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Impacts of industrial encroachment in residential vicinity, A case study of Lahore

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Abstract

Industries contribute to a major part of a country's economy. But this contribution nullifies when these industries operate without the eco-friendly standard operating procedures, and in turn become key contributors to environmental pollution. The sign of this burden on the environment due to industrialization is sought in the present study. The research was conducted at Gulberg; a multi-sect oral (residential, commercial and industrial) study area to monitor noise, air and water quality for three months. For environmental monitoring, drinking water samples were analyzed against fourteen (14) parameters of concern with concentration for Fluoride, Lead, Arsenic and Total Coli forms exceeding the NEQS in some samples. Similarly, the wastewater samples were tested against twenty-three (23) physio-chemical parameters that showed pH, TSS, TDS, COD, BOD, Oil & Grease, Copper, Nickel, Chromium, Silver, Cadmium and Zinc to be exceeding the NEQS in some samples. Results showed that wastewater discharges from newspaper printing press, beverage industry, ice-cream factory, towels and rubber goods industries are major contributors to environmental pollution. Ambient air and noise quality monitoring was carried out at fourteen (14) locations (four residential, eight industrial and two commercial) for PM_{10}, NO_2, CO_2, SO_2 and CO which were found to be within the NAAQS. Whereas, noise monitoring conducted for eight (8) working hours from 8:00 am to 3:00 pm indicated noise levels exceeding the limits set in the National Standards. Subsequently, the health survey verified poor health conditions of the inhabitants due to poor water quality and noise pollution.

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Introduction

Industries are essential to developing nations in fueling economic development. With the inevitable process of urbanization, industrial growth has concurrently gained momentum. Unsustainable patterns of production practices in Industries are linked invariably with degradation of the environment, mainly in the form of air, water, land and noise pollution.

The more urbanized a city, the higher its trend towards industrialization therefore, presenting a potential threat to the environment (Uttara S *et al*., 2012). Highlighting this nexus between industrial existence and environmental pollution was the basic aim of this research. Since, the demarcated multi-sectoral study area was previously unchecked and industries have been operating here for the past 25 to 30 years. Therefore, it was chosen for its noise, water and air quality monitoring to develop a baseline of the prevailing critical environmental conditions being faced by its residents. By analyzing the level of prevalent environmental contamination the research assists in giving a streamline for the best possible sustainable solutions that could be specified through further research.

Some of the studies conducted nationally and internationally aid in providing a background for conducting this research. Such researches justify the relation between the existence of industries and environmental pollution ultimately causing a threat to human health. A very recent research conducted in India demonstrates the fact that nonetheless, the existence of industries is an important ingredient for economic growth and for upgrading the living standards; it simultaneously burdens the environment throughout the production and disposal (Bhandari D and Garg RK, 2015). This contaminated environment directly or indirectly affects the humans.

The most significant sources of water pollution include industrial discharges, domestic discharges and agricultural runoff. When the untreated effluents are discharged into the rivers, canals and drainage systems, socio-economic and environmental repercussions are bound to happen (IPD, 2008). These outcomes mainly range from contamination of water to ecosystem imbalance and threatening the life of marine species (Zahidi G *et al*., 2012).

Pakistani supply systems generally consist of low water pressure which together with pipes leakages has led to infiltration of contaminated water. As reported in the year 2004, the leakage of sewage and industrial waste into drinking water through damaged pipes caused major outbreaks of waterborne disease epidemics which swept major cities of Pakistan including Lahore (WI, 2005). According to some estimates each year more than three million Pakistanis become a target to the waterborne diseases including typhoid, cholera, dysentery and hepatitis resulting from intake of contaminated water (Bridges and Geoff, 2007).

With the ever increasing population and subsequent industrialization, problems of air quality and noise have become more pronounced in cities. Cities in Pakistan are already experiencing high levels of air pollutants especially PM. Experts now declare noise to be a major contributor of environmental pollution that has a direct potential to cause health effects (Colbeck *et al*., 2010). Ambient noise levels in Lahore have been found to be above the standard levels in all its zones. Hence, indicating probability of severe effects on the nervous system and all related diseases in the target population mainly insomnia, mental disturbance, stress, tension, aggravation of heart diseases and hearing loss (Shahid and Bashir, 2013).

Materials and methods

Introduction to Study Area (Lahore)

Lahore, a dominantly populated city of Pakistan successfully remains an economic, political, social and educational hub. It is broadly divided into 9 administrative towns with Gulberg Town being the area of interest. The main block of concern in Gulberg accommodates approximately 200 inhabitants and comprises of 55 plots that are shared between residences, commercial activities and industries. The classification of industries in the study area is presented in table 1.

Table 1. Production and Pollution Details of Industries in the Study area.

Sr. No.	Industries	Operating Hours and Days	Major Chemicals Used	Environmental Impacts
1	Newspaper Printing Press	10 hrs. for 7 days a week	Volatile organic Solvents including dyes, bleaches, inks,	Air Emissions, Noise Pollution and Wastewater discharges
2	Beverage		4-Methylimidazole, Phosphorus acid, caffeine, citric acid, flavors and sugar	Wastewater discharges
3	Ice-cream		Milk, sugar, cream and flavors	Wastewater discharges
4	Flour Mill		Bleaching agents	Air Emissions
5	Rubber Goods1	8 hrs. for 6 days a week	Caustic Soda, solvents and oil	Noise Pollution and Wastewater Discharges
6	Rubber Goods2		Caustic Soda, solvents and oil	Noise Pollution and Wastewater Discharges
7	Towels		Bleach and dyes	Noise Pollution and Wastewater discharges
8	Heating Pads Mills		-	Wastewater discharges

Sampling and analysis

Monitoring was conducted for three months .For the water quality monitoring, eight (8) drinking water samples were collected from the respective industries, two (2) from the kachi abaadi, two (2) from residences and four (4) from commercial shops in each month. The wastewater samples were collected from eight (8) industries and from points (4) of the drain, whereas, the air and noise monitoring was carried out at fourteen (14) different locations including eight (8) points near industries, two (2) from residences, two (2) from kachi abaadi and two (2) from the commercial shops in each month respectively.

Sample Collection

Fig. 1. identifies the sampling points within the demarcated study area.

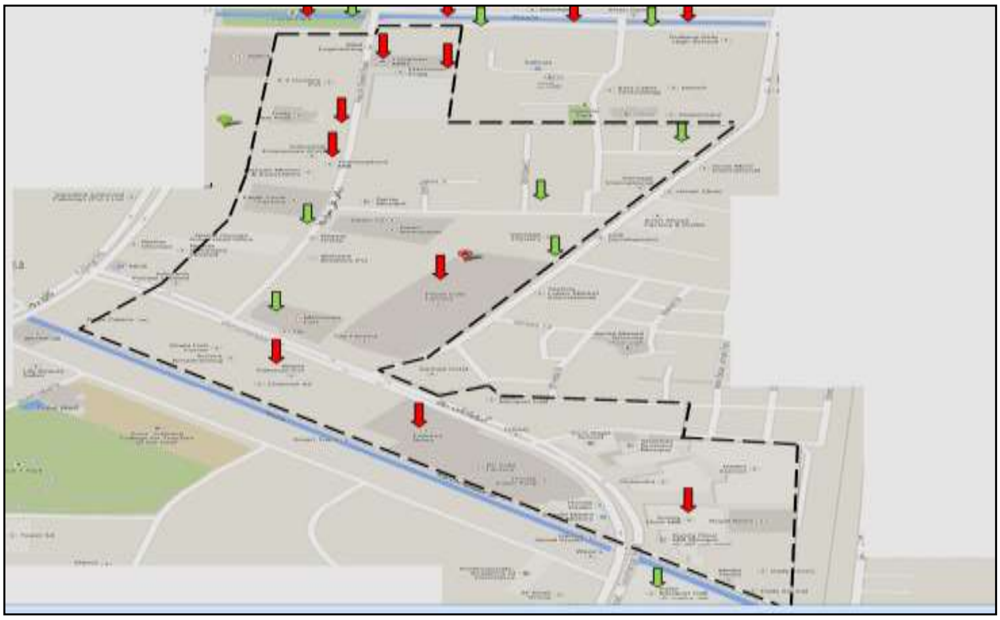


Fig. 1. Sampling points in Study area.

Parameters for Analysis

The selected drinking water parameters and the instruments/methods used for analyzing the samples include pH (pH meter- Eco Testr), temperature (thermo hunter PT-2LD), total dissolved solids (TDS meter- Eco Testr), turbidity (turbidity meter HI 93703), odor (dilution), carbonates (titration), bicarbonates (titration), total hardness (titration), chloride (titration), arsenic (mercuric bromide stain method), lead (spectrophotometer-Merck), total coli form (viable counting), nitrate and fluoride (spectrophotometer- DR 2800).

Similarly, the parameters selected for wastewater analysis and the instruments/methods used include temperature (thermo hunter PT-2LD), pH (eco testr pH1/ USEPA 8156), total suspended solids (filtration/ USEPA 8158 & 8164), total dissolved solids (evaporation/ USEPA 8163), turbidity (turbidity meter), COD (COD reactor), BOD (BOD track), dissolved oxygen (DO meter), electrical conductivity (conductivity meter DIST 3), oil & grease (gravimetric method/USEPA 10056), chloride (titration/ USEPA 8206), sodium (flame Photometer 1381 E), calcium & magnesium (titration/USEPA 8222), carbonates & bicarbonates (titration/ USEPA 10244), iron (Atomic Absorption Spectroscopy/USEPA 2361 Method TNT858), copper (Atomic Absorption Spectroscopy/USEPA 2201 Method 8506), nickel (Atomic Absorption Spectroscopy/USEPA 2201 Method 8037), chromium (Atomic Absorption Spectroscopy/ USEPA 2201 Method 8023), cadmium (Atomic Absorption Spectroscopy/USEPA 2201 Method 8222), silver (Atomic Absorption Spectroscopy/USEPA 2201 Method 8207) and zinc (Atomic Absorption Spectroscopy/USEPA 2201 Method 8009).

For air quality analysis, periodic monitoring was carried out using HAZ-Scanner Model No. HIM-6000 over one week(Monday, Wednesday and Saturday) for three months from January to March 2014.The monitoring against NO_2, SO_2 and CO was done for one (1) peak hour from 12:00pm to 1:00pm. Whereas, PM_{10} and CO_2 were monitored for three (3) Peak Hours (11:00am to 1:00pm).

Likewise, noise monitoring was conducted using a Digital Sound Level Meter (TES 1350A) for eight (8) working hours from 8:00 am to 3:00 pm for three days (Monday, Wednesday and Saturday) during the study period. The results were assessed against the day time National Standards for Residential, Industrial and Commercial zones respectively.

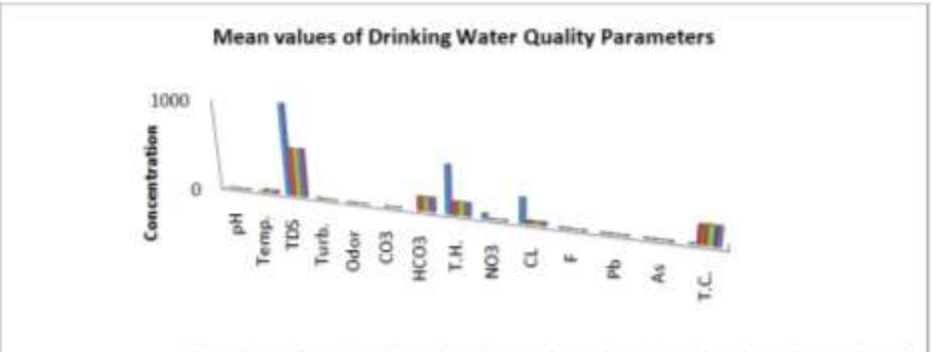
Moreover, a health survey questionnaire was designed and administered to facilitate the research by determining that the health issues of residents were due to poor water quality and high noise levels prevalent at the study area.

Results and discussion

When the results for drinking water analysis of samples were compared with National Environmental Quality Standards, fluoride and arsenic concentrations in some samples, while lead and total coliforms in all samples were found higher. Table 4 gives the summary of results.

Table 2. Mean Results of Drinking Water Parameters.

Sr. No.	Parameters (Units)	NEQS (Drinking Water)	Mean Values		
			January	February	March
1	pH	6.5-8.5	6.6	6.7	6.7
2	Temperature (°C)	NGVS	30.2	29	30.2
3	Total Dissolved Solids(mg/L)	<1000	524	521	526
4	Turbidity (NTU)	<5	0.07	0.08	0.08
5	Odor (TON)	Nil	Nil	Nil	Nil
6	Carbonates(mg/L)	NGVS	2.71	2.64	2.78
7	Bicarbonates (mg/L)	NGVS	149.9	152.3	149.7
8	Total Hardness(mg/L)	<500	136.3	140.5	136.5
9	Nitrate(mg/L)	≤50	1.60	1.75	1.71
10	Chloride (mg/L)	<250	30.90	31.70	31.59
11	Fluoride (mg/L)	≤1.5	1.01	1.12	1.01
12	Lead (mg/L)	≤0.05	0.06	0.07	0.07
13	Arsenic (mg/L)	≤ 0.05	0.04	0.04	0.04
14	Total Coliform (CFU/100mL)	Must not be detected in any 100 mL sample	182	190	183



	pH	Temp.	TDS	Turb.	Odor	CO3	HCO3	T.H.	NO3	CL	F	Pb	As	T.C.
NEQS	0	0	1000	5	0			500	50	250	1.5	0.05	0.05	0
Mean in January	6.6	30.2	524	0.07	0	2.71	149.9	136.3	1.6	30.9	1.01	0.06	0.04	182
Mean in Febraury	6.7	29	521	0.08	0	2.64	152.3	140.5	1.75	31.7	1.12	0.07	0.04	190
Mean in March	6.7	30.2	526	0.08	0	2.78	149.7	136.5	1.71	31.59	1.01	0.07	0.04	183

Fig. 2. Mean values of drinking water quality parameters in all months.

The average values of drinking water analysis of each industry in the study area are presented in table 5.

Table 3. Mean drinking water analysis results of each industry in the study area.

Sr. No.	Parameters / (Units)	NEQS (revised 2010)	ZONE							
			Industrial							
			Newspaper Printing Press	Beverage	Ice-cream	Flour Mill	Towels	Heating Pads Mill	Rubber Goods1	Rubber Goods 2
1	Flouride (mg/L)	≤1.5	1.54	1.66	1.52	0.91	1.57	1.46	1.55	1.55
2	Lead (mg/L)	≤0.05	0.03	0.03	0.05	0.02	0.05	0.05	0.05	0.05
3	Arsenic (mg/L)	≤ 0.05	0.02	0.06	0.05	0.01	0.05	0.05	0.06	0.07
4	Total Coliforms (CFU/100mL)	Must not be detected in any 100 mL sample	111.6	50	43.3	486.6	186.6	50	50	46.6

The results show that average fluoride concentrations were 1.01mg/L in January, 1.12mg/L in February and 1.01mg/L in March. Comparing with the National Standard (≤1.5mg/L) the concentrations were found to be exceeding in the drinking water samples of Printing Press, Beverage Factory, Ice-cream factory, Textile industry and Rubber Goods manufacturing. Therefore, the use of adhesives, copper and Sulfuryl fluoride in the industries justifies the presence of fluoride in drinking water of the study area and is reported to result in molting of teeth or has risk of bone cancer in case of high intake (WHO, 2010).

Mean lead concentrations in the drinking water samples were 0.06mg/L in January, 0.07mg/L in February and 0.07mg/L in March.

While, the average arsenic concentrations in the drinking water samples were found as 0.04 mg/L during the three months monitoring period. Both lead and arsenic concentrations were exceeding the standards (≤ 0.05 mg/l)in the samples from tube-well, Kachi Abaadi 1 and 2, workshop, market, Ice-cream factory, Textile industry, Thermosphere Mill and Rubber Goods manufacturing facilities.

Direct relation of arsenic ingestion with a risk of various health issues such as stomach pain, nausea, vomiting, diarrhea, partial paralysis, numbness in hands and feet, blindness, thickening and discoloration of the skin, cancer of the bladder, lungs, skin, kidneys, nasal passages, liver and prostate have been reported (Hopenhayn, 2006).

According to the health survey of the study area, 3% of the residents were reported with arsenicosis (hardening of skin) which results from the intake of drinking water with high arsenic contents.

According to NEQS, Total Coli forms must not be present in any 100mL sample of drinking water, but, unfortunately, the drinking water samples of the study area show an average concentration of 182, 190 and 183 CFU/100mL Coli forms in January, February and March respectively. However, only the samples from residences were free from Total Coli forms.
One reason for this contamination is the existence of tube-well exactly on the drain passing through the entire study area. Secondly, this area was constructed approximately 30 years ago and no maintenance work has been carried out.

As the sewage and drinking water pipelines exist together, they require reconstruction for maintenance and prevention from mixing of sewage with drinking water. Studies state *E. coli* as' dangerous' in terms of its long-term intake causing various health effects like acute intestinal infections, gastrointestinal illness, typhoid, hepatitis and cholera and in severe cases can result in mortality of infants and adults (Zuane, 1996).

This can be seen from the health survey results which reports30% respondents diagnosed with diarrhea and 6% with typhoid. The results for wastewater samples showed TSS, TDS, COD, BOD, Oil & Grease, Copper, Nickel, Chromium, Silver, Cadmium and Zinc to be exceeding the standards at some locations.

The other tested parameters were found to be within the limits. Table 6 and Fig. 3 present the average results of all tested parameters showing the overall wastewater quality of the study area.

The wastewater of study area on an average had 457mg/L of TSS in January and 448 mg/L in February and March respectively, these concentrations were in excess of NEQs (200 mg/L). The only sample showing high TDS was the one collected from the drain passing through the study area. Whereas, generally the average concentration of dissolved solids in the wastewater was found as 1336mg/L, 1321mg/l and 1328 mg/L in January, February and March respectively.

Table 4. Mean Results of Wastewater Parameters.

Parameters	Units	NEQS (Wastewater)	Mean Values		
			January	February	March
pH	___	6-9	7.7	7.6	7.8
Temperature	°C	40	34	33	32
Total Suspended Solids (TSS)	mg/L	200	457	448	448
Total Dissolved Solids (TDS)	mg/L	3500	1336	1321	1328
Turbidity	NTU	-	66.15	63.24	63.73
Electrical Conductivity	dS/m	-	2185.5	2192.2	2192.0
Carbonates	mg/L	NGVS	0	0	0
Bicarbonates	mg/L	NGVS	111.6	108.3	108.7
Calcium	mg/L	NGVS	42.2	40.3	39.5
Magnesium	mg/L	NGVS	27.8	25.6	24.5
Chloride (Cl)	mg/L	1000	113.4	116.0	114.7
Sodium	mg/L	NGVS	310.7	320.7	309.9
COD	mg/L	150	298.6	292.2	292.9
BOD	mg/L	80	130.3	129.2	127.6
DO	mg/L	NGVS	2.65	2.78	2.65
Oil & Grease	mg/L	10	66.7	65.7	67.5
Iron	mg/L	8.0	1.6	1.5	1.6
Copper	mg/L	1.0	1.00	0.97	0.95
Nickel	mg/L	1.0	0.24	0.26	0.25
Chromium	mg/L	1.0	0.41	0.40	0.42
Silver	mg/L	1.0	0.41	0.38	0.39
Cadmium	mg/L	0.1	0.44	0.42	0.44
Zinc	mg/L	5.0	3.22	3.27	3.32

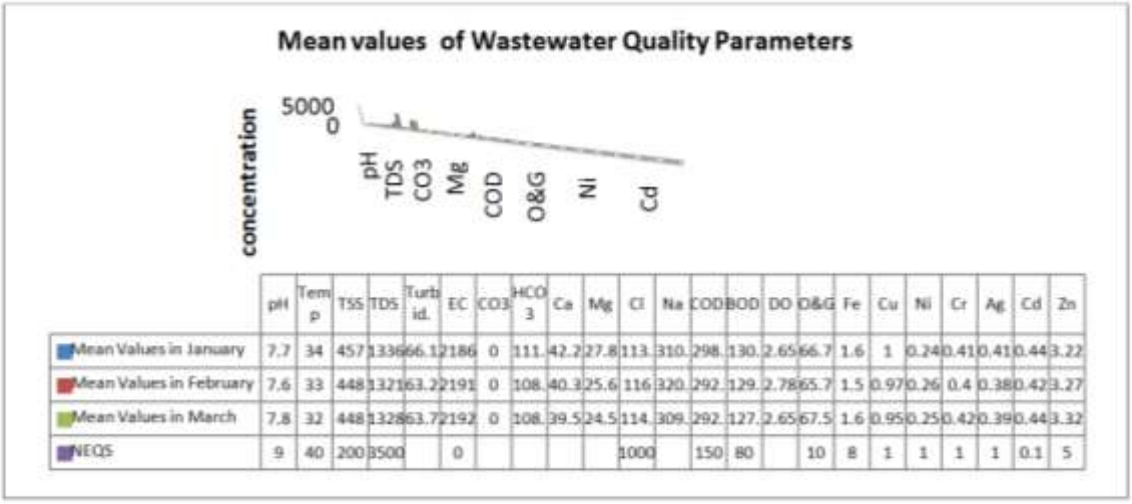


Fig. 3. Mean values of Wastewater Quality Parameter.

The average values of wastewater analysis of each industry in the study area are presented in table 7.

Table 5. Mean wastewater analysis result of each industry in the study area.

Sr. No.	Parameters	Units	NEQS (revised 2010)	ZONE							
				Industrial							
				Newspaper Printing Press	Beverage	Ice-cream	Flour Mill	Towels	Heating Pads Mill	Rubber Goods1	Rubber Goods 2
1	Total Suspended Solids (TSS)	mg/L	200	1560	378	456	580	533	468	233	253
2	COD	mg/L	150	195	367	506	87.3	573	63.3	206.3	175.3
3	BOD	mg/L	80	75.3	161.6	242.7	48.6	243	18	96.5	26.6
4	Oil & Grease	mg/L	10	16.9	25	238	7.3	16.2	14.5	15.1	3.2
5	Copper	mg/L	1.0	0.21	0.01	0.01	1.22	2.10	0.60	0.20	2.72
6	Nickel	mg/L	1.0	0.23	0.01	0.02	0.03	0.02	0.02	0.37	1.88
7	Chromium	mg/L	1.0	1.81	0.32	0.16	0.03	0.51	0.44	0.41	0.72
8	Silver	mg/L	1.0	1.86	0.73	0.24	0.02	0.09	0.04	0.12	1.03
9	Cadmium	mg/L	0.1	1.73	0.15	0.04	0.27	0.37	0.07	0.07	1.23
10	Zinc	mg/L	5.0	5.23	3.73	1.81	6.79	2.63	2.41	3.23	5.67

The mean COD concentration in wastewater samples was 298.6 mg/L in January, 292.2mg/L in February and 292.9mg/L in March. Comparing with the standard of 150 mg/L, almost all the samples were above the limit value. Most commonly, high contents of COD are released from Rubber Goods manufacturing facility, Printing Press, Beverage factory, Ice-cream factory and Textile industry, with the latter two being the major contributors. The mean BOD concentration was found to be 130.3mg/L in January, while 129.2mg/L and 127.6 mg/L in February and March. The samples exceeding NEQS value (80 mg/L) were from Rubber Goods Manufacturing facility, Beverage factory, Textile industry and Ice-cream factory, with the latter two being its major contributors.

All the wastewater samples except that of Flour mill and Rubber Goods manufacturing facility showed high concentrations of oil and grease. The mean concentrations were calculated as 66.6mg/L. Further, results indicated the usage of industrial and domestic agents rich in oil and grease to be major reasons of such concentrations in samples. This presence ambushes garbage that attracts flies and mosquitoes increasing the BOD of wastewater while inhibiting the flow of sunlight ultimately causing decreased dissolved oxygen.

Hence, this wastewater quality impairs the growth of crops and vegetables when used for irrigation (Thornton *et al*., 2001).

Heavy metals showed variation in different waste water samples. Copper concentrations were found in wastewater samples of three parts of drain and two industries including Textile and Rubber Goods manufacturing. On an average, the overall concentration of Cu in wastewater of study area was 0.97mg/L. Such concentrations are mainly present as a resultant of coating processes for manufacturing rubber goods. Average Nickel concentration ranged between 0.24mg/L to 0.26mg/L. Amount of Ni in all the samples, except that of Rubber goods manufacturing facility, were within the NEQS (1.0 mg/L).

Thus, the use of nickel in the coating process for manufacturing rubber goods makes it a major contributor of nickel concentration in the wastewater (Huo *et al.,* 2004). Despite the monitored amount of nickel in wastewater, if these concentrations persist or tend to increase, it can greatly result in impaired plant growth when used for irrigation (Thornton *et al*., 2001). The mean Chromium, Zn and Silver concentrations in almost all samples were also within the limits except in samples from printing press and rubber goods manufacturing. Cr, Zn and Ag concentrations were only found to be higher in Printing press waste water mainly due to the use of chromium based inks. While the samples from Rubber Goods manufacturing facility (Electroplating Process) showed increased levels of Ag and Zn as compared to their standards 1.0mg/L(Ag) and 5mg/L (Zn).

Mean concentration of cadmium in wastewater was analyzed to be 0.44mg/L in January and March while 0.42mg/L in February. The results showed Cadmium concentrations to be below the set standards of 0.1mg/L except in samples from Printing Press (Cadmium based inks), Beverage Factory and Rubber Goods manufacturing facility (Electroplating Process).

The cadmium based inks used in printing processes and the electroplating process in beverage and rubber goods manufacturing are the main contributors of cadmium concentrations (Wilson, 2012).

Further, the monitored results of air quality were within the standards and presented no significant difference in any month. One major reason for all these pollutants to be within the standards is because of the absence of any evident burning activities and also this area is not a busy area in terms of traffic for the entire day except when the trucks arrive for either raw material delivery or for loading the prepared consignments. Table 8 shows the overall trend of ambient air in January, February and March.

Table 6. Mean Values of Ambient Air Quality Parameters throughout the study area.

Sr. No.	Parameters	NAAQS	Average Ambient Air Quality of study area		
			January	February	March
1	PM_{10} (µg/m³)	150µg/m³ (24 hravg)	41 µg/m³ (3hrs avg)	41 µg/m³ (3hrs avg)	41 µg/m³ (3hrs avg)
2	NO_2 (ppm or ppb)	0.1 ppm (1 hr avg.) or 100 ppb (1 hr avg.)	0.034ppm (34 ppb)	0.035ppm (35 ppb)	0.034ppm (34 ppb)
3	CO_2 (ppm)	-	285 ppm	286 ppm	287 ppm
4	SO_2 (ppm)	0.075 ppm (1 hr avg.)	0 ppm	0 ppm	0 ppm
5	CO (ppm)	35 ppm (1 hr avg.)	0 ppm	0 ppm	0 ppm

Average concentrations of PM_{10} for 3 peak hours on the selected fourteen (14) locations catering the entire study area were monitored to be 41µg/m³ in all three months respectively. Whereas, the mean concentrations of NO_2 for 1 Peak hour on the selected locations was observed as 34ppb in January and March while 35ppb in February.

The results were compared with the National Ambient Air Quality Standards of 100 ppb for a 1 hour average. Similarly, the average CO_2concentration for 3 Peak hours on the selected locations was 285ppm in January, 286ppm in February and 287ppm in March.

The results of SO_2 were 0ppm throughout against the National Ambient Air Quality Standards of 0.075 ppm for a 1 hour average. Likewise, the monitoring of CO also showed 0 ppm concentrations against the National Ambient Air Quality Standards of 35 ppm for a 1 hour average. Monitoring of noise levels showed no varied results in all months. The overall trend of noise levels in the study area is shown in Fig. 5.

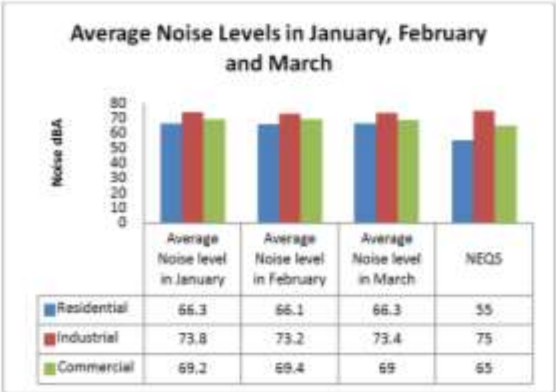


Fig. 5. Mean Values of Noise levels in all three months.

The average trend of noise levels for three months was monitored as 66.3 dBA in Residential locations, 73.8 dBA in Industrial Locations and 69.2 dBA in Commercial Locations in January, 66.1 dBA in Residential Locality, 73.2 dBA in Industrial Locality and 69.4 dBA in Commercial Locality in February and 66.3 dBA in Residential Locality, 73.4 dBA in the Industrial Locality and 69.0 dBA in Commercial Locality as of March. When compared with National Standards of 55 dBA in Residential Locality, 75 dBA in Industrial Locality and 65 dBA in the Commercial Locality, the results presented higher noise levels in residential and commercial localities and near some industries. Generally, noise intensities were observed to be high during the peak hours from 11:00 am to 1:00 pm and then a little low but still above during the break hours from 1:00 pm to 2:00 pm mainly due to the traffic passing through the adjacent road. Furthermore, traffic congestion caused by the humongous trucks delivering raw materials in the industries and taking the consignments ready to be sold in mark*et al*so accounted to the increasing levels of noise in the study area. Moreover, the health survey conducted in the study area reported 35% of residents with hypertension, 10% with insomnia and 5% with tinnitus (ringing in the ears). Hence, the survey proved that the reported health effects were an evident result of noise pollution in the study area.

Along with the environmental impacts, this research also highlights the health conditions of the study area inhabitants. This proves the nexus between the evident impacts and the industrial encroachment in the study area. Regarding the health survey of three months (January, February and March), 30% patients were diagnosed with diarrhea, 6% with typhoid, 3% with arsenicosis (hardening of skin), 35% with hypertension, 10% with insomnia, 5% with tinnitus (ringing in the ears), 9% with seasonal allergies, 1% with food poisoning and 1% with Low Blood pressure.

Whereas, 32 drips were consumed and 5 stitching cases were dealt with in the months of January, February and March 2014. These reported diseases are either related to contaminated drinking water or noise pollution, hence, giving an evidence of water and noise pollution in the study area.

For further confirmation, the reported health effects in study area were compared with another survey conducted at a control area (a similar area but with no industries). These same health problems with evidently low percentages of people reporting them were observed. According to the survey conducted for three months(January, February and March), 7% patients were diagnosed with diarrhea, 1% with typhoid, 0% with arsenicosis (hardening of skin), 15% with hypertension, 7% with insomnia, 1% with tinnitus (ringing in the ears), 47% with seasonal allergies, 7% with food poisoning and 15% with low blood Pressure. Whereas, 25 stitching cases were dealt with and 20 drips were consumed in the months of January, February and March 2014. The percentages of reported diseases in both the health facilities were different as shown in Fig.s 6A and 6B. This difference clearly indicates the health status of the study area inhabitants to be due to their exposure to contaminated water and high levels of noise produced as a result of industries in their residential vicinity.

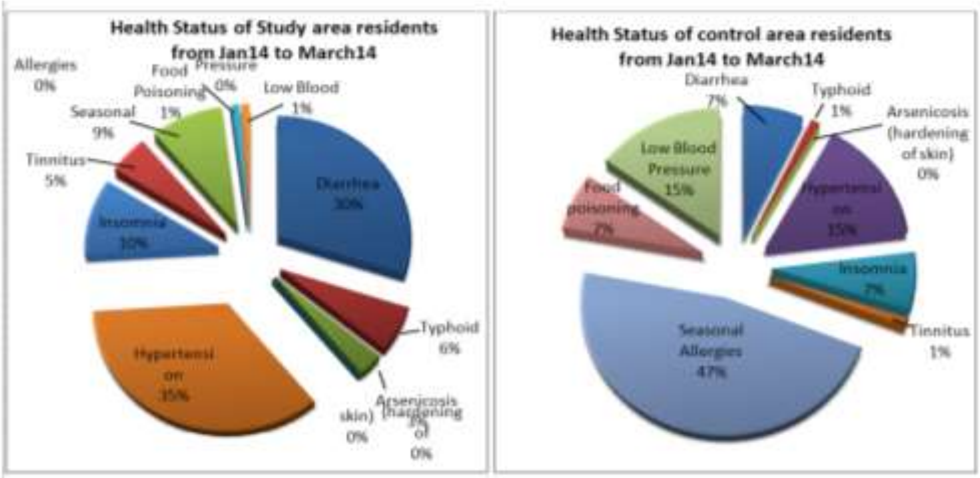


Fig. 6A. Reported Health status of Study area **Fig. 6B.** Health Status of Control area Residents.

Conclusion

The analysis depicted poor water quality and high levels of noise in the study area. Whereas, the air quality was comparatively better as the measured parameters were within the National Ambient Air Quality Standards (NAAQS). Further, the study also deduced that the effects of contaminated water and noise pollution were in direct relation with the health of study area inhabitants. This relation was deciphered with the help of health survey conducted at the study area where the diseases mainly reported by the patients were either due to contaminated water or noise pollution. Further, the study also concludes that these impacts have a double effect due to close proximity between the industries and residences. Therefore, these effects of industrialization will continue to multiply as the industries persist until some environmentally sound and health wise solutions are strictly implemented.

Acknowledgment

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Abbreviations

BOD	Biological Oxygen Demand
CFU	Colony Forming Unit
Cd	Cadmium
Cl	Chloride
Cr	Chromium
Cu	Copper
CO	Carbon Mono-oxide
CO_2	Carbon Dioxide
COD	Chemical Oxygen Demand
Cu	Color unit
dBA	Decibels
DO	Dissolved Oxygen
EC	Electrical Conductivity
Fe	Iron
mg/L	Milligrams per liter
Mn	Manganese
NAAQS	National Ambient Air Quality Standards
NEQS	National Environmental Quality Standards
NGVS	No Guideline Value Suggested
Ni	Nickel
NO_2	Nitrogen Dioxide
NTU	Nephelometric Turbidity Units
TON	Threshold Odor Number
SO_2	Sulfur Dioxide
Pb	Lead
pH	Potential Hydrogen
PM	Particulate Matter
TDS	Total Dissolved Solids
TSS	Total Suspended Solids
Zn	Zinc

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