Strengthening Performance Management in Government

Climate Change Vulnerability and Adaptation Assessment District - Datia

Mainstreaming Climate Change Adaptation in Development Planning of Madhya Pradesh

EPCO
SKMCCC

UKaid
from the British people

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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	:	Litres per Capita Daily
LULUCF	:	Land Use, Land Use Change and Forestry
LVI	:	Livelihood Vulnerability Index
MCM	:	Million Cubic Metres
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 Datia 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, Co-ordinator 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 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 Bhopal team of Development Alternatives. I also extend my sincere thanks to Dr. S.N. Pandey, his team and all stakeholders of four 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 Husbundary, Krishi Vigyan Kendra, Department of Land records, Water Resource Departments, Central Ground Water Board etc. Thanks are due to the respondents who have spared their valuable time while providing the inputs for 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 Datia 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 Datia 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 (53 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 – Bhander - was the most vulnerable on the composite scale, which perfectly fitted in with Health, Forest and social dimensions but displayed variance in Agriculture and water vulnerability scale. Further, the comparative analysis of calculated sensitivity and adaptive capacity of both primary and secondary data have shown that Seondha block ranked second in the secondary and also second in the primary data analysis in case of adaptive capacity whereas in sensitivity secondary and primary data are ranked third and second respectively, concluding that there was no significant variation in primary and secondary studies as far as vulnerability was concerned. 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 effort 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 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 adopted adaptation tools in the sectoral context of Datia 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 in blocks based on a set of multivariate data (Secondary and Primary). This vulnerability assessment is useful in terms of 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 Datia 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 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.

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[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

1.2.3. Adaptive Capacity

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 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 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

Madya 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 Datia case, it moves to higher vulnerability categories. In the end century scenario, the vulnerability is again predominant in higher categories for Datia 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 more 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 *rabi* season, groundwater recharge is projected to decline despite the projected higher precipitation.

In case of Datia, 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'.

Ajay et al (2013)[5] assessed the surface hydro-environmental loss as surface runoff of water which was received in the Pahuj river basin and passes out within a short time period. The whole basin is inclined towards North East with hilly area in South West, whereas the North East area is plain. Curve number (CN) was used by the author for calculation of loss of basin water as runoff of the river basin. Estimated runoff was 62012.59*106 CM, which was a huge quantity of hydro-environmental loss. Pahuj River basin has a good surface hydro-environment potential to reduce the water scarcity problem of the district. Current situation demands to prepare an appropriate plan for reducing the losses of surface water of the basin.

Agriculture Resource: The study highlighted the impact assessment on agriculture, which was done on wheat and Soybean crops in the Datia 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 indicated 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 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), Datia highlighted major climatic challenges, its consequences and suggested various interventions.

Forest Resource: 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 Datia, the entire forest area is projected to be highly vulnerable; it distinctly highlighted the forest vegetative changes by 2080s under A1B scenarios for Madhya Pradesh.

[5] Ajay et al (2013), Assessment of hydro-environmental loss as surface runoff using CN method of Pahuj River Basin Datia, India, International Academy of Ecology and Environmental Sciences, 2013, 3(4): 324-329

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 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, 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. Blockwise Climatic Trend analysis of Datia District

3.2.1. Rainfall Pattern

The average annual rainfall of Datia, Bhander and Seondha blocks were 643.9, 637.9, and 662.8 mm respectively. About 92% rainfall was received in the South West monsoon season of June to September in about 41 days. 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. Analysis of recent eight years (2005-06 to 2013-2014) (Fig1) depicts a positive rainfall trend in each and every block of Datia district.

In current eight years (2006-2014), the rainfall distribution has been above the normal level by 41% to 21%, except the years 2008-09 (7.9%), 2011-12 (5.8%) and 2012-13(32.1%). In Datia district, an increasing trend can be seen during the South West monsoon, summer monsoon and winters, whereas the North East monsoon shows a decreasing trend. There was an increasing trend in the rainfall pattern in Datia, Seondha and Bhander in the last eight years (2005-06 to 2013-14). The annual water excess amounts observed were between 70-200 mm.

The normal annual mean maximum temperature observed seasonwise and during the South West monsoon revealed that the temperature did not rise significantly and was similar in all seasons. The minimum temperature during the month of January is about 5.1 ^{o}C .The normal annual mean maximum and minimum temperatures of the district are about 32.8 ^{o}C and 17.4 ^{o} C respectively.

The recent trend unfolds that the mean annual relative humidity is 76.04% (2007-2013) in the morning (07.19hr) and at day time (14.19 hr) it reaches up to 39.79% (2007-2013).

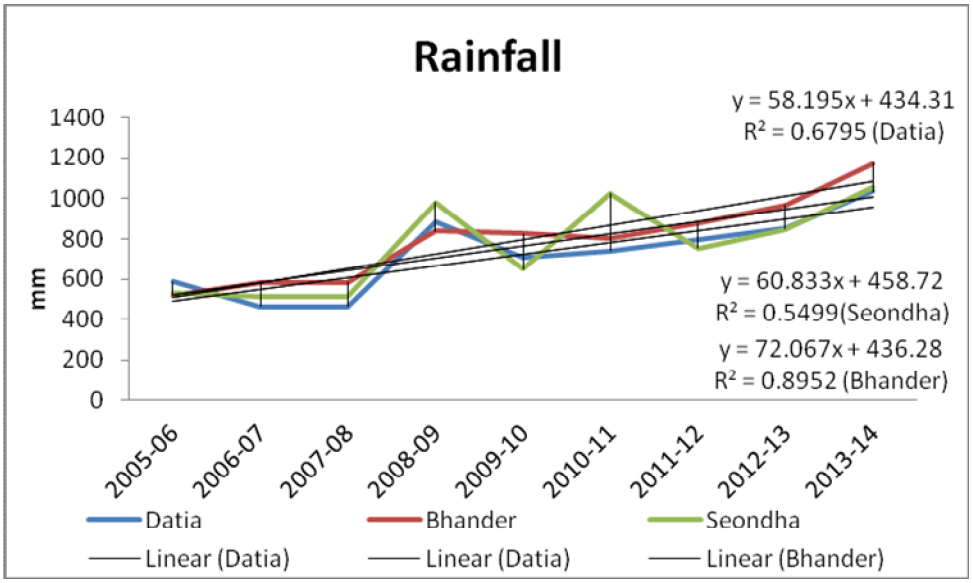
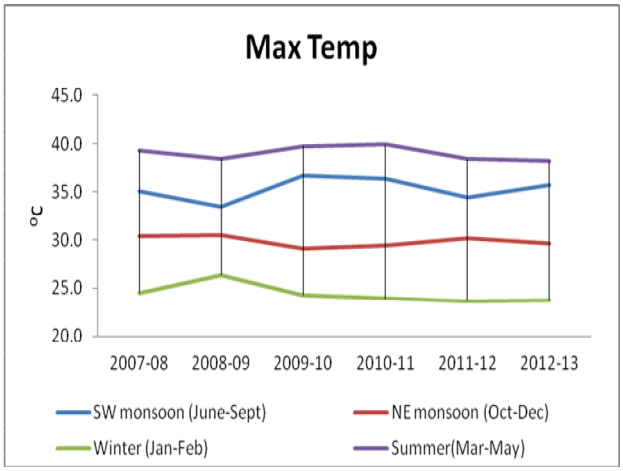


Fig 1: Annual Average Trend (2005-2014) of Rainfall in Datia District



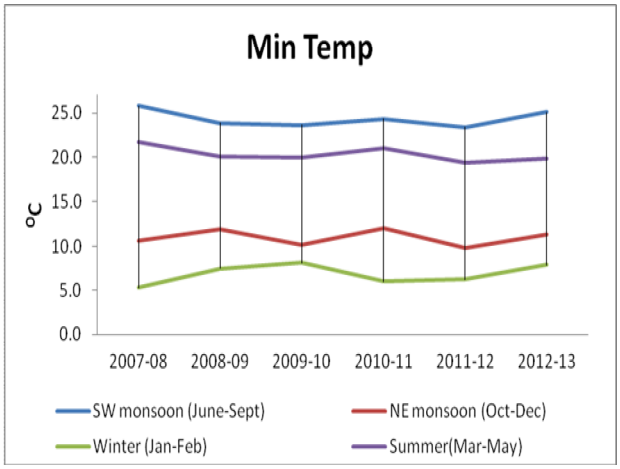
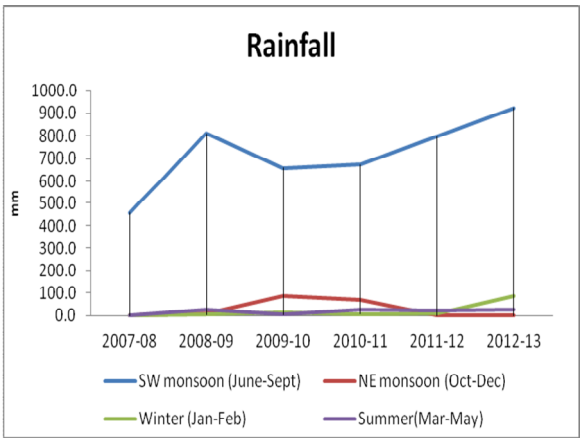


Fig 2. and Fig 3.: Seasonal trend (2010-2014) of Maximum temperature and Minimum Temperature in Datia



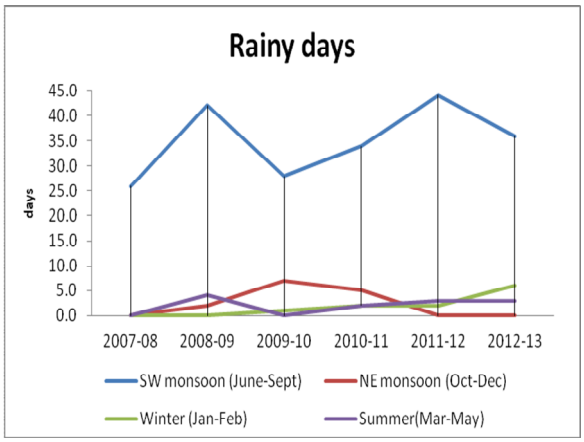


Fig 4. and Fig 5.: Seasonal Trend of Average Rainfall and Number of Rainy Days in Datia

3.2.2. Soil Status

Datia district has the maximum light (red mixed – 44%) soil followed by medium (sandy loam – 36%) and minimum black (clay–20%) soils. There is no problem of salinity in this district, but nearly 7760 ha of land suffers due to mild alkalinity. Micro-nutrient deficiency is also prevalent. The fertility indices based on soil sample analysis indicates that the soils in the whole Datia district are neutral in reaction with medium EC. Majority of soils are low in terms of organic carbon, low to medium in nitrogen, phosphorous and medium to high in potash.

3.3. Impact on Agriculture

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

3.3.1. Rain-fed Agriculture

A large area of land under rain-fed agriculture (58% of the state) is expected to undergo changes in terms of the rainfall pattern, temperature and extreme events over the next several decades due to climate change, thus making rain-fed agriculture more risk prone. After the collection of long term data from different locations of Madhya Pradesh, climatic characterization was done for long term trends and occurrence of extreme events for precipitation and temperature in relation to crop growth phases since climate change related occurrence of these extreme events can have serious negative impacts upon the agricultural production.

In Madhya Pradesh, the success of rain-fed farming almost entirely depends on the South West Monsoon (SWM), which in itself is very erratic and unevenly distributed over the entire crop growing season. It ranges from 800 mm in the Western part of the state to 1500 mm in the East which shows that its total value decreases from South to North and East to West. The total quantum of rainfall throughout the State should be sufficient enough to meet the entire water requirement in crop production. However, it requires better rainwater management strategies to make the best use of this important natural resource. The crop growing season is limited by the water availability, as temperatures are generally favourable for crop growth except for a limited period during summers. Though most rain-fed crops tolerate high temperatures, rain-fed crops grown during rabi are vulnerable to changes in minimum temperatures (Venkateswarlu and Shanker, 2009).

3.3.2. Cropping System

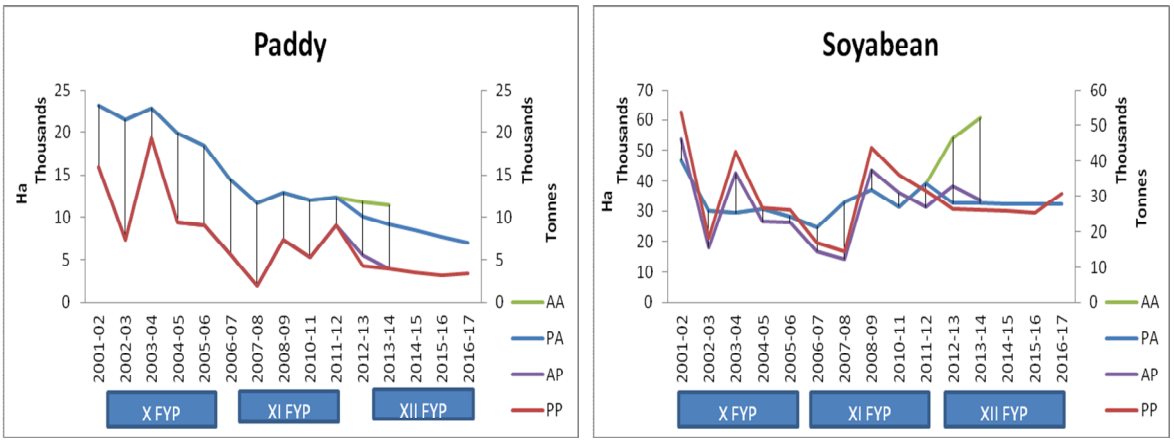
The principal crops grown in the district are paddy, sorghum, maize, green gram, black gram, groundnut, sesame, soybean, wheat, barley, gram, field pea, lentil and mustard. The area under horticulture crops like fruits, vegetables and spices is 1265, 33297 and 3359 ha, respectively. Main horticultural crops are guava, mango, aonla, custard apple, papaya, table pea, potato, colocasia, tomato, brinjal, okra, onion, ginger, chilli, turmeric and coriander. The total livestock population in the district is 10.07 lakh, out of which the cattle number 4.90 lakh, buffaloes 1.81 lakh, sheep 0.44 lakh, goat 2.82 lakh and poultry birds 1.27 lakh. The total water area amounts to 6952 ha in 789 tanks for fisheries.

3.3.3. Trend of Area and Productivity

The area and production in both Xth and XIth Five Year Plan of Kharif crops (Paddy, Soybean and Tur) and Rabi crop (wheat and Gram) was studied. The projections (using growth formula in excel) of the same crops were worked out for the XII Five Year Plan to ascertain the anticipated future trend. The actual sowing area and the production depicted a declining trend for the past fifteen years (2001-2002 to 2016-2017) in all studied kharif crops. But, the actual area and projected area are not showing a similar trend in case of paddy and soybean. In other words, the area of sowing has slightly increased in case of paddy and soybean. The result reveals that Datia area is highly vulnerable because the production has remained low despite an increase in the area, which perfectly matches with the projected production (PP). It has been further overlaid with precipitation and temperature data; and, it was witnessed that the annual rainfall during the South West monsoon was low, whereas the temperature was slightly high. Climate variability has influenced the crop production to a great extent, interfering with the yield in terms of adequate production.

Similarly, during the Rabi season, the actual area versus the projected area was not depicting an identical trend. One could witness that the projected production and actual production, both, were declining in the last fifteen years. In case of gram, the actual area witnessed an increment as compared to the projected area. However, the actual production was low as compared to the projected one. Both the Rabi crops clearly indicated that extreme climate had influenced the production in a negative manner even though the sown area revealed an increasing trend.

Kharif crops



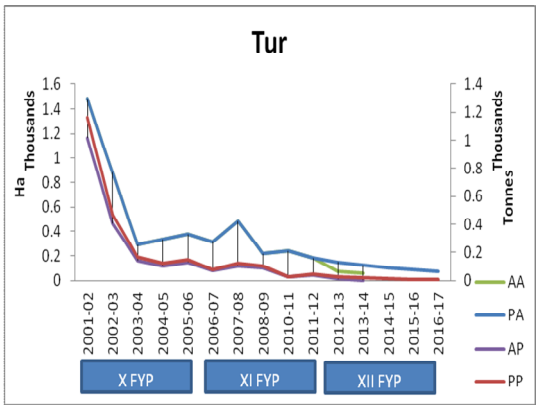


Fig 6., Fig 7., and Fig 8.: Trend in X and XI FYP and projection in XII FYP (Paddy, Soybean and Tur)

Rabi Crops

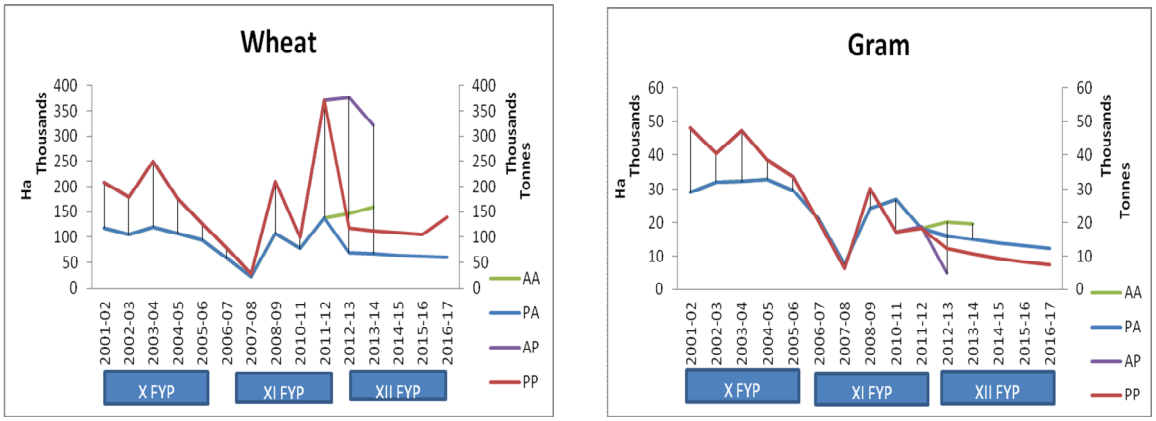


Fig. 9 and Fig. 10: Trend in X and XI FYP and projection in XII FYP (Wheat and Gram)

3.3.4. Impact on Horticulture

A positive growth had been observed in the district in the horticulture area and the overall yield. It can definitely change the status of individual farmers. Crops are sensitive to climate change, particularly in terms of drought conditions, which can affect the overall production. Increasing crop diversity can secure livelihood and income in the district as is shown in the following table (in Table1).

Table 1: Status of Horticulture in Datia District

Horticulture Crops	2011-2012		2012-2013	
	Area (ha)	Production (Metric tons)	Area (ha)	Production (Metric tons)
Vegetables	14173	179941	16985	346024.3
Fruits	439	3857	602	14080.5
Spices	7685	69867	11520	91708.5
Flowers	71	340	73	107.5
Medicinal Plants	59	186	72	87.56

3.3.5. Impact on Livestock

Milk is an important component for food security and human health. 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 producing cross-bred cows and buffaloes will be impacted more than the indigenous cattle. VA & A report states that a rise of 2-6^{O}C due to warming will negatively impact growth, puberty, and maturity of cross breeds and buffaloes. The 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 Datia district, cows and buffaloes (Table 2) are the domesticated elements and the district may suffer with climatic stresses.

Table2: Livestock Statistics

Category	Population	Production (MT)	Productivity
CATTLE			
Cows	1,35,247	0.46	1.7 lit./Animal/day
Buffaloes	2,27,603	1.09	2.23 lit./Animal/ day
SHEEP& GOAT			
Sheep	23,740	-	
Goat	93,792	-	
POULTRY			
Broiler			
Poultry (Hen)	50,341	37.75 Lakh	10.50/year

3.3.6. Thrust area- Potential and Problems

In Datia district, the thrust areas recorded in agriculture and horticultural crops for boosting up the production are Soil health management, water harvesting for recycling and groundwater recharge, in situ soil and moisture conservation, varietal diversification, integrated nutrient management, integrated pest management, and crop diversification. While in terms of livestock, the thrust areas are breed up-gradation in buffalo, goat and cattle, health management, green fodder availability, along with composite fish farming. The major thrust areas for the upliftment of women in the district comprise income generation of farm women, drudgery reduction and efficiency enhancement, reduction in malnutrition, and nutritional security at the household level. .

3.4. Impact on Water Resource

The impacts of climate change on water availability and water quality will affect many sectors, including energy production, infrastructure, human health, agriculture, and ecosystems. Warming air temperature can directly raise temperatures of streams, ponds, and lakes, which can directly harm aquatic organisms and indirectly impact the human, agriculture and allied sectors, along with forests.

Some regions of Datia, particularly the projected dam (proposed or developed), use water to produce energy through hydropower. If climate change results in lower stream flows in areas where hydropower is generated, it will reduce the amount of energy that can be produced. Changes in the timing of stream flow can also have an impact on the ability to produce hydroelectricity. Lower water flows would also reduce the amount of available water.

Climate change impacts on water supply and quality will also affect tourism and recreation. The quality of lakes, streams, and other water bodies that are used for swimming, fishing, and other recreational activities can be affected by changes in precipitation, increases in temperature.

Agriculture and livestock heavily depend upon water. Heavy rainfall and flooding can damage crops, increase soil erosion and delay the planting. Additionally, areas that experience more frequent droughts will have much less water available for crops and livestock. (*To learn more about how climate change will impact agriculture and food production, visit the Agriculture and Food Supply Impacts page.)*

Aquatic species that live in only cold water environments, such as Salmon, will be affected by rising water temperatures. Changing water temperatures would also affect the geographic range of fish species.

Non-availability of water for various uses is a major concern in the region. A major portion of the water resources in the region caters to the agriculture and allied activities due to the absence of any major industry in the district.

3.4.1. Groundwater Resources

Datia district is characterized by alluvial formation, and Bundelkhand granite gneiss, and Gwalior series. Dynamic Groundwater is occupied by Bundelkhand granite with a thin soil cover. Dynamic Groundwater Resource Book of the district has estimated (2008-09) the ground water status in a blockwise manner. Out of the total 2,69,000 ha of geographical area, 2,66,200 ha (99%) is groundwater recharge worthy area and 2800 (1%) is hilly area. All blocks of the district are categorized as safe blocks, except the Datia block (under non-command) which is categorized as semi- critical (safe in 2003/04), with highest stage of groundwater development of 87%. After making allocation for future domestic and industrial supply for the next 25 years, the balance available ground water for future irrigation would be 14,005 ham. The net groundwater availability in the district is 33,420 ham and the groundwater draft for all uses is 19,162 ham, making the status of groundwater development 57.3% (44.3% in 2003/04) as a whole for district.

3.4.2. Water Resource (Past, Present and Future in Datia)

Historically, the need for water security has been recognized and Datia district is well known for its water bodies, including the Pahuj reservoir and lakes. A host of smaller tanks and ponds (*tals*) are found in the district and the availability of water from tanks and other surface bodies are very important sources to sustain irrigated agriculture and provide security to farmers. The main body of the district is drained by two important rivers, viz, the Sind and Pahuj. The Sind flows along the Western boundary for a considerable distance, whereas the Pahuj touches the Eastern boundary only for about a kilometre and a half. The character of the rivers is seasonal. Most of the streams and the span of river-beds dry up in the winter and summer seasons. The run-off in the rainy season is very large. The overall water potential has not been assessed so far. Ajay et al (2013), Loss of basin water as surface runoff of Pahuj river in Datia district is calculated using various parameters such as Pasture, Crop land, Forest, Water bodies, Built up area, unused land with wild vegetation. Total runoff is 26.83 inches, amounting to a total quantity of 62012.59×10^6 CM of the Pahuj river basin area. This amount reveals that Pahuj river basin, with a normal average rainfall, is having a good hydro-environment.

3.4.3. Migration due to Water Resource Depletion

In the past, it was evident in the meteorological drought[6] hazard frequency map that Datia district faced the highest number of drought years, followed by Lalitpur and Mahoba in the range of 6 to 8 times in 12 observed years. There are several manifestations of drought which impacts the water resource availability like late arrival of rains, early withdrawal, long breaks in between, evaporation rate and water in reservoirs, infiltration rate and drying up of wells leading to crop failure and even un-sowing of the crops, which ultimately curtails livelihood and may lead to migration.

Irrigation area is about 73.20% of the total cultivable land in which 61.46% is irrigated through the Rajghat Canal and the rest (11.47%) is covered by open well, tube well and ponds etc.

According to the data available in the year 2009-10, the total cultivated area was 175,364 ha; the irrigation capacity from officially built sources and percentage of irrigated area is presented in the table below (Table 3 and 4):

Table 3: Reporting Area of Irrigation

District	Total cultivated area (ha)	Officially built irrigation capacity (ha)	Irrigation (%)
Datia	175364	104040	70.15

Table 4: Area irrigated by various sources in hectares

S. No	Sources	Irrigation area (ha)
1	Canal	104040
2	Tube well	10529
3	Well	59303
4	Ponds	Nil
5	Others	1492

Source: *District Statistical Handbook, 2010*

3.5. Impact on Forest Ecosystem

The Datia Forest Division of the district is most vulnerable to Climate Change as per the SAPCC Report (EPCO 2014). The forest is located on a plateau, with an undulating topography where the slope varies from gentle to steep. The climate trend has been noticeably observed depicting drier to hotter condition. Besides adverse climatic condition, the forest areas have been infested with the problem of excessive grazing and illicit felling for fodder and fuel wood. Natural regeneration of main species is scanty. Most of the *Anogeissus pendula* (Kardhai) and *Acacia catechu* (Khair) trees are malformed and bushy due to the biotic pressure. According to FSI 2003 and 2013 reports, the total forest cover has decreased from 164 to 157 sq kms within a decade. Moreover, there has been a decline in the moderately dense forest cover from 81 sq kms in 2003 to 78 sq kms in 2013. Further, there

[6] Bundelkhand drought - Retrospective Analysis and Way Ahead (2014), published by National Institute of Disaster Management,ISBN:87893-8257108-7

is a decrease in the open forest cover from 83 sq km in 2003 to 79 sq km in 2013. These changes directly and indirectly unfold that the biotic pressure and climatic factor are influencing the forest cover which needs to be studied further. The FSI reports of 2011 and 2013 shows that there is no change in the moderately dense and open forest area and the district does not possess a very dense forest cover. In the year 2013, the forest cover occupied 5.83% of the total geographical area (GA -2691 sq km) of the district.

Table 5: Forest Area under Different Forest Covers (sq km)

Forest Cover	FSI 2013		FSI 2003		Change
	Area	Percentage of Geographical Area	Area	Percentage of Geographical Area	
Very Dense Forest	0	0	0	0	0
Moderately Dense Forest	78	2.90	81	3.01	-3
Open Forest	79	2.93	83	3.08	-4
Total	157	5.83	164	6.09	-7
Scrub	101	3.75	-	-	-
Grand Total	**258**	**9.58**	**164**	**6.09**	**-**

Source: *FSI 2003 and FSI 2013*

Forest Cover Status

The Table shows the moderately dense and open forest cover of Datia district year-wise. The trend indicates that the forest cover has been decreased from 164 sq km to 157 sq km in the decade period.

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 parameters like temperature, drought etc and mitigating the decreasing rainfall and soil and moisture availability.

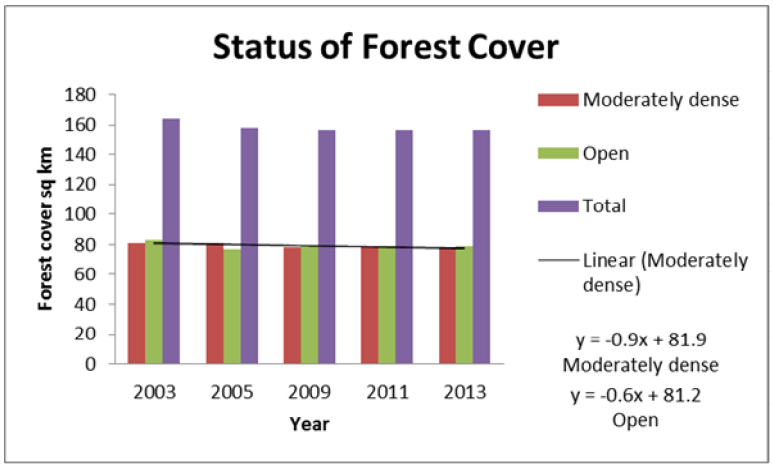


Figure 11: shows the decreasing trend in the forest cover.

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

Forest Area and Resources

The Datia Forest Division has the following forest types:

- 5B Northern Tropical Dry Deciduous Forests and
- 6B Northern Tropical Thorn Forests

The major trees in Northern Tropical Dry Deciduous (NTDD) Forests are Kardhai, Tendu, Palash, Sainta, Reunjha, Kanker, Ghont and Prosopis, whereas the Thorn Forest (TF) comprisingf Khair, Ber, tree species. NTDD and TF together constitutes 5277.75 ha in the reserved forest and 23826.53 ha in the protected forest, thus the total forest area of the division is 29104.28 ha, which forms 10.82% of geographical area.

According to the Working Plan of Datia Forest Division 2005-06 to 2014-15, 9.20% of total forest area is under NTDD-*Anogeissus pendula* (kardhai) forests, 0.13% under mixed forest and 0.71% under TF-*Acacia catechu* (khair) forest. NTDD and TF are under stock due to climatic factors viz., Frost, drought, temperature, storm and lightening, flood and biotic factors viz., heavy pressure of livestock grazing, forest fire, rampant felling of trees for timber, poles, fuel wood, agricultural implements, unsustainable collection of NTFPs by the people.

The major climatic and biotic factors influencing forest vulnerability are described below:

3.4.1. Climatic Pressure

3.4.1. a. Frost

The frost occurs in the Forest Division in the areas like river, runnel (nallah) and valley during the winter season (December to February). The major portion of the Forest Division is affected by the frost. It impacts the young regeneration greatly. The regeneration of plant species affected by the frost includes kardhai, khair, tendu and others.

3.4.1. b. Drought

Erratic and deficient rainfall occurs in the Datia region, which leads to the occurrence of drought. Due to the high temperature during summers, there is a continuous flow of hot air currents. It affects the regeneration of plants, young saplings and causes forest fire in small areas. The combined occurrence of drought and forest fire speeds up the drying of green leaves and their subsequent fall from trees. This all leads to availability of dry leaves even after the first fire of the season and there are frequent fire incidences in a particular area. The number of fire incidences is presented in the Table below

Table 6: Year wise Number of Fire Incidences in the Division

Year	Number of Fire Incidences
2010-11	6
2011-12	5
2012-13	15
2013-14	4
2014-15	11

The fire occurring in small areas has less intensity and mostly burns *Lantana camera.* However, it does not affect the main forest species. Forest Department has been executing the fire scheme to control forest fires. In this scheme, fire lines are prepared in the blocks and compartments.

3.4.1.c. Temperature

After February, the ambient temperature rises progressively. May and June are generally the hottest month with the maximum temperature of about 48.2 degree Celsius and a low of 0 degree Celsius. The maximum and minimum relative humidity is 90.8% and 31.0% respectively. During the rest of the year, the air is comparatively dry. The driest part of the year is the summer season i.e., April, May and June. Such environment is favourable for occurrence of forest fires. The temperature greatly influences the forest flora and fauna. During the dry period, there is huge impact on water and fodder available for wild animals as well as for the livestock.

3.4.1.d. Storm and Lightning

The storm and lightning affect the forest trees of the Forest Division during the rainy season. There are incidences such as uprooting of trees from the areas where the soil depth is low. The lightning leads to burning and breeaking down of trees. Trees on a shallow soil depth are greatly affected as compared to the trees standing on deep soil. Sometimes, the trees break down during the a storm-like situation.

3.4.1.e. Flood

Datia's average annual rainfall is 742.9 mm and the monsoon rainfall takes place during the months of July, August and September. The Datia district comes under the Gangetic drainage system and is drained by the Sindh, Pahuj, Mahuar and Betwa. The former two rivers, however, form the drainage system of the main body of the district. The rivers are almost seasonal and have a heavy runoff only during the peak period of July and August. 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 situated on hills and mountains. Due to this reason, there is a colossal flow of rainwater at a high speed, which causes soil erosion and uproots the trees with a shallow root system.

Biotic Pressure

3.4.2.a. Collection of Wood and NTFPs

The geographical area of Datia district is 2691 sq km, with 291.04 sq km (about 10.82% of GA) area being under forests. The legal extraction of wood from the forests is not followed; however, there is dependency of community living within a periphery of 5 km on forest. The community extracts wood and Non-Timber Forest Produces (NTFPs) from the forest which goes unreported in the conventional practice of forest management. The forest resource obtained by forest dependent communities includes wood for new house construction, old house repairing, agricultural implements, fuel wood, bamboo, grass (livestock grazing) and NTFPs viz., Tendu leaves, gum (Dhaoda, Khair and Babool), *Eblica officinalis* (aonla), *Madhuca indica* (mahua), honey etc. This practice has been causing a large scale damage to the forest ecosystem. There is also lack of livelihood options which leads to the sale of fuelwood head load to the nearby city areas. There is also illegal felling of poles for Nistar[7] purpose in the areas viz., Datia and Sheondha blocks. The quality of forest is degrading day by day due to this biotic pressure.

[7] 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 fuelwood, 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.

3.4.2.b. Livestock Grazing

The grazing/ carrying capacity of the forest was 39,753 animal units, whereas 414,445 animal unit grazing pressure was actually taking place. This is ten times more than the land's actual carrying capacity. Most of the forest area of Datia Forest is scattered and surrounded by human habitat. This culminates into an enormous pressure of livestock grazing in the area. There is no practice prevailing in the villages for stall feeding. So, local people set their livestock free to graze in the forest to avoid the cost of grasses. This practice is diminishing the availability of palatable grasses and inducing the population of unpalatable grasses in the forest region. During the rainy season, there is a good growth of palatable grasses, but the livestock graze them even before flowering. This unwanted grazing decreases the availability of palatable grasses and increases the growth of unpalatable grasses. During the rainy season, the regeneration of the desired forest viz., Kardhai, Khair and other species does take place but the livestock devour them even before their full growth and also press them under their feet. It leads to the damage of young saplings and retards regeneration. Due to this unprecedented grazing, the soil becomes compact and the filtration of rain water in the soil does not take place during the rainy season, hence affecting the available soil moisture.

3.4.2.c. Forest Fire

In summer season, an occurrence of forest fire is common in the area. The forests of the Datia district are mostly dry and deciduous and prone to forest fires in the summer season from February to June. There is at least a one-time incidence of forest fire taking place in the Forest Division. The conducive environment (like temperature, availability of dry leaves, grasses etc in summer season) favours forest fires. The main reasons 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 leave collectors with a view to obtain the early and better quality leaves.
- Fire set by the livestock grazers and people near the forest area to obtain large quantity of green grass in the rainy season.
- Fire caused by the bidi/cigarette smokers and careless use of fire lit by the people in the forest area
- The fire is also caused by the villagers for encroachment purposes

All these reasons lead to forest fires and adversely affect the standing crop, regeneration, NTFPs, grass, and wild animals.

Plantation

The Datia Forest Division has carried out plantation of *Dalbergia sissoo* (shisham), *Tectona grandis* (teak) and other forest species under the plantation programme and Compensatory Afforestation Fund Management and Planning Authority (CAMPA). The area under plantation is presented in the following table.

Table 7: Yearwise Area under Plantation

Year	Area (ha)
2010-11	45
2011-12	375
2012-13	700
2013-14	90
2014-15	56.9

Production of wood and NTFPs

In the Datia Forest Division, there is no production of wood. The Division involves communities for collection of Tendu leaves only from forest areas. The production of tendu leaves (standard bags) and revenue are presented in the Table

Table 8: Production of tendu leaves in the Division

Year	Quantity (Standard bags)	Value (Rs)
2010-11	470.480	865365
2011-12	390.429	550413
2012-13	330.600	770690
2013-14	374.064	132952
2014-15	232.304	321601

The Figure reveals the decreasing trend in Tendu leaves production, which varies from 232.304 to 470.480 standard bags.

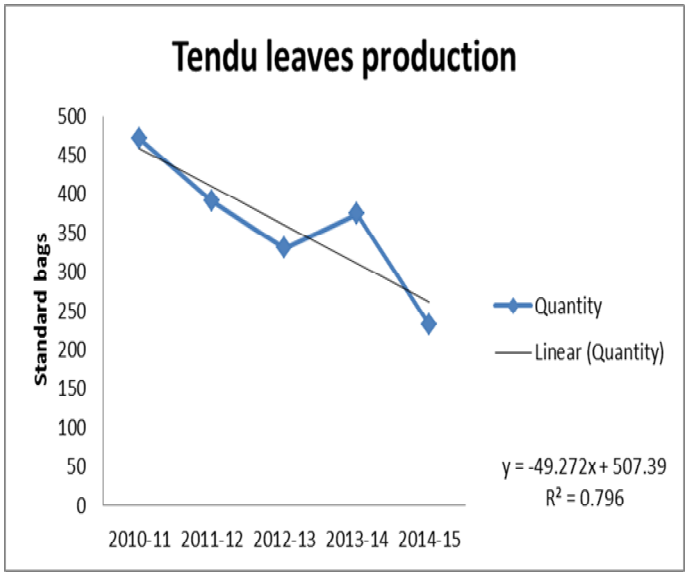


Fig 12: Tendu Leaves Production

Revenue and Expenditure

The division receives revenue from sale of tendu leaves, auction of seized items, Preliminary Offence Report (POR) cases and registration fees. As such, there is no extraction of wood products and hence no revenue obtained from it. The Table shows revenue earned and expenditure (plan and non-plan) incurred in the forest division

Table 9: Revenue and Expenditure of Datia Forest Division

Year	Revenue (Rs)			Expenditure (Rs)
	Tendu leaves	Auction of seized items	Total	
2010-11	865365	665602	1530967	55112498
2011-12	550413	693356	1243769	54850005
2012-13	770690	329261	1099951	57517383
2013-14	132952	981664	1114616	73501578
2014-15	321601	1292322	1613923	117290838

The figure reveals that there is a wide gap in the revenue and expenditure of Datia Forest Division. The total revenue ranged from Rs.10.99 lakh to Rs.16.13 lakh whereas the total expenditure ranged from Rs. 5.48 crore to Rs.11.72 crore.

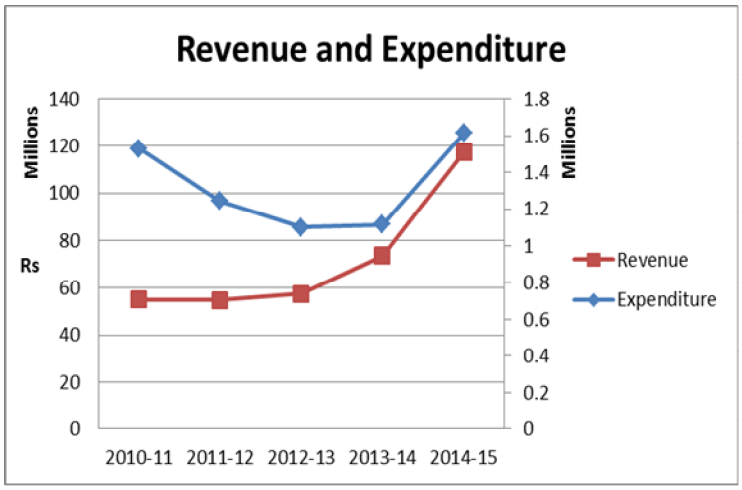


Fig 13: Revenue and expenditure of Datia Forest Division

Forest Ecosystem of Datia Vulnerability to Climate Change

Datia District is most vulnerable to climate change in the Forest Index in the base period (EPCO 2014). The forest is located on a plateau whose topography is undulating and the slope varies from gentle to steep. The climate is dry to hot. The forest areas are infested with the problem of excessive grazing and illicit felling for fodder and fuel wood. Natural regeneration of main species is scanty. Most of the *Anogeissus pendula* (Kardhai) and *Acacia catechu* (Khair) trees are malformed and bushy. FSI 2003 and 2013 reports unfold that the total forest cover has decreased from 164 to 157 sq km in a decade. However, there has been a decrease in the moderately dense forest cover from 81 sq km in 2003 to 78 sq km in 2013. Further, there is a decrease in the open forest cover from 83 sq km in 2003 to 79 sq km in 2013. This shows that there has been a decrease in the moderately dense forest cover and open forest cover. The FSI reports of 2011 and 2013 show that there is no change in the moderately dense and open forest area and the district does not possess a very dense forests cover. In the year 2013, the forest cover occupied 5.83% of the total geographical area (2691 sq km) of the district. As per the Working Plan (2005-06 to 2014-15) of Datia Forest Division, the climatic factors viz., frost, drought, temperature, storm and lightning, flood and biotic factors viz., heavy pressure of livestock grazing, forest fire and rampant felling of trees for timber, poles, fuel wood, agricultural implements, collection of NTFPs by the people and pest and diseases lead to the degradation and depletion of forest resources.

Serious efforts are required to convert the area under open, blank and scrub forests to moderately dense and very dense forest cover through reforestation and afforestation. 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.

The district of Datia is most vulnerable to climate change as per the SAPCC Report. All this is due to its undulating topography, resource exploitation, intensified ravines, agrarian and forest-based economy and high poverty (EPCO 2014). According to FSI 2003 and 2013 reports, the total forest cover has increased from 325 to 403 sq km. However, there has been a decrease in the moderately dense forest cover from 101 sq km in 2003 to 93 sq km in 2013. Further, there is an increase in the open forest cover from 224 sq km in 2003 to 309 sq km in 2013. This shows that there has been a decrease in the moderately dense forest cover and increase in the open forest cover as given in the following table (Table 10).

Table 10: Forest Area under Different Forest Cover (sq km)

Forest Cover	FSI 2013		FSI 2003		Change
	Area	Percentage of Geographical Area	Area	Percentage of Geographical Area	
Very dense forest	1	0.02	0	0	1
Moderately dense forest area	93	1.84	101	2	-8
Open forest area	309	6.12	224	2.44	85
Total	403	7.98	325	6.44	78
Scrub	133	2.63			
Grand Total	**536**	**10.62**			

Source: *FSI 2003 and FSI 2013*

4. Datia - District Vulnerability Assessment

4.1. Approach and Methodology

The methodology used for the drill-down Vulnerability Assessment (VA) for Datia 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 11: Sample Size for Primary survey

Block Name	Total No. HH	Sample size (1:500)
Seondha	18824	38
Datia	57045	114
Bhander	27784	56
Indergarh	22814	46

Datia 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/community 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 Datia district was based on secondary and primary data analysis.
(1) Secondary data (53 indicators) – Data collected from state and district line departments: *Depicted in Table 11.*

(2) Primary data – Sample size (Table 10) 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 was depicted in Table 8.

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 11 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	2005-2014
2		Max.T (°C)	DSR/KVK	2007-2013
3		Min.T (°C)	KVK	2007-2013
4		Rainy days(No.)	KVK	2007-2013
5		EP (mm)	KVK	2007-2013
6		Wind velocity (km/hr)	KVK	2007-2013
7		Daily bright sunshine (hr)	KVK	2007-2013
8		RH (Morning)	KVK	2007-2013
9		RH (Evening)	KVK	2007-2013
Adaptive Capacity				
Sl. No.		Indicator		Source/Period
10	Environmental/Social Indicator	Percentage of Households With Access To Safe Drinking Water (within premises and near premises)		DSR (2010)
11		Percentage of Households With Access To Sanitation Facilities		DSR (2010)
12		Percentage of Households With Access To Electricity		DSR (2010)
13		Percentage of Households with TV, Computer/Laptop, Telephone/mobile phone and Scooter/ Car (Households owning Radio, Transistor, Television and Telephones)		DSR (2010)/ Land records
14		Road		DSR (2010)
15		Population Served per Health Centre (Community, Primary and Sub Health Centres) (2009)		DSR (2010)
16		Number of Primary, Middle, High and Higher Secondary Educational Institutions Per Lakh of Population		DSR (2010)
17		Total number of households availing banking services (Scheduled commercial banks per lakhs of population)		DSR (2010)
18		Agricultural credit societies per lakhs of population		NA
19		Diesel pump for irrigation		DSR (2010)
20		Electric pump for irrigation		DSR (2010)
21	Environmental/Agriculture Indicators	Percentage of Net Irrigated Area To Geographical Area By Surface Water		DSR (2010)/WRD
22		Percentage of Net Irrigated Area To Geographical Area By Sub surface water		WRD
23		Fertilizer Consumption (kg/ha)		DSR (2010)
24		Cropping intensity		Land records (2013)
25		Livestock Population		Land records (2013)

26		Poultry Population	Land records (2013)
27	**Environmental/Forest Indicators**	Percentage of Reserved Forest area to geographical area	Land records (2013)
28		Percentage of Conserved Forest area to geographical area	Land records (2013)
29		Percentage of Revenue Forest area to geographical area	Land records (2013)
30		Number of JFM Communities	Annual report, Forest Department 2010
31	**Environmental/ water**	Net ground water availability for future irrigation development (ham-2009)	WRD (2009)
32		Ground Water Availability (ham-2009)	WRD (2009)
33	**Environmental/ Health**	No. of Hospital	DSR(2010)
34		No. of health centres	DSR (2010)
		Sensitivity	
35	**Socio Economics**	**Literacy Rate (2011)**	**Census (2011)**
36		Density of Population (2011)	Census (2011)
37		Sex-ratio (2011)	Census (2011)
38		Proportion of Child Population In the Age Group 0-6 (2011)	Census (2011)
39		Percentage of People Below Poverty Line (2011)	Census (2011)
40		Percentage Share of Marginal Workers (2011)	Census (2011)
41		Percentage of Scheduled Tribes population (2011)	Census (2011)
42		Percentage of Scheduled Caste population (2011)	Census (2011)
43		Percentage of Households With Access To Safe Drinking Water (away) 2013	Land records (2013)
44	**Environmental/ Agriculture Indicators**	Percentage of Net Irrigated Area To Geographical Area By Ground Water	DSR (2010)
45		Percentage Share of Agricultural Workers	DSR (2010)

46		Percentage Share of Cultivators Workers	DSR (2010)
47	**Environmental/ Forest Indicators**	Percentage of wasteland to geographical area	Land Records (2013)
48		Area effected by fire incidence (ha)	Land Records (2013)
49	**Environmental /water**	Water level trend (cm/year)	CGWB (2009)
50		Ground Water Recharge Worthy Area	CGWB (2009)
51	**Environmental/ Health**	Animal and Hospital ratio	DSR (2010)
52		Poultry and Hospital ratio	DSR (2010)
53		Population /Health practitioner (Doctor, compounder and nurse)	DSR (2010)

Table 12: Indicators of Secondary data collection

(*DSR- District Statistical Report, LR- Land Records, KVK- Krishi Vigyan Kendra, CGWB- Central Ground Water Board)

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) vulnerability 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 six blocks of Datia. 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 its 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 equal weightage

Step 4: Vulnerability Index

The combination of the value 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 depicts the relationship between the CVI and the sectoral index. Discussions on these sectoral indices are presented in the following paragraphs on sectoral issues.

Table 13: Blockwise Vulnerability Index (Exposure, Sensitivity and Adaptive Capacity)

Profile	Exposure	Sensitivity	Adaptive Capacity
Seondha	0.78	0.23	0.52
Datia	0.28	0.82	0.65
Bhander	0.52	0.45	0.32

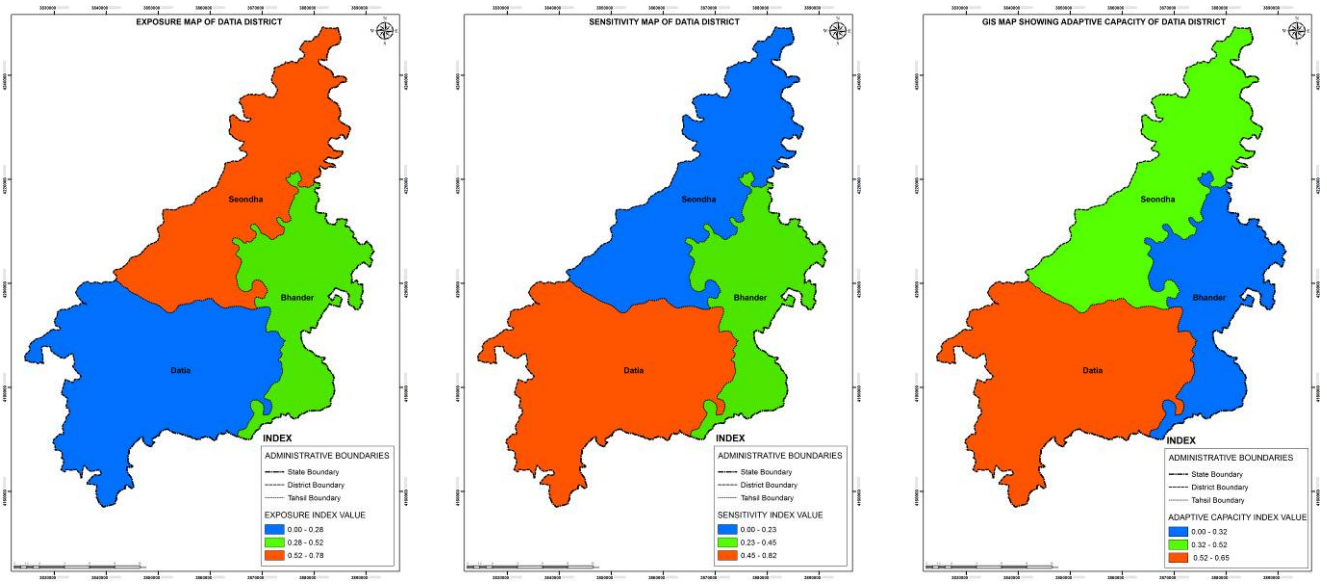
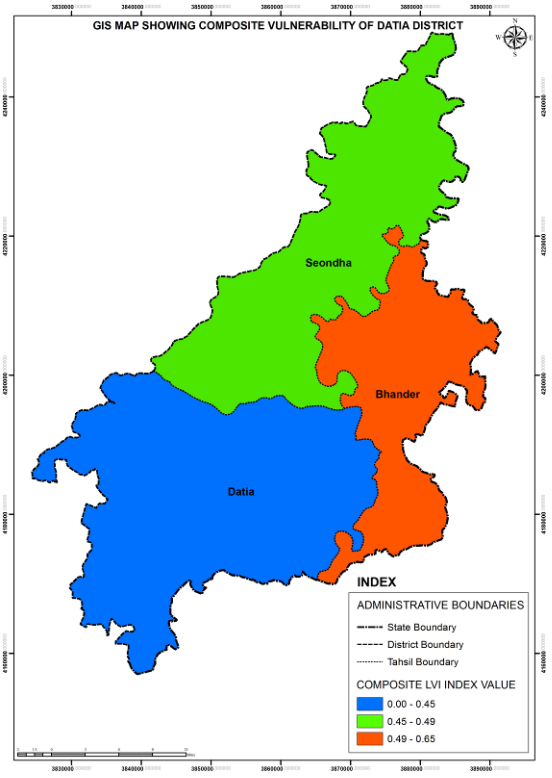


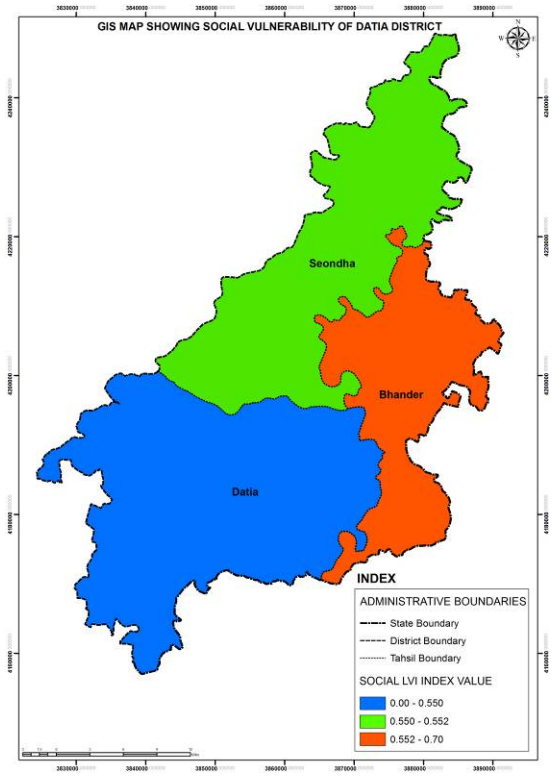
Fig 14: Map on Exposure, Sensitivity and Adaptive Capacity in Datia district

Table 14: Blockwise Sectoral Vulnerability Index (Composite, Social, Agriculture, Water, Forest and Health)

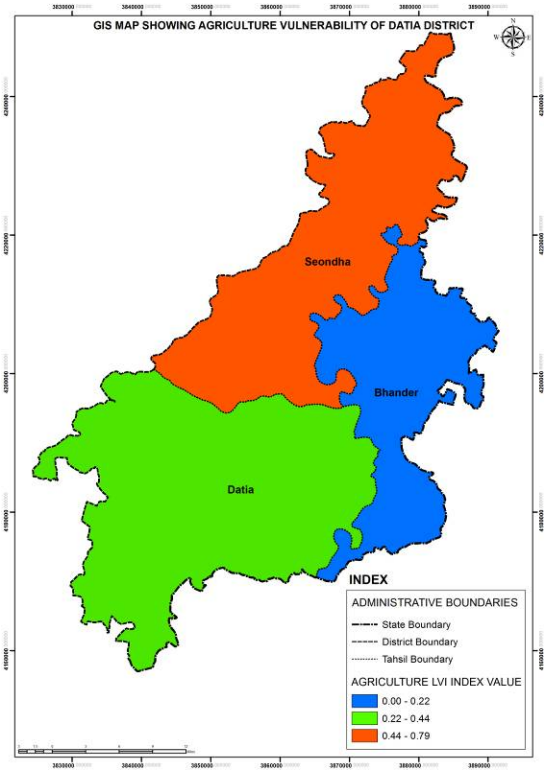
Block	Composite		Social		Agriculture		Water		Forest		Health	
	LVI	Rank	LVI (S)	Rank	LVI (A)	Rank	LVI (W)	Rank	LVI (F)	Rank	LVI (H)	Rank
Seondha	**0.49**	2	0.55	2	0.79	1	0.43	3	-0.18	3	0.60	2
Datia	**0.45**	3	0.55	3	0.44	3	0.78	1	0.23	2	-0.06	3
Bhander	**0.65**	1	0.70	1	0.22	2	0.51	2	0.84	1	1	1


GIS MAP SHOWING COMPOSITE VULNERABILITY OF DATIA DISTRICT
Seondha
Bhander
Datia
INDEX
ADMINISTRATIVE BOUNDARIES
State Boundary
District Boundary
Tahsil Boundary
COMPOSITE LVI INDEX VALUE
0.00 - 0.45
0.45 - 0.49
0.49 - 0.65

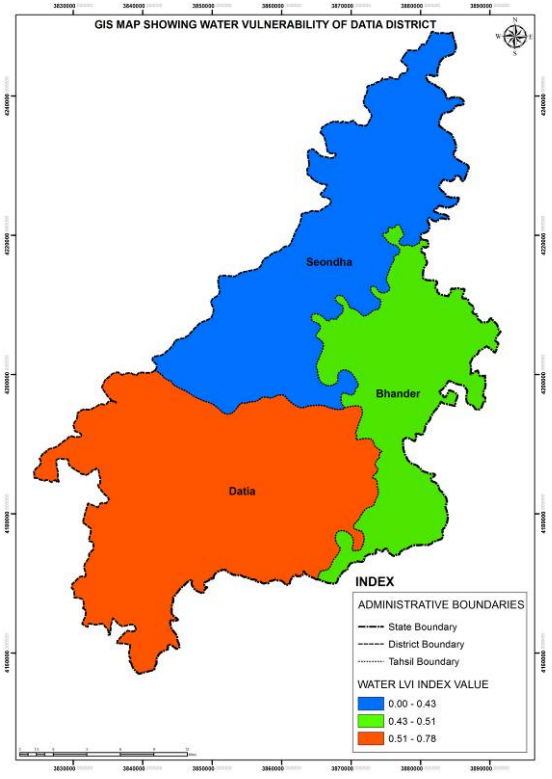
(a)


GIS MAP SHOWING SOCIAL VULNERABILITY OF DATIA DISTRICT
Seondha
Bhander
Datia
INDEX
ADMINISTRATIVE BOUNDARIES
State Boundary
District Boundary
Tahsil Boundary
SOCIAL LVI INDEX VALUE
0.00 - 0.550
0.550 - 0.552
0.552 - 0.70

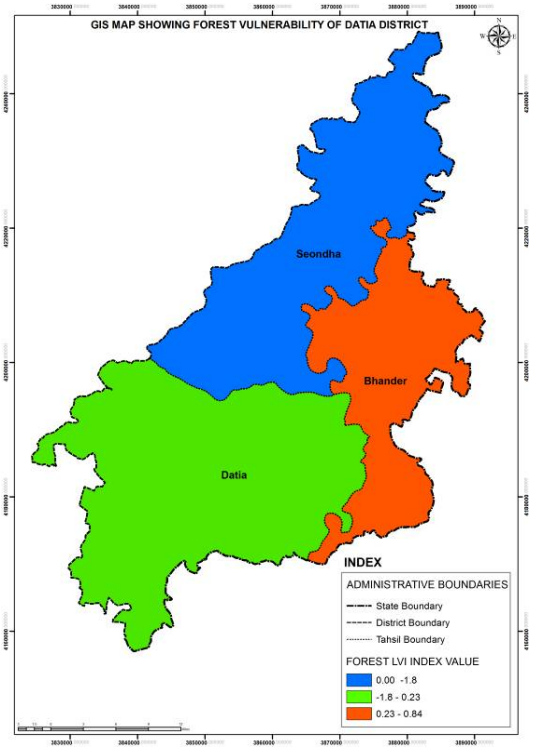
(b)


GIS MAP SHOWING AGRICULTURE VULNERABILITY OF DATIA DISTRICT
Seondha
Bhander
Datia
INDEX
ADMINISTRATIVE BOUNDARIES
State Boundary
District Boundary
Tahsil Boundary
AGRICULTURE LVI INDEX VALUE
0.00 - 0.22
0.22 - 0.44
0.44 - 0.79

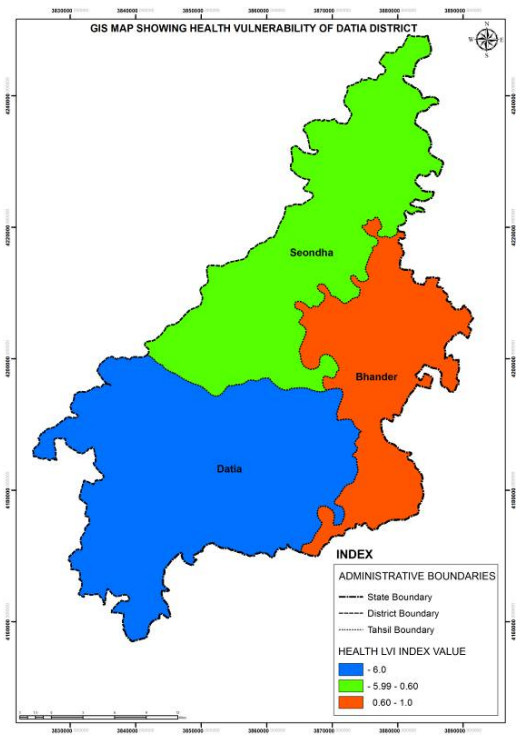
(c)


GIS MAP SHOWING WATER VULNERABILITY OF DATIA DISTRICT
Seondha
Bhander
Datia
INDEX
ADMINISTRATIVE BOUNDARIES
State Boundary
District Boundary
Tahsil Boundary
WATER LVI INDEX VALUE
0.00 - 0.43
0.43 - 0.51
0.51 - 0.78

(d)



(e)



(f)

Fig. 15 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 worked out from 53 indicators related to Exposure (9), Sensitivity (27) and Adaptive Capacity (17) in social, Agriculture, Water, Forest and Health sectors. The composite vulnerability parameters (in Table 5) 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 Datia block is the most sensitive one and Seondha block is highly vulnerable (composite).

In overall composite vulnerability, Bhander block attained the First Rank, whereas Seondha was Second and Datia block formed the Third Rank. It is evident that necessary steps need to be taken to enhance the adaptive capacity through development programmes in all blocks of Datia district where Bhander needs to be given more emphasis to bring them in the mainstream of development by supporting the priority list provided in the figure below (Figure No.15).

4.3.1.b. Social Vulnerability Index

Bhander, Seondha and Datia are ranked high to low vulnerable blocks respectively in Datia 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 climate (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 better adaptive capacity.

The comprehensive analysis of the data sowing vulnerability in the agriculture sector determined that the most vulnerable block of the district was Seondha, followed by Datia and Bhander. The situation may differ if State and National government schemes will be used judiciously and implementing policies/missions could be targeted 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 National Mission on Agricultural Extension and Technology.

4.3.1.d. Water Vulnerability Index

The water sectors indicated that Datia, Bhander and Seondha were ranked high to low vulnerable blocks. All three 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 interest 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 Bhander are highly vulnerable due to the non-0.18 -availability of forest, whereas Seondha is less vulnerable than Datia block, where LVI ranges (-0.18 - 0.84) reflect that their adaptive capacity is also high, which clearly demonstrates district adherence to implementation of the Working Plan. Datia and Seondha districts depict less vulnerabity, LVI being 0.23 and respectively, 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

Bhander block was found to be highly vulnerable among all other blocks of Datia district where LCI ranges from -0.06 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 professional who can advice and attend the commonly found diseases in the society, awareness camps on outbreak of diseases, animal camps, vaccination campaign etc.

4.3.1. g. Suggestions

The findings of the study indicate that the government needs to take serious steps to improve the health care facilities and forest resource management in Datia block.

In case of Prithivipur block, it was recorded that the Forest, Agriculture, and Water needs have 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.

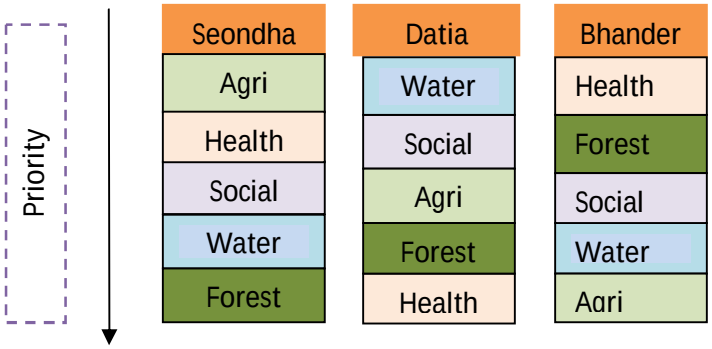


Fig. 16: Priority Areas to Address Sectoral Vulnerability in Different Blocks of Datia District

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 team 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 ‘top to bottom’ and ‘bottom to top’ the state of agriculture, water

and forest sectoral performance. Accordingly, blocks were ranked between1 to 4 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 lie (i) close to the forest and (ii) 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 252 households in Datia district for the study through questionnaires. This section describes the preliminary findings that emerged from the data and the profile of the sample.

The data, illustrated in the table below, indicated sensitivity and adaptive capacity based on the primary survey of four blocks of Datia district. The data indicated that the highest sensitivity was recorded in Datia block while its adaptive capacity was the highest. In order to capture the sensitivity, eight indicators were used (as given in Table 1). Each indicator of sensitivity also recorded their vulnerability in colour code and ranked 1 to 4. In case of Datia block, the sensitivity was slightly higher than that of Seondha block. As far as the sensitivity of Bhander and Indergarh was concerned, it was less than 0.5. Indergarh block was discovered to be the lowest in terms of sensitivity.

Among the eight parameters (Table 13) worked out to draw the sensitivity, it was recorded that in the case of Datia, only four parameters depicted a high vulnerability trend. Rest of them were distributed between rank 2 to rank 4. 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.

Table12.: Blockwise Vulnerability Index based on Primary Data (Sensitivity and Adaptive Capacity)

Block	Sensitivity	Adaptive Capacity
Seondha	0.49	0.36
Datia	0.54	0.50
Bhander	0.38	0.31
Indergarh	0.29	0.33

Rank 1	Rank 2	Rank 3	Rank 4

Table 13: Exposure and Adaptive capacity of the stakeholders

		Seondha	Datia	Bhander	Indergarh
Sensitivity	**Summary Statistics for Indicators of Household Profile**	0.38	0.36	0.39	0.52
Sensitivity	**Income, Occupation and Consumption Profile for the sample**	0.56	0.56	0.47	0.17
Sensitivity	**Sources of Income for the sample (Primary Income Source)**	0.42	0.34	0.50	0.63
Sensitivity	**Sources of Income for the sample (Secondary Income Source)**	0.50	0.50	0.50	0.50
Sensitivity	**Migration Profile of the sample**	0.36	0.57	0.25	0.32
Sensitivity	**Reason for Migration**	0.34	0.70	0.19	0.04
Sensitivity	**Ownership of Assets in the sample**	0.73	0.61	0.26	0.08
Sensitivity	**Land, Crop and Livestock Details for the sample**	0.66	0.71	0.50	0.08
Adaptive Capacity	**Benefit from Govt. Interventions**	0.40	0.528	0.17	0.53
Adaptive Capacity	**Funds Statement for Govt. Interventions for the sample**	0.02	0.86	0.29	0.32
Adaptive Capacity	**Coping Mechanism adopted through them**	0.47	0.62	0.11	0.24
Adaptive Capacity	**Adopted Coping Mechanism and their Average funds generated**	0.26	0.29	0.67	0.19
Adaptive Capacity	**Perception of households regarding farm based interventions and impacts**	0.44	0.36	0.40	0.42
Adaptive Capacity	**Schemes**	0.57	0.38	0.22	0.29
		Rank 1	Rank 2	Rank 3	Rank 4

The adaptive capacity ranks of four blocks of Datia (as depicted in Table 13) district revealed that the adaptive capacity of Datia block was the highest while the adaptive capacity of Seondha and Indergarh recorded a similar trend of adaptive capacity. In case of Bhander block, the adaptive capacity was slightly less.

The plausible regions of higher adaptive capacity might be the 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 Datia district (in the Annexure Table 1).

From Table 1, it can be observed that the blocks Datia and Seondha are the ones that are highly sensitive, having rank 1 and 2, whereas they rank 1 and 2 respectively in terms of their adaptive capacity, which is quite good.

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, 252 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 252 households, which have been further categorized in different social groups (General, Other Backward Class, Scheduled Tribe and Scheduled caste) in two villages. The average household size in the sample is approximately five members and two children. The age of the head of the household is around 40 to 47 years in different blocks, with the youngest head being 20 years of age and the oldest one aged 47 years. The level of education (number of years of education) is poor, with the average years of education being 10 years (Seondha) and the minimum and maximum varying from 4 to 10 years respectively in these blocks. A small proportion of the sample (0-2%) possesses technical education / privately trained skills of traditional knowledge, which is generally used for generation of secondary income. Approximately 37 percent (Indergarh) of the head of the households are reported of having dropped out of school during some stage of education. The primary reasons for dropping out include helping in household work, not being interested in continuing further studies and sometimes also due to the inability to pay the school fees.

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 0-3 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 49 to 87 percent of the households in the study area don't have this card. It emerges that the penetration of disaster / crop insurance in this region is negligible and further implies that majority households are excluded from the various government sponsored schemes to compensate against losses from climatic aberrations and extremes. Similarly, female headed households are very few in the sample, with only 0-16 percent households reporting to be headed by females.

(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 find 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 28457.45 (Datia) to INR 76970.15 (Seondha), which was INR 23,673.91 and INR 51,131.15 five years before respectively. Similarly, the average secondary income has also increased from INR 22130.43 (Datia) and INR 18,810.81 (Bhander) five years back to INR 20,363 and INR 11,282 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 around 12.95 percent (Datia) and 41.46.11 (Indergarh) percent during the last five years. Further, table 4 reveals that the consumption pattern of the households has exhibited challenging trends. The Datia block's average consumption profiling has increased around 15.9% whereas the increment in the case of Indergarh is only 38.1%.

While the average annual consumption in Datia block expenditure for the mean was INR 48,000 five years ago, it has increased to INR 57,136 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 6,373 five years ago, it has risen to INR 11,233 during the last year, exhibiting an increase of approximately 43 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 low of 35 days five years ago, the same has increased to 39 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 38.6 percent 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).

In the same vein, around 0-51.3 percent of the households either don't have any secondary source of income or depend on salaried employment as an income-supplementing activity in each block (Indergarh and Bhander are more vulnerable). A small proportion of households report the sale of assets (land, building and livestock) as a secondary source of income (which varies from 43 percent to 51 percent, such as Bhander (43%) and Datia (51%)).

(iii) **Migration Profile**: 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. 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 2-26 percent of the households in the sample have migrant members. Similarly, the number of migrating members in these households is also constant at 2-4 members per migrant household. In other words, the people who opted to migrate five years ago continue to do so even now. The average remittances from migrant members used to range from INR 12,500 (Seondha) – INR 40,000 (Indergarh) five years ago. Two percent (Datia) to 37 percent (Seondha) of the sample was reported of having migrated due to incidence of climatic aberrations and extremes like droughts and rainfall gaps five years ago. The average months of migration used to be around 1 month (Seondha) to 6 months (Bhander and Indergarh) whereas it used to be around 1- 3 months five year back. However, almost entire sample (98 percent) agreed that the level of migration has increased in their villages now as compared to earlier times. The places for migration have not changed over the last decade and migrant members generally travel within districts (seasonal migration) and almost none outside the state for seeking work. Around 16 percent (Datia) and 2 percent (Bhander) migrate to outside districts and states respectively for seeking employment (Annexure Table 7).

It can also be inferred from table 7 that the primary reason for migration is for employment in the lean season (2% in Bhander to 14% in Seondha), followed by 2 (Datia) to 23 (Datia) percent migrating for medical requirement and repayment of loans respectively. 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 the households state that migration has had no impact (neither on the economic or social front) of the family. It is important to note that around ten (Bhander) percent of the migrants opine that it has some positive economic impact on the family and around eight (Datia) percent feel that migration has led to a negative social impact on the family. Migration due to medical emergencies and health requirements has increased in the sample during the last five years.

(iv) **Living Conditions and Assets:** The source of water for drinking and cooking information 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 well and open dug well had reduced. Similar trends have been exhibited for sources of water for cooking. Although access to private 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 2.8 lakhs (Indergarh) to 13.4 lakhs (Seondha) but is skewed with high standard deviation and range varying between INR 0.79 – 2.3 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 6.4 lakh (Indergarh) to 10.6 lakh (Seondha) while that for homestead land is INR 55,822 (Indergarh) to INR 69,459.5 (Seondha) respectively. The average value of agricultural machinery and tools is also skewed and stands at a low of INR 26,954 (Indergarh) to INR 55,879 (Seondha), while the same for

electrical equipments and furniture is INR 26,495 to INR 71,112 respectively. An average inventory value of INR 1,61 to INR 6,20 is also owned by the households in the sample.

(v) **Land, Crop and Livestock Details**: The total agricultural land ownership in the sample has remained unchanged at 2.37 acres (Indergarh) to 3.13 acres (Bhander) over the last five years, but the skewness has slightly decreased in Datia, though a few households have reported a marginal increase in the ownership of land in the respective blocks, particularly in Seondha. However, the irrigated land has only increased in Indergarh and Bhander; and, the rest has remained the same over the years. While five years ago, the average irrigated land was 2.3 acres (Indergarh) to 3.6 acres (Datia), it has increased to 0.02 acres 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 almost doubled in Seondha and Indergarh over the last five years from INR 5,195 (during 2009) to INR 10,796 (in 2014) in case of Seondha. Correspondingly, the output value from crop production has slightly decreased during the said time. While it stood at INR 1,06,906 five years ago, the same has increased to approximately to INR 1,00,375 during the previous year. In Seondha, the ownership of big ruminants has also decreased from an average of 4 (in 2009) to 2 (in 2014) per household. The ownership of small ruminants though has changed with a decreasing trend over the years (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 (less than 10% in each block). However, the participation in other governmental programmes is very low in the study area, with less than one percent of the households benefitting from these interventions. Around one to twenty percent of the households in the sample have benefitted from the LP subsidy. AAY schemes have substantial beneficiaries in each block. 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 one member per household. Each beneficiary family has contributed around 12 man days (Bhander) to 49 man days (Datia) per annum in the programme and has received an income of approximately INR 1,717.5 to INR 6,033.3.5 respectively. Similarly, two percent of the household have received funds from the SRLM. From the different ongoing housing schemes, the average funds received amount to around INR 9,000.6 (Datia) and the rest of the blocks' respondents have not received the funds from SRLM. The beneficiary households, on an average, have received around INR 210.2 (Seondha) to INR 1,347.5 (Datia) from the LP subsidy, though the number of beneficiaries is quite small.

(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 summer

cropping season (June -October), when paddy is 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: use of loans and credit (25% in Datia and 93% in Indergarh) and selling of livestock (19% in Datia and 8.89% in Indergarh). Selling of land and Migration used to be the preferred coping mechanisms five years ago and though the households might not be responding positively, but the data reveals that dependency on govt. relief (which is negligible in all blocks) is not one of the coping mechanisms. 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 49 percent (Datia) of the sample has witnessed an increase in the groundwater level, with the average level of increase being around 0-9.87 feet over the last five to ten years. Similarly, 20-50 percent of the households have noticed a rise in the water holding capacity of the land and 2-24 percent report the increment in the number of cropping seasons respectively. Due to these interventions, 0-32 percent households report that there has been an increase in the level of farm output and revenue over last ten years. The value of crop loss due to climatic extremes has considerably decreased over the last decade. While the average value of crop loss stood at INR 25,184 five years ago, the same stands at INR 25,000 during the last drought season in Datia block. Similarly, the percentage and scale of crop loss has also reduced over the years. The average percentage of crop loss stood at 88 percent five to ten years ago, but it has risen to 1.5 percent during the previous drought like condition. The average recovery time for the households for the consumption loss has also decreased from 40-110 days during the previous decade to around 34-120 days now. In the same manner, the recovery time for the loss of income due to crop loss has also decreased from 40-180 days in earlier times to 34-213 days during the last drought event. Finally, a distinct proportion (2%) of the sample opines that crop failure has decreased over the years due to the interventions (governmental and non-governmental). Similarly, around one 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 Mitigating Climate Change in Datia

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 Bundelkhand Package	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 increases the area of irrigation	Participatory 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 GW regulation and management Adopt conversion-based model at panchayat/ block level using MNREGA or other associated fund		It is essential to identify the favourable areas for Ground water 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 rural areas (e.g. Grey	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 efficiency and productivity.	Schemes under Irrigation Department Command area Development Authority Department of Agriculture Watershed Management Programme Bundelkhand Package	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)

	water use in agriculture field, cleaning etc.)		Agriculture Dept. 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)	A sound knowledge base in the Natural and social dimensions can support decision and policy makers in implementing evidence based interventions.	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 Bundelkhand Package	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
apacity 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 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 & 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 Program, 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 & 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 program.	
	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 & method of sowing,. Ridge & Furrow method)	Crop can be secured under water stress and access condition Yield enhancement	RKVY, Integrated cereal development program, ISOPAM, National Food Security Mission	
	Conservation Agriculture technology.	Reduce cost of production, time saving and adding	Micro management in Agriculture	

	(e.g. After harvest of kharif crop sowing of rabi crop without land prepration to tap residual moisture)	carbon in soil Residual moisture conservation	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 balance use of fertilizer , 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 agri- 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 punchayat and other PRIS. Field visits Krishi Rath Training of farmers & 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 insects pests disease and weeds. New agriculture products. Publicity of Agriculture events.	Various government schemes initiated for dissemination of technology (e.g Dordarsaran, 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 program 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 rising temperature and reduction in water availability for irrigation
Development of agro-horticulture system for securing livelihood	1. Agri crops- vegetables (e.g Maize – lady finger/chilly) 2. Agri crops-fruits (e.g. Soybean – Papaya) 3. Agr crops- spices (e.g Gram – Coriander) 4. Agri 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 development program. 5. Development of Kitchen gardening	Crop diversification will facilitate assure income and employment for attracting and retaining youth in the village

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 CO2 & 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.
	Pamology, 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 program Promoting hybrid chilies	
Creating cooperatives for enhancing the livelihoods of marginal farmers	Seed producer company Co-operative Cold Storage Marketing Network	Strengthening of existing and new cooperatives can enhance the livelihood of small and marginal farmers Marketing strategy with cold storage linkages can reduce the wastages of produce and support better prices.	National Horticulture Mission Department of Agriculture	The producer seed companies of the farmers will facilitate the 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 strengthen for collection processing and market
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 under Bundelkhand special package	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 (upto 2 yearsof age) can be reduced Mineral mixture may be	i) National Mission for Protein. Supplements (NMPS)	Distribution of mineral mixture may be assured to improve Life expectancy.

		made available locally Knowledge dissemination on Nutritive feed need to be promoted	ii) Calf rearing scheme	Milk productivity and quality can be maintained Govt may establish animal feed plant at block level with equipped laboratory
Enhanced capacity for disease forecast, monitoring and management	Mass media Livestock practitioner Animal Camps (Rainy season, summer etc.)	To help animal rarers to 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 Datia	Creating life saving system for sick, non-domesticated livestocks	NA	Similar program like aasra need to be initiated
Promote research on native species breeding and rearing	Natural breeding of indigenous breed and upgradation of non-descriptive livestock Artificial Insemination	The improve breeds of animal can be made available which can sustain with extreme conditions and giving better yield performance.	i)Nandishala scheme ii)Sammunat Pashu Prajanan Karyakram	It imbibes the character of highly tolerant to heat. 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 Datia) 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 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 Datia.
Integrated approach to livestock	Crop-Livestock-manure (Cyclic) Crop-Poultry-manure-	The requirement of energy can be met out at local level through biogas	Indirect programs run by MP New	Self sufficient in energy generation and manure

development	energy (cyclic) Work is being done in coordination with MPWSRP		Renewable Energy Development to address the same	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 equi 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
Stregthen the extension arm of the Animal Husbandry department	Provide short term trainings		i)Establishment of training center 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 center 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 climate change cell to address the same.	The center will addressed 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 affoestration 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 HadRM3 using	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

	and forest based ecosystem services	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 occuring in Several communities need to be conserved and propagated in 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	considered to improve the model prediction because 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 Program (BAIF-NABARD)	Energy saving and efficiency by introducing solar and energy plantation can reduce the pressure

	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 cookstove.	Forest Department (Plantation programmes) National/State Bamboo Mission MP New and Renewable Energy Department programme State Rural Livelihood Mission and their schemes	on forest resources. 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 Program (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. Biodiversity register will indicate the availability of various species, likely to be extinct, climate and drought tolerant and futuristic vegetation growth.	Department of Forest - MP State Biodiversity Strategy and Action Plan, (2002) Madhya Pradesh Forest Produce (Conservation of Biodiversity and Sustainable Harvesting) Rules, (2005)	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 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 disseminated and transferred to a knowledge disseminating system which is principally an extension system engaged in diffusing the technology to the beneficiaries. So far, technologies related to agriculture, horticulture, animal husbandry etc. are a district level concern.

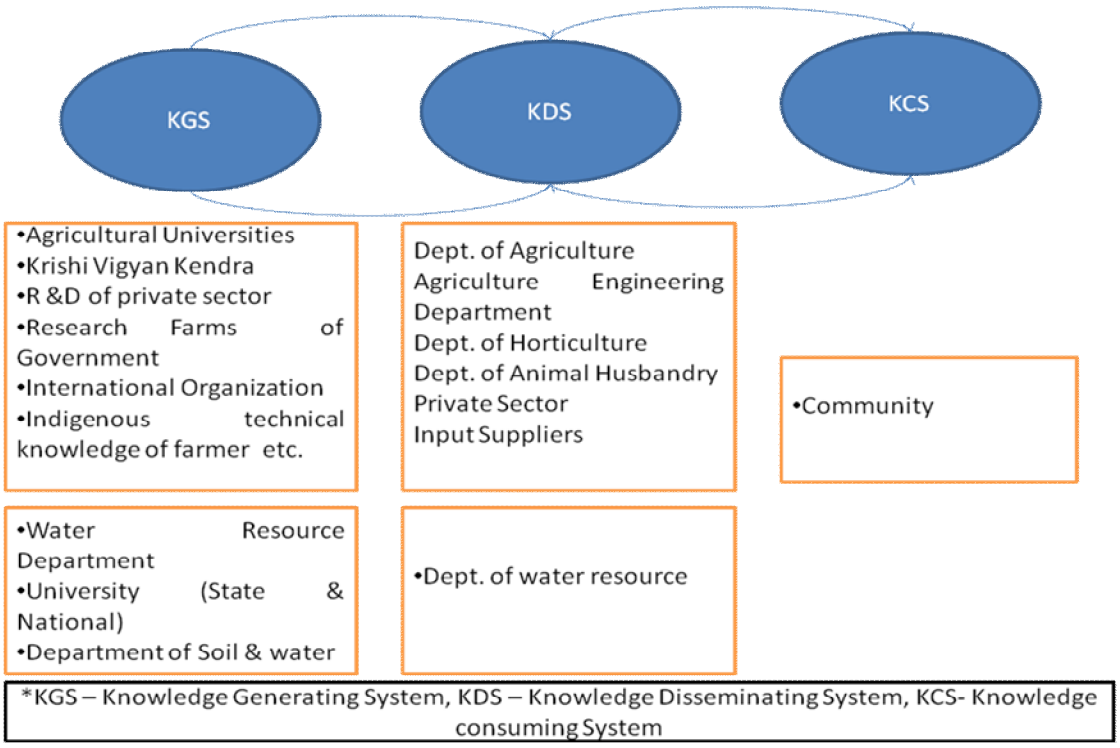


Figure 17. Institutional framework of knowledge generation, dissemination and consuming system

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 Datia 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 (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 contacts 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 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 technology reached 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. Constraint 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 remained 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 contacts of development agencies to the common stakeholders. The strategy for execution of the programme need 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 of 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 leave enormous scope for being ineffective and unaccountable.

Name of rivers and lakes:	Status
No. of dams, embankments:	Seven earthen dams on Lahar branch Canal, Lahar river and 22 earthen dams in Rajghat distributaries were completed where eight dams work has been ongoing process in Datia 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 is the source of drinking water. Provision of maintain hand pumps are 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 irrigation sector in the district even after huge investments, both by government and international agencies (roughly Rs. 167,384 crore on developing major and medium irrigation schemes alone till Tenth Five Year Plan)

- **Bio-social barrier**

  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 kind of policies in inter-sectoral water allocation is required at the basin level if water is very scarce at the aggregate level? People having a sound understanding of 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 forest ecosystem to climate change includes:- 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 and 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 load. 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[8] purpose in the areas viz., Datia and Seondha.

[8] 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, Forest in Datia district

The study has analyzed weather parameters viz. Rainfall, Temperature, Evaporation, Relative Humidity and wind velocity. It indicated that vulnerability related to weather was more sensitive in Seondha block followed by Bhander and Datia. The exposure value more than 0.50 indicates more stress conditions viz. Seondha block (0.78) and Bhander (0.52) in exposure table.

The impact has further compared with all the sectors and it was found the Seondha block ranked high vulnerable in Agriculture (Rank 1) and Health (Rank 2) Sector with high statistical value that clearly indicated the impact of climatic pressures. Overall composite vulnerability including social was also high in the block. It has been observed that on contrary to other sectors block has less vulnerability rank in Water (Rank 3) and Forest (Rank 3).

6.2. Stressors and underlying processes related to above threats

The comparative livelihood vulnerability analysis as shown, Seondha block ranked 1st in secondary and 2nd in primary analysis on sensitivity where as adaptive capacity was also high in Seondha block . Thereby, concluding that there was no significant variation in primary and secondary studies so far vulnerability and adaptive capacity were concerned. The analyzed stressors are mainly related to income, occupation, migration, assets owned by the people including agriculture, forest, water, health and social accessibility and affordability by the community.

The Seondha block was less sensitive in secondary data having 3rd rank where in primary data it was 2nd rank. The pattern of primary and secondary data in each blocks are less diverse. Thus it has given strength to our study by conducting 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)[9]. 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 effect was 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.

[9] 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 Datia and Seondha blocks was more visible as compare to Bhander block of Datia district. Increased visibility of research focused on vulnerability on sectoral issues with communities dimension 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.

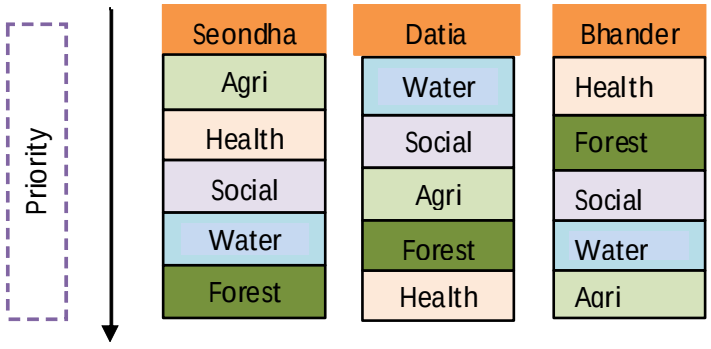
6.5. Coping mechanism for stakeholders/community

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 to climatic and weather aberrations. Some suggestions are need to be immediately taken into in 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, compensation for the damage cost by hail storm and erratic rainfall. The knowledge accumulated over centuries in the communities should be used for mitigation strategy at 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 Datia District:



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 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 aberrations. Departments (Agriculture and allied sector, horticulture, livestock, and local environment) of the district and local authorities, NGO's, 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 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 affects on landuse and microclimate, which cann'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 insure to be very effective in creating a common understanding of the linkages in the farming system.

Conversions to certified organic farming have emerging interest of growers. Organic can be more stable commodity today, but organic farming also helps farmers avoid vulnerability to fluctuating agrochemical 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 & 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 Datia district.

Training in sustainable land management, data base creation on GIS platform, river basin management, regular monitoring, water budgeting cum quality analysis both surface and subsurface were critically documented and raised in earlier vulnerability assessment report in Madhya Pradesh which should be prioritized and required immediate action.

The dealing above by region specific emphasis on water resource efficiency has obvious environmental co-benefits. It preserves water, resources, both agrobiodiversity and wild biodiversity (by preserving land). The adaptation cum mitigation project Enhanced Strategies for Climate-Resilient and environmentally sound agricultural production in River Basins of 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 provides that can be a good example of tapping potential synergies. As composite vulnerability focusing on a multiple issue (Social, Agriculture & 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 utilize nutrients, water and external inputs more efficiently. A Climate Smart Adaptation approach adds a more forward looking dimension, more concern about future potential changes and the need to be prepared for them.

7. References

- http://www.datia.nic.in
- http://www.mp.gov.in
- http://www.maharashtraweb.com/MadhyaPradesh/MadhyaPradeshculture.htm
- http://www.health.mp.gov.in
- http://nrega.nic.in/homedist.asp?check=1andstate_name=MADHYA%20PRADESHandstate_
- code=17anddistrict_name=DATIAanddistrict_code=1707andfin_year=2008-2009
- planningcommission.nic.in/reports/sereport/ser/seeds/seed_agri.pdf
- http://www.mpmandiboard.com/comp/comp1.htm
- http://www.mpmining.org/index.html
- www.planningcommission.nic.inreportssereportserbndelstdy_bndel.pdf
- www.health.mp.gov.insurvey.HTM
- www.planningcommission.nic.inreportssereportserbndelstdy_bndel.pdf
- http://www.mppcb.nic.in/RWH.htm - Madhya pradesh pollution control board .
- http://cgwb.gov.in/NCR/GWmonitoring.htm
- http://mpforest.org//developmentscheme.html
- EPCO (2014) Vulnerability Assessment of Madhya Pradesh towards Climate Change, State Knowledge Management Centre on Climate Change (SKMCCC), Environment Planning and Coordination Organization (EPCO), Bhopal
- Ummed Singhoya (2014) District Disaster Management Plan [DDMP] Datia, Madhya Pradesh, Indian Institute of Technology Kanpur, In consultation with School of Good Governance & Policy Analysis, Bhopal Seeds Technical Services, Government of Madhya Pradesh, District Administration, Jhabua

8. Annexures

Appendix (Tables)

Table 1: Study Blocks in Datia

Sl. No.	Study Blocks in Datia District	Performance of overall Sensitivity Rank	Performance of overall Adaptive Capacity Rank
1	Seondha	2 (0.49)	2 (0.36)
2	Datia	1 (0.54)	1 (0.50)
3	Bhander	3 (0.38)	3 (0.31)
4	Indergarh	4 (0.29)	4 (0.33)

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**	**N**	**Social groups**
1	Seondha	Tharet	37	G-6,OBC-18,SC-13,ST-0
2		Mangrol		
3	Datia	Chirula	114	G-20,OBC-40,SC-34,ST-20
4		Udguwan		
5	Bhander	Salon	56	G-5,OBC-27,SC-24,ST-0
6		Deguva		
7	Indergarh	Pipraua	45	G-5,OBC-15,SC-25,ST-0
8		Badheri		

Table 3: Summary Statistics for indicators of Household Profile

	Seondha				Datia				Bhander				Indergarh			
Indicators	Mean	Std. Dev.	Max	Min	Mean	Std. Dev.	Max	Min	Mean	Std. Dev.	Max	Min	Mean	Std. Dev.	Max	Min
Age of the Head	42.19	9.80	62.00	25.00	47.13	12.22	76.00	20.00	41.84	12.32	75.00	23.00	40.49	8.47	65.00	26.00
Number of Years of Education of the Head	10.03	2.69	15.00	5.00	4.36	4.13	12.00	0.00	6.66	4.19	15.00	0.00	7.33	3.30	15.00	0.00
Training in Technical Education / Privately Trained Skills / Traditional Knowledge	0.00	0.00	2.00	2.00	0.01	0.09	2.00	1.00	2.00	0.00	2.00	2.00	2.00	0.00	2.00	2.00
Membership in SHG	0.00	0.00	2.00	2.00	0.00	0.00	2.00	2.00	1.98	0.13	2.00	1.00	1.98	0.15	2.00	1.00
School Dropouts	30.00	0.40	2.00	1.00	0.37	0.49	2.00	1.00	1.09	0.29	2.00	1.00	1.16	0.37	2.00	1
Possession of Kisan Credit Card (KCC)	27.03	0.45	2.00	1.00	33.04	0.47	2.00	1.00	12.50	0.37	3.00	1.00	51.11	0.51	2.00	1.00
Female Headed Households	0.00	0.00			24.3	0.43			1.79	0.13			2.22	0.15		

Table 4: Income Occupation and Consumption Profile for the Sample

	Seondha				Datia				Bhander				Indergarh			
Indicators	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	76970.15	141332.72	1000000.00	15000.00	28457.45	31703.49	190000.00	2000.00	58358.70	83858.00	600000.00	1800.00	30714.29	21119.39	110000.00	4000.00
Primary Income 5 Years Back	51131.15	100996.94	700000.00	10000.00	23673.91	24387.49	130000.00	1000.00	38320.45	54799.92	450000.00	1800.00	18553.33	14412.42	70000.00	1800.00
Secondary Income Now	17391.30	5702.78	36000.00	10000.00	22130.43	21795.86	180000.00	4000.00	18810.81	6728.21	40000.00	5000.00	15146.34	7588.02	40000.00	4000.00

Secondary Income 5 Years Back	10304.35	2991.42	20000.00	5000.00	20363.64	21296.58	165000.00	4000.00	11282.05	3691.73	24000.00	3000.00	8292.68	4124.58	24000.00	2000.00
Total Income Now	94361.45	99395.89	1036000.00	25000.00	50587.88	37957.10	370000.00	6000.00	77169.51	60954.27	640000.00	6800.00	45860.63	25836.02	150000.00	8000.00
Total Income 5 Years Back	61435.50	67305.60	720000.00	15000.00	44037.55	24396.88	295000.00	5000.00	49602.51	39038.41	474000.00	4800.00	26846.02	15850.04	94000.00	3800.00
Annual Consumption Expenditure Now	47540.54	19591.09	130000.00	25000.00	57135.96	27261.95	180000.00	30000.00	38250.00	14137.31	84000.00	16000.00	38857.78	17234.99	84000.00	18000.00
Annual Consumption Expenditure 5 Years Back	23770.27	9795.55	65000.00	12500.00	48000.00	82828.86	900000.00	11000.00	23692.86	8966.44	52000.00	13000.00	26233.33	18039.45	123000.00	12000.00
Medical Expenditure Now	2670.27	773.83	4500.00	1500.00	11233.38	25928.28	36000.00	1000.00	4064.29	1778.81	10500.00	1700.00	3920.00	1976.98	9000.00	1400.00
Medical Expenditure 5 Years Back	1335.14	386.92	2250.00	750.00	6373.68	14196.55	10000.00	1000.00	2766.07	1346.01	8000.00	700.00	2493.33	1396.00	8000.00	600.00
Total Loss in Wage Days Now	69.62	15.52	95.00	40.00	39.67	26.59	120.00	10.00	76.07	22.40	140.00	35.00	67.18	26.32	140.00	28.00
Total Loss in Wage Days 5 Years Back	69.89	15.08	95.00	40.00	34.95	26.67	100.00	10.00	72.77	24.42	140.00	20.00	61.07	27.91	140.00	20.00

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

Activities	Seondha		Datia		Bhander		Indergarh	
	Primary Income Source (%)		Primary Income Source (%)		Primary Income Source (%)		Primary Income Source (%)	
	LY	5YB	LY	5YB	LY	5YB	LY	5YB
Agriculture and Allied	28.5	31.6	38.6	48.0	39.0	42.0	24.9	22.8
Salaried	18.4	18.9	15.9	15.6	17.0	19.0	18.9	15.6
Business	33.5	39.1	17.3	0.0	11.3	0.0	14.3	11.9
Sale of Assets	19.6	10.4	28.2	36.4	31.0	37.4	38.9	47.6
Income from Govt. Schemes	0.0	0.0			0.0	0.0	0.0	0.0
Rents	0.0	0.0	0.0	0.0	1.7	1.7	3.1	2.1
Others	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

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

Activities	Seondha		Datia		Bhander		Indergarh	
	Secondary Income Source (%)		Secondary Income Source (%)		Secondary Income Source (%)		Secondary Income Source (%)	
	LY	5YB	LY	5YB	LY	5YB	LY	5YB
Agriculture and Allied	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Salaried	51.6	51.2	48.7	47.6	56.1	53.3	100.0	100.0
Business	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sale of Assets	48.4	48.8	51.3	52.4	43.9	46.7	0.0	0.0
Income from Govt. Schemes	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rents	0.0	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
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 6: Migration Profile of the Sample

	Seondha				Datia				Bhander				Indergarh			
Indicators	**Mean**	**SD**	**Min**	**Max**	**Mean**	**SD**	**Min**	**Max**	**Mean**	**SD**	**Min**	**Max**	**Mean**	**SD**	**Min**	**Max**
Migration Last Year	0.13	0.40	1.00	2.00	0.26	0.44	1.00	2.00	0.05	0.23	1.00	2.00	0.02	0.15	1.00	2.00
Number of Migrants Last Year	0.13	0.40	0.00	1.00	0.07	1.87	0.00	12.00	0.05	0.23	0.00	1.00	0.02		1.00	1.00
Migration Last 5 Years Back	0.07	0.31	1.00	2.00	0.24	0.44	1.00	2.00	0.04	0.96	0.00	2.00	0.02	0.15	1.00	2.00
Number of Migrants 5 Years Back	0.07	0.31	0.00	1.00	0.07	1.74	0.00	10.00	0.04	0.19	0.00	1.00	0.02		1.00	1.00
Remittance from Migration Last Year	46857.14	34594.93	96000.00	15000.00	42225.81	24249.69	120000.00	18000.00	0.04	40624.29	96000.00	15000.00	50000.00		50000.00	50000.00
Remittance from Migration 5 Years Back	12500.00	5000.00	20000.00	10000.00	36813.79	20950.75	86000.00	15000.00	25333.33	13613.72	36000.00	10000.00	40000.00		40000.00	40000.00
Migration due to Climatic Aberrations / Extremes Last Year	37.00	0.00	1.00	1.00	0.84	0.32	2.00	1.00	0.00	0.00	2.00	2.00	0.00	0.00	2.00	2.00
Migration due to Climatic Aberrations / Extremes 5 Years Back	37.00	0.00	1.00	1.00	0.85	0.32	2.00	1.00	0.00	0.00	2.00	2.00	0.00	0.00	2.00	2.00
Months of Migration Last Year	37.84	92.37	0.00	365.00	160.21	56.18	70.00	340.00	186.67	120.55	60.00	300.00	180.00		180.00	180.00
Months of Migration 5 Years Back	15.68	46.64	0.00	180.00	155.76	42.84	90.00	280.00	136.67	70.95	60.00	200.00	100.00		100.00	100.00
Notice Reduction in Migration for Village	2.00	0.00	2.00	2.00	8.81	21.45	1.00	90.00	2.00	0.00	2.00	2.00	0.80	0.08	0.65	0.90

Table 7: Places and Reasons of Migration

	Seondha		Datia		Bhander		Indergarh	
Place of Migration	**Last Year (%)**	**5 Years Back (%)**	**Last Year (%)**	**5 Years Back (%)**	**Last Year (%)**	**5 Years Back (%)**	**Last Year (%)**	**5 Years Back (%)**
Within District	0.16	0.05	0.01	0.01	0.02	0.02	0.00	0.00
Outside District	0.03	0.05	0.08	0.06	0.02	0.02	0.02	0.00
Outside State	0.00	0.00	0.16	0.15	0.02	0.02	0.00	0.00
Type of Work	**Last Year (%)**	**5 Years Back (%)**	**Last Year (%)**	**5 Years Back (%)**	**Last Year (%)**	**5 Years Back (%)**	**Last Year (%)**	**5 Years Back (%)**
Unskilled	0.19	0.08	0.22	0.19	0.02	0.02	0.02	0.02
Semiskilled	0.00	0.03	0.02	0.02	0.04	0.04	0.00	0.00
Skilled	0.00	0.00	0.02	0.02	0.00	0.00	0.00	0.00
Reason for Migration	**Last Year (%)**	**5 Years Back (%)**	**Last Year (%)**	**5 Years Back (%)**	**Last Year (%)**	**5 Years Back (%)**	**Last Year (%)**	**5 Years Back (%)**
Employment in Lean Season	0.14	0.11	0.00	0.00	0.02	0.02	0.02	0.02
Medical Requirement	0.00	0.00	0.23	0.20	0.00	0.00	0.00	0.00
Repay Loan	0.00	0.00	0.02	0.02	0.00	0.00	0.00	0.00
Others	0.05	0.00	0.01	0.01	0.00	0.00	0.00	0.00
Economic Impact	**Last Year (%)**	**5 Years Back (%)**	**Last Year (%)**	**5 Years Back (%)**	**Last Year (%)**	**5 Years Back (%)**	**Last Year (%)**	**5 Years Back (%)**
No Impact			0.18	0.16	0.00	0.00	0.02	0.02
Positive			0.01	0.01	0.10	0.10	0.00	0.00
Negative			0.06	0.03	0.00	0.00	0.00	0.00

Social Impact	Last Year (%)	5 Years Back (%)	Last Year (%)	5 Years Back (%)	Last Year (%)	5 Years Back (%)	Last Year (%)	5 Years Back (%)
No Impact	0.11	0.05	0.04	0.03	0.00	0.00	0.02	0.02
Positive	0.00	0.00	0.08	0.08	0.05	0.05	0.00	0.00
Negative	0.05	0.03	0.14	0.10	0.00	0.00	0.00	0.00

Table 8: Ownership of Assets in the sample

Items	Seondha				Datia				Bhander				Indergarh			
	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	1060937.50	1791680.34	9000000.00	100000.00	667943.93	1672178.41	15210000.00	40000.00	745212.77	820054.98	4000000.00	100000.00	644318.18	594080.87	2000000.00	100000.00
Homestead Land	69459.46	40990.92	200000.00	20000.00	97052.63	101621.18	800000.00	10000.00	78888.89	50203.99	300000.00	20000.00	55822.22	28535.69	150000.00	2000.00
Land Building and Water Bodies	12652.17	998.58	15000.00	11000.00	6600.00	2366.43	10000.00	5000.00	18945.45	766.93	21000.00	18000.00	15380.95	6544.11	27000.00	9000.00
Agricultural Machinery and Tools	55879.52	11215.45	68235.29	41823.53	39938.02	8591.64	61223.53	27317.65	30708.24	10829.54	51176.53	18588.29	26954.63	1437.09	41647.12	17382.41
Means of Transport	69702.38	17008.31	114785.71	61571.43	81692.47	1562.39	83714.29	76571.43	7696.35	2428.98	14857.14	3785.71	9719.78	955.35	12071.43	8071.43
Electrical Equipments	71112.50	6296.48	82100.00	61620.00	56473.49	32981.33	146800.00	20551.00	30097.19	8955.30	56550.00	18360.00	26495.56	6408.55	38400.00	15950.00
Furniture	2912.76	839.51	2654.17	1288.24	3678.66	2089.69	8333.33	1255.78	2135.41	923.51	2833.33	811.11	1700.38	945.47	2688.24	460.00
Inventory	620.78	919.08	2000.00	50.00	1506.08	1363.65	2976.19	152.38	211.68	85.46	147.62	35.71	161.82	57.36	107.14	26.19

Total Assets	1343277.08	233743.58	1185596.90	37169.15	954885.28	227844.34	2040380.92	22606.03	913895.98	111781.09	555820.58	22447.60	780553.52	79870.56	283989.24	19111.25
Note: INR in Current Prices																

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

Indicators	**Seondha**				**Datia**				**Bhander**				**Indergarh**			
	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	3.43	6.47	34.00	0.60	3.83	5.40	50.00	0.50	3.13	2.78	18.00	0.70	2.37	1.37	6.00	0.50
Total Land for Farming 5 Years Back	3.35	6.37	34.00	0.60	3.84	5.47	50.00	0.50	3.11	2.78	18.00	0.70	2.35	1.34	6.00	0.50
Irrigated Land Now	3.35	6.38	34.00	0.60	3.58	5.28	50.00	0.00	3.13	2.78	18.00	0.70	2.33	1.33	6.00	0.50
Irrigated Land 5 Years Back	3.35	6.38	34.00	0.60	3.58	5.28	50.00	0.00	3.11	2.78	18.00	0.70	2.30	1.30	6.00	0.50
No. of Crops Cultivated Now	2.00	0.00	2.00	2.00	1.96	0.19	2.00	1.00	1.94	0.24	2.00	1.00	1.95	0.21	2.00	1.00
No. of Crops Cultivated 5 Years Back	2.00	0.00	2.00	2.00	1.96	0.19	2.00	1.00	1.94	0.24	2.00	1.00	1.95	0.21	2.00	1.00
Input Cost for Crops Now	10796.88	18853.33	100000.00	2800.00	46964.42	21361.43	300000.00	4000.00	32402.04	19834.76	252000.00	3000.00	20147.29	7906.21	73000.00	3050.00
Input Cost for Crops 5 Years Back	5195.59	9173.60	50000.00	1400.00	35662.80	34192.54	243000.00	5700.00	17908.25	17507.85	101000.00	1600.00	10329.10	8428.22	35800.00	1550.00
Total Production Value Now	100375.00	215208.04	1000000.00	20000.00	44235.85	35698.16	190000.00	5000.00	97163.27	106491.07	600000.00	16000.00	56750.00	27875.24	120000.00	23000.00
Total Production Value 5 Years Back	106906.25	331053.78	1825000.00	10000.00	38457.55	30216.92	165000.00	5000.00	62755.10	68366.82	450000.00	10000.00	33818.18	17154.93	70000.00	10000.00

No. of Big Ruminants Now	2.73	1.67	6.00	1.00	3.83	2.80	16.00	1.00	2.59	1.88	12.00	1.00	2.24	2.17	12.00	1.00
No. of Big Ruminants 5 Years Back	4.53	3.41	15.00	2.00	5.92	4.30	20.00	1.00	2.67	1.90	8.00	1.00	2.25	1.65	8.00	1.00
No. of Small Ruminants Now	4.86	2.12	8.00	2.00	4.64	4.54	20.00	1.00	7.17	9.70	25.00	1.00	2.00	0.71	3.00	1.00
No. of Small Ruminants 5 Years Back	15.00	7.07	25.00	5.00	13.71	22.16	100.00	1.00	18.43	22.53	65.00	2.00	7.83	6.49	20.00	2.00

Table 10: Benefit from Govt. Interventions

	Seondha		Datia		Bhander		Indergarh	
Govt. Interventions	**Yes (%)**	**No (%)**	**Yes (%)**	**No (%)**	**Yes (%)**	**No (%)**	**Yes (%)**	**No (%)**
Participation in MGNREGA	0.00	100.00	13.79	83.62	7.14	92.86	8.89	91.11
Participation in SRLM	0.00	100.00	0.00	98.28	0.00	100.00	2.00	88.00
Participation in IAY / RAY / BAY	0.00	66.07	0.86	96.55	0.00	100.00	0.00	100.00
Participation in AAY	72.97	27.03	49.14	48.28	55.36	44.64	73.33	26.67
LPG Subsidy	18.92	81.08	12.07	86.21	1.79	98.21	0.00	100.00

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

	Seondha				Datia				Bhander				Indergarh			
	Mean	**Std. D...**	**Max**	**Min**	**Mean**	**Std. D...**	**Max**	**Min**	**Mean**	**Std. D...**	**Max**	**Min**	**Mean**	**Std. D...**	**Max**	**Min**
No. of Members participated in MGNREGA	0.00	0.00	0.00	0.00	1.44	0.51	2.00	1.00	1.00	0.00	1.00	1.00	1.00	0.00	1.00	1.00
No. of Man-days contributed in MGNREGA	0.00	0.00	0.00	0.00	49.33	38.21	130.00	10.00	12.67	8.74	20.00	3.00	11.75	2.36	15.00	10.00
Income from MGNREGA	0.00	0.00	0.00	0.00	6033.33	3326.87	11000.00	1600.00	1786.67	1271.43	2800.00	360.00	1717.50	337.48	2200.00	1470.00
Whether received any funds from SRLM	0.00	0.00	2.00	2.00	0.00	0.00	2.00	2.00	1.79	0.00	2.00	1.00	2.22	0.15	2.00	1.00

Funds received from IAY / RAY / BAY / Mo Kudia	0.00	0.00	0.00	0.00	9000.60	20124.28	45000.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Man-days contributed to IAY / RAY / BAY	0.00	0.00	0.00	0.00	30.00	0.00	30.00	30.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Funds contributed IAY / RAY / BAY / Mo Kudia	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
Funds received from LP Subsidy	210.16	405.66	972.00	0.00	1347.50	193.33	1612.00	1000.00	14.14	105.84	792.00	0.00	0.00	0.00	0.00	0.00

Means of Coping	**Seondha**				**Datia**				**Bhander**				**Indergarh**			
	Present Times		**5 Years Back**		**Present Times**		**5 Years Back**		**Present Times**		**5 Years Back**		**Present Times**		**5 Years Back**	
	%	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**
Selling of Livestock	0.00	0.00	0.00	0.00	19.83	0.00	23.28	0.00	3.00	5.36	0.00	0.00	8.89	0.00	0.00	0.00
Sold Household Assets	0.00	0.00	0.00	0.00	1.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Use of Loans and	48.65	0.00	42.00	0.00	25.00	0.97	24.14	1.00	45.00	80.36	25.00	44.64	93.33	0.00	26.67	0.00
Selling of Land	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
Govt. Relief	0.00	0.00	0.00	0.00	0.86	2.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Transfers from Friend	0.00	0.00	0.00	0.00	1.72	0.00	0.86	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Use Past Savings	78.38	0.00	36.00	0.00	9.48	3.05	11.21	3.06	32.00	57.14	20.00	35.71	26.67	0.00	97.78	0.00
Migration	18.92	0.00	4.00	0.00	6.90	3.45	6.03	3.60	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

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

Means of Coping	Seondha				Datia				Bhander				Indergarh			
	Present Times		5 Years Back		Present Times		5 Years Back		Present Times		5 Years Back		Present Times		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.
Selling of Livestock	0.00	0.00	0.00	0.00	19619.05	21816.22	26946.43	19447.15	46666.67	46188.02	0.00	0.00	48600.00	47432.06	0.00	0.00
Sold Household Assets	0.00	0.00	0.00	0.00	8000.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Use of Loans and Credit	86666.67	130811.94	18153.85	17793.13	28191.78	37630.76	19065.57	25949.87	9680.43	6516.60	12400.00	6474.31	6866.67	4472.01	9454.55	2621.59
Selling of Land	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
Govt. Relief	0.00	0.00	0.00	0.00	36666.67	30550.50	35000.00	21213.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Transfers from Friend and Relatives	0.00	0.00	0.00	0.00	5000.00	0.00	5000.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Use Past Savings	4931.03	2871.42	4972.22	2804.79	13384.62	9646.04	12307.69	10971.85	11954.55	7876.35	4475.00	2130.45	14615.38	4770.37	8000.00	2602.45
Migration	46857.14	34594.93	10000.00	0.00	29600.00	15945.74	23046.15	12642.30	53666.67	40624.29	25333.33	13613.72	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

Table 13: Perception of households regarding farm based interventions and impacts

Description of Activities	**Seondha**				**Datia**				**Bhander**				**Indergarh**			
	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	0.32	0.47	0.00	0.00	0.38	0.49	0.08	0.27	0.31	0.41	0.00	0.29	0.71	0.46	0.09	0.29
Average Ground Water increase in feet	8.92	3.73	0.00	0.00	9.87	4.37	1.86	0.38	5.32	4.68	0.00	0.00	6.50	3.47	0.00	0.00
Building Field/ Contour Bunding or Check Dams in the field	0.00	0.00	0.00	0.00	0.09	0.28	0.09	0.28	0.55	0.49	0.29	0.47	0.00	0.00	0.00	0.00
Increase in water holding capacity of land	0.22	0.42	0.00	0.00	0.03	0.18	0.39	0.49	0.45	0.51	0.09	0.31	0.00	0.00	0.00	0.00
Use Drought-Tolerant Last Year Varieties for different crop products	0.00	0.00	0.00	0.00	0.01	0.09	0.01	0.09	0.00	0.00	0.00	0.00	0.02	0.15	0.02	0.15
Introduce farming diversification by rearing small ruminants																
Increase the number of cropping seasons	0.00	0.00	0.00	0.00	0.01	0.09	0.01	0.09	0.05	0.24	0.04	0.20	0.04	0.36	0.00	0.00

Noticeable increase in farm output	0.00	0.00	0.00	0.00	0.01	0.09	0.01	0.09	0.32	0.49	0.13	0.35	0.00	0.00	0.00	0.00
Increase in revenue from sale of agricultural outputs	0.00	0.00	0.00	0.00	0.41	0.50	0.41	0.50	0.88	0.00	0.43	0.51	0.00	0.00	0.00	0.00
Value of crop Loss in INR for previous drought like condition	24162.16	45635.34	15388.89	28170.17	25184.21	26316.51	25000.00	32918.24	32973.21	22460.96	0.00	0.00	33727.27	20388.51	0.00	0.00
Percentage of Crop Loss for previous drought like condition	0.86	0.35	0.86	0.35	0.89	0.25	0.88	0.26	0.88	0.00	0.00	0.00	0.96	0.21	0.00	0.00
Did you Insure the Crop?	0.04	0.00	0.04	0.00	0.04	0.14	0.04	0.14	0.13	0.21	0.02	0.00	0.00	0.00	0.00	0.00
Recovery time for consumption loss in months for previous drought like condition	3.62	0.89	4.32	1.06	3.59	1.32	3.92	1.40	12.00	0.00	0.00	0.00	4.00	1.35	4.36	1.14
Recovery time for income	4.57	1.17	5.00	1.08	6.35	3.65	7.01	4.33	12.00	0.00	0.00	0.00	2.00	0.00	2.00	0.00
Do you think crop loss is reducing?	2.00	0.00	2.00	0.00	1.97	0.16	1.97	0.16	2.00	0.00	2.00	0.00	2.00	0.00	2.00	0.00
Do you think rainfall gaps are increasing over the years?	1.00	0.00	0.00	0.00	0.58	0.50	0.00	0.00	0	0	0	0	1.00	0.00	0.00	0.00

Table 14: Responses on Existing schemes in Madhya Pradesh

Agriculture/ Livestock/Water																
	Seondha				Datia				Bhander				Indergarh			
	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	
Government Schemes	%	Stdev	%	Stdev	%	Stdev	%	Stdev	%	Stdev	%	Stdev	%	Stdev	%	Stdev
Seed Village Programme	100.00	0.00	97.30	0.16	43.10	0.00	43.10	0.00	100.00	0.00	98.21	0.00	100.00	0.00	91.11	0.00
Integrated Cereal (coarse cereal) Development Programme	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
Integrated Plant Nutrient Management & balanced use of fertilizer	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
National Watershed Development Programme	2.70	0.00	2.70	0.00	24.14	0.00	24.14	0.00	1.79	0.00	1.79	0.00	2.22	0.00	2.22	0.00
(1) Wheat	100.00	0.00	100.00	0.00	98.28	0.00	43.10	0.00	100.00	0.00	100.00	0.00	100.00	0.00	100.00	0.00
(2) Pulses	0.00	0.00	0.00	0.00	41.38	0.00	41.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Micro Irrigation Projects	0.00	0.00	0.00	0.00	6.90	0.00	6.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Balram Talab Yojana	0.00	0.00	0.00	0.00	2.59	0.00	2.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Soil Testing Programme	100.00	0.00	100.00	0.00	96.55	0.00	41.38	0.00	100.00	0.00	100.00	0.00	100.00	0.00	100.00	0.00
Crop Insurance Scheme	100.00	0.00	100.00	0.00	40.52	0.00	40.52	0.00	100.00	0.00	100.00	0.00	100.00	0.00	100.00	0.00
Promote Farm Mechanization	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
Establishment of Custom Hiring Centres	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
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	0.00	0.00	0.00	0.00
Goat Rearing Scheme	0.00	0.00	0.00	0.00	24.14	0.00	24.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fodder/Forage Development 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	0.00	0.00	0.00	0.00
Special Animal Husbandry for Hybrid Calf	91.89	0.00	91.89	0.00	0.00	0.00	0.00	0.00	94.64	0.00	94.64	0.00	80.00	0.00	80.00	0.00
Fruit Development Programme	0.00	0.00	0.00	0.00	57.76	0.00	2.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Vegetable Development Programme	0.00	0.00	0.00	0.00	90.52	0.00	35.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Condiment and Species Development Programme	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
Greenhouse and Net House Development Programme	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
Kitchen Garden	2.70	0.00	2.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.67	0.00	6.67	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	0.00	0.00	0.00	0.00
Demonstration/ Mini-kit Scheme for horticultural crops	1.00	0.00	1.00	0.00	39.66	0.00	39.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Protected cultivation of horticultural crops	2.00	0.00	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
Farmers' Training cum Field Visit Programme	3.00	0.00	3.00	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
Crop Insurance based on season	4.00	0.00	4.00	0.00	55.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Others	5.00	0.00	5.00	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)	6.00	0.00	6.00	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
Capacity Building in forestry scheme: human resource	7.00	0.00	7.00	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	8.00	0.00	8.00	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

Intensification of Forest Management Scheme: management of forest areas, strengthen infrastructure, control forest fires, etc.	9.00	0.00	9.00	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	10.00	0.00	10.00	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	2.70	0.00	2.70	0.00	0.00	0.00	0.00	0.00	1.79	0.00	1.79	0.00	11.11	0.00	11.11	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

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