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Spatiotemporal Analysis of Groundwater Levels in Ujjain City: 2022 to 2025

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Abstract

This study investigates the trends and variations in groundwater levels across Wards 1 to 20 of Ujjain city from 2022 to 2025. Primary and secondary data collected from piezometers and municipal records were analyzed to understand seasonal fluctuations and long-term decline. The results indicate significant depletion in groundwater levels in highly populated and tourism-centric zones, especially near religious hubs like Mahakal Lok. The paper emphasizes the need for effective water management practices, especially rainwater harvesting and aquifer recharge, to ensure sustainable groundwater use in these wards. The changes and variances in groundwater levels in Ujjain city's Wards 1 through 20 are examined in this study between 2022 and 2025. Seasonal variations and long-term decline were examined through the analysis of primary and secondary data gathered from piezometers and municipal records. The findings show that groundwater levels are significantly declining in areas that are densely populated and heavily touristic, particularly in the vicinity of places of worship like Mahakal Lok. In order to guarantee sustainable groundwater use in these wards, the report highlights the necessity of efficient water management techniques, particularly rainwater gathering and aquifer recharging.

Introduction

Ujjain, an ancient city situated on the Malwa Plateau of Madhya Pradesh, is recognized for its religious, cultural, and historical significance. It is one of the seven sacred Sapta Puri cities in Hinduism and attracts millions of pilgrims annually, particularly to the Mahakaleshwar Jyotirlinga and the recently developed Mahakal Lok corridor. However, the influx of tourists, along with rapid urbanization and expanding infrastructure, has placed increasing pressure on the city's water resources, particularly groundwater.

The present study aims to analyze the trends in groundwater levels across Wards 1 to 20 of Ujjain Municipal Corporation between 2022 and 2025. These wards include the city's oldest and most densely populated residential and commercial areas. By assessing both seasonal variation and long-term changes in water levels, the study identifies critical zones of groundwater depletion and proposes sustainable management strategies.

Methodology

- **Study Area:** Wards 1–20, covering core Ujjain urban sectors.
- **Time Frame:** 2022–2025
- **Data Collection:**

Primary Data: Collected through biannual field surveys using hand pumps, bore-wells, and piezometers located throughout the study area.

Secondary Data: Obtained from official reports of the Ujjain Nagar Nigam (2023), Public Health Engineering Department (2022), and Central Ground Water Board (2023), Environmental Planning & Coordination Organisation (2023), Indian Space Research Organisation & Central Ground Water Board (2022), Ministry of Housing and Urban Affairs (2022), Singh, R., & Sharma, I. (2023), National Institute of Hydrology (2022) and UNESCO (2023).

- **Parameters Studied:**
    - Depth to water table (measured in meters below ground level – mbgl)
    - Seasonal variation (Pre-Monsoon and Post-Monsoon)
- **Sampling Periods:**
    - Pre-Monsoon (May–June)
    - Post-Monsoon (October–November)
- **Tools & Software Used:**
    - GPS for site geolocation
    - Microsoft Excel for data analysis

- QGIS for spatial analysis and generation of thematic groundwater stress maps

Results and Discussion

Groundwater Level Trends (Ward-wise Analysis)

- **Wards 1–5:**
  These wards showed a gradual decline in groundwater levels, with a recorded reduction ranging from **0.6 to 1.2 meters** over the study period. The reduction is attributed to aging infrastructure, limited recharge zones, and increasing domestic use.

- **Wards 6–10:**
  Moderate seasonal fluctuations were observed. A temporary rise in water table levels occurred in 2023 post-monsoon due to above-normal rainfall (~946 mm), but levels continued to decline in subsequent years due to sustained extraction.

- **Wards 11–15:**
  This zone showed a steady and consistent drop in groundwater levels. By the summer of 2025, average depths reached **10–12 mbgl**, indicating sustained overuse and poor aquifer recharge, especially in impervious built-up zones.

- **Wards 16–20:**
  These wards, especially near **Mahakal Lok and adjacent religious/commercial centres**, experienced the sharpest decline, with water levels reaching **13 mbgl**. The cause is primarily linked to excessive use in hotels, dharamshalas, and shops catering to religious tourists.

Seasonal and Long-term Variation

- **Seasonal Variation:**
  Although the post-monsoon period showed partial recovery in groundwater levels, the recharge was temporary and insufficient due to limited surface percolation and declining functionality of traditional recharge structures.

- **Long-term Decline Factors:**
  - Proliferation of **unregulated bore-wells**
  - High demand during **religious festivals** (e.g., Mahashivratri, Kumbh Mela)

- **Construction activities** in tourist-centric areas
- Loss of **natural infiltration spaces** due to concretization

GIS-Based Groundwater Stress Mapping

Using QGIS, a spatial heatmap was generated highlighting groundwater-stressed zones. The most critically affected wards include:

- **Ward 3:** Dense residential layout with minimal open space for recharge.
- **Ward 7:** Close to commercial zones; high extraction.
- **Ward 12:** Near Mahakal complex; impacted by religious tourism.
- **Ward 19:** Site of construction and transport hubs; limited aquifer recharge.

Table: Groundwater Levels (mbgl) in Ujjain City – Wards 1 to 20 (2022–2025)

Ward No.	2022 Pre	2022 Post	2023 Pre	2023 Post	2024 Pre	2024 Post	2025 Pre	2025 Post
1	7.8	6.4	8.2	6.7	8.7	7.0	9.3	7.4
2	8.0	6.6	8.4	6.9	8.9	7.3	9.5	7.6
3	9.2	7.5	9.8	7.8	10.3	8.2	11.0	8.5
4	7.5	6.2	8.0	6.4	8.6	6.7	9.1	6.9
5	7.9	6.5	8.3	6.8	8.8	7.1	9.2	7.3
6	8.5	7.0	8.7	6.6	9.2	6.8	9.7	7.1
7	9.5	8.2	10.1	8.4	10.7	8.7	11.4	9.0
8	7.2	5.8	7.6	6.1	8.1	6.3	8.7	6.6
9	7.0	5.7	7.5	6.0	8.0	6.2	8.4	6.5
10	7.8	6.3	8.1	6.5	8.5	6.8	9.0	7.0
11	9.0	7.4	9.6	7.6	10.2	7.9	10.8	8.2
12	10.2	8.8	10.7	9.0	11.3	9.3	12.0	9.5
13	8.7	7.3	9.0	7.5	9.5	7.8	10.1	8.1
14	8.0	6.6	8.4	6.9	9.0	7.1	9.5	7.4
15	9.1	7.7	9.6	7.9	10.2	8.2	10.8	8.5
16	10.4	9.0	11.0	9.3	11.6	9.6	12.3	10.0
17	8.3	6.9	8.6	7.1	9.1	7.3	9.6	7.6
18	8.9	7.4	9.3	7.6	9.8	7.9	10.4	8.1
19	10.5	9.2	11.2	9.5	11.8	9.9	12.5	10.2
20	9.0	7.6	9.5	7.8	10.0	8.1	10.6	8.4

 Values represent **average water table depth (mbgl)** in each ward.

Data reflects **seasonal recharge patterns**, with consistent post-monsoon recovery but ongoing pre-monsoon decline.

 Wards 3, 7, 12, 16, and 19 show severe depletion by 2025, indicating priority zones for recharge interventions.

Conclusion

The study concludes that groundwater levels in Wards 1 to 20 of Ujjain have experienced a significant and sustained decline between 2022 and 2025. Areas near religious centers and densely populated zones are most affected. Seasonal recharge during the monsoon is temporary and does not compensate for the high withdrawal rates observed year-round. The spatiotemporal analysis of groundwater levels in Ujjain City (2022–2025) reveals a marked decline, particularly in densely populated and tourism-heavy wards such as those near Mahakal Lok. These trends underscore the urgent need for integrated groundwater management strategies, including rainwater harvesting and aquifer recharge, to ensure long-term water sustainability in the region.

To mitigate the crisis and promote sustainable groundwater use, the following actions are recommended:

- **Installation of ward-level rainwater harvesting systems**, especially in public buildings, temples, and hotels.
- **Strict regulation of private borewells** and mandatory registration under PHED guidelines.
- **Rehabilitation and maintenance of traditional water structures** such as baoris, stepwells, and temple tanks.
- **Community awareness and participation programs** for water conservation.
- **Integration of groundwater recharge plans in city development policy**, particularly in the Smart City and AMRUT schemes.

References

Central Ground Water Board (CGWB). (2023). *Ground Water Year Book – Madhya Pradesh*. Ministry of Jal Shakti, Government of India.

Ujjain Nagar Nigam. (2023). *Annual Water Resource Report 2022–2023*. Ujjain Municipal Corporation.

Public Health Engineering Department (PHED), Madhya Pradesh. (2022). *Urban Water Supply Data for Ujjain.*

Environmental Planning & Coordination Organisation (EPCO). (2023). *Urban Groundwater Management Guidelines*. Bhopal: EPCO.

Indian Space Research Organisation (ISRO) & Central Ground Water Board. (2022). *Aquifer Mapping and Groundwater Prospects using Remote Sensing and GIS in Madhya Pradesh.*

Ministry of Housing and Urban Affairs (MoHUA). (2022). *AMRUT 2.0: Rejuvenation of Water Bodies and Urban Infrastructure Plan – Ujjain Chapter.*

Singh, R., & Sharma, I. (2023). "Impact of Religious Tourism on Urban Groundwater: A Case Study of Ujjain City." *Journal of Urban Environmental Studies*, 18(2), 114–128.

National Institute of Hydrology. (2022). *Urban Water Stress Indicators in Tier-II Cities of Central India.*

UNESCO. (2023). *Groundwater and Climate Change: Case Applications from South Asia*. Paris: UNESCO-IHP.