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The Effects of Sunlight on Particle matter & Radiation Pollution in Baghdad Airport Area

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K E Y W O R D S

Sunlight, Particle matter, Radiation, Airports.

A B S T R A C T

The gasses emitted from the various activities, in addition to particle matter (PM10) play a major role in air quality deterioration. Particles matter and radiation are two of the most important parameters that exist in airports and were evaluated considering the variations in sunlight energy. The measured values were collected from eleven sites, which were chosen based on their influence by aviation activities. The measurements were compared to the (Iraqi Regulations and U.S EPA) for particle matter. While for radiation, the measurements were compared with the U.S. National Institute of Health (NIH), International Commission on Radiological Protection (ICRP), and the Occupational Safety and Health Administration (OSHA). The data were statistically analyzed, and the values of maximum, the mean, and the standard deviation were calculated. It was found that the values of the above statistical parameters of PM were within the limitation in all points. On the other hand, values of radiation were also within the limits except for the mean, which was higher than the standard limits. Moreover, the analysis proved that sunlight decreases the ratio of detecting particle mater. On the contrary, radiation detection was increased with sunlight due to the amount of radiation, which enters the atmosphere from the sun. These findings are important to assess the environmental quality of airports.

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1. Introduction

Air pollution is a common phenomenon throughout the world, but is mainly concentrated in highly populated urban areas and high-density industrial areas have a higher amount of air pollutants. Air pollution and its impact are the most challenging issues which have to be addressed on topmost priorities and generated from different sources including both natural and manmade which polluted the atmosphere to a greater extent [1-2]. Aerosols are known to have adverse effects on human health and on the global climate. The World Health Organization (WHO) recently added anthropogenic aerosol and air pollution to their list of known carcinogens [3], in addition to the high mass concentrations of particles, such as those emitted by fuel combustion processes. These pollutants are known to be harmful to humans and the environment [4]. Aircraft traffic is a large source of sub-micrometer anthropogenic aerosol and proximity to large sources of fuel combustion emissions was proved to increase lung and heart disease, especially in children [5]. Atmospheric particulate matter (PM) is generally defined as a mixture of solid and/or liquid particles that remains individually dispersed in the air. The gaseous and particulate components emitted into the atmosphere lead to a change in the composition and transparency of the air over large parts of the world [6].

Concentration, composition, and toxicity of PM are important factors that greatly lead to the possible human health problems associated with exposure to airborne PM. Ambient concentrations of total suspended particulates (TSP) and PM10 have been investigated on fine particles such as PM1.0 and PM2.5 because of strong correlations of PM to adverse health effects [7-10]. Primary particles are released into the atmosphere from a number of stationary and mobile sources. The major mobile source is road transport, which produces primary particles when fuels are burned or lubricants used up in the engine [11].

On the other hand, radiation is energy, can come from unstable atoms or it can be produced by machines. Radiation travels from its source in the form of energy waves or energized particles. There are actually two kinds of radiation (ionizing radiation and nonionizing radiation) [12]. Background radiation consists of three sources I) Cosmic radiation from the sun and stars. II) Terrestrial radiation from low levels of uranium, thorium, and their decay products in the soil, air, and water. III) Internal radiation from radioactive potassium-40, carbon-14, lead-210, and other isotopes found inside our bodies.

Aircraft occupants are exposed to elevated levels of cosmic radiation of galactic and solar origin. The intensity of the different particles making up atmospheric cosmic radiation, their energy distribution, and their potential biological effects vary with altitude, geomagnetic latitude, and the point of time in the sun's magnetic activity cycle [13].

Many types of research have been carried out to measure the amounts of radiation and its effect on human health. Radioactivity is a natural phenomenon and natural sources of radiation that are features of our environment. Radiation and radioactive substances have many beneficial applications, covering (to name a few) power generation, engineering, and medicine [14]. Radiation from air travel comes from cosmic radiation or radiation from space. Cosmic radiation is produced by the stars, including our own sun [15].

Air pollution is affected by the amount of PM and radiation, which is varied with the sunlight presence and with the seasons.

The main aim of this study is to evaluate the amount of PM and radiation pollution, which are emitted from Baghdad International Airport to the ambient air, and to investigate the effects of sunlight on the airborne particulate. Consequently, their negative impacts on the environment could be quantified.

2. Materials and Methods

I. Study area

The concerned study area is Baghdad International Airport (BIA), which is shown in Figure 1. BIA is the main airport in Baghdad and its geographical coordinates are 33.258-degree latitude, 44.233-degree longitude, and its latitude is 118 feet m.s.l. The area is characterized as arid, sweltering with long summer, while winter is cold, dry, and mostly clear.

In view of the (PM 10 and radiation) pollutants, ambient air quality for eleven stations was selected for monitoring the pollutant, as shown in Figure 2. Based on the atmospheric conditions, stations were selected to assess the impacts arising from the aircraft take-off direction and transportation movement in the study area.

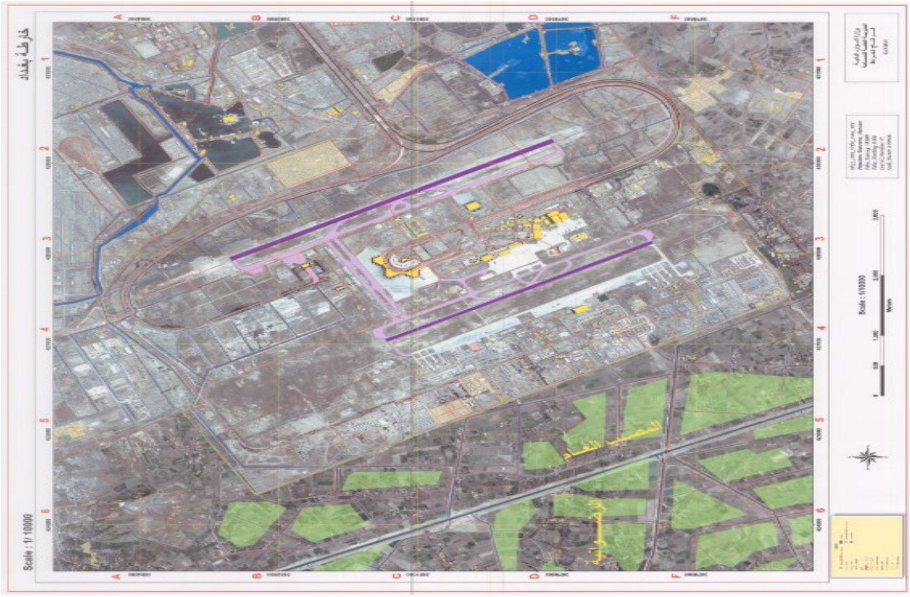

Figure 1: Baghdad International Airport

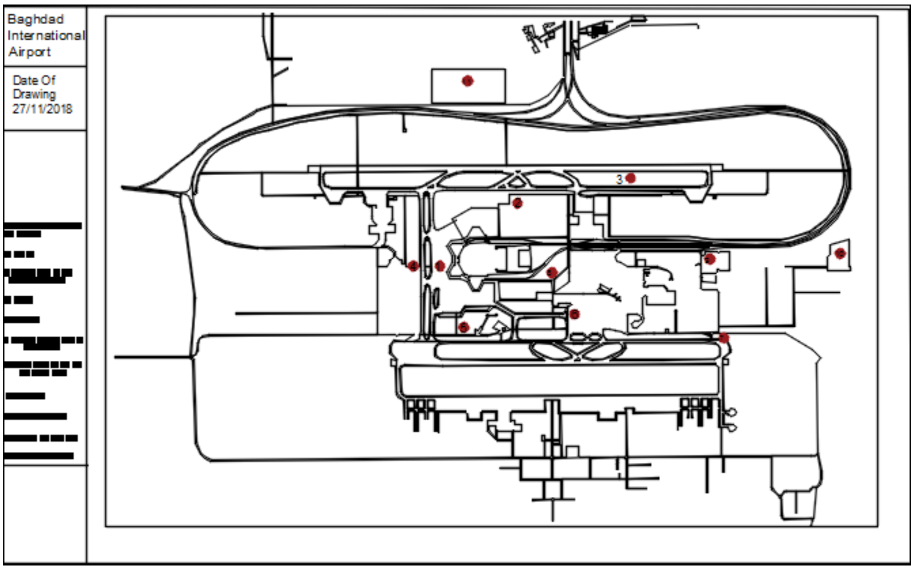

Figure 2: Particle matter and radiation measurement locations

II. Sampling methodology

Ambient air pollutions were monitored for a period of seven months as per the standard methods and were compared with the standards to assess the pollutant's range of airports with respect to particle matter (PM10) and radiation. For PM10, the Iraqi Regulations and U.S EPA. The limits for both Regulations are PM10 is 150 µg/m3. The standards for radiation are; U.S. National Institute of Health (NIH), maximum levels of radiation, for occupational is 5R/yr =5000 mR/yr while for nonoccupational is 1R/yr = 1000 mR/yr. For International Commission on Radiological Protection (ICRP), the occupational 20mSv/y =0.228 mR/h and non-occupational is 1 mSv/y =0.0114mR/h, where the other standard in Occupational Safety and Health Administration (OSHA), occupational is 3.5mSv/y = 0.0399mR/h and non-occupational 1.5mSv/y = 0.017mR/h. These pollutants are emitted to the ambient air from the aircraft activities, in addition to the operation and maintenance processes. The emitted pollutants are greatly dependent on the type of fuel used in the aircraft engine and on the quality controlling according to the regulations. Table 1 shows the specifications of the instruments and the methods used to measure the pollutants.

TABLE I: Specifications of Particle matter and radiation instruments

S. No.	Parameters	Methods	Instrument	Model	Company and Origin	Lower Detection Limit	Instrument Range	Resolution
1-	PM µm	Mass or counts concentration	Particle matter	Aerojet 531	U.S.A.	0.5 µm	0 – 3,000,000 particles per cubic foot	± 10%
2-	Radiation mR/hr µSv/hr.	Ionizing Radiation	Radiation alert inspector EXP	Halogen-quenched Geiger-Mueller tube.	U.S.A.	-	0.001 to 100.	0.001

3. Results and Discussion

The mean and standard deviation (SD) of monitoring values of the two ambient air quality parameters with respect to stations and shown in Table 2. The maximum values of PM10 varied from (0.138±0.046) in site 2 to (0.323±0.047) in site 8, site 2, which is a cargo location where the impact of aircraft movement is lower than other locations. While site 8 which is gas station position, the continuous use of the different type of trucks, which used to transport and unload fuel, also for the many cars that pass through this site, increases the presence ratio of PM. Mean values varied from (0.037±0.015) in site 2 to (0.064±0.035) in site 11, site 2 is the cargo position that is not all the time effect to the aviation activities, while site 11, the location of the apartment complex; its accumulated emission from particle matter due to living activities in addition to the aircraft influence increase the mean value of this pollutant. Comparing the results of particle mater to the Iraqi Regulations and U.S EPA, which the limits of PM10 are 150 µg/m3. The results show that all values of variables were not exceeding these limits in all sites. The movement and maintenance of aircraft, which include using different instruments and vehicles during traffic day, increased the amount of PM. Nevertheless, this matter would be dispersed in the ambient air and accumulated on the surface of the earth leading to a decrease air pollution ratio. On a sunny day, the mean values decreased rather than hazy days where the relative humidity is high, due to dispersion and spreading of air and these processes abound with the increasing the height of the earth's surface, Figure 3 shows the obtained average values of PM10.

The radiation data, which was obtained from the analysis, from maximum values, which varied from (0.02±0.33) in site 8 to (0.02±0.62) in site 2. Site 8 is a gas station position that is less affected by aircraft movements. Site 2-cargo position, the higher values depend on the type of instrument used in fright the goods. On the other hand, mean values varied from (0.97±0.4) on-site 11 to (2.31±0.42) on-site 4. Apartment complex which is located on site 11had the lowest value since it does not expose to the effects of aviation like other sites, while site 4 which is tower position, it uses a different type of techniques that in operation it a higher ratio of radiation are emitted, which increase the ratio of radiation obtained value. Data approved that the mean detection values for all locations increased and exceeded the limits, as compared with the U.S. National Institute of Health (NIH). The maximum levels of radiation, for occupational are 5R/yr =5000 mR/yr, while for non-occupational is 1R/yr = 1000 mR/yr. Also, for International Commission on Radiological Protection (ICRP), the occupational 20mSv/y =0.228 mR/h and non-occupational is 1 mSv/y =0.0114mR/h. With respect to the other standards like Occupational Safety and Health Administration (OSHA), the maximum value is 3.5mSv/y = 0.0399mR/h and for non-occupational 1.5mSv/y = 0.017mR/h. Eventually, the value of max. ± S.D. did not exceed the limitations of standards.

Higher values of radiation are due to the type of activities, which are exposed to, and these values are based on the movement of aircraft and the position of take-off and landing of aircraft. However, on a sunny day, the ratio of detection radiation was increased due to the relative increase in the amount of cosmic radiation from solar radiation. Figure 4 shows the obtained average values of radiation. As can be seen from the figure, there were obvious fluctuations in the mean values of radiation across the selected sites, which could be attributed to the proximity/ remoteness of the sites on the pollution sources.

4. CONCLUSION

Two air pollutant parameters were measured across eleven sites in Baghdad International Airport over seven month's period from Dec 2018 to Jul 2019, and the measured data were compared with their counterparts from the standards. It was found that the obtained value in the study area did not exceed the limit values of PM10. The measured radiation values exceeded the recorded limitations and explained on the bases that the pollutant emissions affected by the sunlight increase. On a sunny day, the obtained value of PM decreased even it is not exceeding the limitations, while the radiation increased with an increase in sunlight. These actions increased in airport areas because of the air traveling cosmic radiation, which ultimately affects the ratio of the amount of detection radiation.

TABLE II: Statistical summary of particle matter and radiation variable data

Sites	Particle mater (PM10) (ppm)			Radiation (µSv/hr)		
	Max.	Mean	S.D.	Max.	Mean	S.D.
Site 1	0.318	0.053	0.046	0.02	1.17	0.59
Site 2	0.138	0.037	0.015	0.02	1.50	0.62
Site 3	0.188	0.032	0.023	0.03	0.93	0.46
Site 4	0.182	0.040	0.022	0.03	2.31	0.42
Site 5	0.251	0.032	0.033	0.10	1.86	0.45
Site 6	0.253	0.036	0.032	0.03	0.89	0.50
Site 7	0.209	0.034	0.03	0.02	0.97	0.46
Site 8	0.323	0.047	0.047	0.02	1.06	0.33
Site 9	0.186	0.041	0.027	0.02	0.97	0.50
Site 10	0.209	0.051	0.023	0.04	1.06	0.32
Site 11	0.185	0.064	0.035	0.02	0.97	0.40

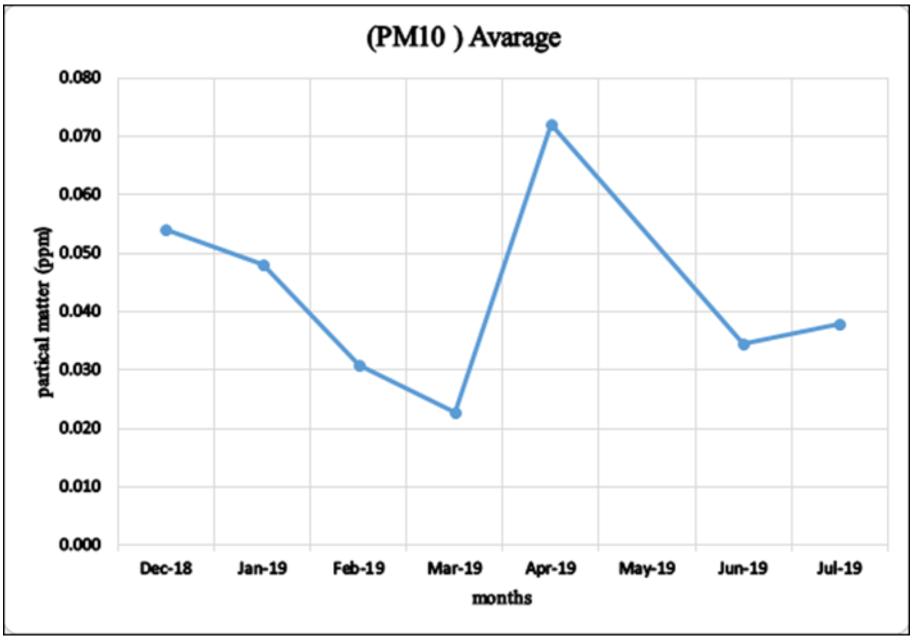

Figure 3: Statistical summary of particle matter (PM10) variable data

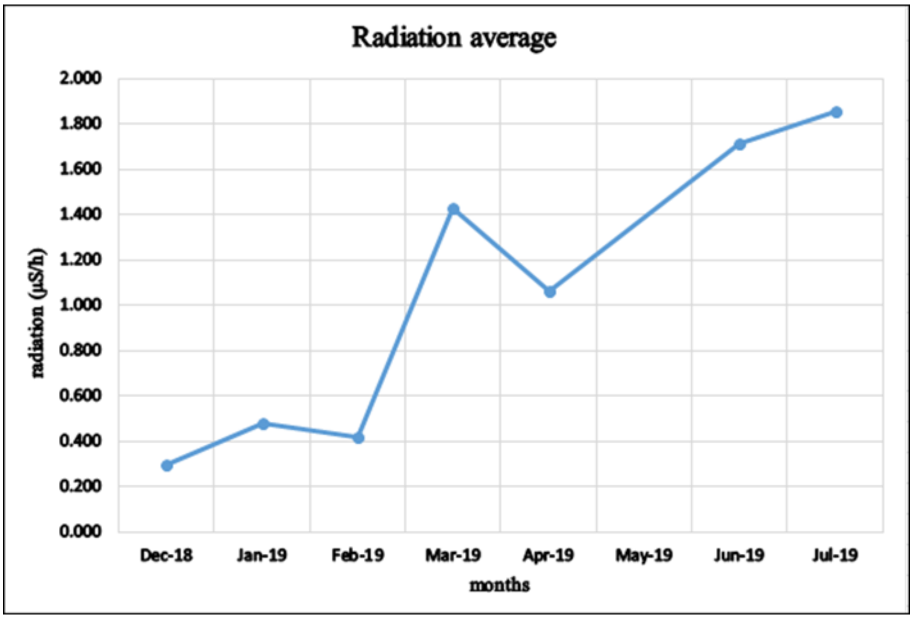

Figure 4: Statistical summary of radiation variable data

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