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APPRAISAL OF THE AMBIENT AIR QUALITY THROUGH AIR QUALITY INDEX MAPPING (AQIM) IN A RESIDENTIAL AREA

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ABSTRACT

The Air Quality Index (AQI) serves as a valuable tool for appraising the current state of air quality. In recent years, global concerns have arisen regarding the adverse health effects resulting from deteriorating air quality, primarily stemming from extensive industrialization and urban development. To gauge the AQI, a comprehensive evaluation of air quality in Residential area was conducted, utilizing a synergistic assessment of five key pollutants: PM_{10}, $PM_{2.5}$, NOx and SO_2. Continuous monitoring of ambient air quality was conducted from January 2023 to June 2023 at three distinct locations, with a 24-hour sampling duration. The AQI was computed using the NAAQS procedure. The highest PM_{10} concentration was observed in close proximity to the highway in RSL. The findings reveal that pollutant levels exceeded permissible limits, leading to a pronounced AQI within the severe air pollution range. Specifically, the NAAQS values observed for a period of six months, during the investigation period consistently exceeded a rating of 75, indicating, that primary culprits for the elevated pollution levels in the local atmosphere are maintenance of roads, automobile emissions and transportation activities.

Highlights

- **A comprehensive evaluation of ambient air quality in the residential area was conducted by considering the synergistic effects of five pollutants.**
- **The assessment involved the observation of National Ambient Air Quality Standards (NAAQS) values during the investigative period spanning from January 2023 to June 2023.**

KEY WORDS : Air quality index mapping, NAAQS, Air Monitoring, residential zone.

INTRODUCTION

Air pollution stands as a grave environmental concern that affects both developed and developing nations, with dire consequences for human health. As per a 2021 report, 22 cities in India rank among the world's top 30 most polluted urban centers. These cities include Ghaziabad, Bulandshahar, Bisrakh Jalalpur, Noida, Greater Noida, Kanpur, Lucknow, Meerut, Agra, and Muzaffarnagar in Uttar Pradesh; Bhiwari in Rajasthan; Faridabad, Jind, Hisar, Fatehabad, Bandhwari, Gurugram, Yamuna Nagar, Rohtak, and Dharuhera in Haryana; as well as Muzaffarpur in Bihar. Notably, most of these cities are industrial hubs, experiencing rapid growth in population, technological advancements, and economic development compared to non-listed cities. Epscially, New Delhi holds the unfortunate title of being the world's most polluted capital.

The alteration of the atmospheric makeup caused by the introduction of detrimental substances is commonly known as air pollution. The escalation in the levels of airborne pollutants is contingent upon both emissions originating from diverse sources and the subsequent chemical and dynamic transformations that transpire within the atmosphere. These emissions are generally denoted as Particulate Matter (PM), encompassing a combination of solid and liquid particles suspended in the air (Chaudhary *et al.*, 2013). In accordance with the National Ambient Air Quality Standards (NAAQS) established by the Ministry of

Table 1. NAAQ Standards for Selected Variables (µg/m³) [4]

Area	Air Pollutant Concentration (µg/m³)							
	PM_{10}		$PM_{2.5}$		SO_2		NO_2	
Industrial, Residential, Rural and other Areas	Annual*	24 hours**	Annual*	24 hours**	Annual*	24 hours**	Annual*	24 hours**
	60	100	40	60	50	80	40	80

Note: * Annual arithmetic mean of min 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform interval. ** 24 hourly 08 hourly or 01 hourly monitored values, as applicable shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Environment, Forest and Climate Change under the Government of India's jurisdiction, Table 1 provides the designated levels of concern for the specified pollutants.

This issue is tackled through the calculation of the Air Quality Index (AQI) for a given area. The AQI, also referred to as the Air Pollution Index Mapping (APIM) in some instances (Murena, 2004), or the Pollutant Standards Index (PSI) as designated by the EPA in 1994, has been devised by numerous agencies across countries such as the United States, Canada, Europe, Australia, China, and others (Cairncross *et al.* 2007). An Air Quality Index can be described as a numerical representation used to report air quality concerning its impact on human health (Chaudhary, *et al.*, 2013). Alternatively, it can be defined as a method that combines weighted values of various air pollution parameters into a single numerical value (Reddy, *et al.*, 2004). Consequently, this study was undertaken to assess the air quality of residential areas in Davangere City utilizing the Air Quality Index (AQI). The findings obtained serve as foundational information, illustrating the increase in air pollutant levels within Davangere City.

MATERIALS AND METHODS

Study area

Davanagere is a town in towards the centre of the southern Indian state of Karnataka. Davanagere is the "Heart of Karnataka". Davangere is surrounded from Chitradurga, Vijayanagara, Shimoga, Chikmagalur and Haveri districts. Davangere is appearing the centre of Karnataka. 14°28' N altitude, 75°59' azimuth and 602.5 metres (1,977 ft) above sea level. This district acquires adequate annual rainfall of 644 mm (25.4 in). From the census the population in the year of 2022-23 is 530,000 and the growth rate is upto 1.73%.

The study employed a random sampling technique to gather air pollution samples from three distinct stations situated in and around Vidyanagar area (VA), P J Extension (PJE) and Ranganatha Swamy Layout (RSL). The selection of these sampling stations prioritized locations are the influence of stagnant spaces or large buildings, ensuring an accurate representation of the atmospheric conditions.

The parameters under investigation included Suspended PM_{10}, $PM_{2.5}$, Sulfur Dioxide (SO_2) and Nitrogen Oxides (NOx). To collect air samples for each parameter, a high-volume air sampler was utilized at each designated sampling station, adhering to established standards. Subsequently, the collected samples underwent analysis in a laboratory, following prescribed methods. This data collection and analysis spanned the period from January 2023 to June 2023.

Air Quality Index Mapping (AQIM)

The AQIM is determined using the following equation, which takes into account various air quality parameters. These parameters include PM_{10}, $PM_{2.5}$, SO_2, and NOx, which represent the observed values of air quality. By comparing the observed air sample data with the standard AQIM values found in Table 2, the air quality categories for the samples can be determined and interpreted. In the present study, 24 hours monitored air quality value was compared with current NAAQS (Table 1).

Table 2. Rating of AQIM (Ravikumar *et al.*, 2014)

Index value	Descriptive category for air Pollution
(0 ≥ AQIM ≤ 25)	Clean
(26 ≥ AQIM ≤ 50)	Light
(51 ≥ AQIM ≤ 75)	Moderate
(76 ≥ AQIM ≤ 100)	Heavy
(AQIM > 100)	Severe

RESULTS AND DISCUSSION

Out of three sampling stations surpass the residential standard limit of 60 µg/m³ but remain within the range of 100 µg/m³ for $PM_{2.5}$ and PM_{10} variables within a 24-hour period. Notably, PM_{10} (Particulate Matter 10) levels were exceptionally elevated in all directions. The highest PM_{10} concentration was observed in close proximity to the highway in Ranganataha Swamy layout (RSL), primarily attributed to the accumulation of ground dust from vehicle emissions resulting from inadequate road maintenance and service road working in progress. For a comprehensive overview of air quality in various regions is given in Table 3, which gives the AQIM values.

Table 3. AQIM at various sampling stations in the selected Residential areas.

Residential Area	Location	AQIM	Remarks
VA	L1	62.62	Moderate
	L2	63.46	Moderate
	L3	60.32	Moderate
PJE	L1	61.43	Moderate
	L2	62.24	Moderate
	L3	63.58	Moderate
RSL	L3	76.23	Heavy
	L3	78.46	Heavy
	L3	79.49	Heavy

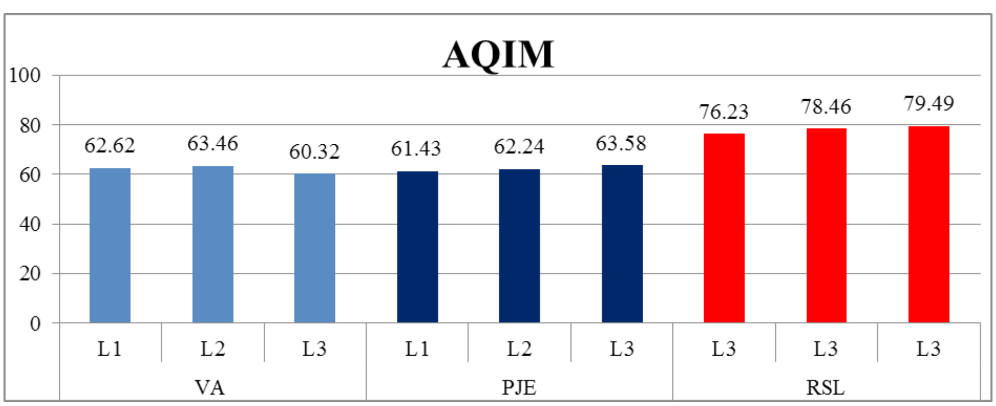
The table reveals that in the Ranganataha Swamy layout (RSL), stations VA and PJE exhibit lower values compared to other two stations. This disparity can be attributed to increased vehicular activities, traffic congestion and ongoing road construction projects. Conversely, in the VA and PJE, recorded values are notably lower than in the other one residential zones (Fig. 1). This difference can be attributed to the presence of a highway and ongoing construction activities.

The results of the air quality monitoring indicate significant variability in pollutant concentrations across different sampling locations. This variation is influenced by stationary pollution sources and the density of mobile pollution sources. Notably, PM_{10} and $PM_{2.5}$ concentrations exceed permissible standards, primarily due to activities such as road repair work, vehicle movement, sand unloading and the effects of automobile emissions along the national highway. Additionally, construction activities near RSL residential area contribute to these elevated levels.

The study findings suggest that while the concentration of PM_{10} and $PM_{2.5}$ is near the threshold limit, other atmospheric variables in the study area do not pose a severe threat to public health. However, it is worth noting that residents in the vicinity of the study area have reported suffering from respiratory and other health issues, highlighting the importance of addressing air quality concerns.

CONCLUSION

The findings of this study unequivocally demonstrate that PM_{10} and $PM_{2.5}$ stands out as the predominant air pollutant within the study area. Throughout the entirety of the study area, PM_{10} and $PM_{2.5}$ pollutants consistently exceeded the allowable thresholds, whereas gaseous pollutants remained within acceptable levels. The primary culprits for the elevated pollution levels in the local atmosphere are maintenance of roads, automobile emissions and transportation activities. Moreover, this study underscores the significance of public awareness in crafting innovative solutions to address health, transportation, and other air pollution challenges. A strategic plan for the implementation of these solutions is essential for the betterment of the community.



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