

Air Pollution: A Study of Its Concept, Causes, Sources and Effects

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Abstract: Air pollution is very important topic for those interested in studying the environment because of its importance and the damage caused by it to human, animal and plant life. This research addresses the concept of air pollution, its causes, and its danger, and sheds light on the influence of climate elements on environmental pollution and the effect of temperature, rain, humidity, wind direction and speed, and atmospheric pressure on the increase or decrease of air pollution. This research discusses the sources of air pollution, including natural ones, including dust, smoke resulting from fires, erupting volcanoes, and others, including those resulting from human uses such as the use of fuel and others. The research addressed the damages caused by the emission of gases in its various sources. This research work discusses the types of air pollutants and methods of measuring them, as well as the sources and causes of indoor air pollution. The research sheds light on the effects of air pollution on environmental pollution due to the escalation of toxic gases that cause serious diseases to humans and other living organisms. The research deals with ways to reduce air pollution, most notably the search for an alternative source of energy, improving vehicle engines, agriculture and increasing green spaces.

Key words: Environment, factories, energy, cars, gas, oil, heat, rain, sun.

Introduction

Air pollution and its causes, sources and effects is very important, not only for researchers and those who advocate of environmental issues but for everyone, given the great damage that it causes to human health, animals, plants and the environment, in general, due to the serious diseases resulting from it. That is why it is necessary to educate everyone to contribute to maintain a clean environment and reduce air pollution.

Air pollution is one of the most important problems that our world suffers from today, as this pollution does not stop at certain limits, but extends over great distances where the polluted air mass merges with the general air movement. There is a group of factors that interact with each other to determine the amount and

density of pollutants and affect the process of pollutant transport, concentration and dispersal. One of the most important of these factors is the prevailing climatic conditions (Jassim, 2016). Air pollution is distinguished from other forms of pollution by its rapid spread, as its impact is not limited to the source area, but extends to neighbouring and distant areas (Kaddouri and Radeef, 2014; Salah et al., 2013).

Air pollution is defined as a change in the concentration of some components of the air, directly or indirectly, as a result of natural factors such as winds, storms, forest fires, volcanic eruptions, or unnatural factors, which are those carried out by humans that are among the largest contributors to air pollution (Jaber, 2011; Jadoua et al., 2016; Jassim, 2016; Matar and Khudair, 2014; Taha, 2016). Air pollution is defined as the direct or indirect

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introduction of any substance into the atmosphere in a quantity that affects the quality and composition of the atmosphere, thereby adversely affecting humans, the environment, ecological systems, natural resources, and the possibility of benefiting from the environment and its elements in general (Ali and Abd, 2017).

The troposphere represents the first layer of the gaseous atmosphere, the layer directly in contact with the Earth's surface, and its thickness ranges between (8-16) km. It is about 8 km above the poles and widths of the tropics (16 km). It contains 75% of the gaseous atmosphere in temperate regions also called the troposphere because it is the most turbulent layer of the gaseous atmosphere. All kinds of weather disturbances occur in this region. This layer of the atmosphere is the most vulnerable to pollution. The air in the troposphere, especially in parts close to the Earth's surface has high concentrations of pollutants (Jadoua et al., 2016; Taha, 2016).

Some of the adverse effects of air pollution are as follows (Jadoua et al., 2015):

1. The transmission of polluted air according to wind speed and direction from one area to another and sometimes for distances estimated at hundreds of kilometers. Therefore, the possibility of avoiding polluted air, or limiting it, becomes practically impossible.
2. The large quantities of air that enter the human body daily, amounting to about 15 kg, correspond to 2.5 kg of water, and about 1.5 kg of food.
3. The negative effects of air pollution lead to changing the climatic systems on the surface of the earth, increasing the average rainfall, soil moisture, water storage in some regions and decreasing it in other regions, leading to rising sea levels due to the melting of ice in the polar continents. The clean, dry air has certain specifications in terms of the availability of gases in it and acceptable proportions, as shown in Table 1 (Jadoua et al., 2016).

Effect of Climate Elements on Environmental Pollution

Climatic factors affect air pollution as follows:

1. Temperature: The high temperature during the day and the accompanying heating of the materials close to the surface lead to the occurrence of upward air movements that raise the components vertically to

Table 1: The Components of Dry Fresh Air

<i>Element</i>	<i>Symbol</i>	<i>Percentage</i>
Nitrogen	N ₃	78.08%
Oxygen	O ₂	20.94%
Argon	Ar	0.93%
Carbon Dioxide	CO ₂	0.3%
Neon	Ne	18 parts of a millionth
Helium	He	5.2 parts of a millionth
Methane	CH ₄	3.1 parts of a millionth
Krypton	Kr	0.1 parts of a millionth
Hydrogen	H ₂	0.5parts of a millionth
Nitro oxide	N ₂ O	0.25parts of a millionth
Carbon Monoxide	CO	0.1parts of a millionth
Ozone	O ₃	0.02parts of a millionth
Sulphur Dioxide	SO ₂	0.001parts of a millionth
Nitrogen Dioxide	NO ₂	0.001parts of a millionth

the greatest possible extent (Jassim, 2016; Taha, 2016).

What determines the vertical spread of air pollutants is the degree of air stability, which is primarily related to the vertical difference in temperature (Taha, 2016).

2. Rain: Rain purifies the air by combining with polluted particles. But some components, especially gaseous ones such as (Cox-Nox-Sox) produce acids such as carbonic acid, nitric acid and sulphuric acid when combined with water droplets, forming what is known as acid rain is harmful to the soil, plants and buildings (Jassim, 2016; Taha, 2016).
3. Relative humidity: Relative humidity is defined as the relationship between the actual water vapour present in a particular air mass and the saturated vapour pressure in this mass. As for the concentration of gases, it decreases with increasing humidity, due to an increase in water vapour that interacts with gases such as (Sox, Nox, Cox) (Jassim, 2016; Taha, 2016).

Sources of Pollution

The most important sources of pollution are as follows:

- a. Natural sources of pollution: They are represented by volcanic projectiles, dust, dust raised by wind, smoke from burning forests, pollen, and microorganisms (microbes) (Kaddouri and Radeef, 2014; Matar and Khair, 2014; Taha, 2016).
- b. Human sources of pollution: They are unnatural

sources resulting from various human uses, both industrial and non-industrial, and classified into the following (Kaddouri and Radeef, 2014; Matar and Khudair, 2014; Taha, 2016):

1. Pollutants result from the consumption of fuel in the production of energy for heating and for the management of factories, laboratories, and various household uses.
2. Pollutants resulting from the emission of exhaust from means of transportation that use gasoline, diesel oil, or kerosene.
3. Dust from multiple industrial sites, including chemical plants (iron, steel, and cement factories, quarry plants, electric power plants, etc.).
4. Gases emitted from various wastes, human and industrial waste.

The most important gases polluting the air are as follows:

1. Gases: They are dispersed in the air of cities and industrial areas, and the most important source is the burning of fuel. The most important gases polluting urban air are carbon monoxide, sulphur dioxide, nitrogen gas and hydrocarbons, which are emitted directly from fuel combustion (Jassim, 2016). The industry represents one of the main sources of pollution of the natural environment, as emissions from industrial activities represent about one-third of the total polluting gases in the air (Ali and Abd, 2017).
2. Cars: Studies have proven that cars are responsible for more than 50% of air pollution in non-industrialised third world countries. Cars lead the other sources of air pollution, especially with regard to gases (Adnan, 2010; Jassim, 2016).

The amount and quality of pollutants emitted from vehicle exhausts vary according to the type and components of the fuel used, the condition of movement, as well as the density and degree of fluidity of the vehicles. Gas pollution levels vary from month to month, day to day, and even hour to hour. For example, the average nitrogen monoxide gas increases significantly when temperatures range between 2°C and 18°C compared to the averages recorded with the lowest and highest temperatures. Pollution rates vary with the levels of sunlight, as the concentration levels of carbon monoxide (CO), sulphates (SO) and hydrocarbons (H₂S) increase with lower temperatures, while the opposite occurs with ozone gas, as shown in Table 2 (Mahdi, 2010).

Table 2: The rate of pollutants emanating from petrol and diesel cars, estimated in mg/l

<i>Type of Pollutant</i>	<i>Benzene Cars (gm/l)</i>	<i>Diesel Cars (gm/l)</i>
CO	249.00	29.50
NO	9.85	7.20
SO ₂	0.37	4.15
HC	9.62	1.80
Pb compounds	0.73	-
Soot	-	1.90

3. Electric power plants: They are considered one of the important fixed sources in the release of pollutants into the surrounding air, where two types of pollutants are emitted: particulate and gaseous. These stations in the country are divided according to the type of fuel used into thermal, gas and hydroelectric stations (Jassim, 2016; Majid, 2010).

Air Pollution Methods

Among the most important methods of air pollution are the following (Majid, 2010):

1. The increase in the population and the inflation of cities, which led to an increase in pollution, with the failure to take measures to protect the air from pollution.
2. Industrial and technological progress and its concentration in cities have led to environmental pollution, with no measures taken to protect the air.
3. The widespread use of modern and practical methods of spraying pesticides and plant growth regulators in the city led to the pollution of the soil and vegetation cover in the city.
4. Means of transportation: the expansion of the movement of transport and its used devices, especially cars, trains and planes.
5. The pollution of the modern city resulting from population congestion, means of transportation, mechanisation of agriculture, wheel spinning of factories.
6. Unplanned urban expansion within cities as a result of the increase in population numbers and the lack of scientific planning for urban expansion areas, and leaving waste unattended.
7. Burning fuel for heating inside residential units in the city, which led to the pollution of the city's environment.
8. Random burning of waste and garbage inside or near cities, without paying attention to the direction

of wind movement, which led to the pollution of the city's environment.

9. Wars and the explosion of equipment and weapons, and the use of different types of radioactive materials.

Types of Air Pollutants and Methods of Their Measurement

Air pollutants are many and varied, and they are as follows:

1. Gaseous pollutants: The most important gaseous pollutants polluting the air are carbon oxides (CO , CO_2), sulfur oxides (SO , H_2S , CO_4 , SO_2), nitrogen oxides, or ozone (NO_x), hydrocarbons and others (Jaber, 2011; Jadoua et al., 2016; Jassem et al., 2008; Salah et al., 2013; Taha, 2016).

The most important of these gases are:

- a. Hydrocarbons: They are gaseous, liquid, or solid organic compounds and consist of numbers of carbon and hydrogen atoms in very multiple shapes and types (Jaber, 2011; Jassem et al., 2008; Majid, 2010).
- b. Carbon monoxide (CO): The carbon source in these cases is petroleum fuels, coal of all kinds, or natural gas (Jaber, 2011; Jassem et al., 2008; Majid, 2010; Salah et al., 2013).
- c. Carbon dioxide (CO_2): This type of gas is present in large quantities in the atmosphere due to the combustion of fossil fuels used in transportation, electricity generation, and various industries, as well as the burning of waste (Jaber, 2011; Jassem et al., 2008; Majid, 2010; Salah et al., 2013).
2. Heavy metals: the most important of which are lead, zinc, nickel, cadmium, mercury, and copper are harmful pollutants, which can be measured by means of the atomic absorption device (Jadoua et al., 2016; Salah et al., 2013).
3. Chlorofluorocarbons (CFCs): They are very harmful to the ozone layer, and these compounds are emitted from some products whose use has been banned at the present time (Salah et al., 2013).
4. Ammonia (NH_3): It is one of the substances that are emitted from agricultural operations. Ammonia is a chemical compound with the formula NH_3 .
5. Odours: such as odours emitted from garbage, sewage, and various industrial processes (Salah et al., 2013).

Sources of Indoor Air Pollution

The dangers facing humans due to indoor pollution were not known and announced about fifteen years ago. There are serious health problems caused by air pollution inside buildings, homes, offices, schools, and hospitals (Adel, 2016).

There are two main sources of indoor air pollution, which are as follows:

The first source: the design of the building and furniture: The air pollutants inside the buildings resulting from the building itself and the furniture it contains can be classified into the following (Adel, 2016):

1. Gaseous pollutants: Air pollutants accumulate in closed places to a high degree due to the lack of ventilation in those places. They include carbon monoxide (CO), which is known to be toxic, as it is emitted from coal, wood, cigarette, candle, and kerosene stoves. As for carbon dioxide, CO_2 , its concentration increases in places where ventilation is weak and crowded with people, which leads to an increase in its quantity and a decrease in the amount of oxygen through the process of breathing (inhalation and exhalation) and the consumption of the amount of oxygen present in that space exceeds the renewable amount of air in it.
2. Building materials and furniture: VOCs are emitted from materials used in construction, building furniture and carpets, such as asbestos used in construction in the past, and inhaling it in the long term increases the incidence of lung cancer. In addition to the concentration of radon gas in the ground level (basement) of buildings, which is caused by building materials (stones, cement, soil, water and fine dust), which is the second cause of lung cancer after smoking. Radon gas leaks from cracks in the earth's crust.
3. Persons: Many pollutants are emitted from people and animals through breathing and sweat, such as acetone, ammonia, carbon dioxide, carbon monoxide, methane, and propane.
4. Biological pollutants: Concentrations of biological pollutants increase inside the buildings as a result of their high humidity. Therefore, the indoor humidity should not exceed 50% and the use of moisture-absorbent materials to keep the indoor air from increasing concentrations of biological pollutants.

The second source: the outdoor air: It is one of the factors that affect the air quality inside the places.

The characteristics of the external sources of pollution such as the movement of vehicles and industrial or agricultural activities make the process of controlling them out of scope for the designers, owners, and occupants of the building; therefore, the environmental authorities must take responsibility to set the basic lines of environmental protection and to ensure adherence to them (Adel, 2016).

Air Pollution and Its Danger to Health and The Environment

Polluted air affects human health by harming the skin and eyes, or it may reach the body through the respiratory system. The impact of air pollution on human health is highly dependent on the quality and quantity of polluting materials. The duration of exposure and personal factors such as age, gender, susceptibility to disease resistance, and type of food must be taken into account (Jadoua et al., 2015).

Another health effect of air pollution is the occurrence of suffocation, or poisoning, and the health impact as a result of the concentration of pollutants in the air, most of which result from the increased consumption of energy from its polluted sources with the occurrence of fog that interacts with these pollutants, producing toxic substances (Jaber, 2011).

Among the most important air pollutants that affect human health is smog, which is water mist that contains smoke and various chemical pollutants, some of which are generated in the smoggy atmosphere itself by the influence of ultraviolet radiation and the presence of hydrocarbons and nitrogen dioxide. Among the pollutants that are frequently present in the foggy atmosphere, we mention sulphur dioxide (SO_2). Therefore, the frequency and continuity of fog formation in cities and industrial areas were greater than in rural areas far from factories. One of the most dangerous chemical compounds to health that are formed in the smoky atmosphere is the compound peroxyacetyl nitrate (PAN), which is formed due to the photolysis of nitrogen dioxide (NO_2) by the action of ultraviolet rays, turning it into nitric oxide (NO) and atomic oxygen (O) (Taha, 2016).

Plants play an important role in removing gaseous and solid pollutants from the air by absorbing a large part of them either directly, or after dissolving them in rain water through the respiratory stomata openings and absorbing pollutants on the outer surfaces of leaves (Fakhry, 2017).

Means of Treating Air Pollution: Conclusion

There are several means to reduce pollution, including (Adnan, 2010; Taher, 2009):

1. Reducing gases and particles emitted from factory chimneys, such as chemical waste, by finding sealed production methods. It is recommended to use several means to collect particles and gases such as the use of chemical precipitants and special combustion equipment.
2. Searching for an alternative source of energy that does not contain lead or sulphur. Natural gas is the least polluting source of thermal energy.
3. Periodic inspection of used cars and exclusion of damaged ones.
4. Introducing improvements and modifications in the design of automobile engines.
5. Continuing the large-scale afforestation programme around the big cities.
6. The necessity of focussing on how to burn fuel for optimal combustion, as incomplete combustion of fuel, whether in factories or transportation, is the main cause of air pollution.
7. Developing advanced technical means of controlling the air that includes the technology of controlling factories and applying modern technical devices to reduce the pollutants emitted.
8. Proper disposal of various industrial wastes, solid, liquid and gaseous, before they are released to the terrestrial or air environment.
9. Spreading environmental awareness on pollution among citizens so that they are aware of the extent of the danger and damages of pollution and also involve them in the decision-making process about reducing pollution.
10. Planning cities in a way that ensures maintaining a clean environment while building small cities instead of the continuation of large and bloated cities in terms of growth and urban and population density.

Conclusion

The research reached a number of important results, the most important of which are as follows:

1. Air pollution is one of the most important problems at the present time due to its seriousness and the fact that it does not stop at certain limits, but extends over wide distances and spreads quickly.

2. It is difficult to notice air pollution with the naked eye due to the multiplicity and diversity of its sources.
3. Air pollution is a change in its components, directly or indirectly, as a result of several factors, including natural factors such as winds, volcanic eruptions, storms and others, and unnatural ones resulting from various human activities.
4. Rising temperatures affect the increase in air pollution, as this leads to a rise in the surface temperature of the earth, and the occurrence of rising air compounds that raise the components and thus pollute the air.
5. Rain, high humidity, wind speed and atmospheric pressure contribute to an increase in air pollution.
6. There are many sources of air pollution, including natural ones such as dust, volcanic projectiles, forest fires and others, including human sources resulting from various human activities, both industrial and non-industrial.
7. Cars and vehicles, in general, are a major cause of air pollution because of the fumes, gases and smoke they emit, and this depends on the type of fuel you use and the age of the vehicle.
8. Electric power plants are an important source of air pollution due to the resulting gases, fumes, and smoke.
9. The dangerous levels of gaseous air pollutants such as carbon monoxide and carbon dioxide, nitrogen oxides, ozone, and others causes diseases.
10. One of the most important air pollutants that affect human health is fog, which is water mist that contains a high percentage of smoke and harmful chemicals.

References

- Adel, E. (2016). Air pollution inside buildings and its impact on the health of the occupants. *The Plan and Development Magazine*, **3**: 272-274.
- Adnan, A. (2010). The effect of air pollution on the level of some physiological and biochemical variables in the blood and some physical characteristics. *Journal of Physical Education Sciences*, **3**(4): 124.
- Ali, R. and J. Abd (2017). A geographical analysis of the reality of industrial activities polluting the air in the city of Hilla and their environmental impacts. *Journal of Human Sciences*, **24**(1): 6.
- Fakhry, A. (2018). Air pollution tolerance guide for roadside trees and shrubs in Tikrit city. *Kirkuk University Journal of Agricultural Sciences*, **9**(3): 53.
- Hassan, F.I. (2009). Air pollution and its role in the spread of respiratory diseases in Karbala Governorate for the period from 1997-2006. *Karbala University Scientific Journal*, **7**(4): 307.
- Jaber, A. (2011). Air pollution, water, its sources, its effects. *Babylon University Journal of Human Sciences*, **19**(1): 8.
- Jadoua, B., Hassan, A. and E. Adel (2016). Air quality in Baghdad City for 2010. *Journal of the College of Education for Girls*, **27**(2): 461-464.
- Jadoua, B., Hassan, A. and E. Adel (2015). The effect of some air pollutants (particulate matter and lead) on human health. *Journal of the College of Education for Girls*, **26**(4): 933-934.
- Jassim, M. (2016). The effect of climate elements on the process of environmental pollution (air pollution). *Journal of the College of Basic Education*, **22**(96): 361, 364, 366-369.
- Jassem, S., Muhammad, R. and H. Ali (2008). Air pollution and environmental hazards from vehicle exhaust in Basra Governorate. *Maysan Journal of Academic Studies*, **7**(13): 2, 5, 7.
- Mahdi, A. and A. Youssef (2017). The impact of human characteristics on the increase of air pollutants in Al-Qadisiyah Governorate. *KufaAdab Journal*, **10**(31): 314.
- Mahdi, S. (2010). The effect of vehicle exhaust on air pollution in the city of Al-Amarah. *Wasit Journal of Humanities*, **6**(15): 165.
- Majid, L. (2010). The lack of electric power and its impact on the pollution of the city's environment (2003-2009): A field study compared to the study area, the city of Baghdad (Al-Karkh and Al-Rusafa). *Journal of Human Sciences*, **1**(4): 173.
- Matar, A. and M. Khudair (2020). Geographical analysis of air pollution resulting from brick factories in Al-Saniyah district. *Al-Qadisiyah Journal of Arts and Educational Sciences*, (3): 296-299.
- Salah, S., Kazem, A. and R. Salah (2013). Environmental pollution study of the effect of electric generators on the surrounding environment (case study: home generators). *Babylon University Journal of Engineering Sciences*, **21**(5): 1706-1708.
- Taha, M. (2016). The phenomenon of air pollution and its health impact on humans. *Al-Adab Journal*, **116**: 553, 555, 554, 558, 562, 560-561, 574-577.
- Taher, J. (2009). Environmental pollution, waste management and treatment. *Assiut Journal of Environmental Studies*, **33**: 130-131.