

Drought Mitigation by Management of Surface Water Resources of Bundelkhand Region

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Abstract

Bundelkhand is a geographic region of central India. The region is now divided between the states of Uttar Pradesh and Madhya Pradesh, with the larger portion lying in the latter. The region was the site of the ancient Chedi Kingdom. The name of the region derives from the BundelaRajputs, who succeeded the ChandelRajputs as the rulers of the region in the 16th century. The major towns of Bundelkhand are Jhansi, Banda, Chitrakoot, Datia, Tikamgarh, Rath, Lalitpur, Sagar, Damoh, Orai, Panna, Hamirpur, Mahoba, Banda, Narsinghpur and Chhatarpur. Bundelkhand's most well-known place may be is Khajuraho, which has numerous 10th-century sculptures devoted to fine-living and eroticism. The mines of Panna have at times been famous for magnificent diamonds; and a very large one dug from the last active mine was kept for a time in the fort of Kalinjar.

In Bundelkhand region Groundwater being resource is often develop without proper understanding of its occurrence in time and space. Because of over exploitation the wells are gradually getting dried up in due course of time. In some of areas of Bundelkhand region, the situation is so serious that there is a scarcity of water even for drinking purpose. In these areas, the groundwater needs to be recharged artificially as the natural recharge is not sufficient.

Looking to the immensity of the water crises in Bundelkhand region, the area has been selected for identification and monitoring of

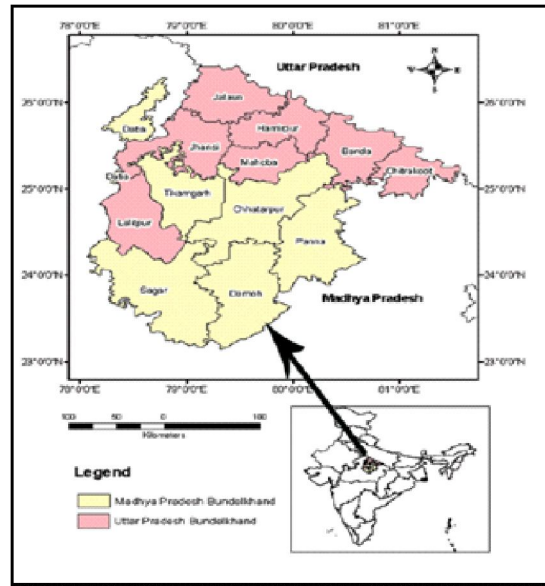


Fig-1: REFERENCE MAP OF BUNDELKHAND REGION

surface water resources of the region. The area comprise of hard rock formations like Archaean's granite and Vindhyan's sandstones and shales which creates tough situation for recharging of groundwater. Thus no rock unit in the area is represented by primary characteristics responsible for movement and storage of groundwater. On the other hand, the region is full of surface water bodies as its bird eye view of satellite imagery pertaining to Bundelkhand region depicts. These surface water bodies if properly manage, can recharge the area, fulfil their domestic needs and the region may become self-sufficient to combat drought. Proper identification, recognition, classification, and monitoring of all water bodies of Bundelkhand region is an attempt of this paper. The water body's database created during the study, also contain their spatial location and available water during post and pre monsoon season.

Key word: Surface water bodies, Wetland, Drought.

Introduction

Since 2007 Bundelkhand region have facing problem of drought. Normal rainy day in Bundelkhand is 52 days (metrological department of India) but last six years it is

restricted 24 days. Timing of Monsoon usually in this area is second week of June but, Year 2008 this season saw rains, but in the second week of June alone the region received around 32 percent of its total rainfall. Farmers were not prepared for sowing. Then till July 2008,

most of the Bundelkhand region received around 55 percent of its total average rainfall. This change caused floods and widespread losses in livestock and top soil. (<http://www.mediaforrights.org/environment/1002-environment>). In Bundelkhand region, average level of rainfall is 800–900 mm. (Ramesh et al. 2002), But last six years Bundelkhand received only 400–450 mm. Agriculture production also decreases in this areas in 2000 this region used to contribute 15 percent of the state's total food grain production, which has now come down to seven percent. A once food secure zone has now become a symbol of insecurity and migration due to climate change. In this area various livelihoods such as fishing, vegetable production and traditional betel leaf farming are facing one of the worst crises ever¹⁻⁷.

Water bodies, which generally consist of water, soil, vegetation and microorganism systems, are important for maintaining aquatic ecosystem biodiversity (Mitsch and Gosselink, 2007). These are one of the crucial natural resources, also known as wetlands. If properly managed, may be the hope to fulfil at least domestic needs of the Bundelkhand during drought. Thus, water bodies exhibit enormous diversity according to their genesis, geographical location, water regime and chemistry, dominant plants and soil or sediment characteristics. Water bodies are of two basic types: natural and constructed or manmade. Natural water bodies are natural areas where water covers the soil, including swamps, marshes, fens, sloughs, and bogs. Constructed water bodies are ecosystems similar to natural water bodies, combining physical, chemical and biological processes (USEPA, 2000; Mitsch and Gosselink, 2007).

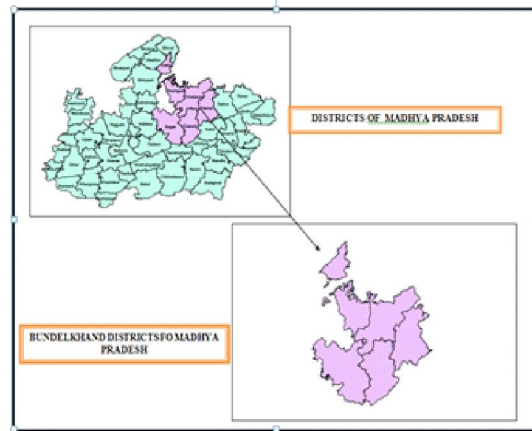


Fig-2: Study area of Bundelkhand Region

Further a detailed analysis based on interaction with officials of disaster management authority, statistical data and existing literature is to be carried out for drought impact and mapping the ongoing mitigation measures. The paper is concluded with a set of strategic recommendations for improving livelihood and reducing the drought vulnerability of Bundelkhand²⁻⁷.

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 23°20' and 26°20' N latitude and 78°20' and 81°40' E longitude (NGSI, 1989).

From Madhya Pradesh, India the District boundary of Datia, Chhatarpur, Damoh, Panna, Sagar and Tikamgarh are considered as Bundelkhand area in present study. Bundelkhand lies between the Indo-Gangetic Plain to the north and the Vindhya Range to the south. It is a gently sloping upland, distinguished by barren hilly terrain with sparse vegetation, although it was historically forested. The plains of Bundelkhand are intersected by three mountain ranges, the Vindhya, Fauna and Bander chains, the highest elevation not exceeding 600 meters above sea-level. Beyond these ranges the area is further diversified by isolated hills rising abruptly from a common level, and presenting from their steep and nearly inaccessible scarps eligible sites for forts and strongholds of local kings. The general slope of the Bundelkhand region is towards the northeast, as indicated by the course of the rivers which traverse or bound the territory, and finally discharge themselves into the Yamuna River¹⁻⁷.

The principal rivers are the Sindh, Betwa, Shahzad River, Ken, Bagahin, Tons, Pahuj, Dhasan and Chambal. The Kali Sindh, rising in Malwa, marks the western frontier of Bundelkhand. Parallel to this river, but further east, is the course of the Betwa. Still farther to the east flows the Ken, followed in succession by the Bagahin and Tons. The Yamuna and the Ken are the only two navigable rivers. Notwithstanding the large number of streams, the depression of their channels and height of their banks render them for the most part unsuitable for the purposes of irrigation, which is conducted by means of ponds and tanks. These artificial lakes are usually formed by throwing embankments across the lower extremities of valleys, and thus arresting and

impounding the waters flowing through them.

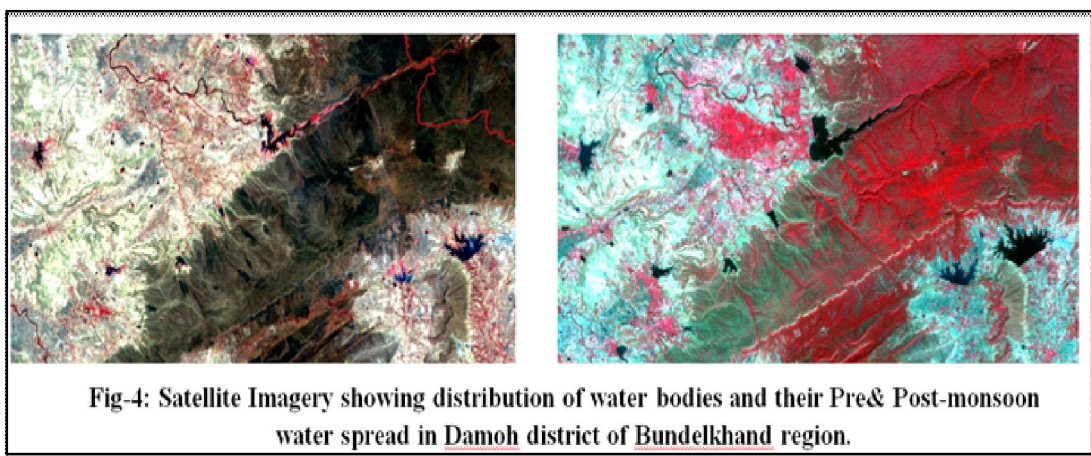
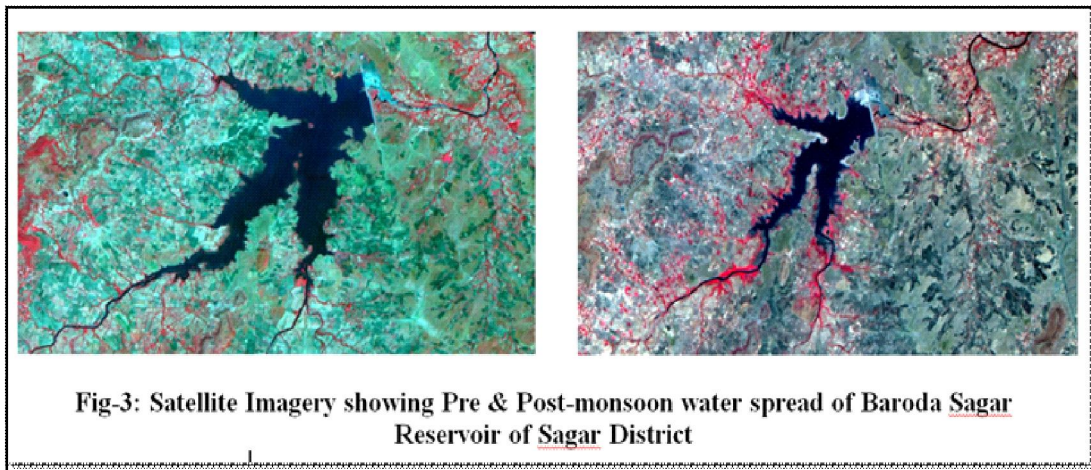
Data Used :

IRS P6 LISS III data was used to map the water bodies. LISS III provides data in 4 spectral bands; green, red, Near Infra Red (NIR) and Short wave Infra Red (SWIR), with 23.5 m spatial resolution and 24 day repeat cycle. The spatial resolution is suitable for 1:50,000 scale mapping. Two-date data, one set acquired during March to June and another during November to December were used to capture the pre-monsoon and post-monsoon hydrological variability of the water bodies of the region. Survey of India topographical maps (SOI) were used for reference purpose.

Methodology :

To conserve and manage surface water resources, it is important to have inventory of water bodies and their catchments. The ability to store and analyse the data is essential. Digital maps are very powerful tools to achieve this. Maps relate the feature to any given geographical location has a strong visual impact. Maps are thus essential for monitoring and quantifying changes over a time scale, and assist in decision-making process. The overview of the steps used, are as follows –

- Generation of spatial framework in GIS environment for database creation and organisation.
- Geo-referencing of satellite data.
- Identification of classes as per the classification system.
- Generation of base layers (rail, road network, settlements, drainage, administrative



boundaries) from satellite image and ancillary data.

- Mosaicking/edge matching to create district level database.
- Preparation of map compositions and generation of statistics.

In the present study, Modified National Wetland Classification system is used for water body delineation and mapping comprising 19 wetland classes which are organized under

a Level-III hierarchical system as natural and man-made under which 19 wetland classes are suitably placed. Two date satellite data pertaining to pre-monsoon and post-monsoon was used to confirm the classes and also to demarcate temporal variations in its features. Following layers are generated for each water body of Bundelkhand area:¹⁻⁷

- Wetland extent: As water body encompass open water, aquatic vegetation (submerged,

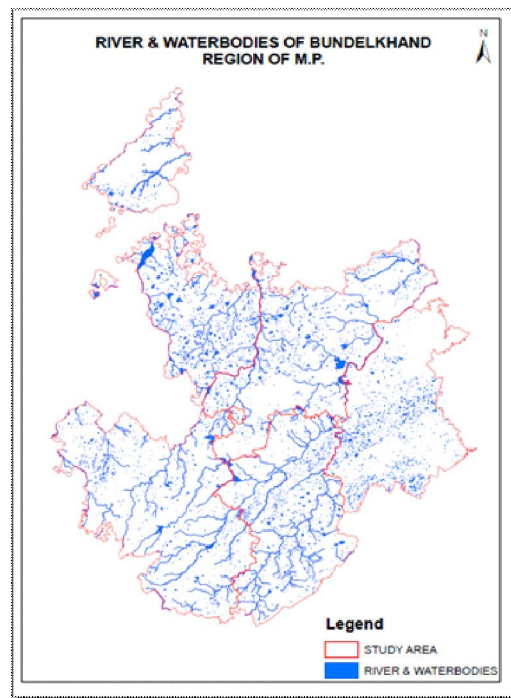
floating and emergent) and surrounding hydric soils, the water boundary is ideally include all these. Satellite image gives a clear signature of the wetland extents from the imprint of water spread over the years.

- Water spread: Each water body have two water spread layers representing post-monsoon and pre-monsoon during the year of data acquisition.
- Aquatic vegetation spread: As is known, aquatic vegetation is of four types, viz. benthic, submerged, floating, and emergent. It is possible to delineate last two types of vegetation using optical remote sensing data.
- Turbidity level of open water: A layer pertaining to a qualitative turbidity rating is generated. Three qualitative turbidity ratings or levels (low, medium and high) were assigned to pre-monsoon and post-monsoon waters of all water bodies, which include lakes, reservoirs and other large water bodies.
- Small water body (smaller than minimum mappable unit) are mapped as point features.
- Base layers like major road network, railway, settlements, and surface drainage are updated from the current image and taken from other SOI database and distribution of water bodies and their status in the area.

Result Discussion & Conclusion

As we know our limitation to combat drought, neither we can increase rainfall nor minimize the population growth. Only the way is to know our resources and manage them properly. Present study indicates that the total numbers of water bodies in these 6 Bundelkhand

districts of Madhya Pradesh, (India) are 1015. (Table 1) In addition 258 other water bodies smaller than 56.26 ha could be detected. The water spread, as observed by analysis indicates that during post-monsoon season water spread is 38438ha, and 14322 ha during the pre-monsoon season in Bundelkhand region. Thus there is very wide variation of water spread during the course of year. Tikamgarh is noticed as the largest water spread area during post monsoon 7171 ha and 2845 ha during pre-monsoon period. (Table 2). This is 2.34% of total geographical area of the Tikamgarh district.



Under the water bodies categories there are 57 lakes 134 reservoirs and 824 tanks in the Bundelkhand region of MP (India). Tank/Pond ranks 1st and occupy 824 in number while Reservoirs occupy 134. (Table 1)

Table 1. District-wise area of Water bodies (type-wise) in Bundelkhand

| District | Geographic Area (Sq Km) | Water Bodies Types | | | | W B <2.25 ha | Total |
|--------------------------|-------------------------|--------------------|--------------|-----------|-----------|--------------|-------|
| | | Lake/Pond | River Stream | Reservoir | Tank/Pond | | |
| Datia | 2694 | - | 26 | 2 | 8 | 258 | 10 |
| Tikamgarh | 5055 | - | 74 | 24 | 136 | 258 | 160 |
| Chhatarpur | 8687 | - | 83 | 39 | 156 | 258 | 195 |
| Panna | 7135 | 16 | 67 | 12 | 148 | 258 | 176 |
| Sagar | 10252 | 41 | 66 | 32 | 296 | 258 | 369 |
| Damoh | 7306 | - | 60 | 25 | 80 | 258 | 105 |
| Total No of water bodies | | 57 | | 134 | 824 | 258 | 1015 |

Table 2. District-wise area of Water bodies in Bundelkhand

| District | Geographic area (Sq Km) | Wetland area (Ha) | % of total wetland area (Ha) | % of district geographic area (Ha) | Open Post-monsoon (Ha) | water Pre-monsoon (Ha) |
|------------|-------------------------|-------------------|------------------------------|------------------------------------|------------------------|------------------------|
| Datia | 2694 | 3337 | 0.41 | 1.24 | 2158 | 273 |
| Chhatarpur | 8687 | 15221 | 1.86 | 1.75 | 8214 | 3475 |
| Damoh | 7306 | 10532 | 1.29 | 1.44 | 6910 | 3706 |
| Panna | 7135 | 10529 | 1.29 | 1.48 | 4947 | 2084 |
| Sagar | 10252 | 14506 | 1.77 | 1.41 | 9038 | 1939 |
| Tikamgarh | 5055 | 11849 | 1.45 | 2.34 | 7171 | 2845 |

Turbidity wise, analysis of water bodies of the study area is shown in Table 3. Area of water spread with low turbidity, moderate turbidity and with a very high turbidity has been

calculated. By the analysis we can say that most of the water bodies come under moderate turbidity class. High turbidity water spread area increases in pre-monsoon period and reaches up to 1781 ha. These highly turbid water bodies should be given special attention to make them pollution free.

Table 3. District-wise area of Turbidity in Water bodies of Bundelkhand

| District | Turbidity (Post-monsoon) | | | Turbidity (Pre-monsoon) | | |
|------------|--------------------------|---------------------|-------------------|-------------------------|---------------------|-------------------|
| | Low Area in (Ha) | Medium Area in (Ha) | High Area in (Ha) | Low Area in (Ha) | Medium Area in (Ha) | High Area in (Ha) |
| Datia | - | 2150 | 8 | - | 258 | 15 |
| Chhatarpur | - | 8149 | 65 | - | 3191 | 284 |
| Damoh | - | 6831 | 79 | - | 3677 | 29 |
| Panna | 507 | 4277 | 163 | 225 | 1806 | 53 |
| Sagar | - | 8865 | 173 | - | 882 | 1057 |
| Tikamgarh | - | 7082 | 89 | - | 2502 | 343 |

Study also includes spread area of aquatic vegetation in pre and post-monsoon period showing result in Table 4. About 6291 ha area is covered by aquatic vegetation in post-monsoon and 2589 ha area is covered in pre-monsoon period. In post-monsoon period, Chhatarpur district shows the largest aquatic vegetation cover area.

In view of above study, we can say that the region is full of surface water resources. The only thing is to give attention and manage these assets properly in such a way that their water holding capacity and their life can be

Table 4. District-wise area of Aquatic Vegetation in Water bodies of Bundelkhand

| District | Aquatic Vegetation | |
|------------|--------------------------|-----------------------------|
| | Pre-Monsoon Area in (Ha) | Post – Monsoon Area in (Ha) |
| Datia | 64 | 54 |
| Chhatarpur | 1086 | 2710 |
| Damoh | 301 | 1182 |
| Panna | 269 | 290 |
| Sagar | 332 | 747 |
| Tikamgarh | 537 | 1308 |

increase for the peak summer or drought period.

- 1- Most of the part of water bodies is infested by thick growth of macrophytes which reduce the lake volume, carrying capacity in term of fisheries. The concerned authorities may chalk out an action plan to eradicate water plants from the system.
- 2- Cleaning of water bodies by means of machines can also be proposed.
- 3- It is very much required to decide whether the water body should be used for drinking purpose or not. If the water body is used only for drinking purpose, dredging is very much required at number of places to increase the water holding capacity.
- 4- Massive de-siltation programmes (ondams) should be launched to improve the water holding capacity and to promote the aquatic life of the water body.
- 5- The river water bed and the bank profile should be built-up with a filter to hold, over size particles, dirt etc.
- 6- Unauthorised agricultural practices should be prohibited in the lake bed and adjacent

agricultural land which influences the sedimentation within and be replaced by afforestation.

- 7- All types of dirt/ sewage water reaching the water body from adjacent residential areas must be diverted, treated and recycled.
- 8- All efforts should be made to use economic use of water throughout the year and to keep our surface water assets reserve for peak summer and drought situation.
- 9- Cropping pattern of the Bundelkhand region needs reconsideration. A crop requires less water should be promoted instead traditional pattern.

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