Strengthening Performance Management in Government

Climate Change Vulnerability and Adaptation Assessment District - Chhindwara

Mainstreaming Climate Change Adaptation in Development Planning of Madhya Pradesh

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Acronyms

AGI	:	Agriculture Indices
BASIC	:	Basic and Strengthening Institutional Capacities on Climate Change
CC	:	Climate Change
CCA-RAI	:	Climate Change Adaptation in Rural Areas of India
CDM	:	Clean Development Mechanism
CERES	:	Clouds and Earth's Radiant Energy System
CLI	:	Climate Indices
CSA	:	Climate Smart Agriculture
CVI	:	Composite Vulnerability Index
DA	:	Development Alternatives
DFID	:	Department for International Development
EC	:	Electrical Conductivity
ECI	:	Economic Indices
ENI	:	Environment Indices
EPCO	:	Environmental Planning and Coordination Organization
FSI	:	Forest Survey of India
GA	:	Geographical Area
GHG	:	Green House Gases
GIS	:	Geographic Information System
HA	:	Hectare
HLI	:	Health Indices
IAY	:	Indira Aawas Yojana
IBS	:	Integrated Biosphere Simulator
IBIS	:	International Benchmarking of the Information Society
IGNOU	:	Indira Gandhi National Open University
IIFM	:	Indian Institute of Forest Management
IITM	:	Indian Institute of Tropical Meteorology
INR	:	Indian National Rupee
IPCC	:	Inter-governmental Panel on Climate Change
ISOPAM	:	Integrated Scheme of Oilseeds, Pulses, Oil Palm and Maize
IWRM	:	Integrated Water Resource Management

JFM	:	Joint Forest Management
JFMC	:	Joint Forest Management Committee
KCC	:	Kisan Credit Card
KVK	:	Krishi Vigyan Kendra
LPCD	:	Liters per Capita Daily
LULUCF	:	Land Use, Land Use Change and Forestry
LVI	:	Livelihood Vulnerability Index
MCM	:	Million Cubic Meters
MGNREGA	:	Mahatma Gandhi National Rural Employment Guarantee Act
MOEFCC	:	Ministry of Environment, Forest and Climate Change
MPCDF	:	MP Cooperative Dairy Federation
MPWSRP	:	Madhya Pradesh Water Structure Restructuring Project
NABARD	:	National Bank for Agriculture and Rural Development
NAPCC	:	National Action Plan of Climate Change
NATCOM	:	National Communications Center
NGA	:	Nirmal Gram Yojana
NGO	:	Non-Governmental Organization
NMPS	:	National Mission for Protein Supplements
NPP	:	Net Primary Productivity
NTFP	:	Non-Timber Forest Produce
PFC	:	Project Facilitating Committee
PIA	:	Project Implementing Agency
PIM	:	Participatory Irrigation Management
PP	:	Projected Production
PPM	:	Parts Per Million
PRECIS	:	Providing Regional Climate Model Diagnosis and Inter-comparison
PRI	:	Primary Rural Institution
PRIS	:	Performance Related Incentive Scheme
RAY	:	Rajiv Aawas Yojana
RBI	:	Reserve Bank of India
REDD+	:	Reducing Emissions from Deforestation and forest Degradation
RKVY	:	Rastriya Krishi Vikas Yojana
R&D	:	Research and Development

SAPCC	:	State Action Plan on Climate Change
SI	:	Social Indices
SHG	:	Self Help Group
SOC	:	Standard Occupational System
SKMCCC	:	State Knowledge Management of Climate Change Cell
SRLM	:	State Rural Livelihoods Mission
SWAT	:	Soil and Water Assessment Tool
SWM	:	South West Monsoon
TEEB	:	The Economics of Ecosystem and Biodiversity
TFRI	:	Tropical Forest Research Institute
UNDP	:	United Nations Development Programme
UNFCCC	:	United Nations Framework Convention on Climate Change
UP	:	Uttar Pradesh
VA&A	:	Vulnerability Adaptation and Assessment
VI	:	Vulnerability Index
WHS	:	Water Harvesting Structures
WRI	:	Water Resources Indices
WSRP	:	Water Sector Restructuring Project
WTO	:	World Trade Organization

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Acknowledgement

A comprehensive study of climate change vulnerability of Chhindwara district was conducted and the major findings were lucidly drafted and presented in the form of this booklet. The facts emerged in the study were validated with primary and secondary data of each block to draw scientific conclusions about the extent of vulnerability in the sectors of water, agriculture and forest. The information generated through the study and discussion with the members of the focused group of stakeholders made valuable contributions, which would facilitate the concerned development departments to incorporate the findings in their action plans for dealing with the issues of climate change, thereby improving the quality of life of people by ensuring their livelihoods.

I sincerely acknowledge my gratitude to Shri Ajatshatru Shrivastava, IAS, Executive Director, EPCO, Bhopal for providing guidance and encouragement for undertaking the study. I also gratefully acknowledge a deep sense of gratitude towards Shri Lokendra Thakkar, Coordinator State Knowledge Management Centre on Climate Change (SKMCCC) EPCO, Bhopal for providing the technical guidance, thought provoking comments, and constructive criticism in conducting the study and preparing the report. I also avail this opportunity to express my heartfelt thanks to Mr. Shantanu Das, Governance Advisor, Department for International Development, New Delhi for the technical and financial support. I would like to express my gratitude to those who have provided their valuable contribution for completing the work, in particular to Mr. Jay Anand, resource person on Water, Dr. K.K. Saxena, resource person on Agriculture, Mr. Kiran P. Mali, resource person on Forest, Mr. Rohit Johri and the Bhopal team of Development Alternatives. I also extend my sincere thanks to Dr. S.N. Pandey and Mr. Vishal Jagtap, their team and all stakeholders of eleven blocks who spared their valuable time for providing the detailed information for primary data collection. I acknowledge the support and guidance by the officials and staff of the Directorate of Economics and Statistics, State Forest Department, District Statistical officer, Divisional Forest Officer, Department of Farmers' Welfare and Agriculture Development, Department of Horticulture and Animal Husbandry, Krishi Vigyan Kendra, Department of Land records, Water Resource Departments, Central Ground Water Board etc. Thanks are also due to the respondents who have spared their valuable time while providing the inputs for the primary survey. Dr. Umnesh Pattnaik deserves a special mention, who guided us in framing the interview schedule for the study purpose.

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Executive Summary

The study of Chhindwara district is based on the scientific analysis of observed climatic trends (Exposure), their impacts (Sensitivity) as well as capacities to deal with the impacts (Adaptive Capacity). With the above conceptualization of climatic variability, the present study developed and tested the application of a Livelihood Vulnerability Index (LVI) for water, agriculture and forest resource dependent communities in the semi-arid regions of Chhindwara district. The index was administered for a composite-cum-sectoral (Agriculture, Water, Social, Forest and Health) study of each block of the district that is known to bear extremely severe impacts of climate change year after year.

The adopted LVI entailed a secondary data (49 indicators at the block level) and primary data analysis that highlighted Household Details, Migration Status, Housing Conditions, Land, Crop and Livestock Details, Awareness and Access to Govt. Interventions and Schemes, Consumption and Health Expenses, Health and Food Security, Household Assets, Loan, Credit and Savings, Impact of Climatic Aberrations and Adaptation (Farm and Non-Farm Based including water, agriculture and forest), focusing exposure, sensitivity and their adaptive capacity.

The results of the secondary data analysis suggested that one of the blocks – Tamia - was the most vulnerable on the composite scale, which perfectly fitted in with Social (Rank1), Water (Rank1), Forest (Rank1) and Health (Rank1) dimensions but displayed variance in Agriculture in vulnerability scale. Further, the comparative analysis of calculated sensitivity and adaptive capacity of both primary and secondary data have shown that Amarwara block ranked first in the secondary and second in the primary data analysis in case of sensitivity whereas in adaptive capacity secondary and primary data are ranked seven and seven respectively, concluding that there was less significant variation in primary and secondary studies as far as vulnerability was concerned. Bichhua, Chura, Harrai, Jamai and Sausar were highly non-significant in terms of vulnerability correlation. In both Primary and Secondary cases, values above 0.5, need to be given more emphasis sectorally to reduce the vulnerability. The analyzed stressors were mainly related to income, occupation, migration, and assets owned by the people including agriculture, forest, water, health, social accessibility and affordability by the community.

The study can be contextualized in terms of the measurement of vulnerability, pointing out the need to take risks at the block level into account in designing poverty-reduction strategies by policy makers and practitioners. Overall, the study suggested that the LVI can be broadly applied in comparable settings in small developing states and other developing countries. In doing so, it provides a reliable methodology that can be used to assess community vulnerability and design management integrated plans for the overall development in areas with limited resources and access to reliable data. It highlights a number of ways to develop sound strategies for measurement of vulnerability, and also provides directions for planning in terms of policy options and taking up appropriate measures like capacity building and adequate adaptation, including insurance under the State and National Adaptation Assessment Process.

The element of information drawn from the study will develop a future roadmap to conduct Vulnerability Assessment and Adaptation, package of practices, besides an overview of the National Circumstances which the challenges of Climate Change are being addressed and responded to. Suggested technologies for adaptation measures in relation to climate challenges are diverse and that deployment required some serious efforts for successfully leveraging technologies to meet the Climate Change challenges. The agenda for moving ahead must be viewed with the understanding that the necessary ranked adaptation sectors in each block must be appropriately tailored, for specifics of the technology as well as for regional circumstances. It would be a win-win situation if the technology-cum-adaptation framework could encompass the following elements: financial assistance, technology deployment for sectoral upliftment, integrated technology development, knowledge-sharing for enhancing deployment and capacity building. A better understanding of the adopted adaptation tools in the sectoral context of Chhindwara and State of Madhya Pradesh needs to be further refined, assessed and identified therein.

1. Introduction

Vulnerability is described as a function of exposure to climate hazards and perturbations, sensitivity, and adaptive capacity (IPCC 2011)[1] and is an emerging concept for climate science and policy[2][3][4]. In other words, it is the degree to which a system is susceptible or unable to cope with the adverse effects of climate variability and extremes. The extent to which systems are vulnerable to climate change depends on the environmental, physical, and socio-economic conditions of the area. Understanding the pattern, extent and driving factors of vulnerability is desirable for climate adaptation efforts. The purpose of the analysis of vulnerability to climate change at the Block level is to identify, classify and map the vulnerability based on a set of multivariate data (Secondary and Primary). This vulnerability assessment is helpful for developing and prioritizing strategies to reduce the vulnerability, and for determining the effectiveness of those strategies.

1.1. Literature Review

A vulnerability assessment is the process of identifying, quantifying and prioritizing (or ranking) the vulnerabilities in a system, which has to be carried out by the Environmental Planning and Coordination Organization (EPCO) and Development Alternatives (DA) at the state and district level. Four previous joint study reports on vulnerability assessment by reputed institutions (EPCO, GIZ, UNDP and DA) for Madhya Pradesh and Chhindwara state that adaptation to climate change requires integrated solutions that simultaneously address livelihood improvements and environmental sustainability. Proactive measures for adaptation to climate variability and change can substantially reduce many of the adverse impacts, and thus contribute to the livelihood security of the vulnerable rural population.

1.2. Vulnerability to Climate Change

Based on the IPCC Third, Fourth and Fifth Assessment Report in 2001, 2006 and 2012 respectively, Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, as well as its adaptive capacity. Thus, vulnerability comprises three major components:

1.2.1. Exposure

Exposure can be interpreted as the nature and extent of changes to a region's climate variables. A rise in the extreme events such as high temperature and low precipitation will impact the health and lives of the local populace as well as generate the associated environmental and economic impacts.

1.2.2. Sensitivity

Sensitivity describes the human-environmental conditions that can worsen the hazard, and ameliorate or trigger an impact of climate change.

1.2.3. Adaptive Capacity

[1] IPCC working Group paper (2011): Impacts, Adaptation and Vulnerability.

[2] "Vulnerability" may be defined in various ways. UNDP and GIZ describe vulnerability as a function of exposure to climate hazards and perturbations, sensitivity, and adaptive capacity (UNDP 2011).

[3] Bünner (2013) lists the following reasons for conducting VAs: "Internationally, VAs are often used for comparing vulnerabilities of countries, often in form of vulnerability indicators"; "At national level, VAs support the setting of development priorities and … preparing Adaptation Strategies [such as] NAPAs"; "VAs on a sectoral level assist in setting strategic targets in development planning. At local level, VAs are used for developing local adaptation strategies or for mainstreaming adaptation into existing district or community plans. They are often the first step to be realized before designing and implementing an adaptation project."

[4] The term "resilience" here is intended to encompass and go beyond adaptation

Adaptation is a process through which societies are taking the measures to reduce the negative impact of climate change. There are many ways to adapt such as better water management in times of drought, early warning systems for extreme events, improved risk management and various insurances.

1.2.4. Vulnerability to Climate Change in Madhya Pradesh

Climate observations stated in Madhya Pradesh State Action Plan highlight that the state has observed a gradual increase in temperatures across all seasons and a decrease in monsoon rainfall in all agro-climatic zones with erratic and uneven spatial and temporal distribution. The climate data analyzed by IITM Pune indicates a declining trend for rainfall over the state of MP from 1901 to 2000. The water availability in the state has also been declining. Shifting of the rainfall pattern has also affected the cropping patterns. Erratic weather conditions, shifting monsoons and uncertain precipitation patterns are not only impacting the productivity of the agriculture sector but are also negatively affecting the economy and livelihoods of communities directly dependent on it.

1.3. Madhya Pradesh and Vulnerability Assessment

Madhya Pradesh (MP) State is already registered as a pioneer in terms of carrying out Vulnerability and Risk Assessment with respect to Climate Change in Madhya Pradesh, under the Climate Change Adaptation in Rural Areas of India (CCA-RAI). Being ahead and imperative to act earlier, the State has come forward to step down its analysis from district level to block level in order to address how vulnerable a population (human or other) is to climate change at the local level, by using secondary and primary data, and what are the priorities in terms of investing in building adaptation/resilience, based on the extent of vulnerability in the three thematic areas (Agriculture, Water, and Forest).

Vulnerability assessment is conducted to assess trends in a population's (or geographic area's) exposure and vulnerability to climate change. Most of the adopted vulnerability indicators (26 of the 61 indicators) from the previous study (GIZ-EPCO- CCA-RAI) are to assess impacts, risks, and the adaptive capacity of a region or sector to the effects of climate vulnerability. For the purposes of this overview, vulnerability assessment is considered separate from adaptive capacity assessment. A quantitative "top-down" vulnerability assessment is focused to be used in developing climate change adaptation policies or taking action at the district level by sectoral (Agriculture, Water and Forest) authorities. A qualitative and quantitative method's "bottom-up" vulnerability assessment approach has been used to assess the social vulnerability of communities while considering adaptation options at a smaller scale.

2. Summary of SAPCC and State Vulnerability Assessment Report

The recent study by Environmental Planning and Coordination Organization (EPCO), Bhopal and GIZ, India Madhya Pradesh, has elaborated climate projections that reveal that the average surface temperature and precipitation variability will increase at the regional scale, triggering hydrological variations and alterations in river flows and groundwater table levels. Climate change impacts on freshwater resources are likely to affect freshwater availability and quality and (by extension) the ability of water systems to support natural processes and ensure population needs. As a result, the vulnerability of water systems to adverse conditions (e.g. water shortages, over-exploitation, and quality deterioration) is intensified; hence, methods and tools for vulnerability assessment and identification of adaptation measures are necessary for agriculture, forest and water sectors.

2.1. Overall Future Vulnerability

The assessment of overall future vulnerability was performed by applying the rigorous model runs of each sector and spatial distribution of districts of the Composite Vulnerability Index (CVI) in Madhya Pradesh for projections pertaining to baseline, mid-century and end century scenarios. In the mid-century scenario, a number of districts move to higher CVI categories as compared to the current vulnerability conditions. In the Damoh case, it moves to higher vulnerability categories. In the end century scenario, the vulnerability is again predominant in higher categories for Chhindwara district.

2.2. Climate Scenario

The climate Scenario of Madhya Pradesh is assessed by using the PRECIS simulation data. Future climate exposure was considered for two time frames in the future: mid-century (2021-2050) and end century (2071-2050). In the mid-century scenario (2021-2050), the minimum and maximum air temperatures are expected to rise by 2.3^{o}C and 1.9^{o}C respectively. By the end of the century (2071-2100), minimum and maximum air temperatures are expected to rise by around 4.8^{o}C and 3.9^{o}C respectively above current conditions. Mean annual precipitation is simulated to increase by about 11% in the mid-century and about 30% towards the end of century. PRECIS simulation also indicated that the frequency of certain climatic extremes will significantly increase. Warm days and nights and consecutive dry days are expected to increase while the number of cold days and nights is expected to decrease.

Warm days: Spatial distribution of trend indices are projected for the mid-century and end century scenarios with respect to the baseline and it has been discovered that the confidence level is high, which simply means the mid and end century will be much hotter.

Warm nights: Confidence levels are also high in the baseline scenario, mid and end century, which highlights that nights will be hotter as compared to those in the base years.

Some of the sectoral impacts highlighted in the state vulnerability assessment report are as follows:

Water Resources: The state VA Report has projected an increase of 29% of precipitation by the end century (2071-2100) as compared to the baseline data (1961-1990) using SWAT model on Narmada basin. It has also depicted clearly that during the monsoon months, surface runoff and evaporation are projected to increase considerably and offer opportunities for enhanced water harvesting and groundwater recharge. Due to

substantially enhanced evaporation rates during the *rabbi* season, groundwater recharge is projected to decline despite the projected higher precipitation.

In case of Chhindwara, the projections depict a significant rise in precipitation surface runoff and base flow. Evaporation and groundwater recharge have mixed results; the areas are divided between 'no significant change' and 'significant increase'.

The Chhindwara watershed, covering an area of approximately 11,84,923 ha (Total No. 1,264)' is highly undulating and rolling in nature with hills and valleys. The forest cover is sparsely distributed on sloping lands and most of the area is under a thin vegetation cover. Chhindwara district is a pioneer in terms of Integrated water resource management to address severe drought, famine situations while ensuring sustainability of water supply and eradicating guinea worm diseases as focused objectives. Similarly, *Eke Pinch Eke Talban* (a pond for every panchayat) in 1999 was an innovative idea to build at least one water harvesting structure in the village by the Panchayat member. Secondly, *Pani Roko Abhiyan* (Save water Campaign), which is one of the world's biggest ever rainwater conservation programme-cum-water adaptation plan designed to increase water storage capacities, facilitate irrigation through stored water, recharge wells, renovate old water tanks and construct new ones was implemented to combat the erratic rainfall situations and climatic pressure. These two programmes were also vital because they were well designed to address the highest concentration of Tribal and Schedule Castes population who are more vulnerable to stresses in terms of water supplies and poor sanitation. The community comprises the most socially and financially marginalized groups with extremely limited coping strategies.

Agriculture Resource: The study highlights the impact assessment of agriculture, which was done on wheat and soybean crops in the Chhindwara district through CERES-Wheat and CROPGRP-soybean models. It states that the potential yield is already low due to temperatures higher than that in northern India. It also indicates a decline in wheat and soybean productivity by 14-20% and 14-17% respectively in the district (PRECIS A1B 2030 scenarios). Adaptation assessment suggests that the possible changes in sowing dates and hybrid selection can reduce the negative impact of projected climate in 2030s, along with other options such as widespread adoption of resource-efficient farming practices, promoting and reviving traditional drought-coping mechanisms, traditional water harvesting structures, drought-resistant crop varieties etc.

In a study conducted under the National Initiative on Climate Resilience Agriculture (NICRA), Chhindwara highlighted major climatic challenges and their consequences and also suggested various interventions.

Forest Resources: The impact of climate change on forest resources in Madhya Pradesh was assessed using a dynamic vegetation model called IBS (Integrated Biosphere Simulator), whose basic inputs are the given climatic data (PRECIS simulation), soil parameters and topographic data. The IBIS simulation indicates that in the near future (2021-2050), 23% of the State's forested area is going to be negatively affected by climate change. At the end of the century (2071-2100), 48% of the total forested area is expected to suffer from the impacts of climate change. In Chhindwara, the entire forest area is projected to be highly vulnerable; it distinctly highlighted the forest vegetative changes by 2080s under the A1B scenarios for Madhya Pradesh.

3. Climate Change Trends and Sectoral Vulnerabilities in Madhya Pradesh

3.1. Climate Change trends in Madhya Pradesh

Climate Change is one of the most serious threats to MP, especially to the semi-arid regions which are more vulnerable due to the pressures of natural resources and poor coping mechanism. It is inducing an additional stress on the ecology and socio-economic conditions of the local populace. The drought, increase in temperature, decrease in rainfall, uneven distribution of rainfall with high intensity in a shorter period of time, frost, and hail storm are some of the observed phenomenon due to climate change in the State.

These variations in climatic parameters are responsible for **crop damage, reduction in soil fertility, increase in disease and death, weak live-stock, reduced water quantity and quality, reduced availability of drinking water, reduced irrigation water and more moisture stress, reduced fuel wood and migration of people in search of livelihoods**. In rural areas, climate change is significantly impacting the economic front due to the high dependence on climate-sensitive factors like agriculture, horticulture, animal husbandry, fisheries, forest, water etc. as being the main supportive recourse for population at large in terms of sustainable livelihoods.

The greenhouse gases are well known to have caused serious problems in terms of increase in temperature, resulting in more demand for water and increase in biotic and abiotic stresses. For the MP region under South Asia Inter-Governmental Panel on Climate Change (IPCC 2007), the projected rise in temperature is from 0.5^0C to 1.2^0C by 2020, 0.88^0C to 3.1^0C by 2050, which is also endorsed by the SAPCC report.

3.2. Block-wise Climatic Trend analysis of Chhindwara District

3.2.1. Rainfall Pattern

The average annual rainfall (2006-07 to 2013-14) of Chhindwara, Amarwara, Harrai, Chaurai, Bichhua, Mohkhed, Sausar, Pandhurna, Parasia, Tamia and Jamia blocks used to be 1090.8, 1212.0, 1092.8, 1086.4, 1155.6. 1099.7, 986.0, 1101.1, 1122.0, 1455.5 and 1146.3 mm respectively. About 91.7 % rainfall was received in the South West monsoon season of June to September. Variation within the seasonal rainfall is important for crop production and the rain received in the month of September is vital for crop production and crucial for the maturity of Kharif crops and sowing of Rabi crops. Delayed onset of rains, early withdrawal or long dry spells is a natural phenomenon in Chhindwara district. Analysis of recent eight years (2006-07 to 2013-2014) (Fig 1) depicts a positive rainfall trend in all eight blocks out of eleven blocks of Chhindwara district where Amarwara, Chaurai and Bichhua blocks have found negative trend. The average rainy days trends were positive in all blocks where 2012 and 2014 years were fluctuating from the normal.

In current eight years (2006-07 to 2013-14), the rainfall (Fig 1) distribution each year has been fluctuating from the normal (eight years' mean) level, the years 2007-08 to 2011-12 was high variability compare to average annual rainfall. The trend shows that these periods rainfall was below than annual average, varies -777.5 to 292.6 mm in all blocks of the district. The recent year (2013-14) noticeable increased was noticed, in all blocks viz Tamia (52.8%), Sausar (40.1%) and Parasia (35.8%) from the annual average of last eight years' data.

In Fig 4, the overall fluctuating trend (2010-13) can be seen in all seasonal rainfall distribution viz. South West monsoon, North East monsoon, summer monsoon and winters in Chhindwara district. The South West monsoon

could prove to be positive for all the sectors as there was a range varies from -68.2 (2010) to 206.28 (2013) mm as compared to the annual average rainfall of four years (2009-13).

The normal annual mean maximum temperature observed annually revealed that the trend (2006-07 to 2015-16) of maximum and minimum temperature decreased significantly. The average maximum temperature during the period 2006-07 to 2015-16 was 30.4°C (Fig 2) which was fluctuated from -1.92°C to 0.59 (2012-13 to 2014-15), whereas in the minimum temperature also fluctuated from -1.4 to 1.5 °C from 2012-13 to 2014-15 that indicates high vulnerability.

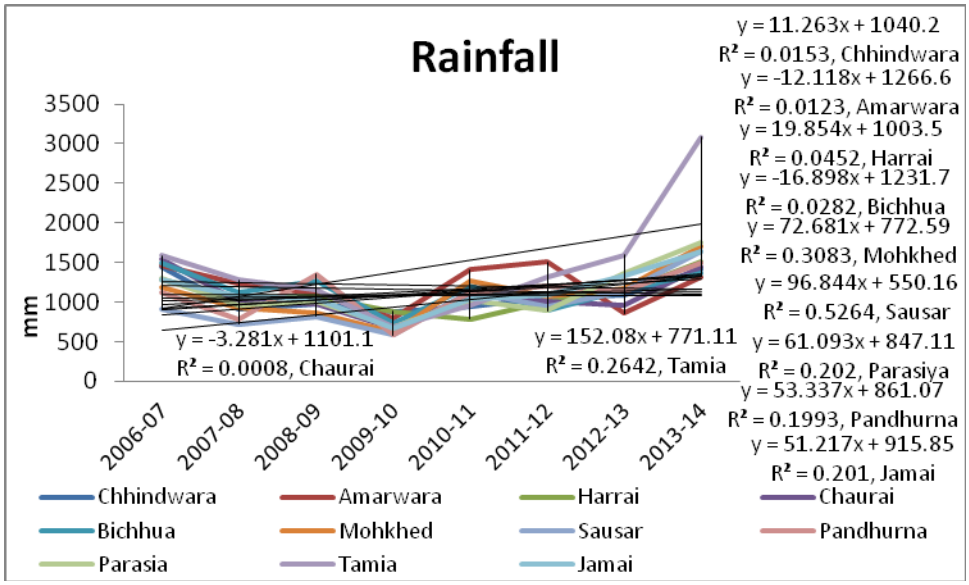
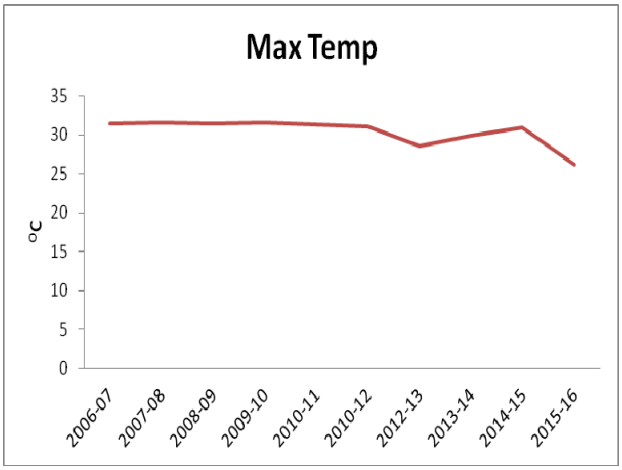


Fig 1.: Annual Average Trend (2006-07 to 2013-2014) of Rainfall in Chhindwara District



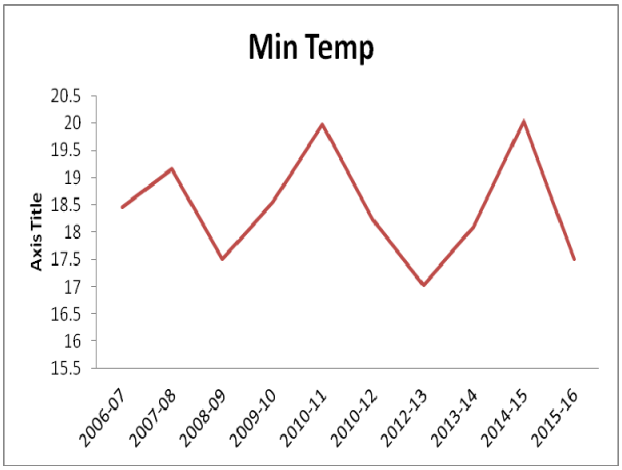
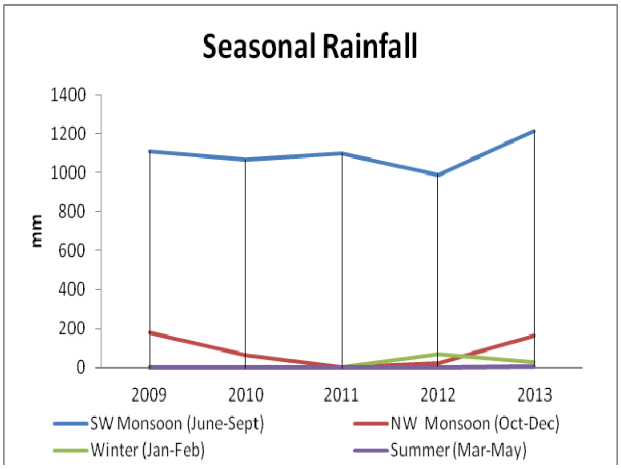


Fig 2. and Fig 3.: Seasonal trend (2006-07 to 2013-2014) of Maximum temperature and Minimum Temperature in Chhindwara



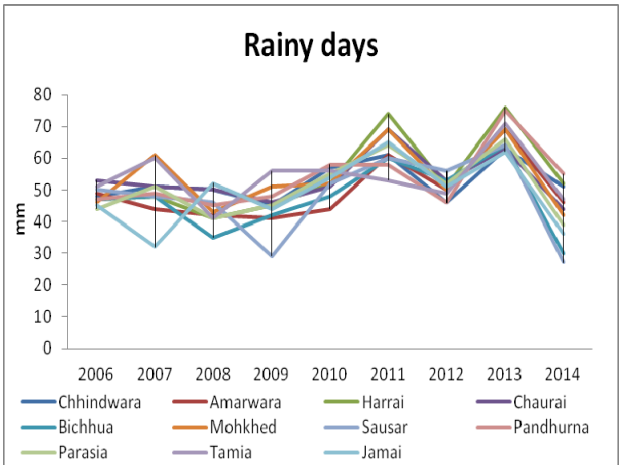


Fig 4. and Fig 5.: Seasonal Trend of Average Rainfall and Number of Rainy Days in Chhindwara

The S-W Monsoon rainfall has fluctuated -10.8 to 9.8% in Chhindwara in the recent period 2012-2013. In the rest of the period (NW-Monsoon, Winter and Summer) is showing mixed trend from year 2009.

3.2.2. Soil Status

The soils of the zone were grouped under shallow black soils. Some of the patches of the soils are covered under red and black soil group. Its scrapes representing the area are typified by moderately to gently sloping. The dominant soils of the district are ustochrepts. These are light to medium textured, slightly calcareous and slightly alkaline in nature. Soils developed in low lying area show wide cracks. The light reddish brown upland soils locally called Bhata are subjected to severe erosion losses. Therefore, these soils are shallow, gravelly light textured low in clay content. These soils are very low in nutrient status and available water capacity. Invariably they are left fallow or minor millets are grown. In general, soils of the zone are low in nitrogen, medium in phosphorus and high in potash. In all, deep soils are 34.0 per cent, medium deep soils are 9.0 per cent and shallow soils are 57.0 per cent.

3.3. Impact on Agriculture

From the facts narrated above, a greater instability could be anticipated in highly sensitive sectors pertaining to climate change, like agriculture and allied enterprises.

3.3.1. Rain-fed Agriculture

Rain fed agriculture occupies prominent place in Chhindwara district. The climate is largely sub humid and rainfall received from south west and north east monsoon which is also erratic and not uniformly distributed during the crop growth and development period. The cultivation of kharif crops preferred by farmers as very limited sources of irrigation are available. In the district insufficient perennial source of irrigation and lack of rain water storage structure impede rabi crops cultivation. Out of total cultivated area of 555.5 thousand ha gross irrigated area was 150.4 thousand ha and 357.6 thousand ha is rain fed. Open and bore wells are the major source of irrigation in Tamia, Parasia and Junnardeo (Jamai) tehsils the irrigation is limited to only 14.63 per cent. As reported in forest working plan of Chhindwara district.

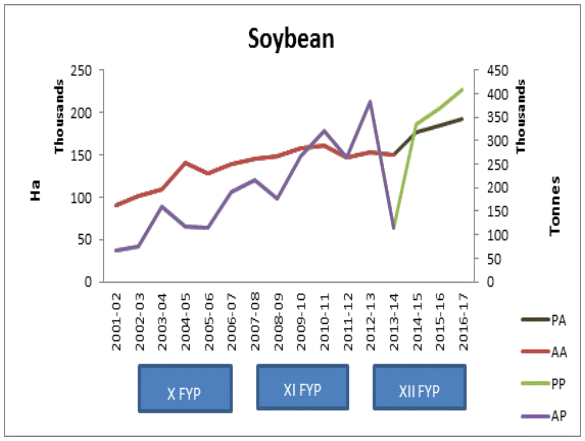
3.3.2. Cropping System

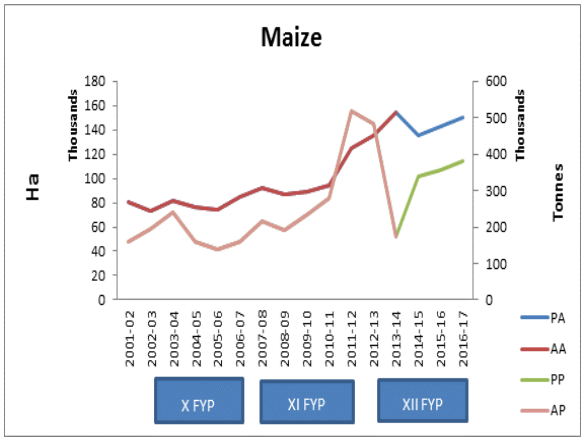
The district is known as soybean-wheat crop zone and famous for soybean, maize, cotton, ginger, groundnut, orange and vegetables, specially cabbage and cauliflower. A good quality of oranges is produced in Pandurna block while vegetables are grown on the large scale in the district, marketed in nearby places.

3.3.3. Trend of Area and Productivity

The trends in area and production of kharif crops (soybean, cotton, maize) and rabi crops (wheat and gram) was studied in Xth and XIth five year plans .The projections using growth formula in excel of the same crops were determined for XIIth five year plan to ascertain the anticipated future plan .The actual sowing area and production of soybean crop indicated that there has been an increasing trend in the area but the production substantially reduced in the year 2013-14 due to climate variability and incidence of insect pest and diseases. In case of cotton, there was marginal variation in the area of sowing while the production indicated fluctuating trend in the year 2010 and 2011.The production shown substantial increase in the year 2010-11 which reduced in subsequent years and fall down to a greater extent in the year 2012-13. The projection of the crop indicated slight increase in the area and production in XIIth five year plan. In the district, maize crop trends shown good performance in area and production in all three five year plans. The crop has potential to withstand in varying climatic conditions over other kharif crops. There are chances of substitution in the area of soybean and cotton by maize crop. In case of rabi crops viz wheat and gram under study indicated increasing trends in area and production during all the three five year plans. In wheat crop there was fluctuation in the production while area shown increasing trend.

Kharif crops





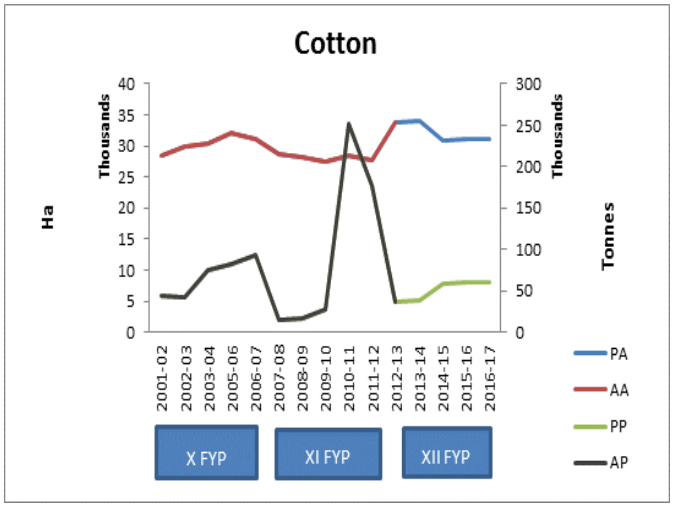
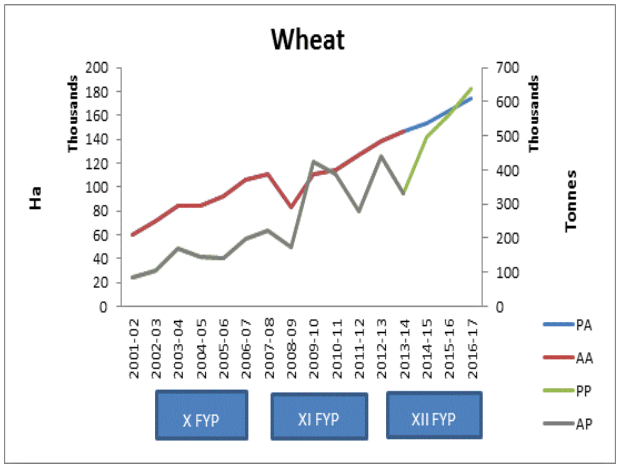


Fig 6., Fig 7. And Fig 8.: Trend in X and XI FYP and projection in XII FYP (Soybean, Maize and Cotton) [*AP- Actual Production, PP- Projected Production, AA- Actual Area, PA- Projected Area]

Rabi Crops



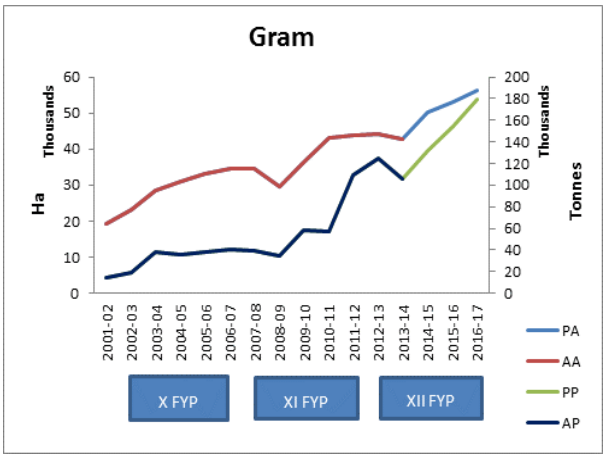


Fig 9. and Fig 10.: Trend in X and XI FYP and projection in XII FYP (Wheat and Gram)

3.3.4. Impact on Horticulture

Positive growth has been observed in the district in the horticultural crops. The climatic conditions of the district are favourable for cultivation of fruit and vegetable crops like orange, aonla, guava, pomegranate, ber, custard-apple, potato, garlic, onion, chillies, ginger and flowers, orange cultivation predominantly done in Pandurna tehsil while vegetable crops especially potato cultivated in the entire district. In the horticulture sector crop diversification has proved a viable source of livelihood for farmers as horticulture crops are grown along with the field crops. The role of horticulture as a whole is changing rapidly from traditional to high income generating activity. The process of change from low input technology of agriculture to horticulture proved more market oriented given regular income to farmers and generating employment.

Table 1: Status of Horticulture in Chhindwara District

Horticulture Crops	2011-2012		2012-2013	
	Area (ha)	Production (Metric tons)	Area (ha)	Production (Metric tons)
Vegetables	19,665	3,64,795	22,058	4,27,288.2
Fruits	18,090	3,11,587	27,964	5,32,737
Spices	20,907	2,25,697	13,835	1,48,692.5
Flowers	543	5,806	1,617	15,396
Medicinal Plants	19,665	3,64,795	22,058	4,27,288.2

Source: *Department of Horticulture and Farm Forestry, Government of Madhya Pradesh, Bhopal*

3.3.5. Impact on Livestock

The livestock sector is an integral part of agriculture which constitutes the most important resource for livelihood security of rural population especially during drought conditions when other enterprises suffer. Increased heat stress associated with global climate change may, however, cause distress to dairy animals and possibly impact milk production. It is highlighted that high milk producing cross-bred cows and buffaloes will be impacted more than the indigenous cattle. VA & A report states that a rise of 2-6° C due to warming will negatively impact growth, puberty and maturity of cross breeds and buffaloes. Time required for attaining puberty of cross breeds and buffaloes will increase by one to two weeks due to their higher sensitivity to temperature than the indigenous cattle. In Chhindwara district most of the cattle and buffaloes are non-descriptive local breeds which are low yielding. Poultry production is being done in backyard, very limited number of commercial poultry units are available in the district

Table 2: Livestock Statistics

Category	Population	Production ('000 MT)	Productivity
CATTLE			
Cows	6,99,067	158.6	0.18 tonnes
Buffaloes	1,36,696		
SHEEP & GOAT			
Sheep	56	0.6	10.71 Kg per sheep
Goat	2,73,070		
POULTRY			
Poultry (Hen)	3,61,116		

Source: *Administrative report 2014-15 Department of Animal Husbandry Government of Madhya Pradesh Bhopal*

3.3.6. Thrust Area - Potential and Problems

- Promoting use of soil and water conservation technology
- Crop diversification
- Promotion of medium and short duration varieties of cotton, soybean, wheat and gram
- Pulse production needs to be increased through area expansion with improved technology
- Promotion of poly house and net house for vegetable and flower production
- Promotion of integrated plant nutrient, management practices
- Promotion of integrated plant protection measures
- To develop facilities of food processing and value addition at the block level
- Adoption of balance diet and mineral nutrition to increase milk production of animals
- Introduction of climate smart agriculture through integrated farming system approach.

3.4. Impact on Water Resources

The Chhindwara district is bounded by Narsinghpur and Hoshangabad district in the north, Seoni district in the east, Betul district in the west and by Maharashtra state in the south. The district can be divided into three main regions, the southern region of plains, the central Satpura mountain region and the northern region comprising of hilly terrain. The district has fairly extensive network of rivers, most of which are rain-fed. There are six major rivers, which flow through the district namely Kanhan, Pench, Jam, Kulbehra, Shakkar and Doodh.

Galkate et al. (2008)[5], reported that Chhindwara district of Madhya Pradesh is facing various challenges like water scarcity, recurrent drought condition, poor development of the available water resources and declining ground water table. The water resources development and planning of the region is to be done by systematic approach to meet these challenges. The priority tehsils were identified by studying various sets of parameters like (1) population and availability of drinking water source, (2) total cultivable area, unirrigated area and availability of irrigation water source, (3) rainwater availability and (4) occurrence of extreme events like drought and groundwater fluctuation. An attempt was made to highlight present and projected daily domestic water demand (Estimated present domestic water requirement for this population, based on the standard norms of per capita requirement of 60 lpcd – Table 3). Finally, the study has discussed on status of water availability for domestic and agriculture water requirements that was evaluated for each tehsil of Chhindwara district. Amarwara tehsil has the largest availability of water from total rainfall, followed by Tamia, Jamai and Chhindwara. On the other hand, Tamia has the largest volume of water as an ineffective rainfall, followed by Amarwara, Jamai, Pandhurna and Chhindwara whereas Sausar and Bichhua tehsils have very small volume of water as an ineffective rainfall. This indicates that the potential of rainwater harvesting is more in Tamia and Amarwara as compared to Sousar and Bichua.

[5] Galkate Ravi, Thomas T., Pandey R. P., Singh Surjeet and Jaiswal R.K. (2008), Assessment of rainwater availability and planning for water resources development in Chhindwara district of MP, India, Journal of Indian Water Resources Society Vol. 28, No.2, April, 2008

Table 3: Present and Projected Daily Domestic Water Demand

Year Tehsil	2001		2021		2041		2061	
	Population	Water demand (m^3)	Population	Water demand (m^3)	Population	Water demand (m^3)	Population	Water demand (m^3)
Chhindwara	431163	25870	663491	39809	1021007	61260	1571166	94270
Tamia	89278	5357	137385	8243	211413	12685	325331	19520
Amarwara	248300	14898	382094	22926	587982	35279	904810	54289
Chaurai	169438	10166	260738	15644	401234	24074	617435	37046
Sausar	169480	10169	260803	15648	401334	24080	617588	37055
Pandhurna	177602	10656	273301	16398	420567	25234	647185	38831
Bichhua	77544	4653	119328	7160	183626	11018	282572	16954
Parasiya	272158	16329	418808	25128	644478	38669	991749	59505
Jamai	214320	12859	329804	19788	507516	30451	780986	46859
Total (Daily)	**1849283**	**110957**	**2845751**	**170745**	**4379156**	**262749**	**6738822**	**404329**

Usmani et. al[6] (2015), has highlighted high fluoride content in the ground water in Chhindwara block, Chhindwara district, Madhya Pradesh. The fluoride content was up to 8.9 ppm. It has been found that main source may be the presence of apatite bearing granites of the Archean in aquifers. The fluoride content in ground water samples of the study area varies from 0.433 to 10 ppm. Permissible limit of fluoride in water is 1.5 ppm according to WHO (1996). The data reveals that in most of the villages of the study area, the fluoride concentration is very much beyond the permissible limit which is mainly responsible for dental and skeleton fluorosis. Central Ground Water Board (CGWB)[7] report also highlighted that ground water in phreatic aquifer is potable but excessive fluoride (1.60-20.00 Mg/l) is noticed in deeper aquifers. EC- 280-1600, Nitrate- 1-243, Fluoride - .09-.97 in phreatic aquifer was also varied to permissible to impermissible limit.

3.4.1. Groundwater Resources

Chhindwara district is underlain by Deccan trap basalt Archaean granite-gneisses and Gondwana sandstone-clays. Dynamic ground water resources of the district have been estimated for base year -2010/11 on block-wise basis. Out of 11,81,500 ha of geographical area, 8,84,777 ha (75%) is ground water recharge worthy area and 2,96,723 ha (25%) is hilly area. There are eleven number of assessment blocks in the district which fall under non-command (99%) and command (1% Mohkhed and Sausar) sub units. Amarwara, Bichhua, Chaurai, Harrai, Jamai, Mohkhed, Sausar, Pandhurana, Parasia and Tamia blocks of the district are categorized as safe blocks, Chhindwara (semi critical in 2008/09 is semi critical with highest stage of ground water development is computed as 93%. The net ground water availability in the district is 1,32,627 ham ad ground water draft for all uses is 70,320 ham, making stage of groundwater development 53% (51 % in 2008/09) as a whole for district. After making allocation for future domestic and industrial supply for next 25 years, balance available ground water for future irrigation would be 60,390 ham. (Source: Dynamic Ground Water Resources of Madhya Pradesh (2015), jointly published by Central Ground Water Board and Water Resource Department).

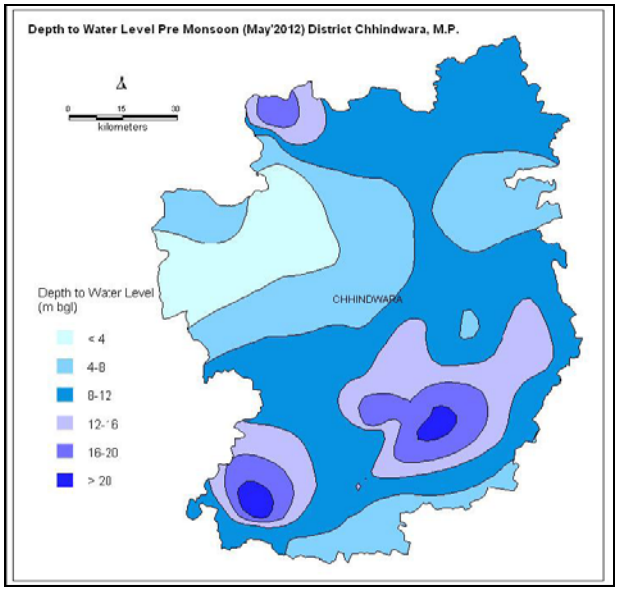
[6] Usmani H. U. and Md. Khan Maroof (2015), Hydrochemistry of groundwater with special reference to fluoride, Chhindwara block, District-Chhindwara, Madhya Pradesh, IJSART- Volume1 Issue 10-October -2015

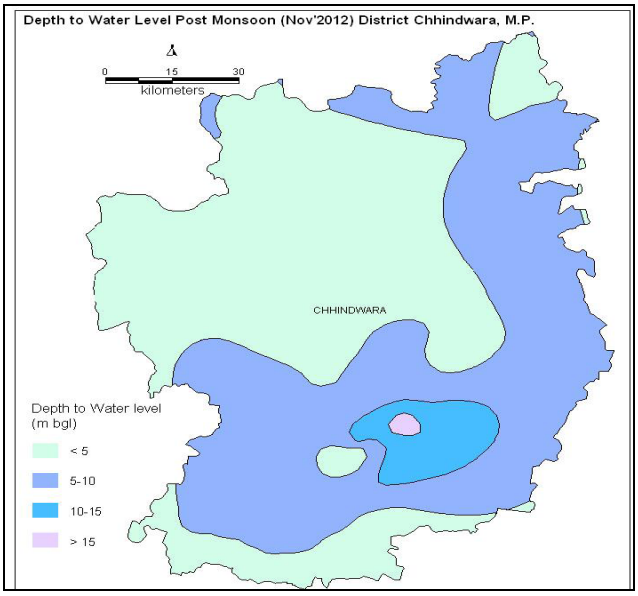
[7] District Ground Water Information Booklet (2013)– Chhindwara District – Madhya Pradesh, published by Ministry of water resources and Central Ground Water Board

The Groundwater in the district occurs under phreatic and semi-confined to confined conditions (Fig 13). The ground water occurrence is mainly controlled by formation, topography, drainage, lithology (Table 5) and disposition of fractures and joints specially in hard rocks. In general depth to water level in the district, ranges between 3.6 to 35 m bgl during pre Monsoon and post monsoon ranges between 0 .70 to 15.00 m bgl. The long-term water level trend (2001 to 2010) shows declining trend ranges from 0.02 to 0.2 m/year (Pre- monsoon). Water level fluctuation between pre and post monsoon period ranges from 0.30-to7.60 m. (Fig 11 and 12).

Table 4: Block wise geological formation and their yield status

Geological Age	Lithology	Blocks	Potentials (lps)
Quaternary to recent	Soil, river alluvium	Sausar	3-10
Lower Eocene to Cretaceous	Basalts, weathered, vesicular & Fracture	Harrai, Amarwara, Chhindwara, Tamai. Jamai, Parasia, Mohkhed, Pandhurna, Bichhua, Churai	1-8
Upper Triassic	Upper Gondwana stone & clay	Tamia, Jamai	2-8
Permo carboniferous	Lower Gondwana a sandstone, Barakar sandstone and shale, Talchir sandstone and day	Jamai, Tamia, Parasia	2-8
Archeans	Sausar series, Gneisses, Granite/ Pegmatite	Jamai, Parasia, Mohkhed, Pandhurna, Bichhua, Churai	1-10





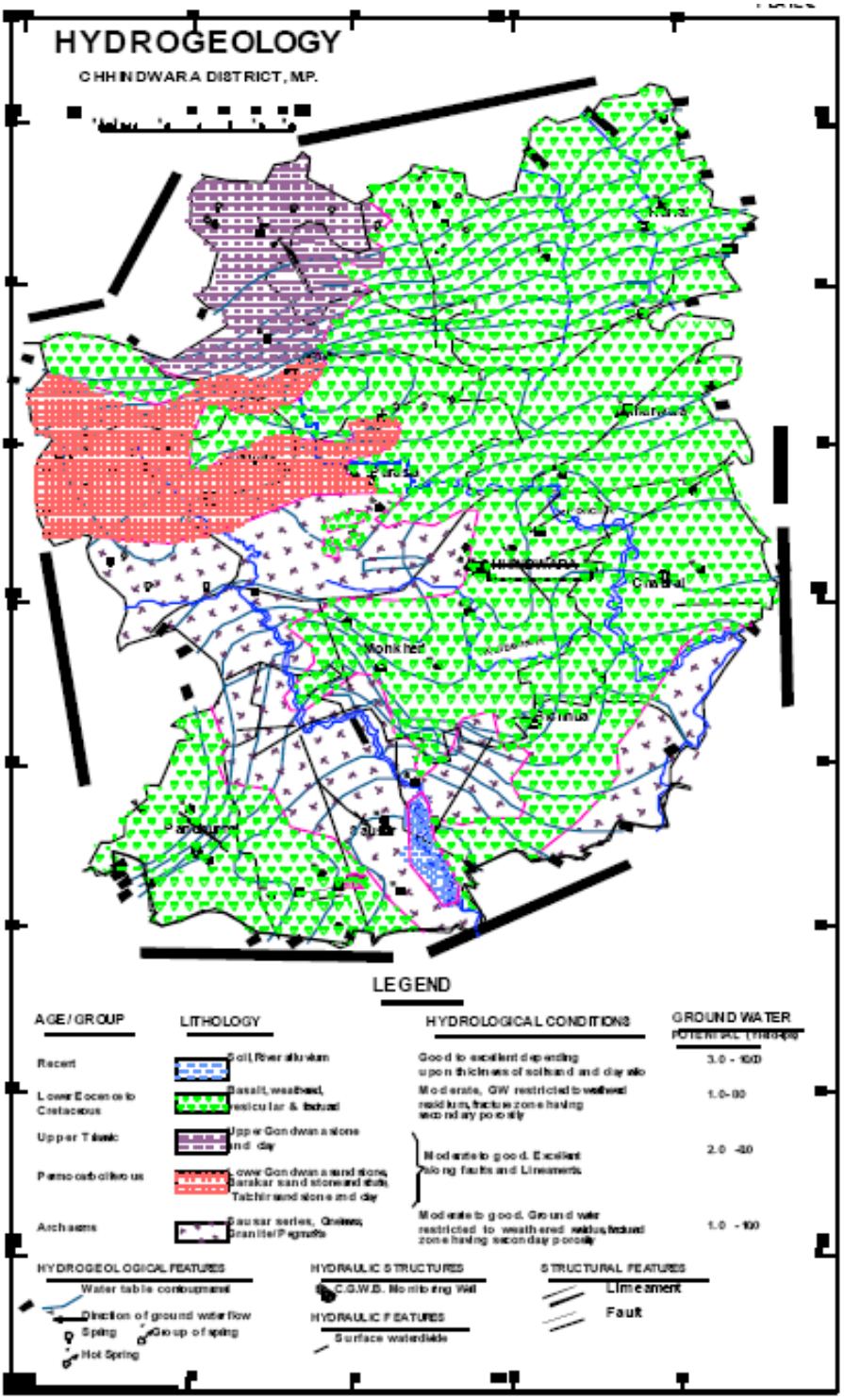


Fig 11., Fig12. and Fig 13. Depth to water level- Pre-Monsoon (May' 2012), Post-Monsoon (Nov'2012) and Hydrogeology Map of Chhindwara

3.4.2. Water Resources (Past, Present and Future in Chhindwara)

Historically, Rajiv Gandhi Watershed Management Development (RGWMD) in 1994 created an infrastructure at the block level, involving rural folk as key players, to restore ecological degradation and improve the environmental resource base. To focus on disadvantaged communities through equitable distribution of resources and sharing of benefits by equal participation of community and Panchayati Raj members. As an impact, 536 numbers and 2,63,000 hectares' area of total watershed have been benefited by government schemes such as IWMP, DPAP, DDP and IWAP. Net watershed areas are yet to be covered 8,89,410 hectares which is 33.2 percent of total watershed area.

Table5: Status of Micro-watershed covered by Government Institutions

Names of Districts	Total micro-watersheds in the District		Micro-watersheds covered so far						Net watersheds to be covered	
			Dept. of Land Resources		Other Ministries/ Depts.		Total watersheds covered			
			Pre-IWMP projects (DPAP +DDP +IWDP)		Any other watershed project					
	No.	Area	No.	Area (ha.)	No.	Area (ha.)	No.	Area (ha.)	No.	Area (ha.)
Chhindwara	1,264	11,84,923	536	2,63,000	66	32,513	602	2,95,513	662	8,89,410

Source: *http://www.watermissionmp.org/Orders/chapter-VI.pdf*

Table 6: Status of Drinking Water Availability by Different Sources

Parameters	Availability of Drinking Water - Yes / No							
	Tap water (Treated/Untreated)	Well water / (Covered Uncovered	Hand Pump	Tube wells / Bore well	Spring	River / Canal	Tank / Pond / Lake	Others
Total number of village	744	1622	1761	691	131	694	534	31
% (out of 1906 village in Chhindwara)	39.03	85.10	92.39	36.25	6.87	36.41	28.02	1.63

Source: *Census 2011*

Community lift Irrigation Scheme (1989-2008), was implemented on a large scale, ostensibly to make up for the injustice of building the dams on Narmada river serving the non-Adivasi people in control of the plains land. The Scheme has a block-wise spread in the Chhindwara district.

Swajaldhara programme[8] (2002 to present), was initiated as an extension of the Ministry's sector reform programme that was a paradigm shift from a supply-driven to a demand driven economy, and from a centralized to decentralized policy implementation and also a shift in the government's role from being a service provider to that of a facilitator. It is based on empowerment of villagers to ensure their full participation in the project through a decision-making role in the choice of the drinking water scheme, planning, design, implementation, control of finances, management arrangements including full ownership of drinking water assets.

Table 7: Major Irrigation Dams in Chhindwara District

Sl. No.	Dam Name	Completion Year	River	Nearest city	Basin	Height (m)	Length (m)	Purpose
1	Bangai Dam	1993	Local	Parasia	Narmada	27.44	480	Irrigation
2	Bargona Dam	1978	Local	Chhindwara	Godavari	15.68	383	Irrigation
3	Borgawan Dam	2003	Local	Sausar	Godavari	18.35	300	Irrigation
4	Changoba Dam	1991	Local	Sausar	Godavari	18.1	387	Irrigation
5	Deogaon Dam	1991	Local	Parasia	Narmada	17.43	1410	Irrigation
6	Deokhoh Dam	1978	Local	Parasia	Narmada	22.08	186	Irrigation
7	Dongergaon Dam	1980	Local	Sausar	Godavari	18.74	396	Irrigation
8	Harrai Dam	1987	Local	Amarwara	Narmada	12.5	380	Irrigation
9	Harranbhata Dam	1985	Local	Amarwara	Godavari	18.64	255	Irrigation
10	Junewani (MP) Dam	1998	Local	Sausar	Godavari	18.13	520	Irrigation, Water Storage
11	Kabadia Dam	1983	Local	Chhindwara	Godavari	16.25	770	Irrigation
12	Kanhargaon Dam	1986	Chotti Kulbhera	Parasia	Godavari	30.31	2378	Irrigation, Water Storage
13	Kanhasagar Dam	2002	Local	Amarwara	Godavari	19.8	540	Irrigation
14	Khapabihari Dam	1992	Local	Amarwara	Godavari	18.7	680	Irrigation
15	Kohpani Dam	2001	Local	Parasia	Narmada	16.63	888	Irrigation
16	Kotabardi Dam	1977	Local	Chhindwara	Godavari	14.75	335	Irrigation
17	Mandvi Dam	2001	Local	Sausar	Godavari	29.7	940	Irrigation
18	Manegaon Dam	1982	Local	Parasia	Narmada	12.48	732	Irrigation
19	Mehra Khapa Dam	1980	Local	Sausar	Godavari	23.48	210	Irrigation
20	Mohi Dam	1986	Local	Sausar	Godavari	29.34	345	Irrigation
21	Mordongri Dam	2001	Local	Sausar	Godavari	20.84	405	Irrigation
22	Moursani Dam	1991	Local	Amarwara	Narmada	12.5	501	Irrigation

[8] http://ddws.gov.in/ddwsimis/swajaldhara/rep_schemeDistrictWise.aspx

23	Nandna Dam	1988	Kanhar	Amarwara	Godavari	21.2	398	Irrigation
24	Navegaon Dam	1987	Local	Chhindwara	Godavari	20.37	600	Irrigation
25	Pakhadia Dam	1986	Local	Chhindwara	Godavari	22.83	633	Irrigation
26	Pathari (MP) Dam	1980	Local	Sausar	Godavari	16.48	313.25	Irrigation
27	Pench Dam		Pench	Amarwara	Godavari	41	6330	Irrigation,Water Storage
28	Pindaraikala Dam	1976	Local	Chhindwara	Godavari	20.35	379	Irrigation
29	Pulpuldoh Dam	2001	Local	Chhindwara	Godavari	13.31	690	Irrigation
30	Rajdhana Dam	1980	Local	Amarwara	Narmada	17.5	1080	Irrigation
31	Tamia Dam	2000	Local	Parasia	Godavari	21.585	365	Irrigation
32	Tawa Dam	2001		Amarwara	Godavari	28.78	1170	Irrigation
33	Umaria Dam	1984		Parasia	Narmada	25.15	1020	Irrigation
34	Umariya Dalel Dam	2002	Local	Chhindwara	Godavari	18.45	360	Irrigation
35	Wagya Dam	1976	Waghya Nalla	Sausar	Godavari	30.05	650	Irrigation

Source: *Water Resource Department, 2013*

Migration due to Water Resources

In the past, Chhindwara, was evident that migration took place during the farming season in search of water, food and fodder that was also highlighted in Water Aid prospective study. The basic causes of distress and seasonal migration are undependable drinking water supply system, water quality, deforestation leading to imbalance in the rainfall cycle, along with reduction in natural recharge rate 0.13 (rainfall infiltration factor in fraction) in each blocks of total precipitation. Apart from this, overexploitation of groundwater by indiscriminate sinking of deep tube wells caused drying up of perennial open wells, step wells and created acute shortage of drinking water as well as water for Irrigation. A huge failure of agricultural produce was witnessed in kharif and Rabi crops in past.

Total irrigation area of Chhindwara is 31.05% of the total net area sown in which 61.7%, 24.4% and 2.8% is irrigated through the dug well, tube/Bore wells and Tanks/Ponds respectively, and rest areas are irrigated by minor irrigation tanks and Ponds (Table 9).

According to the data available in the year 2013, the total gross irrigated area was 1,504 sq. kms. The irrigation capacity from officially built sources and the percentage of irrigated area is presented in the tables below (Table 8 and 9):

Table 8: Reporting Area of Irrigation

District	Gross Irrigated area (sq. kms)	Net Area Sown (sq. kms)	Cultivable area (sq. kms)
Chhindwara	1,504	4,844	5,555

Table 9: Area Irrigated by Various Sources (in hectares)

S. No	Sources	Number	area (Sq km)	%
1	Dug wells	86,282	928	61.7
2	Tube wells/Bore wells	7,280	367	24.4
3	Tanks/Ponds	69	42	2.8
4	Canals	63	108	7.2
5	Other sources		59	3.9

Source: *District Ground Water Information Booklet, 2013*

3.5. Impact on Forest Ecosystem

The Chhindwara district of Satpura plateau is considered highly vulnerable to climate change as per the SAPCC report (EPCO 2014). Forest blocks are mostly located on mountainous range of Satpuda hills and Chhindwara plateau. The slope varies from gentle to steep. The area mainly drains off through rivers viz., Dhudi, Harad, Sakkar, Kanhan, Sitarewa, Khajari, Thail, Maccharewa, Kundani, Pench, Kanhan, Tawa, Bel, Dudher, Sonbhadra, Denva and Jam. These rivers are seasonal and flow in monsoon season, however they dry in summer season. The 70% of the forest areas forms catchments of the Narmada basin. The climate is dry, extreme cold and hot. In the forests the damage to crop is mainly by human population. In addition, damage to forest ecosystem is also caused by grazing, illicit felling for fuel wood and fodder, weed infestation (viz., chind, lantana, gajar grass, chakoda) and soil erosion. Natural regeneration of main species is scanty and perennial grasses are reducing. Most of the forest species are teak, bamboo, sal and mixed forests. Damage to crop by fire, grazing and illicit felling is conspicuous. In summer season due to non-availability of fodder forest species lopped for fodder purpose includes Ber, Khair, Kari, bamboo, Salai, Dhaoda, Shisham, Saja, Bija, Tinsa. This has affected regeneration very adversely and also the natural regeneration is not adequate. Most of the regeneration in forest areas is of coppice (87%) origin and regeneration from seed (13%) is negligible. Soil erosion is prevalent in various forms along water courses and areas on steep slopes. According to FSI 2003 and 2015 reports of Chhindwara district shows that over a decade total forest cover has increased from 4409 to 4531 sq km. There has been increase in the very dense forest cover from 203 sq km in 2003 to 575 sq km in 2015. However, there is decrease in moderately dense forest cover from 2368 sq km in 2003 to 2039 sq km in 2015. In case of open forest here has been increase from 1838 in 2003 to 1917 in 2015. Thus FSI reports of 2003 and 2015 shows that there is increase of 122 sq km in total forest cover. In the year 2015 forest cover occupied 38.35% of the total geographical area (11815 sq km) of Chhindwara district.

Table 10: Forest Area under Different Forest Cover (Ha)

Forest Cover	FSI 2015		FSI 2003		Change
	Area	% of geographical area	Area	% of geographical area	
Very dense forest	575	4.87	203	1.72	372
Moderately dense forest	2039	17.26	2368	20.04	-329
Open forest	1917	16.23	1838	15.56	79
Total	4531	38.35	4409	37.32	122
Scrub	240	2.03	-	-	-
Grand Total	**4771**	**40.38**	**4409**	**37.32**	**-**

Source: FSI 2003 and FSI 2015

3.5.1. Forest cover status

The Table shows year wise very dense, moderately dense and open forest cover of Chhindwara district. The trend indicates that the forest cover varies in the range from 4396 sq km to 4541 sq km over a decade period and shows increasing trend.

Table11: Forest cover status from 2003 to 2015

Year	Forest cover (sq km)				% of GA
	Very dense forest	Moderately dense forest	Open forest	Total	
2015	575	2039	1917	4531	38.35
2013	575	2039	1917	4531	38.35
2011	575	2044	1922	4541	38.43
2009	575	2044	1920	4539	38.42
2005	115	2335	1946	4396	37.21
2003	203	2368	1838	4409	37.32

Source: *State of Forest Report 2003, 2005, 2009, 2011, 2013 and 2015*

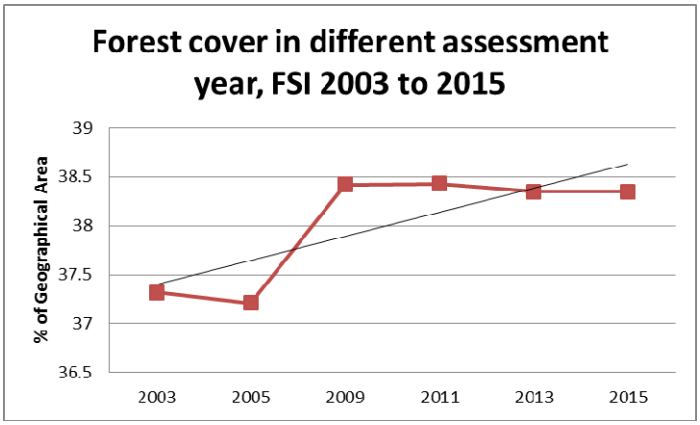


Fig 14.: Trend of Forest Cover Status in Chhindwara

The above Table indicates that efforts are required to convert area under open and scrub forest to moderately dense and very dense forest cover. This would facilitate as an adaptive measure in controlling the climatic parameter like temperature, drought etc and mitigating the decreasing rainfall and soil and moisture availability.

3.5.2. Forest Area and Resources

Chhindwara district has three Forest Divisions which are East Chhindwara, West Chhindwara and South Chhindwara. The forest resources of these Forest Divisions are described below

3.5.2.a. East Chhindwara Forest Division

The East Chhindwara Forest Division has three forest types

1) 5 A/C-1b3 South Indian tropical dry deciduous teak forest (42.63%)
2) 5A/C3 South Indian tropical dry deciduous mixed forest (24.18%)
3) 5B/C-1c Northern Indian tropical dry deciduous Peninsular Sal forest (0.31%)

The Table indicates forest area under different forest category/plantation

Table 12: Forest area under different forest category/plantation

Forest category/plantation/encroachment	Area (Ha)	% of total forest area
Teak dense forest	31861.88	24.77
Teak open forest	23066.35	17.93
Mixed dense forest	21946.32	17.05
Mixed open forest	8878.92	06.91
Sal dense	401.95	0.31
Blank	26991.62	20.98
Forest village	1339.77	1.04
Other forest area	14164.92	11.01
Total	**128651.73**	**100**
Bamboo forest stocked	2760.62	49.12
Bamboo forest degraded	2858.94	50.88
Total bamboo forest	**5619.56**	**100**

Source: *Working Plan 2008-09 to 2017-18, East Chhindwara Forest Division*

The forest resources of East Chhindwara Forest Division were divided into three forest type viz., teak, mixed and sal for management point of view. The mixed forest comprised saja, dhaoda, lendia, moyen, salai, tinsa, dhoban, achar, tendu, kari, aonla, bhirra, bel, harra, behada, amaltas, haldu etc. Out of the total forest area, 42.7% is teak forest, 23.96 % is mixed forest, 0.31% is sal forest, and 20.98% is blank and 11.01% other forest area. This indicates that 66.97% forest is stocked. Rest of the forest are under blank, open and encroachment. The site quality consists of III, IVa, IVb and Va. Tree density and mean volume per hectare in East Chhindwara Forest Division is presented in Table

Table13: Tree Density and Mean Volume per hectare in East Chhindwara Forest Division

S N	Forest type	No of trees per hectare	Mean volume per hectare cmt/ha
1	Teak	157.784	17.084
2	Sal	0.719	0.089
3	Mixed	357.304	23.085
	Total	**515.808**	**40.258**

Source: *Working Plan 2008-09 to 2017-18, East Chhindwara Forest Division*

It is evident from the Table that mixed forest comprised of maximum number of trees per hectare followed by teak and sal forests. The forest comprised of young, middle age and mature crop which is presented in Table.

Table 14: Per hectare young, middle age and mature crop in East Chhindwara Forest Division

Age Class	Number of Trees/ha	Volume cmt/ha
Young	712.500	26.583
Middle aged	528.932	44.556
Mature	500.100	75.308
Average	514.516	59.932

Source: *Working Plan 2008-09 to 2017-18, East Chhindwara Forest Division*

The above Table indicates that forest is rich in terms of the growing stock and volume per hectare.

In East Chhindwara Forest Division, Reserved Forest constitutes 30495.53 (24% of total forest area) ha and Protected Forest constitutes 98156.20 ha (76% of total forest area), thus the total forest area of the division is 128651.73 ha which 10.89% of geographical area of Chhindwara district.

Table 15: Area under reserved forest and protected forests (ha)

S N	Name of range	Reserved forest	Protected forest	Total forest
1	Chhindi	2317.33	10928.72	13246.05
2	West Butakakhappa	-	25594.83	25594.83
3	East Butakakhappa	-	14068.45	14068.45
4	West Harrai	-	15499.00	15499.00
5	East Harrai	-	15899.13	15899.13
6	Amarvada	9961.18	9924.05	19885.23
7	Chhindwara	9624.96	3332.56	12957.52
8	Chaurayi	8592.06	2909.46	11501.52
	Total	**30495.53**	**98156.20**	**128651.73**

Source: *Working Plan 2008-09 to 2017-18, East Chhindwara Forest Division*

Average per hectare seedling is 1361, number of trees is 514.516 and tree volume is 59.932 cmt. The number of established seedlings per hectare according to forest type in different range is presented in Table

Table16: Per Hectare Number of Established Seedlings in Different Ranges

S N	Name of range	Teak	Mixed	Sal	Total
1	Chhindi	43.72	447.53	84.88	576.13
2	West Butakakhappa	33.17	1465.60	-	1498.77
3	East Butakakhappa	104.17	1277.42	-	1381.59
4	West Harrai	218.75	1814.25	-	2033.00
5	East Harrai	142.28	1622.64	-	1764.92
6	Amarvada	221.63	1091.91	-	1313.54
7	Chhindwara	396.34	1170.40	-	1566.75
8	Chaurayi	162.04	597.65	-	759.69
	Average	165.26	1185.93	84.88	1361.80

Source: *Working Plan 2008-09 to 2017-18, East Chhindwara Forest Division*

From the above table it is evident that the condition of established natural regeneration is satisfactory in case of mixed forests however efforts are required to enhance the regeneration of teak and sal forests through afforestation and reforestation programme with community participation at massive scale.

3.5.2.b. West Chhindwara Forest Division

The West Chhindwara Forest Division has three forest types

1) 5 A/C-1b South Indian tropical dry deciduous teak forest
2) 5A/C-3 South Indian tropical dry deciduous mixed forest
3) 5B/C-1c Northern Indian tropical dry deciduous Peninsular sal forest

The Table indicates forest area under different forest category/plantation

Table 17: Forest Area under Different Forest Category/Plantation

Forest category/plantation/encroachment	Area (Ha)	% of total forest area
Teak dense forest	47442.68	28.22
Teak open forest	9478.90	5.64
Mixed dense forest	54754.60	32.57
Mixed open forest	22388.60	13.32
Sal dense	11351.33	6.75
Sal open	684.52	0.41
Other forest area	22011.14	13.09
Total	**168111.77**	**100**
Bamboo forest stocked	4654.29	68.18
Bamboo forest degraded	2171.69	31.82
Total bamboo forest	**6825.98**	**100**

Source: *Working Plan 2006-07 to 2015-16, West Chhindwara Forest Division*

The forest resources of West Chhindwara Forest Division were divided into four forest type viz., teak, mixed, sal and bamboo for management point of view. The mixed forest comprised of teak, saja, dhaoda, lendia, moyen, sal, mahua, jamun, koha, mundi, tendu, haldu, bija, harra, behada, dhaman etc. Out of the total forest area, 33.86% is teak forest, 45.89 % is mixed forest, 7.16% is sal forest and 13.09% other forest area. This indicates that 67.54% of total forest area is stocked. Rest of the forest are under blank, open and encroachment. The site quality consists of III, IVa, IVb and Va.

Tree density and mean volume per hectare in West Chhindwara Forest Division is presented in Table

Table 18: Tree Density and Mean Volume per Hectare in West Chhindwara Forest Division

S N	Forest type	No of tree per hectare	%	Mean volume per hectare cmt/ha	%
1	Teak	127.87	20	11.18	27.54
2	Saja	44.19	6.91	3.18	7.83
3	Other	467.31	73.09	26.24	64.63
	Total	**639.37**	**100**	**40.60**	**100**

Source: *Working Plan 2006-07 to 2015-16, West Chhindwara Forest Division*

It is evident from the Table that other forest comprised of maximum number of trees per hectare followed by teak and saja forests. The forest comprised of young, middle age and mature crop which is presented in Table19.

Table 19: Per Hectare Young, Middle age and Mature Crops in West Chhindwara Forest Division

Age class	Number of trees/ha	Volume cmt/ha
Young	684.38	28.64
Middle aged	627.45	43.73
Mature	510.00	78.87
Average	607.28	50.41

Source: *Working Plan 2006-07 to 2015-16, West Chhindwara Forest Division*

The above Table indicates that forest is rich in term of growing stock and volume per hectare.

In West Chhindwara Forest Division, Reserved Forest constitutes 54609.85 ha (30.42% of total forest area) ha and Protected Forest constitutes 124919.3 ha (69.58% of total forest area), thus the total forest area of the division is 179529.15 ha which 15.20% of geographical area of Chhindwara district.

Table 20: Area under Reserved Forest and Protected Forests according to GIS Mapping (ha)

S N	Name of range	Reserved forest	Protected forest	Total forest
1	Zirpa	-	25215.59	25215.59
2	Delakhari	-	23016.48	23016.48
3	Tamiya	-	19375.7	19375.7
4	Sangakheda	-	27316.66	27316.66
5	Damua	149.17	19696.45	19845.62
6	Jamai	18181.15	3195.91	21377.06
7	Savri	25235.09	1943.08	27178.17
8	Parasiya	11044.44	5159.43	16203.87
	Total	**54609.85**	**124919.3**	**179529.15**

Source: *Working Plan 2006-07 to 2015-16, West Chhindwara Forest Division*

Average per hectare seedling is 1274, number of trees is 607.28 and tree volume is 50.41 cmt. The number of seedlings (natural and coppice origin) per hectare according to forest type in different range is presented in Table.

Table 21: Per Hectare Number of Natural and Coppice origin Regeneration in Different Ranges

S N	Name of range	Teak		Mixed		Total
		Natural	Coppice	Natural	Coppice	
1	Zirpa	7.80	72.06	11.85	1173.92	1265.63
2	Delakhari	9.00	81.02	10.31	1021.07	1121.40
3	Tamiya	13.19	118.75	12.44	1232.36	1376.74
4	Sangakheda	4.73	42.62	9.64	954.69	1011.68
5	Damua	4.20	37.89	8.22	814.59	864.90
6	Jamai	25.60	231.34	7.63	756.26	1020.83
7	Savri	32.50	292.56	24.15	2391.63	2740.84
8	Parasiya	27.90	251.86	5.11	506.80	791.67
	Average	15.62	141.01	11.17	1106.42	1274.21

Source: *Working Plan 2006-07 to 2015-16, West Chhindwara Forest Division*

From the above table it is evident that the condition of natural and coppice regeneration is not satisfactory in pure teak. In case of mixed forests, the natural regeneration is also not adequate. However, efforts are required to enhance the regeneration of teak and mixed forests through afforestation and reforestation programme with community participation at massive scale.

3.5.2.c. South Chhindwara Forest Division

The South Chhindwara Forest Division has three forest types

1) 5 A/C-1b Southern tropical dry deciduous teak forest

2) 5A/C-3 Southern tropical dry deciduous mixed forest

The Table indicates forest area under different forest category/plantation

Table 22: Forest Area under Different Forest Category/Plantation

Forest category/plantation/encroachment	Area (Ha)	% of total forest area
Teak dense forest	66914.60	67.24
Mixed dense forest	11384.22	11.44
Teak open forest	6058.49	6.09
Mixed open forest	650.69	0.65
Blank	2645.76	2.66
Plantation	4613.24	4.64
Encroachment/Agriculture	2964.54	2.98
Forest village	3472.90	3.49
River bed/ submergence/other	817.23	0.82
Total	**99521.67**	**100**

Source: *Working Plan 2011-12 to 2020-21, South Chhindwara Forest Division*

The forest resources of South Chhindwara Forest Division were divided into two forest type viz., teak and mixed for management point of view. The mixed forest comprised of teak, saja, dhaoda, lendia, moyen, mahua, jamun, koha, mundi, tendu, haldu, bija, shisham, dhoban, bhirra, rohan, harra, behada, dhaman etc. Out of the total forest area 73.32% is teak forest, 12.09 % is mixed forest, 4.64% is under plantation forest and 11.92% other forest area viz., forest village, encroachment, river bed/ submergence/other. This indicates that 79.33% of total forest area is stocked. Rest of the forest are under blank, open and encroachment. The site quality consists of III, IVa, IVb and Va.

Tree density and mean volume per hectare in South Chhindwara Forest Division is presented in Table

Table 23: Tree density and mean volume per hectare in South Chhindwara Forest Division

S No.	Forest type	No of tree per hectare	Mean volume per hectare cmt/ha
1	Teak	542	62.364
2	Mixed	490	52.228

Source: *Working Plan 2011-12 to 2020-21, South Chhindwara Forest Division*

It is evident from the Table that forest comprised of satisfactory number of trees and volume per hectare. The forest comprised of young, middle age and mature crop which is presented in Table.

Table 24: Per Hectare Young, Middle Age and Mature Crops in South Chhindwara Forest Division

Age class	Number of trees/ha	Volume cmt/ha
Young	650	28.394
Middle aged	529	63.663
Mature	310	80.045
Average	496	57

Source: *Working Plan 2011-12 to 2020-21, South Chhindwara Forest Division*

The above Table indicates that forest is rich in term of growing stock and volume per hectare.

In South Chhindwara Forest Division, Reserved Forest constitutes 71429.07 ha (30.42% of total forest area) ha and Protected Forest constitutes 28092.60 ha (69.58% of total forest area), thus the total forest area of the division is 99521.67 ha which is 8.42% of geographical area of Chhindwara district.

Table 25: Area under Reserved Forest and Protected Forests (ha)

S N	Name of range	Reserved forest	Protected forest	Total forest
1	Kanhan	7187.28	9976.39	17163.67
2	Bichuva	10445.06	1200.68	11645.74
3	Silewani	9613.15	2665.76	12278.91
4	Pandurna	6686.53	6620.05	13306.58
5	Sausar	5531.96	4922.01	10453.97
6	Ambada	16560.98	193.21	16754.19
7	Lavaghori	15404.11	2514.50	17918.61
	Total	**71429.07**	**28092.60**	**99521.67**

Source: *Working Plan 2011-12 to 2020-21, South Chhindwara Forest Division*

Average per hectare established seedling is 820.50, number of trees is 496 and tree volume is 57 cmt. The number of established seedlings per hectare according to forest type in different range is presented in Table

Table 26: Per Hectare Number of Established Regeneration in Different Ranges

S N	Name of Range	Teak	Mixed	Total
1	Kanhan	151.52	729.17	880.69
2	Bichuva	176.97	613.00	789.97
3	Silewani	221.13	968.58	1189.71
4	Pandurna	50.68	579.96	630.64
5	Sausar	61.43	923.17	984.60
6	Ambada	119.83	385.35	505.18
7	Lavaghori	100.70	662.04	762.74
	Average	126.04	694.47	820.50

Source: *Working Plan 2011-12 to 2020-21, South Chhindwara Forest Division*

From the above table it is evident that the condition of is not satisfactory in both teak and mixed forest and hence efforts are required to enhance the regeneration of teak and mixed forests through afforestation and reforestation programme with community participation at massive scale.

The climatic factors viz., drought, storm, frost, soil erosion, temperature, flood and biotic factors viz., heavy pressure of livestock grazing, browsing, forest fire and rampant illegal felling of trees for timber, poles, fuel wood, bamboo, agricultural implements, unsustainable collection of NTFPs viz., chironji, Mahua seed and flower, aonla, tendu leaves, kullu gum, mahul leaves, sitaphal, bel, dhawra, honey and encroachment adversely impacting forest ecosystem of Chhindwara district. Besides, there is damage caused by fungus, insects, climber,

parasites and weeds to forest. These factors lead to degradation and depletion of forest resources and dense forest cover converting to open and scrub forests. The major climatic and biotic factors influencing forest vulnerability are described below:

3.5.3. Climatic Pressure

3.5.3.a Drought

The erratic and deficient rain fall is occurred in the Chhindwara which lead to the occurrence of drought. The rainy season prevails from June to September. The drought occurs from March to May which is common phenomenon and retard growth of young forest crop greatly. There is drying of trees during dry period however trees recoup its growth in rainy season. However, drought for the prolonged period leads to dying of trees and the incidences of grazing and lopping of trees can be noticed. Due to high temperature during summer there is flowing of hot air current. It affects the regeneration, young plants and causes forest fire in forest areas. Due to occurrence of drought and forest fire speed up the conversion of green leaves of trees to dry and its subsequent fall from trees. This all lead to availability of dry leaves even after the first fire of season and in a particular area there is incidences fires more than once. The forest on the ridges and hills affected mostly due to drought. The Forest Department has been executing fire scheme to control forest fire. In the scheme fire lines are prepared in the blocks and compartments.

3.5.3.b. Storm

In the area during rainy season, wind blows in high velocity. Due to this, there are incidences such as quick uprooting of mainly teak trees which are having a shallow root system. Due to the high wind velocity, the average height of the trees in open areas remains shorter than the normal height of the trees in forests. The hot air current also favours forest fires and adversely impacts the regeneration. Sometimes, there are incidences of complete fall of trees. The maximum damage is caused to trees which are planted on a shallow soil depth compared to the ones rooted in deep soil depth. The impact of storm was much more severe in pure teak forests as compared to the one in mixed forests.

3.5.3.c. Frost

The frost occurs in the Forest Division in the areas like rivers, runnels (nallah) and valley during the winter season (January to February) as compared to the plateau. These areas block cold air which drops down the temperature for long duration in winter season. Mainly, it impacts the young regeneration, new plantation, and young plants greatly which leads to its drying. Under such circumstances, it is very difficult to obtain the regeneration of desired species. However, frost occurs for very short duration and their impact is not much on forest ecosystem. The impact of frost observed in the open forest as compare to dense forest.

3.5.3.d. Soil Erosion

Forests are dry deciduous in nature, affected by fire and heavy grazing pressure and mainly occurred mountainous (40-45% of forests have slope more than 300) region which accelerates soil erosion during rainy season. It has been observed that there is heavy pressure of soil erosion in forest areas. Due high speed of runoff the fertile top washed away which lead to loss of soil productivity. The topography is undulating and hence the erosion of soil is obvious. Gully erosion observed along the main stream of water courses of river Sitarewa, Dudhi, Sakkar and Harad. Moreover, forest ranges viz., West Butakakhapa, Chhind, Chhindwara, East Harrai, Amarwada, Sangakheda, Damua, Jamai, Tamiya, Jirpa, Delakhari, Savri, Parasiya have been greatly affected by soil erosion. However, there is need to protect the top fertile soil at high priority. Besides due to heavy livestock grazing the top soil has been loosened and hence it washed away with water during rainy season. But soil below the top soil becomes compact which does not allow the rainwater to percolate. As a

results soil moisture availability is low and it is very difficult to obtain the regeneration of desired species and also affects the growth of tree species. Due to flow of rainwater there is loss of soil along the rivers and runnels (nallah).

3.5.3.e. Temperature

After February, temperature rise progressively. March and June are generally the hottest month with maximum temperature at about 41.3 degree Celsius and minimum at 8.2 degree Celsius. The maximum and minimum relative humidity ranged from 84.65% to 52.46%. The driest part of the year is summer season i.e., March, April, May and June. Such environment is favorable for occurrence of forest fire. The temperature greatly influences forest flora and fauna, soil moisture as well as regeneration. During the dry period there is huge impact on water and fodder availability for wild animals and as well as livestock.

3.5.3.f. Flood

The average annual rainfall was 1288.89 mm with average 55 rainy days. Monsoon rainfall takes place during the months of June, July, August and September. The forest water drains through rivers viz., Dhudi, Harad, Sakkar, Kanhan, Sitarewa, Khajari, Thail, Maccharewa, Kundani of Chhindwara district. The rivers are almost seasonal and have heavy run off only during the peak period of June, July, August and September. During the dry season most of the streams become dry and water is available only in a few channels of the main stream. Most of the forest areas are on hills and mountain. Due to this reason there is flow of the rainwater in high speed which causes soil erosion and uproots the trees which are having swallow root system.

3.5.4. Biotic Pressure

3.5.4.a Collection of wood and NTFPs by the community

The geographical area of Chhindwara district is 11815 sq km with 4477.03 sq km (about 34.52% of GA) area under forests. There is dependency of community living within periphery of 5 km on forest. There is provision by the Madhya Pradesh Government that people are allowed to collect naturally dried, broken and fallen wood from the forest. Besides people cut small trees and left as such in the forests and allowed to dry and after some days they collect it in the form of head load. In this way people cut small and medium size trees and use as fuel wood, poles and timber. Due to this practice there is large scale damage has been causing to forest ecosystem of all three ranges. There is also lack of livelihood options which leads to sale of fuel wood in the form of head load to the nearby city areas. Besides, the community unsustainably extracts wood and Non-Timber Forest Products from the forest which were unreported in the conventional practice of forest management. The forest resource obtained by forest dependent and rural communities includes wood for new house construction, old house repairing, agricultural implements, bamboo, wood for fencing, grass (livestock grazing) and NTFPs (tendu, mahua, achar, aonla, bhilva, honey). An illegal felling has been observed in the form of lopping, girdling, debarking of saja, cutting of trees which cause heavy damage to forest ecosystem. There is illegal felling of trees not for Nistar requirement but for business purposes and earning a livelihood. Due to this practice, a large scale damage has been caused to the forest ecosystem. Because of this biotic pressure, the quality of forest is degrading day by day and forests are being observed on mountains and hillocks.

3.5.4.b Encroachment

An increasing human population and lack of land for agriculture and construction of new house creates demand for land which leads to encroachment of forest land. The community has been encroaching forest land all around the forest area by cutting and setting fire in forest areas. The people encroaches forest land by cleaning small area first and then go on spreading in adjoining forest areas step by step. This practice leads to meeting of two boundaries of encroached areas by two different people. It results into decreasing precious forest area and

cover. The maximum centre of encroachment found in the plain area but its impact has been observed in adjoining sloppy area. Due to reducing the forest cover, the top fertile forest/agriculture soil washed away. In East Chhindwara Forest Division 10833.87 ha forest land has been encroached upon whereas in West Chhindwara Forest Division 2272.22 ha forest land has been encroached upon and in South Chhindwara Forest Division 2964.54 ha forest land under encroachment. Thus in Chhindwara district, 16070.63 forest land has been encroached upon, mainly for raising agricultural purpose.

3.5.4.c Livestock Grazing

Most of the forest area is scattered and surrounded by human habitat. Because of this there is heavy and intense pressure of livestock grazing in the area. An actual carrying capacity of forest area of East Chhindwara Forest Division was 136100, but there were 515906 livestock which is equivalent to 507008 cattle unit graze inside forest, which is 3.73 times more than carrying capacity of forest. In case of West Chhindwara Forest Division, an actual carrying capacity of forest area of was 182669, but there were 453828 livestock which is equivalent to 423164 cattle unit graze inside forest, which is 2.32 times more than carrying capacity of forest. In case of South Chhindwara Forest Division, an actual carrying capacity of forest area of was 76675, but there were 381589 livestock which is equivalent to 367274 cattle unit graze inside forest, which is 4.79 times more than carrying capacity of forest. There is no practice prevails in the villages for stall feeding, people set their livestock free in the forest which avoid the cost of grasses and also requires no efforts. Due to this practice the availability of palatable grasses is decreasing and induces the population of unpalatable grasses in forest areas. Besides, there is decrease in fodder yielding tree and bamboo species due to heavy lopping of such species. During rainy season there is growth of palatable grasses but the livestock graze them before flowering. Due this there is decrease in availability of palatable grasses and increase in the availability of unpalatable grasses. In some cases, due to non-availability of grass in forest area, the communities lopped/cut trees species viz., ber, khair, kari, bamboo, salai, dhaoda, saja, bija, tinsa, anjan, aonla, shisham for feeding livestock. During rainy season the regeneration of desired forest species and medicinal plants come up but livestock graze them and also press them under their foot. It leads to damage young regeneration. Due to grazing the soil become compact and during rainy season infiltration of rain water in the soil does not take place hence affecting the available soil moisture. Efforts are required for making awareness among communities about advantages for keeping useful and high yielding livestock, stall feeding and control grazing in the forest.

3.5.4.d Forest Fire

In summer season an occurrence of forest fire is common in the area. The forests of the Chhindwara district are mostly dry and deciduous and prone to forest fires in the summer season from February to June. There is an at least one-time incidence of forest fire take place in the Forest Divisions. The conducive environment like temperature, availability of dry leaves, grasses, air circulations etc in summer season favours forest fire. The majority of fire is man-made and they set up fire for taking revenge. The main reasons of causing forest fires are as follows:

- Fire set for clearing of ground below the Mahua trees in March and April;
- Fire set by the Tendu leaves collectors with view to obtain the early and better quality leaves;
- Fire set in agriculture field near forest areas;
- Fire set by the livestock grazers and people near to forest area to obtain large quantity of green grass in rainy season;
- Fire caused by the bidi/cigarette smokers and carelessness use of fire light by the people in the forest area;

- The fire is also caused by the villagers for encroachment;
- Fire set for poaching of wild animals;
- The fire is also caused by the villagers while preparing food in and around forests area;

All these reason lead to forest fire and adversely affects the standing crop, plantation (due to availability of dry grass), regeneration, NTFPs, grass, wild animals and compaction of soil. The quality of wood also gets deteriorated. The Forest Division takes immediate action with the involvement of local JFMCs for extinguishing forest fire.

4. Chhindwara - District Vulnerability Assessment

4.1. Approach and Methodology

The methodology used for the drill-down Vulnerability Assessment (VA) for Chhindwara district has involved a top-down as well as a bottom-up approach. The top-down approach was based on the secondary data using **Livelihood Vulnerability Index (LVI)**. The bottom-up approach comprised household level primary surveys for conducting **Community-based Vulnerability Mapping.**

Table 27: Sample Size for Primary survey

Block Name	Total No. HH	Sample Size (1:500)
Chhindwara	30464	61
Tamia	23290	47
Parasia	36119	72
Mohkheda	34932	70
Jamai	39263	79
Saunsar	27307	55
Pandhurna	32720	65
Bichhua	18635	37
Amarwara	29854	60
Churai	36747	73
Harrai	26229	52

Chhindwara district Level Vulnerability Assessment Report, jointly developed by EPCO and DA, was based on secondary data assessment using the Livelihood Vulnerability Index (LVI) tool. Therefore, the recent VA report at the block level focused on secondary data analysis using the same methodology (whose steps are written below). **Community-based Vulnerability Mapping** through primary survey and analysis was considered to strengthen the secondary data and reduce the bias towards the statistical information.

In order to assess the vulnerability at the block level: a LVI was tested by multivariate analysis of individual indicators (Social, Economic, Agriculture, Water Resource, Forest, Climate and Health) which are vulnerable to climate change. The LVI was adopted to provide the data/ map to sectoral (Agriculture, Water, Forest) departments for their decision-making process to reduce vulnerability at the Block level.

The study was also visualized to get convergence of primary and secondary data analysis while addressing the following objectives to enhance the adaptive capacities at the local level:

- What are the current and future climate change threats in the three sectors (Agriculture, Water and Forest) in MP State?
- What are the stressors and underlying processes related to these threats?
- What is the sensitivity towards the projected hazards and perturbations?
- How will sectors/communities/populations be affected by these hazards and perturbations? Are there current socio-economic trends that interact with these sensitivities (and run the risk of amplifying them)?
- How will stakeholders/communities be able to cope with and manage these changes?

- How do stakeholders conceive of systemic effects of climate change? Which vulnerability-decreasing strategies may be used to reduce the risk? What is the priority of these strategies?

Research Instruments

Drilled down Vulnerability Assessment for Chhindwara district was based on secondary and primary data analysis. **(1) Secondary Data (49 indicators) –** Data collected from state and district line departments: *Depicted in Table 28.*

(2) Primary Data – Sample size (Table 27) and questionnaire touching upon the local community vulnerability sector-wise, which are lacking in secondary data at the block level under climate change/vulnerability lenses, filling up the gap of adopted indicators**.**

- **Primary data (Questionnaire)**
  - Household information with social dynamics
  - Migration
  - Land use and cropping details
  - Awareness/Access to government schemes
  - Livestock
  - Social and Natural Capital
  - Food Security
  - Household assets
  - Loan, Saving and Credit
  - Climate Aberrations and Adaptation (Non-farm based, including agriculture and water-irrigation, RWH)
  - Climate Aberrations and Adaptation (farm-based)
  - Climate aberrations and Adaptation (farm-based) and crop loss
  - Schemes (Adaptation support)
  - Forest

Survey frame and coverage

The procedure for drawing the sample for primary data collection at the household level was based on the sample of 1:500 of the total number of households. The total number of households being selected for the survey is depicted in Table 27.

Data Source - Indicators

Reliable and systematic data, integrated with socio-economic conditions, help in determining vulnerability. This analysis is based on the secondary data obtained from the various sources as presented in Table 28 below under the heading of 'Exposure, Sensitivity and Adaptive capacity' and the primary data, based on stratified interviews conducted, and their detailed analysis along with the questions asked are framed on the above-listed heads.

Sl. No.		Exposure		
		Indicator	Source	Period
1	Climatic Indicators	Rainfall (mm)	DSR/KVK	2006-07 to 2014-15
2		Max.Temp. (°C)	DSR/KVK	2006-07 to 2014-15
3		Min.Temp. (°C)	KVK	2006-07 to 2014-15
4		Rainy days(No.)	KVK	2006-07 to 2014-15
5		Relative Humidity (mm)		2006-07 to 2014-15
Adaptive Capacity				
Sl. No.		**Indicator**		**Source/Period**
6	Environmental/Social Indicator	Percentage of Households with Access to Safe Drinking Water (within premises and near premises)		Census (2011)
7		Percentage of Households with Access to Electricity		Census (2011)
8		Percentage of Households with access to Sanitation Facilities		Census (2011)
9		Percentage of Households with TV, Computer/Laptop, Telephone/mobile phone and Scooter/ Car (Households owning Radio, Transistor, Television and Telephones)		DSR (2013)
10		Number of Primary, Middle, High and Higher Secondary Educational Institutions Per Lakh of Population		Census (2011)
11		Population Served per Health Centre (Community, Primary and Sub Health Centres)		
12		Agricultural credit societies per lakh population		KVK
13		Percentage of households availing banking services (Scheduled commercial banks per lakhs of population)		
14		Diesel pump for irrigation		DSR (2013)
15		Electric pump for irrigation		DSR (2013)
16	Environmental/ Agriculture Indicators	Percentage of Net Irrigated Area to Geographical Area by Surface water		DSR (2013)
17		Percentage of Net Irrigated Area to Geographical Area by Sub -surface water		DSR (2013)
18		Cropping intensity		DSR (2013)
19		Livestock Population		DSR (2013)
20		Poultry Population		DSR (2013)
21	Environmental/Forest Indicators	Percentage of High Density Forest area to geographical area (Reserved)		DFO office (2015)
22		Percentage of Medium Density Forest area to geographical area (Conserved)		DFO office (2015)
23		Percentage of Low Density Forest area to geographical area (revenue)		Census (2011)
24		NTFP coverage area		DFO office (2015)
25	Environmental/ water	Net ground water availability for future irrigation development (ham-2009)		WRD (2012)

26		Ground Water Availability (ham-2009)	WRD (2012)
27	**Environmental / Health**	No. of health centre	DSR(2013)
28		No. of Veterinary Hospital	DSR (2013)
29		Number of Hospital	Census (2011)
Sensitivity			
30	**Socio Economics**	Literacy Rate (2011)	Census (2011)
31		Density of Population (2011)	Census (2011)
32		Sex-ratio (2011)	Census (2011)
33		Proportion of Child Population in the Age Group 0-6 (2011)	Census (2011)
34		Percentage Share of Marginal Workers (2011)	Census (2011)
35		Percentage of Scheduled Tribes population (2011)	Census (2011)
36		Percentage of Scheduled Caste population (2011)	Census (2011)
37		Percentage of Households with Access to Safe Drinking Water (away)	Census (2011)
38	**Environmental/ Agriculture Indicators**	Percentage Share of Agricultural Workers	Census (2011)
39		Percentage of Land Holdings below 1 Hectare	Census (2011)
40		Percentage Share of Cultivators/Workers	Census (2011)
41	**Environmental/ Forest Indicators**	Area prone to Soil erosion (ha)	DFO (2015)
42		Area under degradation (ha)	DFO (2015)
43		Total blank area (ha)	DFO (2015)
44		Percentage of wasteland to geographical area	DFO (2015)
45	**Environmental / water**	Water level trend (cm/year)	WRD (2011)
46		Ground Water Recharge Worthy Area	WRD (2011)
47	**Environmental / Health**	Animal and Hospital ratio	DSR (2013)
48		Poultry and Hospital ratio	DSR (2013)
49		Population /Health practitioner (Doctor, compounder and nurse)	DSR (2013)

Table 28: Indicators of Secondary data collection

**DSR- District Statistical Report, LR- Land Records, KVK- Krishi Vigyan Kendra, CGWB- Central Ground Water Board, DFO- District Forest Officer*

Vulnerability Calculation Method

The exposure and sensitivity aspects are linked and, together, they express the potential impacts on the analyzed systems, being positively associated with vulnerability. On the contrary, adaptive capacity expresses the potential of the systems to effectively cope with the impacts and associated risks and is negatively associated with vulnerability. Consequently, the functional form of vulnerability could be:

V =f (PI-AC) (1) where V is Vulnerability, PI is Potential Impact (=exposure + sensitivity), and AC is Adaptive Capacity.

Higher adaptive capacity is associated with lower vulnerability, while higher potential impact is associated with higher vulnerability. Adaptive capacity includes both physical and sectoral (Agriculture, Water, Forest and health) vulnerabilities and their socio-economic attributes, e.g. technological development, access to resources, and governance of the sectors as the way in which society adapts to changes in sectoral resources may be more critical than the resource availability. The vulnerability of any sectoral system can be defined as the degree to which the analyzed systems may be unable to function under environmental and socio-economic changes, specifically changes either arising from or bringing about adverse conditions (i.e. scarcity, shortages, resources variation, and deterioration etc.). A comprehensive framework is needed to assess its multifaceted nature, considering the different vulnerability dimensions, i.e. natural, physical, economic, social, and institutional. Such a framework had been proposed in this study, and was also applied in eleven blocks of Chhindwara district. All blocks were facing certain scarcity or stress conditions due to climatic variability, and/or lack of adequate infrastructure and proper governance mechanisms.

The proposed framework was used to assess the degree to which the systems (i.e. resources, uses, and users) were vulnerable to adverse related conditions, and to identify potential adaptation strategies for vulnerability mitigation. The adopted framework enabled the comprehensive vulnerability assessment of all the chosen sectors as well as the analysis of the systems' potential for improvement through the assessment of different adaptation strategies.

The proposed vulnerability assessment can be used for development programmes and, in the context of climate change, for adaptation and resilience programming; however, it can also be used in the future for sectoral investments in all three thematic areas where consideration would be given to ranked vulnerable communities and ecosystems. It had also been focused where and how to invest in the priority sector. The proposed vulnerability assessment can be used for development programmes.

Steps to Measure Vulnerability Index (VI)

The VI index for a specific sector (Agriculture, Forest and Water) is typically based on a number of indicators which determine the vulnerability of that sector to climate vulnerability/change. Construction of vulnerability index for each sector will have the following general methodology.

- Identifying and defining the indicators: Indicators are selected according to assumptions, baseline considerations and limitations for each sector.
- Quantification of indicators: Indicators are quantified, based on secondary data sources.

Step1: Normalization

For aggregation purposes, each indicator is normalized to render it as a dimensionless measure or number. Values for all the indicators are to be standardized for all the blocks.

Indicator Index (Ix) = Ia – I (min)/ I (max) – I (min)

- Where, Ix = Standardized value for the indicator
- Ia = Value for the Indicator I for a particular block
- I (min) = Minimum value for the indicator across all the blocks
- I (max) = Maximum value for the indicator across all the blocks

Step2: Profile

Indicator Index Values are combined to get the values for the profiles.

Profile (P) = $\sum^{n}_{i-1} Ix / n$

- Where, n – number of indicators in the profile
- Indicator Index i- Index of the ith indicator

Step 3: Components

Values of the profiles under a component are to be combined to get the value for that component.

Component (C) = $(\sum^{n}_{i-1} W_{pi\ Pi}) / (\sum^{n}_{i-1} W_{pi})$

- where $W_{pi\ is}$ the weightage of the profile i
- Weightage of the profile will depend on the number of indicators under it such that within a profile each indicator has an equal weightage

Step 4: Vulnerability Index

The combination of the values of the three components will give the vulnerability index.

Vulnerability Index = f (exposure, adaptive capacity, Sensitivity)

Scaling in done from –1 to +1 indicating low to high vulnerability

4.3. Result and Discussion

4.3.1. Secondary Data Analysis

The study is focused on facilitating the decision makers to present the drill-down version of the CVI (Composite Vulnerability Index). The drill-down is performed sectorally along the same concept presented in the explanation of Composite Vulnerability Index.

Sectoral Index for Vulnerability of the district with respect to Social Indices (SI), Vulnerability of district with respect to Economic Indices (ECI) individually and combined as Vulnerability of district with respect to Socio-economic Indices (SEI), Climate Indices (CLI), Vulnerability of State with respect to Water Resources' Indices (WRI), Vulnerability of State with respect to Agriculture Indices (AGI), Vulnerability of State with respect to Forest Indices (FVI), Vulnerability of State with respect to Health Indices (HLI) and these five combined as Vulnerability of the district with respect to composite Environment Indices (ENI) have been derived, using the indicators shown in the table above, using the relevant sector/sub-sector for arriving at the individual indices. This drill-down exercise is designed to help the decision makers to prioritize the development activities in any chosen district by identifying the sector which makes that district vulnerable. Fig15 and Fig 16 depict the

relationship between the CVI and the sectoral index. Discussions on these sectoral indices are presented in the following paragraphs on sectoral issues.

Table 29: Block-wise Vulnerability Index (Exposure, Sensitivity and Adaptive Capacity)

Profile	Exposure	Sensitivity	Adaptive Capacity
Chhindwara	0.21	0.39	0.560
Mohkhed	0.43	0.48	0.32
Tamia	0.86	0.33	0.34
Jamai	0.32	0.49	0.51
Parasia	0.52	0.52	0.54
Amarwara	0.44	0.56	0.430
Harrai	0.54	0.48	0.44
Chaurai	0.41	0.44	0.427
Sausar	0.44	0.38	0.54
Bichhua	0.33	0.33	0.30
Pandhurna	0.49	0.46	0.555

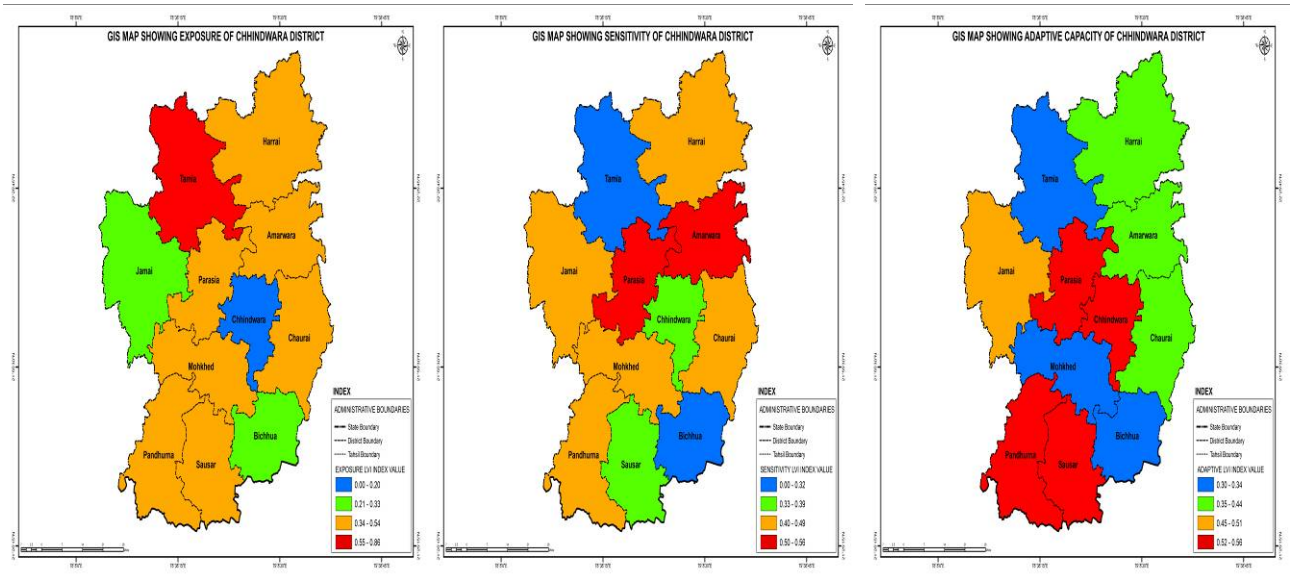
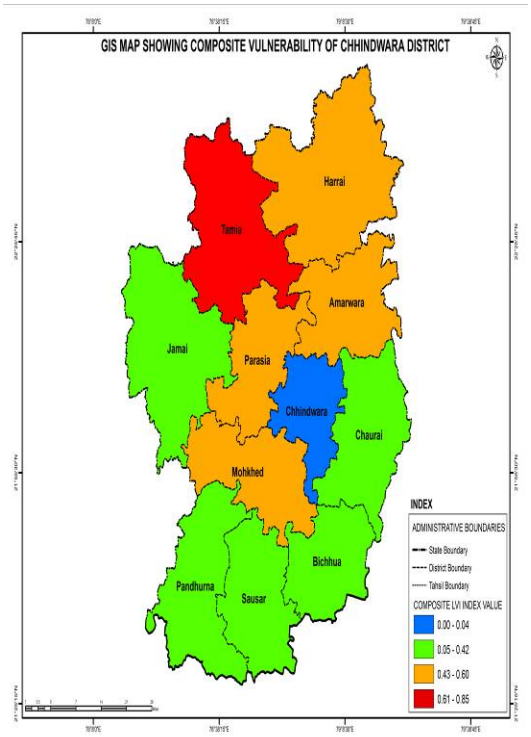


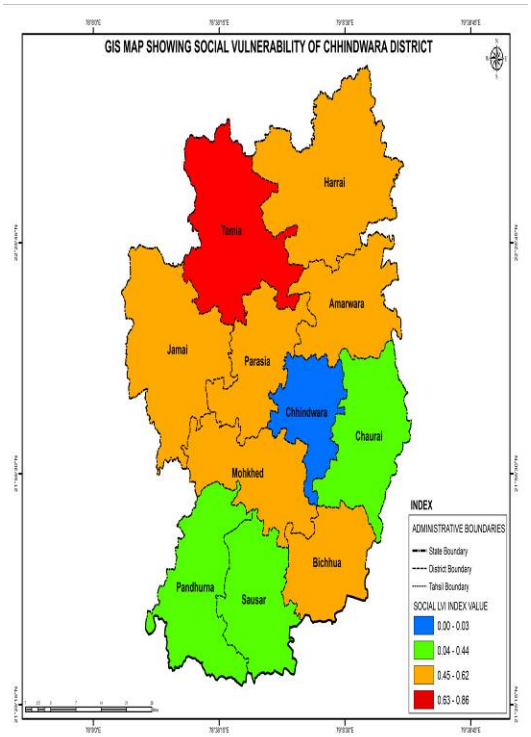
Fig 15: Map on Exposure, Sensitivity and Adaptive Capacity in Chhindwara district

Table 30: Block-wise Sectoral Vulnerability Index
Composite, Social, Agriculture, Water, Forest and Health

Blocks	Composite		Social		Agriculture		Water		Forest		Health	
	LVI (C)	Rank	LVI (S)	Rank	LVI (A)	Rank	LVI (W)	Rank	LVI (F)	Rank	LVI (H)	Rank
Chhindwara	0.04	11	0.004	11	0.20	10	0.04	10	0.161	8	-0.07	11
Mohkhed	0.60	2	0.555	4	1.00	1	0.55	4	0.37	6	0.56	5
Tamia	0.85	1	0.86	1	0.57	4	0.904	1	0.902	1	1.00	1
Jamai	0.30	9	0.515	6	0.23	9	-0.08	11	0.11	10	0.24	8
Parasia	0.50	5	0.529	5	0.271	7	0.51	5	0.69	3	0.63	3
Amarwara	0.578	4	0.561	3	0.4612	6	0.4613	6	0.81	2	0.593	4
Harrai	0.582	3	0.62	2	0.50	5	0.894	2	0.12	9	0.891	2
Chaurai	0.42	6	0.44	8	0.59	3	0.22	9	0.58	4	0.12	10
Sausar	0.28	10	0.29	10	0.265	8	0.44	7	0.165	7	0.43	6
Bichhua	0.36	8	0.508	7	0.18	11	0.72	3	0.08	11	0.34	7
Pandhurna	0.40	7	0.38	9	0.65	2	0.39	8	0.44	5	0.19	9



(a)



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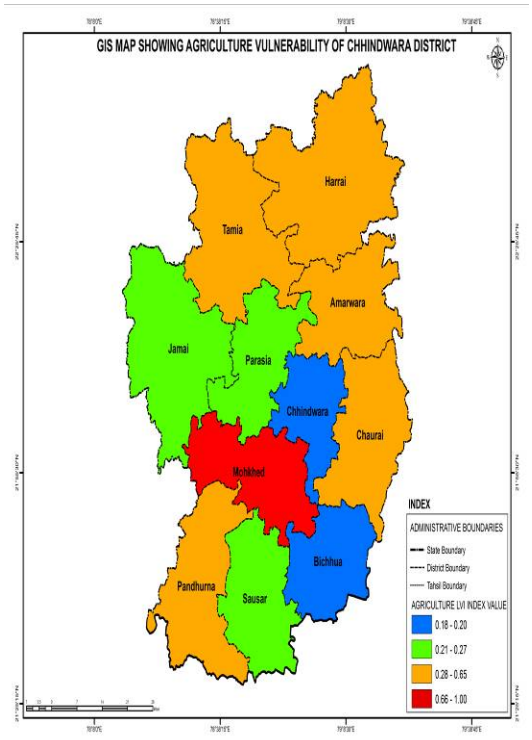

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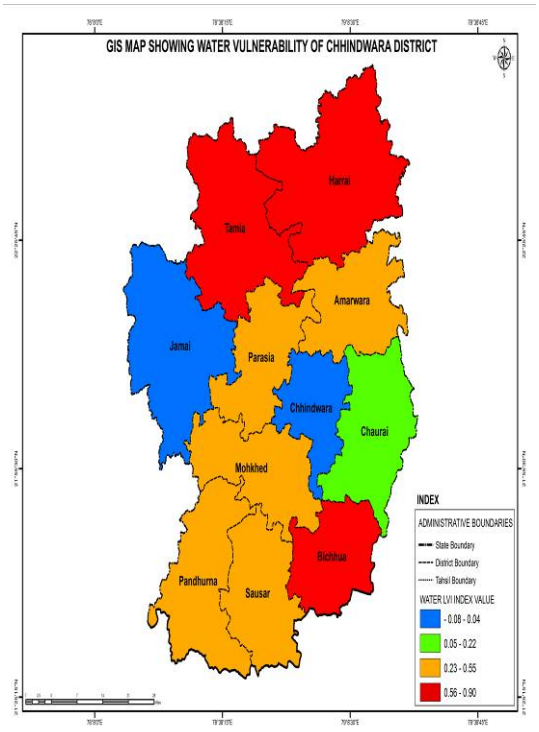

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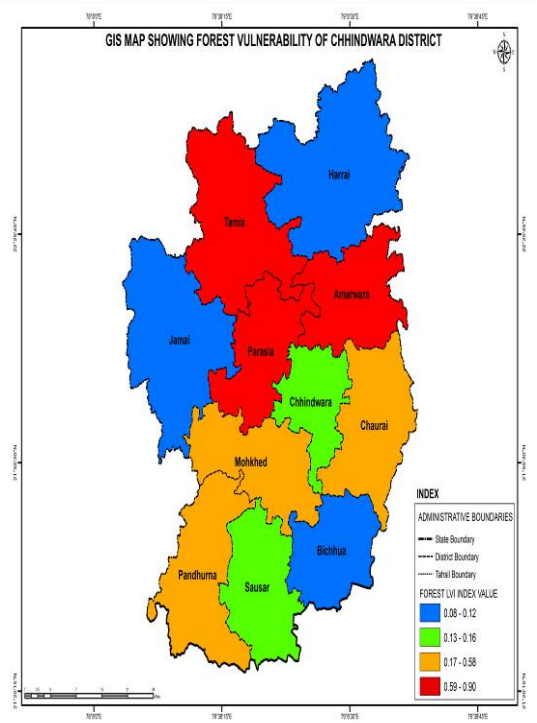

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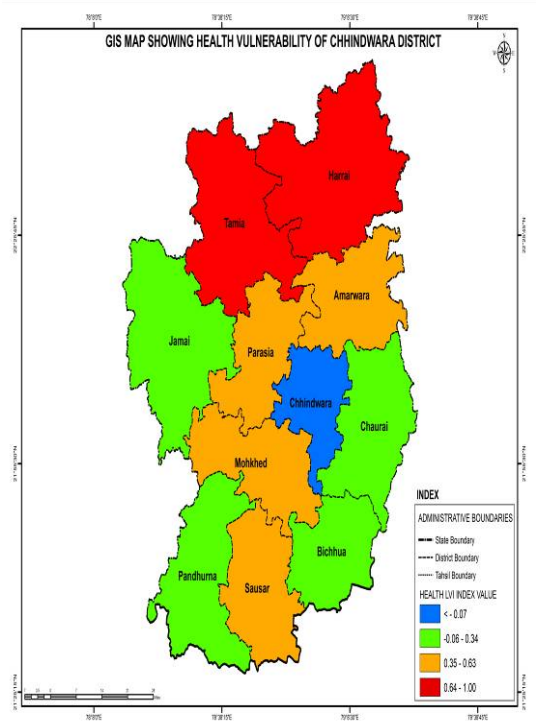


(f)

Fig. 16 Composite Vulnerability Map
(a), Social Vulnerability Map (b), Agriculture Vulnerability Map (c), Water Vulnerability Map (d), Forest Vulnerability Map (e) and Health Vulnerability Map (f).

4.3.1.a. Composite Vulnerability Index

The composite vulnerability has been worked out from 49 indicators related to Exposure (5), Sensitivity (20) and Adaptive Capacity (24) in social, Agriculture, Water, Forest and Health sectors. The composite vulnerability parameters (in Table 28) of all sectors indicated that if values exceed 0.5 in the set categories then a block can be considered as a highly vulnerable block with low adaptive capacity, whereas the blocks categorized in less than 0.5 might be having better adaptive capacity, though vulnerable. The inferences drawn from the vulnerability table indicated that Tamia block is the most sensitive in climatic exposure which reflects at highly vulnerable in overall composite scale too.

In overall composite vulnerability, Tamia block attained the First Rank, whereas Mohkhed was Second and Harrai and Amarwara blocks formed the Third and fourth Ranks respectively. It is evident that necessary steps need to be taken to enhance the adaptive capacity through development programmes in all blocks of Chhindwara district where Tamia block needs to be given more emphasis to bring them in the mainstream of development by supporting the priority list provided in the figure below (Fig. 17).

4.3.1.b. Social Vulnerability Index

Tamia, Harrai, Amarwara, Mohkhed, Parasia, Jamai, Bichhua, Chaurai, Pandhuna, Sausar and Chhindwara are ranked high to low vulnerable blocks respectively in Chhindwara district. The basic infrastructure needs such as roads, water accessibility at HH level, electricity, sanitation, education etc. have not been fulfilled so far in these blocks.

The term ‘adaptation to optimize resource use’ may be secondary for the community, but the well-structured governmental plan and schemes such as MNREGA, SRLM, Balram Talab, Pulse Panchayat, KVK involvement in crop intensification, Swachh Bharat Abhiyan, Nirmal Bharat Abhiyan have addressed the recent environmental and climatic (e.g., land use, soil/water quality, food and health security) challenges.

4.3.1.c. Agriculture Vulnerability Index

The composite vulnerability parameters of Agriculture sectors indicated that the blocks above 0.5 fall in the category of highly vulnerable blocks as their adaptive capacity is low, whereas the blocks categorized in less than 0.5 (though vulnerable) might be having a better adaptive capacity.

The comprehensive analysis of the data showing vulnerability in the agriculture sector determined that the most vulnerable block of the district was Mohkhed, followed by Pandhurna, Chaurai, Tamia, Harrai, Amarwara, Parasia, Sausar, Jamai, Chhindwara and Bichhua. The situation may differ if State and National government schemes used judiciously and implementing policies/missions could be targeted at various threats facing agriculture. Some of the important ones are National Food Security Mission, Mission for Integrated Development of Horticulture, National Mission for Sustainable Agriculture, Paramparagat Krishi Vikas Yojana to promote organic farming practices, Pradhan Mantri Krishi Sinchayee Yojana to promote efficient irrigation practices and the National Mission on Agricultural Extension and Technology.

4.3.1.d. Water Vulnerability Index

The water sectors indicated that Tamia, Harrai, Bichhua, Mohkhed, Parasia, Amarwara, Sausar, Pandhurna, Chaurai, Chhindwara and Jamai were vulnerable blocks which had ranked high to low. All blocks fall in the ‘safe to semi critical’ zones category, but the value of more than 0.5 can be taken as a serious threat and immediate action is required to develop water management plan for these regions. Climatic water stress mapping with sectoral interests (such as seasonal agro-irrigation, industry-water, domestic-water, urban-rural-water-pressure) can be used as an adaptive mechanism for efficient use of water resources in the block.

4.3.1.e. Forest Vulnerability Index

The forests of Tamia are highly vulnerable due to the less-availability of forest cover, whereas Bichhua is less vulnerable than rest of the blocks, where LVI ranges (0.08 - .90) reflect that their adaptive capacity is also high, which clearly demonstrates district adherence to implementation of the Working Plan. Bichhua block depicts less vulnerability; LVI was 0.08 which perfectly matches with the pressures from forest fires, cattle grazing, encroachment and illegal harvesting. Some adaptive measures should be initiated with immediate effect - such as surveying, mapping, and demarcation of forest boundaries as well as installation of permanent boundary pillars. Natural rejuvenation through assisted natural regeneration and implementation of agro-forestry, silvi-pasture development and social forestry programmes, along with the control of species prone to overexploitation.

4.3.1.f. Health Vulnerability Index

Tamia, Harrai and Parasia are first three blocks were found to be highly vulnerable among all other blocks of Chhindwara district where LVI ranges from -0.07 to 1. The value after calculation appears to be non-significant due to the poor quality of the available data. Due care should be taken in collection, recording and tabulation of the data to draw logical conclusion for health. Similarly, in terms of shortage of human and veterinary hospitals in the districts, the timely healthcare and life expectancy are always under threat. Therefore, some remedial measures must be adopted for maintaining the good health of human beings and livestock.

A number of prophylactic measures could be taken, such as developing a team of rural men and women as medical Para extension professionals who can advice and attend the commonly found diseases in the society, organize awareness camps on outbreak of diseases, animal camps, vaccination campaigns etc.

4.3.1. g. Suggestions

The findings of the study indicate that the government needs to take serious steps to improve the Composite Forest, Agriculture and Health sector in Chhindwara block (Fig 16).

In case of Chhindwara block, it was recorded that the Agriculture and Forest sectors need to be prioritized in an ascending order. The concerned departments, stakeholders, policy makers and authorities may use this result as a base to prioritize the area to address the vulnerability in the block.

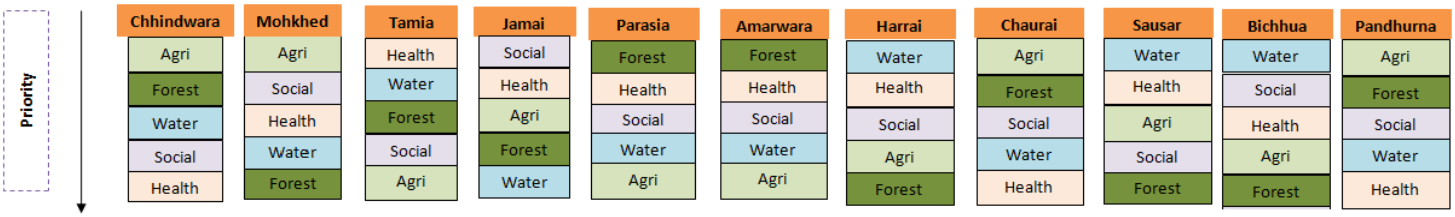


Fig. 17: Priority Areas to Address Sectoral Vulnerability in Different Blocks of Chhindwara District

4.3.2. Primary Survey Analysis

4.3.2.a. Survey Instrument

The development of a suitable questionnaire was an iterative process and lasted around 1-2 hours with each respondent. Initially, an internal consultation was conducted between DA and DFID teams regarding the issues to be covered in the surveys, set of questionnaire and sample size. Based on the data requirements for the empirical analysis and discussions with stakeholders, questionnaires were formulated in English. The survey

instrument was categorized into the following nine sections: (i) Household Details, (ii) Migration Status, (iii) Housing Conditions, (iv) Land, Crop and Livestock Details, (v) Awareness and Access to Govt. Interventions and Schemes, (v) Consumption and Health Expenses, (vi) Health and Food Security, (vii) Household Assets, (viii) Loan, Credit and Savings, (ix) Impact of Climatic Aberrations and Adaptation (Farm and Non-Farm Based). Questions were asked regarding the details of each of the above-listed aspects to the households and recorded. Most of the questions were close-ended and responses were recorded as nominal, ordinal or scale variables. The survey was conducted with the help of field surveyors who were given an in-depth orientation about the purpose of the survey and the process of undertaking the same.

4.3.2.b. Sampling Design

The sampling design is one of the most crucial aspects of this research and the present study adopted a stratified random sample design. The stratification was done for all blocks (Annexure -Table1) with the agreed sample size at 1:500 Households for the survey. The targeted primary data analysis was further correlated by the secondary data vulnerability matrix to cater to the 'top to bottom' and 'bottom to top' state of agriculture, water and forest sectoral performance. Accordingly, blocks were ranked between 1 to 11 in terms of: (i) Sensitivity and (ii) Adaptive capacity.

The sample sizes of chosen villages of these blocks were also equally distributed. The complete list of villages falling under these blocks was taken randomly. Villages were categorized into the ones that (i) lie close to the forest and (ii) where the village is well representative of all three sectoral areas viz. water, agriculture and forest.

4.3.2.c. Preliminary Findings from the Survey

As described in the preceding section, household level data was collected from 628 households in Chhindwara district for the study through questionnaires. This section describes the preliminary findings that emerged from the data and the profile of the sample.

The Chhindwara district, illustrated in the table below, indicated sensitivity and adaptive capacity based on the primary survey of the eleven blocks of the district. The data indicated that the highest sensitivity was recorded in Bichhua (0.55) block while its adaptive capacity was the second highest. In order to capture the sensitivity, eight indicators were used (as given in Table 32). Each indicator of sensitivity also recorded their vulnerability in colour code and ranked 1 to 11.

In case of Chhindwara district, the sensitivity was almost similar to four blocks (Chaurai (0.392), Harrai (0.391) Chhindwara (0.36) and Pandhurna (0.37)). As far as the sensitivity of these blocks was concerned, it was less than 0.5. Sausar block was established to be the lowest in terms of sensitivity.

Among the eight parameters (Table 32) worked out to draw the sensitivity, it was recorded that in the case of Bichhua, only four parameters depicted a high vulnerability trend. Rests of them were distributed between rank 2 to rank 8. It can be concluded that much greater attention needs to be given to induce sensitivity among the people by focusing on other mentioned parameters according to their ranks.

Table 31: Block-wise Vulnerability Index based on Primary Data (Sensitivity and Adaptive Capacity)

Block	Sensitivity	Adaptive Capacity
Amarwara	0.40	0.345
Bichhua	0.55	0.47
Chaurai	0.392	0.23
Chhindwara	0.36	0.431
Harrai	0.391	0.315
Junnardeo (Jamai)	0.28	0.305
Mohkheda	0.25	0.39
Pandhurna	0.37	0.49
Parasia	0.30	0.454
Sausar	0.24	0.336
Tamia	0.29	0.35

Rank 1	Rank 2	Rank 3	Rank 4	Rank 5	Rank 6	Rank 7	Rank 8	Rank 9	Rank 10	Rank 11

Table 32: Exposure and Adaptive Capacity of the Stakeholders

		Amarwara	Bichhua	Chaurai	Chhindwara	Harrai	Jamai	Mohkheda	Pandhurna	Parasia	Sausar	Tamia
Sensitivity	**Summary Statistics for Indicators of Household Profile**	0.191	0.48	0.45	0.44	0.14	0.17	0.38	0.35	0.02	0.42	0.212
Sensitivity	**Income, Occupation and Consumption Profile for the sample**	0.29	0.65	0.32	0.41	0.15	0.133	0.129	0.264	0.42	0.34	0.12

Sensitivity	**Sources of Income for the sample (Primary Income Source)**	0.36	0.493	0.479	0.30	0.40	0.392	0.750	0.389	0.486	0.748	0.36
Sensitivity	**Sources of Income for the sample (Secondary Income Source)**	0.489	0.562	0.50	0.18	0.505	0.501	0.563	0.39	0.46	0.45	0.495
Sensitivity	**Migration Profile of the sample**	0.389	0.65	0.388	0.71	0.840	0.37	-0.29	0.49	0.12	-0.10	0.52
Sensitivity	**Reason for Migration**	0.37	0.06	0.00	0.50	0.66	0.22	-0.10	0.49	0.14	-0.30	0.25
Sensitivity	**Ownership of Assets in the sample**	0.60	0.63	0.37	0.13	0.18	0.31	0.28	0.36	0.48	0.17	0.08
Sensitivity	**Land, Crop and Livestock Details for the sample**	0.49	0.87	0.62	0.21	0.25	0.15	0.322	0.263	0.285	0.22	0.257
Adaptive Capacity	**Benefits from Govt. Interventions**	0.431	0.55	0.24	0.31	0.48	0.43	0.455	0.41	0.16	0.462	0.44
Adaptive Capacity	**Funds Statement for Govt. Interventions for the sample**	0.57	0.36	0.23	0.69	0.47	0.52	0.54	0.38	0.50	0.72	0.49
Adaptive Capacity	**Coping Mechanism adopted through them**	0.04	0.078	0.00	0.61	-0.24	0.16	0.17	0.31	0.54	0.01	0.05
Adaptive Capacity	**Adopted Coping Mechanism and their Average funds generated**	0.01	0.92	0.40	0.55	0.518	0.41	0.26	0.84	0.58	0.524	0.47
Adaptive Capacity	**Perception of households regarding farm based interventions and impacts**	0.75	0.27	0.15	0.26	0.22	0.00	0.33	0.69	0.49	0.06	0.05
Adaptive Capacity	**Schemes**	0.26	0.63	0.38	0.17	0.44	0.31	0.56	0.29	0.45	0.24	0.59
		Rank 1	Rank 2	Rank 3	Rank 4	Rank 5	Rank 6	Rank 7	Rank 8	Rank 9	Rank 10	Rank 11

The adaptive capacity ranks of eleven blocks of Chhindwara (as depicted in Table 31 and 32) district revealed that the adaptive capacity of Pandhurna block was the highest while the adaptive capacity value of Chaurai, Jamai and Harrai recorded lesser compared to Pandhurna. The adaptive capacity was noticed less than 0.5 in all blocks of Chhindwara district that means all blocks need a special attention.

The poor adaptive capacity (Table 31) can be enhanced by implementation of government welfare schemes, coping mechanisms adopted by the farmers and better perception to deal with climate aberration to sustain livelihood. The efforts of the government through developmental schemes to enhance the socio-economic status of the community were beyond doubt as per the data gathered from the blocks. However, the development schemes launched by the government for the prosperity of people couldn't make the desirable dent to harness the required benefits.

4.3.2.d. Analysis of Primary Survey

The inference of each table has been captured in the annexure and its inferences have explained below as to what all has contributed towards ranking sensitivity and adaptive capacity of each block of Chhindwara district (in the Annexure Table 1).

From Table 1, it can be observed that the blocks Bichhua and Amarwara are the ones that are highly sensitive, having rank 1 and 2, whereas they rank 2 and 7 respectively in terms of their adaptive capacity, which is quite satisfactory as a well being option.

Sample villages for conducting the household surveys were identified from the ones satisfying the above criteria and checked for the availability of baseline income data for households. Finally, the primary data collection was conducted to test the questionnaire in the villages. Household selection for the survey was drawn randomly and surveyed, based on their availability and willingness to participate in the survey. In all, 628 households were surveyed, which had captured an all-mixed group of people. Annexure Table 2 shows the sampling design adopted for the present study and the social groups that participated (Annexure Table 2).

It was also observed (during the exploratory visits and the pilot survey) that the head of the household is the one who takes all the decisions for the family and other members in the household follow his/her decisions. Therefore, the data for the present study was collected from the head of the household, so that she/he can recall the economic activity of the family and also answer about the selection of coping mechanisms adopted by the household.

Household Profile: As described in the preceding section, the sample size of the present study is 638 households, which have been further categorized in different social groups (General, Other Backward Class, Scheduled Tribe and Scheduled caste) in two villages. The age of the head of the household is around 41 to 53 years in different blocks, with the youngest head being 21 years of age and the oldest one aged 95 years (Mohkheda). The level of education (number of years of education) is poor, with the average years of education being 9 years (Bichhua) and the minimum and maximum varying from 5 to 9 years respectively in these blocks. A small proportion of the sample (0-0.7%) possesses technical education / privately trained skills of traditional knowledge, which is generally used for generation of secondary income. Instead of being school drop-outs, most of the heads could not attain proper education due to unavailability of a primary school, helping in household chores, not being interested in continuing further studies and sometimes also due to the inability to pay the school fees. Jamai block has 13.43 percent families headed by the women where other blocks have less than twelve but Chaurai block has eighty-six percent (it can be considered as exceptional) households headed by women, respectively.

Table 3 presents the descriptive statistics pertaining to these indicators. Next is the case of self-help groups (SHGs) in the sample. A SHG is a registered or unregistered group of micro entrepreneurs, having homogenous social and economic background, voluntarily coming together to save small amounts regularly, to mutually agree to contribute to a common fund and to meet their emergency needs on a mutual help basis (RBI, 2008). Hence, they are financial intermediaries owned by the poor. These groups are usually started by pooling the voluntary savings of the members on a regular basis. These voluntary savings are pooled with resources from external banks to provide interest bearing loans (nominal interest rates) to their members during their time of need and hence, such loans provide additional liquidity or purchasing power to the borrower for use in production, investment, and consumption activities. Formation of these groups was also an additional task under the interventions in the study area (Annexure Table 3).

From Table 3, it can be observed that 0-5 percent of the sample has membership in the local SHGs. Further, it is found that the penetration of these groups is more among the beneficiaries compared to the non-beneficiaries.
It should be noted that government-funded crop insurance / agricultural credit schemes are targeted at those households having a Kisan Credit Card (KCC). Under the KCC programme, registered farmers receive a passbook against which they can get an agricultural loan for a pre-specified crop from banks and crop insurance is granted to pre-notified crops. Hence, KCC is a prerequisite to be eligible for the government schemes. In view of this, analysis of data from the study area reveals that 48.65 to 95.7 percent of the households in the study area don't have this card. Approximately, 51.35 percent (Bichhua) head of the households are reported to be having the Kisan Credit Card, where other blocks are having less than 4.3 to 31.25 percent.

It emerges that the penetration of disaster / crop insurance in this region is negligible among respondent and further implies that majority households are excluded from the various government sponsored schemes to compensate against losses from climatic aberrations and extremes.

(ii) **Income, Occupation and Consumption Profile**: As described in the previous sections, the objective of the adaptation and resilient interventions was to increase the income of the households by providing them opportunities for livelihood diversification. The analysis of the sample data confirms similar trends. Comparing the primary sources of income for the households, we found that the average income of the households during the last year has increased as compared to that of five years ago. The primary income during last year ranges from INR 17,289.86 (Chaurai) to INR 61,750.00 (Bichhua), which was INR 25,684.9 and INR 1,11,794.9 five years before respectively. Similarly, the average secondary income has increased from INR 11,600.0 (Mohkheda) and INR 40,578.9 (Bichhua) five years back to INR 14000.0 (Tamai) and INR 1,18,842.11 (Chaurai) during the last year respectively (Annexure Table 4).

From table 4, it can also be observed that the total income (income in constant prices) of the households has increased by 6.83 percent (Tamai) to 62.29 percent in Bichhua block and where other blocks were pragmatic increased by around 24.1 percent (Jamai) to 48.8 percent (Amarwada) during the last five years. Further, table 4 reveals that the consumption pattern of the households has exhibited challenging trends. The Amarwada block's average consumption profiling has increased around 12.18% whereas the increment in the case of Bichhua was 71.47%.

While the average annual consumption in Pandhurna block expenditure for the mean was INR 60,789.1 five years ago, it has increased to INR 73,569.2 during the last year (both measured in constant prices). Similarly, the medical expenses incurred by the households have increased during the period of measurement. While the average annual medial expenditure was INR 11,964.4 five years ago, it has risen to INR 15,262.3 during the last year, exhibiting an increase of approximately 43.6 percent. From table 4, it

is also evident that the incidence of climatic extremes has also increased in the study area. While the wage days lost due to the incidence of such extreme events stood at a high, varies between 31 to 77 days five years ago, the same has remain constant to 33 to 157 days during current times.

Looking at the different sources of income for the sample, it is found that for the majority of the households, agriculture is the primary source of income. While 52.01 percent (Amarwada) of the beneficiaries' report agriculture and allied activities as their primary sources of income, rest of the income sources in households have been distributed in salaries, business, sale of assets and rents as their primary sources of income (Annexure Table 5). Rest of the blocks ranges varies between 16.26 to 52.01 percent of income through agriculture and allied sectors.

In the same vein, around 59.9 percent (Pandhurna) of the households involved in agriculture and allied sectors as a secondary source of income and rests are depends on salaried employment as an income-supplementing activity in these blocks that can be considered as a highly vulnerable blocks mainly to cope with any climatic impacts lead to food security. It has been reported that agriculture has become less priority option as a secondary source of income which varies from 6.8 (Chaurai) to 37.7 (Mohkheda)

(iii) **Migration Profile**: Chhindwara tribal Migration is an important indicator from the adaptation point of view and the socio-economic set-up of any region which reflects the employment opportunities present in an area. It has been well captured in various studies that people migrate in search of employment opportunities and in turn contribute to increase in consumption of the households by sending back remittances to their households. (Annexure Table 6 shows the migration profile in the present study area)

Table 6 depicts that all blocks varying between 1.5 percent (Mohkheda) to 17.3 percent (Harrai block were high in migration) of the households in the sample have migrant members. Similarly, the number of migrating members in these households is varying from 2-11 members per migrant household. In other words, the people who opted to migrate five years ago are trying to settle down. The average remittances from migrant members used to range from INR 40,000 (Baldi) – INR 80,000 (Harrai) five years ago which has increased INR 30,000.0 (Jamai) and INR 82,000 (Harrai) respectively. Less than two percent of the respondents accepted of having migrated due to incidence of climatic aberrations and extremes like droughts and rainfall gaps in the last five years. The average period of migration is around 7 months (Amarwada) to 11months (Bichhua), whereas it used to be around 7 months (Amarwada is maximum by respondent) five year back respectively. However, almost the entire sample (98 percent) agreed that the level of migration has increased in their villages now as compared to earlier times but hesitated to share information on migration members. The places for migration have changed over the last decade and migrant members generally travel outside districts (Max in Amarwada block – 15%) and within district (Maximum in block Chhindwara - 8.3%) and outside district (Maximum in Harrari - 11.5%) for seeking work (Annexure Table 7).

It can also be inferred from table 7 that the primary reason for migration is for employment in the lean season (15 % in Amarwada - maximum), and minimum 1.3 percent in Chaurai block. The maximum migration has shown in Pandhurna (3.1%) for medical requirement. This has also not changed during the last five years. The migrant members are mostly employed in unskilled work and relatively few find employment as semi-skilled and skilled workers. However, employment of migrants as semi-skilled and skilled employees has increased during the last five years. Majority of households stated that migration have had no impact (neither on the economic or social front) of the family such as 1.3 (Chaurai) to 17.3 percent (Harrai). It is important to note that around 1.7 percent (Amarwada) of the migrants opine that it

has some positive economic impact on the family and around 8.3 percent (Amarwada) feel that migration has led to a negative economic impact on the family. Chhindwara block responded (6.6%) were disagreed on any social impact changes during or after migration. Migration due to medical emergencies and health requirements has increased in the sample during the last five years.

(iv) **Living Conditions and Assets:** The information on sources of water for drinking and cooking reveals some interesting findings that were captured during the data collection. Interviewers had observed that the access of household to piped drinking water had increased during the last five years and dependence on tube wells and open dug wells had reduced. Similar trends have been exhibited for sources of water for cooking. Although access to privately owned toilets has decreased over this time, access to shared toilets has increased over the last five years.

Looking at the value of household assets, it is found that the average total assets owned by the households in the sample is around INR 5.7 lakhs (Sausar) to 21.5 lakhs (Bichhua) but is skewed with high standard deviation and the range varying between INR 3.6 – 26.7 lakhs (Annexure Table 8).

Similar trends are also exhibited for other items for household assets. While the ownership status has not changed much during the last five years except for a few households, the higher value to the asset owned could be attributed to the general price rise over the years. The average value of agricultural land is around INR 3.7 lakh (Jamai) to 16.9 lakh (Bichhua) while that for homestead land is INR 0.40 lakh (Jamai) to INR 2.7 (Bichhua) respectively. The average value of agricultural machinery and tools is also skewed and stands at a low of INR 0.28 lakh (Sausar) to INR 1.7 lakh (Parsia), while the same for electrical equipment and furniture is INR 1,374.2 (Sonar) to INR 4001.2 (Chaurai) respectively.

(v) **Land, Crop and Livestock Details**: The total agricultural land ownership in the sample has increased from 0.1 to 0.4 acres in Bichhua and Chhindwara respectively over the last five years where other six blocks were unchanged and decreasing trend was noticed in Jamai and Amarwada blocks of Chhindwara district. However, the irrigated lands were neutral in five blocks (Mohkheda, Harrai, Parasia, Amarwada, Sausar and Tamai); Chaurai and Chhindwara blocks depict a slight increase where Pandhurna, Jamai, Bichhua and Harrai.

While five years ago, the average irrigated land was 5.4 to 5.7 acres (Chaurai) and 3.2 to 3.4 acres (Chaurai), which was increased by 0.3 to 0.2 acres respectively during the last year. Most of the farmers cultivate around two crops a year, but only a handful of big farmers are now cultivating around three crops a year.
The input cost of cultivation has increased in each blocks over the last five years from INR .75 lakh (during 2009) to INR 1.29 (in 2015) in case of Bichhua. Correspondingly, the output value from crop production has decreased during the said time. Data shows that input cost has got up in eight blocks such as INR 0.31 (five years ago) to 0.46 lakh (during the previous year) in Mohkheda where INR 0.49 lakh to INR 0.74. In lakh in Chhindwara. Jamai block was neutral in the production on value.

In Bichhua, the ownership of big ruminants has increased from an average of 4.4 (in 2010) to 5.8 (in 2015) per household which was maximum but two blocks (Jamai and Chaurai) have also shown a negative trend. The ownership of small ruminants though has also noticed a mixed trend over the years, out of eleven only two blocks (Sausar and Pandhurna) have a positive trend (Annexure Table 9).

(vi) **Awareness and Access to Govt. Interventions and Schemes**: Community benefitting schemes through other developmental interventions of the govt. are also being implemented in the study area - like the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA), Indira Aawas Yojana (IAY), Rajiv Aawas Yojana (RAY), State Rural Livelihoods Mission (SRLM) / Mission Shakti. The MGNREGA is an Act that provides livelihood security to the households in rural India, supplying at least hundred days' guaranteed wage employment to every household. Similarly, the IAY / RAY scheme aims at providing affordable dwelling structures to the households on a mutually contributory basis. The SRLM / Mission Shakti aims to provide sources for diversification of income and income enhancement. Table 10 presents the participation of households of the sample in these programmes.

It can be observed from Table 10 that maximum households in the sample have benefitted from the MGNREGA programme. A non-significant share of the households has participated in this programme from 7.69 percent (Pandhurana) to 70.0 percent (Amarwada) in MNREGA. However, the participation in other governmental programmes is well adopted by the community in the study area. The households have availed LPG subsidy in sample HH ranges 2.7 (Jamai) to 50.9 (Sausar). AAY/IAY/RAY schemes have substantial beneficiaries in each block such as 1.6 percent (Mohkheda) to 15.6 percent (Bichhua). Table 11 reports the receipt of funds and contributions made by the households in these govt. interventions.

From the households who have benefitted from the MGNREGA programme, the average participation was around 1 person to 3 persons per household. Each beneficiary family has contributed around 15.9 man days (Bichhua) to 132.4 man days (Chhindwara) per annum in the programme and has received an income of approximately INR 2,983.6 (Bichhua) to INR 20,000.0 (Sausar) respectively. Similarly, two percent of the household have received funds from the SRLM.

(vii) **Impact of Climatic Aberrations and Adaptation (Farm and Non-Farm Based):** The incidence of drought, hail storm, erratic rainfall and rainfall gaps (in terms of number of days) is reported during the Kharif cropping season (June -October), when soybean and Gram are grown in the study area. The direct impact of droughts and rainfall gaps is the resultant crop loss due to the unavailability of water in the growing periods. Adaptation and Coping describe the action taken to cope with changing climate conditions (for example - changes in the cropping system to suit the climatic aberrations, soil texture and structure). They also refer to the specific efforts undertaken at the micro and macro level to address the risk of such extremes and aberrations. At the outset, the government projects were not designed with any climate change objectives in mind. Nonetheless, the nature of poverty reduction (income enhancement) and the benefits of increasingly sustainable and diversified livelihoods (groundwater recharge and assistance for creating water resources) are such that the project contributed to people's ability to cope with climatic aberrations or extremes or, in other words, enhanced the adaptive capacity in the present study region. At the household level, the following coping options are identified that could be in use in the study area to cope against climatic aberrations and extremes: (i) Selling of Livestock, (ii) Selling of Household Assets, (iii) Use of Loans and Credit, (iv) Selling of Land, (v) Use of Govt. Relief, (vi) Interest free transfers from Friends and Relatives, (vii) Use of Past Savings, (viii) Migration and (ix) Insurance.

Out of these, the most preferred means of coping are selling of livestock (1.6% in Mohkheda and 8.2 % in Chhindwara). Government Relief and Supports from friend and relative used to be the preferred coping mechanisms recently and five years ago and The details about the relative use of these options and the average amount of funds generated through these options are presented in Table 12 and Table 12a.

These options are not mutually exclusive and households choose to employ any measure or a combination of measures (both farm and non-farm based). With regard to farm-based options for coping with extreme events, we find the following measures in use in the study area: (i) creation of water harvesting structures and water sources, (ii) soil and moisture conservation activities (Field & Contour Bunding and Check Dams in the field), (iii) changing of cropping system, (iv) use of drought-tolerant varieties, (iv) farming system diversification, (v) use of zero tillage technology and resorting to alternative sources of income through rearing of small ruminants. (Table 13 presents the changes witnessed by the households due to the government or non-governmental schemes.)
The most noticeable increase due to the interventions relates to the increase in the groundwater level in the fields.

Around 63.3 percent (Amarwada) of the sample has witnessed an increase in the groundwater level, with the average level of increase being around 0-10 feet over the last five to ten years. Similarly, less than 21.6% (Parasia) households have noticed a rise in the water holding capacity of the land where rest of the blocks, households have not observed any remarkable change in water holding capacity.

The Baldi block were noticed 59.1 percent increment in the number of cropping seasons where other blocks have not seen any transformation.

Similarly, it has been found that 36.6 percent (Sausar) households report, there has been an increase in the level of farm output and revenue over the last ten years where other blocks have negative responses on same. The value of crop loss due to climatic extremes has considerably increased over the last decade. While the average value of crop loss stood at INR 7,961.5 (Amarwada) to INR 59,317.8 (Chaurai) in recent year that was maximum. In other ten blocks, it was varied from INR 11690.9 to INR 38,257.1 in Chhindwara district. On the other hand, it was noticed that the percentage and scale of crop loss has increased over the years. The average percentage of crop loss stood highest at Chhindwara 70.7 percent five to ten years ago, but it has varied from 0.29 (Amarwada) to 59.7 (Pandhurna) percent during the previous drought-like conditions. The average recovery time for the households for the consumption loss has also increased from 2.8-3.1 months (Bichhua) during the previous decade to now.

The recovery time for the loss of income due to crop loss has also increased (4.68% in Chaurai was maximum) which has accepted by stakeholders in each blocks. Finally, a distinct proportion (less than 2%) of the sample opines that crop failure has decreased over the years due to the interventions (governmental and non-governmental). Similarly, around 0.95 to 100 percent of the sample feels that the incidence of climatic aberrations and extremes like rainfall gaps, and unavailability of water during critical times has increased during the last decade.

5. Adaptation Strategies for addressing Climate Change in Chhindwara

To address the challenges emerging from the primary and secondary data analysis, a comprehensive sector-wise strategy related to Water, Agriculture, Horticulture, Animal Husbandry, and Forest was drawn from Madhya Pradesh State Action Plan on Climate Change Report (2014). Each strategy has been taken as the reference point to provide the suitable technology, adaptation, existing policy strength and possible outcome to address appropriate adaptive options, which are presented in a tabular form below. It depicts, at a glance, the various activities which are being carried out in different departments to address the issues of climate change or vulnerability, which further pave the path of adaptation. It may be pointed out that various policies and programmes in each sector are being executed to mitigate the aberration of weather, but it requires a more visionary approach for the welfare of stakeholders. The policy makers and practitioners can also derive benefits out of it.

5.1. Water Resource Sector and Climate Change Adaptation Strategies

Strategy	Technology	Adaptation	Policy Strength	Remarks
Comprehensive water data base in public domain and assessment of the impact of climate change on water resources of the State	-Rajiv Gandhi Drinking Water Programme (1:50,000) -Physical monitoring systems are setup by Water Resource Department and Central Ground Water Board. -Limited study made on water basin at block level prospective	-Adding climate change/ vulnerability scenario data in existing data set can improve water resource uses to all stakeholders -Block level basin-wise surface water availability and their future projection including water quality are essential and surplus water can be shared. -Remote Sensing and GIS-based decision making tool need to be prepared -Scientifically, plantation method need to be analyzed or adopted along canal or river system; Conservation method need to be strategized on priority basis	MP Water Sector Restructuring Project (WSRP) Watershed Development Fund National Afforestation Programme Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS) National Rain-fed Area Authority Integrated Watershed Management Programme Participatory Irrigation	The database can validate that the programme has achieved – (i) increased water storage capacity, which augmented irrigation; (ii) Increased cropping intensity (iii) reduced runoff, which enhanced groundwater recharge; and (iv) reduced soil loss.
Promote accelerated pace of surface water development in the state	Command area development and completion or renovation of canal system	Improved canal water distribution and more water well use in head water area result in better water availability in tail end area		Learning and testing new case study on climate Proofing of irrigation projects in sensitive areas to

	Lined and unlined Channel	and avoid head water drainage problems Lined channel reduces the seepage loss and it may increase the area of irrigation	Management (PIM) Act 2006	Climate Change needs to be proposed
Water conservation, augmentation and preservation with special focus on areas with over-exploited conditions of groundwater	Rain water harvesting and Artificial Recharge Traditional water system (exploring and maintaining)	To achieve the maximum water user benefits while minimizing the associated environmental impact Role of PRI's in rual areas and WUAs in urban areas Legislation revision on Ground Water regulation and management need to be addressed in future Adopt conversion based model such as Catchment Water Allocation Tool (CaWAT), developed by IWMI or Soil-Aquifer Treatment (SAT) developed by FAO or others at panchayat/ block level model using MNREGA or other associated fund		It is essential to identify the favourable areas for Groundwater Development within the over exploited area by Remote Sensing and GIS techniques. State water authority and National Water mission programme (Priority can be over-exploited zone) must be merged. Promotion of traditional system including repair, renovation and restoration of water storing bodies
Increase water use efficiency in irrigation, domestic chores and industrial functions	Recharge Structure, Wells and pump installation irrigation Small water bodies and lined as well as unlined channels Water budgeting, water metering under Public Private Partnership model Common waste water treatment & recycling plant in	Appropriate action on maintaining existing structure, futuristic vision on covering population and their drinking water demand, irrigation and industry use on propose structural and non structural measures for water storage against different climate change and socio economic scenario can minimize the livelihood shocks due to climate and hazard related uncertainty. Incentive based mechanism may also improve water use	Schemes under Irrigation Department Command area Development Authority Department of Agriculture Watershed Management Programme Agriculture Dept.	Appropriate Technological adoption and adaptation can improve groundwater recharge efficiency, rainwater harvesting, surface water availability for all sectors users. Wise water practices and harvesting techniques (Necessary for building Govt. & Private Partnership and it can be monitored by student projects)

	rural areas (e.g. Grey water use in agriculture field, cleaning etc.)	efficiency and productivity.	programmes (mentioned below) MGNREGA	Appropriate pricing policy for water usage in industrial, agriculture and domestic sectors. Water use audit for industries and allied sectors
Promote basin level integrated water shed management	Knowledge base – Basin wide knowledge base of Institutional, socio economic and biophysical context Climate and hydrological impacts of water availability and agriculture (Climate –Water-Agriculture-Hydropower) Water related hazards (Water hazards) Adaptation & livelihood Promotion (Adaptation and livelihood) Integrated responses through improved basin wide cooperation and capacity building (Integrated responses)	Site Specific model need to be developed	National Water mission Some program served indirectly: National Afforestation Programme Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS) National Rain-fed Area Authority Integrated Watershed Management Programme	Guidelines of different uses of water Integrated water resource management and basin development Integrated watershed development and management in Climate sensitive areas Management plan for the river basin or sub-basin Water resource modeling including quality aspect Comprehensive Scheme for flood management and reservoir sedimentation Regular Monitoring on source point of aquifers to facilitate natural recharge Projects on water stressed areas to enable improved efficiency in water use
Capacity building	Groundwater prospecting	Capacity building at all level is needed to support communities and institutions	Irrigation department	Training to professional for various departments,

	Geo hydrological surveys Drilling technologies Water level and Quality monitoring	so that integrated responses, such as Integrated Water Resource Management, can be developed effectively.	Water resource department Public Health and Engineering Department Central Ground Water Board Ground water planning and evaluation agencies Water and land management institutions	Organization, PRIs/ULBs associated to address water resource and linkage of Climate change
Building Institutional mechanism for Climate Change Action Plan	Promotion of planned and integrated conjunctive use of Institutional reforms, Public investment Practical measures	A new over arching state government apex agency or enhancing in existing structure for water resources to perpetuate the status quo on water supply distribution and utilization for drinking, irrigation and industry need to be considered Campaign to educate farmers through water user association on the benefits of conjunctive use of canal and ground water, crop diversification and land micromanagement according to prevailing hydro-geological conditions.	National Water mission Central Water Commission Central Ground Water Board Irrigation Department	Integrating CC concern and programmes with the appropriate agencies Strengthening objectives of National Water Mission and Program, therefore it is necessary to manage the conjunctive development of water resources – a balance is created between local recharge and groundwater use The impact of surface water off take doesn't extend into the low river flow period check impact of water well abstraction until high river flow periods

5.2. Agriculture Sector and Climate Change Adaptation strategies

Strategy	Technology	Adaptation	Policy Strength	Remarks
Promotion of soil & Water conservation technology	Micro and Macro measures (Soil mulching, plastic sheet mulches, deep Tillage, contour Bunding and trenches etc.)	water and nutrient conservation can be enhanced Weed control	Micro watershed programme	It checks soil and nutritive losses. Reduce the rate of runoff and soil erosion, maintains the productivity of the soil.
Development of water storage structure	Trenches around fields, Injection well, drip and sprinkle irrigation, SRI technologies etc.	Avoiding moisture stress in drought situation Providing life saving irrigation during moisture stress	National Watershed Development Programme, Micro irrigation schemes, Balram Talab, MNREGA	Adequate yield can be obtained under adverse climatic condition.
Planning Cropping system suitable for each agro-climatic condition.	Promotion of heat and drought tolerant crop varieties of soybean, wheat, paddy and maize etc crops.	Establishment of community seed-bank.	Seed village scheme Annapurna Scheme Surajdhara Scheme	Improved crop management practices which can minimize the effect of climate change on various crops.
	Land races promotion	Maintenance of land races of various crops which could perform well in adverse climatic condition. Adjustment of planting dates to minimize the effect of high temperature.	Micro-management schemes (coarse cereals).	
	Inter cropping and crop rotation	Maintaining soil fertility and reducing infestation of insect, pest and disease	Rastriya Krishi Vikas Yojana (RKVY), Intensive cotton development programme.	
	Crop diversification	assured income at field level To meet ever increasing demand at household level for nutritional consumption	National food security mission. RKVY	
	Modify crop management practice (e.g. Line sowing, Broad bed and method of sowing, Ridge and Furrow method)	Crop can be secured under water stress and access condition Yield enhancement	RKVY, Integrated Cereal Development Programme, ISOPAM, National Food Security Mission	
	Conservation	Reduce cost of production,	Micro management in	

	Agriculture technology. (e.g. After harvest of kharif crop sowing of rabi crop without land preparation to tap residual moisture)	time saving and adding carbon in soil Residual moisture conservation	Agriculture engineering, RKVY	
	Exploiting biotechnological techniques. (e.g. tissue culture, Biological markers)	Higher seed material production in small area, reduce cost of production, time saving, transportation	NA	
Nutrient Management	Integrated plant nutrient management (e.g. Soil testing Use of bio-fertilizers)	Judicious use of chemical fertilizers and enhance its use efficiency	Integrated plant nutrient management and balanced use of fertilizers, National Biogas and manure management program, State level organic farming promotion projects. RKVY ISOPAM,	The State Government has developed the various strategies for mitigation and adaptation plan for the Climate Change. Adaption of integrated plant nutrient management. Various provisions were made under state and centrally sponsored scheme for the above.
	Increase nitrogen use efficiency. (e.g. Use of Neem Coated urea)	Nitrogen use efficiency of crop enhanced Volatilization and leaching of nitrogen reduced	2. State organic farming promotion project	
	Organic farming	Physical properties of soil maintained, Beneficial to human health	State organic farming promotion project	
Integrated insect pest and disease management	Integrated insect pest and disease management (e.g. seed treatment with fungicides To develop strategy checking the life cycle of insect pest and micro-pathogens coming up due to climatic variability.)	Strategy to reduce the crop loss Protects soil and seed borne diseases, cost reduction and yield enhancement	Micro Management, all agro-crop development schemes including cash crops	Integrated insect pest and disease management practices Popularized specially focusing on plant based insecticides like neem, tobacco and other plant derivatives.

	Identify the new insect pests and diseases coming up in changing climatic conditions.	Entomological and pathological study need to be done	RKVY	
Enhancing dissemination of new & appropriate technologies developed by research.	Use of electronic mass media like T.V, Radio, Mobile phone, Internet, Kisan Call centre. Publication of extension literature for distribution among farmers through panchayat and other PRIS. Field visits Krishi Rath Training of farmers and extension personnel.	Gaining knowledge about the agriculture technologies. Package of practice of crops. Weather forecast and decision making, Cost reduction, income generation, market rates, reducing crop and diseases impacts Weather related forecast up to block level. Various scheme and projects for farmers. Market rates. Incidence of any insect/ pest disease and weeds. New agriculture products. Publicity of Agriculture events.	Various government schemes initiated for dissemination of technology (e.g. Doordarshan, AIR, Department of Agriculture, Krishi Vigyan Kendra etc.)	

5.3. Horticulture Sector and Climate Change Adaptation strategies

Strategy	Technology	Adaptation	Policy to strengthen	Remarks
Promotion of soil and water conservation technologies for improving productivity.	1. Application of mulching 2. Drip Irrigation 3.Micro-Irrigation programme 4. Poly-Houses 5. Shed nets	1. Reduction in water requirement 2. Enhance water use efficiency 3. Assure production under stress condition	1. M.P water shed re-structuring project 2.Micro Irrigation scheme 3. RKVY	Technology useful in view of the rising temperature and reduction in water availability for irrigation
Development of agro-horticulture system for securing livelihood	1. Agro crops- vegetables (e.g. Maize – lady finger/chilly) 2. Agro crops-fruits (e.g. Soybean – Papaya) 3. Agro crops- spices (e.g. Gram – Coriander) 4. crops- flowers (e.g. Gram – marry gold)	Insure regular income under rain fed condition Survival rate can be enhanced	1. National horticulture mission 2. Badi project 3.Integrated fruit development program 4. Integrated vegetable	Crop diversification will facilitate assure income and employment for attracting and retaining youth in the village

			development program. 5. Development of Kitchen gardening	
Developing horticulture policies and plans according to agro climatic conditions	Scientific policies for technology for horticulture crop need to be strengthen	Attractive Scheme need to be promoted to covert planting and fruiting into enterprises mode (e.g. Food processing center, Farmer producer company etc.)	1. Block level 2.District level	Policies as per agro-climatic condition of the zone.
Creating business hubs	Value additional processing and marketing	Creating more opportunities to develop enterprises for youth and interested farmers	1. Entrepreneurship Development 2. Rural hart, Market fairs 3. Training of farmers	It can create fair price mechanism; reduce wastage, and developing backward and forward marketing network.
Adequate research and extension support creating cooperatives	1. Breeding strategies 2.Agronomic management 3. Biotechnical 4. Mitigation strategies for Carbon Dioxide and GHG 5.Plant protection strategies 6. Post Harvest technology 7. Training of officers 8. Training of farmers	Better Seeds and cropping techniques with modern techniques can be boon to ensure productivity under extreme condition	1. Research work in agriculture university. 2. R&D of private sectors	Zoning of selective crops and their focused research need to be conducted to site specific crops and their appropriate management practices.
	Palmology, floriculture, floriculture, food preservation, protected horticulture	Suitable varieties for the crops will be available for high yield and monetary gain. Crop value addition can minimize the risk perishability.	Integrated fruit development scheme Banana orchard development scheme Integrated vegetable development programme Promoting hybrid chilies	
Creating cooperatives for enhancing the livelihoods of	Seed producer company Co-operative Cold Storage Marketing Network	Strengthening of existing and new cooperatives can enhance the livelihood of small and marginal farmers	National Horticulture Mission Department of	The producer seed companies of the farmers will facilitate the

marginal farmers		Marketing strategy with cold storage linkages can reduce the wastages of produce and support better prices.	Agriculture	availability of fruit, vegetable and flower seed of good quality at reasonable price. Small cold storage with assistance of National Horticulture Mission may be constructed at block level which can operated on cooperative basis by the farmers themselves. Market network for perishable produce of horticulture crops need to be strengthened for collection, processing and marketing.
Building Institutional mechanism for climate change action plan	Prioritizing the integrated action plan under climatic lenses	Alteration in existing extension can ensure productivity even in the climate variable or extreme conditions.	National Horticulture Mission Department of Agriculture	Liasoning with agriculture department would be useful for crop diversification to sustain under climate vulnerability.

5.4. Animal Husbandry sector and Climate Change Adaptation strategies

Strategy	Technology	Adaptation	Policy Strength	Remarks
Ensuring availability of adequate feed, fodder and water for livestock	i)Azola production ii)Makka (Maize) fodder seed production in Kharif iii)Berseem (Trifolium alexandrinum) seed production in Rabi.	Feed and fodder requirement can be adequately address for livestock. Water availability of livestock managed by local institute (Panchayat) need to be supported	i)Feed and fodder development scheme. ii) Fodder bank scheme	Horizontal spread of the scheme may be done to curve the problem of feed and fodder that can solve the scarcity issues.

Ensuring nutrient solvency in livestock	(1) Mineral mixture and food supplement	Mortality rate of Rearing calves (up to 2 years of age) can be reduced Mineral mixture may be made available locally Knowledge dissemination on Nutritive feed need to be promoted	i) National Mission for Protein. Supplements (NMPS) ii) Calf rearing scheme	Distribution of mineral mixture may be assured to improve Life expectancy. Milk productivity and quality can be maintained Govt. may establish animal feed plant at block level with well-equipped laboratory
Enhanced capacity for disease forecast, monitoring and management	Mass media Livestock practitioner Animal Camps (Rainy season, summer etc.)	To help animal rarer know about diseases in advances. In advance information about outbreak of the diseases may be given for adoption of prophylactic measures	i) Navachaar Protsaahan Yojana. Go Sewak training ii)e-Vet scheme iii)Integrated sample survey iv)National Animal Disease Reporting System.	Weather based vaccination system to address control of diseases and it can be executed by following: Upgradation of district veterinary hospitals to polyclinics. Upgradation of veterinary hospitals and dispensaries. Providing vehicles to mobile units and ambulatory clinics.
Ensure adequate housing and dedicated water bodies for livestock to overcome heat stress.	Aasra (Shelter), Not executed in Chhindwara	Creating life saving system for sick, non-domesticated livestock	NA	Similar program like Aasra need to be initiated
Promote research on native species	Natural breeding of indigenous breed and upgradation of non-	The improve breeds of animal can be made available which can	i)Nandishala scheme	It imbibes the character of highly tolerant to heat.

breeding and rearing	descriptive livestock Artificial Insemination	sustain with extreme conditions and giving better yield performance.	ii)Sammunat Pashu Prajanan Karyakram	It also secures protein intake and additional income source. Awards can motivate the farmers to speed up white revolution
Promote use of livestock and poultry waste for use as organic manure	Integrated Farming System	Organic manure will be useful for improving and maintain the physical properties of soil. It can be supplementary and complimentary to agriculture and allied sector system e.g. Crop-Livestock, Crop-Poultry etc.	Panchgavya production at Jabalpur (Not able in Chhindwara) RKVY	It can reduce the fertilizer consumption at field scale and promote income activity.
Promote new varieties of poultry and native species of small ruminants	Financial support on Kadaknath (poultry bird) Backyard poultry unit Financial support on improved breed of Goat and Pig.	Economic condition of the beneficiaries can be directly addressed where nutrition intake with egg and meat production can be enhanced.		Subsidiary occupation for income and employment generation Financial assistance for Women centric program can be initiated: i)Subsidy on Goat unit distribution. ii)Subsidy on buck distribution. iii) Subsidy on poultry backyard unit iii)Subsidy on distribution of pig trio. v)Subsidy on Kadaknath chicks. vi)Rural backyard poultry scheme. vii)Establishment of goat farm at Chhindwara.

Integrated approach to livestock development	Crop-Livestock-manure (Cyclic) Crop-Poultry-manure-energy (cyclic) Work is being done in coordination with MPWSRP	The requirement of energy can be met out at local level through biogas	Indirect programmes run by MP New Renewable Energy Development to address the same	Self sufficient in energy generation and manure production and their consumption at lower cost can be achieved. It will be additional source of income generation to local people.
Infrastructure for processing, storage and transport of livestock products	Milk cooler Milk Tankers Refrigerate Van Milk Processing Unit Milk powder (Indore) Auto Flavored milk filing line plant(Ujjain)	Production of milk and milk products can be protected and preserved for longer duration to use and get maximum benefit to the stakeholders.	M.P Cooperative Dairy Federation	Livestock owners will fetch remunerative prices for their produce.
Encourage formation of cooperatives	Sanchi dairy or Dairy Society (community based)	Procurement and pricing of milk produce for stakeholder can be secured and equitable distribution of profit among the producers.	i) MP Co-operative Dairy Federation (MPCDF) II)Dairy unit by bank loan and subsidy	Strengthening the cooperative sector can be encouraged by financial agencies
Strengthen the extension arm of the Animal Husbandry department	Provide short term trainings		i)Establishment of training centre at Saagar ii)Residential training of farmers in collaboration with IGNOU	Strengthen the extension arm of the Animal Husbandry department
Building Institutional mechanism for Climate Change	Kisan call centre Short term training program	Queries about livestock rearing and their maintenance will be replied in shortest possible time Skill up-gradation of livestock owners can add their income substantially.	i)Government of India and Madhya Pradesh Department of Animal husbandry has created a climate change cell to address the same.	The centre will address the issues related to yield, quality, disease, feed etc. in the lens of climate variability and change.

5.5 Forest Sector and Climate Change Adaptation strategies

S.No	Strategy	Technology	Adaptation	Policy Strength	Remarks
1)	Develop forest management plans for different forest types in view of CC	Afforestation and reforestation in Working/Management plan and Micro & Annual Plan	Community awareness and involvement can secure and enhance the open and scrub, and dense forest Effective working plan preparation and execution need to be prioritized in a line of CC and vulnerabilities	National Forest Policy 1988 Madhya Pradesh State Forest Policy 2005 National/ State Working Plan Code Revision	Degradation and depletion of forest cover can be addressed more scientifically which intern to maintain ecological balance.
2)	Forest conservation and afforestation /reforestation through viable models including PPP models	Assisted natural regeneration (ANR) Compensatory afforestation Watershed development Prevention of fire with community support and razing of forest tower	Activities under Natural regeneration program through community participation can be induced their livelihood, soil and moisture conservation, growing stock. Community fencing under this can restrict the entry of livestock in the forest to avoid grazing. In situ and ex-situ conservation for soil and water conservation Supervision and surveillance by Fire watchers can prevent fire incidence.	National Forest Policy 1988 Madhya Pradesh State Forest Policy 2005 Fire Scheme under beat budget/development fund	Interventions through PPP model can reduce pressure on forest and maintain biodiversity and ensure livelihood security. Dependency on forest can be minimized by promotion of agriculture and allied enterprises in the focused area.
3)	Ensure soil and water conservation measures in forest management	Contour Bunding, Nallah Bunding, Gabionic structures, Trenching	In situ measures have been in practice which reflected in forest enrichment. Technology intervention on open and scrub has upgraded in forest cover.	National Water Mission National/ State watershed mission (e.g. Rajiv Gandhi Drinking and Sanitation programme)	Right technology plays pivotal role to upgrade Forest area and resources. Defunct structures need to be maintained for longevity of above.
4)	Research on impact of climate change on forest types	IBIS model Dynamic vegetation model	Forest diversity need to be conserved while knowing the prediction of Dry Savanna and moist Savanna is projected to change to	MOEF&CC Forest Department (Ex-Initiation of Lok Vaniki programmes)	Provisioning, regulatory, supporting and cultural services should also be considered to improve the model prediction because

	and forest based ecosystem services	HadRM3 using BIOME 4 vegetation response model The Economics of Ecosystem and Biodiversity (TEEB) model Implementation of social forestry and forest extension programmes with active participation of local people	Tropical seasonal forest Forest diversity can also addressed Species occurring in Several communities need to be conserved and propagated in situ and ex situ conservation to address 90% Shift in forest vegetation types. Pruning, thinning, top working of desired species need to be carried out for check the quality of changing in phonological and physiological characters. Fencing, Fire watch towers can reduce extreme cases of mortality of tree species.	State Forest research Institute Tropical Forest research Institute Tribal Development Fund	supporting and cultural services are often neglected from climate change prediction model. Adding these services can evaluate the true value of forest ecosystem services.
5)	Capacity building	Division, district and state training for all officials and staff Exposure Visit Demonstration Case studies Success stories Biodiversity Conservation	Improve the Competency of foresters and JFMCs for strengthening of forest ecosystem services. Development Training manual of procedure/methodology for assessing impact of climate change on forestry and vulnerability assessment including REDD+ and CDM mechanism	State Forest Department Indian Council of Forest Research and Education, Dehradun Tropical Forest Research Institute (TFRI) State Forest Research Institute (SFRI) Indian Institute of Forest Management (IIFM)	Training on climate change and forestry to all officials and staff to abreast of latest program and policies of National and International concerns. Development of operational guidelines for implementation of programs foster to improve ecosystem services including benefits of REDD+ and CDM mechanism
6)	Promote alternate source of energy in forest villages and adjoining	Energy Plantation (e.g. prosopis julifora, acacia nilotica, Khamar) Solar lightning	Promotion of agro forestry model can provide alternate source of energy material. Solar lightning can save fuel wood consumption for	Implementation of National Solar Mission Wadi Programme (BAIF-NABARD) Forest Department	Energy saving and efficiency by introducing solar and energy plantation can reduce the pressure on forest resources.

	revenue villages	Solar cooker Energy efficient cook stove Wind Energy	lightening, cooking and heating. Fuel wood consumption and head load can be reduced by using efficient cook stove.	(Plantation programmes) National/State Bamboo Mission MP New and Renewable Energy Department programme State Rural Livelihood Mission and their schemes	Adoption of effective technology can save the money which can be used for other livelihood options.
7)	Livelihoods security of forest dependent communities	Secondary agriculture of Non Timber Forest Produce (NTFP) Plantation and aesthetic promotion to conserve Community area (Rural Tourism) Agro forestry model	Sustainable harvesting is key to ensure forest resource vs. economy of the dwellers that has been followed in all schemes. Rural tourism is in practice in pockets which can ensure engagement of youth as tour guide, botanical and wild life expert and it creates both livelihood and local subject experts to save endanger species.	Wadi Programme (BAIF-NABARD) Forest Department (Plantation programmes) National/State Bamboo Mission State Rural Livelihood Mission and their schemes	To reduce dependency on forest involvement of local communities in protection, management, conservation and improvement of forest resources have to be promoted. Stakeholder can get double income from forest produce as well as crops in low fertile land. Rural tourism can create employment generation and awareness about the conserving biodiversity for future generation. It can also establish the extinct species profiling of plant and animals due to climate change.
8)	Biodiversity Conservation	Biodiversity park Mapping and zoning of endanger species Biodiversity register	Flora and fauna of forest area will remain maintained. Zoning can be strategies to earmark the species for income and employment generation.	Department of Forest - MP State Biodiversity Strategy and Action Plan, (2002) Madhya Pradesh Forest Produce (Conservation of Biodiversity and Sustainable Harvesting)	It will enhance the diversity of the area and hence reduce the incidences of outbreak of pest and diseases. Employment and income options can be created by introducing biodiversity

			Biodiversity register will indicate the availability of various species, likely to be extinct, climate and drought tolerant and futuristic vegetation growth.	Rules, (2005)	park which also supports the ecological equilibrium of flora and fauna.
9)	Enhancing green cover outside forests	Plantation (Road, bund, open spaces etc.)	Micro climatic conditions can be maintained.	Schemes under: Department of Forest Municipal corporation Horticulture Department etc.	It supports the National mission on a Green India and national forest policy 1988. The Tree outside forest area can be increased by introducing mix concept of agroforestry, social forestry and community forestry programmes with climate smart village concept.
10)	Building Institutional Mechanism for Climate Change Action Plan	Prioritized the technology developed at state and National level	Enrichment of forest by the various technologies can be adopted in the district. The most effective technologies may be shared with REDD+ for reducing GHG emission and conservation of forest	MP Vision Document (2018) National mission on a green India National Biodiversity Act (2002)	It will form basis for strong liaison with National and International organization to showcase the technologies developed to reduce emissions from forested lands and invest in low-carbon paths to sustainable development.

5.6. Institutional Capacity to Address Climate Change

The development of water resources, agriculture and allied enterprises in the district is based on three major pillars of development system. One deals with a knowledge generating system, basically, engaged in evolving the new technologies, practices, pursuit and products etc. The developed technologies are then disseminated and transferred to a knowledge disseminating system which is principally an extension system engaged in diffusing the technology to the beneficiaries or the community – the third pillar of the development system. So far, technologies related to agriculture, horticulture, animal husbandry etc. are a district level concern.

Interactions with the district and block level functionaries took place during surveys and also during one to one meetings. These interactions provided ample opportunities to gauge the current capacity of the various departments and institutions. The district administration for example is well versed in drought prone areas to reach out to the community for aid purposes. However, interaction between various departments has potential for improvement. For example, in order to adapt to climate change in the agriculture, a number of departments will need to act in unison. Agriculture extension services in the district are highly understaffed. For the new methods and resources to reach out to the maximum number of farmers it is essential that the numbers of

extension cadre be enhanced substantially. As of now the Krishi Vigyan Kendras (Agriculture Science Centers or KVKs for short) have limited staff which is sufficient only for demonstration purposes but not for roll out. In case further recruitment is against policy of the state then in this condition partnership with private sector needs to be established.

Another area where capacity needs further strengthening, is outreach to the community in terms of participatory planning methods. Most of the planning processes do not involve the communities directly. This leads to disconnect with the ground reality as a result of which the intended benefits of schemes are not seen.

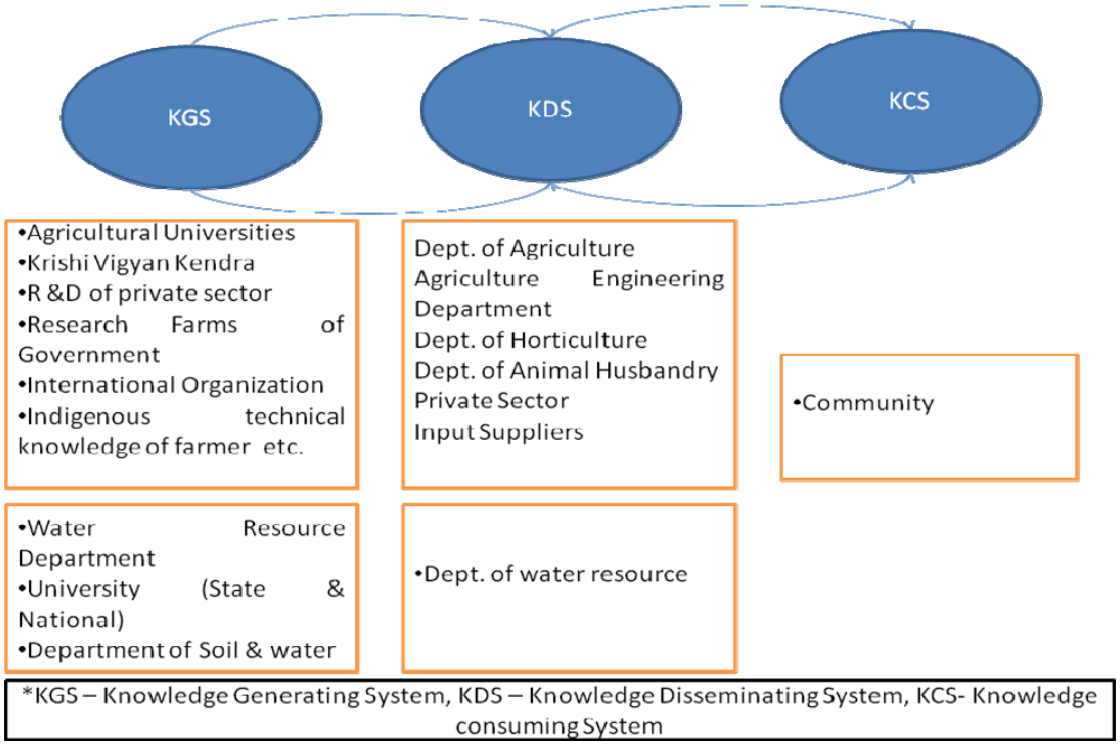


Fig 17. Institutional Framework of Knowledge Generation, Dissemination and Consuming System

5.6.1. Limitations of Existing Structure to Address Climate Change:

- Lack of infrastructure at the block level to provide weather forecasting information to the community.
- There are various schemes and programmes for the welfare of the farmers, however it is experienced that there is shortage of staff to harness the maximum output. At the same time, awareness among the farmers for the same is also weak.
- The mitigation measures for climate change, like the availability of suitable variety of crops and measures, are not available in the required quantity.
- Participation of primary rural institutions is lacking.
- Stakeholder selection and participation to avail schemes and funds should be unbiased.

5.6.2. Issues and Barriers to Mainstreaming Adaptation and their Recommendations

Adaptation is inevitable to address the impact of climate variability in water, agriculture and allied sectors, as well as forests, but the adaptation strategy is impeded in many ways. Many issues and barriers to adaptation restrict stakeholders in terms of wide adaptation of sustainable agriculture, irrigation and forestry with innovative technologies to mitigate the aberration of weather and climate change. Some of the important barriers impending the growth of each sector are listed below:

a. Agriculture Sector

Agriculture and allied enterprises are commonly facing the following barriers which can be overcome by developing appropriate strategies under the lens of climate change/ variability:

- **Communication Barrier** – farmers were not exposed to scientific knowledge fully; they have inadequate information about coping with climate resilience, though they are becoming increasingly cautious about local climate variability issues. In addition, they have limited understanding and access to adaptive measures given in the contingency plan of the Chhindwara district. For example, the package of practices as guided by Krishi Vigyan Kendra, to deal with drought situation after sowing in kharif season, are not horizontally spread in the district.

Poor access to the information sources by stakeholders in the district is another constraint. The dissemination of weather information like rainfall, temperature, drought, crop management practices at the local level is inadequate due to lack of infrastructure.

- **Technological Barrier –**Stakeholders' attentiveness and attractiveness towards the technology to enhance the adoption rate are mainly dependent on the degree of the merit in the technology itself. It has basically five attributes to understand the barriers in adoption: (1) *Economic viability* – it should be comparable with the existing practices such as improved varieties of various crops as compared to indigenous varieties, wider use of technologies to harvest water, conserve soil moisture (e.g. crop residue retention), and use and transport water more effectively where drip and sprinklers are used ((2) *Compatibility* – present and past experience of the technology consistency, altering the timing or location of cropping activities(3) *Simplicity* – easy to understand and use, (4) *Divisibility* – tested on a small scale for effectiveness of pest, disease control and maintaining or improving quarantine capabilities of the same, and (5) *Communicability* – using climate forecasting at block level to reduce the production risk, technology can be spread immediately if post and pre-emergence weedicides can support the income; diversifying income through altering integration with other farming activities such as livestock raising.

Poor outreach of extension machineries (Grass root level officials) in interior villages and infrequent contact of farmers with development agencies of various departments is limiting the acquisition of technical knowledge in the district. Gap in technology development and actual adoption by farmers – in spite of all the efforts of government and NGOs to disseminate the technology of agriculture and allied sectors developed by the National Agriculture research system of the country and the state, hardly twenty-five percent of the technology reached the farmers and was adopted by the tillers of the soil in the district, as is evident from the productivity of various crops in the district.

The technology barrier alone can't cope up with recent climate variability issues, the constraints need to be looked into seriously. Non-availability of short and medium duration crop varieties and required inputs like fertilizers, pesticides, lack of access to weather forecasting technology are influencing the adoption of mitigating

measures. There are various constraints in shifting different cropping patterns, crop diversification etc. due to weak agricultural support delivery mechanism.

- **Bio-social barrier** – Socio-economic barrier, agriculture technology to be seen as an important route for poverty emancipation of the district, agriculture innovations are adopted slowly and several socio-economic variables of adoption still remain poorly understood due to the age, education, participation in local institutions, income, degree of cosmopolites etc of stakeholders.
- **Policy barrier** – The government has launched a number of programmes for the welfare and prosperity of the farmers; however, the benefits of these are not being harnessed by farmers due to less publicity and infrequent contact of development agencies with the common stakeholders. The strategy for execution of the programme needs to be strengthened, including the selection of the beneficiary farmers which is based on socio-economic status, combining with recent composite vulnerable areas including the climate change.
- **Market barrie**r – It has been seen that market linkages are very poor in terms of selling the farm produce, which always creates issues related to excessive competition, lengthy procedures, low transparency in the process, weak market system for fruits and vegetables, market hubs and *mandis* to support the minimum support price of various farm commodities. The farmers do not fetch a reasonable profit due to the involvement of middlemen in marketing the produce in the district.

b. Water sector

- **Technological barrier**

Check/Stop *d*am/Canal/ Bore well

There are no standard technical guidelines and Schedule of Rates for construction of stop dams for the state, resulting in varying cost norms and technical parameters being used by different departments in the same geographical area without any proper justifications for such variance.

Construction of stop dam or check dam is a socio-technical issue. But, most of the executing agencies do not have any mandate and orientation for community mobilization. More so, there is no budgetary provision for community mobilization during or after the construction of the check dam.

There are technical problems related to the site selection, appropriateness of the design suitable to the site and construction quality. Lack of proper supervision mechanism and quality assessment through a third party leaves an enormous scope for being ineffective and unaccountable.

Parameters	Status
No. of dams, embankments:	Thirty-five earthen dams were constructed in tributaries of Narmada and Godavari river - Kanhan, Pench, Jam, Kulbehra, Shakkar and Doodh in Chhindwara District. Actual water spread area can be fluctuated due to irregular rainfall and the extensive usage of the water.

Bore well/ hand pump

During drought situations, most of the functional hand pumps do not work which may be the only source of drinking water. Maintenance of hand pumps is also very poor.

- **Communication barrier**

Lack of ability to integrate knowledge from disciplines other than hydrology into water resource planning compounds the problem. For instance, the irrigation departments, which deal with the bulk of developed water resources in the state, do not have professionals qualified in environmental hydrology, hydro-chemistry, agricultural sciences and irrigation economics. Often, observations are made by experts to change the curriculum of technical degree courses. Training institutions by far also lack an integrated approach. This is considered to be one of the reasons for the inefficient performance of the irrigation sector in the district even after huge investments, both by government and international agencies.

- **Bio-social barrier**

Managing the surface and sub-surface water flows in a river basin in the undulated terrain in Chhindwara district is a bit challenging, especially in dry land areas as one has to start from the ridges of the topmost micro watersheds that constitute the catchment of the river and then work down to the river itself. It is economically much cheaper, socially more just and environmentally much safer to do this than build big dams, which should only be constructed if necessary to service the needs that cannot be met through in situ water conservation and extraction. As contrary to large dam's benefits, which have been planned and are under construction on the rivers Betwa and Orr, they will serve the scheduled tribe people in control of the plains' lands, leaving the tribes literally high and dry.

Water has a clear linkage to all the three development dimensions: Environmental, Economic, and Social. The challenges necessitate the need for a sustainable policy regime that facilitates Integrated Water Resource Management (IWRM) for efficient use of what is going to become a scarcer resource regionally. The matter is assuming greater urgency as the district/state rapidly urbanizes and undergoes industrial transformation, because the regional pattern in such cases is that water for urban and industrial use goes up substantially and reallocation of water between urban and rural areas (as a result) has the potential to create social tensions and even conflict.

An effective adaptation process in water resource conservation would also hinge on the ability of livelihoods, which includes social networks, cultural traditions and activities that provide food and income, to be sufficiently flexible so that no adverse impacts of climate change are discernible on the social system. Such enabling conditions would clearly facilitate a sustainable development process, but this would also require overcoming factors that cause vulnerability to climate change.

- **Policy barrier**

Developing policies for water allocation calls for a good understanding of the factors influencing: the demand for water and the human behaviour with regard to water use, including pollution, or the factors that are capable of altering the socio-economic systems determining the demands for water. For instance, what kinds of policies in inter-sectoral water allocation are required at the basin level if water is very scarce at the aggregate level? People having a sound understanding of the physical (agro-meteorological and climatic), socio-economic, institutional and cultural factors influencing the water demands are required here. The institutions for water allocation can include state regulations as well as market instruments such as property rights in water; water tax and pollution tax, water and electricity pricing etc. Deciding the nature of regulations (whether "top down" or enabling and location specific) and designing effective regulations

require sound understanding of laws, and the complex social systems and cultures, apart from the characteristics of the water-related ecological system which is to be co-managed with water.

c. Forest Sector

The issues and barriers that influence the adaptation of a forest ecosystem to climate change include: - dependency of the people on forest for fuel wood, wood for house construction, agricultural implements, illegal felling of teak trees due to high market value, grazing of huge livestock in forest areas and unsustainable NTFPs collection etc.

There are climatic/natural issues causing injuries to forest crops including frost, drought, temperature, storm and lightning plus floods. Non-availability of naturally dried and fallen wood in the forest has declined due to the increasing needs of human population from forests. Under such circumstances, people cut small trees and leave them lying in the forests to collect them after some days in the form of head loads. This practice is causing large scale damage to the forest ecosystem. Also, there is lack of livelihood options leading to the sale of fuel wood to the nearby city areas.

There is also illegal felling of poles for Nistar[9] purposes in the areas viz., Chhindwara, Bichhua etc.

[9] By Nistar, we mean a provision made under the Indian Forest Act, 1927 for providing to local people living within the 5 km radius of the forest some special privileges in the form of supply at concessional rate/free of charge of fuel wood, poles, bamboo and other forest produce for their own use, or consumption. The Nistar benefits vary from year-to-year depending on the quantity of the forest produce available in the year which is distributed through Village Forest Committees/Forest Protection Committees/ JFMCs/Gram Panchayats.

6. Conclusion

6.1. Current Climate Change Threats in Agriculture, Water and Forest in Chhindwara

The study has analyzed weather parameters viz. Rainfall, Temperature, rainy days and relative humidity. It indicated that vulnerability related to weather was more sensitive in Tamia, Mohkhed, Harrai and Amarwara. The exposure value which is more than 0.50 indicates more stress conditions viz. Tamia block (0.85), Mohkhed (0.60), Harrai (0.582) and Amarwara (0.578) in exposure table.

The impact has further compared with all the sectors and it was found that Tamia block ranked highly vulnerable in Composite (Rank 1), Health (Rank1), Water (Rank1), Forest (Rank1), Health (Rank 5) and Agriculture (Rank 4 but has values-0.57) due to its adaptive capacity. Similarly, Mohkhed block has high climatic pressure values (Rank 2) which illustrated high correlation with Agriculture (Rank 1), whereas Water (Rank 4), Health (Rank2) and Social (Rank 4) sectors have value more than 0.5 that clearly indicated the impact of climatic pressures. It has been observed that on the contrary, the sector such as Forest has low rank (Rank 6) which is less vulnerable (0.37).

6.2. Stressors and Underlying Processes Related to Threats

The comparative livelihood vulnerability analysis has shown that Amarwara block ranked 1st in secondary and 2nd in primary analysis on sensitivity whereas in adaptive capacity, secondary and primary data are ranked seven and seven respectively but the values differences are difference are less (0.16) in sensitivity and lesser (0.09) in adaptive capacity. Similarly, Chhindwara block sensitivity and adaptive capacity for both primary and secondary data are also showing closer value differences and their rank in secondary was 8th and 6th in primary in case of sensitivity. In adaptive capacity, ranks in secondary was 1st and Primary was 4th where value difference in secondary and primary were 0.03 to 0.13 respectively. Thereby, concluding that there was statistical significance in primary and secondary studies so far as vulnerability and adaptive capacity were concerned. The analyzed stressors are mainly related to income, occupation, migration, and assets owned by the people including agriculture, forest, water, health and social accessibility and affordability by the community. Thus, it has given strength to our study by conducting the primary survey and adding additional points of working out the stressors.

6.3. Sensitivity to the Projected Hazards and Perturbations

Resilience refers to the capacity of a social-ecological system both to withstand perturbations for instance responses on climate or economic shocks and to rebuild and renew itself afterwards (Stockholm Resilience Centre 2007b)[10]. Unseasonal rain, hailstorm and erratic rainfall are few examples which witnessed by the state in last few years, as such no study was conducted to observe hazardous situations at block level in the district. However, two recent hailstorm effects were experienced on rabi crops which has created havoc to policy makers. Situation got worse in case of rural community when all sectoral practitioners differ depending on their sensitivity to the hazards and perturbations to which the sectors are exposed.

This is well reflected in primary survey by the community and their impacts on overall productivity and livelihood which further leads to insecure their food consumption. Groundwater availability, Water quality for drinking and irrigation and depletion of forest, NTFP collections were also important issues related to hazard as pointed out by the communities.

[10] Stockholm Resilience Centre. 2007b. "What is resilience?"
http://www.stockholmresilience.org/research/whatisresilience.4.aeea46911a3127427980004249.html

6.4. Sectors/communities/populations be affected by these hazards and perturbations - correlation with current socio-economic trends and interaction with the above sensitivities

The response of hazards in Chhindwara and Pandhurna blocks were more visible as compared to the rest of the blocks of Chhindwara district. Increased visibility of research focused on vulnerability on sectoral issues with communities in Madhya Pradesh and its associated terms – resilience, adaptation, and adaptive capacity – has spawned more research; scientists from adjacent fields such as climate impacts, natural hazards, and sustainability have turned their attention to vulnerability and resilience. But the terms remain contested, studies are fragmented or too aggregated to be useful to decision-makers, and policy relevance continues in short supply, particularly correlation of hazards and perturbation with socio-economic trends.

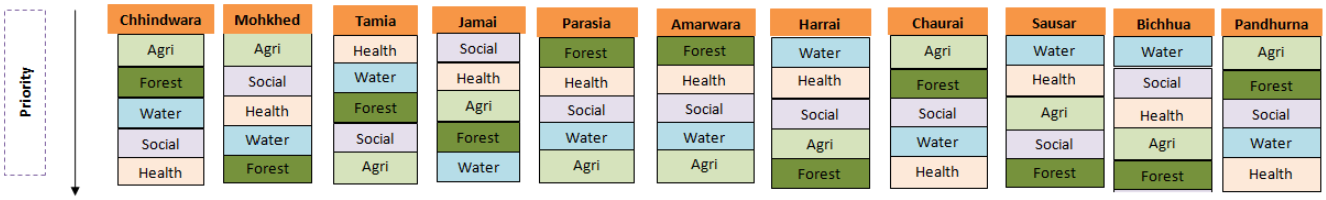
6.5. Coping mechanism for stakeholders/community

The adopted strategy from the earlier work of SKMCCC has been further fine-tuned after analyzing primary and secondary data to provide and suggest appropriate technology support, adaptation tools, existing policy strength which can be supportive document for the implementer and decision makers to reduce the risk-related climatic and weather aberrations. Some suggestions are need to be immediately taken into account such as establishment of knowledge platform contributing to policy formation leading to community empowerment, engagement of stakeholders for effective participation in drought mitigation actions, fiscal compensation for the damage caused by hail storm and erratic rainfall. The knowledge accumulated over centuries in the communities should be used for evolving a mitigation strategy at the local level after validation of traditional practices through modern scientific methods.

6.6. Priority Strategies for Stakeholders to Reduce the Effects of Climate Change

The development schemes run by the government agencies should be easily accessible to resource poor people of the community. The serious effort should be initiated to deal with the social, water, agriculture, forest and health issues of the community. The block-wise priorities to take up the activities have been illustrated below.

Priority areas to address sectoral vulnerability in different blocks of Chhindwara District are presented below:



6.7. Lessons Learnt and Recommendations

6.7.1 Agriculture

The policy makers may be abreast of Climate–Resilient interventions to test local models for enhancing the adaptive capacity of the community. The interventions can be specific for a short term (a year) and long term (five years), partly due to adoption of 'backward' farming practices. A crucial step to build support in the government is to engage focal points in a Project Facilitating Committee (PFC) or other similar structures to deal with aberrations. Departments (Agriculture and allied sector, horticulture, livestock, and local environment) of the district and local authorities, NGOs, farmer cooperatives, businesses and community leaders can be involved in the planning and execution of the project. To support the Adaptation project, which has been emerging in

India, it will be essential to work across the various sectors and levels, with agents with different expertise and government mandates. Because an intervention in one part of the system is likely to have repercussions in other parts, a sectoral view cannot encompass the full ecology and the human aspects of the farming system which stake the maximum livelihood in the district. For example, the choice of seed selection, crop variety, fertilizer use, water efficiency measure for replanting effects on land use and microclimate, which can't be translated as a blanket approach. The various interventions need to be continuously harmonized. This process requires high levels of information-sharing, discussion and cooperation. The blending of Science, Technology and local knowledge with stakeholder consultations by the PFC can ensure to be very effective in creating a common understanding of the linkages in the farming system.

Conversions to certified organic farming has an emerging interest of growers. Organic farming can be a more stable commodity today, but organic farming also helps farmers avoid vulnerability to fluctuating agro-chemical prices and support market linkages.

6.7.2. Forest

The community forest concession system has significantly changed the organizational and institutional landscape in the district and has brought a higher level of sophistication and capability to the forest management regime. Key challenges for the future include simplification of the NTFP produce, process and the harmonization of the requirements to enhance the produce.

6.7.3. Water

Rehabilitation of the irrigation system, check dams (small and medium) to reduce water loss and expansion of the capacity of storage ponds to cope with longer dry seasons due to climate change are essential for the Chhindwara district.

Training in sustainable land management, data base creation on GIS platform, river basin management, regular monitoring, water budgeting-cum-quality analysis (of both surface and sub-surface) have been critically documented and raised in the earlier vulnerability assessment report of Madhya Pradesh, which should be prioritized as it requires immediate action.

The dealing above by region-specific emphasis on water resource efficiency has obvious environmental co-benefits. It preserves water, resources, agro-biodiversity as well as wild biodiversity (by preserving land). The adaptation-cum-mitigation project 'Enhanced Strategies for Climate-Resilient and Environmentally Sound Agricultural Production in River Basins of the District' can be aiming to contribute to the adaptation of vulnerable communities to climate change and to reduce the impact of agricultural practices on the environment and, hence, provide a good example of tapping potential synergies. As a composite vulnerability focusing on a multiple issue (Social, Agriculture and Allied sectors, Forest, Health), potential trade-offs with other issues have to be identified and addressed.

It uses an ecosystem approach that draws on nature's contribution to crop growth – soil, organic matter, water flow regulation, pollination and natural predation of pests – and applies appropriate external inputs at the right time, in the right amount, to improved crop varieties that are resilient to climate change and utilizes nutrients, water and external inputs more efficiently. A Climate-Smart Adaptation approach adds a more forward looking dimension, and more concern about future potential changes and the need to be prepared for them.

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8. Annexure

Appendix (Tables)

Table 1: Study Blocks in Chhindwara

Sl. No.	Study Blocks in Chhindwara District	Performance of overall Sensitivity Rank	Performance of overall Adaptive Capacity Rank
1	Amarwara	0.40 (2)	0.345 (7)
2	Bichhua	0.55 (1)	0.47 (2)
3	Chaurai	0.392 (3)	0.23 (11)
4	Chhindwara	0.36 (6)	0.431 (4)
5	Harrai	0.391 (4)	0.315 (9)
6	Junnardeo (Jamai)	0.28 (9)	0.305 (10)
7	Mohkheda	0.25 (10)	0.39 (5)
8	Pandhurna	0.37 (5)	0.49 (1)
9	Parasia	0.30 (7)	0.454 (3)
10	Sausar	0.24 (11)	0.336 (8)
11	Tamia	0.29 (8)	0.35 (6)

Table 2: Sampling Criteria and Number of Households Surveyed in the Study Area

Sampling Criteria 1: Performance of Local Vulnerability Assessment (1:500 HH)		Sampling Criteria 2: Random Sampling of Village		
Sl. No.	**Blocks**	**Sample Village**	**No.**	**Social groups**
1	Amarwada	Sonpur	60	G- 0, OBC - 34, SC-8, ST- 18
2		Dhasanwada		
3	Bichhua	Pipariya Kla	37	G- 2, OBC - 20, SC-10, ST- 5
4		Dhanegauo		
5	Chaurai	Salai Chindi	75	G- 1, OBC - 61, SC-8, ST- 5
6		Parsgao		
7	Chhindwara	Umariya isara	61	G- 1, OBC - 30, SC-8, ST- 22
8		Bijori Khurd		
9	Harrai	Jhirna	52	G- 0, OBC - 6, SC-30, ST- 16
10		Bichhua		
11	Junnardeo (Jamai)	Umradhi Karmohnibandhi	75	G- 0, OBC - 50, SC-11, ST- 14
12				
13	Mohkheda	Sarang bihari	64	G- 10, OBC - 37, SC-16, ST- 1
14		Rajegao		
15	Pandhurna	Mordongari	65	G- 0, OBC - 64, SC-1, ST- 0
16		Badegao		
17	Parasia	Footera	37	G- 1, OBC - 21, SC-1, ST- 14
18		Chitri		
19	Sausar	Choti	55	G- 2, OBC - 52, SC-1, ST- 0
20		Devi		
21	Tamai	Etava	47	G- 1, OBC - 7, SC-6, ST- 33
22		Mutoir		

Table 3: Summary Statistics for indicators of Household Profile

Indicators	Amarwada				Bichhua				Chaurai				Chhindwara				Harrai				Junnardeo				Mohkheda				Pandhurna				Parasia				Sausar				Tamai			
	Mean / %	Std. Dev.	Max	Min	Mean / %	Std. Dev.	Max	Min	Mean / %	Std. Dev.	Max	Min	Mean / %	Std. Dev.	Max	Min	Mean / %	Std. Dev.	Max	Min	Mean / %	Std. Dev.	Max	Min	Mean / %	Std. Dev.	Max	Min	Mean / %	Std. Dev.	Max	Min	Mean / %	Std. Dev.	Max	Min	Mean / %	Std. Dev.	Max	Min	Mean / %	Std. Dev.	Max	Min
Age of the Head	44.75	10.51	67.00	28.00	45.30	11.40	75.00	21.00	50.23	9.68	70.00	24.00	48.08	10.58	70.00	30.00	43.02	9.94	70.00	24.00	43.67	11.45	70.00	23.00	48.26	10.82	95.00	25.00	53.23	11.19	95.00	30.00	42.0	8.3	65.0	28.0	52.4	11.8	85.0	21.0	49.1	12.5	90.0	30.0
Number of Years of Education of the Head	8.79	4.08	18.00	1.00	9.35	3.16	15.00	5.00	6.52	2.69	12.00	2.00	5.36	2.41	12.00	1.00	7.28	3.47	15.00	1.00	6.88	3.02	15.00	1.00	6.94	2.87	12.00	2.00	8.14	3.36	15.00	2.00	5.8	2	12.0	2.0	8.9	4.0	17.0	2.0	6.6	3.2	15.0	2.0
Training in Technical Education / Privately Trained Skills / Traditional Knowledge	0.04	1.84	15.00	1.00		0.37	2.00	0.00		0.00	2.00	2.00		1.32	10.00	2.00		0.00	2.00	2.00		0.00	2.00	1.00	0.07	0.26	2.00	1.00		0.00	2.00	2.00		0.0	2.0	2.0		0.2	2.0	1.0		0.2	2.0	1.0
Membership in SHG	0.13	0.35	2.00	1.00	0.53	0.51	2.00	1.00		0.00	2.00	2.00	5.00	0.23	2.00	1.00		0.00	2.00	2.00		0.00	2.00	2.00	0.19	0.40	2.00	1.00	0.12	0.33	2.00	1.00	0.1	0.2	2.0	1.0		0.2	2.0	1.0		0.2	2.0	1.0
School Dropouts	0.71	0.43	2.00	1.00	0.77	0.43	2.00	1.00	0.26	0.63	4.00	1.00	86.67	0.59	2.00	1.00	0.51	0.51	2.00	1.00	0.46	0.50	2.00	1.00	0.93	0.26	2.00	1.00	0.54	0.53	3.00	1.00	0.9	0.7	5.0	1.0	0.7	0.4	2.0	1.0	0.6	0.5	2.0	1.0
Possession of Kisan Credit Card (KCC)		0.00	2.00	2.00	51.35	0.51	2.00	1.00	16.00	0.49	3.00	1.00	4.92	0.26	3.00	1.00		0.14	3.00	2.00		0.37	4.00	2.00	31.25	0.47	2.00	1.00	16.92	0.38	2.00	1.00		0.0	2.0	2.0	14.5	0.4	3.0	1.0	4.3	0.5	3.0	1.0
Female Headed Households	3.85	0.19				0.00			86.36	0.35			8.33	0.28			2.13	0.15			13.43	0.34			8.77	0.29			12.28	0.33			3.1	0.2			8.3	0.3			11.9	0.3		

Table 4: Income Occupation and Consumption Profile for the Sample

Indicators	Amarwada				Bichhua				Chaurai				Chhindwara				Harrai				Junnardeo (Jamai)				Mohkheda				Pandhurna				Parasia				Sausar				Tamai			
	Mean (INR)	Std. Dev.	Max (INR)	Min(INR)	Mean (INR)	Std. Dev.	Max (INR)	Min(INR)	Mean (INR)	Std. Dev.	Max (INR)	Min(INR)	Mean (INR)	Std. Dev.	Max (INR)	Min(INR)	Mean (INR)	Std. Dev.	Max (INR)	Min(INR)	Mean (INR)	Std. Dev.	Max (INR)	Min(INR)	Mean (INR)	Std. Dev.	Max (INR)	Min(INR)	Mean (INR)	Std. Dev.	Max (INR)	Min(INR)	Mean (INR)	Std. Dev.	Max (INR)	Min(INR)	Mean (INR)	Std. Dev.	Max (INR)	Min(INR)	Mean (INR)	Std. Dev.	Max (INR)	Min(INR)
Primary Income Now	71669.9	193200.8	1500000.0	1500.0	111794.9	131391.8	800000.0	15000.0	25684.9	9735.2	50000.0	3000.0	52230.6	31001.2	200000.0	3000.0	28786.2	13452.9	96000.0	10000.0	32712.6	16445.1	90000.0	1000.0	47362.3	76156.2	600000.0	8000.0	36525.64	28128.98	250000.00	6000.00	71818.2	96099.1	580000.0	20000.0	58314.8	74745.8	500000.0	10000.0	27577.8	11621.9	60000.0	2000.0
Primary Income 5 Years Back	35518.5	56168.5	400000.0	3000.0	61750.0	46042.8	200000.0	10000.0	17289.9	6523.9	35000.0	5000.0	34705.6	17951.1	80000.0	2000.0	17725.5	7074.1	30000.0	2000.0	24994.1	13143.1	80000.0	2000.0	21878.8	9926.7	50000.0	2000.0	24955.22	10744.18	50000.00	2000.00	35363.6	16019.2	90000.0	10000.0	34166.7	37727.3	300000.0	10000.0	25767.4	32747.1	50000.0	1000.0
Secondary Income Now	24751.0	12874.3	70000.0	1300.0	43500.0	45799.9	200000.0	10000.0	118842.1	436266.6	45000.0	8000.0	31295.7	51479.4	350000.0	3000.0	25931.0	19530.1	96000.0	10000.0	21285.7	17885.9	51000.0	2000.0	19857.1	10652.5	30000.0	4000.0	25472.9	15748.7	70000.0	1200.0	17833.3	5247.5	30000.0	6000.0	28000.0	12516.7	40000.0	10000.0	14000.0	6264.0	20000.0	2000.0
Secondary Income 5 Years Back	18138.9	8506.0	45000.0	7000.0	40578.9	34684.8	100000.0	5000.0	16558.8	7348.2	30000.0	8000.0	18205.9	21019.5	100000.0	1500.0	18818.2	21875.5	100000.0	1000.0	16000.0	19718.0	50000.0	2000.0	11600.0	5941.4	20000.0	5000.0	22685.7	11232.2	50000.0	5000.0	15791.7	14497.3	80000.0	3000.0	18600.0	8289.2	30000.0	8000.0	12904.8	18035.8	90000.0	5000.0
Total Income Now	83697.4	195074.6	1560000.0	3000.0	155294.9	32899.0	1000000.0	25000.0	55851.4	222227.9	90000.0	3000.0	59382.6	36299.5	200000.0	6000.0	41044.1	20053.0	105000.0	20000.0	34034.1	17800.6	92000.0	1000.0	49376.8	79483.5	630000.0	8000.0	51540.5	31268.9	250000.0	6000.0	89651.5	95541.8	590000.0	12000.0	62345.5	74386.2	500000.0	10000.0	34422.2	13619.0	65000.0	4000.0
Total Income 5 Years Back	42850.0	56154.1	415000.0	3000.0	102328.9	25175.7	300000.0	15000.0	21064.3	11371.8	65000.0	5000.0	44288.8	29992.7	170000.0	2000.0	24867.9	18075.7	120000.0	2000.0	25819.8	13802.6	80000.0	2000.0	22757.6	11245.6	60000.0	2000.0	36264.7	17996.4	80000.0	2000.0	51155.3	24386.0	120000.0	10000.0	36927.3	37953.1	300000.0	10000.0	32069.8	35826.6	120000.0	10000.0
Annual Consumption Expenditure Now	27318.6	17186.6	100000.0	2000.0	133600.0	180872.3	550000.0	4000.0	26234.4	29506.6	170000.0	400.0	55586.7	58902.5	450000.0	1200.0	71713.7	247213.4	1800000.0	6000.0	35517.7	23341.8	91000.0	400.0	48807.8	93967.5	650000.0	3700.0	73569.2	162096.6	1350000.0	3000.0	35973.0	14001.0	60000.0	5000.0	33636.4	16524.2	60000.0	1000.0	40457.4	50963.4	320000.0	3500.0

Annual Consumption Expenditure 5 Years Back	23991.7	14918.8	80000.0	3000.0	38111.1	17039.1	85000.0	2000.0	15322.5	14425.2	60000.0	300.0	31322.0	20650.2	75000.0	1000.0	30550.0	23139.8	160000.0	3500.0	30176.1	18998.6	77000.0	1600.0	28209.4	54723.1	450000.0	1200.0	60789.1	149407.4	1230000.0	3000.0	21480.0	14205.0	50000.0	1200.0	28600.0	27346.6	115000.0	3000.0	33180.9	47575.0	300000.0	2500.0
Medical Expenditure Now	2785.3	3173.8	22000.0	400.0	6097.2	3909.4	21500.0	1500.0	12655.3	19900.3	120000.0	240.0	15262.3	24302.2	92000.0	800.0	6249.8	11747.1	60500.0	200.0	4881.1	3895.1	21500.0	600.0	2220.3	1989.0	10000.0	800.0	5406.9	6352.2	44000.0	600.0	12321.6	18978.1	92000.0	2400.0	9470.9	8999.8	35000.0	2500.0	3212.8	1698.2	7000.0	200.0
Medical Expenditure 5 Years Back	2025.6	1866.7	10400.0	55.0	3811.1	1168.6	6000.0	1600.0	5647.3	5638.1	31500.0	400.0	11964.4	22708.3	85000.0	60.0	3547.7	5410.1	21000.0	200.0	4186.5	3516.2	16000.0	400.0	1571.1	1581.5	10500.0	300.0	3328.2	3677.2	23000.0	350.0	7669.5	15039.2	85000.0	270.0	7274.5	6104.0	27000.0	2200.0	2003.2	1646.9	10000.0	300.0
Total Loss in Wage Days Now	77.4	105.1	700.0	6.0	52.1	15.4	85.0	25.0	72.2	29.6	180.0	5.0	65.0	17.4	100.0	22.0	34.0	15.7	80.0	8.0	44.0	15.3	90.0	10.0	58.4	25.4	120.0	20.0	48.1	13.4	80.0	14.0	157.3	480.7	3000.0	50.0	85.0	23.1	120.0	45.0	63.3	22.5	160.0	35.0
Total Loss in Wage Days 5 Years Back	71.7	65.6	470.0	20.0	46.6	14.7	85.0	20.0	77.7	42.6	165.0	20.0	51.5	19.6	166.0	16.0	30.7	13.0	60.0	10.0	35.9	16.9	90.0	10.0	44.8	17.7	100.0	20.0	34.5	13.4	80.0	15.0	55.0	13.7	90.0	20.0	59.1	16.3	90.0	35.0	41.0	12.0	80.0	20.0

Table 5: Sources of Income for the Sample (Primary Income Source)

Activities	Amarwada		Bichhua		Chaurai		Chhindwara		Harrai		Junnardeo		Mohkheda		Pandhurna		Parasia		Sausar		Tamai	
	Primary Income Source (%)		Primary Income Source (%)		Primary Income Source (%)		Primary Income Source (%)		Primary Income Source (%)		Primary Income Source (%)		Primary Income Source (%)		Primary Income Source (%)		Primary Income Source (%)		Primary Income Source (%)		Primary Income Source (%)	
	LY	5YB	LY	5YB	LY	5YB	LY	5YB	LY	5YB	LY	5YB	LY	5YB	LY	5YB	LY	5YB	LY	5YB	LY	5YB
Agriculture and Allied sectors	52.0	43.6	17.0	19.4	46.4	52.6	22.7	21.9	17.8	24.5	25.6	24.9	40.6	37.8	27.3	28.9	31.2	33.6	32.1	30.7	16.3	34.2
Salaried	9.7	17.7	26.7	13.2	31.8	35.2	14.3	14.2	16.7	18.9	22.7	20.9	31.0	31.2	27.8	30.7	46.9	39.3	39.5	35.2	21.5	31.2
Business	17.8	25.0		0.0		0.0	9.2	10.7	24.5	25.1	23.4	27.8	28.3	31.0	23.1	17.3		0.0	28.4	34.1	18.4	34.5
Sale of Assets	20.5	13.6	56.3	67.4		0.0	26.7	25.6	41.1	31.4	28.3	26.3		0.0	21.8	23.1	21.9	27.1		0.0	43.8	0.0
Income from Govt. Schemes		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0
Rents		0.0		0.0	21.8	12.2	27.0	27.7		0.0		0.0		0.0		0.0		0.0		0.0		0.0
Others		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0
Total	100	100	100.0	100.0	100.0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Table 5a: Sources of Income for the sample (Secondary Income Source)

Activities	Amarwada		Bichhua		Chaurai		Chhindwara		Harrai		Junnardeo (Jamai)		Mohkheda		Pandhurna		Parasia		Sausar		Tamai	
	Secondary Income Source (%)		Secondary Income Source (%)		Secondary Income Source (%)		Secondary Income Source (%)		Secondary Income Source (%)		Secondary Income Source (%)		Secondary Income Source (%)		Secondary Income Source (%)		Secondary Income Source (%)		Primary Income Source (%)		Secondary Income Source (%)	
	LY	5YB	LY	5YB	LY	5YB	LY	5YB	LY	5YB	LY	5YB	LY	5YB	LY	5YB	LY	5YB	LY	5YB	LY	5YB
Agriculture and Allied	34.8	59.6	36.9	43.8	6.8	49.7	23.0	24.4	27.0	69.7	7.5	9.6	37.7	32.2	59.8	46.6	37.0	30.1	20.0	18.7	32.6	49.5
Salaried	25.5	40.4	63.1	56.2	93.2	50.3	26.9	29.1	34.5	30.3	92.5	90.4	62.3	67.8	36.5	38.6	31.9	25.7	46.2	44.3	25.4	23.5
Business	39.7	0.0		0.0		0.0	18.0	31.9		0.0		0.0		0.0	3.7	14.8	31.1	44.1	33.8	36.9	42.0	27.0
Sale of Assets	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Income from Govt. Schemes	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rents		0.0		0.0		0.0	32.0	14.6	38.5	0.0		0.0		0.0		0.0		0.0		0.0		0.0
Others	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Table 6: Migration Profile of the Sample

Indicators	Amarwada				Bichhua				Chaurai				Chhindwara				Harrai				Junnardeo (Jamai)				Mohkheda				Pandhurna				Parasia				Sausar				Tamai			
	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max
Migration Last Year	15.00	0.36	1.00	2.00	2.70	0.16	1.00	2.00	2.67	0.16	1.00	2.00	8.33	0.28	1.00	2.00	17.31	0.38	1.00	2.00	9.33	0.29	1.00	2.00	1.56	0.13	1.00	2.00	13.85	0.35	1.00	2.00	2.70	0.17	1.00	2.00		0.00	2.00	2.00	6.38	0.26	1.00	2.00
Number of Migrants Last Year	11.67	0.35	1.00	2.00		0.00	2.00	2.00	1.33	0.00	1.00	1.00	6.67	0.00	1.00	1.00	11.54	0.46	1.00	2.00	6.67	1.25	1.00	4.00		0.00	0.00	0.00	6.15	0.45	1.00	2.00		0.00	3.00	3.00		0.00	2.00	0.00	4.26	1.15	1.00	3.00
Migration Last 5 Years Back	3.33	0.18	1.00	2.00	2.70	0.16	1.00	2.00	1.33	0.12	1.00	2.00	3.33	0.18	1.00	2.00	9.62	0.30	1.00	2.00	6.67	0.25	1.00	2.00		0.00	2.00	2.00	1.54	0.12	1.00	2.00	2.70	0.17	1.00	2.00		0.00	2.00	2.00	2.13	0.15	1.00	2.00
Number of Migrants 5 Years Back	3.33	0.00	1.00	1.00		0.00	2.00	2.00		0.00	0.00	0.00	6.67	0.00	1.00	1.00	7.69	0.52	1.00	2.00	6.67	0.82	1.00	3.00		0.00	0.00	0.00	3.08	0.58	1.00	2.00		0.00	3.00	3.00		0.00	2.00	0.00	6.00	0.00	6.00	6.00
Remittance from Migration Last Year	30000.00	15000.00	15000.00	45000.00		0.00	0.00	0.00		0.00	0.00	0.00					82000.00	27784.89	50000.00	100000.00	30166.67	27895.64	1000.00	80000.00		0.00	0.00	0.00	37000.00	24392.62	5000.00	60000.00		0.00	0.00	0.00		0.00	0.00	0.00	45000.00	21213.20	30000.00	60000.00
Remittance from Migration 5 Years Back		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00	80000.00	0.00	80000.00	80000.00	40000.00	37749.17	5000.00	80000.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00
Migration due to Climatic Aberrations / Extremes Last Year	1.44	0.53	1.00	2.00	2.00	0.00	2.00	2.00	1.00	0.00	1.00	1.00	2.00	0.00	2.00	2.00	1.75	0.46	1.00	2.00	1.43	0.53	1.00	2.00		0.00	0.00	0.00	2.00	0.00	2.00	2.00		0.00	0.00	0.00		0.00	0.00	0.00	2.00	0.00	2.00	2.00

Migration due to Climatic Aberrations / Extremes 5 Years Back	1.00	0.00	1.00	1.00	2.00	0.00	2.00	2.00	2.00	0.00	2.00	2.00	2.00	0.00	2.00	2.00	1.50	0.71	1.00	2.00	1.50	0.55	1.00	2.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00
Months of Migration Last Year	210.13	98.21	80.00	355.00	350.00	0.00	350.00	350.00	300.00	0.00	300.00	300.00		0.00	0.00	0.00	233.33	28.87	200.00	250.00		0.00	0.00	0.00		0.00	0.00	0.00	280.00	25.17	250.00	300.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00
Months of Migration 5 Years Back	215.00	120.21	130.00	300.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00
Notice Reduction in Migration for Village	1.89	0.33	1.00	2.00		0.00	0.00	0.00	2.00	0.00	2.00	2.00	2.00	0.00	2.00	2.00	2.00	0.00	2.00	2.00	0.87	1.06	0.02	2.00		0.00	0.00	0.00	2.00	0.00	2.00	2.00		0.00	0.00	0.00		0.00	0.00	0.00	2.00	0.00	0.02	0.02

Table 7: Places and Reasons of Migration

Place of Migration	Amarwada		Bichhua		Chaurai		Chhindwara		Harrai		Junnardeo (Jamai)		Mohkheda		Pandhurna		Parasia		Sausar		Tamai	
	Last Year (%)	5 Years Back (%)	Last Year (%)	5 Years Back (%)	Last Year (%)	5 Years Back (%)	Last Year (%)	5 Years Back (%)	Last Year (%)	5 Years Back (%)	Last Year (%)	5 Years Back (%)	Last Year (%)	5 Years Back (%)	Last Year (%)	5 Years Back (%)	Last Year (%)	5 Years Back (%)	Last Year (%)	5 Years Back (%)	Last Year (%)	5 Years Back (%)
Within District	15.0	1.7	2.2	2.2	1.333	0.000		3.279		0.000	4.000	2.667		0.000		0.000	2.70	0.00		0.0		0.0
Outside District		0.0		0.000	5.3	4.0	8.3	1.7	5.8	5.8	5.3	4.0		0.0	7.692	0.000		0.00		0.0	6.4	2.1
Outside State		0.0		0.0		0.0		0.0	11.5	1.9		0.0		0.0	7.692	1.538		0.00		0.0		0.0
Type of Work	**Last Year (%)**	**5 Years Back (%)**	**Last Year (%)**	**5 Years Back (%)**	**Last Year (%)**	**5 Years Back (%)**	**Last Year (%)**	**5 Years Back (%)**	**Last Year (%)**	**5 Years Back (%)**	**Last Year (%)**	**5 Years Back (%)**	**Last Year (%)**	**5 Years Back (%)**	**Last Year (%)**	**5 Years Back (%)**	**Last Year (%)**	**5 Years Back (%)**	**Last Year (%)**	**5 Years Back (%)**	**Last Year (%)**	**5 Years Back (%)**
Unskilled	6.7	1.7		0.0	1.3	1.3		0.0	1.9	1.9	5.3	4.0		0.0	3.077	1.538	2.70	2.70		0.0		0.0
Semiskilled	1.7	0.0		0.00	1.3	0.0		0.0	5.8	3.8	1.3	0.0		0.0	7.692	0.000		0.00		0.0	4.3	0.0
Skilled	6.7	0.0	2.22	2.22		0.0	3.3	0.0	9.6	0.0	2.7	2.7		0.0	3.077	1.538		0.00		0.0		0.0
Reason for Migration	**Last Year (%)**	**5 Years Back (%)**	**Last Year (%)**	**5 Years Back (%)**	**Last Year (%)**	**5 Years Back (%)**	**Last Year (%)**	**5 Years Back (%)**	**Last Year (%)**	**5 Years Back (%)**	**Last Year (%)**	**5 Years Back (%)**	**Last Year (%)**	**5 Years Back (%)**	**Last Year (%)**	**5 Years Back (%)**	**Last Year (%)**	**5 Years Back (%)**	**Last Year (%)**	**5 Years Back (%)**	**Last Year (%)**	**5 Years Back (%)**
Employment in Lean Season	15.0	1.7	2.2	2.2	1.3	0.0	1.6	1.6	3.8	1.9	8.0	5.3		0.0	6.154	0.000	2.70	2.70		0.0	6.4	2.1

Medical Requirement		0.0		0.0		0.0		0.0		0.0		0.0		0.0	3.1	0.0		0.00		0.0		0.0
Loan Repayment		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.00		0.0		0.0
Others		0.0		0.0	1.3	0.0		0.0	5.8	3.8		0.0		0.0		0.0		0.00		0.0		0.0
Economic Impact	Last Year (%)	5 Years Back (%)	Last Year (%)	5 Years Back (%)	Last Year (%)	5 Years Back (%)	Last Year (%)	5 Years Back (%)	Last Year (%)	5 Years Back (%)	Last Year (%)	5 Years Back (%)	Last Year (%)	5 Years Back (%)	Last Year (%)	5 Years Back (%)	Last Year (%)	5 Years Back (%)	Last Year (%)	5 Years Back (%)	Last Year (%)	5 Years Back (%)
No Impact	3.3	1.7	2.2	2.2	1.3	0.0	6.6	6.6	17.3	5.8	5.3	4.0		0.0	######	0.000	2.70	0.00		0.000	2.128	0.000
Positive	1.7	1.7		0.0		0.0		0.0		0.0	1.3	1.3		0.0		0.000		0.00		0.000		0.000
Negative	8.3	8.3		0.0		1.3		0.0		9.6	2.7	1.3		0.0		4.615		0.00		0.000	2.128	4.255
Social Impact	Last Year (%)	5 Years Back (%)	Last Year (%)	5 Years Back (%)	Last Year (%)	5 Years Back (%)	Last Year (%)	5 Years Back (%)	Last Year (%)	5 Years Back (%)	Last Year (%)	5 Years Back (%)	Last Year (%)	5 Years Back (%)	Last Year (%)	5 Years Back (%)	Last Year (%)	5 Years Back (%)	Last Year (%)	5 Years Back (%)	Last Year (%)	5 Years Back (%)
No Impact	1.7	1.7	2.2	2.2		0.0	6.6	6.6	3.8	1.9	4.0	4.0		0.0		0.000		0.00		0.0		0.0
Positive		0.0		0.0		0.00		0.00		0.00		0.00		0.00		0.0		0.00		0.0		0.0
Negative	1.7	1.7		0.0	1.3	1.3		0.0	11.5	13.5	2.7	1.3		0.0	7.7	3.1		0.00		0.0	4.3	4.3

Table 8: Ownership of Assets in the Sample

Items	Amarwada				Bichhua				Chaurai				Chhindwara			
	Mean (INR)	Std. Dev.	Min (INR)	Max (INR)	Mean (INR)	Std. Dev.	Min (INR)	Max (INR)	Mean (INR)	Std. Dev.	Min (INR)	Max (INR)	Mean (INR)	Std. Dev.	Min (INR)	Max (INR)
Agricultural Land	1311951.2	1545579.5	60000.0	6000000.0	1695277.8	1725490.4	80000.0	7000000.0	786222.2	771531.2	10000.0	3600000.0	479800.0	684840.2	10000.0	5000000.0
Homestead Land	165022.7	171503.0	1000.0	1000000.0	270882.4	847103.3	10000.0	5000000.0	133931.5	218513.9	5000.0	1400000.0	70275.9	57274.6	1000.0	300000.0
Land building and Water Bodies	40600.0	45110.7	10500.0	120000.0	75652.0	64470.0	26833.3	243333.3	15794.9	8835.5	10666.7	43333.3	17739.0	14117.6	1750.0	45000.0
Agricultural Machinery and Tools	117385.7	34172.9	81555.6	147966.7	79764.3	32976.3	54525.0	159375.0	72470.2	26529.7	48636.4	120363.6	76942.6	27771.5	45825.0	117000.0
Means of Transport	107352.3	5929.4	101000.0	121250.0	21408.3	3353.0	14166.7	24666.7	23980.8	4628.1	16625.0	32750.0	11459.3	8455.5	1833.3	36666.7
Electrical Equipments	2127.0	2083.7	564.5	7691.3	2803.1	1040.8	2066.7	5000.0	4001.2	978.0	3103.6	7478.6	1537.2	693.8	878.6	3107.1
Furniture	2607.4	1477.8	1630.0	8296.2	1687.2	588.4	1042.0	2690.0	2468.4	1522.9	985.5	6572.7	2180.0	634.9	1450.0	4177.8
Inventory		0.0	0.0	0.0	200.0	0.0	200.0	200.0		0.0	0.0	0.0		0.0	0.0	0.0
Total Assets	1747046.3	1805857.1	256250.1	7405204.1	2147675.1	2675022.2	188833.7	12435265.0	1038869.1	1032539.3	95017.1	5210498.3	659934.0	793788.1	62736.9	5505951.6

Items	Harrai				Junnardeo (Jamai)				Mohkheda				Pandhurna			
	Mean (INR)	Std. Dev.	Min (INR)	Max (INR)	Mean (INR)	Std. Dev.	Min (INR)	Max (INR)	Mean (INR)	Std. Dev.	Min (INR)	Max (INR)	Mean (INR)	Std. Dev.	Min (INR)	Max (INR)
Agricultural Land	929347.8	1549644.3	50000.0	10000000.0	372222.2	312589.9	50000.0	1200000.0	451000.0	965818.4	50000.0	7000000.0	1074218.8	1022911.8	100000.0	5000000.0
Homestead Land	89134.6	65235.0	10000.0	300000.0	40466.7	12551.9	10000.0	80000.0	96875.0	124831.6	5000.0	600000.0	86206.9	74453.0	10000.0	500000.0
Land building and Water Bodies	10441.7	4439.0	300.0	20000.0	10513.9	4552.3	5166.7	15000.0	15691.8	27470.7	750.0	150500.0	67260.9	8892.6	58500.0	76500.0
Agricultural Machinery and Tools	39447.6	15327.7	21140.0	82240.0	149851.2	12952.5	137583.3	168666.7	60429.4	27375.1	38950.0	104000.0	70500.4	21362.5	46555.6	113333.3
Means of Transport	17676.9	10917.7	8866.7	39833.3	18213.0	21197.7	1250.0	90000.0	68747.2	8621.6	59400.0	90000.0	12136.4	4736.7	2166.7	26500.0
Electrical Equipments	2233.4	669.8	1717.0	3950.0	2975.4	1756.3	1853.8	9946.2	2291.5	1069.3	1590.8	8138.5	2306.2	1252.1	1091.7	6275.0
Furniture	1558.3	777.5	891.1	4622.2	3546.4	3292.3	1875.0	20941.7	2893.0	1486.6	1045.0	7910.0	1968.2	1617.8	745.8	8250.0
Inventory		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0
Total Assets	1089840.3	1647010.9	92914.8	10450645.6	597788.7	368892.9	207728.8	1584554.5	697927.9	1156673.4	156735.8	7960548.5	1314597.6	1135226.6	219059.7	5730858.3

Items	Parasia				Sausar				Tamai			
	Mean (INR)	Std. Dev.	Min (INR)	Max (INR)	Mean (INR)	Std. Dev.	Min (INR)	Max (INR)	Mean (INR)	Std. Dev.	Min (INR)	Max (INR)
Agricultural Land	392285.7	393880.3	30000.0	2200000.0	422857.1	591599.3	40000.0	3000000.0	442307.7	281670.8	100000.0	1200000.0
Homestead Land	126216.2	221539.5	10000.0	1000000.0	79407.4	100568.5	4000.0	500000.0	112127.7	101326.8	30000.0	500000.0
Land building and Water Bodies	79361.1	137447.9	17000.0	360000.0	18750.0	10307.8	10000.0	30000.0	14592.9	12238.6	1400.0	30000.0
Agricultural Machinery and Tools	165726.6	30365.4	115166.7	195333.3	28177.8	29494.5	13900.0	96900.0	32638.5	16711.7	20250.0	51000.0
Means of Transport	15506.9	10986.0	3000.0	40000.0	11782.3	6308.9	1400.0	19666.7	11149.2	2545.4	6800.0	17500.0
Electrical Equipments	2312.1	1347.8	1504.5	6836.4	1374.2	503.8	847.5	3129.2	1745.3	432.7	1375.0	2730.0
Furniture	3757.0	1410.8	2446.7	8222.2	3869.6	5007.2	1290.0	15800.0	1647.7	636.1	694.4	3144.4
Inventory		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0
Total Assets	785165.6	796977.6	179117.9	3810391.9	566218.4	743789.9	71437.5	3665495.8	616208.8	415562.2	160519.4	1804374.4

Note: INR in Current Prices

Table 9: Land, Crop and Livestock Details for the Sample

Indicators	Amarwada				Bichhua				Chaurai				Chhindwara				Harrai				Junnardeo (Jamai)				Mohkheda				Pandhurna				Parasia				Sausar				Tamai			
	Mean	Std. Dev.	Max	Min	Mean	Std. Dev.	Max	Min	Mean	Std. Dev.	Max	Min	Mean	Std. Dev.	Max	Min	Mean	Std. Dev.	Max	Min	Mean	Std. Dev.	Max	Min	Mean	Std. Dev.	Max	Min	Mean	Std. Dev.	Max	Min	Mean	Std. Dev.	Max	Min	Mean	Std. Dev.	Max	Min	Mean	Std. Dev.	Max	Min
Total Land for Farming Now	5.2	4.6	25.0	1.0	7.2	6.3	30.0	1.0	5.8	3.2	13.0	0.5	4.0	2.1	11.0	1.0	4.8	3.3	15.0	1.0	3.8	2.1	9.0	1.0	4.6	2.5	10.0	1.0	4.6	3.8	18.0	1.0	3.7	2.6	15.0	1.0	4.9	2.9	11.0	1.0	4.2	2.8	10.0	1.0
Total Land for Farming 5 Years Back	5.9	5.3	25.0	1.0	7.1	6.3	30.0	1.0	5.8	3.2	13.0	0.5	3.6	2.1	11.0	1.0	4.8	3.3	15.0	1.0	4.1	2.3	9.0	1.0	4.6	2.6	10.0	1.0	4.4	4.0	18.0	1.0	3.7	2.6	15.0	1.0	4.9	2.9	11.0	1.0	4.2	2.5	10.0	1.0
Irrigated Land Now	4.6	4.7	20.0	2.0	5.6	4.9	28.0	1.0	5.7	3.2	13.0	0.5	3.4	1.9	11.0	1.0	3.5	2.7	12.0	1.0	3.0	2.4	9.0	1.0	4.9	2.6	10.0	2.0	3.1	2.3	12.0	1.0	3.6	2.6	15.0	1.0	4.9	2.9	11.0	1.0	2.9	2.8	10.0	1.0
Irrigated Land 5 Years Back	4.6	4.7	20.0	2.0	5.7	5.0	28.0	1.0	5.4	3.3	13.0	1.0	3.2	2.0	11.0	1.0	3.6	2.7	12.0	1.0	3.2	2.4	9.0	1.0	4.9	2.6	10.0	2.0	3.3	2.5	12.0	1.0	3.6	2.6	15.0	1.0	4.9	2.9	11.0	1.0	2.9	2.8	10.0	1.0
No. of Crops Cultivated Now	2.5	1.3	9.0	2.0	3.53	1.38	6.00	1.00	4.0	1.2	6.0	1.0	4.7	1.9	9.0	2.0	3.9	1.6	6.0	1.0	2.3	0.7	4.0	2.0	1.9	0.5	4.0	1.0	2.1	0.6	5.0	1.0	5.7	1.0	8.0	3.0	1.2	0.8	5.0	1.0	3.6	0.9	4.0	1.0
No. of Crops Cultivated 5 Years Back	2.3	0.8	6.0	2.0	3.39	1.30	6.00	1.00	4.0	1.4	6.0	1.0	3.3	1.0	5.0	1.0	4.0	1.5	6.0	1.0	2.1	0.9	4.0	1.0	1.9	0.5	4.0	1.0	2.1	0.5	5.0	1.0	4.4	0.9	7.0	3.0	1.2	0.8	5.0	1.0	3.6	0.9	4.0	1.0
Input Cost for Crops Now	33909.8	11844.1	85500.0	8400.0	129192.3	29081.3	231000.0	42000.0	97828.5	40000.4	388000.0	9200.0	64282.0	27066.1	196500.0	3800.0	41961.1	11869.5	94500.0	9200.0	39573.7	13643.1	111800.0	11300.0	64516.0	28328.1	306200.0	10300.0	36940.2	15759.0	160000.0	5300.0	29588.6	17107.2	147600.0	2000.0	27422.1	9340.1	96000.0	6800.0	35481.0	9104.8	79000.0	11400.0
Input Cost for Crops 5 Years Back	20569.5	5968.6	55300.0	4100.0	75351.3	17121.6	138000.0	30000.0	61051.8	20779.6	234000.0	10800.0	42563.0	20372.9	203800.0	5200.0	32225.9	10300.1	76000.0	6700.0	28315.8	12659.7	97500.0	4900.0	53596.0	21797.2	225100.0	15950.0	25328.5	10497.7	103000.0	4100.0	17308.8	7785.7	72800.0	1000.0	20060.3	7641.4	83000.0	5900.0	23600.3	6375.9	57100.0	7500.0

No. of Small Ruminants 5 Years Back	No. of Small Ruminants Now	No. of Big Ruminants 5 Years Back	No. of Big Ruminants Now	Total Production Value 5 Years Back	Total Production Value Now
7.3	7.1	4.6	4.6	58480.0	69624.4
6.9	6.8	3.9	2.8	40682.6	67413.7
18.0	31.0	19.0	11.0	184500.0	220000.0
2.0	1.0	1.0	1.0	4500.0	6000.0
5.4	4.9	4.4	5.8	230272.7	216000.0
3.7	4.5	3.4	5.5	308566.7	146928.6
11.0	15.0	14.0	27.0	1100000.0	600000.0
1.0	1.0	1.0	1.0	22000.0	30000.0
4.1	3.9	4.4	4.0	107243.9	129113.3
1.9	1.7	3.9	2.5	85119.3	83104.6
7.0	6.0	26.0	15.0	357000.0	306000.0
1.0	1.0	1.0	1.0	5000.0	8000.0
3.1	2.9	3.0	3.3	49375.0	74733.3
1.5	1.4	1.4	1.4	34666.3	42975.9
6.0	6.0	6.0	6.0	201000.0	190000.0
1.0	1.0	1.0	1.0	5500.0	9000.0
4.5	2.5	3.0	3.3	43569.0	45876.4
3.1	1.2	1.4	1.4	33079.8	24042.1
10.0	5.0	7.0	7.0	160000.0	100000.0
1.0	1.0	2.0	2.0	2000.0	5000.0
3.4	2.7	3.9	3.7	45363.6	45363.6
4.2	2.7	3.2	2.6	40682.4	17839.7
20.0	15.0	18.0	14.0	160000.0	80000.0
1.0	1.0	1.0	1.0	8000.0	18000.0
5.0	4.3	3.2	3.6	30820.0	46340.0
0.0	4.3	1.7	2.7	22137.5	23250.7
5.0	10.0	7.0	16.0	140000.0	110000.0
5.0	1.0	1.0	1.0	6000.0	10000.0
	5.3	3.1	5.7	66593.2	85967.7
0.0	7.5	1.2	3.8	52907.2	116901.9
0.0	30.0	6.0	20.0	240000.0	898000.0
0.0	1.0	1.0	1.0	10000.0	10000.0
3.6	3.5	3.9	4.1	42958.8	70773.5
2.7	2.4	2.0	2.4	31169.5	31023.9
10.0	10.0	10.0	12.0	201000.0	170000.0
1.0	1.0	1.0	1.0	19500.0	40000.0
	2.0	3.3	3.3	77748.7	91071.4
0.0	0.0	1.4	1.4	107704.8	47752.4
0.0	2.0	8.0	8.0	600000.0	250000.0
0.0	2.0	2.0	2.0	2964.1	30000.0
4.5	3.7	4.1	4.1	51070.4	50668.5
1.8	2.4	2.4	2.1	43325.5	34592.4
7.0	10.0	11.0	11.0	200000.0	130000.0
2.0	1.0	1.0	1.0	7900.0	9500.0

Table 10: Benefits from Govt. Interventions

Govt. Interventions	Amarwada		Bichhua		Chaurai		Chhindwara		Harrai		Junnardeo (Jamai)		Mohkheda		Pandhurna		Parasia		Sausar		Tamai	
	Yes (%)	No (%)	Yes (%)	No (%)	Yes (%)	No (%)	Yes (%)	No (%)	Yes (%)	No (%)	Yes (%)	No (%)	Yes (%)	No (%)	Yes (%)	No (%)	Yes (%)	No (%)	Yes (%)	No (%)	Yes (%)	No (%)
Participation in MGNREGA	70.00	28.33	22.22	60.00	10.67	71.43	45.90	54.10	67.31	30.77	68.00	32.00	7.81	92.19	7.69	92.31	18.92	75.68	14.55	85.45	63.83	36.17
Participation in SRLM	1.67	96.67		71.11		97.40		100.00		100.00		100.00		100.00		98.46		100.00		100.00		100.00
Participation in IAY / RAY / BAY	5.00	95.00	15.56	66.67	10.67	87.01	3.28	96.72		100.00	5.33	94.67	1.56	98.44		100.00	2.70	97.30		100.00	4.26	95.74
Participation in AAY	50.00	48.33	44.44	37.78	12.00	81.82	24.59	75.41	7.69	92.31	50.67	49.33	98.44	1.56	43.08	56.92	27.03	72.97	32.73	61.82	27.66	72.34
LPG Subsidy	3.33	80.00		73.33	13.33	67.53		100.00		100.00	2.67	96.00	42.19	57.81	43.08	53.85		100.00	50.91	40.00		100.00

Table 11: Funds Statement for Govt. Interventions for the Sample

Activities	Amarwada				Bichhua				Chaurai				Chhindwara				Harrai				Junnardeo (Jamai)				Mohkheda				Pandhurna				Parasar				Sausar				Tamai			
	Mean	Std. Dev.	Max	Min	Mean	Std. Dev.	Max	Min	Mean	Std. Dev.	Max	Min	Mean	Std. Dev.	Max	Min	Mean	Std. Dev.	Max	Min	Mean	Std. Dev.	Max	Min	Mean	Std. Dev.	Max	Min	Mean	Std. Dev.	Max	Min	Mean	Std. Dev.	Max	Min	Mean	Std. Dev.	Max	Min	Mean	Std. Dev.	Max	Min
No. of Members participated in MGNREGA	2.0	0.8	4.0	1.0	1.4	0.5	2.0	1.0	1.5	0.7	3.0	1.0	2.1	0.9	4.0	1.0	2.0	0.8	5.0	1.0	1.3	0.5	3.0	1.0	1.6	0.5	2.0	1.0	1.2	0.4	2.0	1.0	1.6	0.5	2.0	1.0	2.5	1.0	4.0	2.0	1.5	0.7	4.0	1.0
No. of Man-days contributed in MGNREGA	75.5	31.1	100.0	2.0	15.9	4.9	25.0	10.0	33.1	40.5	158.0	2.0	132.4	188.7	1000.0	30.0	71.8	26.1	100.0	30.0	31.5	23.5	100.0	10.0	62.0	39.0	90.0	10.0	66.0	21.9	100.0	40.0	43.8	35.1	100.0	15.0	85.0	76.8	200.0	40.0	38.3	22.9	100.0	12.0
Income from MGNREGA	13595.8	8358.4	52000.0	2000.0	2983.6	1840.4	6310.0	2.3	4841.6	5101.6	18000.0	2.0	15939.1	9880.8	39600.0	2000.0	7890.2	3710.6	20000.0	100.0	4574.0	4235.3	25000.0	1500.0	4560.0	2448.1	8000.0	1300.0	8020.0	1837.7	10000.0	5500.0	10625.0	2326.1	15000.0	8000.0	20000.0	13063.9	36000.0	4000.0	4938.4	2672.2	12500.0	1130.0
Whether received any funds from SRLM	2.0	0.0	2.0	2.0	2.0	0.0	2.0	2.0	2.0	0.1	2.0	1.0	2.0	0.0	2.0	2.0	2.0	0.0	2.0	2.0	2.0	0.0	2.0	2.0	2.0	0.0	2.0	2.0	2.0	0.0	2.0	2.0	2.0	0.0	2.0	2.0	2.0	0.0	2.0	2.0	2.0	0.0	2.0	2.0
Funds received from IAY / RAY / BAY / Mo Kudia	70000.0	0.0	70000.0	70000.0	70000.0	0.0	70000.0	70000.0	15346.9	17159.5	45000.0	2.0		0.0	0.0	0.0		0.0	0.0	0.0	49166.7	26699.8	100000.0	15000.0		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0
Man-days contributed to IAY / RAY / BAY	22.0	25.5	40.0	4.0	2.0	0.0	2.0	2.0	31.1	34.5	90.0	2.0	2.0	0.0	2.0	2.0	2.0	0.0	2.0	2.0	24.4	14.4	40.0	2.0		0.0	0.0	0.0	2.0	0.0	2.0	2.0		0.0	0.0	0.0	30.7	25.3	50.0	2.0	90.0	0.0	90.0	90.0
Funds contributed IAY / RAY / BAY / Mo Kudia	70000.0	0.0	70000.0	70000.0		0.0	0.0	0.0	5835.0	14287.9	35000.0	2.0		0.0	2.0	2.0		0.0	2.0	2.0	110000.0	131053.4	300000.0	5000.0		0.0	0.0	0.0		0.0	2.0	2.0		0.0	0.0	0.0		0.0	0.0	0.0		0.0	45000.0	45000.0
Funds received from LP Subsidy	450.0	70.7	500.0	400.0		0.0	0.0	0.0	707.1	510.3	1400.0	150.0		0.0	0.0	0.0		0.0	0.0	0.0	700.0	0.0	700.0	700.0	684.6	115.6	800.0	400.0	600.0	0.0	600.0	600.0		0.0	0.0	0.0	558.6	159.3	900.0	400.0		0.0	0.0	0.0

Table 12: Percentage of HHs benefited by Coping Mechanism

Means of Coping	Amarwada				Bichhua				Chaurai				Chhindwara				Harrai				Junnardeo (Jamai)				Mohkheda				Pandhurna				Parasia				Sausar				Tamai			
	Present		5 Years Back		Present		5 Years Back		Present		5 Years Back		Present		5 Years Back		Present		5 Years Back		Present		5 Years Back		Present		5 Years Back		Present		5 Years Back		Present		5 Years Back		Present		5 Years Back		Present		5 Years Back	
	%	S.D.	%	S.D.	%	S.D.	%	S.D.	%	S.D.	%	S.D.	%	S.D.	%	S.D.	%	S.D.	%	S.D.	%	S.D.	%	S.D.	%	S.D.	%	S.D.	%	S.D.	%	S.D.	%	S.D.	%	S.D.	%	S.D.	%	S.D.	%	S.D.	%	S.D.
Selling of Livestock		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00	8.20	0.28	0.00	0.00		0.00	0.00	0.00	4.00	0.20	0.00	0.00	1.56	0.13	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00
Sold Household Assets		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00	6.56	0.25	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00	24.32	0.43	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00
Use of Loans and Credit	1.67	0.13	0.00	0.00	4.44	0.21	0.00	0.00	1.33	0.12	0.00	0.00	31.15	0.47	0.00	0.00		0.00	0.00	0.00	5.33	0.23	0.00	0.00	17.19	0.38	0.00	0.00	7.69	0.27	0.00	0.00	13.51	0.35	0.00	0.00	1.82	0.13	0.00	0.00		0.00	0.00	0.00
Selling of Land		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00	14.75	0.36	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00	1.54	0.25	0.00	0.00	8.11	0.28	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00
Govt. Relief		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00	45.90	0.50	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00	59.38	0.50	0.00	0.00	93.85	0.13	0.00	0.00	78.38	0.42	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00
Transfers from Friend and Relatives	5.00	0.22	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00	52.46	0.54	0.00	0.00		0.00	0.00	0.00	8.00	0.27	0.00	0.00		0.00	0.00	0.00	1.54	0.00	0.00	0.00	43.24	0.50	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00
Use Past Savings	5.00	0.22	0.00	0.00	15.56	0.37	0.00	0.00		0.00	0.00	0.00	24.59	0.43	0.00	0.00		0.00	0.00	0.00	4.00	0.20	0.00	0.00	4.69	0.21	0.00	0.00	87.69	1.66	0.00	0.00	13.51	0.35	0.00	0.00	1.82	0.67	0.00	0.00	6.38	0.25	0.00	0.00
Migration		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.50	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00
Insurance		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00	1.56	0.13	0.00	0.00	10.77	2.19	0.00	0.00	56.76	0.50	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00

Table 12A: Adapted Coping Mechanism and their Average Funds Generated

Means of Coping	Amarwada				Bichhua				Chaurai				Chhindwara				Harrai				Junnardeo (Jamai)				Mohkheda				Pandhurna				Parasia				Sausar				Tamai			
	Present		5 Years Back		Present		5 Years Back		Present		5 Years Back		Present		5 Years Back		Present		5 Years Back		Present		5 Years Back		Present		5 Years Back		Present		5 Years Back		Present		5 Years Back		Present		5 Years Back		Present		5 Years Back	
	Mean (INR)	S.D.	Mean (INR)	S.D.	Mean (INR)	S.D.	Mean (INR)	S.D.	Mean (INR)	S.D.	Mean (INR)	S.D.	Mean (INR)	S.D.	Mean (INR)	S.D.	Mean (INR)	S.D.	Mean (INR)	S.D.	Mean (INR)	S.D.	Mean (INR)	S.D.	Mean (INR)	S.D.	Mean (INR)	S.D.	Mean (INR)	S.D.	Mean (INR)	S.D.	Mean (INR)	S.D.	Mean (INR)	S.D.	Mean (INR)	S.D.	Mean (INR)	S.D.	Mean (INR)	S.D.	Mean (INR)	S.D.
Selling of Livestock		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0	1000.0	0.0	0.0	0.0	5000.0	0.0	0.0	0.0	1500.0	707.1	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0	5000.0	0.0	0.0	0.0
Sold Household Assets		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0	2250.0	500.0	0.0	0.0	3166.7	1607.3	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0	3900.0	2282.8	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0
Use of Loans and Credit	6000.0	0.0	0.0	0.0	19381.0	17746.8	8250.0	9545.9	12000.0	0.0	0.0	0.0	20957.9	39450.1	0.0	0.0	19000.0	16727.2	0.0	0.0		0.0	0.0	0.0	13666.7	8896.7	0.0	0.0	18200.0	28960.3	0.0	0.0	7500.0	2886.8	0.0	0.0	13833.3	4262.2	0.0	0.0	12181.8	7639.6	0.0	0.0
Selling of Land		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0	5833.3	1834.8	0.0	0.0	1000.0	0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0	4500.0	707.1	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0
Govt. Relief		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0	5741.9	1124.5	0.0	0.0	4133.3	1501.1	0.0	0.0		0.0	0.0	0.0	4965.8	2575.7	0.0	0.0	8786.9	7483.0	0.0	0.0	8758.1	13519.7	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0
Transfers from Friend and Relatives	2666.7	288.7	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0	7941.2	8602.1	0.0	0.0	7666.7	2516.6	0.0	0.0	7666.7	6658.3	0.0	0.0		0.0	0.0	0.0	7500.0	3535.5	0.0	0.0	5812.5	4501.5	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0
Use Past Savings	3666.7	5484.8	0.0	0.0	14190.5	7698.2	26857.1	54318.3		0.0	0.0	0.0	8769.2	5214.6	0.0	0.0	6000.0	4626.0	0.0	0.0	5000.0	0.0	0.0	0.0	4333.3	1154.7	0.0	0.0	8407.4	5530.4	0.0	0.0	10000.0	7118.1	0.0	0.0		0.0	0.0	0.0	3187.5	2315.7	0.0	0.0
Migration		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0
Insurance		0.0	0.0	0.0	11166.7	7756.7	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0	6000.0	0.0	0.0	0.0	12285.7	5345.2	0.0	0.0	4095.2	2022.5	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0

Table 13: Perception of Households regarding Farm-based Interventions and Impacts

Description of Activities	Amarwada				Bichhua				Chaurai				Chhindwara				Harrai				Junnardeo (Jamai)				Mohkheda				Pandhurna				Parasia				Sausar				Tamai			
	Mean	S.D.	Mean (FYB)	S.D.	Mean	S.D.	Mean (FYB)	S.D.	Mean	S.D.	Mean (FYB)	S.D.	Mean	S.D.	Mean (FYB)	S.D.	Mean	S.D.	Mean (FYB)	S.D.	Mean	S.D.	Mean (FYB)	S.D.	Mean	S.D.	Mean (FYB)	S.D.	Mean	S.D.	Mean (FYB)	S.D.	Mean	S.D.	Mean (FYB)	S.D.	Mean	S.D.	Mean (FYB)	S.D.	Mean	S.D.	Mean (FYB)	S.D.
Ground Water Increase in the Field	63.33	0.48	46.67	0.68	13.33	0.37	0.00	0.00	5.33	0.23	1.33	0.13	4.92	0.22	31.15	0.48	19.23	0.40	0.00	0.00	1.33	0.12	0.00	0.00	3.13	0.18	3.13	0.18		0.00	0.00	0.00	5.41	0.23	0.00	0.00		0.00	1.82	0.13	2.13	0.15	2.13	0.15
Average groundwater increase in feet	10.00	0.93	6.67	1.04	4.44	1.41	4.44	1.41		2.41	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	1.56	0.38		0.00	0.00	0.00		0.00	0.00	0.00		2.12	1.82	0.71		0.00	0.00	0.00
Constructed Field / Contour Bunding or Check Dams in the field	3.33	5.13	6.67	3.76	2.22	0.16	2.22	0.16	2.67	0.17	2.67	0.17		0.00	8.20	0.28	1.92	0.14	0.00	0.00	1.33	0.12	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00	21.62	0.42	8.11	0.30	1.82	0.13	4.26	0.20	4.26	0.20	4.26	0.20
Increase in water holding capacity of land	51.67	0.50	45.00	0.68	8.89	0.31	2.22	0.16	12.00	0.34	9.33	0.31		0.00	8.20	0.28	21.15	0.42	9.62	0.31	2.67	0.17	2.67	0.17	7.81	0.27	4.69	0.21		0.00	0.00	0.00	24.32	0.43	13.51	0.37	5.45	0.23	1.82	0.14	2.13	0.15	2.13	0.15
Use drought tolerant Last Year varieties for different crop products	46.67	0.50	15.00	0.38	68.89	0.35	11.11	0.35	18.67	0.41	17.33	0.40	32.79	0.47	22.95	0.43	13.46	0.34	0.00	0.00	1.33	0.12	1.33	0.12	59.38	0.50	15.63	0.37	47.69	0.50	13.85	0.36	32.43	0.48	16.22	0.40	7.27	0.26	3.64	0.19		0.00	0.00	0.00
Introduced farming diversification by rearing small ruminants	20	0.411306	18.33333	0.398147	31.11111	0.49	17.78	0.42	4.00	0.21	4.00	0.21	19.67	0.40	16.39	0.38	9.62	0.30	11.54	0.33	5.33	0.23	5.33	0.23	10.94	0.31	6.25	0.24	15.38	0.36	10.77	0.31	29.73	0.47	16.22	0.40		0.00	1.82	0.13	4.26	0.20	4.26	0.20
Increased the number of cropping seasons	30.00	1.08	28.33	0.83	15.56	1.76	11.11	1.57	6.67	1.30	9.33	1.21	4.92	0.56	1.64	0.47	15.38	1.04	9.62	1.01	4.00	0.20	1.33	0.12	15.63	0.48	14.06	0.47	1.54	0.28	1.54	0.18		1.48	2.70	0.99	36.36	0.67	36.36	0.67	8.51	0.28	8.51	0.28

Noticeable increase in farm output	56.67	0.49	50.00	0.60	13.33	0.54	0.00	0.34	13.33	0.35	8.00	0.29	4.92	0.22	22.95	0.43	23.08	0.43	0.00	0.00	1.33	0.12	1.33	0.12		0.00	0.00	0.00		0.00	0.00	0.00	2.70	0.16	2.70	0.17	7.27	0.26	12.73	0.34	4.26	0.20	4.26	0.20
Increase in revenue from sale of agricultural outputs	71.67	0.43	63.33	0.47	91.89	0.23	67.57	2.17	49.33	0.50	37.33	0.50	81.97	0.39	39.34	0.50	84.62	0.35	46.15	0.50	46.67	0.50	36.00	0.49	95.31	0.21	93.75	0.24	95.38	0.21	60.00	0.49	89.19	0.31	37.84	0.49	5.45	0.23	7.27	0.26	23.40	0.43	6.38	0.33
Value of crop Loss in INR for previous drought like conditions	7961.54	10930.62	7540.00	5751.67	38257.14	100060.30	12080.00	11593.47	59317.78	185582.63	5600.00	6222.54	20934.78	13365.63	9571.43	1133.89	13421.74	13271.94	3666.67	1527.53	14923.08	5693.00	10125.00	5194.43	23312.50	22193.15	2109.38	7281.46	29635.38	37756.40	1207.69	4213.90	19270.27	14021.11	0.00	0.00	11690.91	15093.38	0.00	0.00	17238.10	16649.04	11500.00	12020.82
Percentage of Crop Loss for previous drought like conditions	0.29	0.03	0.23	0.07	33.22	0.12	34.79	0.17	57.07	0.14	30.00	0.00	70.76	0.11	62.86	0.13	40.40	0.15	33.33	0.12	37.31	0.17	35.63	0.22	51.09	0.19	42.14	0.11	59.77	0.20	37.50	0.07	41.00	0.18	0.00	0.00	24.26	0.06	0.00	0.00	43.95	0.15	82.50	0.11
Did you Insure the Crop?	1.61	0.17	1.61	0.17	1351.35	0.36	0.00	0.49	2.67	0.17	0.00	0.00	1.61	0.13	0.00	0.00	12.90	0.38	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00	12.12	0.34	0.00	0.00	20.97	0.48	8.06	0.35		0.00	0.00	0.00		0.00	0.00	0.00
Recovery time for consumption loss in months for previous drought like conditions	2.35	1.07	2.05	0.67	3.06	1.10	2.81	1.10	2.81	1.07	2.88	2.03	2.56	0.69	2.00	0.71	2.74	0.76	3.00	0.00	2.03	0.17	2.00	0.00	2.16	0.61	2.16	0.61	2.86	0.35	0.00	0.00	2.49	0.51	2.47	0.51	2.25	0.55	2.23	0.56	2.36	0.58	2.50	1.00
Recovery time for income	2.60	1.05	2.41	0.71	2.89	1.11	2.62	1.10	4.68	11.35	2.50	0.84	2.26	0.71	1.56	0.53	3.36	4.16	3.00	0.00	2.23	0.43	2.00	0.00	2.08	0.68	2.07	0.68	2.78	0.49	2.25	0.96	2.35	0.54	2.29	0.47	2.11	0.60	2.13	0.61	2.57	0.59	2.67	1.15
Do you think crop loss is reducing?	1.54	0.50	1.66	0.48	1.23	0.43	1.52	0.51	1.78	0.42	1.85	0.37	1.33	0.54	1.54	0.57	1.73	0.54	1.74	0.44	1.88	0.33	1.90	0.31	1.73	0.45	1.77	0.43	1.46	0.53	1.57	0.50	1.11	0.31	1.47	0.51	1.75	0.44	1.78	0.42	1.87	0.50	1.97	0.80
Do you think rainfall gaps are increasing over the years?	73.33	0.36			75.56	0.23			70.667	0.454			96.72	0.18			40.38	0.50			73.33	0.34			82.81	0.38			60.00	0.49			100.00	0.00			0.95	0.23			63.83	0.48		

Table 14: Responses on Existing Schemes in Madhya Pradesh

Agriculture/ Livestock/ Water	Amarwada				Bichhua				Chaurai				Chhindwara				Harrai				Junnardeo (Jamai)				Mohkheda				Pandhurna				Parasia				Sausar				Tamai			
	Scheme penetration		Need alteration in existing one		Scheme penetration		Need alteration in existing one		Scheme penetration		Need alteration in existing one		Scheme penetration		Need alteration in existing one		Scheme penetration		Need alteration in existing one		Scheme penetration		Need alteration in existing one		Scheme penetration		Need alteration in existing one		Scheme penetration		Need alteration in existing one		Scheme penetration		Need alteration in existing one		Scheme penetration		Need alteration in existing one		Scheme penetration		Need alteration in existing one	
	%	Stdev	%	Stdev	%	Stdev	%	Stdev	%	Stdev	%	Stdev	%	Stdev	%	Stdev	%	Stdev	%	Stdev	%	Stdev	%	Stdev	%	Stdev	%	Stdev	%	Stdev	%	Stdev	%	Stdev	%	Stdev	%	Stdev	%	Stdev	%	Stdev	%	Stdev
Seed village Programme	50.00	0.50	1.67	0.13	45.95	0.51	13.51		0.35	66.67	0.33	0.00	0.00	22.95	0.51	0.00	0.00	51.92	0.50	0.00	0.00	42.67	0.50	0.00	0.00	95.31	0.21	0.00	0.00		0.00	0.00	0.00	94.59	0.23	0.00	0.00	89.09	0.20	0.00	0.00	74.47	0.44	0.00	0.00
Integrated cereal (coarse cereal) development programme	13.33	0.34	0.00	0.00	8.11	0.28	0.00		0.00	37.33	0.47	0.00	0.00	13.11	0.45	0.00	0.00	5.77	0.24	0.00	0.00	1.33	0.12	0.00	0.00	10.94	0.32	0.00	0.00		0.00	0.00	0.00	2.70	0.24	0.00	0.00	21.82	0.43	0.00	0.00	10.64	0.31	0.00	0.00
Integrated plant nutrient management & balanced use of fertilizer	6.67	0.25	0.00	0.00	16.22	0.37	0.00		0.00	36.00	0.44	0.00	0.00	8.20	0.39	0.00	0.00	11.54	0.32	0.00	0.00		0.00	0.00	0.00	12.50	0.34	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00	3.64	0.20	0.00	0.00	6.38	0.25	0.00	0.00
National watershed development programme	15.00	0.36	0.00	0.00	16.22	0.37	0.00		0.00	13.33	0.47	0.00	0.00	26.23	0.49	0.00	0.00	13.46	0.34	0.00	0.00		0.00	0.00	0.00	15.63	0.37	0.00	0.00		0.00	0.00	0.00	21.62	0.48	0.00	0.00	38.18	0.50	0.00	0.00	6.38	0.25	0.00	0.00
(1) Wheat	38.33	0.49	1.67	0.13	78.38	0.42	0.00		0.00	36.00	0.34	0.00	0.00	52.46	0.39	0.00	0.00	48.08	0.50	0.00	0.00	21.33	0.41	0.00	0.00	76.56	0.41	0.00	0.00	50.77	0.24	0.00	0.00	62.16	0.44	0.00	0.00	10.91	0.33	0.00	0.00	40.43	0.50	0.00	0.00

(2) Pulses	6.67	0.25	0.00	0.00	2.70	0.16	0.00	0.00	10.67	0.47	0.00	0.00	22.95	0.50	0.00	0.00	57.69	0.50	0.00	0.00	20.00	0.40	0.00	0.00	34.38	0.48	0.00	0.00	10.77	0.35	0.00	0.00	67.57	0.20	0.00	0.00	1.82	0.35	0.00	0.00	27.66	0.45	0.00	0.00
Micro-irrigation projects	21.67	0.42	0.00	0.00	37.84	0.49	0.00	0.00	2.67	0.58	0.00	0.00	13.11	0.44	0.00	0.00	51.92	0.50	0.00	0.00	6.67	0.25	0.00	0.00	12.50	0.51	6.25	0.52	6.15	0.53	0.00	0.00	18.92	0.48	0.00	0.00	1.82	0.71	0.00	0.00	25.53	0.44	0.00	0.00
Balram Talab Yojana	20.00	0.40	0.00	0.00	43.24	0.50	0.00	0.00	4.00	0.20	0.00	0.00	6.56	0.36	0.00	0.00	17.31	0.38	0.00	0.00	13.33	0.34	0.00	0.00	79.69	0.41	0.00	0.00	3.08	0.55	0.00	0.00	8.11	0.50	0.00	0.00	5.45	0.50	0.00	0.00	6.38	0.25	0.00	0.00
Soil testing programme	28.33	0.45	0.00	0.00	54.05	0.51	0.00	0.00	21.33	0.41	0.00	0.00	6.56	0.35	0.00	0.00	51.92	0.50	0.00	0.00	37.33	0.49	0.00	0.00		0.00	0.00	0.00	12.31	0.47	0.00	0.00	37.84	0.49	0.00	0.00	9.09	0.41	0.00	0.00	48.94	0.51	0.00	0.00
Crop insurance scheme	20.00	0.40	0.00	0.00	48.65	0.51	0.00	0.00	24.00	0.43	0.00	0.00	8.20	0.40	0.00	0.00	38.46	0.49	0.00	0.00	41.33	0.50	0.00	0.00		0.00	0.00	0.00	58.46	0.16	0.00	0.00	35.14	0.48	0.00	0.00	1.82	0.13	0.00	0.00	53.19	0.50	0.00	0.00
Promote Farm mechanization	1.67	0.13	0.00	0.00	18.92	0.40	0.00	0.00	20.00	0.40	0.00	0.00	9.84	0.42	0.00	0.00	11.54	0.32	0.00	0.00	26.67	0.45	0.00	0.00		0.00	0.00	0.00	3.08	0.17	0.00	0.00	24.32	0.43	0.00	0.00	16.36	0.32	0.00	0.00	51.06	0.51	0.00	0.00
Establishment of custom hiring centres		0.00	0.00	0.00	10.81	0.31	0.00	0.00	2.67	0.16	0.00	0.00	4.92	0.32	0.00	0.00		0.00	0.00	0.00	4.00	0.20	0.00	0.00		0.00	0.00	0.00	1.54	0.12	0.00	0.00	10.81	0.31	0.00	0.00		0.00	0.00	0.00	8.51	0.28	0.00	0.00
Supply of Bull (Murrah)		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00	1.92	0.14	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00	1.54	0.12	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00	8.51	0.28	0.00	0.00
Goat- rearing scheme	1.67	0.13	0.00	0.00	29.73	0.46	0.00	0.00		0.00	0.00	0.00	3.28	0.27	0.00	0.00	11.54	0.32	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00	1.54	0.12	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00	4.26	0.20	0.00	0.00
Fodder/Forage development scheme		0.00	0.00	0.00	8.11	0.28	0.00	0.00		0.00	0.00	0.00	6.56	0.36	0.00	0.00	7.69	0.27	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00	3.64	0.19	0.00	0.00	6.38	0.25	0.00	0.00
Special animal husbandry for hybrid calf		0.00	0.00	0.00	2.70	0.16	0.00	0.00		0.00	0.00	0.00	3.28	0.27	0.00	0.00	1.92	0.14	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00	10.64	0.31	0.00	0.00

Fruit Development programme		0.00	1.67	0.13	8.11	0.28	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00	11.54	0.32	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00	1.54	0.12	0.00	0.00	5.41	0.23	0.00	0.00		0.00	0.00	0.00	17.02	0.38	0.00	0.00
Vegetable development programme		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00	1.64	0.19	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00	2.70	0.16	0.00	0.00		0.00	0.00	0.00	8.51	0.28	0.00	0.00
Condiment and species development programme		0.00	0.00	0.00	8.11	0.28	0.00	0.00		0.00	0.00	0.00	3.28	0.27	0.00	0.00	1.92	0.14	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00	10.64	0.31	0.00	0.00
Green house and net house development programme		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00	1.64	0.42	0.00	0.00	9.62	0.30	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00	14.89	0.36	0.00	0.00
Kitchen Garden		0.00	1.67	0.13		0.00	0.00	0.00		0.00	0.00	0.00	1.64	0.19	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00	4.26	0.20	0.00	0.00
Vegetable area expansion scheme		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00	1.92	0.14	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00	4.26	0.20	0.00	0.00

Demonstration / Mini-kit Scheme for horticultural crops		0.00	0.00	0.00	8.11	0.28	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00	4.26	0.20	0.00	0.00
Protected cultivation of horticultural crops		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00	3.28	0.26	0.00	0.00	15.38	0.36	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00	2.13	0.15	0.00	0.00
Farmers' training cum field visit programme	3.33	0.18	0.00	0.00	10.81	0.31	0.00	0.00		0.00	0.00	0.00	1.64	0.19	0.00	0.00	9.62	0.30	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00	64.62	0.48	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00	2.13	0.15	0.00	0.00
Crop insurance based on season		0.00	0.00	0.00	27.03	0.39	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00	34.04	0.48	0.00	0.00
Others	5.00	0.22	0.00	0.00	27.03	0.44	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00	1.92	0.14	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00
Launch of Compensatory Afforestation Fund Management and Planning Authority (CAMPA)		0.00	0.00	0.00	29.73	0.43	0.00	0.00		0.00	0.00	0.00	6.56	0.36	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00	2.70	0.16	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00

Capacity building in forestry scheme: human resource		0.00	0.00	0.00	51.35	0.39	0.00	0.00		0.00	0.00	0.00	1.64	0.20	0.00	0.00	38.46	0.49	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00
development programme for forest personnel, with special focus on training frontline staff	5.00	0.22	0.00	0.00	62.16	0.28	0.00	0.00		0.00	0.00	0.00	3.28	0.27	0.00	0.00	42.31	0.50	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00	47.69	0.50	0.00	0.00	2.70	0.16	0.00	0.00		0.00	0.00	0.00	25.53	0.44	0.00	0.00
Intensification of Forest Management Scheme: management of forest areas, strengthen infrastructure, control forest fires, etc.	11.67	0.32	0.00	0.00	8.11	0.28	0.00	0.00		0.00	0.00	0.00	1.64	0.20	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00
Accelerated Programme for Restoration & Regeneration of Forest Cover		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00	1.64	0.20	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00
Inclusion of Forestry within NREGA		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00
India's Forest and Tree Cover as a Carbon Sink		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00

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