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# MEASURING THE CONCENTRATIONS OF SOME AIR POLLUTANTS AND STREET DUST IN SELECTED LOCATIONS IN HILLA CITY, IRAQ

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## Abstract

Rapid development in recent years associated with atmospheric pollution which is defined as "the presence of pollutant or contaminant substances in the air that effect on human health or wellbeing, or cause other harmful environmental effects, this pollutants might be gases, suspended particles, and heavy element that interact with human physiological process. Six type of regions in Hilla city was selected to evaluate of pollutants during four seasons of year by using 2 type of sample (air sample and street dust), pollutants included gases like (CO, $CO_2$, $NO_2$, and $SO_2$), suspended particles included ($PM_{2.5}$ and $PM_{10}$ suspended particulates), and heavy elements included (Pb, Cu, Co, and Fe). Most of gases pollutant recorded values over permissible limitation, while all values of suspended particles for both type were over permissible limitation, regarding of heavy elements showed that most of the sites and observations of the lead element were higher than the permissible limits, copper also recorded higher concentrations than the permissible limits in different sites and observations, while cobalt recorded higher concentrations than the permissible limits in sites (1, 2) while iron concentrations have recorded higher values than the allowed limits in (15) values distributed over the monitoring sites. We conclude that the air of the city of Hilla suffers from pollution with some gases, particles suspended, and some of heavy elements, which might be effect on human physiological process.

***Key words:*** Air pollutants; street dust; Hilla

## Introduction

The world has recently witnessed a major development in the scientific which led to a significant increase in air pollutants like elements and compounds, this led to an imbalance in the natural balance of the environment, which led to a quantitative and qualitative changes in the components of the atmosphere in such a way that the environment does not absorb these new materials, and air pollutants are a mixture of solid and gaseous particles in the air, such as emissions from exhausts Automobile chemicals from factories, pollen and dust (Lucas *et al.,* 1992). So atmospheric pollution can be defined as "the presence of pollutant or contaminant substances in the air that effect on human health or wellbeing, or cause other harmful environmental effects" (Vallero, 2008)**.** Air pollution could be arises naturally by gases from volcanoes and fire, pollen, microbes and dust or industrially from fuel consumption and pollutants released from automobile exhaust as well as gases from domestic waste and particulates (Mousa, 1996). Carbon-Monoxide resulted from the incomplete combustion of black oil (fuel) during burning which affects the nervous behavior and circulatory system when absorbed via lungs and interacted with protein of blood (hemoglobin) and transformed it's to hemoglobin carboxyl which if exceeds 10%, it will cause pains in the head, fatigue, non-concentrating and hard breathing among the workers which affect their health and productive efficiency(Lee Jae-Joon, 2005). Nitrogen dioxide $NO_2$ resulted from incomplete combustion of fuel which contains nitrogen or from boiler which forms a group of nitrogen oxides (Lisa and Dana, 2002). Sulfur dioxide SO2 resulted from the combustion of sulfur which found in black oil which used as fuel (Michel and Simara, 2006). suspended dust particles is a common problem almost all year , due to wind and toxic pollutants they carry such as petroleum hydrocarbons and suspended particulates trace metals

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(Dockery, 2009). Moreover certain heavy elements in dust can act as carcinogenic; lead (Pb), Cupper (Cu) , cobalt (Co) and iron (Fe) are ( Kim *et al.,* 2015). Heavy element can be carcinogenic compound via different mechanism as follow:

(1) Interference with cellular redox regulation and induction of oxidative stress, which may cause oxidative DNA damage or trigger signaling cascades leading to stimulation of cell growth.

(2) Inhibition of major DNA repair systems resulting in genomic instability and accumulation of critical mutations.

(3) Deregulation of cell proliferation by induction of signaling pathways or inactivation of growth controls such as tumor suppressor genes (Beyersmann and Hartwig., 2008).

Therefore, due to the rapid development in recent years in the city of Hilla, accompanied by an increase in the amount of pollutants released to the human environment from various sources, this study was designed to determine the suitability of the Hilla environment by measuring some pollutants such as gases, suspended particles and heavy elements that have a direct impact on human health.

## Materials and Methods

This study continuous for one years (from April 2018 to April 2019), distributed over four seasons of year, The month of January represents the winter season, the month of April represents the spring, the summer represents the month of July, and the month of October represents the autumn. The study was conducted in Hilla city, six regions were selected as following: the industrial area (Nader Al-Thalatha) and a upscale residential area (Al-Bakrli district), a popular residential area (Al-Thawra), and a site representing a major way (Street 60) near the transportation garage and the city center (transportation garage). As well as an agricultural site (Abu Kastawi). Measurements were taken from this sites which were previously determined dependent on the degree of their impact on the concentrations of environmental pollutants. Two type of sample was used (air and street dust), air sample were selected to measure the following gases $SO_2$, $NO_2$, $CO_2$ and CO by gases meter device, while street dust sample used to measure the following heavy elements such as lead, copper, cobalt via digestion and extraction from street dust and then using atomic absorption spectrophotometer to measurement of concentration of heavy elements, in addition to suspended particles were measured for both type ($PM_{2.5}$ and $PM_{10}$ suspended particulates) and comparative the result with global levels as recorded in table (1) (WHO 2005, WHO 2008, WHO 2017), in addition to find of mean for each region in year during four seasons.

## Results and Discussion

### Carbon monoxide (CO)

As show in table 2, The highest level of CO was recorded at site (1) during summer (39.2), this risen in the level of CO may be due to the presence of factories, workshops, and machinery (it consider as industrial area) (Holban *et al.*, 2017), or might be due to increasing the population (it represents a popular area and a main transport road), in addition to this, the climatic factor play very important role in this altitude in level of CO via high temperatures that increase the concentration of pollutants and low wind speed during measurement hours (Ramanathan and Feng, 2009). While the lowest level of CO was recorded in site (6) during November, so the decline can be attributed to presence of agriculture area with green area and decrease number of population in this area, as well as the absence of any factory or workshops, which contributed to reduce the concentration of CO (Zhang *et al.*, 2016). All sites were over normal values except of sites (4, 6), this refers to an environmental threat to the study area.

### Carbon dioxide ($CO_2$)

Regarding of $CO_2$ concentration, the high level was recorded in site (1) during summer for the same reasons mentioned above, while the lowest level recorded in site (6) during autumn for presence of green area in addition to climate factor which represent by fall of the heavy rain, which worked to wash the atmosphere, also the speed and direction of the wind significantly influenced on level of $CO_2$, as it was during the measurement direction of wind was north-westerly. The highest mean was in site (2) while the lowest

**Table 1:** International atmospheric standards of Air quality and heavy elements.

| | Name of pollutants | Duration | Permissible concentration (PPM) | Heavy elements | Permissible concentration(mg/kg) |
|---|---|---|---|---|---|
| 1 | Carbon monoxide (CO) | One hour | 28.4 | Lead | 0.05 |
| 2 | Carbon dioxide (CO2) | One hour | 300 | Copper | 1 |
| 3 | Sulfur dioxide (SO2) | 10 minutes | 0.18 | Cobalt | 0.1 |
| 4 | Nitrogen dioxide (NO2) | One hour | 0.10 | Iron | 5 |
| 5 | Suspended particles $PM_{2.5}$ | 24 hour | 25 | ----- | ----- |
| 6 | Suspended particles $PM_{10}$ | 24 hour | 50 | ----- | ----- |

mean was in site (6), site (5) recorded altitude level over normal values for all month of year.

**Nitrogen dioxide (NO2)**

Regarding of $NO_2$ concentration as its illustrated in table 4, the high level was recorded in site (2) during summer, because this site represents a public transport road in the Babylon governorate with the presence of public transport garage, which is a gathering place for cars, which is moving around 24 hours and is increasing during the morning hours (Chen and Borken-Kleefeld, 2017), as well as the presence of some commercial sites and workshops repair machines and equipment, while the lowest level recorded in site (6) during spring for presence of green area in addition to climate factor (Zhang *et al.*, 2016), while the measuring device was not sensitive to any concentration during winter and autumns. The study also show that most of the sites recorded the highest concentrations of permissible limits, which were represented in positions (1, 2, 3, 5), while (4, 6) within the permissible limits during the duration of the study. The highest mean was in site (2) while the lowest mean was in site (6), site (5) recorded altitude level over normal values for all month of year.

**Table 2:** Carbon monoxide concentration in atmosphere.

| No | Regions | Carbon monoxide (CO)/(PPM)) | | | | |
|---|---|---|---|---|---|---|
| | | Winter | Spring | Summer | Autumn | Mean |
| 1 | Nader Al-Thalatha | 37.4 | 37.9 | 39.2 | 36.7 | 37.8 |
| 2 | Street 60 | 34.7 | 35.1 | 36.6 | 35.8 | 35.55 |
| 3 | Al-Thawra | 36.1 | 35.7 | 37.8 | 33.9 | 35.87 |
| 4 | Al-Bakrli district | 17.5 | 15.9 | 18.3 | 15.3 | 16.75 |
| 5 | transportation garage | 33.7 | 35.4 | 36.7 | 36.4 | 35.55 |
| 6 | Abu Kastawi | 9.2 | 10.7 | 13.3 | 11.2 | 11.1 |

**Table 3:** Carbon dioxide concentration in atmosphere.

| No | Regions | Carbon monoxide ($CO_2$)/(PPM)) | | | | |
|---|---|---|---|---|---|---|
| | | Winter | Spring | Summer | Autumn | Mean |
| 1 | Nader Al-Thalatha | 313 | 307 | 349 | 287 | 314 |
| 2 | Street 60 | 335 | 337 | 341 | 300 | 328.25 |
| 3 | Al-Thawra | 253 | 243 | 277 | 220 | 248.25 |
| 4 | Al-Bakrli district | 198 | 189 | 202 | 207 | 199 |
| 5 | transportation garage | 303 | 312 | 327 | 310 | 313 |
| 6 | Abu Kastawi | 162 | 159 | 179 | 143 | 160.75 |

**Table 4:** Nitrogen dioxide concentration in atmosphere.

| No | Regions | $NO_2$/(PPM)) | | | | |
|---|---|---|---|---|---|---|
| | | Winter | Spring | Summer | Autumn | Mean |
| 1 | Nader Al-Thalatha | 0.32 | 0.31 | 0.37 | 0.23 | 0.30 |
| 2 | Street 60 | 0.53 | 0.58 | 0.61 | 0.47 | 0.54 |
| 3 | Al-Thawra | 0.42 | 0.39 | 0.49 | 0.36 | 0.41 |
| 4 | Al-Bakrli district | 0.03 | 0.04 | 0.09 | 0.08 | 0.06 |
| 5 | transportation garage | 0.43 | 0.41 | 0.53 | 0.39 | 0.44 |
| 6 | Abu Kastawi | Nil | 0.01 | 0.02 | Nil | 0.01 |

**Table 5:** Sulfur dioxide level in atmosphere.

| No | Regions | $SO_2$/(PPM)) | | | | |
|---|---|---|---|---|---|---|
| | | Winter | Spring | Summer | Autumn | Mean |
| 1 | Nader Al-Thalatha | 2.4 | 2.4 | 2.7 | 2.5 | 2.5 |
| 2 | Street 60 | 1.17 | 1.21 | 1.19 | 1.19 | 1.19 |
| 3 | Al-Thawra | 0.18 | 0.16 | 0.19 | 0.12 | 0.16 |
| 4 | Al-Bakrli district | 0.03 | Nil | 0.05 | 0.01 | 0.03 |
| 5 | transportation garage | 0.91 | 0.99 | 0.91 | 0.71 | 0.88 |
| 6 | Abu Kastawi | 0.01 | 0.01 | 0.02 | Nil | 0.013 |

**Table 6:** Suspended particles concentration with $PM_{2.5}$.

| No | Regions | Suspended particles $PM_{2.5}$/(µg/m$^3$) | | | | |
|---|---|---|---|---|---|---|
| | | Winter | Spring | Summer | Autumn | Mean |
| 1 | Nader Al-Thalatha | 291.25 | 279.23 | 357.31 | 270.53 | 299.58 |
| 2 | Street 60 | 352.76 | 370.47 | 399.71 | 313.21 | 359.03 |
| 3 | Al-Thawra | 313.8 | 314.89 | 345.41 | 270.79 | 311.22 |
| 4 | Al-Bakrli district | 193.39 | 216.11 | 257.33 | 158.44 | 206.31 |
| 5 | transportation garage | 290.6 | 303.64 | 338.7 | 280.81 | 303.43 |
| 6 | Abu Kastawi | 117.33 | 133.75 | 137.31 | 97.25 | 121.41 |

**Sulfurs dioxide ($SO_2$)**

As show in table 5 the highest level for $SO_2$ was recorded in table 1 during all seasons of the study for the same reasons that mention above, while the lowest value was in site (6) during spring and winter, this is due to the fact that the site is an agricultural area which is characterized by increasing green areas and low population (Zhang *et al.*, 2016), as well as the climatic factor represented by the amounts of rain (Sharma and Kumari 2017)during the measurement hours and the wind direction was alternating between the north and northwest, reducing the arrival of pollutants from to the site of the study. Sites (1, 2, 5) were over normal values. The high and lowest means were in site (1, 6) respectively.

**$PM_{2.5}$ suspended particles**

The highest value was recorded in site (2) as show in table 6. This is due to the fact that the site represents a link between several governorates and represents a traffic momentum area as well as the presence of transport garages next to the site (Zhang *et al.*, 2008), which increases the concentration of particles suspended in the air, while the lowest value was recorded in site (6) in autumn which due to that this site as mentioned above represents an agricultural area characterized by trees and various plants, which served as filters and fenders for winds loaded with dust, gases and

other air pollutants (Lindahl, 2016), as well as the start of the rainy season, which led to the washing of air pollutants and sedimentation on soil and streets. The highest and lowest mean were in sites (2, 6) respectively, all sites were over permissible limits.

**Table 7:** Suspended particles concentration in atmosphere with $PM_{10}$.

| No | Regions | Suspended particles ($\mu g/m^3$)$PM_{10}$ | | | | |
|---|---|---|---|---|---|---|
| | | Winter | Spring | Summer | Autumn | Mean |
| 1 | Nader Al-Thalatha | 198.91 | 207.22 | 225.27 | 168.54 | 199.98 |
| 2 | Street 60 | 363.32 | 393.75 | 422.45 | 310.22 | 372.43 |
| 3 | Al-Thawra | 298.47 | 320.63 | 310.33 | 302.41 | 307.96 |
| 4 | Al-Bakrli district | 171.98 | 210.73 | 198.28 | 139.97 | 180.24 |
| 5 | transportation garage | 273.96 | 264.21 | 298.72 | 225.78 | 265.66 |
| 6 | Abu Kastawi | 98.35 | 89.53 | 113.10 | 107.13 | 102.02 |

**Table 8:** Lead concentration in atmosphere.

| No | Regions | Lead(pb) | | | | |
|---|---|---|---|---|---|---|
| | | Winter | Spring | Summer | Autumn | Mean |
| 1 | Nader Al-Thalatha | 1.23 | 1.09 | 1.17 | 0.09 | 0.89 |
| 2 | Street 60 | 1.42 | 1.18 | 1.37 | 1.13 | 1.27 |
| 3 | Al-Thawra | 0.79 | 0.53 | 0.78 | 0.43 | 0.63 |
| 4 | Al-Bakrli district | 0.02 | 0.01 | 0.03 | Nil | 0.02 |
| 5 | transportation garage | 1.13 | 1.06 | 1.07 | 0.99 | 1.06 |
| 6 | Abu Kastawi | Nil | 0.02 | 0.03 | Nil | 0.02 |

**Table 9:** Copper concentration in atmosphere.

| No | Regions | Copper (Cu) | | | | |
|---|---|---|---|---|---|---|
| | | Winter | Spring | Summer | Autumn | Mean |
| 1 | Nader Al-Thalatha | 1.42 | 1.32 | 1.33 | 1.29 | 1.34 |
| 2 | Street 60 | 0.99 | 0.78 | 0.93 | 0.83 | 0.88 |
| 3 | Al-Thawra | 0.79 | 0.63 | 0.71 | 0.68 | 0.70 |
| 4 | Al-Bakrli district | 0.72 | 0.83 | 0.81 | 0.39 | 0.68 |
| 5 | transportation garage | 1.16 | 0.95 | 0.98 | 1.07 | 1.04 |
| 6 | Abu Kastawi | 0.27 | 0.19 | 0.22 | 0.03 | 0.17 |

**Table 10:** Cobalt concentration in atmosphere.

| No | Regions | Cobalt | | | | |
|---|---|---|---|---|---|---|
| | | Winter | Spring | Summer | Autumn | Mean |
| 1 | Nader Al-Thalatha | 0.12 | 0.03 | 0.09 | 0.07 | 0.07 |
| 2 | Street 60 | 0.13 | 0.07 | 0.12 | 0.03 | 0.08 |
| 3 | Al-Thawra | 0.07 | 0.09 | 0.07 | 0.02 | 0.06 |
| 4 | Al-Bakrli district | 0.03 | 0.02 | 0.01 | Nil | 0.02 |
| 5 | transportation garage | 0.08 | 0.07 | 0.08 | 0.04 | 0.06 |
| 6 | Abu Kastawi | 0.01 | Nil | Nil | Nil | 0.01 |

**Table 11:** Iron concentration in atmosphere.

| No | Regions | Iron(Fe) | | | | |
|---|---|---|---|---|---|---|
| | | Winter | Spring | Summer | Autumn | Mean |
| 1 | Nader Al-Thalatha | 8.13 | 7.63 | 7.86 | 6.32 | 7.48 |
| 2 | Street 60 | 7.72 | 6.44 | 6.89 | 5.87 | 6.73 |
| 3 | Al-Thawra | 6.54 | 6.13 | 6.47 | 4.33 | 5.86 |
| 4 | Al-Bakrli district | 3.62 | 3.22 | 3.70 | 2.96 | 3.37 |
| 5 | transportation garage | 7.31 | 6.15 | 6.86 | 5.7 | 6.50 |
| 6 | Abu Kastawi | 2.99 | 2.18 | 2.67 | 2.78 | 2.65 |

### $PM_{10}$ suspended particles

From table 7, the highest value was recorded in site (2) during summer, this might due to high temperatures and an increase in wind speed with the increased movement of cars during the measurement hour, which led to the occurrence of air swirls loaded with dust, as well as the absence of rain and increased soil dryness, all of which contributed to increase the concentrations of suspended particles as mentioned previously, while the lowest value was recorded in site (6) during winter, this is due to rainfall during the measurement period, which led to the washing of the atmosphere of the suspended dust as well as the site is an agricultural area that helps to reduce the concentrations of dust pollutants suspended. The highest and lowest mean were in sites (2, 6) respectively. All sites in table (5, 6) recorded values over permissible limits, this might be indicated, this is due to the expansion of desertification phenomenon in the research area with no attention to the state of green land and the expansion of the population and the conversion of type from agricultural land to residential land as well as the lack of green spaces in many of the sites studied (Zhang *et al*., 2003).

### Heavy elements

#### Lead (Pb)

The highest value of lead was recorded in site (2) as showed in table 8, this is because of the impact of car exhausts because the site represents a main road in the province and connects several governorates in the city of Hilla (Dabrowski *et al*., 2016), as well as the impact of public transport garages, which is located next to the site, which represents the concentration of cars as well as the climate factor of high temperatures and wind silence, which led to an increase in lead concentrations, while the lowest value recorded in sites (4, 6) in winter and spring respectively, this is because the first site represents an upscale residential area characterized by an increase in the areas of gardens and decline of population as well as the small number of cars passing through the site (Zhang *et al*., 2016), while the second site (6) is represented agricultural area characterized by the increased of green areas and the lack of population. The highest mean in site (2) while lowest mean was in sites (4, 6). There were about 16

reading in table 8 were over permissible limits.

**Copper (Cu)**

Regarding of Cu element, the high level was recorded in site (1) during winter as showed in table 9, This was due to the impact of the Hilla asphalt factory located to the southeast of the site, which was working at high production capacity during the measurement hours and the wind was southeasterly, which led to pollutants towards the site and thus increased copper, while the lowest value was recorded in site (6) during autumn, the highest and lowest mean were recorded in sites (1, 6) respectively. There are (6) readings recorded values outside the internationally allowed limits represented by the site (1) and for all months, while recorded at the site (5) only and during the winter and autumn values higher than the allowed limits.

**Cobalt (Co)**

About level of Cobalt, the highest value was in sites (1, 2) during winter and summer respectively as show in table 10, high level in site (1) was due to the impact of the Hilla asphalt factory located as well as this region considered as industrial area, while in site (2) might be due to the presence of the garage and the large number of vehicles passing through the site as well as the movement is almost continuous during the day, but the lowest reading recorded in site (6) during summer, in the same time this region (6) didn't recorded any value during summer, autumns, and spring in addition to site (4) during autumn didn't sensing any concentration for cobalt. The highest and lowest mean recorded in site (1, 2) during winter and autumn respectively. Some regions was over permissible limits such as site (1) in winter and site (2) during winter and summer.

**Iron (Fe)**

Table 11 represent concentration of Fe, in which the highest value recorded in site (1) during winter due to the impact of the Hilla asphalt factory , while the lowest value recorded in site (6) because of this site represents an agricultural area with a low population density as well as its location in the northwest of the city and therefore the wind is coming out of the site towards the city and not vice versa. The highest and lowest mean recorded in site (1 and 6) respectively. Some region recorded value over permissible limitation such as sites (1, 2 and 5) during all seasons, and site (3) during spring, summer, and winter.

## Conclusion

From this we conclude that the air of the city of Hilla suffers from pollution with some gases, particles suspended, and some of heavy elements.

## Recommendation

1- Issuing environmental legislation such as the establishment of green area around the city of Hilla areas, as well as prevent the expansion of the phenomenon of desertification at the expense of agricultural land.

2- Preventing the use of some industries that contribute to the pollution of the study area.

3- Encourage the use of improved fuel in vehicles.

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