

Spatiotemporal Variation in Seasonal Air Quality Index Study in the Urban Part of East Godavari, Andhra Pradesh

Kudipudi Satya Mahesh^{*1}, Bhupati Sai Chaitanya¹, K. Lakshmi Harika²,
M. Manikanta³, N. S V Phani Kumar⁴, A. Rambabu⁵

1 Assistant professor, Department of Civil Engineering, Boonam Venkata Chalamayya Institute of Technology and Science, Batlapalem*

1 Assistant professor, Department of Civil Engineering, Boonam Venkata Chalamayya Institute of Technology and Science, Batlapalem

2 UG Student, Department of Civil Engineering, Boonam Venkata Chalamayya Institute of Technology and Science, Batlapalem

3 UG Student Department of Civil Engineering, Boonam Venkata Chalamayya Institute of Technology and Science, Batlapalem

4 UG Student, Department of Civil Engineering, Boonam Venkata Chalamayya Institute of Technology and Science, Batlapalem

5 UG Student, Department of Civil Engineering, Boonam Venkata Chalamayya Institute of Technology and Science, Batlapalem

Abstract

This study examines the variation in ambient air quality parameters in east godavari one of the under city of Rajamahendravaram, a rapidly expanding urban center in Andhra Pradesh, India, during the months of May and September in 2023 and 2024. Air quality monitoring was conducted at four locations—Sriram Nagar, A.V. Apparao Road, LeLacheruvu, and Godavari Gattu. The analysis focuses on major air pollutants, including particulate matter (PM₁₀ and PM_{2.5}), nitrogen dioxide (NO₂), sulfur dioxide (SO₂), and ammonia (NH₃). Data obtained from these monitoring stations were subjected to statistical analysis and graphical interpretation to understand the influence of anthropogenic activities, industrial emissions, vehicular traffic, and meteorological conditions on air quality. Rajamahendravaram, being a key urban center in East Godavari district, has experienced rapid urbanization, industrial growth, and increased vehicular movement, contributing to the deterioration of air quality. The study evaluates the Air Quality Index (AQI) using pollutant concentrations for the selected months in 2023 and 2024. The results indicate that the highest AQI was recorded in May 2024, while the lowest AQI occurred in September 2024, reflecting overall moderate air quality conditions.

Keywords: *Ambient Air Quality, Rajamahendravaram, Particulate Matter (PM₁₀ and PM_{2.5}), Nitrogen Dioxide (NO₂), Sulfur Dioxide (SO₂), ammonia (NH₃), Air Quality Index, Air Pollution.*

Date of Submission: 07-02-2026

Date of Acceptance: 17-02-2026

I. INTRODUCTION

Air pollution has emerged as one of the most serious environmental challenges of the modern era, posing a direct threat to living organisms and human well-being. It refers to the presence of harmful gases, particulate matter, dust, and smoke in the atmosphere at concentrations that negatively affect human health[1,4]. Rapid industrial growth, increased mechanization, deforestation, and extensive reliance on fossil fuels have significantly contributed to the rising levels of atmospheric pollutants, making air quality increasingly hazardous. Exposure to polluted air is closely linked to a wide range of respiratory and cardiovascular illnesses. Major air pollutants such as nitrogen dioxide (NO₂), carbon monoxide (CO), sulfur dioxide (SO₂), lead, ground-level ozone (O₃), and particulate matter (PM) are known to cause substantial environmental and health impacts[2,7]. Fine particulate matter, especially PM_{2.5}, can penetrate deep into the lungs and bloodstream, leading to long-term respiratory and systemic health problems. According to global health assessments, millions

of premature deaths each year are attributed to air pollution, along with increased incidences of diseases such as asthma, lung cancer, heart ailments, and other chronic conditions[5,6]. Consequently, the analysis of air pollution has become a crucial component of environmental protection efforts, as it helps evaluate mitigation strategies and long-term impacts. Traditionally, air quality assessment relies on ground-based monitoring stations equipped with sensors for continuous data collection of pollutants like PM₁₀, PM_{2.5}, NO₂, and SO₂. While such monitoring networks are well established in major urban areas, their deployment is limited in smaller cities and rural regions due to logistical and financial constraints. In recent years, satellite-based observations have emerged as a valuable alternative for estimating atmospheric pollutant concentrations over wide spatial scales[3,8]. These satellite-derived datasets can be stored and analyzed quantitatively to support further research. This study emphasizes short-term forecasting of the Air Quality Index (AQI) using advanced time-series modeling techniques and evaluates pollutant concentrations based on pollution data. The approach is particularly useful for air quality monitoring in regions lacking permanent ground-based monitoring infrastructure[8].

II. SYUDY AREA

Rajahmahendravaram (Rajahmundry), the largest town in East Godavari district, serves as a Divisional Headquarters and holds significant administrative and historical importance. The Howrah–Chennai (Madras) railway line runs longitudinally through the town, supported by two major railway stations—Godavari and Rajahmundry. The iconic road-cum-rail bridge across the River Godavari, connecting Rajahmundry with Kovvur, stands as a remarkable engineering achievement. Rajahmundry was the first town in East Godavari district to be elevated to municipal corporation status. Situated on the left bank of the River Godavari, the city has a population of approximately three lakh residents.

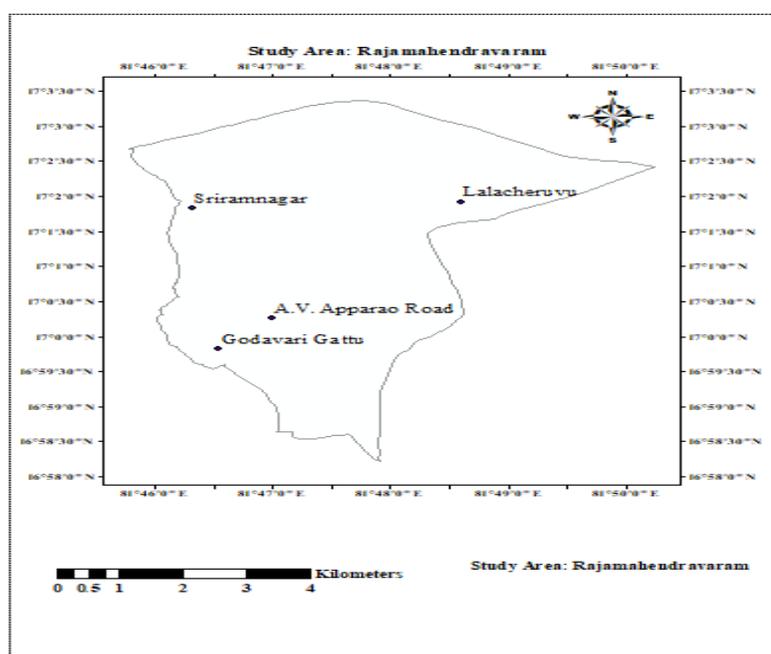


Figure 1: Study area

III. OBJECTIVES OF THE STUDY

1. To assess ambient air quality data in order to evaluate changes in pollutant concentrations over time.
2. To examine the variation in individual air quality parameters contributing to the Air Quality Index (AQI).
3. To analyze the temporal fluctuations in the Air Quality Index across the study period.

IV. SCOPE OF THE STUDY

1. The study aims to conduct a comprehensive assessment of ambient air quality in Rajamahendravaram.
2. Air quality monitoring is carried out at selected locations in Rajamahendravaram, namely Sriram Nagar, A.V. Apparao Road, Lalacheruvu, and Godavari Gattu.
3. The analysis focuses on key air quality parameters, including sulfur dioxide (SO₂), nitrogen dioxide (NO₂), ammonia (NH₃), particulate matter (PM₁₀), and particulate matter (PM_{2.5}).

- These five pollutants are considered for the evaluation and determination of the Air Quality Index (AQI).

V. METHODOLOGY

The methodology adopted for the Air Quality Index (AQI) study in Rajamahendravaram is designed to systematically assess ambient air quality and evaluate spatial and temporal variations in pollutant concentrations. The study was conducted in Rajamahendravaram city, Andhra Pradesh, India. Four representative monitoring locations were selected to capture variations in land use and emission sources are Sriram Nagar, A.V. Apparao Road, Lalacheruvu, and Godavari Gattu. Ambient air quality data were collected for the months of May and September during the years 2023 and 2024 from andhra pradesh state pollution control board. The pollutants considered for the study include sulfur dioxide (SO₂), nitrogen dioxide (NO₂), ammonia (NH₃), particulate matter (PM₁₀), and particulate matter (PM_{2.5}). Data were obtained from established monitoring stations/sources and compiled for further analysis.

Data Processing and Quality Assessment

Spatial analysis is a method used to transform raw data into meaningful information by examining the spatial distribution of measured parameters. In this study, samples of various parameters are collected from different locations and their values are analyzed to understand spatial variability across the study area. The spatial distribution of these parameters is determined using the Inverse Distance Weighting (IDW) method. IDW is based on the principle of spatial autocorrelation, which assumes that locations closer to each other exhibit more similar characteristics than those farther apart. To estimate values at unmeasured locations, the IDW technique utilizes the weighted influence of surrounding measured values, with greater weight assigned to nearer points.[3]

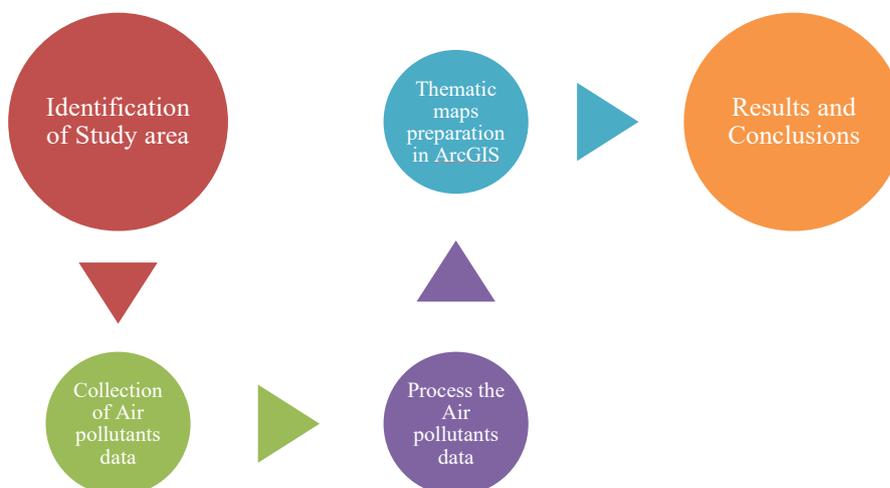


Figure 2: Methodology for air quality assessment

For this study, the Air Quality Index (AQI) is calculated using the standard sub-index method, which is widely adopted by CPCB (India) and WHO-based frameworks. The AQI is computed by first calculating the **sub-index (I_i)** for each pollutant and then selecting the **maximum sub-index** as the overall AQI.

VI. RESULT AND DISCUSSION

The present study was carried out in Rajamahendravaram city, Andhra Pradesh, India, to evaluate ambient air quality by analyzing key air quality parameters, including particulate matter (PM_{2.5} and PM₁₀), sulphur dioxide (SO₂), nitrogen dioxide (NO₂), and ammonia (NH₃). The assessment was conducted during the months of May and September in the years 2023 and 2024. The results indicate that the Air Quality Index (AQI) reached its highest level in May 2024, while the lowest AQI was observed in September 2024.

Table 1: Averages concentrations of pollution parameters for May & Sept. months in 2023 & 2024

Pollutants	May-23	Sep-23	May-24	Sep-24
SO ₂ µg/m ³	22.50	24.00	26.98	27.43
NO ₂ µg/m ³	16.00	16.25	16.48	16.90

NH ₃ µg/m ³	29.25	26.00	26.43	25.88
PM ₁₀ µg/m ³	59.25	62.50	63.75	57.00
AQI	59.25	62.5	63.75	57

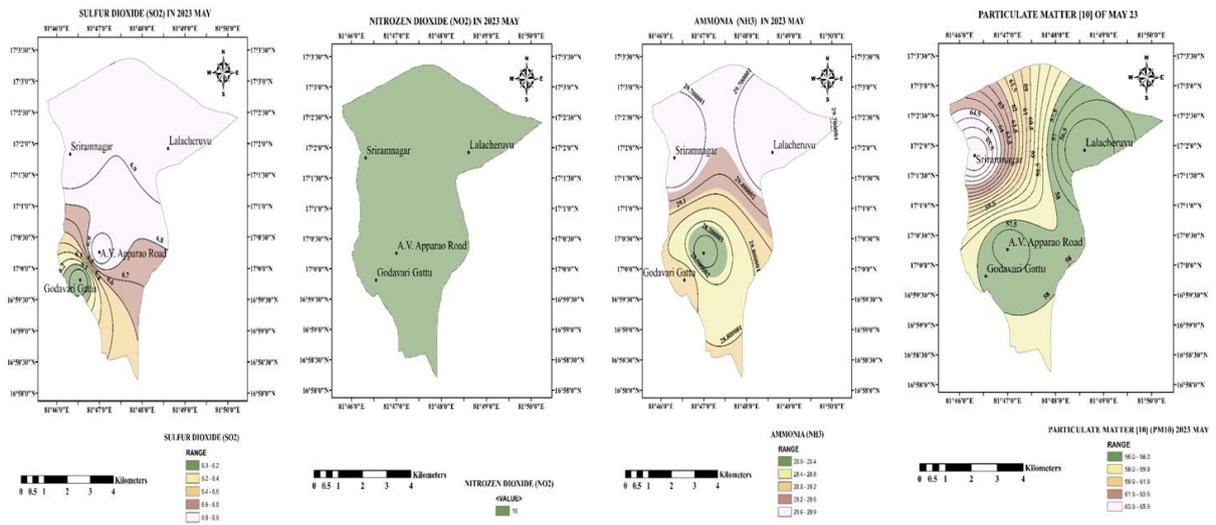


Figure 3: Air pollutants distribution across the study area for May 2023

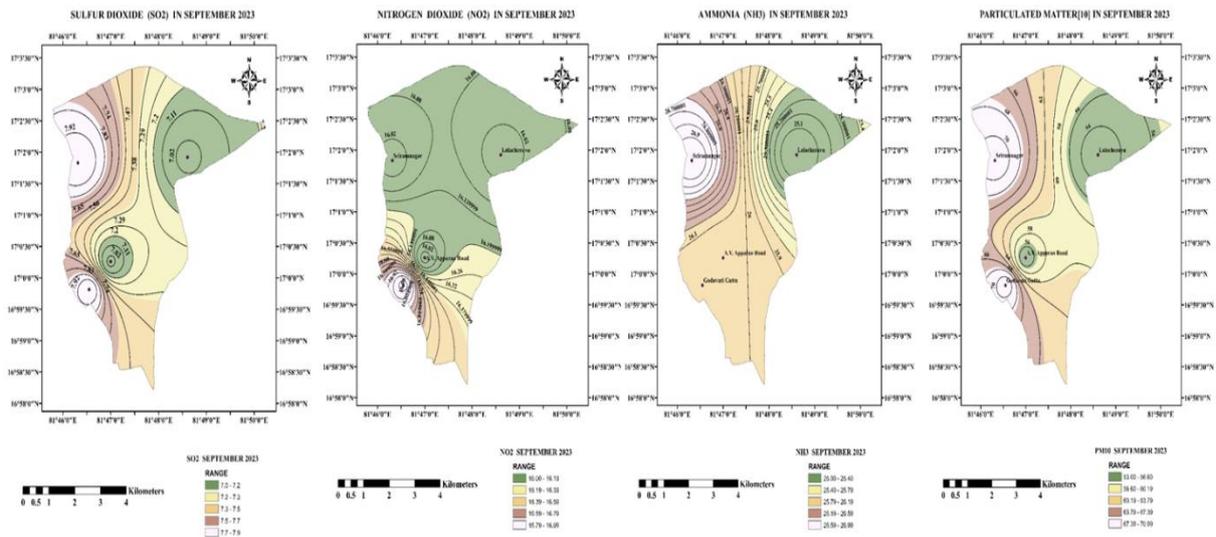


Figure 4: Air pollutants distribution across the study area for September 2023

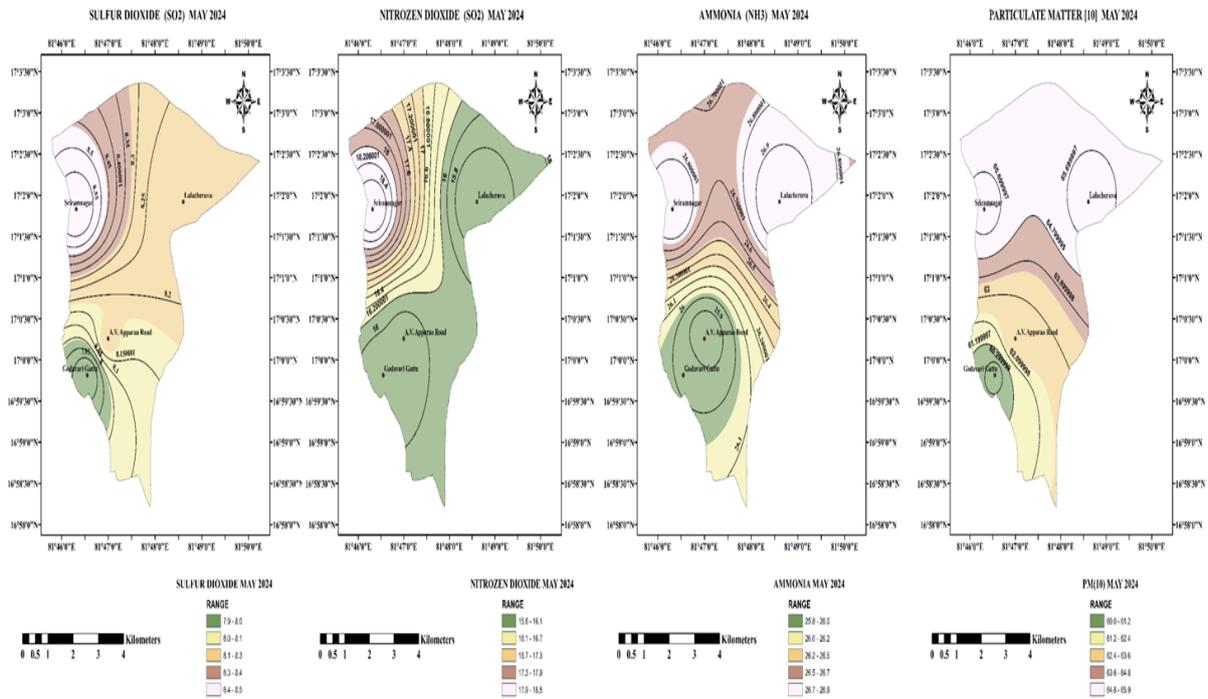


Figure 5: Air pollutants distribution across the study area for May 2024

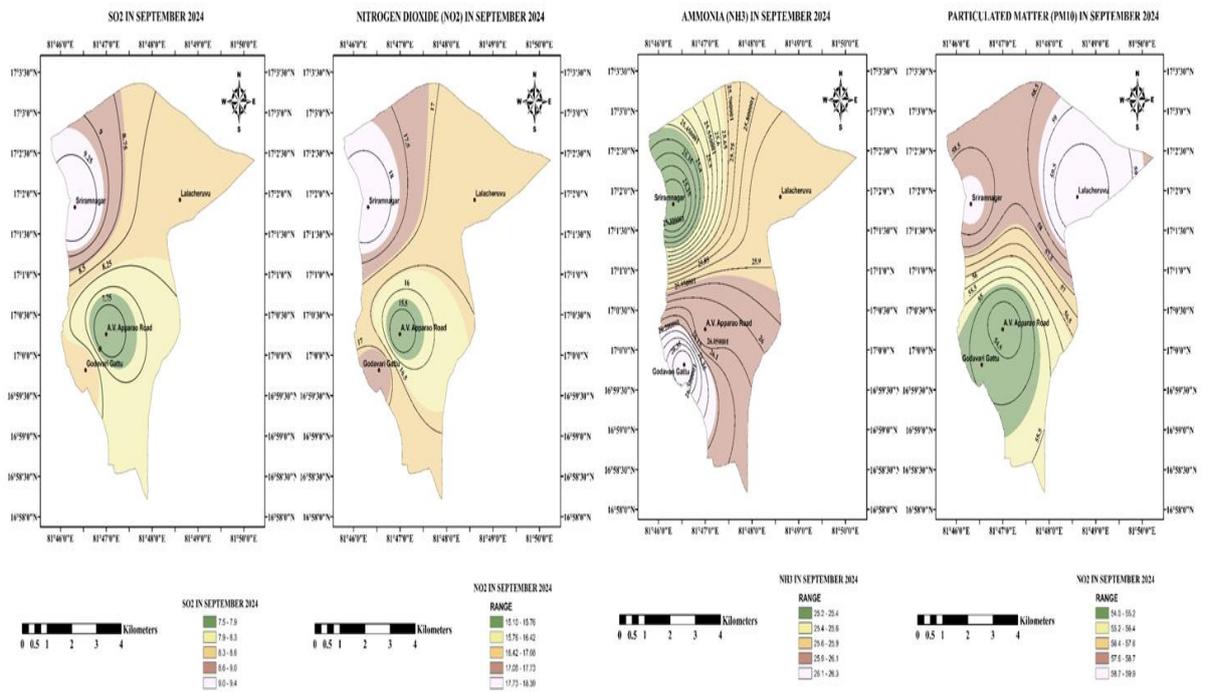


Figure 6: Air pollutants distribution across the study area for September 2024

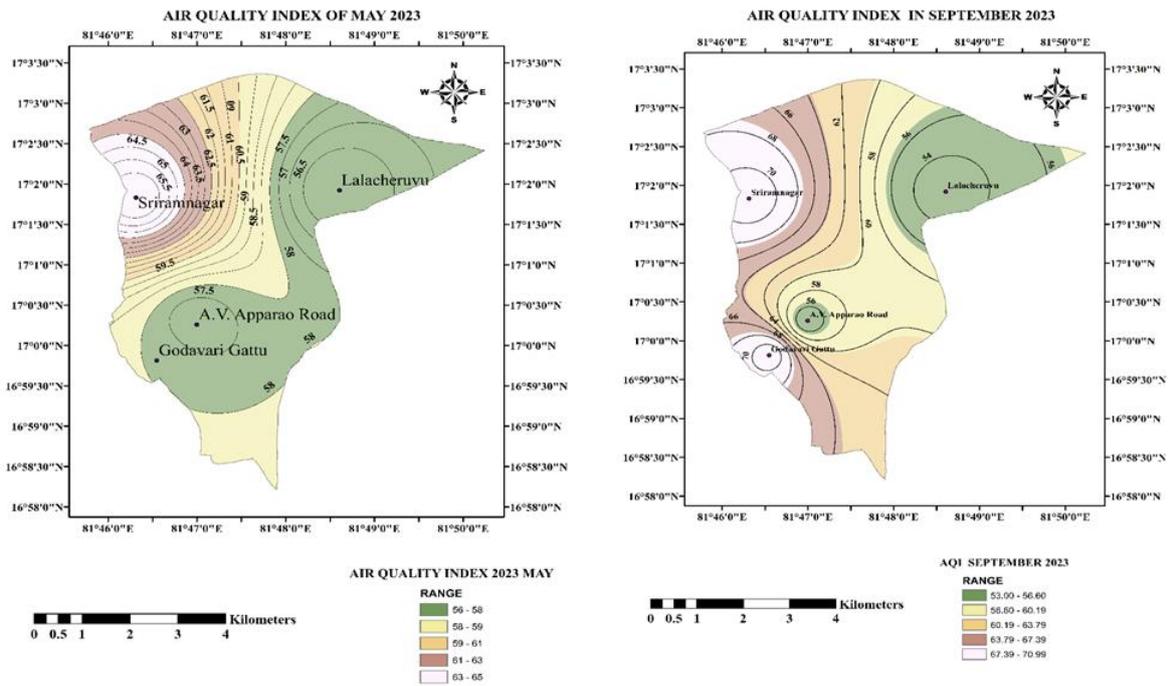


Figure 7: Air quality Index distribution over the study area for May & September 2023

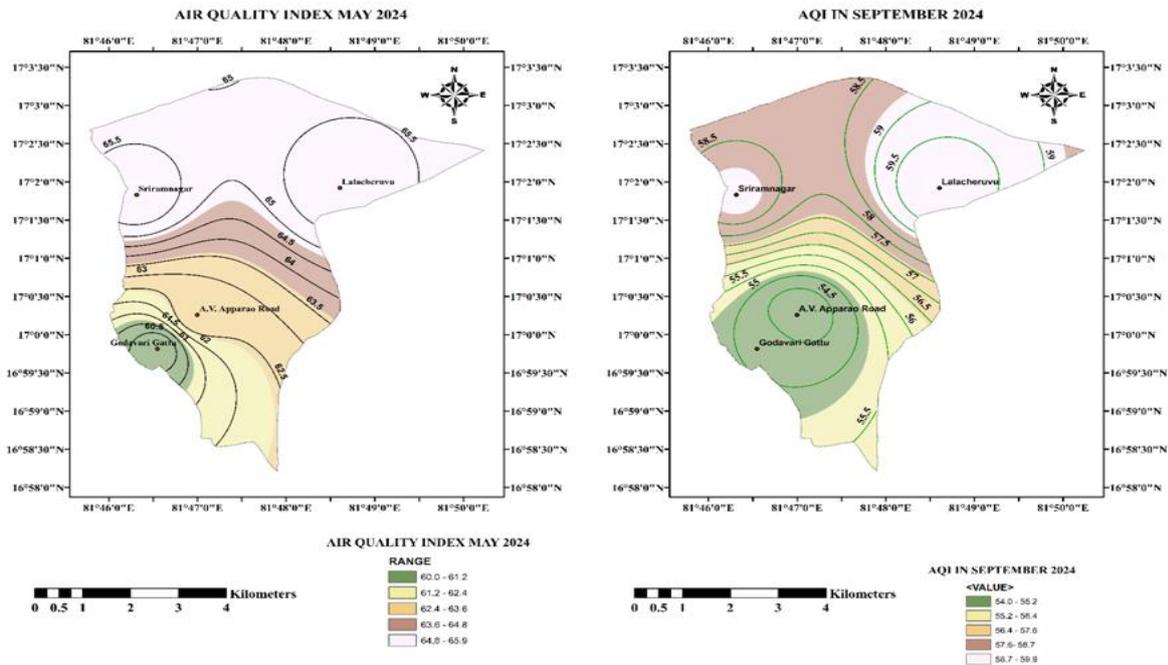


Figure 8: Air quality Index distribution over the study area for May & September 2024

VII. CONCLUSION

1. Particulate matter (PM₁₀) concentrations peak in May 2024 and show a noticeable decline in September 2024, which may be influenced by seasonal variations and meteorological conditions such as rainfall.
2. Sulfur dioxide (SO₂) concentrations show a gradual increase from May 2023 to September 2024, indicating a rising trend that may be associated with increased industrial and combustion-related activities.
3. Ammonia (NH₃) concentrations exhibit a decreasing trend over the study period, indicating possible improvements in waste management practices or reduced agricultural and domestic emission sources.

4. The Air Quality Index (AQI) values closely follow the trend of PM₁₀ concentrations, with the highest AQI recorded in May 2024 and the lowest in September 2024.
5. Overall, AQI values across all periods fall within the moderate category, indicating that while air quality is not severely polluted, continued monitoring and mitigation measures are necessary to prevent further deterioration.

REFERENCES

- [1]. Manisha Jane, Sangita Ingole, Department of Environmental Science, Shri Shivaji Science College, Amravati, India. "**Analysis of Air Quality: In Concern to the NO_x Concentration in Amravati city**" International Journal of Science and Research (IJSR) Volume 4, Issue 4, April 2015.
- [2]. Boni Anil Kumar, B .Prasanna Kumar B. Vinay Sagar "**Assessment of Air quality index of Visakhapatnam urban area Andhra Pradesh**" International Journal of Innovative Research and Creative Technology. Volume 1 | Issue 4,2015.
- [3]. K. Satya Mahesh, "**Qualitative Analysis of Ground Water Quality through Index Method Using Spatial Distribution Technique at Dr. B. R. Ambedkar Konaseema District**" International Journal of Research in Engineering and Science, Volume 12, Issue 6, PP 43-50, 2024.
- [4]. G. S. Gopi Krishnan J. Kuttippurath S. Raj, A. Singh, K. Abhishek "Air Quality during the COVID-19 Lockdown and Unlock Periods in India Analyzed Using Satellite and Ground-based Measurements". ORIGINAL ARTICLE, 2022.
- [5]. R. Dangayach, M. Pandey D. Gusain, A.L.Srivastav⁴ and A. K. Pandey¹ R.Jain¹ B.M.Bairwa, Banasthali Vidyapith, P.O. Banasthali. "**Assessment of Air Quality Before and During COVID-19-Induced Lockdown in Jaipur, India**". MAPAN-Journal of Metrology Society of India 2023.
- [6]. Jasbir Singh Bedi, Pankaj Dhaka, Deepthi Vijay, Rabinder Singh Aulakh, Jatinder Paul Singh. "**Assessment of Air Quality Changes in the Four Metropolitan Cities of India during COVID-19 Pandemic Lockdown**". Bedi et al., Aerosol and Air Quality Research, 2020.
- [7]. Darapu Srikanth Satish Kumar Assistant Professor, Department of Civil Engineering, GIT, GITAM University, Visakhapatnam, Andhra Pradesh, India. "**Air Pollution In Visakhapatnam - An Overview**" "Engineering (UCE) ISSN 2278-9987 Vol. 2, Issue 4, Sep 2013.
- [8]. Sadhan Gope & Subhojit Dawn & Shreya Shree Das. "**Effect of COVID-19 pandemic on air quality: a study based on Air Quality Index**" Environmental Science and Pollution Research 2021.