

Urbanization and Air Quality in Chapra (Bihar): Understanding the Dynamics, Impacts, and Mitigation Strategies

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Abstract : Rapid urbanization has become a defining feature of the 21st century, profoundly transforming landscapes, societies, and economies. However, alongside the benefits of urban development come significant challenges, including the deterioration of air quality. This journal article explores the complex relationship between urbanization and air quality, drawing on interdisciplinary research from environmental science, urban planning, public health, and social sciences. Through a comprehensive review of literature and case studies, this paper examines the drivers and impacts of urbanization on air quality, including emissions from transportation, industrial activities, energy production, and urban heat island effects. Furthermore, it investigates the disproportionate burden of air pollution on vulnerable populations in urban areas, such as low-income communities and minority groups. Finally, this article discusses innovative strategies and policy interventions for mitigating urban air pollution, promoting sustainable urban development, and fostering healthier and more livable cities in the face of ongoing urbanization trends.

Keywords: urbanization, air quality, pollution, transportation, industrial emissions, urban heat island, public health, sustainable development, policy interventions

INTRODUCTION

Chapra, a historically significant city in Bihar, India, has experienced rapid urbanization in recent decades, driven by factors such as population growth, rural-to-urban migration, and economic development. This urban transformation has brought about significant changes in the city's landscape, infrastructure, and socio-economic fabric. However, alongside the benefits of urbanization, Chapra has also grappled

with various environmental challenges, chief among them being air pollution.

Air pollution in Chapra is a complex issue with diverse sources and far-reaching impacts on public health, environmental quality, and overall urban livability. The dynamics of urbanization, including industrial expansion, vehicular congestion, residential energy consumption, and waste management practices, contribute to the generation and accumulation of air pollutants in the city. These pollutants, including particulate matter (PM), nitrogen oxides (NO_x), sulfur dioxide (SO₂), volatile organic compounds (VOCs), and ozone (O₃), pose significant risks to human health, exacerbating respiratory illnesses, cardiovascular diseases, and other adverse health outcomes among the city's residents.

Understanding the nexus between urbanization and air quality in Chapra is essential for devising effective mitigation strategies and sustainable urban development pathways. This paper aims to elucidate the dynamics, impacts, and mitigation strategies related to urbanization and air quality in Chapra, Bihar. By synthesizing existing research, empirical data, and stakeholder perspectives, this study seeks to provide a comprehensive understanding of the challenges posed by air pollution in Chapra and identify actionable solutions to address them.

Through a multidisciplinary approach that integrates insights from environmental science, urban planning, public health, and policy analysis, this paper will explore the following key aspects:

1. Dynamics of Urbanization: An overview of the patterns and drivers of urbanization in Chapra, including population trends, land use changes, industrial activities, and infrastructure

development, and their implications for air quality.

2. Impacts of Air Pollution: An assessment of the health, environmental, and socio-economic impacts of air pollution on the residents of Chapra, highlighting vulnerable populations, hotspots of pollution, and long-term trends in air quality.
3. Sources and Composition of Air Pollutants: An analysis of the primary sources and chemical composition of air pollutants in Chapra, identifying major emission sources, pollution pathways, and seasonal variations in pollutant levels.
4. Mitigation Strategies and Policy Interventions: A review of existing and potential mitigation strategies and policy interventions aimed at reducing air pollution in Chapra, including technological solutions, regulatory measures, public awareness campaigns, and community engagement initiatives.

By shedding light on the interconnected challenges of urbanization and air quality in Chapra, this paper seeks to inform evidence-based decision-making and foster collaboration among government agencies, civil society organizations, academia, and the private sector to promote sustainable urban development and improve the quality of life for all residents of the city.

2. Objectives

- Conduct a comprehensive literature review to synthesize existing knowledge on urbanization, air quality, and related issues in the context of Chapra, Bihar.
- Analyze demographic, land use, and socio-economic data to understand the patterns and drivers of urbanization in Chapra and their implications for air quality.
- Collect primary data on air quality parameters, including concentrations of pollutants such as particulate matter (PM), nitrogen oxides (NO_x), sulfur dioxide (SO₂), volatile organic compounds (VOCs), and ozone (O₃), using air quality monitoring stations and field measurements.
- Assess the health impacts of air pollution in Chapra through epidemiological studies, including the prevalence of respiratory illnesses, cardiovascular diseases, and other

adverse health outcomes among the population.

This study work is based on the collection of secondary sources of data, which have been observed and collected from various books, journals, and government authorises websites & reports like census reports, District census handbook Gaya, C.D.P. Chapra Bihar census report, M.S.M. report Chapra Bihar state pollution control board etc. Reasons for Urbanization- Cities and towns have always been a big attraction for people, especially from the rural areas of our country. The increasing trend of the urban population is due to the following reasons:

- Better employment facilities, medical facilities,
- Better facilities for trade and commerce,
- Better facilities for higher education,
- Facilities for entertainment, sports & games,
- Proximity to administration and important government offices.

Due to these reasons, such an increase in the urban population induces several environmental problems [4].

Significant problems of Urbanization-

The rapid growth of urban population both natural and through migration, has put heavy pressure on public utilities like housing, sanitation, transport, water, housing, sanitation, transport, water, electricity, health, education, and so on.

Impact on Atmosphere and Climate-

1. The creation of heat island- In the city of Gaya, Materials used like concrete, asphalt, bricks, etc. absorb and reflect energy differently than vegetation and soil. The city remains warm at night when the countryside has already cooled.
2. Changes in Air Quality- Due to various Human activities occurring around the city release a wide range of emissions into the environment, including carbon dioxide, carbon monoxide, ozone, sulphur oxides, nitrogen oxides, lead, and many other pollutants.
3. Changes in Patterns of Precipitation- Compare to the last decade City often receives more rain than

the surrounding countryside since dust can provoke the condensation of water vapour into rain droplets.

Pollution-

- a) Air pollution- The air of urban areas gets polluted by a tremendous amount of harmful substances due to a lot of anthropogenic activities. The high number of motor vehicles, Industrial processes, and tree reduction are primary reasons for urban air pollution. emission of harmful gases like CO₂, CH₄, SO₂, NO₂, CO etc., from industries, motor vehicles, and kitchens disrupt the basic structure of the atmosphere. There is a creation of pollution domes over the urban areas because of the accumulation of a large number of gases, smoke, dust and many other pollutants.
- b) Noise Pollution-The noise produced by automobiles, vehicles, social functions, industries, etc., causes noise pollution in urban areas which causes psychological and physical ailments.
- c) Water pollution- The water quality has degraded with time due to urbanization that which ultimately leads to increased sedimentation thereby also expanding the pollutant in run-off [5]. The disposal of human wastes as well as from industries directly into the water bodies has increased water pollution in urban areas.

2. Impacts on The Hydrosphere and Water Resources

Most of the city’s population is dependent on underground water directly and indirectly for drinking, cooking, washing, carrying away waste, and other domestic & economic activities needs. Most of the water pumping stations are installed along the river bank for water supply to the town. Due to urbanization and population growth in the city, encroachments have been done on either side of the Ganga river , waste dumping, the flow of municipal waste & drainage water into the river, and illegal mining of sand from the river bed are affecting negatively the river ecosystem. The peculiar nature of Ganga river to absorb river water and maintain the groundwater level may be lost by illegal sand mining.

Table.1: Patterns and Trends of Urbanization in Bihar

Census Year	Urban Population	% of Urban the Population	Decadal Growth (%)
1911	13,22,953	3.44	-
1921	14,10,070	3.71	6.59

Urbanization, population growth, and pollution have a huge impact on significant ponds of Gaya, namely Bisar, Dighi, vaitarani, Ramsagar and, Suryakund. After a study of these ponds' water, the WQI; value of more than 130 reveals that ponds are facing heavy pollution. The pond's water and sediments are heavily contaminated with trace metals like cobalt and lead in sediments [6]. Gov. Of Bihar’s project named Ganga water lift project construction work is ongoing. The main objective of the project is to supply Ganga water through a pipeline to the Ganga river . there is being built a rubber dam in the river for the storage of water. It may be a life changer for Gayaites.

Chapra is situated on the bank of the Ganga river, which is a non-perennial river because the water flows for a few months during and after the rainy season; the rest of the year remains dry, but the river is the lifeline of the city.

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Urbanization in Bihar- A case study of Chapra
 Urbanization is a sign of development, but the unscientific process of urbanization impact negatively on the environment. It is a process of population concentration and refers to the changes in size, density, and heterogeneity of the city [9]. High urban fertility rates transform rural areas resulting in an increasing population in the past few decades population of Chapra city has been growing continuously.

1931	16,99,552	4.02	20.52
1941(after Orissa separation)	19,91,061	5.24	17.15
1951	27,04,731	6.72	35.84
1961	39,13,920	8.43	44.71
1971	56,33,966	9.99	43.95
1981	86,99,013	12.46	54.40
1991	1,13,14,994	13.1	30.07
2001(after Jharkhand separation)	86,79,200	10.47	-23.29
2011	1,75,58,016	11.29	35.47

Source: District census handbook, Chapra 1971,1981,1991,2001,2011 [10]

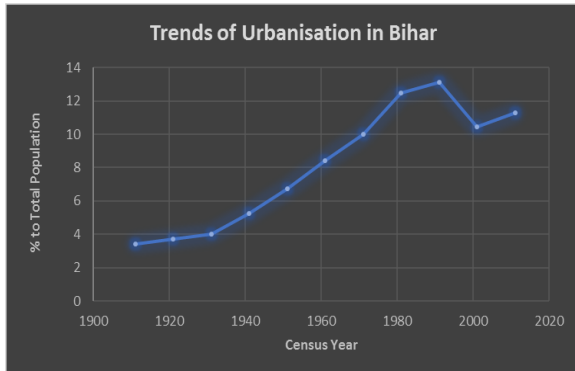


Fig No.2 showing: -Patterns and Trends of Urbanization in Bihar

As data are shown in table 1 above, the urbanization of Bihar has increased continuously from 1901 to 2011. The separation of Orissa and Jharkhand from Bihar decreased the urban population through population migration. As we can see, there is the highest population growth in the year 1981 and the lowest population growth in 2001 because of the Jharkhand separation

Status of Municipal Solid Waste Generation in CHAPRA (As per Census 2001 &2011)

Year	Total Population	Total Waste Generation (MT per day)	Per capita generation (kg per day)
2001	389192	234.3	0.3-0.4
2011	468614	275	0.59
2030(projected)	703250	415	0.6

Source: (i) Chapra CDP Report 2011[12].

(ii) Final CSP Chapra 2015[13]

It is clearly visible from table no. 4 that in Chapra waste generation works out to be 0.39 to 0.4 kg/capita/day during the last 10 decades. As the waste generation estimated by Chapra CDP 2011 & 2015, SPUR Cell is higher, therefore, for planning purposes the waste generation is estimated as per 0.59 – 0.6

kg/capita/day. As per latest information collected from SPUR Cell, the waste collected per day in Chapra is 234.3 MT/day and efficiency of waste collection is 90%, with which the waste generation works out to be 275 MT/day. Thus, for the target year 2030, with projected population of 703250, the waste generation works out to be 415 MT/day. II.

Table.3: Slum Population in Chapra (As per Census 2001 & 2011)

Year	Total Slum Population	No. of Households	Percentage of Slum Population
2001	18,881	2796	4.85%
2011	27,724	4793	5.91%

Source: (i) District Census Handbook, 2001&2011

(ii) Draft Master Plan 2027 [15]

With the help of table no.5 it is observed that as per Draft Master Plan 2027 referred to the Census of India 2001 there were 15 notified slum wards in Gaya, wherein 2796 households with 18881 population is living in slum like condition. It can be observed that

there is an increase in slum population from 4.85% to 5.91%.

III. GROWTH OF MOTOR VEHICLES IN GAYA- Over the years, there has been an increase in population and strengthened transport infrastructure triggered the growing number of motor vehicles on the

road in Gaya. Table 6. We can observe that the total no of registered vehicles from 10124 in the year 1980 to 4,46,863 in the year 2021 [16].

Table. 4: Growth of motor vehicles in Chapra

Year	Total No. Of Vehicles Registered
1980	10,124
2010	42888
2021	446863

Source: (i) Dept. Of Transport, Gov. Of Bihar 2021

As mentioned earlier, cycle, cycle rickshaw and pedestrians are important components of the composition of traffic in Gaya. Further in motorized vehicle two wheelers is the main modal choice. Table 6. Is showing that there is a rapid increase in total no of registered vehicles from 10124 in the year 1980 to 4,46,863 in the year 2021.

IV. AVERAGE AIR QUALITY INDEX OF CHAPRA

Air quality in Chapra city is getting worse due to population increase, growth of motor vehicles, heavy traffic, burning waste, construction and demolition increase, and use of fossil fuel for energy. According to an air quality database of 2018 released by WHO, Chapra has been declared the fourth most polluted city in the world in terms of PM 2.5 concentration. There was a worse condition with 149 micrograms per cubic meter of PM 2.5 concentration [17].

CONCLUSIONS

From the above data & analysis, we can conclude that there have been many adverse impacts on the environment due to continued urbanization. Urbanization causes several damages and creates problems which are dealt with every day. Intensive urban growth leads to water pollution, noise pollution, deforestation, global warming, air pollution & air quality degradation. Urbanization creates many opportunities for a better lifespan for newly rural migrants but due to unexpected urbanization, increasing population become a burden for the resources of the city. It leads to slum formation,

poverty, scarcity of potable water, overcrowding, hazardous diseases among city dwellers, etc. The study reveals that urbanization has affected the environment of Chapra city in many ways. Due to the ongoing expansion of the city, agricultural and forest cover lands are shrinking, and concrete infrastructure is being developed on fertile ground, and either side of the Ganga river . The city has become the most polluted city in terms of PM 2.5 concentration, and there is a shortage of water, overcrowding and slum development in the city. Roads of Chapra town are unable to bear huge traffic with the increasing number of vehicles day by day which causes jams and noise pollution. Major ponds and rivers of the city are being polluted by sewage from illegal settlements & industries and dumping of waste on the riverside.

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