Bundelkhand Drought

A Retrospective Analysis and Way Ahead










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Foreword

Dr. Satendra, IFS

Executive Director
National Institute of Disaster Management
New Delhi

Drought in India has resulted in tens of millions of deaths over the course of the 18th, 19th, and 20th centuries. Indian agriculture is heavily dependent on the climate of India: a favorable southwest summer monsoon is critical in securing water for irrigating Indian crops. Therefore, drought is a perennial feature in one or other part of India. About 68% of the net sown area of India is prone to drought. Three hundred and twenty nine million hectare of land covering 103 districts and 16 states of India are chronically drought prone as per the National Drought Manual, 2009.

Drought has multiple dimensions in its occurrence, impacts and in its mitigation. Drought an environmental phenomenon which can be categorized as meteorological, hydrological or agricultural drought depending upon its stage – rainfall deficit and/or level of impacts on hydrological cycle and agro-ecosystems. Drought when affects the food security and livelihood support systems beyond the level of community resilience, is known to be a disaster. Globally there is a paradigm shift in approach to disaster management, with a special pace with the understanding of climate-change implications and role of vulnerability reduction in disaster management.

Bundelkhand is historically known drought prone region of the country but the frequency and intensity of drought has increased over past decades. There were several but compartmentalized studies by NGOs and special committees on drought challenges in Bundelkhand in the recent past. However, a systematic study on understanding the patterns of different aspects of drought disaster in Bundelkhand has been lacking. Looking to this need, NIDM with the support of Indian Council of Social Science Research (ICSSR) has undertaken a research study to understand the drought patterns and differential role of mitigation strategies in Bundelkhand, in order to suggest the strategies for future. The document is based on the out come of the research study titled " Vunerability Assessment and mitigation anlysis for drought in Bundelkhand region" that has been coordinated by Dr. Anil K Gupta, Associate Professor and Ms. Sreeja S. Nair, Assistant Professor of the institute. I congratulate them and their research team for excellent piece of work.

I am happy to forward this report for the wider publicity and feedback of the researchers, civil society and public for value addition to our understanding of the challenge of managing drought in Bundelkhand. We will welcome any suggestions.

Dr. Satendra, IFS

Preface

Agriculture in Bundelkhand is rainfed, diverse, complex, under-invested, risky and vulnerable. In addition, extreme weather conditions, like droughts, short-term rain and flooding in fields add to the uncertainties and seasonal migrations. The scarcity of water in the semi-arid region, with poor soil and low productivity further aggravates the problem of food security. Total population of Bundelkhand is 18.3 million, and 79.1% of population lives in rural areas (Census 2011) and more than one third of the households in these areas are considered to be Below the Poverty Line (BPL). The poverty situation in the region has also become extremely critical in the recent years. This is because of lack of employment and lack of opportunities. The insecurity of livelihoods and lack of supportive governance have led to forced large-scale migration of the local population.

Chronically drought prone regions like Rajasthan is known for its resilience and coping systems against the devastating implications of meteorological drought, whereas Bundelkhand has recently become a news hotspot due to consecutive drought amidst susceptibility, poverty and lack of effective mitigation strategies. Although several efforts and schemes are in records, reports and many of those on ground as well, launched by Central and State governments, the risk has been growing with more and more complexities. There has been Bundelkhand Package, a specially designated committee to understand the Bundelkhand challenge, and the long existing institutions like Indian Grassland and Fodder Research Institute (IGFRI), National Centre for Agroforestry (NRCF), Bundelkhand University, Central Soil & Water Conservation Training & Research Institute Datia, and Development Alternative's Taragram, the risk of making a meteorological failure into a drought disaster doesn't seem to have reduced.

I owe a lot to Bundelkhand, particularly for my concern for socio-economic sustainability and environmental justice, my intent on hydrometeorological disaster management particularly drought. as I owe the soil of Bundelkhand and have experienced the ground realities of water crisis, ecological imbalances and livelihood challenges while being with the Department of Natural Resource Management of Bundelkhand University. A realization of the need to install a systematic study of Bundelkhand drought emerged with association of TERI's natural resource's scholar Anjali Singh and was then fuelled by my colleague Sreeja Nair. The mismatching trends of meteorological, hydrological and agricultural drought, triggered the idea of a research project to assess the socio-environmental and developmental programmes with drought mitigation values which alter the vulnerability and also cause the differential impact of the mitigation measures.

This study of Bundelkhand presents a peculiar example of 'lack of appropriate vision' and 'lack of integrated planning process' at various levels, sometimes referred as 'drought of vision'. The unproductive cattles of Bundelkhand have been talked in relation to drought vulnerability whereas the challenge of 'overdependence on god' and 'unproductive youth' have never been critically studie. Planning and investigation by 'high level expert group' sometimes fails to account the vision and experiences at the 'medium' and 'low' levels which are relatively more closer to ground realities. Therefore, it is important that the assessments and planning for the regions involve their own people and local experts. There are several questions and clues that emerge from the study and this book brings in the knowledge base about almost all important aspects of Bundelkhand drought.

The contents are based on compilation, analysis, data interpretation and ground observations, including a range of sources—published & unpublished reports, websites, viewpoints, etc. Sreeja S. Nair, as Co-Principal Investigator of the study organized the philosophy and analytical exercises particularly those related with application of remote sensing and GIS. Her key contribution in data collection, field investigations and their interpretations has been critically significant. Concept of 'mitigation analysis' when mooted was accepted by the research team and its framework was formulated by her involving Oishanee Ghosh and Sunanda Dey. The historical and literary context of the report has been well contributed by Oishanee whereas the editorial and review process has been organized by Ms. Sunanda besides bringing in the contents with relevant data and their interpretations. Anjali Singh, as a TERI University student of M.Sc. (NRM) worked with us for her minor and major projects on Bundelkhand drought and contributed to the scientific study based on Geoinformatics application, outcome of which forms a crucial part of this book.

The publication also brings the science based study along with an assessment of development programmes in relation to drought disaster risk management. Support of ICSSR in the form of research grant is duly acknowledged. I am pleased to present this publication for the reference of practicing readers and citizens with concern for sustainability in Bundelkhand region.

Dr. Anil K Gupta
Principal Investigator,
ICSSR Project on Bundelkhand Drought
Vulnerability & Mitigation Analysis

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The research study on Bundelkhand drought vulnerability and mitigation analysis has been supported by Indian Council of Social Science Research (ICSSR). The research team is thankful to Dr. Satendra, Executive Director NIDM for his constant support and encouragement during the execution of the project. Authors acknowledge the support from Government officials of the districts of Bundelkhand, particularly Mr. Ranveer Prasad (District Magistrate, Lalitpur), Mr. M. R Raghuraj (Collector & DM, Tikamgarh), Shri Sanket Bhondwe (Collector & DM, Datia), Mr. Niraj Kumar Sharma (Technical Expert, IWMP, Datia), Mr. Manish Jain (District Project Officer, Tikamgarh) and Mr. Awadesh Nigam (Tahsildar, Lalitpur) in data collection and field observations.

Experts from NGOs and other research, academic institutions Shri Krishna Murari (Sr. Programme Manager Taragram Datia, Developmental Alternatives), Dr. Rajiv Kumar Niranjan (Assistant Professor, Degree College Lalitpur, MP) and Dr. V.K.Sehgal, (Sr. Scientist, IARI) were instrumental in facilitating field work and community interactions during the study. Authors also acknowledge the support of the colleagues from NIDM, Prof. Santosh Kumar and Prof. Chandan Ghosh who have been extremely supportive to the project execution. Thanks are also due to Ms. Swati Singh, Consultant, Mr. Santosh Kumar Tiwari, Librarian and Ms. Anupama Sethi, Programmer at NIDM, for their inputs and support in design and finalization of this publication.

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1

Introduction

1.1 Background

Drought is a natural hazard, known primarily in terms of scarcity or supply deficit of water due to failure of rainfall, deficiency of reservoirs and water resources, resultant failure of crops, and consequently a level of serious socio-economic distress. Drought is a weather-related natural disaster often aggravated by environmental degradation and socio-economic deprivation. It can affect large geographical areas for shorter or longer periods and, thus, has serious impact on life, ecosystems, livelihoods, economy, environment and the overall human well-being. During 1967-1991, droughts accounted for the 50% of the natural disasters (all types), affected 2.8 billion people, and have been responsible for 35% of the 3.5 million lives lost (Rao, 2000). In recent years large-scale intensive droughts have been witnessed in all continents leading to huge economic losses, destruction of ecological resources, food shortages and starvation of millions of people. Most policy responses to drought tend to address immediate needs, i.e., to provide what are often more costly remedies, and attempt to balance competing interests in a changed atmosphere.

The incidence of drought is recurring phenomenon in India. It should be noted that drought is different from aridity and seasonal aridity since it is an irregularity of the climatic condition of the afflicted region. During 1871-2002, there were 22 major drought years, defined as years with All India Summer Monsoon Rainfall (AISMR) less than one standard deviation below the mean, i.e., anomaly below -10% (Department of Agriculture and Cooperation, 2009). Time after time the rate of incidence has varied but there is a stoic inevitability to its occurrence. According to the manual, the condition and recurrence rate of drought varies with different agro-climatic zones of the country. It is also observed that around 33% of the cropped area receives less than 750 mm of rainfall and rightly calls that percentage 'hotspot' of drought. One such hotspot which has been in the national as well as international news for its dire socio-economic condition is the geographical heartland of India, Bundelkhand. Since crop production, livestock rearing and seasonal out-migration provide more than 90% of rural income in Bundelkhand region (Samra, 2008), the effect of recurrent drought on this region is palpably devastating.

Bundelkhand region has a long standing history of droughts and famines. The region witnessed "The Panic Famine" of 1873-74 (Loveday, 1914, p.138). The Indian famine of 1896–1897 began in Bundelkhand early in 1895 and spread across many parts of the country, including the United Provinces, Central Provinces and Berar, Bihar, parts of the Bombay and Madras presidencies, and the Hissar district of Punjab, in addition to the princely states of Rajputana, Central India Agency and Hyderabad. The Bundelkhand district of Agra Province experienced drought in the autumn of 1895 as a result of poor summer-monsoon rains. When the winter monsoon also failed, the provincial government declared a famine early in 1896 (Imperial Gazetteer of India Vol. III 1907, p. 490-91). According to the report on drought mitigation strategies for UP and MP Bundelkhand by the Inter-ministerial Central Team headed by Dr. J. S. Samra, the region experienced a major drought in every 16 years during the 18th and 19th centuries, which increased by three times during the period 1968 to 1992 (Samra, 2008). During 1905-06 Bombay and Bundelkhand provinces were affected by severe drought and cholera outbreak. However, drought associated mortality is unknown for Bundelkhand (Raychaudhuri et al 1983, p. 531).

Historically, the region was thickly forested but is now characterized by bare hilly terrain with sparse vegetation. Besides this the region has many wonders. As a tribal homeland, Bundelkhand is known as a cultural repository of folk dances, songs, festivals, and for the countless monuments that dot the landscape including the impregnable Gwalior, Kalinjar and Govind Mahal forts, the renowned Khajuraho temples and the exquisite Chaturbhuj and Dashavatara temples. The region was ruled principally by the Chandela and Bundela Rajputs and most of the architecture (including a number of village tanks) dates from their reign. The Mughals ostensibly controlled the region, but the hilly, undulated and rugged topography made it difficult to sustain their rule. With its vibrant history, Bundelkhand is famous for the bravery of its women, epitomized by the freedom struggle of Rani Laxmi Bai during the first war of independence in 1857.

1.2 Present Scenario

Ironically, this once rich region has now become one of the poorest parts of the country. Except for Sagar and Jhansi districts, around 60 % of main workers in Bundelkhand are engaged in agriculture as cultivators or labourers, showing a higher reliance on agricultural land compared to other parts of rural India. Industrialization has been sporadic and this in turn has led to low levels of urbanization. Living conditions are harsh especially for the rural poor who depend mainly on agricultural incomes for sustenance, and are therefore highly vulnerable to drought and failure in cropping systems and loss of employment and incomes. According to Tendulkar Committee Report 2009 estimates of poverty line and HDR 2004-05 with recurring drought and failure in agriculture, the level of poverty in rural areas has increased since a large number of farmers depend on rain fed agriculture (Planning Commission, 2009 & CSO, 2010). According to the inter-ministerial central team report (Samra, 2008), even though about 45 % of net sown area in Bundelkhand is irrigated, the water supply is not adequate.

The failure of the monsoon has severely affected the available water in river systems. The resulting diminishing water available in surface water sources as well as depletion of groundwater tables has not only decreased the availability of drinking water for people and domestic animals, but also impacted the natural vegetation and growing grasses (crucial as fodder). Most tribal population inhabiting forests areas adjacent to rivers have no choice but to continue to exploit forests for survival and cause further over exploitation of resources. The repetitive crop failures and depletion of natural resources has led to widespread and increasing trends of migration to urban areas. With the collapse of monsoons and arrival of successive dry years, the inhabitants of Bundelkhand are now facing scarcity of water in almost every season. Urban areas are no better off than rural areas. The expense of securing water has been raised and the resource is treated as a commodity. Most urban municipalities supply water in the urban areas of Bundelkhand only twice or thrice a week.

There were several manifestations of drought like, late arrival of rains, early withdrawal, long break in between, lack of sufficient water in reservoirs and drying up of wells leading to crop failure and even un-sowing of crops which ultimately curtailed livelihoods and led to some out-migration during 2000-2010 period. During the 2002-03 drought, all the 6 districts of MP Bundelkhand and 3 districts of UP (Banda, Hamirpur & Jalaun) were affected. The most recent and continued period of poor rainfall recorded in Bundelkhand was during 2004-10, when below average and erratic rain was reported in most part of the region in all the years.

Drought is the combined effect of meteorological (reduced rainfall) and hydrological (reduced available water supply) factors. In the UP part of Bundelkhand, drought became evident in 2004-05 with a 25% short fall in monsoon rains. The rainfall deficit increased further to 43% in 2006-07 and 56% in 2007-08, leading to severe (metrological) drought conditions in Mahoba, Jhansi and Chitrakut districts. Except Tikamgarh and Datia districts, drought in the Bundelkhand region of MP commenced from 2006-07.

Face to face with the reality in Bundelkhand

(DTE Issue: June 15, 2007)

Government records show that Bundelkhand had only 12 years of drought in the 19th and 20th centuries. But the arid spell has already lasted five years this century. Crop failure and debt has driven more than 400 farmers to commit suicide in the seven districts that make up the UP part of Bundelkhand. Starvation deaths have also being reported. Acting on these, the UP government declared Banda drought-hit (more than half of the crop affected) in December 2006. Chitrakoot, Mahoba and Hamirpur districts were also declared drought-hit. The last five years have been tough for 55-year old Saraswati Devi. Her two sons have left their village to work as construction workers in Jabalpur,Madhya Pradesh (MP). The family's one hectare patch in Ragauli Bhatpura gram panchayat in Uttar Pradesh's (UP) Banda district has been mortgaged. The money barely helps Saraswati tide over a drought that's ravaging Banda and 12 other contiguous district in UP and MP for the last five years.

(Source: http://www.downtoearth.org.in)

Drought affected all districts of UP Bundelkhand during 2004 and 2007. Similarly, over the three years period 2005-2007, hydrological drought or diminishing availability of water supply was evident from the situation of surface water reservoirs – the proportion of reservoirs remaining unfilled increased sharply from 15% to 47% in Madhya Pradesh and from 28% to 64% in Uttar Pradesh, indicating tripling in the inadequacy of water supply. Around 70% of tanks, ponds and dug-wells dried up as a result of the steep fall in surface and ground water table. Drought affected all six districts of MP Bundelkhand and five districts of UP Bundelkhand during 2009 (Drought Management Division, Ministry of Agriculture, 2009).

The climatic modeling experiments by United Nations Institute for Training and Research (UNITAR) has predicted that temperatures are likely to be higher by about 2 to 3.5°C in Bundelkhand region by the end of this century (Kedia, 2010). The impacts of drought years are already visible. In the last four to five years, there has been news of mass migration, starvation deaths, farmer suicides and even the 'mortgaging' of women. To emphasize the uncertainty related to erratic rainfall in the last decade, Bundelkhand received normal to above normal rainfall in

2011 with the danger of flooding replacing the water scarcity of drought. According to the state Met department, Banda district received 252.4 mm rainfall (214% above normal) between June 1 and June 30. During the same period, Hamirpur recorded 253.9 mm rains (334% above normal), Jalaun 266 mm (153% above normal), Jhansi 266.1 mm (203% above normal) and Mahoba recorded 185.2 mm rains (210% above normal). Lalitpur reeled under the threat of floods with 644 mm rains, which is 5.8 times (588%) more than the normal for the district (www.bundelkhand.in).

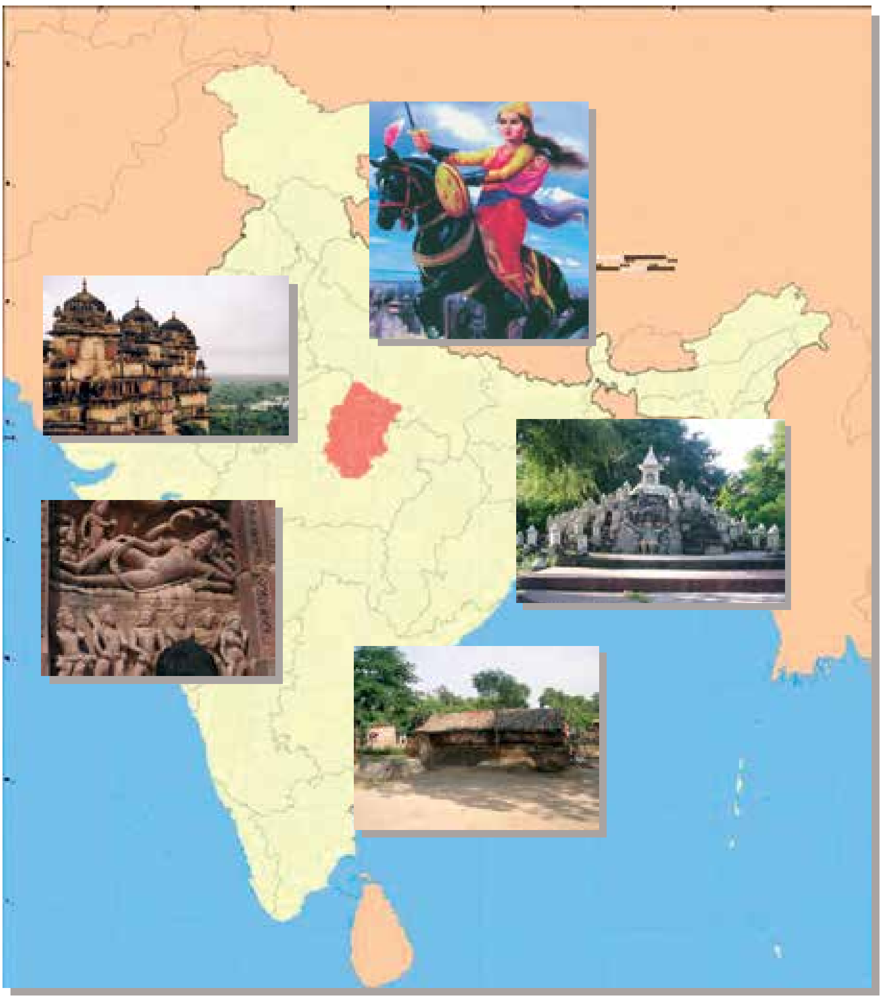
Since last 4 years the situation in Bundelkhand is improving since Rajghat Dam and distributaries are functional. Further, under Bundelkhand Special Package, various mitigation measures are integrated with developmental schemes. Interestingly Lalitpur District has not been affected during the major drought of 2009 despite low rainfall. Although marginal improvement has been happening in recent times, the region needs special attention in terms of mitigation impacts of droughts and also for improving the social security, governance and well being at large.

1.3 Past Studies

Number of studies related to drought and socio-economic factors of vulnerability and mitigation measures were carried out in Bundelkhand region. Some of the reports provide a profound insight into the problem and strive towards correction measures. Recent and most comprehensive detailed report on Drought Mitigation Strategies in Bundelkhand by Inter-ministerial team chaired by Dr. J.S. Samra, based on a thorough study of the social and economic scenario, recommends the mitigation strategies specific to the area that can be effective in drought management. Efforts to study various aspects of natural resources, agro forestry, water management, and perspective planning for the region has been reported in publications by Indian Grassland and Fodder Research Institute (IGFRI), the National Research Centre for Agro forestry (NRCAF) and U.P. Council of Agricultural Research (UPCAR). However, a systematic scientific research on drought hazard identification and vulnerability assessment in Bundelkhand has been lacking despite of the region being known for droughts. Another notable work on the water crisis in the region titled 'Drought and Water Crisis in Bundelkhand' carried out by WaterAid incorporates the information on the declining agricultural productivity and the dire water situation. It also suggests the improvement measures for drought management. A study by OXFAM and Samarthan delves into the Madhya Pradesh part of Bundelkhand and carries out a detailed socio-economic analysis of the different districts. Development Alternatives carried out studies in Tikamgarh District with major impetus to the local community for livelihood security. TARAgram Datia undertakes extensive research and demonstration related to energy efficient and environment-friendly technology for firing clay bricks. However most of the studies related to Bundelkhand region are limited to either scientific or socio economic factors alone. Since Bundelkhand covers two states, there exists diversity in implementation of programmes and their outcomes. Most of the exiting studies on Bundelkhand drought considers geographical coverage limited to few districts or one state only (MP or UP). Such studies although useful for micro level planning were unsuccessful in representing the comparative analysis, comprehensive strategies and effective implications of different mitigation measures.

1.4 Scope of the Present Study

The present study attempts to identify the areas prone to different types of drought, i.e., meteorological, hydrological and agricultural droughts. The report presents a detailed scientific analysis of the spatial, temporal and typological distribution of drought at district level for the period during 1998-2009 in the region of Bundelkhand. Further a detailed analysis based on interaction with officials of disaster management authority, statistical data and existing literature has been carried out for drought impact and mapping the ongoing mitigation measures. The report is concluded with a set of strategic recommendations for improving livelihood and reducing the drought vulnerability of Bundelkhand.



2

Bundelkhand Profile

2.1 Study Area

The Bundelkhand region lies at the heart of India located below the Indo-Gangetic plain to the north with the undulating Vindhyan mountain range spread across the northwest to the south. The region span across thirteen districts: seven in Uttar Pradesh - Jhansi, Jalaun, Lalitpur, Hamirpur, Mahoba, Banda and Chitrakut, and six in Madhya Pradesh - Datia, Tikamgarh, Chattarpur, Damoh, Sagar and Panna. It covers an area of 7.08 million hectares (mha) and is located between 23020' and 26020' N latitude and 78020' and 81040'E longitude (NGSI, 1989).

2.2 History

The Bundelkhand region shows evidence of early settlements, seen through the rock paintings found in the Patha region of Chitrakoot as well as in Sagar, Panna and Chhatarpur districts. In the epic Ramayana, there are many references to the forests of Chitrakoot where Rama, Lakshman and Sita supposedly spent their years in exile. In the Mahabharata, there are descriptions of the Chedi kingdom located between the Ken and Betwa rivers of Bundelkhand. Evidence of urban settlement dating to this period come from the discovery of a large number of coins excavated at Eran, a locality 60 km north-west of Sagar town. In the coins the place was referred to as Erikana and seemed to be an important region till the Gupta period. After the 5th century AD when the power of the Guptas dwindled, the whole region broke up into miniature kingdoms ruled by warring monarchies, with evidence of the Gond tribals taking over certain parts of Bundelkhand. The Chandela Rajputs took over from the Pratiharas of Kannauj and ruled from 10th century to 16th century AD. They emerged as a formidable power, whose rule was further fortified by Yashovarman and his son Dhanga during the middle of the 10th century when Mahoba was made the capital. The Chandelas were astute architects of temples

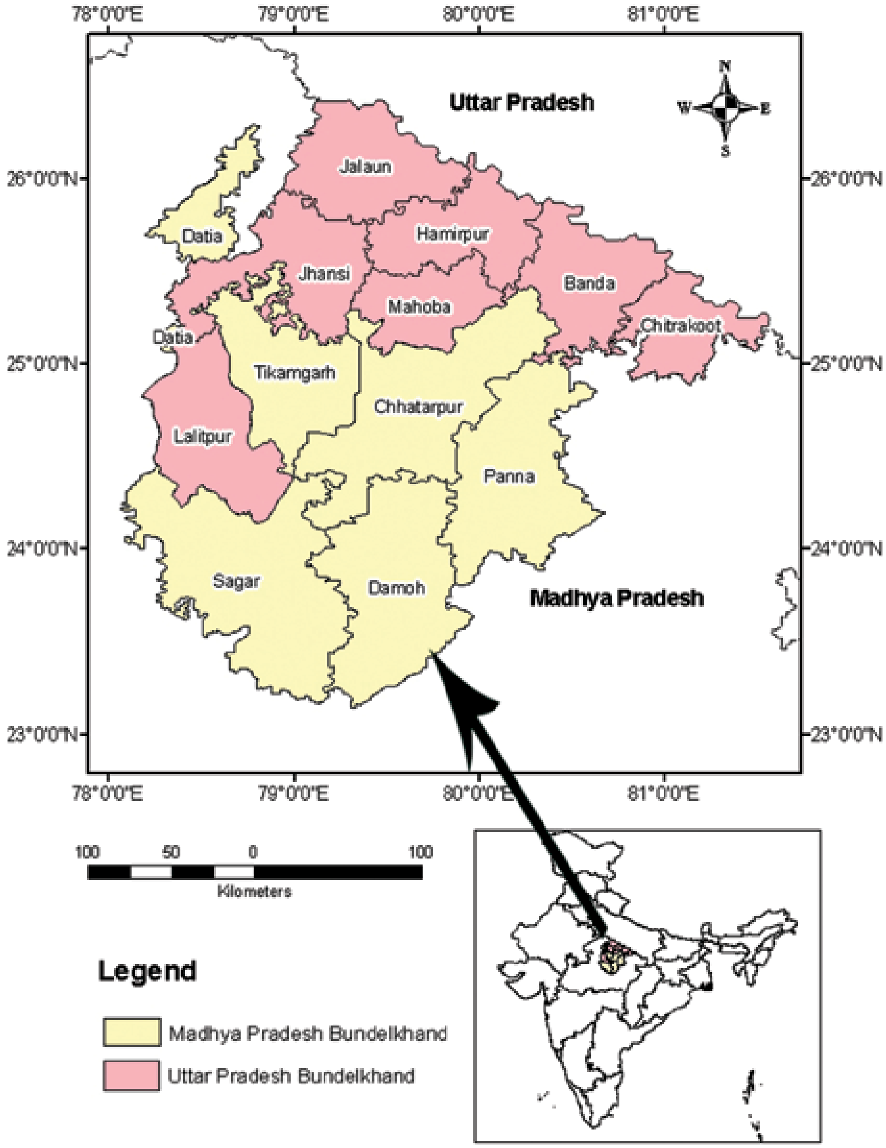


Figure 1. Location of Bundelkhand

and tanks, the latter necessary to sustain the needs of large populations in non-monsoon months. They had knowledge of water constraints in the region and built innumerable tanks to cope with the situation. The tanks were usually located near or adjacent to temples, signifying that they attached divine significance to water as a natural resource, especially one which was so scarce. Yashovarman is given credit for the construction of the large Vishnu temples in Khajurao (Chhatarpur) and the Lakshman temple. His rule was one of tolerance - Jainism must have been a popular as well as a tolerated religion, as evident from a number of Jain temples found within the boundaries of the fort of Deogarh. Brahmins were donated lands, dwellings and given gifts as evident from numerous records of this era.

The Afghan invader Mahmood of Ghazni attacked the Chandela dominions during Vidydhara's reign but did not succeed in holding on to the territory. There was a long siege at the Kalinjar fort in Banda district after which Ghazni had to retreat. Over half a century later, the Chandela ruler Paramardideva fought Prithviraj Chauhan the ruler of Delhi, and the story of their conflict has been poetically depicted in literary pieces known as the Prithviraj Raso and the Parmal Raso. After Prithviraj Chauhan's rule was overthrown by Muhamad Ghor in 1192, the Kalinjar fort was taken over by the Turkish Muslims. Finally in the 14th century the Bundelkhand region came under the control of Alauddin Khilji. In the 16th century the whole region came under Bundela Rajput rule. Subsequently though the region did come under the Mughals, the rugged topography made it hard for them to maintain a tight grasp. Under Akbar, there was a nominal Mughal authority based at Kalpi. Subsequently, under the leadership of Chhatrasal, the Bundela chiefs revolted leading to a war of independence. The Marathas assisted in this endeavor and the Bundela chief entrusted the Maratha allies with a large part of the kingdom which included Jhansi. There were constant wars under the Marathas and the Bundelas resisted till they extricated the region from Maratha control at the end of the 18th century.

During the British period, the parts of Bundelkhand that came under the British came to be known as British Bundelkhand. This was formalized in 1802 by the Treaty of Bassein, which provisioned that leases be given to some local rulers. The lease stated that the rulers could control the lands after they signed a written bond of allegiance *(ikrarnama)* to the British. A British officer was assigned for the 'supervision' of these rulers. In 1806 British protection was promised to the Maratha ruler of Jhansi, and in 1817 the British, while recognizing his king's hereditary rights to Jhansi state, brought Bundelkhand under the Central India Agency with its headquarters in Indore. The territory of Jhansi was annexed into the

British Empire when the Raja died without leaving an heir. In the revolt of 1857, the Rani of Jhansi played a major part against the annexation of Jhansi and died fearlessly in the battlefield in Gwalior. The British formed the Bagelkhand agency in 1871, which was later merged with Bundelkhand in 1931. Finally in 1947 the Bundelkhand and Bagelkh and agencies were merged to form Vindhya Pradesh.

2.3 Ecophysiography, Climate and Natural Resources of Bundelkhand

2.3.1 Ecophysiography

The northern and central part of Bundelkhand is characterized by undulating plains falling below 300m covering around 67% of the area (Singh, 1993). The remaining 23% geographical area lies mainly between 300m to 450m with some parts of the Vindhyanchal table land to the west and south, rising up to 600m. The Bundelkhand region is rocky and mainly constitutes non-arable land broadly divided into four sub-regions: Bundelkhand Plain in the north, Bundelkhand Upland in the centre and south, and Sagar and Damoh (Vindhyanchal) plateaus in the deep south. As a geographical region, the Sagar plateau is part of Malwa and Damoh plateau is part of Vindhyanchal.

The soil in the region is a mixture of black and red-yellow soils which are poor in organic nutrients. A yellowish lightcolored variety of red soil called parua, is sandy and has some clay content with its characteristic property of enclosing air bubbles thus making it easier for aeration. This soil is found in UP Bundelkhand and is good for cultivation of wheat. The black soils are of two types: kabar found in Lalitpur, Jalaun, Banda and Hamirpur districts in the uplands and plains, suitable for the growth of gram and jowar; and the black cotton soil usually called mar. Since the organic matter content is high it rarely needs fertilizer. The region presents a unique set of geologic and geographic characteristics which have had profound effects on human development in the region.

2.3.2 Climate

Bundelkhand has a hot and semi-humid climate. Usually the hottest days are in May and coldest days in December or January. The temperatures are much higher locally due to conditions such as lack of haze and radiation from rocky soils or outcrops. In summer there are local squalls of short intervals. This frequently results in a cloud of dust that can be so thick that it becomes murky during the daytime.

The average annual temperature is over 25°C. However, the mean monthly values vary considerably from the annual means and consequently

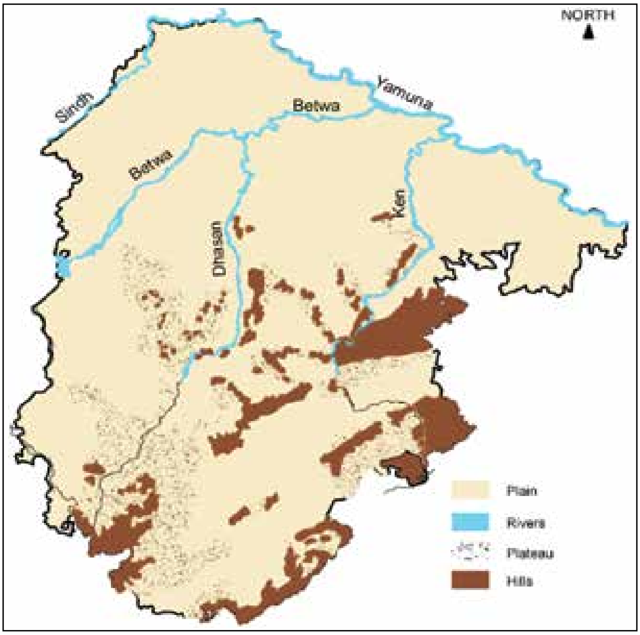


Figure 2. Physical map of Bundelkhand
(Source: www. bundelkhand.in)

the temperature range is high. In summer mean temperatures range around 30°C and can rise beyond 40°C in May - June. The monsoons from June to September bring down temperatures to around 22°C - 25°C with relative humidity varying between 70 to 80%. The mean annual precipitation varies from 75 cm in the north to 125 cm in the south-east. The average for the region can be considered around 100 cm and falls mainly in the monsoon months of June to September. Around 75% of rain falls in these three months, and the total amount is highly variable and capricious. This uncertainty is notoriously responsible for the large number of famines, droughts and deluges experienced in the region since time immemorial. Some shallow westerly depressions cause winter rain which is highly beneficial to the rabi crop.

2.3.3 Mineral Resources

The Bundelkhand region is an important source for some of country's rare mineral deposits. The Panna district of Madhya Pradesh was world renowned for its diamond reserves, especially in the medieval period, but has since faded into obscurity. Nowadays Bundelkhand is more important for the availability of stone for construction and is famous for the gigantic blocks of medium to coarse-grained varieties of pink, red and grey granite found in Jhansi, Lalitpur, Mahoba, Banda, Datia, Chhatarpur, Panna and Sagar districts. Two varieties called Jhansi Red and Fortune Red are mined in Chhatarpur and are unique to this region. Different colored sandstone like white, buff, cream, pink and red sandstone are found scattered across Panna and Sagar districts. Sandstone being soft in nature can be chiseled to create exquisite designs and architectures; for example found in the famous sculptures of Khajurao temple in Chhatarpur district. Lalitpur is known for sandstone varieties called Lalitpur Grey and Lalitpur Yellow. Stone of lower value is crushed and used for road and building construction. Sagar, Damoh and Panna districts are known for their limestone and dolomite reserves. Excluding granite, the most precious resource of UP Bundelkhand is silica sand found in Mau tehsil of Chitrakoot. The deposits are said to be the best source of glass sands in India. Lalitpur is important for low grade iron ore as well as rock phosphate which is an essential part of fertilizer industry. The districts of Datia, Panna and Tikamgarh provide clay needed in different industries. Agate pebbles found in some places in the gravel of Ken River are used for making artifacts and trinkets.

2.3.4 Water Resources

Bundelkhand region is drained by a number of rivers of the Yamuna river system. The main rivers are the Yamuna in north, Ken in east and Betwa and Pahuj in the west. The river Yamuna flows from west to east and its first order tributaries – the Betwa, Ken, Pahuj, Baghain, and Paisuni flow from south to north. Numerous second order tributaries of the Yamuna such as the Dhasan, Jamni, Birma, Sonar, Katne, Bewas, and Kopra drain the area. Also flowing along the west is the Sindh and Chambal rivers, with the Narmada flowing in the south. The region of Malwa and Udaipur-Gwalior forms the southern section of Bundelkhand.

The Betwa contributes around 50% of the water available in Bundelkhand Upland and Bundelkhand Plain sub-regions; the Ken contributes around 25%. The rivers flow through both the states of UP and Madhya Pradesh. The Betwa, Ken, Pahuj and Dhasan are very important for irrigation in the region. Their seasonal fluctuations however, are very large. For example, the average annual discharge of river Ken is around 800 cusecs, but in winter it is reduced to around 300 cusecs and dwindles to practically nothing in May. Such fluctuations undermine the security of irrigation.

According to various estimates quoted in a WaterAid India paper on the 2003-2007 drought, more than 5000 tankers were deployed in May-June 2008 throughout the Bundelkhand region to meet domestic water needs, as the majority of hand-pumps yielded no water (WaterAid).A study of the water situation done in 131 villages of UP Bundelkhand, found that only 7% of villages had enough water to meet domestic needs throughout the year. In more than 60% of villages, drinking water was available for only one month. Throughout the Bundelkhand region, women had to spend an average 4 - 5 hours a day to secure around 20 liters of drinking water.

Under such conditions of uncertain water supply in rivers, the availability of water from tanks and other surface bodies is very important to sustain irrigated agriculture and provide security to farmers. Historically the need for security of water was recognized and Bundelkhand is known for its water bodies including the Pahuj reservoir, Barwasagar, Barwarlake, Aiaori Lake, Pachawara lake, Dakwan and Parichha reservoirs. A host of smaller tanks and ponds (tals) are found near Mahoba and Yikamgarh is famous for its tanks such as the Madansagar, Nandwara, Birsagar and Arjan lakes. In Chhatarpur district the important tanks include the Jagatsagar, Goratal, Gangau reservoirs and the post independence period tanks such as Matatila, Lalitpur and Saprar reservoirs.

2.3.5 Natural Vegetation

Bundelkhand has lost its forest cover to a large extent. The flora mainly seen is of semi-arid type especially along the Bundelkhand Plain sub-region areas of Banda, Hamirpur and Datia districts, along the banks of rivers like the Pahuj, Betwa and Yamuna. The region has a range of flora like *Acacia nilotica, Acacia catechu, Buteamonosperma, Zizyphus varieties, Diospyrosmelanoxylon, MahucaIndica, Salmaliamalabarica*. Sagar and Damoh districts have some teak vegetation though timber is not produced on a large scale.

Forest products like *Mahua* flowers, fruits and seeds, *Tendu* leaves and firewood are a major source of livelihood for people living in hilly areas of Bundelkhand, specially the *Kols* in Patha area of Chitrakoot, and tribal groups living in and around forests of Panna district and *Sahariyas* of Lalitpur district. *Tendu* and *Mahua* trees are an indispensable part of tribal life and supply seasonal revenue to people living in and around forests. The forest income can be improved in a sustainable manner by improving the relation between the forest authorities and the tribal people for their joint concern in managing natural resources. Their rights need to be respected and current management can be altered tactfully.

2.4 Land Use and Settlement Pattern

Historic evidence suggests that systematic settlements began after the rise of the Chandel Rajputs in the 12th century with waves of immigrants coming in from the northern Gangetic plains, with the population confined to small forest villages or along trade routes. Today most rural people dwell in small villages with a cluster of mud and brick houses in the midst of fields. Roofing materials vary from concrete to corrugated sheets and thatch.

According to the Inter-ministerial central team report on Drought mitigation strategy in Bundelkhand, about 8.8% of the geographical area of Uttar Pradesh, 26.2% of Madhya Pradesh and 21.4% of overall Bundelkhand is under forest and scrubs. About 50% of geographical area is cultivated and rest is categorized under various other land uses. In the area under cultivation, chick peas, wheat, sorghum, paddy, maize, barley, lentil, sesame, mustard, groundnut, soybean, peas, urad, moong, vegetables and fruits are the most important crops cultivated.

According to 2002 satellite data, about 6.5% of the total land was available for grazing. Area under paddy, green gram, black gram and soya bean increased, while the cultivation of pearl millet (Bajra), sorghum (Jowar), pigeon peas and maize decreased. In Uttar Pradesh chickpea cultivation went down by about 11% and area under peas went up by about 12%. In Panna, Damoh and Sagar districts of Madhya Pradesh, the area under wheat decreased in the range of 13% to18% whereas the area under chickpeas (gram) increased by around 19%.

Table 1: Trend of Land use change (%) during 1985-2003 in Bundelkhand region (Uttar Pradesh & Madhya Pradesh) (Report on Drought mitigation strategy for Bundelkhand region of UP and MP by Inter-Ministerial Central Team)

	Major Land Use categories	1985	2003	Change
1.	Forest cover/open tree cover	18.71	21.41	2.70
2.	Land use other than agriculture (LUOTA)	5.16	6.40	1.24
3.	Fallow & Rangelands	13.36	5.48	-7.88
4.	Wastelands	11.25	8.44	-2.81
5.	Cropped land	51.52	58.27	6.75

In general the nucleus of the village is occupied by farmers' homes, each with a few neem trees. Typically one side of the village is fringed by orchards and the other side by the village tank, the whole inhabited area surrounded by fields. At the outer fringes are pasture lands called maidan, which often act as the boundary between villages.

Table 2: Land use in UP Bundelkhand (2004-05) and MP Bundelkhand (2005-06) districts

District	Total area in hecares	Percentage of total area under different uses						
		Notified forest land	Non-agri use	Barren land	Grazing land	Under misc tree crops	Cultivable waste-land	Net sown
Jhansi	5,01,329	6.9	8.4	6.3	0.1	0.2	3.1	68
Lalitpur	5,07,500	15	7.7	3	0.6	0.2	11.9	54.8
Jalaun	4,54,434	5.6	8	2.7	0.1	0.8	0.4	0.4
Hamirpur	3,90,178	6.2	8	2.4	0	0.2	1	79.1
Mahoba	3,27,429	4.9	11.3	2.6	0.1	0	3.5	72.8
Banda	4,38,767	1.2	6.7	2.6	0	0.3	2.5	80.1
Chitrakoot	3,38,897	16.4	8.3	7.1	0	8.4	3.2	51.3
UP Bundelkhand	29,48,534	8	8.2	3.8	0.2	1.2	3.9	69
UP	2,42,01,294	7	10.9	2.1	0.3	1.4	1.9	68.9
Datia	2,95,874	8.4	7.3	4.9	1.5	0.9	5.2	66.7
Chhatarpur	8,63,036	24.8	5.1	0.2	7.4	0	7.5	46.8
Tikamgarh	5,04,002	13.7	4.7	14.2	4.6	0	4.2	47.8
Panna	7,02,924	42.6	5.9	3.2	1.2	NA	8	35.8
Damoh	7,28,583	36.8	4.4	8.1	4.6	0	1.8	42.7
Sagar	10,22,759	29.1	5.1	1.9	8	0	0.9	52.7
MP Bundelkhand	41,17,178	28.5	5.2	4.6	5.2		4.4	47.2
MP	3,07,55,752	28.3	6.3	4.7	4.3	0	3.8	48.7

Source: District-wise Land Use Statistics, Union Ministry of Agriculture, May 2008. Percentages derived from absolute figures and rounded off. Note: Fallow land categories are not included. NA= Not available.

2.5 Demography and Urbanization

According to the Census 2011, Bundelkhand has a total population of 18.3 million (7 districts in UP having a population of 9.6 million and 6 districts of MP having 8.6 million). The sex ratio or number of females to males is 877 women to 1000 men in UP and 930 in MP, both lower than the national average of 940 for India, showing a bias against the girl child in the region.

The average density of population in the 7 UP Bundelkhand districts is 277 per square km, much lower than the state average of 828 persons / sq km; and density in MP Bundelkhand districts is 233 persons /sq km more or less equal to the state average of 236 for MP. There is higher population density in the Bundelkhand Plain areas (Jalaun, Hamirpur, Banda), and Bundelkhand Intermediate region areas (Jhansi, Tikamgarh), and lower population density in Bundelkhand Upland (Panna) and the southern Damoh and Sagar plateaus. Figure 3 shows major towns and roads of Bundelkhand region.

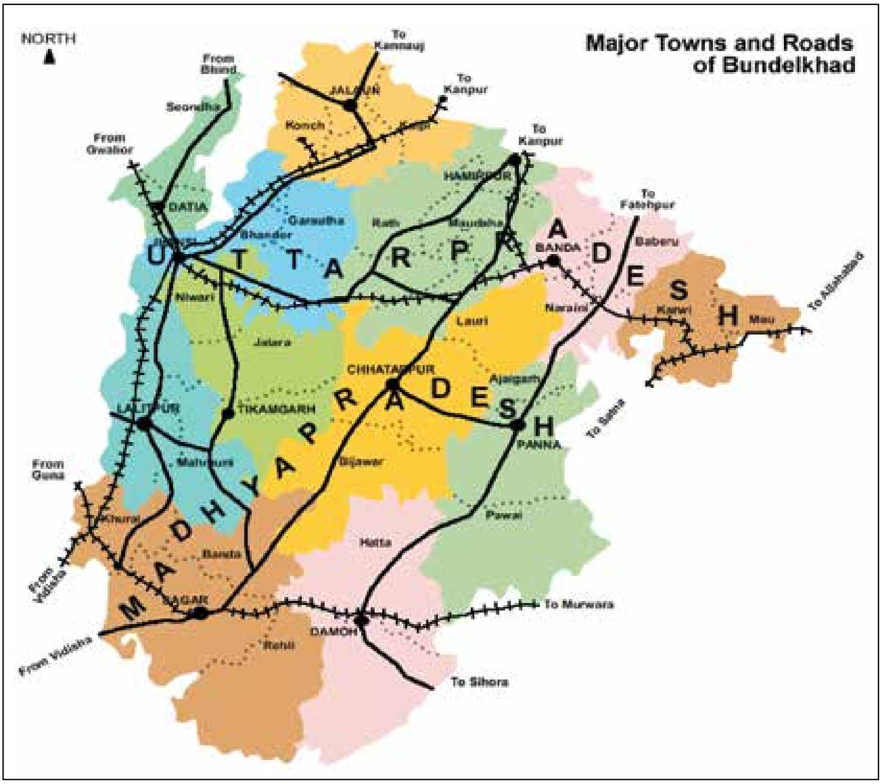


Figure 3 : Major towns and roads in Bundelkhand
(Source: Bundelkhand info.in)

Table 3: Basic demographic data (Census 2001 and 2011) of Bundelkhand districts and comparison with State level and national data

District	Population 2001	Population 2011	Sex ratio 2011	Persons		Rural Population %		% growth rate
				/sq km	(%)	2001-11		
				2001	2011	2001	2011	
Jhansi	17,44,931	20,00,755	885	347	398	59.20	58.20	14.66
Lalitpur	9,77,734	12,18,002	905	192	242	85.50	85.60	24.57
Jalaun	14,54,452	16,70,718	865	319	366	76.60	74.90	14.87
Hamirpur	10,43,724	11,04,021	860	232	275	82.50	81.00	11.09
Mahoba	7,08,447	87,60,55	880	263	279	79.50	78.80	15.52
Banda	15,37,334	17,99,541	863	337	408	83.70	84.60	19.84
Chitrakoot	7,66,225	9,90,626	879	250	308	90.50	90.20	23.53
Total UP	8,232,847	9,659,718						
Datia	6,28,240	7,86,375	875	224	292	79.30	76.80	18.40
Chhatarpur	14,74,723	17,62,857	884	171	203	78.00	77.40	19.50
Tikamgarh	12,02,998	14,44,920	901	238	286	82.30	82.70	20.10
Panna	8,56,558	10,16,028	907	122	142	87.40	87.70	18.60
Damoh	10,83,949	12,63,703	896	148	173	81.10	80.20	16.60
Sagar	20,21,987	23,78,295	913	197	232	70.80	70.20	17.60
Total MP	72,68,455	86,52,178						
UP average			908	689	828	79.20	77.72	20.09
MP average			930	196	236	73.50	72.40	20.30
India average			940	324	382	72.20	68.80	17.60

There is low level of urbanization and around 80% of the total population lives in rural villages. There is however wide variation within the Bundelkhand region – some districts like Jhansi with 42% urban population are highly urbanized and on the other hand, in Chitrakoot district, less than 10% of the population reside in urban areas. The population growth rate over the last decade 2001-2011 was 20.09% in UP and 20.30% in MP, both higher than the national average of 17.64%.

In the 13 districts of Bundelkhand region, the population growth rate was 18.06%. The literacy rate in the region is lower than the national average and state average (Census 2011) Approximately 60% of the population is workers. Of these workers, almost 60% are working in the agricultural sector as cultivators and agricultural laborers.

Child sex ratio nosedives in water-scarce Bundelkhand

After drought and hunger deaths, the distressed region of Bundelkhand has once again come into focus for its declining child sex ratio (CSR). According to the Census 2011 Provisional Population Totals, the region has seen a sharp decline in the CSR in the age group of 0-6 years and along with the Indo-Nepal border districts, it is one of the major contributors to the poor sex ratio of UP. While in the 2001 Census, it was the western UP that was red-marked for killing girls, the 2011 Census figures show that in Bundelkhand, the ratio has dipped starkly. In 2001, the 0-6 CSR in Jhansi district was 886/1000. But as per the 2011 figures, it has dipped further to 859/1000 with a further difference of 27 girls than the last decade. Similarly the ratio in Chitrakoot, which was known for its dacoits so far, has fallen from 928 to 907, creating a gap of 21. In Banda, it has dipped from 917 to 898, while in Hamirpur, it has come down from 903 to 885. Lalitpur came down from 931 to 914 while Mahoba came to 897 from 917.

Source: The Indian Express, Lucknow, April 12, 2011

2.6 Development of Agriculture (the main occupation)

Assured irrigation for crop production is the most effective mitigation strategy to ensure agricultural production. In Bundelkhand, agriculture is the single most important activity in sustaining livelihoods of people and there are a number of major and minor irrigation schemes being operated in Bundelkhand to provide irrigation water to farmers. Their success has however been insignificant compared to the grave socio-economic needs of the region. The quality of irrigation services is poor and most of the cultivated area is still dependent on rainfall. The tables below depict the effects of the schemes on areas that are being irrigated.

Table 4 (a) : Net irrigated area as % of net sown area in Bundelkhand (Uttar Pradesh)

Districts	Major/ Medium Schemes	Ground Water (Wells)	Minor Surface Water	% of net irrigated area to net sown area
Jalaun	13	27	2	42
Jhansi	7	14	4	25
Lalitpur	9	39	1	49
Hamirpur	35	28	1	64
Chitrakoot	5	18	6	29
Banda	22	27	1	50
Mahoba	19	26	2	47
Region Total	16	26	2	44

Table 4 (b) : Net irrigated area as % of net sown area in Bundelkhand (Madhya Pradesh)

Districts	Major/ Medium Schemes	Ground Water (Wells)	Minor Surface Water	% of net irrigated area to net sown area
Chattarpur	6	47	12	65
Tikamgarh	7	64	7	78
Damoh	1	28	11	40
Sagar	2	18	8	28
Datia	10	29	1	40
Panna	1	10	13	24
Region Total	4	33	9	46

Source: Minor Irrigation Census (2001)

2.7 Industrial Growth

There were many small traditional industries sponsored by the ruling class as well as the elite before the advent of British rule, but they gradually died after 1857 when the imperial rule wholly assumed control and cottage artisans lost royal patronage and markets.

Today, there are no major industries in the Bundelkhand region and beedi making is the single largest source of non-agricultural employment in Bundelkhand that provides direct employment to over 200,000 persons. Across the Bundelkhand Upland sub-region, stone quarrying is widespread and has grown rapidly since 1990s. Lalitpur, Jhansi and Mahoba districts account for around 15% of the country's reserves and nearly 40% of the country's production of diaspore (Planning Commission, 2007, p 102). In Hamirpur district, excavation of sand from the Betwa river bank is carried out on a large scale. Clay is mined in Chhatarpur and Panna districts.

Table 5: Large and medium industrial units in Bundelkhand

District	Industries (product/process)
Jhansi	Bharat Heavy Electricals (rail engines, transformers)
Datia	Gwalior Synthetics (cotton yarn, art silk), Agro Solvent Products (solvent extraction), KishoriPujari Granite (granite cutting)
Tikamgarh	K P Solvex (solvent extraction)
Panna	MP Carbide and Chemicals (calcium carbide), National Mineral Development Corporation (diamond mining)
Damoh	Diamond Cements (cement, clinker) Abhishek Cement (Portland cement), Shobha Soya Oil (soyabean oil)
Sagar	Central India Paper & Board Mills (straw board), Madhya Bharat Agro Products (single super phosphate fertiliser), Arvind Foods (solvent extraction), Sanmati Forest Industries (katha), Sagar Soya Products (soyabean oil)

According to the Planning Commission's *Uttar Pradesh Development Report*, Jhansi district of UP Bundelkhand contributed 5-10% of the state's industrial output, while all other districts of the UP Bundelkhand contributed to less than 1% of the state's industrial output in 2001-02. In spite of having highest number of sugar factory in Uttar Pradesh, not a single factory exists in Bundelkhand region. There is hardly any skilled labourer since most of the populations are farmers. Industries have failed to succeed or establish in the region. Since Jhansi is still relatively urbanized and can be approached through Kanpur there is a ray of hope of industrial development in that corner of Bundelkhand. Jalaun district may also benefit in the future as it falls along the industrial corridor towards Nagpur and the Planning Commission has proposed this aspect.

The MP government has been receiving many proposals for industrial investment in the Bundelkhand districts. There have been talks of cultivating Jatropha for production of bio-diesel. Bundelkhand does not specialize in major exports. Some tribal brass-work from Jhansi and Lalitpur is exported; a betel leaf of a certain kind found in Mahoba has a foreign market. There is a variety of stone called Shafar from Banda which is exported along with granite from Chhatarpur and sandstone from Panna.

2.8 Institutions

Among good educational institutions in the region, Bundelkhand University in Jhansi is the one which came into existence in 1975 under the provisions of the Uttar Pradesh Universities Act. The university has many affiliated colleges. There are 11 colleges in Banda, while Jhansi has 14, Lalitpur has 5, Hamirpur has 7 and Jalaun has 17 colleges. The government degree college in Manikpur, Chitrakoot and Veer Bhumi Government College in Mahoba are well-known (*www.bujhansi.org*). The academic programs of the Institute of Engineering & Technology, J C Bose Institute of Life Science, Institute of Agricultural Sciences, Institute of Basic Sciences, Institute of Biomedical Sciences, Institute of Environment & Development Studies, Vaidua Pt. R.N. Sharma Institute of Alternative Medical Education & Research and Dr B.R.Ambedkar Institute of Social Sciences, offer interesting courses on subjects such as agroforestry, horticulture, plant pathology, entomology and genetics & plant. The university also has post graduate courses in natural resource management and environmental bio-technology.

The Indian Grassland and Fodder Research Institute (IGFRI) under the aegis of Indian Council of Agricultural Research (ICAR) is also located in Jhansi. It stands as the premier R&D institution in South Asia for sustainable agriculture through quality forage production for improved animal productivity. Another important institute located in Bundelkhand is the National Research Centre for Agroforestry (NRCAF) which is also under ICAR. The research institute's mission is "to improve quality of life of rural people through integration of perennials on agriculture landscape for economic, environmental and social benefits" (*http://jharenvis.nic.in*). Their mandate includes undertaking not only basic and applied research for developing and delivering technologies based on sustainable agro forestry practices on farms, marginal and wastelands for different agro-climatic zones in the country but also to provide consultancy and act as a database for information on the subject. The U.P. Council of Agricultural Research with its headquarters at Lucknow has developed expertise to find out solutions to the emerging problems related to agriculture and allied sectors in the state with the active coordination of the State Agricultural Universities (SAUs), ICAR and CSIR Institutes. It has also established strong linkages with Government Departments and other institutions engaged in the fields of agriculture, horticulture, animal husbandry, fisheries, sericulture, environment, natural resource management and allied disciplines (www.upcaronline.com). Since it is an apex state organization, research and development work related to Bundelkhand region comes under its supervision.

Other institutions worth mentioning are the remote sensing centers which operate under the aegis of ISRO and are supervised by NRSC. Agricultural drought assessment using space technology inputs has been operational in India since 1989, through a project 'National Agricultural Drought Assessment and Monitoring System (NADAMS)'. NADAMS provides near real-time information on prevalence, severity level and persistence of agricultural drought at state/district/sub-district level. Currently, the project covers 13 states of India, which are predominantly agriculture based and prone to drought situation (www.dsc.nrsc.gov.in). The state of Uttar Pradesh is included in the project and yearly agricultural drought reports are available on their website. Although there is no RRSC (Regional Remote Sensing Center) presently located in Bundelkhand, the RRSC in Nagpur operates for central India.

2.9 Major NGOs and their initiatives in Bundelkhand

The Bundelkhand region suffers from deforestation and land degration, a situation compounded by water scarcity. The small land holdings and small agricultural yields force the locals to resort to migration almost throughout the year. Irrespective of the notorious limelight that Bundelkhand has attained in the last decade, there has not been much pro-active implementation of sustainable strategies to curtail the adverse effects of rampant drought. Although there are many NGOs working in the area, their existence is not uniform in all the districts and there is lack of convergence in non-governmental efforts.

There is, however, some groundbreaking effort being undertaken by a number of NGOs that needs mentioning. AFPRO (Action for Food Production) and its funding partners CRS, OXFAM, IGSSS – Lucknow, and FORRAD, Apada Niwaran Manch, Akhil Bhartiya Samaj Sewa Sansthan, Chitrkoot, have formed a consortium with the common goal of development of natural resources for three poor villages in Bundelkhand and are implementing a project - *Bundelkhand Consortium Watershed Development Programme* with technical support from AFPRO. The 3 villages, Nathupura, Rampura and Pathrondi are populated by 576 SC, ST and OBC households. Soil and water conservation measures have been implemented under the programme. This has helped control the soil erosion and land degradation as well as increased water for irrigation. Wells have been dug for the purpose of irrigation of agricultural land.

The people have been trained on organic farming, Vermi-composting, Integrated Pest Management, Seed grading and priming, and other sustainable and environmentally friendly agricultural practices (source: *www.afpro.com*). In addition to this, Apada Nirawan Manch and Akhil Bharatiya Samaj Sewa Sansthan (ABSSS) are among few NGOs who work on the food security, livelihood and rights of people of Bundelkhand region (ANM, 2012; ABSSS, 2007).

There is another group called Vrutti which aims to promote livelihoods of disadvantaged groups by working with communities and development partners for developing effective strategies, processes, models and support systems; through participatory action research, management services and sector level support (source: *www.vrutti.org*). They have done some research on Bundelkhand and have a publication entitled 'Developing a Marketing Strategy for Fisheries Intervention aiming at Livelihood Promotion in Bundelkhand Region of India'. Many NGOs are supported by UNICEF and UNDP in executing their projects. The organization Wateraid has been involved in some integrated water resource management programmes for achieving drinking water security in the region of Chattarpur in Dhasan river sub-basin using a community based, demand driven and participatory approach.

The NGO Development Alternatives has set up multiple Sustainability Resource Centre or TARAgram centers in Bundelkhand. These TARAgrams are based on a model for sustained low-carbon economic growth among rural communities, through the application of clean technology solutions. Diversity of livelihoods and efficient resource and energy use has been critical in defining a path of sustainability in this region (source: *www.devalt.org*). Currently these centres are located in Tikamgarh, Datia and Jhansi and these districts are the main focus of the activities undertaken. This initiative has met with considerable success especially for innovation of new sustainable and applicable technologies. For example the centre at Datia has come up with the concept of the Eco-Brick Kiln with demonstration of the Vertical Shaft Brick Kiln (VSBK) – energy efficient and environment-friendly technology for firing clay bricks. The technology reduces coal usage by 40-50% and allows small-scale entrepreneurs to earn carbon revenues by negotiating as a cluster (*source: www.devalt.org*).

3

Miseries in Bundelkhand

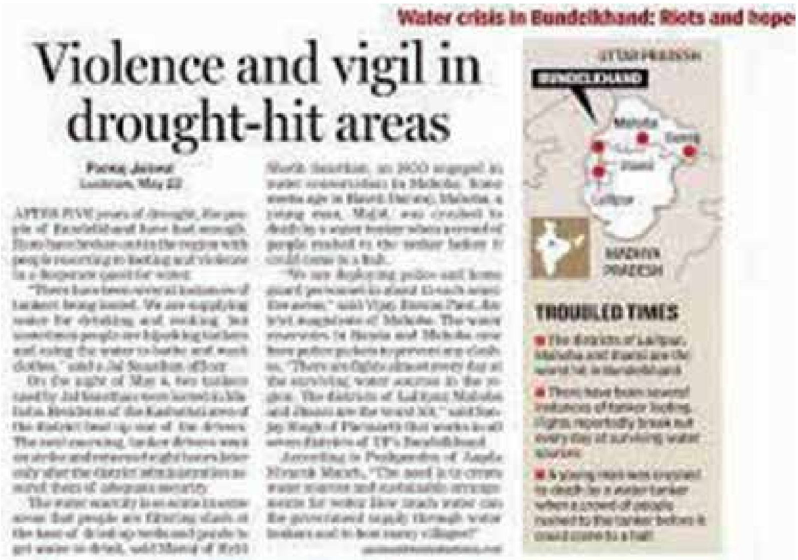
3.1 Bundelkhand Drought: A Tale of Miseries

The Bundelkhand region is one of the most poverty stricken regions in India and has currently experienced recurring droughts. The Rajputana famine of 1869 (also the Great Rajputana Famine, Bundelkhand and Upper Hindustan famine, Rajputana famine of 1868-70) affected an area of 296,000 square miles (770,000 km^2) and a population of 44,500,000, primarily in the princely states of Rajputana, India, and the British territory of Ajmer. Other areas affected included Gujarat, the North Deccan districts, the Jubbal Pore division of the Central Provinces and Berar, the Agra, Bundelkhand division of the United Provinces, and the Hissar division of the Punjab. The monsoon of 1868 was late, moreover, when it came, duration was short, lasting until only August 1868.

ACT Intl. Alert India Bundelkhand Region: Drought and Severe Food Shortages (February 5, 2008)

As reported by Church's Auxiliary for Social Action (CASA)- a member of the global alliance Action by Churches Together (ACT) International- the past five years have seen significant changes in weather patterns, which have adversely affected farmers and farming, including decreased annual rainfall and increasing incidence of hail, frost and storms. Crops have been seriously and increasingly damaged causing extreme distress to people, with this year expected to be worse still as the drought has been severe. Crop failure and debt has driven more than 400 farmers to commit suicide in the seven districts within Uttar Pradesh. Over the last year, many families have locked up their homes and migrated in search of paid labour elsewhere in order to survive, most working in hazardous and exploitative conditions.

(Source;http://reliefweb.int/report/india/act-alert-india-bundelkhand-region-112008-drought-and-severe-food-shortages)


Water crisis in Bundelkhand: Riots and hope

Violence and vigil in drought-hit areas

TROUBLED TIMES

The Indian famine of 1896–1897 was a famine that began in Bundelkhand early in 1896 and spread to many parts of the country, including the United Provinces, the Central Provinces and Berar, Bihar, parts of the Bombay and Madras presidencies, and the Hissar district of the Punjab. Later on the princely states of Rajputana, Central India Agency, and Hyderabad were affected by the famine. During these two years, the overall famine affected an area of 307,000 square miles (800,000 km^2) and a population of 69.5 million. Although large-scale relief was offered throughout the famine-stricken regions in accordance with the Provisional Famine Code of 1883, the mortality, both from starvation and accompanying epidemics, was very high: approximately 1 million people are thought to have died as a result of the famine (Imperial Gazetteer of India vol. III 1907, p. 490).

Drought also affected Bombay, British territory and Bundelkhand during 1905-06. About 2,35,062 perished in Bombay (of which 28,369 attributed to Cholera). Mortality is unknown for Bundelkhand (Roychaudhuri, 1983, p. 531). The government of a developing country such as India and; in this case, the states of Uttar Pradesh (U.P.) and Madhya Pradesh (M.P.) are facing the dilemma of whether to emphasize development or disaster mitigation and environment protection as a central agenda. In the last six-seven years, it was in the news for the drought conditions and distress that has plagued it. There has been news of mass migration, starvation deaths, farmer suicides and even the 'mortgaging' of women over the years. The Irrigation Commission in the year of 1972 identified 17 districts of UP and MP as drought-prone comprising an area of 49.7 mha. Hamirpur, Jalaun, Banda district of Uttarpradesha and Datia district of MP are in the list of chronically drought prone districts. There is no mention of further drought afflicted districts of Bundelkhand. This goes to expound the fact that the social and political situation in the region is also responsible for the human miseries more than the geo-climatic conditions. As discussed earlier the Bundelkhand region of U.P. and M.P. had a drought every 16 years in 18th and 19th centuries, which increased by three times during the period 1968 to 1992 and now becoming an annual feature. The most recent and continued period of poor rainfall recorded in Bundelkhand was in 2004-10, when below average and erratic rain was reported in most part of the region throughout the year. There are several manifestations of drought like late arrival of rains, early withdrawal, long break in between, lack of sufficient water in reservoirs and drying up of wells leading to crop failure and even un-sowing of the crops which ultimately curtails livelihood and may lead to migration. However, Bundelkhand received normal to above normal rainfall in 2011.

According to the state Meteorology Department, Banda district received 252.4 mm rainfall (214% above normal) between June 1 and June 30. During the same period, Hamirpur recorded 253.9 mm rains (334% above normal), Jalaun 266 mm (153% above normal), Jhansi 266.1 mm (203% above normal) and Mahoba recorded 185.2 mm rains (210% above normal). Lalitpur is reeling under the threat of floods with 644 mm rains so far, which is 5.8 times (588%) more than the normal for the district (www.bundelkhand.in).

For most of the year, the residents of Bundelkhand experience acute scarcity of water for agricultural and domestic use. Water sources are varied and often seasonal, ranging from ponds, tanks, lakes and streams to open wells, bore wells and irrigation canals radiating out from large-scale dams. Most agriculture is of the single-crop variety and rain fed, with supplementary water from open wells. Thus, a large number of farmers are highly dependent on the monsoon rains to recharge these wells.

Ground water is an integral part of the environment, and hence cannot be viewed in isolation. There has been a lack of adequate attention to water conservation, water re-use, ground water recharge and ecosystem sustainability. An uncontrolled use of the bore well technology has led to extraction of ground water at such high rate that often recharge is not sufficient. The grim situation of water may be the best illustrated by one Bundelkhandi expression, which is roughly translated to mean *"let the husband die but the earthen pot of water should not be broken"* (Rai, 2007).

Even though Government of India has poured huge amounts of money for all possible mitigation measures in Bundelkhand, the expected outcomes have not been achieved in any part of the region. This indicates the gap between what is being done for drought mitigation in different districts and what is actually required in Bundelkhand. The poor results are primarily due to the non prioritization of mitigation measures according to the needs of people.

Agriculture: A hopeless proposition

The Bundelkhand area in MP is reporting more than double food grain production decline in comparison to the state figure What is worrisome is the drop in yield; it is around four times that of the state.

District	Decline in food production (%)	Reduction in yield (%)
Chattarpur	58.06	35.35
Tikamgarh	76.81	48.48
Panna	28.02	10.41
Sagar	30.75	2.58
Damoh	15.94	10.51
Datia	44.18	18.31
Budelkhand	44.67	22.13
M.P.	13.86	6.41

Source: MP Right to Food Campaign, May 2008, Bhopal

“Water, Drought and Livelihoods in Bundelkhand”

—Dr. Shailendra Nath Pandey

It is worth noticing that the frequency of drought in Bundelkhand is increasing. The records from Government show a spell of one drought in 16 years during the 18th and 19th centuries in Bundelkhand. From 1968 to 1992, the region saw a drought in every five years. However in the 21st century the region has already suffered seven years of drought. There is not an iota of doubt that the drought conditions in Bundelkhand is largely due to ecological instability and inappropriate policies have led to its perpetuation. The current situation calls for immediate action, rather an integrated action from the Government, the civil society and private sector. Though in the news for political reasons, the manifestation of dialogues in state assemblies and parliament have culminated in the announcement of relief packages, but is yet to demonstrate any achievements in changing the quality of life of people in Bundelkhand. The state government of Uttar Pradesh revived the Bundelkhand Divisional Corporation in April, 2008 and constituted a Bundelkhand Special Area Development Authority in July, 2008. However, such bodies fail to deliver right services to the right people on right time because of lack of long term development perspective and short term political mileages. It is imperative that water is the top priority for Bundelkhand. “Water for all and always”, enumerating the sense of availability and accessibility with its sustainability must be the mandate of any developmental strategy for the area. Communities in Bundelkhand need to understand that they have as strong role as that of the Government and Civil Society in management of water and water resources. Therefore, appropriate institutional mechanisms need to be instituted at grassroots levels for management of water.

Source: January 2011, Development Alternatives Newsletter.

Women and Water in Bundelkhand

—M Manoj Kumar

Women play a central role in village and family life, and are usually responsible for preparing meals and fetching water, in many cases, walking long distances to collect water for their families. Water solutions should give every woman a reliable source of drinking and domestic water along with a toilet in her home, to release her from drudgery and let her participate in the economy. Women, traditionally being responsible for procuring water for domestic purposes, are the worst affected of the lot in the wake of severe water crisis. They have to walk for miles to draw water from the drying hand pumps and wells in addition to carrying out household chores. They also carry out economically productive activities like livestock rearing and working in the fields. And, when water is not readily available, they have to wake up earlier than usual to walk even longer distances or stand in queues. Children, mostly girls, are equally engaged in meeting the water requirements of the families, directly or indirectly. In some cases, while mothers are away in search of water, their girl children are taking care of housework or the younger siblings. This is a major hurdle in the growth and development of children from the perspective of not only education time but also play. There are reports and instances where children have been dismissed from schools for being irregular, as a result of long hours spent in fetching water. All this while, barring some exceptions, men in most of the villages while away their time gambling on the streets. It is a very common sight in these villages to see men sitting in groups, playing cards or chatting away, while women and children are constantly engaged in fetching water. No wonder that during discussions, many debates have sparked off a reaction from men when water crisis was highlighted as a priority issue by the women and children, prompting the latter to say 'jeeke paon phateen na bimai, bo ka jaane peer parai' meaning those who haven't cracked their heels working, do not understand the toil of others.

(Source: Development Alternative Newsletter, March 2009)

Communicating Risks of Climate Change to Vulnerable Communities of Bundelkhand - Shubh Kal Campaign

Soma Biswas

Eighteen out of the last thirty years of recurring and long droughts, attributed by meteorologists to climate change, are playing havoc with the lives of 21 million poor and marginalised people of Bundelkhand region in Central India. Most households have sold assets and stories of hundreds of farmers' suicide due to starvation and debts abound in the local and national media. Others are forced to migrate to towns in search of food and livelihoods. It is estimated that almost 6000 people are migrating from this region every day. India's First National Communication to the UNFCCC and recent projections by the Indian Institute of Tropical Meteorology clearly show climatic changes (increased mean temperatures and reduction in precipitation) in the area, both in the last 30 years, as well as in the next 60 years. Assessments by the Indian Agriculture Research Institute, New Delhi have also shown that this will reduce yields of wheat, the prime staple crop, by up to 25 per cent. This is likely to further exaggerate the existing problems of food and livelihood insecurity, poor health and migration along with breaking of social support systems. Communities clearly have a weak capacity to manage climate threats, as also highlighted by vulnerability assessments conducted by Development Alternatives at different times. Development Alternatives is working in the region for more than two decades and it has understood the need of the people, while realizing the urgency of communicating the risks of climate change to the vulnerable communities. However, communities are sceptical and unwilling to change without knowing the benefits. They are at the receiving end and do not have the capacity to absorb concepts, which have long-term benefits. They need quick results with multiple benefits.

Source: Development Alternatives News Letter, June 2011.

A Tale of Distress in Bundelkhand

Sixty-year-old Nand Kumar is from Mahoba district of southern Uttar Pradesh (UP), but he works at a factory in Gurgaon in Haryana, 400km from home. “We have had persistent drought for many years here. I have to support my family and it is just not possible being a farmer,” he says.

Kumar hails from Bundelkhand—an economically backward region where the rains are scarce and the land is parched. “Depending on farm income is impossible. There are at least 500 people who have migrated from here just in the past six months,” he says.

A few kilometres away, cataract has almost blinded Rita Devi in her left eye, but she has no money for the routine surgery. “Our crops have failed year after year. There is almost no rain and no water to irrigate the land,” she laments. “What do we do? There is no means of livelihood.”

These are stories repeated across Bundelkhand, which comprises seven districts of southern UP—Lalitpur, Jhansi, Jalaun, Mahoba, Hamirpur, Banda and Chitrakoot, besides six districts of Madhya Pradesh (MP). Most of the area—right in the heart of India—receives scanty rainfall, but recently, consecutive years of drought have resulted in repeated crop failures. While the people of Banda and Chitrakoot voted in the fourth phase of the seven-stage polls in UP on Sunday, people in the other five districts of Bundelkhand are among the 13 districts readying to cast their votes on 23 February.

Rising discontent

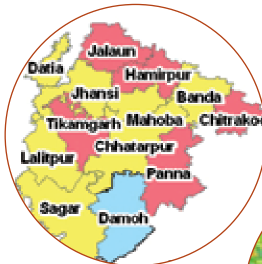
“Well, they announced the package, but where is it?” asks Ved Prakash Vishwakarma, resident of Hamirpur. “It’s nowhere to be seen. And anyway, whenever any important person comes, they do an aerial survey and no one comes to ask us how we are.” In Nathikheda village in Lalitpur, water scarcity is an issue for Somnath Yadav. But equally worrying is the lack of medical facilities in his village of about 1,000 people. “We have one medical centre that opens once a week. But the lady in charge doesn’t come for weeks. The nearest hospital is 3-5km away. All we are asking for our basic health facilities, no more than that. Why can’t we get this?” he asks.

Discontent is on the rise in other parts of Bundelkhand as well. In Jalaun, it’s not just the lack of water or medical facilities that is agitating the people. “Mayawati’s administration is good in terms of law and order. But in terms of generating jobs, her administration is bad," says 19-year-old Vineet Raj, a student at one of the hundreds of private colleges that have sprung up in the state.

Raj, who belongs to an OBC (other backward classes) community, feels that Mayawati has neglected the OBCs at the cost of Dalits. "I am against reservation. It should be based on income group and capability, not merely on caste lines alone," he says. Ram Prasad Yadav, a teacher at the Inter college in Jalaun, feels education and health have not been a priority for successive UP governments. Education, for example, "has been like a laboratory, a test case, for each government. They change the syllabus, exam timetables, textbooks, at their whim without looking at how it will affect the students."

Even among Dalits, awareness of the importance of development is growing. "We need jobs for our children, roads, schools, hospitals," says Mithilesh Kumar, a resident of a neighbourhood named after Dalit icon B.R. Ambedkar, in Lalitpur. "Reservations are all right, but without water, electricity, schools, we will be left behind," he says. "Other states are doing better than us. Development is key to the future.

Source: http://www.bundelkhand.in/portal/news/tale-of-distress-in-bundelkhand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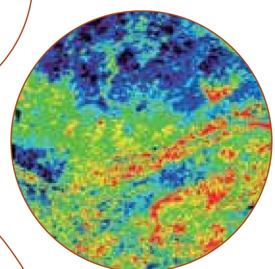

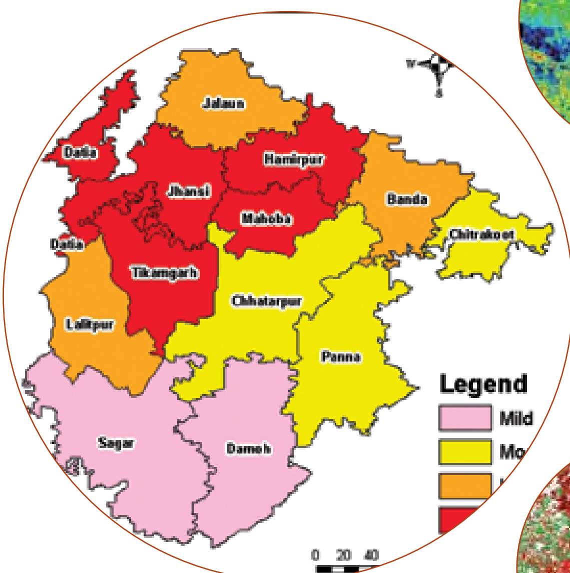
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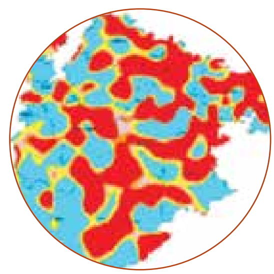
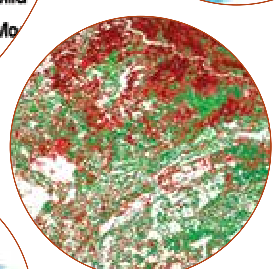




4

Drought Hazard Analysis

4.1 Scientific Study

Drought is the combined effect of meteorological (reduced rainfall) and hydrological (reduced available water supply) factors and the resulting agricultural drought (reduction in crop yield). Drought indices assimilate thousands of bits of environmental data related to rainfall, stream flow and other water supply indicators, vegetation vigour, etc., which present a concise picture of the drought risk scenario. A drought index value is typically a single number that is far more useful than raw data for decision making, as it allows comparisons on temporal and spatial scales helping planners to prioritize and communicate information to diverse users (Wilhite et al., 2000). Global level mapping of drought patterns and impacts through the mapping of several drought related characteristics either at a country level or at regular grid scales were undertaken by International Water Management Institute covering various aspects of droughts from global distribution of meteorological and hydrological drought covering various aspects of droughts from global distribution of meteorological and hydrological drought risks to social vulnerability and indices related to water infrastructure (Eriyagama et al., 2009).

Different indices were selected for the present study on the basis of four preferred criteria:

- suitability based on the topography and geography of the region,
- should be flexible and able to detect short-term droughts,
- matching with the data availability,
- easy to compute and easy to understand

(a) **Meteorological drought:** the following indices chosen for the study were

(i) **Deciles of Precipitation.** (The deciles are the partition values which divides the set of observations into ten equal parts. There are nine deciles namely. The first decile is a point which has 10% of the observations below it)

(ii) **Standard Precipitation Index (SPI)** (The Standardized Precipitation Index (SPI) is a relatively new drought index based only on precipitation. This index is based on the probability of precipitation for any time scale. It can be used to monitor conditions on a variety of time scales. Positive SPI values indicate greater than median precipitation, and negative values indicate less than median precipitation. Because the SPI is normalized, wetter and drier climates can be represented in the same way, and wet periods can also be monitored using the SPI.

Table 6*:* Standardized Precipitation Index

SPI Values	
2.0+	Extremely wet
1.5 to 1.99	Very wet
1.0 to 1.49	Moderately wet
-.99 to .99	Near normal
-1.0 to -1.49	Moderately dry
-1.5 to -1.99	Severely dry
-2 and less	Extremely dry

(*Source:* www.drought.unl.edu)

(iii) Percent by Normal

The percent of normal precipitation is one of the simplest measurements of rainfall for a location. Analyses using the percent of normal are very effective when used for a single region or a single season. In India IMD declares drought based on percent below normal rainfall. Another reason to follow this index was lack of continuous rainfall data.

$$\text{Percent by normal} = \frac{(\text{Actual} - \text{Normal})}{\text{Normal}}\ 100$$

Table 7: Percent by Normal

%Normal	
+/-19%	Normal
20 to 59%	Moderate drought
>60%	Severely drought

(*Source:* Samra, 2004)

(b) Hydrological Drought Index

(i) Standardized Water-level Index (SWI)

The SWI expression is given by

$$SWI = \frac{(W_{ij} - W_{im})}{\sigma}$$

W_{ij} is the seasonal water level for the i^{th} well and j^{th} observation. W_{im} is the long term seasonal mean and σ is standard deviation (Bhuyian et al, 2006).

Table 8: Standardized Water Level Index

SWI Values	
SWI > 2.0	Extreme drought
SWI > 1.5	Severe drought
SWI > 1.0	Moderate drought
SWI > 0.0	Mild drought
SWI < 0.0	No-drought

Source: Bhuyian, 2004

(c) For agricultural drought, the following were selected

(i) Normalized Difference Vegetation Index (NDVI)

NDVI reflects vegetation vigour, density and biomass. It varies in a range of -1 to +1. Among the all the vegetation indices that are available, it is a universally acceptable index for operational drought assessment because of its simplicity in calculation, easy to interpret and its ability to partially compensate for the effects of atmosphere, illumination geometry *(http://dsc.nrsc.gov.in)*.

NDVI is derived as under;

NDVI=NIR-R/ NIR+R

Where, near Infra Red and Red are the reflected radiations in these two spectral bands. Higher value of NDVI (more than 0.7) shows good vegetation condition. NDVI is only a indicator of vegetation vigour (not only agriculture).

(ii) Vegetation Condition Index (VCI)

Vegetation Condition Index- VCI was designed to signal out the impact of meteorological condition on the vegetation of that area. It shows how close the NDVI of the current month is to the minimum.

$$\mathbf{VCI_{\mathit{j}} = (NDVI_{\mathit{j}} - NDVI_{min} / NDVI\ max- NDVI_{min})}$$

Where NDVI min and max are calculated from long term record for that month and 'j' is the index of current month VCI values around 0.5 reflects fair vegetation condition. VCI between 0.5 to 1 indicates optimal to normal condition. Different drought severity is indicated by VCI values below 0.5. Kogan (1995) illustrated that the VCI threshold of 0.35 may be used to reflect extreme drought condition. Low VCI values over served consecutive time interval points to drought development. (http://dms.iwmi.org/).

4.2 Data Used

The failure of monsoon is the prime cause of drought and it becomes very important to study the historical rainfall pattern in the region. To study the frequency and severity of meteorological drought the 'Decile of precipitation' was computed using a 102 year rainfall dataset. Decile is a non-parametric index useful to understand the overall pattern, and used only in areas with undulating topography such as north Bundelkhand. For more concrete results, the SPI was computed from 1970 to 2002.

Monthly rainfall data from 1998 to 2009 for the 13 districts of Bundelkhand was procured from Indian Meteorological Department (IMD), New Delhi. Monthly and annual rainfall data from 1901 to 2002 was acquired from India Water Portal website (http://www.indiawaterportal.org/metdata).

Monthly data of groundwater for years 1998 to 2010 for 264 stations distributed over thirteen districts of Bundelkhand was obtained from Central Ground Water Board, Faridabad. Satellite scenes of South-East Asia of 11th September from 1998 to 2009 were downloaded from SPOT Vegetation data freely available at website *(http://free.vgt.vito.be/)*.

4.3 Methodology of Study

The following flow chart gives the basic methodology followed in this study.

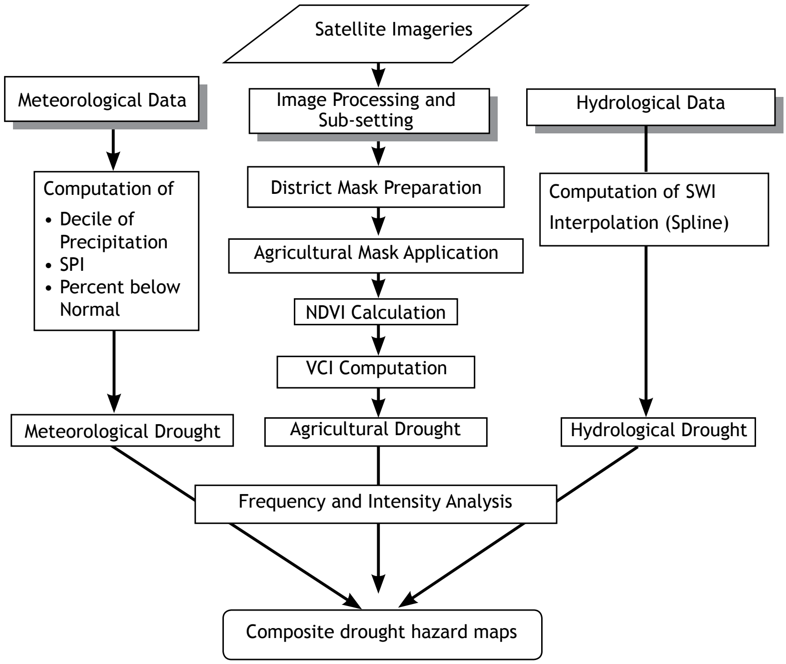


Figure 4: Methodology Flow chart.

4.4 Analysis of Datasets

Computation of Drought indices

In this process of computation of Drought indices,

- Stage I dealt with data processing and computation of the indices for all three types of drought.
- Stage II included data analysis: frequency and intensity calculations over the 12 years, combining frequency and intensity to produce

hazard and vulnerability maps and lastly identifying the chronology of drought occurrence.

- In Stage III hazard and vulnerability were assigned with appropriate ranks to their categories and weightage, to arrive at the final composite drought risk map

The data were pre-processed for computation of these indices.

Bundelkhand receives the maximum amount of rainfall during June to September. The % of departure of rainfall from the average in these 4 months was calculated to analyse the severity of meteorological drought for 12 years. According to IMD's criteria, a negative deviation up to 19% is considered 'normal', from -19 to -59% drought is termed 'moderate' and beyond -60% it is considered as 'severe' meteorological drought. The results obtained were put into pictorial format for better representation of spatial and temporal changes over the period 1998-2009.

Selection of the hydrological drought index was based on being easy to understand, carrying physical meaning, sensitive to wide range of drought conditions, independent of area of application, which could reveal drought with short lag after its occurrence, and be based on data which are readily available. Thus, the Surface Water level Index (SWI) was selected for the assessment of hydrological drought, as one of the most preferred indexes for drought detection (Bhuiyan, 2006). For SWI computation, pre and post monsoon months in May and November, respectively, were selected to understand the role of monsoon on water resources. Data was processed for all 264 ground water monitoring stations in Bundelkhand and the SWI was computed. Interpolation was done using the Inverse Distance Mean method; however, the results were not satisfactory as surface layers generated were not smooth. A Regularized Spline method was therefore adopted for creation of the surface layers. This method gave a smooth surface and satisfactory results. This spline is a general purpose interpolation method which fits a minimum-curvature surface through the input points. This method is best for gradually varying surfaces such as water-table depths.

The result of Stage-I was further analyzed to calculate drought frequency and intensity. The number of drought occurrences in 12 years were then categorized into different classes i.e. extremely high, very high, high, moderate and low; these results were shown separately in maps for each type of drought. The sum of deviations from the reference level, gives the drought severity. The drought intensity was calculated for each district over 12 years for each type of drought. Finally, the drought intensity was classified into five groups: extreme, severe, high, moderate and mild.

In order to derive a risk index, meteorological factors depicting hazard; hydrological and agricultural indices which represented the vulnerability analysis and drought frequency and intensity values were multiplied. The risk index was further classified into 5 categories. For each district, correlation was carried out between meteorological and hydrological drought, and between meteorological and agricultural drought with and without time lag over 12 years.For preparation of the composite drought risk map, three maps were used namely; hazard, agricultural and hydrological vulnerability maps. Since all three maps are classified in similar categories, each category was assigned a rank. Similarly, each drought variable i.e. rainfall, agriculture and groundwater was given a weightage based on expert knowledge. These three layers were then integrated to get one composite value for each district. Finally the composite drought risk map was obtained and further classified into four classes .i.e. Severe, high, moderate and mild.

Table 9: Weightage to categories

Category	Rank
Extreme	5
Severe	4
High	3
Moderate	2
Mild	1

Table 10: Weightage to drought variables

Drought Variables	Weightage
Meteorological (Rainfall)	0.35
Hydrology (Groundwater)	0.20
Agricultural (Agriculture)	0.45

4.5 Drought Hazard Mapping

4.5.1 Meteorological Drought

Meteorological drought is usually defined on the basis of the degree of dryness (in comparison to some “normal” or average amount) and the duration of the dry period. Definitions of meteorological drought must be considered as region specific since the atmospheric conditions that result in deficiencies of precipitation are highly variable from region to region (NDMC). According to the Inter-ministerial team survey in Bundelkhand, more than 19% deficit in the normal rainfall, late onset of monsoons, early withdrawal of rains, long breaks during growing season and permutations or combinations of these factors are manifestations of triggering drought. The cumulative buildup of meteorological droughts has rippled into hydrological drought with a complex set of highly differentiated adverse impacts and tradeoffs.

4.5.1.1 Deciles of Precipitation

In Figure 5 horizontal axis represents time period while the vertical axis represents the number of districts in Bundelkhand region experiencing drought. The graph provides a picture of 20th century. It clearly indicates that the number of normal years has decreased and the moderate and severe drought years have sharply increased in last 30 years.

4.5.1.2 Percent by Normal

Results obtained from the '%by normal' method have been shown in the form of thematic maps (figure 6) to reveal the patterns of meteorological drought in Bundelkhand region. Severe to moderate drought was observed during 2004 to 2009 in different districts of this region. Hamirpur, Mahoba and Jhansi districts experienced consecutive drought from 2004 to 2009. However, the year 1999 and 2003 witnessed above to normal rainfall during the period of study. During the last 6 years, UP Bundelkhand has faced more consecutive drought as compared to the MP Bundelkhand districts. It has been found that the U.P. part of the region experienced rainfall deficit of 35% in 2004-05, 26% in 2005-06, 41% in the year 2006-07, which went up to 54% in 2007-08, 39% in 2008-09 and 42% in 2009-10. All the districts experienced meteorological drought in 2009. These results are verified with the Central Ministerial Report, 2008.

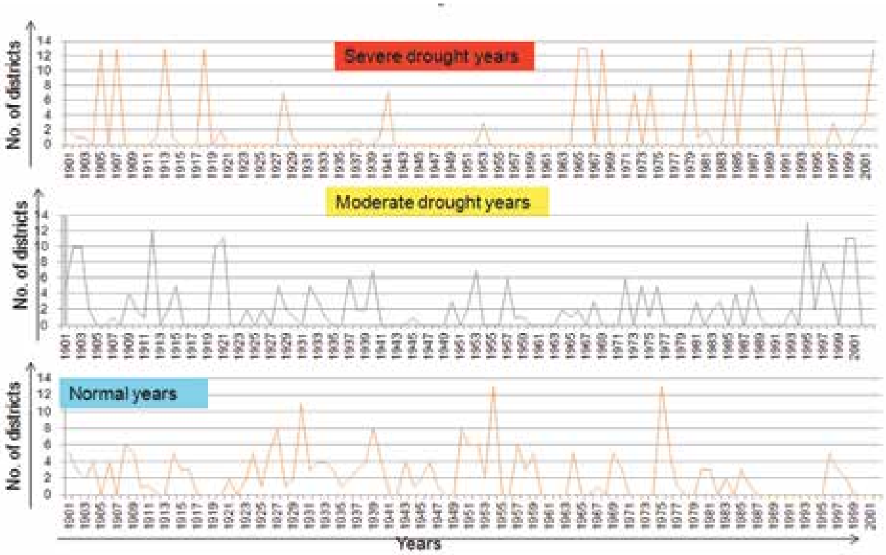


Figure 5: Deciles of Precipitation

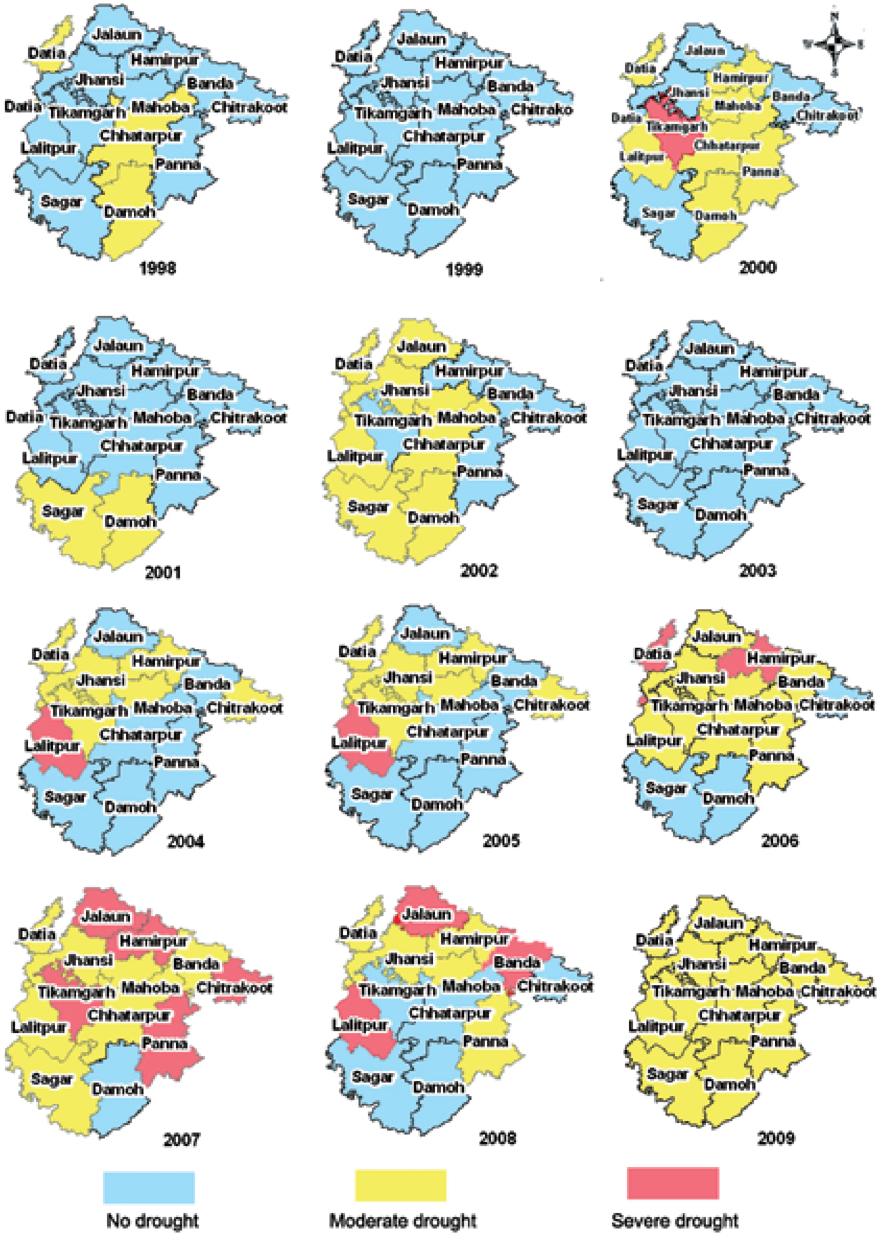


Figure 6: Thematic maps representing meteorological drought during the period 1998 to 2009.

In Madhya Pradesh, the rainfall was almost normal during 2004-05 and 2005-06 except in Tikamgarh and Datia which experienced drought in 4 consecutive years. In 2006-07 the region experienced overall shortfall of 41%, with 6 Budelkhand districts receiving deficit rainfall ranging from 45% to 82%. Severe drought occurred in Tikamgarh and Pannaand. The overall shortfall in precipitation went up to 41% during 2007-08. Except Panna, all districts received normal rainfall in 2008-2009 and in the following year, once again all the districts experienced moderate drought with overall deficiency of 32%.

4.5.2 Hydrological drought

Hydrological drought is associated with the effects of periods of precipitation shortfalls on surface or subsurface water supply (i.e., stream flow, reservoir and lake levels, and groundwater). The frequency and severity of hydrological drought is often defined on a watershed or river basin scale. Although all droughts originate with a deficiency of precipitation, hydrologists are more concerned with how this deficiency plays out through the hydrologic system.

Hydrological droughts are usually out of phase with or lag behind the occurrence of meteorological and agricultural droughts. It takes longer for precipitation deficiencies to show up in components of the hydrological system such as soil moisture, stream flow, and groundwater as well as reservoir levels. As a result, these impacts are out of phase with impacts on other economic sectors (Wilhite & Glantz, 1985)

4.5.2.1 Standardized Water level Index (SWI)

The entire region has been classified into 5 categories based on interpolated maps of SWI as shown in figure 7a and 7b. Bhuyian et.al. (2006) used SWI and analyzed dynamic water stress in the Aravali region in India for mapping of SWI with SPI and VHI. The result of SWI from 1998 to 2009 indicated that water level declined over the period in various districts both during pre and post monsoon months. During 1998 to 2000, most parts of the region were free from water stress due to normal rainfall. Lalitpur, Panna and Chattarpur districts faced extreme to moderate drought in 2001, and it is worth mention that meteorological drought was recorded in previous year 2000 in these districts as well. From 2004 onwards a remarkable decline in water level has been noticed which aggravated year after year by the monsoon failure. Year 2006 and 2007 were hydrological drought years for the entire Bundelkhand region. Datia, Tikamgarh, Chitrakoot and Jhansi districts faced extreme drought for 3 consecutive years.

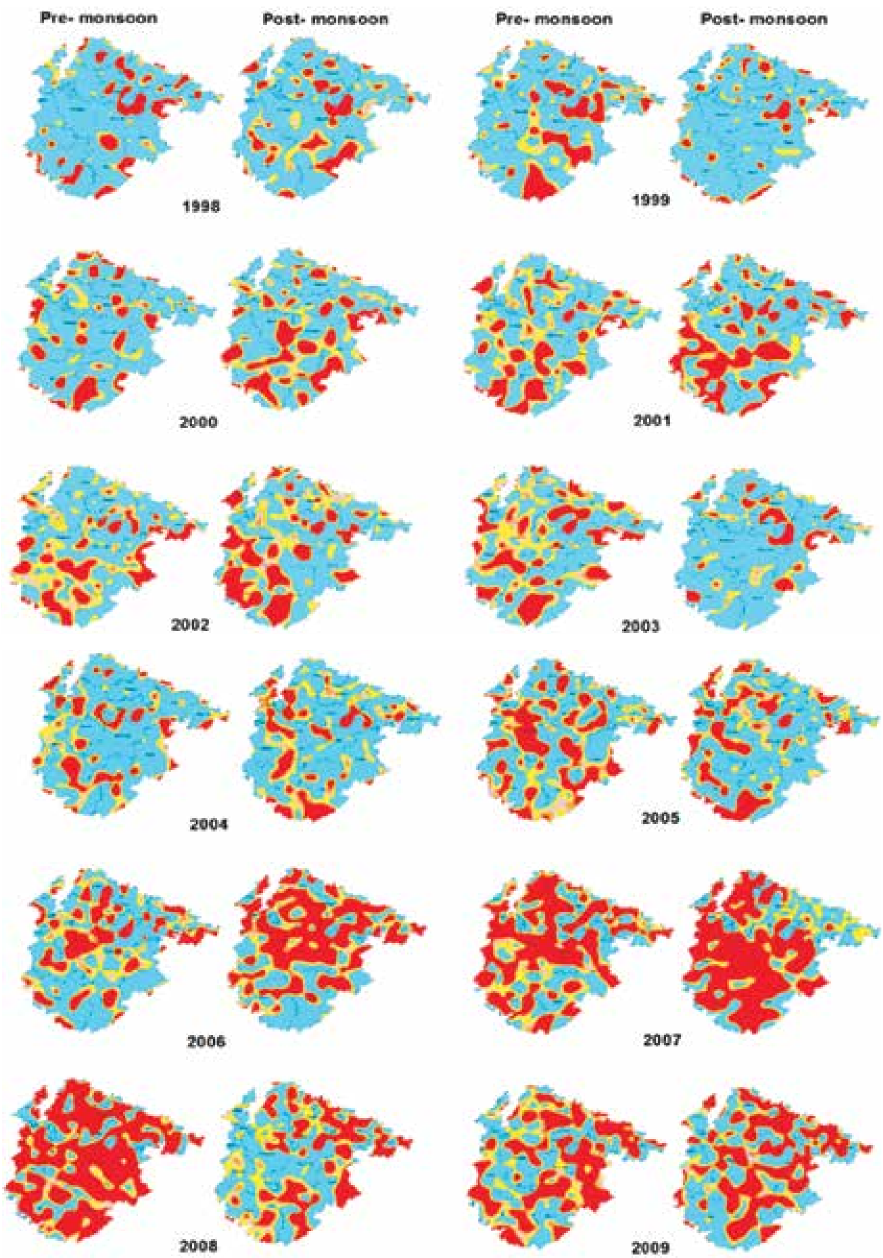


Figure 7: Hydrological drought maps from year 1998 to 2009

Legend

Normal | Mild | Moderate | Severe | Extreme

The SWI for Datia in 2006 was up to 4.35, whereas extreme drought in 2007 saw SWI up to 5.50 in Tikamgarh district, 5.01 in Damoh district and 4.93 for Jhansi district. It is important to mention that 2006 and 2007 were also meteorological drought years for Bundelkhand region. 3 out of 13 districts became free from drought in 2008 while other still remained under extreme to moderate drought. The continuous decline of water level during the period of 2004 to 2007 may be attributed to the reduced rainfall runoff pouring into reservoirs. Only 17% of the total capacity of reservoirs was filled in 2008. The situation was even more alarming in the Madhya Pradesh (MP) portion of Bundelkhand region. As against the total storage capacity of 950 MCM in 19 reservoirs, the actual filling of water progressively reduced from 52% in 2004 to 10% in 2007 (Samra, 2008).

4.5.3 Agricultural Drought

Agricultural drought links various characteristics of meteorological and hydrological drought to agricultural impacts, differences between actual and potential evapo-transpiration, soil water deficits, reduced groundwater or reservoir levels, and so forth. Demand for water from plants depends on prevailing weather conditions, biological characteristics of the specific plant, its stage of growth, and the physical and biological properties of the soil. A good definition of agricultural drought should be able to account for the variable susceptibility of crops during different stages of crop development, from emergence to maturity (Whilite & Glantz, 1985).

4.5.3.1 Normalized Difference Vegetation Index

The NDVI images reflect vegetation vigor, density and biomass. NDVI images corresponding to the mid September period of Bundelkhand region has been analyzed. Vegetation under stress has been found in the northern portion of the region as compared to the southern part, where a healthier vegetation cover was observed throughout the study period. Doi (2001) examined the serial relationship between NDVI and rainfall occurrences at different stations in the Thar Desert region. NDVI hasf been used successfully to identify stressed and damaged crops and pastures, but suffered with interpretive problems when the results were extrapolated over non-homogeneous areas. Kogan (1995) introduced the method of “geographic filtering of NDVI” and enumerated the concept of NDVI stratification and applications of the modified NDVI for more accurate monitoring of vegetation in non-homogeneous areas.

4.5.3.2 Vegetation Condition Index

As this study was focused on agricultural drought, and not on vegetation vigor, an agricultural mask was prepared to exclude all the pixels falling in non-agricultural area from the analysis. The smoothed NDVI data is normalized and VCI values were calculated for each year for all the thirteen districts of Bundelkhand region and the results are shown in figure 9. The region showed normal vegetation (95% < VCI> 51%) in year 1998. During 1999, all the districts except Mahoba and Chattarpur were observed to be under severe to extreme agricultural drought. Vegetation under severe stress was evident from the VCI value dropped to 5% in Damoh district.

However, there was a remarkable improvement in vegetation condition in the following year and VCI ranged between 84% and 95%. 2000 was the best year for vegetation health among the 12 year period analyzed in the study. Vegetation condition remained fluctuating due to the variation in rainfall in the following two years. Year 2002, was a normal year in terms of agriculture drought whereas 2003 was a complete drought year for the entire region. The worst situation of drought impact prevailed in this year. Drought continued again for the subsequent two years in most districts. The region was almost drought free in the years of 2007 and 2009 whereas in 2008 various districts were affected by agricultural drought of different degrees.

4.6 Drought Frequency and Intensity Analysis

Frequency and intensity (severity) maps obtained from the analysis of meteorological and agricultural drought were categorized into five classes of drought i.e. Extremely High, Very high, High, Moderate and Mild; whereas the hydrological drought frequency map was categorized into three classes i.e. Severe, High and Moderate. These maps are shown in figure 10 and 11. Mahoba, Sagar and Damoh districts faced the highest number of hydrological drought i.e., 5 to 6 drought years out of 12 observed years.

As evident in the meteorological drought hazard frequency map, Datia district faced the highest number of drought years followed by Lalitpur and Mahoba in the range of 6 to 8 times in 12 observed years. Tikamgarh, Jhansi, Jalaun, Hamirpur and Chhatarpur districts faced 5 to 6 droughts in 12 observed years. The agricultural drought frequency was the highest in Hamirpurin i.e. 8 out of 12 observed years followed by Datia, Tikamgarh, Jhansi, Jalaun, Mahoba and Banda facing 4 to 6 drought years in 12 observed years.

Specific maps representing intensity (severity) of meteorological, hydrological and agricultural droughts were prepared and drought intensities were categorized (figure 11). Meteorological drought incidences were extremely severe in Lalitpur district; agricultural droughts in Datia, Jhansi and Hamirpur, and hydrological droughts were more severe in Tikamgarh and Banda districts of Bundelkhand region.

The results of the correlation analysis between meteorological and agricultural drought for all the 13 districts from 1998 to 2009 are given in the table below.

Table 11: Correlation between meteorological and agricultural drought

District	With zero lag	With 1 year lag
Banda	-0.33483	-0.07646
Chitrakoot	-0.90221	-0.18436
Hamirpur	-0.46048	0.473797
Jalaun	-0.17115	0.168141
Jhansi	-0.25909	0.282094
Lalitpur	-0.14638	-0.02247
Mahoba	-0.33692	0.395351
Chhatarpur	-0.81569	0.174062
Damoh	-0.37758	0.416816
Datia	-0.51005	0.303156
Sagar	-0.71041	0.462438
Panna	-0.67833	0.202472
Tikamgarh	-0.50788	0.37793

It is important to mention that meteorological drought has been represented in decreasing values of %from normal, while hydrological drought is represented with increasing SWI values. Therefore, negative values of the coefficient represent a higher correlation.

It is evident from these results that hydrological drought follows meteorological drought without a time lag, whereas agricultural drought follows meteorological drought with a time lag of a year.

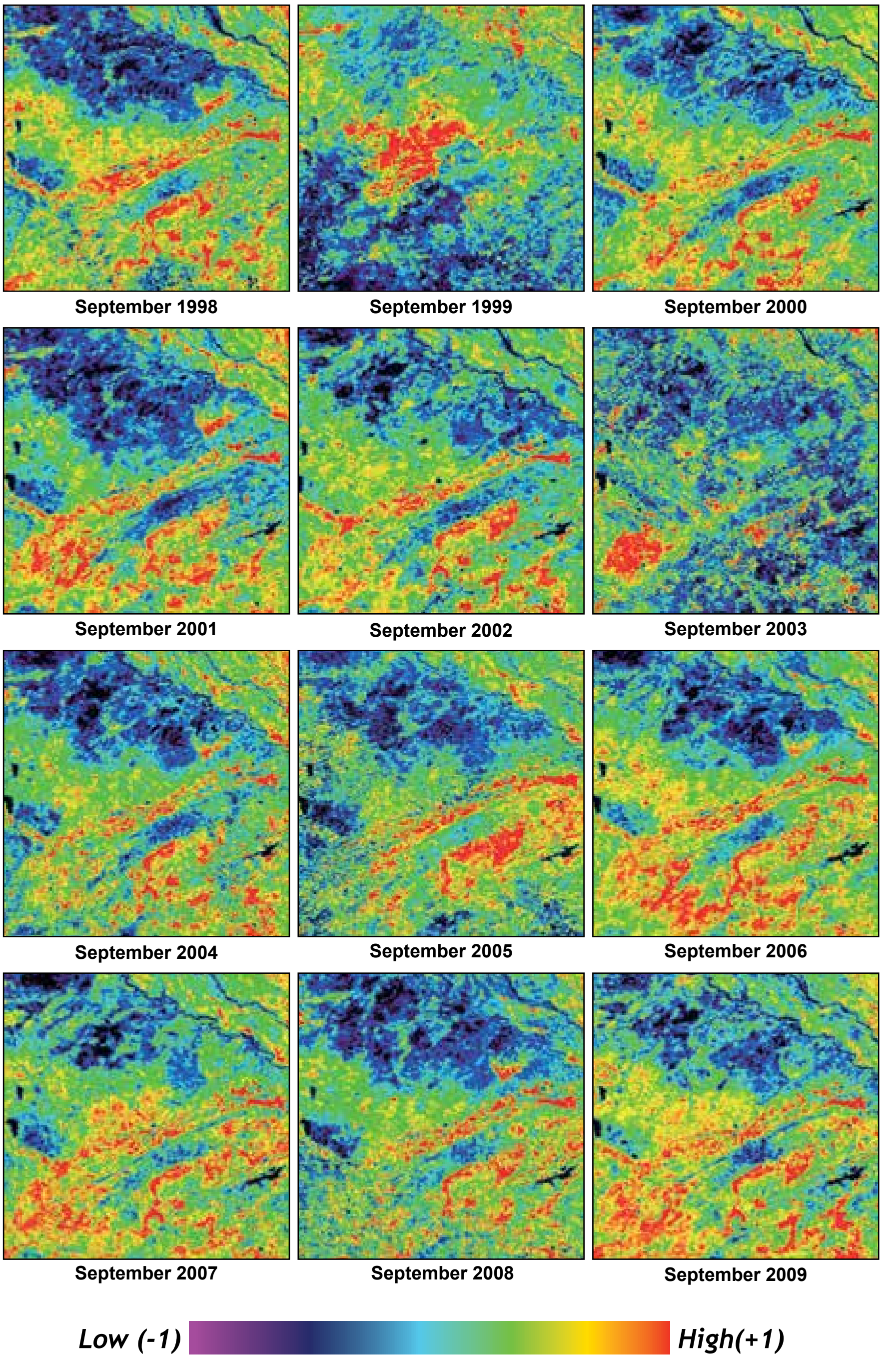


Figure 8: NDVI images of Bundelkhand region from 1998 to 2009

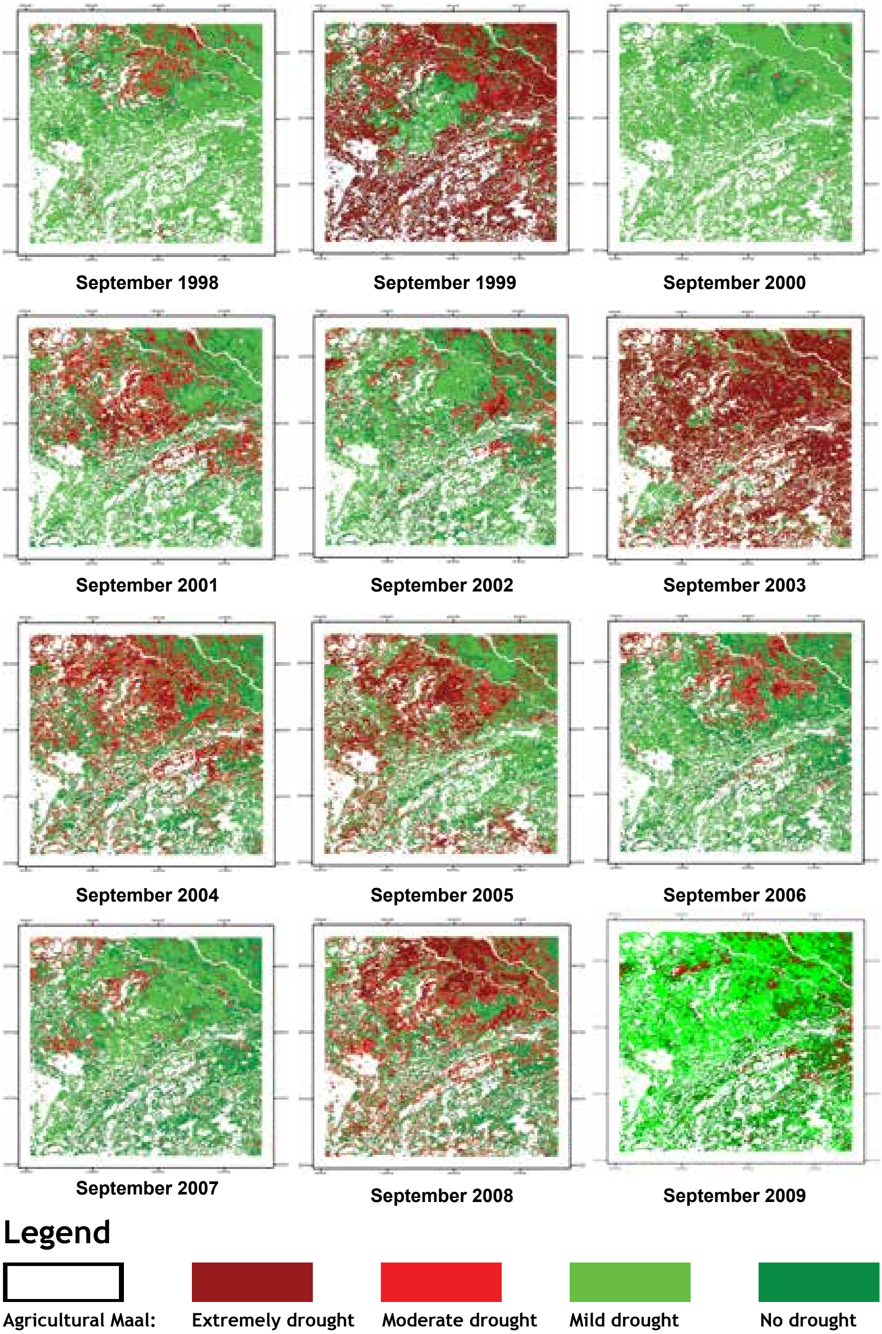


Figure 9: Agriculture drought interpretations based on VCI for Bundelkhand region

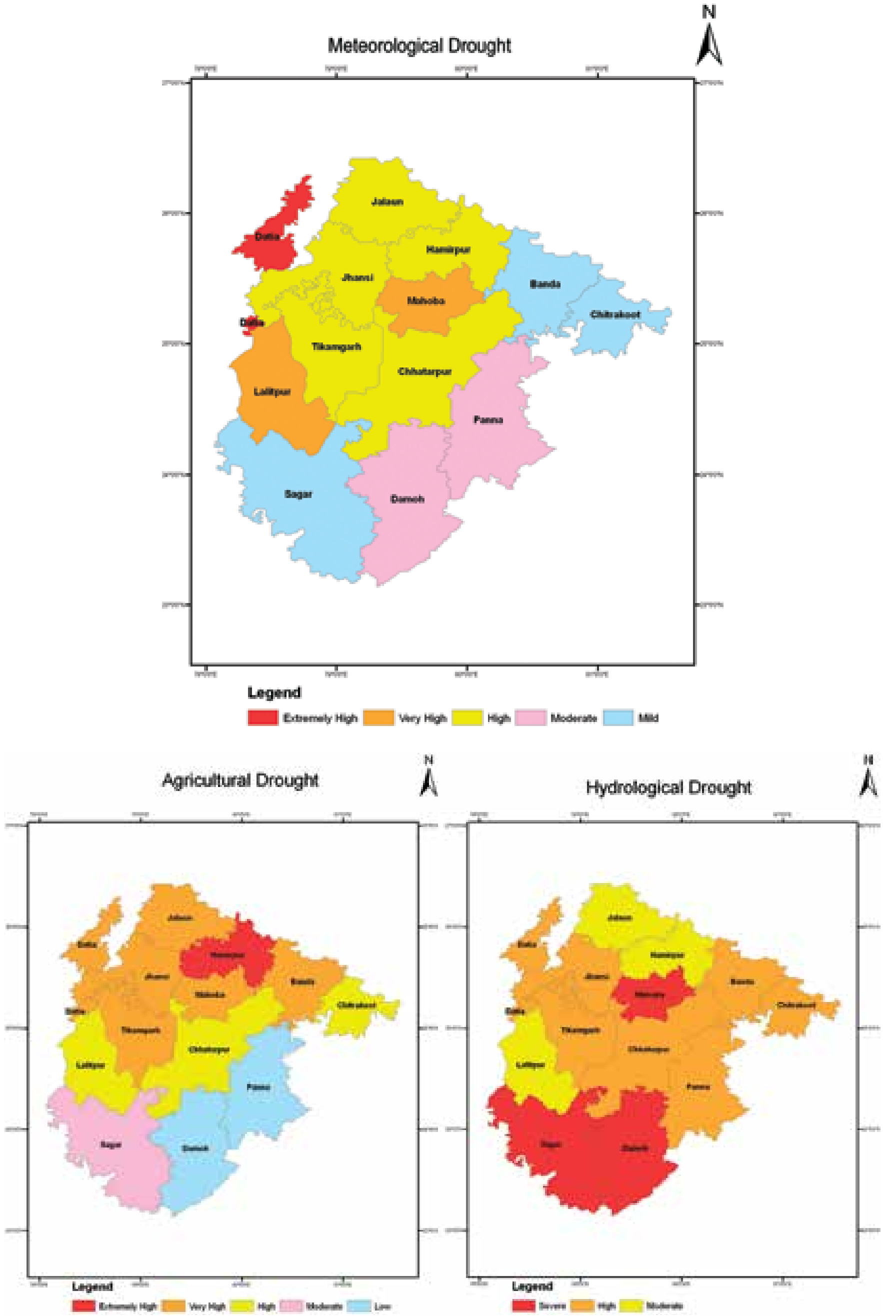


Figure10: Frequency maps of meteorological, agricultural and hydrological drought

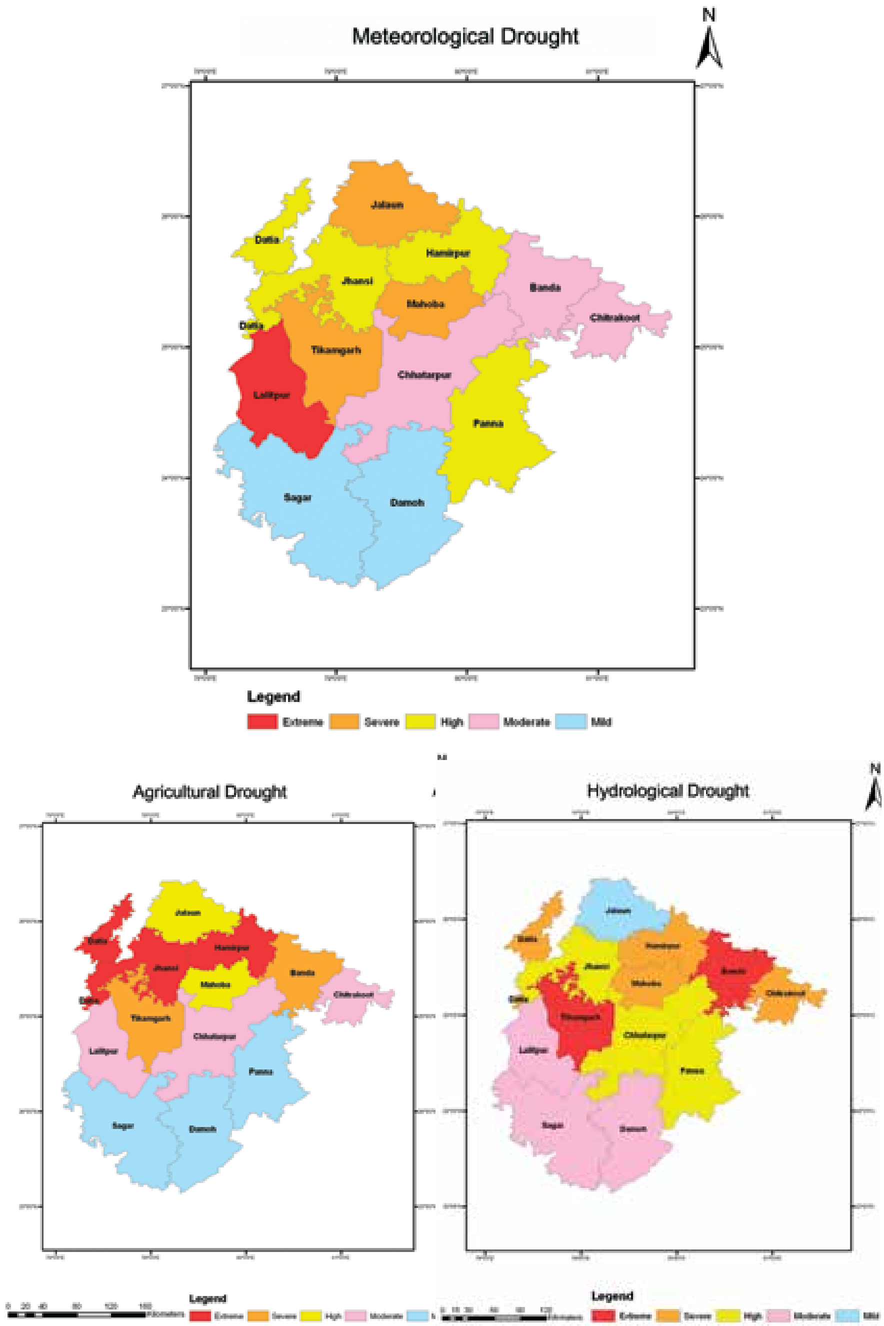


Figure 11: Intensity maps of meteorological, agricultural and hydrological drought

Table 12: Correlation between meteorological and hydrological drought

District	With zero year lag	With 1 year lag	With 2 year lag	With 3 year lag
Banda	-0.89664	-0.58658	-0.53985	-0.32887
Chitrakoot	-0.42107	-0.38818	-0.79538	-0.36141
Hamirpur	-0.22709	-0.38316	-0.89637	-0.51286
Jalaun	-0.59294	-0.65567	-0.58307	-0.19532
Jhansi	-0.61299	-0.03042	-0.18485	-0.18926
Lalitpur	-0.11162	-0.18708	-0.33495	0.10719
Mahoba	-0.79556	-0.38071	-0.58882	-0.10781
Chhatarpur	-0.86521	-0.08559	-0.17298	0.32488
Damoh	-0.03784	0.26590	0.79486	0.44961
Datia	-0.72710	-0.39377	-0.15281	0.43852
Sagar	-0.76011	-0.49113	-0.05289	0.13221
Panna	-0.65246	-0.21415	-0.37806	0.02635
Tikamgarh	-0.72815	0.13632	0.58308	0.38472

4.7 Hazard Analysis (Frequency and Intensity)

Drought hazard map for meteorological, hydrological and agriculture were prepared based on drought frequency and intensity. The study area is classified into five classes of drought severity i.e., extreme, severe, high, moderate and mild. The outcome maps are given in the figure 12.

It has been interpreted that Datia district experienced extremely high frequency of drought - 9 out of 12 years. Almost every year there was meteorological drought in Datia, whereas severely high drought occurred in Lalitpur and Mahoba districts - 8 in 12 years. However, drought intensity was observed to be moderate in Datia. In Lalitpur district droughts were of very intensive type but the frequency came under the moderate category. Thus, it can be concluded that drought hazard was overall of extreme level in Lalitpur followed by severe drought hazard in Datia and Mahoba districts of Bundelkhand region.

The response of the environmental system (i.e. in terms of hydrological and agricultural system) to meteorological drought has also been analyzed. The frequency of hydrological drought increased after 2004 in almost all the districts of Bundelkhand and relatively higher frequency was recorded for Sagar, Damoh and Mahoba districts and very severe drought occurrences observed in Tikamgarh and Banda districts. Tikamgarh, Banda and Mahoba were assessed to be the hydrologically the most vulnerable districts of Bundelkhand region.

In case of agricultural drought, results showed that Hamirpur experienced very high frequency of drought (8 out of the 12 years). High drought intensity was reported for Datia, Jhansi and Hamirpur districts. Overall, the agricultural vulnerability was found to be extreme in Datia, Jhansi and Hamirpur followed by severe in Tikamgarh and Banda districts.

The hazard map indicated very high probability of meteorological drought in Lalitpur, whereas Datia, Jhansi and Hamirpurare indicated as most vulnerable to agricultural drought and Tikamgarh and Banda as most vulnerable to hydrological drought.

4.8 Composite Drought Hazard Mapping

Aim of the present study was to develop a 'Composite Drought Hazard Map' for the Bundelkhand region by integrating the hazard frequency and intensity maps for Meteorological, Hydrological and Agricultural drought. This composite vulnerability map has been prepared combining effect of all the three droughts – meteorological, hydrological, and agricultural, for individual districts in the region. The composite was prepared after assigning weightages for all the three categories of drought. The results have shown that the districts namely Datia, Tikamgarh, Jhansi, Mahoba and Hamirpur districts were facing severe drought vulnerability followed by Lalitpur, Jalaun and Banda. In Datia the contribution of agricultural drought was more visible than meteorological and hydrological drought. In Tikamgarh the hydrological drought contributed more for the high vulnerability. In Jhansi and Hamirpur districts the agricultural drought was more evident than the other two types, and pushing these districts into the severe vulnerability category. Both meteorological and hydrological drought equally contributed to the high risk in Mahoba district.

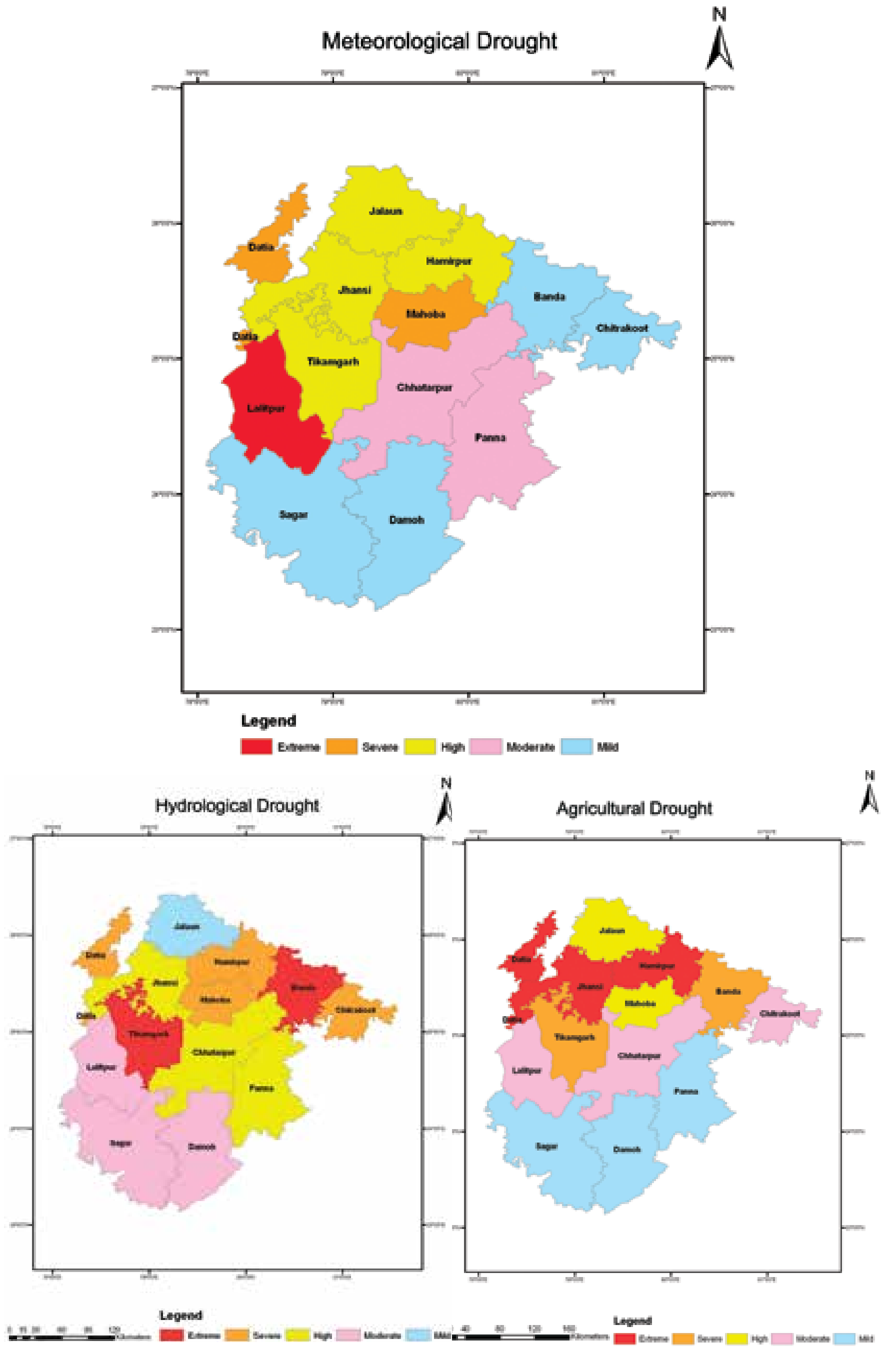


Figure 12: Maps of meteorological, agricultural and hydrological drought

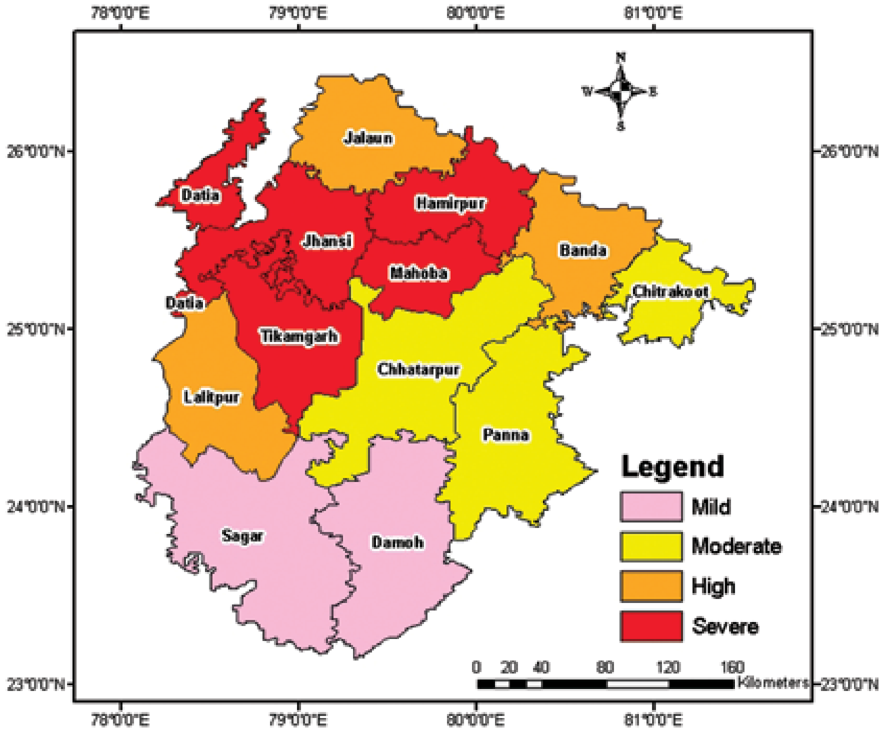


Figure 13: Composite drought hazard map of Bundelkhand


Groundnut
Demonstration

बुन्देलखण्ड को 'पानी की फसल' से हरा-भरा कर रही जल सहेलियां

पहल : जल सहेलियों ने दिखाया जज्बा

कुंओं के संरक्षण को महिलाएं आगे आयीं

5

Capacities: Mitigation and Development

Bundelkhand region is characterized as a hot, semi-arid, eco-region and the agriculture depends on rainfall. The J S Samra committee report on drought mitigation strategy for Bundelkhand has suggested that historically drought came every 16 years, which rose three fold during 1968 – 1992 to once every 5 years and became a recurring annual feature since 2004. Rampant poverty in the region has forced the population to exploit the environment. For instance, collection of fuel-wood through unsustainable tree-felling and reckless mining are the only activities left for the survival of local people's livelihood. The environmental problems in the region have a very complicated relationship with climatic conditions, variability and different aspects of the population.

In Bundelkhand there is also the problem of massive discrimination against certain sections of the society, which aggravates the already festering problem of discontent. The lack of proper implementation of government schemes further aggravates the problem of backwardness and environmental degradation

5.1 Traditional knowledge

Traditional technologies have evolved to fit the environmental and social context of the region and that is why they are so very effective. Systematic integration of cultural heritage and appropriate traditional technology, skills and local knowledge systems within present day developmental efforts, can provide effective means of reducing the impact of disasters. In view of the desertification and land degradation processes in Bundelkhand, learning from traditional knowledge and mitigation strategies comprises tapping a wide range of accumulated experience to manage natural resources in farming, grazing, landscape restoration as well as the institutional and organizational arrangements required (Gupta & Singh, 2011). The ancient knowledge and technology of Bundelkhand incorporates wisdom instilled through millennia of experimentation and trial and error.

Figure 14: Madansagar tank

Bundelkhand had a vast number of traditional irrigation methods and environmental friendly methods of storing water from the time of the Bundela Rajputs. An example is the talabs or natural ponds called *pokhariyan* at Tikamgarh, which were used for drinking and agricultural purpose. Incidentally when these would dry, the beds were used for cultivating rice. Another system of irrigation was the pat system in which the specificity of the terrain was taken into account and water was engineered to flow from swift flowing hill streams into channels. This was possible due to the presence of gullies and ravines in the area. Stone check dams called bandhas were built across streams and gullies to capture the monsoon run-off for irrigation. These check dams also helped in increasing the fertility of the soil by facilitating silt deposition due to the checked water. *Chandela tanks* are unique reservoirs of the region which get their name from their origin during the rule of the Chandela kings. The main structure used to be earthen embankments supported by partitions made of rough stones. These were built to catch rainfall run-off flowing through gullies as streams. These tank structures have a width of 60m or more and have survived so many centuries since they are constructed with lime and mortar. The only problem which these tanks are facing is siltation of tank beds. The region also has bigger more elaborate *Bundela tanks* with a flight of stairs leading to the water. They were symbols of power and glory of royalty and were usually accompanied by orchards and other grand decorations. They were costlier to build than Chandela tanks and maintenance was also expensive.

Figure 15 : One of the largest tanks built by Chandela rulers in Belatal, Jaitapur Block of Mahoba

Jhansi is the “Gateway of Bundelkhand” and is an important destination of the bundelkhand region. Its greatest claim to fame is huge water harvesting ponds of the period of bundela and Chandelas. These have been encroached upon and demolished by the local and/or influential people. The Government can not solve entire problem; it is ultimately up to the people to become familiar with their local water resources. Trees and plants should be preserved now in order to prevent soil erosion and promote infiltration of water into the soil and ultimately, the aquifers. Civil society institutions need to be educated and strengthened to respond to water quality problem quickly. This is possible through better knowledge and information about the nature of the ground water contamination, potential sources of threats to ground water quality in their region and degree of vulnerability, the ill effects of using contaminated water and the possible preventive measures.

However the original irrigation systems have been largely ignored for the last couple of decades as a result of the emergence of green revolution that swept the whole country, with its associated surge in the implementation of bore wells and submersibles. This has resulted in water being abundantly extracted without appropriate counter-mechanisms to recharge the removed water. The traditional Chandela and Bundela tanks have been largely neglected and population has encroached on these structures. There needs to be proper and scientific exploitation of water from rivers to help rural areas located near rivers and renovate the thoroughly neglected canal system. There is a huge scope for improving available water resources by proper repairing of these tanks; as well as provide employment to the rural population through the restoration of these structures and construction of check dams.

Other examples of traditional wisdom are windbreaks, made of trees or stones and built at right angles to the prevailing winds or as obstacles at an angle to the wind so as to force it to change direction for simply spreading water on land after ploughing; this stabilizes the fertile components of the soil by increasing soil cohesion. In traditional cultivation methods, crop production and fertility of soil is improved by application of ash to plants, application of dilute urine to plants and seeds in order to clean them and give protection against diseases and pests; and harvesting of spontaneous fodder and burning of land to promote re-growth. One should remember Native American Proverb "We do not inherit the earth from our ancestors; we borrow it from our children".

Figure 16: Traditional well with steps used for drinking water purposes.

5.2 Mitigation Activities and Development

The Bundelkhand region is lagging behind in terms of development, human, social, economic and environmental indicators as compared to other agro-ecological zones of the UP and MP state (source: Report On Drought mitigation strategy for Bundelkhand region of Uttar Pradesh and Madhya Pradesh, Inter-Ministerial Central Team, nraa.gov.in). The tables below showcase the development scenario in Bundelkhand. As per the planning Atlas of UP, the Bundelkhand districts are among the least developed in the state. The Human Development report further brings out the low level of development in the region across both the states.

Table 13: Comparative development of Bundelkhand and other districts of Uttar Pradesh based on scoring of 36 indicators. (Source: Planning Atlas Uttar Pradesh, 2007)

Development Category And Scores	Districts
I) Very High Development: (125 - 388 Scores)	Gautam Buddha Nagar, Gaziabad, Meerut, Lucknow (Western Uttar Pradesh)
Ii) High Development: (105 – 125 Scores)	Jhansi (Bundelkhand)
Iii) Medium Development: (90 – 105 Scores)	Jalaun, Mahoba (Bundelkhand)
Iv) Low Development: (78 – 90 Scores)	Lalitpur, Hamirpur (Bundelkhand)
V) Very Low Development : (Below 78 Scores)	Banda, Chitrakut (Bundelkhand)

Table 14: HDI of UP Bundelkhand, 2005 (source: UP Human Development report, 2007)

S. No	District	Human Development Index
1	Jhansi	0.6214
2	Jalaun	0.6059
3	Chitrakoot	0.5907
4	Mahoba	0.5690
5	Hamirpur	0.5678
6	Banda	0.5456
7	Lalitpur	0.5345

Table 15: HDI of MP Bundelkhand, 2005 (source: MP Human Development report, 2007)

S. No .	District	Human Development Index
1	Damoh	0.571
2	Sagar	0.563
3	Datia	0.550
4	Panna	0.479
5	Tikamgarh	0.459
6	Chattarpur	0.451

5.3 Development Schemes in Bundelkhand

For mitigating the impacts of drought and improving the livelihoods and overall well being of the people, the Central and State Governments have implemented several schemes in the region, and various activities and interventions are facilitated by the involvement of Panchayati Raj Institutions, NGOs and other non-profit organizations. Although Bundelkhand districts were not covered under the major programmes on disaster risk management, i.e., GOI-UNDP programmes like Disaster Risk Management Programme (2002-07) and Disaster Risk Reduction (2008-12), there are several programmes and schemes having provision for vulnerability reduction and drought and flood proofing are implemented in these districts. A detailed mapping of the exiting development programmes and their implications on reducing the impacts of drought, i.e., drought mitigation value has been carried out and is given as following.

5.3.1 Bundelkhand Package

Government of India had constituted an Inter-Ministerial Central Team during December 2007 with Dr. J. S. Samra, Cheif Executive Officer of the National Rainfed Area Authority as its Chairman, for suggesting integrated drought mitigation strategies in Bundelkhand region of Uttar Pradesh and Madhya Pradesh states. Based on the report of the Central Team, the Central Cabinet in its meeting held in November 2009, approved a special package for implementing drought mitigation strategies in Bundelkhand region at a cost of Rs. 7266 crore comprising Rs.3506 crores for Uttar Pradesh and Rs. 3760 crores for Madhya Pradesh, to be implemented over a period of 3 years starting 2009-10. It was envisaged to provide an Additional Central Assistance (ACA) to the tune of Rs. 3450 crore for implementation of the package. The share of Uttar Pradesh and Madhya Pradesh in ACA was envisaged to be Rs. 1596 crore and Rs.1854 crore respectively. The balance cost of the package was provisioned to be met by converging resources from ongoing central sector and centrally sponsored schemes. Further, keeping in view of the demand from the Minister of State in the Ministry of Rural Development and other Members of Parliament from Bundelkhand, the Government on 19th May 2011 approved an Additional Central Assistance of Rs. 200 crore (Rs. 100 crore each for the State Governments of Uttar Pradesh and Madhya Pradesh) a component to provide drinking water in the Bundelkhand region. Government of India approved the continuation of the Bundelkhand special Package during the 12th Plan period (2012-2017) under the Backward Regions Grant Fund (BRGF) with a financial outlay of Rs. 4400 crore. Till November 2012, NRAA have received confirmation for completion of works worth Rs. 179 crore out of Rs 1,005 crore allocated. This amounts to only 18% of the total allocated fund. Progress as on 31 March 2013 indicates that MP and

UP Percent of expenditure against total ACA Allocated is 58.4% and 43.89 only. Rupees 1,400 crore is allocated for the financial year 2013-14 under the package. Out of this, UP will get Rs 690.25 crore while Madhya Pradesh will get Rs 527.57 crore.

A special project for forest areas in Bundelkhand was implemented for the time period 2009-2010 and 2011-2012. Soil moisture and water conservation work was proposed in forest areas of different watershed catchment area of the region. Under the package a total of 60,000 Ha forest land identified for treatment. The main component of the project was soil and water conservation works. The main purpose of such works is in-situ moisture conservation, conservation of ground water and more availability of water for agricultural and other use by various village communities. This involved construction of water harvesting structures, check dams, gully plugs, contour and graded bunds, contour trenches, and field bunding.

Under the package, the process for forest regeneration was also promoted, since the Bundelkhand forest area has very good root stock. Simply protecting the area with assisted planting can help natural regeneration of locally found species like Kardhai, Dhak, Tendu, Teak etc. The main basis of this project component was the ever increasing demand for forest produce such as fuel wood, small timber, fodder and MFPs. The shortage of water for irrigation and essential community needs was to be addressed by proper soil & water conservation practices and ensuring maximum tapping of rain water by surface storage & recharging and intensive soil & moisture conservation, and putting least pressure on forest biodiversity. The project also tends to ensure the participation of forest dwellers & particularly women for their strengthening.

The project aims to restore ecological balance by harnessing, conserving and developing natural resource like soil, water and forest and improve the ecosystem by checking soil erosion and deforestation. Forest products like fodder, fuel-wood and small timber would be improved to provide alternative employment. The productivity of agricultural land could be improved by an increase in the soil moisture regime of the water sheds. The project also aims at empowering the local community to manage natural resources using traditional knowledge (Source: forest.up.nic.in: Special Project for Bundelkhand Region 2009-10 To 2011-2012). Table 4 depicts the progress in implementation of Bundelkhand Package till March 2013.

Table 16: Physical Progress of various activities under Bundelkhand package as on 31.12.2012

UTTAR PRADESH Physical Progress of activities under Bundelkhand Package					
Sl No.	Component	Unit	As on 31.12.2012		
			Target	Achievement	% Achievement
A	**Water Resource Sector**				
1.	Command Area Development of Rajghat Project	Hectares	69,500	39,140	56.32
2.	Betwa Gursarai Canal System	Hectares	27,000	20,570	76.19
3	Numbers	39	8 complete, 22 under progress and 11 in process of sanction		
4	Repair of Lift irrigation schemes	Numbers	1	1	100.00
5	Changing Pump sets	Numbers	3	3	100.00
6	RRR of water Bodies	Numbers	28	18 complete, 10 under progress and 11 not yet sanctioned by GOI	
7	HDPE Pipe distribution	No. of Beneficiaries	17,751	17,569	98.97
8	Reconstruction of water bodies		21 works	0	
B	**Watershed Management Sector**				
I	IWMP Projects				
1	DPR Preparation	Numbers	130	77	59.23
2	Entry Point Activities	Numbers	2,928	2,799	95.59
3	Watershed Development works	Hectares	4.51 Lakh ha		
II	Other Activities				
1	Construction of New dug wells/ blast wells	Numbers	8,834	3,219	36.44
2	Recharge of dug wells/tanks/ ponds	Numbers	30,864	5,442	17.63
3	Renovation of dug wells	Numbers	11,194	2,665	23.81
4	Community tube wells	Numbers	140	Not yet sanctioned	
C	**Forest Sector**				
1	Treatment of forest area for soil & moisture conservation (hectares)	Hectares	60,000	54,246	90.41
D	Agriculture				
1	Construction of warehousing and Marketing infrastructure facility - Development of specialised market yards	Numbers	7	Site finalised in 4 districts. Tender to be issued shortly	
2	Development of Rural Infrastructure Nuclues (RIN)	Numbers	168	Land available is 118 sites. Woprk started in 85 sites	
E	**Animal Husbandry**				
1	Distribution of Goal Units	No. of units	2,560	1,335	52.15
2	Distribution of Murrah Baffalo Bulls	Numbers	410	70	17.07
3	Establishment of fodder Banks	Numbers	3	3	100.00
4	Establishment of AI Centres	No. of Centres	120	120	100.00
F	Dairy Sector				
1	Establishment of Dairy cooperative societies	Number of societies	560	560	100.00
2	Daily Milk collection (kg/day)	Kg/day	59,680	37,427	62.71
G	Rural Drinking Water Supply				
1	Installation of Hand pumps	Numbers	2,725	2,560	93.94
2	Surface water scheme	Numbers	8	4 under progress and 4 not yet started	

MADHYA PRADESH Physical Progress of activities under Bundelkhand Package as on 31.03.2013					
S. No.	Component	Unit	As on 31.03.2013		%
			Target	Achievement	
A	Water Resource Sector				
1	Command Area Development of Rajghat Project	Hectares	22,624	16,500	73
2	New and ongoing minor Irrigation projects (146)	Hectares	50,232	39,479	78
3	Major / Medium Irrigation Projects (1)				
a	Bariyarpur Medium Projects (1)	Hectares	43,850	34,000	78
b	Singhpur Barrage Medium Projects (1)	Hectares	10,200	0	0
4	Canal Renovation (3)	Hectares	24,391	83,926*	
B	Watershed Management Sector				
I	IWMP Projects				
1	DPR Preparation	Numbers	57	41	72
2	Entry Point Activities	Numbers	245	297	121
3	Watershed Development works	Hectares	3,31,000	32,000	9
II	Other Activities				
1	Construction of Stop dams	Numbers	353	161	46
2	Distribution of Water lifting devices (pump sets)	Numbers	45,000	28,219	62
C	Forest Sector				
1	Treatment of forest area for soil & moisture conservtion	Hectares	2,00,000	1,00,000	50
D	Agriculture				
1	Construction of warehousing and Marketing infrastructure facility	Numbers	110	120	109
		Capacity (MT)	6.46 lakh	6.46 lakh	100
2	Development of mini markets run by the PACS	Numbers	27	23	85
E	Animal Housbandry				
1	Distribution of Goat Units	No. of units	5,061	2,598	51
2	Distribution of Murrah Buffalo Bulls	Numbers	2,434	930	38
3	Establishment of fodder Banks	Numbers	3	3	100
4	Establishment of AI Centres	No. of Centres	225	110	49
F	Dairy Sector				
1	Establishment of Dairy cooperative societies	No. of societies	500	561	112
2	Bulk Milk coolers	Numbers	9	10	111
3	Daily Milk collection (kg/day)	Kg/day	25,000	34,538	138
G	Rural Drinking Water Supply				
1	Supply through Tubewells/dugwells with Power pumps and cisterns	Numbers	1,288	668	52

(*Source*: NRAA progress report for Bundelkhand Package)

*63,926 Ha. Irrigated outside Bundelkhand area because of Rajghat canal renovation.

However, since Bundelkhand Package was announced in 2009, it has been marred with controversies. The package was meant for the comprehensive development of the Bundelkhand region spread across seven districts in Uttar Pradesh and six districts in Madhya Pradesh. Massive portion of the funds was to be allotted for the already existing schemes of watershed management, irrigation, drinking water, animal husbandry and environment. The progress of the package has been rather slow and it has become a battlefield for many political wars fought between different parties. The main problem lies in shoddy monitoring of the development work and improper expenditure of funds. It can be assumed that there had been a lack of co-ordination between the local and central authorities.

5.3.2 Other Projects and Schemes

A stock of other projects in the Bundelkhand districts were also been taken. Many of the programmmes listed below are completed or integrated with Bundelkhand package.

5.3.2.1 SWAJAL and Swajaldhara

In 1996, when the SWAJAL project was started in the Bundelkhand and the hill districts of the then undivided UP, with support of the World Bank, a paradigm shift in both approach and institutional structure was initiated to facilitate integrated service delivery that included drinking water, sanitation and hygiene promotion, effective community participation and long term sustainability of facilities, services and the overall sector in terms of effective policies and institutions. SWAJAL also envisaged setting into motion the decentralised process as envisaged in the 73rd Constitutional Amendment. The Village Water and Sanitation Committees at the community level were the key institutions under SWAJAL project. Initially the project implemented remained delinked from the constitutionally mandated Gram Panchayats (GPs), but later these committees were brought within the scope of GPs through a Government order. However, although this initiative has taken outside the constitutional framework.

'SWAJALDHARA' project was launched on 25 December 2002, to scale up the reforms in rural drinking water sector. Swajaldhara-1 provides a choice for any village to participate in the reform programme directly. Swajaldhara-2 provides scope for an entire district to participate in the reform programme if more than 50% of its villages in the district are ready to participate in the reform programme. For this, the respective State Government has to enter into an MoU with the Central Government. For both the schemes the Central Government funds will be routed through the State Government and an identified District Implementation Agency (DIA). This project was implemented in 356 villages covering all the seven districts of Uttar Pradesh Bundelkhand. Swajaldhara is also implemented in few villages of MP Bundelkhand districts, viz., Datia, Damoh and Tikamgarh.

Table 17: District wise list of villages in Bundelkhand where Swajal/ Swajaldhara project implemented (till Sep 2003).

S No	District	Total No. of Villages	Work Completed
1	Jhansi	58	58
2	Jalaun	100	100
3	Lalitpur	52	52
4	Mahoba	42	42
5	Chitrakoot	56	56
6	Banda	15	15
7	Hamirpur	33	33
	Total	356	356

Source: http://swsmup.org/?page_id=118

5.3.2.2 Total Sanitation Campaign (TSC)

TSC is a demand-driven programme that gives cash incentives to poor rural households for construction of toilets and children friendly toilets in Anganwadis. It also gives a 60% grant for construction of community toilets and toilets in schools; the rest of the money has to come from the state government and village communities. Scores developed based on benchmarks of implementation till March 2010 published in 'A Decade of the Total Sanitation Campaign: Rapid Assessment of Processes and Outcomes" by Ministry of Rural Development, Department of Water and Sanitation and World Sanitation Programme of World bank, clearly indicates the poor implementation of Total Sanitation Campaign across all districts of Bundelkhand Region.The score is below average in 5 out of 13

Bundelkhand districts and none of the districts have above average score (see Table 14).

Table 18 : Performance Benchmarking of Districts (March 2010)

<25 Below Average   26-29 Average   50-74 Above Average

State	District	Score Color
Uttar Pradesh	Mahoba	19
	Chitrakoot	21
	Hamirpur	23
	Jalaun	29
	Jhansi	31
	Lalitpur	31
	Banda	33
Madhya Pradesh	Damoh	18
	Tikamgarh	21
	Panna	21
	Chhattarpur	28
	Datia	31
	Sagar	39

(*Source*: www.wsp.org/sites/wsp.org/files/publications/WSP_India_TSC_Report_Vol_2_Press.pdf)

5.3.2.3 National Watershed Development Project for Rainfed Areas (NWDPRA)

The National Watershed Development Project for Rainfed Areas (NWDPRA) was launched in 1990-91 in 25 States and 2 Union Territories based on twin concepts of integrated watershed management and sustainable farming systems. During IX Plan, the scheme was extended to 3 newly formed States of Uttaranchal, Jharkahand and Chhattisgarh. Under the centrally sponsored NWDPRA scheme, Ministry of Agriculture, Government of India has accorded high priority to the sustainable integrated farming systems of rainfed areas on watershed basis through National Watershed Development Project for Rainfed Areas [NWDPRA]. The development efforts are concentrated on both arable and non-arable lands including treatments of natural drainage lines. The watershed approach represents the principal vehicle for transfer of rainfed agriculture technology. The National Agriculture Policy seeks to promote the integrated, holistic and harmonious development of rainfed areas through the conservation of rainwater and soil and augmentation of biomass production through agro and farm forestry with the active involvement of the watershed community. The project aims at in-situ moisture conservation primarily through vegetative measures to conserve rainwater, control soil erosion and generate the green cover both on arable and non-arable lands. The scheme is implemented at the field level by an inter-disciplinary team of members from line departments of state government and the beneficiaries of the watersheds. Several districts of Bundelkhand are covered under this programme. Monitoring and evaluation report of 7 watersheds covering 5 districts (Junginala Watershed in Damoh, Sasoornala, Kalapaninala, amd Chirgaon Watersheds in Jhansi, Jhakora Watershed in Lalitpur, Mau Watershed in Chitrakoot and Kuthod Watershed in Jhalaun) of Bundelkhand are available online on websites. These projects brought out 10-25% improvement in the watershed areas during the 8th and 9th Plan period. General increase in biomass and water bodies was observed in all the watersheds. Increase in employment opportunities, ground water level, productivity of paddy and groundnut and improvement in general socio-economic condition were observed in the impact areas. Under the Household Production Scheme for Landless Labourers, improved adaptation towards blacksmith, carpentry, basket and rope making was also evident. Cropping intensity increased and ground water conditions was improved in Damoh districts and migration was found to be reduced as compared to previous times.

(*Source:http://*www.intranet.icrisat.org/gtaes/projects/ca_watersheds/-NWDPRA/UP_ph02.htm).

5.3.2.4 Integrated Wasteland Development Programme (IWDP)

The Integrated Wasteland Development Programme (IWDP) of the Government of India was started in 1989-90 and aimed to develop government-owned wastelands and common property resources (CPRs), on the basis of village-level or micro-watershed plans. Chattarpur, Damoh, Datia, Tikamgarh, Sagar and Panna districts of Madhya Pradesh part of Bundelkhand are covered under the IWDP programme.

5.3.2.5 Drought Prone Areas Programme (DPAP) (1995-2006)

The basic objective of the programme is to minimize adverse effects of drought on production of crops, livestock and productivity of land, water and human resources, and thereby ultimately leading to drought proofing of the affected areas. The programme also aims to promote overall economic development and improving socio-economic conditions of the resource poor and disadvantaged sections inhabiting the programme areas. Coverage upto 1994-95, DPAP was in operation in 627 blocks of 96 districts in 13 States. DPAP seeks to reduce effects of drought by funding projects for developing watersheds, water resources and pastures/ afforestation projects in identified 'drought prone' blocks. The DPAP list includes Development Blocks of Jalaun, Banda, Chitrakoot, Hamirpur and Mahoba districts of UP Bundelkhand, and Panna and Damoh districts in MP Bundelkhand.

5.3.2.6 Integrated Watershed Management Programme (IWMP)

IWPM is a modified programme of erstwhile Drought Prone Areas Programme (DPAP), Desert Development Programme (DDP) and Integrated Wastelands Development Programme (IWDP) of the Department of Land Resources. This consolidation is for optimum use of resources, sustainable outcomes and integrated planning. The scheme was launched during 2009-10. The programme is being implemented as per Common Guidelines for Watershed Development Projects 2008. The main objectives of the IWMP are to restore the ecological balance by harnessing, conserving and developing degraded natural resources such as soil, vegetative cover and water. The outcomes are prevention of soil erosion, regeneration of natural vegetation, rain water harvesting and recharging of the ground water table. This enables multi-cropping and the introduction of diverse agro-based activities, which help to provide sustainable livelihoods to the people residing in the watershed area. IWMP is implemented in all the 7 districts of UP Bundelkhand and 6 districts of MP and now integrated with the Bundelkhand Package.

5.3.2.7 Artificial Recharge to Groundwater through Dug Wells (ARGTDW)

ARGTDW supports recharging groundwater resources by collecting rain water and diverting it to existing open wells that are dry or almost dry. Artificial Recharge To Groundwater Through Dug Wells (ARGTDW) supports recharging groundwater resources by collecting rain water and diverting it to existing open wells that are dry or almost dry. Recharge pits with desilting chambers have to be constructed near the open well; desilted water is led from the pit to the bottom of a well by a PVC pipe. The total cost involved is estimated to be Rs 4000 per installation. The Central government provides a 100% subsidy for construction of these structures to small and marginal farmers who have lands in 'over-exploited', 'critical' and 'semi-critical' blocks; the last category of blocks are found in Tikamgarh, Chhatarpur and Datia districts. The subsidy is provided through NABARD. (Source: http://www.apnabundelkhand.com and field data obtained from Datia and Tikamgarh Districts).

5.3.2.8 Accelerated Rural Water Supply Programme (ARWSP)

The basic objective of ARWSP (Accelerated Rural Water Supply Programme) launched in 1972-73 was to supplement the efforts of the State Governments in providing safe and potable drinking water to rural habitations on a long-term basis. This programme continued till 1973-74. But with the introduction of the Minimum Needs Programme (MNP) during the Fifth Five Year Plan (from 1974-75), ARWSP was withdrawn. The programme was, however, reintroduced in 1977-78 when the progress of supply of safe drinking water to identified problem villages under the MNP was not adequately focused.

5.3.2.9 Backward Region Grant Fund (BRGF)

The Backward Regions Grant Fund is designed to redress regional imbalances in the development. The fund is envisaged to provide financial resources for supplementing and converging existing developmental inflows into 250 identified districts, so as to (i) bridge critical gaps in local infrastructure and other development requirements that are not being adequately met through the existing inflows, (ii) strengthen, to this end Panchayat and Municipality level governance with more appropriate capacity building, to facilitate participatory planning, decision making, implementation and monitoring, to reflect local felt needs, and (iii) provide professional support to local bodies for planning, implementation and monitoring their plans. BRGF, set up in 2006 under the Union ministry of Panchayati Raj, provides a good opportunity to identify challenges and opportunities in backward districts and make realistic plans with involvement of people and elected representatives up to the district level. Chattrarpur, Damoh, Panna and Tikamgarh districts of MP and 6 districts of UP Bundelkhand (except Jhansi) is covered under this scheme.

5.3.2.10 Rashtriya Krishi Vikas Yojana (RKVY)

RKVY, launched in 2007, provides ‘additional central assistance’ to Central Government and state schemes related to agriculture. Among the projects funded by RKVY is region-specific agriculture research and preparation of district agriculture plans, taking into account local needs and conditions. (Source: Bundelkhandinfo.org)

5.3.2.11 Integrated Child Development Services (ICDS)

ICDS aims to provide supplementary nutrition, health care and pre-school education to the children below the age of six years. Under a Supreme Court order of December 13, 2006 in the Right to Food case, all settlements that have at least 40 children under the age of six have to set up ANGANWADIS within three months of the rural communities and slum dwellers making such a demand.

5.3.2.12 Mid-day Meal Scheme

The Mid-day Meal scheme is the result of order of the Supreme Court in the Right to Food case (November 28, 2001), directing state governments to provide cooked mid-day meals in all government and government-assisted primary schools.

5.3.2.13 Swarnajayanti Gram Swarozgar Yojana (SGSY)

SGSY is meant to promote entrepreneurship among the rural poor by organizing them in self help groups (SHGs), and providing income-generating assets through a mix of bank credit and government subsidy, so that the poor rise above the poverty line. The central government provides 70% of the funds for implementation of the scheme in a state; the state government provides the rest.

5.3.2.14 Indira Awas Yojana (IAY)

IAY provides a grant of up to Rs. 20,000 to the scheduled caste and below poverty line (BPL) households for construction of houses, or improving their kaccha dwelling units.

5.3.2.15 Sarva Shiksha Abhiyan (SSA)

SSA aims to provide useful and relevant elementary education for all the children in the age-group of 6-14 years, bridging social, regional and gender gaps, and with the participation of communities in management of schools. It also supplements resources for building elementary education infrastructure.

5.3.2.16 Urban Infrastructure Development Scheme for Small and Medium Towns (UIDSSMT)

UIDSSMT partially helps small and medium towns get over chronic resource problems. UIDSST provides funds for water supply, sewage and solid waste management schemes; re-development of old congested areas and construction of roads and parking spaces. The central government provides 80% of the funds for projects appraised by a state-level implementing agency.

5.3.2.17 Pradhan Mantri Gram Sadak Yojana (PMGSY)

PMGSY provides 100% funds for constructing all-weather roads to unconnected habitations in rural areas. The scheme also funds construction of necessary culverts and drainage structures

5.3.2.18 National Food Security Mission (NFSM) is in operation in 27 states of the country. National Food Security Mission-Rice (NFSM-Rice), National Food Security Mission-Wheat (NFSM-Wheat) and National Food Security Mission –Pulses (NFSM-Pulses) are being implemented in Bundelkhand Region as well. The key objectives of this mission include increasing production of rice, wheat and pulses through area expansion and productivity enhancement, Restoring soil fertility and productivity at the individual farm level, creation of employment opportunities and enhancing farm level economy (i.e. farm profits) to restore confidence amongst the farmers etc.

5.3.2.19 Mahatma Gandhi Rural Employment Guarantee Scheme (MNREGA)

The Mahatma Gandhi National Rural Employment Guarantee Scheme aims to guarantee the 'right to work' and ensure livelihood security in rural areas by providing at least 100 days of guaranteed wage employment in a financial year to every household whose adult members volunteer to do unskilled manual work. Ministry of Rural Development issued guidelines detailing the strategy for convergence, including representatives from Ministry of Water Resources, Ministry of Environment and Forests, Department of Land Resources, Ministry of Agriculture, Ministry of Human Resources, Ministry of Women and Child Development etc. Two fold convergence approach is adopted i.e. through planning; the other through programmes and activities. Under the MANREGA the following types of activities were carried out for providing employment to both skilled and unskilled laborers. Activities include Rural Connectivity, flood control and protection, water conservation and harvesting, drought proofing including afforestation, micro-irrigation works, provision of irrigation facility to land owned by SC/ST& IAY allotees, renovation of traditional water bodies, land development including plantation etc. Most of the activities under MNREGA are integrated with activities under Bundelkhand package.

5.4 Agroforestry

Rainfed agriculture is gamble in this region because some times either low rainfall or long dry spell during the crop growth periods or high rainfall for a short period creates water logging. In both the situation, crop simply fails. To overcome the above problem, appropriate use of land, water and livestock in integrated manner through Agroforestry system has been found to be suitable in creating livelihood, employment generation for pro poor people under environmental stress condition. Agro forestry is one of the most viable alternative land use systems for degraded lands for maximum sustainable productivity (fuel, fodder and food), while preserving the environment. It is defined as an integrated, self-sustaining land management system which involves deliberate introduction or retention of woody components including trees, shrubs, bamboo etc. It is fast emerging as an integrated system which is capable of yielding both wood and food (for man and livestock) and at the same time conserving and rehabilitating the ecosystem. Agro forestry systems fulfill both productive and service roles and have great potential for higher and sustained crop production and farm income. Properly applied, it is a system which is productive, protective and environmentally sound and has the potential not only to increase food, fuel, and income for the marginal farmers, but also to help stop degradation of land and forests.

In terms of statistics India is estimated to have between 14,224 million and 24,602 million trees outside forests, spread over an equivalent area of 17 million ha, supplying 49% of the 201 million tonnes of fuelwood and 48% of the 64 million m^3 of timber consumed annually by the country. The Forest Survey of India has estimated that 2.68 billion trees exist outside forests over an equivalent area of 9.99 million ha. More recent estimates suggest that an equivalent area of 92,769 km^2 (2.82% of the geographical area) is under tree cover in India. Haryana is one state whose statistically analyzed data is available in this context. With merely 3.5 % of area under forests, the state has become self-sufficient in small wood, fuel-wood and industrial timber by establishing large-scale plantations on farmlands. Trees in agro-ecosystems have increased the extent of area under forest and tree cover to 6.63 percent. (Source: Multifunctional Agroforestry Systems in India: Science-Based Policy Options, RSPCB report, Singh and Pandey, 2011)

The types of Agroforestry suitable for Bundelkhand are:

(i) Agri-silviculture

It is possible to grow up to 800 trees per hectare, without significantly reducing the crop yield in the initial years. Even in the fourth year, by annual pruning and reducing the number of trees by 40 percent, (from 800 to 480 trees per hectare), the relative crop productivity could be maintained above 85 % level in the case of wheat and gram. The reduction in yield is more than compensated by the additional income in the form of fuel-wood and fodder.

(ii) Agro-horticulture

In Bundelkhand, this system revolves around the cultivation of improved varieties of ber *(Zizyphusmauriitiana)*, amla *(Emblicaofficinalis)* and kinnow *(Citrus reticulata)*.

(iii) Agri-horti-silviculture

In this system, in addition to arable crops, MPTS (Multi-Purpose Tree Species) like subabool are grown along with fruit trees like ber and amla.

(iv) Silvi-pasture

Silvipastoral system is an ideal combination of grasses, legumes, shrubs and trees and where livestock are either stall-fed or managed under rotational grazing. (Source: devalt.in)

A major difficulty for agroforestry practices is to choose a proper sustainable tree mixture. The major factor to consider while deciding on the selected species is root-competition. The differences in functional group composition have quite an effect on the ecosystem. Proper implementation of agroforestry systems, needs decentralized and region specific planning.

The severe drought in the country requires a contingency plan for meeting the needs of vast populations of humans and the animals. While, the requirements of grains for the human consumption can be met during the period, animals are likely to suffer due to non-availability of fodder and crop residues. Due to the failure of crops and uncertainties of the monsoon, it is of utmost importance to emphasize growing of fodder crop even if there is slight availability of moisture so that, the animals do not suffer and they should survive. IGFRI prepared strategy to Drought combat wirh drought for perennial grasses, grasslands and fodder crops in the country and proposes the technologies, varieties and feeding management to meet the demands.

Strategy to combat with drought for perennial Grasses & grasslands

If rain comes during August 1 - 10	• Interculture of grass areas for better growth • Top dressing of N in 2-3 split doses @ 20-25 kg N/ha with the monsoon pattern • Increased use of top feed resources like *Leucaena lucocephala* for feeding
August 11 - 30	• Interculture of grass areas for better growth • Top dressing of N in 2-3 split doses @ 20-25 kg N/ha with the monsoon pattern
September 1 - 15	• Interculture of grass areas for better growth • Increased use of top feed resources like *Leucaena lucocephala* for feeding
September 16 - 30	• Interculture of grass areas for better growth • Top dressing of N in 2-3 split doses @ 20-25 kg N/ha with the monsoon pattern • Increased use of top feed resources like *Leucaena lucocephala* for feeding

Feeding Strategy for Livestock during Droughts

The feeding strategy for livestock during drought should aim to optimize the efficiency of utilization of available feed resources. The approach should be to supply feeds rationally in such a manner that provides essential nutrients to maintain the physiological function of livestock and also to protect their productive traits.

Approaches:

(i) Maximum exploitation of dry roughages – available *kadbi* in chopped form and enrichment thereafter.

(ii) Use of unconventional feed resources –

  (a) Tree leaves like Bargad, Pipal, Gular, Shisam, Bamboo, Mulbery, Ardu, Subabul, Dhaman etc.

  (b) Use of kitchen waste- mixing with dry fodder.

  (c) Use of sugarcane bagasee and food industry by products.

  (d) Riverbed and fallow land grazing of livestock.

(iii) Use of crop residues: Crop residues such as straw, paddy straw, maize/sorghum stover, residue from oilseed crop and pulses.

(iv) Resurgence in fodder-agronomic practices – The legume fodder crop like Sesbania, subabul, *Egyptica*, *Desmanthus* etc. can be propagated on all waste lands. Canal banks, hillock slopes and field boundaries.

(v) Use of Fodder enrichment technologies:

  (a) Straw/stover treatment with urea and molasses. Use of 2 kg fertilizer grade urea to dissolve in 10 lit. of water, then mixed 10 kg molasses. This mixture is sprayed over the Straw and Stover (100 kg) and allowed to remain in sunlight for a while. The treated Stover may be given @ 4-5 kg/animal/day.

  (b) Alkali treatment of fodder: Alkali like sodium hydroxide, calcium hydroxide and ammonium hydroxide may be used @ 2% with molasses. Treated straw can be fed @ 5-6 kg/animal/day.

  (c) Use of Common salt: Straw soaking with 1% common salt solution and sun dried for a while.

(d) Use of non-toxic fungi for straw treatment.

(e) Use of Urea molasses mineral blocks.

(f) Use of complete feed blocks from unconventional roughages or Straws.

(g) Mineral and Vitamin supplementation with available feeds. (www.igfri.res.in)

Integrated Natural Resource Management: An approach for Sustainable Livelihood

Bundelkhand has been facing severe water scarcity over the last many years, affecting the agriculture production. Even so, farmers continue to practice traditional and rudimentary cropping patterns. Looking at the fluctuation in climatic conditions and to fulfil the need of the farmers, an agro forestry based farming system was initiated with 50 farmers in 10 villages. Aonla (*Emblica offcinalis*) and Kanchan were introduced in existing cropping system at the spacing of 8*8 between plants and rows. Aonla, a very hardy tree, can survive in 48° C temperatures and also tolerate hot winds as well as frost. It can be grown in marginal lands under rain fed conditions with an annual rainfall of 500 -1100 mm. In Kachhipura village, farmers adopted the Aonla based agro forestry system with vegetables as an under story crop. These farmers used to cultivate the Desi variety (Utkal) of brinjal but this year they have shifted to its high yielding variety. During the fourth year of plantation, Aonla will start fruiting and give around 450 kg/ha (worth approx Rs 9000) and in the seventh year, the yield will be around 3500 kg/ha (Rs 70,000), which will be a welcome additional income to the farmers. The saplings planted at the boundaries as biofencing will act as a barrier in the future and also yield a produce. The same kind of model was adopted by the farmers of Hastinapur, Rundrakarari, Bamhori Sheetal, Bagan, Richari, Vijaypur and Sarmau villages. The maximum rainfall (around 800 mm) occurred from June 15 to July 20 and decreased amount of rain was anticipated during August and September. Keeping this issue in mind, low water requirement and low input cost crops were promoted to reduce the risk faced by the farmers. The 30 farmers of Bilt villages decided to cultivate a low water intensive crop (Lentil) during the Kharif season. Although the rainfall during the year 2008 has been above average, the underground water is not adequately recharged. The agro forestry system and alteration in cropping patterns as per the existing weather conditions is a sustainable option in improving the livelihood as well as creating employment opportunities for the rural underprivileged people of Bundelkhand region (Rai, 2008).

5.5 Alternative Employment

Bundelkhand region faces extreme levels of poverty and environmental damage. Even though the region is abundant in minerals, rivers and some of the areas record adequate rainfall, it is still continuously ravaged by drought, and social issues such as unemployment, suicides and large scale migration. Some natural resources specially forests and mining areas are being arbitrarily exploited by a few at the expense of the common public, while tribal and marginal farmers who depend on forest products for a livelihood face depletion of resources and livelihoods. During the green revolution phase, Bundelkhand followed the rest of the country in emulating an intensive agricultural development approach based on promoting irrigation. This strategy adversely affected farming systems since Bundelkhand did not have adequate ground water level to sustain submersibles, deep boring tube wells and water pumps.

There is clearly need to improvise and devise other ways of proper sustenance, radically different from the existing one. There need to be a thorough analysis of the existing strategies and working out the nitty-gritty's of suitable policies which can be effectively implemented, since the root of the problem lies not only in implementation but also in framing of the relevant policies. There needs to be suitable action for protection of environment chiefly of farmland, pastures, forests, water-sources and air since they are the main sustenance of life and livelihood. Most of all there is need for alternative planning of employment strategies that can supplement direct incomes from agriculture.

Both on-farm and off-farm alternative employment opportunities exist in rural Bundelkhand as seen from numerous examples of income generation government and NGO projects. These opportunities range from handloom weaving, vermi-composting, handmade paper manufacture, to employment in new types of watershed management activities or construction of bio gas plants. The availability of adequate quality feed and fodder is of primary importance for development of livestock in the region and building fodder banks is especially suited for this region. For this specific purpose, dry fodder (Bhusa) & Hay can be procured at post harvesting time on prevailing reasonable price and can provide some financial respite to the locals in the area. Alternate employment strategies can also include agricultural variations like growing oats and jatropha which can withstand dry conditions. Oats crop gives a good output and the average yield varies from 45 to 55 tons of green fodder per hectare. Although the maximum yields are usually not achieved until sufficient lime is added to bring the soil pH upto 5.3-5.7 range, the oat cereal can supply superior and nutritious forage for a long duration. The good quality protein and nutritional components are suitable for maintaining animals and increasing milk production.

Another plant which can be a source of alternative employment in a semi arid region like Bundelkhand is the *Jatropha curcas*. This plant grows nearly at any place with gravelly, sandy and stony soils, and hence is suitable for development of wastelands like Bundelkhand. The plant can grow in almost xerophytic condition and requires minimum water. The seeds conveniently germinate in almost nine days and the plant can stand long periods of drought and has high resistance to pests. After processing the seeds, the oil is used for manufacture of soap, lubricants and dyeing chemicals, and as 'biofuel'. Jatropha oil seed cake obtained after extracting oil, has potential as an organic fertilizer and as organic pesticide. There is much employment potential in planting in nurseries, replantation in fields, regular maintenance activities like pruning, and manual collection of seeds. An indigenous website established by Satish Lele states that the per hectare employment generation in a jatropha plantation is 263 person-days in the first year, and around 50 person-days in the second year.

The Jatropha mission of Uttar Pradesh was launched with much fanfare as a Joint venture of BPCL, Nandan Biomatrics and ShapoorjiPallonji. The programme was to join hands with Panchayats of selected Districts to plant Jatropha on village wastelands. Jatropha seeds were to be bought back by BPCL. Further, the Indian BioFuel Policy announced on 23rd Dec 2009 stated that employment provided in plantations of trees and shrub bearing non edible oilseeds will be made eligible for coverage under the National Rural Employment Guarantee Program (NREGP). The contract farming on private wasteland could also be taken up through the Minimum Support Price mechanism proposed in the Policy. This whole process however lacked speed in implementation due to various problems at different levels. Mainly, farmers need to be given better prices for their endeavor.

There needs to be a revamping of forestry practices so that villagers are encouraged to access minor forest produce without any resistance from authorities. Changes in forestry practices have begun with initiatives such as the Joint Forest Management programmes for afforestation/ plantations on communal village lands; and the Forest Act of 2005 with legal provision for community and individual rights given to tribal and other forest dwellers, to own forest land and extract forest products according to traditional norms. There is however, need for spreading awareness about sustainable collection and opportunities for new use of forest resources and minor forest products to create new means of employment. For instance in Karnataka some tribes have carved out a niche in making toys and furniture out of Lantana, well known as a serious invading alien species. Under Joint Forest Management, in return for unhindered access to sustainable collection of minor forest produce, villagers and their organizations fully cooperated in protecting forests. Often villagers assisted the Forest department and carried out soil and water conservation work, build boundaries and planted trees and herbs. All this is wage-based work in addition to voluntary work to protect trees.

Another very productive venue in building additional employment is the water shed management sector, as seen from the example of Tikariya panchayat area of Chitrakut district. The idea of watershed development comprises a broad multi-disciplinary perspective in which repair and construction of tanks, construction of check dams, soil and water-conservation, and planting of trees are combined with social recruitment of villagers, particularly weaker sections and women and initiation of activities such as micro-finance to promote livelihoods and development in villages.

In conclusion it can be said that an innovative yet cautious and holistic approach in furthering alternative employment is needed for improving/enhancing the socio-economic situation of Bundelkhand.

5.6 Drought Impact Assessment

'Drought impact assessment' is the method used to systematically identify and evaluate the parameters indicating damages and losses to environmental, societal and economic components, thereby affecting availability, capacity, quality, and sustainability of resources in the region, for immediate, short-term and long-term periods. Depending upon the need and time – a Drought Impact Assessment may be Rapid EIA, Comprehensive DIA or an Extended DIA. The latter two are important for strategic planning for dealing with recurrent drought situations in a region.

Drought impact assessment may incorporate two stages:

1. Organizational/expert level assessment

2. Community Level Assessment

The final report may be based on the consolidation of the two in order to offer a balance in opinions. Drought impact assessments begin by identifying direct consequences of drought, such as reduced crop yields, livestock losses, and reservoir depletion. These direct outcomes can then be traced to secondary consequences (often social effects), such as the forced sale of household assets or land, dislocation, or physical and emotional stress. This initial assessment identifies drought impacts but does not identify the underlying reasons for these impacts.

Drought is typically associated with a number of potential impacts. For practical purposes, the drought impacts can be classified as economic, environmental, or social, even though several of the impacts may actually span more than one sector. Using an impact checklist is one easy way to help categorize drought impacts that affect activities.

5.6.1 Economic Impacts

Many economic impacts of drought occur in agriculture and related sectors including forestry and fisheries, because of the reliance on surface and subsurface water supplies. In addition to obvious losses in yields in crop and livestock production, drought is associated with increases in insect infestations, plant disease, and wind erosion. Droughts also bring increased problems with insects and diseases to forests and reduce growth. The incidence of forest and range fires increases substantially during extended droughts, which in turn places both human and wildlife populations at higher levels of risk.

Income loss is another indicator used in assessing the impacts of drought because so many sectors are affected. Reduced income for farmers has a ripple effect. Retailers and others who provide goods and services to farmers face reduced business. This leads to unemployment, increased credit risk for financial institutions, capital shortfalls, and loss of tax revenue for local, state, and federal government. Less discretionary income affects the recreation and tourism industries. Prices for food, energy, and other products increase as supplies are reduced. In some cases, local shortages of certain goods result in the need to import these goods from outside the stricken region. Reduced water supply impairs the navigability of rivers and results in increased transportation costs because products must be transported by rail or truck. Hydropower production may also be curtailed significantly.

5.6.2 Environmental losses

These are the result of damages to plant and animal species, wildlife habitat, and air and water quality; forest and range fires; degradation of landscape quality; loss of biodiversity; and soil erosion. Some of the effects are short-term and conditions quickly return to normal following the end of the drought. Other environmental effects linger for some time or may even become permanent. Wildlife habitat, for example, may be degraded through the loss of wetlands, lakes, and vegetation. However, many species will eventually recover from this temporary aberration. The degradation of landscape quality, including increased soil erosion, may lead to a more permanent loss of biological productivity of the landscape. Although environmental losses are difficult to quantify, growing public awareness and concern for environmental quality has forced public officials to focus greater attention and resources on these effects.

5.6.3 Social impacts

Social impacts mainly involve public safety, health, conflicts between water users, reduced quality of life, and inequities in the distribution of impacts and disaster relief. Many of the impacts specified as economic and environmental have social components as well. Population out-migration is a significant problem in drought affected areas, often stimulated by greater availability of food and water elsewhere. Migration is usually to urban areas within the stressed area or to regions outside the drought area; migration may even be to adjacent countries, creating refugee problems. When the drought has abated, these persons seldom return home, depriving rural areas of valuable human resources necessary for economic development. For the urban area to which they have immigrated, they place ever-increasing pressure on infrastructure, possibly leading to greater poverty and social unrest. The drought-prone northeast region of Brazil had a net loss of nearly 5.5 million people between 1950 and 1980. Although this entire population shift was not directly attributable to drought, it was a primary factor for many people's decision to relocate.

5.6.4 Assessment of direct and indirect damages

1. Direct damages: Direct damages (complete or partial destruction) may be inflicted on immovable assets and on stock (including final goods, goods in process, raw materials, materials and spare parts). In essence, this category consists of damage to assets that occurred right at the time of the actual disaster.

2. Indirect losses: This effect refers essentially to the flows of goods and services –expressed in current values– that will not be produced or rendered over a time span that begins after the disaster and may extend throughout the rehabilitation and reconstruction periods. Convention calls for a maximum five-year time-frame although most losses occur during the first two years. In any case, the estimate of these effects must be extended throughout the period required to achieve the partial or total recovery of the affected production capacity. These indirect losses result from the direct damage to production capacity and social and economic infrastructure. Indirect losses also include disaster-induced increases in current outlays or costs in the provision of essential services, as well

as diminished expected income in cases where these services cannot be provided under normal conditions or at all (which in turn will be reflected in macroeconomic effects).

The assessment must consider that some indirect effects of a disaster might generate benefits to society, instead of damage, costs, harm or losses. Indeed, indirect effects sometimes produce major benefits that can be estimated and must be deducted from the total damage estimate. Disasters also produce some major indirect effects that may be difficult to identify and impossible to quantify. These effects lead to “intangible” damage (or benefits) such as human suffering, insecurity, a sense of pride or antipathy at the way in which authorities have faced the disaster’s consequences, solidarity, altruistic participation, the impact on national security and many other similar factors that have an effect on well-being and the quality of life. The comprehensive effect of a disaster must be included in the final assessment.

Finally, some indirect effects of disasters can be given a monetary value but are very difficult to calculate owing to the limited time available for the assessment. This category of effects includes the estimate of lost opportunities due to the impact of the disaster on the structure and functioning of economic activities, distributive and redistributive effects, losses in human capital represented by victims and so forth.

The assessment must be focused so as not to waste time in quantifications that do not yield applicable results, such as the intangible effects of the disaster on human production capacity, or the indirect effects resulting from how the emergency process was handled, or even certain drastic economic measures that might have been taken.

5.6.5 Methodological considerations

The ultimate goal of the Drought Impact Assessment methodology presented herein is to measure in monetary terms the impact of disasters on society, and the economy and environment of the affected country or region. National accounts are used as a means of valuation, supplemented with procedures for specific estimation such as environmental damages and the differential impact on women. Application of this methodology determines value of lost assets, recognizes affected areas, prioritizes reconstruction necessities and determines effect on the economics of the country due to the drought situation.

Expressed in the simplest terms, impacts may be (a) disaster impact on assets/property (damages); (b) impact on productivity of goods and services (losses); and (c) on the performance of the socio-economic aggregates of the affected country (social effects). For convenience, the term used is damage or loss; however, disasters may also have a positive result. The assessment is therefore aimed at determining the net effect, giving due consideration to both negative and positive results.

5.6.6 Checklist for Drought Impact Assessment

This checklist of the effect of drought can help planners anticipate problems that might arise in future droughts. Many planners find it useful to identify the "drought of record" (the worst ever recorded), examining its actual effects and projecting what the effects would be if the same drought were to occur under current conditions and in the future. It is useful to conduct impact studies based on common droughts, extreme drought(s), and the "drought of record" for the region under study. This would yield a range of impacts related to different degrees of severity for:

H = Historical Drought

C = Current Drought

P = Potential Drought

5.6.7 Impacts of Drought

The key economic, environmental and social impacts of drought are following:

Economic Impacts

1. Costs and losses to farmers due to decline in agricultural productivity
2. Costs and losses to livestock producers
3. Loss from timber production
4. Loss from fishery production
5. Loss to recreation and tourism industry
6. Energy-related effects
7. Water Supplies
8. Transportation Industry
9. Decline in food production/disrupted food supply
10. Disengagement of women from workforce

Environmental Impacts

1. Damage to Biodiversity
2. Hydrological effects
3. Increased intensity and frequency of fires
4. Degradation due to erosion
5. Air quality effects (e.g., dust, pollutants)
6. Visual and landscape quality (e.g., dust, vegetative cover, etc.)

Social Impacts

1. General wellbeing
2. Health
3. Increased conflicts
4. Reduced quality of life, changes in lifestyle
5. Disruption of cultural belief systems (e.g., religious and scientific views of natural hazards)
6. Reevaluation of social values (e.g., priorities, needs, rights)
7. Public dissatisfaction with government drought response
8. Perceptions of inequity in relief, related to socioeconomic status, ethnicity, age, gender, seniority etc.
9. Increased data/ information needs; coordination of dissemination activities.
10. Recognition of institutional restraints on water use

5.6.8 Procedural Framework for Drought Impact Assessment

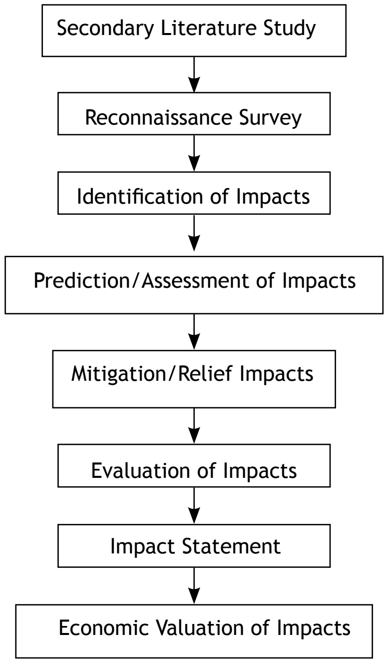


Figure 17: Procedural Framework for Drought Impact Assessment

The key challenges in the drought impact assessment appear during the stages 2 and 3 given in Figure 17 above for the Identification of Impacts and Prediction/Assessment of Impacts.

The methods that can be used to study impacts are:

1. Ad-hoc method
2. Checklist methods
3. Network method
4. Matrix method
5. Computer Aided DIA method

Checklist methods have the edge over the ad-hoc method as it reduces chances of missing important components or aspects from consideration. The present drought assessments methods are more or less adhoc methods with use of checklists in rare cases. A better approach is the network method which is based on development of an impact tree for each primary symptom of drought for identifying the vulnerabilities and social, economic or environmental settings in the region. This approach helps in producing impacts of secondary, tertiary and other orders. The Matrix method may offer a cost and time effective solution by putting data in a matrix – the parameters of drought symptoms on row axis and impacts on various parameters (economic, social and environmental systems) on column axis and placing the relationship. This method can even help to identify positive and negative impacts and give a score on a designated scale. A combination of the network and Matrix method may prove very useful in decision making. A computer aided DIA facility may be developed as a software module for placing the above methods as well.

Concurrent mitigation and relief actions influence the actual extent and levels of the impact of drought, and it is therefore important to adjust relief and mitigation actions in assessing impacts, so as to arrive at the 'net' impact levels in the case of a particular component. A weighted score system (for example, derived from Leopold Matrix or Battle Environmental Evaluation System, or Yale University's ESI scoring model) may be developed for evaluation of drought impacts, so that the total scope of all weightage sums to 1000 or so and the particular impact component can be evaluated for significance.

5.7 Mainstreaming Drought Risk Mitigation through Convergence

Mitigation of drought disaster risk in Bundelkhand comprises of following key aspects: (i) Reducing dependence on rain and rain-fed systems, (ii) reducing Vulnerability of ecosystems and their services including water and soil resources, forests, grasslands, climate moderation, etc. (iii) reducing vulnerability of agricultural system including horticulture, fisheries, dairying, etc. (iv) reducing social and economic vulnerability of people by enhancing their resilience and coping capacity, and (v) enhancing adaptation to climatic risks across ecological, natural resources and socio-economic settings & activities. An analysis of various programmes and schemes of the Government has been carried out to understand and assess the state of mitigation and preparedness regarding drought risk in the region of Bundelkhand. However, many programmes which were meant for natural resources management, agriculture and water management, and particularly for social advancement including alternative employment have been covered under the Bundelkhand package which was meant to address the challenge of drought impacts in the region. However, the package didn't look much from the futuristic angel of drought proofing the region, and therefore, long-term strategies which can enable a sustainable approach of people's practices, attitudes and overall adaptive framework is still remains gap area.

The interventions like National Watershed Development Project for Rainfed Areas (NWDPRA), Integrated Wasteland Development Programme (IWDP), Drought Prone Areas Programme (DPAP), Integrated Watershed Management Programme (IWMP), Artificial Recharge to Groundwater through Dug Wells (ARGTDW), Command Area Development & Water Management (CAD&WM), etc. help improve the resilience of ecosystems and their services, and thereby the natural resource base in the areas of their intervention. Water storage and canal irrigation schemes helped people reduce their dependence on rain and thus provided them opportunity to move from purely rainfed agriculture. Whereas the programmes or interventions like Agriculture Investment and Technology Extension Centres, Horticulture Mission, Diary development programme, etc. help in reducing further dependence on rain-fed systems.

On the other hand, the schemes like Backward Region Grant Fund (BRGF), etc. offered diversification of livelihood options from the core and helped people move to non-crop occupations. Alternative employment opportunities particularly during drought hit periods in such areas could come as a drought relief under the programmes and schemes such as Swarnajayanti Gram Swarozgar Yojana (SGSY). Interventions aimed for promoting agriculture productivity were, for example, Village Level Pulses Seed Development Programme, Mechanization programme.

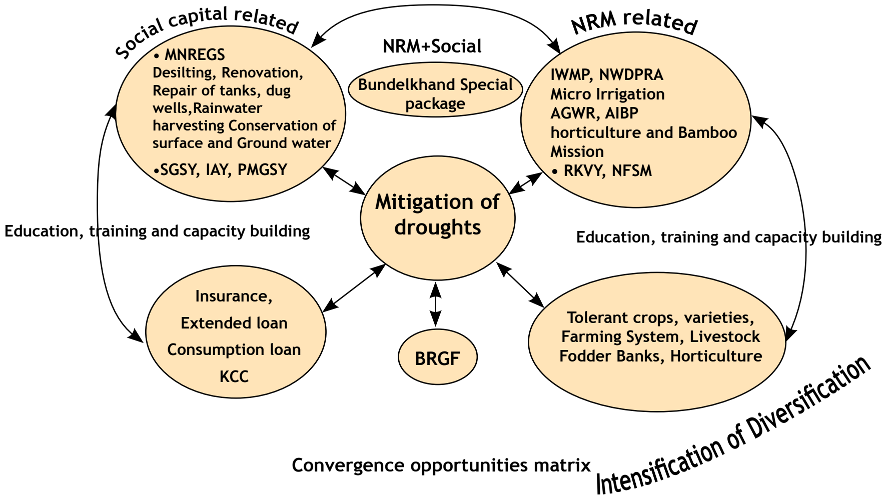


Figure 18: Mainstreaming Drought Risk Reduction through convergence (Gupta & Nair, 2013 modified after Samra et al., 2008)

Projects, viz. Swajal and Swajaldhara, Total Sanitation Campaign, Accelerated Rural Water Supply Programme (ARWSP), Indira Awas Yojana (IAY), Urban Infrastructure Development Scheme for Small and Medium Towns (UIDSSMT), Pradhan Mantri Gram Sadak Yojana (PMGSY), National Food Security Mission (NFSM), Mahatma Gandhi Rural Employment Guarantee Scheme (MNREGA) has their impacts on people's health and social living standards. Certain programmes like Rashtriya Krishi Vikas Yojana (RKVY) focused on research extension and capacity building. There were certain purely social welfare programmes like Integrated Child Development Services (ICDS), Mid-day Meal Scheme, Sarva Shiksha Abhiyan (SSA), etc.This has also been observed that there has been significant but varying degree of overlap in specific areas of impacts and benefits between different schemes meant primarily for different objectives. Table 25 summarizes activity areas of different developmental and social welfare schemed including those under Bundelkhand package and MNREGA of their significance to drought disaster mitigation.

Table 19: Convergence Matrix of different programmes/schemes and projects in Bundelkhand region

S No	Name of the Scheme/ Project/ Programme	Activity	Drought Mitigation (NRM/ Social/ Both)
1.	Bundelkhand Package	• Watershed Management • Water Resource Management • Environment and Forests Including water shed management, soil and water conservation in forests • Agriculture including Warehousing and integrated marketing infrastructure development, contingency Cropping and seed multiplication, micro irrigation, mechanization, capacity building, insurance • Horticulture • Animal Husbandry • Diary • Rural drinking water supply	
2.	MNREGA	• Include Rural Connectivity, flood control and protection, water conservation and harvesting, drought proofing including afforestation, micro-irrigation works, provision of irrigation facility to land owned by SC/ST& IAY allotees, renovation of traditional water bodies, land development including plantation etc	Both

S No	Name of the Scheme/ Project/ Programme	Activity	Drought Mitigation (NRM/ Social/ Both)
3.	IWMP (DPAP, DDP and IWDP of the Department of Land Resources have been integrated in 2009)	• Restore the ecological balance by harnessing, • conserving and developing degraded natural resources such as soil, vegetative cover and water. • prevention of soil erosion, regeneration of natural vegetation, rain water harvesting and recharging of the ground water table • multi-cropping and the introduction of diverse agro-based activities, which help to provide sustainable livelihoods to the people residing in the watershed area.	NRM
4.	Backward Region Grant Fund (BRGF)	• Strengthening local governance system • Strengthening local infrastructure • Professional support	Social
5.	Rashtriya Krishi Vikas Yojana	• Addition financial assistance for Agriculture research and preparation of district agriculture plans, taking into account local needs and conditions.	NRM
6.	National Food Security Mission	• Increasing production of rice, wheat and pulses through area expansion and productivity enhancement • Restoring soil fertility and productivity • at the individual farm level • Creation of employment opportunities; • Enhancing farm level economy	Both

S No	Name of the Scheme/ Project/ Programme	Activity	Drought Mitigation (NRM/ Social/ Both)
7.	National Watershed Development Project for Rainfed Areas [NWDPRA]	• in-situ moisture conservation primarily through vegetative measures to conserve rainwater • control soil erosion and generate the green cover both on arable and non-arable lands	NRM
8.	Swarnajayanti Gram Swarozgar Yojana (SGSY)	• providing income-generating assets through a mix of bank credit and government subsidy	Social
9.	Pradhan Mantri Gram Sadak Yojana (PMGSY	• constructing all-weather roads to unconnected habitations in rural areas. • The scheme also funds construction of necessary culverts and drainage structures	Social

6

Strategic Recommendations

Policy and programmes for the development of drought prone areas must aim at restoration of the ecological balance by harnessing, conserving and developing in a sustainable manner the natural resources like land, water, vegetation cover,livestock and at raising land productivity in India. Conservation and optimal use of water and effective land water management are the prime requirements of life as well as governance, in desert, drought prone and dry (rainfed farming) areas. The nature of agriculture and livestock bearing in such areas is conditioned by this. Techniques of desert irrigation, water harvesting and watershed development, grassland management, afforestation, selection of appropriate crops; in fact the strategies of agricultute and rural development for desert areas-8;l have to be geared to coping with the desert environment. Community involvement should be encouraged (Hooja and Choubisa, 2009).

6.1 Policies And Strategies

Conceptually, drought proofing means the capacity to meet the basic material and physical needs of the local population - human and animal - in a drought period so that there is minimal distress (Chopra, et al., 1995). As a process, drought proofing is a continuing one that spans lean and normal years. The nature of drought - proofing works and activities during the two periods can be quite different. For example, in normal years, land and water management must focus on enhancing the biomass on lands of marginal farmers and on landless people. During droughts, they must be targets of employment generation programmes. In India, policy approaches to handle drought and drought proneness rely on three aspects: rainfall, soil moisture and irrigation. Soil moisture and water balance lie at the heart of how we understand the related concept of dryness and dry lands. Soil moisture depends on several factors: rainfall, temperature, moisture retention and porosity of soil, run off of rainwater, vegetation, etc.

A range of diverse factors go into the making of a drought as disaster. These factors are based in the ecology, bio-production conditions, socio-economic conditions, etc. Rainfall deficiency (quantum, distribution and reliability) need not necessarily result in distress and shortages to the level of causing disaster. The effect of rainfall deficiency depends on the implications of policy, technology and land-ownership regime in the area and is an outcome of a complex interaction between socio-economic, agro-ecological and governance issues. The new policy interventions are driving the focus to address 'drought vulnerability' understood as the ability (or inability) of the land and people to withstand drought or soil moisture distress and experience lower crop failure, out-migration, land alienation, livestock distress, water shortage, hunger and starvation, poor health, and broadly the range of ecological services, etc. Drought vulnerability expresses itself as shortfalls in food, fodder, fuel, water and livelihood.

Rainwater is retained at different rates on the plains and on the hills as soil moisture or groundwater. Hence, the eco-geo-physiographical condition of a location where the rain falls is important, determines drought mitigation interventions. Rain shadow areas with investment in sound water management strategies and extensive irrigation may experience less crop failure or out-migration than higher rainfall sugarcane growing areas. High forest and vegetative cover will reduce fodder shortages and livestock loss and helps maintaining resilience for ecosystem and agriculture recovery after the stress is over. Grain banks, fodder banks and a good network of the public distribution system may prevent hunger and starvation.

6.1.1 National Policies and their Implications

The National Water Policy (NWP) of 2002 of India has taken into account the problems faced by drought (and flood) prone areas and have set concerned parameters (section 1.5). Under the Water Resource Planning (section 3.1 and 3.2) emphasized on non-conventional methods for utilization of water such as through inter-basin transfers, artificial recharge of ground water and desalination of brackish or sea water as well as traditional water conservation practices like rainwater harvesting, including roof-top rainwater harvesting. NWP sheds light on reforestation and prioritizing water resource management. Section 19.2 is regarding relief works for the drought afflicted masses. The new proposed version of National Water Policy 2012 tries to recall water as an ecosystem service; however, neither provides adequate linkage with other environmental and natural resources policies nor with the disaster management policy. But, the new version NWP recognizes the commercial aspects of water management and corporate involvement in policy implementation. This may have multiple implications for drought prone and dry areas, especially on agro-ecosystems, marginal farming, drinking waters, people's health, power generation, irrigation, commercial development, etc. Emphasis of the NWP on watershed based practices is of direct relevance to Bundelkhand region besides other means of water conservation and management for drought risk mitigation and drought proofing. The traditional water resource management systems should be revitalized which would need manpower provided by the affected population who would in turn find employment. The rural employment schemes can be converged with this aspect to improve the livelihood of thousands.

The National Forest Policy (NFP) (MoEF, 1988) dwells multiple references on degraded and barren lands and calling concern to the calamities of drought and floods. Bundelkhand went through major deforestation during the colonial times. Recently the forest cover has improved relatively and the menace of timber collection has decreased in comparison to bygone times. While discussing the essentials of forest management it has been stated that the forest and vegetation cover should be increased rapidly on hill slopes, in catchment areas of rivers, lakes and reservoirs and ocean shores and, on semi-arid, and desert tracts. Strategic importance has been laid on afforestation, social-forestry and farm-forestry. Under section 4.2.3 it is noted that village and community lands, including those on foreshores and environs of tanks, not required for other productive uses, should be taken up for the development of tree crops and fodder resources. Technical assistance and other inputs necessary for initiating such programmes should be provided by the Government. Importance has been placed on encouraging the rural population to cultivate less water consuming crops like legume, oilseeds and fodder. The special forest project for Bundelkhand which has been planned for the period 2009 - 2012 proceeds along these guidelines. It can be an effective solution to the watershed deficit in the area. As regarding the troubles related to mining it has been stated under the section 4.4.2 that beneficiaries who are allowed mining and quarrying in forest land and in land covered by trees should be required to repair and re-vegetate the area in accordance with established forestry practices. No mining lease should be granted to any party, private or public, without appraised from the environmental angle. There are also provisions for tribal, scheduled class and rural population living near forest area whose livelihoods depend on forest products.

The National Environment Policy (MoEF, 2006) bestows importance on forest and maintenance of forest cover and there are certain features regarding drought which coincide in both NEP and NFP. Section 5.3.3 refers that large scale forest loss would lead to catastrophic, permanent change in the country's ecology, leading to major stress on water resources and soil erosion, with consequent loss of agricultural productivity, industrial potential, living conditions, and the onset of natural disasters, including drought and floods. In addition to messages on forest degradation it has given legal recommendation for instance, giving legal recognition to the traditional entitlements of forest dependent communities taking into consideration the provisions of the Panchayats (Extension to the Scheduled Areas) Act (PESA). This would remedy a serious historical injustice, secure their livelihoods, reduce possibilities of conflict with the Forest Departments, and provide long-term incentives to these communities to conserve the forests. Measures given for management of desert ecosystem are of relevance for drought. Section 5.3.2 states the measures of intensive water and moisture conservation through practices based on traditional and science based knowledge, and relying on traditional infrastructure, Enhancing and expanding green cover based on local species and reviewing the agronomic practices in these areas, and promoting agricultural practices and varieties, which are well adapted to the desert ecosystem.

A key focus of this dialogue is the land use and land resources management strategies prevailing in the country. Land-use is badly affected by actions like deforestation, inadequate land-use, unsuitable farming and grazing practices, demographic pressure, lack of appropriate and improved technologies, poor markets and other legal institutional faults. It is interesting to note that though urbanization and industrialization are two main events which adversely distresses the land management situation yet these two are not so relevant in the case of Bundelkhand, instead the presence of social hierarchy and feudal system of land ownership. According to a report of the Study Group for Preparation of Roadmap for Rapid Economic Development of Uttar Pradesh, September 2008 (Planning Commission's State Plan Division, Delhi) the percentage of industrial unit in Bundelkhand is only 1.5 % of the total state percentage. It all started in the colonial time with the Permanent Settlement Act 1793 by which the British popularized the zamindari system at the cost of the jajmani relationship that the landless shared with the landowning class (Sethi, 2005). This was further aggravated by the caste system ingrained in the Indian society and Bundelkhand which never saw much development in most sectors is still stuck in an obsolete timeframe. Loopholes in land tenure legislation have facilitated the evasion of some of the provisions in land ceiling reforms by those large landholders who have wanted to maintain the status quo. At the same time, tardy implementation at the bureaucratic level and political hijacking of the land reform agenda, by both the state and private interests, have traditionally posed impediments in the path of effective land reforms (Sethi, 2005).

Union Minister of Agriculture is the chairman of this Board with effect from January, 1998. The Board is the highest policy planning and coordinating Agency for all issues concerning the health and scientific management of country's land resources. The basic objectives of the Board are to formulate and implement the National Land Use Policy, to prepare perspective plan for country's land resources, make overall review of the progress of implementation and also to launch awareness campaign for conservation of land resources in the country. The states themselves have land-use boards which should have effective mechanisms for monitoring the land use situation. Since the popularization of market driven approach and the flourish of neo liberal policies in agriculture there has been instances of national overproduction of crops and yet there are cases of farmers erstwhile villagers taking their lives. There is a need for land-use reforms as much as there is need for agricultural reforms in the area. The green revolution was not entirely a boon for Bundelkhand. The subsidies on submersibles, seeds of water intensive crops and chemical fertilizers aggravated the drought prone environment and mostly it was the large land-holding farmers who benefited from the revolution. The subsidies have outlived their original objective which was to popularise the technologies and procedures. There is need for agricultural reforms specific to the circumstances.

India finalised and released a National Policy on Disaster Management (NDMA, 2009) with the paradigm shift in disaster management from 'response and relief' to 'mitigation and preparedness' based approach. The objectives of the policy focus on promoting a culture of prevention, preparedness and resilience at all levels through knowledge, innovation and education. The policy calls for encouraging mitigation measures based on technology, traditional wisdom and environmental sustainability. The sustainability concept is proposed to be implemented through mainstreaming disaster management into the developmental planning process. As a prerequisite it prescribed for ensuring efficient mechanism for identification, assessment and monitoring of disaster risks. The disaster management policy calls for each and every Ministry and Department at every level to development and implement a disaster management plan incorporating the information on hazard, risk and vulnerability analysis, risk reduction and mitigation measures and emergency management and coordination plan. The policy lays special concerns on ecosystem based disaster risk management approaches, climate-change adaptation linkage with disaster management, and ensuring livelihood resilience within the overall framework of disaster risk management.

There are several major features of the policy which coincide with the topics of interest. It states that a regionally differentiated strategy shall be pursued, taking into account the agronomic, climatic and environmental conditions to realize the full growth potential of every region. Special attention will be given to development of new crop varieties, particularly of food crops, with higher nutritional value, A major thrust will be given to development of rain-fed and irrigated horticulture, floriculture, roots and tubers, plantation crops, aromatic and medicinal plants, bee-keeping and sericulture for augmenting food supply, promoting exports and generating employment in the rural areas and development of animal husbandry, poultry, dairying and aqua-culture will receive a high priority in the efforts for diversifying agriculture, increasing animal protein availability in the food basket and for generating exportable surpluses.

Block/Village Level Planning

A natural disaster is the subject area of intervention that requires convergence of the majority of the policies concerning environment, natural resources, livelihoods and other facets of development to bring in the lessons and guidance for local planning and problem-solving actions on ground. The climate-risk awareness that focus on adaptation and ecosystem based approaches form mainstreaming disaster risk reduction with the strategies of natural resource management and regional development. While addressing the challenge of drought risk it is more important to look at agriculture, water systems and rural development as key drivers of land management for drought proofing the region.

For drought proofing a region, comprehensive planning at block or panchayat/village level must be based on three aspects, viz., (i) ecological profile (ii) production conditions, and (iii) socio-economic status. The ecological profile includes total rainfall and its distribution and reliability; geology and groundwater potential; soil particle size, depth, drainage, erosion, etc; slope and landform; vegetation and forest cover; watershed and drainage characteristics to understand run off rates; etc. Production conditions include yield, cropping pattern, source-wise irrigation, groundwater potential, utilization of ultimate and existing irrigation potential, land-use patterns, etc. Socio-economic status looks at land distribution, poverty, workforce characteristics, composition by caste and tribe, etc.

Since the drought risk and vulnerability factors are associated with the land, ecological features and social settings at local level, planning for drought proofing need to be scaled down at least to the Block level. Ideal and desirable unit of such comprehensive assessment and planning needs to be the Panchayat or a village. The serious concern needs to be drawn to the local level policy making and capacity development for understanding the risk and delineate the counter strategies. National policies can provide wider and broader framework of approach, whereas it is the regional and local process that will generate the field level wisdom for evolving area-specific approach to drought risk and vulnerability reduction.

6.2 Institutional Framework

A proactive response to any natural disaster calls for an efficient co-ordination and resourcefulness at every tier of the government. As discussed earlier there are number of institutions under the aegis of the central government which are sufficiently capable of monitoring as well as acting in advisory capacity regarding the drought situation. Yet there seems to be a significant shortcoming in the management of the devastating scenario in Bundelkhand. The reaction of the Government from the moment it declares a drought should be swift and retrospective so as to avoid any major debacle and disastrous long-term conditions. The timing of the declaration of the drought is extremely vital to the subsequent development.

Sometimes there can be a co-ordination gap as a result of which the team may reach the area after a major portion of the crop had already been harvested which might result in inaccurate assessment. This can be prevented by collaborating with the experts in the premier Central Government as well as State Government institutions where a thorough study is carried out on the different indices like Normalised Difference Vegetation Index, Moisture Adequacy index, rainfall deficiency.

The occurrence of drought is unavoidable since it is a normal recurrent feature of climate and occurs in all climatic regimes. The National Drought Assessment and Monitoring System (NADAMS) established under the National Remote Sensing Centre (NRSC) maintain detailed monthly records of crop and seasonal situations. The states of Uttar Pradesh and Madhya Pradesh are covered under NADAMS and can declare drought by utilizing the data on NDVI that are made available. However, while proclaiming drought occurrence other parameters and indices should be considered instead of any one.

For a long time the main focus of drought management have been temporary relief measures. However, recently there has been a directional change towards stable and enduring mitigation strategies. The benefits of agroforestry, as well as alternate crops like pulses, oilseeds, fodder crops and Jatropha sp. have already been considered. However, there need to be an appropriate method to introducing and cultivating these less water-intensive crops at a village level in the 13 districts of Bundelkhand. There are district agricultural plans but there is a need for constant revision since both the climate and society is ever changing. There has been a massive allocation of funds through the Bundelkhand package especially to the Water-shed sector. However, there has been a meagre improvement in comparison to the generous amount of funding.

Along with proper functioning of the government institutional mechanism there is requirement of balanced community participation. The local population always has the wisdom required for formulating necessary adaptation strategies. Benefits of alternative land-use models with community participation in the case of Sukhomajri in Harayana are well known, where watershed management was effectively carried out by the village people along with the government help to build a catchment area since the entire area was barren and degraded. This one model brings forth not only micro-level success example but also the success of Joint Forest Communities and women empowerment.

Figure 18: Catchment area of Sukhomajari

Continuous drought has disrupted not only the way of life but also the social structure of the entire community. Rainwater harvesting is a process whereby the rainwater falling to the earth is collected for later productive use.

The region and its grim situation of drought risk, vulnerability and environmental degradation, call for a centrally supported academic and research institution or University to hold and deliver through a consortium of training, education and outreach institutions relating to agriculture, ecology & natural resources, climate-change, disaster management, tourism, rural industries and alternative employment which is due since long. The regional has great potential in its soil, nature and its people, but needs systematic and accountable interventions from outside and inside at the same time, and the enabling institutional and planning framework is crucial requirement.

Irrigation Reforms for Responsible Farming and Accountable Services

Participatory Aquifer Management

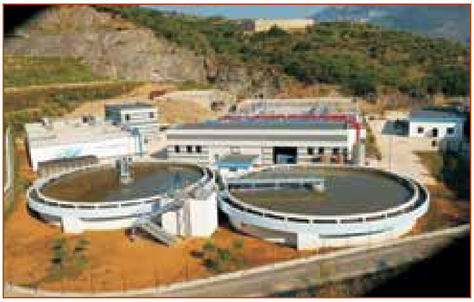
Breaking Groundwater - Energy Nexus

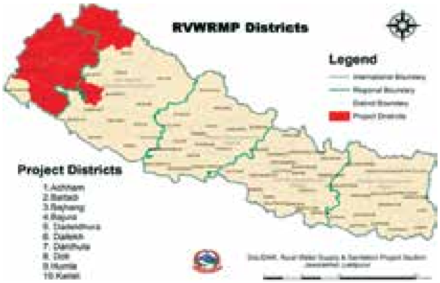
Watershed Restoration and Water Recharge

Environmental-health - Water & sanitation

Figure 19: Suggestive 10 Key Agenda to Sustainable Water Management in Bundelkhand

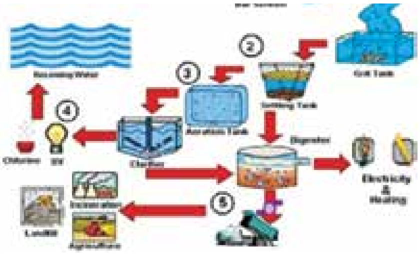
Conjoint Water and Wastewater Management

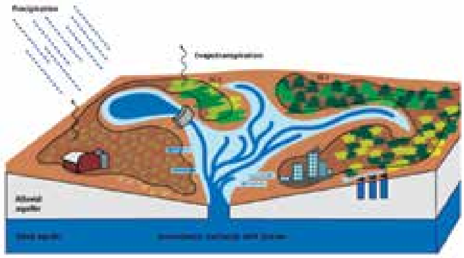




Water System Database Development and Management

Industrial Water Efficiency





Non-structural Measures for Flood Management & Drought Mitigation

Institutional and Legal Framework

Development Alternatives with the help of Self help Group designed and demonstrated fifty rainwater harvesting structures covering 18 kuchha roofs and storing water in 42 storage tanks (the rest being recharged into the aquifers) covers an approximate 29,000 sq ft roof area. It turns the average 600 sq ft roof size into storage capacity of the 300 m3 installed tanks with the potential to harvest about 3500,000 litres of water. Rooftop rainwater harvesting in Bundelkhand is probably the first effort to ensure not only the water sustainability but also to protect the vulnerable communities against the ills of climate change (Kulshrestha, 2008).

6.3 Information Flow

A formidable obstacle in effective operation of the continuous chain of actions is proper flow of information through all the official levels as well as the society at large. There is very little awareness at the grass-root level about the scientific causes as well as management procedure of drought. The disaster management institutes have training programs to disseminate drought specific information to educators as well as administrators in the states but this need to be intensified. A major role is played by the media in propagating news and occurrences in these districts. However there is still a lack of scientific journalism even in the present time. The news-reports are usually regarding individual miseries and the dire state of fund management but rarely insightful about the broader horizon of the ingrained problems. Most of the information is still confined to government and NGO manuals and reports. The media if and when it wants to, has the power and resources to give a positive direction to a grave issue such as Bundelkhand drought. The power of audio-visual and print goes a long way in imprinting facts and evidence on the minds of the masses. This is one important scenario where synchronization between the government and media can work wonders for improving thousands of livelihoods. It would be definitely interesting if media personnel are inducted into the drought specific training programs which will shed light on Bundelkhand and in turn the research community is introduced to the concepts and knowhow of scientific journalism. There is an assortment of statistics and scientific literature on drought and a lot of research personnel are skilled in the art of presenting, be it writing or creating documentaries. The government and society as well as the national newspapers and private media will benefit from such endeavours.

To generate awareness among the community about the conservation of Rain water, various rain water harvesting plans were demonstrated in various schools and college of Jhansi. “Rain water harvesting” is a very important technique for collection or storage of rainwater at a surface or in sub surface aquifer before it is lost as surface run off. The augmented resource can be harvested in the time of need. Artificial recharge to ground water is a process by which the ground water reservoir is augmented at a rate exceeding that under natural condition of replenishment. After development of rain water harvesting structures, the defunct boring become functional during first year of harvesting and also the nearby hand pumps become recharged (Rai, AK & Divya Sharma, 2006). These RWH model was developed not only to conserve rain water but to make show case for others to replicate the same for their houses and institutions.

6.4 Opportunities and Limits

It is only reasonable that a fair conclusion to this retrospective analysis can be drawn by discussing the prospects that can be harnessed under the circumstances and the limitations present in achieving them. Earlier under the heading of Capacities: Mitigation and Development we have discussed the specifics of traditional knowledge, agroforestry and alternative employment. These are vistas of opportunities in Bundelkhand under the present conditions. With the right intent, accurate information and sustainable technologies they have the capacity to flourish and provide resilience to the population in the region.

Chandela and Bundela rajputs, who themselves seem to be wise disaster managers of their times, built Indigenous tanks and water reservoirs. However, these tanks and reservoirs are currently in a state of neglect and degradation. The restoration of these structures will not only bring long term relief but also provide employment for the larger population. The government already has social sector schemes like NREGS which provide employment to the rural population. Incorporation of services like rejuvenation of these ancient irrigation systems into the schemes would increase the benefit for the masses. The Bundelkhand Package has already allotted a magnanimous proportion of funds to resurrect the water management in the area. A wholesome administration would improve the employment situation in this context. The haveli system of irrigation has few takers in Bundelkhand after the dawn of the green revolution.

This is a Bundelkhand geography and climate specific irrigation system which can bring relief to the farmers without putting strain on the depleting water level. The concept of drip irrigation is still confined to well to do farmers and agriculturally prosperous states. However, if a micro-level finance system can be contrived with the help of government subsidies and a percentage of interested native population then there is a chance that micro-irrigation will have quite a few takers in Bundelkhand. The importance of popularizing Jatropha curcas as a crop has already been considered, however there is a need for popularizing cultivation of a variety of fodder crops. There is a large animal population in Bundelkhand which suffers the same fate as their human counterparts. Fodder crops are less water intensive and they are also commercially valuable. Along with this construction of animal husbandry facilities for cattle and goats can be highly profitable. There is a big market for dairy products in our country and a proliferating dairy industry which goes side by side with animal husbandry can be favourable to the people.

According to a report on small scale industries of Uttar Pradesh the percentage of Industrial units in Bundelkhand is only 1.5% as comparison to 51.3% in the Western region of UP. The stark contrast reflects the aggravated socio-economic scenario in the region. The report recommended that the new small scale and tiny units in 26 districts of eastern UP and 7 districts of Bundelkhand should be given capital subsidy. The extent of small scale industries can be diverse ranging from micro-irrigation to bio-diesel and even manufacturing toys and pickles by the rural female community which would enhance not only the economy but also improve the conditions of women in Bundelkhand. Bundelkhand also has some of the country's most historically significant and beautiful architecture. The tourism industry in Bundelkhand has great potentials and can be improved many folds by environmental improvements, hospitality and market promotion.

Every dynamic opportunity presents itself with a number of hurdles. Bundelkhand is in a quandary not only because of an unfavourable climate but also an overtly feudal social system which exists even in these modern times. Although some of the districts in the region are chronically drought prone, but the economic demise and social tensions are spread throughout the whole region. Most of the suicides are related to debts that could not be repaid to the money lenders who levy a high interest rate taking advantage of the dire state of affairs.

It is important to mention that Bundelkhand region hosts a range of institutes of higher education and professional education in the field of natural resources, agriculture, environment, biotechnology, fisheries, engineering & technology, medical & ayurveda, tourism and hotel management, sports, etc. There are a number of good NGOs promoting people centric endeavours to use technological knowledge like bio-gasification, handmade paper making, pickle and sauces industry, etc. The universities viz. Bundelkhand University and the newly established Agriculture University are inculcating knowledge and skills into the youth of the region for professional advancement and employability. The ICAR institutions like Indian Grassland and Fodder Research Institute, National Centre for Agroforestry, Central Soil & Water Research and Training Institute, offer significant potentials for capacity development on various aspects of drought proofing. However, impact of these institutions at the ground level have not been realised to the level expected. CSIR and ICMR can also be approached for their regional research centres, whereas MoEF and Planning commission can help strengthen the process by locating their centres on climate-change adaptation research and planning and integrated land-use planning. As the region has been calling for a Central University to foster the growth of academic advances and with chain of research institutes to help promote the natural resource management with inputs of affordable modern science and technologies as a blend to the traditional and local knowledge aiming at improving people's attitude, directing to right adaptations, livelihood and social security and cultural strengthening as the basic grounds of sustainability.

The concept of micro-financing is still a spectre in these districts since micro-finance enterprises fear the social as well as environmental upheavals of this area. There are caste related ripple effects which is a cause of distress for each and every sector; for instance education, agriculture, health and finally affecting the economy. There are reports of women being mortgaged to repay debts and statistics shedding light on the abysmal child sex ratio. The land is a dubious territory for both farmers and capitalists. In this context again it is worth mentioning the value of a solid collaboration between the central and state government bodies and the media to disperse knowledge and uphold transparency in the different development undertakings. The fiery history and the austere beauty of the Bundelkhand deserve a fitting resurrection and the time is now or never.

6.5 Way Forward

The detailed analysis of the past and present scenario on Bundelkhand Drought, its reasons, impacts and preventive solutions; depicts that there is further requirement of focusing ourselves on some more points which shall help the region adapt better in future and also built its own resilience. Despite of several schemes and programmes which are directly and indirectly related with drought risk mitigation and drought relief in the region encompassing UP and MP districts, following are the weaknesses and lacunae identified:

(a) Wasteland reclamation and dry land agriculture: Despite of recurring drought as a chronic problem of Bundelkhand region, the focus has been only on alternative employment as relief, drinking water and agriculture promotion through irrigation to some extent, whereas there has been very less emphasis on promotion of dryland agriculture and reclamation of wastelands in the region. Dryland agriculture holds the key to departure from dependence on rain and rain-fed systems.

(b) Agroforestry and mixed cropping: Despite of the Bundelkhand region hosting the national institutions, viz. Indian Grassland and Fodder Research Institute (IGFRI) and National Research Centre for Agroforestry (NRCAF) which has developed and tested agroforestry and other mixed-cropping models suitable for different soils and climate in different agro-climatic zones in the country, the technology has been far from acceptance by the people in the region. Compositions like agri-silvi, agri-pastoral, agri-horti, etc. can prove to be of significant benefit towards integrated soil and water management in the region.

(c) Grassland/Grazing lands: There has been significant loss in the area under grazing land/ grassland in the villages/panchayats, in the Bundelkhand region like many other regions in the country, and like the fate of most other Common Property Resources. Sustainable mitigation of disaster risk cannot be visualized without a central focus on natural resources, and thereby, management and promotion of common property resources such as grazing/grasslands, water bodies, etc.

(d) Minor crops: A major lacunae in the Bundelkhand drought mitigation strategy has been the focus of agriculture on the major crops of Kharif or Rabi seasons, whereas the focus on promotion of people's acceptance and practice of minor crops like essential oils, other aromatic and medical plants, floriculture, fisheries, and dairying promotion integrated with wasteland development, animal husbandry and livelihood diversification programmes.

(e) Stray animals: A peculiar problem in the Bundelkhand region is the 'Chutta jaanwar' (i.e., stray animals). A large number of cattle particularly cows when these are unproductive in terms of milk, or when their masters lack resources and capacity to sustain their maintenance due to losses in agriculture or other livelihood interventions. These stray animals further affect the vegetation – saplings, crops and crop yields in the forms besides causing a menace on the traffic.

(f) Climate awareness and cropping adjustments: There has been significant focus on enhancing water availability but the focus has been on more actually on sources and less on sustainability of its resources. Land and water management cannot be separated while working out the framework of sustainable water supplies and recharge of resources. Promotion of agriculture productivity has been on core agenda but not the issues related with adaptation to the changing climatic regime and uncertainties related with availability and quality of key resources. There has been no plan or scheme on increasing awareness on impacts of climate change, its local implications on water systems, and adaptation know-how to cope with the challenges for agriculture and food security. In the present context, no strategy of drought disaster management can be complete without including climate awareness and adaptation framework. Crop improvement must be augmented with crop adjustment to suit the changing environmental settings and events of deficit rainfall.

(g) Rejuvenation and renovation of traditional water systems: Bundelkhand, like Rajasthan has been historically known for its traditional water harvesting structures, for example, Bundela and Chandela tanks, besides rainwater harvesting systems existed in forts and monuments. However, recognition of their significance in solving water challenges and need of their rejuvenation and maintenance has been seldom emphasized in the developmental programmes and schemes in the region. No such emphasis has been in the drought mitigation or contingency plan documents as well. Adaptation to drought risk and climatic challenge must integrate traditional wisdom and structural of water resource management for sustainable development at local levels.

6.6 Recommendations and Future Research Needs

Based on the results of the study, and the findings, following are the recommendations for strategic interventions of planning and drought mitigation in Bundelkhand region:

(a) A holistic programme of integrated land management comprising of wasteland reclamation, crop diversification, integrated nutrient management, integrated pest management, integrated water resource management, soil amelioration, etc. need to be conceptualized and implemented.

(b) Adaptation to climate-change impacts and challenges of uncertainty relating to water and weather conditions/events, need to be a central component in disaster risk reduction and natural resource management for sustainable livelihood in the region.

(c) Integration natural resource management and adaptation must focus on ecosystem services sustainability and socio-economic simultaneously, enabling the practice disaster mitigation against drought risk in a cost effective manner. The ecosystem based adaptation and drought mitigation shall form the basis of disaster risk reduction.

(d) Focus on knowledge promotion and extension has been significantly low than what was actually required. A knowledge management programme and system for hazard risk and vulnerability analysis at local/village, taluka/tehsil and district level must be commissioned as part of district disaster management framework.

(e) Traditional and local knowledge of dealing with climatic uncertainties and drought challenges need to be documented across the places in Bundelkhand. This need to include historical and latest developments, innovations and technological interventions in this direction, and must be made an integral part of overall drought proofing strategy.

(f) Changing the attitude of the people in Bundelkhand and the official in the Government needs significant improvement towards taking the challenge and improving the situation from the futuristic and preventive approach. Thus, crop adjustment, livelihood diversification, accepting and practicing innovations, socio-political interventions and exchange of know-how with other areas of the country and beyond, need to be facilitated.

(g) Land-use has been the topic of discussion and research at different levels and institutes but the concept of perspective planning for sustainable land-use and land resource management has been seldom affected in the results. Perspective plans at district/taluka/tehsil levels must be drawn as a baseline of integrated district plan which shall also serve as basis for disaster mitigation plan (a component of district DM plan). This shall be done by bottom-up decentralized planning approach.

(h) A network or consortium of institutions in Bundelkhand may be established considering the educational, research, training institutes, Universities and NGOs, which can be facilitated by the Central Government, to help promote exchange of knowledge and experience on relevant interventions. "An Integrated Disaster Risk Reduction & Sustainable Development Institute" is needed to be setup in Bundelkhand, by Central Government, with mandate of regional capacity building research, policy planning and extension.

(i) Higher education needs diversification with emphasis on new areas of learning and training especially on alternative practices of livelihood and employment, economic and regional development, environment and natural resources, and management sciences. Though and will power strength of the youth, in particular of the women group need to be strengthened to enable the change from deprivation towards sustainable management of resources and systems.

(j) Fundamental and action research aimed at evolving and testing hypothesis regarding patterns of drought and their impacts, implications of mitigation measures on land resources and peoples well being, in particular food security, health and employment, need be promoted which shall also help evaluate various development programmes in terms of their relevant to the region.

(k) Future research need to focus on developing easily understandable maps of spatial rainfall patterns showing temporal variations, and indicating hazard risk pertinent to water scarcity and drought, vulnerability profiling of ecosystems, agriculture, water resources and socio-economic settings against drought risk. The outcome shall be utilized for conducting training need analysis of various sectors and stakeholders for designing and implementing training and education programmes on drought mitigation and sustainable development at district and sub-district level.

As social cohesion is the basis of any growth for a region or area, disarray among natives (which is observed)shall not let reach the fruit of good practices or policy programmes to the ground level which in turn will hamper the holistic aim of development of the Bundelkhand region in background of drought problem. Community involvement is the need of the hour.

Also another perspective is of gender. It is seen that in harsh conditions either the women are not coming out of their adobes or are not actively involved in decision making process. The menfolk don not understand or cannot see the problems which womenfolk present in harsh climatic conditions which demean their social status further. Encouraging women to participate in decision process and capacity building will help households become pliable in future. Women takes take of children, old and inform members of the household. Their empowerment towards disaster preparedness like drought shall give them an upper hand to protect their families. Their proper upbringing and education is required in this direction.

The national level policies and programmes which are made for local level dissemination need to be on the lines of "Think Global, Act Local". This connotes that the plans should be such that suffice the needs and priorities of the area which is in issue. If the standard charters are implemented as it is, they may not fulfil the purpose of the policy which is made for a special reason. If above mentioned dots are considered for further research and policy making, it shall benefit the locals in a more enriched way and help the authorities accomplish the aim of disaster resilient communities which can face any disaster challenge in future.

Courtesy: Shri K. Murari, Sr. Programme Officer, TARAGRAM Datia

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Vulnerability Assessment and Mitigation Analysis for Drought in Bundelkhand Region

(A Research Study Funded by ICSSR)

EVALUATION REPORT

Dr. Anil K. Gupta, Principal Investigator & Project Director
Ms. Sreeja S. Nair, Co-Principal Investigator

Drought ranks first among natural disasters in terms of extent of effect on population, livelihoods, environment, society and economy. The present research project (is an innovative study) on vulnerability and mitigation analysis for drought in Bundelkhand region.

The report is well designed in six chapters. In an introduction the conceptual frame work, background of the study region review of literature, aims and objectives have been systematical y outlined. In chapter two, an overview of the Bundelkhand region and district profiles both in Uttar Pradesh and Madhya Pradesh has been given. The third chapter includes detailed methodology indicating statement of the research problem, research design, analysis of data and various phases in which the study has been completed. Chapter four deals with hazards, vulnerability mapping and risk analysis. In this chapter selection of indices on the basis of five preferred criteria have been included. All types of droughts have been mapped from 1998-2009. Hazard frequency map of Bundelkhand has been prepared. Maps of frequency of meteorological, agricultural and hydrological drought have been generated and composite mapping of drought has also been prepared. Chapter fifth analyses vulnerability and mitigation. District wise profiles of three selected districts have been wisely done in this chapter. Conclusions and recommendations of the study have been well presented in the last chapter.

The study is indeed an innovative and comprehensive. The methodology perused by researchers is sound and clearly spelt out. The use of VCI derived using SPOT vegetation data for various droughts is praiseworthy. Through the study is based on secondary data, however, the analytical approach is quite systematic. The analysis and evaluation of various Government schemes is also praiseworthy.

The candidates have done justice to the financial support provided by ICSSR New Delhi. In my opinion researchers deserve appreciation for analyzing the drought vulnerability and mitigation of a backward region of the country. I recommend that the report may be accepted for publication after minor editing.

About the Authors

Dr. Anil K. Gupta

Dr. Gupta is Associate Professor at NIDM since the year 2006 and presently the Head of Division of Policy Planning and Training Cell at NIDM. Before joining NIDM in 2006, Dr. Gupta was Associate Professor and Director of Institute of Environment & Development Studies of Bundelkhand University of Govt. of Uttar Pradesh and headed its Department (s) of Environmental Science and Natural Resource Management since the year 2003. He has completed several projects viz., UNDP/MoEF GEF-FSP on Climate resilient Development and Adaptation, National Coordinated Project on Urban Flood Case Studies, Development of Guidelines/Tools for Mainstreaming DRR (UNDP), ICSSR project on Drought Vulnerability and Mitigation Analysis, Indo-German project ekDRM (environmental knowledge for disaster risk management) with GIZ – IGEP / inWEnt & MoEF, European Union project with GIZ-IGEP on Climate change adaptation through DRR in Coastal Andhra & Tamil Nadu, CDKN-START project with ISET (USA)-GEAG on Mainstreaming CCA and DRR into district planning. His special contributions were in development of National Human Resource Plan for DM, National DM Plan, Perspective Plan for NIDM's Strengthening & Expansion, National strategy on Climate-change, Technical Advisory Committee of NIDM, DM in University/professional education and promotion of Ecosystem Approach to DRR (now internationally with UN-PEDRR/UNEP). He has been recipient of Young Scientist Award 1996 and Elected Fellow of Society of Earth Scientists in 2008. He has the credit of over 100 publications including 45 papers in refereed journals, 4 books and 7 training modules.

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Sreeja S. Nair is Assistant Professor at National Institute of Disaster Management since 2007. Before joining NIDM she was working with GOI-UNDP, Disaster Risk Management Programme. She is disaster management professional having more than 14 years of experience in the field. Her main areas of research, documentation and training activities at NIDM include geoinformatics applications in disaster management, environmental law, disaster data and information management, ecosystem approach to disaster risk reduction and chemical disaster management. She is the coordinator of Indo German Cooperation on Environmental Knowledge for Disaster Risk Management and co-principal investigator of ICSSR research project on drought vulnerability and mitigation analysis for Bundelkhand region. She is also involved as a technical expert in the GIZ-European Union pilot project on integrating climate-change adaptation with disaster management planning process in coastal Andhra & Tamil Nadu. She has been collaborating with UN-SPIDER, UNEP, ICIMOD and UNDP for undertaking various training and GIS application related activities. She has published 15 papers in national and international journals, authored 8 training modules and author/ editor of 4 books.

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