AIR QUALITY INDEX DETERMINATION OF COMMERCIAL AREAS OF JODHPUR CITY: A CASE STUDY

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***Abstract:** This paper presents a case study of Jodhpur City in which an attempt has been made to prepare an inventory of pollutants (PM_{10}, $PM_{2.5}$, SO_2, NO_x, CO) at regional level to know the current cumulative air pollution load in the study area and thereafter computing Air Quality Index by computing sub index for every pollutant. Monitoring stations were set up at seven different locations and samples have been analysed and subsequently air quality index has been computed. The results reveal that gaseous pollutants such as SO_2, NO_2& CO are within the permissible limits. $PM_{2.5}$ levels exceed the prescribed National Ambient Air Quality standards (NAAQS) and PM_{10} levels also exceeded the prescribed NAAQS during all the monitoring location thus particulate matter is the predominant cause of air pollution in the study area. The AQIs were calculated using IND-AQI procedure. It has been observed that the calculated AQIs value for SO_2 falls under 'good' category. The calculated AQIs values for NO_2 & CO fall under 'good' and 'satisfactory' categories. The calculated AQIs values of PM_{10} fall under 'moderate' and 'poor' categories. The calculated AQIs values of $PM_{2.5}$ fall under 'moderate', 'poor' and also in 'very poor' categories. The overall AQI was found to fall under the category 'Poor' owing to $PM_{2.5}$. Thus it is observed that $PM_{2.5}$ is responsible pollutant at these seven locations in Jodhpur.*

***Keywords:** Air quality index, ambient air quality, Jodhpur city, Residential area, PM_{10}, $PM_{2.5}$, SO_2, NO_2, CO.*

I. INTRODUCTION

Today pollution in urban areas especially in commercial areas has become an important issue to all the government. Because of increasing commercial activities, industrial activities and transportation load air quality is continuously deteriorating. The acute health effect of suspended particulate matter (SPM), even at short term low levels exposure; include increased daily mortality and hospital admission rates for exacerbation of respiratory disease. Long term exposure to PM2.5 increases the risk of the non accidental mortality. Living close to busy traffic appears to be associated with elevated risk. The available human clinical results do not establish a mechanistic pathway leading to adverse health impacts for short term NO_2 exposure at present day ambient environment. In all the analytical studies total mortality was directly associated with long term exposure to particulate matter .Each day our lungs are directly exposed to more than 7000 liters of air, which contain varying amount of inorganic, organic particles and various types of gases. Air Quality Index is a medium to communicate the quality of ambient air to common people so it is easy to understand. It transforms the complex data of various air pollutants into a single number which is called index value along with nomenclature and colour.Jodhpur is the second largest city of Rajasthan and is a well-known tourist place. Varieties of pollutants are emitted in ambient air of Jodhpur city but particulate matters primarily dominate. Jodhpur is Rajasthan's most polluted city as per May 2016 report of World Health Organisation. Therefore an attempt was made to present overall air quality in residential areas of Jodhpur city in terms of Air Quality Index & AQI has been calculated as per the guidelines of Central Pollution Control Board of India.

II. MATERIAL AND METHOD

Seven sampling stations were selected for monitoring of air quality in the commercial areas of Jodhpur City for the analysis of air pollution and determination of Air Quality Index i.e. Paota Circle, Jaljog Circle, BasniCircle, Akhaliya Circle, NaiSarak, Ratanada Circle and Near Pungalpada. Five ambient air pollutants (i.e.PM_{10}, $PM_{2.5}$, SO_2, NO_2 and CO) were determined using Respirable Dust Sampler, Fine Particulate Sampler, gaseous sampling attachment (EPA modified-West and Gaeke method for $SO_2$and Modified Jacobs Hochheiser method for NO_2) and CO meter respectively. Readings were taken during the months of March to May as per the norms established by Central Pollution Control Board. Particulate matters measured by Cyclonic Flow Technique and Gravimetric method using GF/A filter papers on 8 hourly basis for 24 hours. Size of filter paper for PM_{10} was 20.3 cm×25.4 cm with a flow rate of 1000 L/min and 47 mm at the rate of 16.7 L/min for $PM_{2.5}$. Gaseous pollutants which were SO_2 and NO_2 were measured using gaseous sampling attachment attached with Rapid Dust Sampler. Carbon Mono-oxide was measured using CO meter at the desired locations instantly.

2.1 Sub-Index calculation

Air Quality index (AQI) is so deigned that any three of the parameters from PM_{10}, $PM_{2.5}$, SO_2, NO_2, CO, O_3, Pb, &NH_3, are sufficient to calculate the AQI. Sub-indices of eachselected pollutants were calculated and then highest value from among all the values of sub index was considered as AQI for that area.

The sub-index (I_p) for a given pollutant concentration (C_p) was calculated as,

$$I_P = \left[\left\{ \frac{I_{HI} - I_{LO}}{B_{HI} - B_{LO}} \right\} \times (C_P - B_{LO}) \right] + I_{LO}$$

Where,

B_{HI}= Breakpoint concentration greater than or equal to given concentration
B_{LO}= Breakpoint concentration smaller than or equal to given concentration
I_{HI}= AQI value corresponding to B_{HI}
I_{LO}= AQI value corresponding to B_{LO}, subtract one from I_{LO} if $I_{LO}$is greater than 50
C_p= Pollutant concentration
Finally, AQI = Max (I_p) (where, p = 1, 2, 3 …denotes n pollutants)

III. OBSERVATIONS & ANALYSIS

Table-1 represents the location of sampling stations whereas table -2 gives the breakpoint concentration of various pollutants . These breakpoint concentrations are used to calculated the sub index of each pollutants and value of highest sub index is called AQI. Table -3 indicates the calculated values of sub index for each pollutants for maximum, minimum and average concentrations of pollutants and also gives the maximum, minimum and average AQI at a sampling station.

Table 1: Location of monitoring stations

S. No.	Station Name	Location	
		Latitude	**Longitude**
1	Paota Circle	26°17'35.59" N	73°2.0'17.31" E
2	Jaljog Circle	26°16'27.22" N	73°00'25.45" E
3	Basni Circle	26°14'1.86" N	73°00'20.44" E
4	Akhaliya Circle	26°16'38.30" N	72°59'23.26" E
5	NaiSarak	26°17'18.05" N	73°01'35.36" E
6	Ratanada Circle	26°16'14.45" N	73°2.0'22.74" E
7	Near pungalpada	26°17'34.83" N	73°0.0'58.90" E

Table 2: Breakpoints for AQI Scale 0-500 (Units: µg/m^3 unless mentioned otherwise)

AQI Category	**PM_{10}**	**$PM_{2.5}$**	**NO_2**	**CO**	**SO_2**
(Range)	**24-hr**	**24-hr**	**24-hr**	**8-hr (mg/m^3)**	**24-hr**
Good (0-50)	0-50	0-30	0-40	0-1.0	0-40
Satisfactory(51-200)	51-100	31-60	41-80	1.1-2.0	41-80
Moderately polluted(101-200)	101-250	61-90	81-180	2.1-10	81-380
Poor(201-300)	251-350	91-120	181-280	10-17	381-800
Very poor(301-400)	351-430	121-250	281-400	17-34	801-1600
Severe(401-500)	430+	250+	400+	34+	1600+

Table 3: Sub Index of Pollutant at different monitoring stations

Station Name: Paota Circle						
Sub Index	**Pollutants**					AQI
	SO_2	**NO_2**	**PM_{10}**	**$PM_{2.5}$**	**CO**	
Maximum	13	48	246	337	81	337
Minimum	7	26	132	147	27	147
Average	10	37	189	242	54	242
Station Name: Jaljog Circle						
Sub Index	**Pollutants**					AQI
	SO_2	**NO_2**	**PM_{10}**	**$PM_{2.5}$**	**CO**	
Maximum	10	56	208	307	46	307
Minimum	8	48	178	241	30	241
Average	9	52	193	274	38	274
Station Name: Basni Circle						
Sub Index	**Pollutants**					AQI
	SO_2	**NO_2**	**PM_{10}**	**$PM_{2.5}$**	**CO**	
Maximum	10	53	243	301	34	301
Minimum	8	47	187	221	26	221
Average	9	50	215	261	30	261
Station Name: Akhaliya Circle						
Sub Index	**Pollutants**					AQI
	SO_2	**NO_2**	**PM_{10}**	**$PM_{2.5}$**	**CO**	
Maximum	13	67	254	325	43	325
Minimum	11	51	196	305	27	305
Average	12	59	225	315	35	315
Station Name: Nai Sarak						
Sub Index	**Pollutants**					AQI
	SO_2	**NO_2**	**PM_{10}**	**$PM_{2.5}$**	**CO**	
Maximum	12	62	217	309	41	309
Minimum	8	50	159	191	31	191

Average	10	56	188	250	36	250
Station Name: Ratanada Circle,						
Sub Index	**Pollutants**					AQI
	SO_2	**NO_2**	**PM_{10}**	**$PM_{2.5}$**	**CO**	
Maximum	9	42	162	178	30	178
Minimum	7	38	130	118	20	130
Average	8	40	146	148	25	148
Station Name: Pungal Pada						
Sub Index	**Pollutants**					AQI
	SO_2	**NO_2**	**PM_{10}**	**$PM_{2.5}$**	**CO**	
Maximum	10	49	182	259	38	259
Minimum	8	31	158	207	26	207
Average	9	40	170	233	32	233

The observations reveal that SO_2 levels were within the prescribed NAAQS during all the monitored location. The reason for low levels of SO_2 may be various measures taken such as reduction of sulphur in diesel, lesser old vehicles etc. NO_2 levels were also within the prescribed NAAQS during all the monitored location. The reasons for low levels of NO_2 may be various measures taken such as removal of old vehicles, better traffic management etc. CO levels were also within the prescribed NAAQS during all the monitored location as there were no major sources present in the study area which can produce or emit CO in large quantities. PM2.5 levels exceed the prescribed NAAQS and PM10 levels also exceeded the prescribed NAAQS during all the monitoring Location. The reason for high particulate matter in the study area can be high traffic density, heavy vehicle movement, natural dust, dust storms, etc. At Akhaliya, NaiSarak, Paota, Jaljog and Basni station PM10 & PM2.5 concentration were at very high level. The reasons for higher level of particulate matter in these locations can be high traffic density, heavy vehicle movement, presence of industrial area in the vicinity, & natural dust. But at Ratanada location PM10 & PM2.5 concentration were at lower level as compared to concentration at other location. The reason for lower level of Particulate matter in this location is the green belt development in the area and also low density of vehicles. Also at pungalpada(old city) station PM10 & PM2.5 concentration were at lower level as compared to Akhaliya, NaiSarak, Paota, Jaljog and Basni station. The reason for lower level of particulate matter in this location is no heavy vehicles movement in this area.

IV CONCLUSION

The main air pollution problem in Jodhpur city is the increasing level of particulate matter (PM2.5 & PM10) concentration in air. The predominant source of air pollution in the study area is the growing number of vehicles. Particulate matter when inhaled in large quantities lead to the development of respiratory diseases such as chronic bronchitis etc. The degree of impact is also dependent on the size of the particulate matter. Coarse particles result in adverse effect on lung system while fine particles are deposited in the deeper parts of the lungs. The results reveal that Akhaliya Circle is having very poor Air Quality Index and is the most polluted station among all the other monitored stations. AQI of all the sampling station indicates that pollutants concentration in the air of Jodhpur is continuously increasing and deteriorating the quality of air. The air quality in these areas falls under moderately polluted to poor category.

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