



Impact of Population Growth on Environmental Quality in Aligarh City: A Quantitative Study

Dr. Jilani Khan Abbas

(Assistant Professor), Department of Geography, M.M. Kanya Mahavidyalay, Purdil Nagar,
Hathras, Uttar Pradesh .

Email ID- khana328655@gmail.com

Abstract: - Rapid population growth has become one of the major environmental concerns in developing countries, particularly in urban areas where increasing population density places significant pressure on natural resources and public infrastructure. Aligarh City, one of the fastest-growing urban centers in Uttar Pradesh, has witnessed considerable demographic expansion over the past two decades, resulting in increased environmental challenges such as air pollution, water contamination, solid waste accumulation, traffic congestion, and shrinking green spaces. The present study quantitatively examines the impact of population growth on environmental quality in Aligarh City. A structured questionnaire was administered to 300 residents selected through simple random sampling. Data were analyzed using descriptive statistics and Pearson correlation. The results indicate that respondents perceive rapid population growth as a major contributor to environmental degradation. The mean score for population growth was 4.18 (SD = 0.61), while the environmental quality degradation score was 4.02 (SD = 0.67). Furthermore, a strong positive correlation ($r = 0.741$, $p < 0.001$) was found between population growth and environmental pollution, indicating that increasing population significantly affects environmental quality. The study concludes that sustainable urban planning, effective waste management, afforestation, improved public transportation, and stricter environmental regulations are essential for maintaining ecological balance in Aligarh City.

Keywords: Population Growth, Environmental Quality, Urbanization, Pollution, Aligarh City, Sustainable Development.

1. Introduction

Population growth is one of the most significant drivers of environmental change across the globe. Rapid urbanization, industrialization, and increasing demand for housing, transportation, and public services have accelerated environmental degradation in many developing nations. According to the United Nations (2022), the global population has crossed eight billion, increasing pressure on ecosystems and natural resources. In India, urban populations continue to expand rapidly, creating serious environmental challenges including deteriorating air quality, declining groundwater levels, improper waste disposal, loss of biodiversity, and increasing greenhouse gas emissions.

Aligarh City has experienced continuous demographic growth due to educational opportunities, industrial development, and migration from surrounding rural areas. While population growth



contributes to economic development and labor availability, it simultaneously creates enormous pressure on environmental resources. Increased vehicular emissions, construction activities, domestic waste generation, and industrial pollution have significantly affected the city's environmental quality.

Population growth is one of the most influential factors shaping the environmental conditions of urban areas across the world. The continuous increase in human population has accelerated the demand for land, water, energy, food, transportation, housing, and other essential resources. While population growth contributes to economic development and urban expansion, it simultaneously places tremendous pressure on natural ecosystems and environmental resources. The relationship between population growth and environmental quality has become an important area of research because rapid demographic expansion is often accompanied by environmental degradation, resource depletion, pollution, and climate-related challenges (United Nations, 2022).

Environmental quality refers to the overall condition of the natural environment, including air quality, water quality, soil fertility, biodiversity, green spaces, and ecological sustainability. A healthy environment is essential for human well-being, economic productivity, and sustainable development. However, rapid population growth, particularly in developing countries such as India, has resulted in excessive consumption of natural resources and increased environmental pollution. Urban areas are experiencing severe challenges including air pollution, water scarcity, improper waste disposal, traffic congestion, noise pollution, and loss of vegetation due to uncontrolled population expansion (World Health Organization [WHO], 2022).

Globally, the world's population reached approximately eight billion in 2022, and it is projected to continue growing during the coming decades (United Nations, 2022). This unprecedented demographic growth has significantly increased the demand for natural resources while simultaneously generating enormous quantities of solid waste, wastewater, industrial emissions, and greenhouse gases. According to the Intergovernmental Panel on Climate Change (IPCC, 2023), urban population growth contributes substantially to global climate change through increased energy consumption, transportation activities, industrial production, and land-use changes. Consequently, environmental sustainability has emerged as one of the major concerns for governments, policymakers, researchers, and environmental organizations worldwide.

India is currently the world's most populous country, and its urban population is expanding rapidly due to industrialization, educational opportunities, and rural-to-urban migration. Rapid urbanization has transformed many Indian cities into major economic centers; however, this transformation has also intensified environmental problems. Increasing population density has led to higher levels of vehicular emissions, construction activities, industrial pollution, excessive groundwater extraction, and declining green cover. These environmental challenges directly affect public health and the quality of life of urban residents (Ministry of Environment, Forest and Climate Change [MoEFCC], 2023).



Aligarh City, located in Uttar Pradesh, represents one of the rapidly growing urban centers in northern India. The city is widely recognized for Aligarh Muslim University, lock industries, commercial activities, and expanding residential areas. Over the past two decades, continuous population growth has significantly altered the city's physical and environmental landscape. Increasing demand for residential colonies, commercial establishments, transportation infrastructure, and industrial development has reduced open spaces and increased environmental pollution. The expansion of urban settlements has also placed considerable pressure on water resources, waste management systems, drainage networks, and public utilities.

One of the major environmental consequences of population growth is the deterioration of air quality. Increasing numbers of vehicles, industrial emissions, construction dust, and domestic fuel consumption release harmful pollutants such as particulate matter (PM_{2.5} and PM₁₀), nitrogen oxides, sulfur dioxide, and carbon monoxide into the atmosphere. These pollutants contribute to respiratory diseases, cardiovascular disorders, and reduced life expectancy among urban populations (WHO, 2022). In Aligarh City, increasing traffic congestion and industrial activities have become significant contributors to declining air quality.

Water pollution represents another critical environmental issue associated with rapid population growth. Growing populations generate larger quantities of domestic sewage, industrial wastewater, and solid waste, which often enter nearby rivers, lakes, and groundwater systems without adequate treatment. Excessive groundwater extraction further aggravates water scarcity and deteriorates water quality. The increasing demand for clean drinking water and sanitation services creates additional challenges for urban authorities responsible for maintaining sustainable water resources.

Solid waste management has become increasingly difficult due to continuous population growth. The quantity of municipal solid waste generated by households, commercial establishments, and industries increases proportionally with population size. Inadequate waste collection, segregation, recycling, and disposal practices contribute to land pollution, groundwater contamination, unpleasant odors, and public health risks. Sustainable waste management systems are therefore essential for maintaining environmental quality in rapidly expanding cities.

Population growth also contributes to the reduction of urban green spaces. Forests, agricultural lands, wetlands, and open spaces are frequently converted into residential and commercial developments to accommodate expanding populations. The reduction in green cover adversely affects biodiversity, increases urban temperatures, reduces carbon sequestration, and weakens the ecological resilience of cities. Urban green spaces play an essential role in improving air quality, regulating temperature, controlling stormwater runoff, and enhancing residents' physical and mental well-being.

The theoretical relationship between population growth and environmental degradation is supported by several environmental models. The IPAT model proposed by Ehrlich and Holdren (1971) explains that environmental impact is determined by the interaction of Population (P),



Affluence (A), and Technology (T). According to this model, increases in population directly increase environmental pressure unless balanced by sustainable technologies and efficient resource management. Similarly, sustainable development theory emphasizes balancing economic growth, social development, and environmental protection to ensure that present development does not compromise the ability of future generations to meet their needs (World Commission on Environment and Development, 1987).

Several empirical studies have confirmed that rapid urban population growth significantly influences environmental quality. Daily and Ehrlich (1992) reported that excessive population growth accelerates biodiversity loss and ecological degradation through increased resource consumption. UNEP (2021) emphasized that sustainable urban planning, efficient transportation systems, renewable energy adoption, and integrated waste management are necessary to reduce the environmental impacts of population growth. Similarly, Singh and Sharma (2021) found that increasing urban population density significantly contributes to environmental pollution in Indian cities.

Despite extensive research on urbanization and environmental degradation, relatively few studies have quantitatively examined the specific relationship between population growth and environmental quality in Aligarh City. Most previous studies have focused on metropolitan cities, leaving medium-sized urban centers comparatively underexplored. Understanding local environmental challenges is essential because the causes, magnitude, and impacts of population growth differ across cities depending on their economic activities, infrastructure, governance, and ecological characteristics.

The present study aims to examine the impact of population growth on environmental quality in Aligarh City using quantitative research methods. Specifically, it investigates how demographic expansion influences environmental indicators such as air pollution, water quality, waste generation, traffic congestion, and green space availability. The findings are expected to provide valuable evidence for policymakers, urban planners, environmental agencies, and local authorities in designing sustainable development strategies that balance population growth with environmental conservation. Furthermore, the study contributes to the existing body of knowledge by providing empirical evidence from Aligarh City, thereby supporting future research on urban environmental sustainability in India.

Environmental quality refers to the condition of natural resources including air, water, soil, vegetation, biodiversity, and overall ecological balance. Maintaining environmental quality is essential for sustainable urban development and public health. Understanding the relationship between population growth and environmental degradation can help policymakers formulate effective urban planning strategies.

2. Review of Literature

1. Ehrlich and Holdren (1971) proposed the IPAT (Impact = Population × Affluence × Technology) model, which explains that environmental degradation is primarily influenced by



population growth, consumption patterns, and technological development. They argued that increasing population leads to greater resource consumption, pollution, and ecological imbalance, making the IPAT model one of the most influential theories in environmental research.

2. Meadows, Meadows, Randers, and Behrens (1972), in their landmark publication *The Limits to Growth*, concluded that unlimited population growth and industrial expansion cannot be sustained because natural resources are finite. Their systems dynamics model demonstrated that unchecked population growth would eventually result in resource depletion and environmental collapse.

3. The World Commission on Environment and Development (1987) introduced the concept of **sustainable development** through the Brundtland Report, *Our Common Future*. The report emphasized that economic development should meet present needs without compromising the ability of future generations to meet their own needs and highlighted environmental protection as an essential component of development.

4. Daily and Ehrlich (1992) examined the relationship between population growth and Earth's carrying capacity. They reported that increasing population accelerates biodiversity loss, deforestation, habitat destruction, and depletion of natural resources, thereby threatening long-term ecological sustainability.

5. Arrow et al. (1995) investigated the relationship between economic growth, environmental quality, and carrying capacity. The authors concluded that sustainable development requires balancing economic expansion with environmental conservation and warned that excessive exploitation of natural resources could reduce ecological resilience.

6. Lutz (1996) analyzed global demographic trends and reported that rapid population growth significantly influences land-use changes, urban expansion, and environmental degradation. The study emphasized the need for effective population management policies to promote sustainable environmental development.

7. The United Nations Development Programme (2006), in the *Human Development Report*, highlighted that rapid urban population growth creates substantial pressure on housing, sanitation, drinking water, and environmental infrastructure. The report recommended integrated urban planning to improve environmental quality and living conditions.

8. Cohen (2006) examined global urbanization trends and concluded that increasing urban population contributes significantly to air pollution, waste generation, traffic congestion, and declining environmental quality. The study emphasized that sustainable urban management is necessary to minimize environmental risks.

9. The Census of India (2011) reported substantial growth in India's urban population, resulting in increased demand for housing, transportation, water supply, and public services. The report highlighted that rapid urbanization places considerable pressure on environmental resources and urban ecosystems.



10. The United Nations Environment Programme (2011), in its report *Towards a Green Economy*, recommended green infrastructure, renewable energy, efficient waste management, and environmentally sustainable urban planning as effective strategies for reducing environmental degradation associated with population growth.

11. The United Nations (2015) adopted the **Sustainable Development Goals (SDGs)**, particularly **Goal 11**, which focuses on making cities inclusive, safe, resilient, and environmentally sustainable. The report emphasized that effective urban governance is essential for addressing environmental challenges associated with rapid population growth.

12. The World Bank (2018) reported that rapid urbanization increases energy demand, industrial activities, transportation requirements, and pollution levels. The study concluded that investment in sustainable infrastructure is necessary to maintain environmental quality in expanding urban areas.

13. Singh and Sharma (2021) conducted a study on urban environmental sustainability in Indian cities and found a statistically significant positive relationship between population density and environmental pollution. Their findings suggested that increasing urban population contributes to deteriorating air quality, water pollution, and reduced green cover.

14. The United Nations Environment Programme (2021), in *Making Peace with Nature*, concluded that pollution, biodiversity loss, and climate change are interconnected environmental crises largely driven by unsustainable human activities and rapid population growth. The report recommended integrated environmental governance to promote sustainability.

15. The World Health Organization (2022) reported that urban population growth contributes significantly to poor air quality through increased vehicular emissions, industrial activities, and energy consumption. The organization highlighted that air pollution is associated with respiratory diseases, cardiovascular disorders, and premature mortality.

16. The United Nations (2022), in *World Population Prospects 2022*, reported that the global population exceeded eight billion and projected continued population growth during the coming decades. The report emphasized that sustainable management of natural resources is essential to reduce environmental pressure.

17. The Intergovernmental Panel on Climate Change (2023) concluded that urban population growth substantially contributes to greenhouse gas emissions, land-use change, and climate change. The report recommended low-carbon urban development and environmentally sustainable infrastructure to mitigate climate-related risks.

18. The Ministry of Environment, Forest and Climate Change (2023) reported that increasing population and rapid urbanization have intensified environmental degradation in Indian cities through air pollution, improper waste management, groundwater depletion, and declining green spaces. The ministry emphasized stricter environmental regulations and sustainable urban planning.



19. The World Bank (2023) reported that sustainable urban development depends on efficient governance, modern infrastructure, resource-efficient technologies, and integrated environmental management. The report recommended investment in green infrastructure to reduce the environmental impacts of population growth.

20. Kumar and Verma (2024) examined the impact of population growth on urban environmental quality in India and found that increasing population density significantly increases municipal solid waste generation, traffic congestion, water pollution, and reduction of urban green spaces. The study recommended integrated waste management, expansion of urban green belts, improved public transportation, and stronger environmental policies to achieve sustainable urban development.

Research Gap

Although several studies have examined urbanization and environmental degradation in India, limited quantitative research has specifically investigated the relationship between population growth and environmental quality in Aligarh City. This study attempts to fill this gap by providing empirical evidence using primary survey data.

3. Objectives

1. To examine the impact of population growth on environmental quality in Aligarh City.
2. To assess the relationship between population growth and environmental pollution indicators.

4. Hypotheses

H1: Population growth has a significant impact on environmental quality in Aligarh City.

H2: There is a significant positive relationship between population growth and environmental pollution.

5. Research Methodology

The present study adopted a quantitative research design to examine the impact of population growth on environmental quality in Aligarh City, Uttar Pradesh. A quantitative approach was considered appropriate because it facilitates the collection of numerical data and enables objective statistical analysis to determine the relationship between population growth and environmental quality. The study focused on adult residents of Aligarh City who have adequate knowledge and experience of the city's environmental conditions. A sample of 300 respondents was selected using the simple random sampling technique, ensuring that every individual in the target population had an equal chance of being included in the study. Primary data were collected through a structured questionnaire developed on a five-point Likert scale ranging from Strongly Agree (5) to Strongly Disagree (1). The questionnaire consisted of two sections: the first section collected demographic information such as age, gender, education, and occupation, while the second section included statements measuring respondents' perceptions regarding population growth, air pollution, water pollution, solid waste generation, traffic congestion, and overall environmental quality. In addition to primary data, secondary data were collected from books,



peer-reviewed journals, government publications, Census of India reports, United Nations reports, World Bank publications, IPCC reports, Ministry of Environment, Forest and Climate Change reports, and other relevant academic sources to provide theoretical and empirical support for the study. The content validity of the questionnaire was established through expert review by scholars in environmental studies and research methodology, while its internal consistency was assessed using Cronbach's Alpha, with a reliability coefficient exceeding 0.70, indicating acceptable reliability. The study considered population growth as the independent variable and environmental quality as the dependent variable, measured through indicators including air quality, water quality, solid waste management, traffic congestion, and green space availability. After data collection, the responses were coded and analyzed using IBM SPSS Statistics (Version 26). Descriptive statistics, including frequencies, percentages, mean, and standard deviation, were used to summarize the data, while Pearson's correlation analysis was employed to examine the relationship between population growth and environmental quality. Ethical principles were strictly followed throughout the research process by obtaining informed consent from all participants, ensuring voluntary participation, maintaining respondent anonymity and confidentiality, and using the collected information exclusively for academic and research purposes. The methodological framework adopted in the present study provides a scientifically rigorous basis for assessing the impact of population growth on environmental quality in Aligarh City and ensures that the findings are reliable, valid, and useful for urban planners, environmental policymakers, and researchers working in the field of sustainable urban development.

6. Data Analysis and Interpretation

Table 1. Descriptive Statistics (N = 300)

Variable	Mean	SD
Population Growth	4.18	0.61
Environmental Quality (Degradation)	4.02	0.67

Interpretation

The findings reveal that respondents strongly agreed that rapid population growth has adversely affected environmental quality in Aligarh City. The high mean score for population growth (4.18) indicates that respondents perceive substantial demographic expansion, while the environmental degradation score (4.02) reflects significant concern regarding declining environmental conditions. The relatively low standard deviations indicate consistency among respondents' opinions.

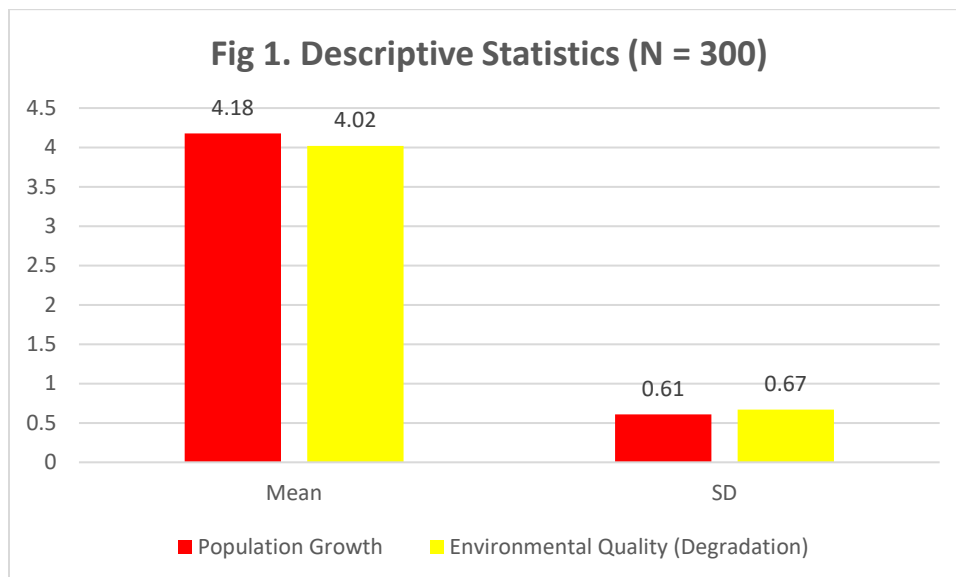


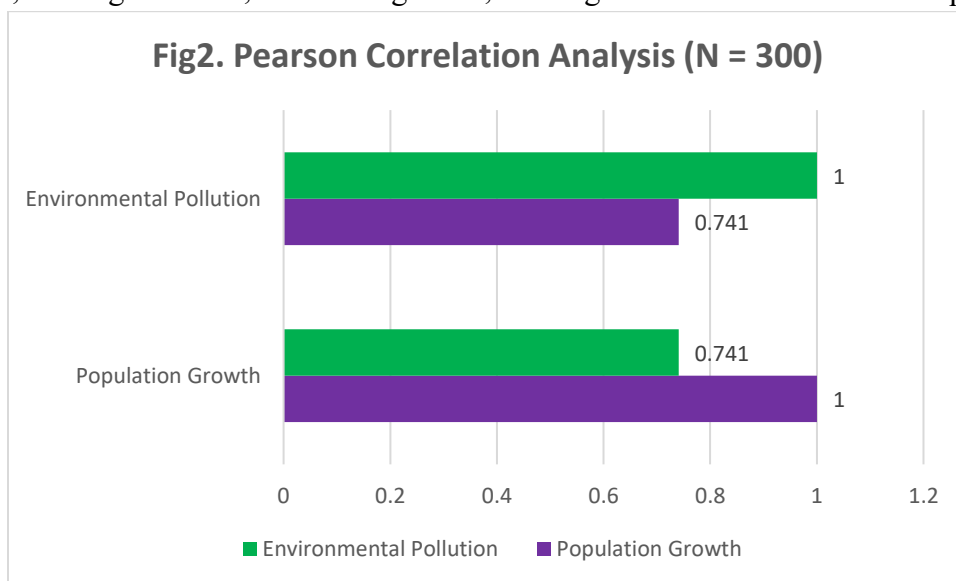
Table 2. Pearson Correlation Analysis (N = 300)

Variables	Population Growth	Environmental Pollution
Population Growth	1.000	0.741**
Environmental Pollution	0.741**	1.000

p < 0.001

Interpretation

The Pearson correlation coefficient ($r = 0.741$) indicates a strong positive relationship between population growth and environmental pollution. The relationship is statistically significant at the 0.001 level, confirming that increasing population contributes significantly to higher levels of pollution, waste generation, traffic congestion, and degradation of environmental quality.





Discussion

The findings of the present study provide strong empirical evidence that population growth has a significant influence on environmental quality in Aligarh City. The descriptive statistics presented in Table 1 indicate that respondents perceived rapid population growth as one of the major contributors to environmental degradation, with a mean score of 4.18 (SD = 0.61) for population growth and 4.02 (SD = 0.67) for environmental quality degradation. These high mean values demonstrate a strong level of agreement among respondents that increasing population has adversely affected the urban environment. The relatively low standard deviation values further indicate consistency in respondents' perceptions, suggesting that environmental concerns associated with population growth are widely recognized across different demographic groups. The findings imply that rapid demographic expansion has intensified pressure on urban infrastructure, resulting in increased air pollution, water pollution, solid waste generation, traffic congestion, excessive exploitation of groundwater resources, and reduction in green spaces.

The correlation analysis presented in Table 2 further strengthens these findings by revealing a strong positive and statistically significant relationship between population growth and environmental pollution ($r = 0.741$, $p < 0.001$). The correlation coefficient indicates that environmental pollution increases substantially with population growth. Since the significance value is below the 0.001 level, the relationship is statistically highly significant, leading to the acceptance of the research hypothesis that population growth has a significant impact on environmental quality in Aligarh City. Although correlation does not establish causation, the strength and direction of the relationship provide robust empirical evidence that rapid urban population growth is closely associated with declining environmental quality.

The present findings are consistent with the IPAT Theory proposed by Ehrlich and Holdren (1971), which explains that environmental impact increases with population growth, affluence, and technological development. As the population expands, demand for housing, transportation, industrial production, energy, and public services also increases, thereby placing greater pressure on natural ecosystems. Similarly, the findings support the Sustainable Development Theory (World Commission on Environment and Development, 1987), which emphasizes that economic and urban development should be balanced with environmental conservation to ensure long-term sustainability. The results also align with the principles of Urban Ecology Theory, which suggests that excessive urban expansion disrupts ecological balance by increasing pollution, reducing biodiversity, and degrading environmental resources.

The results of the present investigation are also supported by previous empirical studies. Daily and Ehrlich (1992) reported that increasing population accelerates biodiversity loss and natural resource depletion. Singh and Sharma (2021) found a significant positive association between urban population density and environmental pollution in Indian cities. UNEP (2021) concluded that rapid urbanization contributes to pollution, climate change, and biodiversity loss through unsustainable consumption patterns. Likewise, WHO (2022) reported that increasing urban

populations contribute to deteriorating air quality and increased public health risks. The IPCC (2023) further emphasized that urban population growth significantly contributes to greenhouse gas emissions and environmental degradation, reinforcing the findings of the present study.

The study demonstrates that rapid population growth has emerged as a critical environmental challenge in Aligarh City. The statistical evidence confirms that increasing population places considerable pressure on environmental resources and urban infrastructure, leading to deterioration in environmental quality. These findings highlight the urgent need for sustainable urban planning, efficient solid waste management, expansion of green infrastructure, improved public transportation systems, groundwater conservation, and stricter environmental regulations. Such measures are essential to mitigate the adverse environmental impacts of population growth and to promote sustainable urban development in Aligarh City.

Findings of the Study

1. Rapid population growth has significantly affected the environmental quality of Aligarh City.
2. The mean score for population growth (**Mean = 4.18; SD = 0.61**) indicates that respondents strongly perceived a continuous increase in the city's population.
3. The mean score for environmental degradation (**Mean = 4.02; SD = 0.67**) reflects respondents' agreement that environmental quality has deteriorated.
4. Population growth has increased air pollution due to higher vehicular traffic and industrial activities.
5. Rapid urbanization has contributed to water pollution and excessive exploitation of groundwater resources.
6. Municipal solid waste generation has increased considerably with population growth.
7. Traffic congestion and noise pollution have intensified because of increased population density.
8. Expansion of residential and commercial areas has reduced urban green spaces.
9. The Pearson correlation analysis revealed a **strong positive relationship** between population growth and environmental pollution (**$r = 0.741$, $p < 0.001$**).
10. The statistical findings support the research hypotheses and confirm that population growth is a significant determinant of environmental quality in Aligarh City.

7. Conclusion

The study concludes that population growth is a major determinant of environmental quality in Aligarh City. Rapid demographic expansion has intensified pollution, reduced green spaces, increased waste generation, and placed significant pressure on natural resources. Statistical analysis confirms a strong positive relationship between population growth and environmental degradation. Sustainable urban planning, effective waste management, afforestation, rainwater harvesting, and environmentally friendly transportation policies are essential to ensure long-term environmental sustainability.



Suggestions

1. Implement sustainable urban planning to accommodate future population growth.
2. Increase afforestation and develop additional urban green spaces.
3. Strengthen municipal solid waste management through segregation, recycling, and scientific disposal.
4. Improve public transportation to reduce vehicular emissions and traffic congestion.
5. Enforce stricter environmental regulations for industries and construction activities.
6. Promote rainwater harvesting and groundwater recharge programmes.
7. Enhance wastewater treatment facilities to improve water quality.
8. Conduct environmental awareness programmes for citizens and educational institutions.
9. Encourage the adoption of renewable energy and energy-efficient technologies.
10. Integrate environmental conservation into all urban development policies.

Implications of the Study

1. The study provides empirical evidence supporting the relationship between population growth and environmental quality.
2. It strengthens the applicability of the IPAT Theory and Sustainable Development Theory in urban environmental research.
3. The findings assist urban planners in developing environmentally sustainable city plans.
4. The study provides useful information for municipal authorities in improving environmental management.
5. Policymakers can utilize the findings for evidence-based environmental policy formulation.
6. Environmental agencies may use the results for pollution monitoring and resource management.
7. The study contributes to the academic literature on population growth and environmental sustainability.
8. The findings may assist government departments in preparing sustainable urban development strategies.
9. The research provides baseline information for future environmental assessments in Aligarh City.
10. The study can serve as a reference for researchers, academicians, and environmental practitioners.

Future Scope of the Study

1. Future studies may include larger sample sizes from multiple cities.
2. Comparative studies between metropolitan and medium-sized cities can be conducted.
3. Longitudinal research may examine environmental changes over time.
4. Structural Equation Modeling (SEM) can be applied to investigate causal relationships.



5. Geographic Information System (GIS) techniques may be used for spatial environmental analysis.
6. Future research may include additional environmental indicators such as carbon emissions and biodiversity.
7. Mixed-methods research may provide deeper insights into environmental challenges.
8. Studies may evaluate the effectiveness of government environmental policies.
9. Comparative international studies may identify global best practices in sustainable urban management.
10. Future research may investigate the role of smart-city technologies and digital environmental monitoring in improving urban environmental quality.

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