SPATIAL AND TEMPORAL VARIATIONS OF AMBIENT AIR QUALITY DURING CROPS HARVESTING PERIOD (PREMONSOON) IN SONIPAT CITY (HARYANA)

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ABSTRACT

Air pollution due to crop harvesting and burning is causing a serious health issues and impacting air quality disastrously. Particulate matter PM_{10}, Lead Pb, Manganese Mn, Chromium Cr and Cadmium Cd are some of the parameters which have significant impact on the environmental pollution. Purpose of the paper is intended to show the changes in above mentioned parameters and compare the same with NAAQS and CPCB standards. Highest concentration of PM_{10} is found in Murthal village i.e 499.5 µg/m^3 which is mainly due to crops cutting and residual burning due to which smoke rises and swarns over adjacent areas (upto capital city Delhi); this accumulation is seen to be very harmful in winter season as it causes poisonous smog which consecutively plays a major role in increase of suspended matter in air. Lowest concentration of PM_{10} is found in sector-10 Sonipat i.e 240.8 µg/m^3 which is a residential site far away from National Highway surrounded by ample green environment. Regarding heavy metals the average value of Pb, Cd, Cr and Mn; the average values are 0.721, 0.0824, 0.124, 0.0625 µg/m^3 respectively.

KEYWORDS: - Particulate Matter, Heavy Metals, Crop Harvesting, Premonsoon.

1. INTRODUCTION

Clean air has so far been treated as unlimited and free natural resource. But now a day's clean air can no longer be taken for granted. Air pollution can be defined as any atmospheric condition in which certain substances are present in such concentrations and duration that they may produce harmful effects for people and atmosphere. The amount of pollutants present in the air is expressed in terms of its mass/volume concentration, usually as micrograms of pollutant per cubic meter of air (µg/m3).

And these concentrations vary widely depending on the sources of pollution and their distribution. Cutting of crops and burning of agricultural biomass residue has been identified as a major health hazard in NCR vicinity. It is causing exposure to extremely high levels of Particulate Matter concentration in air with immediate vicinity.

In addition, it causes loss of essential components such as phosphorus, nitrogen, sulphur and potassium from the top-soil layer, making the land less fertile and unviable for agriculture in the long run.

Causes and Scale

There are mainly two causes for crop residue burning; firstly there is a very short window of time between harvesting of paddy and cultivation of wheat crop, at the end of the Kharif season. Paddy, or rice, is a water-dependent crop. The high consumption of water in its cultivation has resulted in the central government and various state governments restricting the cultivation of paddy in the summer months. In order to prevent scarcity of water resources in the summer, paddy cultivation can legally begin only around mid of June, when the monsoons typically arrives over Northern India. This further delays the cut short to the root with a knife, the large units of harvesters leave 7-10 cm of paddy stalk on the field. The rise in incomes and the subsequent availability of mechanical equipments in Punjab and Haryana lead to increased mechanization of agriculture over the past 10-15 years.

The launch of an assured rural income under NREGA scheme has further led to income opportunities in their home states. As a result, agricultural labour has become a scarce commodity in parts of Punjab and Haryana. The removal of the paddy stalk that remains on the field is a labour-intensive work. With labour being unavailable and the time window for preparation of the field for wheat cultivation being limited, the options that the farmer has are either investing in expensive and rarely used agricultural implements, or burning the residue right on the field. Of the above two, the latter is both cheaper and requires very less effort.

As per latest estimates, Punjab produces approximately 19-20 million tonnes of paddy straw and about 20 million tonnes of wheat straw. Approximately 85-90 per cent of this paddy straw is burnt in the field, and increasingly, wheat straw is also being burnt during the Rabi harvesting season. In Haryana, the problem of paddy straw burning also exists, although the scale is smaller than in Punjab.

2. METHODOLOGY

Basically we have divided whole Sonipat in five zones viz :- industrial area (I1, I2, I3, I4, I5), residential area (R1, R2, R3, R4, R5), highway area (H1, H2, H3, H4, H5) and villages (V1, V2, V3, V4, V5). The thinking behind bifurcation of whole Sonipat in twenty sites was to closely examine the adverse effects of crop harvesting and burning during the season. High volume dust sampler (HVS) and Atomic absorption spectrometer (AAS) is used for the analysis of samples. Ambient air laden with suspended particulates enters the system with a certain flow rate into a cyclone type inlet situated on top of equipment. As the air passes through the cyclone, coarse and non respirable dust particles are separated from the air stream by centrifugal forces acting on the solid particles. These separated particulates fall through the cyclone's conical hopper and is collected in the sampling bottle placed at the bottom. The fine dust forming the respirable component of the total suspended particulate matter (TSPM) passes through the cyclone and is carried by the air stream to the filter paper, placed and clamped between the top cover and filter adaptor assembly. The respirable dust (RSP) is retained on the filter and the carrier air exhausted from the system through the blower. Throughout the experiment the

parameters which have been studied are as follows- respiratory suspended particulate matter, total suspended particulate matter, Pb, Cd, Mn & Cr.

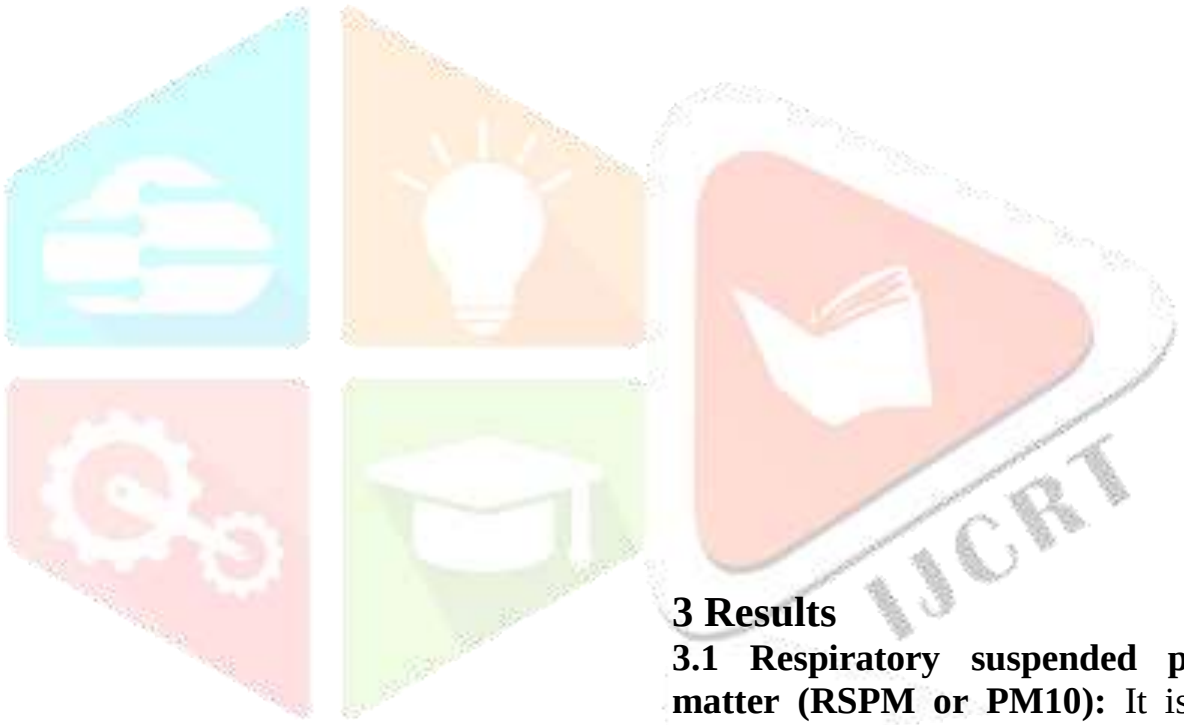
2.1 Digestion procedure for Filters:

The exposed glass filters are cut into four pieces by means of clean stainless steel scissors and transferred into a 250 ml beaker. To the sample, 9 ml of freshly prepared acid mixture of 65 % HNO_3 was added, and 37 % HCl was added. Then, the mixture was boiled gently over a water bath having temperature (95 °C) for 4 to 5 hours (or until the sample had completely dissolved). During this digestion period, the inner walls of the beakers were washed with 2 ml of deionized water to prevent the loss of the sample, and at the last part of the digestion processes, the samples were filtered with Whatman filter paper 42 (2.5-µm particle retention). Then, a sufficient amount of deionized water was added to make the final volume up to 50 ml. a blank unexposed filter paper is similarly digested for blank correction. This digestion method is chosen because it is most efficient and accurate method for the analysis of heavy metals researched by uddin et al 2016.

2.2 National Ambient Air Quality Standard (NAAQS)

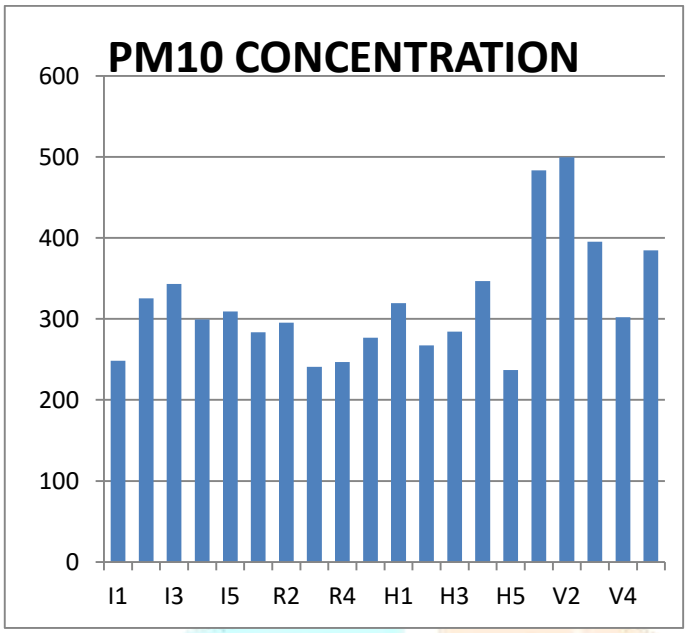
The National ambient air quality standards were developed to protect human health, agricultural productivity, commercial activities, tourism and aesthetic value of ecosystem which might be affected due to the deteriorated air quality. These set of standards specify pollutants of interest along with their concentrations, averaging time and assessment procedures etc. Generally standards are of two types primary and secondary. Primary standards set limits to protect public health, including the health of "sensitive" populations such as asthmatics, children and the elderly. Secondary standards set limits to protect public welfare, protection against decreased visibility, damage to animals, crops, vegetation and buildings. Some of National ambient air quality standard and OSHA standards for heavy metals is given below.

All Pollutants (µg/m^3)	Time weighted	Concentration in ambient air in average		
		Sensitive	Industrial	Residential and others
Suspended particulate Matter(SPM)	24h	100	500	200
Respirable Suspended Particulate Matter	24h	75	150	100
Lead (Pb)	24h	0.75	1.5	1
Managanese (Mn) (OSHA)	8h	0.5	5	1.5
Cadmium (Cd)	8h		2.5	0.15
Chromium (Cr)	8h		0.5	0.15



3 Results

3.1 Respiratory suspended particulate matter (RSPM or PM10): It is observed that average RSPM concentration of all four zones i.e industrial, residential, highway and village zones are 305.10 μg/m^3, 268.68 μg/m^3, 291.00 μg/m^3, 413.04 μg/m^3 In general it is observed that the average concentration of PM10 show distinct seasonal variations with high value in the study area due to crop cutting and farm burning activities. This increase in the concentration of PM10 in premonsoon may be due to the crop cutting which lead increase in concentration of suspended particles in the environment.

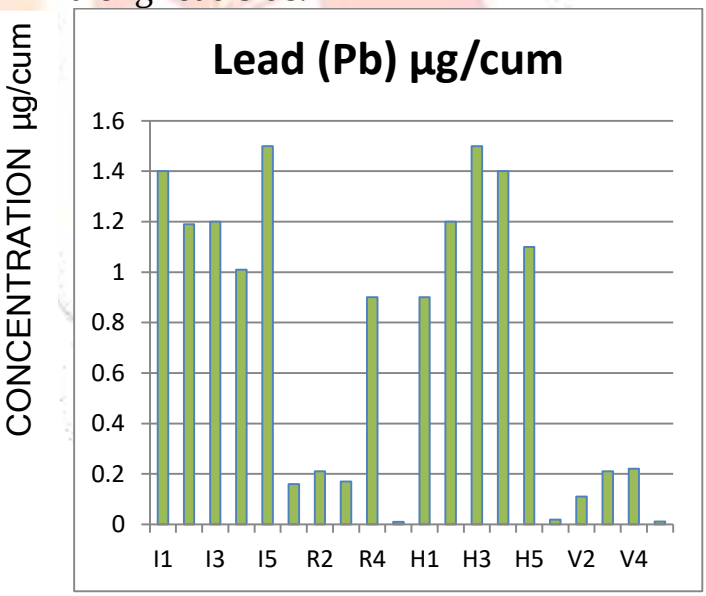


So, in crops harvestation period season maximum violence of prescribed standard is occurred in comparison to the other two seasons. In case of village zone has exceeded the prescribed standard in premonsoon season. The concentration of PM_{10} in the entire industrial sites lies above the NAAQS standard in postmonsoon and lies above the said standard at the site V1, V2, V3, V4 and V5 including I1, I2, and I4 has also shown increase trends; this increase is mainly due to the presence of paddy in village area. The particulate matter of paddy swarn up in the air and high concentration is analysed. Industrial sites have shown increased trends due to industrial activities and crop harvesting activities in the vicinity.

3.2 Lead (Pb):-

The average value for lead (Pb) in the study area is found 0.0160 to 1.5 µg/m^3. During crop harvestation period site I5 (industrial site) is seen to have a very high concentration while in site R5 and V5 have very low concentration respectively.

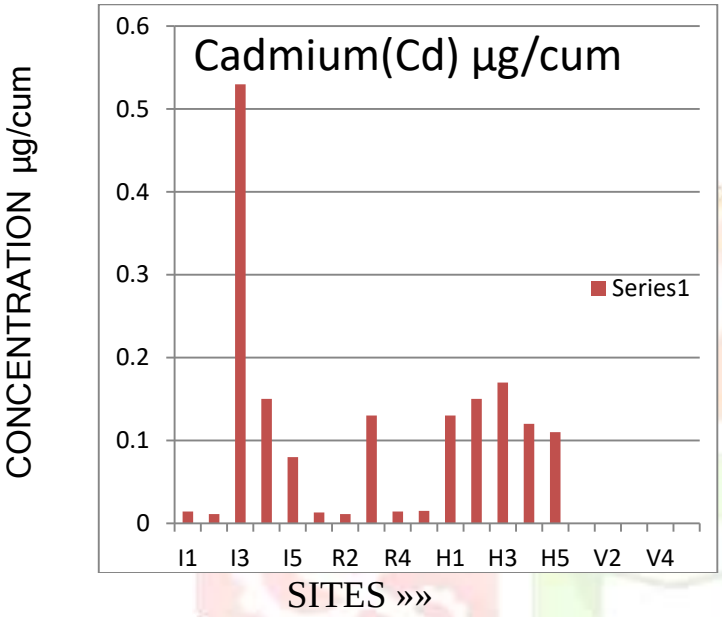
Site I1-I5 and H1-H5 are located just beside two main roads like Grand trunk road (GT road) and National highway 1 (NH-1) respectively. A very high concentration of Pb is also observed in site I5 and H3 during crop harvesting time. R5 and R1 are residential sites and are far away from national highway and factories; so they are having less concentrations of lead. But I5 and I1 are having high concentration due industrial activities along with vehicle pollution could be a major source of this much atmospheric lead in the study area. Apart from vehicle emission, soil resuspension along the road side may also release some short of Pb. As in the past few decades continuous use of leaded petrol and emission of Pb into atmosphere has led to a conservable concentration of Pb in soil along road side.



3.3 Cadmium (Cd):-

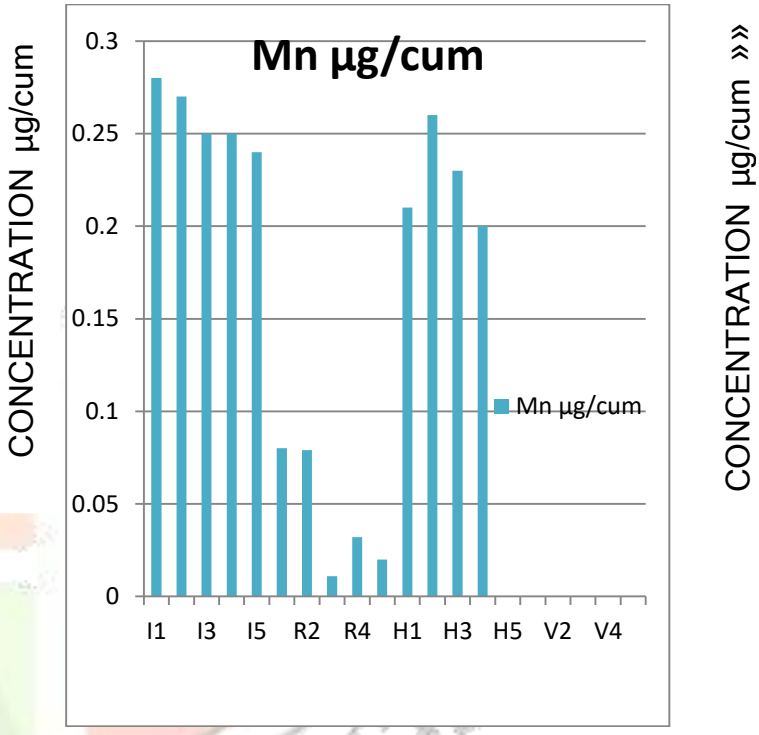
It is observed that average Cadmium concentration of all four zones i.e industrial, residential, highway and village zones are 0.157 µg/m^3, 0.0366 µg/m^3, 0.136 µg/m^3, 0 µg/m^3. High concentrations of cadmium are found in industrial site (I3) which is located

in Rai industrial area and on all highway sites (H1, H2, H3. H4, H5) sites are located absolutely in the rice mill zone. So, elevated level of Cd may be due to the release of it from the different anthropogenic activities like combustion of coal and waste material in residential area as well as by the local people (mainly the labors of rice mill) residing beside the industrial area. No cadmium is detected in village area.



3.4 Manganese (Mn):

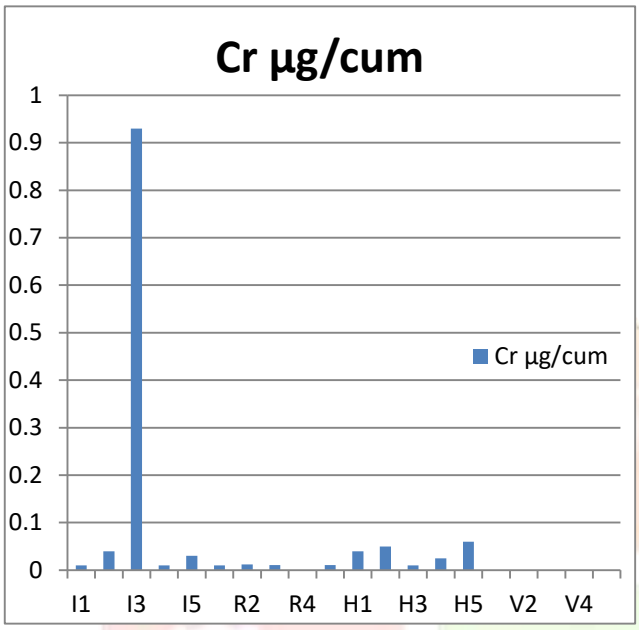
It is observed that average manganese concentration of all four zones i.e industrial, residential, highway and village zones are 0.258 µg/m^3, 0.222 µg/m^3, 0.18 µg/m^3, 0 µg/m^3 The maximum concentration of Mn is found at site I3 (0.270 µg/m^3) and H2 (0.322 µg/m^3) in premonsoon and winter season respectively. Both of these two sites are situated beside road. So, vehicle emission may be a major source of Mn at these sites in the study area. The exceptionally higher level (0.270 µg/m^3) is found at site I3, the district bus stand of the city during crop harvesting time (premonsoon) So, automobile exhaust is the main source of pollution here. Manganese tricarbinyl compound which being an additive is used in unleaded petrol to enhance automobile performance. High use of pesticides in agricultural activities has also lead to increase concentration of manganese in air.



3.5 Chromium (Cr):

It is observed that average chromium concentration of all four zones i.e industrial, residential, highway and village zones are 0.204, 0.0825, 0.037, 0 µg/m^3 respetively. Except a few sites all the monitoring sites have no Cr in ambient air in the study area. The concentration of Cr is found very high in I3 (0.925 µg/m^3). Cycle repairing shops beside this site, dealing with rubber works to engineering works and grill works, electroplating, chrome Ni plating may be a major contributor of Cr in this location. However, apart from these sources Cr is

mostly emitted to the atmosphere from coal combustion, the metal industry and waste incineration. As per the data chrome plating sources are estimated to contribute 695 metric tons of chromium per year to the atmospheric pollution, out of which 100% is chromium (4).



4.0 Conclusion

This dissertation work is intended to monitor and check an in-depth analysis of spatial and temporal variation of ambient air quality due to crop harvesting in premonsoon period in the Sonipat area. Due to rapid industrialization, urbanization, increase in population, number of vehicle and commercialization of land available within Sonipat, environment has degraded a lot within last few years because of which ambient air quality is deteriorating. The project investigates loads of particulate matter PM_{10}, concentration of heavy metals and their variation during crops harvesting time i.e April to June. Twenty sampling sites were selected which include 5 sites in Sonipat's industrial area, 5 sites in residential area, 5 sites on National highway (NH-1) and 5 five sites in different villages of Sonipat which were monitored using respirable dust sampler. Glass fibre filter papers (whatman filter paper) are used for the collection of PM_{10}. From these collected samples and concentration of heavy metals was thus determined using atomic absorption spectrometry. Sampling duration was twenty hours at each monitoring site. The mean concentration of PM10 concentration is found to be higher than the specified norms of CPCB and OSHA.

Highest concentration of PM_{10} is found in Murthal village i.e 499.5 µg/m3 which is mainly due to crops cutting and residual burning due to which smoke rises and swarns over adjacent areas (up to capital city Delhi); this accumulation is seen to be very harmful in winter season as it causes poisonous smog which consecutively plays a major role in increase of suspended matter in air. Lowest concentration of PM_{10} is found in sector-10 Sonipat i.e 240.8 µg/m3 which is a residential site far away from National Highway surrounded by ample green environment. Effect of suspended matter caused due to crops cutting is found very less in residential sites. Regarding heavy metals the average value of Pb, Cd, Cr and Mn; 0.721, 0.0824, 0.124, 0.0625 µg/m3 respectively. Highest level of Pb is found on highway site Bahalgarh chowk site i.e 1.5 µg/m3 and lowest level is found in residential site sector-62 i.e 0.01 µg/m3; high concentration of Pb is mainly due to high vehicular motion, causing pollution, battery repair shops in nearby vicinity, industrial area having smelting process (brass). Highest level of Cd is found on NH-

1 nearby factories located in Rai industrial area i.e 0.53 µg/m3 and lowest level is found in village sites that are below detection limit. High level of cadmium is mainly associated with tobacco burning and pesticides and insecticides spray on farms containing cadmium. Highest level of Mn is found in industrial site sector-38 i.e 0.28 µg/m3 high level of manganese shows more combustion of fossil fuel and high industrial emissions. There are many industries located near NH-1 in Sonipat which are causing increase in acceptable levels. Highest level of chromium is found in Rai industrial area i.e 0.93µg/m3 and minimum permissible level may be due to limited use of leaded fuel. Some sites are seen to have concentration of cadmium above the standard. Mn seems to have violated prescribed standards and is found to occur at many sites but exceptionally high concentration of Mn is found in many sites which are located near National highway-1 or are in trafically congested area. A levels were in levels were in non-detectable zones. High concentrations of chromium in air are mainly due to electroplating activities going in industrial areas of Sonipat. Chromium can also be released in atmosphere by burning of natural gas, oil or coal. The maximum violence of prescribed standard of TSPM is occurred during crops harvestation period i.e March to May. The concentration of Pb in the study area is found to be in limit as atmospheric Pb does not exceed the NAAQS standard on any of twenty selected sites. This controlled concentration of the lead Pb is within the

compound called "Manganese Tricarbinyl" which is being used now a days as a additive in unleaded petrol to enhance performance of automobile may be possible reason for the high concentration of Cd^{+} is found in industrial area and highway region, mainly dominated by rice mills in all season where bunch of rice mill in all season where bunch of rice mills are present in monitoring area.

RESULTS FOR VARIOUS SITES ARE GIVEN IN TABLE BELOW:-

S.NO	DESCRIPTION	RSPM ($\mu g/m^3$)	Pb ($\mu g/m^3$)	Cd ($\mu g/m^3$)	Cr ($\mu g/m^3$)	Mn ($\mu g/m^3$)
	INDUSTRIAL SITES					
1.	Sector-38	248.2	1.4	0.014	0.28	0.01
2.	Sector-36	325.4	1.19	0.011	0.27	0.04
3.	NH-1 Adjacent Factories	343.2	1.2	0.53	0.25	0.93
4.	RGEC	299.3	1.01	0.015	0.25	0.045
5.	Dawat Rice Mill	309.4	1.50	0.08	0.24	0.039
	RESIDENTIAL SITES					
1.	Agrasen chowk	283.5	0.15	0.013	0.087	0.01
2.	Sector-15	295.6	0.21	0.011	0.079	0.011
3.	Sector-10	240.8	0.17	0.13	0.011	0.010
4.	ITI chowk	246.8	0.9	0.014	0.032	0.012
5.	Sector-62	276.7	0.01	0.015	0.022	0.011
	HIGHWAY SITES					
1.	Kundli border	319.6	0.9	0.13	0.21	0.04
2.	Ansal plaza	267.4	1.2	0.15	0.24	0.03
3.	Bahalgarh chowk	284.5	1.51	0.17	0.23	0.01
4.	Murthal flyover	345.7	1.4	0.12	0.19	0.025
5.	Gannaur Highway	236.8	1.1	0.11	0.20	0.08
	VILLAGE SITES					
1.	Bakhtawarpur	483.4	0.019	0.001	0.001	0.002
2.	Murthal	499.5	0.112	ND	ND	ND
3.	Basaudi	395.4	0.212	ND	ND	ND
4.	Palda	302.3	0.22	ND	ND	ND
5	Nandnaur	384.6	0.011	0.012	ND	ND

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