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IDENTIFICATION OF SUITABLE LOCATIONS FOR WATER HARVESTING STRUCTURES IN DODDABALLAPUR TALUK, BANGALORE, KARNATAKA USING GIS AND REMOTE SENSING

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ABSTRACT

This study presents a GIS-based Multi-Criteria Evaluation (MCE) approach to identify suitable sites for rainwater harvesting structures in Doddaballapur Taluk, Bangalore Rural District, Karnataka. Using thematic layers—geology, geomorphology, soil, LULC, lineaments, and drainage—generated through ArcGIS 10.0 and LISS IV satellite imagery, site suitability zones were mapped. Each layer was assigned ranks and weights based on their influence on groundwater recharge. The integrated output was classified into Excellent, Good, Moderate, Poor, and Not Suitable zones. The most suitable zones were found near Adkepalya, Kilaranahalli, and Bandammanahalli, where structures like check dams, recharge pits, and contour bunds are recommended. The methodology provides a cost-effective, scientifically validated alternative to conventional site identification techniques.

Keywords: GIS-Based Multi-Criteria Evaluation (MCE), Geomorphology, Remote Sensing, Water Harvesting

1. INTRODUCTION

Water scarcity, especially in semi-arid regions like Doddaballapur in Karnataka, poses a significant challenge to sustainable development and agricultural productivity. Rapid urbanization, industrial growth, and overexploitation of groundwater resources have widened the gap between water demand and availability. Traditional water management practices are increasingly proving insufficient in addressing these imbalances. Therefore, efficient and sustainable water resource management strategies have become imperative.

One promising approach involves the identification and development of suitable sites for artificial groundwater recharge. Artificial recharge is a process by which surface water is directed into the ground to replenish aquifers, especially during monsoon seasons. This process can mitigate the impacts of water scarcity by enhancing groundwater levels and ensuring availability during dry periods.

Geographic Information System (GIS) and Remote Sensing (RS) technologies provide powerful tools for the identification of suitable recharge zones. By integrating and analyzing spatial data such as slope, soil type, lithology, land use/land cover (LULC), drainage density, lineament density, rainfall distribution, and groundwater depth, researchers can create thematic maps that depict the hydrogeological and topographical conditions of the study area.

These thematic layers are assigned weights based on their influence on groundwater recharge potential using methods such as the Analytical Hierarchy Process (AHP) or Weighted Overlay Analysis (WOA). The layers are then overlaid using GIS techniques to generate a Groundwater Potential Zone (GWPZ) map, which highlights the most suitable areas for artificial recharge structures such as check dams, percolation tanks, recharge pits, and farm ponds.

This study aims not only to generate a scientifically sound recharge potential map but also to assist planners and local governing bodies in making informed decisions regarding water resource development. Ultimately, the integration of geospatial tools with hydrological expertise can lead to effective water harvesting strategies, improved agricultural resilience, and sustainable management of water resources in drought-prone regions like Doddaballapur.

2. LITERATURE REVIEW

Numerous national and international studies have demonstrated the effectiveness of GIS and Remote Sensing in water resource planning, particularly for identifying suitable sites for artificial recharge. Al-Dabbas et al. (2016) conducted a study in Iraq's arid regions using GIS-based spatial analysis to determine optimal dam locations for groundwater recharge, emphasizing the role of topography, drainage, and lithology. Similarly, Shalaby and Gad (2010) utilized integrated RS and GIS tools in Egypt to select dam sites in flash flood-prone areas, significantly contributing to groundwater replenishment and sustainable agriculture in desert terrains.

In India, Jaiswal et al. (2003) applied GIS techniques in a semi-arid region of Karnataka to delineate groundwater potential zones by analyzing slope, geology, and land use data, enabling the prioritization of watershed development efforts. Naik and Aher (2015) performed a comprehensive study in Maharashtra integrating remote sensing data and weighted overlay analysis to identify recharge zones, which guided the construction of check dams and farm ponds. In Goa, Prasad et al. (2017) used RS and GIS to assess rooftop rainwater harvesting potential, proposing decentralized recharge methods based on runoff and catchment characteristics.

Further, Magesh et al. (2012) applied the Analytical Hierarchy Process (AHP) within GIS to prioritize recharge zones in Tamil Nadu, demonstrating a reliable methodology for multi-criteria decision-making. Rahmati et al. (2015) in Iran combined machine learning with GIS to predict groundwater potential zones, illustrating the versatility of GIS across diverse climatic regions. Saraf and Choudhury (1998) were among the early adopters of remote sensing for groundwater targeting in hard rock terrains in India, laying the groundwork for modern GIS-based hydrological modeling.

These studies collectively highlight the growing reliance on geospatial technologies to support water management policies, particularly in areas experiencing hydrological stress. The consistent use of terrain, geology, drainage, and land use parameters across various contexts validates the robustness of GIS-based methodologies for groundwater recharge planning.

3. THE METHODOLOGY

adopted for identifying suitable groundwater recharge zones in the Doddaballapur region involved a systematic integration of both primary and secondary data sources. Primary data were collected through detailed field surveys, while secondary data were obtained from satellite imagery and Survey of India toposheets. High-resolution LISS IV satellite imagery and toposheets served as foundational resources for spatial analysis. The first step involved the preparation of a base map, which included the digitization of major physical features such as roads, rivers, and settlements using ArcGIS 10.0. Subsequently, multiple thematic layers relevant to groundwater recharge were developed, including geology, geomorphology, soil type, land use/land cover (LULC), lineament density, and stream order. Each of these layers was analyzed and classified based on their influence on groundwater recharge potential. A suitability score ranging from 0 (unsuitable) to 4 (excellent) was assigned to different features within each layer. These thematic layers were then overlaid using the Weighted Overlay Analysis technique in GIS to generate a composite map highlighting optimal zones for artificial recharge. This integrated geospatial approach enabled the precise identification of areas with high potential for implementing water harvesting and recharge structures.

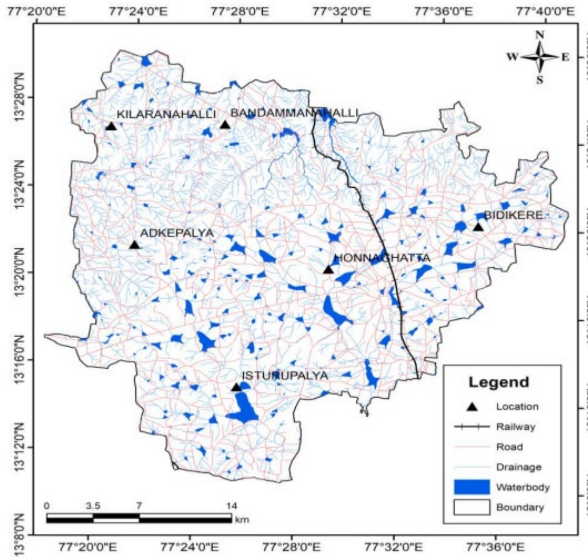

Figure 1 Base Map of Doddaballapur

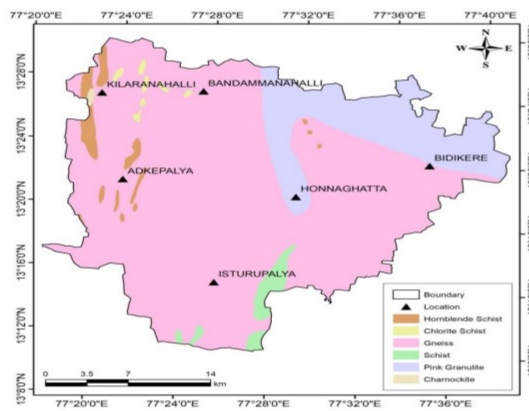

Figure 2 Geology Map

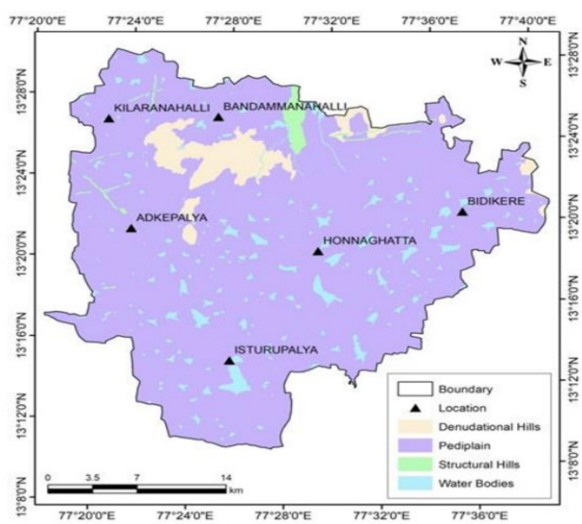

Figure 3 Geomorphology Map

4. RESULTS AND DISCUSSION

The thematic maps generated—comprising geology, geomorphology, soil type, land use/land cover, lineament density, and stream order—were overlaid using the Weighted Overlay Analysis tool in ArcGIS 10.0. Each thematic layer and its respective classes were ranked and assigned weightages in accordance with standard NRSC/IMSD guidelines, ensuring consistency and scientific rigor in the classification process. The final output was a site suitability map for groundwater recharge, which categorized the study area into five classes based on cumulative suitability scores. Areas scoring above 100 were classified as 'Excellent', with Adkepalya emerging as a highly suitable zone for artificial recharge interventions. Regions with scores between 60 and 100 were labeled 'Good', including Kilaranahalli, while those with scores between 40 and 60 were deemed 'Moderate', such as Bandammanahalli. Zones scoring below 40 were categorized as 'Poor', and areas with a score of 0—primarily reserved forests and dense built-up zones—were considered 'Restricted' and unsuitable for recharge structure development. This classification offers a spatially precise guide for prioritizing water harvesting interventions in the Doddaballapur region.

5. CONCLUSION

The GIS-based suitability analysis demonstrated its effectiveness as a powerful decision-making tool for identifying optimal zones for water harvesting in the Doddaballapur region. By integrating multiple spatial datasets and applying weighted overlay techniques, the study successfully highlighted Adkepalya, Kilaranahalli, and Bandammanahalli as the most suitable locations for implementing artificial recharge structures. Compared to traditional field-based surveys, this geospatial approach offers significant advantages, including higher spatial accuracy, cost-effectiveness, and the ability to synthesize diverse environmental and geological parameters. The use of GIS not only streamlines site selection but also enhances the scientific reliability of planning groundwater recharge interventions in semi-arid landscapes.

CONFLICT OF INTERESTS

None.

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None.

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