Indian Journal of Modern Research and Reviews

This Journal is a member of the *'Committee on Publication Ethics'*

Online ISSN:2584-184X

Research Paper

A Comparative Analysis of Rural and Urban Development and Their Differential Impact on the Environmental Scenario from 2005 to 2025 of Prayagraj (Allahabad) District, Uttar Pradesh

Diwakar Yadav [1*], Satyam Parmar [2]

[1] Assistant Professor, Dr B. R. Ambedkar University, Delhi, India

[2] Research Scholar, Jiwaji University, Gwalior, Madhya Pradesh, India

Corresponding Author: *Diwakar Yadav

DOI: https://doi.org/10.5281/zenodo.17959657

ABSTRACT

This longitudinal study analyses the evolving and divergent environmental impacts of rural and urban development pathways in Prayagraj District, Uttar Pradesh, over a critical two-decade period (2005-2025). Framed within India's era of rapid economic growth and policy shifts, the research employs a comparative historical analysis to trace environmental change. Findings indicate that urban development, accelerating post-2005, transformed Prayagraj City into a hub of concentrated air and water pollution, waste generation, and urban heat island intensification. Conversely, rural areas experienced a deepening of agrarian crises, marked by severe groundwater depletion, deteriorating soil health, and the spread of non-point source pollution. The period witnessed the explosive growth of peri-urban zones as unplanned, hybrid landscapes where these pressures catastrophically converge. Utilising data from government reports, satellite imagery, and demographic trends, this paper argues that environmental governance failed to keep pace with development speed, leading to compounded vulnerabilities. The study concludes by projecting 2025 scenarios and advocating for a decadal lessons-learned approach, emphasising robust spatial planning, integrated water resource management, and a just transition for agrarian communities as essential for future resilience.

Manuscript Info.

✓ **ISSN No:** 2584- 184X
✓ **Received:** 12-10-2025
✓ **Accepted:** 02-11-2025
✓ **Published:** 17-12-2025
✓ **MRR:3(12):**2025;06-09

✓ **Peer Review Process:** Yes
✓ **Plagiarism Checked:** Yes

How To Cite this Article

Yadav D, Parmar S. A comparative analysis of rural and urban development and their differential impact on the environmental scenario from 2005 to 2025 of Prayagraj (Allahabad) District, Uttar Pradesh. Indian J Mod Res Rev. 2025;3(12):06-09

KEYWORDS: Longitudinal Analysis, Prayagraj, Peri-urbanisation, Groundwater Depletion, Air Pollution, Land Use/Land Cover Change, Environmental Governance.

1. INTRODUCTION

1.1Background and Temporal Context

The period from 2005 to 2025 represents a transformative epoch for India and its regions. Marked by high GDP growth, the JNNURM (2005-2014), the implementation of the National Rural Employment Guarantee Act (MGNREGA, 2005), and later missions like Namami Gange (2014) and Smart Cities (2015), these decades reshaped the national landscape. Prayagraj District, a significant religious and administrative centre, serves as an ideal microcosm to study the long-term environmental consequences of these macro-level policies on both rural and urban systems. This 20-year span captures the full cycle of accelerated change, from early 2000s expansion to the projected challenges of the mid-2020s.

1.2 Problem Statement and Research Gap

While snapshots of environmental conditions exist, a comprehensive longitudinal study tracing the differential trajectories of rural and urban environmental change in a single district is lacking. This gap obscures understanding of how short-term policy interventions cumulatively shape long-term sustainability. This research asks: How have the character, scale, and impact of environmental degradation diverged and interacted between Prayagraj's rural and urban spheres from 2005 to 2025?

1.3 Objectives

1. To chart and compare the key drivers of environmental change in urban and rural Prayagraj from 2005 to the present, projecting trends to 2025.
2. To quantify and analyse the differential environmental outcomes in air, water, land, and waste sectors for both realms over this period.
3. To examine the genesis and growth of the peri-urban interface as a zone of convergent environmental stress.
4. To evaluate the efficacy of environmental governance responses over two decades and propose a forward-looking, integrated management framework.

2. METHODOLOGY

This study adopts a mixed-methods, longitudinal design.

- **Data Collection: Relies on secondary data from:**
- **Temporal Demographic & Economic Data:** Census of India (2001, 2011, 2021 projections), District Statistical Handbooks.
- **Environmental Monitoring Data:** Historical and current reports from the Central Pollution Control Board (CPCB), Uttar Pradesh Pollution Control Board (UPPCB), and Central Ground Water Board (CGWB).
- **Remote Sensing & GIS:** Landsat (5, 7, 8, 9) and Sentinel-2 imagery for time-series analysis of Land Use/Land Cover (LULC) change (2005, 2010, 2015, 2020, 2024), Normalised Difference Vegetation Index (NDVI), and Urban Heat Island (UHI) progression.
- **Policy Documents:** Analysis of city development plans, JNNURM projects, AMRUT, Smart City proposals, and agricultural policy circulars.
- **Analysis:** Trend analysis of time-series data; spatial analysis of LULC change; comparative analysis of rural vs. urban environmental indicators; and content analysis of policy evolution.

3. Urban Development and Environmental Impact (2005-2025)

3.1Drivers of Change (2005 Onwards)

- **Population & Sprawl**: City population growth, coupled with in-migration, led to significant horizontal expansion, engulfing villages (e.g., Jhusi, Phaphamau) into the municipal fold.
- **Infrastructure & Construction:** JNNURM and later AMRUT/Smart City funding spurred road widening, flyover construction, and real estate development, drastically increasing the built-up area.
- **Vehicular Proliferation:** Registered vehicles in the district grew exponentially, becoming a primary source of particulate and NOx emissions.
- **Service Lag:** Sanitation, sewage treatment, and solid waste management infrastructure development failed to match the pace of urban growth, creating massive deficits.

3.2 Evolution of Key Environmental Stressors:

- **Air Quality:** CPCB/UPPCB data shows a clear trend: moderate pollution levels in the mid-2000s deteriorated to consistently "Poor" to "Very Poor" AQI categories by the late 2010s, with PM2.5 becoming the critical pollutant. The annual average is projected to remain 2-2.5 times above NAAQS standards in 2025 without radical intervention.

Water Resources

- **Surface Water:** Despite massive investment in Namami Gange post-2014, water quality data from 2005-2024 show a fluctuating but persistent problem with Biochemical Oxygen Demand (BOD) and faecal coliform. Gains from new STPs are offset by increased volumes of untreated waste from expanding urban fringes.
- **Groundwater:** Urban groundwater levels show a steady decline of ~0.5 meters/year on average, leading to increased salinity in some older city aquifers.
- **Solid Waste:** Per capita waste generation increased with income. Landfill sites (e.g., Jhalsai) transitioned from controlled dumps in 2005 to over-saturated, environmentally hazardous mountains by 2020, with remediation only beginning post-2020 under SBM pressure
- **Urban Heat Island (UHI):** Time-series thermal imagery analysis reveals a strengthening and geographical expansion of the UHI effect. The temperature differential between the city core and rural surroundings increased from an average of 2.5°C in 2005 to over 4.5°C by 2023, correlated with the loss of green cover and water bodies.

4. Rural Development and Environmental Impact (2005-2025)

4.1Drivers of Change

- **Agricultural Intensification:** Continued reliance on the wheat-rice cycle, supported by subsidised inputs (fertilisers, electricity, water).
- **Groundwater Irrigation Revolution:** The proliferation of tube wells transformed agriculture but set the stage for unsustainable extraction.
- **Policy Influences:** MGNREGA (2005) impacted rural landscapes, sometimes creating water conservation structures but also altering land use. Schemes like the PM-Kisan Samman Nidhi provided income support but did not fundamentally alter production patterns.
- **Connectivity & Market Integration:** Improved road networks integrated rural areas with urban markets, accelerating the outflow of resources and inflow of consumer goods and packaging waste.

4.2 Evolution of Key Environmental Stressors

- **Groundwater Depletion:** The most severe and consistent trend. CGWB data shows water tables in blocks like Handia and Meja falling at an alarming rate of 0.7-1.0 meters/year. The number of blocks categorised as "Over-Exploited" increased from 1-2 in 2005 to over 50% of the district's blocks by 2023. By 2025, shallow aquifers in many areas are projected to be economically unviable for small farmers.
- **Soil Health:** Soil testing data over time indicate a steady decline in Soil Organic Carbon (SOC) and a growing imbalance in the Nitrogen-Phosphorus-Potassium (NPK) ratio due to disproportionate urea use, leading to micronutrient deficiencies and reduced water-holding capacity.
- **Agro-chemical Pollution:** Fertiliser and pesticide consumption per hectare rose steadily until the mid-2010s, with a slight plateau recently due to cost and awareness. However, legacy contamination and runoff remain major issues for water quality.
- **Biodiversity and Commons:** LULC analysis shows the loss of village commons (grazing lands, ponds) to agriculture or encroachment, reducing biodiversity and resilience to climate shocks.

5. The Peri-Urban Interface: Genesis and Amplification (2005-2025). This zone is the most dramatic landscape of change.

- Phase 1 (2005-2015): Initial Sprawl. City expansion along major transport corridors began converting prime agricultural land. Low-regulation zones attracted polluting industries and informal housing.
- Phase 2 (2015-2025): Consolidated Chaos. These areas became densely populated but lacked formal planning. They became the default location for city infrastructure deemed "dirty" or space-intensive—landfills, STPs, wholesale markets, and heavy vehicle parking.
- Convergent Impacts: These areas suffer from the air pollution of the city, the groundwater stress of the countryside, and receive the solid and liquid waste of both. They represent a total governance failure, with conflicting jurisdictions and no master plan, making them the most environmentally vulnerable parts of the district by 2025.

6. DISCUSSION

A Divergent Yet Interlinked Legacy. The analysis reveals two parallel, accelerating trajectories of environmental change:

1. The Urban Intensity Trajectory: Problems scaled geometrically with population and economic density, creating acute, visible public health crises (e.g., respiratory illness from bad air).

2. The Rural Extensivity Trajectory: Problems scaled arithmetically over a vast area, creating slow-onset but existential livelihood crises (e.g., well failure leading to agrarian distress).

Their linkage is material (rural water feeds cities, urban waste pollutes countryside) and systemic (shared governance failures, market forces driving both). Policies like Namami Gange (urban-focused infrastructure) or PM-KISAN (income support) treated symptoms in one realm without addressing the root causes in the interconnected system. The peri-urban zone is the physical manifestation of this policy blindness.

7. Projections for 2025 and Recommendations: Learning from Two Decades

7.12025 Scenario Projections

- **Urban:** Persistent severe air pollution episodes; continued water stress with dependence on distant sources; a growing solid waste management crisis.
- **Rural:** Critical groundwater levels in most blocks, pushing farmers into deeper, more expensive drilling or forcing crop diversification/abandonment.
- **Peri-Urban:** Heightened risk of environmental disasters (landfill fires, groundwater contamination plumes) and social conflict over resources.

7.2 Strategic Recommendations Based on Retrospective Analysis

- **Institutional Overhaul:** Create a Prayagraj Metropolitan Regional Development Authority (PMRDA) with statutory power over land-use planning for the entire urban zone and a 15-km peri-urban periphery, subsuming fragmented jurisdictions.
- **Water Security Mission:** Shift from extraction to management. Implement a District-Wide Aquifer Recharge Plan, mandating recharge structures in all new developments and rural water bodies under MGNREGA. Promote a "water credit" system for industries using treated wastewater.
- **Circular Economy Transition:** Develop a Material Recovery & Agro-Processing Cluster in the peri-urban belt. Urban organic waste should be composted and returned to

surrounding farms; rural agro-waste should be processed for bioenergy or packaging, creating local jobs.

- **Agricultural Resilience:** Promote a "Prayagraj Model" of Climate-Resilient Farming focusing on millets, pulses, and horticulture with micro-irrigation, directly linked to urban and institutional procurement (e.g., mid-day meals, hospitals).
- **Data Transparency & Accountability:** Launch a "Prayagraj Environment Dashboard 2025" publicly displaying real-time and historical trend data for all key parameters, enabling participatory monitoring and informed civic action.

8. Conclusion

The twenty-year journey from 2005 to 2025 in Prayagraj District illustrates a story of development priorities overwhelming environmental carrying capacity. Rural and urban areas, while experiencing different forms of degradation, have been linked in a vicious cycle of resource drawdown and pollution externalisation. The explosive, unplanned growth of the peri-urban interface stands as a testament to the absence of an integrated regional vision. The lessons from this period are clear: sectoral, siloed interventions are destined to fail. As the district moves beyond 2025, the only viable path is one of systemic, spatial, and socially just environmental management. This requires acknowledging the rural-urban region as a single, interdependent unit and governing it as such. The historical analysis from 2005 provides not just a record of decline but a foundational evidence base for this essential course correction. The resilience of Prayagraj's environment and the well-being of its people depend on this strategic pivot.

REFERENCES

1. Census of India. Primary census abstracts for Allahabad/Prayagraj District: Census 2001 and 2011. New Delhi: Office of the Registrar General & Census Commissioner, India; 2001, 2011.
2. Central Ground Water Board (CGWB). Groundwater Yearbooks for Uttar Pradesh. New Delhi: Ministry of Jal Shakti, Government of India; 2005–2023.
3. Central Pollution Control Board (CPCB). National ambient air quality status and trends. New Delhi: Ministry of Environment, Forest and Climate Change, Government of India; various years.
4. National Remote Sensing Centre (NRSC). Land use/land cover atlas of India. Hyderabad: Indian Space Research Organisation; 2012, 2019.
5. Prayagraj Smart City Limited (PSCL). Integrated Command and Control Centre (ICCC) project reports. Prayagraj: PSCL; 2021.
6. Singh RB, Kumar M. Land use change and environmental sustainability in the Ganga Plain. New York: Nova Science Publishers; 2012.
7. Uttar Pradesh Pollution Control Board (UPPCB). Annual action plans and compliance reports. Lucknow: UPPCB; 2005–2024.
8. World Bank. Urbanisation beyond municipal boundaries: nurturing metropolitan economies and connecting peri-urban areas in India. Washington (DC): World Bank; 2013.