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Assessment of Power Plant Emission and Its Health Impacts in Gaza

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ABSTRACT: The aim of study was to investigate the concentrations of the ambient air pollutants (i.e $PM_{2.5}$, CO, CO_2) and to examine the health impacts on the residentials living surrounding the power plant in Gaza City-Palestine.The pollutants were monitored several distance surrounding the plant for a period of four months during both summer and winter seasons using a portable laser particle counter and gaseous monitor. A public health questionnaire was also distributed on the residents living around the power plant in order to assess the impact of air pollution on their health status.The results showed that the concentration of particulate matter exceeded the WHO standard where the highest level was 79 μg/m^3 and the lowest level was 49μg/m^3. However the concentration of carbon monoxide was lower than the WHO standards where the highest level was 2.18 ppm and lowest level was 0.1 ppm. Moreover, the concentration of carbon dioxide oscillated from 254 ppm to 514 ppm. The health assessment results showed that 50% of the study sample suffered of breathing difficulties.This study concluded that the concentration of particulate matter and carbon dioxide were high, while the level of carbon monoxide was low, furthermore the level of public awareness was good. Meanwhile 40% of population sample visited the hospital because of a disease that infects the respiratory tract.

Keywords: CO, Gaza, Health, $PM_{2.5}$,Power.

1. INTRODUCTION

Power plants release to atmosphere high amounts of particulate matter which contain harmful or toxic substances. Most PM_{10} in the atmosphere comes from power plants, vehicles and some combustion sources and is usually associated with significant toxic matter (Yi et al, 2006). The emissions from power plants are mainly due to the type of fossil fuels burnt, which results in the discharge of various pollutants into the atmosphere. (Nenadovic et al, 2010). Climate change is the greatest environmental challenge facing the world today. Power

stations play a major role in producing greenhouse gas emissions. Nearly 21.3% of greenhouse gases are emitted by power plants alone.

The main sources of greenhouse gases are due to burning of fossil fuels and deforestation leading to higher carbon dioxide concentrations. Fossil fuel burning produced about three-quarters of the increase in CO_2 from human activity over the past 20 years. (Senthil et al, 2010). Large amounts of CO_2 are emitted, which lead to warming of the Earth and the associated climate changes. Coal-fired power plants also emit substantial amounts of sulfur dioxide (SO_2) and a precursor of fine particulate that harmful to human health. (Shindell and Faluvegi, 2010).

Power plants are a major source of particulate matter (PM) pollution, the result of both unburned fuel particles and of chemicals that react to form particles. Particles can contain hundreds of different metals, such as arsenic and zinc. Fine particles can remain suspended in the air for weeks and can penetrate to the deepest part of the lung, where they are attracted and absorbed by immune cells. (Environment Maryland Research & Policy Center, 2007).

In Gaza Strip there is one power plant provide part of the required electricity, industrial diesel is used as a fuel for its operation, Gaza power plant (GPP) is located in the southern part of Gaza City at the middle governorate of Gaza Strip. It provides electricity to 1.8 million people, where it consume 15 million liters of fuel per month, consequently a huge a mount of pollutants being released to atmosphere which should be monitored continuously.

2. MATERIAL AND METHOD

Gaza Governorates are situating in the southeastern coast of Palestine located on the Mediterranean coast. They are a highly dense area, with 1.8 million people live in 365 km^2, the estimated density is 4,000 people per square kilometer distributed across five governorates. Gaza power plant is located in the Middle Gaza Governorate, bordered from north by Gaza city, from south by Al-Nuseirat, from east by Salah El dein Street and from west by the Mediterranean Sea. Power plant) shown in Fig. 1) was constructed on approximate area 150 hectare on an agriculture land. People were lived around power plant in all direction, but they are concentrated in the West and South directions. Power plant designed with a capacity of 140 Mega Watt (MW) and mainly comprised of four steam turbines. The primary fuel of power plant is diesel which supplied from Israel.

Fig. (1) Gaza power plant location from Google Earth.

Five monitoring campaigns were carried out to determine the levels of air pollutants and to illustrate the changes in the concentration of pollutants more clearly: Particulate matter ($PM_{2.5}$) and Carbon dioxide (CO_2). The first campaign, the measurements done at 3 different points of varying distance (30,500, 100 m) ended at 1 km distance from the station in all directions, while in the second campaign, the measurements were carried out at 15 points on different distances started by 20 m and end by 300m from the station in all directions.

Lastly in the third campaign, level of pollutants were measured at five points at a distance started with 20 m and end with 100 m from the station in order to assess the impact of pollutants emitted from the station to the population living in that region. The measurements of particulate matters ($PM_{2.5}$) were carried out for five days in different times around power plant by Super-thin 3-Channel Handheld Laser Particle Counter (HAL-HPC300). (HAL Website, 2015).

Measurements of the level of Carbon dioxide (CO_2) were carried out for five days in different time and different distances from power plant by Kanomax meter. Meteorological factors (Temperature and Humidity) were also monitored using the multi meter, while wind speed was monitored using Anemometer, to study their effect on the pollutants behavior. A questionnaire was used to evaluate the health effects of air pollutants on the human health.

3. RESULTS AND DISCUSSION

3.1. Particulates Matters ($PM_{2.5}$)

Monitoring of $PM_{2.5}$ were carried out in tow monitoring campaigns, firstly at a distance of 30, 500, 1000 m and secondly on 20, 40, 60, 80,100 m distance . The levels of $PM_{2.5}$ around power plant in the 1st, 2nd and 3rd day of the monitoring shows in Fig.)2). In first day, the concentration at 30 m from power plant was 51 mg/m3, the concentration of particle matter at 500 m from the power plant was 62 μg/m3, while the concentration at 1000 m was 79 μg/m3 with an increase of 28 μg/m3 on concentration of particulate matter at 30 m from the power plant.

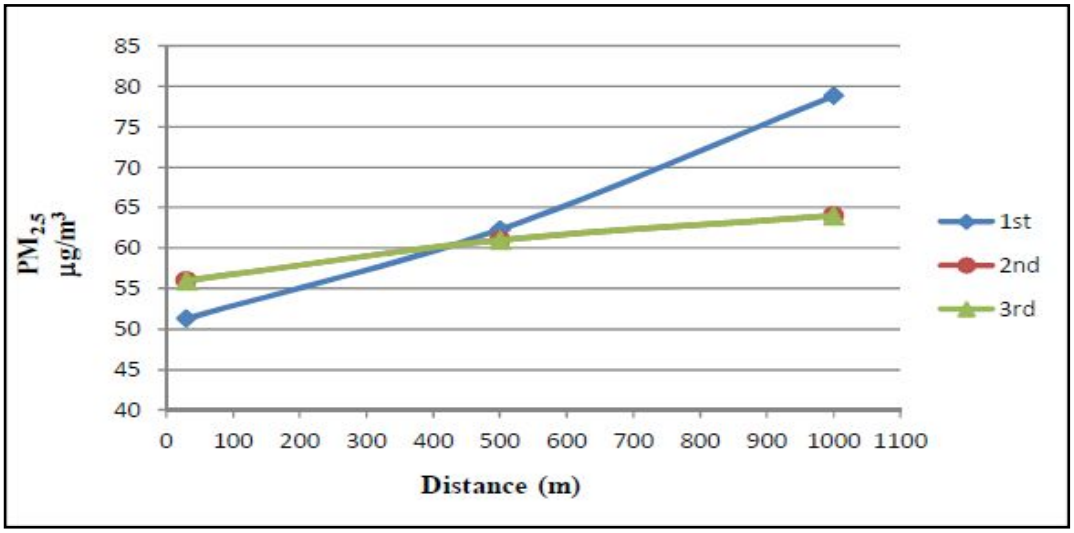

Fig. (2), Particle Matter levels around power plant (1st, 2nd, 3rd day)

The levels of particulate matter around power plant in the 2nd day of the monitoring at 30 m from the power plant was 56 µg/m³, the concentration of particle matter at 500 m from the power plant was 61 µg/m³, while the concentration at 1000 m was 64 µg/m³ with an increase of 8 µg/m³ on concentration of $PM_{2.5}$ at 30 m from power plant, there is a slight rise in the concentration, may be due to unstable weather conditions and wind movement, where the wind velocity was 2.5 m/s, temperature was 34 C , and humidity was 60%.

According to the same figure (3), the levels of particulate matter around the power plant in the 3rd day of the monitoring at 30 m from power plant was 56 µg/m³, the concentration of $PM_{2.5}$ at 500 m from the power plant was 61 µg/m³, while the level at 1000 m was 64 µg/m³. The 2nd and 3rd monitoring day have the same weather and wind conditions, therefore, the results appeared almost similar.

The concentration of $PM_{2.5}$ around power plant in the 4th and 5th monitoring day during night shown in Fig. (3). In the 4th day, the measurement was at the night and the concentration at 20 m was 50 µg/m³, the concentration at 40 m was 52 µg/m³, the concentration at 60 m was 49 µg/m³, and at 80 m was 50 µg/m³, while the concentration at 100 m was 51 µg/m³. The figure shows a slight decrease in the concentration of particulate matter as we move away from the power plant where temperature was 28 C, humidity was 49%, and wind speed was 1 m/s down to zero at the end of the measurements.

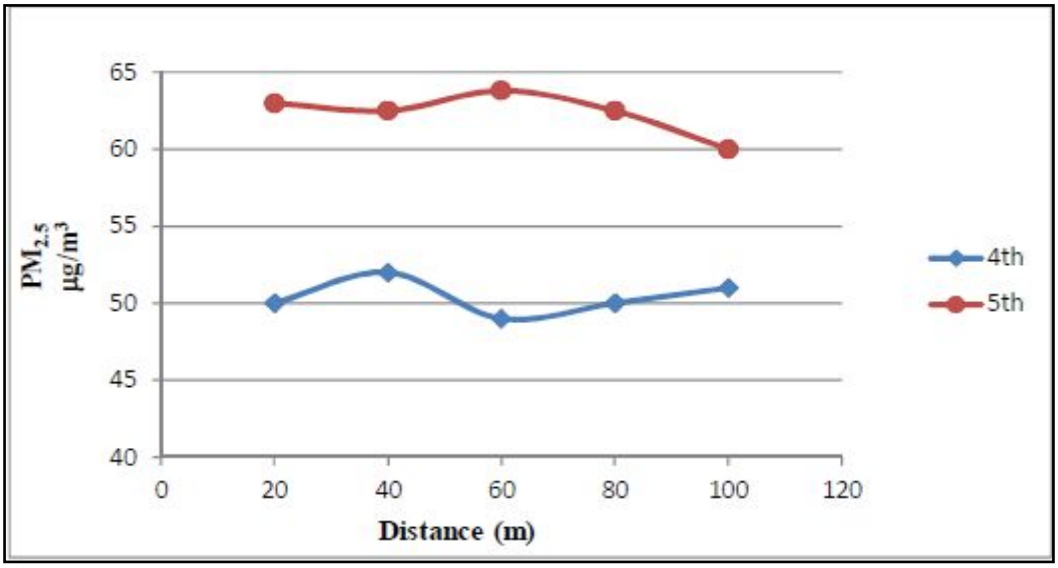

Fig. (3). Particle Matter levels around power plant (4th and 5th day)

In the 5th monitoring day, the concentration at 20 m was 63 µg/m³, the concentration at 40 m was 62.5 µg/m³, and then the concentration increased to 63.8 µg/m³ at 60 m, and at 80 m was 62.5 µg/m³, while the concentration at 100 m was 60 µg/m³. The figure shows a decrease in the concentration of particulate matter as we move away from the power plant, where temperature was 30c, humidity was 51%, and wind speed was ranging from 1 m/s to 3 m/s.

3.2. Carbon Dioxide (CO_2)

Monitoring of CO_2 were carried out on tow campaigns, firstly at a distance of 20, 40, 60, 80, 100 m and secondly on 20, 40, 60, …., 300 m. The levels of CO_2 around the power plant in the 1st day during night, 2nd , 3rd and 4th monitoring day shows in Fig.(4). In the 1st day, the concentration at 20 m was 262 ppm, then it is increased to 307 ppm at 40 m and increased to 308 ppm at 60 m from power plant, then the concentration increased at 80 m to 310 ppm, the concentration at 100 was decreased to 307 ppm. The figure (4) shows an increase in the concentration of CO_2 as we move away from the power plant, where temperature was 28 C, humidity was 49%, and wind speed was 1m/s then decline to zero during measurement.

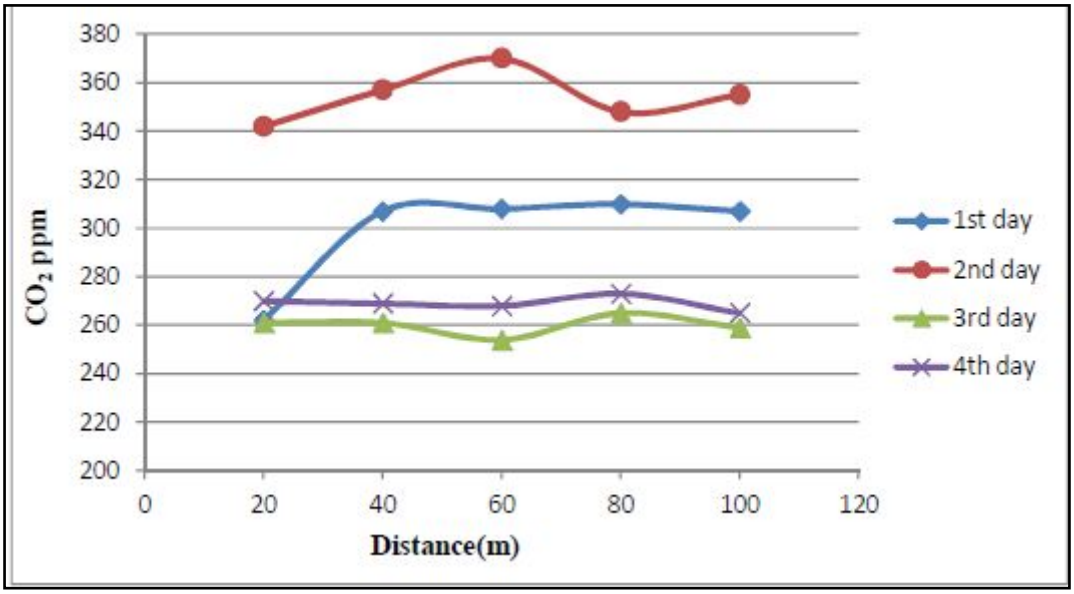

Fig.(4). CO_2 levels around power plant (1st , 2nd , 3rd , 4th day)

According to the same Fig (4), the levels of carbon dioxide CO_2 around the power plant in the 2nd monitoring day at 20 m was 342 ppm, and then it is increased to 357 ppm at 40 m. While it was 370 ppm at 60 m from power plant, then the concentration was decreased at 80 m to 348 ppm, the concentration at 100 was back to increase to 355 ppm. The Fig (4) shows an increase in the concentration of carbon dioxide CO_2 as we move away from the power plant where the temperature was 30 C, humidity was 51%, and wind speed was ranging from 1 m/s to 3 m/s during measurement.

The level of CO_2 around the power plant in the 3rd monitoring day at 20 and 40 m was 261 ppm and then it was increased to 254 ppm at 60 m, while it was 265 ppm at 80 m from power plant, then the concentration was back to decreased at 100 m to 259 ppm. The figure shows a slight decrease in the concentration of carbon dioxide CO_2 as we move away from the power plant where temperature was 29 C, humidity was 50%, and wind speed, was 1 m/s.

The levels of CO_2 around the power plant in the 4th monitoring day at 20 m was 270 ppm, at 40 m it was 269 ppm, it was decreased to 268 ppm at 60 m then increased to 273 ppm at 80 m from power plant. The concentration was back to decreased to 265 ppm at 100 m. The figure shows a decrease in the concentration of CO_2 as we move away from the power plant where temperature was 30 C, humidity was 60% and wind speed was 3 m/s.

3.3. Health Assessment

The measured level of $PM_{2.5}$ in all the monitored sites which range between 49-79 μg/m3 exceeded the World Health Organization (WHO) standards which is 25 $\mu g/m^3$ and according to literature , the acceptable level of CO_2 must be less than 350 ppm while the level of CO_2 around power plant oscillated from 254 ppm to 514 ppm,

Health assessment survey results show that 83.7% from the sample around power plant know

that air pollution on their public health and just 16.3% from the sample do not think that and this indicates on the awareness of citizens about health risks resulting from the power plant.

Moreover, 65.4% from the sample are feel difference between the quality of the air inside and outside the house, but 34.6% from the sample are not feel difference between the quality of the air inside and outside the house. Table 4.22 shows that 73.5% from the participant who feel difference between indoor and outdoor air quality agree that the better quality is " Indoor" , and 26.5% from the sample agree that the better quality "Outdoor". This means that residents feel air pollution in the region.

The assessment results show that 40.4% from the sample are visited the hospital because of a disease that infect the respiratory tract. Many researchers support this finding (Salnikov and Karatayev et al, 2011; Tramuto et al, 2011; Carbonell et al, 2007). The results in table 1, show that 81.7% from the sample are suffered from colds and flu, 63.4% feel with insomnia and lack of sleep. (Basrur, 2000 and Suter, 1991) obtained similar results. 56.8% from the sample feeling a burning sensation in the eyes, while 57.7% suffered from excessive nervousness, (Atmaca et al, 2005) support this finding.

Table ((1.The percent of sample suffer from diseases.

Items	Yes %	Sometime %	No %
Suffer from colds and flu	39.4	42.3	18.3
feel with insomnia and lack of sleep	31.7	31.7	36.5
feeling a burning sensation in the eyes	38.5	18.3	45.2
suffer from excessive nervousness	30.8	26.9	42.3
feeling short of breath and rapid breathing	19.2	33.7	47.7
feeling pain in the nose and difficulty in breathing	29.4	20.6	50.0
feeling bronchial infection	10.6	25.0	62.5
The birth of a child and weighed less than normal	12.2	2.4	85.4

52.9% from the sample feeling short of breath and rapid breathing and 50 % feeling pain in the nose and difficulty in breathing. 35.6% from the sample feeling bronchial infection, (Carbonell et al, 2007) obtained similar results. 14.6% from the sample had influence on the occurrence of low birth weight (Stankovic et al, 2011 and Morello-Frosch et al, 2010) support this finding.

4. CONCLUSION

Air pollutants emitted from power plant are considered a large hazardous to public health in the long term. The concentration of particulate matter $PM_{2.5}$ around power plant (49 to 79 $\mu g/m^3$) was higher than WHO air quality standards. The concentration of carbon dioxide CO_2 around plant (300 to 500 ppm) was high. The West and the south of the power plant had the

highest level because of the other pollution sources.

The public health questionnaire showed that 22% from the sample evaluate the quality of the atmosphere around power plant were that bad and 83.7% from the sample said that air pollution significantly affect the health. This means that the level of awareness among resident was good. 40% of population sample visited the hospital because of a disease that infects the respiratory tract.

Its recommended that a periodic maintenance for the power plant to be carried out and installing of modern control technology to reduce the emission of pollutants. Establishing of a continuous monitoring program of pollutants emitted from the power plant and modeling of data to serve the public and researchers. Furthermore, increase the public awareness about the risks of air pollutants on health and environment.

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