Water Crisis in the Bundelkhand Region: An Observation

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Abstract. Bundelkhand region is getting an average annual rain of about 1000 mm, almost about 90\% of its within two months of July and August and drained by major rivers. But in this region, there is a water crisis due to an increase in agriculture, population, vagaries of rainfall, climate change, political issues, mismanagement of water, misuse of water, and negligence of the environmental problems, neglect of traditional sources of water resource etc. In the present study, the issues related to water scarcity are identified, and remedial measures are suggested to improve this region's water resources. If these measures are adequately implemented, the water crisis of the study area will be diminished.

Key words: Water crisis, Bundelkhand region, Water resources.

1. Introduction
Water is considered as one of the essential commodities for human beings. Safe drinking water became a basic need for human beings. However, there are lots of people who are not able to get sufficient potable safe drinking water. Studies show one of the causes reported related to infant mortality has resulted from the conception of polluted water for drinking purposes [1, 2, 3, 4]. Global count on water consumption shows that over one billion people are forced to rely on unsafe drinking water sources for their drinking purpose [5, 6]. The major factors that control groundwater quality in any area are the rocks and soil through it moves and its location concerning other surface water bodies like lakes, streams, tanks, canals, and nearby industrial establishment [7, 8]. Therefore, It is essential to identify the polluted zone concerning their lateral and vertical extent and the composition of the water [9] to evolve a scientific basis for the development and management of groundwater resources in different situations concerning groundwater quality. Lack of knowledge about groundwater quality in a particular area, the quantity of available groundwater for any purpose, leads to hazards for animals, plants, and human beings.

The Bundelkhand region is confined between 23°10' and 26°27' North latitude and 78°4' and 81°34' East longitude; however, its areal extension is beyond this region. It partially touches several adjacent districts, namely Gwalior, Bhind, Shivpuri, Morena, Narsinghpur, Hoshangabad, Guna, Jabalpur, Satna. Yamuna, Narmada, Chambal surround it, and Tons river, respectively in the North, South, West, and East and falls in India's central zone.

The Bundelkhand region is drained by its perennial rivers, tributaries, and seasonal nalahs, bringing all the water, including the rainwater to the river in the north. The major rivers of the area are Betwa, Sind, Dhasan, Son, Chambal, Ken and Tons, etc. The general slope of the area is towards the
northeast. During the summer season, the maximum temperature is 45 °C, and in the cold season, it is 5°C. In general, the climate is pleasant in this region.

The area is gifted by its pleasurable natural resources, including beautiful mountain, good perennial rivers, fast-flowing seasonal rivulets, springs, waterfalls, large forest areas with traditional timber, tendu, and herbal plants, and rich fertile soil. It has homogeneous dissected upland, presenting an old eroded surface. It also has good mineral wealth. There are two types of soils: (a) red soil and (b) black soil, present in this region. This specialty of the area attracted the researchers, and tempted them to explore the land for different research purposes [10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26].

2. Geology and Hydrogeology
The Bundelkhand region is mainly comprised of geological formations such as Bundelkhand granitoid complex, metasediments and metabasic, Bijawar group, Vindhyan supergroup, Deccan Traps, and Alluvium. The granite gneisses and migmatite are closely associated with schistose rocks and meta-sedimentary mainly comprise quartzite, quartzose-schist and quartz sericite schist. The metasediments and metabasites, which occur as enclaves within the granitic rocks, form good exposures in Mahroni tehsil of Lalitpur district. The metabasites are represented by peridotite, serpentinite, pyroxenite and amphibolite rocks. The scattered small exposures of these rocks are also found at many other places. These rocks occur in Jhansi, Lalitpur, Datia, Sagar, Chhatarpur, Tikamgarh, Panna, and Banda District of Bundelkhand region. Bijawars consisting of limestone, dolomite, quartzite, shale, sandstone, banded hematite quartzite, basic dykes, and lavas are exposed in a narrow zone in the south of the granitoid complex. Vindhyan Supergroup mainly consists of sandstone, limestone, and shale. Deccan Trap of the area contains basalt with intertrappean beds that occur in Sagar, Damoh, and Panna district. They are exposed in the form of flat-topped hills, plateaus, and conical hills. Lametas consisting of limestone, clays, etc. are found in Sagar and Damoh districts of the Bundelkhand region are fossiliferous and overlain by Deccan Trap rocks. The alluvial deposits of the area consist of sand, silt, gravel, clay etc., that occur along the banks of the river of the Bundelkhand region such as Datia, Jalaun, Mahoba, Jhansi, and Banda.

The Bundelkhand region's groundwater scenarios mostly occur under unconfined aquifers conditions in hard terrain due to secondary porosity permeability. There is an occurrence of unconfined and confined aquifer's conditions in the alluvial condition. The groundwater is abstracted by large diameter open dug wells, tube wells, and hand pumps. Groundwater occurs in sand and gravel horizons of alluvial formations and weathered portion of granite, basalts, jointed and fractured sandstone, and cavernous limestone. The wells' yield in alluvial formation is more than the yield of wells in the hard rock terrain due to overexploitation of groundwater, and the water table is depleting year after year. The quality of groundwater is also degraded, and there is a shortage of safe drinking water in this region.

3. Problems in the Bundelkhand region
The recorded annual average rainfall of the region is about 1000 mm, which shows a positive and negative variation. Ninety percent of the annual rainfalls of the area receives during July and August. The high intensity of rain scarcely leaves any time for the water to infiltrate to the soil. The less density of the forest cover in the region inversely affects the water's infiltration and groundwater recharge. This itself causes the unusually high water runoff rate gushing towards the north, creating deep gorges and rapids because of the Vindhyan plateaus flanked by high cliffs. Hence, despite the sufficient rainfall, this region-particularly its southern and central parts, forming the district of Sagar, Damoh, Panna, Tikamgarh, and Chhatarpur, face more problems of water depletion. According to CGWB, the Government of India, almost 59.317 MCM (84.72%) precipitation goes as surface runoff and 10.691 MCM (15.28%) get infiltrates total 70.008 MCM.

4. Methodology
This study mainly focused on understanding the causes of water crises, perception of the people, mechanism of maintenance of these sources, agricultural practices, etc., by conducting an extensive survey on the forest cover, floods and drought situation, water supply through other modes, traditional relevant practice, specific problems of the area, and the Governmental efforts in this direction. The
source of water for drinking and irrigation was collected and evaluated along with perceptions of villages people about the roots of their water problems were also surveyed, which can mitigate or solve these problems.

5. Results and Discussion
The surveyed facts that received from the local people side, which contains their views in relation to the situation of water, its problems, potential, and the possible solutions as predicted by them which are mentioned as follows-

- The available average rainfall of the region is recorded as 1000 mm, which is considered a sufficient amount per the region, but the sporadic nature of precipitation results in frequent flood and drought conditions. This condition indicates the lack of knowledge on water resources management in this region, especially the precipitation. Hence, the southern and central part of the regions forming the districts of Sagar, Damoh, Panna, Tikamgarh, and Chhatarpur face more water depletion problems, regardless of the sufficiency of rainfall.
- The high rate of soil runoff, especially in the middle segment of the long stretched rivers, where many down flowing streams conjoin to lend even greater force to the surging waters. The softer formations-the ancient alluvial deposits in this segments-contribute to this higher soil runoff rate, creating ravines which look like giant ugly pockmarks on the once-lovely Bundelkhand’s landscape.
- Another notable fact about the rock formation of the Bundelkhand is the extensiveness of impermeable base rocks at shallow depths. The same prevents the down flowing of water to the deep, i.e., subsurface. This conduces to the formation of subterranean flow-channels in many areas.
- In the Bundelkhand region, due to the occurrence of hard rocks, groundwater occurs in the fractured and jointed granite and gneiss, which is very difficult to investigate. The high evaporation loss of surface water in this region is also a difficult problem.
- A study about the soil character of the region concluded that they have low water holding capacity. In contrast, the poor distribution of the drainage on it results in water logging instead of infiltration. This nature of the soil leads to undulating topography and ravine-formation, which increases the rate of surface water runoff and reduces the water storage capacity.
- It is interpreted that the region's water scarcity might be caused by the distribution of different environmental factors such as rocky surface, high temperature, fast runoff of water, lowered groundwater table, and deforestation of the upper slopes.
- It is the locality's culture in the region to develop ponds to help the residents fulfill their domestic water-needs without considering the area's local condition. These uncontrolled activities of the localities over local natural resources, the introduction of canal irrigation, and the destruction of forests began to cause the decaying of the area's water resources and its decline.
- The habit of exploiting the resources’ exceptionally extensive deforestation of the Bundelkhand localities has been incorporated since British rule. The continuation of this swadeshi regime since then is the root of all sufferings of this region.
- Besides these natural killing activities, there is another kind of human activity, i.e., mining is also taking place, severely reducing water availability and leading to its pollution.
- A profound observation regarding groundwater quality triggered by the elevated concentration of fluoride in some of the Bundelkhand districts has been reported while surveying the region's villagers.

The big picture derived from the survey and evaluation of the observed facts point out that the water crisis problem is not the shortage of rainfall, but its availability, which irregular both in space and time. Moreover, the region suffers from over-runoff and a high evaporation rate due to harsh climatic conditions rather than insufficient rainfall. The problem also lies in people's attitude towards the violation of rules on forest resources, in the form of forced appropriation, centralization, and
commercialization of all-natural resources by the government and destruction of the traditional culture of local community-controlled water resources.

The question arises, why is there water scarcity in this region? To answer this question, we found many reasons which are mentioned here. There is a lack of reservoirs for storage in the Bundelkhand, and water conservation is not in practice. Rainfall is uneven over the year. There is a lack of water conservation awareness among people and a careless attitude towards water use and water crises.

The following reasons become apparent for the existing water crises in the Bundelkhand region based on exhaustive study and analysis of people’s perceptions during the field-survey and discussions with distinguished scientists and technologists.

5.1 Geo-Meteorological Characteristics of Bundelkhand
There is insufficient groundwater recharge in the Bundelkhand region due to speedy runoff of surface water and low intensity of the short rain-spell. High evaporation of the surface water due to bare plateau-areas. Most of the Bundelkhand region comprises hard rocks that are inappropriate for harnessing groundwater potential.

5.2 Altering the attitude of Civilians as well as Government towards the Traditional Water Harvesting System
In the Bundelkhand regions, there is total negligence of traditional water conservation structures and low priority to these in the Government planning. It is found the low upkeep decreased the capacity of these traditional water harvesting structures due to due to siltation. Encroachment of people on both the catchment areas and the ponds' beds for commercial exploitation, including construction activities, such as shopping complexes or certain posh colonies, decreases the spatial distribution of reservoirs. Besides, this poor caring of water resources leads to the degradation of water quality due to the growth of different types of aquatic weeds within the ponds, wastage of water from an artesian well, and alternate usage tanks as the garbage dumpsites etc.

5.3 Issues neglected at the Policy-Planning levels
In this region, it is found water that there is total negligence of local resources and traditions water management system in the name of development. Illogical and blind policies for short-term monetary gains related to ests, mines, mountains, rivers, etc. also raise water crises in this region. Lack of suitable scientific study before implementing projects related to roads, forests, and tube wells. Decreasing agriculture and changing cropping-pattern demanding intensive water for irrigation.

5.4 The Neglect of Environment Related Issues
There is widespread irrational exploitation of groundwater and a lack of long-term eco-friendly planning for resource utilization. There are enormous deforestation and indiscriminate and uncontrolled mining, increased urbanization. In the Bundelkhand region, centralized water supply systems are laying adverse load over the groundwater. There is the construction of dams and canals has increase soil-salinity and brackishness in the region. There is wastage of water due to uncontrolled mining. In the Bundelkhand region, due to water pollution, many health-problems arise.

5.5 Political Issues
Distribution of the region in two different politically two-state Uttar Pradesh and Madhya Pradesh negatively affects the management of resources and various political and administrative problems. This different political culture has partitioned the natural systems such as hills, rivers, watersheds in their aspects. There is a lack of a holistic approach to resolving issues that obstruct the equitable distribution of natural resources, including water, and create tension among the people of the two states.
6. Recommendations for solving existing water crises
There is a need for extensive afforestation in the Bundelkhand region. Development of various small ponds and some large tanks in each cluster of villages in the pediments, alluvial areas, and valley plains of plateau Areas will help to resolve the problem to a certain extend. Conversion of the Bavdis, Chohpuras, etc. into Masonry Wells, reviving the traditional culture of Jal-mandirs with a New understanding, is another method that can opt to get a positive result. Development of contour bunding on gently sloping terrain, shallow broad-area percolation tanks, narrow channels within the farms, proper rainwater harvesting, and artificial recharge system as per hydrogeological conditions can also improve the quantity and quality of water. Moreover, there is a need for an all-pervasive attempt to enhance the organic matter of the soil.

The feasibility of these methods is very high and can be implemented by people with cooperative efforts. The government, on its part, instead of spending the time and resources on ambitious projects, would redirect their focus on the local people who are the direct consumers of these natural resources and help people in the implementation of these measures on decentralized levels.

7. Recommendations for prohibitive measures
There is a strong need to implement proper regulation and reduce mining to have minimal impact on water resources. There is a need to ban the crushing of sandstone, granites, and basalt and quarrying of riverbank sand. Need to stop the wastage of water from flowing artesian wells. There is an urgent need to control the conversion of agricultural land into residential use.

Integration of the recommendations, as mentioned above, helps for the management of different elements of the ecosystem, to meet the needs of people in different situations in the most natural and inexpensive ways, supports the enhancement of the basement of the resources, and assists the harmonization between the man and nature.

8. Conclusion
It is concluded that there is a water crisis in the Bundelkhand region due to an increase in demand for water for irrigation, drinking, and small-scale industries and depletion of water resources and other environmental issues. If the recommended remedial measures are implemented, the water crisis will be reduced in the Bundelkhand region, and the socio-economic conditions of the people of this region will be improved.

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Acknowledgments
The authors are grateful to Prof. S. H. Adil, Head, Department of Applied Geology, Dr. Hari Singh Gour Central University, Sagar Madhya Pradesh, for providing the necessary facilities to carry out this work.