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India Water Partnership

Water & Climate Resilience Programme *(WACREP), India*

Report on
Vulnerability and Adaptation Assessment of Datia District, Bundelkhand Region, Madhya Pradesh

Activity No. 3.6.3: *Climate Adaptive Planning, Capacity building and Training Programs*

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EXECUTIVE SUMMARY

India Water Partnership (GWP-India) with the support of Development Alternatives (DA) launched the WACREP initiative in Datia district, situated in the semi-arid Bundelkhand region of Madhya Pradesh. The objective of this initiative under the WACREP programme is **mainstreaming climate change concerns into development planning**. The initiative aimed to integrate climate change adaptation in development planning processes of Madhya Pradesh.

In order to achieve climate resilience in planning processes, it has been considered important to first understand the underlying locale specific vulnerabilities to climate change. Considering the local sensitivities to climate change, this vulnerability assessment report has been developed for Datia district of Madhya Pradesh. This is a comprehensive combination of top-up and bottom-up vulnerability assessment and provides a holistic picture of the climate change sensitivities and existing coping capacities of communities in Datia district of Madhya Pradesh. The study indicates that temperature and precipitation patterns in the study region show uneven fluctuations over the past 20 years. This is not definitive of climate change but shows clear trends of climate variabilities in the district. Bottom-up primary consultations reveal that the current state of the farming community is alarming and any productivity decline would result in mass scale migration to urban areas, worsening an already precarious labor shortage in the rural regions. Farmers have taken up a number of coping measures prominently, shifting to crops which require lesser water and diversification into trade of vegetables. Forests in Datia district have shown high vulnerability to climate change and the district has been ranked highest with respect to forest vulnerability in the state of Madhya Pradesh. This is an area of serious concern and demands serious actions.

Thus, it is clear that Datia has high exposure to climatic variability and extremes, the farming community has very low adaptive capacities and the social capital has depleted due to long term climatic stress particularly in the last five years. Financially, the farmers are under debt primarily resulting from inability to pay back old loans. Additionally, the study has found that the farming community, particularly women, do not have access to information and the linkages with the institutional set up at the grassroots is weak.

Therefore, there is a clear need for assistance to adapt to climate change in the agriculture and forest sector. The study has identified a set of short/medium term and long term adaptation options including no cost options. Capacity enhancement of the institutional structure within the district is critical for successful implementation of a climate change adaptation project as is cross departmental coordination.

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1. INTRODUCTION

1.1. Purpose & Approach

India Water Partnership (GWP-India) with the support of Development Alternatives (DA) launched the WACREP initiative in Datia district, situated in the semi-arid Bundelkhand region of Madhya Pradesh. The objective of this initiative under the WACREP programme was to "**Mainstream Climate Change Concerns into Development Planning**". The aims to integrate climate change adaptation in development planning processes of Madhya Pradesh. In order to achieve climate resilience in planning processes, it is very important to first understand underlying locale specific vulnerabilities to climate change. This is a detailed assessment report has been developed to identify key climate change vulnerabilities in Datia district of Madhya Pradesh. The prime objective of vulnerability assessments is to identify people or places that are most susceptible to harm due to climate. Identification of such target groups and their specification in terms of enhanced sensitivity or low adaptive capacity to the exposure helps decision makers to recommend or implement specific policies to reduce the vulnerability. Specific district level assessments on climate change provide the necessary evidences for planning adaptation and mitigation against climate change. It will particularly help to design adaptation strategies for weaker and vulnerable sections of the society and will move the planning processes towards climate resilience.

1.2. General Context

Climate Change in India

India is the seventh largest country in the world with nearly 700 million rural populations directly dependent on climate sensitive sectors (agriculture, forests and fisheries) and natural resources (such as water, biodiversity, mangroves, coastal zones, grasslands) for their subsistence and livelihoods. It is particularly vulnerable to climate change owing to its geographic diversity, stronger dependence on agriculture, increasing exploitation of natural resources coupled with population growth and socio-economic challenges. In coming future, climate change may alter the distribution and quality of India's natural resources and adversely affect the livelihoods of its people by affecting the agricultural productivity and thereby quality of human life. The key environmental and climate change induced challenges in India are increasingly becoming sharper and have increased over the past two decades. Climate change will also cause increased frequency of extreme events such as floods, and droughts. These in turn will impact India's food and water security[1].

The current observed climate and projected changes in the country as consolidated by the Second National Communication to UNFCCC are highlighted below (MoEF, GoI). According to India's Second National Communication, the annual mean temperature in India has shown a warming trend of 0.56°C per hundred years during the period 1901-2007. Accelerated warming has been observed in the recent period between 1971 and 2007 and is attributed to intense warming caused in the decade of 1998-2007. Although no significant trend in rainfall has been observed on an all India basis, increasing and

[1] India, Ministry of Finance, Economic Survey, 2012-13, pp. 256-57.

decreasing trends have been observed on a regional basis within the country. Certain extreme precipitation trends have also been noticed in the country. All these concerns are indicative of the fact that climate change is likely to hamper the achievement of sustainable development in the coming future.

Some of the potential impacts will adversely impact availability of water resources, increased vulnerability of forest areas through expected increase in species losses and induced changes in habitat for many species and a negative impact on agricultural productivity and in turn food and livelihood security. Studies by Indian Agricultural Research Institute (IARI) and others indicate greater expected losses in the Rabi crop. While in certain scenarios some crops such as groundnut and chickpea show an increase in yields with an increase in temperature and CO_2 emissions, the yield of certain crops such as potato could decline. [2]

Scenarios show that every 1 °C rise in temperature will reduce wheat production by 4-5 million tones. Small changes in temperature and rainfall will have significant effects on the quality of fruits, vegetables, tea, coffee, aromatic and medicinal plants, and basmati rice. Pathogens and insect populations are strongly dependent upon temperature and humidity, and changes in these parameters may change their population dynamics. Other impacts on agricultural and related sectors include lower yields from dairy cattle and decline in fish breeding, migration, and harvests. Global reports indicate a loss of 10-40% in crop production by 2100.[3]

Climate Change in Madhya Pradesh

Madhya Pradesh is the second largest state of India comprising of fifty districts spread across eleven agro- climatic zones. The rural areas of Madhya Pradesh are primarily dependent on climate sensitive sectors such as agriculture making them highly vulnerable to impacts of climate change. As of 2011, the total population of the state stands at 72.6 million with 72.3% being rural. The rural population heavily relies on primary sectors like agriculture, horticulture, fishery, livestock, poultry and forestry for livelihood. Due to climate change, these natural-resource based livelihood sources are expected to be impacted more than the other sectors. Water is a critical resource in the state because several regions such as Bundelkhand suffer the dual challenges of scanty rainfalls and high run-off rates. The state is drained by rain-fed rivers and receives 1160 mm average rainfall annually *(MP Resource Atlas 2007, MPCST).* 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 been declining. *T*hus, the dependence on dwindling rain for the rejuvenation of water resources makes the state highly susceptible to the variations in the distribution and pattern of rain. This irregular pattern eventually influences groundwater resources. Already, the groundwater extraction is unsustainable (for reasons such as highly subsidised electricity and diesel based pump sets) which increases the insecurities in future scenario.

2 Sanjeev Kumar, M.Z. Hussain and N. Kalra *etal*(2009)Climate Change, Climate Variability and Indian Agriculture: Impacts Vulnerability and Adaptation Strategies: http://www.springer.com/978-3-540-88245-9,2009

[3] Mall R.K. et al. (2006) 'Impact of Climate Change on Indian Agriculture: A Review' Climatic Change No. 78 pp 445-478

Agriculture is pivotal to the state's economy, accounting for about 45% of the State Domestic Product (SDP) and more than 70% of the rural labour force[4]. The state is classified into 11 agro-climatic zones and five cropping zones (based on cultivation of major crops) on the topography, soil type, land-use and climatic conditions. The net area sown is about 150.74 lakh hectares which is half of MP's geographical area. Total irrigation area of the state is 30.5 per cent and about 70 per cent of the area is rain fed. Cropping Intensity[5] of the state is calculated to be 135%, 126% being the national average and 29 districts of the state have a higher net irrigated area than the country average. Also, the state contributes to 7% of the food production in India.

These figures point to the huge weightage agriculture has on the state's economy and livelihoods. The state has a large number of marginal and small farmers. Mono-cropping practice, which is prevalent even today in certain farms in the state, makes the crops susceptible to failure if there is any change in the climate conditions for optimal production.[6]

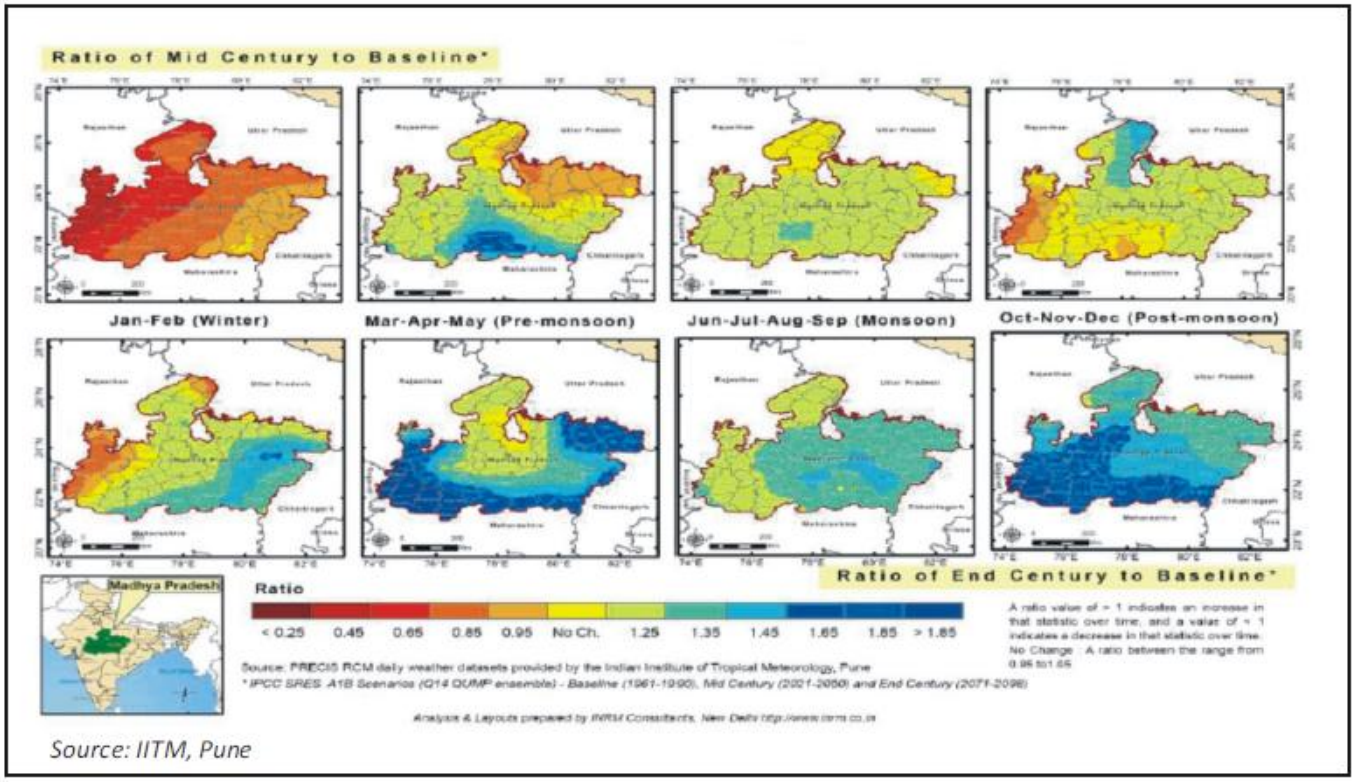


Figure: Change in annual seasonal precipitation in Madhya Pradesh in 2021-2050 and 2071-2100 with respect to base line (1961-1990) (Source: IITM, Pune)

[4]Indo- UK Collaborative project on Vulnerability assessment and adaptation planning for Madhya Pradesh, 2011
[5]MP COST, Resource Atlas
[6]Indian State of Forest Report -2009

According to future climatic projections, average surface daily maximum temperature, in the period 2030s is projected to rise by 1.8-2.0°C throughout Madhya Pradesh and the daily minimum temperature is projected to rise between 2.0°C to 2.4°C during the same period; the eastern half of the state experiencing more warming than the western half. By 2080s, the maximum temperature is projected to rise between 3.4°C to 4.4°C, with northern region experiencing warmer temperatures. The minimum temperatures are likely to rise by more than 4.4°C all over MP[7]. Projections of rainfall in Madhya Pradesh for the period 2021 to 2050 indicates that there is likely to be a decrease in winter rainfall as one moves from the eastern part of MP to its western part. The decline in winter precipitation will impact wheat crop. In the pre-monsoon period, there will be a projected increase in rainfall only in southern part of MP, with a decrease in rainfall in all other parts.

Climate Change in Bundelkhand

Climate Change stressors are likely to invariably impact the highly sensitive semi-arid regions of India. Limited options of alternative livelihoods and widespread poverty continues to threaten livelihood security of millions of small and marginal farmers in the arid and semi - arid regions of India (State of the Environment Report 2009). The semi-arid Bundelkhand region of Central India with six districts in Madhya Pradesh and seven in Uttar Pradesh suffers from significant development deficit and challenges of poverty and is one of the most backward regions of our country. It is highly perturbed with variable climatic conditions intensified by erratic precipitation trends, high evapo-transpiration losses, high run off rates and poor water retention capacity of the soil and large area of barren and uncultivable land. Drought conditions are frequent in the region leading to unstable socio-economic conditions. Varying weather conditions such as extreme temperatures, erratic rainfall, frost etc. influence crop productivity in summers as well as winters. Monsoon is a critical determinant of sowing time, which has been varying drastically in the past few years, causing huge losses to the native farmers. Therefore, the development challenge of regions such as Bundelkhand together with uncertainties posed by climate change impacts becomes a strong rationale for focus on climate adaptation interventions.

- Aggregated HDI rank is amongst the lowest in the country
- 10 out of 13 districts classified backward[1]
- 80% population dependent on agriculture and livestock
- 85% cropped area in Kharif and 55% in Rabi (60% gross) is un-irrigated due to absence of irrigation facilities.
- ~70% irrigation is dependent on ground water sources
- Migration in normal rainfall years 15-20%, enhanced to 40% in drought years of 2007-08
- Industrial development and tertiary sector contribution to economy is less than 20% (2 industrial units registered in UP part between 1991 and 2006)
- Per capita energy consumption 130Kwh in UP side (All India average 411 Kwh) with industry share being only 18.7%

Source: Multiple sources, UNDP Human Development Report, 2012, Report of Drought Mitigation, Inter-Ministerial Team, 2008, www.Bundlekhandinfo.org,ABSSS, http://bundelkhand-water-rights.org

The economy of Bundelkhand is predominantly agrarian; agriculture, livestock rearing and seasonal out migration provide more than 90% of rural income in the Bundelkhand region. Climate change

[7] Madhya Pradesh State Action Plan for Climate Change, 2012

sensitivities in Bundelkhand are majorly aggravated by water stress in the region. Irrigation heavily relies on the availability of water through rainfalls which increases the climate change sensitivities. Loss of traditional water management practices and insufficient water harvesting structures have further added to the stress in the region. The growing population and parallel increase in demand for natural resources has left agricultural and water resources in the region susceptible to increasing climate change risks, affecting livelihoods of the communities.

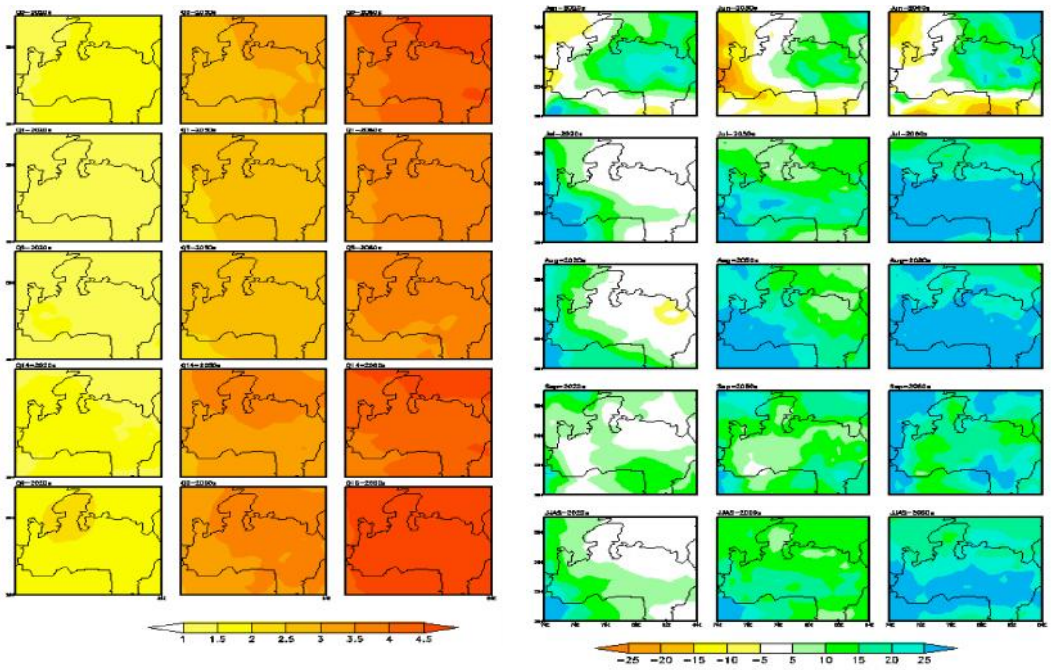
Analysis reveals changes in weather patterns and increase in climatic variability in the region. Climate data from 1980 to 2005 period has indicated an increase in mean maximum temperature of Bundelkhand region by 0.28^{o}C as compared to the baseline period of 1960-1990. Analysis of the simulated data generated by PRECIS Regional Climatic Model predicts that temperature throughout the year is likely to be higher, in the range of 2 to 3.5º C by midcentury.[8] The major precipitation season is expected to shift by one month (from July to August). The shift in the monsoon causes delay in sowing, which in turn delays harvesting and culminates in reduction of the potential yields in drier conditions.

Climate science data developed by Indian Institute of Tropical Meteorology, IITM has revealed the climatic change exposure of Bundelkhand region by the end of the century[9]. The data was developed using the PRECIS model run over three time slices (2020s, 2050s and 2080s) using 1970s as the baseline period. A 50 × 50 km resolution was used to develop the results for 5 QUMP (Quantifying Uncertainties in Model Predictions) simulations for A1B scenario. A1B describes a future world of very rapid economic growth with global population that peaks mid-century and declines thereafter. The study focused on two major indicators of climate change - rainfall and temperature in the region. The results from the model predicted variability in climate by the end of the century. The annual average surface temperatures are projected to rise by 1-2^{o}C, shooting up to 3^{o}C and even up to 5^{o}C towards 2020s, 2050s and 2080s respectively, especially in the northern part of Bundelkhand. Projected rise in the minimum temperature is more as compared to the rise in maximum temperature.

In near future, there may not be much change in the seasonal monsoon rainfall; however, it may increase by 5-10% towards 2050s and up to 20% towards 2080s with respect to the baseline. July rainfall is likely to decrease, but other months reveal an increase in the rainfall by the end of the century. The number of cyclonic disturbances may decrease in future but the systems may be more intense with increase in the associated rainfall by 10-15 mm. The number of rainy days may decrease, but they may be more intense in the future.

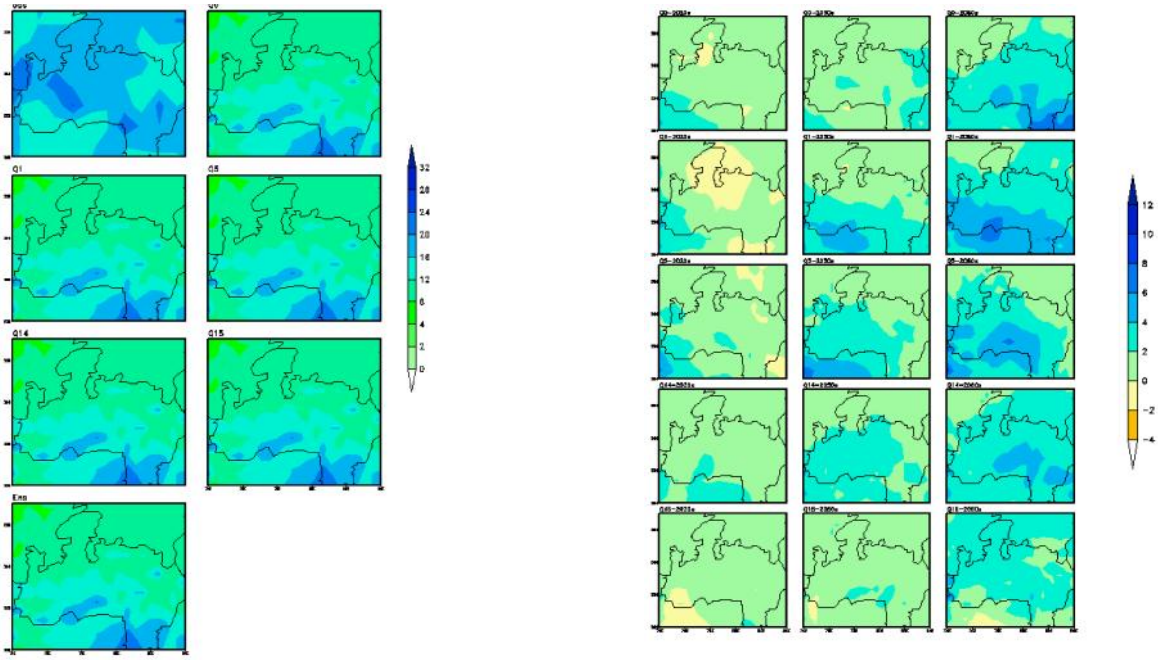
[8] IITM, Pune, India, Second National Communication to The United Nations Framework Convention on Climate Change, MoEF, Government of India, 2002.

[9] The climatic projections were shared by the IITM in the National workshop on “Climate Resilient Development for semi arid region – A case of Bundelkhand region” organized by Development Alternatives and Swiss Agency for Development and Cooperation (SDC)

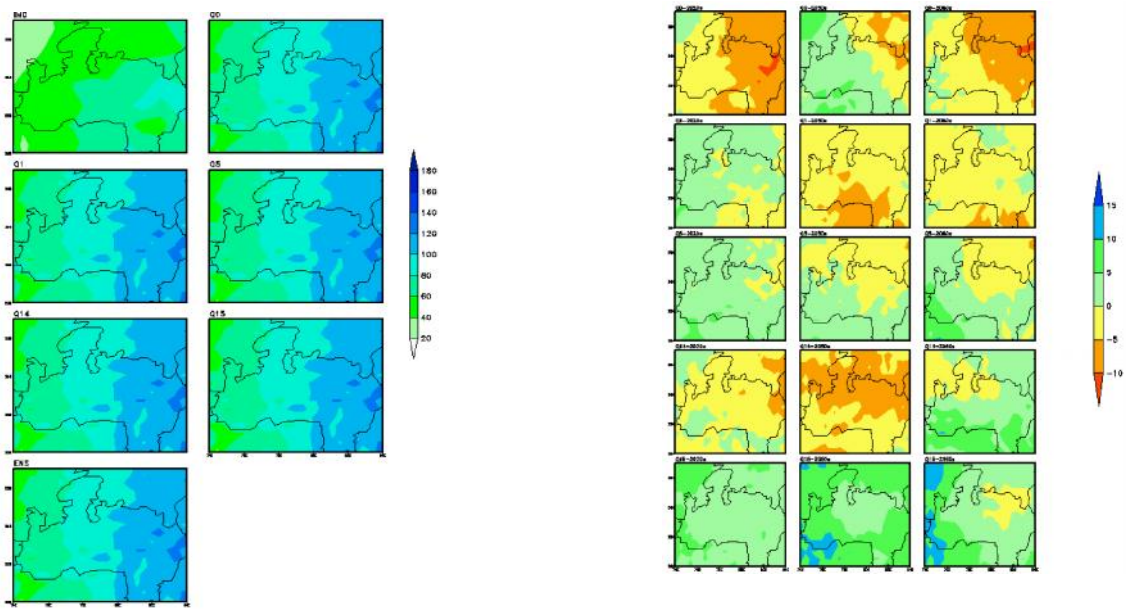


Change (^{o} C) in Annual average Surface Temperature towards 2020s, 2050s and 2080s (IITM, Pune)

Monthly rainfall change (%) in QUMP simulations towards 2020s, 2050s and 2080s in individual monsoon months and season as a whole (IITM, Pune)



Simulated rainfall intensity (mm/day) and projected changes through 2020s, 2050s and 2080s (IITM, Pune)



Simulated number of rainy days and projected changes through 2020s, 2050s and 2080s (Source: IITM, Pune)

1.3. Institutional Context

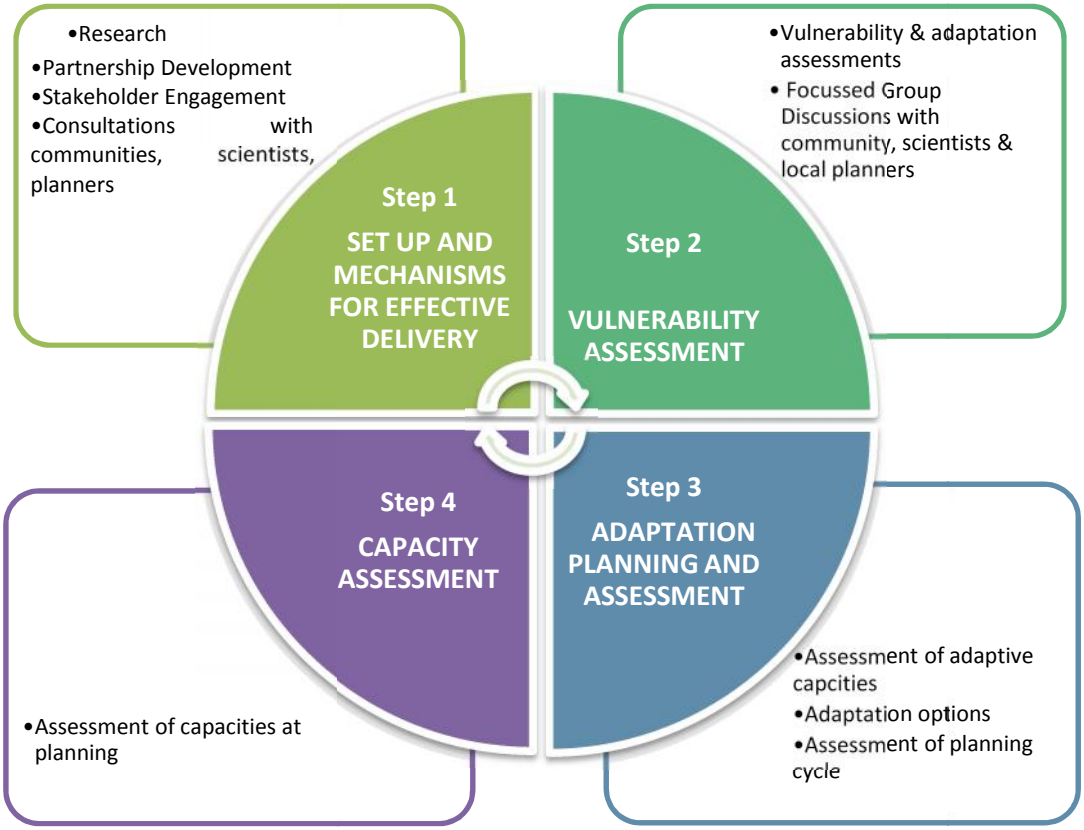
Having multifold impacts on development and wellbeing, climate change is increasingly becoming a serious concern for development planners, policy makers, decision makers, government officials, practitioners and community based institutions. Consequently, due to the disproportionate and localised developmental impacts of climate change, vulnerable communities, local institutions and stakeholders are best suited to addressing them.

At sub-national level, Madhya Pradesh at present is one of the most climate change conscious states in the country and its government is taking several measures to protect the communities of climate sensitive regions such as Bundelkhand. Efforts taking place under MPSAPCC, Bundelkhand Package and National Initiative on Climate resilient Agriculture (NICRA) are some attempts in this direction. However, gaps in the institutional mechanism have so far minimized the pace of efforts towards climate change. Currently, the government is making significant efforts for ensuring water and food security of the region through various schemes and policies, yet information and institutional gaps exists particularly at state and district level, which have limited the action against climate change. Large sections of marginalized communities (particularly in backward regions of Bundelkhand) face difficulties related to lack of information such as public scheme/programs, timely weather forecasts, localised climate impacts etc.; access to new technologies, infrastructure and most importantly information from a climate change lens is largely limited at localised level. Furthermore, the capacities of community groups and institutions are insufficient to design vulnerability based solutions. Therefore, active cooperation of local groups, communities, local institutions and stakeholders, building up their capacities and empowering them as active participants in decision making processes are a foundational pre-condition for efficient and effective adaptation measures. This report analyses the underlying factors behind these information and capacity gaps and provides necessary recommendations for strengthening institutional mechanisms from a climate change lens.

2. APPROACH & METHODOLOGY

2.1. Assessing Vulnerabilities: Overview & Methodological Approach

The overall approach followed for vulnerability assessments sought to proactively engage stakeholders/ stakeholder institutions in a process of dialogue through the course of the assignments via workshops, brainstorming sessions, in-depth interviews, observing on-site conditions and Focused Group Discussions (FGDs). The assessments were divided into four key components and under each component major activities were as follows:



a) **<u>Set Up and Mechanisms for Effective Delivery:</u>** In order to assess climate change vulnerabilities for mainstreaming climate change adaptation in development planning, a short scoping phase was designed to engage with relevant stakeholders at state and district level. It comprised of situation analysis and **partnership development** with EPCO and State Planning Commission and Planning Department of Datia district, Government of Madhya Pradesh. This helped to engage with government officials in the project area who are responsible for designing plans for the region.

b) **<u>Vulnerability Assessment:</u>** Comprehensive methodology consisting of primary and secondary assessments was used to study district level vulnerabilities. **Livelihood Vulnerability Index** was used to calculate vulnerabilities to climate change in the district. Using the information from district level

statistics, vulnerability assessment in Datia district was calculated using the Livelihood Vulnerability Index Methodology (Hahn et al, 2009). This methodology was used to prioritize the most vulnerable blocks of Datia district. To validate the study, primary consultations (with line departments and local CSOs in the district) and focused group discussions (with farmers in eight villages of study area) were conducted.

c) **Adaptation Planning and Option Assessment:** In addition to assessing vulnerabilities in the region, the project approach emphasized on researches to study and analyze adaptation interventions for setting priorities of adaptation needs.

d) **Planning & Capacity Development Assessment:** Focused group discussions at district and village level helped to assess the capacities of village panchayat members and district level officials to identify capacity gaps for integrating climate change vulnerabilities of institutional setups.

Figure: Showing Focused group discussions being held at village level to assess the capacities of villagers for better understanding of vulnerabilities
Source: DA

2.2. Conducting Vulnerability Assessments

Several researchers have put forward various methodologies to assess the vulnerabilities to climate change. One such methodology is the vulnerability assessment using **Livelihood Vulnerability Index** given by Hahn et al, 2009. The LVI methodology comprehensively evaluates livelihood risks of vulnerable communities posed by climate change. The methodology was tailored (using climatic data and secondary information verified by primary consultations) to meet the local rapid assessment needs of the current study. It measures the socio economic vulnerabilities of a region using IPCC's three contributing factors to vulnerability - **exposure, sensitivity and adaptive capacity**.

Exposure is the magnitude and duration of climate related exposure such as a drought temperature variability or change in precipitation

Sensitivity is the degree to which a system can be affected, negatively or positively, by change in climate. This includes change in mean climate and the frequency and magnitude of extremes. The effect may be direct or indirect.

Adaptive capacity is a system's ability to adjust to climate change (including climate variability and extremes), to moderate potential damage, to take advantage of opportunities or to cope with consequences[10].

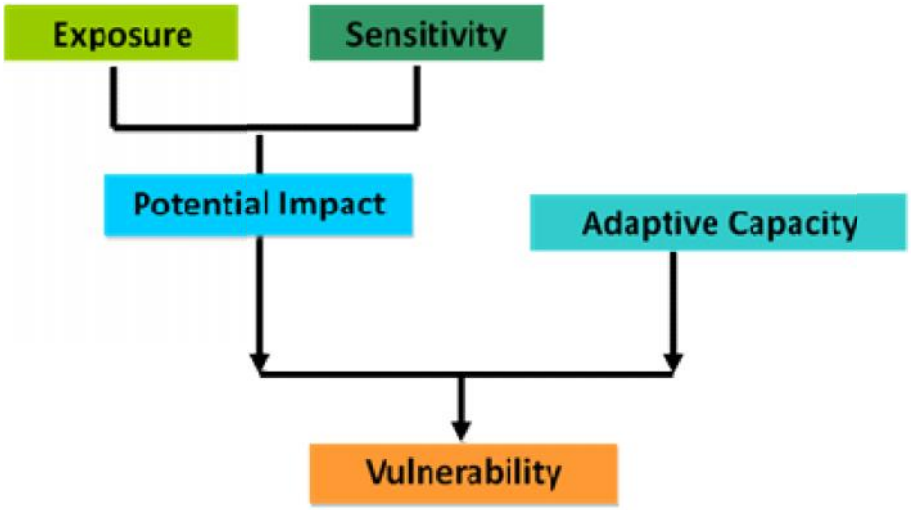


Figure: IPCC Framework for assessing vulnerability

The reason for selection of this methodology is that it presents a framework for grouping and aggregating indicators at district level, which can be critical for development and adaptation planning. In addition, the sub components and weighing measures of index can be adjusted in relevance to the local community needs of Datia. This provides an added advantage over other methodologies where these components are more or less fixed. Lastly, it is a socio-economic vulnerability index in which socio-economic indicators are standardized, therefore it is designed to provide development organizations, policy makers, and public health practitioners with a practical tool to understand demographic, social,

[10] Ebi KL, Mills DM, Smith JB, Grambsch A. 2006. Climate change and human health impacts in the United States: an update on the results of the U.S. national assessment. Environ Health Perspect 114:1318–1324.

and health factors contributing to climate vulnerability at district or community level[11]. It is a flexible tool so that the researchers and planners can tailor the framework to meet the needs of unique geographic areas (*Hahn et al, 2009*) such as that of Bundelkhand. Thus, variation and applicability are its biggest advantage[12].

The vulnerability profile for Datia district was calculated using climatic data for the region and secondary information obtained from district's statistical records. The results were further verified by primary data collection in the region. The climate data was used to understand the variability of climate and the long term trend of parameters. For the purpose of conducting vulnerability assessment, indices were computed for all three blocks of Datia district and were used to derive vulnerability contributing factors—***exposure (E), sensitivity (S)*****, and *adaptive capacity (A)***. Each contributing factor was determined using proxy indicators listed in the table below. The LVI uses a balanced weighted average approach[13] where each sub-component contributes equally to the overall index even though each major component is comprised of a different number of sub-components. The LVI formula uses the simple approach of applying equal weights to all major components[14].

The following equations were used in the calculations:

[11] Hahn, M. B., Riederer, A. M., & Foster, S. O., 2009. The Livelihood Vulnerability Index: A pragmatic approach to assessing risks from climate variability and change—A case study in Mozambique. *Global Environmental Change*, *19*(1), 74–88.
[12] Hahn, M. B., Riederer, A. M., & Foster, S. O., 2009. The Livelihood Vulnerability Index: A pragmatic approach to assessing risks from climate variability and change—A case study in Mozambique. *Global Environmental Change*, *19*(1), 74–88.
[13] Sullivan, C., Meigh, J.R., Fediw, T.S., 2002. Derivation and testing of the water poverty index phase 1, Final Report. Department for International Development, UK, 2002.
[14] Hahn, M. B., Riederer, A. M., & Foster, S. O., 2009. The Livelihood Vulnerability Index: A pragmatic approach to assessing risks from climate variability and change—A case study in Mozambique. *Global Environmental Change*, *19*(1), 74–88.

Steps to calculate Livelihood Vulnerability Index

Step 1: Indicators

- Values for all the indicators are to be standardized for all the blocks.
- **Indicator Index(Ix) =** $\frac{Ia - I(min)}{I(max) - I(min)}$

Where, Ix = Standardized value for the indicator
Ia = Value for the indicator I for the 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

Step 2: Profiles

- Indicator Index Values are combined to get the values for the profiles
- **Profile (P) =** $\sum_{i}^{n} \frac{I}{n}$

Where, n= number of indicators in the profile
i= Index of the i th indicator

Step 3: Components

- Values of the profiles under a component are to be combined to get the value for that component.
- **Component (C) =** $\frac{\sum_{i=1}^{n} Wpi\ Pi}{\sum_{i=1}^{n} Wpi}$

Where, Wpi 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 = (exposure- Adaptive Capacity) * Sensitivity**

Major components and sub components comprising Livelihood Vulnerability Index for Datia district of Bundelkhand region of Madhya Pradesh

Contributing Factors	Components	Weightage(Wpi)	Sub-Components
Exposure (E)	Climate	2	Temperature Variability
			Rainfall Variability
	Demographics		Rural to Urban Ratio
		3	Sex Ratio
			Below poverty level population
Sensitivity(S)	Ecosystem		Percentage of forest cover
			Groundwater Availability
		3	Area of waste land
	Agriculture		Irrigation Intensity
			Cropping Intensity
			Fertilizer Usage
		6	Livestock population per hectare net area sown
			Number of people dependent on Agriculture
			Number of small scale farmers
Adaptive Capacity(A)	Socio-economic		Literacy Rate
			Number of health care centers
			Number of villages with access to drinking water
		5	Number of hand pumps
			Number of Agricultural machinery

In addition to assessing district and block level vulnerabilities, the study also developed **village level vulnerability profiles** for eight villages in Datia block. These vulnerability profiles were an attempt to highlight sensitivities and adaptive capacities at grassroots level that determine local level vulnerabilities faced by communities at the last mile.

2.3 Selection of Indicators for Measuring Vulnerability Index

A holistic set of indicators have been selected in order to represent the contributing factors for vulnerability i.e. exposure, Sensitivity and adaptive capacity. Vulnerability is a function of 3 aspects with respect to climate change. These indicators are representative of the livelihood and socio- economic vulnerabilities in the Datia district of climate sensitive region of Bundelkhand.

Exposure

Climate

This factor includes current climate variability in the region indicating temperature and rainfall variability. Higher inter-annual rainfall variability indicates a higher probability of unanticipated amounts of rainfall in a given year. This could mean flooding, drought, or simply below/above average rainfall that impacts agriculture. Also, rainfall is crucial in water recharge and in rain-fed cultivation systems. Additionally, temperature variability exposes the region by affecting crop productivity (due to uncertainties), increased evapo-transpiration losses and decrease in soil moisture.

Demographics

Rural to Urban ratio

More than 70% of rural labor force is engaged in agricultural sector and is therefore highly dependent on agriculture for their subsistence and income. Agriculture is one of the most sensitive sectors to variable climatic conditions. Therefore, rural population percentage acts as a proxy for the degree to which a district's population relies on agriculture for their livelihood, which correlates with climate change sensitivity.

Sex Ratio

Low sex ratio further increases the sensitivity of women towards climate change due to increased cultural and social pressures additionally increasing their already high vulnerability to climate change.

Below poverty level population

Poor families have lack of resources because of which they will be less adapted to climatic stress indicators. Districts with higher numbers of BPL families will have a lower adaptive capacity.

Sensitivity

Ecosystem

Percentage of forest cover

Forest resources are highly sensitive to the impacts of climate change. Climatic uncertainties in future may affect the composition and distribution of forest resources. This will disturb the delicate balance of bio-geochemical cycle, making the forests prone to degradation. This will also affect forest productivity. Lastly, this may result in habitat shifting of fauna in the region.

Ground water availability

The variability in rainfall may affect recharging of groundwater in the region. This may also result in over-extraction of groundwater resources. There is a high reliance on groundwater in the region, for irrigation, drinking water and other. The situation is aggravated by low percolation rate and sudden extreme drought conditions.

Area of wasteland

Wasteland in the region increases the sensitivities due to loss of land's fertility, thus decreasing the land area fit for farming or grazing in the region. The area of wasteland increases with changing soil moisture conditions, climate change is thus likely to affect the situation of wasteland in the semi-arid geography.

Agriculture

Irrigation intensity

Climate variability and impacts such as drought will affect the water resources (e.g. water in wells, dug wells, ponds) available for agriculture. The vulnerability of irrigation sources makes irrigation highly sensitive to climate change.

Cropping intensity

It refers to raising a number of crops from the same field during one agricultural year. This indicates the pressure on same amount of land for farming. Cropping is directly related to the irrigation facilities available, thus indirectly making it sensitive to climate change.

Fertilizer usage

They serve as an environmental indicator and vulnerability to failure of rains would lead to an increase in its usage.

Livestock population per hectare net area sown

Livestock, an adaptation option, has itself become highly prone to uncertainties of climate change. Adverse impacts of climate change in Bundelkhand region (such as increasing extreme temperatures, increased frequency of droughts, scarcity of water resources, and poor availability of fodder) have severely affected livestock population in the region. In semi-arid geography, livestock is a main alternative source of livelihood. Their sensitivities may increase due to the occurrence of new unidentified diseases, heat strokes and low productivity.

Number of people dependent on agriculture

This indicates the dependency on agriculture as a major source of livelihood, which is one sector that is highly sensitive to climate change.

Number of small scale farmers

Small and marginal farmers are more sensitive to climate variability because they tend to have less resources/means to respond to external pressures. Districts with relatively higher numbers of small farmers will be more sensitive to climate variability.

Adaptive Capacity

Socio-economic

Literacy rate

Literacy rate acts as a proxy for the general level of human capital (i.e. education) in a district. This indicates the level of awareness people might have. Higher the level of access and information to the people, higher is the adaptive capacity.

Number of health care centers

Health care facilities increase adaptive capacity by providing infrastructures to respond to the health impacts of climate variability.

Number of villages with access to drinking water

Assesses water resource of a particular area and an access to drinking water reduces vulnerability.

Number of hand pumps

The availability of hand pumps indicates access to groundwater resources, an additional source of water for the community. Having access to this type of water resource increases adaptive capacity to drought and related climate stressors.

Number of agriculture machinery

Agricultural machinery serves as a proxy for the state of agricultural development in any district. Districts with more agricultural machinery are assumed to be more developed. A more developed agricultural sector will have a higher adaptive capacity to climate variability. It also indicates the mechanization adopted in farming practices for ease and better crop productivity.

3. INTEGRATED ASSESSMENT FINDINGS

As stated above, vulnerability is defined as a function of exposure, sensitivity and adaptive capacity. Based on these three functions climate change vulnerabilities of Datia district is as follows:

3.1. Vulnerability Assessment- An Analysis

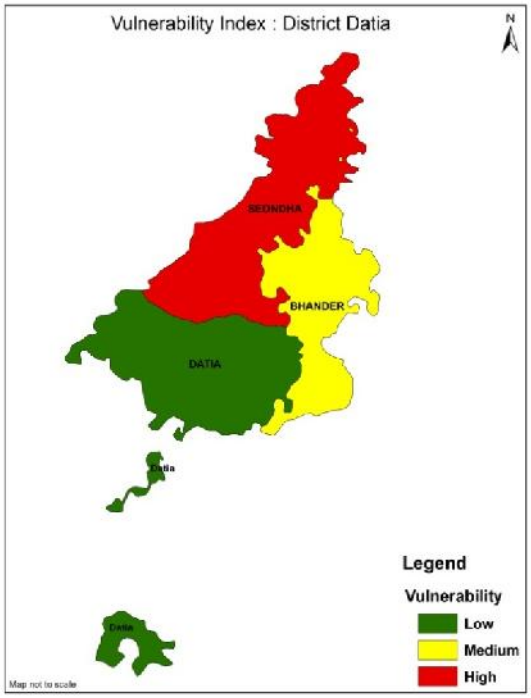
District Vulnerability Profiles of Datia

Datia district is located in the eastern region of Gwalior region of Bundelkhand covering 2959 sq km and is the smallest district of Madhya Pradesh[15]. The mainland extends between 25°27'N & 26°17'N and the east-west extent of district is contained between 78°13'E & 78°15'E of longitude and has an elevation of 215 meters above sea level. It is divided into three tehsils, Seondha, Datia and Bhander. Entire soil in the area is composed of vertisols and inceptisols which make it highly alkaline. The factor that makes rural population in Datia district vulnerable to climate change is that they are highly dependent on climate sensitive sectors such as agriculture and low adaptive capacities to deal with climate induced risks. The vulnerability index calculated for Datia district is as follows:

Vulnerability indices of three blocks of Datia district

(Note: Scaling is done from -1 to +1 indicating low to high vulnerability)

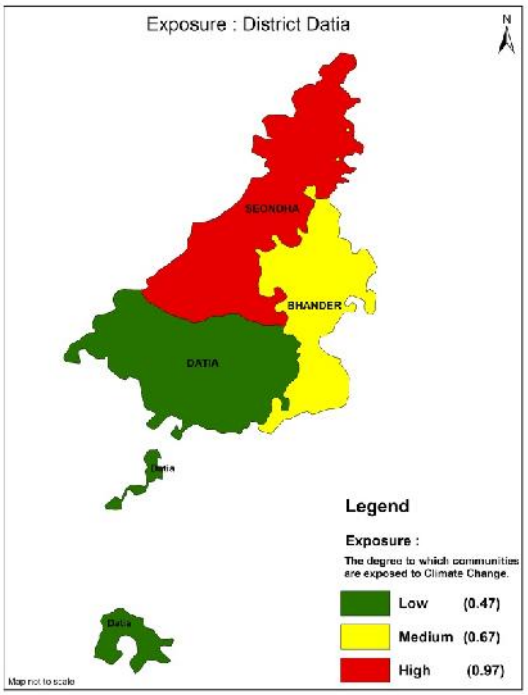
Block	Livelihood Vulnerability Index Value
Seondha	0.2356
Datia	-0.2363
Bhander	0.17287



[15] According to the state revenue records

District Vulnerability Map

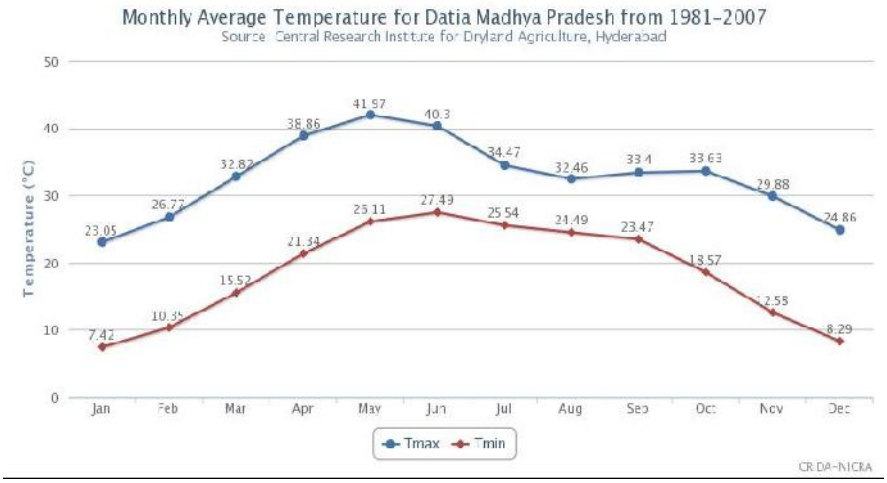
Exposure to Climate Change



District Exposure Map

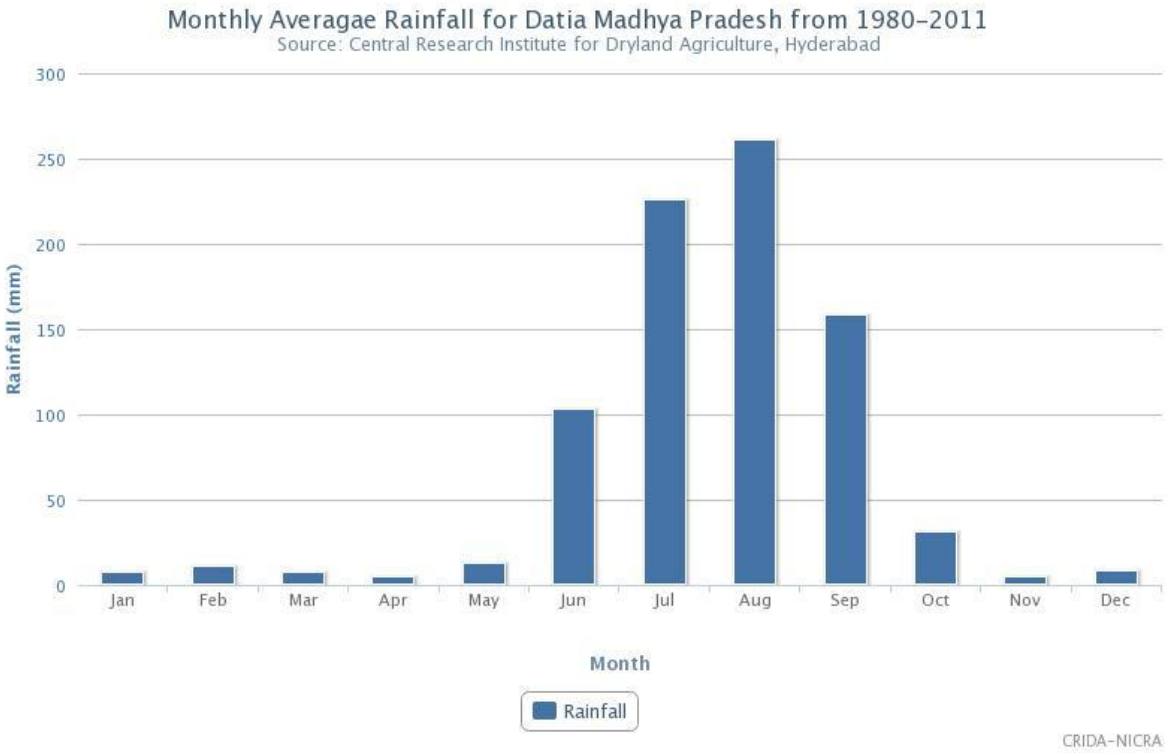
Climate:

The climate of Datia is characterized by general dryness and hot summers except south west monsoon season. May is the hottest month of the year with an average temperature of 42.1°C and January being the coldest with an average temperature of 23.2°C. The mean humidity in the region drops to as low as 26% in evenings and remains below 40% in the mornings and with the onset of rainfall, humidity rises sharply. The large gap in day and night and summer and winter temperatures and the prevalence of extremely low levels of humidity is the reason for the climate of the district being arid.

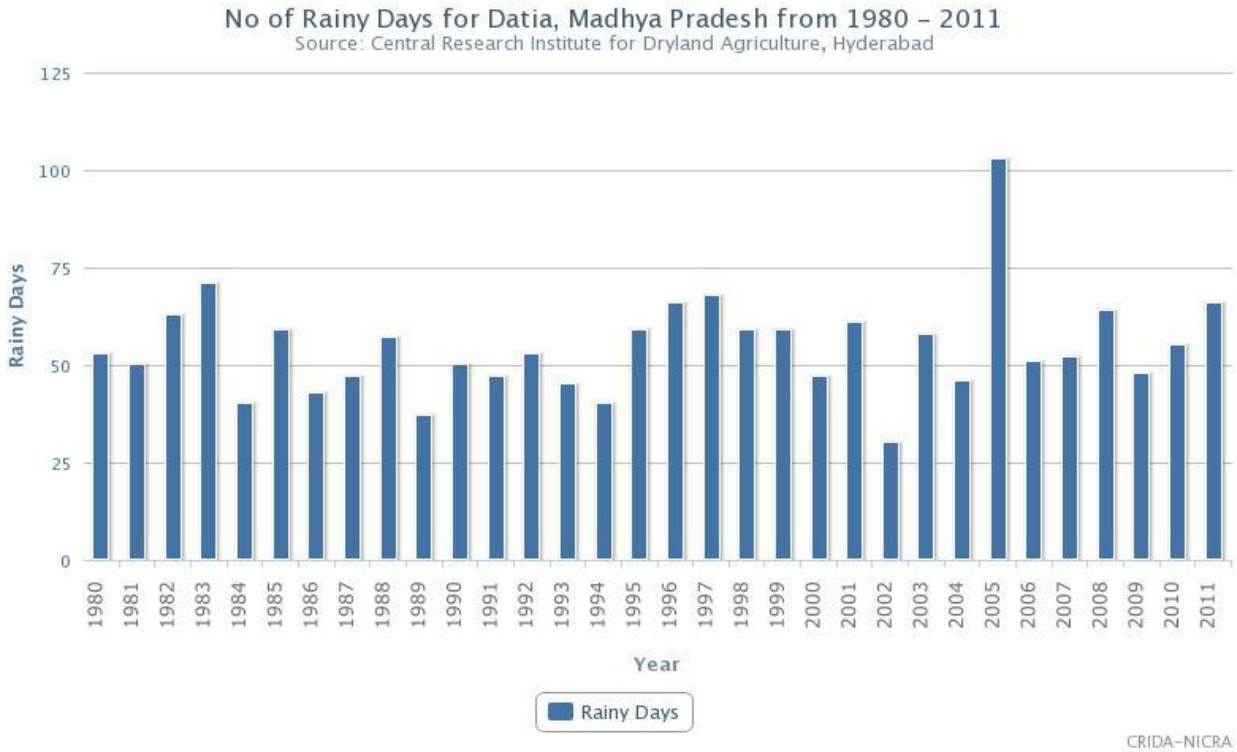


(Source: NICRA)

The average annual rainfall recorded in the district during 1964-2011 is 776mm. Out of these 47 years; annual rainfall has been within ± 150mm of the average of around 750mm for the initial 29 years (for initial 9 of these 29 years, rainfall has been in the range of 601-650mm, for the next 4 years it has been between 851-900mm and for the rest within ±100 of the norm and above 750mm for the remaining years). For the next 18 years, rainfall has been highly deficit for initial 7 years (for the initial 3 years it has been below 500 mm out of which during 1979-80 it went as low as 313mm) and excessive for the next 11 years (for the initial 9 years it has been around 1000 mm, for the next 8 years between 1001-1150 mm and for the year 1985-86 it went as high as 1362mm). Last decade in Datia has been one of the worst since it has undergone through a period of relatively deficit rainfall both in terms of quantity of rainfall received as well as number of rainy days. The onset of rainfall in Datia is considerably later than in the other district and almost all the rainfall falls within a short span of time and follows a typical monsoon pattern.



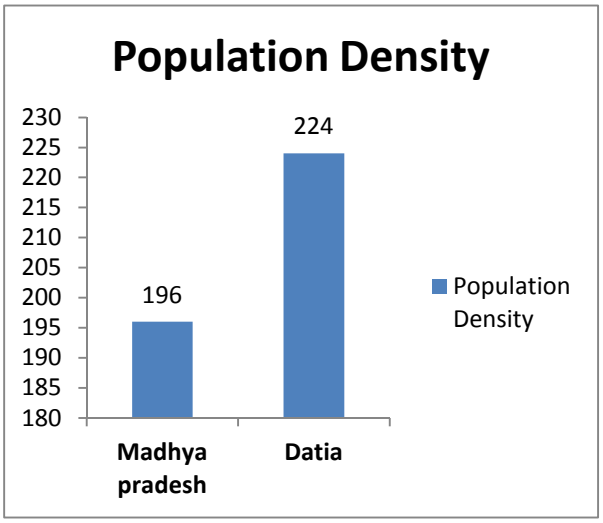
(Source: NICRA)

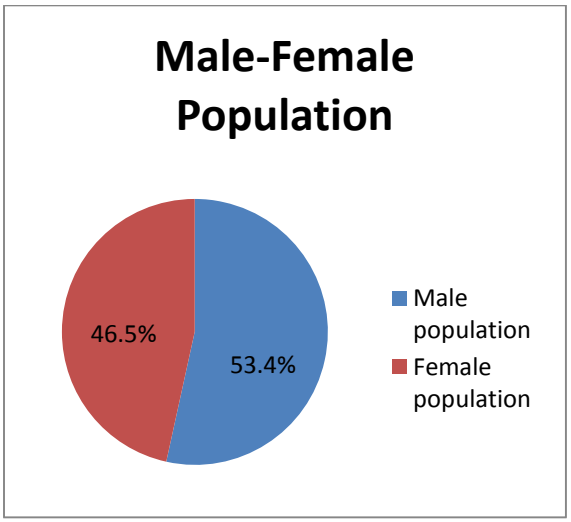


(Source: NICRA)

Demographics:

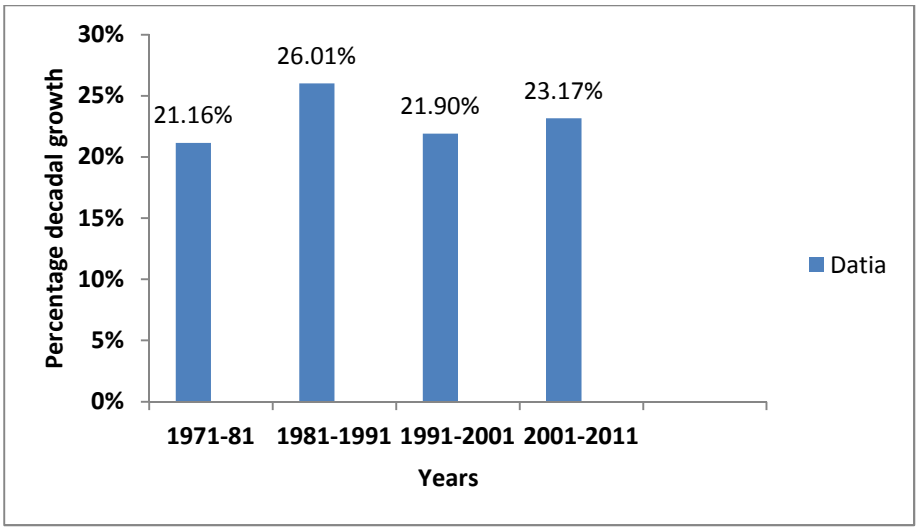
The population of Datia is 786,375 (53.4% males and 46.5% females) as per the 2011 Census and the district population density is 292 persons per sq. km. In all, 76.83% of the population resides in the rural areas indicating the inclination towards the agriculture sector. The sex ratio is 875 females per thousand males which is much less than the state ratio of 930 and the national figure of 940 respectively. The decadal population growth of the district is 18.4%, which is lower than that of the state (20.3%) and little higher than the national average of 17.64%. The increasing rate of population and subsequent decline in the resource base adds to the susceptibility of the people to be affected by any untoward incident. Without any robust development scheme, the increasing population will be constantly at risk without sufficient capacity to cope with the impacts of climate change on agricultural productivity, water availability, health and other sectors.





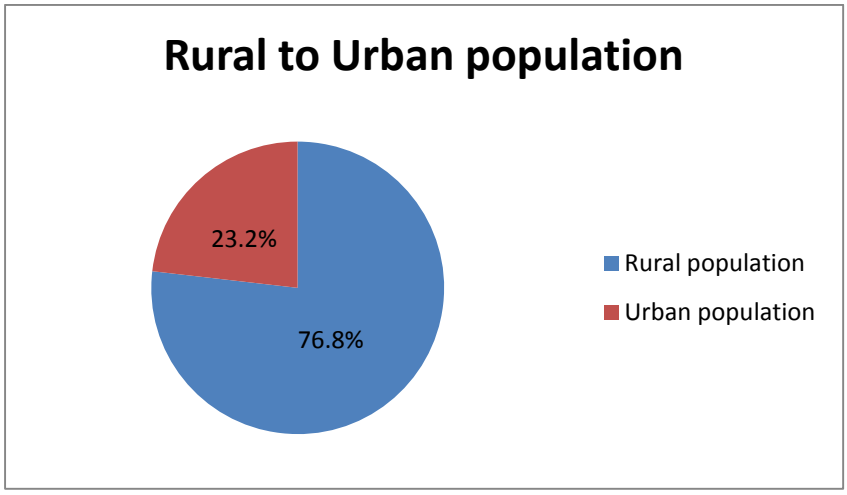
(Source: Datia Resource Atlas, 2013)

The share of district in the population during pre-Independence period had a decline of 0.88% and has grown by 18.37% during 2001-2011 but is still lower than the state average growth rate.



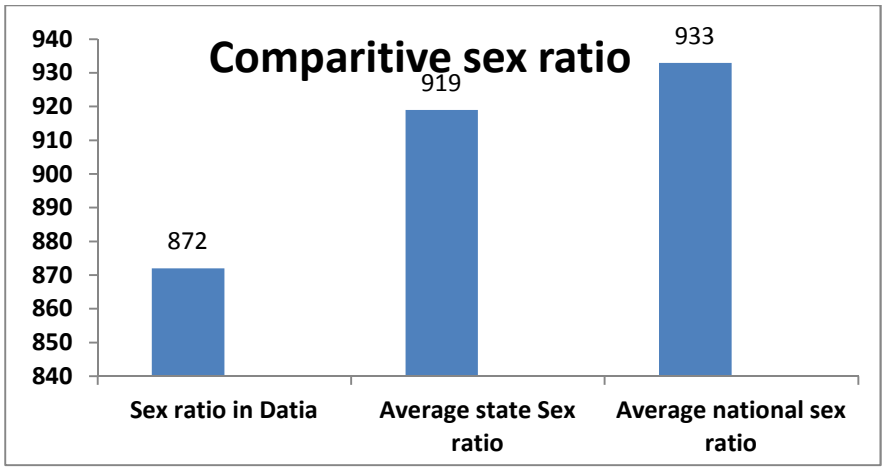
(Source: Datia Resource Atlas, 2013)

The district is predominantly rural with a rural to urban population of 76.8% to 23.2%. Urbanization ratio of the district is 20.7% which is considerably lower than the state ratio of 26.5 %. This ratio has however increased from 21.90% in 2001 to 23.17% in 2011. However, the below poverty level population for the district is 20080.



(Source: Datia Resource Atlas, 2013)

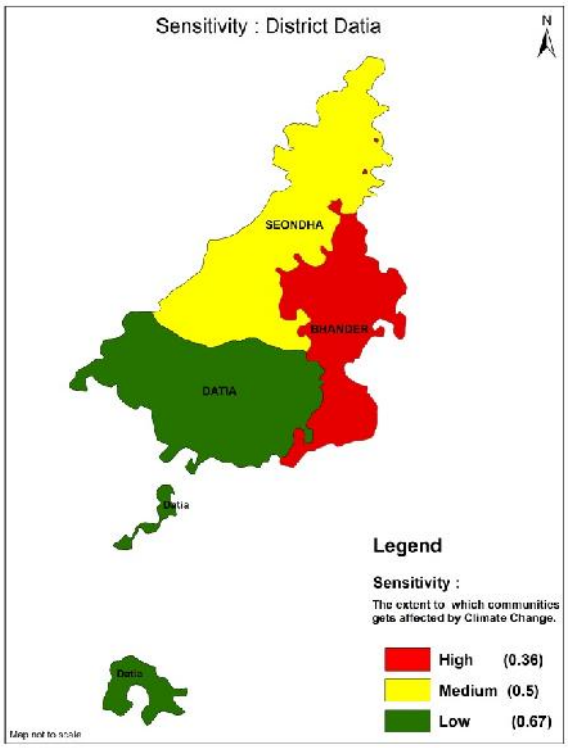
Female- male ratio in the district as counted in 2011 is quite low at 872 females per thousand males when compared to the state average of 919 females per thousand males and national average of 933. The gap has however narrowed from 2001 when the district had even fewer females.



(Source: Datia Resource Atlas, 2013)

Sensitivity to Changing Climate

The semi-arid drought prone geography of Datia district is highly sensitive to climatic variabilities. Natural resource base and agriculture are some of the most sensitive indicator in the region.



District Sensitivity Map

Ecosystem Sensitivities

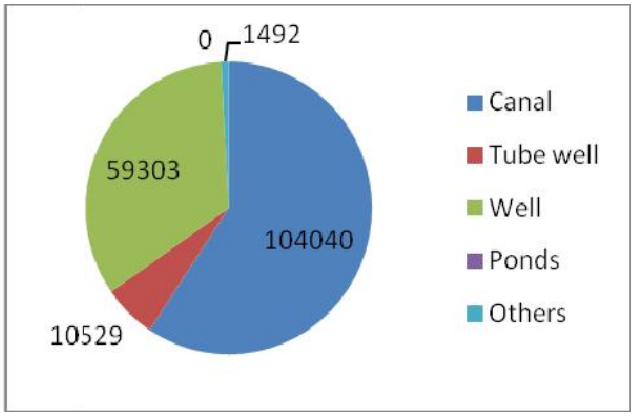
A large area of soil in the district, particularly along the Seondha block the block is characterized by deep gullied ravines. These ravines are highly vulnerable to intense rainfalls, which often causes soil erosion in these gullies and result in the removal of top soils.

Forests

Total forest area in Datia district is around 38,000 hectares. However, only 38% of this forest cover is dense forest. The remaining forested area is either open (52.63%) or scrub forests (11%). The ravines of Datia district consists of thorny (often leafless) shrubs and trees. Forest cover of Datia commonly includes *kardhai, babul, ber, sheesham* etc. According to India State of Forest Report (2011), forest cover in Datia is merely 5.835% of total geographical area. Population growth, increase in cultivable land, increased extraction of fuel wood, anthropogenic pressures and climatic changes have, all-in-all, affected quality of forests in the region. Losses in the agricultural produce due to variable climate have also increased people's dependence on forests for other livelihood options. Deforestation has also become rampant, which has led to slow environmental degradation of the district. Over the years, forested area in the region has shrunken. Due to declining forest cover, the land at several places is losing its fertility due to increased rates of erosion. This has also lowered water holding capacity of soil in several areas. Datia is particularly vulnerable with respect to both forest and climatic vulnerabilities. In fact, Datia is one of the most vulnerable districts in Forest index (stated in MP State Action Plan on Climate Change) in the base period and is highly vulnerable environmentally[16].

Water

Most of the agricultural area in Datia is irrigated by tube wells, dug wells and tanks however the total area irrigated from all the sources is 175364 hectares. Groundwater is the main source of irrigation in the area.



Area irrigated by various sources of irrigation in hectares (Source: District Statistical Handbook, 2010)

[16] Vulnerability assessment report of Madhya Pradesh towards climate change , February, 2014

As rainfall distribution pattern changes with the changing climate, groundwater resources are also under threat. Along with geological conditions, climatic variables also impose threat to the resources. It is essential that water management practices are adopted in the region for water security reasons.

Groundwater resources are particularly vulnerable to climate change in the district. Showing dependency on rainfall and precipitation trends, groundwater reserves are sensitive to climate change and act as an important indicator in highlighting the sensitivities of Datia district. The analysis of decadal (1995-2005) average ground water levels in Datia district show that in past years groundwater level trends have shown a decline all over the district. The long-term water level trend shows declining of 0.221-0.839 and 0.379-0.959 m/year during pre–monsoon and post -monsoon respectively which are quite significant. The long-term water level trend shows rising of 0.054-0.251 and 0.007-0.027 m/year during pre-monsoon and post-monsoon respectively in the command canal area in the north central part of the district. Declining groundwater levels in the region highlight that erratic rainfall, heat stresses and excessive exploitation of groundwater resources have made it highly vulnerable to climate change. This factor puts Datia district at risks and jeopardizes the management of water resources in the region. Decreasing levels of groundwater resources over the years is also credited to the construction of wells for irrigation purpose. These practices have increased in the recent past without much consideration of well spacing. This has caused adverse impact on ground water regime in some localized areas[17].

Livestock

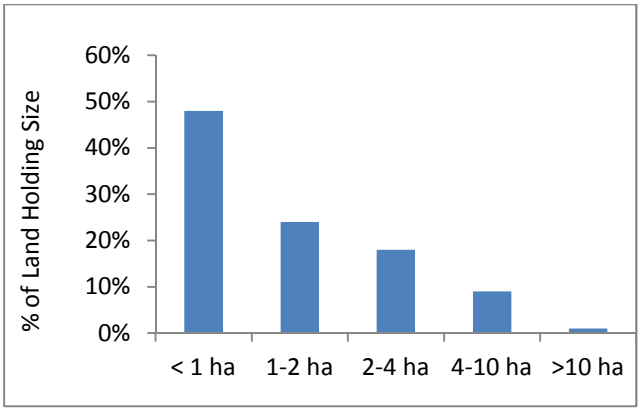
In the semi-arid geography of Datia district, livestock-rearing is a common livelihood option practiced by the communities. Over the years, people have moved beyond cattle and are taking up poultry and goat-rearing as options. But, growing unavailability of grazing pastures has added to the woes in livestock rearing. According to statistical records, livestock population in Datia district has decreased over the years. Except a few communities, such as the *Yadav* clan which chiefly depends on cattle, others have shown a declining trend in continuing with this livelihood option due to lack of resources to keep the animals healthy. Lack of fodder availability and water has reduced the interest of local communities in livestock-rearing, which has further lowered their adaptive capacities.

Agriculture Sensitivities

Around 85% of population in Datia district is dependent on climate sensitive agriculture sector for livelihood and income generation. In all, 62.1% of the total workers are cultivators and 16% are agricultural laborers, who will be badly affected by impacts of rising temperatures and extreme events on crop productivity. Despite having maximum share in livelihood generation, the share of agriculture and allied activities in Datia has reduced over the years. Between 2005-06 and 2008-09, net sown area decreased from 1, 97,200 hectares to 1, 96,000 hectares. The production output of wheat has gone down from 266 thousand metric tons in 2006-07 to only 29.08 thousand metric tons in 2009-10. This was attributed to erratic weather conditions in the region. (District Statistical Handbook, 2010).

[17] Datia: District Groundwater Information Booklet, Ministry of Water Resources ,Central Ground Water Board (2009)

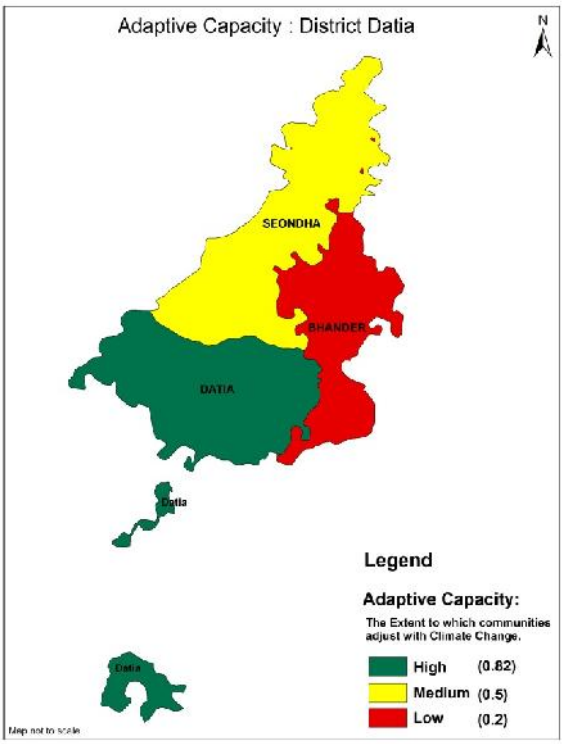
Datia district shows a high percentage of small land holding size with an average of just 0.46 hectares. Marginal land holdings of size less than 1 hectare forms the bulk of cultivation and accounts for 47.7% of all holdings and command only 12.8% of the total area. This shows that climate sensitive agriculture sector has become a gamble for farmers with small land holding size that solely depend on small agricultural lands and raise single crop in a year.



Percentage of Land Holding Size in Datia (Source: Datia Resource Atlas, 2013)

Adaptive Capacities to Cope Up With Climate Change

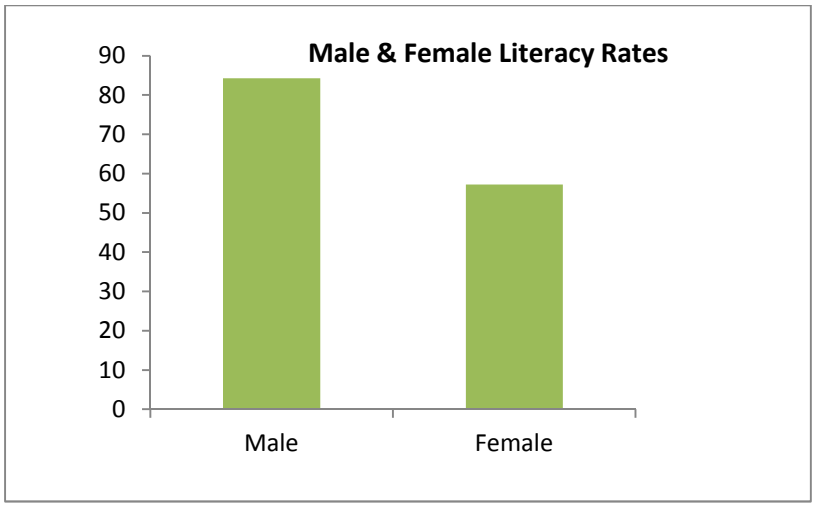
Datia's adaptive capacity is determined by the district's ability to withstand exposure and overcome its sensitivities. Socio-economic conditions play a major role in determining the adaptive capacities of a region and help the communities to cope up with climate induced risks.



District Adaptive Capacity Map

Socio-Economic Adaptive Capacity

Total literacy rate in the district is 59.39%. There is a general lack of awareness among the communities due to illiteracy and lack of support services which could have enabled them through information. The status of women is further low in the region due to cultural and social barriers and low development indices. Water for drinking and other household purposes is fetched from far off sources by the females of households, adding to their normal work load.



Difference in male and female literacy rates in Datia district (Source: Datia Resource Atlas, 2013)

Farmers in the district are small scale with an average land holding size of two hectares. In addition, the productivity is low and is dependent on weather conditions. Also, only a very small number of farmers are able to get access to national crop insurance schemes of the government.

Migration is also commonly prevalent in several parts of Datia. This is particularly high in area with low levels of urbanisation and high levels of industrial activity. Overall, the urbanisation ratio of Datia district is relatively low (20.7%) when compared to the urbanisation ratio (26.5%) of Madhya Pradesh state.

Household level Vulnerabilities to Climate Change

In addition to the quantitative assessments of Datia at a district level, primary consultations with communities reveal micro level climate change vulnerabilities at household level. Some of the key findings from primary household assessments are as follows:

Demographically, imbalanced male-female ratio and caste structures are some of the social dynamics which play a great role in varying sensitivities and adaptive capacities of communities in Datia. Even though, females in the villages are involved in farming activities such as sowing, thrashing, harvesting, sorting and storage, however their involvement in decision making processes is limited. This highlights that they are still largely restricted to manual labour and have diminished adaptive capacities. Similarly lower caste and below poverty line population are also restricted due to low resource base, limited incomes and exhibit poor adoption to new and advanced adaptation strategies.

- Small scale farmers and landless farmers are also prevalent in villages of Datia. These farmers do not have fixed source of income and often migrate when weather conditions disrupts economic activities in the region. To further add to the socio-economic vulnerabilities, illiteracy and lack of information is significant in the region. . A large number of people face problems due to lack of

information, low levels of awareness about welfare schemes and poor information capacities to cope up with high risk situations.

- A large number of farmers practice open irrigation through diesel powered motors and have still not adopted micro-irrigation techniques. Diesel cost is an additional cost input for the farmers and is particularly heavy on their pockets. This coupled with over extraction has increased the burden on ground water resources.
- Several villages in the district are surrounded by patchy areas of forests. These patches are fragmented are accessed by the communities for livestock grazing, fuelwood and other forest products. These factors put the available forest resources available to the communities at risks. If not used efficiently, exploitation of fragmented forests can degrade the resources available and affect micro-climate in the region.
- Alternate sources of income such as livestock rearing, agroforestry, vegetable farming and poultry have shown to minimise risks of communities against climate change. These activities are not only bringing additional incomes to the farmers but are also proving to increase their resilience.
- Climate change impacts are severely affecting soil quality and fertility in the region. Discussion with farmers revealed that over the last few years, excessive rainfall in a short period of time has intensifies the problems of soil erosion in several regions of the district. This often leads to erosion of soil from farming fields and causes loss of nutrient rich top soil. Additionally, large number of farmers has shown increased dependency on chemical fertilizers over organic fertilizers.

Institutional Capacity Assessment

Currently, the government is making significant efforts for ensuring water and food security of the Datia district through various schemes and policies, but evidence from the primary consultations indicates that implementation at the ground level is limited. Given the level of vulnerability of blocks of Datia, this chapter/section maps the institutional capacity to address the vulnerabilities faced by the communities.

Agriculture Contingency Plan

The agriculture department of Datia district prepare a contingency plan to advise farmers on appropriate adaptation responses in the situation of a delayed or deficient monsoon. The plan advises the farmers on drought-resistant and short duration crop varieties, improved crop management techniques, and soil nutrient and moisture conservation measures that can help to mitigate potential impacts of different rainfall situations. However, responses received during primary consultations signalled that dissemination of this information to the grassroots farming communities is limited due to:

- Inadequate implementation of the policies
- Lack of institutional capacity and manpower
- Weak agricultural support delivery mechanisms
- Poor outreach to interior villages
- Limited number of information centres

Krishi Vigyan Kendra (KVK) Extension Services

The KVKs have established several model villages to demonstrate improved agricultural and water management techniques. KVK also conducts exposure visits for farmers to villages in other states with

similar agro-climatic zones, such as Maharashtra, for exchange of knowledge and experience. These focussed model demonstrations and exposure visits are a good platform for farmers to understand and adopt new and advantageous technologies. The primary consultations with line departments and other stakeholders suggest that such demonstrations and training visits need to be scaled up to larger masses to enhance the efficiency and adaptive capacity of small farmers. The underlining problem with this framework is that far-off villages are left unaware.

Outreach

There were strong recommendations from stakeholders to strengthen the information flow from government departments to villages. From ground level fieldwork, however, there is evidence that the dissemination of this information to the grassroots farming communities is limited for several different reasons. First, there are staff shortages in extension agencies. There are not Rural Agriculture Extension Officers (RAEOs), at the grassroots level to meet the information needs of the entire region for which they are responsible. Each RAEO is in charge of providing extension services to around one to five villages, but these agents often do not adequately serve these villages because of lack of dedication and adequate skills. Focus group discussions revealed that for many farmers, their only option to receive beneficial information and scheme assistance is to travel directly to the appropriate extension agency. Unfortunately, the spatial distribution of the locations where farmers can access information directly such as KVK, ATMA, or Agricultural and Irrigation Department offices is widespread. Often, farmers find out that the cost in terms of time and money of travelling to these distant locations is not worth the perceived benefit that they will receive from their efforts.

Additionally, in order to receive assistance in many cases, farmers feel that they must navigate many administrative obstacles such as lengthy paperwork and procedures. This barrier, in addition to the long travel distances, further reduces farmers' interest in seeking these benefits. Additionally, the group discussions with farmers revealed that toll-free agricultural help lines operated by the KVKs are largely unutilized due to general unawareness among farmers. The farmers also stated that information received from KVK's agricultural SMS service is often lacking in clarity or usefulness in its totality.

Weak Delivery Mechanisms

Extensive fieldwork and consultations in the Datia reveal that scheme implementation and resource allocation at the local level is not efficiently distributed and that long-term planning, as is required to address climate change, is not present. This deficiency is driven by a variety of factors including lack of climate change related information and communication capacity at the district and community level, insufficient scheme and policy outreach, and top-down budget allocation processes that do not necessarily reflect the needs on the ground. Thus, even though currently, there is a framework in place to allow planning to occur in a decentralized manner where information and plan formation flows from the ground level to the state level, the climate change perspective is still missing. Though this framework develops perspective district plans for five years it does not highlight climate adaptation.

Weakened Market Situation for Agricultural Produce

Community farmers also stated that they face difficulties in selling their agriculture produce to mandis due to:

- Excessive competition
- Time consuming procedures
- Low transparency in the process
- Weakened market system for vegetables as in Chhatarpur
- Weak market linkages

In another initiative, the agricultural department is promoting low-input technologies such as vermin-composting and bio-fertilizers. The focus group discussions, however, indicated that majorly of large farmers were the primary beneficiaries of the agricultural department's outreach efforts due to higher levels of awareness and the financial ability to adopt such measures.

4. RECOMMENDATIONS FOR CLIMATE CHANGE ADAPTATION

The long-term nature of climate change and the significant impact it can have on agricultural systems requires future agricultural development policy and practices to include both short-term and long-term planning that incorporates climate change knowledge and understanding in order to adequately respond to the reality of a changing climate—a process referred to as climate change adaptation.[18]. There are several adaptation measures available in the short term and long term perspective which, if incorporated well for the present geography, can create significant change in the lives and livelihoods of the communities. Currently, there are many existing schemes, policies, and practices that have been formulated, implemented, and deployed to enhance the livelihoods of rural communities. These actions can be further retrofitted and efficiently implemented to serve the purpose of climate-resilient development. Some of these practices are detailed below.

Agriculture:

- **Usage of improved seeds and varieties like drought tolerant crops and short duration crops:** Can allow crops to better adapt to scarce water situations by shortening the duration of time water is needed; can also increase cropping intensity by allowing more additional crops to be planted and harvested.

- **Encourage mixed cropping (multi-cropping, intercropping) and crop diversification to reduce risk:** Depending on crop selection, can reduce the risk of total crop failure through the diversification of crops as well as increase overall yields through synergistic effects between different crop types.

- **Agro-horticulture and Agro-forestry:** Can help diversify a farmer's crops, increase sustainability, income and productivity of fields through synergistic effects between crops and trees/shrubs as well as increase resource base and/or income through increased production of woody materials

- **Dry sowing and Line sowing:** Allows for timely planting on crops during dry conditions, which can increase yield compared to late sowing and can increase yield by decreasing inter-species competition; uses less seed than 'broad casting' sowing technique.

- **Employing different agricultural methods:** Ridge and furrow method allows for water drainage in the case of extreme rainfall; provides better aeration to roots and conserves soil moisture during times of scarce rainfall. Counter cultivation slows the water runoff from hilly slopes, which reduces soil erosion and allows more water to infiltrate the soil

- **Provision for weather based crop insurance and fortification of the existing credit scheme linked with insurance:** Weather indexed crop insurance will be better suited to the region as the

[18]Smit, B., Burton, I., Klein, R. J. T., & Wandel, J. (2000). An anatomy of adaptation to climate 01change and variability. *Climatic Change*, *45*, 223–251.

current insurance is against loss of crops which is difficult and non-transparent. Also, the number of farmers who are able to avail the facility of insurance schemes is limited. Efforts are needed to bring a larger number of farmers within the ambit of insurance schemes. Kisan credit card scheme was found to have better acceptance among the farmers in the region. The scheme simultaneously insured the farmers against crop loss. Such similar insurance mechanism for the farmers in the region can benefit them in case of crop damage due to the weather variability

- **Wadi-little orchards to enhance livelihood security:** It is a tree based farming model that has helped tribal communities of Bundelkhand region to use the potentials of their underutilized resources for sustainable small farm based livelihoods. It has been employed specifically to minimize climatic, biological and marketing risks and gives an opportunity to small and marginal farmers for better management of natural resources and enhanced adaptive capacities against climatic risks.

- **System of Crop Intensification/System of Rice Intensification (SRI):** Can significantly reduce water and seed requirements for rice while simultaneously significantly increasing yield. The System of Rice Intensification, known as SRI is an agro-ecological methodology for increasing the productivity of irrigated rice by changing the management of plants, soil, water and nutrients. It is based on the cropping principles of significantly reducing plant population, improving soil conditions and irrigation methods for root and plant development, and improving plant establishment methods.
- The benefits of SRI include 20%-100% or more increased yields, up to a 90% reduction in required seed, and up to 50% water savings. SRI principles and practices have been adapted for rain fed rice as well as for other with yield increases and associated economic benefits. We use 'SCI' as a generic term for all other crops besides rice. For a specific crop the term is adapted, for example for wheat, System of Wheat Intensification or SWI is used. SRI systems teach us that we can produce more by using less. RI is a knowledge-based approach, and once farmers have learned about the new principles, they can become more independent in improving their agriculture. It is fascinating to see the transformation of farmers, who have started working with SRI, becoming so much more confident and entrepreneurial in developing their own innovations.
- **Use of organic fertilizers:** Organic fertilizers like manure, compost and green manures add organic matter to the soil and feed the life that lives within the soil. These are not only cost effective but also make the soil rich and ideal for planting. With a good soil, plants will get the nutrients that they need. Furthermore, organic fertilizers do not upset the balance in the soil as it does not leave behind any artificial compounds.

Water:

- **Improved irrigation methods like drip irrigation, sprinkler Irrigation and furrow irrigation :** These can significantly increase water and fertilizer use efficiency by reducing

evaporation and water runoff, can reduce labor inputs while increasing the area of irrigable land and allows large areas of land to be irrigated with relatively little technological inputs

- **Ground water recharging structures such as check dams and gabions:** Can help reduce erosion and increase soil water infiltration; retained water can be used for irrigation, reduces required channel maintenance and thus increases groundwater levels and recharge rate.

- **Farm ponds:** A farm pond is a large hole dug out in the earth, usually square or rectangular in shape, which harvests rainwater and stores it for future use. The pond is surrounded by a small bund, which prevents erosion on the banks of the pond. They provide irrigation water during dry spells between rainfalls. This increases the yield, the number of crops in one year, and the diversity of crops that can be grown. Bunds can be used to raise vegetables and fruit trees, thus supplying the farm household with an additional source of income and of nutritious food. Farmers are able to apply adequate farm inputs and perform farming operations at the appropriate time, thus increasing their productivity and their confidence in farming. They check soil erosion and minimizes siltation of waterways and reserves, provides water for domestic purposes and livestock, promote fish rearing, recharge the ground water, improve drainage.

- **Rain water harvesting:** As the water crisis is becoming severe, there is a need of reform the water management systems so that water could be available to all. Water can be conserved using one such technique called rain water harvesting wherein rain water could be stored and has proven to be an efficient way of conserving water for future needs. It also helps in ground water recharging through percolation. It will cater to the demands of the people. Rainwater harvesting provides an independent water supply during regional water restrictions and drought conditions, can help to mitigate flooding of low-lying areas, and reduces demand on wells which may enable ground water levels to be sustained.
- **Weir embankment:** These are the structures around the field that helps in retaining the soil moisture which is exceptionally beneficial in an area of low water availability and in situations like drought.
- **Integrated Watershed Management Programme:** IWMP provides a good platform for conservation and management of water resources and drought- proofing the semi-arid region of Bundelkhand against the cascading effects of adverse climatic conditions. This programme integrates the Drought Prone Areas Programme (DPAP), Desert Development Programme (DDP) and Integrated Wastelands Development Programme (IWDP) of the Department of Land Resources with key objectives of drought risk mitigation, augmentation of land productivity and harness the water storage potential of the region. Integrated Wastelands Development Programme (IWDP) focuses on restoration of cultivable wastelands through afforestation of degraded forests and non-forest wasteland. The Drought Prone Areas Programme (DPAP) identifies drought-prone blocks and functions to minimize the adverse effects of drought on production of crops, livestock, and the productivity of land, water, and human resources through development of watersheds, percolation tanks, check dams and other measures. It works towards enhancing the adaptive capacity of the communities by introducing soil and moisture conservation measures, promoting agro-forestry and horticulture, superior drainage structures and rainwater harvesting. The Desert Development Programme (DDP) has been

conceived as a long-term measure for combating desertification and restoring ecological balance by conserving, developing and harnessing land, water, livestock and human resources. It seeks to promote the economic development of the village community and strengthen the disadvantaged sections of society in the rural areas.

Farmer's Adaptation Cluster

Farmers Adaptation Cluster is an initiative by Development Alternatives. The initiative started with an initial limited sample of 100 small and marginal farmers in Bundelkhand to explore and adopt, on a pilot basis, measures that would increase adaptive capacity to drought conditions through the use of sustainable agriculture practices and efficient use of energy and water. Some of these measures included promotion of efficient irrigation, soil conservation methods and agro-forestry involving demonstration plots and exposure visits of farmers. Although single interventions have limited impacts; putting together different available technical options coupled with institutional strengthening demonstrate significant impacts. Farmers are ready to adopt 'demonstrated beneficial practices' even if these are not formally validated by research / Government institutions. Some of the key aspects of FAC include:

- Extension of crop insurance to cover more farmers as the current penetration of the insurance scheme is not adequate.
- Establishment of “Farmers Adaptation Clubs/Clusters” to bring farmers together to respond to threats of climate change by connecting them to local markets.
- Enhancing the access to information of farmers by use of innovative platforms such as radio based Rural Reality Shows and mobile telephony. Access to knowledge and information and cooperative action will enable farmers to enhance productivity, reduce input costs and bring about a quick change in strategy when the monsoon variability threatens the Kharif sowing.
- As exchange of knowledge is critical to adaptation, there is a need to set up or strengthen the existing knowledge platforms.
- No cost options such as change in sowing dates have been shown to minimize losses or to actually increase the yields of agricultural crops. Such measures need to be tested at a pilot level for research purposes and then if found feasible, be scaled up.
- Increasing the number of information wherein the farmers can attain information about the weather, schemes, agricultural inputs and climate resilient adaptation options viable in Bundelkhand region.

Others:

- Knowledge sharing and communication-Transfer of knowledge relating to agricultural, water resource, or other adaptation strategies through various channels including workshops, farm visits, and information and communication technology. The backward regions have always suffered from lack of information, which has quite often termed them susceptible to extreme events. It is important that knowledge sharing network of civil society organizations,

government authorities and scientific community is strengthened for better communication to benefit the grassroots. Only with the validated and relevant information can the communities adapt to the change through online softwares like Skymet, from where one can easily get information about weather.

- Livestock rearing: Can help reduce agricultural risks and increase overall income by utilizing marginal lands for grazing and fodder; can still be susceptible to climatic conditions that reduce available grazing lands and fodder. There is a need to improve variety and breeds of milking animals.

Implementation of Pashu Sakhi model: The Pashu Sakhi model of animal health care is an initiative in Bundelkhand region and consists of a cadre of trained women animal health workers at the village level. Their main objective is to focus on strengthening livestock rearing as a viable livelihood option. These services range from vaccination and de-worming to providing first aid and medication for diseases such as diarrhoea, common cold, fever, and bloated stomach. In addition, they also raise awareness of livestock rearers regarding management practices such as shed maintenance, low cost feed and fodder, and provision of clean drinking water. This integrated model helped to develop a community based participatory adaptation system for livestock rearing and alternative income generation in the region. Its successful implementation by communities was helpful in identifying the business potential of this model in good livestock management practices and yielding better financial returns. A lot of such models could be thought of and could be replicated by sharing the knowledge related with others through platforms like street play. BKP's since appropriate dissemination of knowledge is even more important than capturing of knowledge.

Some of the short and medium term (2-3 years) measures which may be suggested are:

- ❖ Promotion of efficient irrigation, soil conservation methods and agro-forestry involving demonstration plots and exposure visits of farmers. Although single interventions have limited impacts; putting together different available technical options coupled with institutional strengthening demonstrate significant impacts. Farmers are ready to adopt 'demonstrated beneficial practices' even if these are not formally validated by research / Government institutions
- ❖ Extension of crop insurance to cover more farmers as the current penetration of the insurance scheme is not adequate
- ❖ Establishment of "Farmers Adaptation Clubs/Clusters" to bring farmers together to respond to the threats of climate change by connecting them to local markets
- ❖ Enhancing the access to information of the farmers by use of innovative platforms such as radio based Rural Reality Shows and mobile telephony. Access to knowledge and information and cooperative action will enable farmers to enhance productivity, reduce input costs and bring about a quick change in strategy when the monsoon variability threatens the kharif sowing
- ❖ As exchange of knowledge is critical to adaptation, there is a need to set up or strengthen the existing knowledge platforms

- No cost options such as change in sowing dates have been shown to minimize losses or to actually increase the yields of agricultural crops. Such measures need to be tested at a pilot level for research purposes and then if found feasible, be scaled up.
- Increasing the number of information wherein the farmers can attain information about the weather, schemes, agricultural inputs and climate resilient adaptation options viable in Bundelkhand region.

In the long run, there needs to be a systematic approach to the problem that may consist of:

- Conducting research to identify the best approach to adapt agriculture to climate change by determining the crop mix which would be most resilient to the impacts of climate change in different regions of the state
- Establishment of a meteorological network in the state to provide customized local information and forecasting services to the farmers that will help in reducing the impacts of climate variability
- Institutional capacity building will play a crucial in adapting to climate change by providing appropriate direction and channelization of funds and efforts. Therefore, there is a need of a long term programme for capacity building on key aspects of climate change adaptation
- The Government of MP needs to review its procurement policy to include/enhance quota for alternate crops such as sesame for preferential purchase in drought prone areas.

For decision makers, it has been observed that it is very important for them to understand the relevance of the suggested adaptation options in case the predictions made by modeling exercises do not happen or happen at a magnitude which was lesser or more than that predicted. Below is a robustness matrix which presents the various adaptation options and how relevant each one of them is in case climate change does not take place, the impacts of climate change are less than that predicted, impacts are as they were predicted and impacts are more than they were predicted to be. The robustness of each one of the adaptation options has been derived from a combination of expert views, consultations and direct on ground observations.

Table 4: Robustness Matrix for Adaptation Options in Different Scenarios

Adaptation options	Scenarios				Action required	Relevant department
	No climate change	Climate change impacts less than predicted	Climate change impacts as predicted	Climate change impacts more than predicted		
Short term options						
Efficient irrigation	✔ ✔ ✔	✔ ✔ ✔	✔ ✔ ✔	✔ ✔ ✔	Large scale application of technology in farmers' fields	Agriculture, Irrigation
Crop insurance	✔ ✔ ✔	✔ ✔ ✔	✔ ✔ ✔	✔ ✔ ✔	Wider dissemination	Finance, Agriculture

Establishment of "Farmers Adaptation Clubs/Clusters"	✔ ✔ ✔	✔ ✔ ✔	✔ ✔ ✔	✔ ✔ ✔	Mobilization of farming community	Agriculture
Access to information	✔ ✔ ✔	✔ ✔ ✔	✔ ✔ ✔	✔ ✔ ✔	Conceptualize and plan for programmes	Information Technology, Telecom, Information Broadcasting
Knowledge exchange	✔ ✔ ✔	✔ ✔ ✔	✔ ✔ ✔	✔ ✔ ✔	Set up/support platforms	Information Technology, Telecom
Sowing dates	✔	✔ ✔ ✔	✔ ✔ ✔	✔	Pilot level tests	Agriculture
Long term options						
Research and development for determining crop mix	✔ ✔ ✔	✔ ✔ ✔	✔ ✔ ✔	✔ ✔ ✔	Plan and initiate field level experiments	Agriculture, Irrigation, Power
Establish meteorological network	✔ ✔	✔ ✔	✔ ✔ ✔	✔ ✔ ✔	Plan and implement network	Meteorology
Institutional capacity building	✔ ✔ ✔	✔ ✔ ✔	✔ ✔ ✔	✔ ✔ ✔	Develop curriculum	Human Resources
Procurement policies	✔ ✔ ✔	✔ ✔ ✔	✔ ✔ ✔	✔ ✔ ✔	Review existing policy	Planning

✔ ✔ ✔ = robust; ✔ ✔ =less robust; ✔ =need for reassessment

It is clear that the options are such that they do not result in allocation of resources into assets which become immobilized in event of climate change impacts not happening. That is these are options which in any case will be useful for the farming community. Though, the departments have been identified it needs to be mentioned that the support of Civil Society Organizations, research institutions and private sector will be vital for large scale application of adaptation options.

Annex I: Block Vulnerability Profiles

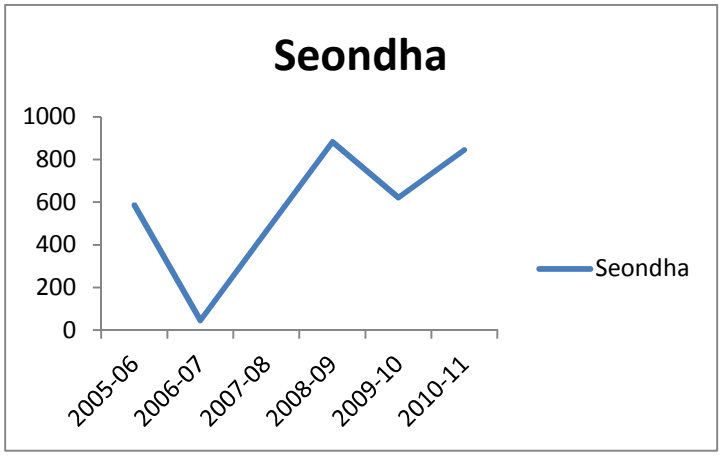
1. SEONDHA BLOCK

Geography

Seondha is located at 26.16°N 78.78°E. It has an average elevation of 251 meters above sea level and is situated at edge of Sindh River with a geographical area of 926.19 sq. kms. It has 222 villages which are divided into 1545 wards. While moving towards left bank of Sindh River, there is a scrap of sandstone hills that forms part of Gwalior range. Seondha is situated on one such hill having a long stretch of steep slope formed of sandstone and shale. The soil along the block is characterized by deep gullied ravines. These ravines are highly vulnerable to intense rainfalls, which often causes soil erosion in these gullies and result in the removal of top soils.

Climate

Being a semi-arid region and largely rain fed, rainfall is an important factor in considering vulnerabilities of Seondha block. This indicator is extremely crucial in determining extreme events in the block and affects agriculture here the most. The average rainfall for the block is 813.8 mm from the period from 1941-90 with 36.2 average annual rainy days. In Seondha, most of the water for irrigation comes through ground water resources and rainfall plays a vital role in groundwater recharging as well. Furthermore, the district has also shown peculiar vulnerabilities to temperature variabilities which are the cause of high evapo-transpiration losses and heat stresses in the district.

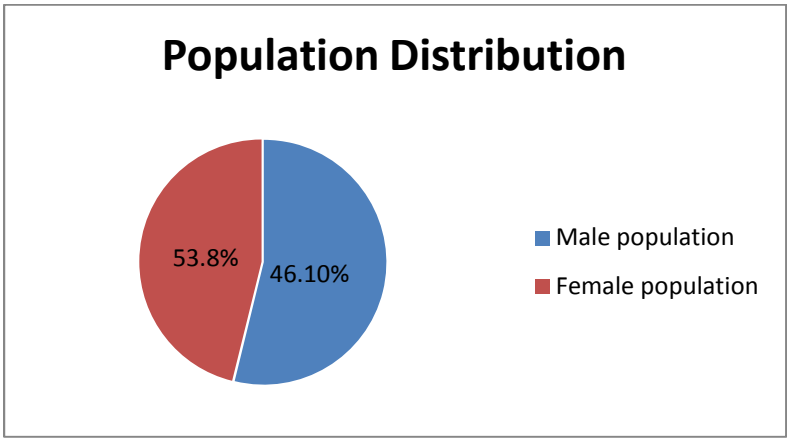


Showing average rainfall pattern in the block (Source: District statistical handbook, 2011)

Demographics

As of 2011 India census, Seondha has a population of 253153 out of which 53.8 % are males and 46.1 % are females with a below poverty level population of 5882 and population density of 226 people per sq. km. A total of 81.7% of the population resides in rural areas which implies that majority of the population are dependent on climate sensitive sectors such as agricultural sector. The sex ratio is 857 females per thousand males which is quite less than the state ratio, the population growth of the district

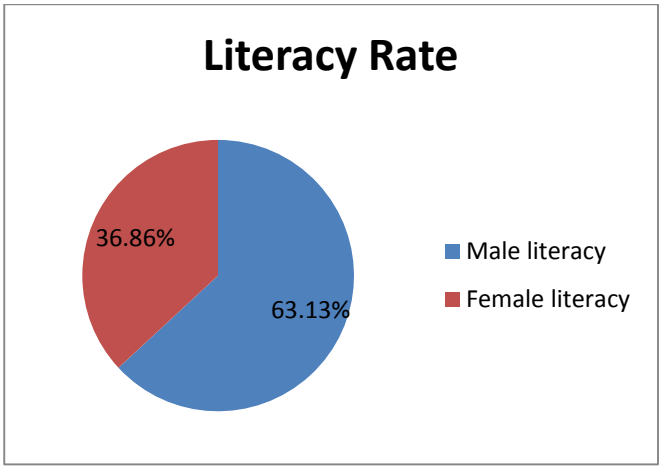
being 23.2%**.** This increased growth in population and decline in resources base adds to the susceptibility of people affected by the vulnerabilities of climate change without having sufficient capacities to cope up with its impacts.



Comparison of male & female population in Seondha block (Source: District statistical handbook, 2011)

Literacy

Out of the total population, 152161 people are literate and hence the literacy rate for the block works out to be 60.10% which is extremely low compared to the state average. The male literacy rate works out to be 63.13% while female works out to be 36.86% showing a large gap of 26%. Low literacy rate indicates the lower level of awareness in people especially females hence depicting lower adaptive capacities in the block. In order to increase adaptive capacities, the state needs to strengthen the education level thus increasing the literacy rate.

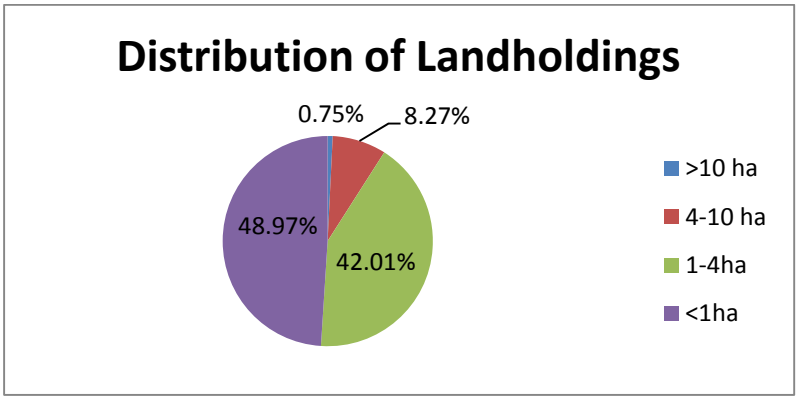


(Source: District statistical handbook, 2011)

Agricultural dependence

In Seondha, 40666 people are dependent on agriculture for their livelihoods out of which 19913 are small scale farmers who will be worst affected by climatic impacts on agriculture due to their weak socio-economic status. The gross irrigated area is 58933 hectares. The ratio of net sown to total

geographical area is 78.25% while the intensity of cultivation is 127.78%. With rapid increase in intensity of cultivation over the years especially due to establishment of new and extensive canal network, winter crops are now grown extensively in Seondha which has also led to increase in cultivation of crops. The net irrigated area has increased to 87%. The area of non-agricultural land is 7151 hectares, barren and uncultivable land being 2040 hectares and the total waste land area is 9191 hectares. 33 percent of the net area in the block is covered with forest. According to statistical handbook 2011, number of machineries used for irrigation has increased to 19922 which show awareness amongst farmers who are gradually adopting improved mechanization in farming practices for ease and better crop productivity. It ensures enhanced adaptive capacity of farmers in the long run and will help in increased farm returns.



(Source: District statistical handbook, 2011)

Water

Groundwater is the main source of water supply in the block. Out of 222 villages in the block, 194 have access to drinking water through hand pumps. There are 13 villages in Seondha having piped tap water supply. Provisions could be taken to ensure safe access to drinking water in all the villages. Water management practices could be adopted to ensure nexus of water security. The major source for irrigation in fields is through groundwater supply with the help of oil/diesel engines. Out of the total irrigated land, 35449 hectare is irrigated through canals; 6845 hectare is irrigated by tube wells, 16378 hectare of land by dug wells and 261 hectare by other sources. Due to high reliance on rainfall dependent ground water resources for irrigation, change in rainfall pattern will eventually affect availability of water resource in the region.

Livestock

In a semi-arid region like Bundelkhand, livestock rearing is a common livelihood option for people. Seondha has an average of 4.79 animals per household out of which number of bullocks per household is 0.29, number of cows per household being 0.73, buffaloes being 1.72 and goats/sheeps being 1.16. The average livestock population per hectare net sown area in the block is 1.47.

2. DATIA BLOCK

Geography

Datia block is located at 25.50°N 78.45°E. It has an average elevation of 210 meters above sea level and is the largest block of district with a geographical area of 1378.17 sq. kms. It has 255 villages which are divided into 1973 wards. While the other two blocks falls in the plains, the south western parts of Datia block fall under Bundelkhand craton formed of old granites and gneisses of the Archean age and the elevation being the highest in the south west part of the block.

Climate

Climate of this block is specifically dry in summer months of April and May. Since the temperature is highest in these months, mean humidity also drops down to significant levels. Highs and lows of changing temperatures, humidity and rainfall can be encountered very well which makes the cropping pattern in the blocks very different. What makes the climate of Datia arid is the large difference between day and night and summer and winters which also entails predominance of low levels of humidity in the region. The rainfall is much higher in Datia than in other blocks which play an important role in irrigation which is now supplemented by extensive canal systems. The average rainfall in the block is 876.3 mm from the period 1941-90 with 38.8 average annual rainy days.

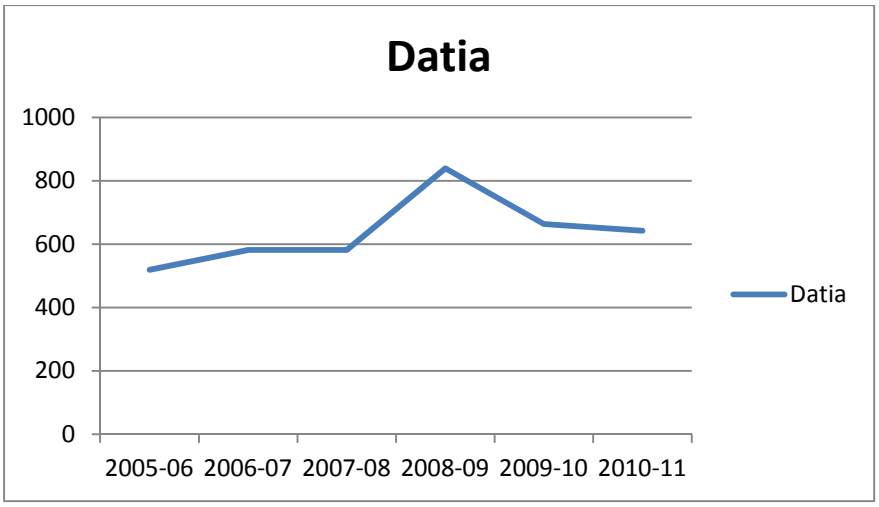
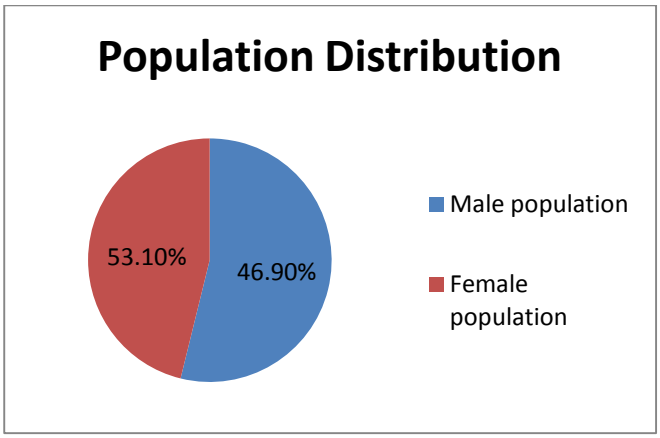


Figure: Showing average rainfall pattern in the block (Source: District statistical handbook, 2011)

Demographics

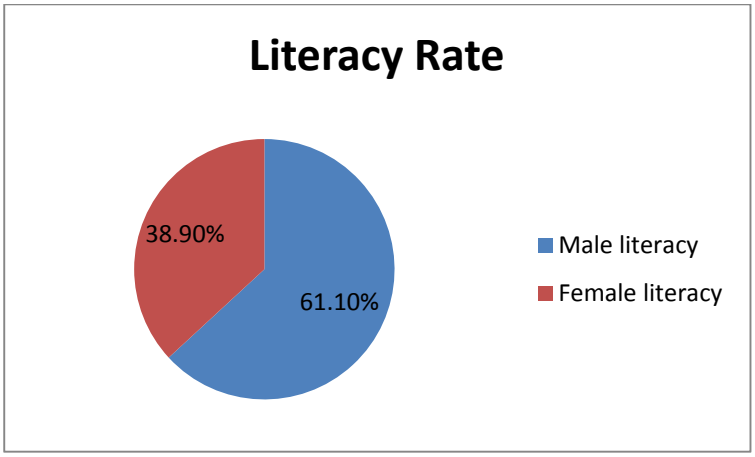
As of 2011 India census, Datia had a population of 373772 out of which 53.1% are male and 46.9% are females with a below poverty level population of 9693 and population density of 228 people per sq. km. A total of 72.67% of the population resides in rural areas which implies that majority of the population is dependent on agricultural sector. The sex ratio is 883 females per thousand males and the population growth of the district is 23%. Comparatively Datia is the most urbanized block in the district with an urbanization ratio of 26.31% which is considerably higher. Due to expansion of agriculture and administration, it is now being counted as urban on the census criteria.



(Source: District statistical handbook, 2011)

Literacy

Out of the total population, 232458 people are literate and hence literacy rate for the block works out to be 62.19%. Literacy in men works out to be 61.10% which is much higher than in women which is only 38.9% showing a large gap of 21%. Low literacy rate indicates the lower level of awareness in people especially females hence depicting lower adaptive capacities in the block. This shows that there is a large gap between block level and state literacy rate. In order to increase adaptive capacities, the state needs to strengthen the education level thus increasing the literacy rate.

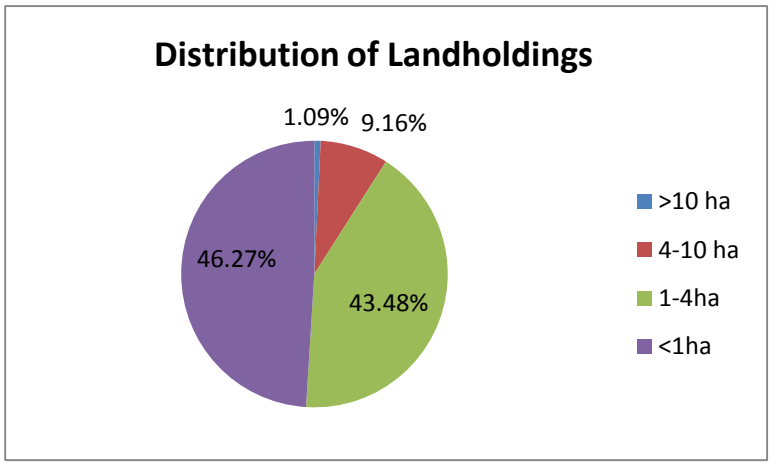


(Source: District statistical handbook, 2011)

Agricultural dependence

Agriculture in Datia basically relies upon the waters of Pahuj and Betwa. 49654 people are dependent on agriculture for their livelihoods out of which 23003 are small scale farmers who will be worst affected by climatic impacts on agriculture due to their weak socio-economic status. The gross irrigated area is 72185 hectares. The ratio of net sown to total geographical area is 87.6% while the intensity of cultivation is 143.44%. With the rapid increase in intensity of cultivation over the years especially due to establishment of new and extensive canal network, there is an increase in cultivation of crops. The net sown area is 82437 hectares. The area of non-agricultural land is 15,209 hectares, barren and uncultivable land is 9856 hectares and total wasteland is 25,065 hectares. 9.83% of the net area in the

block is covered with forest. According to statistical handbook 2011, number of machineries used for irrigation has increased to 16638 which show awareness amongst farmers who are gradually adopting improved mechanization in farming practices for ease and better crop productivity. It ensures enhanced adaptive capacity of farmers in the long run and will help in increased farm returns.



(Source: District statistical handbook, 2011)

Water

Hand pumps and wells are the main source of water supply in the block. Groundwater is the main source of water supply in the block. Out of 255 villages in Datia, 240 have access to drinking water through hand pumps. There are 5 villages which have no source of drinking water at all. There are 30 villages in Datia block having piped tap water supply. There is sufficiently good water supply in rural areas of Datia. Provisions could be taken to ensure safe access to drinking water in all the villages. The major source for irrigation in fields is through groundwater supply with the help of oil/diesel engines. Out of the total irrigated land, 40672 hectares is irrigated through canals, 3605 hectare is irrigated by tube wells, 27874 hectare of land by dug wells and 34 hectare by other sources. Due to high reliance on rainfall dependent ground water resources for irrigation, change in rainfall pattern will eventually affect availability of water resource in the region.

Livestock

Number of animals in the block has grown much slower than human population. Although Datia is rich in poultry, decline in number of bullocks is accompanied by an increase in mechanical implements since most of the agricultural operations are now carried out through mechanical power. In a semi arid region like Bundelkhand, livestock rearing is a common livelihood option for people. Datia has an average of 6.17 animals per household out of which number of bullocks per household is 0.52, number of cows per household being 1.19, buffaloes being 1.01 and goats/sheeps being 1.54. The average livestock population per hectare net sown area in the block is 2.57. This figure shows that Datia is rich in livestock and seems to be less commercialized.

3. BHANDER

Geography

Bhander is located at 25.34°N 78.35°E. It has an average elevation of 244 meters above sea level and is situated at edge of Sindh River with a geographical area of 654.38 sq. kms. It has 140 villages which are divided into 1040 wards.

Climate

The average annual rainfall of the block is 888 mm and average annual number of rainy days is worked out to be 36.6 days from the period 1941-90. The average temperature being the highest in May which makes it the driest month. Rainfall and temperature are the most important factors contributing in climate change. Both the factors can greatly impact crop production thus leaving an impact on agriculture sector. Rainfall is although crucial in water recharging and rain fed cultivated systems. Since irrigation in this area has been dependent on rains, rainfall plays a vital role in groundwater recharging of Bhander district.

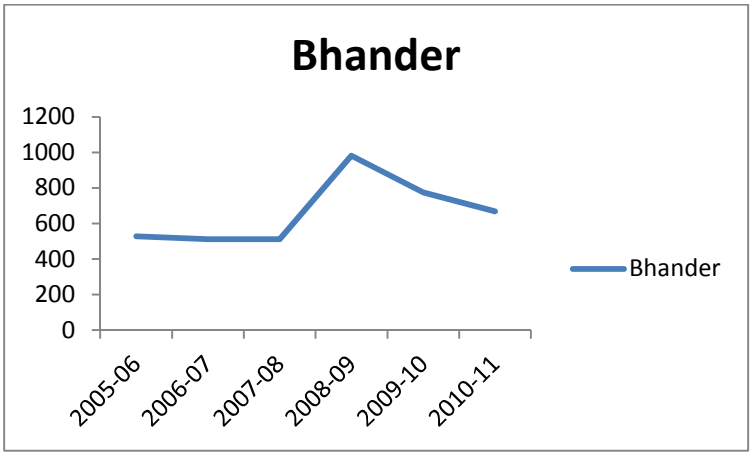
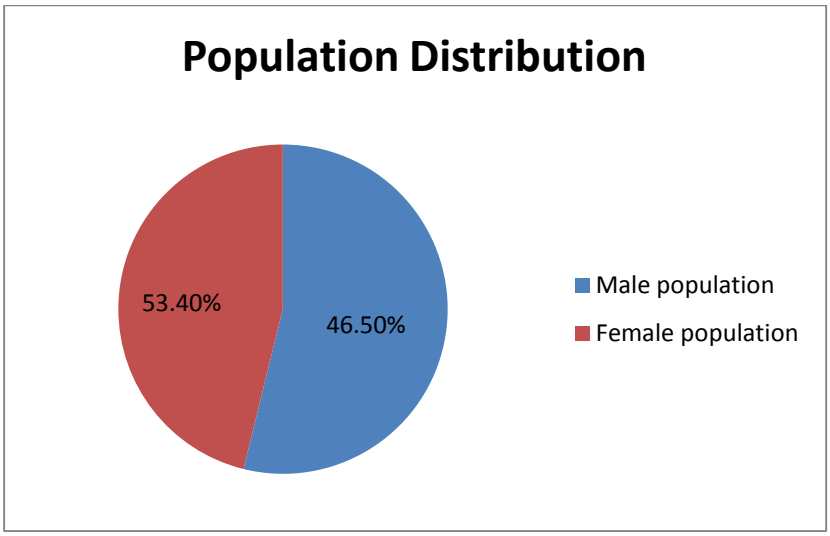


Figure: Showing average rainfall pattern in the block (Source: District statistical handbook, 2011)

Demographics

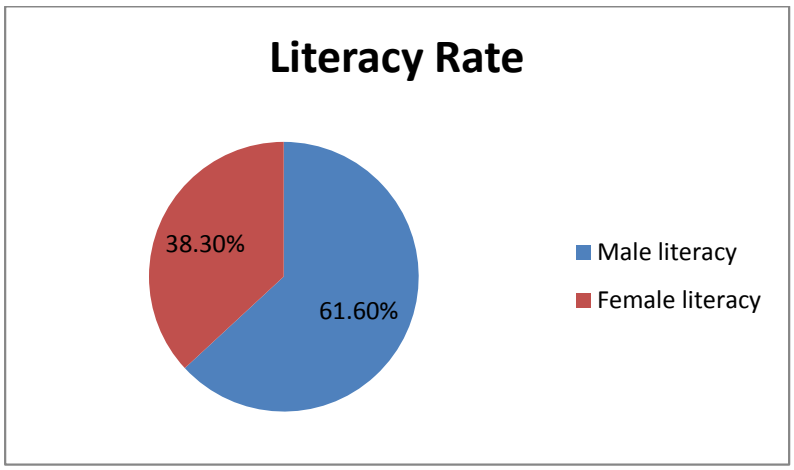
As of 2011 India census, Bhander has a population of 159829 (males are 85376 and females are 74453) with a below poverty level population of 4505 and population density of 226 people per sq. km. A total of 84.2 percent of the population resides in rural areas which implies that majority of population is dependent on agricultural sector. The sex ratio is 872 females per thousand males which is quite less than the state ratio, the population growth of the district being 17.9% while the urban ratio is calculated as 14.72%. This increased growth in population and decline in resource base adds to the susceptibility of people affected by vulnerabilities of climate change without having sufficient capacities to cope up with its impacts.



(Source: District statistical handbook, 2011)

Literacy

Out of the total population, 106826 people are literate and hence the literacy rate for the block works out to be 66.83% which is extremely low compared to the state average but highest in all the other blocks of Datia. Male literacy rate in Bhander works out to be 61.6% while female works out to be 38.3%, showing a large gap of 23.3%. Low literacy rate indicates the lower level of awareness in people especially females hence depicting lower adaptive capacities in the block. In order to increase adaptive capacities, the state needs to strengthen the education thus increasing the literacy rate.

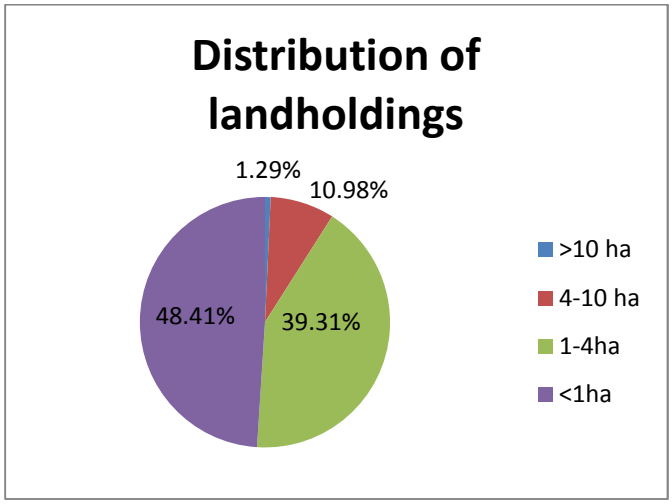


(Source: District statistical handbook, 2011)

Agricultural dependence

Agriculture is the main occupation of people in Bhander and has improved massively because of extended canal system. 30619 people are dependent on agriculture for their livelihoods out of which 14824 are small scale farmers who will be worst affected by climatic impacts on agriculture due to their weak socio-economic status. The gross irrigated area is 42250 hectares. The ratio of net sown to total geographical area is 75.5%. The net sown area is 55961 hectares. The total non agricultural land is 3744

hectares, barren and uncultivable land being 3033 hectares and the area of total wasteland is 6777 hectares. Since changing climate has the most adverse impact on forest degradation and distribution, absolutely no forest cover shows great sensitivity of forest resources towards changing climate. According to statistical handbook 2011, number of machineries used for irrigation has been increased to 3840 which is although lesser than other blocks but it shows awareness amongst farmers for using better equipments in order to increase their yields. It ensures enhanced adaptive capacity of the farmers.



(Source: District statistical handbook, 2011)

Water

Hand pumps and wells are the main source of getting water in village. Out of 140 villages in the block, all of them have access to drinking water through hand pumps thus depicting good availability of water resource in the region. There are 14 villages in Bhander having piped tap water supply. Almost all the villages here rely on hand pumps and wells for drinking water but maintenance of these remain a major chore especially for women. The major source for irrigation in fields is through groundwater supply with the help of oil/diesel engines. Out of the total irrigated land, majority of land which is 26046 hectare gets irrigated through canal; 856 hectare is irrigated by tube wells, 14141 hectare of land by dug wells and 1207 hectare of land by other sources. Since the area is chiefly rain fed and due to high reliance on ground water resources for irrigation, change in rainfall pattern will eventually affect availability of water resource in the region.

Livestock

In a semi-arid region like Bundelkhand, livestock rearing is a common livelihood option for people. Bhander has an average of 5.24 animals per household out of which number of bullocks per household is 0.39, number of cows per household being 1.00, buffaloes being 1.63 and goats and sheep being 1.39. The average livestock population per hectare net sown area in the block is 2.70. The figures significantly show that the block is rich in livestock and is an important source of livelihood here.

Annex II: Village Vulnerability Profiles

1. Village: Nauner

Panchayat: Nauner

Socio-economic Vulnerabilities

Village Profile

It is a medium sized village with an average distance of about 21 k.m. from district headquarter and block-Datia. Its distance from Datia block often creates a problem for village communities who have to travel long distances to buy commodities, gather information and avail benefits of different government schemes. The total geographical area of Nauner village is about 1242.83 ha. out of which 837.67 ha. is agricultural land, 333.56 ha. is uncultivable wasteland and 71.6 ha. is administrative land.

Geologically, Nauner village has three types of soil profiles: laterite soil, black soil and red soil. Around 13% of the agricultural land consists of red soil which is poor in nutrient quality and is limited for certain crop types such as maize.

Demographics

The total population of Nauner village is 3982, 40% of which comprises female population and 60% male population. This indicates the imbalance in sex ratio and highlights the sensitivities of female gender in the village. Females in the village are engaged in farming activities such as sowing, thrashing, harvesting, sorting and storage. Their involvement in decision making processes is however limited and highlights they are still restricted to manual labor. Out of the total population of the village, 30.63% belongs to Scheduled Castes. This population occupies low status in social dynamics of the village. Around 44% families in the village are below poverty line (BPL). Owing to low resource base and limited income, BPL section of the village has limited resources for agriculture and shows poor adoption of new and advanced adaptation strategies.

Livelihood

Beedi making industry is also a means of livelihoods to certain communities in the village. Over the years, livestock rearing practices have reduced in the villages due to labour requirement and economic weakness of several farmers. People in the village face problems due to lack of information sources. Gram sewaks are also not always available for dissemination of agriculture related schemes which creates a knowledge gap within the farmers.

Agriculture

80% of population in the village depends on agricultural activities for their livelihoods. Agriculture sector is directly impacted by climatic vulnerabilities and is highly sensitive to the weather fluctuations that often occur during summer and winter months in the region. The village consists of around 10 landless families consisting of landless farmers as primary bread earners. Such families do not have fixed source of income and often migrate when weather conditions disrupts the economic activities in the region.

Out of the 837.67 ha agricultural land in Nauner, 62.52% land is unirrigated and is dependent on unpredictable rains for meeting water requirements of agriculture. This factor puts Nauner at high risks of climate vulnerability. Kharif crops grown in the village include wheat, ground nut, soyabean and rice (in some patches) and rabi crops comprises of wheat, gram, mustard and black gram (*urad*). During drought conditions, farmers usually shift to less water intensive crops such as barley and millet. Farmers primarily depend upon chemical fertilizers and do not make much use of organic fertilizers. Primary surveys of farmers revealed that according to them organic fertilizers are likely to reduce farm productivity and are therefore neglected. Furthermore, farmers are used to raising single crops at a time and practice of multiple cropping is still a rare phenomenon in the village.

Socio-economic

Out of the total population of Nauner, around 36% is illiterate. This shows that poverty in the village is deeply interlinked with high levels of illiteracy and lack of information. This situation further diminishes the adaptive capacities of communities who face problems due to lack of information, low levels of awareness about welfare schemes and poor capacities to cope up with high risk situations

Water

A large number of farmers practice open irrigation through diesel powered motors and have still not adopted micro-irrigation techniques. Wells present in the villages are used for irrigating agricultural fields only for restricted times of the year. Around 75% of wells in the village offer water for 6 months in a year and 25% offer water for 10 months in a year. During peak summer months, water in these wells reduces by 10 feet. These months are water scarce and pose difficulties for the farmers in meeting water needs. 17 handpumps act as a major source of drinking water in the village. 10 of these handpumps offer water for 9 months in a year. Peak summer months often pose difficulties for the farmers and minimize drinking water supply as well.

2. Village: Kamher

Panchayat: Pathari

Village Profile

Kamher is a small sized village in Datia block and has a total geographical area of around 445.45 ha. The village is at a distance of around 22k.m. from Datia district and block. The village is at a distance of about 3k.m. from Pathari panchayat. 30% of village land belongs to forest department. Communities in the village often find their way through this area to meet their household energy needs and extract fuel wood from forests on several occasions.

Demographics

The total population of Kamher is 684, 43% of which is female population. Out of the total 88 families in the village, 53% of the families are below poverty line. These families include landless families and poor agricultural families. Some of these families have limited agricultural lands which merely meet their financial needs and further increases their risks during adverse weather conditions. Half of village's

population comprises of scheduled castes. SC population of the village has an average of .63 ha of land which highlights their poor economic status and low adaptive capacities.

Livelihood

Being an agrarian economy, livelihoods of communities in Kamher are largely dependent on agriculture. In addition to agriculture, livestock rearing is also practiced in the village. Cows, buffaloes, goats and poultry are commonly reared in the village and used for raising income. This is a step forward taken by communities of Kamher village which gives them an edge when farm returns are compromised due to extreme conditions.

Agriculture

Out of the total available land in the village, 289.26 ha land is available for farming, 56% of which is irrigated. This shows that farmers in the village are progressive and are availing different irrigation methods to reduce their dependence on life giving monsoons. Farmers in the village raise both kharif and rabi crops in the village. Out of the total agricultural land, farmers grow kharif crops such as maize and groundnut in 146.99 ha of land. Rabi crops such as wheat and mustard are grown in around 164 ha of land. Gram, groundnut and wheat are major crops in the area and have largely attracted farmers in the village due to cash value in the market. Thus both of the cropping seasons, Rabi and Kharif are important in the village. Wheat and groundnut crops out of all the other varieties stand out with the highest production.

Farming communities in the village are still at high levels of climatic risks as monocropping is practiced in around 93% of farm lands. This shows that extreme conditions of temperature and rainfall may adversely affect crops in the village where other crops are not available as alternative reserves. The farming decisions of communities in the village have however dwindled in the recent past, owing to unpredictable rainfall patterns and variable weather conditions. Since there is an increase in rainfall percentage from last 2 years, villagers have decided to grow water intensive crops like rice this year so that there could not be any loss due to weather change.

Results from soil testing of Kamher reveal that slightly basic pH of the soil affects seed germination in the village land which increases the seed utilization by farmers. Soil in the village consists mainly of residual red and black cottony soil of varying degrees of quality and has less moisture. Even after low moisture content of the soil, majority of farmers do not practice composting and green manuring. Composting activitiy is considered as an add-on burden and is often neglected by farmers in the village. This shows that farmers need a behavioral change for adopting low cost simple solutions which can help them to increase resource content of their soils.

Water

There are around 36 wells and 2 ponds in Kamher. Wells in the village meet water needs of the communities for 6 months in a year. These structures not only contribute in irrigating agricultural fields but also help people of Kamher village in conserving rain water. Farming communities of the village were earlier dependent on seasonal rains and traditional methods for irrigating their agricultural fields,

but now with the advent of technologies, government initiatives and schemes, farmers have been provided with engines for irrigation purposes and tractors for supplying water to the fields.
Community awareness on drinking water quality is also high in the region. In recent years, communities in Kamher village are testing drinking water quality on a regular basis. As a result, quality of drinking water in the village has increased subsequently. Civil Society Organizations in the region have played an important role in building community awareness on drinking water quality and has also helped in increasing the penetration of good adaptation practices in the mindsets of village people.

Socio-economic

Even though the village is electrified, grid connections have not reached the fields. Yet, some farmers have managed to find illegal ways to electrify their motors in some neighboring fields. Intermittent supply of electricity in the village area however forces the communities to rely on diesel for running water engines. This is an additional input cost and is particularly heavy on the pockets of small and marginal farmers. With all these technologies, ground water still stands as a major source of irrigation for fields. Primary health centres are present at a distance of around 2k.m. in Nauner village. For meeting drinking water facilities, handpumps and tap water services are available in the village. Under the Nal Jal Yojna, tap water available to the communities has helped to reduce water woes of communities to a large extent.

3. Village: Chakram Sagar

Panchayat: Nichroli

Village Profile

Total geographical area of the village is around 104 hectares. This is the smallest village in the study area and carries peculiar vulnerabilities specific to it. A small percentage of this geographical area (19.32%) belongs to forest area. Although, a large population of this village depends on agriculture for livelihoods, only 24% percent of the total geographical area is used for agriculture purposes. This highlights that despite of the largest livelihood provide to the village, agriculture land available to farmers is quite low. This shows that a large population of village belongs to landless farmers and agricultural laborers. It is at a distance of around 10k.m. from the district and block.

Demographics

The total population of Chakram Sagar is around 680. Entire population of this village belongs to backward classes. Out of total families in the village, 79% is below poverty line (BPL). This village has the highest BPL population among all the villages of study area. This shows that poverty ridden challenges are deeply interspersed in this village and hinders adaptive capacities of communities residing here. Out of the total agriculture families in Chakram Sagar, 30% families consist of small and marginal farmers.

Socio-economic

Around 70% of the village population is illiterate and Chakram Sagar has the highest ratio of illiterate population in the study area. Overall, the adaptive capacity of Chakram Sagar is relatively poor, when compared to other seven villages in the study area.

Livelihood

Despite of its vulnerabilities related to agriculture sector, Chakram Sagar shows a good graph record of communities practicing alternative livelihoods. Livestock rearing for dairy products and fisheries is commonly practiced by several villagers. Besides animal and fish rearing activities, several people are also associated with Self Help Groups (SHGs) for candle making activities. Such initiatives of Civil Society Organisations (CSOs) have not only helped in providing livelihood opportunities to communities but also empowered women and have reduced their dependency on male members of their families. This factor has played an important role in increasing the adaptive capacities of communities in Chakram Sagar and has reduced their vulnerabilities (despite of high sensitivity of agriculture sector). Additionally, a large number of farmers are also engaged in labour works and often travel to Datia district for this purpose. Labour works is an alternative livelihood for a lot of landless farmers in the village who avail its opportunities when extreme weather conditions diminishes their work in agriculture sector.

Forest

The village is surrounded by patches of forest area which is easily accessed by communities for livestock grazing purposes. This factor puts the forest resources available to the communities at risks. If not used efficiently, it can degrade the resources available to farmers and affect the micro climate in their region.

Agriculture

25% of families in the village belong to landless farmers; these farmers do not a fixed income source and usually depend on dwindling resources for meeting basic amenities. More than 80% of the agricultural land in Chakram Sagar is irrigated which largely belongs to medium and few large scale farmers. Both Kharif and Rabi crops are raised by farmers in the village. Kharif crops in the village include sesame, maize, groundnut etc. and rabi crops include wheat, gram, mustard etc. According to the respondents, rabi crop offers better productivity to the farmers. During field assessments of the village, it was observed that the farmers have very low awareness levels and are not yet aware of different adaptation strategies available for agriculture. They have been raising crops in age old definitive patterns are have low information on drought resistant seed varieties, organic fertilizers and modern irrigation techniques. Both chemical and organic fertilizers are used in farming. However, farmers in the region prefer using chemical fertilizers due to inadequate information and myths associated with organic fertilizers. The village severely suffered from droughts that affected the region few years back. This created a water crisis situation in the area and communities were forced to migrate out of their villages.

Water

MGNREGS has played an important role in meeting irrigation needs of communities in the village. Under MGNREGS, several wells that were constructed on farms have reduced the burden on the farmers. There are around 25 wells in the village. Other sources of water such as ponds and rain water harvesting

structures are not present. Wells in the village meet water needs of the communities for 6 months in a year. The village has good amount of water resources and availability of water from handpumps and wells in not a major problem. However, despite of good water supply, salty drinking water becomes a problem for residents of the village.

4. Village: Chopra

Panchayat: Bajni

Village Profile

It a medium sized village with a geographical area of about 1252.4 ha . It is at a distance of merely 7k.m. from the district and is still deprived of development related to agriculture, land development, livestock and livelihoods (to some extent). 30% of village land comprises of forest areas and belongs to forest department. Due to varying boundaries, this is a major cause of administrative issues for communities of Chopra village who are often deprived of any developmental works in available lands.

Demographics

The total population of Chopra village is about 740 with 48% comprising of female population. A large population of the village (68%) belongs to backward classes. These families of Chopra village are not only socio-economically weak but are also backward with respect to development climate change resilience. Out of the total population of Chopra, 54% of population is below poverty line. Moreover, 33% of population belongs to Scheduled Castes. These are weaker sections of the society and are largely poverty ridden.

Livelihood

Besides agriculture sector, communities of Chopra village have chosen diverse range of livelihood options. These alternative options helped the communities during drought conditions and less migration has been witnessed by the village. This shows that communities in the village are trying to increase their resilience and have proven that they have good potential of risk coping capability in adverse conditions. These include brick making activities, livestock rearing for dairy production and labor works. Communities of the village have also shown low participatory behavior in the study. This is particularly because low levels of awareness and social responsibility and poor maintenance of some water conservation structures has resulted in poor utilization for water conservation.

Socio-economic

Around 48% of village population is illiterate and is often deprived of benefits enjoyed by literate population. This puts them at additional risks of socio-economic growth and climate change resilience. The status of rural electrification in Chopra village is good and new schemes have improved the situation of electricity availability to the village. The agricultural fields are not yet electrified and farmers use engines to irrigate fields.

The status of information on agriculture and other schemes is good in the village. Gram sewaks come from time to time and provide villagers with the latest information. These extension officers also

provide new variety seeds which have led to an increase in production and thereby improving economic conditions in the village in recent past.

Agriculture

The situation of agriculture sector is quite weak in the village. Out of the total land area of the village, only 13% land is utilized for farming practices; most of which witnesses monocropping. This shows that farmers depending on agriculture for livelihoods are at a greater threat of climate change. Monocropping not only reduces their farm returns but also put them at direct losses during sudden variation of weather conditions. According to discussions with communities in the village, farmers are already facing the brunt of climatic changes and variabilities. Over the last few years, excessive rainfall in short period of time has intensified the problems of soil erosion. This often leads to erosion of soil from farming fields and causes loss of nutrient rich top soil. Common Kharif crops include maize, groundnut and groundnut and rabi crops include mustard and wheat.

Results from soil testing of Chopra reveal that slightly basic pH of the soil affects seed germination in the village land which increases the seed utilization by farmers. The village is located in a high slope area, where soil erosion with runoff water has resulted in loss of nutrient rich top soil of farms and has decreased farm productivity in the region. Certain farmers in the village also face problems due to accumulation of water which increases the alkalinity of soils.

Communities in the village have shown good acceptance for organic farming. Low input adaptation options such as composting, vermicomposting and gobar gas are widely accepted by communities of Chopra village. There is an increased awareness in the famers about the usage and advantages of using organic fertilizers in fields for which some of the farmers have started using composting. There are around 8-10 composts in the village and Gobar gas is also produced.

Farmers in the village recently witnessed huge losses due to excessive rainfalls in the region this year. As a result of sudden fluctuations in the weather, groundnut crops in the village got destroyed and led to a lot of loss in production.

Forest

Communities of Chopra were observed to be good at maintaining their natural resource base. Forest reserves have been well conserved by communities and encroachment activities are not common. This shows that with the efforts of Forest Department and resource efficient ways of communities, valuable forest resources can be put at good use when adverse climatic situations will increase the risks of communities.

Water

Wells in the village meet water needs of the communities for 6 months in a year. Water runoff is a critical issue in the village and often restricts the communities in rain water harvesting. The topographic location of the village is not very suitable for water harvesting and is the cause of water woes for the

communities. Furthermore, restricted forest land of forest department interspersed with village land, restricts the communities of Chopra village to construct any water harvesting structure. This issue of administration land further restricts the communities. As a result, communities in the village face water problems, particularly in summer months of the year. Such problems highlight that rising temperatures in the future are likely to increase the difficulties of communities in coming years. Furthermore, 2 out of 6 handpumps available are not functional thus increasing the adversities of communities for drinking water availability.

5. Village: Nichrouli

Panchayat: Nichrouli

Village Profile

It is a medium small village with a total geographical area of about 680 ha. It is at a distance of about 10k.m. from the district which gives it an access to basic facilities such as health centers, banks etc. A very small portion (4.7%) of the total geographical area is forest area. 6% area of land in the village is wasteland and is currently not being put to any use.

Demographics

The total population of Nichrouli village is around 1768. Out of the total 445 families, 58% families are below poverty line. These families live with limited resources and have restricted access to basic needs. Owing to low resource base and limited income, BPL section of the village has limited resources for agriculture and shows poor adoption of new and advanced adaptation strategies.

Literacy

54.24% of village population is illiterate and poor levels of information. Communities in Nichrouli (particularly illiterate population) do short term planning for agriculture and water management. During discussions with the responds, it was observed that due to low awareness and information gaps, long term planning is not envisioned by the communities.

Livelihood

Besides agriculture, livestock rearing is practiced by communities to some extent. Livestock rearing was a life saver for communities during 2004-2009 droughts when many farmers depended on livestock rearing for earning incomes. Such alternative options helped communities to bear the risks of climate change and very few families of the village migrated to cities.

Agriculture

Out of the total geographical area of the village, 128 ha is for farming in agricultural fields. The village consist a large population (59%) of small and medium farmers. Around 11% population in the village belongs to landless farmers. The village consists of around 42 landless families consisting of landless farmers as primary bread earners. Such families do not have fixed source of income and often migrate when weather conditions disrupts the economic activities in the region. Agriculture is the main source of livelihood for people residing in this village and majorly grown crops are beans, maize, wheat, rice and

peas. This shows that besides cash crops, communities in the village also practice vegetable farming which not only gives them good returns in local market but also provide them alternate source of income. Farmers have shifted to modern farming and irrigation techniques. Tractors are now commonly used by farmers who are shifting to modern and improved ways of farming. Modern technologies used in farming not only save time and efforts of farmers but also help them to use agricultural adaptation practices such as ridge and furrow sowing. These practices not only help in soil and water conservation but have proved beneficial in low rainfall situations. The topographic location has benefitted Nichrouli village and soil quality for agriculture is good.

Water

Moving away from the traditional means of irrigation, farmers are using diesel pumps for supplying water to the fields and tractors are used for irrigation purposes. There are wells in the village constructed under the MGNREGS scheme. Schemes such as MGNREGA have proven to be beneficial for several people of the village who now have improved sources of irrigation for their fields. Farming communities of the village were earlier dependent on seasonal rains and traditional methods for irrigating their agricultural fields, but now with the advent of technologies, government initiatives and schemes, farmers have been provided with engines for irrigation purposes and tractors for supplying water to the fields. Even though the village is electrified, grid connections have not reached the fields. Farmers use diesel powered pumps to irrigate their fields.

6. Village: Pathari

Panchyat: Pathari

Village Profile

It is a small sized village with a total geographical area of about 368 ha. This village is at a distance of around 22k.m. from district.

Demographics

There are around 221 families in the village, 216 of which are directly dependent on climate sensitive agriculture for livelihood. Out of the total number of agricultural families, 37% belong to small and marginal farmers. This is a relatively developed village of the study area with farmers having larger land holding size. Less number of small and marginal farmers is a good indicator. This is because farmers with bigger land holding size have more number of resources and better capacities to cope up with the risks of climate change. 58% of village population is below poverty line. Out of the total population in the village, 43% is female population.

Livelihood

Besides household works, women in the village are also engaged in livelihood generation activities. Candle, *dona pattal* and scented sticks are made by several women Self Help Groups (SHGs) in the village. Such initiatives of civil societies have helped to empower women who now shoulder men in sharing household responsibilities. In extreme weather conditions when erratic rainfalls can disturb climate sensitive sectors such as agriculture, such small yet useful alternative livelihoods have proved to

help communities cope up and ensured steady sources of income. Agriculture and labour works on agricultural fields are a major source of livelihoods in the village.

Forest

Effective implantation of Government schemes and support of communities has increased forest cover in the region. Encroachment activities are rare and communities pay good attention to conserve forest reserves available to them.

Agriculture

Agriculture is practiced in 72% of land in the village. This shows that farmers have largely made use of the land available to them and extensively practiced farming. Out of the total agriculture land, Kharif crops are raised in 107.6 ha. and Rabi crops are raised in 214.31 ha. of land. Kharif crops grown in the village are rice, barley, maize, lentils and groundnut. Rabi crops grown in the village are wheat, gram, mustard etc. Monocropping is still more prevalent in the village and shows higher statistical data when compared to multicropping. Monocropping is practiced in 150.07 ha. of land in the village while multicropping is practiced in 83.34 ha. of land. The village is located in a high slope area, where soil erosion with runoff water has resulted in loss of nutrient rich top soil of farms and has decreased farm productivity in the region.

Water

Out of the total agriculture land available, 92% (216. 17 ha) of land is irrigated and shows that farmers of Pathari have relatively less dependency on life giving rains. This is a positive indicator for the village and plays an important role in raising the adaptive capacities of communities. There are 96 wells in the village which have a fair share in facilitating irrigation in the village. Lack of maintenance and poor planning in the village is increasingly causing loss of rain water (through run-off), which could otherwise have been conserved through rain water harvesting. Handpumps and taps in the village fulfill the drinking water needs of the communities all year round. Communities in the village have constructed weir embankment as an adaptation solution to retain soil moisture and conserve rain water.

This village is a good example of effective implementation of sustainable rural development schemes. Several initiatives such as Kapil Dhara Yojna, Nirmal Vatika and Jal Sangrakshan Yojna are some of the initiatives which have intiated plantation and water management activities in the village.

7. Village: Govind Nagar

Panchayat: Bajni

Village Profile

The total geographic area of Govind Nagar is around 650 ha.

Demographics

The total population of village is 390. All the 97 families of village belong to Scheduled Castes and 96%of the population is below poverty line (BPL). A large population of the village has migrated to the cities.

The ones remaining behind are backward Scheduled Castes and are mostly below poverty line. These factors show that vulnerability of communities in the village is quite high because of social backwardness and low income which increases their sensitivities.

Literacy

The village has a high literacy rate of 65%, comprising of a large number of female population. Female population in the village particularly witnesses high rates of drop out from schools due to increasing household responsibilities and work burdens of collecting resources for family. Such burdens intensify during peak summer months of the year. This is not only an indicator of lower adaptive capacities but is also a factor responsible for increasing the sensitivities to climate change.

Agriculture

The situation of agriculture sector is quite weak in the village. Out of the total land area of Govind Nagar village, only 14.5% land is utilised for farming practices; most of which witnesses monocropping. Monocroping is practiced in 83% of land used for farming. Out of the total farmers in Govind Nagar, 10% are landless. Commonly grown Kharif crops in the village are rice, barley, groundnut and maize and Rabi crops are wheat, gram and mustard. Results from soil testing of Govind Nagar reveal that slightly basic pH of soil affects seed germination in the village land which increases the seed utilisation by farmers. 91% families in the village are dependent on agriculture for livelihoods. Out of this percentage 56% of farmers are small and marginal farmers. Low human development indices of the village explain the high number of poor and marginal farmers in the village.

Besides agriculture, farmers in the village are also practicing kitchen gardens and water them with household level waste water. This not only help them to utilise water from kitchen etc. but also helps them to grow some vegetable and fruits for meeting household nutritional needs.

Water

There are around 130 wells in the village. Respondents in the village emphasized that erratic and low levels of rainfall is reducing the ground water levels and water availability of water from wells and handpumps has reduced significantly. These factors highlight that farmers understand that erratic rainfall patterns have influenced the groundwater levels but they still fail to understand that excessive exploitation of groundwater through diesel powered and engines and borewells is also a cause of their water miseries. This highlights low awareness and understanding of communities towards exploitative ways which also contributes to higher climate change vulnerabilities. The village is located in a high slope area, where soil erosion with runoff water has resulted in loss of nutrient rich top soil of farms and has decreased farm productivity in the region. Farmers in the village complained of decreasing groundwater levels in the village. They said that despite of watershed works in their village, water levels have still not increased to a great extent. This indicates a serious problem of depleting ground water levels in the village and highlights that environmental assessments are required to check the water related problems in the village.

Socio-economic

Even after their backward and weak socio-economic status, communities of Govind Nagar have been progressive towards new and modern technologies. To get rid of problems related to intermittent electricity supply and off shooting diesel prices, farmers have found alternate measures thus cutting down the expenses in their pockets. Farmers in Govind Nagar have shifted to renewable sources of energy for solving water crisis and meeting their irrigation needs. Realizing the solar potential in semi-arid region of Bundelkhand, farmers have employed solar panels in the village. The energy generated from these panels is used for running motor and supplying water to the field. This indicates that farmers are increasingly becoming aware and realize the importance of using efficient sources of energy.

8. Villager: Salaya Pamar

Panchayat:

Village Profile

The total geographical area of Salaya Pamar is about 1515.18 ha. It is at a distance of about 12 k.m. from the district headquarters and increases the dependency of communities who have to travel to district for every small requirement.

Socio-Economic

The total population of Salaya Pamar is 1387, 44.7% of which is illiterate. 49% of village population is below poverty line. Problems faced by communities particularly increase when they have to make several trips to district for availing schemes. This issue was particularly highlighted by several people of Salaya Pamar who find it difficult to go through red tapism for availing Government Schemes.

Livelihood

Common livelihoods practices in Salaya Pamar are farming, agriculture labour works and livestock rearing. Around 50 families of Salaya Pamar also practice livestock rearing for earning livelihoods and generating alternative incomes. Small percentages (5.77%) of farming families in the village are landless. This is good indicator for reducing the vulnerability of village. Discussions with respondents highlighted that communities who did not possess land shifted to alternative means of livelihoods and reduced their dependency on climate induced extremities on agriculture sector.

Forest

Out of the total geographical land available in the village, forest land is merely 2.4%. This is the smallest percentage of forest cover in the study area and indicates that communities of Salaya Pamar have low levels of natural resource base available. Based on the discussions with respondents, it was observed that low percentage of forest cover affects micro-climate in their area and puts them at additional pressure of heat stresses during summer months.

Agriculture

Out of the total agricultural area available for farming in Salaya Pamar, Kharif cropping is done in 600.92 ha. and Rabi crops are raised in 212.72 ha. Single type of crop is raised by farmers in around 78% (526

ha) agricultural land and two crops are raised in the rest 144.77 ha of agricultural land. Results from soil testing of Salaya Pamar reveal that slightly basic pH of the soil affects seed germination in the village land which increases the seed utilization by farmers. The village is located in a high slope area, where soil erosion with runoff water has resulted in loss of nutrient rich top soil of farms and has decreased farm productivity in the region. As compared to other villages of study area, Salaya Pamar has a very low percentage of wasteland. This is indicative of the fact that small land management practices adopted by village communities have helped to conserve natural resource base and land reclamation practices prevented the increase of wasteland in the area.

To increase their incomes and reduce dependency on limited crops, farmers in the region have started vegetable farming in some areas of their lands. They are now waiting to reap the benefits of increased incomes and would like to expand this in coming years. Furthermore, simple adaptation options such as land leveling have been adopted in agricultural lands. This has largely helped farmers and has improved the yields by overcoming water loss and clogging at some places. Despite of largely using chemical fertilizers, farmers are now opening up to low input and soil conservation methods of organic farming. There are 6 vermicomposting and 4 composting units in the village with the help of which villagers use organic composts to retain soil nutrient and moisture of their agricultural lands.

Water

There are around 172 wells, 1 pond and 8 hand pumps in the village. Besides relying on irrigation sources such as well and ponds farmers of Salaya Pamar are adopting efficient water management irrigation technologies such as drip irrigation. In addition to drip irrigation, farmers largely rely on diesel powered engines to irrigate their fields. Drainage structures for sewers and soak pit structures around hand pumps have reduced water clogging problems of communities. Respondents emphasized that such structures have improved the situation of water hygiene in the region and water related health issues have also reduced drastically.

Certain policies such as MGNREGS have shown promising results in Salaya Pamar. Weir embankments and watersheds works initiated in the village under MGNREGS, has greatly increased farm production in the region and has helped to conserve water resource base available to them.

ABOUT THE PARTNERS

India Water Partnership (IWP) is a non-profit organization with a goal of promoting Integrated Water Resources Management (IWRM). It is an initiative supported by the Global Water Partnership (GWP). The Mission of India Water Partnership is to support action of sustainable and integrated development and management of water resources at national, regional river basin/sub-basin and local levels in India.

The Global Water Partnership's vision is for a water secure world. Its mission is to support the sustainable development and management of water resources at all levels.

Development Alternatives (DA) has acted as a research and action organisation, designing and delivering eco-solutions for the poor and the marginalised. With a deep understanding of the rural market and a strong presence in the Indian heartland, its existence has been a credible and visible one – nationally and internationally – in addressing poverty challenges in a climate-sensitive environment.