

Impact on Air Quality, Water Resources and Land Use in Mahakumbh: A Geographical Analysis in The Reference of Prayagraj District, Uttar Pradesh

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ABSTRACT

In Mahakumbh, Prayagraj District of Uttar Pradesh has had a significant impact on air quality, water resources, and land usage, it's impact to population growth, industry, and rapid urbanization. This study investigates these effects, focusing on the environmental and socioeconomic implications. Vehicle emissions, industrial discharges, and construction activities have all contributed to increased levels of particulate matter and hazardous substances in the atmosphere. These pollutants exacerbate respiratory and cardiovascular health problems, particularly in metropolitan areas of the main city. Water resources are under significant strain, with unsustainable groundwater extraction outpacing natural recharge rates and extensive contamination of rivers and lakes from untreated sewage discharge. It has severely encroached on agricultural land, diminishing areas vital to security and changing ecosystems. The move from rural to urban areas has raised environmental concerns, such as biodiversity loss, the urban heat island effect, and hydrological imbalances. Government measures to address these issues, such as reviving water bodies and encouraging sustainable land use, have showed promise, but they confront problems such as community participation, security and effective execution. This study underlines the critical necessity for coordinated it's planning and policy approaches that might limit negative effects while accommodating growth. To balance development and environmental preservation, key proposals include tougher pollution regulations, the adoption of effective groundwater management procedures, and the protection of it's land. The findings underline the importance of a sustainable development framework that balances economic advancement, security of the people and ecological stability, ensuring a healthier and more resilient environment for upcoming people from the different areas of the country and other people upcoming from the other countries of the world. During the Kumbh Mela, a number of Ceremonies take place; the traditional Procession of Akharas called 'Peshwai' on Elephant backs, horses and chariots, the Shining swords and rituals of Naga Sadhus During 'Amrit Snaan, and many other Cultural activities that attract millions of Pilgrims to attend the Kumbh mela. It is situated in the North Indian State of Uttar Pradesh. Prayagraj is one of the fastest growing cities In India at present. It is located 205 kilometers south of the state capital, Lucknow. It is one of four sites of the mass Hindu Pilgrimage Kumbhmela, the others being Haridwar, Ujjain and Nashik. Every year in the Month of January Magh mela is organized at Sangam, while every six-year Ardh Kumbh and every twelve-Year Maha Kumbh is organized. It has a position of importance in Hindu scriptures for it is situated at Triveni Sangam, the confluence of the holy rivers Ganges, Yamuna and ancient Saraswati

River. Allahabad district has a population of about 60 lakhs while Prayagraj city has a population about 12 lakhs as per the 2011 census. It has literacy rate is 72.3% and an area of about 70 km. and is 98 mt. (322ft) above Sea level. Hindi, Urdu and English are the languages that are spoken in Prayagraj. The dialect of Hindi Spoken in Prayagraj is Awadhi, although Khariboli is most commonly used in the city area. Bengali and Panjabi are also spoken in some areas of the city. All major religions are practiced in the city. Major tourist Destinations are Anand Bhawan, Chandra Shekher Azad Park, Khusoro Bagh, Akhabar Fort, Nag Basuki Temple, All Saint Cathedral Church, High Court etc.

Keyword: Air Quality, Groundwater Depletion, Land Use, Environmental Impact, Prayagraj Mahakumbh Mela, Sustainable Planning, Mass Gathering.

Introduction

Due to this Mahakumbh Mela, it is the process by which people move from rural areas to urban areas in quest of greater economic opportunities and a higher standard of living. Projections indicate that by 2031, India's urban population would be around 600 million, accounting for 40% of the total population. Despite being mainly rural with villages at its core, India has witnessed tremendous urbanization in recent decades. Currently, urban regions are home to around 31.16% of the overall population. Mahakumbh Mela in Prayagraj District, Uttar Pradesh has had a significant impact on society, with both positive and negative outcomes. On the plus side, it has increased income opportunities, aided the construction of advanced transportation and communication networks, and expanded access to healthcare and spirituality. There are many developments in Prayagraj city have cumulatively raised living standards, improving access to key resources and general quality of life.

Furthermore, Mahakumbh Mela has accelerated industrial growth, which has considerably aided the country's economic development and prosperity as well as Uttar Pradesh. However, while it has fueled progress and modernity, it has also created issues such as overpopulation, environmental degradation, and infrastructural strain, needing long-term planning and management.

On the negative side, urbanization in India has created a number of difficulties that have a substantial impact on both the quality of life and the environment. One important concern is the rise of pollution, particularly air, water, and noise pollution, which has been compounded by increased traffic congestion. Deteriorating air quality has resulted in an increase in health issues such as respiratory ailments and cardiovascular disease, posing a severe public health risk. Furthermore, inadequate waste management and sewage systems have caused water pollution, endangering both the environment and human health. The Mahakumbh Mela has also resulted in a housing crisis, with a lack of cheap homes forcing many people into congested slums. These slums frequently lack basic utilities such as clean water, sanitation, and power, continuing the cycle of poverty.

It has also exacerbated socioeconomic inequality, as the gap between rich and poor continues to expand. Urban growth's economic gains are frequently unequally distributed, leaving marginalized areas with limited access to resources and opportunities. This imbalance has

destabilized the social fabric, leading to increased crime and social instability. Furthermore, the quick transition to urban living has resulted in a loss in communal bonds. The traditional sense of connectivity and mutual assistance that characterizes rural civilizations is frequently supplanted by a more individualistic metropolitan lifestyle, lowering people's inclination to assist one another. These problems highlight the importance of long-term planning and inclusive policies in ensuring that the advantages of mahakumbh are distributed evenly while mitigating its negative effects.

Objectives

- To study the Impact of Mahakumbh Mela on Air Quality.
- To study the Impact of Mahakumbh Mela on Water Resources.
- To study the Impact of Mahakumbh Mela on Land Use.
- To study the Impact of Mahakumbh Mela on Environment.

Literature Review

(Patra et al., 2018) This study aims to understand the spatial and temporal characteristics of urban growth and its implications for the hydro-meteorological parameters. It is often regarded as one of the most significant anthropogenic alterations of the environmental framework. Changes in land use and land cover (LULC) and the normalized difference built-up index (NDBI) calculated using GIS and remote sensing methods form the empirical basis of the article. The urban expansion process is characterized using conventional data and spatiotemporal satellite imagery, whereas LULC changes are analyzed using a K-Means based unsupervised classification technique. The spatial distribution of rainfall, temperature, and groundwater level analysis is performed using the inverse distance weighting (IDW) interpolation approach.

(Gupta and Singh, 2023) Cities are facing water stress due to rural-urban migration. As more and more people seek better prospects in cities, they already scarce water supplies are being further taxed. The issue is being exacerbated by factors such as urbanization and climate change. Changes in groundwater levels are directly tied to variations in the rate of urbanization. The rise of impermeable surfaces, which is a common feature of urban areas, might change the water availability over time. In this area, urban land is the norm. The purpose of this research is to calculate the amount of groundwater that will have been lost between 1995 and 2020 as a result of LULC. According to the study's findings, the average rate of urban growth in the studied region was 2.97 km²/year, and the depletion of groundwater was 0.67 mgbl/year. An examination of how changes in groundwater levels might affect the availability of drinkable water is presented In this paper. In addition, there are some useful takeaways from this study about groundwater management and the city's uncontrolled urban expansion.

Methods and Methodology

A secondary research technique forms the main basis of the methodology used to examine how urbanization has affected Uttar Pradesh's land use, water resources, and air quality. Peer-reviewed research publications, government studies, policy documents, environmental assessments, and statistical datasets accessible on official websites and academic platforms

were among the reliable sources from which the data was gathered. To find patterns, connections, and important information about the impacts of urbanization, pertinent research and publications were thoroughly examined. Quantitative information on land-use changes over time, patterns of water resource use, and air quality indices was available through government publications and environmental monitoring reports. The relationship between urban expansion and environmental changes in city area of Prayagraj district of Uttar Pradesh regions was evaluated using analytical comparisons due to Mahakumbh Mela in 2025 from 13th January to 26th February, 2025.

Result

Impact of Mahakumbh Mela on Air Quality in Prayagraj District

In Mahakumbh Mela of Prayagraj District of Uttar Pradesh, it has greatly exacerbated air quality issues, mostly as a result of increased building, industrial, and vehicle emissions. In the main city of Prayagraj, now it has extremely high levels of air pollution as a result of the state's fast economic growth and population expansion.

Air pollution sources

Vehicle Emissions: Especially in cities like Lucknow and Kanpur, the growing number of cars is a significant source of air pollution. Higher levels of particulate matter (PM), such as PM 2.5 and PM 10, which are detrimental to human health, are caused by increased traffic. (Mishra, 2024), (Sharma, 2022)

Industrial Discharges: Uttar Pradesh's industries emit a range of air pollutants. Inadequate pollution control methods in many factories are a major cause in the general decline in air quality. (Iqair, 2020)

Construction Activities: The air quality is further deteriorated by ongoing construction projects, which produce dust and other particulate matter. This is especially noticeable in places like Varanasi, where despite improvements in air quality measurements, more building has taken place. (Mishra, 2024)

Problems with Waste Management: When waste is burned in the open, harmful chemicals are released into the atmosphere. (Sharma, 2022), (Aqi, 2024)

Effects of Mahakumbh Mela on the Environment and Health in Prayagraj

Poor air quality in Prayagraj has serious negative effects on health:

Problems with the respiratory system: Cardiovascular disorders, respiratory illnesses, and other health concerns are associated with elevated PM 2.5 levels. Chronic health conditions can result from prolonged exposure to these contaminants, according to the World Health Organization (WHO). (Mishra, 2024), (Times, 2023)

Vulnerable Populations: People with pre-existing medical issues, the elderly, and children are more vulnerable to the negative effects of air pollution. Poor air quality in Prayagraj city has been linked to higher rates of respiratory conditions, according to studies.

Environmental Degradation: Wider environmental problems like biodiversity loss and climate change are exacerbated by air pollution. The quality of soil and water can be impacted by pollutants, which can further harm ecosystems and public health. (Iqair, 2020)

Status of the Air Quality Right Now

According to real-time statistics as of December 2024, Uttar Pradesh's overall Air Quality Index (AQI) is classified as "Unhealthy," with PM 2.5 levels hitting $129 \mu\text{g}/\text{m}^3$ and PM10 levels hitting $238 \mu\text{g}/\text{m}^3$ as well as in current Prayagraj Air Quality Index (AQI) is 58 Moderate level with real-time air pollution PM2.5 ($13 \mu\text{g}/\text{m}^3$), PM10 ($38 \mu\text{g}/\text{m}^3$), Temperature (13°C). This emphasizes how urgently sustainable urban design and efficient pollution control methods are needed. (Aqi, 2024)

The Effects of Mahakumbh on Water Resources in Prayagraj District

Urbanization in Uttar Pradesh has had a substantial impact on water resources, specifically groundwater levels and surface water quality. This analysis focuses on two crucial dimensions: groundwater depletion and contamination of rivers and aquatic bodies owing to urban trash.

Depletion of groundwater levels: The Mahakumbh Mela is experiencing serious groundwater depletion, which is mostly caused by rising urbanization and agricultural demands. It is significantly reliant on groundwater of its irrigation relying on this resource, accounting for roughly of total groundwater abstraction in Prayagraj district of Uttar Pradesh. (Sinha, 2021), (Ahmad, 2023)

High Extraction Rates: In metropolitan areas such as Ghaziabad, groundwater extraction has reached worrying levels, with the city apparently removing 123% of its total recharge last year, the highest among all Uttar Pradesh districts. This unsustainable extraction is worsened by industrial development and population growth, resulting in considerable water lable declines. (Jha, 2024)

Aquifer Stress: According to studies, towns such as Lucknow are experiencing irreversible aquifer depletion as a result of extraction rates that surpass natural replenishment capabilities³. The city's aquifers are apparently sinking at a pace of up to 4 cm per year, demonstrating the critical situation of groundwater resources under urban pressure. (Mondal, 2022)

Pollution of rivers and water bodies

It has not only taxed groundwater resources, but it has also resulted in severe pollution of surface water bodies.

Urban Waste Discharge: Rapid development and it have led to a rise in the discharge of untreated wastewater into rivers. This pollution jeopardizes both the quality of drinking water sources and the ecological balance of these bodies. (Ahmad, 2023), (Sengupta, 2024)

Impact on Water Bodies: Uttar Pradesh has roughly 245,088 water bodies, the majority of which are ponds. However, many of these have dried up or become polluted as a result of siltation and industrial waste. These bodies of water are deteriorating, which has an impact on local biodiversity and diminishes their ability to replenish groundwater. (Ahmad, 2023)

Government Initiatives: In response to these difficulties, the state government has launched a number of programs targeted at revitalizing waterways and promoting sustainable water management practices. Efforts include restoring old lakes and ponds as important freshwater sources. However, there are still obstacles in raising community awareness and engagement in these projects. (Ahmad, 2023)

The Effects of Mahakumbh Mela on Land Use in Prayagraj District

The Mahakumbh Mela in Prayagraj district of Uttar Pradesh has altered land use patterns, with agricultural land being particularly affected. These phenomena, caused by socioeconomic variables such as population increase and economic development, has far-reaching consequences for food security, environmental sustainability, and its planning. As cities grow, the delicate balance between its development and agricultural preservation becomes more insecure, necessitating immediate attention to ensure sustainable growth.

Key Findings

1.Urban Growth and Agricultural Land Use

The Mahakumbh Mela has been closely linked to the decrease of agricultural land in Prayagraj district of Uttar Pradesh. This transformation underscores an important trade-off: as cities expand to meet expanding population and infrastructural demands, fertile agricultural land is sometimes sacrificed. The conflict between urbanization and agricultural operations demonstrates the difficulties of managing land resources in quickly growing areas. (Sadaf Khan, 2019)

2.Drivers of Change

Population increases and economic development in Mahakumbh Mela are identified as the key drivers of its development in Prayagraj district of Uttar Pradesh. Increased over population has prompted the expansion of residential, commercial, and economical zones, which have frequently come at the price of its land.

Economic incentives, such as increased work possibilities and living standards in metropolitan areas, exacerbate this trend. This highlights the interaction of demographic and economic variables in affecting land use patterns. (Sadaf Khan, 2019), (Saumya and Rashmi, 2023)

3.Environmental Impacts

The transition from agricultural land to Mahakumbh Mela area has had substantial environmental implications. The conversion of farmland into concrete landscapes disrupts ecosystems, causing an urgent worry for natural vegetation and biodiversity loss. It also exacerbates the urban heat island effect, which raises surface temperatures and alters local weather patterns.

Hydrological effects, such as lower soil moisture and changed water flow, have also been reported in highly developed areas. These environmental consequences underline the importance of sustainable planning that balances development and ecological preservation. (Saumya and Rashmi, 2023), (Mundhe, 2024)

4.Future Implications

The growing urbanization in Prayagraj district of Uttar Pradesh presents severe problems about food security and environmental sustainability. As agricultural land becomes scarcer, local food production may suffer, jeopardizing farmers' livelihoods and the region's food security. Furthermore, loss of fertile land disturbs biological processes, posing long-term difficulties to biodiversity conservation and natural resource management.

Discussion

The study of Mahakumbh Mela's results part includes a detailed analysis of the effects in Prayagraj district of Uttar Pradesh on air quality, water resources, and land use. It has intensified air pollution, particularly through vehicle emissions, discharges, and construction activities, resulting in high levels of particulate matter and related health hazards such as respiratory and cardiovascular illness. Prayagraj's air quality is classified as "unhealthy," emphasizing the importance of sustainable development and pollution control measures.

In Prayagraj district of Uttar Pradesh's water resources are under tremendous strain as a result of unsustainable groundwater exploitation and river and lake contamination. Overextraction, particularly in metropolitan areas like Ghaziabad, has resulted in serious groundwater depletion, while untreated urban garbage has harmed the quality of surface water bodies. Efforts to revitalize water bodies continue, but community engagement remains a difficulty.

Land use patterns have changed considerably, with agricultural land being displaced by its projects. This shift jeopardizes food security, disrupts ecosystems, and leads to environmental concerns such as the urban heat island effect. Urban expansion, fueled by population growth and economic development, emphasizes the critical need for sustainable practices to conserve fertile land and maintain ecological equilibrium.

Conclusion

The Mahakumbh Mela in Prayagraj district of Uttar Pradesh has created economic opportunity and modern infrastructure while also bringing serious environmental and sociological issues. This study emphasizes the varied effects, particularly on air quality, water resources, and land use. Increased air pollution from vehicle emissions, industrial activity, and building has raised health concerns, particularly respiratory and cardiovascular diseases. Groundwater depletion

and contamination of water bodies, caused by excessive extraction and untreated waste disposal, endangers water security and ecological health.

Furthermore, its development has reduced agricultural area, jeopardizing food security and destroying biodiversity. While urban growth is necessary for economic prosperity, the study emphasizes the need of long-term urban development. Effective pollution control, groundwater management, and agricultural land preservation are critical to achieving a balance between it's development and environmental health. Policymakers must include ecological issues into it's design in order to develop sustainable city that suit the demands of their residents while not jeopardizing future generations.

References

1. Ahmad, F. (2023) 'How Uttar Pradesh is moving towards water sustainability'. Available at: <https://www.downtoearth.org.in/water/how-uttar-pradesh-is-moving-towards-water-sustainability-89979>.
2. Aqi (2024) 'Uttar Pradesh Air Quality Index (AQI) | Air Pollution'. Available at: <https://www.aqi.in/in/dashboard/india/uttar-pradesh>.
3. Berry, B.J.L. (2008) 'Urbanization', in *Urban Ecology*. Boston, MA: Springer US, pp. 25–48. Available at: https://doi.org/10.1007/978-0-387-73412-5_3.
4. Gupta, R. and Singh, D. (2023) 'Impact of Urbanization on Groundwater Level in Kanpur City, Uttar Pradesh', in *Integrated Water Resources Management for Quality Enhancement*. Grinrey Publishing, pp. 11–19. Available at: https://doi.org/10.55084/grinrey/ERT/978-81-964105-3-7_2.
5. Iqair (2020) 'Air quality in Uttar Pradesh'. Available at: <https://www.iqair.com/en/india/uttar-pradesh>.
6. Mishra, A. (2024) 'Curious case of squeaky clean Varanasi air — too few sensors, data collection gaps fan questions'. Available at: <https://theprint.in/environment/reports-say-varanasi-has-the-best-air-quality-among-cities-but-there-are-gaps-in-data-collection/2050298/>.
7. Mundhe, D.N. (2024) 'Impact of Urbanization on Land use/Land Covers Change Using Geo-spatial Techniques'. Available at: <https://spcollegepune.academia.edu/DrNitinMundhe>.
8. Patra, S. et al. (2018) 'Impacts of urbanization on land use /cover changes and its probable implications on local climate and groundwater level', *Journal of Urban Management*, 7(2), pp. 70–84. Available at: <https://doi.org/10.1016/j.jum.2018.04.006>.
9. Sarkar, R. (2019) 'Urbanization in India Before and After the Economic Reforms: What Does the Census Data Reveal?', *Journal of Asian and African Studies*, 54(8), pp. 1213–1226. Available at: <https://doi.org/10.1177/0021909619865581>.
10. Saumya, S. and Rashmi, K. (2023) 'Analysis of land cover change and urban heat islands of Lucknow, India', *International Journal of Sustainable Building Technology and Urban Development*. [Preprint]. Available at: <https://doi.org/https://doi.org/10.22712/susb.20230017>.

11. Sharma, M. (2022) 'Air Quality Assessment, Trend Analysis, Emission Inventory and Source Apportionment Study in the City of Kanpur'. Available at: https://kmc.up.nic.in/font/air_quality_report.pdf.
12. Sinha, R.S. (2021) 'State of Groundwater in Uttar Pradesh -A Situation Analysis with Critical Overview and Sustainable Solutions'. Available at: <https://cdn.cseindia.org/gic/state-of-ground-water-20210927.pdf>.