Air Pollution in Iraq Sources and Effects

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Abstract

The current study came to clarify the air pollution in different regions in Iraq. This study reviewed most of the Iraqi studies that dealt with the issue of air pollution and found that pollutants released into the atmosphere include gaseous pollutants of various kinds, especially CO, CO₂, NOₓ, SOₓ, O₃, suspended particles, polycyclic aromatic hydrocarbons and heavy metals. The study showed that the main sources for release these pollutants into the atmosphere included fossil fuels combustion, industry, energy production, transportation, heating, brick and cement industry, oil industries, transportation, agriculture fires and dust storms in addition to domestic and public generators. The result showed that these pollutants in many regions exceeded the national and international standard criteria.

Key word: air pollution in Iraq, gaseous pollutants, suspended particles, polycyclic aromatic hydrocarbons, heavy metals.

1. Introduction

Air is a homogeneous mixture of gases and suspended particles that exist in various compositions and sizes, this chemical composition is in a state of continuous change according to place and time as a result to many chemical reactions and physical transformations that affect air quality [1], it's one of the most important environmental media because it's great contribution in the transportation and spread pollutants in both gaseous and suspended particles forms and redistribution between different environments [2].

One of the most important issues at the present time in developed and developing countries alike is air pollution, that due to the effects it causes on the quality of the atmosphere and the resulting great threat on public health [3], and this is due to what the world is witnessing in terms of significant economic development, rapid industrial development, an increase in population growth, construction and demolition projects, and a critical increase in traffic, especially in recent years, has clearly affected the atmospheric environment as a result of the increase emission of various types and quantities of pollutants [4].

Air pollution defined as "the presence of unwanted substances in the air in large quantities sufficient to cause harmful effects to humans, animals, plants and public property, or it interferes with legitimate human uses such as brown and hazy color in the air or the presence of annoying odors" [5], or it "any accumulation of chemicals in the atmosphere as a result of excessive emissions from anthropogenic and natural sources in sufficient quantities to endanger human and environmental health "[6].
Due to the fact that the breathing process is a continuous process, as the daily intake of air by humans is estimated at about 20 m$^3$/day [7], compared to the daily intake of water and food (2-4) kg/day, air pollution is of great importance to the humans and other living organisms health [8], so air pollution has great attention by researchers worldwide as many studies proved that exposure to gaseous and suspended particles pollutants associated with lung cancer, respiratory infections, and respiratory and cardiovascular diseases [9]. Air pollution is also characterized by its unlimited effect with the place where pollutants are released due to the ability of these pollutants to transfer large distances away from their sources by wind [10], also because suspended particles include high levels of toxic substances such heavy metals and polycyclic aromatic hydrocarbons, which play an important role in pollution of land and aquatic ecosystems when deposited, and contribute to atmospheric pollution when re-suspended in air again [11], therefore these pollutants do not affect the quality of the atmosphere only, but also the quality of water and soil, which negatively affects the quality and productivity of plants, human life and different animals directly or by the food chain [12].

In recent years, Iraq has witnessed a deterioration in air quality, and this is due to the increase in the number of electric power plants especially those that work with crude oil, in addition to the excessive spread in the use of domestic and public generators due to the decrease in the supply of electricity, the huge increase in public and private transport modes, the use of fossil fuels for heating and burning solid waste by uncontrolled methods, which resulted in the release of large quantities of pollutants into the atmosphere [13], the most important types of pollutants that negatively affect air quality in various Iraqi cities and regions can be identified as following:

1. **Gaseous pollutants:** The increase in population growth and the accompanying increase in industrial development and transportation have a significant impact in the increase concentrations of pollutants in the surrounding air, which has a negative impact on human and environmental health [14]. Human activities are the main source of gaseous emissions polluted the atmosphere, especially in cities [15], where the concentration of polluted gases such as CO, CO$_2$, NO$_x$, SO$_x$, O$_3$ and others in the air is closely related to the surrounding pollution sources [16].

Exposure to gaseous pollutants leads to many diseases such as respiratory allergy and infections, weakness in lung function, asthma, cardiovascular diseases, affecting the nervous system, and increasing the incidence of bacterial and viral diseases [17].

Table (1) shows the concentrations of gases air pollutants in different regions of Iraqi cities and the most important sources of these gases emission include transportation [18], power plants [19], industrial activities [20], petroleum industry and oil refinery [21], oil combustion [22], brick factories [23], diesel generators [24], and agriculture fires [25].

| CO | NO$_x$ | SO$_x$ | O$_3$ | Measuring unit | Site  | Year | Reference |
|----|--------|--------|-------|----------------|-------|------|----------|
| 18 | 1.3    | 0.9    | -     | ppm            | Basra | 2013 | 19       |
| 13 | 0.16   | 0.1    | 0.09  | ppm            | Karbala | 2014 | 26       |
2. **Suspended particles**: one of the main atmospheric pollutants that affect the energy balance, climate, human and environmental components health [30], because its contain many toxic organic and inorganic compounds [31], suspended particles emitted from natural and anthropogenic sources, are either primary, which are the particles released directly to the atmosphere, or secondary, which are the particles resulting from interaction of the primary particles in the atmosphere with each other or with the other components of the atmosphere [32], the size of suspended particles ranges from 0.001 to greater than 100 micrometers, in general, the particles are divided according to their aerodynamic diameter into: Coarse particles with a diameter between 2.5-10 micrometers are called PM10 and Fine particles which are less than 2.5 micrometers, it is called PM 2.5, while these two types together are called Total Suspended Particles (TSP) [33], Fine particles PM2.5 can be divided into Accumulation particles between 0.1-2.5 micrometers in diameter and Ultrafine particles, also called Nuclei, are less than 0.1 micrometers in diameter [34].

From a toxicology view point, the most important particles with diameters less than 10 micrometers are called inhalable particles which characterized by its ability to penetrate deep into the respiratory system, causing severe health effects that lead to lung and respiratory diseases [35], exposure to suspended particles leads to death, heart and respiratory diseases, especially in children and the elderly [36], an influential decrease in the life expectancy of the population [37], genotoxicity and mutagenicity [38], cytotoxicity and pro-inflammatory and carcinogen induction [39].

Suspended particles negatively affect plants, directly and indirectly, which leads to reduced growth and productivity [40], and also contribute to the formation of acid rain [41], and can cause severe damage to artistic works, historical monuments and buildings and lead to a reduction in their aesthetic appearance and life span [42].
Table (2) indicates the total concentration reached by the suspended particles in different cities in Iraq, and the most important sources of suspended particles in Iraq are dust storm [18], resuspension of dust [43], agriculture fires [44], building construction process [25], transport [45], tire and brake wear [46], combustion of fossil fuel [25] and crude oil [23], industrial activities [47], oil refinery [43], power plant [46], bricks manufacture [22], and cement plants [48].

Table (2) concentration of total suspended particles in Iraq.

| TSP    | Measuring unit | Site     | Year | Reference |
|--------|----------------|----------|------|-----------|
| 3555.6 | µg/m³          | Kirkuk   | 2012 | 49        |
| 2241.37| µg/m³          | Baghdad  | 2012 | 50        |
| 3223.24| µg/m³          | Daura    | 2014 | 51        |
| 1400   | µg/m³          | Baghdad  | 2015 | 52        |
| 9480.17| µg/m³          | Al Najaf | 2015 | 27        |
| 3985   | µg/m³          | Baiji    | 2016 | 47        |
| 4000   | µg/m³          | Baiji    | 2016 | 43        |
| 317    | ppm            | Baghdad  | 2016 | 18        |
| 510.2  | µg/m³          | Maysan   | 2018 | 53        |
| 2098   | µg/m³          | Baghdad  | 2018 | 23        |
| 4397.57| µg/m³          | Karbala  | 2018 | 54        |
| 6609.68| µg/m³          | Baghdad  | 2018 | 55        |
| 1807.28| µg/m³          | Al-Diwaniyah | 2018 | 46        |
| 114.94 | µg/m³          | Karbala  | 2018 | 20        |
| 757.02 | mg/m³          | Babylon  | 2019 | 22        |
| 1798.1 | mg/m³          | Al Najaf | 2020 | 48        |
| 4787.6 | µg/m³          | Wasit    | 2020 | 29        |

3. Polycyclic aromatic hydrocarbons (PAH): one of the most important environmental pollutants releasing into the air from anthropogenic and natural sources [8], its resulting from pyrolysis or incomplete combustion of fossil fuels and organic materials [56], its includes a large group of compounds contains two or more of aromatic rings joined together and many of them in the air characterized with low vapor pressure so its tend to adsorb on particles suspended in the air [57].
Polycyclic aromatic hydrocarbons poses a serious risk to human health due to its carcinogenicity [58], ability to induce mutations, endocrine disruptions even at relatively low levels [59], in addition to weak immune system [60].

Table (3) indicates the total concentrations reached by the total polycyclic aromatic hydrocarbons in different regions in Iraq, and perhaps the most important sources of their emission to the atmosphere in Iraq include incomplete combustion of inorganic material of both natural and anthropogenic origin like fossil fuel and wood [61], oil refinery [51], power plant [49], home and public generators [28], transportation [62], petrol stations [20], petroleum industry [21], and brick industry [23].

Table (3) concentration of total polycyclic aromatic hydrocarbons in Iraq.

| PAH   | Measuring unit | Site       | Year | Reference |
|-------|----------------|------------|------|-----------|
| 145.3 | µg/m$^3$       | Kirkuk     | 2012 | 49        |
| 1.3   | ppm            | Basra      | 2013 | 19        |
| 952.84| ng/m$^3$       | Daura      | 2014 | 51        |
| 31.23 | ppm            | Basra      | 2015 | 21        |
| 175.5 | µg/m$^3$       | Baiji      | 2016 | 43        |
| 0.381 | ppm            | Baghdad    | 2016 | 28        |
| 0.225 | ppm            | Baghdad    | 2018 | 23        |
| 5031.44| ng/m$^3$     | Al-Diwaniyah| 2018 | 62        |
| 8.122 | ppm            | Karbala    | 2018 | 20        |
| 1.8   | ppm            | Kirkuk     | 2019 | 24        |

4. **Heavy metals:** atmospheric pollution with heavy metals associated with great effects to the environment and finally human health due to increase the route of exposure to such toxic pollutants because of large quantities and wide spread in the air [63]. Heavy metals are those metals or metalloids with high stability that have a density greater than 4.5 gm.cm$^{-3}$ and high atomic numbers greater than 24 such as mercury, lead, cadmium, and others [64]. Many of heavy metals in small quantities are necessary for normal development in living systems, but most of them becomes toxic at high concentrations [65].

The air polluted with heavy metals by emitted from natural and anthropogenic sources which causing increase the air pollution problem, resulting in humans toxic and carcinogenic effects [41], air polluted Heavy metals enter the body by inhalation, ingestion of particulate form or by absorption within the skin [66], heavy metals that absorbed into the body may show different types of effects and may lead to neurotoxicity, renal toxicity, Hepatotoxicity, Immunotoxicity, and congenital abnormalities, which may affect human behavior, and cause
impairment in the functions of the brain and nervous system that may lead to attention impaired and autism disease [67], also its an important source of environmental pollution after being deposited on the surface of soil and water, and thus, these toxic substances will eventually enter the biosphere [68], causing damage to animals, plants and the natural environment, erosion of buildings and contamination of foodstuffs [69].

Table (4) indicates heavy metals concentration in the air in a number of Iraqi cities, and the most important sources of atmospheric pollution with heavy metals include industrial activities [53], oil refinery [49], cement plants [48], brick industries [22], tires wear, brake linings and road construction materials, road traffic [44], fuel combustion [47], power plant [43], resuspension of road dust [25], and home and public generators [70].

Table (4) concentration of heavy metals in Iraq.

| Pb  | Cr  | Cd  | Cu  | Ni  | Co | Hg | Measuring unit | Site  | Year | Reference |
|-----|-----|-----|-----|-----|----|----|----------------|-------|------|-----------|
| 9.08| 2.49| 0.18| 0.22| 0.86| -  | -  | µg/m³          | Kirkuk| 2012 | 49        |
| 24.05| -  | 0.75| 17.50| 55.50| -  | -  | ppm           | Baghdad| 2012 | 50        |
| 6.50| 48.60| 0.40| -   | 26.50| -  | -  | µg/m³         | Baghdad| 2015 | 52        |
| 1.50| 16.51| 3.13| 5.53| -   | 6.57| -  | µg/m³         | Al-Najaf| 2015 | 27        |
| -   | -   | 0.14| -   | 0.63| 0.38| -  | µg/m³         | Baiji | 2016 | 47        |
| 4.90| 0.90| 0.13| -   | 0.65| 0.35| -  | ppm           | Baiji | 2016 | 43        |
| 95.21| 22.99| 0.79| -   | 43.55| -  | -  | µg/m³         | Basra | 2017 | 71        |
| 45.00| -   | 1.10| 27.10| -   | -  | -  | ppm           | Duhok | 2018 | 44        |
| 4.99| -   | 2.01| 7.73| 4.93| -  | 1.82| ppm           | Maysan| 2018 | 53        |
| 6.39| 1.55| 1.58| -   | 1.39| -  | -  | µg/m³         | Karbala| 2018 | 54        |
| 94.00| 2.02| 53.00| 3.10| 38.70| 11.10| -  | µg/m³        | Baghdad| 2018 | 55        |
| 3.19| 0.33| 0.06| 5.25| -   | -  | -  | µg/m³        | Al-Diwaniyah| 2018 | 70        |
| 11.23| -   | -   | -   | 2.51| 3.07| -  | µg/m³        | Babylon| 2019 | 22        |
| 0.56| -   | 1.29| -   | -   | -  | -  | µg/m³        | Al-Najaf| 2020 | 48        |
| 45.00| -   | -   | 27.10| -   | -  | -  | ppm           | Duhok | 2020 | 25        |
| 4.46| 5.55| 0.86| 4.16| 2.48| -  | -  | µg/m³        | Wasit | 2020 | 29        |
2. Conclusions: Through reviewing the various Iraqi studies that dealt with the issue of air pollution in the current study, conclude the following:

1. An increase in gaseous pollutants such as CO, NO\textsubscript{x}, SO\textsubscript{x}, O\textsubscript{3} as a result of the increase in fossil fuel combustion, industry, transportation, electric power generation and agricultural fires.

2. Increase the suspended particles in the air as a result of burning fossil fuels, transportation modes, power generating, industrial activities such as cement manufacturing, dust resuspension by wind and dust storms.

3. High concentrations of polycyclic aromatic hydrocarbons as a result of burning wood, fossil fuels, power generation, oil refining, fuel stations, and the oil and bricks industry.

4. An increase in the heavy metals concentration such as Pb, Cr, Cu, Cd, Ni, Co, and Hg resulting from industrial activities such as the manufacture of cement, bricks, oil industries, combustion fossil fuels, power generation, traffic, and tires and brakes wear.

5. Many pollutants exceeded the national and international standards criteria.

6. Studies have indicated the possibility of many diseases due to an increase in pollutants, such as cancer diseases, respiratory diseases, cardiovascular diseases, brain and nervous system functions defects, and birth defects.

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