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Water Resource Management by QGIS in Baloda Bazar District, Chhattisgarh

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Abstract:

Baloda Bazar in the Chhattisgarh state of India is a semi-arid region with rising challenges concerning water scarcity. With the mounting need for water in agriculture, industrial processes—specifically cement production—and domestic consumption, pressure on available water sources has increased. The area is largely dependent on seasonal rain, groundwater, and surface water sources like rivers and ponds. Even this apparently auspicious water abundance has been jeopardized by unsustainable extraction policies, extremely irregular rainfall patterns, and industrialization. This research seeks to explore the present situation of the water resources in Baloda Bazar through analyzing their distribution, consumption patterns, and management policies. Groundwater, the support system of agriculture in the area, is severely stressed through over-withdrawals, frequently more than natural replenishments. This is clearly reflected in the continuous decrease in the water level in most areas of the district. Surface water resources, by contrast, are underutilized or deteriorating through pollution and siltation. The customary water management structures like village tanks, check dams, and community ponds have long served to manage water supply. These can be of great help in water savings and recharging when properly maintained. Deprivation of upkeep and modernization has decreased their efficiency in meeting today's water requirements. The article supports the transition towards sustainable management of water resources through the promotion of rainwater collection, artificial groundwater recharge systems, wastewater treatment and recycling, and active community engagement. It suggests that both traditional knowledge and modern scientific and technical approaches should be integrated to secure equitable distribution of water and long-term sustainability. Further, the research identifies a necessity for strong policy measures and extensive mass awareness programs to create a water conservation culture. By projecting Baloda Bazar as a typical case, this paper presents a model that can be modified for water resource management across other semi-arid areas with comparable environmental conditions, supporting overall sustainability of development.

List of Abbreviations

- GIS – Geographic Information System
- QGIS – Quantum Geographic Information System
- ISRO – Indian Space Research Organisation
- ULUE – Urban Land Use Efficiency
- T_HH – Total Household
- T_P – Total Population
- SC_P – Scheduled Castes Population
- ST_P – Scheduled Tribes Population
- WDC – Watershed Development Component

Introduction

Baloda Bazar, a leading district in the state of Chhattisgarh, India, is characterized by its agro-economic establishment and increasing industrial presence, especially as a key cement-producing hub. Water is essential in supporting the livelihood of rural people, industrial activities, and maintaining the ecological balance of the district. Nevertheless, the sustainable management of water resources in the district is challenged by numerous important issues.

Water Resources in Baloda Bazar

1. Surface Water:

The region is supplied by a series of small, seasonal streams and rivers that support irrigation and enable local ecosystems to survive. Monsoon rains greatly contribute to filling reservoirs, ponds, and other surface water storage, which is a help during times of drought.

2. Groundwater:
Groundwater is the main source of drinking water and irrigation in the majority of Baloda Bazar. It is abstracted mainly through tube wells and borewells. Yet, excessive extraction over the years has resulted in a consistent drop in the water table, creating long-term sustainability issues.

3. Rainwater
Being located in a tropical climatic region, Baloda Bazar is greatly dependent on monsoon rains for its yearly water supply. Thus, harvesting and utilizing rainwater through good rainwater harvesting methods is essential to combat seasonal water scarcity.

Limitations of Water Resource Management
Agricultural Dependence:
Agriculture is still the biggest user of water in the district. Conventional and inefficient methods of irrigation lead to excessive wastage of water.

Impact of Industries:
Cement factories are significant consumers of water and cause pollution of water, negatively impacting the quality of surface and groundwater.

Groundwater Depletion:
Over-extraction of groundwater, especially in regions with low rainfall, has resulted in an acute fall in water levels, jeopardizing long-term supplies.

Seasonal Water Shortages:
Irregularity in rain and lack of proper water storage facilities cause acute shortages during dry summer seasons.

Pollution and Waste Mismanagement:
Inappropriate waste disposal—both in urban and rural areas—results in the pollution of available water bodies, making the situation even worse.

Current and Proposed Water Management Practices
1. Rainwater Harvesting:
Encouraging roof and community-based rainwater collection systems for increased groundwater recharge and less surface runoff.

2. Better Irrigation Methods:
Promoting the use of drip and sprinkler irrigation methods to conserve water in agriculture.

3. Public Awareness Campaigns
Organizing educational programs and outreach activities to create awareness among citizens regarding the necessity of water conservation and efficient use.

4. Pollution Control Measures:
Enforcing effective controls on industrial effluent discharge and improving solid waste management systems to ensure water quality protection.

5. Infrastructure Development:
Construction and maintenance of check dams, reservoirs, and community ponds for water storage and supply during lean seasons.

Conclusion
Good water management is essential to Baloda Bazar's sustainable development, particularly considering its increasing population, agro-based economy, and growing industrial sector. Through incorporating indigenous wisdom with new technology, and through intersectoral cooperation among local communities, government departments, and industries, the district can ensure a long-term water security. Sustainable water use today will address present demands but also ensure this valuable resource for generations to come.

1.2 Objectives
In order to determine the prevailing availability of water in Baloda Bazar through the observation of surface water bodies, groundwater sources, and patterns of rainfall.

To investigate the key reasons behind water stress in the district, including excessive use in agriculture, industrial usage of water, pollution, and seasonal deficit.

To identify the significance of groundwater as the primary source of irrigation and potable water, and to analyze the consequences of its perennial depletion.

To revisit old methods of water conservation such as check dams, village tanks, and ponds, and determine how effective they still are in today's conditions.

To propose improved irrigation methods such as drip and sprinkler systems to minimize water wastage in agriculture.

To propose rainwater harvesting strategies which can be used to harvest monsoon water and recharge groundwater.

To ensure that people become more aware of saving water and utilizing locally available water resources efficiently, particularly in rural regions where there is greater dependence.
To offer practical recommendations for policy shifts, infrastructure development, and accountable industrial practices for longer-term water security.

1.3 Limitations
•Limited availability of data.
•Technical and software constraints.
•Climatic variations and uneven application of locally applicable policies.

1.4 Hypothesis
Remote sensing and GIS software (QGIS, Bhuvan data by ISRO, Google Earth Pro) were used to collect historical and spatial data in order to evaluate water resource trends and recommend management strategies.

Literature Review

Important References:
• Loucks & van Beek (2017): Stress planning and integrated stakeholder management.
• Gourbesville (2008): Demands a combination of structural and non-structural approaches.
• Hoff (2009): Urges policy coherence across scales for global water security.
• Mariolakos (2006): Recommends managing scarcity and floods together.
• McKinney: Created a GIS-based framework for water allocation.
• Bağdatlı (2024): Emphasizes GIS as a tool for monitoring water quality.
• Singh et al. (2014): Apply GIS to watershed analysis and planning.

Methodology

Study Area: Baloda Bazar District
• Established: 2012
• Blocks: Simga, Bhatapara, Baloda Bazar, Palari, Kasdol
• Wildlife Sanctuary: Barnawapara, diverse in flora, fauna, and rivers such as Mahanadi.

3.1 Agriculture and Irrigation
• Paddy prevails in agriculture.
• Chief irrigation: Mahanadi, Jonk, and Gangrel Dam canals.
• Seasonal Kharif and Rabi crops.
• Rainfed vs. Irrigated lands are analyzed.

3.2 Types of Soil
•Clayey soils: Retain water, suitable for paddy.
•Sandy soils: Need additional irrigation.
•Loamy, red, yellow, and black soils: Varied uses.
•Soil depth has an impact on irrigation and crop suitability.

3.3 Forest Cover Area
•Mainly tropical moist deciduous forests.
•Comprises teak, sal, bamboo.
•Essential for biodiversity, regulation of water, and livelihood.
•Conservation through afforestation and community initiatives.

3.4 Revenue Area & Hydrology
•Types of revenue land: Agricultural, residential, industrial, forest, water bodies.
•Hydrology: Surface water (Mahanadi & tributaries), groundwater (aquifers), rainfall-fed reservoirs.
• Challenges: Water scarcity, pollution, and inefficient irrigation.

Results and Discussion

Rainfall Trends:
• Simga Average Rainfall (2015–2021): ~1041 mm
• Pallari Average Rainfall: ~777 mm
• Peak rainfall: July–August
Irrigation Sources:
• Baloda Bazar and Palari rely heavily on canal irrigation.
• Simga and Bhatapara use wells/tube wells.
Water Storage Infrastructure:
• Total water storage capacity: ~68 million cubic meters
• Types: Pond renovation, check dams, percolation tanks, anicuts, gabions, etc.
Rainwater Harvesting Calculations:
• Pond (1 ha): Can collect ~13,500 m^3 of water/year.
• Stop dam (7 ha catchment): Potential ~29,345 m^3/year
• Borewell (200 m^2): ~84 m^3/year from runoff.

Conclusion

Water resources of Baloda Bazar are varied but stressed. Groundwater is exploited, and surface water is underutilized/polluted. By GIS-based analysis, appropriate planning of water storage and recharge works can contribute greatly to water availability and sustainability.

Recommendations

• Foster rainwater harvesting and artificial recharge.
• Restore traditional water systems such as ponds and tanks.
•puted irrigation (drip/sprinkler).
• Supervise groundwater pumping.
• Enhance local governance and community engagement.
• Implement GIS for long-term water management and planning.
It is presumed that Chhattisgarh's Baloda Bazar is semi-arid.

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