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A COMPARATIVE ANALYSIS FOR AIR QUALITY ESTIMATION FROM URBAN TO SUB-URBAN AREAS IN JAIPUR DISTRICT

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ABSTRACT Air pollution is a matter of great concern worldwide because of the health risks to individuals due to pollution. Great exposure to pollutants such as airborne particulate matter and ozone leads to increases in mortality, respiratory and cardiovascular disease. Air pollution is increasing due to emissions from industries and many residential areas and many anthropogenic activities. It has been become a very big issue for human being worldwide (Yang et al. 2004 and Afroz et al.2003). Average concentration of pollutants analyzed the variance on yearly basis i.e., NO2, SO2, PM at four selected monitoring sites namely Ajmeri gate and Chandpol (Commercial Area in Urban area) in Jaipur City, whereas VKIA (Vishwakarma Industrial Area) and Sitapura (in sub-urban area) Jaipur, Rajasthan, India year from (2021-2022) and to evaluate the ambient air quality assessment on the basis of NAAQS (National Ambient Air Quality Standards) and AQI (Air Quality Index). After the study of different Selected sites, the data shown that SO2 concentration was identified constantly under the permissible limits as specified by means of CPCB (50 µg/m3) at all the selected study sites whereas PM has crossed the permissible limits at all the monitoring sites done the entire study duration by a maximum value detected in VKI (Vishwakarma Industrial) Area in 2022. PM (Particulate matter) shown that the maximum value as compare NO2 and SO2, making it a prominent pollutant. It was noticed that ranges of AQI values from Modest to Very Poor at VKI Area. Therefore, observation shown that VKI (Vishwakarma Industrial Area) site was most polluted site in comparison to other selected study sites, Jaipur.

KEYWORDS : Jaipur, NO_2, SO_2, PM, Air Quality Index.

INTRODUCTION

The term "air quality" describes the condition of the surrounding air. In the developing countries, the air quality is one of the biggest concerns (Dockery *et al.* 1994). Environmental pollution becomes a big health problem. The risk of illness and premature mortality is significantly increased by environmental pollution. One of the countries with the highest exposure to air pollution is India. Because of its direct effects on human health, air pollution is one of the main environmental issues of both developed and developing nations. Due to anthropogenic factors such as fast urbanization, industrialization, an unchecked growth in the number of vehicles on shoddy roads, construction debris, garbage burning, and a lack of public awareness, the air quality around India has steadily gotten worse (Guttikunda et al. 2011). The top 30 most polluted cities in the world are all in India. The ambient air conditions in Indian cities have generally gotten worse as a result of a lack of knowledge about the effects of urbanization and industrial expansion. air toxicity at locations

Many air pollutants that are emitted by businesses and other activities have a negative impact on both human health and the environment. Any material that could endanger people, animals, or vegetation is considered an air pollution. In terms of humans, an air pollution may lead to an increase in mortality or major illnesses. By putting more dangerous materials into the ecosystem, pollutants damage it (Brunekreef et al. 2008). Particle pollution, ground-level ozone, carbon monoxide, sulfur oxides, nitrogen oxides, and lead are the six main air contaminants, according to the WHO.

AQI(Air Quality Index)

AQI is a method of conversion of complex air quality in a single digit to make it easy understandable to the common people (Yadav *et al.* 2012) It is calculated by collecting the ratio of pollutant concentration in surrounding air to the standard limit of pollutants in surrounding air (Ziauddin *et al.* 2006). Basic formula to find out air quality index

AQI = ⅓ {SPM/SPM Standard} + (NOx/NOx standard) ×100 (1)

MATERIALS AND METHODS

Study Area

The easternmost region of Rajasthan is home to Jaipur, the state's capital. India's largest state is Jaipur. Due to the color of its buildings, it is frequently called "Pink City." It is well-known for drawing tourists. Maharaja Swai Jai Singh created Jaipur in the year 1727 AD, and Jaipur is renowned for its Rajputana culture and forts. It is the largest city in Rajasthan and is situated 268 kilometers away from New Delhi, the capital of India. The Jaipur district is situated at 27.1425146 N and 75.0397275 E and covers an area of 11,143 km2. Nearly 3.23% of Rajasthan's total land is covered by the Jaipur district, which has a fairly high population density. It is the tenth most populated city of the country. Jaipur district has attractive forts and beautiful palaces (Dadhich *et al.* 2018). The city is well connected by rail, road, and air transportation network to the country. It has a semi-arid climate with winter, monsoon, and summer season. The relative humidity ranges between 35 and 63%. The average annual rainfall is around 60 mm. Maximum rainfall occurred in the month of August in 2006 which is 166mm. Jaipur city faces hot climate with highest temperature during May- June months. The maximum & minimum temperature of the Jaipur district is 45degree Celsius and 5 respectively. Because of continuous urbanization and industrialization, the most area of Jaipur have been transformed to industry zone and built-up area (Mehta 2019).

Site Description

The quality of air of Jaipur city has become polluted due to various anthropogenic activities, vehicular emissions and various surrounding industrial activities.

Four different sites were selected as monitoring site in the study in order to examine air quality. Sites were selected according to urban and sub-urban area; Two different sites were selected of urban area and 2 sites were selected of sub-urban area. In urban site, Chandpol and Ajmeri gate were selected as monitoring site in study area whereas both the sites are fascinating towards tourists, Chandpol and Ajmeri gate both belongs to a commercial area where bazaar vendors trade in marble, textiles, cotton quilts, footwears, stone sculptures etc. leading to heavy traffic due to two, three and four wheelers and buses.

In sub-urban area Sitapura and VKIA (Vishwakarma Industrial area) were selected as monitoring sites. Sitapura is an industrial region, and VKIA is very close to it. Sitapura is home to a number of different companies, including those related to the automobile, paper, chemical, marble, and rubber. An annual study is being conducted on a time basis. It has been discovered that the pollution in urban and sub-urban areas differs significantly.

Data Set

Data used in this study is secondary data and was collected from Rajasthan State Pollution Control Board (RSPCB) website for Jaipur city from 2021-2022 for four different monitoring sites Chandpole, Ajmeri gate (selected as urban sites) and Vishwakarma Industrial area, Sitapura (selected as sub-urban area).

Table1: National Air Quality Index and its possible health impacts

AQI value	Nomenclature	Health Impact
0-50	Good	Minimal Impact
51-100	Satisfactory	Minor breathing discomfort to sensitive people

101-200	Moderate	Breathing discomfort to the people with Lung, Heart disease, children and older adults
201-300	Poor	Breathing discomfort to everyone on prolonged exposure
301-400	Very Poor	Respiratory illness to everyone on prolonged exposure
>400	Severe	Respiratory effects even on healthy people

Source:http://rspcbmis.environment.rajasthan.gov.in/NAMP_Report.aspx?HeaderId=4&MenuId=6

Table2: AQI of NO_2, SO_2 and PM in selected Urban and Sub-urban areas in Jaipur District (Jan-Dec 2021)

2021	No_2(µg/m^3)		PM (µg/m^3)		SO_2(µg/m^3)		AQI
	Max.	Min.	Max.	Min.	Max.	Min.	
Ajmeri gate	54.19	22.04	314	43	9.88	5.5	264.00
Chandpole	54.27	21.6	234	61	8.86	5.3	189.33
VKIA	39.96	19.43	318	53	13.11	5.98	268.00
Sitapura	45.82	16.25	253	29	10.04	4.83	184.00

Table3: AQI of NO_2, SO_2 and PM in selected Urban and Sub-urban areas in Jaipur District (Jan-Dec 2022)

2022	NO_2(µg/m^3)		PM (µg/m^3)		So_2(µg/m^3)		AQI
	Max.	Min.	Max.	Min.	Max.	Min.	
Ajmeri gate	57.56	8.55	296	30	25.67	2.1	211.00
Chandpole	60.06	9.28	376	50	18.25	3.1	326.00
VKIA	55.25	14.08	540	56	21.49	3.12	510.00
Sitapura	61.65	14.75	257	87	17.77	2.4	207.00

Abbreviation: NO_2- Nitrogen dioxide, PM- Particulate matter, SO_2 - Sulfur dioxide

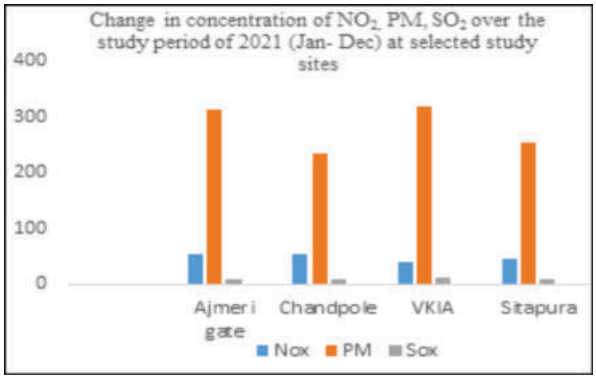

Figure2: Graphical representation of concentration of NO_2, SO_2 and PM in Urban and Sub-urban areas during year from January to December2021 in Jaipur District

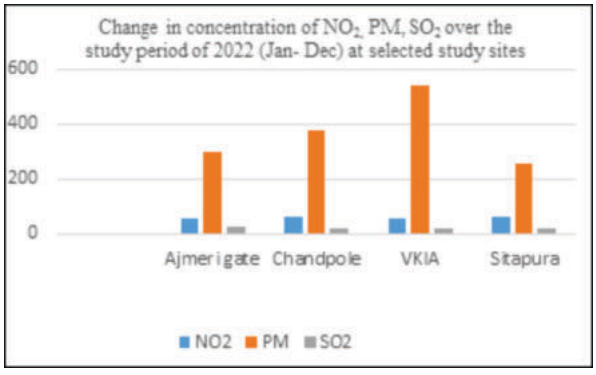

Figure2: Graphical representation of concentration of NO_2, SO_2 and PM in Urban and Sub-urban areas during year from January to December2022 in Jaipur District

RESULT AND DISCUSSION

The yearly average concentration of three pollutants, specifically NO2, PM, and SO2, was used to compute the air quality index (AQI) for the four separate monitoring sites based on urban and sub-urban areas, according to information gathered from the RSPCB website.

Nitrogen dioxide (NO_2)

Due to automotive emissions, nitrogen dioxide is a pollutant associated with traffic (Richmont et al., 2017). Humans experience several harmful consequences from doses over 0.2 ppm, such as respiratory illnesses, whereas T-lymphocytes are affected by quantities above 2.0 ppm. The average NO2 concentration was found to be at its highest at Ajmeri Gate, Jaipur, in 2022, at 57.56 g/m3, and at its lowest in 2021, at 54.19 g/m3, and at its highest in Chandpole, a commercial area, at 60.06 g/m3, respectively.AQI 189.33 average concentrations were observed in year 2022 and 2021. For VKIA maximum (55.25 µg/m^3, AQI 510.00) and minimum (39.96 µg/m^3, AQI 268.00) concentration were observed in 2022 and 2021 respectively. For Sitapura maximum (61.65µg/m^3, AQI 207.00) and minimum (45.82µg/m^3, AQI 184.00) concentration were observed in 2022 and 2021 respectively.

It also demonstrates that the concentration of NO2 has exceeded the CPCB's national ambient air quality standards (40 g/m3) at Ajmeri Gate in 2022, 2021 at Chandpole in Jaipur, and in 2021 at Sitapura. Additionally, it demonstrates that NO2 has exceeded the CPCB's national ambient air quality standards at VKIA in 2022 and in 2021 at Sitapura.

Particulate matter (PM)

It also demonstrates that the concentration of NO2 has exceeded the CPCB's national ambient air quality standards (40 g/m3) at Ajmeri Gate in 2022, 2021 at Chandpole in Jaipur, and in 2021 at Sitapura. Additionally, it demonstrates that NO2 has exceeded the CPCB's national ambient air quality standards at VKIA in 2022 and in 2021 at Sitapura.PM (particulate matter) 5.2 Particulate matter is made up of microscopic liquid or solid particles that can be breathed and have a major negative impact on one's health. (2011) Cheung et al. At both locations over the course of the study period, the yearly average PM concentration exceeds the CPCB-specified 60 g/m3 National Ambient Air Quality Standards. The maximum and the minimum concentration observed for PM10 at Ajmeri gate was in year 2021(314 µg/m^3, AQI 264.00) and in year 2022 (296µg/m^3, AQI 211.00) and for Chandpole, maximum average concentration was observed in year 2022 (376µg/m^3, AQI 326.00) and minimum average concentration in 2021 (234µg/m^3, AQI 189.33) and for VKIA maximum average concentration was observed in year 2022 (540µg/m3, AQI 510.00) and minimum average concentration in 2021 (318µg/m^3, AQI 268.00) and for Sitapura maximum average concentration was observed in year 2022 (257µg/m^3, AQI 207.00) and minimum average concentration in 2021 (253µg/m^3, AQI 184.00). It also shows that the VKIA, Jaipur experiences a higher PM concentration than all remaining study area over the whole study period. This is because of heavy traffic in industrial area due to loading of finished products and unloading of raw materials.

Sulfur dioxide (SO_2)

Sulfur dioxide is a harmful gas that is emitted mainly from fossil fuel consumption (in complete consumption) or industrial activities. The annual average concentration of SO_2 has never crossed the prescribed limit 50 µg/m^3 as specified by CPCB over the whole study period at all the monitoring sites. In Ajmeri gate, Jaipur the maximum concentration was observed in year 2022 (25.67µg/m^3, AQI 211.00) and a minimum was observed in 2021 (9.88µg/m^3, AQI 264.00), while for Chandpole, Jaipur the maximum concentration observed was(18.25µg/m^3, AQI 326.00) in year 2022 and minimum concentration was observed in year 2021 (8.86 µg/m3, AQI 189.33), and in VKIA, Jaipur the maximum concentration was observed in year 2022 (21.49µg/m^3, AQI 510.00) and a minimum was observed in 2021 (13.11µg/m^3, AQI 268.00), in Sitapura, Jaipur the maximum concentration was observed in year 2022 (17.77µg/m^3, AQI 207.00) and a minimum was observed in 2021 (10.04µg/m^3, AQI 184.00).

CONCLUSION

Analysis shows that there are numerous urban areas with better air quality than others, despite some of them having very bad air quality. Because there are fewer automobiles on the road during the day than at night, there are more air pollutants in the air during the day. Compared to residential regions, the amount of air pollution is higher in industrial locations. The government should enforce stringent restrictions for the industries and promote electric automobiles. Government and NGOs should launch awareness campaigns. The planting of trees has to be addressed. It concluded that air pollution at the study site is mainly because of traffic. Traffic diversions, restricting heavy vehicles movement through residential roads, arranging for periodic vehicle maintenance and encouraging public transport instead of private

vehicles are beneficial to control air pollution due to transportation. In addition, public awareness for environment protection should be adopted and green plantation along highway and within industries should be encouraged. It may, thus be concluded that strict implementation of environmental regulations and adoption of adequate pollution control measures is need of the hour.

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