was subjective, individualized and difficult to quantify. Then, Pareto (1896, 1906) talked about 'preference' and 'choice' rather than utility functions. Paul Samuelson (1947) suggested 'revealed preference theory' based on observable behaviour not 'utility'. Meanwhile, the important theory explaining the individuals' behaviour that seeks for the maximization of utility under risk conditions and rationality assumption is as follows:

Utility maximization theory

This microeconomic theory of expected utility maximization was developed by Von Neumann and Morgenstern (1947). It proposed that, when an individual is faced with a choice of outcomes, subject to various levels of chance, the optimal decision will be the one, that maximizes the expected value of the utility (i.e., satisfaction) derived from the choice made. Expected value is the sum of the products of the various utilities and their associated probabilities. The individual is expected to be able to rank the items or outcomes in terms of preference.

Further, when uncertainty regarding decision outcomes dominates, decision making becomes more challenging and difficult. Uncertain conditions are, where more than one type of event can take place and the decision maker is completely in dark regarding the event that is likely to take place. The decision maker is not in a position, even to assign the probabilities of happening of the events. Such situations generally arise in cases where happening of the event is determined by external factors. People have only a meagre data base, they do not know whether or not the data are reliable, and they are very unsure about whether or not situation may change. Moreover, they cannot evaluate the interactions of the different variables. In such scenarios the risk analysis approach (as discussed latter) and subjective considerations dictates the decision choices.

Prospect theory

Moreover, in such uncertain situations, psychological factors influence choices under uncertainty and show departures from rational models. This violates the rationality assumption of earlier discussed theories. The basis of such irrational or illogical decisions, can be explained by another set of theories operating under the arena of behavioural finance. Prospect theory of Kahneman and Tversky (1979), challenged the rationality argument and gave an entire new insight to see the decision making process. Prospect theory, a descriptive technique with roots in psychology, has emerged as an alternative theory of decision making under risk and uncertainty to utility theory and other classic approaches. Theory challenged the explicit rules of rational decision making theory by noting that choices that individuals make under situations of risk and uncertainty exhibit several characteristics that are inconsistent with the fundamental von Neumann Morgenstern (1944) expected utility principles. Prospect theory may explain the individuals' decision making about coping and adaptation choices, in the uncertain situations arising from droughts and floods.

The theory suggests that there are persistent biases motivated by psychological factors that influence individual's choices. As a descriptive technique, prospect theory explains how individuals choose among alternatives when outcomes associated with those alternatives are probabilistic or uncertain in nature. It considers preferences as a function of "decision weights" and assumes that these weights do not always match with probabilities. Individuals often make decisions based on both the expected outcome and the risk associated with losses or gain. Decision weights tend to overweight small probabilities and under-weight moderate and high probabilities. Individuals show a revealed preference for surety over slightly greater mathematical returns with risk. Further, individuals tend to be risk averse with respect to gain (loss aversion) but risk seeking with respect to losses. Individuals appear to have a greater sensitivity to losses than to gains, because their pain associated with a given amount of loss is greater than their pleasure derived by an equivalent gain. This theory helps understand why the same individual can be, at different situations, risk-avoiding or risk-seeking.

Further, behavioural finance theory exhibits important concepts (behavioural biases) under which individuals frame their choices under uncertainty. Behavioural finance seeks to combine behavioural and cognitive psychological theory with economics and finance to provide explanations for why people make irrational decisions. These behavioural biases are the building blocks of individual's decision making under uncertainty. Three such relevant concept for our study, are discussed below. These concepts are prevalent in practice and are dominant drivers of risk perceptions and irrational coping and adaption responses during uncertainty of floods and droughts.

Important concepts under behavioural finance

Overconfidence: Individuals are poorly calibrated in estimating probabilities and usually overestimate their precision of the knowledge and ability to do well. Individuals have overconfidence about good things happening in future than bad. In addition, they overestimate their confidence to the past positive outcomes and usually recall only their successes than their failures. For example, Ballantyne et al. (2000) found that overconfidence bias leads to over belief in self-capability to recall the information of actionable during natural hazard.

Over/under optimism: This pervasive bias is exhibited when an individual systematically overestimates the probability of a favourable outcome and/or systematically underestimates the probability of an unfavourable outcome. Greater optimism can result when individuals believe, rightly or wrongly, that they can exercise effective control over their activities and plans, thus diminishing the perceived risk of failure. For example, Paton and Johnston (2001) confirmed that due to optimistic biases individuals found themselves better prepared to deal with volcanic hazard effects, compared to others.

Herding: It is a tendency of individuals to rationally or irrationally mimic the actions of a larger group. Individuals inherently have a strong belief that their personal security would be better off and even enhanced through cooperative behaviour or following others to whom they value. Herding is observed often, in case of purchasing insurance policy by individuals against natural disaster. Individuals prefer to purchase the protection policies (like home insurance) provided, others (like friends, neighbours or relatives) have purchased it (Kunreuther, 1984).

It is necessary to understand the risks arising out of individual's behaviour to manage them by applying a suitable risk management framework. Risk Management is defined as the systematic application of management policies, procedures and practices to the tasks of identifying, analysing, assessing, treating and monitoring risk (Standards Australia/Standards New Zealand, 1995).

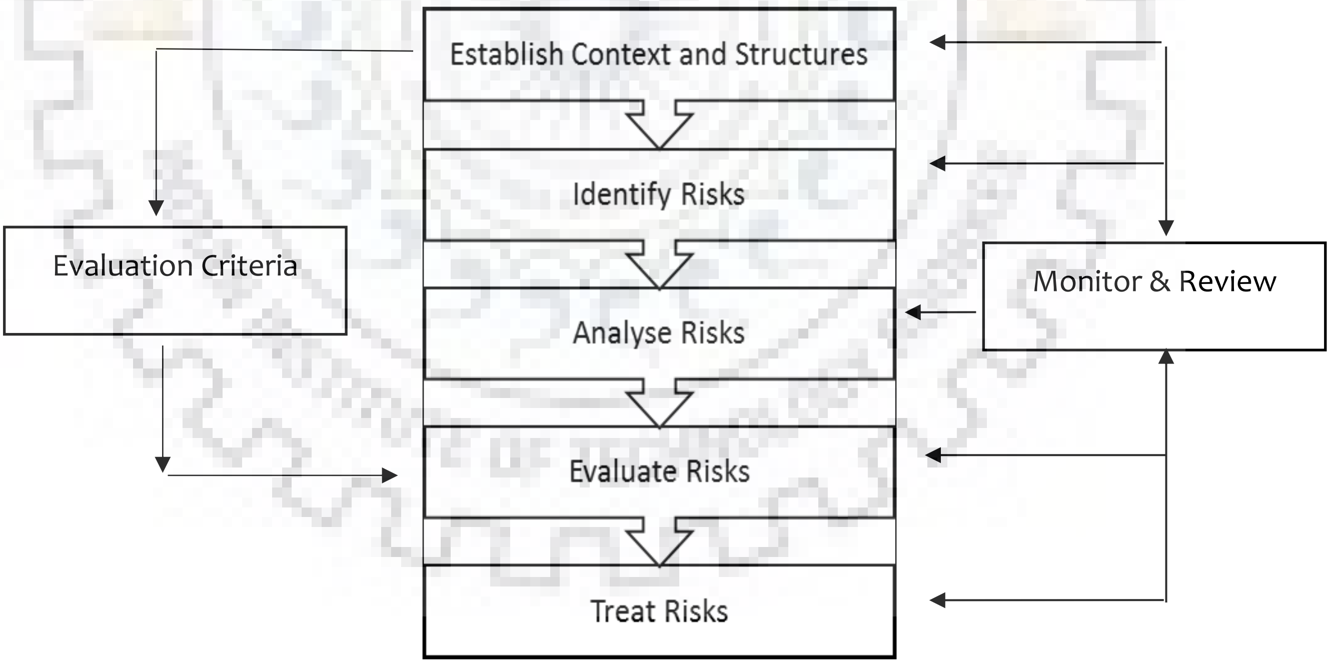

Figure 1.1 Risk Management Framework

Adapted: Australia/New Zealand Risk Management Standard, 1995

The above systematic risk management framework may enhance disaster management. It is helpful for systematic analysis and decision making process, thus designing suitable risk managing strategies for disasters. Establishing context and structures (disaster type, area, who is affected), identifying risk (sources of risk), analysing risk (elements of risk) and evaluating risk (which risk is important and what to be done) are guiding clues for risk analysis and Management. Vulnerability at individual level essentially means coping ability, capacity of individuals to retain their functionality, to resist and recover from adverse impact of disaster. Therefore, risk management focused on vulnerability may provide a flexible and holistic framework for better disaster management at individual level. Considerations related to hazards and strategies of prevention, preparedness, response and recovery are necessary elements of disaster management, however, these are not sufficient. A comprehensive taxonomy of disaster management strategies is necessary. Despite standard global guidelines and practices to deal with natural disasters, it is extremely important to understand how disasters are perceived and managed by different individuals. It is found that economically, socially, technically and culturally the coping and adaptation measures varies across countries, states, communities and at individual level, hence the prescription to risk management too should differ significantly. In the next section, the literature related with all the three aspects of the present study will be explored.

1.4 Overview of existing literature on natural disasters

This review of literature is arranged sequentially for literature explored on four related themes. First, the empirical studies on impacts of natural disasters (primarily droughts) on the economy is explored. Second, the studies examining the financial relief towards droughts and other natural disasters are explored. Third, the aim is to assess the post-disaster micro-economic behaviour of individuals, coping and adaption strategies and behavioural biases. Finally, the government intervention strategies in wake of pre and post disasters are reviewed. A very brief overview of the literature is given below.

In the first set of thematic review, all the studies (multi-countries, single country and firm/region level studies) examining the natural disasters (including drought) impact on economic growth rate are studied. A few studies (Noy, 2009; Vu and Hammers, 2011; Felbermayr and Groschl, 2014) among them, argue that the impact of disasters is negative, whereas a few show positive relationship (Skidmore and Toya, 2002; Leiter et al., 2009) or neutral (Albala-Bertrand, 1993; Caselli and Melhotra, 2004) impact. It is interesting to note that many studies show that the impact of droughts significantly vary on developing and developed (Cunado and Ferreira, 201; Loayza et al., 2012; Fomby et al., 2013; Panwar and Sen, 2019) economies and across sectors. For example, Loayza et al. (2012) show that droughts had a weak negative impact on the GDP growth but significant impact on agricultural growth. In developing economies, droughts negatively affected the overall, agricultural and industrial sectors growth. Fomby et al. (2013) estimated that droughts adversely affect the GDP growth in the developing economies only. However, agricultural growth was affected equally in both types of economies.

In a contrast evidence, Raddatz (2007) show that climatic disasters (including drought) negatively impacted GDP growth in long-term. Further, Raddatz (2009) concluded that among climatic disasters droughts hurt economic growth more than sectoral growth rate. In a recent attempt, Panwar and Sen (2019) empirically concluded that droughts do not have any significant effect on the aggregate growth rate for a pooled sample of developing as well as developed economies. However, the study observed a negative impact on the developing economies. In all, the outcomes of above studies show that the evidences are not unidirectional. Negative, positive or neutral impacts of droughts on macro economy and agricultural sector exist.

The second section of thematic review analyses the financial relief disbursement impact on economic growth. The literature on the subject matter is relatively limited, but is more conclusive than droughts impact. Kishore et al. (2015), Xu and Mo (2013) and Freeman (2004), are few important studies in the subject area. All these studies offer a similar insight that post-disaster financial relief due to drought (Kishore et al., 2015), floods (Xu and Mo, 2013) other natural disasters like earthquakes (Freeman, 2004) have a negative impact on the economic growth.

This third section of the literature review is focused on analysing the micro-economic effects of disasters on the individuals and households, as well as, coping and adaption strategies. The capacity of any government to intervene has limitations (Wamsler and Brink, 2014; Klein et al., 2017), and individuals' resilience offers a first defence mechanism against disasters risk. Chen et al. (2014) finds that 86 percent of rural households in China have taken adaptive measures to protect crop production against drought, most of which are non-engineering measures. Only 10 percent of the households applied both engineering and non-engineering measures. Among the households, who adapted non-engineering measures, only 8 percent bought crop insurance. Drought resistant crops and government support are the common measures on which individuals depend mostly, as revealed by three Indian studies namely Udmale et al. (2014), Negi et al. (2014)

and Bishnoi et al. (2013). Earlier studies (Deressa et al., 2011; Scheffran et al., 2012; Udmale et al., 2014; Khanal et al., 2018) explored the determinants of household adaptation capacity against climate change or natural disasters. Two Indian studies namely, Mishra (2012) and Patnaik (2012) in Orissa and Madhya Pradesh, respectively, found that migration and indulging in non-farm activities, were two important mitigation measures adapted by rural individuals.

Literature review on behavioural biases and natural disasters (including drought) reveals that individuals do commit mistakes and behave irrationally in mitigation and preparedness. Further, individual behavioural biases give a shape to their preparation and responses to deal with natural disasters and for decision choices in such uncertain and risk conditions. Mase et al. (2017) survey around 5000 farmers in the USA and enquired about the factors influencing their adaptation strategies due to climate change. The study found that farmers individual risk perception for their own farm and the attitude towards the adaptation dictates their strategies. The scientific information about the most likely direct impact of climate change on the agriculture had a limited role to invest in adaptation measures.

Meyer and Kunreuther (2017) observed that over-optimism is an important reason of non-preparedness against disaster risks. Kishore et al. (2015) et al. found that a cash transfer programme (financial relief as a diesel subsidiary for irrigation measures) was unable to bring the changes in farmers' behaviour to adopt against drought in Bihar, India. According to Kunruether (2006), individuals believe that natural disasters will not have worse-off impact on them. The short time horizon is the reason behind ignorant behaviour and inaction for disaster risk reduction. These findings are well supported by few more studies on individual's behavioural biases and risk reduction and in particular corroborate earlier studies by Paton and Johnston (2001) and Ballantyne (2000).

In the fourth section, the literature on the standard guidelines (necessary for policy making) and studies regarding government policy intervention for disaster management (including drought) and practices adopted by various nations including India is presented. Yokohama Strategy and Plan of Action for a Safer World, 1994 was the first guiding principle for managing disasters. Yokohama strategy had a focus on the response rather than disaster risk reduction. This strategy emphasized more on coping, adaptation and managing emergencies. United Nations International Strategy for Disaster Reduction (UNISDR) replaced IDNDR in 1999. From post-disaster recovery and assistance, now risk preparedness and prevention was more emphasized (UNISDR, 1994). The Hyogo

Framework for Action (HFA) further extended the disaster reduction objectives. The focus of HFA was the reduction of risk exposure and increasing preparedness to decrease social and physical vulnerability, especially for developing countries. Sendai Framework: 2015-2030 (SFDRR, 2015), replaced the HFA with the revised goals of decreasing the existing risks and preventing the new risks. Vulnerability reduction and improved resilience by the active participation of all stakeholders (SFDRR, 2015) are now the focus areas.

In the above context, Phaup and Kirschner (2010) examined the budgetary polices of selected 30 Organisation for Economic Co-operation and Development countries (OECD) and suggested that the budgeting for disasters should be ex ante (in good times) rather ex post for better results. This creates procedural opportunities to save for the expected cost of relief and recovery and realizes budgetary savings for measure that reduce losses through mitigation and offset to moral hazards. Hallegatte (2015) opines that government with fiscal space or insurance or other risk sharing mechanism will be able to increase public expenditure to deal with the disasters. Linnerooth-Bayer and Hoch Rainer-Stigler (2014) in developing countries found that, largely disaster victims, in vulnerable countries depend on governments and donor assistance to get relief. Informal credit mechanism fail, as whole families and regions get affected, reducing the potential for informal risk sharing.

In India, disasters (including drought) are effectively dealt under Disaster Management Act (2015) with full assistance by the district level authorities and line departments with support from the National Disaster Management Authority (NDMA) and the State Disaster Management Authority (SDMA). The state government have funds for relief measures under State Disaster Response Fund (SDRF). In addition to this, the fund is granted form the National Disaster Response Fund (NDRF) for natural calamities of severe nature. It is approved based on the requests received from State Governments. The post-drought relief measures generally dominate the prevention or mitigation interventions (Manual for Drought Management, 2009 and 2016). However, Shughart (2011) criticized such approach stating that disaster relief as a public policy is not good as it fosters corruption, and creates a problem of moral hazard, encouraging the individuals to put themselves in a risky way. Also, states' dependency on the central government for the relief finances is very high (Prabhakar and Shaw, 2008). The revenue department of the states generally owns the responsibility for relief operations. The relief commissioner heads the responsibility and ensures that timely relief reaches to the affected districts, tehsils or villages in collaboration with their representatives and NGO's. The prevention and mitigation measures are entrusted with the various States as well as the central government departments through budgetary allocation.

1.5 Scope of the study and research issues

The review of literature highlights gaps which may be worth exploring for further research. Empirical studies on the relationship between natural disasters like drought and economy show that there is a divided view regarding the impact of drought disaster on economy in short run. Impact of droughts also varies in developing and developed economies. Despite the growing literature on the subject, the empirical evidences regarding the impact of droughts on overall and agricultural economy is still largely inconclusive. There is a scope to examine the relationship of droughts with agricultural and overall economy for a single country. Therefore, the first research issue is to analyse the empirical relationship between drought and Indian economy in general and agricultural sector in particular. There are only a few such country level studies which have been conducted so far (Please refer the review of literature chapter).

There are limited studies, analysing possible impact on macro economy like effects on the government budget in the aftermath of a disaster like droughts. Post-drought spending by government may divert resources to provide immediate relief or merely used for fulfilling basic needs instead of financing infrastructure. In both the cases effect on Gross Domestic Product (GDP) will be different, affecting the government balance sheet in long run. Therefore, impact of financial relief towards drought on economy is also empirically analysed in the present study. The review of literature reveals that there is a substantial volume of literature on post disaster coping and adaption measures but with certain limitations. For example, some studies which focused on global adaptive measures for droughts and floods, (Samphantharak and Chantarat, 2015; Chen et al., 2014) may not have much relevance for developing countries and especially a droughts prone locale like Madhya Pradesh. A few studies examining the similar issues for Maharashtra (Udmale et al., 2014), Orissa (Pattnaik, 2012) and Haryana (Bishnoi et al., 2013) are less applicable for other states of India due to their different vulnerability profile, cultural factors, economy, beliefs and occurrences of disasters. Also, mitigation, adaption and risk management measures varies at individual level across disasters type, culture, economy, and geography. This presents a scope for quantitative research for other high disaster prone states of India. These studies essentially collected and analysed the primary data at the household level (not at the individual level) to measure the respondent' adaptive capacity. However, most of the studies mentioned above had focus towards adaptation to climate change, not to water scarcity and droughts. The present study fills such gaps existing in the literature.

In this backdrop, the local coping and adaptation mechanism of individuals in disaster prone districts/villages of select state in India will be analysed. Madhya Pradesh has been facing recurrent droughts. Being a state where rural population is high and depending primarily on agriculture, doing such a study makes sense. Few studies on behavioural biases (Grothmann and Reusswig, 2006; Kunruether, 2006; Paton and Johnston 2001; Ballantyne, 2000) in case of natural disasters like drought may be replicated in the Indian context for understanding of individuals' behaviour. Since disaster management is a state subject in India, hence it is important to look into various state policy towards drought risk management. In addition, analysis of the pre and post budgetary policies of selected state in India for drought management will further help to reduce disaster risk. Based on the above discussion on possible gaps and scope for further research in the area, a set of research issues (questions) has been identified, which is assimilated in the research objectives to study in detail.

1.6 Research questions and objectives

The present study aims to address the following research questions:

1. What is the relationship between drought, post-drought financial relief with aggregate and agricultural economic growth at sub-national (state) level in India?
2. How much does drought and financial relief empirically impact the economic growth (aggregate, agricultural as well as sectorial) at the district level to provide statistical evidences for policymakers and governments?
3. What are the key challenges in implementing the drought risk management policies and how does it differ at sub-national levels in India?
4. Do behavioural biases prevail and affect the individuals' risk management practices while dealing with disaster events?
5. What are the risk management strategies and factors determining the individuals' adaptation capacity in severely drought affected regions of India?
6. What are the roles, efficacy, and limitations of existing disaster management policies to support the drought affected individuals?

The study answers the above research questions through the following research objectives:

1. To analyse the empirical relationship between drought, drought-relief and growth parameters of the selected state economy in general and agricultural sector in particular.
2. To explore the behavioural issues, determinants of preparedness and individual risk management practices (coping and adaptation strategies) to reduce losses against droughts with particular reference to Madhya Pradesh.
3. To examine and evaluate the government intervention through policies, especially budgetary policies towards pre and post disaster financing for India in general and Madhya Pradesh in particular.

1.7 Contributions of the Thesis

The study estimates the relationship of drought and post-drought financial relief with the agricultural sector and GDP of Indian states. It also quantifies such impact on the agriculture, secondary, and tertiary sectors of districts' GDP in Madhya Pradesh. Such analysis adds to the existing knowledge by providing a strong statistical evidence for an economy like India as well as Madhya Pradesh, which faces recurrent droughts and are highly dependent on rainfall for the sustainability of the agricultural sector. This is one of the first studies to examine such a relationship using state-level and district level information for a state, in the Indian context. The estimates of impact will be helpful for relevant stakeholders for designing specific pre and post-drought risk management strategies, planning for the state irrigation capabilities, etc.

The study may also be helpful in understanding the behavioural biases of individuals in decision making to respond or manage risk of drought, which are also attributed to climate change in Madhya Pradesh. This study may also provide a deeper insight at the central and state level practices to deal with droughts. The linkage between risk financing, risk reduction and adaptation against drought may get clear. The study explores determinants of preparedness against droughts and analyses the individuals' risk management strategies through a primary survey in the selected districts. However, the findings and recommendations of the study may be equally applicable to other drought-affected regions with similar socio-economic characteristics of respondents. The findings may also be relevant to the government of Madhya Pradesh in designing suitable Disaster Risk Management (DRM) policies ensuring right balance between investments to reduce risk, transferring risk and effectively preparing for and managing disaster impacts considering the behavioural aspect of individuals. Further, the study results may be helpful to understand the pre and post budgetary policies of Madhya Pradesh towards drought risk management.

1.8 Structure of the thesis

The thesis is organized into six different chapters. The brief description of each chapter is as follows. “Introduction” is the first chapter of the thesis which establishes the context as well as rationale of the present study. There is a brief discussion on the background of the study and drought incidences in the study area, which led us to formulate the problem statement. The conceptual framework is proposed for the current research along with the various theories applicable to accomplish the present research enquiry. Following this, a brief overview of the existing literature on natural disasters (primarily drought) are explored. Subsequently, the scope of the present study and various research issues are highlighted. Finally, research questions and three concrete research objectives are framed to study. The Chapter ends with the contribution of the thesis in the existing literature on the subject matter.

The second chapter is “Review of Literature”. In this section the select peer review literature on the economic impact of the natural disasters is discussed, which is useful to fulfil our first objective. Further, the literature pertaining to the impact of financial relief in reducing drought impact and the impact of other disasters is also explored. Following which, the review of literature on risk management strategies in the event of drought and the behavioural issues are also discussed. Finally, the review of literature section ends up with highlighting the role of governments and the different institutions at the national and sub-national levels, responsible for disaster management in the countries.

The empirical analysis begins with chapter 3 in this thesis, which is titled as “Impact of Droughts on Economy: *State level analysis*”. In the chapter, there is an econometric analysis to find the impact of droughts and financial relief on the aggregate and agricultural growth rates of 28 Indian states (full sample) and the three sub-groups (Irrigated, moderately irrigated and least irrigated states) for the period 1990-91 to 2015-16, employing panel fixed effects model. The study helps to empirically establish the importance of adequate irrigation infrastructure to negate the adverse effects of drought.

The fourth chapter is the state level analysis where Madhya Pradesh is the selected state. The chapter is titled as “Impact of Droughts on Madhya Pradesh Economy”. The section 4.1 presents a brief account of the economy of Madhya Pradesh from 1991 to 2015. The contribution of various sectors in the state economy, key indicators of economic growth and other relevant statistics are briefly explored. There is also a discussion on the natural disasters (droughts, floods and earthquakes), prevailing in the state. Section 4.2 focuses on the drought monitoring, declaration and relief process at national as well as the state level. Then, in the subsequent section (4.3), there is an empirical analysis to examine the impact of droughts and post-drought financial relief on the aggregate economic growth and the growth of agriculture, industry and service sectors for the 45 selected districts of Madhya Pradesh. The benefits of financial relief post-drought and the efficacy of irrigation infrastructure is also statistically tested. A two-step GMM procedure is applied to balanced panel data for the period 2005 to 2012. The next sub-section analyses the primary survey of two frequently drought-affected districts of the state. This primary data based study analysed the individuals' risk management strategies and determinants of preparedness against droughts (section 4.4.1). The study employed the descriptive as well as binary logistic regression method to analyse the data, collected through a structured questionnaire from the sampled individuals. Finally, the chapter ends with section 4.4.2 analysing the behavioural biases of individual respondents' in the survey while facing the risk and uncertain situations of droughts in the study area.

The fifth chapter is titled as "Policies and institutions towards Disaster Risk Management". It discusses the budgetary allocations to important state run programmes, trends, and financial contributions of state and centre to reduce the exposure, vulnerability and damage caused by droughts along with measures for the preparedness in Madhya Pradesh. There is also an analysis of the existing policies and institutional framework towards drought risk management, the role of policies and institutions in fostering prevention, preparedness, mitigation, and post-disaster relief. The chapter ends with highlighting the various limitations of the existing policies in achieving the drought risk management objectives.

The final (sixth) chapter is "Conclusion" which briefly summarizes the findings and summary of all the key analysis and discussion undertaken in the thesis. It also presents the major policy implications for various governments and policymakers for effectively managing the drought related risks. At last, the scope of future research on the existing gaps and limitations, which the present study leaves for future research are highlighted.

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CHAPTER TWO

REVIEW OF LITERATURE

2.1 Introduction

Drought is a complex (Wilhite, 2000) and slow onset natural disaster (Swain and Swain 2011) with immediate (Loayza et al., 2012; Panwar and Sen, 2019) as well as long-term effects on agriculture and other sectors of the economy (Dercon, 2004; Panwar et al., 2021). Droughts may not cause any direct property damages (Wilhite, 2000), but may adversely affect individuals and the overall economic growth of the affected region. Ding et al. (2011) systematically reviewed the existing literature and show that drought impact the economy by adversely affecting the agricultural sector (crop and pasture losses) along with the non-agricultural sectors like tourism, horticulture and other water dependent industries and business. These direct effects would lead to secondary effects, as the reduced agricultural output may often be an input for many industries, thus hampering their growth. Further, other non-market impacts (like welfare losses) are added to the total economic losses.

To estimate the total losses from disasters, direct and indirect loss data are required, which at times remain difficult to obtain. Therefore, the researchers and economists prefer to estimate the impact of drought on the crop yields or aggregate and sectorial economy of a single or group of countries. As discussed in the previous chapter, the financial relief towards the crop and other losses to affected population is a preferred measure under the disaster management framework in India (Manual for Drought Management, 2016). The households and individuals have their own preparedness and coping strategies to deal with such recurrent events. Nonetheless, the support of government and policies play a crucial role to mitigate water scarcity and drought related risks faced by households and individuals. The thesis therefore has three precise objectives (as stated in the previous chapter) related to the issues discussed above to accomplish. This chapter is an exhaustive review of literature organized chronologically for literature explored on four related themes relevant to droughts to fulfil the objectives.

The rest of the chapter is structured as follows. Section 2.2 explores the existing literature examining the drought impact on agriculture and other allied sectors and its linkages with secondary and tertiary sectors of the economy. Section 2.3 explores the studies pertaining to the impact of financial relief in reducing drought impact and the impact of other disasters. In section 2.4 the review of literature on determinants of adaptive capacity towards disasters (including drought) and the risk management strategies (coping and adaptation) of households towards drought and climate change are discussed. This section also covers the peer review literature on the selected behavioural biases demonstrated by the individuals during uncertain natural disaster events. Section 2.5 is the review of literature highlighting the role of governments and the different institutions at the national and sub-national levels, responsible for disaster management in the countries. Finally, the chapter ends with the section 2.6, which summarizes the present chapter.

2.2 Economic impact of drought

This section first discusses about the direct and indirect effects of drought on economy and economic sectors. The agricultural sector is most vulnerable, impacted by the scarcity of water, due to crops dependent on it (Diersen et al. 2002; Howitt et al. 2014). According to Sen (1982), the crop loss induced inflation causes a sharp rise in the food grains prices but lowers livestock prices as drought intensifies in the following period. As a result, the poor farmers become poorer in buying food grains and are forced to sell the productive assets like livestock (Helgeson et al., 2013) or land to meet livelihood challenges. The rich, on the other hand, may gain by acquiring these assets at relatively lower prices. Droughts trap the poor into poverty, especially in developing countries with limited government actions. This affects the agrarian growth in the absence of viable and alternative livelihoods (McPeak and Barrett 2001). According to Joshi (2019), a severe drought adversely affects human capital lowering educational outcomes of the school going children, as the drought-induced reduction in parents' income, lower the investment for children education. However, studies also conceptualized and explained multiple dimensions involved in understanding the droughts impact on farm economy.

In the developmental economics literature, discussion on drought is extensive and varying. Fafchamps et al. (1998) and Kazianga and Udry (2006) show that neither livestock nor assets such as land serves as a tool for consumption smoothening. Rather, there are changes in the consumption behaviour of the households and thereby the idiosyncratic shocks are internalised and not felt at all at the aggregate level. Krishnaswamy (2012) analysed the impact of 2009-10 drought on the consumption pattern of rural and urban households in India and revealed that the drought severely affected the 10% well off rural individuals than others. In urban areas, the opposite happened; drought reduced the expenditure of the lower class urbans by 10 percent than the upper class urbans. The author explained that the less affluent rural people are supported by the various safety nets like MGNREGA and other government-sponsored schemes, whereas the upper class urbans were less affected due to engagements in industry and services, than the lower class urbans. Hayati et al. (2010) in Iranian context also observed that the poor farmers were mainly hit hard than the rich farmers. The government intervention could not benefit the poor farmers due to flawed government policies. As a result, the government support was directed more towards less needy and well off farmers than the poor ones, intensifying their poverty. The drought therefore, forced the poor farmers to lower their food consumption, education and health expenditure to cope with the drought-induced income reduction.

In the present theme, the focus is on the aggregate impact of drought and therefore the insights from the household level studies may not be as relevant to understand macro level phenomenon. According to Diersen and Taylor (2003), drought-induced shortage of crops increases crop prices, which finally affects consumers. Additionally, crop insurance and government aid may benefit the farmers, indemnifying partial loses. It all depends upon the interaction of demand and supply of products and market structure and the risk seeking characteristics of the households as identified by earlier literature. Therefore, while calculating the impact of drought on the agricultural sector, only farmers' income loss should not be the sole criteria. Drought is a local phenomenon that affects a particular geographic location, but it may have spill over effects to other regions. Drought-induced supply shortage at one specific location may be negated by higher supply by another place. It may neutralise the overall impact in a broad geographic area.

Desai (2003) argued that in an agricultural dominant economy, drought might negatively impact the supply of food and cotton textiles hence raising their costs. As a result, agro-bases industries suffer, adversely impacting the agricultural value addition. This phenomenon exerts a direct adverse impact on the labourers' income (and purchasing power), which in turn may reduce the economic growth, if the economy is labour intensive. Mueller and Osgood (2009) in reference to Brazil studied the impact of 1992, 1993 and 1995 droughts on the wage rates of labourers. The authors found that droughts decreased the rural wages by 18 and 9 percent respectively within 5 and 5-10 years' period, significantly increasing the vulnerability of agricultural labourers. Singh et al. (2013) in Meghalaya, an Indian state also observed that drought significantly lowered the household income (farm and non-farm income). More than male, drought affected the females' dependent on agricultural activities making them vulnerable and marginalized. Udmale et al. (2015) also support the above findings and analysis of primary data from Maharashtra show that 2012 drought reduced the rural household annual income by 85.4 percent. Severe droughts may reduce the profits and capacity of farmers to invest in advanced techniques, reducing agricultural growth (Sheng and Xu, 2019).

Edwards et al. (2013), in reference to 2007 drought in Australia found that, the drought-induced economic distress in agriculture spreads across other sectors of the local economy. The direct impact on agriculture may cause indirect effects. For example, drought-induced reduction in agricultural income affects rural demand for non-agricultural products and services (Desai, 2003). As a result, manufacturing and service sectors growth rates are affected. Freire-González et al. (2017) show that rainfall deficiency (meteorological drought) primarily affects the agriculture and other water dependent sectors. It triggers the higher order economic impact on other sectors of the economy, if the ground water reservoir storage and management is not adequate. Schwarz and Williams (2014) make similar observations in case of drought impact on small businesses in Australia. One of such noted social impact is the loss of services in the drought-affected area. Further, droughts may trigger migration of labour (Gray and Mueller 2012; Murali and Afifi 2014; Dallmann and Millock 2017), which may cause productivity losses due to decreased labour supply at farmland in subsequent years. Along with migration, unemployment is another important outcome following droughts that may affect economic growth in the short-term to medium-term. There are studies (Dallmann and Millock, 2017; Gary and Mueller, 2011; Badiani and Safir, 2009; Vanwey, 2005; Henry et al., 2004; Curran and Rivero-Fuentes, 2003; Munshi, 2003) in this regard. However, the studies do not directly delve into such outcome.

An economic assessment of drought impact within a defined geographic area is essential because drought is a local event (Griffin, 1998). Of course, drought may sometime affect a larger area. But, if the event is local in nature, then effects too are not widespread, provided the affected area has weak linkages with the macro-economy (Dubhashi, 1992). Drought-induced supply shortage at one specific location may be negated by higher supply by another place. It may neutralise the overall impact in a broad geographic area. However, if a drought occurs in a larger area within a country, it may have adverse consequences on the economic growth of that region, country or both. Therefore, the scale of the hazard and the level of the regions or development of country (nation's adaptive capacity) also determines the nature and intensity of the impact of drought. Richardson (2007), in reference to Zimbabwe observed such phenomenon where the regional impacts due to lesser rainfall on crop production was nullified by the higher crop yield at some other part of the country. The author therefore argued that there is a very little correlation between the rainfall deficiency and economic growth of the country.

The impacts on the economy also depend on the intensity and frequency of droughts. If a drought is mild (less than 20 percent of rainfall deficiency), the average rainfall in the following seasons may offset most of the incurred losses in the short run itself (Dubhashi, 1992). For severe and recurrent droughts, impacts would worsen economic growth. Montaud (2019) empirically examined that mild, moderate and intense drought reduces the agricultural real GDP by approximately 5, 10 and 22 percentage and national real GDP by 3, 6 and 13 percentages respectively.

The extant literature suggests that studies have attempted to analyse the empirical relationship between drought and economic growth. Most of these studies were multi-country, where along with overall disasters effects; the impact of drought was also evaluated. A list of studies is detailed in Table 2.1, highlighting the drought specific impact on the growth dynamics. In the next few paragraphs we discuss some of the key studies specific to droughts. Fomby et al. (2013) estimated the growth impacts for 24 developed and 60 developing countries and concluded that droughts hurt GDP growth in the developing economies only, but agricultural growth was affected equally in both types of economies. Further, in developing economies, the effect was stronger on the agricultural sector than the non-agricultural sectors.

In a study comprising of a pooled sample of 68 developing and 26 developed economies, Loayza et al., (2012) show that droughts had weak negative impact (though statistically insignificant) on the GDP growth but a robust and statistically significant impact on agricultural growth in developed economies. The results for developing economies indicate that droughts negatively affected the overall growth as well as growth of the agricultural and industrial sectors. Raddatz (2007) also observed that climatic disasters (including drought) negatively impact GDP growth in the long term, using panel VAR (Vector Autoregressive model) on 40 low-income countries for the period 1965-1997. Raddatz (2009) further confirmed using panel autoregressive distributed lags model that among climatic disasters droughts hurt economic growth more, i.e. 1 percent of GDP per capita.

There are few studies exploring the relationship of drought disaster with economic growth in the single country context. For example, Diersen et al. (2002) examined the direct economic impacts of 2002 drought on crops and livestock and secondary effects in South Dakota, USA. They estimated that drought induced losses were around USD 1.8 billion, while re-examining the same drought, Diersen and Taylor (2003) estimated USD 1.4 billion losses after adjusting the federal aid of USD 100 million to the state. Kulshreshtha et al. (2003) estimated that the economic costs of the 2001 and 2002 droughts to the regional and national economy of Canada was approximately USD 2.34 billion.

Dercon (2004) studied the impact of reduced rainfall in Ethiopia and revealed that 10 percent lower rainfall, 4-5 years earlier, declined the current economic growth by 1 percent. Horridge et al. (2005) observed 1.6 percent reduction in Australian GDP (1 percent reduction is due to losses in the agriculture sector and remaining 0.6 percent is owing to secondary effects on the economy) using Computable General Equilibrium (CGE) model for 2002-03 drought. Gadgil and Gadgil (2006) analysis of rainfall variations on the growth rate showed that -25, -20 and -15 percent variation causes -7.04, -5.13 and -3.47 percent GDP reduction respectively. The Food Grain Production (FGP) losses due to the similar rainfall variations were -18.61, -13.72 and -9.41 percent respectively for 1951 to 2003 in India. In an another study in Iran, Salami et al. (2008) found that the severe drought of 1999-2000 costs 1605 million USD which is 30.3 percent of the total value added to the cropping sector of Iran. Overall GDP was reduced by 4.4 percentage.

Few studies observed the neutral or positive impact of disasters on economic growth, especially for the developing economies. Albala-Bertrand (1993) in a multi-country (26 economies) study found that droughts had no adverse impact on economic growth. The study argued that droughts have a localised effect and therefore if it is not very widespread, it is not capable of an aggregate negative impact on a diversified economy. Caselli and Melhotra (2004) in a multi-country (172 economies) context failed to show a negative relationship between natural disasters and economic growth. Contrary to their results, Skidmore and Toya (2002) highlighted climatic disasters might have a positive impact on economic growth. Felbermayr and Groschl (2014) used GeoMet data set over the period 1979 to 2010 and observed that droughts had negative impact in the high-income countries rather than the low-income countries. The results differ significantly from the earlier studies and the study further notes that the level of development was negatively correlated with the impact of disaster. Further, Panwar and Sen (2019) in an empirical examination showed that droughts do not have any significant effect on the GDP growth rate for a combined sample of developing and developed economies. However, the impact was negative on the developing economies alone.

Following the extant literature, it may be concluded that the relationship between droughts and its economic impact still lacks a collective consensus. It warrants further empirical evidence especially for different economies to confirm or refute the earlier findings.

Table 2.1 Selected Studies on the Impact of the Drought on Economic Growth

Study	Dependent variable	No. of countries in the study	Significant findings
Albala-Bertrand (1993)	GDP growth	Multi-countries (26)	Neutral or positive on GDP growth.
Skidmore and Toya (2002)	GDP growth	Multi-countries (89)	Positive effect of climatic disasters.
Caselli and Malhotra (2004)	GDP growth	Multi-countries (172)	Failed to show negative impacts on growth rate.
Raddatz (2007)	GDP level	Multi-countries (40, Low-income#)	Negative for climatic disasters, no effect of geological disasters,
Toya and Skidmore (2007)	Killed, damage over GDP	Multi-countries (151, Low income, World and OECD)	Better institutions, better schooling, and higher openness mitigate negative effect.
Leiter et al. (2009)	Value added, employment	Multi-countries (4, Europe)	Positive impact.
Noy (2009)	GDP growth	Multi-countries (109, developing#)	Adverse effect with monetary damage, no effect with alternative measures.
Raddatz (2009)	GDP growth	World, developing# (121)	Negative effect of climate disasters like drought.
Vu and Hammers (2011)	GDP growth	Single country (China)	Adverse impact on output growth.
Loayza et al. (2012)	GDP growth	Multi-countries (Total 94, developing#, 68 and developed# 26)	Negative effect of droughts on Agricultural, Industrial and Overall GDP in developing countries. Negative effect on Agricultural GDP in developed economies.
Fomby et al. (2013)	GDP growth	Multi-countries (60, developing# and 24, developed)	Negative effect of droughts on developing countries overall growth rate and agricultural growth. Agricultural sector is strongly impacted than other sectors. Negative impact on agricultural growth (not on overall growth) in case of developed countries.
Cavallo et al. (2013)	GDP growth	Multi-countries (196)	No effect of disasters; only very large have an adverse effect.
Felbermayr and Groschl (2014)	GDP growth	Multi-countries (108)	Droughts have negative impact on the high-income nations rather than the low-income countries
Lopez et al. (2016)	GDP growth	Multi-countries (184)	Negative for hydro-meteorological disasters up to three years.
Kilimani et al. (2018)	GDP growth	Single Country (Uganda)	Droughts have negative impact on the economic growth rate in short period.
Panwar and Sen (2019)	GDP growth	Multi-countries (102)	Droughts have insignificant effect on the growth rate, whereas in case of developing economies droughts lower the growth dynamics.

Classification as per the World Bank definition
Author's own compilation

2.3 Financial relief towards drought and other natural disasters

Apart from the drought incidences and its impact on the economy, the relationship between post-disaster financial relief and economic growth is also investigated. United Nations International Strategy for Disaster Reduction (UNISDR) defines disaster relief as provision of assistance or intervention during or immediately after a disaster to meet the life preservation and basic subsistence needs of those people affected. It could be of immediate short term or of a protracted duration[8]. Therefore, the financial relief variable in our study is only for drought disaster and does not include other compensation such as insurance, and loan restructuring. Xu and Mo (2013) following Noy (2009), provides statistical evidence that post-disaster relief negatively affects economic growth. The study notes that the post disaster relief amount was used for consumption rather than for productive reconstruction and employment generation leading to adverse impact. The study considered 31 provinces in China and employed a short panel data-set over the period 2004-2010.

Results and discussion in Freeman (2004) may provide rational to observations by Xu and Mo (2013). In the context of post-earthquake reconstruction financing of housing, Freeman (2004) noted that post-disaster relief did not contributed to economic growth for the developing countries. Sainath (1996) critically highlighted the misuse of drought relief fund by various means, leaving no impact on economic growth and livelihoods of poor people. The study highlighted inefficiencies in the utilization of post-drought finances, employing a qualitative approach, for districts in Orissa, Bihar, Tamil Nadu, and Madhya Pradesh during 1993 to 1995. Shughart (2006) also criticized the notion of providing post-disaster relief finance as a public policy. Political economy of financial aid allocation may be a related topic of interest in this regard. Three important studies in the context of disaster aid are Kishore et al (2015), Francken (2012), and Morris and Woden (2003). Kishore et al. (2015) analysed the impact of drought relief as a conditional cash transfer to subsidize diesel on rice production in Bihar, India, employing the panel regression model. They observed that relief disbursements were ineffective due to low awareness and low penetration among small farm holders (who are the potential beneficiaries) along with uncertainties and delays in relief disbursements due to long bureaucratic process. As a result, relief as a policy failed to increase the resilience of agriculture to drought. Therefore, the authors advocated for the long-term sustainable irrigation development rather the ad-hoc subsidiary or relief disbursements for drought proofing.

[8] ***Source***: www.unisdr.org/files/7817_7819isdrterminology11.pdf

The Manual for Drought management (2016) also confirms that in drought like situations in India, there remain plenty of immediate needs to be fulfilled, such as ensuring drinking water availability, food supply, fodder for livestock, compensation for crop loss, cleaning of old wells and pounds, etc. This may dominate the utilization of relief funds, ignoring the long-term mitigation measures in Indian states. Therefore, the present thesis considers the fact that disaster relief may not be efficiently distributed or utilised and the household level experiences may not be one of returning to prosperity while undertaking the empirical analysis in the Chapter 3 and 4.3.

Morris and Wodon (2003), in the context of Honduras Mitch hurricane observed that although the probability of receiving relief was negatively correlated with wealth and positively correlated with assets losses, the amount of relief received was apparently independent of these two variables. Strömberg (2007) observed that the amount of disaster relief disbursed depended on who was suffering. The same argument could be relevant for the Indian states where relief disbursement has been an issue of political debates. Besley and Burgess (2002) noted that governments were more generous with relief to literate districts and those with more media outlets. Khera (2006) in reference to droughts (2002 and 2003) in Rajasthan, India also observed that the scale of relief works was influenced by the collective pressure from public, media, Judiciary and the political dynamics in the state. In all, the literature on the disaster-relief is relatively limited, but is more conclusive than droughts impact.

2.4 Risk management strategies and Behavioural issues in disasters

2.4.1 Individuals risk management strategies

In disaster literature, the risk-reducing (management) strategies are classified as adaptation and coping. The measures employed before the event (ex-ante) are adaptation (preparedness) or resilience, whereas, the measures taken after the event (ex-post) are coping strategies (Ghorpade 2012). According to the Alderman and Paxson (1994), adaptation is the risk management strategy (for example diversification of income and employment sources, etc.). In contrast, coping may be called as a risk coping strategy (sales of assets, reduced consumption, reducing children’s schooling, etc.). Tripathi and Mishra (2017), further argued that farmers do adapt to changes in climate and disasters; however, these measures are passive strategies, not active risk management strategies. These farmers were not consciously adapting but only responding passively to the climate risks. In line with our research objectives, this thematic review section primarily explores the literature relevant to the individuals' risk-management studies (ex-ante).

UNISDR (2015) defines resilience as "the ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of the hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions". It explains that resilience is the ability to "resile from" or "spring back from" a shock. The individual resilience is explained as the capacity to bounce back to baseline functioning after a shock (Butler et al., 2007; Egeland et al., 1993). With the limited government capacity, individuals' preparedness and resilience becomes a primary defence mechanism to contest the disaster risks. Diversification of income sources (agricultural and non-agricultural), crop diversification (cultivating primary and secondary crops) and self-sufficiency (ensuring food security for self) are commonly practiced (ex-ante) measures towards natural disasters (Ghorpade, 2012). The purpose of ex-ante measures is to prevent income shocks or to ensure the income smoothing (Morduch 1995). These risk management strategies strengthen the individual's adaptive capacity (preparedness) towards a disaster event.

Previous studies show that the adaptive capacity depends on some baseline conditions (factors) as well as the availability of the resources. According to the United Nations (2015), income inequality, a single source of income and ability to access the basic services affect the adaptive capacity of groups. Moench and Dixit (2004) for flood disaster found that access to the non-agricultural income sources, information flow and social as well as physical infrastructure, determine the household's ability to bounce back. Jarungrattanapong and Manasboonphempoo (2011) further emphasized on the role of skills, knowledge and technology in addition to the infrastructure, social safety net and earning opportunity as determinants of adaptive capacity. A plethora of studies (Moench and Dixit, 2004; Mcleman and Smit, 2006; Tacoli, 2009: Scheffran et al., 2012; Stojanov et al., 2016, Debnath and Nayak, 2020 among others) argued that migration served as an adaptation strategy for households in response to climate shocks. Kattumuri et al. (2015) also observed that migration was an important adaption strategy in Karnataka, India, towards climate change risk. Jha et al. (2018), in a review study, also concluded that migration was an important tool to manage the climate change risk to diversify the income sources and to smooth consumption.

However, Jha et al. (2018) highlighted the need to conduct a detailed study to measure the net income differences between the migrants and non-migrant households. It may be helpful to generate quantitative pieces of evidence, necessary to obtain the actual financial benefits of migration. Samal and Patra (2012) analysed the secondary data for 45 years (1965-2009) in Odisha, an Indian State. They observed that migration was used as a risk coping strategy by farmers (rather a risk management strategy) against the natural disasters (flood, drought and cyclone). Unlike previous studies, the authors classified migration as a short-term response mechanism than a long-term determinant for adaption. Earlier Kates (2000), as well as Boyd and Ibarraran (2009), also opined that migration was a coping response in rural areas in the absence of adaptive capacity.

Nhemachena and Hassan (2007), and Gbetibouo (2009) show that education, age, gender, farm income and farm size were the significant determinants of farmers' adaptation to climate change. Deressa et al. (2009) in Ethiopian context using the Heckman sample selection method found that gender, education of the household heads and the extension services usage were among the important determinants of farmers' adaptation. Chen et al. (2014) using the household level primary data in China and employing logit regression model observed that early warning information and financial as well as technical support were significant adaption measures against droughts. The study also revealed that 86 percent of rural households had taken adaptive measures against drought, most of which were *non-engineering measures* (changing agriculture production inputs, adjusting harvesting dates and crop insurance). In the households who adapted non-engineering measures, merely 8 percent purchased crop insurance. According to Uddin et al. (2014), irrigation infrastructure, farm diversification and income-generating activities determine the adaptation. In another study, Udmale et al. (2015) in a household level analysis, found that irrigation measures were important to adapt in drought-affected areas of Maharashtra, India.

Later, Asafu-Adjaye et al. (2016) observed that 30 percent farmers in Ethiopia employed the ex-ante risk management strategies, mostly the farm level (like crop diversification) and less often the non-farm measures. An empirical study by Nadamani and Watanabe (2016) in Ghana using data of 100 households, and employing logistic regression analysis found that education, household size, income, access to information and credit determine the farmers' adaptation to climate change. In a study by Jin et al. (2016), education, farm size and household income emerged as the main determinants of household adaption to droughts in China. Khanal et al. (2018) also observed that education and access to credit were the main determinants of farmers' adaptation to climate change. Alam (2015) found that farmers' adaptability to water scarcity was determined by institutional infrastructure, quality of school education, and awareness of climate change, among others. The study employed the multinomial logit regression technique on the primary data of 546 farmers in Bangladesh.

The literature examining farmers' adaptation and risk management strategies towards natural disasters and climate change are rich. A recent analysis by Praveen et al. (2018) for Maharashtra and Telangana states (India), employing factor analysis on primary data, observed that farmers perceive community and government support as important determinants to deal with the inadequate rainfall. Ward and Makhija (2018) in an experimental examination, show that Weather Index Insurance (WII) was less preferred by the farmers of Odisha in India to mitigate the drought risks. The argument against WII was that such products ignore the actual farm loss data, hence could not hedge the actual losses. Recently, Islam et al. (2019) in the context of Bangladesh, confirmed that household income, education, and land ownership determines the adaption capacity. In line to above literature, the Manual for Drought Management (2016) in India also emphasized that irrigation facilities, farm diversification and income-generating activities are the main focus area of government to adequately prepare against droughts in India. In all, the above studies identified socio-economic, institutional, technical, informational and external support factors as determinates of households' adaptive capacity.

2.4.2 Behavioural issues in disasters

It always remains difficult to make rational choices and decisions under the conditions of uncertainty and risk for individuals. The economic theories of behaviour assume that consumption and production choices are made logically, weighing the personal benefits and costs of available actions. Nevertheless, theories developed on stringent assumptions prove to be inaccurate in their empirical applications under real life settings. Behavioural assumptions are expected to increase the explanatory power of economics by providing it with more reliable psychological foundation (Camerer and Lowenstein, 2004). The insights from the prospect theory about the irrational behaviour during risk and uncertainty also applies in the context of disaster events (Ballantyne, 2000; Paton and Johnston, 2001; Grothmann and Reusswig, 2006; Kunreuther, 2017). Llaboya (2019) also found that individuals often exhibit irrational decision choices driven by behavioural issues.

Gifford (2011) highlighted another important behavioural dimension called judgmental discounting which may lead to individual's inaction towards the future risk. For example, long-run negative environmental impacts are discounted by individuals assuming that it will not be affecting their vicinity or to them at all. It could be well inferred that such judgements are not rational and the explanation for such behaviour may certainly help the policy-makers and governments to design the suitable risk reduction policies. Climate change beliefs and risk perceptions may also determine the farmers' behaviour towards adaptation. Mase et al. (2017) studied around 5000 farmers in the USA to understand the factors which determine the adaptation strategies due to climate change. The study finds that the risk perception of farmers about their own farm as well as their attitude towards the adaptation decides their strategies. The decision to invest in adaptation measures is not influenced by the scientific information regarding the direct impact of climate change on the agriculture. Therefore, behavioural studies must be incorporated in policy making for its success.

According to Paton and Johnston (2001), due to optimistic biases[9], individuals remain assured about their preparedness towards volcanic hazard effects, compared to others. This leads to inaction for preparedness for natural hazards. Meyer and Kunreuther (2017) also emphasized that over-optimism is an important reason behind non-preparedness against disaster risks. The authors also observed that social norms (herding) dictated the purchase of insurance cover rather its usefulness. Royal and Walls (2018) further show that individuals' over-optimism (rather usefulness) influenced the likelihood of flood insurance purchase. According to Eiser et al. (2012), optimistic biases, exposure to limited information, inadequate capacity to make correct decisions and even shortcomings in self-learning through experiences, limit oneself for rational decision making. Individuals often display ignorance towards disaster risk reduction because they often believe that the disaster will not harm them. Kishore et al. (2015) with reference to Bihar (India) observed that a conditional cash transfer programme (relief disbursements as a diesel subsidiary for irrigation purpose) was unable to bring the required changes in farmers' behaviour to implement the drought mitigation measures.

Ballantyne (2000) show that overconfidence bias[10] leads to over belief in self-capability to recall the information of actionable during a natural hazard. Another study by Grothmann and Reusswig (2006) in flood risk area of Germany states that influencing

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[9] When an individual systematically overestimates the probability of a favorable outcome and believe, rightly or wrongly, that he/she can exercise effective control over his/her activities and plans, thus diminishing the perceived risk of failure.

[10] Individuals generally overrate their knowledge as well as ability to perform well and therefore remain overconfident about the future life events in comparison to the bad events.

people's risk opinion only is not enough to cause behavioural change proactively. These practices often not followed by individuals in practice. Overall awareness and education regarding such natural disaster risk are less and even if it is there with a few, preparedness at individual and community level is lacking. It clearly shows that risk interpretation and risk actions are different things. Irrational behavioural approach dominates risk perceptions and management.

IPCC (2014) predicts that extreme weather conditions like droughts are expected to rise further, causing survival risk for small and marginalized farmers of poor countries. Therefore, such farmers must adopt the appropriate protective measures like crop insurance. Surprisingly, the statistics show otherwise. According to Dick and Wang (2010), 86.5 percent of global insurance premium comes from high-income countries, 7 percent from upper and lower medium countries and only 0.03 percent from low-income countries. This shows that upper and lower medium and low-income countries are at higher risk than others. Similarly, in the industrializing nations like China, only 8 percent have brought the crop insurance, who have adopted engineering measures as an adaptation strategy (Chen, Wang, and Huang, 2014). According to Clarke (2013), financial illiteracy, low trust on insurance providers and fear that public support for disaster relief (moral hazards) will not be available were observed to be some of the reasons behind low micro-insurance demand in poor countries. Any policy towards promotion of disaster insurance should consider the behavioural issues limiting the reach and demand for such risk transfer financial arrangements.

The above literature confirms that individuals often exhibit irrational decision choices in the context of uncertain and risky disaster events, driven by behavioural issues like overconfidence, over-optimism and herding. Therefore, it is necessary for government and policymakers to consider these behavioural issues especially for decision making under uncertainty and risk, while framing public policies.

2.5 Role of governments and institutions in disaster management

For managing disasters institutions, government policies and their implementation play an important role. The disaster management framework proposed by Godschalk (1991) and Mileti (1999) suggest that disaster management approach has four essential components: preparedness, mitigation, response and recovery, and are guided by the standard policy framework. The last three decades witnessed remarkable progress in the policy guidelines with more emphasis to reduce the disaster risk. Yokohama Strategy and Plan of Action for a Safer World (1994) was the first such global initiative towards disaster management. It was the outcome of the International Decade for Natural Disaster Reduction (IDNDR, 1990-2000) and the World Conference on Natural Disaster Reduction (1994). Yokohama strategy was mainly focused on the response ignoring the disaster risk reduction (DRR). It emphasized more on coping, adaptation and managing emergencies. Later in 1999, United Nations International Strategy for Disaster Reduction (UNISDR) replaced IDNDR. The emphasis of UNISDR (1994) was now on risk preparedness and prevention rather than post-disaster recovery and assistance.

The Hyogo Framework for Action (HFA) extended the disaster reduction objectives to achieve better outcomes. The HFA focused on developing countries to reduce the risk exposure and to increase the preparedness towards social and physical vulnerability. HFA's progress reports suggest that post HFA, deaths due to natural disasters have significantly reduced (UNISDR, 2013; Kellenberg and Mobarak, 2008; Kahn, 2005) due to increased awareness about disaster reduction. Recently, Sendai Framework: 2015-2030 (SFDRR, 2015), replaced the HFA. It aims to decrease the existing risks as well as to prevent the new risks. SFDRR (2015) has the well-defined focus areas such as vulnerability reduction and improved resilience with the active participation of all stakeholders. Given these developments in the broader disaster policies at the global level with increasing participation of countries, the discussion on the DRM policies, their implementation and role of institutions of selected developed as well as developing countries including India are presented for droughts and other natural disasters.

In the United States of America (USA), there exists a pre-disaster mitigation program that provides necessary funds to the state and the local governments for post-disaster reconstruction. Mitigation, as a national priority is executed through the Disaster Mitigation Act (2000). According to the Act, local authorities ensured that building codes were well enforced (Burby, 2006). Another developed country New Zealand focused on risk reduction and designed a National Emergency Management Strategy towards it. The decision-making powers were transferred to local governments from the central government for faster actions, both for ex-ante disaster planning and ex-post relief and reconstruction. The pre-disaster-activities are strengthened to manage the risks rather than providing post-disasters relief (Jensen, 1998; Britton and Clarke, 2000).

European Union (EU) also witnessed a substantial progress towards adoption of disaster risk reduction (DRR) policy and implementation in the member countries. According to Faivre et al (2017), "SFDRR is signed by all the EU member countries, with the approval of European Commission". The data suggests that around 9 percent of EU humanitarian fund was spend towards DRR activities in 2016. Kron et al. (2019) highlighted that European region has a common flood risk reduction policy. EU provides a clear direction (EU Floods Directive, 2007) for flood assessment and management to all member countries. The aim of such directives are to ensure that all countries follow a common framework and show desired actions to minimize the human, economic and environmental risks. It enables the member countries to identify the risk-prone areas, map the assets and humans exposed to flood risks and take measures to reduce the flood induced risks. The participatory role of various levels of government bodies and all the stakeholders is also defined. For example, the government is expected to have early warning system, informational infrastructure along with other necessary structural measures at place.

Jamaica, a Caribbean country gradually progressed in the past two decades to adapt the process of risk analysis, hazard mapping (hurricane and landslides), and risk reduction measures with the developmental plans (see Carby, 2018 and Collymore, 2011). A few Caribbean countries like Barbados, Guyana, and Saint Lucia also integrated the disaster risk management plans with the national developmental plans (Weekes and Bello, 2019). For example, Barbados enforced comprehensive national building codes, promoted a universal home insurance coverage and strengthened the early warning systems. Guyana, on the other hand, enforced the housing, agricultural and flood insurance by coordinating with the insurance companies. Similarly, Saint Lucia collaborated with international insurance company (Munich Re) to safeguard the livelihoods of small farmers, a risk reduction measure, though with limited success.

Disaster literature suggests that ex-ante budgeting by governments is another measure for minimizing losses through mitigation by effective utilization of resources. Phaup and Kirschner (2010) examined the budgetary polices of 30 selected OECD countries and found evidence that New Zealand, Japan, and Turkey have done budgeting for disasters. Based on the critical analysis they proposed that the ex-ante (in good times) budgeting policies have clear merits over the ex post budgeting policies. This creates procedural opportunities to save for the expected cost of relief and recovery and realizes budgetary savings for measure that reduce losses through mitigation and offset to moral hazards. Hallegatte (2015) observed that government with adequate budgets for insurance or other risk sharing mechanism will spend more towards disaster management. Linnerooth-Bayer and HochRainer-Stigler (2015) with reference to developing countries observed that the dependency of the disaster affected population is high on governments and donor assistance especially in vulnerable countries. Informal credit mechanism fall short if a large region is affected by the disaster. This ultimately reduces the probability for informal risk sharing.

Mumbai, the financial capital of a developing country India, faced a devastating flood in 2005 which caused 419 human deaths, loss of 16000 livestock (Gupta, 2007) and affected millions. The estimates of direct economic losses range from USD 1.1 billion (Government of Maharashtra, 2005) to USD 5 billion (Jha et al., 2011; Munich Re, 2011) based on the assumptions and methodologies adopted by different agencies. The insured losses were reported to be USD 770 million by Guha-Sapir (2013), making the event costliest in the history of the Indian insurance industry. The destruction caused by the floods stressed Indian government and policy-makers to frame an appropriate disaster management policy. The devastating floods in Mumbai confirmed that disasters and development cannot be looked into isolation. Earlier, the 2004 tsunami in the Indian Ocean too inflicted damages to both lives and livelihoods. Thus, prompting policy-makers to come up with the Disaster Management Act, 2005 in India.

According to the act, the disaster management remains a state function in India. The Disaster Management Act (2005) has a three-tier system comprising of the National Disaster Management Authority (NDMA), the State Disaster Management Authority (SDMA) and the District Disaster Management Authority (DDMA) at national, state and district level respectively. The role of the central government is to regulate and financially support the states and institutions for building disaster resilience. The district authority, under the state is responsible to coordinate and implement the drought management plan prepared by the state government. The DDMA's functions are to identify prevailing disasters, vulnerable districts, preparing the district response plan such as relief disbursements following the laid down guidelines etc.

Notably, the post-drought relief measures still dominate the prevention or mitigation interventions (Manual for Drought Management, 2009 and 2016). Prabhakar and Shaw (2008) analysed that Indian states heavily depend on the central government for getting the finances relief. The revenue department of the states generally owns the responsibility for relief operations. The relief commissioner heads the responsibility to ensure that timely relief reaches to the affected districts, tehsils or villages. It should be in collaboration with their representatives and NGO's. The prevention and mitigation measures are entrusted with the various states as well as the central government departments through budgetary allocation. There are many lacunas observed in the effective implementation of disaster policies. Udmale et al. (2015) in a household level analysis, found that there was a lack of coordinated efforts by governments to manage the drought issue proactively. The reactive crisis management strategy of the government was inefficient to address the problem. The authors advocated for government intervention, such as providing guaranteed employment and low-interest rate loans to farmers as an effective tool to adapt.

It is widely reported that many South Asian countries also have policy gaps towards addressing disasters effectively (Deen, 2015; Jones, 2014). Experience of Pakistan in DRR is equally discouraging (Deen, 2015; Hashmi et al., 2012; Tariq and Giesen, 2012). Pakistan adopted the disaster management framework and the National Disaster Management Act 2010 (PNDMA). It has a three-layered structure. The first layer is the National Disaster Management Commission (NDMC) headed by the Prime Minister. The NDMC makes policies and has the National Disaster Management Authority (NDMA) responsible for implementation of the plans at the national level. The second layer is the Provincial Disaster Management Commission (PDMC) followed by the Provincial Disaster Management Authority (PDMA) and the District Disaster Management Authority (DDMA) at the district level. National Disaster Management Institute (NDMI) and National Disaster Response Force (NDRF) are the third layer. With this disaster management structure in place, it was expected that the disasters would be dealt effectively.

Deen (2015) did a qualitative study to identify the effectiveness and the gaps (if any) in policy and practice with reference to the 2010 flood in Pakistan. Primary data collected through interviews of government officials were analysed. The results suggest that the government's preparedness could have minimized losses further. The southern Punjab area, with the prior notification of the flood, could have planned to avoid damages. As a precautionary move, livestock was transferred to a safer place, saving their lives. This ensured the livelihood of the owners of this livestock. The floods affected the poor households, as they lost crops, livestock, houses and earning opportunities. Floods reduced the opportunity of getting credit from local friends and relatives as they too were affected economically.

Arranging informal credit from friends and relatives was one of the measure post-disasters (Sawada and Shimizutani, 2008) in the absence of well-functioning credit market. The government was not prepared for such catastrophic event, thus making relief and risk management inadequate and inefficient. The governance structure too limited the effectiveness of disaster management strategies. Government's attempts to allocate the resources from the places not affected by the flood to the areas that were affected. However, it was not fruitful as institutional framework and implementation was weak, planning was missing and inadequate to support these moves efficiently. There were few more policy lapses as highlighted by Hashmi et al. (2012) and Tariq and Giesen (2012) for 2010 flood disaster in Pakistan. The coordination between different layers within the government bodies was poor and the coordination of government with NGOs and other aid agencies was limited, hampering better implementation of the relief measures for the most affected population. In addition to above studies, Shah et al. (2019) analysed DRR practices and capacity of institutions. Aslam (2018) investigated the flood policy and management.

Sri Lanka is also at high risk of natural hazards such as floods, cyclones, droughts and landslides because of the country's typical geography and location on the Indian Ocean. The country lost more than 35000 lives and many buildings in the 2004 Boxing Day tsunami. Un-planned human settlements and land use along with regulatory failures were cited as the main reasons behind severe human and economic losses (Jayawardane, 2006). Ginige et al. (2010) found that the DRM policy of Sri Lanka has several shortcomings such as, inadequate early warning systems, limited funds for disaster risk reduction activities, lack of coordination between different stakeholders, deficiencies in regulatory structure, and lack of training to public as well as key officials.

With reference to the slow onset and complex drought-disaster, the strategies for DRR may be structural and non-structural types. Chen et al. (2014) and Udamale et al. (2014) discuss such measures with reference to China and India, whereas Alam (2015) and Habiba et al. (2012) propose various measures for Bangladesh. Developing adequate irrigation infrastructure (drip and sprinkler), effective early warning and climate forecasting system, rainwater-harvesting measures, investing in wells, development of canals and water pumps, are a few necessary structural measures. Crop diversification, drought-resistant crops, short duration crops, changing agricultural production inputs and buying crop insurance are some of the important non-structural measures, which may help to reduce drought risks.

Khetwani (2020) notices that government introduced various measures for farmers' welfare in drought affected Marathwada region of Maharashtra, India. Drinking water arrangement and supply, cattle camps, employment opportunities, financial relief towards crop loss, and credit access were some of the measures which partially helped to reduce the drought risk. Samra (2008) claimed that drought management was always poor in the Bundelkhand region of India due to administrative negligence by various governments.

Gupta et al (2014) in a study mentioned about a report by Samra (2008), which goes beyond the current drought crisis and its management and observe that the region has never been on the priority of any government in the past. He pointed out that various governments never posted the talented and efficient officers to this region. They always saw the region to transfer the officers as a punishment to the region. As a result, the policies how well-crafted and well-intentioned proved to be inefficient. The already vulnerable condition of the region in lack of prolonged negligence caused such severe distress in the region.

The above discussion on the experiences with disaster risk management and DRR indicate that developing countries often lack efficient institutions, policies and practices. This necessitates that policymakers and the related stakeholders to adopt a culture of preparedness and prevention to lower the economic and life losses. This may be achieved by building strong institutions, and redesigning disaster risk management policies considering the country specific risks and vulnerabilities.

2.6 Conclusion

Drought is a naturally occurring, slow onset and complex disaster. The water scarcity led droughts impact the economy and the different economic sectors through direct as well as indirect effects. The crops and water dependent industries are most directly and adversely affected. An economy with higher contribution of agriculture is also highly susceptible to drought shocks. In disaster literature the economic impact of droughts is mostly analysed either estimating the loss in crop yields or by measuring the aggregate as well as sectorial economic growth rate. The existing empirical literature on the subject matter is divided with the views that droughts have negative or neutral impact on economy, which again varies across sectors and with the level of economic development of the drought-affected region. Generally, financial relief after drought is disbursed to the affected population, however that mostly remain insufficient to sustain their livelihood. Such relief often could not be deployed by the beneficiaries for creating assets useful to support them for long period of time. On the other hand, these relief measures may further adversely affect the economic growth. With limited government intervention, the individuals cope or adapt at their own to deal with drought and other disasters. Their adaptive capacity generally depends on the social, economic, technical and external institutional factors, they are exposed to. However, an effective intervention through policies such as budgetary policy may help them to mitigate the drought related risks. Therefore, the role of government policies towards disaster risk management may not be ignored.

The review of literature also identifies that the individuals often show irrational behaviour while facing the uncertain drought events. They demonstrate systematic departure form rational behaviour and do not adapt adequate measures against disasters. These behavioural shortcomings are also explored in the current chapter. The present chapter reviews all these highlighted and inter-related aspects of droughts. Economic impact of droughts and financial relief, determinants of adaptive capacity of individuals' risk management strategies, behavioural biases of individuals and the role of government to manage or reduce the adversities faced by individuals and economy are the focal agenda for exploration and discussion. In the process, the chapter identifies a few gaps in the disaster literature to frame the problem statement and thesis objectives.

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CHAPTER THREE

IMPACT OF DROUGHTS ON ECONOMY: *STATE LEVEL ANALYSIS*

3.1 Introduction

The purpose of this study is to use the available historical data on drought events and information on drought relief finance to investigate the relationship between a slow-onset disaster with the growth of the agricultural sector and economic growth. We have a sample of 28 Indian states for the period 1990-91 to 2015-16. In India, 68 percent cultivable area is prone to droughts of varying degrees of which 35 percent is drought-prone (Ministry of Home Affairs, 2011, page 18). Droughts are largely due to rainfall deficiency or variability that directly impact the agricultural sector. Estimates show that around 50 percent crops in the country are dependent on the South-West Monsoon. The limited irrigation facilities or the lack of infrastructure to redirect water from water surplus regions to the water deficit regions had led to drought like conditions in few states (Department of Agriculture, Cooperation and Farmers Welfare, 2016). Therefore, inadequate rainfall during the monsoons causes crop failures in few states and in particular, where rain-fed agriculture dominates. As a result, growth of the primary sector and subsequently aggregate economic growth are likely to be affected by droughts but the impacts will vary across states.

There are three reasons for enquiring into the relationship between drought and financial relief. First, the Intergovernmental Panel on Climate Change (IPCC) (2014) opine that climate change induced risk such as droughts are likely to increase in frequency and intensity especially in developing economies like India. Agricultural losses of over 7 billion USD are estimated due to climate related events and that would affect income of 10 percent of the population. Second, Economic Survey of India 2017-18 show that the annual average rainfall during the period 1970 to 2015 decreased by about 86 millimetres and shortfalls in the average rainfall could increase drought risk. Third, droughts are slow-onset disaster events (Tannehill, 1947; Wilhite, 2000), and in some circumstances they can span weeks, years or even longer."

The need for this study can be justified by the fact that there exists plethora of studies relating droughts to climate change. Such as studies by Ahmed et al. (2018), Duffy et al. (2015), Nam et al. (2015), Das et al. (2015), Mann and Gleick (2015), to mention few. Whether induced by climate change or weather variability, losses due to drought of milder intensity are negligible but could be substantial in the absence of adequate policy intervention (Pandey and Bhandari, 2009). In the past, information on agricultural production losses are used as a measure of the overall socio-economic impact of drought. Given the nature of drought and its different types, comparison of its impact with the impact of other natural disasters such as floods, earthquakes, etc. which are fast-onset and persists for a definite period within a geographical boundary (or economic sector) becomes difficult. According to UNFCCC (2012), droughts may cause severe damage to the human lives and economic growth through crop losses (Bidinger, 1991; Chand and Raju, 2009; Kim et al., 2019), intensify migration (Ezra and Kiros, 2001; Munshi, 2003; Feng et al., 2012; Dallmann and Millock, 2017), cause food insecurity (Rao and Deshpande, 2002; Bourke et al., 2015; Maponya and Mpandeli, 2016; Sam et al., 2019), among others, if not dealt with urgency. Previous studies (Loayza et al., 2012; Fomby et al., 2013; Felbermayr and Groschl, 2014; Kilimani et al., 2018; Panwar and Sen, 2019 among others) attempted to statistically establish such effects on the economic growth but the estimates are not identical because studies either displayed positive or negative and even neutral impacts of droughts (along with other natural disasters) on economic growth.

Agriculture and disaster management are state subjects in India. This implies that despite national level policies towards disaster management or management of specific natural disasters, the state and its local authorities by statute are important functionaries in the event of localized disasters such as drought. The States' primarily responds to such slow onset disasters by provisioning the finances for the relief that it obtains from the Central government under the State Disaster Response Fund (SDRF)[11]. Any additional diversion of financial resources towards drought relief by states may impact growth of other sectors. There could be socio-political factors responsible for such diversion of financial resources. In this study, we are only interested in deciphering the economic relationship between drought, drought relief and agriculture growth rates.

The extant literature suggests that though there have been broad empirical work relating changing meteorological variables to agricultural yields, no previous research at the sub-national level explored economic impact of droughts. In this context, the major contribution of the study is to fill the above research gap especially in the Indian context.

[11] According to the Disaster Management Act 2005, State Disaster Response Fund (SDRF) is set up at state level to meet the rescue and relief expenditure for the notified disasters. SDRF has been constituted in each State in which Centre contributed 75% for General Category States and 90% for Special Category States of hilly regions every year. The central contribution is now enhanced to 90 percent from April 2018. Finance Commission of India allots resources to the States to meet the expenses of relief operations of immediate nature only not for compensation of incurred losses.

The study also explores the variations in drought impact, especially on the agricultural sector growth, considering the irrigation infrastructure in the state. For this, we have classified states as highly irrigated, moderately irrigated and least irrigated.

There are mechanisms to identify drought scenarios and the Indian government follows procedures to declare drought. Whatever intensity of drought may be, there is significant impact on crop yield and the agricultural sector (Zhang et al., 2017). The results of this study also show that droughts affect growth of the agricultural sector negatively and drought relief has a positive relationship for the moderately and least irrigated states in the presence of control variables. It is important to note that drought relief is not a proxy for drought but essentially modelled to capture the efficacy of financial disbursements as a post-drought risk management tool. However, the empirical results vary across states and depend on their states' irrigation capacity.

The chapter is structured as follows. In the next section (3.2), we present a brief profile of droughts in India and its occurrences across different states. This section is followed by a detailed discussion on the data (3.3) and the analytical framework (3.4) adopted to identify the empirical relationship. The results and discussions are presented in the next section (3.5) followed by the robustness check (3.6) and conclusion (3.7) of the study at the end.

3.2 Droughts in India

Historically several states in India have faced acute to chronic droughts and Table A3.1 shows historical account of droughts until 2016. For example, it is estimated that the 1972 drought affected large parts of the country affecting more than 200 million people whereas the 1987 drought affected 300 million people. In Figure A3.1, we present the cumulative sum of number of districts declared drought annually state-wise. In recent years, many states faced drought and drought like conditions largely due to inadequate rainfall at the end of the monsoon season. 2002 and 2009 droughts were triggered by rainfall deficiency of 19 percent and 22 percent respectively that led to fall in the food grain production by 29 million tonnes and 16 million tonnes respectively (Drought Manual, 2016). Inadequate irrigation infrastructure in many states often failed to mitigate the drought risk due to higher dependence of agriculture on rainfall in such areas. In 2009 and 2015, government declared 338 districts in 15 states and 270 districts in 12 states as drought affected, which were predominantly agricultural states. The states disbursed approximately INR 590 crores in 2009 and INR 5204 crores in 2015 for relief measures. ASSOCHAM (2016) estimated and predicted that the 2015-16 droughts would affect the national economy by approximately 100 billion USD. The financial impact of drought may be analysed by considering the additional assistance sought by different State governments to the Central government. For example, in 2015-16, the additional financial assistance to the states was INR 155458.56 crores from Natural Disaster Response Fund (NDRF). Rajasthan sought assistance of INR 1053.702 crores but, in the same year, the highest amount was approved to Maharashtra INR 3049.36 crores against requested assistance of INR 4002.82 (Ministry of Agriculture and Farmers Welfare, 2016).

The impact of drought events on the vulnerable population remains more. Sam et al. (2017) observed that 2015 drought significantly affected the rural illiterate, marginalized and poor household in Odisha, making them more vulnerable. Several programmes were launched keeping in view the specific needs of states based on their agro-climatic conditions to minimize the incidence of drought. The Drought Prone Areas Programme (DPAP) and Desert Development Programme (DDP) are being implemented by the Government of India since 1973-74 and 1977-78 respectively. In recent years, with the passage of the Disaster Management Act 2005 and the Drought Management Guidelines 2009, many new initiatives have been undertaken to disentangle the complexities with the impact of droughts in the country. In this background, it is important to empirically establish the impact of droughts on economic growth. In the next section, we present the description of the data employed for the analysis.

3.3 Data

The study uses an unbalanced dataset consisting of 28 Indian states over the period 1990-91 to 2015-16. The states selected for the study are listed in Table A3.2. The study considers two dependent variables: State Agricultural Gross Domestic Product (SAGDP) growth rate (y^1) and State Gross Domestic Product (SGDP) (y^2) growth rate. The state-wise data for SAGDP (Y^1) and SGDP (Y^2) were collected from the Reserve Bank of India (RBI). The figures are in constant 2011-12 prices. The two main explanatory variables of interest are drought dummy variable (D) and the drought relief finances (X^1). D is constructed using yearly rainfall information following IMD definition. If the annual average rainfall of any state deviates negatively, equal or above 25 percent from average, the year is considered as a drought year and D assumes value 1, otherwise zero. There exists a procedure for drought monitoring and declaration at the state level aided by different government line

Departments with Crop Weather Watch Group as the apex body. However, IMD is the most important nodal agency. Further, due to limitations with regard to crop loss estimation parameters, methods, data availability and technological shortfalls and other complexities such as quality of drought monitoring, political dimension and/or interference, among other, we prefer to use the IMD guidelines and consider meteorological droughts (instead of agricultural or other drought types)[12]. We further collate the drought relief financed from the State Finance Accounts of the Comptroller and Auditor General of India (CAG). ID is an interactive dummy variable, product of D and X^1 implying that relief is available in period t if and only if there was drought in period $(t-1)$.

The lagged value of drought relief is considered because there are delays in the release of the relief amount due to complicated administrative processes (Pravakar and Shaw, 2008). Considering drought relief as a proxy for drought may be implausible because often a state may not be drought affected (because only some areas were drought affected) but yet the state may receive or pay relief. However, greater the probability of state falling above the drought affected threshold, higher is the probability of receipt of disaster relief. The relationship between drought and drought relief thus cannot be ignored. Therefore, instead of using drought relief as a proxy for drought, we assess the impact of both (drought relief as well as their interaction with drought) on the sector and economy.

The lagged values of output growth rate (SAGDP growth rate (y^1_{t-1}) and SGDP growth rate (y^2_{t-1})) are considered as independent variables following its significance as highlighted by earlier papers (Noy and Vu, 2009; Noy, 2010; Loayza et al., 2012; Strobl, 2012). This study considers 7 control variables which may affect the relationship between drought and the agricultural sector growth, and drought and economic growth respectively. The variables identified following review of literature are as follows: First, the literacy rate (Z^1) which characterises the education level. Data for literacy rate is available in percentage, compiled by the Office of the Registrar General of India and National Sample Survey Organization reports. Information for few years is missing and therefore we had to extrapolate the missing observations. Second, total bank branches per 1000 population (Z^2) is used to proxy for financial infrastructure. Third and fourth variables are the total length of road per 1000 population (Z^3) in kilometres and the per-capita availability of electricity

[12] In addition to the rainfall deficiency (sometimes it remains the sole criteria), many states follow traditional systems like *annewari*, *paisewari* or *girdawari* to declare droughts. For a detailed discussion refer Manual for Drought Management (2016).

(Z^4) in kilo watt hour to represent physical infrastructure facilities in the state. Fifth and sixth control variables are related to the agricultural sector namely yield of total food grains (Z^5) and cropping intensity (Z^6) respectively. Share of urban population in total population (Z^7) is the seventh control variable. We did consider one more variable, log of per-capita net state domestic product (X^3) at constant 2011-12 prices to capture the income effect at the state level and its relationship with drought in explaining the state gross domestic product. However, due to problem of collinearity we did not include same in the final estimation.

The states are further classified into three categories: Highly irrigated (over 40 percent of net irrigated area), moderate irrigated (less than 40 percent) and least (less than 20 percent) irrigated. This analysis has significance for investigating the within state variation based on irrigation capacity. Table A3.3 provides the definition and sources of all the variables used in this study and Table 3.4 presents the descriptive statistics. The analytical framework is presented in the next section.

3.4 Empirical Methodology

The study estimates the following equation with the objective of analysing the impact of droughts and disaster relief on the growth rate of two outputs, SAGDP (Y^1) and SGDP (Y^2), that is, y^1_{it} and y^2_{it} respectively

$$y^1_{it} = \alpha_i + \beta_1 y^1_{i(t-1)} + \beta_2 D + \beta_3 X^1_{i(t-1)} + \beta_4 ID + \sum_{j=1}^{7} \delta_j Z^j_{i(t-1)} + \epsilon_{it} \quad \text{----- (1)}$$

$$y^2_{it} = \theta_i + \gamma_1 y^2_{i(t-1)} + \gamma_2 y^1_{i(t)} + \gamma_3 y^1_{i(t-1)} + \gamma_4 D + \gamma_5 X^1_{i(t-1)} + \gamma_6 ID + \sum_{j=1}^{7} \lambda_j Z^j_{i(t-1)} + \phi_{it} \quad \text{----- (2)}$$

Where, ${y^k}_{it} = (Y_{it} - Y_{i(t-1)})/Y_{i(t-1)}$, $(k = 1,2)$ denoting the growth rate for i^th^ state t^th^ period outputs (SGDP and SAGDP). ${y^k}_{i(t-1)}$ is the lag of output growth, D is 1 if there was drought in state i in period $(t-1)$, $X^1_{i(t-1)}$ is the relief finances disbursed by state as drought relief and ID is the interaction dummy variable as explained earlier.

With the inclusion of the lagged values of the dependent variable as an independent variable, the above model (1) transforms into a dynamic panel model. Therefore, theoretically, employing the fixed effects model will be giving consistent but inefficient estimators. It happens due to systematic bias arising in the lagged dependent variable estimator as identified by Nickell (1981). This may lead to biases in the estimated coefficients of other variables. Further, this concern is irrelevant for long time series because the bias has an inverse relation with time, t. Therefore, it is assumed that the fixed effect model estimates may be equivalent to the GMM (Generalized Method of Moments) estimates. The empirical estimation is divided into two steps. First, the full sample comprising of 28 states is estimated. Second, we estimate the samples divided into three sub-groups: highly irrigated, moderately irrigated and least irrigated states. The impact of droughts and relief finances on the full sample and the three sub-groups is estimated using three different estimation methods: Pooled OLS, Fixed effect (FE) and Fixed effect corrected (FE-C). In total 18 models are estimated as reported in Table A3.5 and Table A3.6. The fixed effect corrected model (FE-C) represents the model corrected for heteroscedasticity, cross- sectional dependence and auto-correlation. Modified Wald test was conducted to check for group wise heteroscedasticity followed by test for cross-sectional dependence proposed by Pesaran (2004). This test is important as cross-sectional dependence may lead to contemporaneous correlation. To check for possibility of serial correlation, Lagrange-multiplier test was adopted.

3.5 Results and discussion

The review of literature suggests that a negative relationship is expected between drought (as well as drought relief finances) and States' Agricultural Gross Domestic Product. Moreover, the highly irrigated states are assumed to be least affected by droughts in comparison to the moderately irrigated states. A negative impact of droughts especially on the agricultural sector growth for the less irrigated states is expected (Government of India, Economic Survey 2017-18, Chapter 6). The infrastructure and agricultural control variables are also expected to impact SAGDP and SGDP growth rates positively. The results obtained in this study with reference to drought and the control variables are almost in line with a priori expectation albeit with few exceptions. The relationship between drought relief finances with the dependent variables shows positive relationship. The relief finances following drought may benefit the agricultural economy of the moderately and least irrigated states but its effect at the aggregate level remains ambiguous. We discuss in detail our results, presented in Table A3.5 and Table A3.6 in the next few paragraphs.

First, we discuss the result of our analysis with reference to the impact of drought and other variables on the SAGDP growth rate (y^1). As expected, drought shows negative relationship with SAGDP in three cases (all India, moderately irrigated and least irrigated states) except for highly irrigated states. The effect of financial relief $X^1_{i(t-1)}$ on the full sample and the highly irrigated group of states are statistically insignificant. But on the other two groups (moderate and least irrigated) the impact is negative and statistically significant. This implies that for these states, relief may be considered as a proxy for drought. The relationship of the interactive dummy variable is observed to be positive except for those related to the full sample and highly irrigated states. The relief finances following drought may contribute to the growth of the agricultural sector in the subsequent periods. However, its effect at the aggregate level remains ambiguous. As already discussed in the foregoing section, we first estimated the pooled regression to see the plausible relationship. Next, we checked whether the data can be pooled or not. Since we have included dummy variable for drought and an interactive dummy variable, the specification Least Square Dummy Variable (LSDV) type regression model and hence estimation of panel fixed effect (FE) is preferred following the theoretical arguments. Finally, the post-estimation diagnostics of the FE model influenced estimation of FE corrected (FE-C) models to address the problems of ordinary least square regressions. We therefore limit the discussion in the remaining section with regard to the corrected models.

The result (Table A3.5, Model 3) shows that drought may reduce the SAGDP growth rate by 11.89 percent on an average. However, the estimates for the three sub-samples differ. Droughts show a statistically significant negative impact on the least irrigated and moderately irrigated states (Model 12 and 9 respectively). These findings are in line to our a priori expectations. The deficiency of rainfall should have a negative impact on the agricultural sector and on productivity. Magnitude of such impacts on the agricultural growth could be significantly higher for the least irrigated states followed by the moderately irrigated states. The lowest negative impact, which in itself is substantially higher, is obtained for the overall states. Drought decreases the SAGDP growth by approximately 18 percent (Model 12) and 14 percent (Model 9) in the least and moderately irrigated states respectively. The high irrigated states (Model 6) do not have any significant impact of drought in the present analysis. These results clearly show that along with overall agricultural growth, the least irrigated and the moderately irrigated states are vulnerable to droughts whereas the states with irrigation facilities could adopt to short-term drought shock efficiently. One may extend the analysis to observe the impact of shocks beyond $(t-1)^{th}$ period.

The next two important variables are $X^1_{i(t-1)}$ and the ID. For the full sample and the high irrigated states, there is insignificant relationship between previous period relief and current period growth. But, for the moderate and least irrigated states there is significant negative impact and in terms of the size of the coefficient estimate, the least irrigated states are more adversely affected. This implies that if disaster relief increases and SGDP remains constant, the ratio increases and this would adversely affect the growth of the agricultural sector. ID also shows significant positive impact for moderate and least irrigated groups (Model 9 and 12). This could possibly suggest that relief following drought is contributing to growth of the states having limited irrigation infrastructure.

We compare the obtained results with few selected studies in the context of droughts and disaster relief globally. The estimates of our study are in line with Fomby et al. (2013), Loayza et al. (2012) and Raddatz (2009) for drought impact on agricultural growth. The drought relief results by Xu and Mo (2013) and Freeman (2004) showed negative impact on growth dynamics. Our results related to the drought relief partially matches with the outcomes of these studies. The moderate and least irrigated states show negative impact of relief finances that do not translate into the overall agricultural sector growth.

It is important to mention that our study findings with reference to interactive variable (ID) are not directly comparable with the findings of earlier studies. The reason is the way we define the interactive variable in the study. Previous studies measured the effect of drought relief on the economy considering it to proxy for drought. Therefore, with interactive variable, we essentially capture the relief impact on economic and sectoral growth in the immediate future. According to our econometric specifications, in case of no drought event, the drought dummy assumes the value of 0. As a result, the coefficients of ID across specification become zero. Therefore, the mean growth of SAGDP is only determined by other variables included in the model excluding the drought and the interactive variable. In such a situation, the drought relief further substantiates the impact of drought. The coefficient of ID being positive additionally affects the growth rate.

The findings may require further investigation in the Indian context. The systematic enquiry of state wise drought relief disbursement's direct and indirect market impact and the resulting contribution to economic growth may provide the reasons for such a relationship. At present, the unavailability of complete data at the state as well as the national level for relief disbursement and utilisation restricts detailed analysis (Chakrabarti, 2009). Finances towards relief should be employed for rehabilitation and generation of alternative livelihoods rather than being used for immediate consumption purposes. Of course, investment for better physical infrastructure to cope and adapt with drought like slow-onset disasters may be justified. But such investments are of large proportions when compared to the relief disbursed. If relief finances had been used for expansion of livelihood or widening social safety nets, then there could be a positive impact on economic growth (Xu and Mo, 2013). Moreover, Xu and Mo (2013) further articulated that relief finances are not good for any economy as it hampers the labour supply after disasters which in turn affect the economic growth.

We now discuss the effect of all the control variables used in the study. For specification (1), 3 out of 7 control variables (road length per 1000 population (Z^3), per-capita availability of electricity (Z^4), and crop intensity (Z^6)) exhibits positive impact on SAGDP growth rate across different samples (Models 3, 6, 9 and 12). Among these variables, the coefficient of (Z^1) is statistically significant in Model (3) and (9), (Z^3) in Model (3), (9) and 12), and (Z^4) significant in all the Models. These results confirm that the state infrastructure with respect to transportation, electricity and education may ensure growth of the agricultural sector. The results do corroborate theory and studies by Barnes and Binswanger (1986), Binswanger et al. (1993), Fan et al. (2000), Rao et al. (2006), among others. Similarly, higher cropping intensity may also lead to higher agricultural growth. Urban population share in total population (Z^7), shows negative relationship with agricultural growth rate. It confirms that with overall economic growth and demand for labour by the secondary and tertiary sectors along with the push and pull factors responsible for rural out-migration, the SAGDP growth rate declines. The variables bank branches per 1000 population (Z^2) is statistically significant only in Model (3) and (9) whereas yield of total food grains (Z^5), is statistically insignificant across the different samples except for the highly irrigated states.

In this paragraph, we discuss the result of panel regression models for SGDP growth (y^2) estimates and the results as shown in Table A3.6. Further, we report the growth impact for the full sample (28 states). Two regression equations are estimated, one includes incidence of drought as an explanatory variable along with other control variables, and the other includes both drought relief and the interactive dummy variable along with other explanatory variables. The results confirm that droughts have a significant negative impact on the aggregate growth rate. In the first regression, drought decreases the SGDP growth rate by 3.54 percent on an average (Model 15). In the second regression, in the presence of

$X^1_{(t-1)}$ and ID, droughts lower growth rate by 3.46 percent on an average (Model 18). The post- drought relief along with the interactive dummy variable failed to show any significant impact on the SGDP growth rate. The statistical significance of coefficients varies for control variables across different models.

Drought affects the local economy but in particular, is detrimental for the agriculture and the allied sectors such as horticulture, floriculture, fisheries, among others. In India, the percentage share of the agricultural sector to overall GDP has decreased to 15.11 percent in 2016-17 (at 2011-12 prices) in comparison to what it was in the early eighties. This decline is due to several factors including drought like situation or water scarcity as detailed in the growth theories and in the development economics literature. Thus, it is rational to expect that slow-onset disasters like drought, may not affect the agricultural sector so adversely like the fast-onset disaster that the overall SGDP is directly and immediately impacted. This is what we observe in the case of selected earlier studies such as those by Loyaza et al. (2012); Horridge et al. (2005); Virmani (2004), and Kulshreshtha et al. (2003). It is to be noted that the present study considered major Indian states, considered most of the variables following the literature which might portray the consequences of the disaster. Droughts have considerable indirect impacts and consequences that may affect the aggregate economic growth. According to Pelling et al. (2002), the drought-induced direct, indirect and secondary effects may slow down the economic development. This happens fast and for sure if the agricultural sector is highly linked with the industrial sector. As a result, droughts may have many adverse effects on the individuals and the economy as a whole. For example, drought induced inflation may lower the purchasing capacity of the individuals as highlighted by Sen (1982). The economic slowdown may lead to lower employments and the domestic or foreign investors may delay the investment plan for long.

The post-drought relief finances show insignificant effect on the SGDP growth rate for the all states. But, it is statistically significant and has a negative effect on the SAGDP for the moderate and least irrigation equipped states. Shughart (2011) showed that disaster relief is a bad public policy as it fosters corruption and creates a problem of moral hazard. Pelling et al. (2002) also emphasised that post-disaster relief does not exert a positive impact on the economic growth. Relief gives temporary benefit and not serve the development purpose. At times, relief amounts are spent inefficiently in concentrated relief efforts that distort longer-term development and risk reduction efforts. Our study findings are broadly in line to these studies at aggregate level. With conceptualization of the third important variable (interactive variable, ID) in the study, we are measuring the relief disbursements impact on economic growth only when drought occurs. Therefore, the current estimates are robust and provide new empirical insight in the Indian context. A thorough analysis of state-wide drought relief disbursement process, major heads of disbursements and utilization by actual beneficiaries in the agriculture sector may provide the correct explanation for such a relationship.

A comparison of results in Table A3.5 and Table A3.6 suggests that the overall fit of the selected econometric specification for explaining drought impact on the agricultural sector growth rate is lower in comparison to that of the models explaining the effect of droughts on growth rate of SGDP. Therefore, one would argue that some of the relevant variables have been ignored in this analysis. The exclusion is purposive because our objective was to only understand the relationship (the direction) between the drought and the sectoral growth, we assume that the variables in Table A3.5 are some of the important variables explaining agricultural sector growth. We have not considered factors such as prevailing market prices of crops, the input prices, labour market conditions, among others, that could also explain variations in SAGDP. The results therefore are not to be used for generating future predictions. It is observed that while estimating panel data, lower R-square values are obtained. Increasing the sample size may prove to be a solution but information on drought and drought relief is not available for longer periods. In the next section we present the main findings pertaining to the robustness check.

3.6 Robustness Check

Table A3.7 presents the result of robustness check, employing the system GMM method for agricultural growth rate (SAGDP). Drought shows statistically significant adverse impact for all the states (model 19), and least irrigated states (model 22). Drought reduces the SAGDP growth rate by 22 and 21 percent (with GMM) for these groups. However, the SAGDP growth was lowered by 12 and 18 percent with panel fixed effects for all the states and least irrigated states respectively (Table A3.5). For moderately irrigated states also, the effects are adverse, though with lower statistical significance (at 10 percent). The second variable of interest is drought relief. It has negative and significant relationship for the least irrigated group with GMM estimation. Notably, similar results were obtained in the main analysis (Table A3.5) also. However, ID shows positive relationship with growth rate (statistically non-significant) as also observed with the panel fixed effect model. The coefficients of control variables obtained with the system GMM are also largely following (direction and significance) fixed effect model results.

Table A3.8 and A3.9 report the findings of robustness check employing a simple static empirical approach (panel fixed effect model without lagged dependent variable i.e., y_{t-1}). The results for drought, financial relief, ID as well as control variables are almost unchanged in direction and significance, validating the results of dynamic panel model (Table A3.5 and A3.7) estimating the SAGDP and SGDP growth dynamics. As a final robustness check (Table A3.10) the empirical estimates dropping the Z^5 (Yield of total food grains) and Z^6 (Cropping Intensity) variables are estimated for SAGDP growth rates. The obtained results (Table A3.10) with respect to drought, drought relief and ID are quite robust and almost corroborates with the findings as reported in Table A3.5. For example, droughts have significant negative relationship for all the groups except the highly irrigated states (Table A3.10). Interactive dummy variable (ID) also shows significant positive relationship for moderately and least irrigated states as also observed in Table A3.8 and Table A3.5 (Dynamic panel estimation model), which includes Z^5 and Z^6. *Therefore, it may be concluded that the empirically obtained results employing the dynamic panel fixed effects models (Table A3.5) are quite robust and significant*.

3.7 Conclusion

The Indian states which are in the dry, arid and semi-arid regions face acute to chronic droughts every year due to deficient rainfall. According to official estimates, 50 percent cropped area in the country depend exclusively on the South-West Monsoon (SWM). As a result, the economy in general and the agricultural sector in particular are affected by drought which is a climate-induced slow-onset disaster. Such disasters divert financial resources towards relief, consumption smoothing, among others, which may adverse impact the other sectors in the economy. The objective of this study is to find an empirical relationship between droughts and drought relief on the agricultural sector growth and the overall economic growth. The study considers 28 Indian states and analyses data for the period 1990-91 to 2015-16. Results show that droughts adversely affect the State Agriculture Gross Domestic Product (SAGDP) and the State Gross Domestic Product (SGDP) growth rates. The results further indicate that the impact of droughts on SAGDP and SGDP growth rates depends on the available physical infrastructure such as irrigation. The drought relief finance following drought in the previous period, on the other hand, showed a negative and statistically significant effect on SAGDP for moderate and least irrigated states. There is no significant impact on economic growth as effects are largely localised. Further, droughts as well as financial relief are detrimental to growth.

Appendix A3

Table A3.1 Droughts in India

Period	Drought Years	No. of Years
1801-1825	1801,04,06,12,19,25	6
1826-1850	1832,33,37	3
1851-1875	1853,60,62,66,68,73	6
1876-1900	1877,91,99	3
1901-1925	1901,04,05,07,11,13,15,18,20,25	10
1926-1950	1939,41	2
1951-1975	1951,65,66,68,72,74	6
1976-2000	1979,82,85,87,2002,2009	4
2000-2016	2002, 09,14,15	4

Source: Drought Research Unit (DRU), India Meteorological Department (IMD), Pune and *State of Indian Agriculture 2015-16* from Ministry of Agriculture and Farmers Welfare

Table A3.2 Indian States for Empirical Analysis

Sl. No.	State	Sl. No.	State
1	Andhra Pradesh	15	Maharashtra
2	Arunachal Pradesh	16	Manipur
3	Assam	17	Meghalaya
4	Bihar	18	Mizoram
5	Chhattisgarh	19	Nagaland
6	Goa	20	Odisha
7	Gujarat	21	Punjab
8	Haryana	22	Rajasthan
9	Himachal Pradesh	23	Sikkim
10	Jammu & Kashmir	24	Tamil Nadu
11	Jharkhand	25	Tripura
12	Karnataka	26	Uttar Pradesh
13	Kerala	27	Uttarakhand
14	Madhya Pradesh	28	West Bengal

Table A3.3 Variable name, definition and their sources

Variable Name	Definition	Sources
SAGDP (Y^1)	States' Agricultural Gross Domestic Product* in constant 2011-12 prices	Reserve Bank of India (RBI)
SGDP (Y^2)	States' Gross Domestic Product* in constant 2011-12 prices	RBI
D = 1 if drought in period $(t-1)$, otherwise 0	Drought if in period $(t-1)$ annual mean deviation of rainfall is equal to or more than 25 percent from average state rainfall	Following definition of drought and rainfall data from the Indian Meteorological Department (IMD)
X^1	The ratio of total financial relief under the heading drought relief disbursed by the State to the SGDP	Comptroller and Auditor General of India (CAG State Accounts)
ID	Interactive dummy variable which is $D\ times$ X^1. If in the previous period, there was no drought, $ID = 0$ otherwise it is the ratio X^2.	
Z^1	Literacy rate in percentage	Office of the Registrar General of India
Z^2	Total bank branches (Schedule Commercial Banks plus Regional Rural Banks) per 1000 population	RBI and Ministry of Statistics and Policy Implementation (MOSPI)
Z^3	Total length of roads (of all types) in kilometers per 1000 population	RBI and MOSPI
Z^4	Per-capita availability of electricity in kilo watt-hour	RBI
Z^5	Yield of total foodgrains (Total Production by Total (Gross) Area)	RBI
Z^6	Cropping Intensity	RBI
Z^7	Share of urban population to total population	Economic and Political Weekly Research Foundation (EPWRF)

Note: * in the study we have used growth rates and therefore denoted same as y^1 and y^2

Table A3.4 Descriptive Statistics for disaster and control variables, Sample: 28 States, 1990-2015

Variable	Obs.	Mean	Std. Dev.	Min	Max
SAGDP Growth Rate (y^1)	664	11.72	36.43	-34.15	310.91
SGDP Growth Rate (y^2)	664	15.61	46.74	-15.38	391.71
Drought Relief (X^1)	664	0.24	0.07	0	0.60
Literacy Rate (Z^1),	664	69.10	12.36	34	96.00
Bank Branches (Z^2) Per 1000 Population	664	0.10	0.04	0.03	0.44
Road Length (Z^3) Per 1000 Population	664	4.47	3.35	0.37	19.28
Per capita electricity consum	664	513.80	430.62	20	2697.40
Yield of Total Food Grains (Z^5)	664	1796.12	709.91	285	4500
Crop Intensity (Z^6)	664	136.73	24.07	100	196.24

Table A3.5 Effect of Droughts on State Agricultural Gross Domestic Product (SAGDP) Growth Rate (y^1)

Variable	All States (Full Sample 28 States)			Highly Irrigated States (10 States)			Moderately Irrigated States (18 States)			Least Irrigated States (8 States)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Pooled	FE	FE-C	Pooled	FE	FE-C	Pooled	FE	FE-C	Pooled	FE	FE-C
$y^1_{(t-1)}$	-0.0396 (0.0394)	-0.0728* (0.0408)	-0.1188*** (0.0415)	-0.0776 (0.0682)	-0.1013 (0.0715)	-0.1975*** (0.0724)	-0.0169 (0.0493)	-0.0514 (0.0507)	-0.0646 (0.0519)	-0.0639 (0.0780)	-0.0656 (0.0771)	-0.0677 (0.0787)
D	-6.7253* (3.5857)	-10.8576*** (3.9417)	-11.8980*** (4.1661)	-7.8531 (6.1520)	-7.4542 (6.3057)	-10.7687 (6.0726)	-6.6484 (4.5405)	-13.4560** (5.2317)	-13.9265** (5.5117)	-5.6557 (6.8161)	-18.3955** (7.9007)	-17.6713** (8.1995)
X^1_{t-1}	3.2890 (29.7269)	-15.1792 (32.3419)	-8.7034 (33.7459)	40.7220 (40.8975)	32.3324 (44.9783)	47.5389 (47.5712)	-32.3999 (44.3303)	-71.1619 (47.1229)	-68.6418* (48.6245)	-128.808* (77.2910)	-180.0164** (79.8594)	-184.7056** (81.9630)
ID	60.5225 (43.2383)	64.9976 (45.2711)	64.4479 (46.7265)	-7.7905 (75.1232)	-30.2494 (75.9402)	-33.2689 (76.4246)	108.488* (57.4538)	129.8468** (59.8814)	133.282** (61.6521)	170.277 (133.608)	231.5905* (135.5123)	233.0281* (138.2667)
Z^1_{t-1}	0.3324** (0.1469)	0.7787** (0.3097)	0.8744** (0.3547)	0.0409 (0.3920)	1.0196 (0.7078)	1.2641 (0.8467)	0.3753* (0.1956)	0.7430** (0.3576)	0.8002** (0.3983)	-0.2642 (0.4705)	-0.2227 (0.5892)	-0.5242 (0.6840)
Z^2_{t-1}	-134.3812*** (41.1279)	-248.991*** (87.9350)	-279.6451*** (95.6599)	-319.2762** (146.8244)	-241.1057 (169.3954)	-311.9628 (194.3336)	-142.272*** (54.1655)	-267.8584** (106.0611)	-283.0643** (111.473)	73.3093 (94.2996)	-305.7991* (199.6264)	-284.3667 (211.0528)
Z^3_{t-1}	0.8361* (0.5100)	3.7369*** (1.3851)	3.8723*** (1.4933)	2.8634 (3.4017)	4.3597 (4.9319)	5.0028 (5.8272)	0.8910 (0.5658)	3.9245** (1.5657)	3.9698** (1.6340)	1.5866 (1.0846)	5.0583*** (1.9586)	5.2155** (2.0269)
Z^4_{t-1}	0.0214*** (0.0047)	0.0322*** (0.0073)	0.0366*** (0.0080)	0.0313*** (0.0103)	0.0426*** (0.0136)	0.0509*** (0.0160)	0.0236*** (0.0065)	0.0297*** (0.0091)	0.0322*** (0.0097)	0.0427*** (0.0142)	0.0636*** (0.0221)	0.0654*** (0.0231)
Z^5_{t-1}	-0.0022 (0.0027)	-.0088 (0.0060)	-0.0092 (0.0063)	-0.0047 (0.0057)	-0.0207* (0.0120)	-0.0208* (0.0125)	-0.0018 (0.0046)	-0.0062 (0.0075)	-0.0066 (.0077)	0.0035 (0.0056)	-0.0098 (0.0097)	-0.0113 (0.0100)
Z^6_{t-1}	0.1084 (0.0730)	0.2243* (0.1363)	0.2466* (0.1500)	0.2788* (0.1655)	0.2964 (0.4432)	0.2155 (0.4733)	0.0965 (0.0978)	0.2152 (0.1485)	0.2374 (0.1593)	-0.1006 (0.1508)	0.2338 (0.2726)	0.2963 (0.2862)
Z^7_{t-1}	-4.8723 (3.6905)	-9.6877 (11.0025)	-11.0327 (13.1019)	-10.0085 (7.1274)	-16.6557 (15.5884)	-20.0887 (21.1329)	-3.8162 (5.3463)	-6.7077 (16.1797)	-7.9198 (17.2445)	-7.7036 (7.6345)	-9.4682 (15.7413)	-11.5876 (16.3201)
Obs.	636	636	608	227	227	217	409	409	391	179	179	171
R^2	0.0598	0.1030	0.1092	0.0864	0.1319	0.1610	0.0610	0.1030	0.1037	0.0803	0.1440	0.1504
α	-19.2795 (13.6785)	-56.9118** (26.3517)	-64.9147** (27.9157)	-8.8320 (24.6930)	-51.2387 (68.8165)	-51.7049 (71.5891)	-22.3111 (17.5281)	-60.5978** (30.7588)	-66.2669** (32.5932)	16.9314 (33.6898)	4.4177 (52.9761)	20.6347 (58.2637)
Autocorrelation test		$F(1, 27)$ = 525.412***			$F(1, 9)$ = 174.791***			$F(1, 17)$ = 335.561**			$F(1, 7)$ = 59.120**	
Cross-sectional dependence test		CD = 75.712***			CD = 26.671***			CD = 47.144***			CD = 18.290***	
Heteroscedasticity test		$\chi^2(28)$= 25.21			$\chi^2(10)$ = 3.61			$\chi^2(18)$ = 22.00			$\chi^2(8)$ = 2.63	

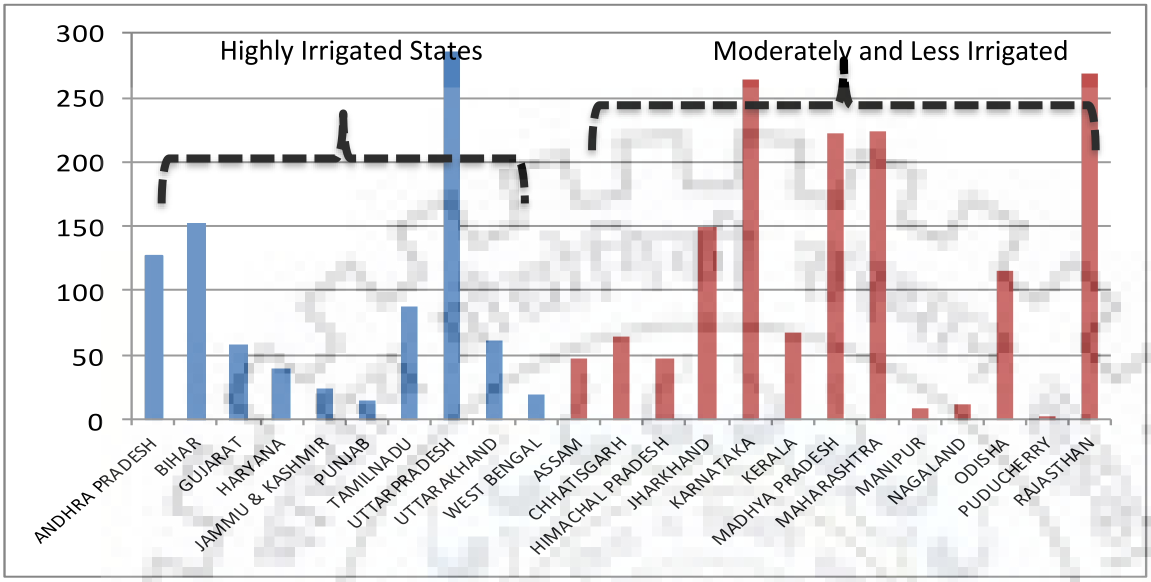
Note: Standard errors are in parentheses. * Significant at 10%, **Significant at 5%, ***Significant at 1%, Pooled – pooled regression, FE – Panel estimation with fixed effects; FE-C – Fixed effects regression corrected for heteroscedasticity, autocorrelation and cross-sectional dependence.

Table A3.6 Effect of Droughts on State Gross Domestic Product (SGDP) Growth Rate (y^2)

All States (Full Sample 28 States)						
	(13)	**(14)**	**(15)**	**(16)**	**(17)**	**(18)**
Variable	**Pooled**	**FE**	**FE-C**	**Pooled**	**FE**	**FE-C**
y_t^1	1.1664*** (0.0215)	1.1694*** (0.0219)	1.1694*** (0.0698)	1.1675*** (0.02162)	1.1696*** (0.0220)	1.1696*** (0.0701)
y_{t-1}^1	0.1364*** (0.0507)	0.1810*** (0.0520)	0.1810** (0.0701)	0.1363*** (0.0508)	0.1811*** (0.0521)	0.1811** (0.0696)
y_{t-1}^2	-0.1209*** (0.0393)	-0.1607*** (0.0399)	-0.1607*** (0.0486)	-0.1208*** (0.0394)	-0.1607*** (0.0400)	-0.1607*** (0.0483)
D	-3.9688** (1.8321)	-3.5497* (2.0485)	-3.5497** (1.3335)	-3.6812* (1.9422)	-3.4663* (2.1318)	-3.4663** (1.4961)
X_{t-1}^1	-	-	-	-5.8281 (16.0476)	2.5973 (17.3780)	2.5973 (9.9765)
ID	-	-	-	-6.0793 (23.3787)	-3.4754 (24.3623)	-3.4755 (12.4224)
Z_{t-1}^1	0.0357 (0.0783)	-0.0816 (0.1668)	-0.0816 (0.1146)	0.0263 (0.0796)	0.0823 (0.1673)	-0.0823 (0.1162)
Z_{t-1}^2	33.9546 (22.1679)	-18.7360 (47.4224)	-18.7360 (52.4271)	32.1419 (22.4118)	-18.4479 (47.5558)	-18.4479 (52.1850)
Z_{t-1}^3	-0.4224 (0.2757)	-0.4921 (0.7423)	-0.4921 (0.5041)	-0.4239 (0.2761)	-0.5017 (0.7485)	-0.5017 (0.5176)
Z_{t-1}^4	0.0002 (0.0025)	0.0005 (0.0040)	0.0005 (0.0029)	0.0005 (0.0026)	0.0005 (0.0040)	0.0005 (.0028)
Z_{t-1}^5	0.0004 (0.0014)	.0067** (.0032)	.0067*** (.0022)	0.0003 (0.0015)	0.0068** (0.0032)	0.0068*** (0.0022)
Z_{t-1}^6	-0.0012 (0.0391)	-0.0458 (0.0733)	-0.0458 (0.0446)	-0.0050 (0.0395)	-0.0457 (0.0735)	-0.0457 (0.0447)
Z_{t-1}^7	-2.5830 (1.9703)	-6.1904 (5.9061)	-6.1904 (5.0245)	-2.5006 (1.9949)	-6.1883 (5.9203)	-6.1883 (5.0176)
α	-0.1399 (7.0148)	9.8846 (14.1933)	9.8846 (12.6960)	1.3716 (7.3960)	9.8228 (14.2235)	9.8228 (12.6416)
Obs.	636	636	636	636	636	636
R^2	0.8348	0.8435	0.8435	0.8349	0.8436	0.8436
Autocorrelation test		F(1, 27) = 179.460			F(1, 27) = 178.293	
Cross-sectional dependence test		CD = 3.895***			CD = 3.880***	
Heteroscedasticity test		$\chi^2(28)$= 902.54			$\chi^2(28)$= 891.35	

Note: Pooled – pooled regression, FE – Panel estimation with fixed effects; FE-C – Fixed effects regression corrected for heteroscedasticity, autocorrelation and cross-sectional dependence. Standard are in parentheses. * Significant at 10%, **Significant at 5%, ***Significant at 1%

Figure A3.1 State wise total number of drought declared districts (2000-01 to 2016-17)



Source: https://farmer.gov.in/Drought/Droughtreport.aspx

Table A3.7 Robustness Check: Effect of Droughts on State Agricultural Gross Domestic Product (SAGDP) Growth Rate (y^1); System GMM Approach

Variable	Full Sample (28 States)	Highly Irrigated (10 States)	Moderately Irrigated (18 States)	Least Irrigated (8 States)
	(19)	(20)	(21)	(22)
$y^1_{(t-1)}$	-0.0573 (0.0585)	-0.0701** (0.0244)	-0.1516 (0.4753)	-0.0142 (0.0364)
D	-22.3919*** (11.7655)	-13.1207* (5.9823)	-42.6894* (24.3347)	-20.7653*** (4.888)
X^1_{t-1}	56.1181 (197.0508)	46.3583 (69.0106)	100.2259 (240.0757)	-198.4456*** (51.8121)
ID	165.8764 (185.6451)	0.7740 (69.0893)	72.1026 (258.505)	594.9881 (364.55)
Z^1_{t-1}	0.5805 (1.1388)	-0.0154 (0.3071)	0.2753 (1.4635)	-0.0599 (0.3550)
Z^2_{t-1}	-96.7713 (317.1663)	-365.132** (142.1238)	-738.5714 (648.2589)	23.1138 (97.9411)
Z^3_{t-1}	0.9553 (1.2857)	3.9711 (4.9765)	3.5424** (1.5947)	1.4301 (1.5458)
Z^4_{t-1}	0.0144 (.0243)	0.0317*** (.00656)	0.0496 (0.0426)	0.0402* (0.0172)
Z^5_{t-1}	0.0001 (0.0137)	-0.0030 (.0029)	0.0202 (0.0348)	0.0021 (0.0079)
Z^6_{t-1}	0.2023 (0.5082)	0.3076 (.1122)	0.7867 (0.5775)	-0.08767 (0.2488)
Z^7_{t-1}	-7.915 (17.6899)	-12.1455 (7.5897)	40.9874 (40.1566)	-4.6375 (14.6516)
α	-50.4188 (111.0896)	-8.6656 (9.4320)	-110.0842 (161.8671)	9.0830 (27.6639)
N	608	217	391	171
AR(1)	-3.76*** (0.000)	-2.98*** (0.003)	-1.01 (0.315)	-2.31** (0.021)
AR(2)	0.19 (0.847)	1.36 (0.175)	-0.16 (0.875)	-2.31** (0.021)
Hansen J test	26.12 (1.000)	0.00 (1.000)	6.89 (1.000)	-0.15 (0.882)

Note: Generalized Method of Movements (GMM). Standard errors are in parentheses.
* Significant at 10%, **Significant at 5%, ***Significant at 1%,

Table A3.8 Robustness check: Effect of Droughts on State Agricultural Gross Domestic Product (SAGDP) Growth Rate (y^1); Static Model

	All States (Full Sample 28 States)			**Highly Irrigated States (10 States)**			**Moderately Irrigated States (18 States)**			**Least Irrigated States (8 States)**		
	(23)	**(24)**	**(25)**	**(26)**	**(27)**	**(28)**	**(29)**	**(30)**	**(31)**	**(32)**	**(33)**	**(34)**
Variable	**Pooled**	**FE**	**FE-C**	**Pooled**	**FE**	**FE-C**	**Pooled**	**FE**	**FE-C**	**Pooled**	**FE**	**FE-C**
D	-6.6554* (3.5850)	-10.7263*** (3.9482)	-11.7492*** (4.1955)	-6.8192 (6.088)	-6.1166 (6.2497)	-8.0658 (6.6390)	-6.7307 (4.5291)	-13.6487*** (5.2584)	-14.3705*** (5.5373)	-6.5394 (6.7239)	-19.3559** (7.8129)	-19.7509** (8.1747)
X_{t-1}^1	2.7719 (29.7227)	-13.9312 (32.3929)	-6.8628 (34.0022)	41.0680 (40.9242)	33.6088 (45.0783)	48.0977 (47.9365)	-32.8789 (44.2594)	-70.4289 (47.1189)	-67.1485* (48.9058)	-126.7957* (77.1768)	-177.7077** (79.7450)	-181.5713** (84.3634)
ID	61.5612 (43.2263)	67.3596 (45.3336)	68.6119 (47.0483)	-9.0981 (75.1656)	-32.8078 (76.1029)	-37.6064 (77.6444)	109.4205* (57.3263)	132.4105** (59.8298)	137.8206** (62.0853)	174.2567 (133.3898)	237.5706* (135.214)	258.3257* (140.9422)
Z_{t-1}^1	0.3217** (0.1465)	0.7091** (0.3078)	0.7386** (0.3554)	-0.0302 (0.3872)	0.8769 (0.7023)	0.8549 (0.8302)	0.3719* (0.1951)	0.7028** (0.3554)	0.7330* (0.4040)	-0.2122 (0.4658)	-0.2022 (0.5882)	-0.4689 (0.7124)
Z_{t-1}^2	-131.8696*** (41.0523)	-253.1534*** (88.0633)	-285.8252*** (96.7010)	-324.9974** (146.8472)	-262.1574** (169.1513)	-335.8765* (192.7201)	-140.8492*** (53.9477)	-269.9989** (106.0435)	-290.9447** (114.0131)	61.3129 (93.0679)	-319.5502 (198.8009)	-319.2619 (220.5247)
Z_{t-1}^3	0.8143 (0.5095)	3.6428*** (1.3866)	3.7111** (1.5075)	2.9366 (3.4034)	4.6787 (4.9387)	6.2196 (5.7936)	0.8825 (0.5646)	3.8584** (1.5644)	3.8631** (1.6618)	1.4572 (1.0720)	4.9258** (1.9507)	4.9377** (2.1046)
Z_{t-1}^4	0.0209*** (0.0047)	.0324*** (0.0073)	0.0373*** (0.0081)	0.0321*** (0.0103)	0.0453*** (0.0135)	0.0564*** (0.0157)	.0233*** (0.0065)	0.0295*** (0.0091)	-0.0083 (0.0078)	0.0403*** (0.0138)	0.0620*** (0.0220)	0.0646*** (0.0241)
Z_{t-1}^5	-0.0023 (0.0027)	-0.0105* (0.0059)	-0.0121* (0.0063)	-0.0057 (0.0056)	-0.0240** (0.0118)	-0.0267** (0.0124)	-0.0020 (0.0046)	-0.0072 (0.0074)	0.2383 (0.1630)	0.0030 (0.0055)	-0.0106 (0.0096)	-0.0122 (0.0103)
Z_{t-1}^6	0.1085 (0.0730)	0.2167* (0.1365)	0.2392 (0.1515)	.2967* (0.1648)	0.2676* (0.4438)	0.1281 (0.4792)	0.0962 (0.0977)	0.2106 (0.1484)	0.2383 (0.1630)	-0.0916 (0.1503)	0.2370 (0.2724)	0.3209 (0.2994)
Z_{t-1}^7	-4.5939 (3.6801)	-9.2626 (11.0198)	-10.8716 (13.2487)	-9.2744 (7.1030)	-16.4476 (15.6255)	-22.2182 (21.0117)	-3.707 (5.3311)	-6.2876 (16.1749)	-7.3783 (17.6747)	-7.1452 (7.5967)	-9.1873 (15.7244)	-11.5390 (17.2242)
Obs.	636	636	608	227	227	217	409	409	391	179	179	171
R^2	0.0598	0.0982	0.1092	0.0809	0.1234	0.1610	0.0607	0.1006	0.0973	0.0766	0.1441	0.1394
α	-18.7400 (13.6681)	-48.4905* (25.9706)	-44.1645 (27.6313)	-6.5681 (24.6295)	-32.4340 (67.6872)	-3.5853 (71.4357)	-22.0673 (17.4943)	-55.5562* (30.3542)	-53.6356* (32.0817)	14.3531 (33.5102)	5.4771 (52.9161)	16.9367 (57.2168)
Autocorrelation test		F(1, 27) = 1.267			F(1, 9) = 0.001			F(1, 17) = 3.666*			F(1, 7) = 0.263	
Cross-sectional dependence test		CD = 75.677***			CD = 26.631***			CD = 47.122***			CD = 18.282***	
Heteroscedasticity test		χ^2(28)= 24.65			χ^2(10) = 3.83			χ^2(18) = 21.48			χ^2(8) = 2.59	

Note: Standard errors are in parentheses. * Significant at 10%, **Significant at 5%, ***Significant at 1%, Pooled – pooled regression, FE – Panel estimation with fixed effects; FE-C – Fixed effects regression corrected for heteroscedasticity, autocorrelation and cross-sectional dependence.

Table A3.9 Robustness Check: Effect of Droughts on State Gross Domestic Product (SGDP Growth Rate (y^2); Static Model

All States (Full Sample 28 States)						
	(35)	**(36)**	**(37)**	**(38)**	**(39)**	**(40)**
Variable	**Pooled**	**FE**	**FE-C**	**Pooled**	**FE**	**FE-C**
D	-9.1755** (4.3737)	-14.0406*** (4.9184)	-16.212*** (5.2811)	-11.2488** (4.6255)*	-15.7517*** (5.1048)	-15.7517 (13.6159)
X_{t-1}^{1}	-	-	-	-2.1699 (38.3490)	-14.7840 (41.8822)	-14.7840 (18.6730)
ID	-	-	-	65.1983 (55.7716)	74.2281 (58.6138	74.2281 (70.0998)
Z_{t-1}^{1}	.3681** (.1863)	.7314* (.3976)	.7528 (.4766)	.3947** (.1891)	.7279* (.3980)	.7279 (.5400)
Z_{t-1}^{2}	-129.4567** (52.4038)	-314.2569*** (113.6995)	-366.0344*** (130.1148)	-124.9045** (52.9667)	-312.9578*** (113.8609)	-312.9578 (294.884)
Z_{t-1}^{3}	.5506 (.6573)	3.8144** (1.7806)	3.9629** (2.0016)	.5649 (.6574)	3.7675** (1.7927)	3.7675 (2.7295)
Z_{t-1}^{4}	.0257*** (.0059)	.03780*** (.0095)	.0435*** (.0109)	.0247*** (.0061)	.0377*** (.0095)	.0377 (.0279)
Z_{t-1}^{5}	-.0025 (.0035)	-.0049** (.0076)	-.0060 (.0083)	-.0021 (.0035)	-.0047 (.0077)	-.0047 (.0049)
Z_{t-1}^{6}	.1067 (.0934)	.2190 (.1764)	.2471 (.2035)	.1188 (.0942)	.2217 (.1765)	.2217 (.1717)
Z_{t-1}^{7}	-8.0194* (4.6959)	-17.5329 (14.234)	-22.0263 (17.8415)	-7.822* (4.7482)	-18.1239 (14.2480)	-18.1239 (15.9576)
α	-16.0879 (16.7573)	-48.6605 (33.5482)	-39.9315 (35.6914)	-20.2265 (17.6349)	-48.5804 (33.5786)	-48.5804 (57.2312)
Obs.	636	636	608	636	636	636
R^2	0.0493	0.0829	0.0771	0.0525	0.0857	0.0857
Autocorrelation test		F(1, 27) = 0.7449			F(1, 27) = 0.034	
Cross-sectional dependence test		CD = 80.925***			CD = 80.349***	
Heteroscedasticity test		χ^2(28)= 5746.87			χ^2(28)= 4289.17***	

Note: Pooled – pooled regression, FE – Panel estimation with fixed effects; FE-C – Fixed effects regression corrected for heteroscedasticity, auto-correlation and cross-sectional dependence. Standard errors are in parentheses.* Significant at 10%, **Significant at 5%, ***Significant at 1%,

Table A3.10 Robustness check: Effect of Droughts on State Agricultural Gross Domestic Product (SAGDP) Growth Rate (y^1); Static Model (dropping Z^5 and Z^6)

Variable	All States (Full Sample 28 States)		Highly Irrigated States (10 States)		Moderately Irrigated States (18 States)		Least Irrigated States (8 States)	
	(41)	(42)	(43)	(44)	(45)	(46)	(47)	(48)
	Pooled	FE-C	Pooled	FE-C	Pooled	FE-C	Pooled	FE-C
D	-6.1886* (3.5401)	-10.7434* (4.1842)	-7.5194 (6.1896)	-7.7890 (6.6937)	-6.3549 (4.5111)	-13.1532** (5.4819)	-6.2214 (6.6674)	-17.0264** (7.9427)
X_{t-1}^1	-0.3454 (28.8761)	-0.2985** (33.9008)	53.5279 (41.4293)	70.6911 (47.4894)	-30.5390 (43.9482)	-64.1785 (48.8363)	-118.1565 (74.9200)	-181.8124** (83.9140)
ID	60.6471 (43.2030)	66.3193 (47.2210)	2.3427 (76.3486)	-22.8832 (77.8242)	104.4459* (57.0837)	134.5671** (62.1425)	171.8802 (131.87)	244.2902* (139.9789)
Z_{t-1}^1	0.2702* (0.1422)	0.5610 (0.3452)	0.5981* (0.3359)	.0612 (0.7637)	0.3278* (.1764)	0.6478* (0.3968)	-0.1399 (0.4538)	-0.3766 (0.7104)
Z_{t-1}^2	-127.644*** (40.8849)	-282.1678* (97.2403)	-50.4085 (114.271)	-348.5191* (196.2566)	-135.1583*** (51.1953)	-280.7521** (113.8832)	47.2226 (89.7164)	-326.4072 (215.495)
Z_{t-1}^3	0.7663 (.5074)	3.5614** (1.4677)	0.9074 (3.3523)	5.2385 (5.7581)	0.8830 (0.5618)	3.8059** (1.5902)	1.3960 (1.0650)	4.5741** (2.0098)
Z_{t-1}^4	0.0213*** (0.0045)	0.0356*** (0.0080)	0.1160 (0.1170)	0.0500*** (0.0151)	0.0237*** (0.0064)	0.0323*** (0.0099)	0.0352*** (0.0121)	0.0703*** (0.0226)
Z_{t-1}^7	-6.1609* (3.3781)	-11.3059 (13.2352)	-6.8083 (5.9495)	-20.99282 (21.3215)	-5.5489 (4.9010)	-5.4408 (17.4133)	-5.1818 (6.9594)	-6.9468 (16.4618)
Obs.	636	608	227	217	409	391	636	171
R^2	0.0549	0.0868	0.0397	0.1083	0.0579	0.0897	0.0730	0.1242
α	-4.3769 (8.8811)	-22.6779 (21.9644)	-35.7966* (21.1103)	9.3915 (39.6976)	-9.8087 (12.2490)	-33.0406 (27.3289)	4.1298 (26.9662)	-6.9468 (16.4618)

Note: Standard errors are in parentheses. * Significant at 10%, **Significant at 5%, ***Significant at 1%, Pooled – pooled regression, FE – Panel Estimation with fixed effects; FE-C – Fixed effect regression corrected for heteroscedasticity, autocorrelation and cross-sectional dependence.

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CHAPTER FOUR

IMPACT OF DROUGHTS ON MADHYA PRADESH ECONOMY

4.1 Economy of Madhya Pradesh and Natural Disasters

4.1.1 Introduction

This chapter presents a brief description about the economy of Madhya Pradesh and the prevailing disasters. Madhya Pradesh, also known as the 'Heart of India' is an agrarian state. It touches the boundaries of five states- Rajasthan, Uttar Pradesh, Maharashtra, Gujarat and Chhattisgarh (Figure 4.1). Madhya Pradesh was undivided until 2000 when Chhattisgarh becomes a separate state. It is divided in 51 administrative districts under 10 divisions. Bhopal is the capital city and Indore is the industrial capital of the state. It covers 308 lakh hectare area and have more than 7 crore population (Census, 2011), the sixth highest in the country, accounting for 6 percent of total national population. The state registered 20.3 percent growth rate in population from 2001 to 2011.

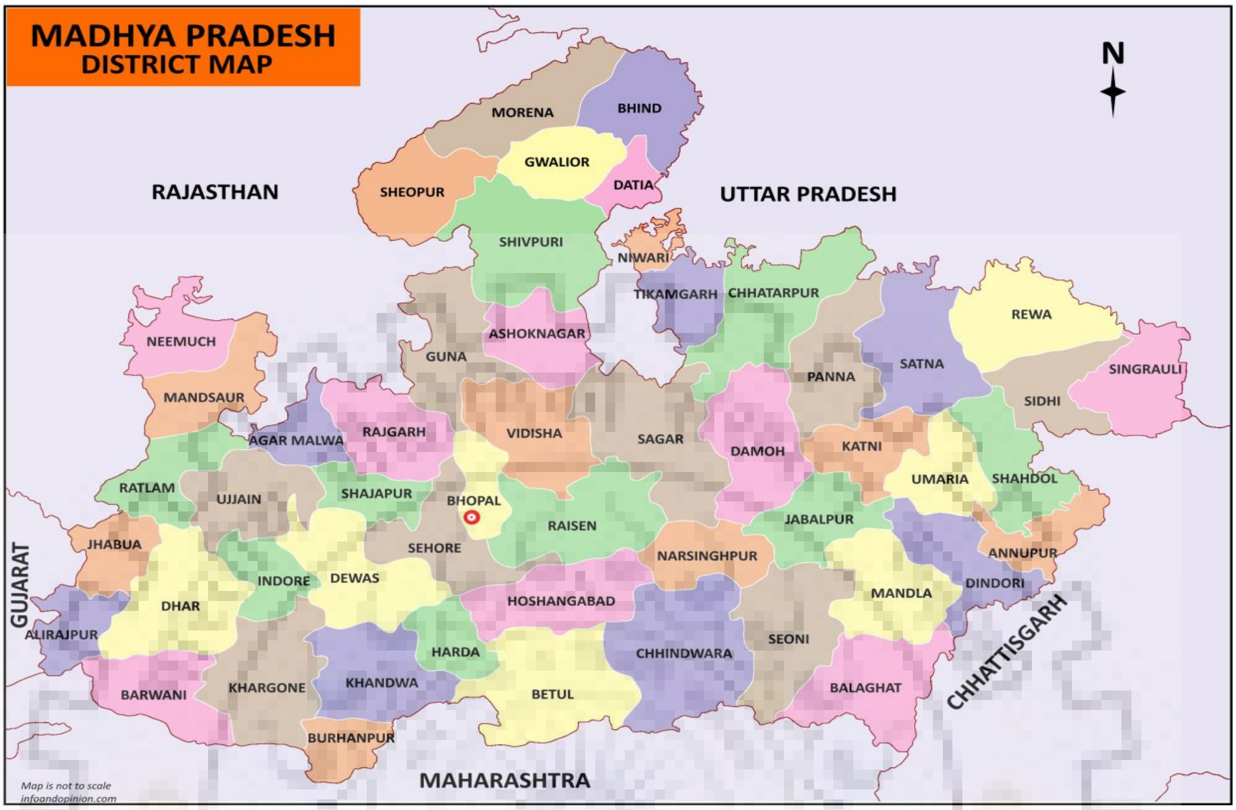
The share of rural population to the total population was 72.4 percent (census, 2011). The economically and socially backward class (Scheduled Tribe and Scheduled Caste) population was 36.7 percent to the total population (Census, 2011). There were 31 percent main workers, 12 percent marginal workers and 57 percent non-workers in the total population of Madhya Pradesh. Their participation in the work (in numbers) in Madhya Pradesh are compared with the Country and presented in Table 4.1. The percentage of cultivators in the state to total workers were 31.2 percent and the number of agricultural labourers were approximately 1.22 crores; which was 38.6 percent of the total workers (Directorate of Economics and Statistics, Madhya Pradesh). Table 4.2 briefly presents some of the notable characteristics of the state.

Table 4.1 Work Profile for Madhya Pradesh and India, 2011 (in million)

Status of Work	Madhya Pradesh	India
Total Workers	31.5	481.8
Main Workers	22.7	362.5
Marginal Workers	8.8	119.3
Non workers	41.0	728.9

Source: Government of India, Ministry of Home Affairs. 2011. Census India. New Delhi: Office of the Registrar General and Census Commissioner of India

Figure 4.1 Madhya Pradesh District Map



Source: Google Map (Infoandopinion.com)

Table 4.2 Key Statistics of Madhya Pradesh

Characteristics/Parameters	**Remarks**
Date of Establishment	November 1, 1956
Population	7,26,26,809 (Census 2011)
Regions	Bundelkhand, Baghelkhand, Malwa, Nimar, ,Chambal and Mahakaushal
Divisions	10 (Bhopal, Chambal, Gwalior, Hoshangabad, Indore, Jabalpur, Rewa, Sagar, Shahdol, Ujjain)
Number of Districts	52
Climate	The climate is moderate and pleasant, but extreme weather is also observed many a times in selected districts
Rivers	Narmada, Chambal, Mahi, Tapti, Betwa, Sone, Banganga, Ken, Pench, Tawa and Shipra.
Main Crops	Soyabean, Rice, Wheat, Jowar, Maize, Gram, Masur, Tuar
Livelihoods	Agriculture, More than 70% population depends on the agriculture for livelihood

Source: State Profile, Government of Madhya Pradesh; Available at: https://mp.gov.in/agriculture

The remaining chapter is organized as follows. Section 4.1.2 describes about the economic profile of the Madhya Pradesh. The key agricultural and economic indicators of the state is also presented. Section 4.1.3 gives an account of natural disasters in the state.

Floods, earthquakes and droughts are the three disaster types which state have encountered. Drought is the most frequent disaster among all three in the state. Few key statistics about the drought events in the state is also presented in this section. The chapter ends with the conclusion section summarizing the key insights from the entire discussion in the chapter.

4.1.2 Economy of Madhya Pradesh

Despite a low relative contribution of agriculture in the state economy, the state is predominantly depending on agriculture from the employment and occupational engagements perspective. Around 61.6 percent employed population were in Agriculture and allied sector (Madhya Pradesh Skills Development project, 2016). Table 4.3 indicates the percentage share of all the three sectors of economy of the state in 1991-92 and 2015-16. It is evident that there is a decline in the share of primary sector during the period. However, it still substantially contributed (34.5%) to the economy of the state. The service sector contribution increased significantly, and secondary sector also registered some growth during the period.

Table 4.3 Share of Primary, Manufacturing and Service sector in Madhya Pradesh

Sector	1991-92	2015-16	% Change
Primary	42.62	34.5	-8.12
Secondary	23.6	25.2	6.77
Tertiary	33.78	40.3	19.30

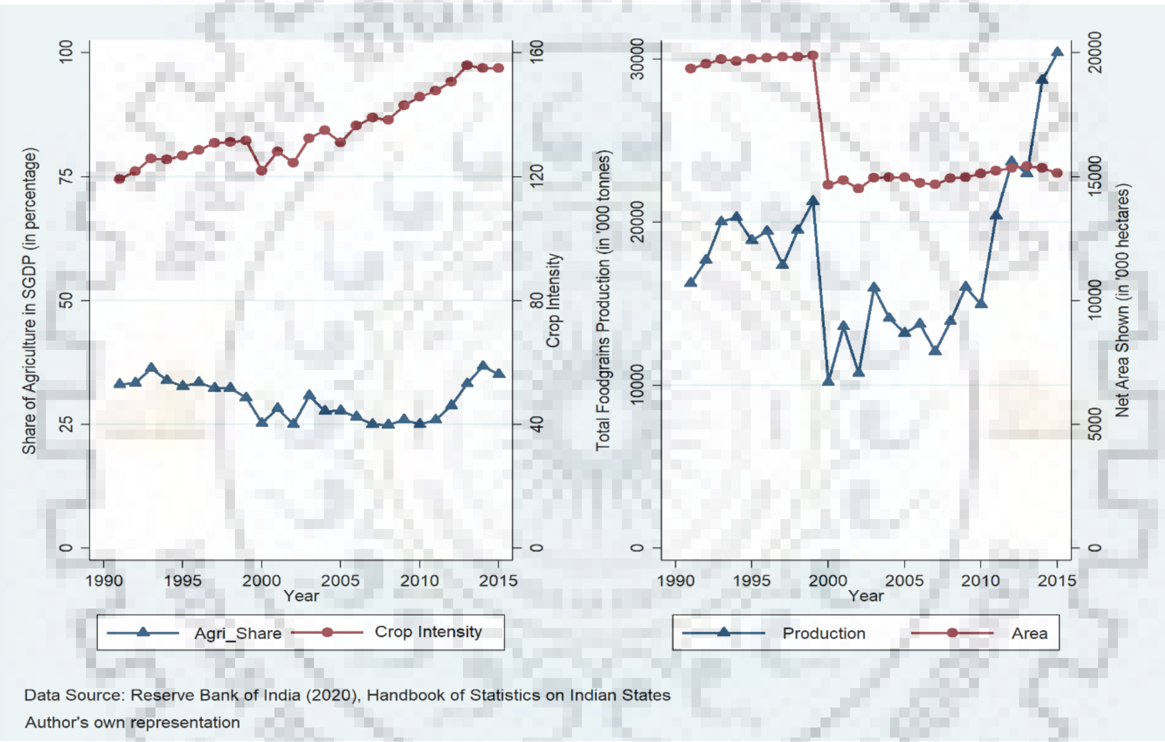
Source: Different Series of Estimates of State Domestic Product Madhya Pradesh (2018), Department of Planning, Economics and Statistics, Directorate of Economics and Statistics, Madhya Pradesh (2018); Estimates are at constant prices.

Among the primary sector, agriculture had 31.6 percent share in 1991-92 that increased to 35.1 percent in 2015-16 as per the Reserve Bank of India (Figure 4.2). The agricultural growth rate between 2005-06 and 2012-13 was highest in the state among other Indian states according to the Ministry of Agriculture and Farmers Welfare (2015-16). Gulati et al. (2017) observed that among many reasons which contributed towards high growth rate were irrigation expansion[13], institutionalization of Wheat procurement system, and investment in road infrastructure by the state government. The major crops by area are

[13] According to Gulati et al. (2017), in 2000-01 the irrigation ratio in MP was 24 percent (down 17.2 percent from national average), which improved in 2014-15 to 42.8 (only 5 percent down to the national average). The improvement in power supply, canal expansion and utilizing World Bank funds to complete the small and medium irrigation projects were the main reasons for such irrigation capacity enhancement.

Soyabean (25.22%), Wheat (19.69%), Gram (14.12%) and Rice (7.27%). The state is the largest producer of Soyabean in the country (Agricultural Statistics, 2015). The crop intensity also witnessed a steady growth. Hoshangabad district (206) registered the highest crop intensity, whereas it is the lowest in Shahadol district (119) in the state. Figure 4.2 also shows that the state has registered a continuous growth in total food production since 2001 and the net sown area in the state has been stagnant from many years.

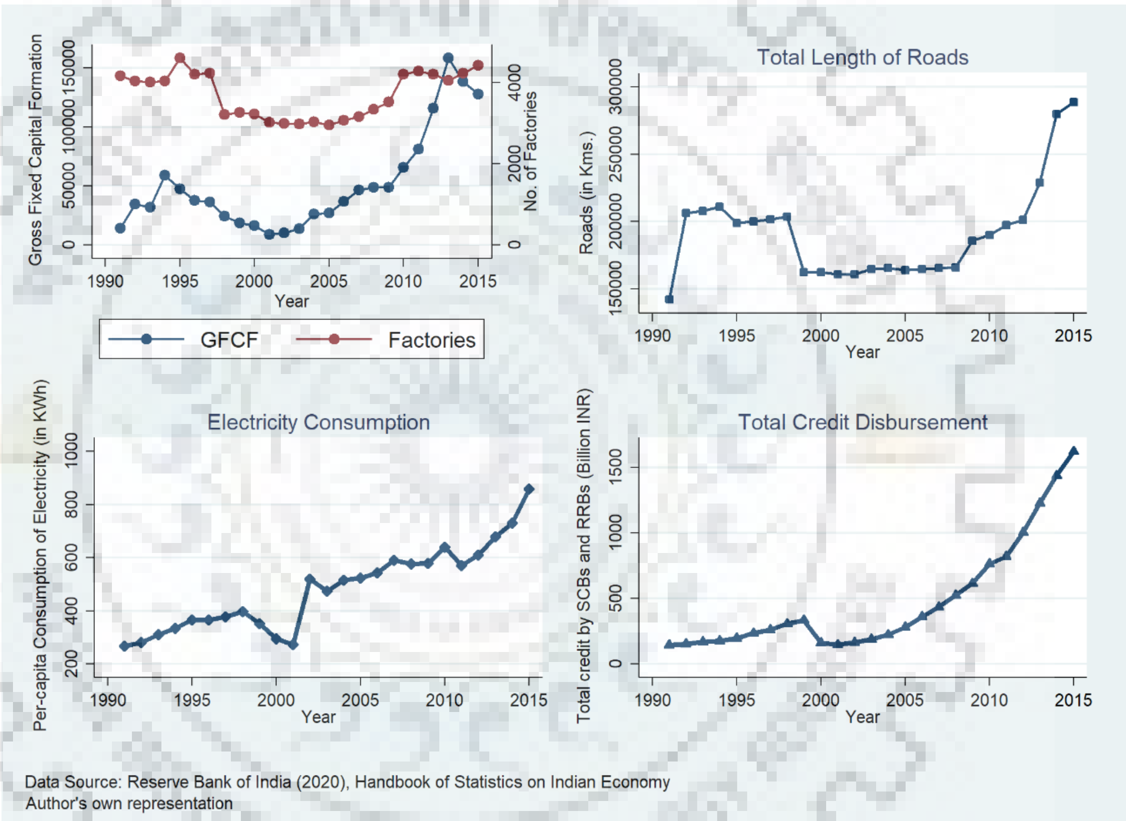
Figure 4.2 Share of Agriculture in the State GDP, Crop Intensity, Total Food Grains Production and Net Sown Area



The state is blessed with abundance of natural resources like minerals in several districts, contributing to the state's economic growth. For example, Bauxite in Balaghat, Guna and Jabalpur; Copper in Balaghat, Betul and Jabalpur; Coal in Betul, Shahdol and Sidhi; and diamond in Panna district. Diamond is solely produced by Madhya Pradesh among other Indian states. Textile industry is also contributing significantly in the growth of the state. The water resources in the state are also rich. There are 10 rivers which originates from the state such as Chambal (Indore), Betwa (Hoshangabad), Ken (Jabalpur), Tapti (Betul), and Mahi (Dhar), and most of them are interstate rivers. Narmada is the longest river in the state.

The per capita income (at constant prices) of the state significantly increased to INR[14] 41287 in 2012-13 and INR 47646 in 2015-16, from INR 15927 in 2005-06. Despite such rise, it was much lesser than the national average of INR 65538 in 2004-05 and 77826 in 2015-16. The state also witnessed a decline in average size of farm holding from 2.3 (1995-96), 2.02 (2005-06), 1.78 (2010-11) to 1.57 hectare (2015-16). (Directorate of Economics and Statistics, Madhya Pradesh, 2018).

Figure 4.3 Gross Fixed Capital Formation, Factories, Road Length, Electricity Consumption and Total credit by Regional rural banks and Scheduled Commercial Banks



The literacy rate increased significantly to 69.3 percent (2011) from 45 percent (1991) and 64 percent (2001) (Directorate of Economics and Statistics, Madhya Pradesh, 2018). The rural literacy rate in the state improved from 35.4 percent (1991) to 63.9 (2011), but it was still lower than the national average of 44.7 (1991) and 74 (2011) (Census 2011). Indore, Bhopal, Jabalpur and Gwalior, the four most literate districts in the state are the main drivers of state economic growth. The least literate districts were Jhabua (43.3) and Alirazpur (36.1). Madhya Pradesh fares lower in UNDP's Human Development Index

[14] INR denotes the Indian Rupee.

(0.585) than the country average (0.627) (Subnational Human Development Index, UNDP). The Gross Fixed Capital Formation in the state depicts that from 1991 to 2001 there was a declining trend, whereas from 2002 onwards the state has seen an upward trend (Figure 4.3). In addition, number of factories, an important indicator of the secondary sector activity has been almost at the same level in 2015 as it was in the year 1991.The Road infrastructure during 1999 to 2008 witnessed no growth. However, during 2011 to 2015 an impressive growth was registered in the state as shown in Figure 4.3.

The State significantly progressed in terms of power infrastructure, an important factor for the growth of an economy. Hydroelectric and thermal power plants are in the state; however, the dependency is more on thermal power. Figure 4.3 depicts that the per capita electricity consumption from 2001 saw a significant rise. Figure 4.3 also presents the total credit disbursed by Regional rural banks and Scheduled commercial banks. The credit to deposit ratio in scheduled commercial banks are highest for Shajapur (145.27) and lowest in case of Singrouli district (12.91) as per the record of the Directorate of Economics and Statistics, Bhopal.

There were 19454 (Micro), 435 (Small) and 14 (Medium) scale industries as the data base of Ministry of Micro Small and Medium Enterprises (MSME), Government of India. The key MSME sectors contributing towards state growth are food processing, pharmaceutical, paper, plastic and engineering. For the period 2005 to 2012, among all the districts, the urban population was highest in Indore followed by Jabalpur, whereas Dhindori and Sidhi districts have mostly the rural population. According to the Madhya Pradesh SDG Report 2014-15, Indore, Bhopal, Jabalpur, Gwalior and Hoshangabad districts were at the top in Human Development Index, whereas Dhindori, Sidhi, Singrauli, Panna and Umaria were at the bottom. The state has the following Public Sector Enterprises: Bharat Heavy Electricals Ltd, Bhopal; National Fertilizer Limited, Guna; GAIL India Ltd, Guna; Manganese Ore India Ltd; National Thermal Power Corporation (NTPC), Singrouli and Northern Coal Fields Ltd. Singrouli, Sidhi. Pharmaceutical, Auto, logistics and warehousing are some other important industries in the state.

Indian Institute of Technology and Indian Institute of Management at Indore, IITM at Gwalior and Indian Institute of Forest Management at Bhopal are the leading educational institutes of the state as well as India. Information Technology and Banking are the important service sectors contributing to the growth of the state economy. With abundant public, private, regional, rural and districts cooperative banks, the state observed a steady growth in credit since 2001. The state also provides tourism services owing to wildlife and religious places. Sanchi (Vidisha) and Khajurao (Chattarpur) are mostly visited by external tourists. Mahakaleshwar (Ujjain), Omkareshwar (Khandwa), Bhedaghat (Jabalpur), Bhimbhetika and Bhojpur (Bhopal), Panchmari (Hoshangabad), Kanha National Park (Mandla) are important travel destinations.

With a brief description of the economy of the state, Table 4.4 summarizes the important agricultural and economic indicators of the state as on 2015-16. However, the data show that intra-district variability for different products and services offering are high in the state. The intra-district variability are discussed in detail in the chapter 4.3 titled as 'Drought, Financial relief and Economy: *Relationship at the district level*'.

Table 4.4 Madhya Pradesh Agricultural and Economic Indicators as on 2015-16

S. No.	Agricultural and Economic Indicators (2015-16)	Value	S. No.	Agricultural and Economic Indicators (2015-16)	Value
1	Per capita Income (INR)	46324	12	No of allopathic medical institutions/Lakh	14.50
2	Crop Intensity	157	13	No of allopathic medical institutions	10528
3	Crop Area Sown (hectare)	24047000	14	No of beds in medical institutions	43969
4	Net irrigated area to net sown area (%)	60.62	15	No of beds in medical institutions/lakh population	60.54
5	Per capita food grain production (Kg)	461.24	16	Per cultivators loan sanctioned by agricultural credit societies	13803
6	Average yield of Soyabean (Kg)	753	17	Cooperatives banks/lakh	1
7	Average yield of Wheat (Kg)	3115	18	Per capita deposits/Cooperative banks	1871
8	Average yield of Gram (Kg)	1115	19	Scheduled commercial banks/lakh	8
9	Average yield of Rice (Kg)	2628	20	Per capita deposit in Scheduled commercial banks	39505
10	Average yield of Sugar cane (Kg)	51272	21	Per capita credit/Scheduled commercial banks	23856
11	Credit to Deposit Ratio of Scheduled commercial banks (%)	59.91	22	Number of hand pumps /thousand	0.13

Source: Reserve Bank of India and Directorate of Economics and Statistics, Madhya Pradesh (2015-16)

4.1.3 Natural Disasters in Madhya Pradesh

The state of Madhya Pradesh is vulnerable to many natural hazards like drought, floods, earthquake and hailstorm etc. These disasters often reoccur and cause immense economic and human losses. Given that the state is under-developed, poverty is at high level, literacy rate is less and most of the population is engaged in the agricultural sector for livelihoods, vulnerability further increases. This section briefly discusses some natural disaster events recorded in the state and districts, the reasons for such events, vulnerability and risk aspects of state population, their impact on assets and humans, and the future projections for occurrence of such disasters.

Floods

Around 80 percent annual rainfall is observed during the 3 months of monsoon season in the state. In lack of effective discharge of flood waters, Madhya Pradesh is prone to flash floods in rainy seasons. The state witnessed severe floods in the year of 1982, 1983, 1984, 1986, 1992, 1994, 1996, 1997, 2003, 2005 and 2012 (State Disaster Management Plan Madhya Pradesh, 2012). All the 51 districts are categorized into 3 categories (Low, Medium and High) of flood hazard risks. The High flood hazard districts observed more than 8 flood events in last three decades. Moderate flood hazard districts faced floods 6 to 8 times, whereas Low level flood hazard districts faced less than 5 events during the period. Table 4.5 below shows the districts falling in 'High' and 'Moderate' flood risks categories.

Table 4.5 List of High and Moderate Flood Hazards Districts

S. No.	District	Risk Category	S. No.	District	Risk Category
1	Neemuch	High	19	Katni	High
2	Mandsaur	High	20	Ratlam	Moderate
3	Jhabua	High	21	Shajapur	Moderate
4	Dhar	High	22	Rajgarh	Moderate
5	Damoh	High	23	Indore	Moderate
6	Khargone	High	24	Betul	Moderate
7	Burhanpur	High	25	Vidisha	Moderate
8	Khandwa	High	26	Raisen	Moderate
9	Harda	High	27	Sagar	Moderate
10	Barwani	High	28	Ashoknagar	Moderate
11	Guna	High	29	Shivpuri	Moderate
12	Hoshangabad	High	30	Sheopur	Moderate
13	Narsingpur	High	31	Gwalior	Moderate
14	Chhindwara	High	32	Morena	Moderate
15	Balaghat	High	33	Chattarpur	Moderate
16	Jabalpur	High	34	Satna	Moderate
17	Damoh	High	35	Rewa	Moderate
18	Mandla	High	36	Dhindori	Moderate

Source: State Disaster Management Plan Madhya Pradesh (2012)

Table 4.6 highlights the flood events, human and cattle losses and economic damages since 1993.

Table 4.6 Flood Events and Losses in Madhya Pradesh (1993 to 2013)

Year	Area affected (m.ha)	Population affected (million)	Crops damage area (m.ha)	Crops damage value (crores)	No. of Houses damage	Houses damage value (crores)	No. of Cattle loss	No. of Human lives lost	Damage to public utilities (crores)	Total damages (crores)
1993	0	0	0	0	4265	0	58	32	0	0
1994	0.377	3.322	0.377	31.55	244700	0	6674	288	0	31.55
1995	0	0	0	0	0	0	0	58	0	0
1996	0.014	0	0.014	0	7075	0	344	48	0	0
1997	0.022	0.456	0.022	0	47963	0	1263	14	0	0
1998	0.115	1.649	0.115	19.677	20738	4.741	516	81	0.438	24.856
1999	0.062	0.436	0.062	10.608	29168	8.75	654	27	0	19.358
2000	0	0.03	0	0	6034	0.05	226	48	0	0.05
2001	0	0	0	0	999	0.02	308	29	0	0.02
2002	0.002	0.143	0.002	1.987	5904	1.12	27	10	0	3.107
2003	0.126	1.436	0.126	22.717	31536	7.367	214	18	51.6	81.684
2005	0	2.5	0.011	5.98	231714	173.88	45293	95	232.01	411.87
2008	0	0	0	0	10039	0	1138	16	0	0
2010	0	0	0	0	143	0	5	38	0	0
2011	0	0	0	0	15431	0	203	82	2.449	0
2013	0.093	0	0	0	22816	0	1166	390	0	0

Source: Central Water Commission, Ministry of Jal Shakti, Department of Water Resources, River Development & Ganga Rejuvenation

Table 4.7 List of Districts for Earthquake Zone III (Moderate) Risk Category

S. No.	District	Risk Category	S. No.	District	Risk Category
1	Sagar	Zone III (Moderate)	15	Jabalpur	Zone III (Moderate)
2	Damoh	Zone III (Moderate)	16	Narsinghpur	Zone III (Moderate)
3	Umaria	Zone III (Moderate)	17	Dhindori	Zone III (Moderate)
4	Dewas	Zone III (Moderate)	18	Mandla	Zone III (Moderate)
5	Dhar	Zone III (Moderate)	19	Chhindwara	Zone III (Moderate)
6	Indore	Zone III (Moderate)	20	Seoni	Zone III (Moderate)
7	Khargone	Zone III (Moderate)	21	Shahdol	Zone III (Moderate)
8	Barwani	Zone III (Moderate)	22	Anuppur	Zone III (Moderate)
9	Sehore	Zone III (Moderate)	23	Sidhi	Zone III (Moderate)
10	Raisen	Zone III (Moderate)	24	Singrouli	Zone III (Moderate)
11	Betul	Zone III (Moderate)	25	Jhabua	Zone III (Moderate)
12	Harda	Zone III (Moderate)	26	Alirajpur	Zone III (Moderate)
13	Hoshangabad	Zone III (Moderate)	27	Khandwa	Zone III (Moderate)
14	Katni	Zone III (Moderate)	28	Burhanpur	Zone III (Moderate)

Source: State Disaster Management Plan (2012) Madhya Pradesh

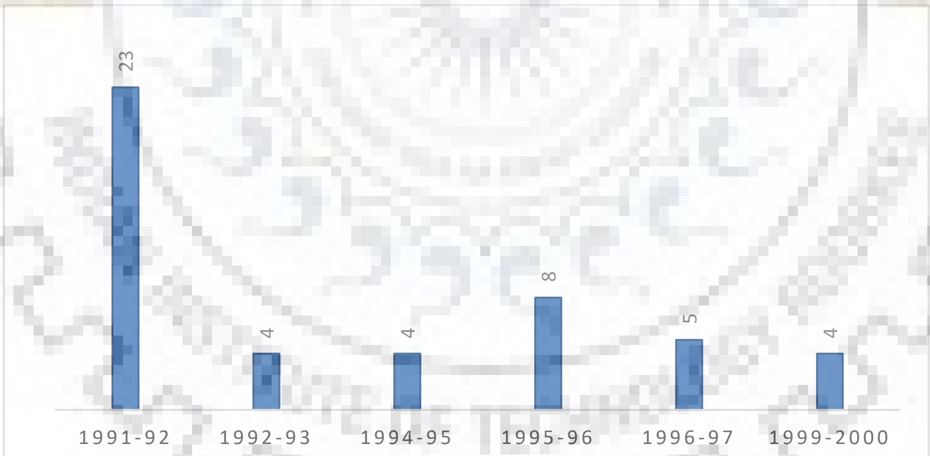
Earthquakes

According to the Madhya Pradesh State Disaster Management Plan (2012), there are 28 districts in the state that come under Zone – III (Moderate risk) and 22 districts features under Zone – II (Low damage risk) of Earthquake. The below table (4.7) highlights the districts featuring in 'Moderate risk' category. The state witnessed a few earthquake events in the past. Most devastating earthquake came in Jabalpur district in 1997. It caused 43 deaths, injured 1500 and affected 125000. Almost 30000 were left homeless. The earthquake caused estimated total damage of US$ 37000 (EMDAT, 2019). Later a light earthquake was also felt in Jabalpur and the connecting parts of eastern Madhya Pradesh in 2000, causing minor damages. No other medium or large scale earthquake events were observed in the state.

Droughts

Many districts in the state have been facing droughts almost every year from the last three decades. Figure 4.4 and 4.5 show the number of drought affected districts for 1991-92 to 1999-2000, and drought affected districts as well as tehsils for 2000-01 to 2015-16 respectively. Figure 4.5 clearly depicts that the frequency and number of drought events have significantly increased since 2000-01.

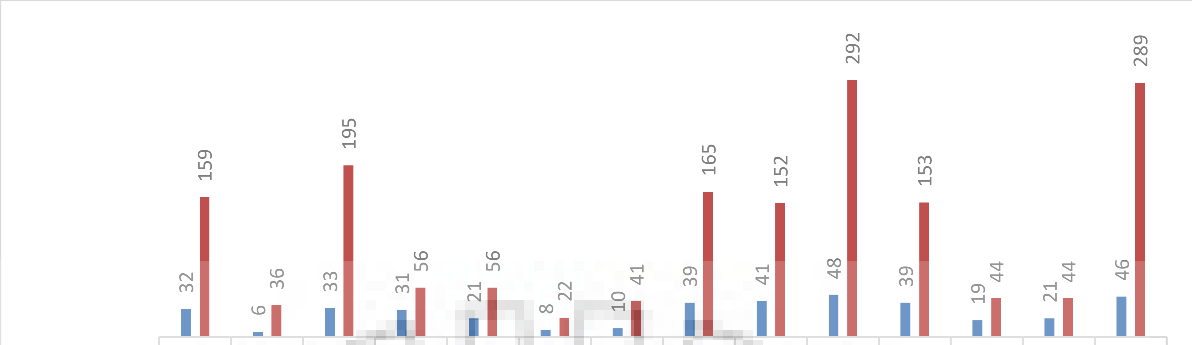
Figure 4.4 Drought affected districts (1991-2000)[15]



Source: Department of Land Uses, Madhya Pradesh.
Accessible at: https://dolr.gov.in/sites/default/files/Madhya%20Pradesh_SPSP.pdf

[15] The districts reported are only those which are the part of Madhya Pradesh post bifurcation. No district of Chhattisgarh is reported.

Figure 4.5 Drought affected districts and tehsils (2000-01 to 2015-16)



	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2015-16
Districts	32	6	33	31	21	8	10	39	41	48	39	19	21	46
Tehsils	159	36	195	56	56	22	41	165	152	292	153	44	44	289

Source: Disaster Management Note, Revenue Department, Govt. of Madhya Pradesh; Table on the history of droughts, floods frost and cold waves in MP; Accessible at: www.finance.mp.gov.in/ffc/TopicNotes16.doc

The drought events have affected districts in the state at different time period (Table 4.8) Notably, the six districts falling in Bundelkhand region of the state (Chhatarpur, Damoh, Datia, Panna, Sagar and Tikamgarh) have been facing regular droughts due to irregular and less rainfall than average. The groundwater level in the region is also depleting fast and has dropped to even 400 feet in many villages (Niazi 2008, MP SPSP). Soyabean is the main crop of the region, which requires a lot of water to grow. Frequent droughts had adversely affected the agriculture growth of the region, and therefore induced the distress migration (Suthar 2010; Anuja et al., 2018) for many years.

4.2 Droughts in Madhya Pradesh: *Monitoring, declaration and financial relief*

4.2.1 Introduction

Drought is of multiple types with different definitions (Wilhite and Glantz 1985). Various states in India follow different drought definitions. As a result, the drought management policy and approaches also vary significantly at the sub-national level. For example, the system of estimating agriculture drought significantly varies among states. A strong institutional setup to study the various facets of rainfall and other related indicators (soil moisture, crop sown and crop loss data etc.) is necessarily required in each state. Further, the post-drought financial relief largely depends on how droughts are monitored and declared. It is observed that drought declaration, codes, manuals and practices vary significantly among Indian states. Therefore, the present study examines the drought phenomenon (concept), its management (monitoring and declaration) and the post-drought relief policy framework in India and Madhya Pradesh. It also compares the new (2016) drought management guidelines with the previous (2009) policy guidelines to assess its efficacy and usefulness in reducing drought-induced losses.

Table 4.8 Drought affected districts in Madhya Pradesh (2000-2015)

Year	No. of Districts	Name of Districts
1991	23	Rewa, Sidhi, Satna, Shahdol, Jabalpur, Balaghat, Chhindwara, Mandla, Seoni, Rajgarh, Betul, Drought Dhar, Jhabua, Khandwa, Sagar, Damoh, Panna, Tikamgarh, Chhatarpur, Gwalior, Guna, Data, Ratlam
1992	4	Mandla, Khandwa, Chhindwara, Balaghat
1994	4	Rajgarh, Tikamgarh, Balaghat, Khandwa
1995	8	Panna, Tikamgarh, Chhatarpur, Rajgarh, Ratlam, Khandwa, Jhabua, Chhindwara
1996	3	Balaghat, Jabalpur, Seoni
1997	35	Indore, Khargone, Khandwa, Ujjain, Dewas, Shajapur, Mandsaur, Ratlam, Gwalior, Shivpuri, Excessive Guna, Bhind, Rewa, Shahdol, Satna, Sagar, Damoh, Panna, Chhatarpur, Tikamarh, Bhopal, Rains &Hail Betul, Raisen, Rajgarh, Sehore, Vidisha, Hoshangabad, Jabalpur, Balaghat, Chhindwara, Seoni, Storms Mandla, Narsinghpur
1998	23	Vidisha, Dhar, Neemuch, Ujjain, Bhopal, Ratlam, Betul, Shajapur, Sagar, Guna, Chhindwara, Hail Storms Damoh, Dindori, Dewas, Khandwa, Khargone, Indore, Mandsaur, Gwalior, Sehore, Mandla, Jabalpur, Rajgarh
1999	4	Dhar, Jhabua, Khargone, Badwani
2000	30	Balaghat, Barwani, Betul, Bhind, Chhatarpur, Chindwara, Damoh, Dhar, Dhindori, Indore, Jabalpur, Jhabua, Katni, Mandla, Mandsaur, Morena, Narsinghpur, Neemuch, Panna, Rajgarh, Ratlam, Satna, Seoni, Shahdol, Shajapur, Sheopur, Sidhi, Tikamgarh, Ujjain, Umaria
2001	06	Ujjain, Shajapur, Ratlam, Rajgarh, Seoni, Chhindwara
2002	33	Ratlam, Rajgarh, Panna, Seoni, Ujjain, Morena, Gwalior, Balaghat, Neemuch, Katni, Shivpuri, Drought Guna, Datia, Bhind, Mandsaur, Chhindwara, Mandla, Jabalpur, Damoh, Chhatarpur, Tikamgarh, Shahdol, Shajapur, Barwani, Sheopur, Satna, Sidhi, Dindori, Raisen, Sagar, Rewa, Umaria and Vidisha
2004	26	Sheopur, Datia, Tikamgarh, Balaghat, Panna, Chhatarpur, Rewa, Shahdol, Sidhi, Chhindwara, Harda, Hoshangabad, Seoni, Betul, Dewas, Ratlam, Umaria, Sehore, Ujjain, Anuppur, Bhind, Khandwa, Gwalior, Morena, Satna, Shivpuri
2006	10	Tikamgarh, Ratlam, Chhindwara, Datia, Chhatarpur, Gwalior, Katni, Rewa, Satna, Shivpuri
2007	38	Anuppur, Ashoknagar, Balaghat, Barwani, Betul, Bhind, Burhanpur, Chhatarpur, Chindwara, Damoh, Datia, Dewas, Dhar, Dhindori, Guna, Gwalior, Hoshangabad, Jabalpur, Katni, Mandla, Mandsaur, Morena, Narsinghpur, Neemuch, Panna, Raisen, Rewa, Sagar, Satna, Sehore, Shahdol, Shajapur, Sheopur, Shivpuri, Sidhi, Tikamgarh, Umaria, Vidisha
2009	37	Alirajpur, Anuppur, Ashoknagar, Balaghat, Barwani, Bhind, Burhanpur, Chatarpur, Damoh, Datia, Dewas, Dhindori, Guna, Gwalior, Jabalpur, Jhabua, Katni, Mandla, Morena, Narsingpur, Panna, Raisen, Rajgarh, Ratlam, Rewa, Sagar, Satna, Sehore, Shahdol, Shajapur, Sheopur, Shivpuri, Sidhi, Singrauli, Tikamgarh, Umaria, Vidisha
2015	43	Agarmalwa, Anuppur, Ashoknagar, Barwani, Betul, Bhind, Burhanpur, Bhopal, Chhatarpur, Chindwara, Damoh, Dewas, Dhar, Dhindori, Guna, Harda, Hoshangabad, Indore, Jabalpur, Jhabua, Katni, Mandsaur, Morena, Narsingpur, Neemuch, Panna, Raisen, Rajgarh, Ratlam, Rewa, Sagar, Satna, Sehore, Seoni, Shahdol, Shajapur, Shivpuri, Sidhi, Singrauli, Tikamgarh, Ujjain, Umaria, Vidisha

Author’s own compilation from various sources

The rest of the chapter unfolds as follows. Section 4.2.2 briefly discusses the mechanism of drought monitoring in India and the state of Madhya Pradesh. Section 4.2.3 explains the process followed by various Indian states to declare drought. Section 4.2.4 elaborates on the drought relief mechanism of the country and the state. The chapter concludes with the section 4.2.5.

4.2.2 Drought Monitoring

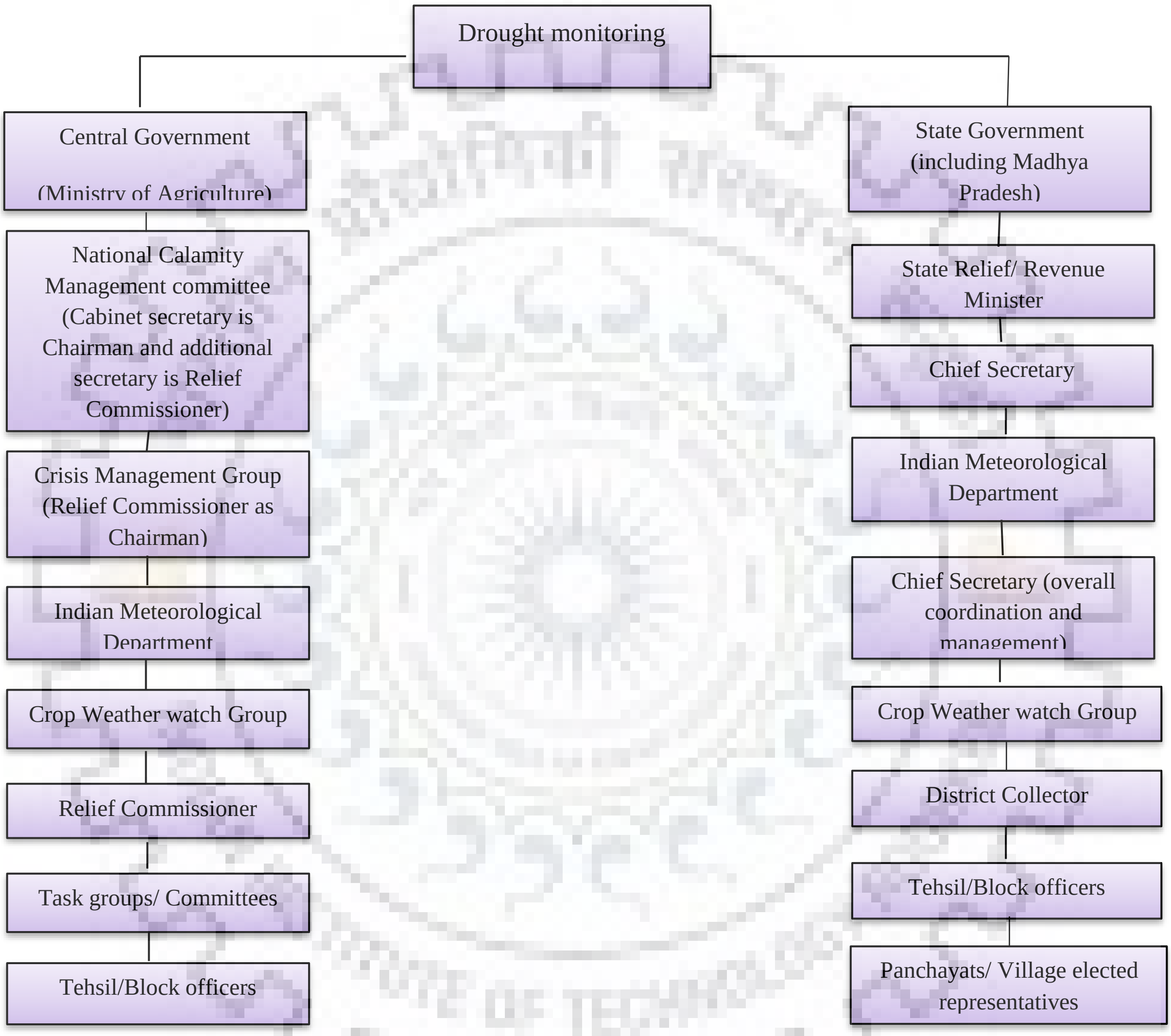
India has developed an institutional mechanism for drought monitoring, early warning, forecasting and impact analysis. Figure 4.6 depicts the flow of drought monitoring at the central and state government level. Crop Weather Watch Group (CWWG) is the apex body at central and state level to monitor drought. It is the Inter-Ministerial mechanism since 1979 within the Federal Ministry of Agriculture.

CWWG is responsible for interacting and evaluating the collected data from various institutions to analyse its impact on agriculture. It closely monitors the agricultural development. CWWG also develops the holistic drought management plan, which includes early warning of drought, forecasting mechanism, immediate response system as well as the long-term mitigation measures. The institutions at the central and state level have been assigned essential tasks to fulfil under the CWWG. Indian Meteorological Department (IMD) is the principal nodal agency, which provides short run and long run rainfall status and forecasts at state, district and block level. CWWG utilizes such inputs to develop a realistic plan and actionable for drought management and declaration. The members of CWWG generally meet once every week during the rainy season and may increase the meeting frequency during the drought-like situations. The findings and interaction between the CWWG at central and state-level trigger the response mechanism for drought declaration and subsequent relief. Along with IMD, the list of all such institutions providing inputs to the CWWG, their specific responsibilities and the indices they monitored is briefly presented in Table 4.9.

4.2.3 Process of Drought Declaration

Disaster Management Act (2005) specifies that drought management and declaration is the state function. The role of the central government is to provide financial and technical aid on request of the states if they lack the sufficient resources. The manual for drought management (2009) specifies that each state is allowed to declare drought for the entire state, selected districts or some parts of the district. States may follow their own rules and systems for drought notification following the relief manual. It is noticed that few states like Chhattisgarh, solely rely on the rainfall deficiency to declare a (meteorological) drought. For this, the actual rainfall data are recorded at district or tehsil/village level.

Figure 4.6 Drought monitoring and management at the state and central level in India



Source: Adapted from working paper by Samra (2004)

Drought monitoring is followed by the declaration which commences the desirable actions from the state authorities. The following section explains the process and current practices in various states with a focus on Madhya Pradesh for drought declaration.

Table 4.9 Institutions, tasks and Indices to be monitored under CWWG

Institutions	Tasks	Indices to be monitored
Additional Secretary, Department of Agriculture, Cooperation & Farmers Welfare & Central Drought Relief Commissioner	Chairperson of the Group: overall coordination	Overall Indices assessment
Economics & Statistical Advisor, DAC&FW	Report behaviour of agro-climatic and market indicators	Soil moisture, area under sowing and type of crop, crop water requirement, status of growth, crop yield, alternative cropping possibilities, land holdings
Agriculture Commissioner	Crop conditions: Availability of Inputs; Contingency Planning	Supply and demand of agricultural input
Animal Husbandry Commissioner	Livestock health; Fodder availability	Availability and prices of food grains, availability of fodder, migration of population
India Meteorological Department	Rainfall forecast and monsoon conditions	Daily, weekly, and monthly rainfall, snow fall / fog
Central Water Commission & Central Ground Water Board	Monitoring data on Important reservoirs / groundwater	Water storage in reservoirs / ponds / lakes, river flow, groundwater level, yield and draft from aquifers, water loss through evaporation, leakage, seepage
Ministry of Power	Availability of power	Statistics related to power availability and supply
Indian Council of Agricultural Research (Crop Specific Research Institutes, Central Research Institute for Dryland Agriculture, Central Arid Zone Research Institute, Indian Agricultural Research Institute etc.)	Technical input and contingency planning	Soil moisture, area under sowing and type of crop, crop water requirement, status of growth, crop yield, alternative cropping possibilities, land holdings
National Centre for Medium Range Weather Forecasting	Provide medium-term forecasts	Daily, weekly, and monthly rainfall, snow fall / fog
Remote Sensing Centres	Provide satellite based inputs	Vegetation monitoring, rainfall, surface wetness and temperature
Mahalanobis National Crop Forecast Centre	Agricultural Drought Information	long-term satellite data on multiple vegetation indices, Rainfall Deficiency (or SPI), Soil Moisture Index, irrigation statistics
Indian Space Research Organization	Technical inputs on drought parameters	Vegetation monitoring, rainfall, surface wetness and temperature

Source: Manual for drought Management (2016)

There is a considerable variation noticed in the capabilities of the different states to observe the rainfall. For example, Karnataka, an Indian state has drought monitoring centres to assess the daily rainfall and the ground-water level. Other states lack such institutional setup and primarily depend upon the external agencies. States other than Chhattisgarh, in addition to rainfall deficiency, also consider the crop losses while declaring the (agricultural) drought. For crop loss estimation, they follow the traditional annawari, paisewari or girdawari system. Actual yield is estimated against the standard sown area yield, by performing the crop cutting experiment in December and March every year for Kharif and Rabi crops respectively. These estimation techniques are highly subjective due to different benchmarks and methods employed for loss assessment.

The state follows annawari system of crop loss approximation[16]. According to the manual of the state[17] 6 crop cutting experiments (2 experiments each for good, average and less crop fields) at village levels are performed for all the major Kharif and Rabi crops. Then, the average of all the 6 experiments are considered, as productivity of the crop. After this, considering the base of 83 paise the crop yield is estimated against the standard yield for the district. The designated officers inspect at least 10 percent of the villages to validate the average crop yield and the estimation process before preparing and submitting the report to the districts officials, who in turn report to the state government. Now, the state government may declare the drought if one or more following conditions are met.

1. If in a block, the average rainfall is 25% less than the average recorded rainfall as on 30th September.
2. If in a block, 25% or more villages observed annawari between 0-50 paise, the entire block may be declared drought affected.
3. If in a block, less than 25% but at least 10 inter-connected villages (which are geographically connected to each other) observed annawari between 0-50 paise, then these villages group may be declared as drought affected.
4. If in a block, 25% or more villages observed 30% less rabi crop sown than the average, entire block may be declared as drought affected.
5. If in a block, less than 25% but at least 10 inter-connected villages (which are geographically connected to each other) observed 30% less rabi crop sown than the average, these villages group may be declared drought affected.

[16] Gujarat also follows the annawari system, but the base is 12 annas[16]. Between 0 to 4 annas the drought is declared and if the crop yield is in between 4 to 6, the state government has a right to declare or not to declare the drought in the state (Samra, 2004). Maharashtra follows the paisawari system, where the base is 50 paisa (out of 100). If the average yield per acre remains less than 50 percent of the long-term standard yield, drought is notified. It is to note that in colonial time the rupee was divided into 16 annas, and each anna was having 4 paisa

[17] Refer the handbook of Permanent instructions for combating drought, drinking water crises or other problems, issued by relief branch of Revenue department of Madhya Pradesh (2007)

In the drought manual (2009), rainfall deficiency and crop losses are the two most important drought declaration criterions. In addition, the availability of water for drinking, irrigation, availability of food and fodder for animals at the local level were also considered for declaring the drought. The states (including Madhya Pradesh) were fully empowered to declare or not to declare the droughts following the criteria most suited to them, ignoring others. It indicates that the drought notification process was highly subjective and flexible. As the result, various states declared drought at different times in a year. For example, Karnataka notified the drought in August 2015, Maharashtra, Odisha, Madhya Pradesh, Chhattisgarh and Andhra Pradesh in October 2015, Jharkhand and Maharashtra in February 2016, and at last Gujarat declared the drought in April 2016 (Sen and Bera, 2016). Two states Haryana and Bihar were even unable to decide that drought was there or not for a long time. It caused more delay in drought notification and provisioning for relief for many states. In lack of uniformity in drought declaration parameters and the declaration timings, the subsequent relief works suffered drastically. The states with lesser resources and higher vulnerable population faced severe consequences. The delay in financial relief disbursements must have deferred the crop sown for the next season if the farmers lacked the resources. The drought management guidelines of 2009 were suggestive (not binding) in nature. Therefore, it gave a fair scope to states to declare the drought or not based on the socio-political motives. Given these lacunas, the Supreme Court of India recommended new directions in 2016. They urged the Indian Government to adopt a new system for drought declaration. As a result, the Union Ministry of Agriculture introduced the Manual for Drought Management (2016), which superseded the 2009 manual. The new manual prescribes standardized, more accurate, transparent and mandatory rules to declare droughts within a reasonable time frame as presented in Table 4.10.

First criteria (trigger 1) is the rainfall measured by the percentage deviation in rainfall from average or the Standardized Precipitation Index (SPI) along with the dry spells as depicted in Table 4.11

The inadequate rainfall leads to the impact (Trigger 2) on the availability of water for crops, soil and at ground level, reducing the crop sown area. Various scientific techniques such as remote sensing are employed to assess the impact on the crop situation, moisture of the soil and groundwater level. The essential indicators for measuring the impact are NDVI, the area under sowing, PASM and RSI. After weighing these indicators, states declare the drought. Thereafter, the Revenue Department of states send the comprehensive report of drought situation and demand financial relief from the agricultural ministry. If at the second stage, three selected indicators out of four exist, it represents “severe drought”. In case of two positive indicators among 3, “moderate drought” may be documented. At the last stage, field verification is employed to validate the states’ estimation of losses and relief demand by the team appointed by the central government. Additionally, a few more factors like the migration of people in search of a job, availability of essential food grains, drinking water availability for human and livestock, fodder availability, and wages for both agricultural and non-agricultural sector may be the supportive parameters for the drought declaration.

Table 4.10 Parameters for Drought Declaration

Levels	Category	Parameters
Trigger 1 (Cause)	Rainfall data	1. RF Deviation or SPI 2. Dry spell[18]
Trigger 2 (Impact)	1. Remote Sensing 2. Crop Situation 3. Soil Moisture 4. Hydrological	1. NDVI & NDWI Deviation or VCI 2. Area under sowing 3. PASM or MAI 4. RSI/GWDI/SFDI
Verification	Field Data	GT in 5 sites, each, of 10% of villagers

Source: Manual for drought Management (2016). SPI- Standardized Precipitation Index[19]; RF- Rainfall; NDVI- Normalized Difference Vegetation Index; VCI- Vegetation Condition Index; NDWI- Normalized Difference Wetness Index; PASM- Plant Available Soil Moisture; MAI- Moisture Adequacy Index; RSI- Reservoir Storage Index; GWDI- Ground Water Drought Index; SFDI- Stream Flow Drought Index; GT- Ground Truth.

Table 4.11 Trigger 1 (Causes)

Rainfall Dev/SPI	Dry spell	Drought trigger
Deficit or scanty rf/SPI<-1	Yes	Yes
Deficit or scanty rf/SPI<-1	No	Yes if rainfall is scanty or SP<-1.5, else N
Normal rf/SPI>-1	Yes	Yes
Normal rf/SPI>-1	No	No

Source: Manual for Drought Management (2016)

With the introduction of the new guidelines, the drought declaration process and parameters changed substantially (Sharma, 2019). The new manual urged to replace the traditional systems of crop loss estimation (annawari, paisawari, etc.) with the more

[18] A condition when the rainfall is less than 50 percent for 3-4 weeks regularly, after the due date of monsoon arrival in a geographic region

[19] SPI is an IMD approved widely used index to measure the rainfall deviation from its long term averages. It shows the probability of abnormal wetness or dryness (drought). -.99 to +.99 values are considered as Normal.

advanced techniques like remote sensing applying Geographic Information System (GIS). It may help to assess the drought loss quickly and on time. The new manual recommended that the Kharif drought should be declared by 30th October and the Rabi drought by 31st March in a drought year. Trigger 2 becomes the base to declare the drought severity, superseding the trigger 1 (rainfall deficiency) criteria. The purpose is to remove the subjectivity and to assess the crop losses scientifically. Now, the states have only moderate or severe drought categories. If a moderate drought occurs, the state government is responsible for managing it with the State Disaster Response Fund (SDRF) or employing own resources. The central government will not provide any financial assistance for moderate droughts, unlike earlier system, where even in case of mild or moderate droughts, the central government additionally funded the states. According to the Disaster Management Act (2005), the Finance Commission of India allocates the resources to all the states in their SDRF account for the disaster management including drought[20]. The state deploys such available funds for providing the post-disaster relief measures. In case of severe drought, the states may approach to the central government for additional funds. The post-drought relief policy is elaborated in the next section.

With the specified changes in the drought declaration criteria, the central government commitment to drought management becomes limited. They now only formulate the guidelines and systems for the early warning, monitoring and declaration, instead of directly intervening in the drought declaration and relief process. Even in the case of severe drought, the central government acts only on the state demand rather than at their own for the additional allocation of the funds. The new drought management process witnessed many improvements over the previous system. Nonetheless, the debate and criticisms are still around some of its aspects and their impact on the vulnerable population. For example, the drought declaration criteria are increased from 4 to 6, making the process lengthy and complicated. In trigger 2 (Impact), the soil moisture index confirms severe drought if the moisture of soil is 25 percent, else not. The critics and experts say that this standard criterion may not be applicable for all the crops and regions in India. According to them, different crops have different requirements of moisture for growth. It is not advisable to fix a stringent 25 percent criterion. In practice, even in the presence of 25 to

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[20] The SDRF was constituted on the recommendation of the Thirteenth Finance Commission, under the Disaster Management Act, 2005. The union government does budgetary allocation to the states in SDRF for five years in advance based on the vulnerability assessment of the states towards various disasters including droughts and a few other factors like previous allocation etc.

40 percent soil moisture, crop loss may be substantial, and the severe drought may exist. It may undoubtedly exclude many villages, tehsils or districts to be eligible for drought relief, even though the severe drought exists.

The new process is also heavily criticized for adding more than three weeks' dry spells criteria along with the rainfall deficiency (trigger 1). Earlier the condition was of less than three weeks' dry spells only. This stringent criterion in drought assessment is difficult to prove and therefore not liked by the states. Following the new criterion, a few deserving states may not claim the additional financial relief from the National Disaster Response Fund (NDRF) if they failed to fulfil the trigger 1 criteria in totality. There is also a debate and dissent of states with the criterion of less than 50 percent crop sown area to prove the drought. Farmers generally sow a substantial amount of land in anticipation of good monsoon. Therefore, many of them may be excluded from the drought-affected list of the central government. In addition, despite the standard guidelines, at administrative units (district, block and gram panchayat) drought declaration timings may still vary.

These variations may be attributed to the differences in the technological advancement or limitations, adaptive capacities, socio-economic and political factors among states. Also, the enhanced financial burden on the states for moderate droughts, may delay the drought declaration by some states or even leave the droughts unnoticed[21]. A lot of public reports verify such apprehensions. For example, Gujarat government declared the Kharif drought in more than 3000 villages of 51 taluka on 17 December 2018, way beyond the timelines of 30 October[22]. Whatever may be the actual reason, this delay would have delayed the relief works and financial disbursements affecting the sowing of Rabi crops on time. With this brief discussion on the drought declaration process, the next section describes and analyses the post-drought relief policy of India and Madhya Pradesh.

4.2.4 Drought Relief Mechanism

The objective of the drought relief policy is to provide financial assistance (post-drought) for livelihood and survival. Figure 4.7 shows the mechanism of drought relief declaration for all the states including Madhya Pradesh. The financial relief are generally provided after drought declaration for a short period. The relief manual specifies the heads where the assistance may be provided. For example, the state may utilize the drought relief finances

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[21] Refer https://www.newsclick.in/severe-droughts-go-unreported

[22] https://www.downtoearth.org.in/news/agriculture/gujarat-declares-drought-after-months-of-delay-62531

towards the crop losses, drinking water supply, fodder supply, and to provide food to malnourished individuals and their family members. It is important to highlight that the post-disaster relief policy ensures that the funds are not diverted towards long-term mitigation measures. The prevention and mitigation measures are entrusted with the various states as well as the central government departments through budgetary allocation. The supreme court of India in 2016 directed the central government to form a separate disaster mitigation fund as required under section 47 of Disaster Management Act, 2005. This fund will only be utilized towards developing long-term projects for drought mitigation. The institutional mechanism for relief operations are also the outcome of the Disaster Management Act, 2005. The Act provides the legal framework for the disaster management activities and the relief measures for all the disasters, including the drought.

The Act constitutes three layers of administration and an institutional mechanism to support all the disaster-related activities. National Disaster Management Authority (NDMA), State Disaster Management Authority (SDMA) and District Disaster Management Authority (DDMA) are the bodies at central, state and district level respectively. The NDMA prepares the national plan and guidelines for drought management, including relief. SDMA at the state level and the DDMA at district level follow these guidelines. The relief operations are executed at district and sub-district levels under the DDMA authorities. The District Collector or the District Magistrate are generally the head of the DDMA, which report to the state authorities. The primary responsibility of the DDMA is to prepare, implement and review the district response plan, and to ensure that the financial relief is disbursed to the affected communities and individuals promptly.

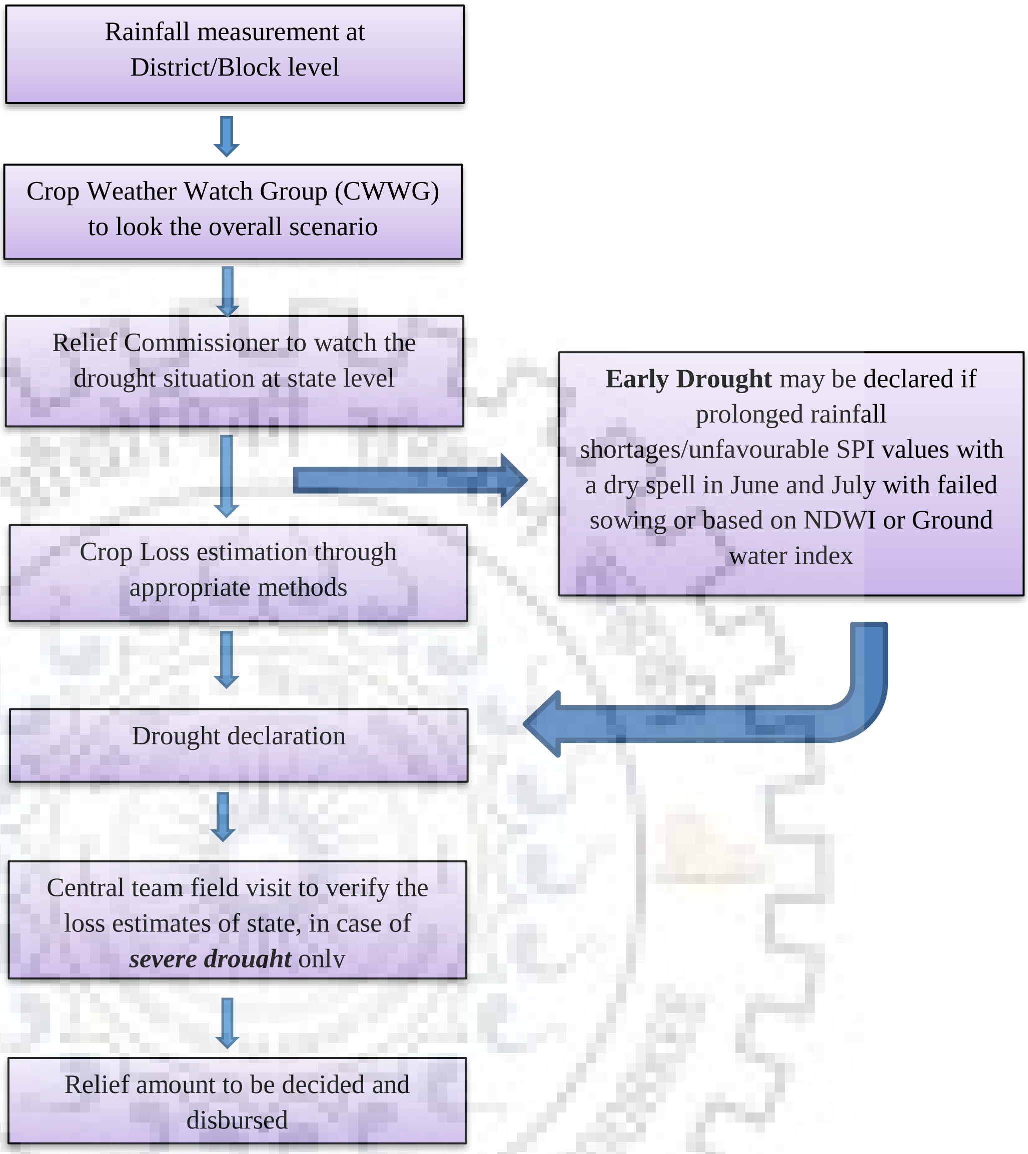
The Finance Commission of India, under Article 280 of the constitution allocates the relief fund to states for five years towards natural disasters relief, including drought. The allocation is directed twice a year from central government to the state governments in the State Disaster Response Fund (SDRF). The central government contributes 75 percent, and the remaining 25 percent is the state contribution. From April 2018, the central contribution has increased to 90 percent. The Manual for Drought management (2016) has specified the rules and the limits of expenditure under different heads of relief. The allocation to the states are mandatorily made every year irrespective of occurrence of natural disasters. The states as per set norms utilize the available funds to provide immediate relief as and when the necessity arises. In 2015, the central government reduced the limit of 50 percent crop loss to 33 percent for seeking additional relief assistance from the central government (NDRF).

The states may even demand the additional financial assistance towards arranging and supplying the drinking water, or the fodder supply etc. After receiving the memorandum of assistance from the state and conducting the due diligence through field visit, the central government releases the appropriate funds. It is noticed that often the financial disbursements from NDRF may be lower than what has been demanded by the states[23]. It is also observed that the financial allocation in SDRF may not be in line with the vulnerability profile of the state from natural disasters. According to Kamepalli (2019), 14th Finance Commission allocated higher SDRF funds (INR 2154 crore) to Punjab (an Indian State) than Karnataka INR 1527 crore), though the vulnerability from all natural disasters (especially drought) was significantly lower of Punjab than the Karnataka.

There are defined timelines to be followed by both states and central governments for seeking financial relief. Within a week of drought declaration, states to demand the additional relief assistance and then in a week time, the central government will decide whether to consider the request or not. In case of the centre’s nod, a committee will visit the drought-affected areas, and will submit the report verifying the extent of claimed losses. Based on the report and recommendation of the committee, central government will decide the quantum of relief to be released to the SDRF. Then the states will issue the appropriate funds to the district authorities under District Disaster Response Fund (DDRF). All the relief related activities are performed under the supervision of the district collector, and a complete record of all the disbursements and beneficiaries are maintained. The necessary inputs about the crop losses at the district level are provided by the National Agricultural Drought Assessment and Monitoring System (NADAMS). Currently, it covers more than half of the Indian states, which are drought-prone and are agriculture-based economy (Mishra and Tayal, 2018). The revenue department of the states generally own the responsibility for relief operations.

[23] Karnataka, Maharashtra and Andhra Pradesh requested the assistance of 2434, 7903 and 1467 ₹Crore for drought relief but received only 950, 4714 and 900 ₹Crore respectively in 2018-19. (Based on the Lok Sabha Question no. 398 on 5th February 2019 as published in https://www.livemint.com/industry/agriculture/caught-up-in-polls-a-drought-forgotten-1555260988957.html

Figure 4.7 Drought and Relief declaration process at the state level in India



Source: Authors own creation

4.3 Drought, Financial relief and Economy: *Relationship at the District level*[24]

4.3.1 Introduction

In India, it is estimated that more than 50 percent crops are dependent on rainfall (the South-West Monsoon) and therefore rainfall deficiency along with limited irrigation

[24] A slightly different version of the analysis presented in this chapter is published as Sharma and Sen (2021)

infrastructure[25] make the agriculture sector highly vulnerable[26]. Inadequate rainfall during the monsoon season results in crop failures in may Indian states, especially where rain-fed agriculture dominates. Madhya Pradesh (MP), a state in central India, is highly vulnerable to droughts among other natural calamities[27] as rain-fed agriculture (72 percent rain-fed area) dominates. It is higher than the country average (49 percent), and the net irrigated area (38.8 percent) is significantly lower than the country average reported for the year 2012-13[28]. Therefore, the agriculture sector growth is affected by droughts and thereby adversely impact the local economy. However, the impacts may vary across districts in the state. With more than 74 percent population engaged in the agriculture sector, poor agricultural performance will affect the other sectors in the local economy, if linkages among sectors are sufficiently high in the state (Pelling et al. 2002).

The frequency of *severe*, *extreme* and *exceptional* droughts has increased significantly in the recent past (Mishra et al. 2016). In response to such drought events, the state government disburses the financial relief to partially compensate the losses incurred mostly by the farmers' and for procuring other necessary provisions, as disaster management is essentially the responsibility of the state governments. The drought relief is likely to impact the state economy as funds are diverted from other sectors of the economy. It is therefore of interest to examine the consequences of drought and relief finances at the aggregate level and on specific economic sectors. This chapter empirically analyses the impact considering a sample of 45 districts of MP over the period 2005 to 2012. System Generalized Method of Movements (GMM) approach is employed to examine the statistical relationship between droughts, drought related relief finances, sectoral growth and overall economic growth. In line with a priori expectation, results show that droughts adversely impact the agricultural sector and the aggregate economic growth rate whereas the financial relief following drought impact the aggregate economic growth as well the industrial sector growth.

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[25] Economic Survey 2017-18 report that the net irrigated area to total cropped area is below 34.5 percent (Volume II, page 109).

[26]. Department of Agriculture, Cooperation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, Government of India, estimates also show that in 2012-13, many Indian states have less than 50 percent net irrigated area (page 16).

[27]The other drought-prone states in India are Andhra Pradesh, Maharashtra, Karnataka and Rajasthan as documented in the 2016 Manual for Drought Management.

[28]The estimate of rain-fed agriculture is according to the Ministry of Agriculture and Farmers welfare (2015), and may be accessed at: Pocket Book of Agricultural Statistics, 2015, Ministry of Agriculture and Farmers Welfare, http://eands.dacnet.nic.in/PDF/PocketBook2015.pdf. Also documented by the directorate of Economics and Statistics, in the pocket booklet (2014) of Madhya Pradesh.

This study contributes to the growing body of research on the impact of disasters on the economy in the following ways. First, the review of extant literature suggests that multicounty studies (Albala-Bertrand, 1993; Raddatz, 2009; Loayza et al., 2012; Fomby et al., 2013; Felbermayr and Groschl, 2014 and Panwar and Sen, 2019 among others) focused primarily on examining relationship between macro (economic) variables. In addition, only those variables are included that are theoretically relevant at the sub-national level to capture the growth dynamics such as crop intensity, electricity consumption, road length, irrigated crop area, etc. For example, the Economic Survey of India 2017-2018 (hereafter ES 2017-18) highlight the role of improved irrigation infrastructure to withstand the drought shock. The study therefore, include the irrigation dummy to explain its impact on economic growth rate. Second, unlike the existing studies, this study includes drought relief as an explanatory variable because the variable also informs the occurrence of drought in the previous periods.

Freeman (2004), Xu and Mo (2013), Kishore et al. (2015), among others analysed the relationship between drought relief and economic growth[29]. However, very few studies explored the statistical relationship between drought relief and economic growth. Third, to best of the authors' knowledge, this is first study examining the impact of droughts using district level data. One of the backward and drought-affected region of the country, namely the Bundelkhand region (having six districts), is included in the sample[30]. Despite the special Bundelkhand Development Package (of INR 37.6 billion during 2009-2011; extended for the period 2012-17), and significant financial allocations for relief spending from the State Disaster Response Fund between 2005 to 2012; issues such as poverty, unemployment and out-migration are prevalent in the region causing further economic distress (Suthar, 2018). Finally, this study estimate growth effects at the district level. The Disaster Management Act (2005) emphasize drought adaptation and mitigation policies, made at the state level and executed at the district level. The analysis is relevant to inform policy at the district level.

The remaining structure of the chapter is as follows. A brief description of the MP economy and a note on the incidences of droughts is presented in section 4.3.2. The section further elaborates the rationale of the study and the research objectives. Data, sources of

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[29] Xu and Mo (2013) included disaster aid from relatives as a proxy for relief, Freeman (2004) examined the post-disaster relief in the wake of earthquake, whereas Kishore et al (2015) studied the subsidy for diesel as relief proxy.

[30] Bundelkhand region of Madhya Pradesh has six districts as Chhatarpur, Damoh, Datia, Panna, Sagar and Tikamgarh. The rest of the 7 districts are in Uttar Pradesh, India.

data, and the empirical methodology adopted are discussed in the section 4.3.3. Section 4.3.4 presents a discussion of the results before the robustness check presented in the section 4.3.5. The chapter concludes with the section 4.3.6, which is a summary of the present chapter.

4.3.2 Economy of Madhya Pradesh and Drought Incidences

MP, the second largest state in the country by area has a population of around 7.2 crores spread across 52 administrative districts. Agriculture has low contribution in the state economy but the population is largely dependent on agriculture. Table 4.12 shows the percentage share of all the three sectors of the economy for the years 2005-06 and 2012-13 for the selected 45 districts. The share of agriculture increased whereas the service sector share declined and industrial share remained constant.

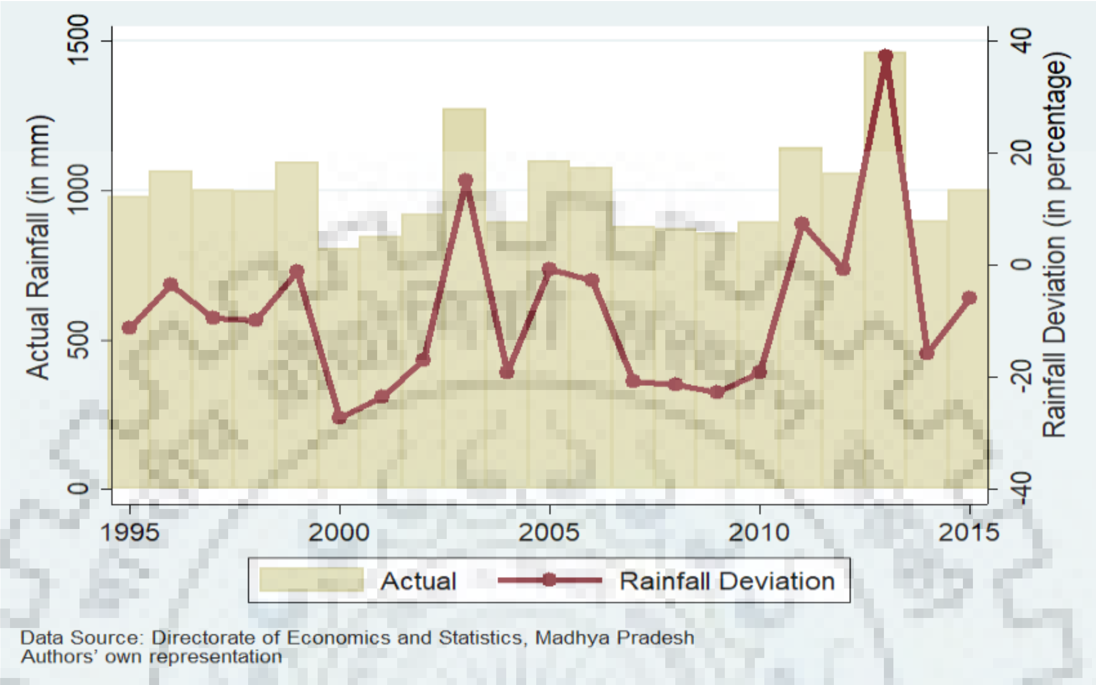
Table 4.12 Share of Agriculture, Manufacturing and Service sector in economy of Madhya Pradesh (in percentage)

Sector	2005-06	2012-13	Change
Agriculture	23	24	4.34
Manufacturing	25	25	0
Service	46	44	-4.54

Note: The Agriculture share is excluding the other sectors like fishing, dairy etc. from the primary sector.
Source: Directorate of Economics and Statistics, Madhya Pradesh

Agricultural growth rate between 2005-06 and 2012-13 was highest in the state in comparison to other Indian states according to the Ministry of Agriculture and Farmers Welfare (2015-16). As a result, the per capita income reached to INR 41287 in 2012-13 from INR 15927 in 2005-06, though the achievement was lower than the national average of INR 65538 (at constant 2004-05 prices). Meanwhile, the state also witnessed a decline in average size of farm holding from 2.02 hectares to 1.78 hectares from 2005-06 to 2010-11 (Agriculture Census, 2010-11). The agricultural sector is affected by droughts and the state is vulnerable to water shortage as it witnessed below normal rainfall during the last 20 years as shown in Figure 4.8. The growth rate of the industrial sector was around 10 percent for the period 2005-06 to 2012-13. The intra-district variability among them was high. For example, Indore, Bhopal, Jabalpur and Gwalior, the four most literate districts in the state are the main drivers of growth (Directorate of Economics, Madhya Pradesh). Their combined contribution to overall state manufacturing output was around 33 percent (NSDC, 2013

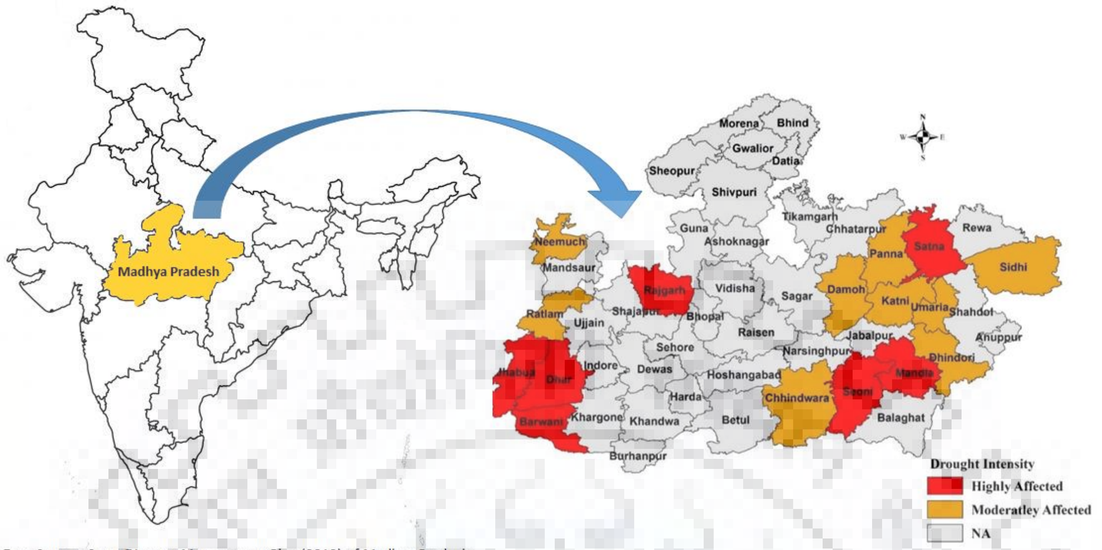
Figure 4.8 Rainfall Statistics for Madhya Pradesh



The Micro, Small and Medium Enterprises (MSME) in the above-mentioned districts contributing substantially towards state growth are food processing, pharmaceutical, paper, plastic and engineering. Raisen district has the least literacy rate followed by Badwani. The urban population was highest in Indore followed by Jabalpur, whereas Dhindori and Seedhi districts have majority rural population. According to the MP State Millennium Development Goals (MDG) Report 2014-15[31], Indore, Bhopal, Jabalpur, Gwalior and Hoshangabad districts top the Human Development Index, whereas Dhindori, Sidhi, Singrauli, Panna and Umaria were at the bottom. The credit to deposit ratio is highest for Harda (108 percent) and lowest in case of Umaria district (17.25 percent). Crop intensity, that is the percentage of gross cropped area to net sown area, is highest in Harda (194) and lowest in Bhind (112). The state has abundant repository of essential minerals and therefore, mining and quarrying too contribute to the state's economic growth as discussed earlier in chapter 4.1. The above facts highlight the existing intra-district variability in terms of resource endowments and economic activities.

[31] Bhanumurthy et al. (2016)

Figure 4.9 Drought affected districts of Madhya Pradesh



Data Source: State Disaster Management Plan (2012) of Madhya Pradesh
Prepared using maps available from https://in.pinterest.com/pin/703406035531467037/ (Accessed on 25th June 2020).
Note: Not to scale. For representational purpose only.

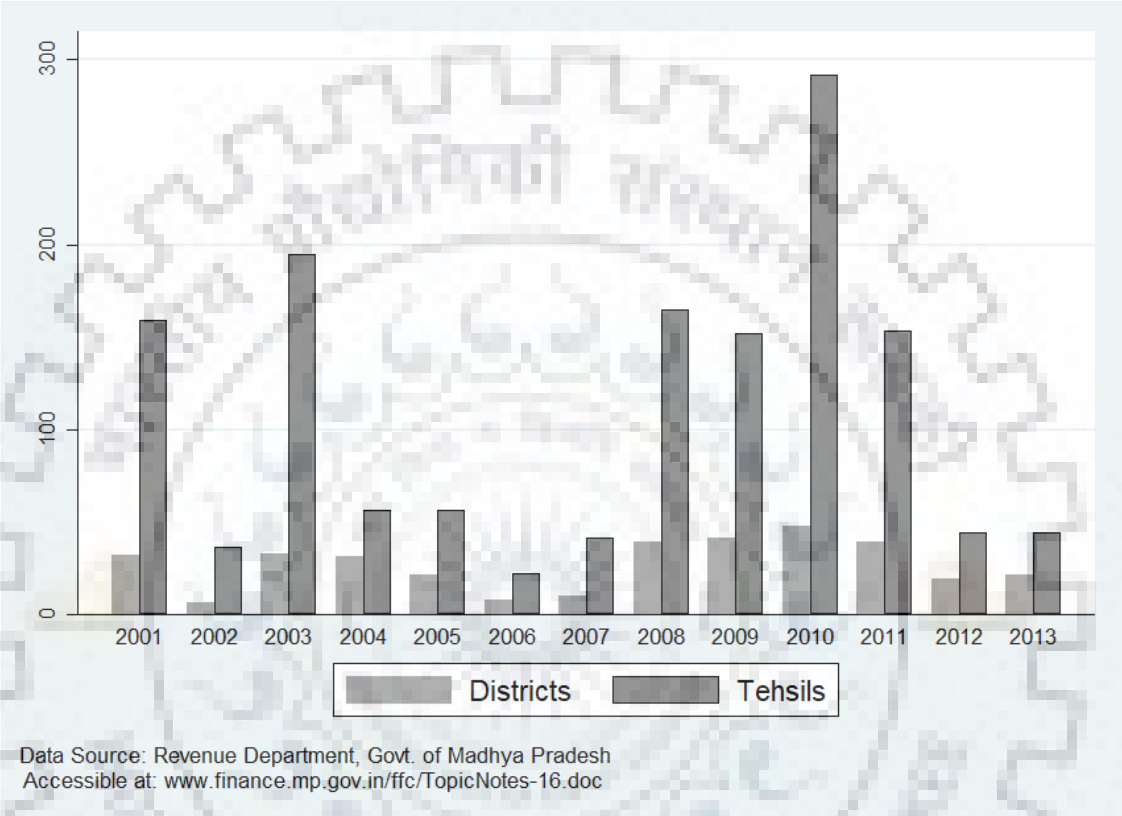
It is important to note that the state was bifurcated into two states namely, MP and Chhattisgarh, but the menace of climate-induced drought, continue to affect districts within the state of MP. Post bifurcation, MP witnessed severe droughts in 2000, 2002, 2004, 2007, 2009, 2010 and 2015-16[32]. It is observed that seven out of fifty-one districts faced recurrent and persistent droughts several times in the last three decades. On the basis of long-term rainfall data, the State Disaster Management Plan (2012) declared Jhabua, Dhar, Barwani, Rajgarh, Seoni, Mandla and Satna as intensively drought-affected districts, whereas Neemuch, Ratlam, Chhindwara, Damoh Panna, Katni, Umaria, Dhindori and Sidhi are moderately drought-affected districts in Madhya Pradesh (Figure 4.9). The government data show that many districts in the state are facing drought recurrently for the last fifteen years (Figure 4.10).

The ES 2017-18 attributed climate change as one of the primary reasons behind frequent drought events. The Indian Meteorological Department (IMD) reports that in comparison to the sub-period 1950-80, during 2005-2010, the drought-prone states in India witnessed low levels of precipitation. In many districts of MP rainfall was 50 millimetres to 500 millimetres lesser (during 2005-2010) when compared to the average rainfall during the period 1950-2018. The data from the State Disaster Response Fund (SDRF) suggests

[32] According to the Ministry of Rural Development, India, the recent (2015-16) drought affected 46 out of 51 districts of Madhya Pradesh.

that during the study period (2005-2012), highest financial relief towards drought were disbursed to Dewas and Tikamgarh districts and the least relief was allocated for Umaria and Sivani districts. The drought relief to the six drought-affected districts in Bundelkhand region was 1.73 percent higher than the districts' average in the state.

Figure 4.10 Drought affected Districts and Tehsils in Madhya Pradesh (2000 to 2012)

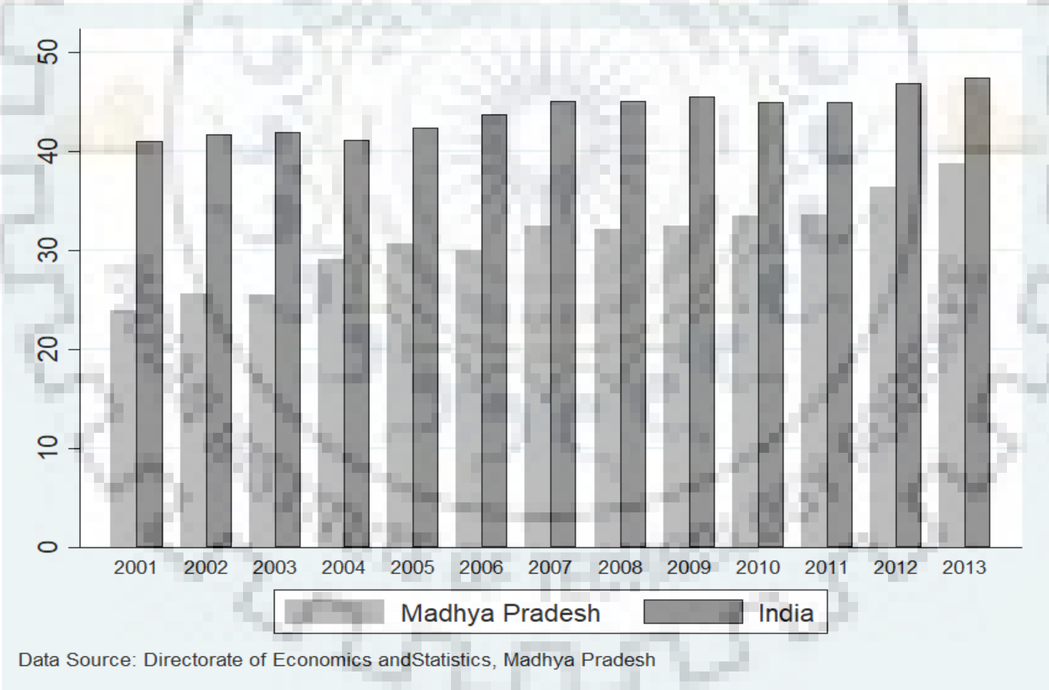


The probable future increase in frequency and intensity of drought events adds to the worries of the state government and policy-makers[33]. In addition, the projected changes in climate directly or indirectly affect the livelihoods of almost 74 percent state population directly engaged with the primary sector. This may cause distress in sectors that are predominantly water-dependent, such as, construction, tourism and energy, among others. (Ding et al. 2011). These worries proliferate because the state's irrigation capabilities are under-developed in comparison to the country average (Figure 4.11). Out of 45 districts, 23 have comparatively lesser irrigation capabilities (an infrastructure) in comparison to the state average (Figure 4.12).

[33] Refer Madhya Pradesh State Action Plan on Climate Change (2014), page no. 56. Available at: http://www.epco.in/pdfs/ClimateChange/ MP_State_Action_Plan_on_Climate_Change.pdf

The districts with adequate irrigation facilities could be more resilient in comparison to the dry districts, as observed by Kuwayama et al (2018) in a study at USA. The ES 2017-18 also warned that the Kharif and Rabi crops yield would be lower by 14.7 percent and 8.6 percent in unirrigated areas respectively. As a result, agricultural income may fall by 15 percent to 18 percent in irrigated and 20 percent to 25 percent in the unirrigated areas. The state government is responsible to mitigate drought by providing post-disaster finance and non-financial relief along with other immediate coping measures[34]. As specified in chapter 4.2, district authorities are responsible for planning, coordination and implementation of the drought management plans and the local agency is the District Disaster Management Authority (DDMA). Disasters are effectively dealt with full assistance by the district level allied departments with support and coordination by the National Disaster Management Authority (NDMA) and State Disaster Management Authority (SDMA) respectively.

Figure 4.11 Gross Irrigated Area as a Percentage of Gross Cropped Area

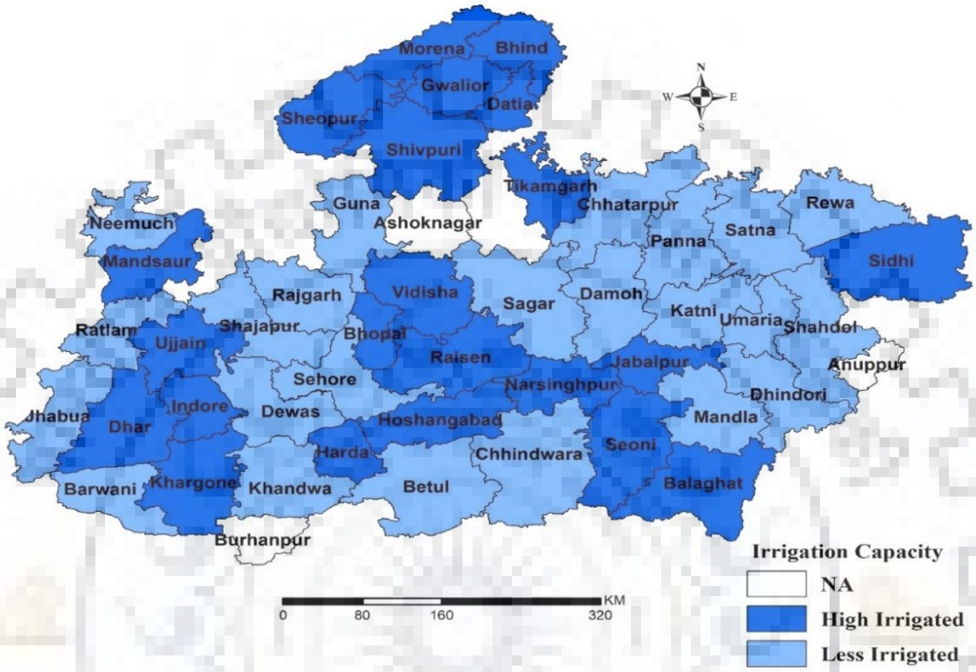


The functions of the DDMA are to identify disasters, vulnerable districts, preparing the district response plan such as estimating the quantum of relief and for management

[34] The state government have funds for relief measures under SDRF. In additional to this, fund is granted form the National Disaster Response Fund (NDRF) for natural calamities of severe nature and is approved based on the requests received from State Governments (Disaster Management Act, 2005). As per the official record, the central government (from National Disaster Response Force) gave additional 2033 crore to the Madhya Pradesh (State Disaster Response Force) towards drought relief for 2015-16 drought.

procedures, follow the guidelines laid down by National and State authorities. DDMA has the power to utilize the allocated resources in pre and post-disaster phases at the district level. In the next section, methodology employed is discussed in detail.

Figure 4.12 Irrigation Facilities at the District level in Madhya Pradesh



Source: Authors representation

4.3.3 Methodology

A balanced panel data consisting of 45 selected district of MP over the period 2005 to 2012 is constructed and analysed in this study. Four dependent variables namely, Aggregate Gross Domestic Product Growth Rate (y^1), Agricultural Gross Domestic Product Growth Rate (y^2), Secondary Sector Gross Domestic Product Growth Rate(y^3), and Tertiary Sector Gross Domestic Product Growth Rate (y^4). The growth rates are derived from the actual macroeconomic variables at 2004-05 base year. Drought (X^1) and drought relief by the state to districts (X^2) from the State Disaster Response Fund (SDRF) are included as independent variables. It is challenging to define a variable representing drought event and its intensity. According to the Indian Meteorological Department (IMD), if there is 25 percent or more rainfall deficiency in a year compared to the long-term average rainfall (generally for more than 30 years) in a district, meteorological drought is declared. Following IMD definition, a dummy variable is created showing “drought” (25 percent or more rainfall deficiency) or “no drought” (below 25 percent of rainfall deficiency) condition. Meteorological, agricultural, and hydrological droughts are three drought types. Drought monitoring and declaration process varies across Indian states. According to the MP Relief Manual (2007), the rainfall deficiency of 25 percent or more than the long-run average rainfall of the district may be a criterion for declaring a meteorological drought. Additionally, the crop cutting experiments (*Annawari*) are performed at the village level to assess the crop loss[35]. Any one of the two criterions or a combination of both assists drought declaration.

The financial relief following drought (X^2) is an important explanatory variable. It is the ratio of financial relief disbursed by the state to the district GDP. There may exist a correlation between drought and financial relief for drought. But in this study, the scope is limited and analyses of same is not undertaken. From 2005 to 2012, for the drought years, financial relief disbursement was INR 167 crore and for normal years it was INR 259 crores, higher than the drought years. The reason behind such allocation is the direction provided in the MP Relief Manual (2007). The manual directs that the districts may proactively demand a certain amount of relief funds from the SDRF towards arranging the resources to combat the impact of possible rainfall deficiency and acute water shortages in the drought-affected districts.

The study assumes that the drought and financial relief are separate variables and are not substitutes. It is also important to mention that the financial relief considered in the study are the funds disbursed from SDRF account to the District Disaster Response Fund (DDRF). Therefore, funds received by districts such as, central government aid, payments of losses via insurance, donations from Non-Governmental Organizations (NGOs) and other donor agencies, are not considered.

Following review of literature, the study includes eight control variables. Literacy rate (Z^1) characterises the human capital, whereas the credit to deposit ratio (Z^2) is a representation of financial inclusion. The number of government hospital beds (Z^3) is a proxy for healthcare infrastructure, and the crop intensity is represented by (Z^4) to account for the dependency of the agricultural sector on water. Similarly, crop yield (Z^5) is the per hectare production of major crops[36] of MP. Per capita electricity consumption for irrigation (Z^6) is a proxy for energy infrastructure across districts and percentage of Gross

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[35] For details on drought declaration criteria's in Madhya Pradesh refer the hand book of Permanent instructions for combating drought, drinking water crises or other problems, issued by relief branch of Revenue department of Madhya Pradesh (2007).

[36] Soyabean, Peddy, Wheat and Chikpeas (Chana) are the four major crops of Madhya Pradesh.

Irrigated Area to Gross Sown Area ratio (Z^7) is a proxy for irrigation capabilities of the districts. A dummy variable for the sugarcane districts (Z^8) is also included. There are few districts in the state where sugarcane is the main crop, which requires comparatively higher supply of water. The sugarcane dummy equals 1 if average crop area for sugarcane is higher than the net irrigated area of the district for the study period, else value is zero. The lagged values of the four dependent variables (y^1_{t-1}, $y^2_{t-1,}$ y^3_{t-1} and y^4_{t-1}) are also included as independent variables following their significance as highlighted by the earlier papers (Noy and Vu, 2009; Noy, 2009; Loayza et al., 2012; Strobl, 2012). Table 4.13 presents the dependent and the independent variables along with their sources. The following equation is estimated:

$$y^k_{it} = \alpha_i + \beta_1 y^k_{i(t-1)} + \beta_2 X^1_{it} + \beta_3 X^2_{it} + \sum_{j=1}^{8} \beta_j Z^j_{it} + \epsilon_{it} \qquad \text{----------------- (1)}$$

where, ${y^k}_{it} = (Y_{it} - Y_{i(t-1)})/Y_{i(t-1)}$, ($k = 1{,}2{,}3$ *and* 4) denoting the growth rate for i^th^ district and t^th^ period outputs i.e., aggregate (DGDP), agriculture (ADGDP), industrial (SDGDP) and service (TDGDP) respectively.

${y^k}_{i(t-1)}$ is the lag of output growth rate,

$X^1_{i(t-1)}$ is the drought dummy (1= if drought, 0= no drought, following IMD definition)

X^2_{it} corresponds to post-disaster relief finance proportionate to the DGDP at t,

Z^j_{it} represents the control variables as described in the earlier section.

The inclusion of the selected control variables is following Noy and Vu (2009), Noy (2009) and Loayza et al. (2012). Four models (Model A, B, C and D) are estimated. Results are reported in Table A4.18 and Table A4.19 respectively in Appendix A4.3. The initial estimates following equation (1) were checked for the presence of problems such as multicollinearity. A very weak correlation (reported in Table 4.15) exists between the variables. The highest correlation coefficient (0.35) is obtained between the variables credit to deposit ratio and per-capita electricity consumption and also between total yield and total irrigated area (0.32). The low correlations favour inclusion of the explanatory variables in the model. Lagged variables are considered in the models and their inclusion transforms the linear model into a dynamic panel model. Therefore, theoretically, a fixed effect model would not generate efficient estimators, although they remain consistent. Nickell (1981) provides a logical explanation showing the inefficiency of such estimators. The systematic bias in the lagged dependent variable estimators may lead to biases in the coefficients of other variables. This is a concern particularly in panel with short time series (in this study the time span is only 8 years).

Table 4.13 Variable name, definition and their sources

Variable Name	Definition	Sources
Y^1	District' Gross Domestic Product at 2004-05 constant prices	Directorate of Economics and Statistics, Madhya Pradesh
Y^2	District' Agricultural Gross Domestic at 2004-05 constant prices	Directorate of Economics and Statistics, Madhya Pradesh
Y^3	District' Secondary Gross Domestic Product at 2004-05 constant prices	Directorate of Economics and Statistics, Madhya Pradesh
Y^4	District' Tertiary Gross Domestic Product at 2004-05 constant prices	Directorate of Economics and Statistics, Madhya Pradesh
X^1	Drought dummy having value 1 if the annual mean deviation of actual rainfall equal to or more than 25% from district average rainfall, else the value is 0.	Directorate of Economics and Statistics, Madhya Pradesh
X^2	Drought relief disbursement by district finances proportionate to District Gross Domestic Product in percentage	Relief commissioner office, Revenue department, Madhya Pradesh
Z^1	Literacy rate in percentage	Directorate of Economics and Statistics, Madhya Pradesh
Z^2	Credit to deposit ratio of the scheduled commercial banks in percentage	Directorate of Economics and Statistics, Madhya Pradesh
Z^3	Number of government hospital beds per 10,000 population in the district	Directorate of Economics and Statistics, Madhya Pradesh
Z^4	Crop intensity = Gross cropped Area / Net Sown Area x 100.	Directorate of Economics and Statistics, Madhya Pradesh
Z^5	The total yield of four major crops (Soyabean, Rice, Wheat and Chikpeas) in Kilogram per hectare	Directorate of Economics and Statistics, Madhya Pradesh
Z^6	Per capita electricity consumption in Kilo watt hour	Directorate of Economics and Statistics, Madhya Pradesh
Z^7	The ratio of percentage Gross irrigated area to Gross sown area	Directorate of Economics and Statistics, Madhya Pradesh
Z^8	Sugarcane dummy, value is 1 if a district Sugarcane average crop area is higher than the net irrigated area for the study period, else the value is 0	Madhya Pradesh Panning, Economics and Statistics Department[1]

[1]https://data.gov.in/resources/district-wise-sugarcane-farming-madhya-pradesh-2006-2007-2012-2013

The two-step system-GMM approach (Blundell and Bond, 1998) is used to overcome the endogeneity problem due to presence of lagged dependent variables and to get the panel corrected standard errors. This is better approach in comparison to the Arellano- Bond (1991) approach of difference GMM estimation that employs the first difference of the explanatory variables as instruments and is expected to control for autocorrelation, panel heteroscedasticity and over-identification problem.

The difference GMM is capable to deal the correlation between individual unobserved heterogeneity and the lagged dependent variable in general. However, the problem arises where the panel is short $(N > T)$. In such cases, the difference GMM estimators' predictive ability remains significantly low as explained by Blundell and Bond (1998). This limitation is addressed by Arellano and Bover (1995) and Blundell and Bond (1998) as they improved the difference GMM model by developing the system GMM estimator(s), which combines both equations i.e., in levels and in differences simultaneously. Another motivation to prefer the system GMM approach over other such as Instrumental Variable (IV) method, is heteroscedasticity diagnosed in the data-set used. In this case GMM estimators are more efficient and consistent than the estimators of IV method. The estimation of dynamic panel follows studies by Loayza (2012) and Noy and Vu (2009).

Table 4.14 Descriptive statistics of variables

Variable	Obs.	Mean	Std. Dev.	Min	Max
y^1	360	8.33	4.85	-4.49	30.00
y^2	360	8.98	16.48	-23.28	157.61
y^3	360	9.76	7.73	-17.75	32.46
y^4	360	0.04	0.07	0	0.50
X^2	360	-0.00	0.01	-0.05	0.08
Z^1	360	67.77	8.16	39.94	83.18
Z^2	360	58.34	25.98	13.21	163.4
Z^3	360	0.43	0.12	0.02	1.01
Z^4	360	150.40	122.05	11.87	1909.67
Z^5	360	4843.83	2400.77	1326.60	22012.78
Z^6	360	0.09	0.08	0.00	0.75
Z^7	360	34.90	20.63	0	300.46

Notes: Sample=45 districts, data period= 2005-2012
Source: Authors own calculations

Hansen J test is undertaken to check the overall validity of the instruments. This endogeneity test in the study identifies lagged output growth rate as endogenous and all the other control variables as exogenous. The null hypothesis "Instruments as a group are exogenous" is supported by the obtained p-value (more than 5 percent). Therefore, a system-GMM specification, considering lagged output growth rate as endogenous variable is estimated. Next, the non-stationarity properties of selected time variables used in the study is tested using the Harris-Tzavalis unit-root test (1999). This test is preferred over other available tests such as Levin-Lin-Chu (2000), lm-Pesaran-Shin (2003), among others because of its suitability as the current study considers a short and balanced panel data set. The test statistics rejects the null hypothesis of unit root and confirm that the variables selected for the study are stationary. The descriptive statistics of the selected variables are presented in Table 4.14. The results are discussed in the next section.

Table 4.15 Correlation Matrix

	X^1	X^2	Z^1	Z^2	Z^3	Z^4	Z^5	Z^6	Z^7	Z^8
X^1	1.00									
X^2	0.15	1.00								
Z^1	-0.06	0.07	1.00							
Z^2	-0.02	0.05	-0.03	1.00						
Z^3	0.00	-0.15	-0.07	0.11	1.00					
Z^4	-0.00	-0.01	0.09	0.10	-0.03	1.00				
Z^5	-0.21	-0.07	0.22	0.26	0.00	0.13	1.00			
Z^6	-0.13	0.02	0.12	***0.35***	0.24	0.07	0.19	1.00		
Z^7	-0.10	0.03	0.16	0.25	-0.05	0.03	***0.32***	0.19	1.00	
Z^8	-0.03	-0.12	0.12	-0.05	0.20	-0.02	-0.07	0.06	-0.02	1.00

Source: Authors own calculations

4.3.4 Empirical results and Discussion

Table 4.16 presents the empirical results, examining the drought and post-drought relief effects on the economic growth rate. The Hansen *J* test of over-identifying restrictions confirms the correctness of the model specifications. It also indicates that the instruments included in the model are valid as well as uncorrelated with the residuals. As a standard practice, Arellano-Bond AR (1) and AR (2) tests have been performed to identify the first- and second-order autocorrelation of the residuals. The study rejects the null hypothesis of no first-order auto correlation and accept the hypothesis of no second-order autocorrelation. Therefore, these tests confirm about the estimator's consistency.

The discussion here is restricted on the two variables of interest. The study observes that drought has a significant negative impact on the aggregate (at 10 percent significance level) and agricultural (at 1 percent significance level) growth rate (column 1 and 2). Drought lowers the aggregate and agricultural growth rates by 6.07 percent and 27.95 percent respectively. The impact on industrial and service sector growth (column 3 and 4) rate is also adverse, though not statistically significant.

The results are elaborated based on the assumption that droughts will have significant income effect. The most direct negative impact of drought is always on the agricultural sector. As known, the major crops of the state are Soya bean and Wheat, which are highly water intensive. Therefore, it is expected that water scarcity will have an adverse impact on such crops, therefore will considerably lower the income of the rural households.

As earlier highlighted, in the state of MP, more than 70 percent population is directly employed or engaged in the agricultural activities. Also, the percentage share of the agriculture in total state GDP is substantially high (around 25 percent). As a result, lower farm income will also reduce the purchasing power and spending capacity of farmers and agricultural labours among others. This should lower the demand for goods and services in rural districts considerably. The ultimate impact is therefore expected to lower the aggregate growth of the districts. This is evident from the results (Table 4.16) and the estimates given by Diersen et al. (2002), Howitt et al. (2014) and Udmale et al. (2015). Also, Loayaza et al (2012). Fomby et al. (2013) and, Panwar and Sen (2019) in context of droughts in developing economies also demonstrated that agriculture and aggregate growth rate was negatively affected by the droughts.

The income effect reasoning is also supplemented by the argument proposed by Sen (1982) and Desai (2003). They opined that crop losses due to water scarcity rises their price, increase inflation, and lower the poor farmers spending on other products and services. To meet the livelihood challenges, the poor farmers' sale their productive assets like land, livestock or gold, which lowers their capacity to earn further. This has a direct bearing on their income and hence on spending power, which ultimately impacts the growth dynamics. The income effect reasoning is also supported by the conceptual framework given by Benson and Clay (2004) regarding droughts economic impact assessment. According to them, if irrigation infrastructure is limited, then in drought years, the farmers divert their financial resources and compel to invest to improve the irrigation facilities at their own level. Such investment towards creating fixed assets, lower their spending for other consumption products and services, which has an adverse impact on the demand side. The drought events therefore are capable of hampering aggregate growth rate. It is further observed that in the state, irrigation infrastructure though has improved but is still inadequate.

Further, the lower crop output may affect the agro-based industries, as the agri-inputs required to them is impacted due to crop losses. As a result, it further reduces the agricultural value-addition. This distress lowers the agricultural wages which may ultimately cause a reduction in rural demand for consumption products declining the economic output. This phenomenon is especially prevalent in the labour intensive economies (Mueller and Osgood, 2008; Hayati et al., 2010; Singh et al., 2013; Udmale et al., 2015) like MP. Another explanation of the findings is that the rainfall deficiency is capable of reducing the employment opportunity in farming as well as the non-farming areas such as construction, export in the agriculture sector as well as other industries. Edwards et al. (2019) in reference to Australia also observed that the drought-induced economic stress in the agriculture get translated into the service sector. The study observed the loss of services in the drought-affected local economy. The severity of the drought also found to be directly linked with the larger effect on the social and economic wellbeing of the farmers. Pelling et al. (2002) also opined that the strong linkages of agriculture with other sectors of the economy may have negative economic consequences at aggregate level. The same reasoning is relevant for the current study. Being an agrarian economy, negative drought impact on the agriculture sector is expected to diffuse quickly into the aggregate economy, lowering the overall growth rate of the districts.

Regarding the second variable of interest, it is observed that drought financial relief has a significant positive effect on the aggregate (Table 4.16, column 1) and the industrial sector (Table 4.16, column 3) growth and positive but non-significant impact on rest of the sectors of the district economy. These findings though contradict with other studies such as Freeman (2004), Xu and Mo (2013), Francken (2012) and Kishore et al. (2015). Interestingly, it is observed that until 2008, the financial relief to the districts were also utilized to provide guaranteed works to any one member of the household in rural areas under Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA), a flagship programme of the central government. In the initial years, the programme created many jobs and infrastructural assets in rural areas, various data suggest.

Therefore, it is likely that for the period of 2005 and 2008, financial disbursements towards MGNREGA may have increased the rural labourers' income and purchasing power. This may be the possible explanation for the positive effect of drought relief disbursements on the manufacturing as well as the aggregate economic growth rate of the districts. Xu and Mo (2013) also conceptualized that if relief finances add to the livelihood options and income of the individuals, it may lead to a positive effect on the economic growth rate. The linkages between the agricultural sector and the service sector being weak, drought-relief finances failed to show any significant impact on the service sector growth as also observed by Kaur et al. (2009).

However, the examination of the financial relief disbursements data for the full study period to the districts also reveal that, a significant share of the relief funds were disbursed towards short-term measures like drinking water arrangements, crop loss compensation and food and fodder supply. The investments to improve the long-term irrigation infrastructure to foster the agricultural development was meagre from the relief funds. This may be the reason that financial relief failed to have any statistically significant impact on the growth of the agriculture sector in the present study. The following section discuss in brief the results from the robustness check pertaining to the drought and relief finance, the two variables of interest in the study.

Table 4.16 Drought, Financial Relief and Growth

Variables	(1) GDP growth	(2) Agricultural growth	(3) Industrial growth	(4) Service growth
y^1_{it-1}	-0.1444 (0.2088)			
y^2_{it-1}		-0.2863 (0.1833)		
y^3_{it-1}			-0.1200 (0.2740)	
y^4_{it-1}				0.0791*** (0.0271)
X^1	-6.0745* (3.2467)	-27.9500*** (7.6184)	-0.4294 (11.0482)	-3.8243 (2.5317)
X^2	83.5176*** (22.4908)	27.0512 (124.4373)	196.726** (78.0203)	1.4627 (16.9475)
Z^1	-0.0180 (0.1380)	-0.0136 (0.3494)	-0.05044 (0.2078)	0.0003 (0.1010)
Z^2	-0.03050 (0.0433)	-0.0659 (.0923)	0.0487 (0.0803)	0.0387 (0.0563)
Z^3	5.9960 (6.5632)	24.0214 (18.6067)	-10.5373 (10.2276)	2.3584 (9.4707)
Z^4	-0.0114* (0.0065)	-0.0114 (0.0228)	-0.0024 (0.0308)	0.0045 (0.0035)
Z^5	0.0031*** (0.0011)	0.0011 (0.0025)	0.0046 (0.0032)	0.0002 (0.0012)
Z^6	24.3992*** (7.6914)	-23.8794 (21.0597)	-31.6833 (27.0016)	-7.4907 (1.4693)
Z^7	-0.1169 (0.1782)	0.3848 (0.3382)	-0.5531 (0.3594)	-0.1186 (0.2111)
Z^8	0.1511 (2.1064)	-3.9110 (10.4917)	4.9376 (7.1411)	-3.6205 (3.1153)
A	0.8659 (9.9526)	-3.5296 (33.4938)	7.3010 (17.9597)	9.0047 (13.0850)
N	315	315	315	315
AR(1)	-2.70*** (0.007)	-2.13** (.033)	-1.26** (0.020)	-1.66* (0.097)
AR(2)	-1.33 (0.183)	-1.79() (0.074)	0.27 (0.791)	0.87 (0.383)
Hansen J test	12.60 (0.182)	11.43 (0.247)	12.63 (0.180)	12.35 (0.194)

Notes: Estimation method: Two-step System GMM; Sample: 45 districts of Madhya Pradesh; Data period: 2005-2012; Numbers in brackets are the corresponding standard errors; *Significant at 10%, **Significant at 5%, ***Significant at 1%; N= observations; AR(1) and AR(2) are Arellano-Bond tests for autocorrelation (in residuals) of order 1 (H_0: no first-order autocorrelation) and 2 (H_0: no second-order autocorrelation); The Hansen *J* test is the test for over-identifying restrictions in the system GMM dynamic model.

Source: Authors own calculations

4.3.5 Robustness check

As a sensitivity analysis, the strength of the first set of results were verified applying the pooled OLS and panel fixed effect (FE) regression models. These methods are not preferred to measure such relationship using relatively small panel, but may provide an indication of the possible relationship among the variables of interest to validate the findings from two-step system GMM method. The results based on robustness tests are in Table 4.17. The empirical results largely validate the empirical findings employing the system GMM approach. The pooled OLS and panel fixed effect models show a statistically negative effect of drought on agricultural as well as the districts aggregate growth rate. Like System-GMM, the fixed effect (FE) panel regression model also establishes the positive and statistically significant impact of drought relief finance at the industrial growth rate. The coefficients of drought and drought relief for fixed effect models are under-estimated. This justify the use of two-step system GMM as the preferred model for the empirical estimation.

Table 4.17 Robustness check: Drought, Relief and Growth

Variables	**(1) GDP growth**		**(2) Agricultural growth**		**(3) Industrial growth**		**(4) Service growth**	
	Pooled OLS	Fixed Effect	Pooled OLS	Fixed Effect	Pooled OLS	Fixed Effect	Pooled OLS	Fixed Effect
X^1	-2.3465*** (0.5903)	-2.2738*** (0.6860)	-9.2601*** (0.0000)	-10.0122*** (1.8693)	0.2093 (2.4805)	0.4630 (1.3584)	2.0700 (2.1351)	2.0772 (2.7262)
X^2	-4.2979 (3.5998)	-3.8834 (4.0927)	30.6440** (12.3030)	-16.0982 (11.2239)	15.4467 (14.9941)	19.1571* (10.3437)	-54.1779 (12.8930)	-63.3053 (60.4451)
N	315	315	315	315	315	315	315	315
R-Square	0.1455	0.2267	0.1823	0.3069	0.0917	0.1618	0.2315	0.1175
Notes: Estimation method: Pooled OLS and Panel fixed effect, Sample=45 districts of Madhya Pradesh, Data period= 2005-2012; N=observations								

Source: Authors own calculations

Appendix A4.3

Table A4.18 Different models estimations for Drought, Relief finance and Growth

	Model A				Model B			
	GDP Growth	Agricultural growth	Industrial Growth	Service growth	GDP Growth	Agricultural growth	Industrial Growth	Service growth
X^1	-6.1768 * (3.1105)	-28.3555 *** (6.7449)	-2.9953 (5.3894)	-3.7960 (2.5901)	-7.7145 *** (2.5691)	-23.6698*** (7.1394)	-6.5399 (5.1530)	-3.5417* (2.0334)
X^2	84.5516*** (22.1279)	26.2169 (83.9051)	153.3614*** (53.6853)	33.6489 (26.1075)	85.7601 *** (23.1994)	39.9741 (113.1289)	154.9282*** (51.3901)	33.5327* (19.4216)
N	315	315	315	315	315	315	315	315
AR(1)	-2.75 *** (0.006)	-2.11** (0.035)	-1.82* (0.069)	-1.69* (0.090)	-2.33 ** (0.033)	-2.22 ** (0.027)	-2.24** (0.025)	-1.66* (0.098)
AR(2)	-1.36 (0.175)	-1.80* (0.071)	-1.62 (0.105)	1.05 (0.292)	-2.04 (0.041)	-1.56 (0.118)	-2.18** (0.029)	1.07 (0.285)
Hansen J test	12.93 (0.166)	11.12 (0.268)	18.25** (0.032)	17.98** (0.035)	22.01 (0.373)	12.52 (0.186)	17.33** (0.044)	19.96** (0.018)

Notes: Estimation method: Two-step System GMM; Sample: 45 districts of Madhya Pradesh; Data period: 2005-2012; Numbers in brackets are the corresponding standard errors; *Significant at 10%, **Significant at 5%, ***Significant at 1%; N= observations; AR(1) and AR(2) are Arellano-Bond tests for autocorrelation (in residuals) of order 1 (H_0: no first-order autocorrelation) and 2 (H_0: no second-order autocorrelation); The Hansen J test is the test for over-identifying restrictions in the system GMM dynamic model.
Model A is estimated by dropping the variable Z^8 from main model as given in the equation 1.
Model B is estimated by dropping the variable Z^7 from main model as given in the equation 1.

Source: Authors own calculations

Table A4.19 Different models estimations for Drought, Relief finance and Growth

	Model C				Model D			
	GDP Growth	Agricultural growth	Industrial growth	Service growth	GDP Growth	Agricultural growth	Industrial growth	Service growth
X^1	-6.1768 * (3.1105)	-25.8692*** (7.8823)	-3.4282 (5.3112)	-2.9152 (2.6466)	-5.7199* (2.9238)	-29.3271*** (6.1036)	-6.1941 (3.7961)	-3.6926 (2.3514)
X^2	84.5516*** (22.1279)	61.1798 (131.5147)	194.2011*** (59.4217)	37.8122 (34.5682)	91.5922*** (24.5880)	-3.4943 (107.2885)	133.7351*** (33.8418)	20.8254 (15.2061)
N	315	315	315	315	315	315	315	315
AR(1)	-2.75 *** (0.006)	-2.11** (0.035)	-1.88* (0.060)	-1.72* (0.085)	-2.62*** (0.009)	-2.11 ** (0.035)	-2.35** (0.019)	-1.62* (0.105)
AR(2)	-1.36 (0.175)	-1.57 (0.117)	-1.37 (0.169)	0.99 (0.321)	-2.62*** (0.009)	-1.56 (0.120)	-2.26** (0.024)	1.12 (0.262)
Hansen J test	12.93 (0.166)	11.28 (0.257)	14.88* (0.094)	15.73* (0.073)	11.81 (0.224)	11.85 (0.222)	21.39** (0.011)	20.69** (0.014)

Notes: Estimation method: Two-step System GMM; Sample: 45 districts of Madhya Pradesh; Data period: 2005-2012; Numbers in brackets are the corresponding standard errors; *Significant at 10%, **Significant at 5%, ***Significant at 1%; N= observations; AR(1) and AR(2) are Arellano-Bond tests for autocorrelation (in residuals) of order 1 (H_0: no first-order autocorrelation) and 2 (H_0: no second-order autocorrelation); The Hansen J test is the test for over-identifying restrictions in the system GMM dynamic model.

Model C is estimated by dropping the variable Z^6 from main model as given in the equation 1.
Model D is estimated by dropping the variable Z^5 from main model as given in the equation 1.

Source: Authors own calculations

4.4 Drought Management Strategies: A survey of select districts

4.4.1 Droughts Risk Management Strategies and Determinants of Preparedness: Insights from Madhya Pradesh

4.4.1.1 Introduction

Drought is a slow-onset, complex and one of the least understood natural disaster (Swain and Swain 2011). It causes severe economic losses (direct and indirect) and jeopardises lives and livelihoods associated with the primary sector. Madhya Pradesh, a state in the central region of India, has been facing recurrent droughts due to inadequate rainfall (Drought Manual, 2016) and climate change (Economic Survey of India, 2017-18) for past several years. Out of 51 districts in the state, droughts in 2015 and 2017 affected 43 and 18 districts respectively[37]. The state government disbursed approximately INR 240 million and INR 100 million as financial relief whereas contribution of the central government stood at INR 20.33 billion and INR 8.36 billion to the State Disaster Response Fund (SDRF)[38]. Importantly, the central government sanctioned only 19 percent to the state against the raised demand. As the result, the deficit or remaining losses were borne by the affected farmers in the absence of crop and livestock insurance. The state is highly vulnerable to rainfall deficiency and livelihoods of around 74 percent population depend on agriculture. According to the Madhya Pradesh State Action Plan on Climate Change (SAPCC) (2014), the intensity and frequency of extreme drought events are predicted to rise. Such may lead to reduction in the per capita income which is already lower than the national average (Directorate of Economics and Statistics, Madhya Pradesh, and Reserve Bank of India).

Individuals engaged in the primary sector and the water-dependent industries like construction, recreation, tourism, energy, etc. are most sensitive to droughts leading to water scarcity (Diersen et al., 2002). Adverse effects of droughts vary across space and communities. Severity depends on the socio-economic conditions, resources availability, and the external support available to individuals and households. The adverse outcomes of droughts are less if the preparedness of individuals, communities and governments are high

[37] Refer to Farmers' Portal at www.farmer.gov.in

[38] Data for State Government financial relief to districts towards droughts are from Revenue Department, Government of Madhya Pradesh. The central Government financial relief data are from the official record of proceedings in Lok Sabha. The Government responded to the unstarred question number 4057 in Parliament on 20th March 2018 citing such figures.

and vice versa. For example, if exposed to drought, two different farmers may face different outcomes based on the resource endowments at their disposal. A farmer with better irrigation capacity may be less affected in comparison to those full dependent on rainfall for irrigation. Similarly, support of the government in the form of financial relief towards crop losses to farmers or other programs (food security through public distribution system etc.) may be instrumental in enhancing the individuals' adaptive capacity towards disasters. In disaster literature, such factors explain the adaptive capacity or preparedness.

The Manual for Drought Management (2016) shows that the states in India respond to droughts in reactive (ex-post) as well as proactive (ex-ante) manner. The ex-post measures are financial relief towards crop losses, provisioning water for drinking purposes, setting fodder camps etc. Examples of ex-ante interventions are development of irrigation infrastructure, strengthening weather forecast systems and an employment guarantee scheme (150 days' job guarantee). Individuals, households and communities also employ several measures to mitigate drought risks.

In the absence of adequate capacity of community and government to mitigate disaster risks, individuals' preparedness becomes a primary defence mechanism (Wamsler and Brink, 2014; Klein et al., 2017). Factors related to the individual's characteristics such as dual source of income, the physical environment and institutional support systems determine their preparedness and coping capacity. Previous studies attempted to explore the determinants of household adaptation capacity against climate change and disasters (Smith and Wandel, 2006; Maddison, 2007; Deressa et al., 2011; Samal and Patra, 2012; Scheffran et al., 2012; Udmale et al., 2014; Arunrat et al., 2016; Stojanov et al., 2016; Jha et al., 2017; Khanal et al., 2018; Islam et al., 2019, among others). These studies analysed the household level data to measure the respondents' adaptive capacity.

Chapter 2 (Review of Literature) has discussed and presented the major empirical and other studies in this reference for various disasters. However, there are limited studies on adaptive strategies for water inadequacy and droughts. The present study attempts to fill this gap in the literature. The study analyses the determinants that may influence preparedness against drought. There are two inter-related objectives. First is to explain the probabilities of individuals' drought-preparedness based on the identified variables. The second objective is to explore the risk management strategies specifically for drought and water scarcity.

The contributions of this study are as follows. First, it provides field evidence of individuals' adaptive capacity via focusing on two drought-affected districts in Madhya

Pradesh. Second, the study employs Pressure and Release (PAR) model for drought disaster (discussed in section 4.4.1.2). Empirical studies employing PAR have mostly analysed fast-onset disasters (Singh, 2014; Daramola et al., 2016 and Shah et al., 2017). Third, existing studies are case specific, therefore the predictor variables are related to the study area and the identified disaster types. The present study therefore includes only those specific explanatory variables, sufficiently predicting the preparedness towards droughts at an individual level.

The respondents in the study area are directly or indirectly mostly engaged in the primary sector for livelihoods. Although droughts directly influence crop output and productivity; along with the farm-owners, agricultural labourers, self-employed individuals in agriculture, allied and non-agricultural sectors are also affected. The existing literature suggests that adaptive strategies are generally designed with the help and collaboration of various institutions and governments. However, it is logical to consider that individuals may also frame strategies minimising disaster risks. Moreover, it may serve as a cost-efficient and supplementary approach to the government's efforts towards climate adaptation and disaster risk management.

The next section (4.4.1.2) discusses the theoretical framework of the PAR model and its applicability in the context of all disasters. A detailed discussion of the primary data and research methodology is in section 4.4.1.3. It is followed by the results and discussion section (4.4.1.4). The final section (4.4.1.5) summarises the discussion and findings of the study.

4.4.1.2 Theoretical Framework: *Pressure and Release model (PAR model)*

The PAR model describes that the preparedness (adaptive capacity) or vulnerability from disasters depend on the respondent's root cause (socio-economic conditions), dynamic pressure (such as inadequate disaster information, crop loss etc.) as well as the unsafe conditions (Access to external aid/government support etc.) (Blaikie et al., 1994). The progression of vulnerability always begins with the root causes. In the presence of dynamic pressure, it finally leads to unsafe conditions. The root causes in the model are related to the respondent's characteristics (economic, social and political factors such as income, gender, education, etc.). It affects the availability and distribution of resources to deal with disasters. Dynamic pressure (Early warning of disasters, migration ability, etc.) is changing (local) conditions that transform the root cause effect on the disaster outcome. The unsafe conditions are external factors or environment which manifests the respondent's vulnerability (such as lack of irrigation infrastructure, unsafe location etc.)

The PAR framework suggests that the disaster risk may be reduced by relieving the vulnerability (pressure) of the affected population. In practice, the vulnerability factors differ according to the disaster type and geographic locations. Therefore, theoretically PAR has limitations of identifying the disaster and location specific root causes, dynamic pressure and unsafe conditions. However, disaster literature shows that studies (Singh, 2014; Awal, 2015; Daramola et al., 2016; Shah et al., 2017; De Silva et al., 2018; Hamis, 2018; Pepela et al., 2019) successfully adopted and applied the PAR model by identifying relevant explanatory variables for different disasters and geographies. Singh (2014) applied the conceptual framing of PAR model for industrial disaster in India for the first time. The variables for the root cause, dynamic pressure and unsafe conditions were modified that fitted well in the context of industrial disaster.

Awal (2015) described the PAR model and its components theoretically. The study stressed on the importance of social security in mitigating the adverse effects of weather related shocks as well as climate in Bangladesh. Daramola et al. (2016) analysed the households' data and explained the severity and non-severity of the adverse effects of floods in Nigeria. The authors applied the binary logit model and found that households with higher income, diversified sources of income and having non-agricultural employment were less affected by the floods. Shah et al. (2017) analysed the risk mitigation strategies against floods for households by employing the Probit model in Pakistan. Gender, age, income, family size and education mainly influenced the choices of mitigation strategies. De Silva et al. (2018) examined the households' vulnerability to floods and droughts in Sri Lanka. The authors show that low-income households with the dependency of livelihood on agriculture were most affected. Pepela et al. (2019) also studied 204 households head in Kenya to examine their coping and adaptation strategies against drought using PAR model.

Given such evidences, the PAR model is appropriate to apply in the present study of drought disaster. It correctly identifies and explains the relevant conditions which adversely affect the respondents' adaptive capacity (preparedness) in the study area (refer data section for details). The exposure to the drought hazard may have a differential impact on the respondents or group of respondents due to their different socio-economic characteristics (income, education etc.), physical environment (example location or access to government schemes etc.), and external factors (financial support by governments etc.). The Binary Logistic Regression Model is applied to estimate the results. The study also examines the risk management strategies of the adequately prepared respondents against droughts.

4.4.1.3 Research Methodology

This section elaborates on the profile of the survey area, sampling procedure, characteristics of the primary data and sources, along with the data analysis techniques (descriptive statistics and the binary logistic model) employed in the present study. There is also a description of the dependent and explanatory variables coding for data and subsequent analysis.

Sagar and Vidisha: ***Vulnerability Statistics***

Droughts have frequently occurred in many districts of Madhya Pradesh for the past several years. However, Sagar and Vidisha districts are purposively selected for the survey study, as both the districts were drought-affected in 2015 and 2017 (refer to Farmers' Portal). Also, all the 'tehsils' (sub-districts) falling under these districts were drought-affected.[39] The actual rainfall observed was significantly below the average-annual rainfall for consequently three years (2014, 2015 and 2016). The standard deviation of rainfall in Sagar district was –27.7, -36.0 and -26.1 and for Vidisha -13.4, -13.8 and -31.0 in 2014, 2015 and 2017 respectively (Indian Meteorological Department). District Composite Vulnerability Analysis by the Environment Planning and Coordination Organization, Madhya Pradesh, also place Sagar and Vidisha districts in 'severe' and 'moderate' risk categories respectively in climate change vulnerability assessment (Figure A4.4.1). Therefore, the outcome of the study is expected to give insights on the determinants of the preparedness against droughts as well as the risk management practices for the selected districts with varying vulnerability profile. The findings and recommendations of the study may be equally applicable to other drought-affected regions with similar socio-economic characteristics of population.

The major crops in selected districts are Soyabean, Wheat, Gram (Chana), and Pulses (Sarson, Arhar, Urad, Moong). The production of Soyabean and Wheat, the two major crops largely depends on rainfall and adequate irrigation facilities. The ratio of net irrigated area to the net sown area was 61.79 in Sagar and 79.07 percent in Vidisha for

[39] Sagar, Banda, Bina, Deori, Jaisinagr, Kesli, Khurai, Malthone, Rahatgarh, Raheli and Shahgarh are tehsils in Sagar districts. Basoda, Gulabganj, Gyaraspur. Kurwai, Nateran, Lateri, Shamshabad, Sironj, Vidisha, and Tyonda are tehsils in Vidisha district.

2015-16 (Directorate of Economics and Statistics, 2015-16). Interestingly, around 71 percent of marginal and small farmers owned less than 32 percent of land (States of Agriculture in Madhya Pradesh, 2013). With limited irrigation infrastructure, these marginal and small farmers are expected to be at high risk in the absence of adequate rainfall.

Registered working factory (per lakh of the population) was only one in Sagar, whereas Vidisha had none in 2015 (Directorate of Economics and Statistics, Madhya Pradesh). The per capita rural electricity consumption in Sagar (225 kwh) and Vidisha (220 Kwh) was below the state average of 307.40 Kwh. A large population in Sagar is engaged in 'Bidi' (a mini cigarette) making activity (unorganized sector); a low paid and labour-intensive work. The raw material for Bidi is 'tendupatta', whose availability also depends on adequate rainfall. Therefore, droughts might have adversely impacted the livelihoods of numerous individuals (both in urban and rural areas) engaged in 'Bidi' making.

The urban population in Sagar and Vidisha was 29.8 and 23.3 percent respectively (Census, 2011). The ratio of cultivators to total workers was 20.2 and 30.6, whereas agricultural labourers to total workers' percent was 37.6 and 41.5 in Sagar and Vidisha. The ratio of household workers to total workers was 14 and 3 percent respectively. Literacy rates were observed as 76.5 and 70.5, less than the state average of 78.7 percent. Given the above statistics, both the districts are highly vulnerable to rainfall deficiency, and also featured very low in the overall Vulnerability Index (State Disaster Management Plan, Madhya Pradesh, 2012).

Sampling procedure

The survey study follows the multi-stage sampling procedure to select individuals (sampling unit) as respondents from the drought-affected districts[40]. The sample survey was conducted in two phases, i.e. February and June 2018. A few tehsils and then a few towns/villages (from the selected tehsils) were chosen from both the districts. Then, randomly respondents were selected to participate in the survey interview. As droughts

[40] Meteorological, agricultural, and hydrological droughts are three drought types. According to the Indian Meteorological Department (IMD), drought occurs due to 25 percent or more rainfall deficiency in a year compared to the long-term average rainfall (generally for more than 30 years) in a district. Globally, there is wide disagreement on following a uniform drought definition (Wilhite and Glantz, 1985). However, Madhya Pradesh essentially considers IMD criteria of rainfall deficiency to declare drought at the district/tehsil/village level, along with other identified criteria (refer state manual for drought relief 2007 for more details). According to the National Commission on Agriculture, prolonged meteorological drought may lower the groundwater availability leading to hydrological, and agriculture drought (reduced soil moisture availability).

largely affect rural areas, engaged in agricultural activities, rural respondents were surveyed more than urban respondents. There were 161 rural and 43 urban respondents, making it 204 total respondents. Around 16 respondents were dropped, who could not complete the interview due to various reasons, therefore reduced from the targeted count of 220. As a result, the sample survey had 92.7 percent response rate. The semi-structured survey questionnaire (attached separately in appendix) was initially tested on 20 respondents as a pilot survey, and then the necessary corrections were incorporated to finalize the questionnaire. All the questions were translated in the Hindi language during face to face Interview of the respondents to note their responses. The list of the areas where the survey was conducted is attached in Appendix (Table A4.33).

Data type and sources

The data were obtained on factors related to socio-economic characteristics, drought-related information, financial relief, access to government schemes, and migration. These factors form the variables to describe the adaptive capacity of individuals. The information was also obtained to explore their risk management strategies against droughts. The respondents also provided information on their capacity to adapt (drought preparedness), which formed the dichotomous (categorical) dependent variable.

Data Analysis

The study employs a descriptive analysis (through cross-tabulations) and Binary Logistic Regression model to analyse the collected data. The cross-tabulations describe the respondents' risk management strategies to deal with droughts. They also describe the various adaptive capacity (drought-preparedness) components (Root cause, dynamic pressure and unsafe conditions) for respondents prepared to deal with the droughts[41].

The respondents show their drought preparedness position as Yes or No. Given this response, the binary logistic regression model has incorporated these outcomes as two dependent variables. The explanatory variables were grouped into three factors (Root cause, Dynamic pressure and Unsafe conditions) following the PAR model to predict the drought-preparedness. In parentheses, the categories to which the group represents are highlighted.

[41] The data analysis is done for the full sample (204 respondents) as well as a sub-sample (100 respondents) comprising of farmers only. The results obtained of sub-sample will give specific insights about the farmers' choices of risk mitigation measures and determinants of preparedness against drought and water scarcity.

Root cause (*All are related to individual characteristics*)

1. Principal employment
2. Economic Status
3. Age
4. Gender
5. Social group
6. Education
7. Sloe earner
8. Number of dependents
9. Land size
10. Income

Dynamic Pressure

1. Livestock loss (*individual characteristic)*
2. Early warning *(knowledge)*
3. Migration *(Migration capacity)*
4. Crop loss*(Farm)*

Unsafe conditions

1. Location *(physical environment)*
2. Access to government schemes *(external factors)*
3. Financial relief *(external factors)*
4. Irrigation source *(external factors)*

These explanatory variables are reclassified to include into the Binary Logistic Regression model, as a predictor of drought preparedness, as discussed in the next section.

Model specification (Full Sample and Sub-Sample)

The Binary Logistic Regression analyses the relationship of the dichotomous dependent variable with the dichotomous or continuous explanatory variables. The logistic model gives the odds of occurring the event (Probability of occurring the event to the probability of not occurring the event).

$$Log\ (Prob.the\ event/Prob.no\ event) = \alpha_0 + \beta_i X_i + \cdots + \beta_n X_n \qquad (1)$$

Table 4.20 Variable Coding, Reference category and Source of Vulnerability for Binary Logistic Regression

Notation	Variables	Type	Description (Categories)	Reference categories (0)	PAR Model (Source of Vulnerability)	Related to
1	2	3	4	5	6	7
Y	Adaptive capacity (Risk management ability due to adapted strategies, (No, Yes)	Dependent Variable	0,1	Adaptive capacity (No)	Root cause	Individual's characteristics
X_1	Principal employment (Self-employed in non-agriculture, self-employed in agriculture regular wage/salary earning, casual labour in agriculture, others	Explanatory Variable	0, 1, 2, 3, 4	Principal employment (Self-employed in non-agriculture)	Root cause	Individual's characteristics
X_2	Economic Status (APL/BPL)	Explanatory Variable	0,1	Economic status (APL)	Root cause	Individual's characteristics
X_3	Age (Years) (18-35, 36-45, 46-55, 56-65, 66 and above)	Explanatory Variable	0, 1, 2, 3, 4	Age (18-35 Years)	Root cause	Individual's characteristics
X_4	Gender (Male/Female)	Explanatory Variable	0, 1	Gender (Male)	Root cause	Individual's characteristics
X_5	Social Group (General, SC, ST, OBC, Unclear)	Explanatory Variable	0, 1, 2, 3, 4	Social group (General)	Root cause	Individual's characteristics
X_6	Education (Graduate, Illiterate, Below high school, High school, Higher secondary school, Post-graduate, Above Post Graduate)	Explanatory Variable	0, 1, 2, 3, 4, 5, 6	Education (Graduate)	Root cause	Individual's characteristics
X_7	Sole earner (No, Yes)	Explanatory Variable	0, 1	Sole earner (No)	Root cause	Individual's characteristics
X_8	Number of dependents (up to 2, 3 to 4, more than 4)	Explanatory Variable	0, 1, 2	Number of dependents up to 2	Root cause	Individual's characteristics
X_9	Income (INR 8.1-11K, Below 5, 5-8, 11.1 to 20, more than 20K, don't know)	Explanatory Variable	0, 1, 2, 3, 4, 5	Income (INR 8.1-11K)	Root cause	Individual's characteristics
X_{10}	Livestock loss (No/Yes)	Explanatory Variable	0, 1	Livestock loss (No)	Dynamic pressure	Individual's characteristics
X_{11}	Early warning received (Yes/No/Don't Know)	Explanatory Variable	0, 1, 2	Early warning received (Yes)	Dynamic pressure	Knowledge
X_{12}	Migration (Yes/No)	Explanatory Variable	0, 1	Yes	Dynamic pressure	Migration capacity
X_{13}	Access to Government Schemes (PDS, Midday meal, MUDRA Loan, MNREGA, PMFBY, Subsidiary for fuel and/or seed, Crop loan at 0%, Bhavantar, KCC, Subsidiary for Irrigation, Soil Check etc.) (5 and above, Less than 3, 3-4,)	Explanatory Variable	0, 1, 2	Access to Government Schemes (5 and above)	Unsafe condition	External factors
X_{14}	Location (Urban/Rural)	Explanatory Variable	0, 1	Location (Urban)	Unsafe condition	Physical environment
X_{15}	Crop Losses in drought year (No loss, Up to 25 %, 26-50 %, More than 50%, Can't say)	Explanatory Variable	0, 1, 2, 3, 4	Crop Losses in drought year (No loss)	Dynamic pressure	Farm
X_{16}	Financial relief (Post-drought relief by the government) received (Yes/No)	Explanatory Variable	0, 1	Financial relief received (Yes)	Unsafe condition	External factors
X_{17}	Irrigation Source (Borewell, Canal, Lake/Pond, River, Rainfall, Others)	Explanatory Variable	0, 1, 2,3,4,5	Irrigation Source (Borewell)	Unsafe condition	External factors

The probabilities that an event will occur are only 0 and 1 following the logistic distribution function. In the present study, the estimation probability 0 represents the absence of respondents' preparedness against drought, whereas 1 denotes the preparedness. The coefficient of logistic regression may be explained as the change in log odds when the explanatory variable changes by a unit. The increase in the odds of experiencing the outcome is depicted by a positive coefficient beta, whereas a negative coefficient indicates a decrease in the odds. The present study measures the adaptive capacity (drought preparedness) of individuals against drought events following the Pressure and Release (PAR) model conceptualized by Blaikie et al. (1994).

It employs the following empirical model to explain the respondents' preparedness for the full sample.

$$Y_1 = \alpha_1 + \sum_{j=1}^{14} \beta_j X_j + \beta_{15}(X_4 \cdot X_{13}) + \beta_{16}(X_1 \cdot X_7) + \varepsilon_1 \qquad (2)$$

and, for the sub-sample (respondents engaged in farming and therefore eligible for financial relief towards drought) as

$$Y_2 = \alpha_2 + \sum_{j=2}^{17} \nu_j X_j + \nu_{18}(X_{10} \cdot X_{16}) + \phi_2 \qquad (3)$$

Where, Y_1 is the adaptive capacity (preparedness for drought) for the full sample consisting of 204 respondents. Y_2 represents adaptive capacity (preparedness for drought) for the sub-sample comprising of only 100 respondents.

Table 4.20 explains the variables (column 2), their type (column 3), variable coding (column 4), reference category (column 5) and source of vulnerability (column 6). These variables are included in the study following their relevance in PAR framework, and in context to droughts in the study area. X_1 to X_9 are the variables which belong to the root cause (related to individuals' characteristics) for preparedness or non-preparedness towards drought events. Variables $X_{10}, X_{11}, X_{12} and\ X_{15}$ are the sources of dynamic pressure and are related to individuals' capacity, knowledge, migration capacity or farm dynamics. $X_{13}, X_{14}, X_{16}, and\ X_{17}$ are those variables that may create unsafe conditions for drought preparedness and are related to the physical environment and external factors.

In view of the selected explanatory variables, it is a priori expected that early warning, financial relief, migration, access to government schemes, adequate irrigation capacity, high income and high level of education should show a positive and statistically significant association with drought preparedness/adaptive capacity. On the other hand, explanatory variables like more number of dependents, livestock loss, crop loss, should show a statistically negative relationship with drought preparedness.

The final estimated model (Equation 2) also includes two interaction variables (for full sample). First is the interaction of 'Access to government schemes' with 'Gender', whereas the second variable is the interaction of 'Employment status' with 'Sole earner'. The objective behind their inclusion is to analyse the moderation effect of such variables on the respondents' capacity to prepare. For example, the first interaction variable should explain how gender moderates the effect of access to government schemes, changing the probability of the individuals' drought preparedness. There is a rationale to study such interaction effect as gender (male and female) may have unequal access to the available government schemes and therefore, may exert different impacts on the preparedness level.

An explanatory variable (Land size) for which data was collected during the survey was dropped from the final estimation model (Equation 2). The multi-collinearity diagnostics to identify the bivariate correlations (Table 4.21: Multicollinearity Diagnostics) indicated a probable high correlation between General education and Land size. The high correlation coefficient (0.46) also confirmed a strong relationship and warranted to drop one of the variables. Henceforth, Land size as an explanatory variable was dropped from the final estimation model.

Table 4.21 Multicollinearity Diagnostic; Full sample

Variables	**Tolerance**	**VIF**	**Significance**
General Education (X6)			
Below high school	0.10	9.738	0.026**
High school	0.097	10.305	0.020**
Higher secondary school	0.149	6.690	0.079*
Post-graduate	0.250	4.003	0.197
Land size (X9)			
Less than 1 hectare	0.097	10.317	0.200
1 to 2 hectare	0.194	5.152	0.122
2 to 4 hectare	0.241	4.143	0.121

*****Significant at 10%; ** Significant at 5%; *** Significant at 1%
Author's own estimates

4.4.1.4 Empirical results and Discussion

This section reports the important results obtained from the data analysis. The discussion on results is focused on three aspects related to drought preparedness. First, there is a description of the important factors (Root cause, Dynamic pressure and Unsafe conditions) affecting drought preparedness. Second, employing descriptive statistics, the risk management strategies of the respondents prepared to deal with drought are analysed. Finally, there is an elaborative insight on the results obtained with Binary Logistic Regression analysis (for full and sub-sample).

Description of factors associated with drought preparedness:

Table 4.22 presents the relationship of important variables related to the 'Root cause' (Economic status, Dependents and Income) and percentage of respondents, who were prepared to face droughts (full sample) by cross-tabulation. The findings for root cause related variables indicated that among the respondents, who were prepared to deal with droughts, 23 percent were from Above Poverty Line (APL), whereas, 77 percent respondents were in Below Poverty Line (BPL) category. In reference to the number of dependents, respondents having up to 2, 3 to 4, and more than 4 dependents were 31, 38 and 31 percent respectively. The results of cross-tabulation further describe the income level association with the preparedness. A majority (43 percent) of prepared respondents belong to the income group of INR 5000 to 8000, followed by INR 8001 to 11000 (28 percent). Only 6 percent respondents were from more than INR 12000 income category among all prepared.

Table 4.22 Root cause (Economic status, Dependents and Income) and Adaptive Capacity (Drought-Preparedness)

Adaptive capacity (Root Cause)	**Percentage of Respondents who were prepared to deal with drought**
Economic Status	
APL	23
BPL	77
Number of dependents	
Up to 2	31
3 to 4	38
More than 4	31
Income level (INR)	
8.1-11K	28
Below 5K	14
5 to 8K	43
11.1 to 12K	09
More than 12K	06

Source: Field Survey 2018

Table 4.23 explains the distribution of two important variables (Livestock and Early warning) related to the 'Dynamic pressure'. 86 percent respondents, who were prepared enough, never had any livestock loss. Those who lost their livestock due to drought but were adequately prepared, were 14 percent. Most of the respondents during field survey informed that they somehow managed to get drinking water for livestock by reaching to distant, common or other external water sources like river etc. 77 percent prepared respondents to have early warning (information) of droughts through various informational sources (Newspaper, Television etc.). Approximately 14 percent respondents did not receive any early warning information and around 9 percent respondents were not able to reveal their opinion on early warning information. It was observed that most farmers (among all respondents) searched about weather, monsoon and rainfall related information, especially before and during the sowing of summer (Kharif) crops.

Table 4.23 Dynamic pressure (Livestock Loss and Early warning) and Adaptive Capacity (Drought-preparedness)

Adaptive capacity (Dynamic Pressure)	**Percentage of Respondents who were prepared to deal with drought**
Livestock Loss	
No	86
Yes	14
Early warning received	
Yes	77
No	14
Don’t know	09

Source: Field Survey 2018

Table 4.24 presents the statistics with reference to the ‘Unsafe conditions’ (Financial relief, Access to government schemes and Location) related variables. Those who received the financial relief from the government towards drought-induced crop losses, 85 percent were ready to deal with the drought situation. Those who never received the financial relief, but were adequately prepared were only 15 percent. The majority (72 percent) of respondents have access to less than 3 government schemes. Respondents having access to 3 to 4, and, 5 and above schemes were 8 percent each. 72 percent prepared respondents were from rural location in comparison to 28 percent from urban areas.

Table 4.24 Unsafe Conditions (Financial relief) and Adaptive Capacity (Drought-preparedness)

Adaptive capacity (Dynamic Pressure)	**Percentage of Respondents who were prepared to deal with drought**
Financial relief received	
Yes	85
No	15
Access to Government schemes	
Less than 3	72
3-4	8
5 or more	8
Location	
Urban	28
Rural	72

Source: Field Survey 2018

Risk management Strategies for drought

Table 4.25 shows the summary of the respondents' risk management strategies to minimize the losses from drought disaster. Diversification of income sources, access to government schemes, migration, securing alternative sources of water for irrigation and diversifying the employment (more than one work) are the major strategies emerged from the survey study. Among respondents who were prepared to face drought, 23 percent have at least one more earning member in the family. Almost 28 percent respondents, who were prepared enough, ensured to access three or more government schemes like food security through PDS, employment guarantee (MGNREGA), crop insurance (PMFBY), agriculture loans etc. Access to more resources may strengthen their capacity to prepare. These respondents were active enough to go extra miles, use social networks and to reach institutions to get the benefit of the existing schemes.

Around 18 percent respondents relied upon migration to some other cities or towns to sustain their livelihoods. Among these migrants, around 75 percent were landless, marginal, small or semi-medium farmers. Those who migrated cited the main reasons as, livelihood loss due to drought (71 percent), no coping strategy at residence/place of work (13 percent), and insufficient or lack of government intervention (7 percent) in providing livelihood opportunities. Most of the migrations (30 percent) were seasonal, for short (6 months to less than 1 year) or very short (2 to 4 months) period. Almost 68 percent respondents migrated alone, without accompanying any of the family members. Notably, respondents migrated to big cities like Indore and Bhopal (Intra-State), as well as to the big cities of neighbouring states (Inter-State) such as Jaipur (Rajasthan), Raipur (Chhattisgarh) and Ghaziabad (Uttar Pradesh) etc.

Table 4.25 Risk Management Strategies (Diversification of Income, Government Schemes, Migration, Irrigation sources and Diversification of Employment) and Drought Preparedness

Adaptive Capacity (Drought Preparedness)	**% of Respondents who are prepared to deal with drought**
Sole earner	
No	57
Yes	23
Access to Government Schemes (Number)	
5 and above	08
Less than 3	72
3 to 4	20
Migration	
Yes	18
No	82
Irrigation Source	
Borewell	03
Canal	05
River	08
Others	20
Employment Status	
More than 1	40

Source: Field Survey 2018

Looking at the period of migration, it appears that migration was used as a short-term coping strategy rather than long-term mitigation strategy, as also observed by Samal and Patra (2012). Other studies (Renaud et al., 2007; Adamo 2010; Warner, 2010 among others) also observed that migration was merely a coping strategy and was practiced when the adaption strategies failed. Further, 82 percent respondents either not migrated willingly or were incapable of migrating due to different reasons. The major reasons for non-migration among interested respondents were ill-health, ageing, lack of non-farm skills, fear and insecurity to work outside native place, no linkages for migration, dependent parents and other family members. Stojanov et al. (2016) also supported the above findings regarding constrains to migrate. They argued that farmers' socio-economic and farm-level conditions dictate their possibility of migration.

To ensure the adequate water supply at farmland during the drought period, 20 percent respondents have arranged well and 3 percent dug bore well at the farm site. Rivers and canals as an alternate source of irrigation were accessed by 8 and 5 percent respondents respectively, who showed preparedness level. Earlier Uddin et al. (2014) and Udmale et al. (2014) also observed that adequate irrigation facilities at the farm are important variables to minimize losses due to less rainfall. It is also observed that among prepared individuals, 40 percent have more than one employment source. These respondents have minimized their dependency on one (primary) source of income. Previous studies (Moench and Dixit, 2004; Daramola et al., 2016, among others) also acknowledged the importance of diversification of income sources for risk minimization against natural disasters. It is to note that for both rural and urban individuals, the diversification of income sources may help to reduce the risks arising from the water scarcity. For example, a rural individual with primary occupation in the agricultural sector and having secondary employment in the non-agricultural sector may better withstand the droughts ill effects and vice versa. Ncube et al. (2018) for Zimbabwe also observed that employment diversification was helpful to minimize the losses from droughts.

Drought preparedness: Binary Logistic Regression Model

This section summarizes the results of the diagnostic tests and binary logistic regression model for the full sample and sub-sample. First, we discuss the diagnostics of the full sample for the preferred model (Equation 2).

Table 4.26 presents the model coefficients test (Omnibus) confirming the statistical significance of the model. The model observed a value of 86.428 for Chi-square at a significance level of 0.000

Table 4.26 The Omnibus Test for model Coefficients

Chi-square value	df	Significance
86.428	35	0.000

Additionally, Hosmer and Lemeshow test for model specification (Table 4.27) also confirms the correctness of the model with the significance value of 0.81.

Table 4.27 Hosmer and Lemeshow Test

Chi-square value	df	Significance
4.493	8	0.810

The classification table (4.28) suggests that in 78.9 percent of cases, the model correctly predicted the outcome variable (Preparedness for drought).

Table 4.28 Result of Logistic Regression (Classification Table)

Observed	**Predicted Adaptive capacity**		**Percentage Percentage correct**
Adaptive capacity	No	Yes	
No	123	16	88.5
Yes	27	38	58.5
Overall Percentage			78.9

The empirical estimation results are presented in Table 4.29 for the binary logistic regression analysis. The coefficients are reported only for the variables observed as statistically significant. The reference categories for explanatory variables are highlighted in Table 4.20 (column 2).

Table 4.29 Logistic Regression Model (1) of Adaptive Capacity

Variable	Coefficients	Significance	Exp (B)
Employment Status (self-employed in agriculture)	-1.050*	0.083	0.350
Gender	3.968***	0.001	52.855
Social group (ST)	1.351*	0.081	3.862
Social group (OBC)	2.319***	0.007	10.163
Income (Below INR 5000)	-1.447**	0.019	0.235
Income (INR 11001 to 20000)	2.111*	0.096	8.259
Migration	1.830***	0.001	6.232
Access to Government Schemes (less than 3)* Gender	-5.554***	0.000	0.004

* Significant at 10%; ** Significant at 5%; *** Significant at 1%; Nagelkerke R Square= 0.498

Employment Status: Drought impact the crops most adversely. Therefore, the self-employed (especially farmers and agricultural labourers) individuals directly associated with the agriculture sector are more vulnerable than others. The result also indicates that the odds of their preparedness is only 35 percent than those who are self-employed in the non-agriculture sector.

Gender: The results suggest that the odds of preparedness for droughts increased over 52 times for female in comparison to the male (reference category). The possible explanation of the obtained result is that cooking, washing and other household activities requiring water are mostly performed by females. Therefore, water security and mitigating risks due to water shortages become their responsibility, motivating them to adapt fast. Okuli W et al. (2012) in a primary study in Tanzania, also found that women were more devoted to the adaption practices regarding water usage in households than men. In the present study, the female respondents were mostly self-employed in 'Bidi' industry. They were contributing towards households' welfare by actively making 'Bidis' and earning around INR 2000-3000 per month. Also, their participation in farm-level activities was also significant. During the interaction most of them revealed that they understand that droughts like situation may come any time. Therefore, they work for a longer duration, earn more in normal years (when they get more work to make 'Bidis') and save some money for difficult (drought) years. The Bidi making skill helped them to adapt to water scarcity and ensuring food safety. Also, some of the women respondents were having access to the microfinance institutions, helping them to generate alternative sources of income and making self-resilient to drought conditions. With such observations, it may be concluded that women are more adaptive to water shortages for household's work, income generation and food security than direct farm-level adaptation in the survey area.

Nhemachena and Hassan (2007) also argued that in South Africa, in comparison to male, the probability of adaption to climate extremes was more of female-headed households. According to them, women were more likely to adapt as in rural areas, most of the agricultural work was done by them. Their knowledge, skills, experience and information flow related to farm management were superior. Therefore, rich farming experience improved the odds of preparation. For the present study, this argument is equally valid, as when men migrated (often alone) to cope with droughts, female-owned the responsibility of farmlands. Their access to resources and experience of farming grows, which may have translated into better adaptation capacity.

Social group: The findings with reference to Social group suggest that Scheduled Tribe (ST) and Other Backward Class (OBC) respondents are better prepared than the reference category (General class). The social safety schemes are more accessed by them than the respondents of general category in the sample survey. Even majority of the government schemes are designed for uplifting these social classes in the state. In numeric terms also, these social classes are dominant in the study area. The same argument is proposed by Krishnaswamy (2012) that drought severely affect the well-off rural individuals than others. In our study, the proportion of the rural respondents is significantly more than the urban respondents.

Income: The respondents having income less than INR 5,000 were found to be less prepared than those having an income of INR 8,001 to 11,000. The preparedness towards drought was around 24 percent than those with an income of INR 8,001 to 11,000 (reference category). The increase in income ladder (INR 11001 to 20,000) was associated with the increase in odds of drought-preparedness by around 8 times in comparison to the reference category. These findings follow the studies like Daramola et al. (2016), Nadamani and Watanabe (2016) and Islam et al. (2019). As income rises, the resources necessary to adapt also increase. Barnett and Webber (2009) findings that financial resources are required to adapt also support the above results. Deressa (2009) also examined that rising income (farm as well as non-farm) was positively correlated with the adaptation capacity of farmers towards climate extremes in Ethiopia. Nguyen et al. (2017) and Reardon (1997) also found that higher income (from non-farm wages) may have a positive (and indirect) impact on crop productivity. Further, Agrawal (2002) and Kim et al. (2017) also confirmed that low level of earnings might negatively impact the aspiration and efforts to adapt towards climate change. In addition, Belay et al. (2017) also observed that increase in income of small farm holders might enhance the likelihood of water conservation practices in Ethiopia.

Migration: The odds of drought-preparedness for those who never migrated, increased by six times than respondents who migrated to some other places. The migration observed in the study area was a push migration. Respondents moved to neighbouring towns to cope up with water scarcity led to distressed economic conditions. It is to note that the migration was always a regular phenomenon in the study area, whenever drought occurred. However, often, it was not a permanent migration. The respondents cope during drought period by migrating elsewhere, earn there, but come back after passing the farm crisis. Therefore, migration helps them and family for a while but fails to emerge as a mitigation strategy against drought. This may be the reason that migration was not statistically significant in determining the preparedness. Previous studies (Samal and Patra, 2012; Tschakert and Tutu, 2010; Bhatta and Agrawal, 2016 among others) also observed that migration was merely a coping strategy for a short duration. Water scarcity for agriculture purpose and non-availability of employment in agriculture as well as non-water sensitive industries caused the migration of landless and marginal farmers from rural areas. Anuja et al. (2018) observed such phenomenon in Bundelkhand region of Uttar Pradesh (an Indian State) that young and unskilled male migrated to cope (for securing livelihood) due to droughts induced economic distress in neighbouring towns. However, migration may reduce the labour supply in the next farming season, aggravating the farm distress. Therefore, though the respondents quoted migration as an adaptation (risk management) strategy in the survey, it appears to serve the purpose of coping alone.

Interaction Variable: In reference to the first interaction variable (Access to government schemes with Gender), the results show that the preparedness of female having access to less than 3 government schemes are 99.7 percent less than the males with access to 5 or more government schemes. It is interesting to note that when the access to the government's welfare or other schemes reached to 5 or more, the gender effects reversed. Now male determines more preparedness than females. This finding clearly highlights the importance of a bundle of social safety schemes (at least five) together. If the bundle of schemes (5 or more) are accessed by the male respondents, it may surely help to prepare against droughts. Table 4.30 rearranges the variables chronologically (from highest to lowest magnitude), i.e., according to their influence on the increase in the odds of drought-preparedness.

Table 4.30 Predictor variables increasing the log odds of Adaptive Capacity (Drought- preparedness) from greatest to least

S. No.	Variable	Exp (B)	*PAR Model (Source of Vulnerability)*	Related to
1	Gender	52.855	Root cause	Individual's characteristics
2	Social group (OBC)	10.163	Root cause	Individual's characteristics
3	Income (INR 11001 to 20000)	8.259	Root cause	Individual's characteristics
4	Migration	6.232	Dynamic pressure	Migration capacity
5	Social group (ST)	3.862	Root cause	Individual's characteristics
6	Employment status	0.350	Root cause	Individual's characteristics
7	Income (Below INR 5000)	0.235	Root cause	Individual's characteristics
8	Access to Government Schemes (less than 3)* Gender	0.004	Unsafe Condition* Root cause	External factor* Individual's characteristics

Among significant variables, Gender, Social group, Income and Principal employment (individual's characteristics) were related to the root cause in the PAR model. Migration represents the individual capacity to move out and belongs to the dynamic pressure category. The interaction variable (Access to government schemes * Gender) was related to the Individual's characteristics. The interaction variable emerged when external factor (unsafe conditions) and root cause (Individual's characteristics) interact. The predictor variables which increased the log odds of drought preparedness in terms of greater magnitude were Gender followed by Social group (OBC) and then Income (INR 11001 to 20000). It shows that individuals' preparedness mostly influenced by the Gender, social class and Income level of respondents in the survey area. The results of the other two less fitted estimation models (1a) and (1b) for the full sample are also reported in (Table A4.34 and A4.35) in Appendix. Table 4.31 reports the finding of the logistic regression analysis for the sub-sample (respondents who are farmers and eligible to receive financial relief due to crop loss from droughts).

Table 4.31 Sub-Sample: Logit Model (2) of Adaptive Capacity

Variable	**Coefficients**	**Significance**	**Exp** (B)
Gender	6.038**	0.043	419.052
Social Group (SC)	-4.853**	0.023	0.008
Social Group (OBC)	-3.044*	0.052	0.048
Income (Below INR 5000)	-6.498**	0.016	0.002
Income (INR 5000-8000)	-8.667***	0.005	0.000
Migration	3.330**	0.027	27.938
Crop loss (26-50%)	-3.838*	0.093	0.022

* Significant at 10%; ** Significant at 5%; *** Significant at 1%, Nagelkerke R Square= 0.707

Similar to the full sample results, the odds of preparedness increased by around 419 times for female when compared to male respondents. The probabilities of preparedness were less for Scheduled Caste (SC) and OBC respondents than the reference category of respondents. The odds of being prepared for the income group below INR 5000 and INR 5000-8000 decreased significantly than the reference group (INR 8001 to 11000). These results are well supported by the observations by Deressa (2009) that higher farm income helps to farm level adaption practices (such as conserving soil and sowing different crop varieties etc.) for farmers with limited land. For the non-migrated respondents, the odds of preparation towards drought increased by around 28 times than the migrant farmers. The odds of drought-preparedness is only 2 percent for the respondents having 26-50 percent crop loss in drought years than those farmers having no crop losses. Table 4.32 rearranges the predictor variables in chronological order (highest to lowest odds ratio), highlighting their relation to the Root cause, Dynamic pressure or with Unsafe condition.

Table 4.32 Sub-sample: Predictor variables increasing the log odds of Adaptive Capacity (Drought- Preparedness) greatest to least

S. No.	**Variable**	**Exp (B)**	***PAR Model (Source of Vulnerability)***	**Related to**
1	Gender	419.052	Root cause	Individual's characteristics
2	Migration	27.938	Dynamic pressure	Migration capacity
3	Social Group (OBC)	0.048	Root cause	Individual's characteristics
4	Crop loss (26-50%)	0.022	Dynamic pressure	Farm
5	Social Group (SC)	0.008	Root cause	Individual's characteristics
6	Income (Below INR 5000)	0.002	Root cause	Individual's characteristics
7	Income (INR 5000-8000)	0.000	Root cause	Individual's characteristics

The outcome (for the sub-sample) signifies that among significant predictor variables, the most important determinant of drought preparedness is Gender (Root cause), Income between INR 5000-8000 (Root cause) scored least. Another important observation is that financial relief (towards drought losses) is non-significant variable in the analysis. These findings get support from the previous studies (Shughart, 2011; Xu and Mo, 2013; Morris and Wooden, 2003; among others). They show that financial relief towards disaster losses failed to have any significant impact on the livelihood of affected individuals. The beneficiaries failed to create productive assets for long-term benefits. The present study generates first-hand empirical evidence about the role and impact of selected determinants to adapt suitable strategies against droughts to policy-makers and state government. As a robustness measure, the results of another empirically estimated model (2a) for sub-sample are reported in Appendix A4.4.1 (Table A4.35).

Appendix A4.4.1

Table A4.33 List of Blocks (Tehsils) surveyed for the study

S.No.	District	Block
1	Sagar	Sagar
2	Sagar	Jaisinagar
3	Sagar	Surkhi
4	Sagar	Mathone
5	Sagar	Rahatgarh
6	Vidisha	Teoda
7	Vidisha	Sironj
8	Vidisha	Tyonda

Table A4.34 Full Sample: Logit Models (1a and 1b) of Adaptive Capacity (Drought-preparedness)

	Model 1a			Model 1b		
Variable	**Coefficients**	**Significance**	**Exp (B)**	**Coefficients**	**Significance**	**Exp (B)**
Income (below INR 5000)	-1.400**	0.013	0.247	Income (below INR 5000)	-1.549**	0.011
Income 3	2.285*	0.041	9.830			
Migration	1.112**	0.011	3.041	1.633***	0.002	5.121
Gender				3.795***	0.001	44.487
Access to Government Scheme (less than 3)*Gender (female)				-5.677***	0.000	0.003
Nagelkerke R Square= 0.058				Nagelkerke R Square= 0.464		

* Significant at 10%; ** Significant at 5%; *** Significant at 1%

Note: Model1a is first estimated employing all the explanatory variables of Equation (1) but without both the interaction variables.Model1b is estimated with all the explanatory variables of Equation (1), but with only first interaction variable (Access to Government schemes* Gender)

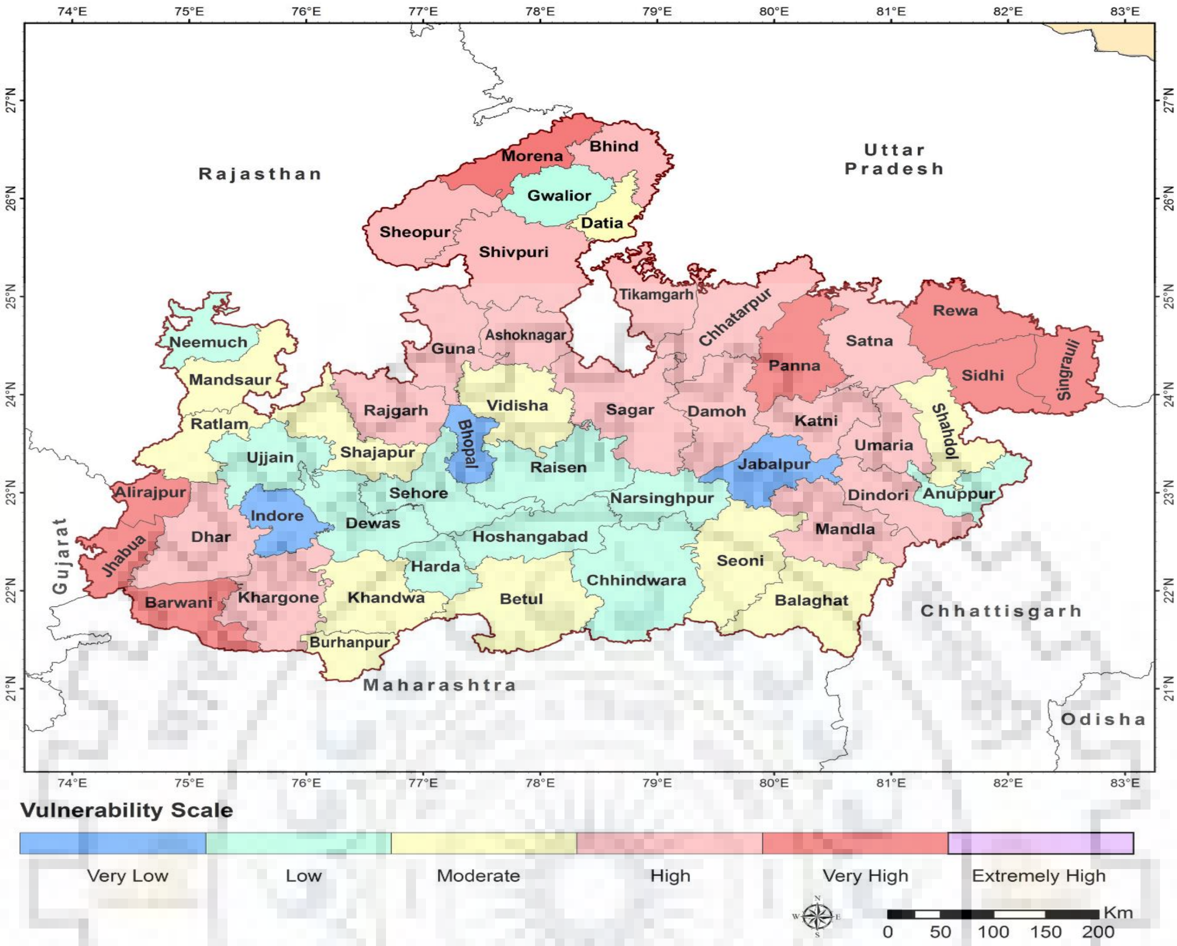
Table A4.35 Sub-sample: Logistic Regression Model (2a) of Adaptive Capacity (Drought-preparedness)

Variable	**Coefficients**	**Significance**	**Exp (B)**
Gender	5.798**	0.033	329.543
Social group (SC)	-4.714**	0.015	0.009
Social group (OBC)	-3.113**	0.034	0.044
Income (Below INR 5000)	-5.475**	0.024	0.004
Income (INR 5000-8000)	-7.384*	0.007	0.001
Migration	2.607**	0.039	13.559
Crop loss (26-50%)	-3.457*	0.097	0.032

*Significant at 10%; **Significant at 5%; ***Significant at 1%; Nagelkerke R Square= 0.676

Note: Model (2a) is estimated employing all the explanatory variables of Equation (2) but without the interaction variable (Financial relief* Livestock loss)

Figure A4.4.1 District Composite Vulnerability – MP Vulnerability 1981-2010



Source: Madhya Pradesh Climate Change Knowledge Portal. Available at http://www.climatechange.mp.gov.in/en/vulnerability-dashboard

4.4.2 Behavioural biases in decision making

4.4.2.1 Introduction

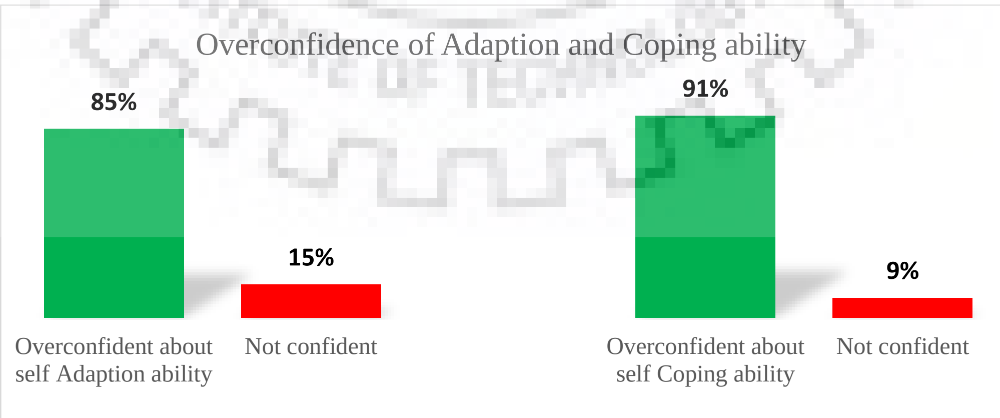
In situations of uncertainty and risk, decision making becomes challenging and difficult for individuals. According to prospect theory (Kahneman and Tversky, 1979), decisions under risk and uncertainty exhibit irrationality that appear to remain equally applicable in the context of disaster events (Rustemli and Karanci, 1999; Ballantyne, 2000; Paton and Johnston, 2001; Grothmann and Reusswig, 2006; Meyer and Kunreuther, 2017). In such circumstances, individuals often exhibit irrational decision choices driven by behavioural issues, which are the building blocks of individual's decision making (Aigbovo and Llaboya, 2019). Often, individuals either simply do not know the risk (Gifford, 2011) or do not understand the actionable after knowing the probable disaster risk (Palm and Hodgson 1993). With this backdrop, the present chapter attempts to explore the three important behavioural biases (Overconfidence, Over-optimism and Herding) through primary survey in the sampled respondents. The theoretical foundation of these psychological biases has been discussed in detail in the 'Introduction' chapter of the thesis.

The arrangement of the subsequent sections in the chapter are as follows. Section 4.4.2.2 attempts to provide the empirical evidences about the presence of selected behavioural biases through the primary survey. The overconfidence, over-optimism and herding biases are explored and subsequently analysed employing descriptive analysis. Section 4.4.2.3 is the conclusion, which summarizes all the key insights on the subject matter.

4.4.2.2 Descriptive analysis

Overconfidence: There were 65 respondents (out of 204) prepared to deal with the droughts at the time of the field survey. In response to the question about their ability to deal with such frequent as well as extreme events in coming years, 55 respondents answered (85%) that they will be able to deal with them easily. Similarly, with reference to coping ability, 73 out of 80 currently prepared respondents (91%) expressed their ability to cope with such extreme events in future also (Figure 4.13). Interestingly, it is to note that, even in such prepared respondents, more than one earner in the family, migrant with access to more than 3 government schemes were less. In the absence of given determinants of adaptive capacity, there preparedness may not be full proof or adequate for future drought events. However, 85% respondents' expression about enough future preparedness indicates the presence of overconfidence bias.

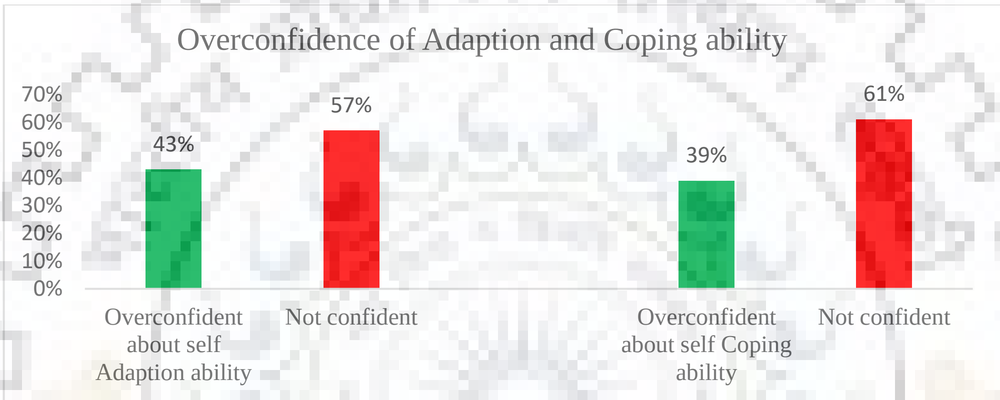
Figure 4.13 Overconfidence of adaption and coping among prepared respondents



Source: Field Survey 2018

To validate above findings, the same questions were also asked to the remaining set of respondents with no preparedness (139) or coping capacity (127) with previous droughts. It was expected that these respondents will not be sure about their ability to deal with droughts in future also. The results however show that, around 60 (out of 139) and 50 (out of 127) non-prepared respondents (43% and 39% respectively) were very much confident about their ability to prepare and cope with future drought events (Figure 4.14). Such results present strong evidences for overconfidence bias among individuals in context of uncertain drought events preparedness.

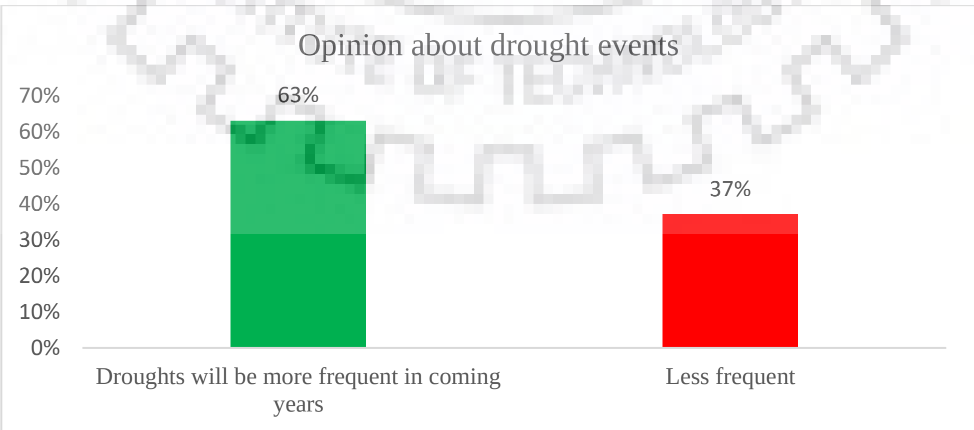
Figure 4.14 Overconfidence of adaption and coping among non-prepared respondents



Source: Field Survey 2018

Over-optimism: The survey finds that around 63% respondents were of the opinion that the rainfall scarcity led droughts will be frequent in coming years (Figure 4.15). In the absence of sufficient irrigation facility with them, it must be a threat to the crops and agricultural productivity.

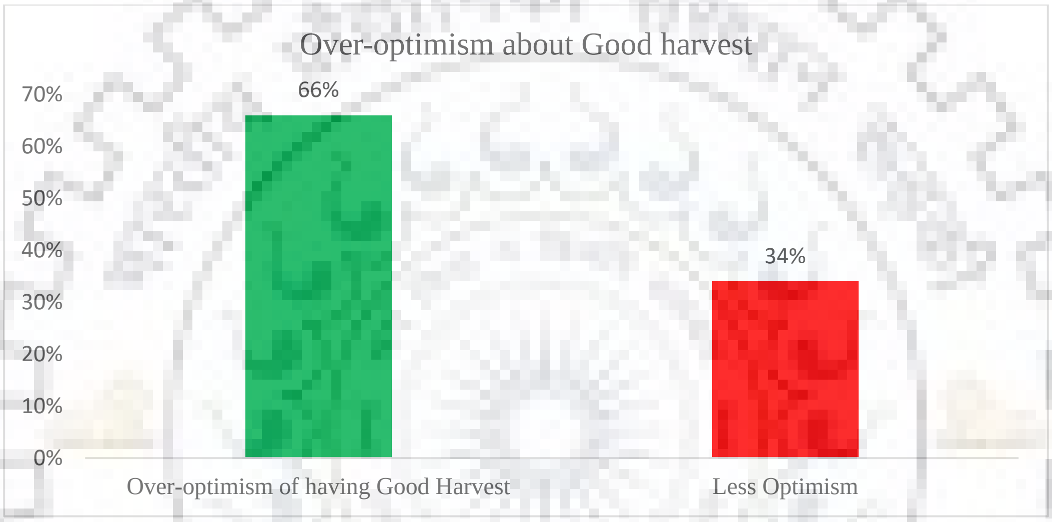
Figure 4.15 Opinion about drought events



Source: Field Survey 2018

However, when questioned about the probabilities of having a good harvest in coming years, 66% farmers (59 out of 90) expressed an optimism of having good harvest despite frequent droughts expectations (Figure 4.16). This paradox indicates that over-optimistic thoughts about own farm production is an irrational behaviour shown by such respondents. If the rainfall is expected to be less, then how rainfall dependent crops may be good in absence of adequate irrigation infrastructure? The explanation of such over-optimism bias among respondents may only be explained with the help of behavioural finance theory of decision making under uncertainty and risks.

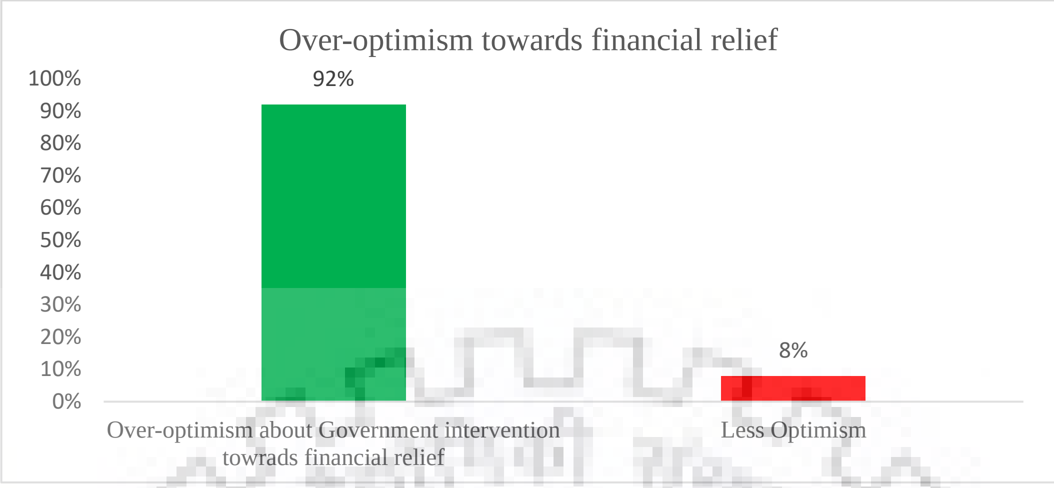
Figure 4.16 Over-optimism about Good harvest



Source: Field Survey 2018

Further, the farmers were asked to give opinion about the chances of getting the financial relief against crop losses by state government for future drought events. Notably, all the surveyed farmers have received the financial relief at least once in last 2-3 drought years by the state government. The droughts were officially declared twice in last three years, but the relief was given only once. In that sense, the probability of getting relief in future should be around 50%, following a common rational. Therefore, it was expected that majority of farmers will register a probability of around 50%. However, the observed responses show otherwise. 83 out of 90 respondents (92%) were optimistic to get financial relief (with 60% to 100% probability score), in case of probable drought events (Figure 4.17). Only 8% farmers assigned the probabilities which were 50% or less. Therefore, it may be confirmed that for the uncertain drought conditions, farmers' expectations with respect to good harvest and financial relief disbursement were not rational.

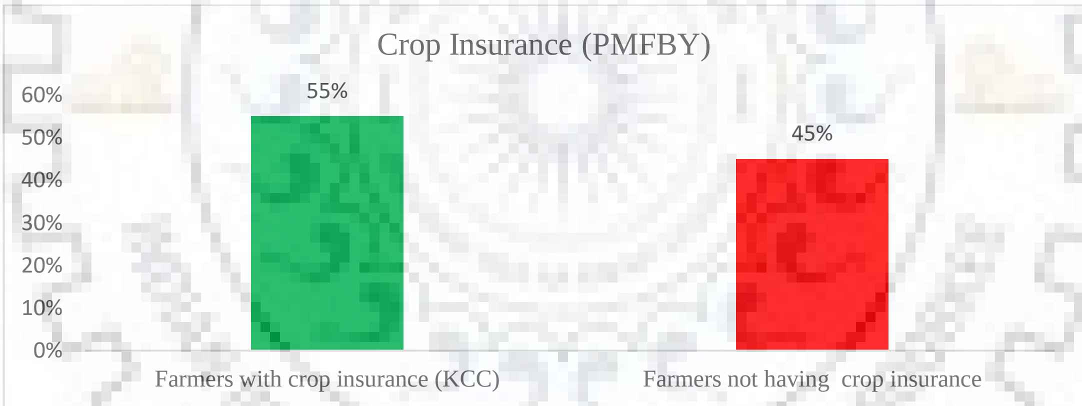
Figure 4.17 Over-optimism towards financial relief



Source: Field Survey 2018

Herding: In the survey study of 90 farmers, 50 were having Kisan Credit Cards (KCC), and therefore crop insurance under PMFBY was attached to it. Total 40 farmers (45%) were not having KCC and therefore not having the crop insurance (Figure 4.18).

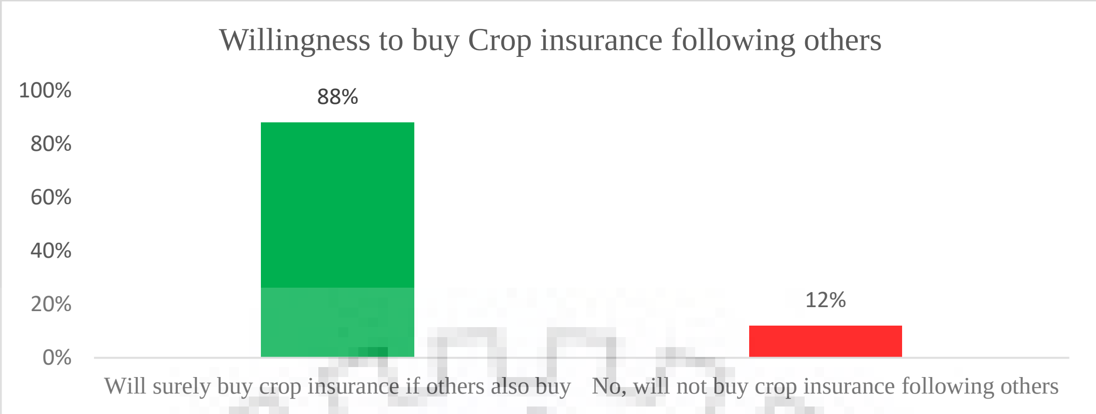
Figure 4.18 Crop Insurance (PMFBY)



Source: Field Survey 2018

Notably, none of the uncovered farmers have been asking for the insurance cover. The question was asked to such uninsured farmers, about their willingness to buy the crop insurance, if their friends or neighbours (uninsured) also buy, and it is well affordable to them (Figure 4.19). In response, 88% (38 out of 43) showed willingness to buy insurance following others. Rest 12% were still unwilling to buy it.

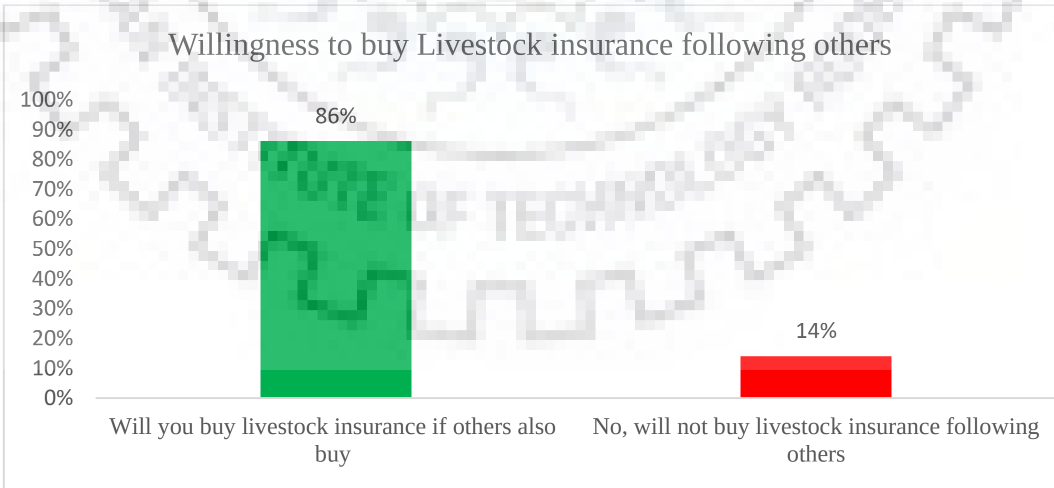
Figure 4.19 Herding: Willingness to buy Crop insurance following others



Source: Field Survey 2018

Similarly, the willingness to buy livestock insurance following others were questioned to 29 out of 38 respondents, who lost some livestock/s, in last 3 years due to droughts. These set of respondents were also non-prepared to deal with droughts. Following the rationality assumption, livestock insurance must be purchased by these respondents to hedge the frequent drought risks. However, none of the respondents were having insurance. It was known to them that the insurance cover for livestock was available in the market. Interestingly, 25 out of 29 (86%) such respondents showed their willingness to buy livestock insurance, if their friends or neighbours also buy (Figure 4.20). These respondents opined that they were not currently owning the livestock as no one else have it. Both the cases, therefore, firmly indicate that herding behaviour was displayed by these respondents.

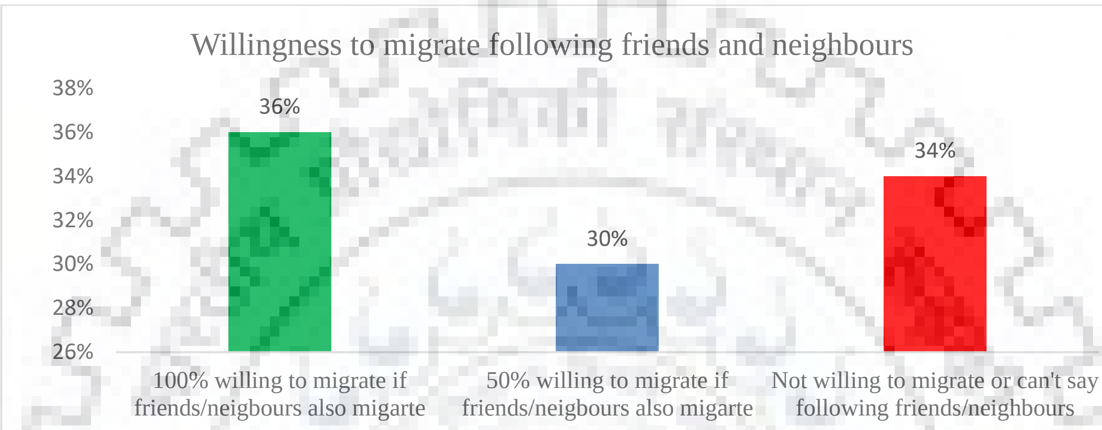
Figure 4.20 Herding: Willingness to buy Livestock insurance following others



Source: Field Survey 2018

Further, in the full sample, there were 135 respondents who never migrated from their residential place to some other places for employment purpose. However, 49 respondents (36%), were completely willing to migrate following others. 40 respondents (30%), showed 50% probability of migration following their friends or neighbours (Figure 4.21). In totality, 66% respondents, who never migrated, were willingly ready to migrate (with the probability of 50% or more) following their friends and neighbours. Only 34% were either unwilling to migrate or could not decide due to various personal reasons.

Figure 4.21 Herding: Willingness to migrate following friends and neighbours



Source: Field Survey 2018

4.5 Conclusion

Section 4.1 in this chapter discusses about the economic status and the prevailing disasters in Madhya Pradesh, an under-developed state in India. The state economy primarily depends upon agriculture and allied products, mineral resources, industries and service sector. It ranks lower in human development indicator within the country. The economically and socially backward population is significantly higher in the state than the national average. The level of physical infrastructure and human capital is inadequate to fuel and sustain the economic growth rate of the state. The stagnant share of manufacturing is also a concern and its contribution towards the growth is limited. It also appears that the rising share of agriculture sector has a great role to play in the economic growth of the state. Also, the irrigation infrastructure has improved, but still it is well below the national average. The discussion in the section 4.1.3 indicates that droughts are the most frequent disaster type in the state among all disasters with rising events.

Section 4.2 is an overview about the concept of drought, its monitoring, declaration process and the post-drought relief policy of Madhya Pradesh and India. The overview shows that India and the state of Madhya Pradesh lacked a practical and effective drought management policy (and strategies) at the national and the sub-national (state) level of administration. The ambiguity arises due to differences in defining and declaring the drought and the variations in the drought assessment and management policy at the state level among others. Therefore, the guidelines of 2009 are revised in 2016 to address some of these shortfalls in the existing policy. However, still there exist a few limitations in assessing the drought accurately. The new criteria to prove the drought occurrence are rigid as well as impractical and do not fit to all the states climatic conditions. The new policy is also criticized based on the observation that the central government almost withdrew itself from providing financial assistance to the states if moderate drought occurs.

Section 4.3 examines the consequences of droughts on the aggregate economic growth and the growth of agriculture, industry and service sectors. The benefits of financial relief post-drought and the efficacy of irrigation infrastructure is also statistically tested considering a sample of 45 districts of Madhya Pradesh. A two-step GMM procedure is applied to a balanced panel data for the period 2005 to 2012. Districts in the state face recurrent droughts, limited irrigation and rainfall variability increases vulnerability to drought risk. Results show that drought adversely impact the growth rate of the agricultural sector and of the aggregate economy. The post-drought financial relief has a positive and significant impact on the growth rate of the industrial sector and economic growth at the district level.

Section 4.4 ends the chapter analysing the risk management strategies and determinants of individuals' preparedness against droughts. A primary survey of the selected districts in Madhya Pradesh is undertaken to fulfil the above objectives. The respondents who were prepared against droughts, diversified the income and employment sources, accessed more social safety schemes of governments and arranged for different irrigation sources for water availability. The results of binary logistic regression analysis showed that the main variables related with an increase in the odds of drought-preparedness were Gender followed by Social group (OBC) and then Income (INR 11001 to 20000) for full sample. The important predictor variables towards drought-preparedness were Gender, Migration and Social group for sub-sample (farmers).

Further, the absence of crop and livestock insurance increases the risk burden of the farmers. It is also found that to mitigate the drought-risk, farm-level irrigation facilities were inadequate, especially with marginal and small farmers. It warranted an urgent policy intervention. The respondents were unaware about the provision of 50 days' additional work under flagship guaranteed employment (MGNREGA) scheme during droughts and other disasters. In addition, there were many operational and beneficial government schemes in the state, but not known to the respondents.

Section 4.4.2 is the last section in the present chapter which explores the behavioural biases (Over-confidence, over-optimism and herding) among individual respondents during the uncertain drought situations. The findings suggest that prepared and non-prepared respondents were equally overconfident about their ability to deal with future drought events. The individuals were also over-optimistic regarding the chances of having good harvest, despite the agreement that droughts may be more frequent and the resources are inadequate with them. The results also reveal that individuals' optimism was higher about receiving the financial relief if crop fails due to future droughts. Respondents also displayed herding behaviour in the decision-making. Their willingness to follow friends and neighbours for crop as well as livestock insurance was significant. The respondents were also willing to migrate at some other places following others. In all, the section highlights that individuals were irrational, demonstrating a few behavioural biases when exposed to the drought like conditions.

In the next chapter, we analyse the budgetary allocations of the Madhya Pradesh government, role of policies and institutions towards disaster risk management, and the limitations of the existing drought management policy of the Madhya Pradesh and India.

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CHAPTER FIVE

POLICIES AND INSTITUTIONS TOWARDS DISASTER RISK MANAGEMENT

5.1 Trends for budgetary allocation for DRM

5.1.1 Introduction

UNISDR (2009) defines Disaster Risk Management (DRM) as "the process of using administrative directives, organizations, and operational skills and capacities to implement strategies, policies and improved coping capacities in order to lessen the adverse impacts of hazards and the possibility of disaster." It aims to minimize the negative impact of disasters such as drought by adopting adequate measures for preparedness, mitigation and prevention. Therefore, DRM is the application of disaster risk reduction (DRR[42]) measures. To reduce and mitigate the water scarcity and drought related risks and adverse socio-economic effects, the governments (Centre and State both) provision financial resources for long-term (mitigation) as well as short-term (relief) measures. The long-term measures (such as watershed development programmes, irrigation projects and insurance) prevent droughts and soil degradation for sustained agricultural growth and well-being of economically weak people. In contrast, the short-term disaster relief and rehabilitation measures provide the immediate assistance post-disaster. The objective of the chapter is to discuss the short-term as well as the long-term budgetary allocations to important state run programmes and trends to reduce the exposure, vulnerability and damage caused by droughts along with measures for the preparedness in Madhya Pradesh.

To fulfil the stated objective, the remaining chapter is organized in the following sections. The budgetary allocations, number of projects and other details pertaining to the drought prone areas programme is discussed in section 5.1.2. The sections 5.1.3, 5.1.4 and 5.1.5 analysed the trends of budgetary allocations of the state government towards integrated wastelands development, integrated watershed management and expenditure for developing the irrigation infrastructure respectively. The statistics related to the crop

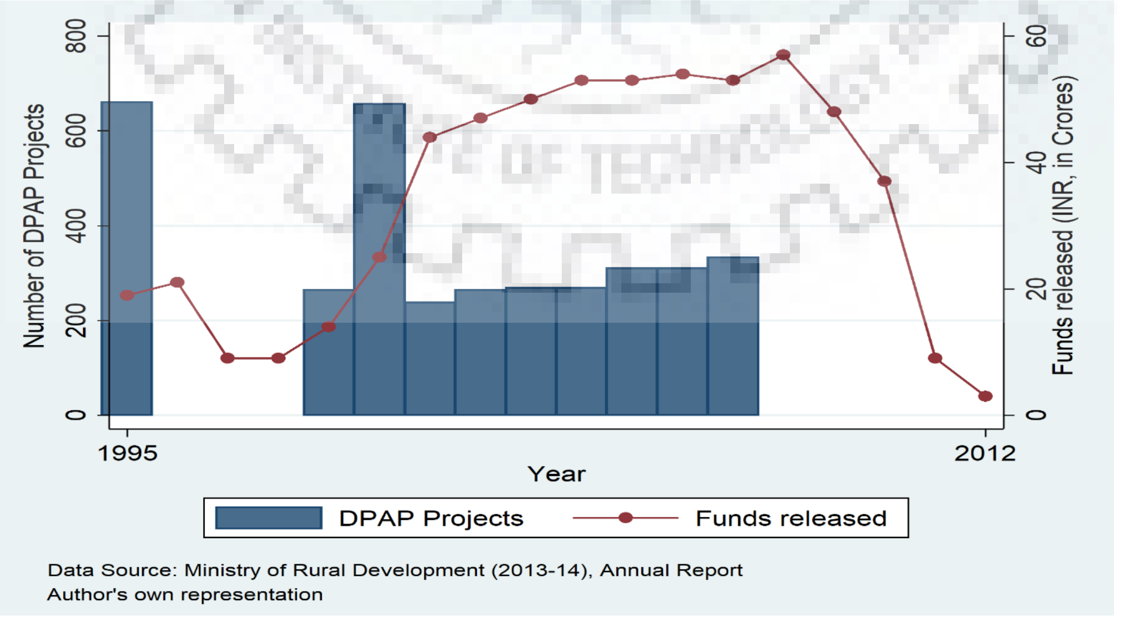
[42] UNISDR (2009) defines DRR as "systematic efforts to analyse and manage the causal factors of disasters, including through reduced exposure to 11 hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events."

insurance and post-drought financial relief by the state to the districts are discussed in section 5.1.6 and 5.1.7 respectively. Section 5.1.8 concludes the discussion by summarizing the key points discussed about the trends of budgetary allocations for DRM.

5.1.2 Drought Prone Area Programme (DPAP)

DPAP was started in 1987 by central Government (under Ministry of Rural Development) for the regular and severely drought affected areas of India. It aims to minimize the effect of droughts on the crop production, livestock, land, water and human beings. The objective was to improve the well-being of marginalized individuals. The financial contributions by centre and state remained equal (50 percent each) till 1999, which later changed to 75 percent and 25 percent for respective governments. Under the DPAP, watershed related developmental works were undertaken in 105 blocks of 26 districts, covering 8.9 million hectares' area in Madhya Pradesh (Annual Report 2013-14, Ministry of Rural Development, GOI). Figure 5.1 shows the project sanctioned and the funds released under DPAP. The total fund for 3267 projects was nearly INR 605 crores. In the initial years, the financial allocation was very less, however, there was a steady rise in the projects and financial disbursements as well from 2001 to 2007. Notably, 2007-08 onwards, there was no new project sanctioned under the DPAP. However, the financial disbursements continued to complete the on-going projects.

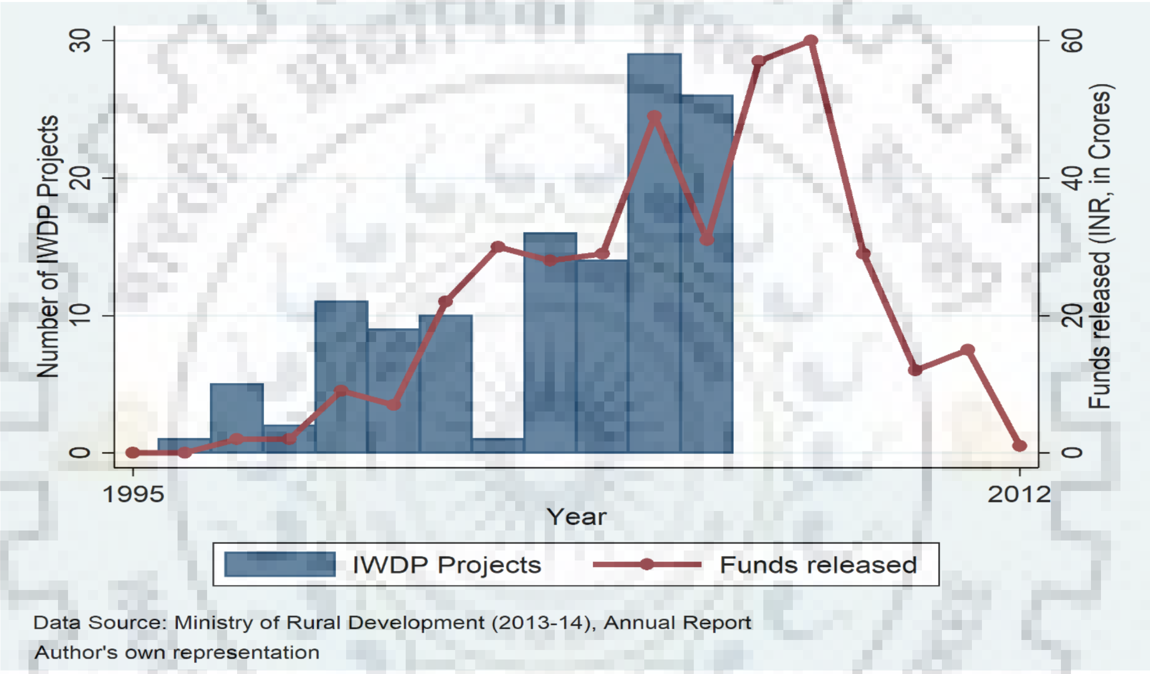
Figure 5.1 Drought Prone Area Programme: Projects and financial disbursements (1995-2012) in Madhya Pradesh



5.1.3 Integrated Wastelands Development Programme (IWDP)

It was a centrally sponsored programme operational since 1989-90. The objective of the programme was to generate employments, remove poverty, develop economic resources in villages, and improve the land productivity in the selected project areas. The programme covered those areas which were not included in the DPAP. Figure 5.2 depicts that around 124 projects received INR 373 crores from 1995 to 2012.

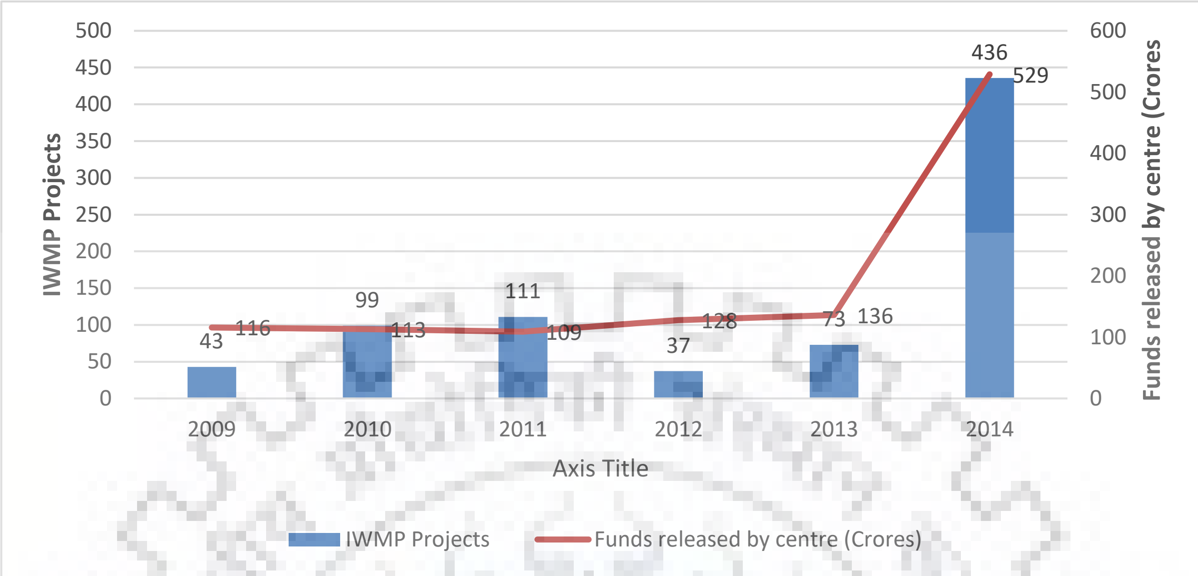
Figure 5.2 Projects and financial disbursements (Crores) in Integrated Wastelands Development Programme (IWDP), Madhya Pradesh (1995-2012)



5.1.4 Integrated Watershed Management Programme (IWMP)

The Drought Prone Area Programme (DPAP), Desert Development Programme (DDP) and Integrated Wastelands Development Programme (IWDP) were merged into a common water integration programme called as Integrated Watershed Management Programme (IWMP) in 2009. The IWMP aims to provide livelihoods to families having no assets for livelihood. The programme saw a consistent increase in the funds for various sanctioned projects from 2009 to 2014 (Figure 5.3). Under the IWMP, there were 872 operational projects. The major funds (INR 529 crores) was contributed by the centre government in 2014. During the entire programme, the financial disbursements from the centre was significantly higher than the state.

Figure 5.3 Projects and financial disbursements in Integrated Wastelands Management Programme (IWMP), Madhya Pradesh (2009-2014)

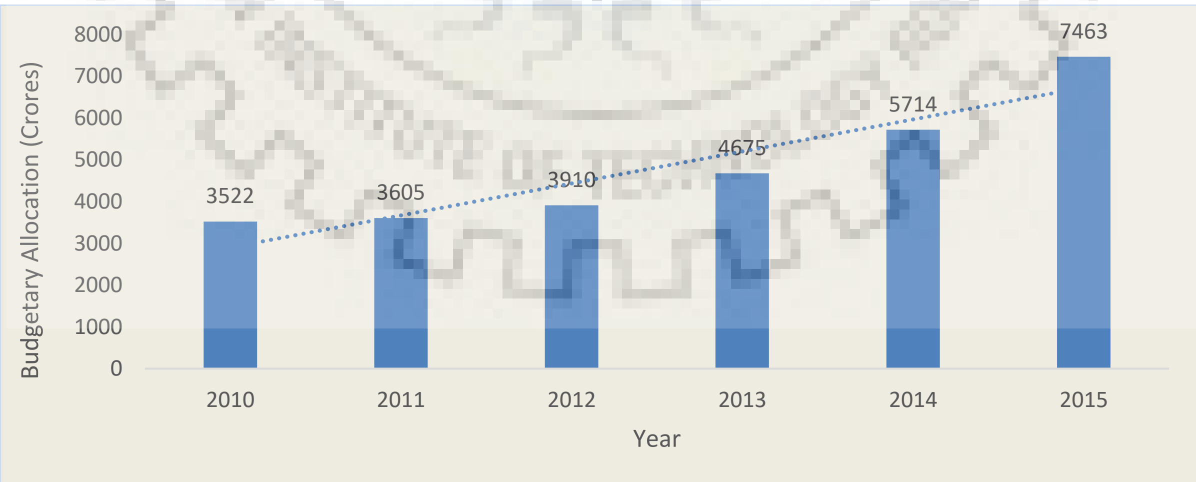


Source: Annual Report 2013-14, Ministry of Rural Development, Government of India (www.rural.nic.in)

5.1.5 Irrigation expenditures

There were around 14 irrigation projects (major and medium) under way in the state to cover 7.37 lakh hectares of land as on 2016. The five major projects among them are Bansagar, Kundalia, Mohanpura, Pench and Bansujara. It is evident (Figure 5.4) that there has been a continuous rise in the state budget to enhance the irrigation capabilities in the recent past.

Figure 5.4 State Investments in Irrigation Infrastructure (2010-2015)



Source: Drought tests Madhya Pradesh irrigation drive (2016). Available at: https://www.business standard.com/article/economy-policy/drought-tests-madhya-pradesh-irrigation-drive-116010600006_1.html

The gross irrigated area was 42.85 lakh hectare in 2000-01, which increased to 103 lakh hectare in 2014-15. It was an impressive increase of 140 percent. However, at country level the gross irrigation area increased from 767 lakh hectare to 964 lakh hectare, an increase of only 26 percent (Reserve Bank of India). The irrigation cover was 6.5 percent (2.30 million hectares to 2.45 million hectares) higher in 2015 from 2014. The budgetary expenditure was also up by 31.6 percent (INR 5714 crores to INR 7463 crores) during the same period.

5.1.6 Crop Insurance

National Agriculture Insurance Scheme (NAIS), Modified Agriculture Insurance Scheme (MNAIS) and Weather Based Crop Insurance Scheme (WBCIS) were the major insurance schemes in India. However, due to the various issues in implementation, NAIS and MNAIS have been merged under the newly launched scheme i.e., Pradhan Mantri Fasal Bima Yojana (PMFBY) since 2016 (Kharif season). Later WBCIS was also merged in PBFMY. Earlier, The National Agricultural Insurance Scheme (NAIS) replaced the erstwhile Comprehensive Crop Insurance Scheme (CCIS) in 1999-2000. NAIS had the objective to safeguard the farmers against crop losses from natural calamities such as droughts, flood, hailstorm, and other notified disasters. The NAIS mandated that State and Centre government contribute equally towards the premium subsidiary and also for the claim settlement (if it crossed the defined limits of premium collected by insurance company).

During the Kharif 2016 period, PMFBY covered 26.5 percent (3.66 crore) farmers in the country, an increase of 15.7 percent over Kharif 2015. The scheme covered 388 lakh hectares area, 15 percent more than the area insured for Kharif 2015[43]. PMFBY ensured that the finances covering risks must be equal to the sum insured, a drawback under the NAIS. As the result, the enrolment of the farmers increased significantly in the scheme. The cost towards premium are 2 percent for Kharif, 1.5 percent for Rabi and 5 percent for the horticulture crops of total sum insured. The farmers get the premium subsidiary up to 75 percent, shared by the state and centre equally. Table 5.1 highlights the important statistics for crop insurance (including the state budgetary outflows) for 15 years.

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[43] Project report, Centre for Governance, Atal Bihari Vajpayee Institute of Good Governance & Policy Analysis. (http://www.aiggpa.mp.gov.in/uploads/project/Crop_Insurance_Models_and_Relief_Measures_in_India_and_Madhya_Pradesh.pdf)

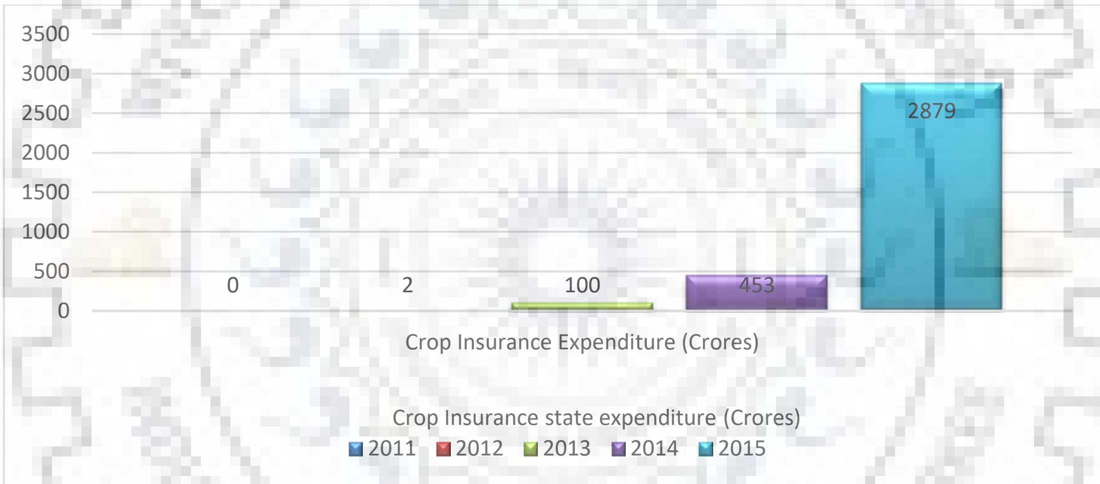
Table 5.1 Madhya Pradesh Insurance Statistics from Rabi 1999-2000 to Kharif 2015

Farmers covered	Area Insured (hectare)	Gross premium (Lakhs)	Total subsidy (Lakhs)	State share in subsidy (Lakhs)	Claims reported	State share in claims (Lakhs)	Centre share in claims (Lakhs)	Farmers benefitted
42010051	98361916	287581	35685	17843	561376	185182	185182	8670413

Source: State of Indian Agriculture 2015-16; Ministry of Agriculture and Farmers Welfare, Department of Agriculture, Cooperation & Farmers Welfare (Credit Division), Directorate of Economics and Statistics.

Further, the Revenue department of Madhya Pradesh showed that the state's total and average budgetary expenditure towards subsidy was INR 3434 crores and INR 858.7 crores for crop insurance premium during 2012 to 2015 (Figure 5.5).

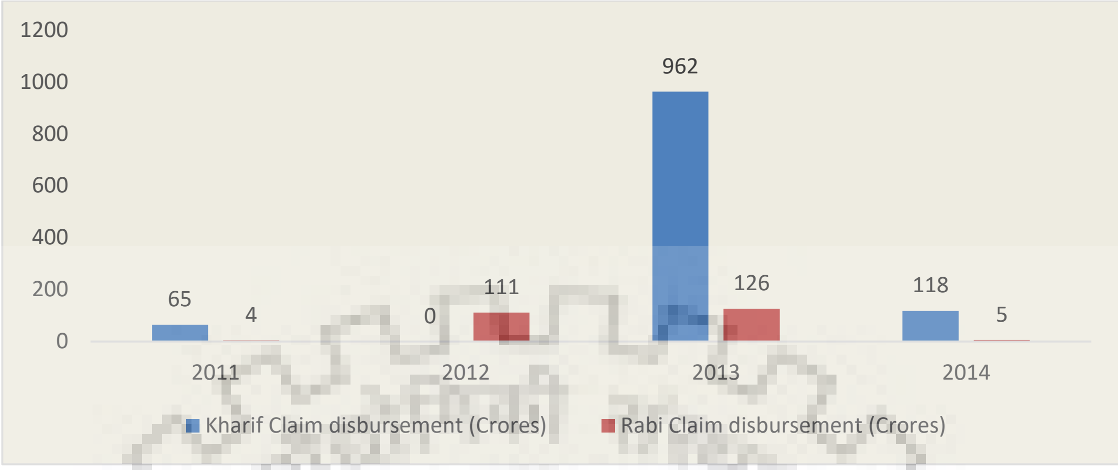
Figure 5.5 Budgetary expenditure on crop insurance premium, Madhya Pradesh (2011 - 2015)



Source: Govindaraj, A. Crop Insurance models and relief measures in India and Madhya Pradesh. Centre for Governance, Atal Bihari Vajpayee Institute of Good Governance & Policy Analysis. (http://www.aiggpa.mp.gov.in/uploads/project/Crop_Insurance_Models_and_Relief_Measures_in_India_and_Madhya_Pradesh.pdf)

Also, the state budgetary outflows were INR 69, 111, 1088 and 123 crores respectively for the year 2011, 2012, 2013 and 2014 against the crop loss claim settlement (Figure 5.6).

Figure 5.6 Budgetary outflows against claim amount for crop loss (Kharif and Rabi, 2011- 2014)

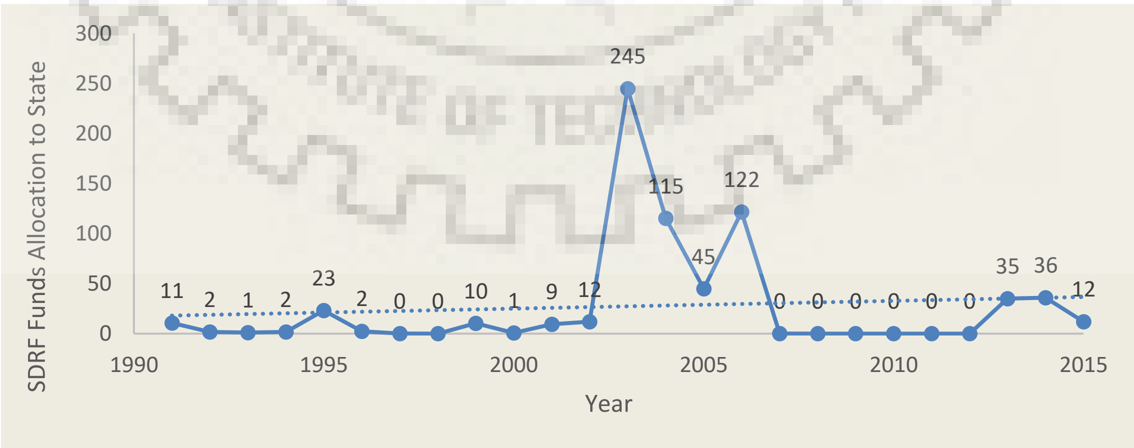


Source: Report of the Controller and Auditor General of India on Economic Sector, 2016 (https://cag.gov.in/sites/default/files/audit_report_files/MP_Report_No_2_of_2017_Economic_Sector.pdf)

5.1.7 Financial relief against drought at district level, Madhya Pradesh

Figure 5.7 depicts the state expenditure towards drought relief from the State Disaster Response Fund (SDRF) for the period 1991 to 2015. The data show that state expenditure was highest during the period 2000 to 2006. SDRF was earlier named as the natural calamity fund and was renamed as SDRF in 2010-11. The SDRF account is a jointly funded account by state and centre. The contribution of the centre is 75 percent as mandated by Disaster Management Act (2015). The figure 5.7 shows that state government deployed INR 683 crores from SDRF towards drought relief during 1991 to 2015.

Figure 5.7 Expenditure from the pooled disaster account (SDRF) as drought relief (1991-2015)

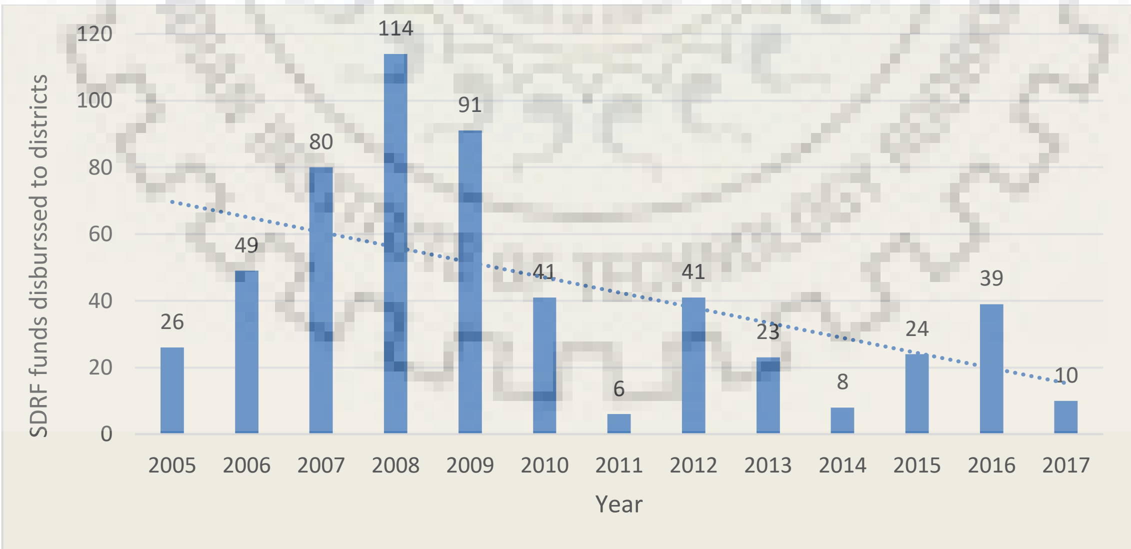


Source: Comptroller and Auditor General of India. State Accounts, Madhya Pradesh (1991-2015) (https://cag.gov.in/state-accounts/madhya-pradesh)

It is observed that if the droughts are severe and widespread, financial relief given by SDRF would be inadequate. In such scenario, the revenue department of the state seek funds from the state government budget to match the incremental requirements. The actual relief disbursements (2005 to 2017) to the districts by the Madhya Pradesh government was more than the SDRF allotments to the state (Figure 5.8). The actual expenditure was approximately twice (INR 502 crores) than the SDRF allocation (INR 250 crores). According to the Revenue Department of Madhya Pradesh, the major head under relief is drinking water supply at rural as well as urban areas. Arrangement of drinking water and its transportation to the areas with drinking water shortages or to the areas which may face water shortages in future are the priority for the state government. District collectors are responsible to arrange the relief works as mandated in Disaster Management Act, 2005. Additional provisions for drought like food for malnourished children, crop loss compensation and fodder supply are other important heads for the relief expenditure.

Dewas and Tikamgarh districts received the highest relief funds, whereas Singrouli and Umaria got the least disbursements (2005 to 2017) according to the office of the relief commissioner, Madhya Pradesh. Six districts of Bundelkhand region (Datia, Sagar, Damoh, Panna, Chatarpur and Tikamgarh) received INR 120 crore of relief funds (24 percent) out of the total state disbursements.

Figure 5.8: Financial relief to districts by the state government (2005-2017)



Authors own creation

Source: Office of Relief Commissioner, Revenue department, Bhopal, Government of Madhya Pradesh.

States may demand extra funds from centre for drought (or other calamities) relief, if the drought scale is large and beyond the state capabilities to fund as per the provision specified in the Disaster Management Act, 2015. Utilizing such clause in 2015-16 and 2017-18, the state requested for additional financial assistance from NDRF. The data show that Madhya Pradesh received INR 2032.68 crores and INR 836.09 crores respectively to meet the enhanced relief requirements[44].

[44] Lok Sabha Unstarred Question No. 4057, Ministry of Agriculture and Farmers, Department of Agriculture, Cooperation and Farmers Welfare, Government of India.

5.2 Policies and Institutions at the State level: Focus on Madhya Pradesh[45]

5.2.1 Introduction

The relationship between the economic theory and the public policy as a cause and effect relationship has been accepted and debated too at different times in different contexts by academicians and policy practitioners (Wilcox, 1960). The critics argue that the Centre problem to the policy-makers for these idealized views is that the logic and intellect behind the economic theory should be converted and imbibed while developing the public policy (Woodbury, 2000). Economists recommend a course of actions for government and policymakers after validating the relevance of the suggested policy based on a theory with data. Though this approach remains evidence-based, value judgement does matter for most policymaking. It has been noticed that different governments have different policy framework for the same problems and circumstances. There are evidences that the same government changes their perspective and policies in different periods, based on the changes in the context or circumstances. (Evans, 2004). The process of policymaking is messier than it appears, and though the link between theory and evidence exists, adoption of the policy is even more tenuous (Woodbury, 2000). In practice, conflict of interests, political motive, environment, and events also dictate the good welfare intentions of economic theory to become policy (Wilcox, 1960). The main objective of this chapter is to analyse the existing policies and institutional framework towards drought risk management. The chapter also explores the role of policies and institutions in fostering prevention, preparedness, mitigation, post-disaster relief and management challenges that the country and the state of Madhya Pradesh face.

With few exceptions, the public policy for welfare backed by economic theory and shreds of evidence is necessary for society. Banking, housing, employment, environment, trade, foreign direct investment and natural disaster are few areas where economic theory complements the policy in practice, delivering visible results. Significant reduction of unemployment rate in Australia in the last two decades (Evans, 2004), successful unemployment insurance policy (UI) in America (Woodbury, 2000) are a few testimonies of an excellent public policy delivering maximum welfare. For the solution of economic and societal problems, economic theory provides a rationale for developing suitable policy

[45] A partially modified version of this section is forthcoming as a book chapter.

measures. Hence, the role of a well-articulated public policy remains essential to resolve the economic stability and growth problems.

With this backdrop, the remaining chapter is organized in the following sections. The progress of global policy framework to effectively manage the disasters is discussed in section 5.2.2. Following this, section 5.2.3 presents the drought management framework of the country and Madhya Pradesh. The National Drought Management Plan (2017) and Madhya Pradesh State Disaster Management policy (2012) is presented in the section 5.2.4. The policy implications of the thesis are highlighted in section 5.2.5. Section 5.2.6 concludes the chapter.

5.2.2 Disaster Risk Management: Global Framework

Disaster management approach has four essential components: preparedness, mitigation, response and recovery (Mileti, 1999; Godschalk, 1991), which are guided by the standard policy framework. In the last three decades, we witness remarkable progress in the policy guidelines towards disaster risk management (Figure 5.9). Yokohama Strategy and Plan of Action for a Safer World, 1994 was first such guiding principle. It was the outcome of the International Decade for Natural Disaster Reduction (IDNDR[46], 1990-2000) and the World Conference on Natural Disaster Reduction (1994). Yokohama strategy focused on the response rather than disaster risk reduction. This strategy emphasized more on coping, adaptation and managing emergencies. However, during 1990-2000, the significant economic and human loss occurred that demanded to reframe the DRM with desired modifications.

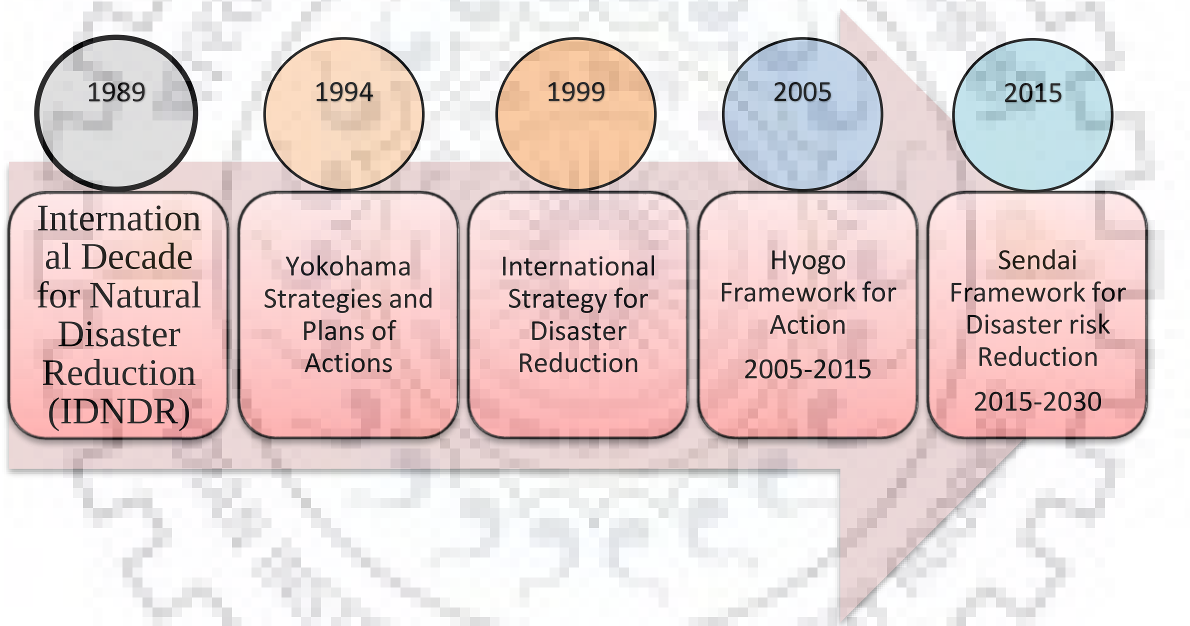
Therefore, the United Nations International Strategy for Disaster Reduction (UNISDR[47]) replaced IDNDR in 1999. From post-disaster recovery and assistance, now risk preparedness and prevention was more emphasized (UNISDR, 1994). The Hyogo Framework for Action (HFA) further extended the disaster reduction and management objectives. The focus of HFA was the reduction of risk exposure and increasing

[46] The General Assembly of the United Nations designated the 1990's as the International Decade for Natural Disaster Reduction (IDNDR). The broad objective of the Decade was to reduce through concerted international actions, especially in developing countries, loss of life, property damage and economic disruption caused by natural disasters such as earthquakes, windstorms, tsunamis, floods etc.

[47] The UN General Assembly adopted the International Strategy for Disaster Reduction in December 1999 and established UNISDR, the secretariat to ensure its implementation. Its mandate was expanded in 2001 to serve as the focal point in the United Nations system to ensure coordination and synergies among disaster risk reduction activities of the United Nations system and regional organizations and activities in socio-economic and humanitarian fields (GA resolution 56/195).

preparedness to decrease social and physical vulnerability, especially for developing countries. It placed an appeal to governments and policymakers to build a culture based on innovation, knowledge and education to develop resilience at all levels. Pieces of evidence suggest that post HFA, deaths due to natural disasters reduced significantly (UNISDR, 2013; Kellenberg and Mobarak, 2008; Kahn, 2005) due to increased awareness about the disaster reduction. According to Helvetas Swiss Intercooperation, 2011 (as cited by Aitsi-Selmi et al., 2015), the HFA broadened the DRM activities. The risk assessment, improved forecasting techniques, better management of resources, knowledge enhancement and sharing, public participation and strong institutional support are some activities under HFA to manage and lessen the risk[48].

Figure 5.9: Progression of Global Disaster Risk Management Framework



Source: Author's own representation

Sendai Framework: 2015-2030 (SFDRR, 2015) replaced the HFA with the revised goals of decreasing the existing risks and preventing the new risks. Vulnerability reduction and improved resilience by the active participation of all stakeholders (SFDRR, 2015)[49] are now the focus areas. The new targets adopted in the framework are to substantially reduce

[48] Helvetas Swiss Interco operation (HIS, Zurich) run development programs and projects that include disaster risk reduction also. The findings are based on such projects in Afghanistan, Armenia and Bangladesh.

[49] SFDRR is Sendai framework for disaster risk reduction.

disasters, mortality, the population affected, economic damages to infrastructure and services by 2030. The subsequent section discusses the framework of drought management in India and Madhya Pradesh following the global guidelines in this reference.

5.2.3 Drought Management framework in India and Madhya Pradesh

India is a voluntary signatory of the Sendai Framework for Disaster Risk Reduction (SFDRR). It also aims to timely achieve a few sustainable development goals of United Nations[50]. For this, it is necessary that at national as well as the sub-national (state) level the policies towards disaster risk management should be appropriate, effective and inline to achieve stated objectives and goals of SFDRR and United Nations. However, academicians and practitioners always questioned their effectiveness at the sub-national level. In India, the Department of Agriculture, Cooperation and Farmers' Welfare (DAC&FW) frames and monitors the drought policy. The DAC&FW is headed by Agriculture & Farmers Welfare Minister, whereas the secretary (AC&FW) is the administrative head of the department. It has around twenty-seven divisions, five attached offices and many sub-offices spread across the country to coordinate with state agencies and to implement the centre government schemes.

A Drought Monitoring Cell (DMC) in the Drought Management Division of the department is responsible for managing drought condition and issuing an advisory. It is also entrusted with the responsibility to set up the institutional mechanism at all the three levels of government, i.e., centre, state and district and to coordinate with them. The drought policy aims to manage drought at two stages. First, at the pre-drought stage, it focuses on the mitigation[51] and prevention measures. Linking rivers, canals, irrigation expansion and watersheds developments are some of the examples of infrastructural measures to be developed in the long duration. Second, at the post-drought stage, the policies are mostly reactive, financially assisting to the drought-affected individuals for a short period. Drought Management Section in the Drought Management Division performs these tasks.

The post-drought relief measures generally dominate the prevention or mitigation interventions in India (Manual for Drought Management, 2009). Inadequate rainfall often

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50 An effective drought management policy of India may be instrumental in achieving the Sustainable Development Goal 1 (No poverty), 2 (Zero hunger), 3 (Good health and well-being) and 10 (Reduced inequality).

51 According to the United Nations Office for Disaster Risk Reduction (UNDRR), mitigation is defined as the lessening or minimizing of the adverse impacts of a hazardous event.

causes drought, reducing the water availability for drinking and irrigation. Due to substantial dependence of agriculture on the monsoon, crop loss increases, lowering farm employment and other livelihood opportunities in agricultural sector. In such a scenario, state governments intervene by disbursing financial relief to support drought-affected individuals.

The discussion below provides a comprehensive overview of the approach of national, state and local governments towards drought management. The following acts, guidelines, policies, plans and programmes about Drought Risk Management are applicable in India.

5.2.3.1. *Disaster Management Act, 2005*

As discussed in the previous chapter, agriculture and drought management is the responsibility of the state in India. The state government responds to mitigate drought by providing post-disaster financial and non-financial relief along with other immediate coping measures[52]. According to the Disaster Management Act (2005), district authorities are responsible for planning, coordination and implementation of the drought management plans and the local agency is the District Disaster Management Authority (DDMA). Disasters (including drought) are effectively dealt with full assistance by the district level authorities and line departments with support from the National Disaster Management Authority (NDMA) and the State Disaster Management Authority (SDMA). It is the final layer having all the powers to utilize the allocated resources in pre and post-disaster phases, impacting mostly the district development. The Act also provides the mechanism for institutional setup. The centre government constitutes National Institute for Disaster Management (NIDM) which provides training and promotes research in the area of disaster management. The institute prepares the training modules and programmes and assists in policymaking for centre as well as state governments. It also develops academic courses for disaster management and spreads awareness through conferences and workshops. It also publishes journals, articles and books in the related domain. The objective of the Act is to ensure that disasters (including droughts) are effectively managed. The details (structure, power and functions) of the three layers in the Act are as follows:

[52] The state government have funds for relief measures under SDRF. In addition to this, the fund is granted form the National Disaster Response Fund (NDRF) for natural calamities of severe nature. It is approved based on the requests received from State Governments (Disaster Management Act, 2005).

National Disaster Management Authority (NDMA): The Prime Minister of India heads the NDMA as a chairperson, who appoints a vice-chairman and up to 9 members' core team. It may also constitute an advisory committee of experts in disaster management. The main objective of NDMA is to draft policies, plans and guidelines for effective and timely disaster management. The various departments of centre and state government must integrate these measures into their plans and projects to prepare for and mitigate disaster risks. The NDMA also drafts the guidelines for the functioning of National Institute for Disaster Management (NIDM). The NDMA functions through the appointment of a National Executive Committee. The secretary of the Government of India is the in charge of the Ministry for Disaster Management. The secretaries of various departments (like Agriculture, Power, Finance, Health, Rural Development, Science and Technology) are part of it. There may be sub-committees also for effective functioning of the NDMA. The National Executive Committee makes national plan, ensures the implementation of the plan, coordinates with various departments and ministries and provides the technical assistance to the state governments. It also evaluates the preparedness of the various levels of government to deal with disasters. As mentioned, one of the important functions of the executive committee is to prepare the disaster management plan, following the policy in consultation with the state governments and experts. The plan specifies the measures for preparedness and capacity building as well as the responsibilities of the various ministries. The National Authority also issues the guidelines for the relief works.

State Disaster Management Authority (SDMA): It is the second layer headed by the Chief Minister at the state level for effective implementation of the National Plan. SDMA consists of eight members' core committee, a state executive committee, and an expert advisory committee. It performs all the functions (as discussed above) in pre-disaster (preparedness and mitigation) and post-disaster (relief and response) phase at the state level. For example, it ensures that food, drinking water, and other essential services/relief reaches to the disaster affected areas. It also ensures that the State Disaster Management Plan is ready and reviewed/updated annually in consultation with state and districts authorities.

District Disaster Management Authority (DDMA): It is the most important layer headed by the Collector, District Magistrate or Deputy Commissioner, having a team of 7 core members. It coordinates with different departments of districts to implement the disaster management plan. It also offers necessary technical assistance, reviews developmental plans, provides financial relief and ensures effective communication system at district level.

5.2.3.2 *National Disaster Management Guidelines for Drought Management (2010)*

NDMA is responsible for framing the holistic drought management guidelines. It has a core committee of representatives from the Department of Agriculture & Cooperation, Indian Council of Agricultural Research and National Remote Sensing Centre. The focus of the guidelines is on risk management and not on crisis management. The following aspects make drought management challenging:

- Being a subject of the state, the criterion and time of declaration of drought varied significantly.
- The coordination between various ministries involved in drought management often delays the effective coordination and relief works.
- The data on various drought parameters (assessment and declaration) are scattered and not available at a centralized place, delaying decision making.

Therefore, the guidelines are intended to overcome such challenges and to achieve the following broad objectives:

a. To utilize all the existing knowledge, experience and information available with all the stakeholders.
b. To develop a sound process for measuring the drought intensity regularly.
c. To follow a standard Operating Procedure (SOP) to declare drought.
d. To manage the data for the drought intensity assessment at centre as well as state level.

Details of the Guidelines

The national guidelines direct the centre and state governments to prepare a detailed and holistic drought management plan. These guidelines are quite elaborative and are presented in eight chapters. The brief description of these chapters are as follows:

(i) *Status and Context*: It emphasizes to examine the drought risk according to the state conditions like climate, water resources, agricultural practices, land use patterns etc. There is an emphasis on assessing the direct impact of droughts on agriculture, macro economy (like employment, inflation and trade deficit) and micro economy (e.g. food insecurity at the household level, loss of livelihood, health risks and saving).

(ii) *Institutional Framework and Financial Arrangement*: The chapter highlights the importance of early warning mechanisms and response, data storage with the centre government for quick decision making, and the various short-term and long-term drought management programmes such as DPAP, DDP, and National Rural Employment Scheme

(MGNREGA) etc. It also discusses the three-layered institutional setups (NDMA, SDMA and DDMA), its functions and organizational structure in detail.

(iii) *Assessment and Early Warning*: There is an emphasis to adopt the scientific technology for crop condition/loss estimation at a local level. It reduces the ambiguity of the manual assessment. Various institutions like IMD, agricultural universities etc., ensure that a robust technology is developed and deployed for timely and effective crop assessment and drought declaration.

(iv) *Prevention, Preparedness and Mitigation*: The chapter suggests that focus should be on the preparation to deal with the possible droughts rather than responding when it occurs through irrigation arrangements (water harvesting techniques & irrigation expansion, watershed development), insurance schemes, mid-day meal for school-going children, Public Distribution System (PDS) etc. For drought monitoring, a strong meteorological and hydrological network, as well as communication technology, should be established. Automatic weather stations and rain gauges should be built for real time weather and rainfall statistics, which is necessary to develop early warning systems.

(v) *Capacity development*: There is a need to systematically enhance the capacity of humans to deal with drought effectively. For this, awareness, training, and institutional support at the district level is essential.

(vi) *Relief and Response*: Financial and other immediate assistance should be provided to the affected individuals.

(vii) *Implementation of Guidelines*: The chapter discusses about preparing a drought management plan and drought manual by each district every year. Detailed information of available resources (drought-resistant seeds, fodder and farming practices etc.) are recorded at a decentralized level.

(viii) *Summary and Action Points*: The chapter is a summary of the all the desired actionable as discussed in the National Guidelines.

5.2.3.3 *Manual for Drought Management (2016)*

The drought manual (2016) is an important policy document to monitor, manage and provide relief measures. It is an updated version of the 2009 manual for comprehensive drought risk management. The manual focuses more on applying scientific tools for drought risk assessment, forecasting and monitoring.

5.2.3.4 *Drought Management Plan (2017)*

About 56 percent rain-fed cultivated area produces 44 percent of the food in India. Therefore, a more comprehensive plan to prevent, mitigate and manage the drought was presented by DAC&FW. The Drought Management Plan is aligned to achieve the goals of the SFDRR. It discusses in detail the institutional mechanisms, various prevention and mitigation measures and programmes (pre-drought phase) along with the response and relief measures (Post-drought relief).

5.2.3.5 *Madhya Pradesh State Disaster Management Policy (MPSDMP, 2012)*

The MPSDMP is a blueprint of the Madhya Pradesh government for disaster management. It specifies the policy, systems, procedures and plans to reduce the disaster risk. This comprehensive document also covers the aspects like vulnerability of districts, principles of disaster management, approaches and strategies, institutional arrangements and the role of various state agencies in pre and post-disaster phases.

The ongoing programmes initiated by the union government for the prevention, mitigation and management of drought are discussed below.

Pradhan Mantri Krishi Sinchayee Yojana (PMKSY*)*: The programme targets extended coverage of irrigation (Har Khet ko Paani) and efficient usage (per drop more crop) of water resources. The activities covered under this programme are described in the Table 5.2.

National Rainfed Area Programme: It is an initiative of the National Rainfed Area Authority (NARC) of the DAC&FW. It aims to enhance agricultural productivity by applying suitable farming practices in the rain-fed areas.

Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA): The objective of the act is to ensure livelihood protection of rural households. It provides one hundred days of guaranteed wage employment every year to a volunteer of each home. The programme aims to enhance wage employment. It also addresses the causes of the poverty like drought by providing an additional 50 days' work to an adult member of a family. According to the Act, the fund may be utilized for water conservation initiatives (for example, Kapil Dhara in Madhya Pradesh, Jalyukt Shivar in Maharashtra etc.). There is a shift from relief driven approach to the Integrated Natural Resource Management (INRM) approach. The idea is to work on the projects which may create sustainable assets for the society with the help of technical institutes like IITs and NIITs. Out of 153 permissible works under MGNREGA, 71 are water-related works which strengthen the rural livelihood mission.

Table 5.2 Pradhan Mantri Krishi Sinchayee Yojna (programme components, Department and Key activities

S. No.	Programme Components	Department	Key activities
1	AIBP	Ministry of Water Resources, River Development & Ganga Rejuvenation (MoWR, RD&GR)	To complete the ongoing (major and medium) irrigation projects
2	PMKSY (Har Khet ko Pani)	MoWR, RD&GR	Develop new water resources, repairing of water bodies, improve water distribution system, Water diversion from high to low availability areas, rejuvenate traditional water systems
3	P M K S Y (Watershed)	Dept. of Land Resources, Ministry of Rural Development (*MoRD*)	To conserve soil and moisture, afforestation, horticulture, pasture development works, to construct water harvesting structures like check dams, farm ponds etc.
4	PMKSY (Per drop more crop)	Dept. of Agriculture, Cooperation & Farmers Welfare, Ministry of Agriculture and Farmer's Welfare (MoA&FW)	To promote efficient water usage devices like sprinkler, drips, construction of tube wells and dug wells, capacity building, water lifting devices such as solar pump sets, monitoring of watershed projects etc.

Source: https://pmksy.gov.in/AboutPMKSY.aspx

Water Harvesting and Conservation: The objective is to ensure that traditional and modern water harvesting methods are applied to revive, recharge and conserve the already available water resources such as ponds in villages with the participation of the local community. It may work as a buffer in drought years at low cost.

Rainwater Harvesting in Urban Areas: It collects and stores the natural water from the roof for domestic and business usage. It helps to use natural water reducing pressure from the water treatment plants. The runoff of water into sewages and drainage is stopped and systematically groundwater recharge increases. In urban areas, the scarcity of water may be addressed by the above technique.

Drip (trickle) and Sprinkler Irrigation Systems: These methods of irrigation effectively save water. The Government provides a subsidiary for installing these tools. The sprinkler system requires pumps, which has high coverage and is particularly useful in sandy terrain. The drip system of irrigation can work even in a shallow pressure, requires low maintenance and is particularly useful for watering vegetables and fruits.

Long-term Irrigation Management: The objective of such projects is to increase the area under irrigation. Monitoring reservoirs, prevention of evaporation of reservoir water, fast completion of state irrigation projects and integrating large reservoirs with small ones are a few policy measures for effective long-term drought management.

Afforestation: The development of forest in drought-prone areas has multiple advantages. For example, it holds the soil, improves its water-holding and productive capacity, and lowers the water run-offs. Sitafal (*annona squamosa*) trees as well as drought-resistant fodder species if planted, may also provide fodder for the cattle during drought.

Crop Insurance: Pradhan Mantri Fasal Bima Yojana (PMFBY) is a flagship scheme of the Ministry of Agriculture & Farmers Welfare, Government of India, effective from 13th January 2016. The objective of the scheme is to cover crop losses at an affordable premium. The farmers pay a subsidised premium of 1.5% for Rabi, 2% for Kharif and 5 percent for annual commercial crops. The state and centre government bear the rest of the premium amount almost equally. The farmers having KCC are compulsorily included in the scheme. It protects the farmers from natural calamities like droughts and hailstorms. The financial assistance against crop loss help them to stabilize the income.

Coverage: The scheme covers the food and oilseed crops as well as the annual commercial crops for which crop cutting experiments are performed. Insurance cover provides the relief to the farmers in case of drought (and other natural disasters) induced crop losses (when the crop loss in a season is more than 50 percent than the standard crop yield). The formula to estimate the crop loss is: (Threshold yield-Estimated yield)/ Threshold yield * sum insured * 25 %. In a situation when crop sown area is less than 25 percent, the pay-out is 25 percent of the sum insured and the insurance cover get ceased.

Monitoring and Review of the scheme: The state government-appointed officials and the insurance company together assess the crop loss at the district level. The basis of loss estimation may be rainfall deviation, weather indicators, satellite-based data of loss or the state or district government estimates. The process of loss estimation has been discussed in chapter 4.2 of the thesis.

Public Distribution System (PDS): It ensures a subsidized/free food grain availability to households (selected items in a specific quantity like paddy, wheat, etc.). It is a crucial drought management tool for a poor and vulnerable population like agricultural labourers, landless and small farmers. Under the National Food Security Act, 2013 (NFSA, 2013), it covers up to 75% rural and up to 50% urban population. The Act proposes that the state government may assess the additional food grain requirements in drought years and may ask for further allocation. The PDS is operational in the state of Madhya Pradesh since 1997. Targeted Public Distribution System (TPDS) is an improved version of PDS, effective from 2014. It covers the households falling below the poverty line, priority households and families registered in Antyodaya Anna Yojana (AAY). The subsidized food grain allocation is 35 KG/family for AAY and 5 KG/member in a family for priority households in a month. The Department of Food Civil Supplies and Consumer Protection is the in charge of the TPDS. The distribution of the food grains is generally through the fair price shops run by cooperatives and financially supported by the state governments.

Supply of Drinking Water through Tankers and Bullock Carts: The state is responsible for supplying drinking water by tankers or in case of any unusual situation by Railways to villages which are drought-affected. There is a provision to provide financial relief from SDRF to drought-affected districts for water transportation. In the anticipation of water shortages, the districts may request the SDRF to allocate the funds for drinking water transport (even in the case where drought has not been declared in a district).

Integrated Child Development Services (ICDS): The objective of this centrally sponsored scheme is to improve the health of the children by providing nutritional food to the age group 0 to 6 years. The pregnant and lactating women are also the beneficiaries under the scheme. The children and women are also the beneficiaries of ready to eat and the food cooked in the Aanganwadi. The state government financially contributes towards the food expenditure, whereas the centre government contributes to develop and maintain the infrastructure. When drought hit a district, ICDS serves as an essential risk management tool ensuring nutrient food availability to this vulnerable section. If drought is severe, additional Aanganwadi centres may also be opened to cover more potential beneficiaries, provided the relief funds are enough to support them.

Mid-day Meal Programmes: This large scale scheme was started in 2001. It provides nutrient meal to the school going children to increase the attendance and it empowers women through employment. It is the responsibility of the Department of School and Literacy, Ministry of Human Resource Development. The scheme also provides mid-day meal during summer vacation in drought affected areas. To keep a buffer stock in anticipation of the food shortages, the centre government may sanction an additional financial relief for mid-day meal in schools.

Waivers and Concessions: The state governments may waive various charges (like electricity), delay the loan recovery and restructure the short-term loans to medium or long-term loans for farmers. Each state government may take decisions on remissions, waivers, deferments, loan restructuring, concessions, etc., taking into account the financial situation of the state and severity of the drought.

Cattle Camp and Fodder Supply: To support the farmers, fodder, drinking water and medicines are arranged for the cattle during the drought years or rainfall deficient years. The cattle are an integral part of the farmers' risk mitigation measures in the rural economy. It may support them financially and therefore, distress selling of the cattle may be lowered. The government regularly assesses the rainfall expectancy and deploy the funds accordingly.

Drought Prone Area Programme (DPAP), Desert Development Programme (DDP) and Integrated Watershed Development Programmes (IWDP): To support the state government, centre government started the DPAP, DDP and IWDP (Special Area Programs) with the objective of ecological conservation in the selected areas. The decrease in the tree coverage area, water level and increased soil erosion increase the severity of drought events. Therefore, to arrest the ecological degeneration and desertification, DPAP and DDP were started. The Department of the Land Resources operated these programmes under the Ministry of Rural Development. DPAP was started in 1973-74, DDP in 1977-78 and IWDP in 1989-90. The precise objective of DPAP was to restore the areas regularly affected by droughts. DDP was to tackle the desertification issues, and the IWDP was to cover those areas left out by the above programs. These programs follow the standard guidelines as prescribed for the watershed Development for 1995 to 200. The District Rural Development Agencies handle all the projects under such programs.

Rajiv Gandhi Mission for Watershed Development (RGMWM), National Watershed Development Project for Rainfed Area (NWDPRA) and River Valley Projects (RVP) covered 66, 20 and 14 percent of the programme area respectively. RGMWM was implemented in 12 districts (Bhind, Chhindwara, Dhar, Jhabua, Khargaon, Ratlam, Raisen, Satna, Shahdol, Sheoni, Shivapuri and Sidhi). NWDPRA was operational in 11 districts (Betul, Chhindwara, Guna, Indore, Jabalpur, Jhabua, Khargaon, Mandla, Mandasaur, Satna, and Shajapu) of Madhya Pradesh. DPAP covered 20.43% of state area and IWDP covered 34.51% area. DPAP is monitored by the Panchayati Raj at district or block level and executed with the participation of local people, community and voluntary agencies.

5.2.4 Drought Management Policy, Practices and strategies of Madhya Pradesh Government

The handbook (Relief Manual, 2015, Madhya Pradesh) for dealing drought and drinking water shortages highlights the following strategies:

1. Less rainfall may reduce the production of Kharif crops and increases the possibility of distress migration of the agricultural labourers. The severity of the drought is assessed through the Kharif crops production (through crop cutting experiments) data (refer chapter 4.2). In addition, the decline in the sowing of the subsequent Rabi crops is also calculated at district level. The state government may declare those districts or tehsils as drought-affected where the estimates are indicating drought situation. Therefore, the district administration should start a continuous work at the panchayat, tehsils or village level to provide employment to the agricultural labourers. It may stop their migration. The funding for such works should be from the DDRF (under demand no. 58).
2. The manual specifies that at departmental level works, priorities should be given to those works which generate direct employment. Preference must go to the tasks related to water storage, ponds construction, water conservation (including water harvesting) and cleaning of old wells.
3. If due to any reasons the fund is not available, then it may be taken from the sanctioned accounts of Member of Parliament and Member of Legislative Assembly.
4. Those districts where MGNREGA is applicable, the labour centric jobs may be increased or created.
5. The manual also specifies that in relief work the priority will go to the water-centric works and then to the forest development related works.
6. The relief works approval should be mandatorily taken from the revenue minister by the district collector.
7. All technical aspects of any proposed work must be adequately studied and their permission must be taken from the appropriate authorities before starting the work. It is noteworthy that no action should be started in anticipation of the approval. Also, for a single work, the permission should be obtained in full not in parts.
8. The manual also specifies the discretionary financial power of the departments and the approving authority as highlighted in Table 5.3.

Table 5.3 Financial powers of Departments in MP (Under Demand No. 58)

S. No.	Department	Approving official	Sanctioning Limit (INR)
1	Water Resource	Divisional Commissioner Collector	30 lakh 20 Lakh
2	Public Works Department	Divisional Commissioner Collector	20 lakh 10 lakh
3	Farmers Welfare & Agricultural Development	Divisional Commissioner Collector	20 lakh 10 lakh
4	Panchayat & Rural Development	Divisional Commissioner Collector	10 lakh 5 lakh
5	Forest	Divisional Commissioner Collector	10 lakh 5 lakh
6	Fisheries	Divisional Commissioner Collector	10 lakh 5 lakh
7	Any other department	Divisional Commissioner Collector	10 lakh 5 lakh

Source: Authors own creation from Relief manual (2007) of Revenue Department, Madhya Pradesh

9. The approved works should get completed by 15th June. Any unfinished work has to be completed by the respective departments with full responsibility.

10. In selecting the works, the priority should be given to the unfinished works of the past (if any) before starting the new one.

11. All the sanctioned works must be completed employing manual labour only not by machines. The objective of the sanctioned works for relief is to employ the labours. Exceptionally, where the machines must be used for transportation of materials, maximum 25 percent of the total sanctioned amount may be used for the transportation expenses.

12. All the works (up to INR 5 lakhs) are routed through the Panchayat, Water User Association or Joint Forest Management Committee. The technical aspects are checked and approved by the technical departments like Water Resource, Public Development Works etc.

13. The payments to the labours are according to the wage rates of the state, and only the technical staff assess the work completion.

14. The wages if not paid within ten days of the work completion to any labour, disciplinary action to be initiated against the concerned officer.

15. The payment mechanism should be transparent; therefore, all the wages against relief work must be given in the presence of public representatives/ Gram Sabha only.

16. Before 31st March the relief works may start for three times of the received amount till date. Any fund received after 31st March must be first utilized to complete the previously

started work. If any new work is planned between 1st April and 15th June, then the amount must be approved, sanctioned and received before commissioning that work.

17. If any district needs additional funds to start a new work, a request to be made and once the funds are sanctioned and received then only the new work should be started.

18. The monitoring of works and expenditure should be regular and within sanctioned limits.

19. The booklet of relief works must be made available at all the workplaces in the appropriate quantity.

20. Second level authorities should do the random inspection of ten percent works and the higher authorities must randomly inspect a few works.

21. In any case, the payments for any unfinished works of two years ago must not be given through relief funds. A new demand with justification should be sent to the relief commissioner.

22. The funds sanctioned for relief works must not be kept/transferred into the account of any agency.

23. A complete record of the expenditure for wages, materials cost, total expenditure etc., should be sent to the relief commissioner office every month on time.

24. Near the worksite a board displaying the work type, starting date, expected completion date and the availability of job days should be placed.

25. The district collector should plan to transport drinking water to the villages facing water crisis. Also, the expected budget for that should be sent to the relief commissioner.

26. The manual clarifies that if damaged or dried hand pumps could not be repaired due to shortage of relief funds, PWD department should own the responsibility to repair them.

27. The transportation expenses for the water supply in urban areas may also be fulfilled through relief funds if the Urban Administration and Development Department is unable to fund these works.

28. If the fodder shortage is expected after the monsoon season in any district, then the district collector should prepare a plan for fodder camp (for 60 days and 90 days, in case of mild to moderate and severe drought respectively) with the help of Animal Husbandry Department, and accordingly should demand the budget from the Relief commissioner.

29. To improve the health of malnourished children (grade 3 and 4), where Aanganbadi does not exist, expenditure on daily nutrition supplementation through the relief funds are permissible.

5.2.5 Policy Implications for Drought Management

Poor and marginalized rural individuals are more vulnerable and hence become the primary victims of natural disasters in developing economies. Since lower-income households spend around 91 percent consumption budget on food items, so any drop in income due to drought or other disasters has severe consequences on them (Zeller and Sharma, 2000). Any idiosyncratic risk arising from natural disasters may make them more vulnerable. Based on our review of natural disaster public policies as well as field survey, it is strongly recommended that first, rather than being reactive, a proactive approach to risk reduction and mitigation for drought has an edge. Policies focusing on preparedness must be the priority of any government for drought risk management. To accomplish this, an inclusive approach is necessary rather than a fundamental top-down approach. There is also a need for in-depth analysis on how to integrate behavioural aspects in policy framework towards drought risk management.

Another critical aspect for drought risk management is ex-ante budgeting. All governments should realize the importance of ex-ante budgeting than being reactive. Governments must choose the most suitable alternative of budgeting based on careful analysis. It may effectively reduce disaster risk and foster recovery in the best possible manner. This is a practice adopted by many OECD countries to mitigate the effects of disasters[53]. The budgeted money is effectively utilized for capacity enhancement purposes. Investment in developing the early warning mechanisms, timely response and communication tools are some measures where budgets may be allotted. Provisioning for risk reduction can also be done in advance by developing a contingency fund without specifying the nature of contingency. Japan is an example that allocates budgets for anticipated disasters. Japan did the provisioning of USD 49.9 billion every year from 1995-2004. Out of this, 23.6 percent was deployed into disaster prevention and preparedness activities. Though 26.4 percent of the budget was provisioned for disaster recovery and rehabilitation, data suggest that in the year 2006 nothing was spent on disaster relief and recovery and alternatively used for other contingencies (Phaup and Kirschner, 2010). This example suggests that if the government understands the importance of risk reduction for

[53] Japan, New Zealand and Turkey are among those 10 OECD countries that does Ex-ante budgeting for disasters (Phaup and Kirschner, 2010)

natural disasters, then it can be achieved through framing such policies. These exercises need a more in-depth cost-benefit analysis.

In developing countries like India, there remains a need for well-developed and capable institutions, financially funded for future research and development. Institutions that innovate, collect and analyse data may help to draft suitable policies based on extensive research. On the other hand, they may effectively roll out various schemes and programs for individuals and communities to educate them about disaster management approaches. The responsibility of government is to financially help these institutions so that they can carry research and development activities. Sufficient budgets must be allocated to these critical institutions for relevant research in areas like weather forecasting techniques, early warning system and other critical areas related to drought and water scarcity.

Figure 5.10: Components and outcomes of Disaster Risk Reduction (DRR) Public Policy

Source: Authors own creation

Another policy initiative may be the financing of start-up initiative in the weather insurance market. Since there is a considerable need of insurance coverage of crops in developing countries, decision-makers at household level should be educated about insurance and other financial services for DRM. The investment made towards education and awareness of micro- insurance (weather insurance) may go a long way. As a compulsory measure, insurance of life and livestock must be included in the disaster risk management framework. The role of media, especially television, radio, and newspapers, remains high and critical. Figure 5.10 presents the author's suggestion related to the components and outcomes of the DRR policy to achieve the goals as specified in the SFDRR.

5.3 Limitations of existing policies and challenges in Drought Risk Management

5.3.1 Introduction

The existing literature suggests that the definition of drought, its management and subsequently, the drought relief practices significantly vary at the sub-national level in India. The variations in states' approach may be attributed to the following facts. Being a slow-onset disaster, with no particular time of arrival and end, monitoring and managing drought have always puzzled the governments, policy-makers and academicians alike. The impacts of drought on farming, rural community and economy are profound. However, drought often lacks visibility as well as media attention like floods, earthquakes, cyclones, etc., as it seldom causes any infrastructural or life losses. Nonetheless, it adversely impacts the agricultural sector growth (refer chapter 3) and often quietly slows down the growth of other sectors of the economy (Loayza et al., 2012 and Fomby et al., 2013; Pelling et al., 2002 among others). Therefore, it is essential that the policies to deal with slow and fast onset disasters to be different and specific. But, in India (and Madhya Pradesh), the existing policies are same for both types of disasters as outlined in Disaster Management Act, 2005.

The remaining chapter is organized as follows. Section 5.3.2 highlights the limitations of the existing drought management policy posing many challenges in drought risk management. Section 5.3.3 discusses the limitations of the existing drought risk management policy based on the observations in the *field survey*. Section 5.3.4 is the conclusion, where the main points elaborated in the present chapter are highlighted.

5.3.2 Limitations of Drought Management Policies (and programs) and challenges in DRM

1. A strong institutional setup to study the various facets of the rainfall and other related indicators (soil moisture, crop sown and crop loss data, etc.) is necessary. The timely and accurate estimation of the drought-induced agricultural and other losses are must for speedy financial relief disbursements. This is an important limitation of the state government.

Technological backwardness, inadequate institutional infrastructure and socio-political motives are a few reasons behind such limitations.

2. There is a broad disagreement among state governments and policymakers about drought definition in India (refer chapter 4.2). The financial relief is mostly based on the declaration of drought and therefore ambiguity among state policies is common. There are mainly four (Meteorological, Agricultural, Hydrological and Socio-economic), or more types of droughts. Indian Meteorological Department (IMD) assesses and defines the meteorological drought, based on the rainfall deficiency in a particular location. Drought occurs if the actual rainfall deviates negatively for 25 percent or more from its long term-average (generally 30 years). The rain is recorded and analysed at district or sub-district (tehsil/village) level in India, and accordingly, the meteorological drought is declared at these administrative units in the states. IMD also declares 'All India drought year' when the rainfall deficiency is more than 10 percent and 20-40 percent area of the country is under drought conditions. 'All India Severe drought year' exists when the rainfall deficiency is more than 10 percent and when the spatial coverage of drought is more than 40 percent.

According to the National Commission on Agriculture, the hydrological drought is the inadequate groundwater situation due to prolonged meteorological drought, whereas the agricultural drought occurs when insufficient soil moisture leads to crop losses. Whatever type of drought it may be, the rainfall deficiency is the most critical factor to cause or trigger the next level complexities (agricultural and hydrological drought), impacting the agricultural and other sectors of the economy. Sometimes, the rainfall may be very scarce, making it irrational for farmers to sow the crops like normal years, limiting the sowing below the average levels. Samra (2004) about the 2002 drought in Rajasthan explained such phenomenon. According to the author, Rajasthan had more than 50 percent less rainfall than average in the month of July. As the result, the sowing of crops could not happen. The drought was declared in 32 districts solely based on the deficit rainfall.

Often the sub-optimal rain (meteorological drought) negatively impacts the crop productivity (agricultural drought) and may also lead to less groundwater storage (hydrological drought). However, the opposite may also happen. There may be a hydrological or agriculture drought but not the meteorological drought. The sum of rainfall for a season may be within the normal range, but its uneven distribution may lead to less soil moisture causing crop loss or even the less storage in ground or reservoir. All these are the possibilities, requiring a comprehensive analysis of the complex ground realities in assessing and declaring the drought by the various governments. Given such complexity in the drought assessment, even IMD changed the nomenclature of drought 2015 onwards. The 'Drought Year' was replaced with 'Deficient Year' and the 'Severe Drought Year' with the 'Large Deficient Year[54].' IMD limited their role by only calculating the extent of rainfall shortages from its long-term averages. Instead of declaring drought based on a single factor, i.e. rainfall, now IMD left the responsibility of the drought assessment and declaration to the states. Thus, either rainfall alone or combined with other parameters should be assessed by the states for notifying the drought event. But, in practice, the differences in ideology of various states and other socio-political dimensions may also affect the way drought is perceived and defined at sub-national level.

Interestingly, like India, even globally[55] drought definition, assessment and declaration parameters differ significantly. It leads to considerable differences in the subsequent relief policy and measures among nations. A few more puzzling aspects, which make drought (as a concept) highly subjective and complex to understand, are discussed briefly. According to Tannehill (1947) and Wilhite (2000), drought is a slow onset disaster. It has no particular arrival or end time, one may guess (National Disaster Management Plan, 2016). Many a time, silent drought leaves no clear basis to identify its severity and the economic losses (World Meteorological Organization, 2006). Many researchers in the past attempted to establish the impacts of drought on the economic growth in developing as well as developed economies. For example, Loayza et al., 2012 and Fomby et al., 2013 showed that drought negatively affects the agricultural and overall economic growth of the developing countries. Desai (2003) found that the droughts direct impact on the farming and allied sectors indirectly impacted the industries and service sector growth. For assessing such impacts, an adequate and credible data is obligatory. Otherwise, the assessment of economic impact of drought (direct and indirect) may not be feasible and accurate. At the sub-national level, technological and institutional limitations are bottlenecks in collecting the actual drought losses.

It is noteworthy that the debate regarding the correct and uniform drought definition is not unique to India. Wilhite and Glantz (1985) first raised this issue, highlighting a disagreement between the scientists and policy-makers of Brazil in defining the drought.

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[54] Refer https://www.livemint.com/Politics/rFVChqP3087xDDfqWSWqYM/IMD-to-discontinue-the-term-drought-from-this-year.html

[55] Refer to National Disaster Management Plan (2016) published by National Disaster Management Authority of India, page No. 24

The meteorologists and agricultural department in Australia also had conflicts regarding parameters and description of drought. Scholars like Sanford (1978) and Wilhite (2000) among others, also debated for long to develop the consensus for a single drought definition and loss estimation process but failed. Indian states still follow multiple drought definitions and crop loss estimation methods. As a result, the drought management policy at sub-national level in India also varies. Contrary to this, we also witnessed a few positive developments to correct the ambiguity and duplicity in recording the global drought data. One of the most credible and largest disaster database EMDAT in the world managed by CRED (Centre for Research on the Epidemiology of Disasters data), cleaned the drought data by defining the drought loss parameters (Below, Grover-Kopee and Dilley, 2007) more accurately. It removed the multiple entries for a single drought disaster (the same loss data registered for more than one year, creating redundant data) and smoothened the database. It helped the policy-makers to account for the exact life and asset losses along with the people affected by a particular drought in a year.

However, the principle issue that what definition of drought is most appropriate remains unsettled in India. As a result, until 2015, the drought assessment method and the declaration process significantly varied in many states of India. It led to the confusion and subjectivity in pre and post-drought management practices across states. To deal with such ambiguity, the union government brought the new drought declaration guidelines in 2016 (refer chapter 4.2).

3. The dependency of the states on the central government for the financial relief funds are very high. Prabhakar and Shaw (2007) also has a similar observation. According to the revised drought management process, the central government has limited its financial obligation towards relief to states. The centre will only provide additional financial assistance if severe drought occurs. In case of mild and moderate drought, states need to manage with their own resources. In such a situation, it is crucial to ensure that the states are financially capable of dealing with future drought or drought-like conditions. Therefore, it is warranted that the states must be financially strong, autonomous and self-dependent. It is expected that the central government will increase the SDRF allocation to the states from its current level. It will ensure that sufficient funds remain with the states for the post-drought relief measures.

4. The political factors also dictate the financial relief disbursements, place and the possible beneficiaries. There is an immediate need to address such lacuna so that the vulnerable and

affected individuals may be benefited and the objective of the drought relief policy may be achieved.

5.3.3 Limitations of Drought Risk Management Policy based on the *field survey*

1. The existing structure for disaster management in India (including drought) have NDMA, SDMA and DDMA levels. The DDMA (terminal level) job is to implement the well thought and designed policies at the district level. However, during the field survey, it was observed that the presence of DDMA authorities in implementing various schemes were limited. Also, the various levels of government and departments lack coordination in implementing the relief measures. In fact, there was a clear disconnect between the theory and practice in implementation of the DRM policies.
2. The economic survey 2017-18 heavily emphasized on the modern irrigation techniques like drip and sprinkler for efficient water usage in absence of adequate rainfall. The importance of adapting such practices becomes even more urgent and important in the study area due to frequent droughts and low ground water level. Despite much emphasis on modern irrigation techniques by experts and policy-makers, its outreach was found to be very limited. Only a handful of rich farmers actually have knowledge and access to such irrigation techniques. It was observed that the adaption of these technologies by poor farmers would depend heavily on the supply of information, materials and services for installation.
3. The objective of providing financial relief against drought induced crop loss is to fulfil immediate pressing needs of affected ones by compensating losses. Farmers in the study area have limited resources, and their dependency on financial relief is very high. Therefore, any delay in receiving the financial relief limit their abilities to procure further resources for farming. It was observed during field survey that farmers have not received the timely financial relief. There was significant delay (4 months to 1 year) in disbursing the relief payments. Such delay may defy the purpose of providing the financial relief by governments and policymakers. Further, the quantum of financial relief was inadequate as reported by most of the respondents.
4. The flagship employment guarantee scheme's (MGNREGA) objective is to ensure 100 days employment to a member of all the interested rural households every year. Therefore, it has the potential to reduce the agricultural and economic distress during droughts in rural areas. However, it is noticed that the scheme has limited outreach. Not all the interested and eligible members of households always get the employment. Also, 50 days additional

employment provision is there in the scheme, if any disaster like droughts occur. However, in practice, such provision is hardly known to the rural individuals. None of the respondents in the survey reported about getting additional 50 days employment in drought years.

5. The decision making models and policies towards disaster risk management may be rational and adequately designed. However, its success and effectiveness may not be ensured without understanding and incorporating individuals' behavioural biases. Humans are normal and their behaviour often display systematic departures from rationality. The same was also observed during the field survey. Choices of the respondents found to be violating the rationality assumptions of standard theories such as expected utility theory. Therefore, the existing policies have limitations in achieving the drought risk management objectives.

5.4 Conclusion

Section 5.1 analyses the budgetary allocations and their trends towards DRM in Madhya Pradesh. The state and centre governments allocate the budgets to reduce the drought risks in short-term for relief works and in long-term to develop irrigation infrastructural capabilities and insurance mechanisms. DPAP, IWDP, IWMP, irrigation projects and crop insurance are the major heads where funds are allocated for long-term. There is an upward trend of budget allocation for DPAP (2001-2007), IWDP (1995-2009), and IWMP (2009-2013), with a few fluctuations in-between. The state also witnessed a consistent rise in the funds towards irrigation infrastructure from 2010 to 2015. Similarly, towards the crop insurance premium, there was a regular increase in budgetary allocations for 2011 to 2015. The state witnessed a declining trend in budget allocation towards financial relief to districts (from the SDRF) (2005-2017), with some fluctuations in-between.

Section 5.2 highlights the importance of having a good public policy for effective disaster management. In this reference, the progression in the global framework for DRM is briefly mentioned. Subsequently, the drought management framework in India and Madhya Pradesh is discussed. The global examples show that disasters (including drought) may be successfully managed if the attention is to proactively reduce the risks through policy tools. Therefore, for effective disaster risk management, a public policy with a focus on risk reduction is necessary. Figure 5.10 highlights the author's proposal related to the components and outcomes of the DRR policy to achieve the goals as specified in the SFDRR. Given that the climate-induced threats of drought are high and unavoidable, the DRR policy if adopted, may significantly reduce the drought impacts on humans, economy, community and individuals. The section further mentions that some inherent challenges with states and union for drought management in India are: technological limitations of the states, inadequate information system, poor and vulnerable population, and budget constraints at state as well as individual-level among others. The state government must further strengthen the irrigation facilities to minimize the drought impact on the agriculture sector. With more development and state support, the irrigation equipped drought-resilient districts may withstand the drought risk or further minimize its impact. The expansion of the irrigation measures like sprinkle and drip-irrigation is immediately warranted in the state, as also advised in the Economic Survey of India, 2017-18.

The state government must ensure that the drought-relief funds are effectively utilized. The funds, if effectively used, may generate employment and create productive assets. The consumption of the financial relief to fulfil the short term needs, however, without constructive asset creation, may not fuel the agricultural economic growth of the districts. Policy-makers have to re-design the approach and avenues to spend the relief funds judiciously. Finally, there is an immediate need to look at the drought management in context of development rather than in isolation. The government should focus on developing and further expanding rural infrastructure like watersheds, irrigation canals, rural electrification and roads construction. It may help the state government to achieve not only the short-term relief objectives but also the long- term sustainable development goal of the state. Section 5.3 in this chapter discusses the major limitations of the drought management policy (based on policy guidelines as well as field survey) and existing challenges in drought risk management. The enquiry shows that drought assessment has many technological and institutional limitations. Often significant delay in declaring the droughts by states causes delay in the financial relief disbursements. Drought multiple types also puzzle the policy-makers to choose one, to base policies, however each chosen type has its own limitations. The same dilemma and challenge also exists at sub-national level governments in India. Further, getting credible, adequate and timely data on drought losses is difficult. It has an impact on empirically examining the effect of droughts in time bound manner, which may provide inputs in stimulating the policies. States' financial dependency on centre for funds and poor infrastructural setting limit the scope and success of drought management policies and programmes. In addition, the drought policy does not incorporate individuals' behavioural shortcomings and therefore, managing droughts remains challenging for policy-makers and practitioners.

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CHAPTER SIX

CONCLUSION

6.1 Introduction

Droughts and floods are two disasters frequently faced by many Indian states, causing significant economic and human loss. Droughts and floods have entirely distinct characteristics. Flood, a fast onset disaster, occurs rapidly, but for a relatively short period. It damages properties and causes loss of human lives and livelihood. On the other hand, drought is the slow onset disaster. Its ability to harm the individuals and economy is very complex than floods. For example, droughts do not cause any direct property damages, but can adversely affect the individuals, community and the overall economic growth of the affected region even more than droughts. Floods induced losses may be minimised by building adequate infrastructure. However, managing droughts is more challenging for governments and policy-makers. Unlike floods, droughts are primarily dealt by coping and adaptation at individual and institutional level. The present thesis therefore, studies only the drought disaster not the floods.

In India, it is estimated that more than 50% of crops are still dependent on rainfall (the South-West Monsoon) and therefore rainfall deficiency along with limited irrigation infrastructure makes the agriculture sector highly vulnerable. Inadequate rainfall during the monsoon season results in crop failure in many Indian states, especially where rain-fed agriculture dominates. Notably, Madhya Pradesh, a state in central India, is one such state which is highly vulnerable to droughts, as rain-fed agriculture (72% rain-fed area) dominates. This is higher than the country average, and the net irrigated area is significantly lower than the country average. Therefore, the growth of the agricultural sector is affected by droughts and this adversely impacts the local economy. However, the impacts may vary across districts in the state. With more than 74% of the population engaged in the agricultural sector, poor agricultural performance will affect other sectors in the local economy, if linkages between sectors are sufficiently high in the state. Post-disaster assistance such as financial relief is the major mechanism to deal with droughts. Rather mitigation, response driven approaches are common in India. In spite of few studies in this area, the outcome regarding possible relationship between natural disasters (including drought) and economy is not decisive.

With this backdrop, this thesis has three objectives to investigate. First is to analyse the empirical relationship between drought, drought-relief and growth parameters of the selected state economy in general and agricultural sector in particular. The impact is also estimated by categorizing the states based on their irrigation capabilities (high, moderate and least). In response or anticipation of possible water scarcity or droughts, individuals and households adapt certain measures to safeguard themselves or minimize the impact. However, their preparedness or adaptive capacity is determined by various economic, social, institutional and technological factors. In addition, there decision-making abilities to prepare against disaster events are often driven by various psychological anomalies called as behavioural biases. The literature suggests that often individuals display systematic departure from rational choices against disasters due to such behavioural biases. Therefore, the second objective of the thesis is to explore such behavioural biases of individuals during uncertain drought or drought like conditions.

In addition, the determinants of preparedness and individuals' risk management practices (coping and adaptation strategies) to reduce losses against droughts with particular reference to Madhya Pradesh is also analysed. The primary survey is undertaken to achieve the stated objective in select drought-affected districts of Madhya Pradesh. As discussed in chapter 1 (Introduction) and Chapter 4.1 and 4.3 (about state economy and disaster), the selected state has been facing regular droughts and is susceptible to drought risks due to the unique geophysical characteristics and vulnerable eco-system. In such situations, the role of governments (state as well as centre) and their support through policy intervention is essential to reduce agricultural and other losses, and to support livelihoods of affected population. The third objective of the thesis therefore examines and evaluates the intervention of the state government through policies, particularly pre and post-disaster budgetary policies for drought risk management.

To achieve the above objectives, the thesis is structured into six chapters related to each other. Chapter 1 is titled as "Introduction". The chapter highlights the background and rationale of the present work. It presents the statistics regarding the incidences of drought events in the study area. The framework of the research as well as the theoretical rationale for the study is also elaborated. Next, an overview of the literature on drought and other natural disasters are highlighted. Following this, the study presents the scope of the thesis and important research issues. Finally, three research objectives are framed to study and the contribution of the thesis in the disaster literature are highlighted.

Chapter 2 is "Review of Literature". The select literature on the economic impact of the droughts and other natural disasters is explored to achieve our first objective. In addition, the literature on the impact of financial relief on economy is studied. Following this, the risk management strategies against drought and the selected behavioural issues are also discussed. Finally, the section ends up highlighting the role of governments and institutions for effective disaster management.

Chapter 3 is titled as "Impact of Droughts on Economy: *State level analysis*". The impact of droughts and financial relief on the aggregate and agricultural growth rates of 28 Indian states (full sample) and the three sub-groups (Irrigated, moderately irrigated and least irrigated states) are analysed. The period of such analysis is 1990-91 to 2015-16 and panel fixed effects models are estimated.

Chapter 4 is a state level analysis for the central state of the country i.e., Madhya Pradesh and is titled as "Impact of Droughts on Madhya Pradesh Economy". The chapter presents a brief description of the economy of Madhya Pradesh from 1991 to 2015. The share and contribution of different sectors in the state economy, major indicators of economic growth and other related statistics are presented. There is also a discussion on the natural disasters (droughts, floods and earthquakes) the state has been facing. The next sub-section of the chapter covers the mechanism of drought monitoring, declaration and relief procedure at the country as well as the state level. Next, we empirically examine the impact of droughts and financial relief on the aggregate economic and sectorial growth (agriculture, industry and service sectors) for the 45 selected districts of Madhya Pradesh. In the analysis, the ability of irrigation infrastructure to reduce the adverse effect on growth rates is also statistically tested. The study employs a two-step GMM procedure on the balanced panel data for the period 2005 to 2012.

In the next sub-section of the chapter, the findings of primary survey of two frequently drought-affected districts of MP, with reference to the individuals' risk management strategies and determinants of preparedness against droughts is reported. The study employs the descriptive and binary logistic regression tools to analyse the field level data. Finally, the chapter ends with a sub-chapter on the behavioural biases of individual respondents in the survey area.

Chapter 5 is titled as "Policies and institutions towards Disaster Risk Management", discusses the budgetary allocations to important state run programmes. The trends and financial assistance of state and centre to reduce the losses caused by droughts, as well as the preparedness measures in Madhya Pradesh are discussed. The ongoing policies and institutional framework to foster prevention, preparedness, and mitigation is highlighted. The chapter at the end highlights the limitations of the existing policies to achieve the drought risk management objectives.

Chapter 6 of the thesis is “Conclusion”. It summarizes the findings and discussions of all the empirical and other analysis undertaken in the thesis. The major policy implications emerging from the thesis to manage the drought related risks are recommended. In the end, the scope of future research work and limitations of the present study are highlighted.

The rest of the chapter unfolds as follows: Section 6.2 documents the major conclusions emerging from the thesis outcomes. Section 6.3 is about policy implications, which may be instrumental to design a few appropriate policies at national and sub-national levels. The chapter finally ends with the section 6.4 giving the future research directions for the interested researchers in the subject area.

6.2 Major Conclusions

The chapter-wise empirical and other major findings of the thesis are summarized as follows: Chapter 3 examines the empirical relationship between droughts and drought relief on the agricultural sector growth and the overall economic growth. At the first instance, the objectives and the empirical exercise in this chapter may look trivial and one may argue that drought would have surely a negative impact on the economy and in particular the agricultural sector. Second, drought relief is often used as a proxy for drought and therefore drought and drought relief are assumed to be correlated. But the extant literature suggests that the impact of natural disasters on economic growth is negative but there is also a lack of universal consensus. This is because impact(s) of disasters not only vary across economies and sectors, but impacts are locale specific, are related to biophysical characteristics and depend on type, intensity and exposure of those affected by the disasters.

The disaster relief impact assessment studies are limited. Therefore, this empirical analysis may be useful to establish such a relationship for an economy like India which faces recurrent droughts and is highly dependent on rainfall for the sustainability of the agricultural sector. Droughts and financial relief being state subjects in India provides additional rational for the study and that the relationship at the sub-national level would be determined by the irrigation facilities. Therefore, the present study empirically estimated the impact of droughts and post-disaster relief finance disbursements on the SAGDP growth rate and SGDP growth rate for 28 selected Indian states over the period 1990-91 to 2015-16.

This is one of the first studies to examine such a relationship using state-level information in the Indian context. The results indicate that droughts significantly reduce the SAGDP and SGDP growth in comparison to no drought or normal weather conditions for the all Indian states at the aggregate level. The strongest negative impact of droughts on SAGDP for least irrigated states is observed. Therefore, droughts are curse for any economy. The drought relief finances following drought in the previous period, on the other hand, showed a negative and statistically significant effect on SAGDP for moderate and least irrigated states. The interactive dummy (ID) variable's impact on SAGDP growth rate was also found to be positive and significant for the moderate and least irrigated group of states. However, ID do not show any significant impact on SGDP growth rate.

Chapter 4.2 presents an overview of the drought management (concept, monitoring and the drought declaration process) and the post-drought relief policy of India. It is observed that India is highly vulnerable to drought (a complex and slow onset disaster) due to the dependency of agriculture on rainfall, limited irrigation infrastructure and climate change risk. The overview shows that India lacks a practical and effective drought management policy (and strategies) at the national and the sub-national (state) level of administration. The principal reasons identified are the ambiguity in defining and declaring the drought and the variations in the drought assessment and management policy at the subnational level among others. Given such lacuna, the drought management guidelines of India are updated in 2016 superseding the previous (2009) guidelines.

The study further noted that the revised guidelines successfully addressed many shortfalls of the 2009 policy. However, with considerable appreciation, there were a few concerns regarding the limitations of the revised guidelines in assessing the drought accurately. The new criteria to prove the drought occurrence is rigid as well as impractical and does not fit in all the states climatic conditions. The new policy is also criticized based on the observation that the central government almost withdrew itself from providing financial assistance to the states if moderate drought occurs. Therefore, now states may be financially more stressed in deploying adequate resources and achieving the Sendai Framework for Disaster Risk Reduction targets and a few sustainable development goals of the United Nations.

The literature exploring drought impact on the Indian economy lacks empirical evidence at the district level. Therefore, a need arises to establish the relationship between drought intensity and post-drought relief with respect to economic growth at the district level for a selected state. Chapter 4.3 attempts to address this gap. Madhya Pradesh has a history of recurrent droughts and the state is vulnerable because it has many dry regions and water scarcity affects a large section of the population dependent on agricultural activities for their livelihood. Irrigation facilities across districts vary with many districts having poor irrigation infrastructure. The lack of irrigation infrastructure further exposes the districts to drought risk. This study is important from three perspectives. First, it is a concise analysis of the impact of slow-onset disaster on the economy at a sub-national level and therefore contributes to the growing literature on the macro-effects of disasters. Second, the focus is on the influence of irrigation infrastructure and financial relief in reducing disaster risk. Finally, unlike previous studies considering the drought impacts on the primary sector, this study presents statistical results of the impact on the secondary and tertiary sectors. Balanced panel data is created consisting of 45 selected districts of MP over the period 2005 to 2012. The study employs a two-step System-GMM approach. Results show that drought has a statistically significant negative impact on the agricultural sector and affects the aggregate growth rate at the district level. The agricultural growth rate falls by 28%, whereas the aggregate growth rate reduces by 6% due to drought incidence. Post-drought financial relief shows a positive and statistically significant effect on the industrial as well as on the aggregate district growth rates.

Chapter 4.4 is the analysis of individuals' risk management strategies and determinants of preparedness against droughts in Sagar and Vidisha districts of Madhya Pradesh, India. The descriptive analysis and subsequent examination of the obtained results show that the proportion of respondents, who received an early warning, financial relief against crop losses, not incurred livestock loss and earn an income of INR 5000 and above, were more among those, prepared to deal with droughts and water scarcity situations. Notably, the respondents in BPL category and those having 3 to 4 dependents were highest in percentage among prepared individuals. Many respondents in the survey study shared their risk management strategies (long-term) towards droughts. They diversified the income and employment sources, accessed more social safety schemes offered by state and central governments, migrated for livelihoods, and arranged for different irrigation sources for water availability. The results of binary logistic regression analysis showed that the main variables associated with an increase in the odds of drought-preparedness were Gender, Income, and Migration (for full sample). The important predictor variables towards drought-preparedness were Income, Social group, Gender, Migration and Financial relief for sub-sample (farmers).

Chapter 4.4.2 explores for three selected behavioural biases (Overconfidence, over-optimism, and herding). The systematic departure from rationality in drought preparedness is shown by many respondents. The respondents during field survey exhibited irrational decision choices driven by psychological biases. For example, the group of respondents, non- prepared to face the droughts were still overconfident about their ability to adapt (43%) and cope (39%) if drought occurs in future. 66% and 92% farmers were highly optimistic to have good harvest, and to receive financial relief from state government post-drought. The respondents also demonstrated herding behaviour. 88% of uninsured respondents were willing to buy crop insurance following friends or neighbours. The respondents who lost the livestock/s, 86% were ready to buy the livestock insurance following others. Similarly, 36% non-migrant respondents were even ready to move to other places for employment following friends, neighbours or someone known to them. In addition, another 30% non-migrants showed 50% chances of migration, if their friends or neighbours also migrate.

6.3 Policy implications

The empirical findings and the in-depth analysis of the existing disaster management framework of the country and Madhya Pradesh are useful as the inputs for future policy formulation. The following major policy implications may be drawn from the present work.

Chapter 3 is the empirical analysis to estimate the drought and financial relief impact on the agriculture and aggregate growth rates of the selected Indian states. The findings of the analysis are very valuable to provide insights on the possible statistical relationship between droughts, relief and the growth variables of the states. These results are for relevant stakeholders for designing specific pre and post-drought risk management strategies, planning for the state irrigation capabilities, etc. For example, there is a clear need to include drought mitigation as an integral part of the rural development strategy at sub-national and national level in India. Moreover, there must be an enhanced expenditure on the agricultural research, drought and climate change related effect on economic growth. This may enhance the farmers' capabilities in the wake of drought risk. These suggested policy initiatives may also help to promote the sub-national and overall agricultural growth in India.

Chapter 4.2 is an overview of the drought management policy of India and Madhya Pradesh. The overview proves to be useful as it contributes to the existing knowledge by highlighting the shortfalls in the existing policy framework. Many states including Madhya Pradesh lack technology and resources to monitor, declare and mange droughts. In addition, the revised drought declaration norms are very rigid and impractical to implement. As a result the states are facing the issues to claim additional financial resources from centre for moderate but detrimental drought events. These findings therefore have important policy implications for reviewing the new guidelines in consultation with the states to address their rationale concerns. In addition, the centre must enhance the financial allocation to the economically stressed states for effective drought management. Therefore, the findings of the overview of drought management policy of the country and Madhya Pradesh may have a rationale for the governments, policymakers and the relevant stakeholders for strengthening the drought management framework at the sub-national level.

Chapter 4.3 is an empirical analysis to estimate the impact of drought and financial relief on the aggregate and other sectors of the economy of select districts in Madhya Pradesh. The results of the study may be helpful in stimulating policy at state level. First, the state must invest in developing irrigation facilities to minimize the drought impact on the agricultural sector. The expansion of irrigation measures such as sprinklers and drip-irrigation is also stated in the Economic Survey 2017–18. Second, the state must ensure that drought-relief funds are effectively utilized. The funds, if effectively used, will generate employment and create productive assets. Further research is warranted on whether the utilization of post-drought financial relief is to fulfil short term consumption needs or for asset creation. If the consumption is the priority, policy-makers may have to re-design the approach and modus operandi of drought relief. Finally, there is an immediate need to look at drought management in the context of the economics of development.

Chapter 4.4 is a field survey to explore the behavioural issues, determinants of preparedness and the risk management strategies of individuals against droughts. The descriptive and inferential analysis is performed on the collected data through primary survey of respondents to arrive on results and subsequently the policy implications. Firstly, the study suggests that there is a need for strong government intervention to strengthen the social safety net (schemes such as crop and livestock insurance), and providing more access to government schemes to individuals residing in the drought-affected areas. The outreach of the crop and livestock insurance were inadequate, increasing the risk burden of the farmers. Therefore, the state government should focus to increase insurance penetration and outreach significantly. Secondly, the state government must also ensure that the farmers timely receive the financial relief towards crop losses due to droughts. Also, the financial relief reimbursement amount should be significantly increased from the current level. The third policy recommendation is to improve the irrigation infrastructure to mitigate the drought-risk. The farm-level irrigation facilities were inadequate, especially with marginal and small farmers. The groundwater level in the study area is at an alarming level to fulfil the drinking water and agriculture water requirements. Therefore, it warrants an urgent policy intervention as suggested. The existing and operational bore wells, public tube wells and farm wells maintenance should also happen regularly. The governments (central and state) must enhanced funds to improve the existing infrastructure in these respects.

The Relief Manual for drought management of Madhya Pradesh (2015) has a provision to provide 50 days of additional work under flagship guaranteed employment (MGNREGA) scheme. As a fourth policy measure the study recommends that this scheme should be implemented effectively to give employment to the landless labourers as well as marginal farmers in drought years. For this, the central government and state government should allocate adequate financial resources to the local government. The fifth policy recommendation is related to a few operational and beneficial government schemes (additional 50 days employment guarantee under MGNEREGA during disasters, micro-irrigation schemes etc.) in the state, but not known to the respondents. The government should educate the public about such schemes through awareness campaigns and other modes in the drought-affected areas. Also, a mechanism should be developed to pass the benefits to the targeted beneficiaries.

The sixth suggestion is for the individuals to take suitable measures to minimize the drought-risk on their own. For example, they may develop some non-agricultural sources (off-farm) of income generation. They may also inculcate the habit of small savings to improve the resilience against drought. It is advised to search for financial institutions to get credit access to become self-resilient towards drought. The findings and recommendation of the study may be equally applicable to other drought-affected regions with similar socio-economic characteristics of respondents like Madhya Pradesh. The exploration of various behavioural issues are useful in knowing the decision making process of individuals. Understanding these concepts of behavioural finance (overconfidence, over- optimism and herding) may be helpful for policy-makers to know how individuals frame choices in risk and uncertainty of climatic disasters like droughts. It may definitely contribute to formulate the appropriate risk management strategies for coping and adaption at individual level.

6.4 Directions for future research work

Chapter 3 findings lead us to few important future research questions. For example, the study failed to include drought intensity into the econometric specification (classification like moderate and severe droughts). In the Indian context and especially at the state level, information on financial losses directly or indirectly attributed or due to droughts, lives lost (due to malnutrition, extreme poverty, food shortages and water scarcity), and population affected (displaced or permanently migrated), among others are unavailable. Future studies may account for these gaps. Measuring long-term effects is also another exercise and important for understanding the impact of slow onset extreme events on any economy.

Chapter 4.2 attempted to present a comprehensive overview of the drought policy of India and Madhya Pradesh, but leaving ample scope for the future researchers to study further. For example, one may discuss and compare the various state-specific drought assessment, declaration and management policies. Interested researchers may also study the pre-drought management (prevention and mitigation) strategies of India. There may also be a study analysing the impact of drought and the financial relief on the economic growth, employment or on the fiscal deficit/budgets of the country or states. Also, the pre and post budgeting policies of the central and state governments towards drought management may be an essential avenue for future researchers.

Chapter 4 failed to address a few issues. First, non-availability of data (beyond 2012) for the selected districts and control variables restricts the empirical study (chapter 4.3) to examination of the period 2005 to 2012. Second, the drought-loss data for a few selected districts had to be excluded due to unavailability. Third, the study failed to explore how the intensity of drought may affect economic growth. These gaps can be filled by the future researchers.

Chapter 4.4 has certain limitations which may also be addressed in future researches. The study has explored the determinants and risk management strategies of adaptation towards droughts. There is a scope to explore and analyse such factors for coping of individuals and households in short-duration.

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QUESTIONNAIRE

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE UTTARAKHAND-247667

INTERVIEW SCHEDULE

Strictly Confidential

(For Research Purpose only)

To explore the behavioural issues and individual risk management practices (coping and adaptation strategies) to reduce losses against droughts

Date of Interview...

Time (beginning)............................. **Ending**.......................................

Name of Interviewer..

Dear Respondent

The survey is being conducted as a part of a PhD dissertation titled "Economic impact of droughts and drought risk management practices: A study of Madhya Pradesh." The information/data collected through this exercise would accomplish the objective: "To explore the behavioural issues and individual risk management practices (coping and adaptation strategies) to reduce losses against droughts." This research is purely academic in nature and your responses will remain strictly confidential. Participation in this study is voluntary and if you think that information related to any particular question is too personal to be revealed then you can skip that question.

Name of the Village: ………………Panchayat: ……………….

Block: ………………
District: ...……………….

Location (1=Urban, 2=Rural)…….

Name of Respondent: …………………

Respondent Code: …………

1. Is drought impacting your livelihood directly? 1=Yes, 2=No (If Yes, go to Q. No. 3.1, if No, go to Q. No. 2)

2. Are you of the opinion that drought affects you indirectly? 1=Yes, 2=No (If yes, go to Q. No. 2.2, if No, go to Q. No. 2.1)

2.1 Comments:

2.2 What kind of welfare loss have you felt due to drought?

Notes:

3. Respondent's details

3.1 Employment status: Principal………Secondary………..

1. Self-employed in agriculture
2. Self-employed in non-agriculture
3. Regular wage/salary earning
4. Casual labour in agriculture
5. Others

Q. No.	Details	Response
3.2	Economic status (1=APL, 2=BPL)	
3.3	Age (years)	
3.4	Gender (1=Female, 2= Male)	
3.5	Category (1=SC, 2=ST, 3=OBC, 4=GEN, 5=Unclear)	
3.6	Education (1=Illiterate, 2=Below High School, 3=High School, 4=Higher Secondary School, 5=Graduate, 6=Post Graduate, 7=Above Post Graduate)	
3.7	Are you the sole earner in the family? (1=Yes, 2=No)	
3.8	Number of dependents	

3.9 Land ownership (if engaged in agriculture):

	Land type and Area (Unit in Acre)		
Land type	Self-owned	Leased in	Leased out
Irrigated			
Non-irrigated			
Total			

3.10 Source of Irrigation:

Source of Irrigation	Bore well	Canal	Lake/pond	River	Rainfall	Others
Area of land irrigated (Acres)						
	1	2	3	4	5	6
Normal Years						
Drought Years						

3.11 If livelihood is dependent on agriculture, the approximate production (Quintal)

Normal Year (last)………			Drought Year (last)…….		
Name of Crop	Acreage	Output	Name of Crop	Acreage	Output
Total					

Crop loss in Drought Years (1= No loss, 2= Up to 25%, 3=26-50%, 4= more than 50%, 5= Can't say) …………

4. Approximate total expenses of the household (INR): ……

Total income/month (INR)	Tick
1. below 5000	
2. 5000-8000	
3. 8001-11000	
4. 11001-20000	
5. more than 20000	
6. do not know/no answer	

5. Effects of drought and Preparedness

5.1 Have you ever experienced drought in last 1-3 years? (1=Yes, 2=No) ……

5.2 Do you believe that the frequency of droughts has increased in the last decade?

1=Yes, 2=No, 3=don't know ……..

5.3 Did you receive early warning of drought? 1=Yes, 2=No, 3=don't know ……

5.4 If yes, Source: 1=television/ radio, 2=newspaper, 3=local authority, 4=self-prediction, 5=friends/neighbours, 6=other sources ………

5.5 Generally how reliable is the information? 1=very reliable, 2= reliable, 3= indifferent, 4= unreliable, 5=extremely unreliable ………

5.6 What information would you like to be delivered by the media/local authority?

Note:

5.7 If you maintain the livestock, has there been any losses (like, mortality) due to drought? 1=Yes, 2=No ……

5.8 Are you prepared enough to deal with the drought? 1=Yes, 2=No

6. Drought Relief

Q. No.		Response
6.1	Are you aware of the drought relief programmes/schemes of Government? (1=Yes, 2=No)	
6.2	Did you receive post-drought relief by government? (1=Yes, 2=No)	
6.3	How much was the delay in receiving the financial relief from the date of sanction to disbursement? 1=one month, 2=two months, 3=three months, 4= more than three to six months, 5= more than six months, 6= no delay,	
6.4	Mode of payment 1=cash, 2=cheque, 3=transfer to bank account	

6.5 Awareness about Government schemes and benefit received during last drought year
(External support/aids for coping and adaptation)

Government Schemes	Awareness (1=Yes, 2=No)	Benefit Availed (1=Yes, 2=No)	Comments on performance
Centrally Sponsored Schemes			
PDS (food security)			S. No. Item Quantity(Kg)/month/person 1. 2. 3. 4.
Mid-day meal			
MUDRA loan (For non- farm income generating business; Shishu-50000 ₹ Kishore-5,00,000 ₹ Tarun -1,00,0000 ₹			Eligibility Loan availed (in ₹) Shishu Kishore Tarun
Pradhan Mantri Jan Aushadhi Yojana (PMJAY; low cost generic medicines provided through selected medical outlets)			
MGNREGA (50 days additional employment in a year)			Workdays………. Average wage received/day (in ₹)
PMFBY (Crop Insurance)			S. No. Crop Sum Insured Sum received (in ₹) 1. 2. 3. 4.

50% subsidy (₹ 2000/hectare for fuel(diesel) and 50% subsidy for farming inputs like pumps/seeds etc. maximum for 2 hectares)			S. No. Item Subsidy received (in ₹) 1. 2. 3. 4.
Early warning advisory of drought/weather through m-kisan portal (SMS)			
Any other schemes (like, goat distribution to poor/land less households; food storage facility; setting of fodder bank nearby)			
State Sponsored Schemes			
Mukhyamantri Yuva Swarojgar Yojana (to setup industry/service/business; for 18-45 years age)			Eligibility (in ₹) Loan disbursed (in ₹) 20% upfront funding, Max ₹ 10,000 Max project cost ₹ 50,000 ROI: 5%/year till 7 years
Rajya Bimari Sahayata Yojana (for BPL labourer, domestic helpers in urban area, street vendors in urban area etc.)			Eligibility (in ₹) Actual reimbursement (in ₹) (25000 to 2,00000)
Deendaya Rasoi Yojana (food at ₹ 5 to BPL individuals through selected canteens)			
Crop loan at 0%/ -10%			Loan availed (in ₹)
Bhavantar Yojana (difference of MSP and market rate for selected crops paid directly/DBT to farmers)			Crops Difference received (in ₹) 1. 2. 3.
Agriculture loan (KCC/acre)			Limit/hectare Amount (in ₹) Availed (in ₹)

Crop loan waiver/acre			Eligibility/acre (in ₹) Relief /acre (in ₹)
Nalkoop Khanan (only for SC/ST farmers, 75% of cost/ ₹ 25000) Rajya Micro Irrigation Mission (for all categories of farmers) Sprinkler-80% of cost/₹12000/hectare Drip irrigation-80% of cost/₹ 40000/hectare Mobile raingun-50% of cost/₹ 15000/raingun			Nalkoop Khanan Disbursement (in ₹) Rajya Micro Irrigation Mission Item Disbursement (in ₹)
Soil Check-up facility			S. No. Type Amount paid (in ₹) 1. General 2. Specific (………….)
Any other			

7. Drought and Migration

7.1 Have you ever migrated because of drought from your village? (1=Yes, 2=No) …..

7.2 If migrated, why? …..

1=limited/no coping strategy

2=livelihood loss (total loss)/ moving out to find some work

3=unavailability of water to drink/cook/bath

4=lack of/insufficient government intervention

5=any other (specify)……………………….

7.3 How long you migrated? ....

1. less than 1 month 2. 1-2 months

3. more than 2 months to 4 months 4. more than 4 months to 6 months

5. more than 6 months to one Year 6. more than 1 year (Specify……)

7.4 Migration was alone or along with family? 1=alone, 2=along with family

8. Behavioral Biases in Decision Making

8.1 Overconfidence:

Q. No.		Response	Remarks
8.11	Are you confident of having good harvest in coming Kharif season despite drought history? (1=Yes, 2=No)		
8.12	How sure are you that loan waiver/relief will be disbursed to you by government, if crop fails again? no (0%) less chance (20%) perhaps (40%) should give (60%) most likely (80%) sure (100%)		

8.2 Over-optimism/Under optimism:

Q. No.	Perception	Response	Remarks
8.2.1	Do you feel that droughts will be frequent in coming years and will harm you more? (1=Yes, 2=No)		
8.2.2	Do you feel that rainfall will be normal or good in coming years/seasons?(1=Yes, 2=No)		
8.2.3	Do you feel that the coping measures will help you again? (1=Yes, 2=No)		
8.2.4	What are the chances of your migration due to the expected drought(s) in forthcoming years? 1=100%, 2=50%, 3=0%, 4=can't Predict		

8.3 Herding:

Q. No.		Response	Remarks
8.3.1	Do you have crop or/and livestock insurance? (1=Yes, 2=No)		
8.3.2	Why have you not insured yourself despite the awareness? (1=economic reasons, 2=non-profitable/wastage, 3=incompetent to understand and buy, 4=bad experience, 5=other reasons/don't know)		
8.3.3	If your friends/neighbours do the same? (1=No (economic reasons), 2= Yes (following others), 3=don't know/don't want to share)		
8.3.4	What are the chances of your migration to some other place to work/live if your neighbours/friends/relatives also migrate due to drought? 1=100%, 2=50%, 3=0%, 4=can't predict now		

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