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RESEARCH ARTICLE

STATUS AND MONITORING OF AMBIENT AIR QUALITY OF REWA CITY, (M.P.) INDIA

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ABSTRACT

Urbanization and industrialization have led to rapid economic growth in different countries of the world including India. However, this has also led to serious air pollution related problems worldwide. Air pollution is considered to be primarily an urban problem as the rate of urbanization and vehicular emission increases and dust contributing a major share of the deteriorating ambient air quality in Rewa city. The present study was undertaken to evaluate the mean concentrations of SPM, RSPM, SO₂, and NO_x in ambient air of Rewa city. The analysed values of SPM, RSPM, SO₂ and NO_x at the sampling sites clearly illustrates that the ambient air of Rewa city is primarily deteriorated by particulate matters (SPM, RSPM) and least by gaseous pollutants (SO₂, NO_x).

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INTRODUCTION

Air pollution is the introduction of harmful pollutants into the air by means of various natural as well as anthropogenic means, released in the air due to industrial as well as commercial activities. Air pollution has become a major environmental problem faced by the people globally in both developing and developed countries in recent times. Ambient air quality in India have progressively deteriorated due to rapid urbanization and industrialization. Increasing population resulted in a tremendous increase in the number of motor vehicles. The automobile emissions constitute a major source of environmental pollution in Rewa city. Although some natural processes such as volcanic eruptions and wildfires may pollute the air but most often, it is caused by human activities such as transportation, industrial work, mining, construction, agriculture, smelting, etc. The pollutants are found in both gaseous and solid form (as particulate matter suspended in the air). The air pollutants such as Particulate Matter (PM), black carbon, Ozone (O₃), Nitrogen Oxides (Nox), Sulfur Oxides (SO_x), carbon monoxide, heavy metals or black smoke often investigated for the assessment of air quality (Chaurasia et.al, 2013) Particulate pollutants reduced the photosynthetic activity of plants by stomatal clogging, and also cause leaf fall and death of tissues (Singh and Sthapak, 1999; Farooq et al., 2000; Shrivastava and Joshi, 2002; Garg et al., 2000).

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Emmanouil Mentzakis and Doriana Delfino. (2010) quantified the impact of air pollution (CO, NO, NO₂, SO₂, O₃) and resulted that significantly increasing the concentration SO₂, NO, O₃ and CO causes circulatory, respiratory and skin diseases in humans. Automobiles and construction works going on in the city are the main source of pollution in urban atmosphere of the Rewa city. This deteriorated air quality lay a recognizable adverse impact on roadside plants as well as human health of the city. Present research work was undertaken to study the ambient air quality of Rewa city.

MATERIALS AND METHODS

Selection of Site

The present study was conducted in Rewa city, which is situated on the north-eastern part of Madhya Pradesh state, central part of India. It lies between 24°18' and 25°12' north latitudes and 81°2' and 62°18' east longitudes. The geographical area of Rewa district is 6,314 kilometers. Nearby Rewa city there are three mega cement plants and some small scale industries present, including a few stone crushers.

Sampling and monitoring

On the basis of anthropogenic activities and relative traffic load, air quality monitoring at six selected sites of Rewa city have been carried out viz; Sirmour square, New Bus stand, PTS square, Dhoba tanki and Rathara By pass along with control site (APS University Campus) of Rewa city for six

months (January 2018 to June 2018). Sampling was carried out at the six different locations using Respirable Dust sampler (Envirotech model APM 460 BL-411) and Gaseous pollutants sampler (Envirotech model APM 443) for 8 hours in a day at an average flow rate of 1.5 LPM as per the standards of Central Pollution Control Board (India). Monitoring is carried out once in a month at sampling sites. Suspended particulate matters (SPM) and Respirable suspended particulate matters (RSPM) were collected on the dust cup and glass fabric filter paper (GRA-3) respectively. Samples for determination of gaseous pollutants (SO_2 and NO_x) were collected by bubbling air samples in Potassium tetra chloromercurate and Sodium hydroxide arsenate absorbent solutions respectively in impingers at flow rate of 1.5 LPM. These samples were analyzed for SO_2 and NO_x spectrophotometrically.

RESULTS

The monthly ambient air concentrations of suspended particulate matter (SPM), Respirable particulate matters (RSPM), Sulphur dioxide (SO_2) and Nitrogen oxides (NO_x) have been monitored at six sites of Rewa city during the year January 2018 to June 2018. Results showed that the SPM of ambient air of Rewa city varied from 180.88 to 605.01 $\mu\text{g}/\text{m}^3$, 170.02 to 612.32 $\mu\text{g}/\text{m}^3$ and 165.99 to 500.02 $\mu\text{g}/\text{m}^3$ 150.32 to 500.23 $\mu\text{g}/\text{m}^3$, 134.44 to 390.11 $\mu\text{g}/\text{m}^3$ and 125.66 to 300.03 $\mu\text{g}/\text{m}^3$ during January, February, March, April, May and June respectively during 2018 (Figure-1). Figure-2 reveals monthly concentrations of Respirable particulate matters (RSPM) for the ambient air of selected sites of Rewa city observed during January 2018 to June 2018. The observed RSPM values of various sites were found in the range of 48.59 to 150.29 $\mu\text{g}/\text{m}^3$ during January month. The ambient air of Sirmour square and University campus exhibited higher and lower concentrations of RSPM respectively during six month. During February, March, April, May and June ambient air RSPM concentrations were estimated in the range of 45.03 to 146.02 $\mu\text{g}/\text{m}^3$, 43.92 to 132.91 $\mu\text{g}/\text{m}^3$, 42.88 to 125.11 $\mu\text{g}/\text{m}^3$, 42.99 to 98.99 $\mu\text{g}/\text{m}^3$ and 30.03 to 90.09 $\mu\text{g}/\text{m}^3$ during respectively. Figure-3 shows monthly concentrations of Sulphur dioxide (SO_2) for the ambient air of selected sites of Rewa city observed during January 2018 to June 2018, the ambient air SO_2 concentrations were estimated in the range of 20.08 to 47.30 $\mu\text{g}/\text{m}^3$. Out of six sampling sites, the ambient air of New Bus Stand exhibited highest concentrations of SO_2 during all six months Whereas the lowest concentration was estimated for ambient air of University campus throughout the sampling periods of this year.

The monthly concentrations of Nitrogen oxides (NO_x) estimated for the ambient air of selected sites of Rewa city during research period are given in Figure- 4. The estimated NO_x concentrations of the studied sites varied between 16.41 to 64.11 $\mu\text{g}/\text{m}^3$ during six months analysis. Out of six study sites, Rathara bypass showed highest value of NO_x concentration in the ambient air whereas, the lowest concentration was estimated for the ambient air of University campus during this period. The ambient air samples showed NO_x concentrations in the range of 16.41 to 69.43 $\mu\text{g}/\text{m}^3$ with maximum and minimum at Transport nagar and University campus respectively. Average concentrations of four pollutants have been computed from the basic data during the year January 2018 to June 2018 (Figure 1 - 4). Results revealed monthly variation in pollutant concentrations in the ambient

air of Rewa city. Average concentrations of SPM was found maximum in the ambient air of Sirmour square (492.12 ± 131.76) during six months to be followed by New Bus stand (463.30 ± 143.19), Rathara Bypass (414.40 ± 328.79), Dhobiya tanki (390.03 ± 76.74), PTS Square (318.12 ± 109.43), and University campus (154.55 ± 25.54). The ambient air of Sirmour square also exhibited maximum average concentration of RSPM (123.90 ± 24.62) during six months to be followed by New Bus stand (102.18 ± 9.26), Rathara Bypass (99.44 ± 8.14), Dhobiya tanki (75.41 ± 10.19), PTS Square (67.33 ± 8.63), and University campus (42.24 ± 6.40). The estimated average concentration of SO_2 was observed to be maximum in the ambient air of New Bus stand (40.77 ± 3.47), followed by Sirmour square (36.09 ± 3.816), Rathara Bypass (30.42 ± 3.75), Dhobiya tanki (29.71 ± 3.12), PTS Square (26.87 ± 1.36) and University campus (20.31 ± 0.12). The Rathara Bypass ambient air exhibited maximum concentration of NO_x (54.85 ± 5.27) during this year to be followed by New Bus stand (48.54 ± 6.11), Sirmour square (47.73 ± 5.69), Dhobiya tanki (33.71 ± 2.46), PTS Square (32.04 ± 3.30) and University campus (17.13 ± 0.37).

It is evident from the results that air quality of Rewa city is deteriorating mainly due to particulate pollutants. Out of six sampling sites, the average concentrations of SPM in the ambient air of all the sites exceeded the standard value ($200\mu\text{g}/\text{m}^3$) prescribed by CPCB, New Delhi. The average SPM concentrations in the ambient air of only one site (University campus) were observed below the prescribed standard value. Only three sites of Rewa city (PTS Square, Dobia tanki and Rathara Bypass) showed RSPM concentrations in the ambient air above the standard value ($100\mu\text{g}/\text{m}^3$) prescribed by the CPCB, New Delhi. On contrary, other sites registered RSPM concentrations in the ambient air below the prescribed standard value. Gaseous pollutants (SO_2 and NO_x) were always found to be below the standard value ($80\mu\text{g}/\text{m}^3$) prescribed by the CPCB, New Delhi throughout the study period. The basic data have been computed with suitable statistical approach (ANOVA) to observe the significant changes in concentrations of various pollutants (Table- 3). Results revealed that there was significant difference in SPM, RSPM, SO_2 and NO_x concentrations in ambient air of Rewa city between different months.

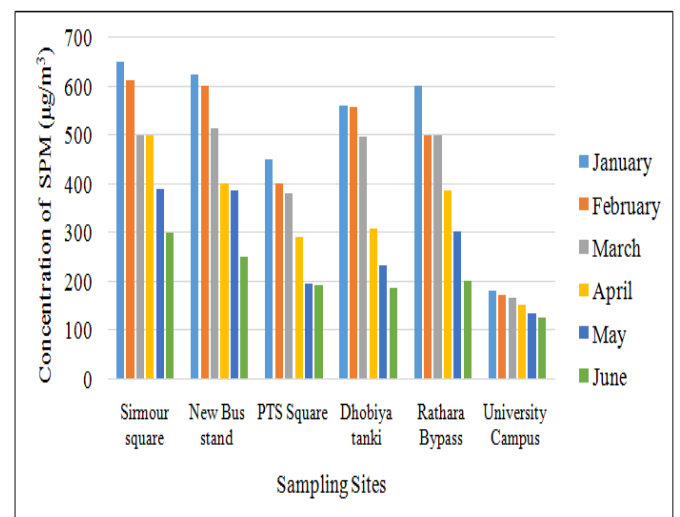


Figure. 1 Monthly concentration of SPM ($\mu\text{g}/\text{m}^3$) in the ambient air at various sites of Rewa city

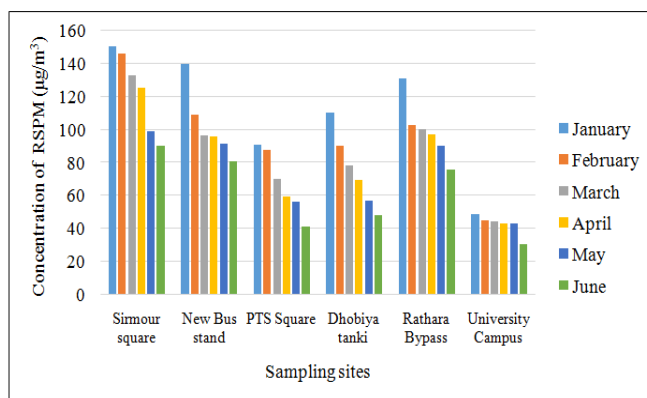


Figure. 2 Monthly concentration of RSPM ($\mu\text{g}/\text{m}^3$) in the ambient air at various sites of Rewa city

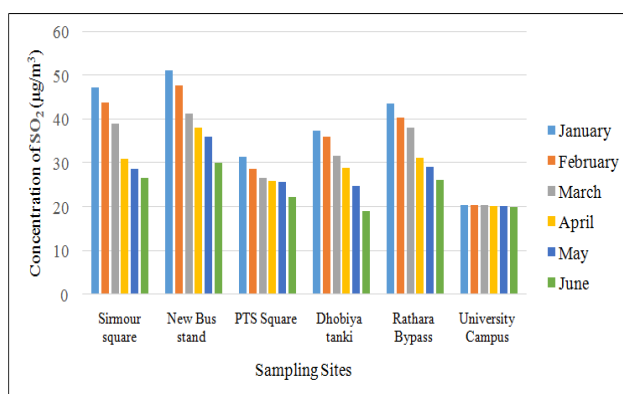


Figure.3 Monthly concentration of SO_2 ($\mu\text{g}/\text{m}^3$) in the ambient air at various sites of Rewa city

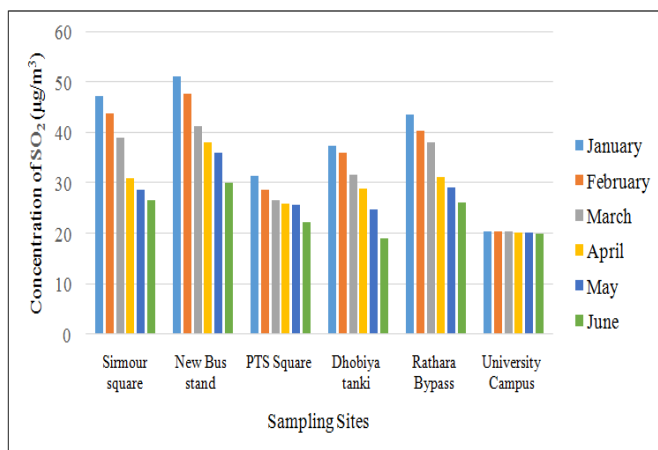


Figure.4 Monthly concentration of NO_x ($\mu\text{g}/\text{m}^3$) in the ambient air at various sites of Rewa city

DISCUSSION

Urban air pollution episodes are primarily due to increased concentrations of pollutants, viz. local meteorology, emissions and dispersion conditions. Rewa has insufficient transport infrastructure. Due to increasing urban population, use of personalized vehicles, mainly two wheelers and intermediate public transport are growing at a rapid rate. The problem is much more aggravated due to narrow and congested roads, and old or not maintained vehicles. Petrol and diesel vehicles release variety of pollutants particularly benzene, carbon monoxide, organic compounds, oxides of nitrogen and sulphur and suspended particulate matters like ultra fine primary particles, smoke, metals and dust.

Also the ultra fine particles when released quickly coagulate to form larger particles, through reaction with other pollutants like ammonia, sulphurdioxide etc. (Street *et al.*, 1996 and Shrivastava *et al.*, 2013). The ambient air of six sampling sites of Rewa has been monitored and analyzed for SPM, RSPM, SO_2 and NO_x concentrations. Table – 1 illustrated the average concentrations of SPM, RSPM, SO_2 and NO_x in the ambient air at various sites of Rewa city. Results demonstrated average SPM concentrations in ambient air at various sites of Rewa city in range of 154.55 to 492.12 $\mu\text{g}/\text{m}^3$ during six months in year 2018. This concentration is much higher than standard (200 $\mu\text{g}/\text{m}^3$) for residential areas prescribed by CPCB, New Delhi. The SPM concentrations obtained under present investigation are consistent with the concentrations reported by various workers for other Indian cities. The higher SPM levels in the ambient air of Rewa city may probably be attributed to the rapid increase in vehicular population. No major air polluting industries are established in the study area thus, current study suggesting that vehicles could be the major source for increasing air pollution. Apart from vehicular emissions, burning garbage and backyard wastes in Rewa city continues significantly to the SPM levels. Average RSPM concentrations in ambient air of Rewa city has been monitored in the range of 42.24 to 123.90 $\mu\text{g}/\text{m}^3$. This average concentration in the ambient air of Rewa city for polluted sites is very high than standard limit of 100 $\mu\text{g}/\text{m}^3$ prescribed by Central Pollution Control Board, New Delhi for residential areas. Almost similar RSPM concentrations have been observed in ambient air of some cities of India. The average SO_2 concentrations have been recorded in the range 20.31 to 36.09 $\mu\text{g}/\text{m}^3$ and average NO_x concentrations have been recorded in the range of 17.13 to 47.73 $\mu\text{g}/\text{m}^3$ in selected sites. Almost similar concentrations have been reported by Horaginamuni and Ravichandra (2010), Chauhan (2010), Jahangir *et al.* (2011), Yadav *et al.* (2012), Chaudhary *et al.* (2013) Chaurasia *et al.* (2013) and Nair *et al.* (2014). Some workers have observed higher concentration of SO_2 in the ambient air as compared to present investigation (Mukhopadhyay and Mukherjee 2013, Nandanwar *et al.* 2014).

This study illustrates that SPM concentrations in the ambient air of Rewa exceeded the maximum permissible limit prescribed by CPCB, New Delhi (200 $\mu\text{g}/\text{m}^3$), except at PTS Square in May and June Months, Dhobia tanki in June month and University Campus in all six months. Similarly, the RSPM concentrations have been observed below the standard permissible limit of 100 $\mu\text{g}/\text{m}^3$ given by CPCB, New Delhi for residential purposes except NO_x which is above the standard permissible limit in few areas. Results demonstrated higher concentrations of pollutants in the ambient air at Sirmour intersection, New Bus stand, Rathara Bypass and Dhobia tanki. Vehicular emission is the dominant source of RSPM along the road sides (Koken *et al.* 2003, Sharma *et al.* 2006). Except two mega cement plants situated at about 15 to 20 km away from the sampling sites, the Rewa city is lacking major industrial units. The location and surroundings of most of these related sites are quite similar. Therefore the moderate concentrations of pollutants in the ambient air at some sites such as PTS square are due to restricted vehicular movement and cleansing activity of the vegetation.

Table 1. Average concentrations of SPM, RSPM, SO₂ and NO_x in the ambient air at various sites in Rewa city.

Pollutant type	SPM	RSPM	SO ₂	NO _x
Sampling Sites				
Sirmour square	492.12±131.76	123.90±24.62	36.09±3.816	47.73±5.69
New Bus stand	463.30±143.19	102.18±9.26	40.77±3.47	48.54±6.11
PTS Square	318.12±109.43	67.33±8.63	26.87±1.36	32.04±3.30
Dhobiya tanki	390.03±76.74	75.41±10.19	29.71±3.12	33.71±2.46
Rathara Bypass	414.40±328.79	99.44±8.14	30.42±3.75	54.85±5.27
University Campus	154.55±25.54	42.24±6.40	20.31±0.12	17.13±0.37

Table-2 One way ANOVA showing the significant changes during six months analysis

Pollutants	F-Value	P-value
SPM	3.286	P=0.0175*
RSPM	31.30	P<0.0001***
SO ₂	35.08	P<0.0001***
NO _x	61.16	P<0.0001***

* Significant

'F' value at 5 and 30 d.f. on 0.05% level is 3.32

The low concentrations University Campus may be attributed to thick vegetation cover and restricted vehicular movements. Statistical analysis revealed (Table- 2) significant monthly variation in pollutant concentrations in the ambient air of Rewa city. Higher concentrations of SPM, RSPM, SO₂ and NO_x have been observed during January and February months, moderate during March, April and May months and low during June month.

This variation in pollutant concentrations during different months under present study may be attributed to variation in wind velocity, temperature, relative humidity as well as periodic rainfall. Almost similar pattern of seasonal variation of pollutant concentrations has been observed by previous workers (Shukla *et al.*, 2010 Mishra and Shrivastava, 2017). Ambient air quality monitoring results show that high concentrations of pollutants were observed at Sirmour Square, Dhobia tanki and Rathara Bypass and moderate at New Bus Stand and PTS Square in comparison to control site (University Campus).

Conclusion

Rapid urbanization and growth of motor vehicles impose a serious effect on human life and its environment in recent years. Transport sectors contributes a major share to environmental pollution (around 70%). This study reveals that the particulate pollutants are mostly above permissible limits at study site. Result of the study for Rewa city is similar with research for other cities of India as the concentration of particulate matter is also high in other cities. High particulate concentration is due to poor traffic management, growth of two, three and four wheeler vehicles, illegal parking of vehicles, road congestion and vehicles of obsolete two stroke technology, heavy transport activity in study area, apart from industrial emissions, dust from paved roads, garbage burning in open, use of conventional fuels like wood, cow dung etc for cooking and other domestic purposes. All pollutants were observed to be high in concentration during winters as compared to summer and monsoon, due to slow dispersion and dilution of pollutants. From the study, it was observed that Particulate pollution is mainly responsible for ambient air pollution in Rewa city. It can be summarised that air pollution at the study site is primarily because of traffic.

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