Islamic University-Gaza
Deanship of Graduate studies
Environmental Sciences
Master program
Environmental Health

الجامعة الإسلامية – غزة
عمادة الدراسات العليا
برنامج ماجستير العلوم البيئية
الصحة البيئية

Monitoring of Air Pollutants Emitted from Gaza Electricity Generation Plant

مراقبة ملوثات الهواء المنبعثة من محطة توليد كهرباء مدينة غزة

Prepared by

Mosab Majed Matar

Supervised by

Dr. Wesam A. Al Madhoun **Dr. Zeyad H. Abu Heen**

Assistant Professor, Islamic University of Gaza

Department of Environment &Earth sciences

A thesis submitted in partial fulfillment of the requirements for the degree of

Master of Environmental Sciences

The Islamic University- Gaza- Palestine

January, 2014

بسم الله الرحمن الرحيم

الاستـهلال

(قُل إنَّ صَلاتِي ونُسُكِي ومَحيايَ ومَمَاتِي لله رَبِّ العَالمينَ)

(الأنعام:162)

Acknowledgment

Prophet Mohammad says " who is thankless to people is thankless to Allah"

In the name of Allah, The most Gracious, the most merciful.

All praise to Allah, the one to whom all dignity, honor and glory are due, the Unique with the perfect attributes, who begets not, nor is He begotten. He has no equal but He is the Almighty Omnipotent. Peace and blessing of Allah be upon the prophet Mohammad and all his followers and family.

It was all to Allah who lead me to search in this topic, and so I exerted a hug effort to get the success by Allah.

My gratitude is deeply paid to my university of Gaza, the Islamic university, and the department of Environmental and Earth Science. Never forgetting everyone who helped me in my study especially Dr. Zeyad Hassan Abu Heen And Dr. Wessam Ibrahim Al Madhoun who supervised my research. I would not forget Dr. Yousef Al Jaish and Dr. Ashraf Al Gedi for their help, supervising and advice in the study questionnaire.

My special thanks and appreciations are due to my teachers Mr. Allaa El Den Al jubb and Raafat Murtajh in facilitating and providing the needed measurement equipment for the study.

All my thanks are to my friends Jawad Abo Selmiah ,Samer Abo Rowidah , Ihab abo Shawish and Husain Ahmad for their support in doing the measurements and distributing the questionnaire of the study.

My appreciation and respect must go to my dear parents, brothers and sisters whose prayers guided, helped and supported me to carry out this work.

Finally, I only ask Allah to bless their work and save everyone giving them the utmost rewards I wish one day return their kindness.

All thanks to Allah, the Almighty and the able to make everything.

Dedication

To my father … whom I ask Allah to prolong his life and keep healthy

To my dear mother..whom I ask Allah to give her the quality of a good life

To my brothers and friends … they were good help in my study

To the honest in my people who defend their land against the brutal occupation

To Palestine, from the sea to the river waiting her salvation from the occupation

Mosab M. Matar

Abstract

Power plants are considered a major air pollution source, which emit to atmosphere many air pollutants such as particulate matter, carbon monoxide (CO), sulfur oxide, and nitrogen oxide. The aim of study is focusing on monitoring the air pollutants ($PM_{2.5}$, CO, CO_2), noise level, and health effects of air pollution on residents around power plant in Gaza City-Palestine.

Gaza power plant site was monitored for four months during summer and winter seasons of 2012 by using air pollutant devices; 3-Channel handheld laser particle counter and Kanomax meter. A public health questionnaire was also distributed on residents around power plant to assess the impact of air pollution on their health status.

The results showed that the concentration of particulate matter exceeded on WHO standard and the highest level was 79 $\mu g/m^3$ and lowest level was 49$\mu g/m^3$, while the concentration of carbon monoxide was less than WHO standards and the highest level was 2.18 ppm and lowest level was 0.1 ppm. The concentration of carbon dioxide oscillated from 254ppm to 514ppm.
The public health questionnaire showed that 40% from population visited the hospital because of a disease that infect the respiratory tract. Other people suffered from a burning sensation in the eyes, short of breathing and rapid breathing, and feeling bronchial infection.

The study concluded that the concentration of particulate matter and carbon dioxide were high, while the level of carbon monoxide and noise were low. The level of public awareness was good.

The study recommended that periodic maintenance for power plant must be carried out and uses modern technology techniques to reduce the emission of air pollutants. The provision of modern devices to monitor air pollutants and train technical staff to carry out the monitoring process. Establishing a continuous monitoring program of pollutants

emitted from plant, this program includes monitoring the health status of the population around the plant and the extent of affected by emitted pollutants and respondent by medical care and proper education. Sampling power plant stacks to be tested and find out their components and increase the public awareness about the risks of air pollutants on health and environment, finally provide financial support for scientific research in the air pollution field.

المستخلص

تعتبر محطات توليد الكهرباء من أكبر مصادر تلوث الهواء، حيث ينبعث منها العديد من الملوثات الهوائية مثل الجزيئات الدقيقة، أول أكسيد الكربون، وأكاسيد الكبريت، وأكاسيد النيتروجين. هدف هذه الدراسة هو التركيز على مراقبة الملوثات الهوائية (الجزيئات الدقيقة، أول أكسيد الكربون، ثاني أكسيد الكربون)، ومستويات الضوضاء، والتأثيرات الصحية للملوثات الهوائية على السكان حول محطة توليد الطاقة في مدينة غزة– فلسطين.

تمت مراقبة موقع محطة توليد كهرباء غزة لمدة أربعة شهور خلال فصلي الصيف والشتاء لعام 2012 وذلك باستخدام أجهزة قياس تلوث الهواء. تم توزيع استبانة تقييم الوضع الصحي على السكان المقيمين حول محطة الطاقة لتقييم أثر تلوث الهواء على الحالة الصحية لهم.

أثبتت نتائج الدراسة أن تركيز الجزيئات الدقيقة أعلى من الحد المسموح به حسب منظمة الصحة العالمية حيث وصل أعلى معدل للجزيئات الدقيقة الى 79 ميكروجرام/م3، وأقل معدل بلغ 49 ميكروجرام/م3، بينما تركيز أول أكسيد الكربون كان أقل من الحد المسموح به حسب منظمة الصحة العالمية حيث وصل أعلى معدل الى 2.18 جزء من المليون، وبلغ أقل معدل 0.1 جزء من المليون. وتراوح تركيز ثاني أكسيد الكربون ما بين 254 جزء من المليون الى 514 جزء من المليون.

بينت نتائج الاستبانة التي تم توزيعها في منطقة الدراسة أن 40% من مجتمع الدراسة قد دخلوا الى المستشفى بسبب أمراض تصيب الجهاز التنفسي. الجزء الأخر من العينة يعاني من حرقان في العيون، ونقص في التنفس وسرعة التنفس، والشعور بالتهابات الشعب الهوائية.

وخلصت الدراسة الى أن تركيز الجزيئات الدقيقة وثاني أكسيد الكربون موجود بنسب كبيرة، بينما تركيز أول أكسيد الكربون ومستوى الضوضاء موجود بنسب قليلة. وقد تبين أن مستوى الوعي لدى السكان جيد.

وأوصت الدراسة بوجوب اجراء صيانة دورية للمحطة، واستخدام تكنولوجيا التقنيات الحديثة لتقليل انبعاث الملوثات الهوائية. كذلك توفير أجهزة قياس الملوثات الهوائية الحديثة، وتدريب طاقم فني لاجراء عمليات المراقبة اللازمة، وتأسيس برنامج مراقبة مستمر للملوثات المنبعثة من المحطة، ويتضمن هذا البرنامج مراقبة الحالة

الصحية للسكان المحيطين بالمحطة ومدى تأثرهم بالملوثات المنبعثة عنها وشملهم برعاية طبية وتثقيفيـــة مناســـبة. وكذلك أخذ عينات من مداخن المحطة لمعرفة مكونات الأدخنة، وأيضا زيادة الوعي لدى السكان بالأخطـــار التـــي تسببها الملوثات الهوائية على صحة الانسان والبيئة، وأخيرا أوصت الدراسة بتقديم الدعم المالي للبحث العلمي فـــي مجال التلوث الهوائي.

LIST OF CONTENT

Acknowledgment II
Dedication III
Abstract IV
Abstract(Arabic) VI
List of Tables X
List of Figures XI
Acronyms and Abbreviations XIV
CHAPTER (1) 1
INTRODUCTION 1
1.1 General Overview 1
1.2 Study Purpose 4
1.3 Resarch Objectives 4
1.4 Research Problem 4
1.5 Research Outline 5
CHAPTER (2) 7
LITRETURE REVIEW 7
2.1 Particulate matter Pollution 7
2.2 Carbon monoxide and Carbon dioxide Pollution 10
2.3 Health Impacts of Air Pollutants 14
2.3.1 Ways that particulate matter affect health 23
2.3.2 Carbon monoxide Toxicity 24
2.4 Noise Pollution and their Health Impacts 24
CHAPTER (3) 26
MATERIAL AND METHOD 26
3.1 Introduction 26
3.2 General description of study area 26
3.3 Study Site 27
3.3.1 Power plant Operation 29
3.4 Monitoring Programs 29
3.4.1 Particulate matter and Noise Monitoring 30
3.4.2 Carbon monoxide and Carbon dioxide Monitoring 32
3.4.3 Meteorological Factors 33
3.5 Questionnaire 33

3.6 data and statistical analysis 34
CHAPTER (4) 35
RESULTS AND DISCUSSION 35
4.1 Particulate matter Monitoring Results 35
4.1.1 Particulate Matter Measurement at East Power Plant 37
4.1.2 Particulate Matter Measurement at West Power Plant 39
4.1.3 Particulate Matter Measurement at North Power Plant 42
4.1.4 Particulate Matter Measurement at South Power Plant 44
4.2 Carbon dioxide and Carbon monoxide Monitoring Results 46
4.2.1 Carbon dioxide Monitoring Results 46
4.2.1.1 Carbon dioxide Measurement at East Power Plant 49
4.2.1.2 Carbon dioxide Measurement at West Power Plant 53
4.2.1.3 Carbon dioxide Measurement at North Power Plant 56
4.2.1.4 Carbon dioxide Measurement at South Power Plant 59
4.2.2 Carbon monoxide Monitoring Results 63
4.3 Noise Monitoring Results 66
4.4 Pollutants Modeling 68
4.4.1 Particulate matter ($PM_{2.5}$) emission modeling 68
4.4.2 Carbon dioxide (CO_2) emission modeling 69
4.5 Meteorological Data 71
4.6 Air Quality and Health Impact Assessment 73
4.6.1 Air Quality Evaluation 73
4.6.2 Questionnaire Data Analysis 74
4.6.2.1 Age and Sex Distribution 74
4.6.2.2 Location and Distance of Houses from Power Plant 75
4.6.2.3 Public Awareness Level of Air Pollution and Health Status 76
CHAPTER (5) 79
CONCLUSION AND RECOMMENDATIONS 79
5.1 Conclusions 79
5.2 Recommendation 80
REFERENCE 82
APPENDIX 91

LIST OF TABLES

Table No.	Title	Page No.
Table (3.1)	Population distribution in Gaza Governorates (PCBS, 2011).	27
Table(3.2)	Monitoring programs	30
Table(3.3)	answers of questions in second field of questionnaire	34
Table (4.1)	Mean values of Air Temperature, Humidity, Weather Conditions and Wind Direction during the whole monitoring	71
Table (4.2)	WHO air quality standard for PM2.5 and CO	73
Table (4.3)	Resident opinions about air quality in the study area.	74
Table (4.4)	Distribution of age and sex group in study population at study area	74
Table (4.5)	Location and distance of study population at study area	75
Table (4.6)	Population percentage live in another place before current place	75
Table (4.7)	Population percentage feels a change in air quality	76
Table (4.8)	Population percentage has awareness of impact of air pollution on health.	76
Table (4.9)	Population feels difference between indoor & outdoor.	76
Table(4.10)	Population percentage for better air quality	77
Table(4.11)	Population percentage suffer from lack of hearing	77
Table (4.12)	Hospital admission	77
Table(4.13)	The percent of sample suffer from diseases.	78

LIST OF FIGURES

Figure No.	Title	Page No.
Fig (2.1):	Power plant stacks	7
Fig (2.2):	Global monthly mean CO_2	11
Fig (2.3):	illustrate carbon monoxide toxicity	24
Fig(3.1):	Gaza Governorate map	26
Fig(3.2):	Gaza power plant location from Google Earth.	28
Fig (3.3):	Gaza power plant.	28
Fig (3.4):	Power plant processes	29
Fig (3.5):	3-Channel Handheld Laser Particle Counter.	31
Fig (3.6):	Researcher during pollutants and noise monitoring.	31
Fig (3.7):	Sound level meter instrument.	32
Fig(3.8):	Kanomax meter	32
Fig(3.9):	Air pollutants emitted from power plants stacks.	33
Fig (4.1):	Particle Matter levels around power plant (1^{st}, 2nd, 3^{rd} day)	36
Fig (4.2):	Particle Matter levels around power plant (4^{th}, 5^{th} day)	37
Fig (4.3):	Particle Matter at east of plant (1^{st}, 2nd, 3rd day)	38
Fig (4.4):	Particle Matter at east of plant (4^{th}, 5^{th} day)	39
Fig (4.5):	Particle Matter at west of plant (1^{st}, 2nd, 3rd day)	40
Fig (4.6):	Particle Matter at west of plant (4^{th}, 5^{th} day)	41
Fig (4.7):	Particle Matter at north of plant (1^{st}, 2nd, 3rd day)	42
Fig (4.8):	Particle Matter at north of plant (4^{th}, 5^{th} day)	43
Fig (4.9):	Particle Matter at south of plant (1^{st}, 2nd, 3rd day)	44
Fig (4.10):	Particle Matter at south of plant (4^{th}, 5^{th} day)	45
Fig (4.11):	Carbon Dioxide levels around power plant (1^{st}, 2^{nd}, 3^{rd}, 4^{th} day)	47
Fig (4.12):	Carbon Dioxide levels around power plant (5^{th}, 6th, 7^{th}, 8^{th}, 9^{th} day)	49
Fig (4.13):	Carbon Dioxide at east of plant (1^{st}, 2^{nd}, 3^{rd}, 4^{th} day)	51
Fig (4.14):	Carbon Dioxide at east of plant (5^{th}, 6^{th}, 7^{th}, 8^{th}, 9^{th} day)	52
Fig (4.15):	Carbon Dioxide at west of plant (1^{st}, 2^{nd}, 3^{rd}, 4^{th} day)	54

Fig (4.16):	Carbon Dioxide at west of plant (5^{th}, 6^{th}, 7^{th}, 8^{th}, 9^{th} day)	56
Fig (4.17):	Carbon Dioxide at north of plant (1^{st}, 2^{nd}, 3^{rd}, 4^{th} day)	57
Fig (4.18):	Carbon Dioxide at north of plant (5^{th}, 6^{th}, 7^{th}, 8^{th}, 9^{th} day)	59
Fig (4.19):	Carbon Dioxide at south of plant (1^{st}, 2^{nd}, 3^{rd}, 4^{th} day)	61
Fig(4.20):	Carbon Dioxide at south of plant (5^{th}, 6^{th}, 7^{th}, 8^{th}, 9^{th} day)	62
Fig (4.21):	Carbon monoxide level around power plant (1^{st}, 2^{nd}, 3^{rd}, 4^{th} day)	64
Fig (4.22):	Carbon monoxide level around power plant (5^{th}, 6^{th}, 7^{th}, 8^{th},	66
Fig (4.23):	Noise level around power plant (1^{st}, 2^{nd}, 3^{rd}, 4^{th}, 5^{th} day)	68
Fig (4.24):	Particle Matter ($PM_{2.5}$) emission model	69
Fig (4.25):	Carbon dioxide (CO_2) emission model	70
Fig (4.26):	Measured and predicted particulate matter	70
Fig (4.27):	Temperature and humidity during monitoring	72

ACRONYMS AND ABBREVIATIONS

ADHS	Arizona Department of Health Services
CAA	Childhood Asthma Admissions
Carbon Sat	Carbon Monitoring Satellite
COHb	Carboxyhemoglpbin
COPD	Chronic Obstructive Pulmonary Disease
CVD	Cerebro Vascular Diseases
dB	Noise Unit
ED	Emergency Department
EHVs	Emergency Hospital Visits
ERF	Exposure- Response Function
EPA	Environmental Protection Agency
FBC	Fluidized Bed Combustor Unit
GAM	Generalized Additive Model
GIS	Geographical Information System
GPP	Gaza Power Plant
GWh	Giga Watt
IF	Intake Fraction
Kt	Kilotonne
LBW	Low Birth Weight
Mg	Mega gram
MI	Myocardial Infarction
NCEP-NARR	Wind Vector Model
NOAA	National Oceanic and Atmospheric Administration
PEF	Peak Expiratory Flow
PM	Particulate Matter
PM10	Particulate Matter with diameter 10mm
PM2.5	Particulate Matter with diameter 2.5mm
Tg	Tera gram
QA	Quality Assurance
QC	Quality Control
STG	Steam Turbine Gas
SVE	Supra Ventricular Ectopy
VE	Ventricular Ectopy
WHO	World Health Organization
YRD	Yangtze River Delta
P.A.R.C	Palestinian Agricultural Relief Committees

CHAPTER (1)

INTRODUCTION

1.1 GENERAL OVERVIEW

Power plants are important source of energy in our life. It provides us with necessary electricity. Worldwide, there is an increased demand on power plants to obtain the energy that they need. Power plants use fossil fuels such as oil, coal, and gas for operation and they contribute to the emission of a significant pollutants such as CO_2, CO ,PM, NOx and SO_2 which affect the ambient air quality . Consequently, it leads to negative health impacts on the public.

According to U.S. Environmental Protection Agency (EPA) data, the power sector is responsible for ~67% of national SO_2 emissions and 28% of national NOx emissions, of which pre-1980 coal-fired power plants are responsible for 97 and 85%, respectively(Levy and Spengler, 2002). Electricity generators released 2.423 billion tons of carbon dioxide (CO_2) in 2010, compared to 2.295 billion tons in 2009, according to information available on EPA's "Clean Air Markets" database (The Environmental Integrity Project, 2011).

The combustion process leads to generation of emission to air, water and soil of which emissions to the atmosphere are considered to be one of the main environment concern and the most important emissions to air from the combustion of fossil fuels are SO_2, NOx, PM and greenhouse gases such as CO_2 (Syla et. al., 2008).

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).

Fossil fuels are abundantly available; burning these fuels presents many environmental problems. Three major concerns arise from the fossil fuel combustion: the release of sulfur dioxide, the formation and release of nitrogen oxides, and the release of particulate matter (ash). Although not considered a pollutant due to its natural presence in the environment, carbon dioxide is a growing concern as it relates to the global warming. Carbon dioxide is the preferred product of the combustion, with its formation resulting in much of the energy released in the burning process. (Rozpondek and Siudek, 2009).

Anthropogenic sources of air pollution involve combustion of fossil fuels (thermoelectric power plants, motor vehicles, communal and household heating installations). 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).

Power is one of the most important components of our modern technological society. Power generation from fossil fuels is a process of combustion of fuels that produces air pollutants, mainly, particulate matter (PM), SO_2 and NOx. Degradation of surrounding ambient air quality would be significant at times, if adequate measures are not being taken prior to commissioning of the plant. (Bandyopadhyay, 2010).

Emissions of CO and CO_2 are considered to be the main cause of global warming, melting of glaciers, heavy rain fall in some areas resulting in catastrophic floods and severe draughts in others (Bhinder et al, 2011).

Climate change is the greatest environmental challenge facing the world today. Power stations play a major role in 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 has produced about three-quarters of the increase in CO_2 from human activity over the past 20 years. (Senthil et al, 2010).

Emissions from coal-fired power plants until 1970, including roughly 1/3 of total anthropogenic CO_2 emissions and they have substantial impacts on both air quality and climate change. Large amounts of CO_2 are emitted, which lead to warming of the Earth and 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).

According to the previous studies, power plant release to the atmosphere a large amount of particulate matter both PM_{10} and $PM_{2.5}$ that cause decrease feasibility and other health impacts. In a study of six U.S. cities, demonstrated that daily mortality was associated with fine particulate matter (aerodynamic diameter $\leq$ 2.5 µm; $PM_{2.5}$) and not coarse particulate matter (aerodynamic diameter between 2.5 and 10 µm $PM_{2.5-10}$). (Laden et al, 2000).

Fossil-fueled power plants contribute approximately 25% of the anthropogenic particulate matter emitted to the atmosphere in the United States. Assessment of the carcinogenic hazard associated with airborne particulate material such as fly ash is very much more difficult than is the case for a gaseous pollutant. This is because particles contain a large number of potentially carcinogenic chemical species including both organic and inorganic compounds. (Natusch, 1978).

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. . (Environment Maryland Research & Policy Center, 2007).

Fine particles can remain suspended in the air for weeks and can penetrate to the deepest part of the lung, where they are attacked and absorbed by immune cells. The chemicals delivered into the body by inhaled particulates are very dangerous. Some of them cause cancer, some irritate lung tissues, and some change how the heart functions. Particulate pollution can cause irreversible damage to children and also can be deadly. (Environment Maryland Research & Policy Center, 2007).

In Gaza Strip there is one power plant provide Gaza with the required electricity. Oil is used as a fuel for its operation. It is released to atmosphere high amount of pollutants. Gaza power plant (GPP) is located in the southern part of Gaza City, the middle governorate of Gaza Strip. It provides electricity to 1.7 million people, Gaza power plant needs 15 million liters of fuel per month and this amount is capable of releasing large amounts of pollutants into the atmosphere which should be monitored.

1.2 STUDY PURPOSE

This study focuses on monitoring of air pollutants emitted from Gaza electricity generation plant to evaluate the air quality and clarify the health impacts on residents of study area.

1.3 RESARCH OBJECTIVES

The main objectives of this study are:

- To investigate the levels of PM, CO_2, CO and noise at different distance from the power plant.
- To measure the health effects of air pollutants and noise on the residents.
- To propose measures that may help to mitigate the negative impacts.

1.4 RESEARCH PROBLEM

According to the previous studies, it was found that the power plants are the most important sources of pollution where released into the atmosphere large quantities of pollutants such as carbon monoxide, carbon dioxide and particulate matter, which must have a system of monitoring and follow-up to predict the behavior of these pollutants and mitigation of health and environmental impacts.

In Gaza strip, there is lack of studies and research in this field, while it's important to find out the real dimension of this issue in the Gaza Strip.

Because of political and economic conditions in the Gaza Strip, that was reflected in a large and negative impact on the performance of the Gaza power plant, which suffers from many problems such as lack of equipment and lack of maintenance and poor quality of fuel used in the operation, leading to low efficiency of the process, which in turn lead to increase the amount of emissions of air pollutants that are harmful to humans and the environment.

Therefore, the study tries to find out the answer of the following questions:

1. What is the level of particulate matter around the site?
2. What is the level of CO_2 and CO around the site?
3. What is the level of noise around the site?
4. Are the Pollutants ($PM_{2.5,}$ CO, CO_2) Level fall within the standards limits?
5. What are the health impacts that caused by the pollutants ($PM_{2.5,}$ CO, CO_2)?

1.5 RESEARCH OUTLINE

The first chapter of the research included identifying and defining the problems and establishment objective of the study and development research plan. The second chapter of the research included a summary of the comprehensive literature review. The third chapter of the research included the methodology and field survey and questionnaire was used to collect the required data in order to achieve the research objective. The fourth chapter of the research presented main findings and their discussion. The fifth chapter of the research presented the conclusions and recommendation for this study.

A list of used references, collected data, and questionnaire are attached at the end of this thesis. Appendix I, Appendix II, Appendix III.

CHAPTER (2)

LITERATURE REVIEW

This chapter presents some of literature review for this research, which divided into fourth major sections. The first is dealing with literature review of particulate matter, the second is dealing with literature review of carbon monoxide and carbon dioxide, the third with literature review of the health effects of their pollutants, the fourth with literature review of noise.

2.1 Particulate matter Pollution

Particulate matter (PM) is one of the most common air pollution entities and has significant impacts on the environment and health human.

Particulate matter refers to a complex mixture of solid particles and liquid droplets found in ambient air. Particles include inhalable coarse, fine and ultra fine particles. Coarse particles have an aerodynamic diameter larger than 2.5micrometer ($PM_{2.5}$) and smaller than 10micrometer (PM_{10}). Fine particles have an aerodynamic diameter less than 2.5micrometer, and ultrafine particles are less than 100 nm in diameter. (Win Lee, 2010)

Figure(2.1): Power plant stacks

Source: scientificamerican.com

Huang et al, (2011) developed an emission inventory for major anthropogenic air pollutants in the Yangtze River Delta (YRD) region. Large amount of activity data on sources and emission factors of pollutants and GIS technology were used to allocate the emissions based on the geographical information. The results show that the emissions of CO, PM_{10} and $PM_{2.5}$ are 6697.1 kt, 3115.7 kt and 1510.8 kt respectively and the industrial sources including power plant contribute about 89% of PM_{10}, 91% of $PM_{2.5}$, 97% SO_2 and 86%NOx.

Tahirsylaj and Latifi, (2010) carried out a study in Pristina city in Kosovo. They investigated suspended particulate matter come from power plants and measures meteorological parameters to see how affecting the distribution of pollution and they use automatic measurement were recorded in each 5 minutes and found increase in concentration of particulate matter of each station especially in winter seasons.

Aziz et al, (2010) studied the environmental and health effects of power plant at Khanote in Pakistan. Samples of ash from fluidized bed combustor unit (FBC) were collected to study the formation of ash and sulfur and they found that the generation rate of fly and bottom ash was 55680 m^3/hr and 16550 m^3/hr respectively and these a huge amount of ash causes environmental and health effects.

It was reported in the study of Tainio et al, (2009) in Finland that the intake fraction(if) of primary $PM_{2.5}$from power plant emission are 0.50per million. They used dataset contains the European-wide anthropogenic air pollution emission for different European countries, the Finnish anthropogenic emission, atmospheric dispersion modeling, population data and intake fraction calculation.

Zhao et al, (2008) explore the atmospheric emission of coal fired power sector in China, a unit-based method was developed based of unit type, fuel quality, emission control technology and geographical location. The results shown that the emissions from 2000 to 2005 of SO_2 and PM (PM_{10}, $PM_{2.5}$) increased by 1.5 times for $SO_2$and was estimated to be 16097Kt, approximately 53% of national emissions and 1.2 times for PM and was estimated to be 2848Kt divided to 1842Kt for PM_{10} and 994Kt for $PM_{2.5}$, approximately less than 10% of total national emission.

Yi et. al, (2008) investigate the fine particles and trace elements emitted from coal power plant before and after the bag- house. Sampling positions are located at both the inlet and the outlet of bag- house. The results shown that emission factors of PM_{10} and $PM_{2.5}$ before bag- house are 50 and 5 Kg/tcoal respectively, and emission factors after bag-house are 0.12 and 0.015 Kg/tcoal.

A study was carried out in Poland to make emission reduction from power industry; they applied a various methods of emission reduction for 10 years. The results have shown that in 1995 So_2 emission equaled to 1,221,992 Mg and particulate emission equaled 193,660 Mg. In 2005, SO_2 emission was lessened to 679,849 Mg and particulate emission came to 39,588 Mg. (Bochenczyk and Mokrzycki, 2007)

In a study that taken in China, Hao et.al,(2006) applied the CALMET/CALPUFF modeling system to estimate the air quality impacts of power plants in 2000 and 2008 in Beijing and intake fractions (IF) were calculated to see the public health risks. The results shown that a high emission of pollutants and a significant impacts on the urban area 9.52 $\mu g/m^3$ SO_2 and 5.29 $\mu g/m^3$ NOx and the intake fractions of SO_2, NOx, and PM_{10} are $7.4*10^{-6}$, $7.4*10^{-6}$, and $8.7*10^{-5}$ respectively.

Goodarzi, (2006) carried out a study in Alberta, Canada. He investigated the particles emitted from three coal- fired power plants. The sampling was carried out and three tests were performed at each station. The results shown that the rates of total emitted particulates from the three power plants are 9.9-53.4 mg/m3 and the emission rates of particle sizes are 8.7-39.5 Kg/hr of PM>10, 10.7-40.8 Kg/hr of PM_{10}, and 9.65-10.7 Kg/hr of $PM_{2.5}$.

Zhou et al, (2006) studied and selected 29 power plant sites throughout China and estimated annual average intake fractions at each site and they developed regression models to interpret the intake fraction value and used CALPUFF model. The results shown that the primary fine particles have the highest average intake fraction $1*10^{-5}$ followed by sulfur dioxide $5*10^{-6}$ and they find that the near- source population is more important for primary coarse particles while population at medium to long distance is more important for primary fine particles and a significance portion of intake fraction occurs beyond 500Km of the source.

Levy et al, (2002) applied the CALPUFF atmospheric dispersion model with meteorological data derived from NOAA,s Rapid Update Cycle model to a set of nine power plants in Illinois to evaluate primary and secondary particulate matter impacts and they found that the impact are moderately insensitive and the annual average concentration of primary fine particulate matter ($PM_{2.5}$) is 0.04 $\mu g/m^3$ with maximum impacts of 0.3 $\mu g/m^3$.

2.2 Carbon monoxide and Carbon dioxide Pollution

Carbon monoxide (CO) is a colorless, odorless, and tasteless gas that is slightly lighter than air. It is toxic to humans and animals when encountered in higher concentrations. Carbon monoxide is produced from the partial oxidation of carbon-containing compounds; it forms when there is not enough oxygen to produce carbon dioxide (CO_2), such as when operating an internal combustion engine in an enclosed space. (http://www.chm.bris.ac.uk/motm/co/coh.htm)

Carbon monoxide is a product of incomplete combustion. It is main source are combustion processes from vehicles, heating, power generation, and biomass burning. (Curtis et al, 2006)

Carbon dioxide (CO_2) is a gas at standard temperature and pressure and exists in Earth’s atmosphere in this state, as a trace gas at a concentration of 0.039 per cent by volume. Carbon dioxide is colorless. At low concentrations, the gas is odorless. At higher concentrations it has a sharp, acidic odor. At standard temperature and pressure, the density of carbon dioxide is around1.98 kg/m^3, about 1.5 times that of air. Although carbon dioxide is not often recovered, carbon dioxide results from combustion of fossil fuels and wood. (http://www.esrl.noaa.gov/gmd/ccgg/trends/#mlo)

Global warming is the greatest challenge that the world is facing today. Power plants play a major role in green house gas emission (CO_2). Nearly 21.3%of green house gases are emitted by these power plants alone. (Kumar et al, 2011)

The high proportion of carbon dioxide lead to a rise in atmospheric temperature, known as the phenomenon of global warming. Figure 2.4 shows the ongoing rise in the proportion of carbon dioxide annually.

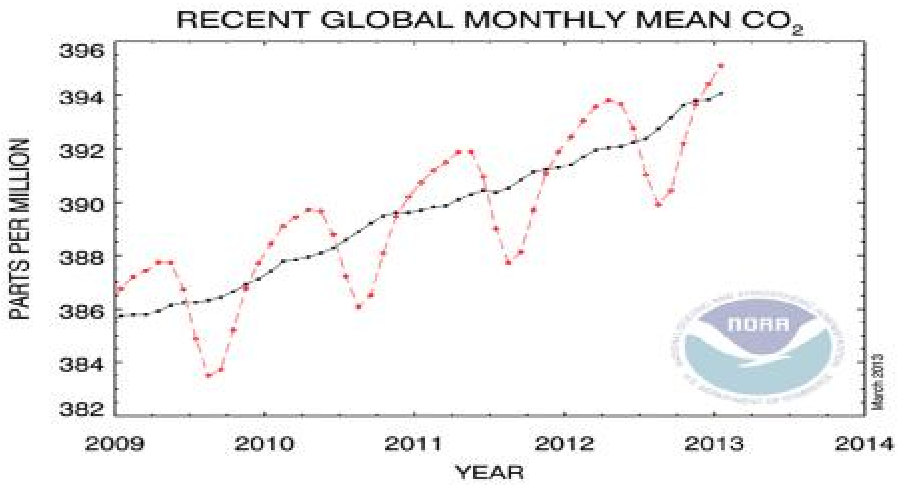

Fig (2.2): Global monthly mean CO_2

Source: National Oceanic and Atmospheric Administration, 2013

Fossil-burning power plants emits various air pollutants (chemical and radioactive effluent, dust, ash, etc) which are dispersed from a power source and transported through various path ways that could lead to the general population exposure. The main drawback with the use of fossil fuel (coal, oil, natural gas) is the emission of carbon dioxide to the atmosphere, which is difficult to control. It is estimated that carbon dioxide emissions will more than double by 2050. Results shown that the amount of CO_2 was 5 million tons produced from 1,400,000 ton crude oil within one year and 6 million tons CO_2 from 2 million ton coal. (Vujic et al, 2012)

It was reported in the study of Velazco et al, (2011) that annual emission of power plant estimates from a hypothetical Carbon Satellite and constellations of several Carbon Sat while taking into account that power plant CO_2 emissions are time independent. The researcher used Environmental Protection Agency Clean Air Market – Data and maps emissions data base, NCEP-NARR wind vectors and cloud cover model uses to correlate between wind and cloud with emission from power plant and estimation of errors and they found annual CO_2 emission from large power plants $\geq$ 5Mt CO_2/Yr with a systematic error of 4.9% or better for 50% of all power plants and 12.45 or better for 90%of all the power plants.

In a study that taken in Cyprus, Greece to reduce air pollutant emissions by using renewable energy sources show that power generation is the major contributor to total emissions with a share of 36% in carbon dioxide and 62% sulfur dioxide. According to the estimation of air pollutant emissions is based on the air pollutant emission inventory of the European Environment Agency for year 2002, the concentration of CO_2, CO, and SO_2 are 2980Kt/year, 30.77Kt/year, and 30.88Kt/year respectively. (Tsilingiridis et al, 2011)

In a study that taken in Iran to make fuel consumption an emission prediction for Iranian power plants until 2025 by using two scenarios based on fuel type and structure of power plants compared with 2009 that produced about 118 M tons CO_2 emission. The first scenario was the same type fuel and power plant structure in 2009 and the second scenario used another type of fuel (natural gas) and the same power plant structure. The results shown that in the first scenario, CO_2 emission was 2.1 times higher than those in 2009 by 2025. If second scenario was applied, CO_2 emission will be 1.6 time by 2025. While CO emission in the first scenario was 2.3 times higher than the amount in 2009 and in second scenario was 1.5 times higher. (Mazandarani et al, 2011)

A study was carried out in India to investigate and determine the net generation from thermal power stations and the total and specific CO_2 emissions for a four year period. The installed generating capacity, net generation and CO_2 emissions figures for the plants have been compared and large generators, large emitters, fuel types and also plant vintage have been identified. The results have shown that 520 million tons of CO_2 were emitted by 158 plants in 2007-2008 and the average emission of CO_2 between 2004-2005 and 2007-2008 was 487 million tons of CO_2. The net annual average generation from all 158 power stations during four years period has been 479 TWh and average specific emission of CO_2 is found to be 1.02tCO_2/MWh. (Ghosh, 2010)

A study was carried out in Iran to determine and analyze emission factor of CO_2, SO_2, and NO_x emitted from Iran's thermal power plants. Emission factors were calculated for fifty thermal power plants over the period 2007-2008 with regard to the power plants operation characteristics including generation capacity, fuel type and amount and the corresponding alterations, stack specifications. Total emission of CO_2, SO_2, and NOx were found to be 125.34, 0.552, and 0.465Tg in turn. (Nazari et al, 2010)

Bovensmann et al, (2010) used a remote sensing technique for global monitoring of power plant CO_2 emissions because the increase of CO_2 concentration around the world and they found increase percentage of CO_2 concentration every year.

In a study that taken in India to measure CO_2, CO, and SO_2 emissions from coal-based thermal power plants by using Flue Gas Analyzer to measure the emission rates of CO_2, CO, and SO_2, quality assurance (QA) and quality control (QC) techniques were adopted to gather the data to avoid any ambiguity in subsequent data interpretation, statistical parameters (standard deviation and arithmetic mean) for the measured emissions have been calculated, the emission coefficients determined for CO_2, CO, and SO_2 have been compared with their corresponding values obtained in the studies conducted by other groups. The total emissions of CO_2, CO, and SO_2 have been found to be 465.667, 1.583, and 4.058Tg. (Chakraborty et al, 2008)

Hammons, (2006) analyzed the impact of electric power generation on green house gas emission in Europe including the Asian parts of Russia. It is shown that CO_2 emissions from fuel combustion at power plants in Russia may increase 1.7-1.8 times by 2030 and 2.6-2.7 times by 2050 in comparison with 2000, the calculation shown that Asian Russia is the most unfavorable region in terms of increase in green house gas emission from power plants.

It is reported in the study of White et al, (2000) in United States of America USA that CO_2 gas emission rate from coal power plant are 974 tons of CO_2 per GWh. They calculated the CO_2 emission per KWh of net electricity produced and determined the CO_2 emission factors for materials. They showed that 98% of the CO_2 emitted during the operation of power plant.

2.3 Health Impacts of Air Pollutants

Air pollution has become one of the most visible environmental problems in the world and causes several diseases for human. According to the previous studies that remind, the air pollution contributes to the occurrence of many diseases such as respiratory diseases and increased morbidity and mortality rates and some genetic diseases.

It was reported in the study of Corea et al, (2012) in Mantua, Italy that among the 781 subjects admitted 75.7% had ischemic stroke, 11.7%haemorrhagic stroke, and 12.6% transient ischemic attack. In men, admission for stroke was associated with PM_{10}. A time series study was conducted to analyze 781 cerebrovascular diseases (CVD) consecutive patients living in Mantua County admitted between 2006-2008. Data on stroke types, demographic variables, risk factors were available from the Lombardia Stroke Registry. Daily mean value of particulate matter (PM_{10}), carbon monoxide, nitric oxide, nitrogen dioxide, sulfur dioxide, benzene, and ozone were used in the analysis. The association between CVD, ischemic strokes and pollutants was investigated by using logistic regression analysis.

In a study that taken in the United States (USA) to assess and investigate the health impacts of power plants in northern Mexico caused by air emissions from two power-exporting plants. For this objective, they used a suit of air dispersion, health impacts, and valuation models. Researchers found that these emissions have limited but nontrivial health impacts, mostly by exacerbating particulate pollution in the U.S because highly mitigation measures were applied. (Blackman et al, 2012)

A study was carried out in metropolitan phoenix, Arizona to investigate the relationship between particulate matter and asthma attacks in children. Spatially distributed PM_{10} concentration were estimated by interpolating the measured concentrations from a permanent network of five continuous monitors, the primary health data were obtained from the Arizona Department of Health Services (ADHS) for the asthma incidents reported between 1January 2004 and 31December 2006. The case-crossover statistical method was applied to determine the relationship between PM10 concentration and asthma attacks. For children ages 5-17, a significant relationship was discovered and an increase in PM_{10} is associated with a 13% increase in the probability of asthma attacks. (Dimitrova et al, 2012)

A study was carried out in Buenos Aires, Argentina to analyze the short term effects of change in temperature and atmospheric carbon monoxide on daily mortality. A time series study conducted and focused on three age groups, gender, and cardiovascular and respiratory mortality, with lags up to four days and temporal variables as modifiers. The results have shown that temperature correlates positively with total mortality for summer months and carbon monoxide correlates always positively with mortality and one day after an increase in CO of 1ppm, about 4% extra deaths can be expected. (Abrutzky et al, 2012)

Emissions of toxic pollutants such as sulfur dioxide and particulate matter are significant burdens on human health. Carbon dioxide emissions also pose risks to human health and fossil fuel power plants emit 64% of green house gases worldwide. (Turney and Fthenakis, 2011)

In a study that taken in Palermo, Italy to investigate the relationship between air pollution and emergency room admissions for respiratory symptoms, the researchers collected air pollutant concentrations and emergency room visits from January 2004 to December 2007. Risk estimates of short-term exposure to particulate matter and gaseous ambient pollutants including carbon monoxide, nitrogen dioxide, and sulfur dioxide were calculated by using a conditional logistic regression analysis. Results have shown that emergency departments provided data on 48.519 visits for respiratory symptoms and a positive association was observed in warm and cold season for PM10. (Tramuto et al, 2011)

In a study to investigate the association between ambient air pollution and daily cardiovascular and respiratory mortality were conducted in Beijing over six year period from January 2003 to December 2008, the researchers measured concentrations of PM_{10}, SO_2, and NO_2 daily during the study period, the time series studied comprises year with lower level interventions to control air pollution (2003-2006) and years with high level interventions (2007-2008), additive model was used to evaluate daily numbers of cardiovascular/respiratory deaths in relation to air pollution with temperature and relative humidity. The results have shown that the daily cardiovascular/respiratory deaths rates were significantly associated with air pollutants, especially deaths related to cardiovascular disease. (Zhang et al, 2011)

A study was carried out to determine the effect of hourly concentration of particulate matter on peak expiratory flow (PEF) in hospitalized children. Researchers was measured PEF twice daily at 7AM and 7PM from October through December, 2000 in 17 children aged 8 to 15 years hospitalized with severe asthma. Measurements were conducted immediately prior to medication under the guidance of trained nurses. The results have shown that increased 24-hour mean concentration of $PM_{2.5}$ was associated with decrease in both morning and evening PEF and hourly concentrations of $PM_{2.5}$ and PEF showed a significant association between some lags of $PM_{2.5}$ and PEF. (Yamazaki et al, 2011)

In a study that taken in Guangzhou, China to investigate the effects of air pollution on preterm births, the correlation between air pollution and preterm birth in Guangzhou city was examined by using the Generalized Additive Model (GAM) extended Poisson regression model. The meteorological data and air pollution data were obtained from the Meteorological Bureau and the Environmental Monitoring Center, while the medical records of newborns were collected from the perinatal health database of all obstetric institutions in Guangzhou in 2007. The results have shown that the average daily concentrations of NO_2, PM_{10}, and SO_2 were 61.04, 82.51, and 51.67microgram/m^3 respectively, and an average 21.47 preterm babes were delivered each day and a positive correlation between the daily concentrations of air pollutants and the preterm births. (Zhao et al, 2011)

A study was carried out in Tehran, Iran to determine the relationship between the CO ambient and low birth weight in women referring to Tehran hospitals in 2007-2008. 225 pregnant women were selected and investigated in Tehran hospitals. An information questionnaire was used for data collection. Women were assigned to low exposure group and high exposure group based on mean exposure to each pollutant during pregnancy and SPSS software version 2 and T statistics used for data analysis. The result showed that 31.6% of CO high exposure group and 7.4% of CO low exposure group had Low birth weight baby. The result also showed a significant relationship between exposure to high amount of CO and LBW. (Kariman et al, 2011)

It was reported in the study of Stankovic et al, (2011) in Serbia that the frequency of anemia, upper respiratory symptoms, and bleeding was significantly higher in pregnant women exposed to outdoor air pollution as compared with the control group and the occurrence of upper respiratory symptoms and bleeding was significantly higher in pregnant women who had been exposed to fossil fuel smoke. They selected the pregnant women nonsmoker, who were not professionally exposed to air pollution and divided them into the exposed group and control group during the exposure to outdoor air pollution. Data on health condition and outcome of pregnancy were obtained from medical records of tested pregnant women. (Stankovic et al, 2011)

Sajjadi and Bridgman, (2011) carried out a study in the Lower Hunter Region, Australia to compare the respiratory hospital admissions before and after closure industry that produce air pollutants. The number of hospital admissions for a group of respiratory diseases including all respiratory disease, Chronic Obstructive Pulmonary Disease (COPD) and asthma were incorporated in this study. Two series of dataset for 3.5 years before and after industry closure allowed a comparison of daily hospital admissions. The results have shown that the disease categories decreased but COPD 65+ increased after industry closure and all-age asthma showed the highest decrease and admission rates was significantly decreased.

In a study that taken in Nis, Serbia to investigate and evaluate the effects of air pollution on the occurrence of low birth weight, researchers measured the outdoor air pollutants, sulfur dioxide and black smoke daily during 2003. Subjects were 367 pregnant women, nonsmokers and who were not professionally exposed to air pollution and data on the characteristics of newborns were taken from the register of Obstetrics and Gyanecology Clinic of Nis. The results have shown that the exposure of pregnant women to outdoor air pollution had influence on the occurrence of low birth weight and caused health effects on pregnant women. (Stankovic et al, 2011)

A study was carried out in Asturias, Spain to investigate the relationship between lung cancer risk and pollution in an industrial region. A hospital based case control study covering 626 lung cancer patients and 626 controls recruited in Asturias and matched by ethnicity, hospital, age, and sex. Logistic regression and odds ratios were used and calculated with adjustment for sex, age, hospital area, family history of cancer, and occupation. The results have shown that an individual's living near industries displayed an excess risk of lung cancer and residents in urban areas showed a statistically significant increased risk of lung cancer and small cell carcinomas. (Lopez-Cima et al, 2011)

In a study that taken in Turkey to determine the adverse effects of air pollution on the nervous system, researchers studied the component of air pollution that represents particles, gases (SO_2, NO_2, CO), organic compounds, and toxic metals and they studied the ways that air pollutants enter into the central nervous system, previous studies, and the cellular and molecular mechanisms of neuronal injury induced by air pollution. The results of this study proved that there is mounting evidence that air pollution contributes to central nervous system damage or increased progression of neurodegenerative disorders, there is a clear link between air pollution and neurological diseases and airborne particles cause neuropathology, which seem to be mediated by direct or indirect proinflammatory oxidative responses. (Genc et al, 2011)

A study was carried out in Kazakhstan to evaluate the impact of air pollution on human health. They studied the study area and monitored the air quality and atmospheric condition on stationary posts in 3 cities and poor air quality has been cited. Regression analysis and model was carried out to determine the relationship between diseases and quantity of air pollutants. The results have shown that the level of disease for last years depend on a degree of harmful polluting substances, respiration disease has exceeded, and higher morbidity rates have been linked to increasing incidences of conditions such as tumors, respiratory disease, nervous system, and gastrointestinal disease. (Salnikov and Karatayev, 2011)

Guo et al, (2010) carried out a study in Beijing, China to investigate the relationship between gaseous air pollution and emergency hospital visits for hypertension, the researchers collected daily data on emergency hospital visits (EHVs) for hypertension and daily data on gaseous air pollutants (SO_2, NO_2) and particulate matter (PM_{10}). A time stratified case-crossover design was conducted to evaluate the relationship between gaseous air pollution and EHVs for hypertension. The results have shown that there is a significant association between gaseous air pollution (SO_2, NO_2, PM_{10}) with increased emergency hospital visits for hypertension.

A study was carried out in California, USA to examine the effects of ambient air pollution exposure on average birth weight and risk of low birth weight in full-term births. They estimated average ambient air pollutant concentrations throughout pregnancy in the neighborhoods of women who delivered term singleton live births between 1996 and 2006 and estimated of air pollutants on birth weight for infant characteristics, maternal characteristics, and year and season of birth. The results have shown that pollutants were associated with decreased birth weight; -5.4g per ppm CO, -9.0g per ppm NO_2, -5.7g per ppm Ozone, -7.7g per 10microgram/m^3 PM under 10micrometer, -12.8g per 10 microgram/m^3 PM under 2.5micrometer, and -9.3g per 10microgram/m^3 of coarse particulate matter. (Morello-Frosch et al, 2010)

It was reported in the study of Nastos et al, (2010) in Athens, Greece that there was a statistically significant relationship between childhood asthma admissions (CAA) and mean daily PM_{10} concentrations on the day of exposure and high mean daily PM_{10} concentration doubled the risk of asthma exacerbations even in younger asthmatic children (0-4 year old). Daily counts of CAA from three children hospitals were obtained from the hospital records during a four-year period (2001-2004) and mean daily PM_{10} concentrations recorded by the air pollution monitoring network were collected. The relationship between CAA and PM_{10} concentrations was investigated using linear models and logistic analysis.

It was reported in the study of Zanobetti and Schwartz, (2009) in united States of America that 0.98% increase in total mortality, 0.85% increase in cardiovascular diseases, 1.18% increase in myocardial infarction (MI), 1.78% increase in stroke, and 1.68% increase in respiratory deaths for a 10microgram/m3 increase in 2-day averaged $PM_{2.5}$. For PM coarse, there is a significant but smaller increases for all causes analyzed. They applied a city and season-specific Poisson regression in 112 U.S cites and combined the city-specific estimates using a random effects approach by season and region.

It was reported in the study of Perez et al, (2009) in Spain that mortality ratios was excessed in the vicinity installations for lung cancer and laryngeal cancer among men. Lung cancer displayed excess mortality for all types of fuel used. From1994 to 2003 there were 172.142 deaths due to lung cancer, 18.175 due to laryngeal cancer, and 38.396 due to bladder cancer in both sex. Ecologic study designed to model sex-specific standardized mortality ratios for the above three tumors in Spanish towns over the period 1994-2003. Population exposure to pollution was estimated on the basis of distance from town of residence to pollution source.

Wong et al, (2008) carried out a study in Bangkok, Thailand and three cites in China, Hong Kong, Shanghai, and Wuhan to assess the effects of short-term exposure to air pollution on daily mortality. Researchers used Poisson regression models to determine the association between air pollution and mortality and effect estimates were determined for each city and then for the cites combined using effects method. The results have shown that in individual cites, associations were detected between most of the pollutants (NO_2, SO_2, PM_{10}, and O_3) and most health outcome under the study (cardiovascular and respiratory mortality).

Carbonell et al, (2007) make assessment of the impacts on health due to the emissions of Cuban power plants that use fossil fuel oils in Cuba. They applied two models in their study, local dispersion modeling and regional dispersion modeling and make revision of the studies conducted in Cuba in the period 1983-2003 to show relationship between air pollution and health impacts and calculate the exposure-response function (ERF). The results have shown that a relationship between air pollution and health impacts such as chronic and acute mortality, chronic bronchitis, hospital admission for respiratory causes, emergency room visits, and acute asthma crisis.

In a study that taken in Alberta, Canada to investigate the association between outdoor air pollution and emergency department (ED) visits for asthma among children and adults, a time stratified case-crossover design was used to examine 57.912 emergency department asthma visits among individuals. Daily air pollution levels were estimated from three fixed site monitoring stations. Odds ratios were estimated using conditional logistic regression with adjustment for temperature and relative humidity related respiratory disease. The results have shown that a positive association for asthma visits with air pollution levels was observed and effects were strongest among young children. An increase of CO levels was associated with 48% increase the number of ED visits among children 2-4 years. Strong associations were also observed among those 75 years of age. Particulate matter was associated with asthma visits. (Villeneuve et al, 2007)

A study was carried out in Turkey to investigate the genotoxic risk to workers occupationally exposed to coal combustion products in power plant. Researchers analyzed chromosomal aberrations, polyploidy, sister chromate exchanges, and micronuclei in 48 male workers without a history of smoking, tobacco chewing, or alcohol consumption and compared with a control group of 30 healthy male individuals without exposure to any known genotoxic agents. Results from this study clearly showed chromosomal hazard in the peripheral lymphocytes of workers exposed to coal combustion products in power plant for several years. (Celik et al, 2007)

The long term air pollution exposure studies consistenly show that the health effects from chronic exposure are nearly an order of magnitude higher than those due to acute exposure alone. (Wang and Mauzerall, 2006)

A study was carried out in United States to summarize a wide range of the recent research on health effects of many types of outdoor pollution. A review of the health effects of major outdoor air pollutants including particulates, carbon monoxide, and sulfur dioxides. Numerous studies have linked atmospheric pollutants to many types of health problems of many body systems including the respiratory, cardiovascular, immunological, hematological, and neurological systems. Air pollution is associated with large increases in medical expenses, morbidity and is estimated to cause about 800.000 annual premature deaths worldwide. (Curtis et al, 2006)

Sarnat et al, (2006) carried out a study in Steubenville, Ohio to examine the association of air pollution and odds of cardiac arrhythmia in older adults. Thirty two non-smoking older adults were evaluated on a weekly basis for 24 weeks during the summer and autumn of 2000. A central ambient monitoring station provided daily concentrations of fine particles ($PM_{2.5}$, sulfate, and elemental carbon) and gases. A logistic mixed effects regression was used to examine the odds of having any supraventricular ectopy (SVE) or ventricular ectopy (VE) in association with air pollution. The results have shown that the odds ratios for having SVE are 1.42, 1.70, and 1.78 for 10 μg/m^3, 4.2 μg /m^3, and 14.9 ppb increase in five day moving average $PM_{2.5}$, sulfate, and Ozone concentrations. Participants reporting cardiovascular conditions were the most susceptible to pollution induced SVE.

In a study that taken in Italy to measure the health status of group of people living in a power plant area compared with a random group sample of the general Italian population. The results have shown that people living near a major thermoelectric plant have a subjective health status comparable to that reported by the general Italian population. (Chatenoud et al, 2005)

In a study that conducted in Israel to assess and investigate the relationships between fine particles and lung function in children with asthma living near two power plants. Two hundred and eighty five children with confirmed asthma performed peak expiratory flow tests (PEF) and completed a respiratory symptoms diary twice a day. Results have shown that there is significant association between air pollution and lung function in children with asthma. (Peled et al, 2005)

2.3.1 Ways that particulate matter affect health

According to Electric Power Research Institute (2007), the ways in which $PM_{2.5}$ can affect respiratory health are somewhat intuitive, and involve direct interaction of particle components with lung tissues.

The proposed mechanisms are as followed:

1- Uptake of particles from the lung into blood:
Particles or certain particles components in the blood could lead to injur of the cells lining the blood vessels and the formation of blood clots.

2- Pulmonary inflammation leading to system-wide inflammation:

System-wide inflammation could cause the release of biochemical substances which could in turn increase the likelihood of atherosclerosis (hardening of the arteries), and

3- Autonomic nervous system activation and direct effects on the heart:

Particles deposited in the airways may activate nerve receptors that could lead to an increase in heart rate and possibly cardiac abnormalities.

2.3.2 Carbon monoxide Toxicity

Carbon monoxide can cause harmful health effects by reduce the oxygen-carrying capacity of the blood. At extremely high level, CO can cause death.

Carbon monoxide can cause tissue hypoxia as a result of binding of CO to hemoglobin to form Carboxyhemoglpbin (COHb) in the blood. Increasing levels of COHb in the blood stream leads to decrease in oxygen availability for organ and tissues because the binding of CO with hemoglobin is faster than binding of O_2 with hemoglobin by 200 times (EPA, 2011). Figure (2.7) illustrate carbon monoxide toxicity.

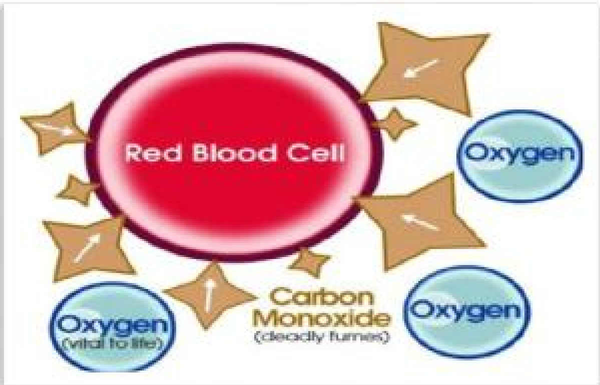

Fig (2.3): illustrate carbon monoxide toxicity

Source: alriyadh.com

2.4 Noise Pollution and its Health Impacts

Atmaca et al, (2005) carried out a study in Sivas, Turkey to determine the effect of noise on human health. Noise measurement and survey studies have been carried out. A questionnaire was completed by 256 workers in industrial places to determine the physical, physiological, and psycho-social impacts of the noise on human. The noise levels detected are much above the 80dB. The results have shown that 73.83% of workers are disturbed from the noise in their workplaces , noise causes the problem of nervousness on workers at rate of 60.96%, and 30.86% of the workers have ailments like ringing in the ear and hearing losses.

Noise has been on the bottom of most environmental priority lists, although more people are affected by noise exposure than any environmental stressor. Noise causes several adverse health effects on human such as hearing loss, annoyance, cardiovascular disease (blood pressure and hypertension), sleep disturbance, immune loss effects, biochemical change effects (specific hormones and metal ions such as magnesium), and reproductive effects. (Basrur, 2000)

In a study that taken in Ohio, United States by Morata et.al, (1993), to investigate the effects of occupational exposure to noise and solvents on workers hearing, an interviews and hearing tests were conducted for groups included unexposed (N=50) workers and workers exposed to noise (N=50). The results have shown that the risk of hearing loss was greater for the exposed groups than for the unexposed group and the relative risk estimates were four times greater for the noise group.

Noise has a significant impact on the quality of life and adverse effects can be cumulative with repeated exposure. Hearing loss is one of the most obvious and easily quantified effects of excessive exposure to noise, it damages the delicate sensory cells of the inner ear, the cochlea. Noise is one of the most common forms of sleep disturbance, when sleep disturbance becomes chronic; its adverse effects on health are well-known. Noise can effect on blood pressure and blood chemistry. (Suter, 1991)

CHAPTER (3)

MATERIAL AND METHOD

3.1 Introduction

This chapter discusses the method and material used to monitor air pollutants emitted from Gaza power plant. Monitoring program was carried out to obtain field data needed to determine the level of air pollutants and their health impact. A questionnaire was used to collect data to evaluate the health impact of air pollutants. Statistical analysis was used to analyze data from questionnaire.

3.2 General description of study area

Gaza Governorates are situating in the southeastern coast of Palestine with Longitudes of 34E and Latitudes 31N. They are located on the Mediterranean coast as shown in figure 3.1. Gaza Governorates is a highly crowded area, where approximately 1,616,490 people live in 365 km^2, estimated density is 4,000 people per square kilometer distributed across five governorates. Gaza Governorates are classified into five governorates: North Gaza, Gaza, middle Gaza Governorate, Khan Yunes, and Rafah governorate. Table 3.1 illustrated the distribution of people into Gaza Governorates (PCBS, 2012).

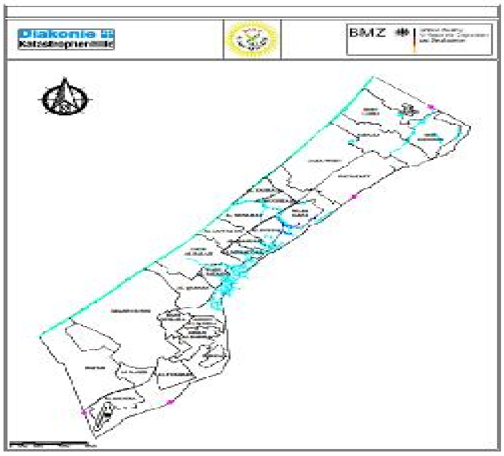

Figure (3.1): Gaza Governorate map

Source: P.A.R.C

Table (3.1): Population distribution in Gaza Governorates (PCBS, 2012).

Governorate	Population number	Percentage
North Gaza	322,126	19.5
Gaza	569,715	35
Middle Gaza	238,807	14.5
Khan Yunes	310,868	19
Rafah	202,777	12
Total	1,644,293	100%

3.3 Study Site

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 site is on approximate area 150 hectare on an agriculture land (called abu-shaaban farm) and most of adjacent lands are agriculture land. Power plant is currently running at 156 employees, mostly managers, engineers, technicians and security officers, they have good qualifications and competencies and carrying Qualifications commensurate with the nature of their business. Inside the station specialized training center equipped with the latest hardware and has a multi-use hall equipped with visual communication technology and equipped with the latest technology. The purpose of this center is to conduct regular training programs for staff members to attend relevant training courses in management for administrators and technicians, as well as the establishment of meetings for employees. Figure (3.2) and (3.3) shows Gaza power plant location from Google Earth. People were lived around power plant in all direction, but they are concentrated and closed of it from West and South.

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 and in the last period from Egypt.

Figure (3.2): Gaza power plant location from Google Earth.


Figure (3.3): Gaza power plant

3.3.1 Power plant Operation

Figure (3.4) shows a schematic diagram for power plant processes.

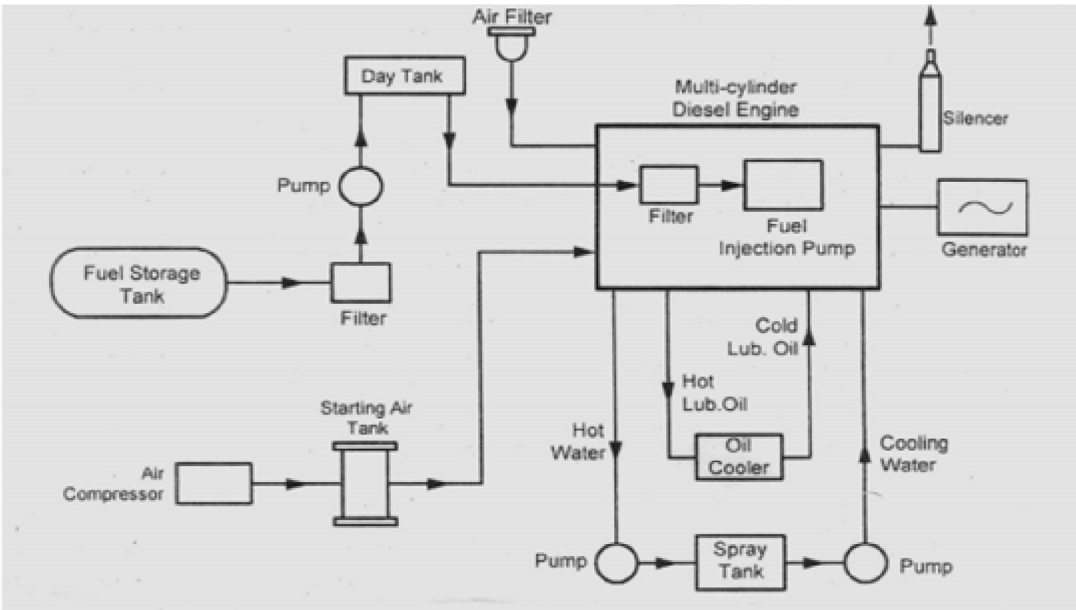

Figure (3.4): Power plant processes

The supplied diesel first is placed in a settlement tanks for 12 hours, then it will pumped into a fuel separator to be prepared for combustion process. The exhaust gases leaving the STG units will be released to the atmosphere through the attached stacks. For each turbine there are two stacks with 2.5 and 1.5m diameter, emission will release from the large stack with 450c where in small stack the emission will released with 150c.

3.4 Monitoring Programs

Three monitoring programs were carried out to determine the levels of air pollutants and to illustrate the changes in the concentration of pollutants more clearly: Particulate matter ($PM_{2.5}$), Carbon monoxide (CO), and Carbon dioxide (CO_2). The study relied on three programs to measure the concentrations of pollutants former are as follows: the first program where they were measuring the concentration of pollutants in the three points at a distance of 1,000 m from the station in all directions, while the second program is the measurement of the concentration of pollutants at 15 points at a distance of 300m from the station in all directions, in the third program concentration of pollutants were measured at five points at a distance of 100 m from the station in order to assess the impact of pollutants emitted from the station to the population living in that region. We have been implementation of these measurements at different times to see how the influence of different weather factors on measurements in addition to the distance factor. Table (3.2) shows the monitoring program that carried out.

Table (3.2): Monitoring programs of study.

Monitoring program	Day	Date	Time
1000 meter (30-500-1000)	Wednesday Thursday Friday	14/8/2012 15/8/2012 16/8/2012	Afternoon Afternoon Morning
300 meter (20-40-60-…,300)	Monday Wednesday Thursday Sunday Monday	26/11/2012 28/11/2012 29/11/2012 2/12/2012 3/12/2012	Afternoon Afternoon Afternoon Afternoon Afternoon
100 meter (20-40-60-80-100)	Tuesday Wednesday Wednesday Thursday	27/8/2012 28/8/2012 4/9/2012 5/9/2012	Evening Afternoon Evening Afternoon

3.4.1 Particulate matter and Noise Monitoring

Super-thin 3-Channel Handheld Laser Particle Counter (HAL-HPC300) that shown in figure 3.5 was used to measure the levels of particulate matter suspended in the air in real time, it is widely used for indoor/outdoor air quality (IAQ) application.

The HAL-HPC300 has up to three adjustable particle size channels starting at 0.3 microns to 10 microns. The settings of measurement parameters as well as results displayed in total counts, number concentration (cumulative).

Figure (3.5): 3-Channel Handheld Laser Particle Counter.

The measurements of particulate matter were carried out for five days in different times around power plant, where the device was setting to measure the particles every minute for different distances and in four directions. For accuracy of the measurement, device leaves for 15 minutes in place before start taking measurements required. Figure 3.6 shows researcher during monitoring process.

Figure (3.6): Researcher during pollutants and noise monitoring.

Then, the algorithm used to transform particle numbers to mass assumed particles were spherical and had a density 1.65 g cm-3. (Tittarelli et al, 2008)

Noise was monitored every twenty meter around power plant by Sound level meter to evaluate the level of noise and health effects of it. The used device is illustrated in figure 3.7.

Figure (3.7): Sound level meter instrument.

3.4.2 Carbon monoxide and Carbon dioxide Monitoring

Measurements of the level of Carbon monoxide CO and Carbon dioxide CO_2 were carried out for nine days in different time and different distances from power plant by Kanomax meter, where the device was setting to take three reading every minute, then the average were calculated. Figure 3.8 illustrate Kanomax meter that used in Carbon monoxide and Carbon dioxide monitoring.

Figure (3.8): Kanomax meter.

Figure (3.9): Air pollutants emitted from power plant stacks.

3.4.3 Meteorological Factors

Meteorological factors (Temperature and Humidity) were also monitored using the multi meter, while wind speed and wind direction were monitored using Anemometer, to study their effect on the air pollutants, readings were recorded every minute over the monitoring duration. (Appendix I, Appendix II)

3.5 Questionnaire

A questionnaire was used to evaluate the health effects of air pollutants on the human health. The populations consist from the citizens surrounding to GPP and we select random sample with size **108** persons, the questionnaires were distributed to the research population and **104** questionnaires are received.

The questionnaire was provided with a covering letter explaining the purpose of the study, the way of responding, the aim of the research and the security of the information in order to encourage a high response. The questionnaire included multiple choice questions: which used widely in the questionnaire. The variety in these questions aims first to meet the research objectives, and to collect all the necessary data that can support the discussion, results and recommendations in the research. The questionnaire is attached in Appendixes III

The items in the questionnaire will verify the objectives in this research about the health effects of pollutants air emitted from the GPP to the citizens and the surrounding population as the following:

<u>First field</u>: **Basic information** consist from 25 questions

<u>Second field</u>: **Health information** consists from 37 questions and all questions follow triple scale as shown in table 3.3:

Table (3.3): answers of questions in second field of questionnaire

Level	Yes	Sometime	No
Scale	3	2	1

3.6 data and statistical analysis

To achieve the research goal, researcher used the statistical package for the Social Science (SPSS) for Manipulating and analyzing the data as follows:

1. Frequencies and Percentile.
2. Person correlation coefficients for measuring validity of the items of the questionnaires.
3. Spearman –Brown Coefficient.
4. One sample t test to test the opinion of the participants about the Health information.
5. One way ANOVA to test the hypotheses that have been established.

CHAPTER (4)

RESULTS AND DISCUSSION

This chapter presents main findings and their discussion of this study, which divided into five major sections. The first is dealing with results from monitoring of particulate matter, the second is dealing with results from monitoring of carbon monoxide and carbon dioxide, the third with results from monitoring of noise, where measurements will be displayed in the east, west, north, and south of each pollutant in the all-day monitoring and display measurements for each day by taking the mean values for each distance in four directions around the power plant, the fourth with results from monitoring of metrological conditions. The fifth section presents results gathered from the public health assessment questionnaire.

4.1 Particulate matter Monitoring Results

Particulate matter results carried out by tow monitoring program, at a distance of 1,000 m (30, 500, 1000) and 100 m (20, 40, 60, 80,100).

The levels of particulate matter around power plant in the first, second, and third day monitoring shows in figure 4.1. In first day, the concentration at 30 m from power plant was 51 $\mu g/m^3$, the concentration of particle matter at 500 m from power plant was 62 $\mu g/m^3$, while the concentration at 1000 m was 79 $\mu g/m^3$ with an increase of 28 $\mu g/m^3$ on concentration of particulate matter at 30 m from power plant. The straight-line equation(4.1) for the first day curve was found to predict the concentration of particulate matter and shown a good agreement(R^2=0.9) between particle concentration and distance as follows:

$$Y = 0.028x + 49.64 \quad , R^2 = 0.990 \qquad \text{.................. equation (4.1)}$$

The levels of particulate matter around power plant in the second day monitoring at 30 m from power plant was 56 $\mu g/m^3$, the concentration of particle matter at 500 m from power plant was 61 $\mu g/m^3$, while the concentration at 1000 m was 64 mg/m3 with an increase of 8 $\mu g/m^3$ on concentration of particulate matter at 30 m from power plant, there is a slight rise in the concentration of particulate matter may be due to unstable weather conditions and wind movement, wind velocity was 2.5 m/s, temperature was 34c, and humidity was 60%. The straight-line equation(4.2) shown a good agreement as follows:

$$Y = 0.008x + 56.13 \quad , R^2 = 0.974 \quad \text{…………………..} \quad \text{equation (4.2)}$$

According to the same figure the levels of particulate matter around power plant in the third day monitoring at 30 m from power plant was 56 µg/m^3, the concentration of particle matter at 500 m from power plant was 61 µg/m^3, while the concentration at 1000 m was 64 µg/m^3. According to the equation(4.3), the concentration of particle matter and distance have a good agreement.

$$Y = 0.008x + 56.13 \quad , R^2 = 0.974 \quad \text{………………..} \quad \text{equation (4.3)}$$

The second and third days monitoring have the same weather and wind conditions, therefore, the results appeared almost similar.

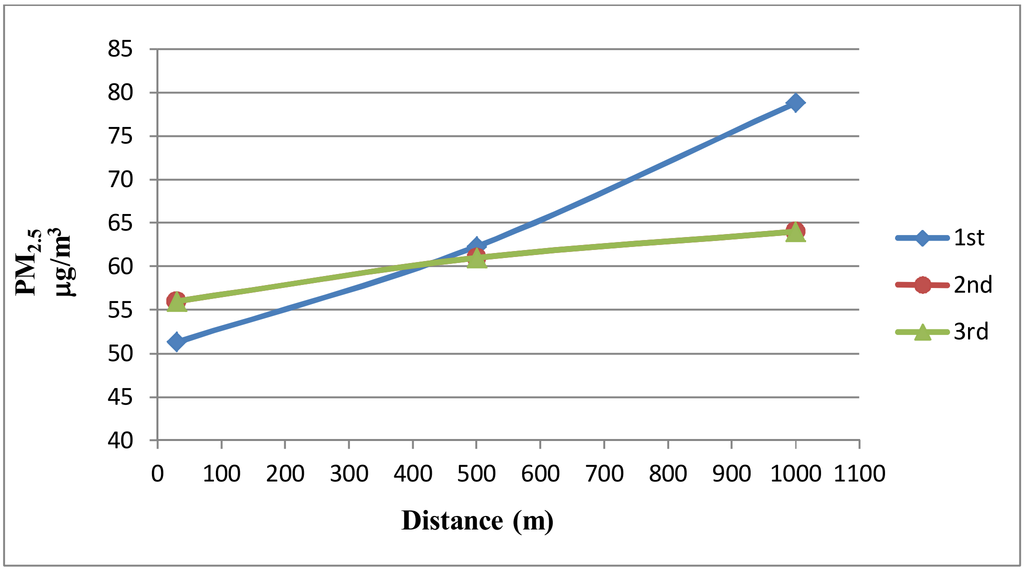

Figure (4.1): Particle Matter levels around power plant (1st, 2nd, 3rd day)

The concentration of particulate matter around power plant in the fourth and fifth monitoring day during the night shows in figure 4.2. In fourth day, the measurement was at the night and the concentration at 20 m was 50µg/m^3, the concentration at 40 m was 52µg/m^3, the concentration at 60 m was 49µg/m^3, and at 80 m was 50µg/m^3, while the concentration at 100 m was 51µg/m^3. The figure shows a slight decrease in the concentration of particulate matter as we move away from the power plant. Temperature was 28c, humidity was 49%, and wind speed was 1m/s and become zero during measurement. The equation(4.4) shows the relation between particle concentration and distance as follows:

$$Y= 5E^{-5}x^3 -0.009x^2 +0.45x +44.4 \quad , R^2= 0.5 \quad \ldots\ldots\ldots\ldots \text{ equation (4.4)}$$

In the fifth monitoring day, the concentration at 20 m was 63µg/m^3, the concentration at 40 m was 62.5µg/m^3, and then the concentration increased to 63.8µg/m^3 at 60 m, and at 80 m was 62.5µg/m^3, while the concentration at 100 m was 60µg/m^3. The figure shows a decrease in the concentration of particulate matter as we move away from the power plant. Temperature was 30c, humidity was 51%, and wind speed was ranging from 1 m/s to 3 m/s. According to the equation(4.5), there is a good relation between distance and concentration as follows:

$$Y= -3E^{-5}x^3 +0.0044x^2 -0.185x + 64.16 \quad , R^2= 0.9 \quad \ldots\ldots\ldots \text{ equation (4.5)}$$

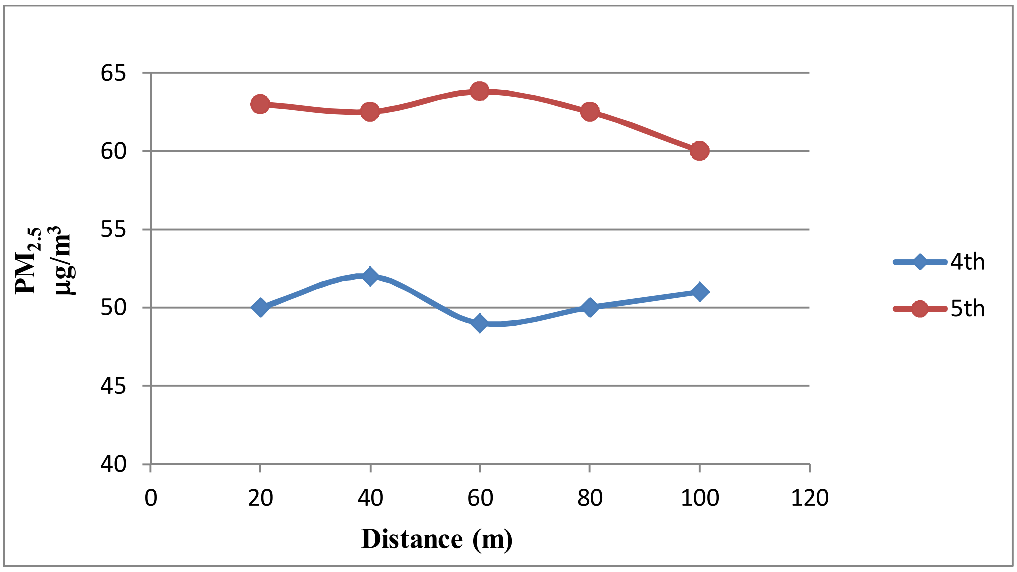

Figure (4.2): Particle Matter levels around power plant (4th, 5th day)

4.1.1 Particulate Matter Measurement at East Power Plant

Figure 4.3 presents concentration of particulate matter at the east of the power plant at the first, second, and third day. In first day, the level of particulate matter at 30 m was 48µg/m^3, and at 500 m was 64µg/m^3, while at 1000 m was 74µg/m^3. The equation(4.6) shows a good relation between particle concentration and distance as follows:

$$Y = 0.026x + 48.36 \quad , R^2 = 0.977 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad \text{equation (4.6)}$$

The concentration of particulate matter in the second day at 30 m was 54μg/m^3, and at 500 m was 63μg/m^3, while at 1000 m was 63μg/m^3. The straight-line equation(4.7) as follows:

$$Y = 0.009x + 55.31 \quad , R^2 = 0.734 \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad \text{equation (4.7)}$$

While the concentration of particulate matter at the east of the power plant in the third day at 30 m was 56μg/m^3, and at 500 m was 65μg/m^3, while at 1000 m was 66μg/m^3. The straight-line equation(4.8) shows the relation between particulate matter concentration and distance as follows:

$$Y = 0.010x + 57.12 \quad , R^2 = 0.810 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad \text{equation (4.8)}$$

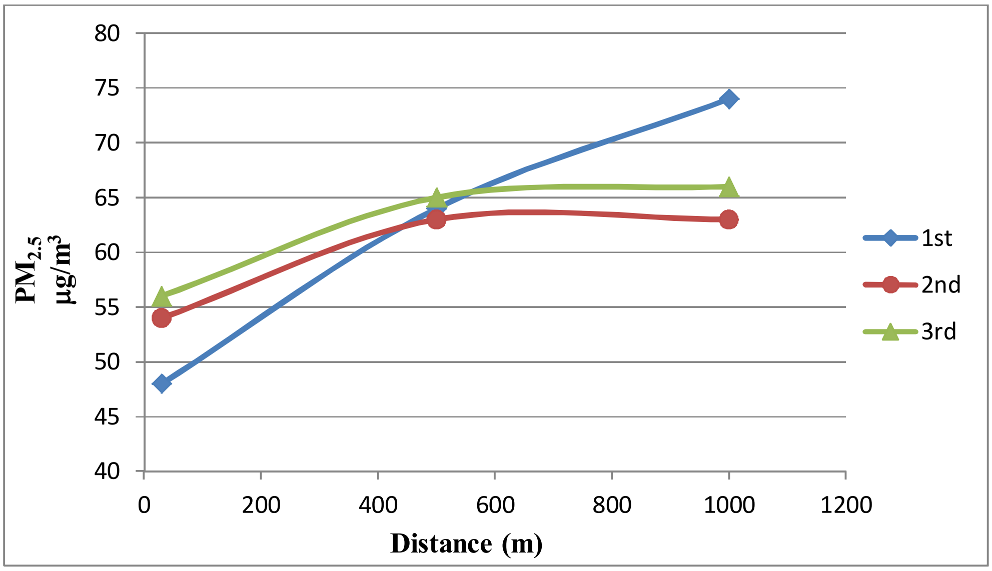

Figure (4.3): Particle Matter at east of plant (1^{st}, 2nd, 3rd day)

The level of particulate matter at the east of the power plant in the fourth and fifth day presents in figure 4.4. In fourth day, the level of particulate matter at 20 m was 48μg/m^3, the level at 40 m was 48μg/m^3, and the level at 60 m was 49μg/m^3, while the levels at 80 and 100 m were 53μg/m^3 and 51μg/m^3 respectively. The figure shows an increase in the concentration of particulate matter as we move away from the power plant because the wind direction was north to west with speed less than 1 m/s. According to the equation(4.9), there is a good relation between concentration and distance as follows:

$$Y = -7E^{-5}x^3 + 0.013x^2 - 0.612x + 55.8 \quad , R^2 = 0.9 \quad \ldots\ldots\ldots\ldots \quad \text{equation (4.9)}$$

According to the same figure, the level of particulate matter in the fifth day at 20 m was 60μg/m^3, the level at 40 m was 59μg/m^3, and the level at 60 m was 58μg/m^3, while the levels at 80 and 100 m were 61μg/m^3 and 60μg/m^3 respectively. The equation(4.10) shows the concentration with distance as follows:

$$Y= -4E^{-5}x^3 +0.008x^2 -0.47x +66.6 \quad , R^2= 0.6 \quad \ldots\ldots\ldots\ldots \quad \text{equation (4.10)}$$

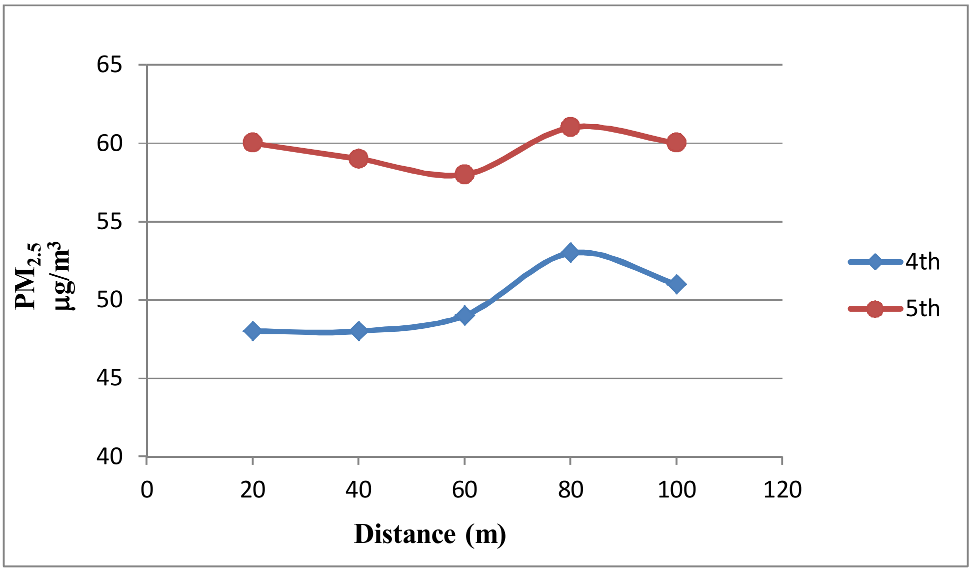

Figure (4.4): Particle Matter at east of plant (4th, 5th day)

The levels of particulate matter at the east of the power plant at the first, second, and third day monitoring are higher than the levels of particulate matter at the fourth and fifth day monitoring because the wind speed at the first, second, and third day (2.5m/s) was higher than the wind speed at the fourth and fifth day (0.5m/s) and wind direction was north to west leads to transported the particulate matter to the east of power plant. Temperature at the first, second, and third day also higher than the temperature at the fourth and fifth day monitoring.

4.1.2 Particulate Matter Measurement at West Power Plant

The concentration of particulate matter at the west of the power plant at the first, second, and third day presented in figure 4.5. In first day, the level of particulate matter at 30 m was 56µg/m^3, and at 500 m was 65µg/m^3, while at 1000 m was 88µg/m^3. Results show an increase in the levels of particulate matter from the eastern side as a result of the presence of the petrol filling station and street vehicles. A good relation between particulate concentration and distance was shown in equation(4.11) as follows:

$$Y= 0.033x + 52.77 \quad , R^2= 0.948 \quad \text{…………...} \quad \text{equation (4.11)}$$

According to the same figure that presents concentration of particulate matter at the west power plant in the second day. The level of particulate matter at 30 m was 56µg/m^3, and at 500 m was 59µg/m^3, while at 1000 m was 64µg/m^3. The equation(4.12) shows a good relation of particulate concentration with distance as follows:

$$Y= 0.008x + 55.45 \quad , R^2= 0.984 \quad \text{…………...} \quad \text{equation (4.12)}$$

The concentration of particulate matter in the third day at 30 m was 55µg/m^3, and at 500 m was 59µg/m^3, while at 1000 m was 63µg/m^3. The straight-line equation(4.13) as follows:

$$Y= 0.008x + 54.79 \quad , R^2= 0.999 \quad \text{…………...} \quad \text{equation (4.13)}$$

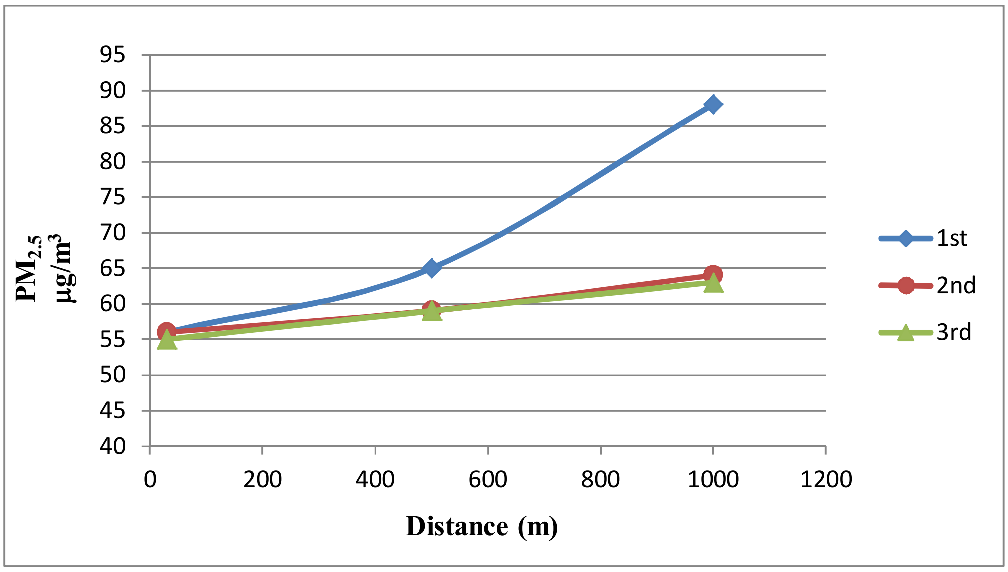

Figure (4.5): Particle Matter at west of plant (1st, 2nd, 3rd day)

The level of particulate matter at the west of the power plant in the fourth and fifth day shown in figure 4.6. In fourth day, the level of particulate matter at 20 m was 68µg/m^3, the level at 40 m was 75µg/m^3, and the level at 60 m was 62µg/m^3, while the levels at 80 and 100 m were 60μg/m^3 and 64μg/m^3 respectively. The wind speed was zero so; the results were high more than other directions because the presence of stone crusher and petrol filling plant. The equation(4.14) shows a good relation between concentration and distance as follows:

$$Y= 0.0003x^3 -0.05x^2 +2.335x +38.8 \quad , R^2=0.86 \quad \ldots\ldots\ldots\ldots \quad \text{equation (4.14)}$$

The level of particulate matter in the fifth day at 20 m was 70μg/m^3, the level at 40 m was 70μg/m^3, and the level at 60 m was 77μg/m^3, the level at 80 was 72μg/m^3, while at 100 m was 64μg/m^3. According to equation(4.15), a good relation between concentration and distance as follows:

$$Y= -0.0001x^3 +0.014x^2 -0.433x + 73.6 \quad , R^2= 0.87 \quad \ldots\ldots\ldots \quad \text{equation (4.15)}$$

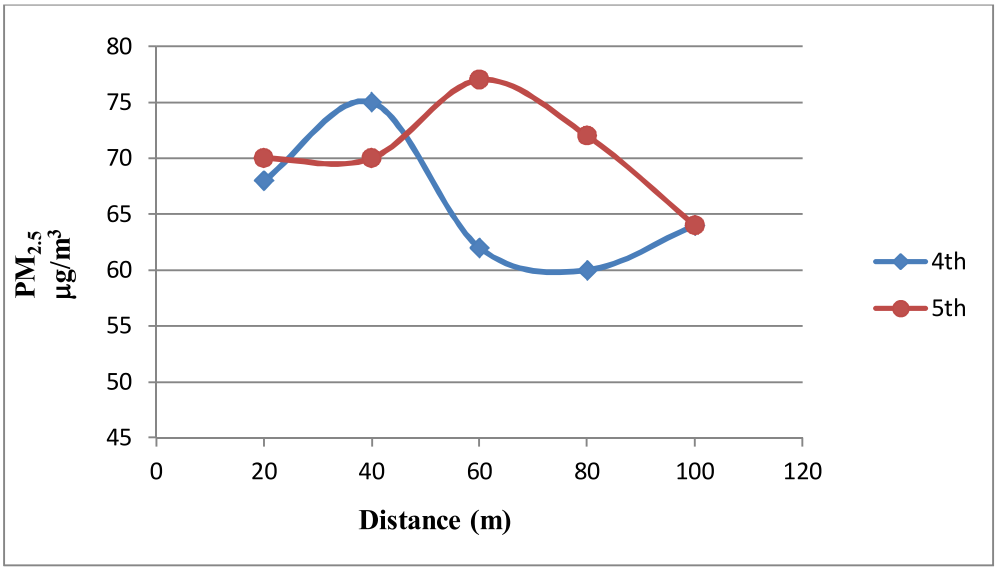

Figure (4.6): Particle Matter at west of plant (4th, 5th day)

According to previous figures, researcher find that the concentration of particulate matter at the west power plant high and may be due to several factors:

1- The presence of a filling fuel station.

2- Street vehicles.

3- The presence of stones factory and

4- Random landfill of much random burning of waste.

4.1.3 Particulate Matter Measurement at North Power Plant

The concentration of particulate matter at the north of the power plant in first, second and third day monitoring presents in figure 4.7. In first day, the level of particulate matter at 30 m was 49µg/m^3, and at 500 m was 58µg/m^3, while at 1000 m was 69µg/m^3. The straight-line equation(4.16) shows a good relation between concentration and distance as follows:

$$Y= 0.020x + 48.14 \quad , R^2= 0.998 \quad \ldots\ldots\ldots\ldots\ldots\ldots.. \quad \text{equation (4.16)}$$

The concentration of particulate matter at the north of the power plant in second day monitoring at 30 m was 56µg/m^3, and at 500 m was 59µg/m^3, while at 1000 m was 63µg/m^3. The straight-line equation(4.17) have a good relation between concentration and distance as follows:

$$Y= 0.007x + 55.64 \quad , R^2= 0.995 \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad \text{equation (4.17)}$$

According to the same figure, concentration of particulate matter in third day monitoring at 30 m was 55µg/m^3, and at 500 m was 58µg/m^3, while at 1000 m was 62µg/m^3. According to equation(4.18), there is a very good relation between concentration and distance as follows:

$$Y= 0.007x + 54.64 \quad , R^2= 0.995 \quad \ldots\ldots\ldots\ldots\ldots.. \quad \text{equation (4.18)}$$

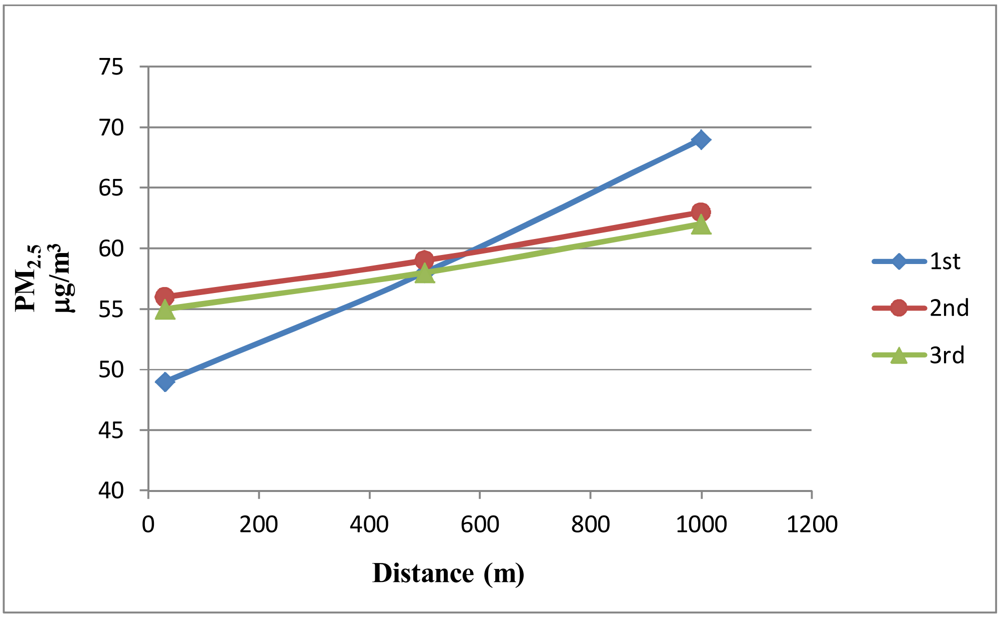

Figure (4.7): Particle Matter at north of plant (1st, 2nd, 3rd day)

The concentration of particulate matter at the north of the power plant in fourth and fifth day monitoring presents in figure 4.8. In fourth day, the levels of particulate matter at 20 and 40 m were 31μg/m^3, and at 60 m was 33μg/m^3, while the concentrations at 80 and 100 m were 36μg/m^3.The straight-line equation(4.19) as follows:

$$Y= 0.075x + 28.9 \quad , R^2= 0.892 \quad \text{………………...} \quad \text{equation (4.19)}$$

The level of particulate matter in fifth day monitoring presented in the same figure. The levels of particulate matter at 20 and 40 m were 58μg/m^3, and at 60 m were 59μg/m^{3,} while the concentration at 80 m was 56μg/m^3 and at 100 m was 55μg/m^3.

The equation(4.20) shows the relation between concentration and distance as follows:

$$Y= -0.0011x^2 +0.09x + 56.6 \quad , R^2= 0.8 \quad \text{…………} \quad \text{equation (4.20)}$$

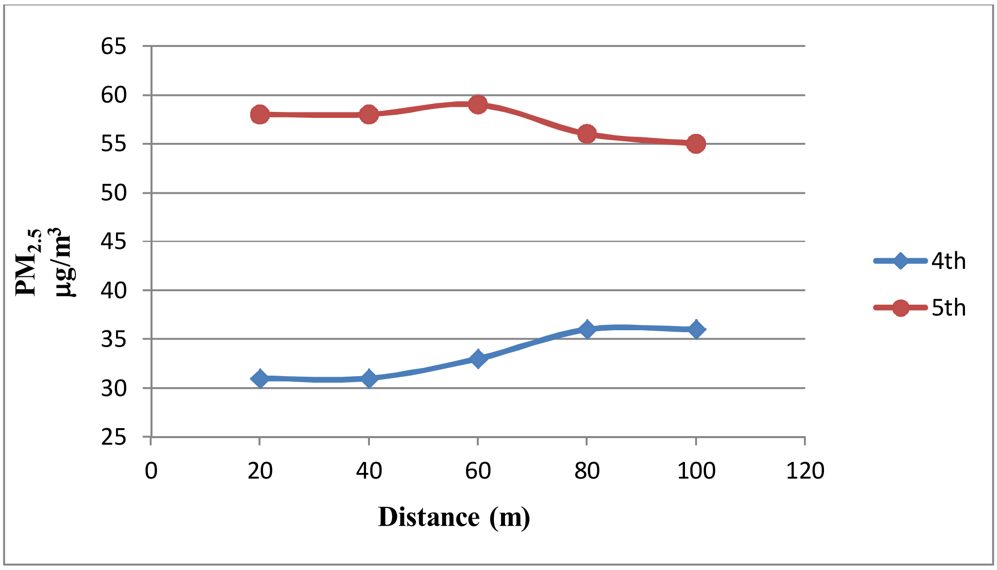

Figure (4.8): Particle Matter at north of plant (4th, 5th day)

The level of particulate matter at the north of the power plant in all monitoring days was less than the level of particulate matter at east and west power plant, but the concentration was high because the region considered as agriculture region and agricultural activities and animals movement were numerous and severe. In Fourth day monitoring, find that the concentration has been as little as possible because the measurement was during the period of the night with less agricultural activities in this period.

4.1.4 Particulate Matter Measurement at South Power Plant

According to figure 4.9 presents concentration of particulate matter at the south of the power plant in first, second and third day monitoring. The level of particulate matter in first day at 30 m was 52μg/m^3, and at 500 m was 62μg/m^3, while at 1000 m was 84μg/m^3. Results appear close compared with the western side as a result of the movement of northern wind during the measurement. The equation(4.21) shows a good relation of particulate concentration with distance as follows:

$$Y= 0.033x + 49.11 \quad , R^2= 0.962 \quad \text{.....................} \quad \text{equation (4.21)}$$

According to the same figure, concentration of particulate matter at the south of the power plant in second day monitoring at 30 m was 57μg/m^3, and at 500 m was 61μg/m^3, while at 1000 m was 64μg/m^3. A good relation between concentration and distance shown in equation(4.22).

$$Y= 0.007x + 56.99 \quad , R^2= 0.99 \quad \text{....................} \quad \text{equation (4.22)}$$

The concentration of particulate matter in third day monitoring at 30 m was 57μg/m^3, and at 500 m was 61μg/m^3, while at 1000 m was 64μg/m^3. The straight-line equation(4.23) as follows:

$$Y= 0.007x + 56.99 \quad , R^2= 0.99 \quad \text{.....................} \quad \text{equation (4.23)}$$

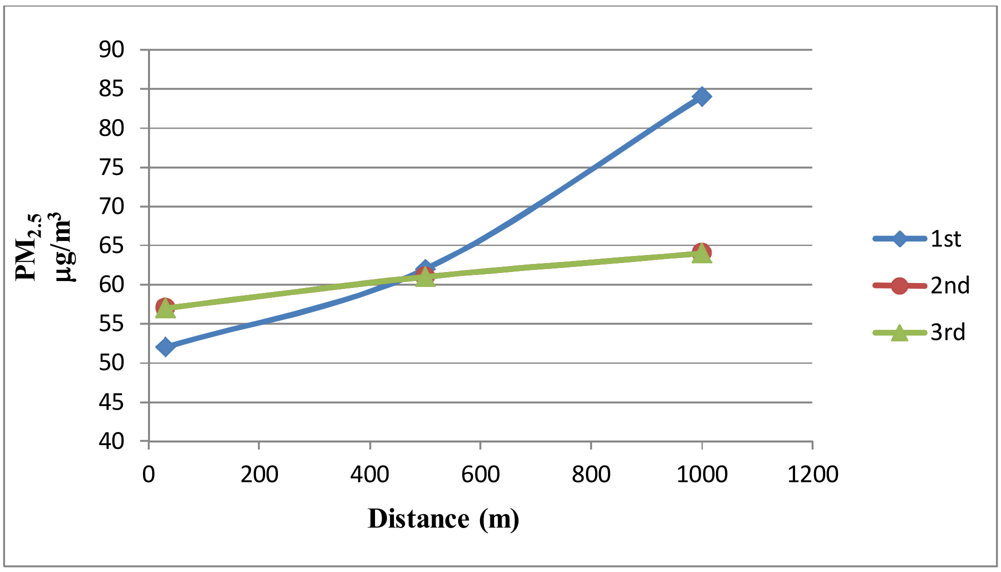

Figure (4.9): Particle Matter at south of plant (1^{st}, 2nd, 3rd day)

The level of particulate matter at the south of the power plant in fourth and fifth day monitoring presents in figure 4.10. In fourth day, the level of particulate matter at 20 m was 53µg/m^3, the level at 40 m was 53µg/m^3, and the level at 60 m was 52µg/m^3, while the levels at 80 and 100 m were 50 µg/m^3 and 51µg/m^3 respectively. The straight-line equation(4.24) shows the relation of concentration with distance as follows:

$$Y= -0.035x + 53.9 \quad , R^2= 0.720 \quad \ldots\ldots\ldots\ldots\ldots \quad \text{equation (4.24)}$$

The level of particulate matter at the south of the power plant in fifth day monitoring at 20 m was 64µg/m^3, the level at 40 m was 63µg/m^3, while the levels at 60, 80, and 100 m were 61µg/m^3.

The straight-line equation(4.25) as follows:

$$Y= -0.04x + 64.4 \quad , R2= 0.8 \quad \ldots\ldots\ldots\ldots\ldots \quad \text{equation (4.25)}$$

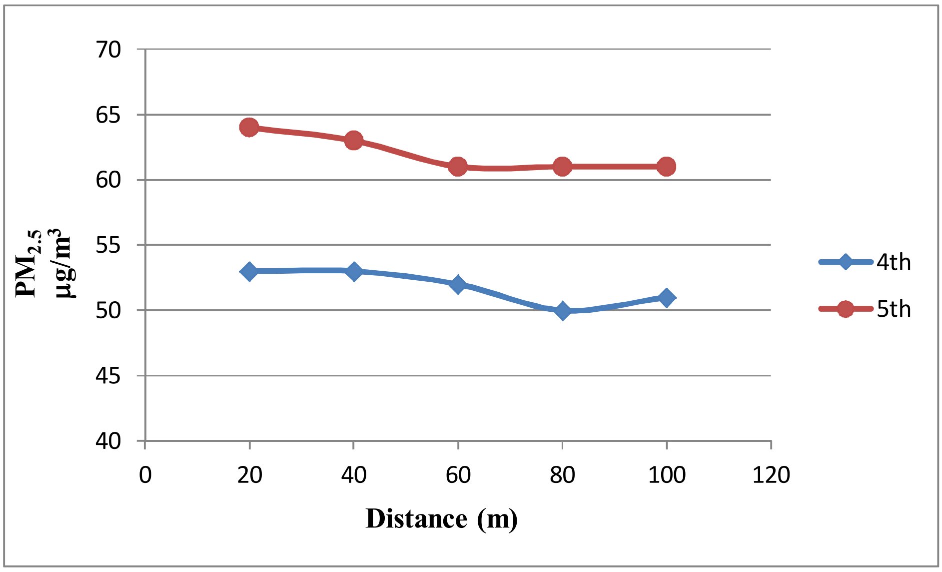

Figure (4.10): Particle Matter at south of plant (4th, 5th day)

The levels of particulate matter at the south of the power plant at the first, second, and third day monitoring are higher than the levels of particulate matter at the fourth and fifth day monitoring because the wind speed at the first, second, and third day (2.5m/s) was higher than the wind speed at the fourth and fifth day (0.5m/s) and wind direction was north to east leads to transported the particulate matter to the south of power plant.

Researcher found that the concentration of particulate matter during the night less than the concentration during the day.

4.2 Carbon Dioxide and Carbon Monoxide Monitoring Results

4.2.1 Carbon Dioxide Monitoring Results

Carbon dioxide results carried out by tow monitoring program, at a distance of 100 m (20, 40, 60, 80,100) and 300 m (20, 40, 60, …., 300).

The levels of carbon dioxide CO_2 around power plant in the first day during the night, second, third and fourth monitoring day shows in figure 4.11. In first day, the concentration at 20 m was 262 ppm, and then it is increased to 307 ppm at 40 m and increased to 308 ppm at 60 m from power plant, then the concentration was increased at 80 m to 310 ppm, the concentration at 100 was decreased to 307 ppm. The figure shows an increase in the concentration of carbon dioxide CO_2 as we move away from the power plant. Temperature was 28c, humidity was 49%, and wind speed was 1m/s and become zero during measurement. The equation(4.26) shows a good relation between CO_2 concentration and distance as follows:

$$Y= -0.017x^2 +2.5007x +223.4 \quad , R^2= 0.8 \quad \ldots\ldots\ldots\ldots.. \quad \text{equation (4.26)}$$

According to the same figure, the levels of carbon dioxide CO_2 around power plant in the second monitoring day at 20 m was 342 ppm, and then it is increased to 357 ppm at 40 m and increased to 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 figure shows an increase in the concentration of carbon dioxide CO_2 as we move away from the power plant. Temperature was 30c, humidity was 51%, and wind speed was ranging from 1 m/s to 3 m/s during measurement. According to equation(4.27) that shows the relation between CO_2 concentration and distance as follows:

$$Y= 0.0003x^3 -0.0672x^2 +4.2262x + 280.4 \quad , R^2= 0.7 \quad \ldots... \quad \text{equation (4.27)}$$

The concentration of carbon dioxide CO_2 around power plant in the third monitoring day at 20 and 40 m was 261 ppm and then it was decreased to 254 ppm at 60 m and increased to 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. Temperature was 29c, humidity was 50%, wind speed was 1 m/s, and wind direction was north to west during measurement.

The levels of carbon dioxide CO_2 around power plant in the fourth monitoring day at 20 m was 270 ppm, at 40 m it was 269 ppm, and then it was decreased to 268 ppm at 60 m and increased to 273 ppm at 80 m from power plant, then the concentration was back to decreased at 100 m to 265 ppm.

The figure shows a decrease in the concentration of carbon dioxide CO_2 as we move away from the power plant. Temperature was 30c, humidity was 60%, wind speed was 3 m/s, and wind direction was north to west during measurement. The equation(4.28) shows a good relation between CO_2 concentration and distance as follows:

$$Y= -0.0001x^3 +0.0229x^2 -1.1369x + 285 \quad , R^2= 0.7 \quad \ldots\ldots\ldots \quad \text{equation (4.28)}$$

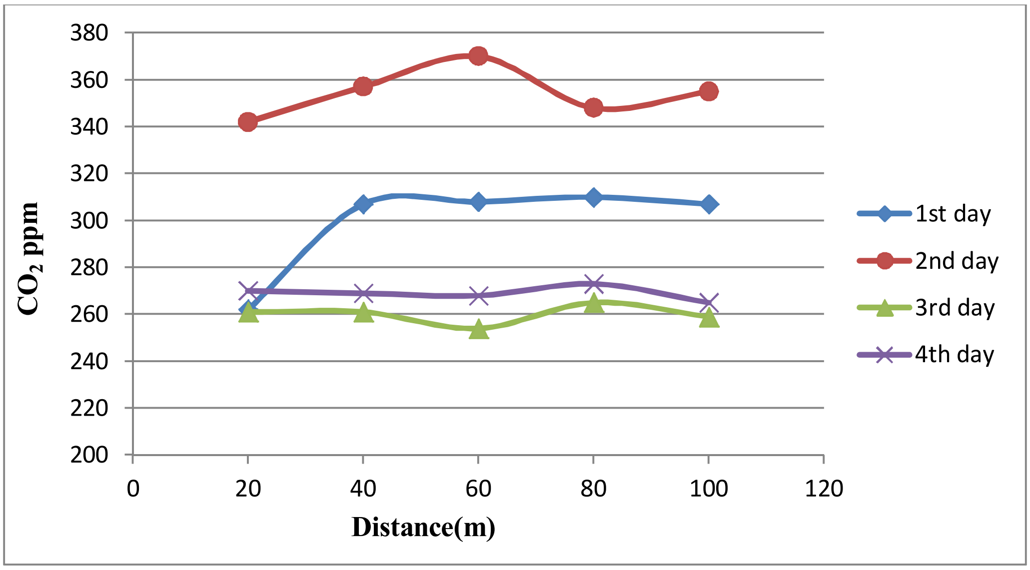

Figure (4.11): Carbon Dioxide levels around power plant (1st, 2nd, 3rd, 4th day)

The levels of carbon dioxide CO_2 to 300 meter around power plant in the fifth, sixth, seventh, eighth and ninth monitoring day shows in figure 4.12. In fifth day, the concentration at 20, 40, and 60 m was 431, 442, and 463 ppm respectively, the concentration was decreased at 80, 100, 120, 140, 160, and 180 m to 453, 448, 438, 434, 439, and 431 ppm respectively, and then the concentration was increased to 443 and 456 ppm at 200 and 220 m, while the concentration was 450 ppm at 240 to 300 m from power plant with an increase of 20 ppm on concentration of carbon dioxide at 20 m from power plant.

The figure shows an increase in the concentration of carbon dioxide CO_2 as we move away from the power plant. Temperature was 21c, humidity was 72%, and wind direction was north direction during measurement. According to equation(4.29), there is a good relation between CO_2 concentration and distance as follows:

$$Y= -2E^{-7}x^4 +0,0001x^3 -0.0247x^2 +1.9963x + 400.3 \quad , R^2= 0.6 \quad .... \quad \text{equation (4.29)}$$

The levels of carbon dioxide CO_2 around power plant in the sixth monitoring day at 20 m and 40 m was 469 ppm and 480 ppm, the concentration was decreased to 474 ppm and 470 ppm at 60 m and 80 m respectively, and then it was increased at 100 m to 496 ppm, while the concentration at 160 m was 487 ppm, the concentration at 240, 260, 280, and 300 m was increased to 490, 496, 509, and 514 ppm. The difference between the first measuring point at 20 meters and the last measuring point at 300 meters was 45 ppm. The figure shows an increase in the concentration of carbon dioxide (CO_2) as we move away from the power plant. Temperature was 23c, humidity was 60%, and wind direction was north during measurement. The equation(4.30) shows a good relation between CO_2 concentration and distance as follows:

$$Y= 1E^{-5}x^3 -0.0046x^2 +0.6503x + 456.13 \quad , R^2= 0.8 \quad ...... \quad \text{equation (4.30)}$$

According to the same figure, the levels of carbon dioxide CO_2 around power plant in the seventh monitoring day at 20, 40, and 60 m was 351, 333, and 324 ppm respectively, and then the concentration was increased at 80 m to 343 ppm and at 100 m to 346 ppm, while the concentration was decreased at 120, 140, 160, 180, 200, and 220 m to 322, 340, 331, 335, 331, and 329 ppm respectively, and then it was increased at 300 m from power plant to 344 ppm.

The concentration of carbon dioxide CO_2 around power plant in the eighth monitoring day at 20, 40, 60, 80, and 100 m was 399, 408, 409, 428, and 419 ppm respectively, the concentration was continue increased at 120, 140, and 160 m to 434, 422, and 446 ppm respectively, and then the concentration was decreased to 426 and 430 ppm at 180 and 200 m, while the concentration was back to increased to 447 ppm at 220 m and continue increased to 458 ppm at 300 m from power plant with an increase of 59 ppm on concentration of carbon dioxide at 20 m from power plant. The figure shows an increase in the concentration of carbon dioxide as we move away from the power plant. Temperature was 21c, humidity was 58%, and wind direction was north during measurement. The straight-line equation(4.31) as follows:

$$Y= 0.169x + 403.2 \quad , R^2= 0.8 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad \text{equation (4.31)}$$

According to the same figure, the levels of carbon dioxide CO_2 around power plant in the ninth monitoring day at 20, 40, 60, and 80 m was 401, 390, 398, and 400 ppm respectively, the concentration was decreased at 100 m to 373 ppm and then the concentration was increased to 403 and 410 ppm at 120 and 180 m, while the concentration was back to decrease to 394 ppm at 200 m and continue decreased to 371 ppm at 240 m from power plant, while the concentration was back to increase at 260 m and 300 m to 408 ppm and 400 ppm from the power plant. The figure shows a slight increase in the concentration of carbon dioxide as we move away from the power plant. Temperature was 21c, and humidity was 50%. The weather condition was unstable and wind direction was north to west, and then was turned south to west during measurement.

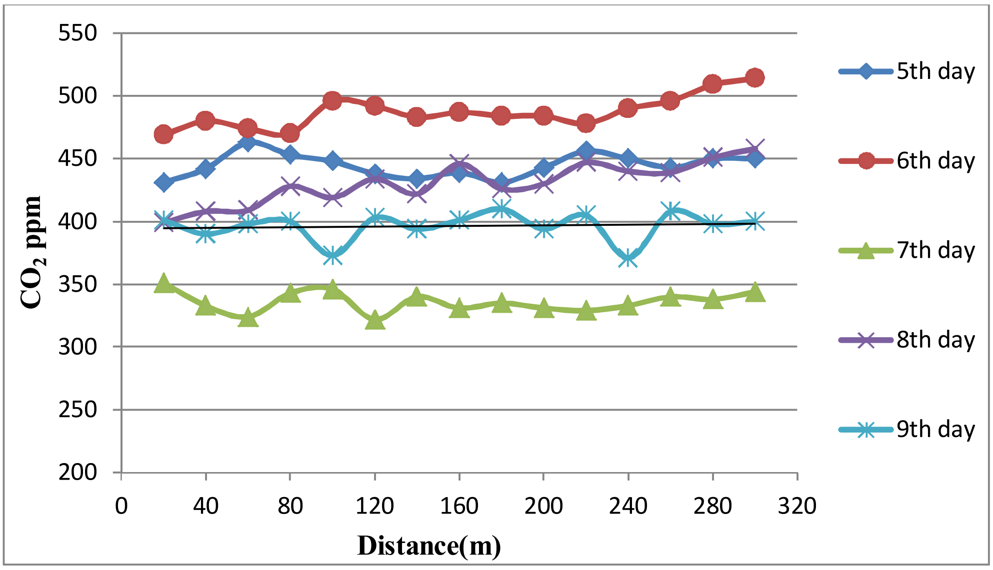

Figure (4.12): Carbon Dioxide levels around power plant (5th, 6th, 7th, 8th, 9th day)

4.2.1.1 Carbon dioxide Measurement at East Power Plant

The concentration of carbon dioxide at the east of the power plant in the first, second, third and fourth day presents in figure 4.13. In first day, the figure shows an increase in the concentration of carbon dioxide as we move away from the power plant and wind direction was north to west during the measurement. The concentration of carbon dioxide at 20 m was 133 ppm, and then it was increased to 308 ppm at 40 m, and at 60 m was 305 ppm, while it was increased at 80 and 100 m to 335 and 325 ppm. A very good relation between CO_2 concentration and distance shown in equation(4.32) as follows:

$$Y= -0.0602x^2 +9.2764x - 10.6 \quad , R^2= 0.9 \quad \text{……………} \quad \text{equation (4.32)}$$

The concentration of carbon dioxide at the east of the power plant in second day at 20 m was 271 ppm, and then it was increased to 304 ppm at 40 m, and at 60 m it was decreased to 292 ppm, while it was increased at 80 and 100 m to 312 and 329 ppm respectively. The figure shows an increase in the concentration of carbon dioxide as we move away from the power plant and wind direction was north to west during the measurement. A good relation between CO_2 concentration and distance shown in equation(4.33) as follows:

$$Y= 0.62x + 264.4 \quad , R^2= 0.8 \quad \text{…………………..} \quad \text{equation (4.33)}$$

According to the same figure, the concentration of carbon dioxide in third day shows a decrease in the concentration of carbon dioxide from 20 m to 60 m from the power plant and then it was increased at 80 m and 100 m, wind direction was north to west during the measurement. The concentration of carbon dioxide at 20 m was 255 ppm, and then it was decreased to 246 ppm at 40 m, and at 60 m it was decreased to 240 ppm, while it was increased at 80 and 100 m to 288 and 262 ppm respectively. The equation(4.34) shows the relation between CO_2 concentration and distance as follows:

$$Y= -0.0008x^3 +0.1479x^2 -7.7202x + 359.2 \quad , R^2= 0.7 \quad \text{…} \quad \text{equation (4.34)}$$

The level of carbon dioxide at the east of the power plant in fourth day shows an increase in the concentration of carbon dioxide from 20 m to 80 m from the power plant and then it was decreased at 100 m, wind direction was north to west during the measurement. The concentration of carbon dioxide at 20 m was 240 ppm, the concentration was 243 ppm at 40 m, and at 60 m it was increased to 253 ppm, while it was increased at 80 m to 270 ppm, and then it was decreased to 262 ppm at 100 m from power plant. The straight-line equation(4.35) have a good relation between concentration and distance as follows:

$$Y= 0.355x + 232.3 \quad , R^2= 0.8 \quad \text{………………} \quad \text{equation (4.35)}$$

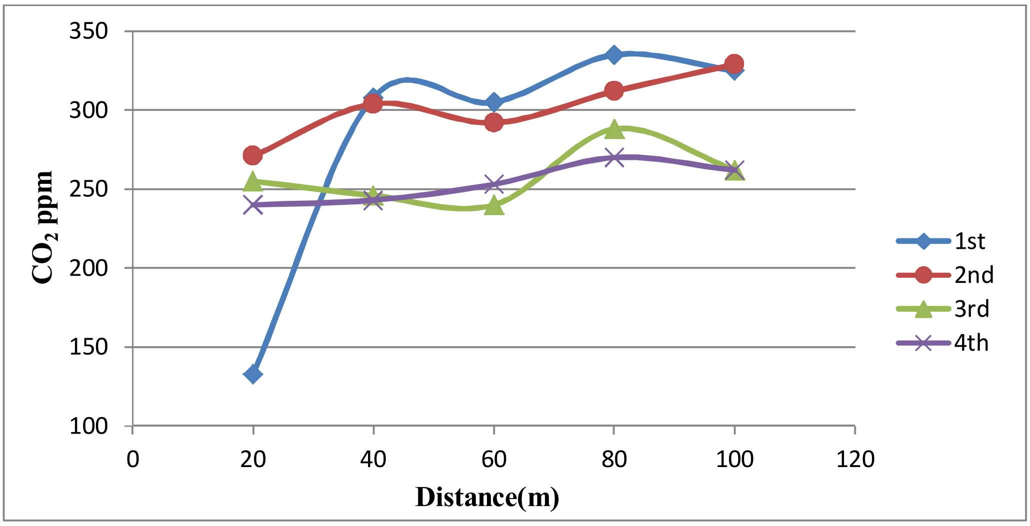

Figure (4.13): Carbon Dioxide at east of plant (1st, 2nd, 3rd, 4th day)

According to figure 4.14 that presents the concentration of carbon dioxide at the east of the power plant in the fifth, sixth, seventh, eighth and ninth day. In fifth day, the figure shows an increase in the concentration of carbon dioxide where the concentration at 20 m was 394 ppm and it was increased at 60 m to 445 ppm, the concentration at 140 m from the power plant was 437 ppm, while the concentration was increased to 439 ppm at 260 m from the power plant.

The concentration of carbon dioxide at the east of the power plant in the sixth day shows an increase in the level of carbon dioxide where the concentration at 20 m was 497 ppm and it was increased at 60 m to 507 ppm, the concentration at 120 m from the power plant was 523 ppm, while the concentration was continue increased to 529 ppm and 547 ppm at 280 m and 300 m respectively from the power plant. There is a good relation between concentration and distance shown in equation(4.36) as follows:

$$Y = 9E^{-6}x^3 - 0.004x^2 + 0.543x + 484.27 \quad , R^2 = 0.75 \quad \ldots\ldots \quad \text{equation (4.36)}$$

The concentration of carbon dioxide in seventh day shows an increase in the level of carbon dioxide where the concentration at 20 m was 315 ppm and it was increased at 80 m to 340 ppm, the concentration at 160 m from the power plant was decreased to 319 ppm, while the concentration was continue increased to 345ppm and 346 ppm at 220 m and 300 m respectively from the power plant.

According to the same figure, the concentration of carbon dioxide in eighth day shows an increase in the level of carbon dioxide where the concentration at 20 m was 332 ppm and it was increased at 160 m to 378 ppm, the concentration at 220 m from the power plant was 404 ppm, while the concentration was increased to 401 ppm at 300 m from the power plant. A good relation between concentration and distance shown in equation(4.37) as follows:

$$Y= 0.230x +332.7 \quad , R^2= 0.76 \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad \text{equation (4.37)}$$

The level of carbon dioxide at the east of the power plant at the ninth day shows an increase in the concentration of carbon dioxide where the concentration at 20 m was 397 ppm and it was increased at 160 m to 416 ppm, the concentration at 220 m from the power plant was 441 ppm, while the concentration was increased to 444 ppm at 260 m and then it was decreased to 440 ppm at 300 m from the power plant.

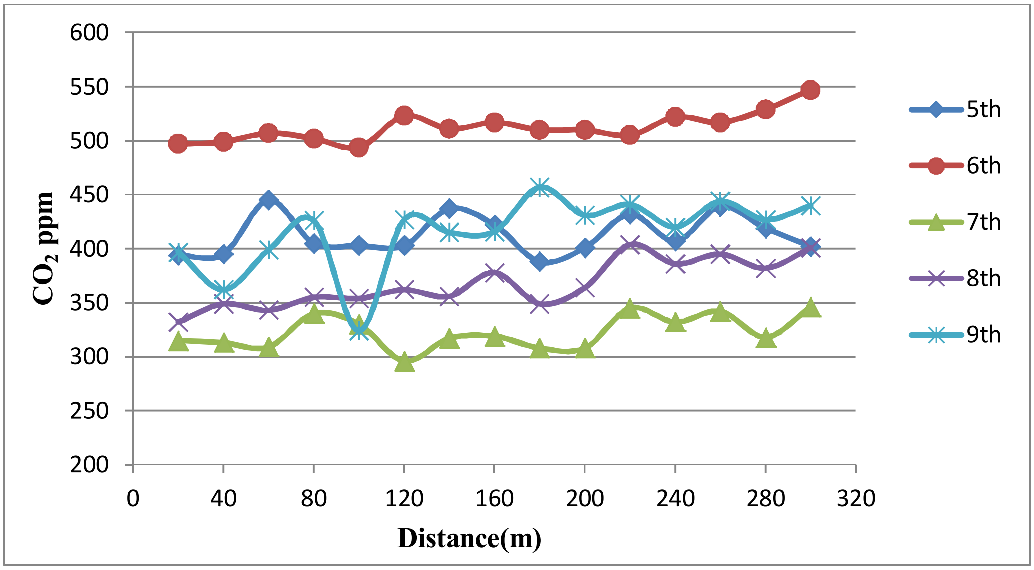

Figure (4.14): Carbon Dioxide at east of plant (5th, 6th, 7th, 8th, 9th day)

The concentration of carbon dioxide at the east of the power plant in first to fourth monitoring days was less than the concentration at fifth to ninth monitoring day because there are random burning in random landfill at west power plant during measurement in the last five days with the presence of the northern and western wind that helped in the transfer of carbon dioxide to the east side of the power plant.

4.2.1.2 Carbon dioxide Measurement at West Power Plant

The level of carbon dioxide at the west of the power plant in the first, second, third and fourth day presents in figure 4.15. In first day, the figure shows a decrease in the concentration of carbon dioxide as we move away from the power plant, where the measurement time at the night and car traffic was a few and maybe because of it there was a decrease in concentration with increasing distance and wind speed was zero. The concentration of carbon dioxide at 20 m was 370 ppm, the concentration at 40 and 60 m was 361 and 371 ppm respectively, then the concentration was decreased at 80 and 100 m to 360 and 353 ppm respectively. The equation(4.38) shows a good relation between CO_2 concentration and distance as follows:

$$Y= -0.0002x^3 +0.0251x^2 -1.2857x + 386 \quad , R^2= 0.7 \quad \ldots\ldots \quad \text{equation (4.38)}$$

The level of carbon dioxide of west power plant at the second day shows an increase in the concentration of carbon dioxide from 20 m to 60 m from the power plant. The concentration of carbon dioxide at 20 m was 380 ppm, the concentration at 40 and 60 m was 396 and 444 ppm respectively, then the concentration was decreased at 80 to 348 ppm, and at 100 m was increased to 368 ppm. According to equation(4.39), there is a good relation between CO_2 concentration and distance as follows:

$$Y= 0.0009x^3 -0.1818x^2 +10.8146x + 223.2 \quad , R^2= 0.5 \quad \ldots\ldots \quad \text{equation (4.39)}$$

According to the same figure, the level of carbon dioxide of west power plant at the third day shows an increase in the concentration of carbon dioxide and during measurement there was random burning in place. The concentration of carbon dioxide at 20 m was 265 ppm, the concentration at 40 and 60 m was 268 and 273 ppm respectively, then the concentration was continue increased at 80 to 285ppm, and at 100 m was increased to 298 ppm. The straight-line equation(4.40) shows a very good relation between concentration and distance as follows:

$$Y= 0.415x + 252.9 \quad , R^2= 0.927 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad \text{equation (4.40)}$$

The concentration of carbon dioxide of west power plant at the fourth day shows an increase in the level of carbon dioxide. The concentration of carbon dioxide at 20 m was

284 ppm, the concentration at 40 and 60 m was 320 and 307 ppm respectively, then the concentration was continue increased at 80 to 318ppm, and at 100 m was increased to 323 ppm. There is a good relation between concentration and distance shown in equation(4.41)as follows:

$$Y= 0.0004x^3 -0.0874x^2 +5.4226x + 208.4 \quad , R^2= 0.85 \quad \ldots\ldots \text{ equation (4.41)}$$

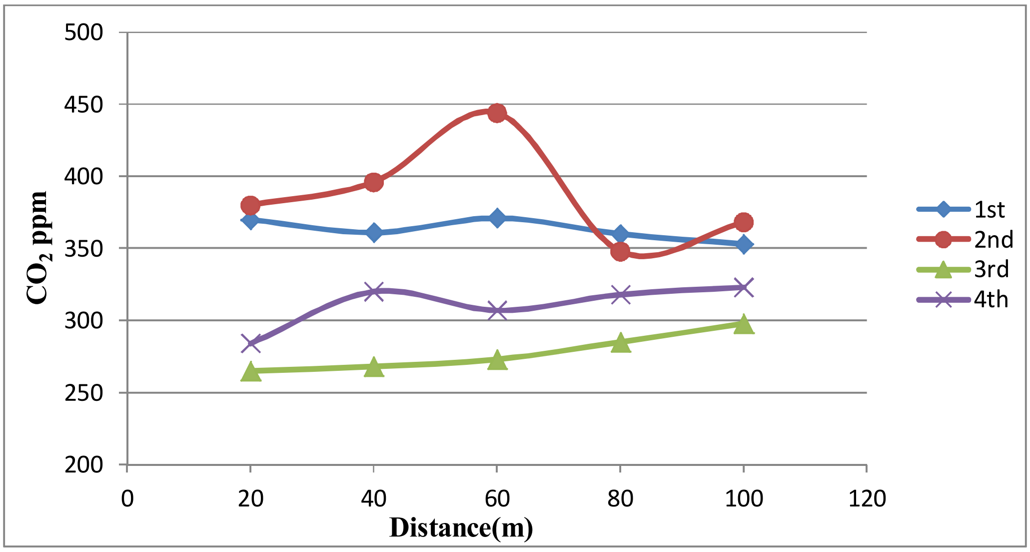

Figure (4.15): Carbon Dioxide at west of plant (1^{st}, 2^{nd}, 3^{rd}, 4^{th} day)

According to figure 4.16 that presents the concentration of carbon dioxide of west power plant at the fifth, sixth, seventh, eighth and ninth day. In first day, the figure shows an increase in the concentration of carbon dioxide where the concentration at 20 m was 458 ppm and it was increased at 40, 60, 80, and 100 m to 464, 471, 511, and 545 ppm respectively, and then it was decreased to 489 and 478 ppm at 120 and 140 m from power plant, then it was back to increase until reached 527 ppm at 300 m from power plant. The straight-line equation(4.42) as follows:

$$Y= 0.223x + 468.5 \quad , R^2= 0.5 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{ equation (4.42)}$$

The level of carbon dioxide of west power plant at the sixth day shows an increase in the concentration of carbon dioxide where the concentration at 20 m was 395 ppm and it was increased at 40, 60, 80, and 100 m to 413, 399, 398, and 460 ppm respectively, and then it was decreased to 395 ppm at 220 m from power plant, then it was back to increase until reached 495 ppm at 300 m from power plant with an increase of 100 ppm in concentration of carbon dioxide at 20 m from power plant. The equation(4.43) shows the relation between concentration and distance as follows:

$$Y= 3E^{-5}x^3 -0.015x^2 +1.82x + 356.1 \quad , R^2= 0.7 \quad .... \quad \text{equation (4.43)}$$

The concentration of carbon dioxide of west power plant at the seventh day shows a slight increase in the level of carbon dioxide where the concentration at 20 m was 372 ppm and it was increased at 40 m to 382 ppm, the concentration was decreased to 361 ppm at 240 m, and then it was increased to 400 ppm and 374 ppm at 280 m and 300 m from the power plant.

The concentration of carbon dioxide of west power plant at the eighth day shows an increase in the level of carbon dioxide where the concentration at 20 m was 489 ppm and it was decreased at 40 m to 487 ppm, the concentration was increased to 562 ppm at 80 m and it was increased to 598 ppm at 160 ppm, and then the concentration was increased to 602 ppm and 596 at 280 m and 300 m from the power plant with an increase of 110 ppm on concentration at 20 m from power plant. The high concentration of carbon dioxide in this day because sever random burning and traffic. According to equation(4.44), a good relation shown between concentration and distance as follows:

$$Y= 2E^{-5}x^3 -0.0122x^2 +2.19x + 435.21 \quad , R^2= 0.8 \quad .... \quad \text{equation (4.44)}$$

According to the same figure, the level of carbon dioxide of west power plant at the ninth day shows a decrease in the concentration of carbon dioxide where the concentration at 20 m was 417 ppm and it was increased at 40 m to 428 ppm, the concentration was decreased to 416 ppm and 424 ppm at 60 m and 80 m. It was decreased to 418 ppm at 140 m, and then the concentration was continue decreased to 400, 405, and 390 ppm at 160, 180, and 200 m from the power plant, while the concentration was continue decreased at 240, 260, and 300 m to 380, 376, and 372 ppm respectively. The straight-line equation(4.45) as follows:

$$Y= -0.205x + 435.8 \quad , R^2= 0.86 \quad .... \quad \text{equation (4.45)}$$

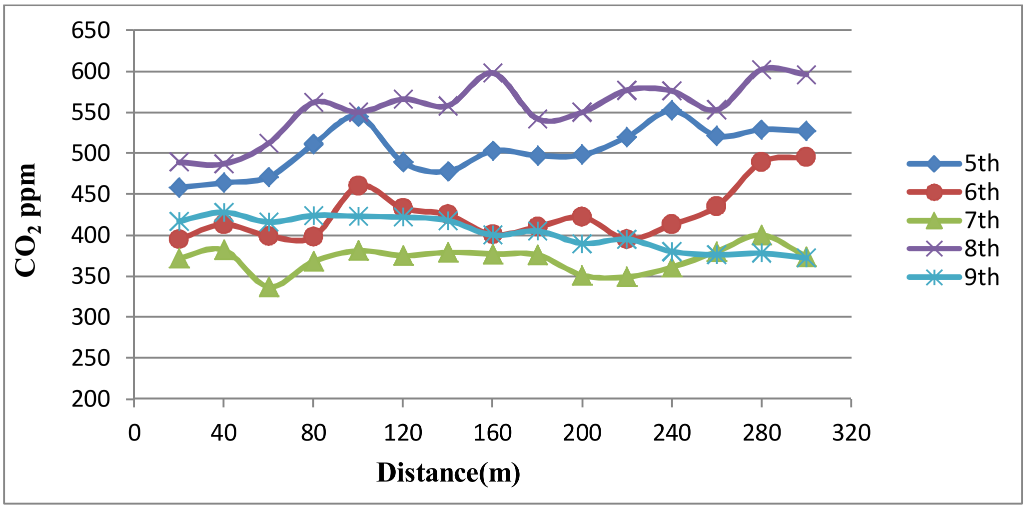

Figure (4.16): Carbon Dioxide at west of plant (5th, 6th, 7th, 8th, 9th day)

The concentration of carbon dioxide at west power plant was higher than the concentration at other sides of power plant because the movement of vehicles and the presence of random landfill which frequently random burning and the presence of the petrol filling station on this side. The concentration of carbon dioxide in fifth to ninth monitoring day was higher than the concentration in first monitoring days because there was random burning during the measurement period in the fifth to ninth days.

4.2.1.3 Carbon dioxide Measurement at North Power Plant

The level of carbon dioxide of north power plant at the first, second, third and fourth day presents in figure 4.17. In first day, the figure shows a decrease in the concentration of carbon dioxide where the concentration of carbon dioxide at 20 m was 239 ppm, the concentration at 40 and 60 m was 252 and 248 ppm respectively, then the concentration was decreased at 80 and 100 m to 215 and 200 ppm respectively. A very good relation between CO_2 concentration and distance shown in equation(4.46) as follows:

$$Y= -0.0152x^2 + 1.25x +222.8 \quad , R^2= 0.9 \quad \ldots\ldots\ldots\ldots \quad \text{equation (4.46)}$$

According to the same figure, the concentration of carbon dioxide at north power plant at the second day was 316 ppm at 20 m, the concentration at 40 and 60 m was 331and 336 ppm respectively, then the concentration was decreased at 80 m to 331, and at 100 m the concentration was 333 ppm. There is a good relation between concentration and distance shown in equation(4.47) as follows:

$$Y= -0.0064x^2 +0.9414x + 301.2 \quad , R^2= 0.86 \quad \text{……… equation (4.47)}$$

According to the same figure, the concentration of carbon dioxide at north power plant at the third day was 226 ppm at 20 m, the concentration was increased at 40 m to 237 ppm, and then it was decreased at 60 and 80 m to 217 and 211 ppm respectively, while the concentration was increased to 222 ppm at 100 m. The figure shows a decrease in the concentration of carbon dioxide. The equation(4.48) shows a very good relation between concentration and distance as follows:

$$Y= 0.0005x^3 -0.0875x^2 +4.25x \;\; 172.6 \quad , R^2= 0.9 \quad \text{….. equation (4.48)}$$

The concentration of carbon dioxide at north power plant at the fourth day presents in the same figure 4.18. The figure shows a decrease in the concentration of carbon dioxide, the concentration of carbon dioxide at 20 m was 273 ppm, the concentration at 40 m was 237 ppm, and then it was decreased at 60 and 80 m to 238 and 235 ppm respectively, while the concentration was decreased to 219 ppm at 100 m. The straight-line equation(4.49) as follows:

$$Y= -0.565x + 274.9 \quad , R^2= 0.82 \quad \text{…………… equation (4.49)}$$

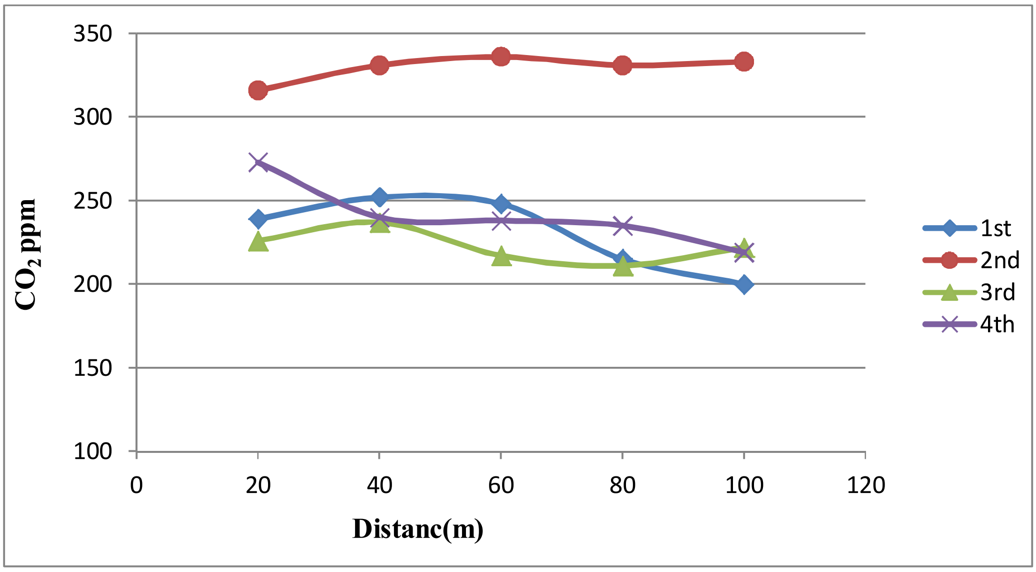

Figure (4.17): Carbon Dioxide at north of plant (1^{st}, 2^{nd}, 3^{rd}, 4^{th} day)

The concentration of carbon dioxide at the north of the power plant in fifth, sixth, seventh, eighth and ninth day presents in figure 4.18. In fifth day, the figure shows a decrease in the concentration of carbon dioxide where the concentration at 20 m was 449 ppm and it was increased at 40 and 60 m to 468 and 529 ppm, and then it was decreased as move away from the power plant to 409 ppm at 300 m from the power plant with decrease of 120 ppm in concentration of carbon dioxide at 60 m from power plant. The equation(4.50) shows the relation between concentration and distance as follows:

$$Y= -4E^{-7}x^4 +0.0002x^3 -0.05x^2 +3.43x + 408.3 \quad , R^2= 0.67 \quad \ldots\ldots \text{ equation (4.50)}$$

The level of carbon dioxide at the north of power plant in sixth day was 512 ppm at 20 m and it was decreased at 40, 60, and 80 m to 507, 504, and 477 ppm, while it was increased to 514 ppm at 100 m from the power plant, and then the concentration was back decreased to 479 ppm at 200 m and to 475 ppm at 300 m with decrease of 40 ppm in concentration of carbon dioxide at 20 m from power plant. The figure shows a decrease in the concentration of carbon dioxide and the relation between concentration and distance shown in equation(4.51) as follows:

$$Y= -3E^{-6}x^3 +0.002x^2 -0.4x +519.3 \quad , R^2= 0.5 \quad \ldots\ldots\ldots \quad \text{equation (4.51)}$$

According to the same figure 4.19 the concentration of carbon dioxide in seventh day shows a decrease in the level of carbon dioxide where the concentration at 20 m was 367 ppm and it was decreased at 40 m to 295 ppm, the concentration was increased at 100 m from power plant to 342 ppm, and then it was decreased to 318 ppm at 240 m and continue decreased to 310 ppm at 300 m from power plant.

The concentration of carbon dioxide at the north of the power plant in eighth day shows a decrease in the level of carbon dioxide where the concentration at 20 m was 375 ppm and it was decreased at 40, 60, 80, 100, 120, and 140 m to 382, 348, 343, 331, 326, and 310 ppm respectively and then it was increased slowly from 160 m to 300 m from power plant but still less than the concentration at 20 m, the concentration at 300 m was 336 ppm with decrease of 40 ppm in the concentration of carbon dioxide at 20 m from power plant. There is a good relation between concentration and distance in equation(4.52) as follows:

$$Y= 0.002x^2 -0.79x +394.5 \quad , R^2= 0.88 \quad \ldots\ldots\ldots\ldots \quad \text{equation (4.52)}$$

The concentration of carbon dioxide in ninth day shows a decrease in the level of carbon dioxide where the concentration at 20 m was 362 ppm and it was decreased at 40, 60, 80, and 100 m to 351, 353, 336, and 345 ppm respectively and then it was increased at 120 m and 160 m to 370 ppm and 400 ppm respectively, while the concentration was back to decrease at 200, 280, and 300 m to 359, 354, and 349 ppm respectively from power plant.

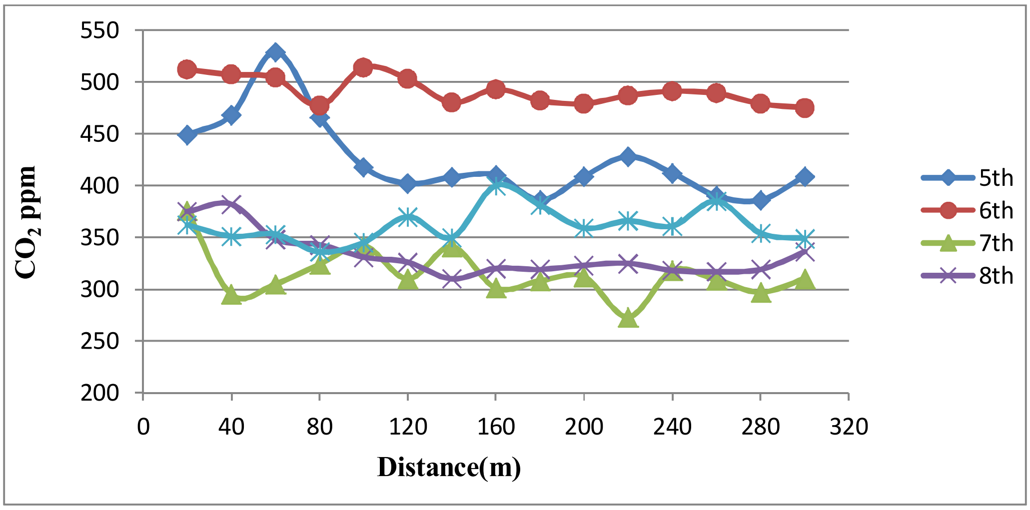

Figure (4.18): Carbon Dioxide at north of plant (5th, 6th, 7th, 8th, 9th day)

The concentration of carbon dioxide at the north of the power plant was less than the concentration at other sides of power plant because there is no other pollution sources affect the measurement results.

4.2.1.4 Carbon dioxide Measurement at South Power Plant

The level of carbon dioxide at the south of the power plant in the first, second, third and fourth day presents in figure 4.19. In first day, the figure shows an increase in the concentration of carbon dioxide as we move away from the power plant because of the proximity of power plant engine from southern side and wind direction was north to west during the measurement. The concentration of carbon dioxide at 20, 40, and 60 m was 307, 306, and 307 ppm respectively, and then it was increased to 328 ppm at 80 and increased to 348 ppm at 100 m from power plant. The straight-line equation(4.53) as follows:

$$Y= 0.52x + 288 \quad , R^2= 0.78 \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad \text{equation (4.53)}$$

According to the same figure the concentration of carbon dioxide in second day shows a decrease in the level of carbon dioxide as we move away from the power plant and wind direction was north to west during the measurement which transfers carbon dioxide away from power plant. The concentration of carbon dioxide at 20, 40, and 60 m was 402, 395, and 406 ppm respectively, and then it was decreased to 401 ppm at 80 and to 391 ppm at 100 m from power plant. The equation(4.54) shows a good relation between CO_2 concentration and distance as follows:

$$Y= -0.0002x^3 +0.04x^2 -1.9x +425 \quad , R^2= 0.79 \quad \ldots\ldots\ldots \quad \text{equation (4.54)}$$

The concentration of carbon dioxide at the south of the power plant in third day shows a decrease in the level of carbon dioxide as we move away from the power plant and wind direction was north to west during the measurement and that make the concentration of carbon dioxide decreased. The concentration of carbon dioxide at 20 m was 296 ppm, the concentration at 40 m was 291 ppm, it was 284 ppm at 60 m, and then it was decreased to 278 ppm at 80 and to 255 ppm at 100 m from power plant. The straight-line equation(4.55) as follows:

$$Y= -0.475x + 309.3 \quad , R^2= 0.885 \quad \ldots\ldots\ldots\ldots\ldots \quad \text{equation (4.55)}$$

The concentration of carbon dioxide at the south of the power plant in fourth day shows a decrease in the level of carbon dioxide as we move away from the power plant and wind direction was north to west during the measurement and that make the concentration of carbon dioxide decreased. The concentration of carbon dioxide at 20 m was 281 ppm, the concentration at 40 m was 272 ppm, it was 270 ppm at 60 m, and then it was continue decreased to 261 ppm at 80 and to 257 ppm at 100 m from power plant. The equation(4.56) shows a very good relation between CO_2 concentration and distance as follows:

$$Y= -0.295x + 285.9 \quad , R^2= 0.97 \quad \ldots\ldots\ldots\ldots\ldots \quad \text{equation (4.56)}$$

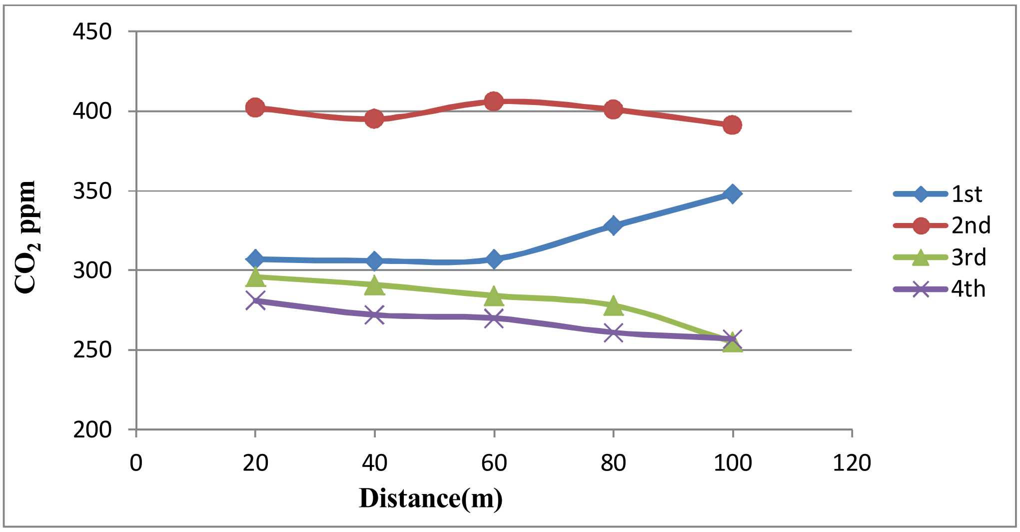

Figure (4.19): Carbon Dioxide at south of plant (1st, 2nd, 3rd, 4th day)

According to figure 4.20 that presents the concentration of carbon dioxide at the south of the power plant at the fifth, sixth, seventh, eighth and ninth day. In fifth day, the figure shows an increase in the concentration of carbon dioxide where the concentration at 20 m was 424 ppm and it was increased at 40 m to 442 ppm, the concentration at 120 m from the power plant was increased to 456 ppm, while the concentration was increased to 464 at 200 m and 280 m from the power plant. Wind direction was north and that made transfer carbon dioxide to south power plant.

According to the same figure 4.21 that presents the concentration of carbon dioxide at the south of the power plant at the sixth day. The figure shows an increase in the concentration of carbon dioxide where the concentration at 20 m was 470 ppm and it was continue increased until reached to 538 ppm at 160 m from power plant, while it was slightly decreased at 200 m to 524 ppm, and then the concentration of carbon dioxide was increased to 538 ppm at 300 m from the power plant. Wind direction was north and that made transfer carbon dioxide to south power plant. There is a good relation between concentration and distance in equation(4.57) as follows:

$$Y = 0.218x + 482.7 \quad , R^2 = 0.8 \quad \text{.................. equation (4.57)}$$

The level of carbon dioxide in seventh day presents in the same figure. The figure shows a slight increase in the concentration of carbon dioxide where the concentration at 20 m was 339 ppm and it was increased at 40 m and 60 m to 342 ppm and 345 ppm, while the concentration was decreased to 307 ppm at 120 m from the power plant, and then it was back to increased at 200 m and 300 m to 351 ppm and 345 ppm respectively.

The same figure presents the concentration of carbon dioxide in eighth day. It shows an increase in the concentration of carbon dioxide where the concentration at 20 m was 411 ppm and it was increased at 40 m to 412 ppm, the concentration was increased to 431ppm and 450 ppm at 60 m and 80 m. It was increased to 482 ppm at 120 ppm, and then the concentration was increased to 489 ppm and 494 at 160 m and 180 m from the power plant, while the concentration was increased to 499 ppm and 497 ppm at 280 m and 300 m with an increase of 90 ppm on concentration at 20 m from power plant. The straight-line equation(4.58) as follows:

$$Y= 0.301x + 418.2 \quad , R^2= 0.78 \qquad \dots\dots\dots\dots\dots\dots \quad \text{equation (4.58)}$$

According to same figure 4.21 that presents the concentration of carbon dioxide at the south of the power plant at the ninth day. The figure shows a decrease in the concentration of carbon dioxide from 20 m to 200 m from power plant where the concentration at 20 m was 429 ppm and it was decreased at 40 m and 80 m to 417 ppm and 412 ppm, while the concentration was at 100, 120, 160, and 200 m from the power plant to 399, 391, 388, and 395 ppm and then it was increase at 260, 280, and 300 m to 425, 434, and 437 ppm respectively.

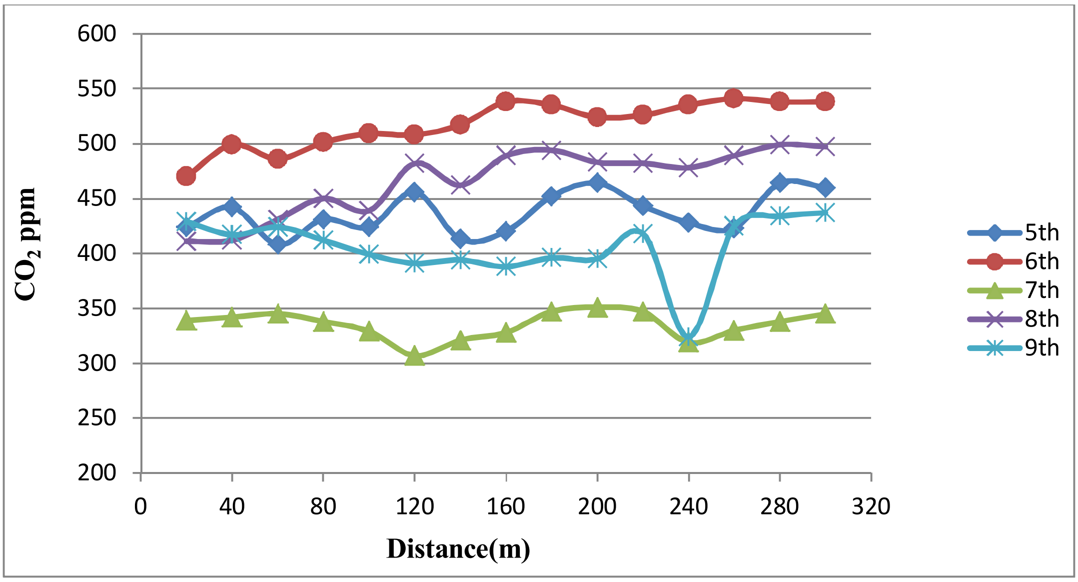

Figure (4.20): Carbon Dioxide at south of plant (5th, 6th, 7th, 8th, 9th day)

The concentration of carbon dioxide at the south of the power plant was high concentration because the northern and western wind working on the transfer of carbon dioxide from the western side of the high concentration to the southern side.

4.2.2 Carbon Monoxide Monitoring Results

Carbon monoxide results carried out by tow monitoring program, at a distance of 100 m (20, 40, 60, 80,100) and 300 m (20, 40, 60, …., 300).

The levels of carbon monoxide CO around power plant in the first, second, third and fourth monitoring day shows in figure 4.21. In first day during the night, the concentration at 20 m was 0.15 ppm, and then it is increased to 0.28 ppm at 40 m and increased to 0.35 ppm at 60 m from power plant, then the concentration was decreased at 80 m to 0.23 ppm, the concentration at 100 was decreased to 0.20 ppm. Temperature was 28c, humidity was 49%, and wind speed was 1m/s and become zero during measurement. The equation(4.59) shows a good relation between CO concentration and distance as follows:

$$Y= -9E^{-5}x^2 + 0.0112x -0.028 \;, \quad R^2= 0.8 \quad \ldots\ldots\ldots\ldots \quad \text{equation (4.59)}$$

According to same figure 4.23 shows the levels of carbon monoxide around power plant in the second monitoring day. The concentration at 20 m was 0.33 ppm, and then it is increased to 0.35 ppm at 40 m and back to 0.33 ppm at 60 m from power plant, then the concentration was decreased at 80 m to 0.3 ppm, the concentration at 100 was increased to 0.43 ppm. Temperature was 30c, humidity was 51%, and wind speed was ranging from 1 m/s to 3 m/s during measurement.

The same figure presents the levels of carbon monoxide around power plant in the third monitoring day. It shows a decrease in the concentration of carbon monoxide where the concentration at 20 m was 0.33 ppm, the concentration at 40 m was decreased to 0.3 ppm and continue decreased to 0.2 ppm at 60 m, while it was increased at 80 m to 0.28 ppm, and then the concentration was decreased to 0.1 ppm at 100 m from power plant. Temperature was 29c, humidity was 50%, wind speed was 1 m/s, and wind direction was north to west during measurement. The straight-line equation(4.60) as follows:

$$Y= -0.002x + 0.386 \;, R^2= 0.67 \quad \ldots\ldots\ldots\ldots\ldots \quad \text{equation (4.60)}$$

According to same figure shows the levels of carbon monoxide around power plant in the fourth monitoring day. The concentration at 20 m was 0.15 ppm, and then it is increased to 0.35 ppm at 40 m and increased to 0.55 ppm at 60 m from power plant, then the concentration was decreased at 80 m to 0.48 ppm, the concentration at 100 was decreased to 0.45 ppm. Temperature was 30c, humidity was 60%, wind speed was 3 m/s, and wind direction was north to west during measurement. The straight-line equation(4.61) as follows:

$$Y = 0.003x + 0.177 \quad , R^2 = 0.55 \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad \text{equation (4.61)}$$

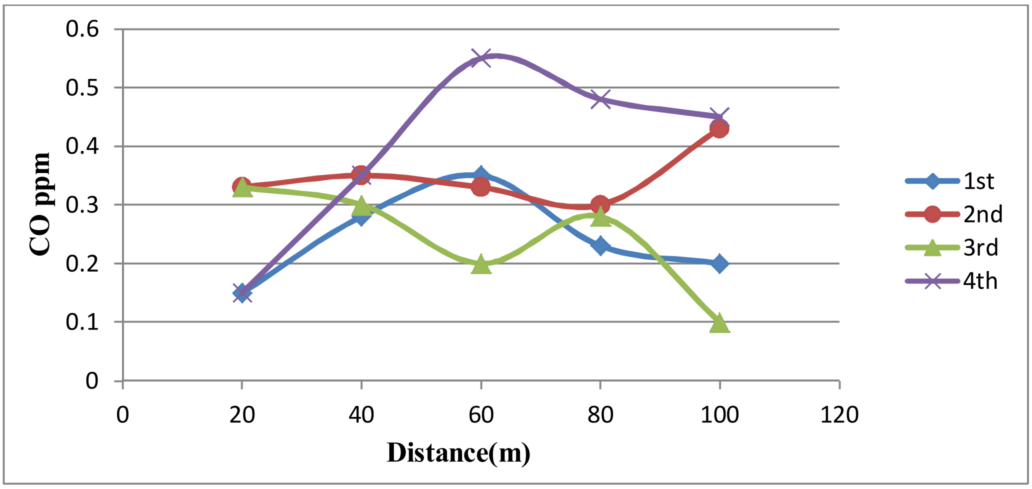

Figure (4.21): Carbon monoxide level around power plant (1st, 2nd, 3rd, 4th day)

Figure 4.22 shows the levels of carbon monoxide to 300 meter around power plant in the fifth, sixth, seventh, eighth and ninth monitoring day. In fifth day, the concentration at 20, 40, and 60 m was 0.85, 1.05, and 2.15 ppm respectively, the concentration was decreased at 80, 100, 120, 140, 160, and 180 m to 1.73, 1.3, 1.53, 1.38, 1.45, and 1.23 ppm respectively, and then the concentration was increased to 1.68 and 2.18 ppm at 200 and 220 m, while the concentration was decreased at 240, 260, 280, and 300 m to 1.6, 1.43, 1.63, and 1.63 ppm respectively. The figure shows an increase in the concentration of carbon monoxide as we move away from the power plant. Temperature was 21c, humidity was 72%, and wind direction was north during measurement.

According to figure 86.4 that shows the levels of carbon monoxide around power plant in the sixth monitoring day. The concentration at 20, 40, 60, and 80 m was 1.43, 128, 1.28, and 0.95 ppm, the concentration was increased to 1.73 ppm at 100 m from power plant, and then the concentration was decreased at 120 m and 140 m to 1.5 ppm and 1.03 ppm, it was back to increase at 180 m to 1.4 ppm, and then it was back to decrease at 220 m to 0.9 ppm, while the concentration was increased at 240 m and 260 m to 1.33 ppm and continue increased to 1.95 ppm and 1.83 ppm at 280 m and 300 m from power plant.

The figure shows a slight increase in the concentration of carbon monoxide as we move away from the power plant. Temperature was 23c, humidity was 60%, and wind direction was north during measurement.

The levels of carbon monoxide around power plant in the seventh monitoring day presents in figure 87.4. The concentration at 20, 40, and 60 m was 0.88, 0.65, and 0.8 ppm respectively, the concentration was increased at 80 m and 100 m to 1.2 ppm and 1.45ppm, and then the concentration was decreased to 0.5 ppm and 0.43 ppm at 120 m and 160 m, while the concentration was increased at 180, 240, and 260 m to 0.83, 0.83, and 0.88 ppm respectively, and then it was decreased to 0.53 ppm and 0.75 ppm respectively at 280 m and 300 m from power plant.

Temperature was 22c, humidity was 50%, and wind direction was north during measurement.

The levels of carbon monoxide around power plant in the eighth monitoring day shows in figure 88.4. The concentration at 20, 40, and 60 m was 1.03, 0.93, and 1.03 ppm respectively, the concentration was increased at 80 m and 120 m to 1.28 ppm and 1.18 ppm, and then the concentration was decreased to 0.98 ppm at 140 m and back increased to 1.38 ppm at 160 m, while the concentration was decreased at 180 m to 0.8 ppm, and then it was increased to 1.08 ppm and 1.45 ppm respectively at 200 m, 220 m, and 240 m from power plant, while it was decreased at 280 m and 300 m to 1.15 ppm and 1.05 ppm but still higher than the concentration at 20 m from power plant. Temperature was 21c, humidity was 58%, and wind direction was north during measurement.

According to figure 89.4 that shows the levels of carbon monoxide around power plant in the ninth monitoring day. The concentration at 20, 40, and 60 m was 0.18, 0.18, and 0.2 ppm respectively, the concentration was increased at 80 m, 100 m, and 120 to 0.5 ppm and 0.48 ppm respectively, and then the concentration was decreased to 0.1 ppm at 140 m, while the concentration was increased at 160 m and 180 m to 0.58 ppm and 0.85 ppm, and then it was decreased to 0.4, 0.48, and 0.28 ppm respectively at 200, 220, and 240 m, the concentration was increased to 0.68 ppm at 260 m and back to 0.45 ppm at 280 m and 300 m but still higher than the concentration at 20 m from power plant.

Temperature was 21c, and humidity was 50%. The weather condition was unstable and wind direction was north to west, and then was turned south to west during measurement.

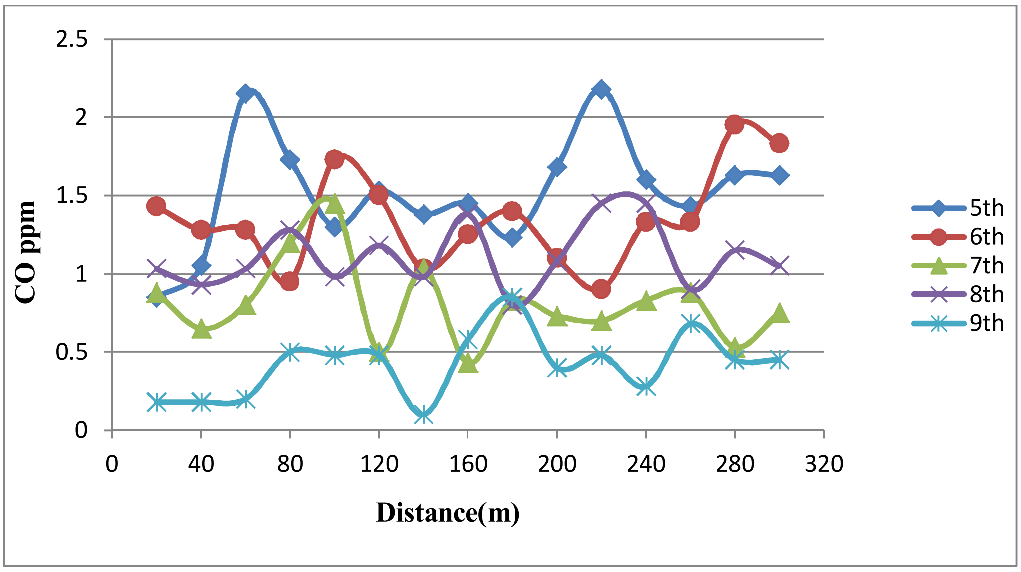

Figure (4.22): Carbon monoxide level around power plant (5th, 6th, 7th, 8th, 9th day)

Previous figures shows that the concentration of carbon monoxide very little and the researcher found that the west and south with a high proportion of the concentration of carbon monoxide because of the movement of vehicles and petrol filling station and random burning in the landfill located west of the power plant.

4.3 Noise Monitoring Results

In this part of the research will show the results of noise monitoring for five days and display measurements for each day by taking the mean values for each distance (20, 40, 60, ….,300) in four directions around the power plant as follows:

The level of noise around power plant in the first, second, third, fourth and fifth monitoring day shows in figure 4.23. In first day, the level of noise at 20 m was 54.5 dB, and then it was decreased to 52.5 dB at 100 m, while it was continue decreased to 46 dB and 42 dB at 200 m and 300 m from power plant. The straight-line equation(4.62) as follows:

$$Y= -0.050x + 56.98 \quad , R^2= 0.952 \quad \dots\dots\dots\dots \quad \text{equation (4.62)}$$

In the second monitoring day, the level of noise at 20 m was 50.3 dB, and then it was decreased to 47.3 dB at 100 m, while it was continue decreased to 43.8 dB and 43 dB at 200 m and 300 m from power plant. The straight-line equation(4.63) as follows:

$$Y= -0.030x + 50.74 \quad , R^2= 0.919 \quad \dots\dots\dots\dots \quad \text{equation (4.63)}$$

According to the same figure, it show that the level of noise around power plant in the third monitoring day at 20 m was 52.3 dB, and then it was decreased to 51.5 dB at 100 m, while it was continue decreased to 48 dB and 45.8 dB at 200 m and 300 m from power plant. The straight-line equation(4.64) as follows:

$$Y= -0.026x + 53.46 \quad , R^2= 0.978 \quad \dots\dots\dots\dots \quad \text{equation (4.64)}$$

The level of noise around power plant in the fourth monitoring day at 20 m was 48.3 dB, and then it was decreased to 48 dB at 100 m, while it was continue decreased to 45 dB and 44 dB at 200 m and 300 m from power plant. The straight-line equation(4.65) as follows:

$$Y= -0.018x + 49.13 \quad , R^2= 0.948 \quad \dots\dots\dots\dots \quad \text{equation (4.65)}$$

The level of noise around power plant in the fifth monitoring day at 20 m was 51.8 dB, and then it was decreased to 50.8 dB at 100 m, while it was continue decreased to 47.3 dB and 45.5 dB at 200 m and 300 m from power plant. The straight-line equation(4.66) as follows:

$$Y= -0.025x + 52.56 \quad , R^2= 0.966 \quad \dots\dots\dots\dots \quad \text{equation (4.66)}$$

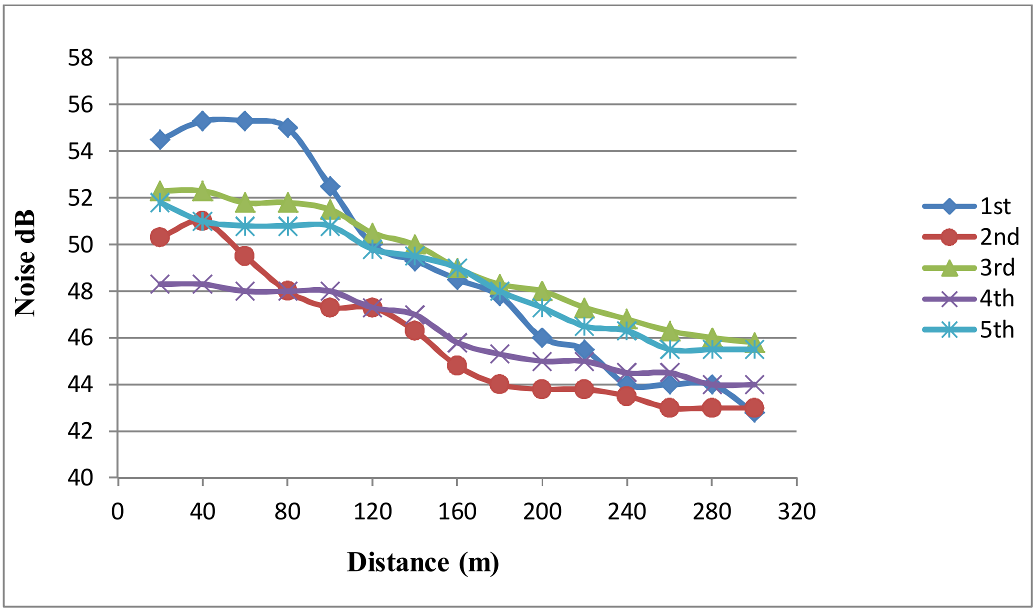

Figure (4.23): Noise level around power plant (1^{st}, 2^{nd}, 3^{rd}, 4^{th}, 5^{th} day)

The figure shows a decrease in the level of noise as we move away from the power plant and the level of noise low, the researcher found that the noise was in acceptable level.

4.4 Pollutants Modeling

Software called Lakes Environmental Screen View Model was used to simulate the trends of the pollutants and compare with the behavior of the real measurements to ensure the validity of measurements.

4.4.1 Particulate matter ($PM_{2.5}$) emission modeling

According to figure (4.24) that shown the particulate matter ($PM_{2.5}$) emission model, many parameters such as emission rate of particulate matter, stack height, stack diameter, stack gas exist velocity, and stack gas exist temperature from GPP company were used to simulate the particulate matter measurement, it was found that the modeled pollutants has similar trends with the real measurements of the pollutants, where the level of particulate matter at 500m and 1000m was 40 $\mu g/m^3$ and 55$\mu g/m^3$ respectively.

Emission rate (g/s)	11
Stack height (m)	60
Stack diameter (m)	1.5
Stack gas exist velocity (m/s)	15
Stack gas exist temperature (k)	423
Ambient air temperature (K)	293

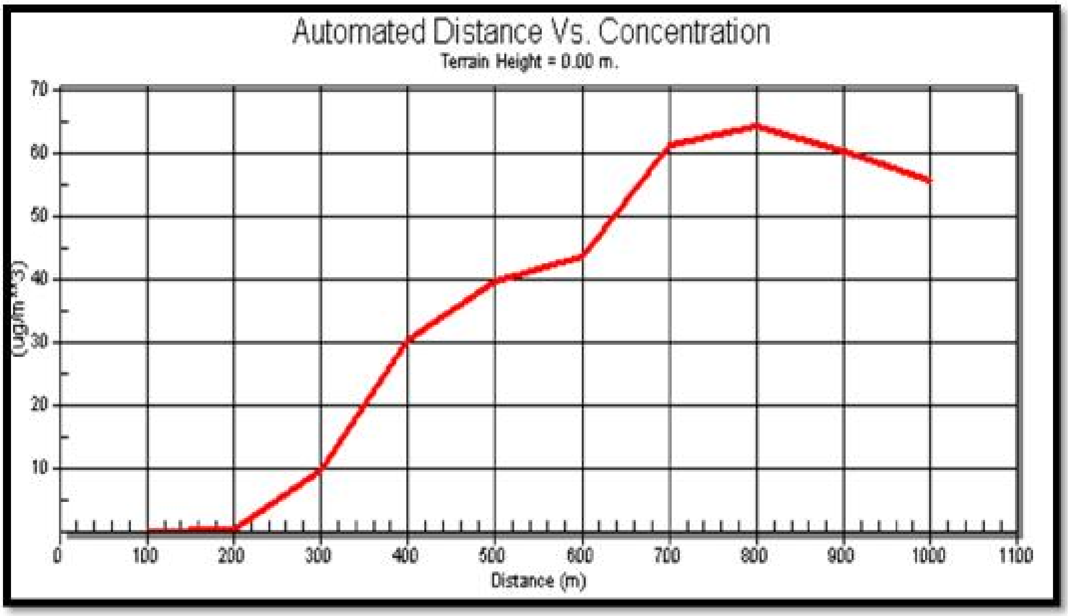

Figure (4.24): Particle Matter ($PM_{2.5}$) emission model

4.4.2 Carbon dioxide (CO_2) emission modeling

Carbon dioxide (CO_2) emission modeling shown in figure (4.25) where parameters such as emission rate of carbon dioxide, stack height, stack diameter, stack gas exist velocity, and stack gas exist temperature from GPP company were used to simulate the carbon dioxide trends, the results revealed that the trends were similar in both modeled and measured concentration of CO_2.

Emission rate (g/s)	753
Stack height (m)	60
Stack diameter (m)	1.5
Stack gas exist velocity (m/s)	15
Stack gas exist temperature (k)	423
Ambient air temperature (K)	293

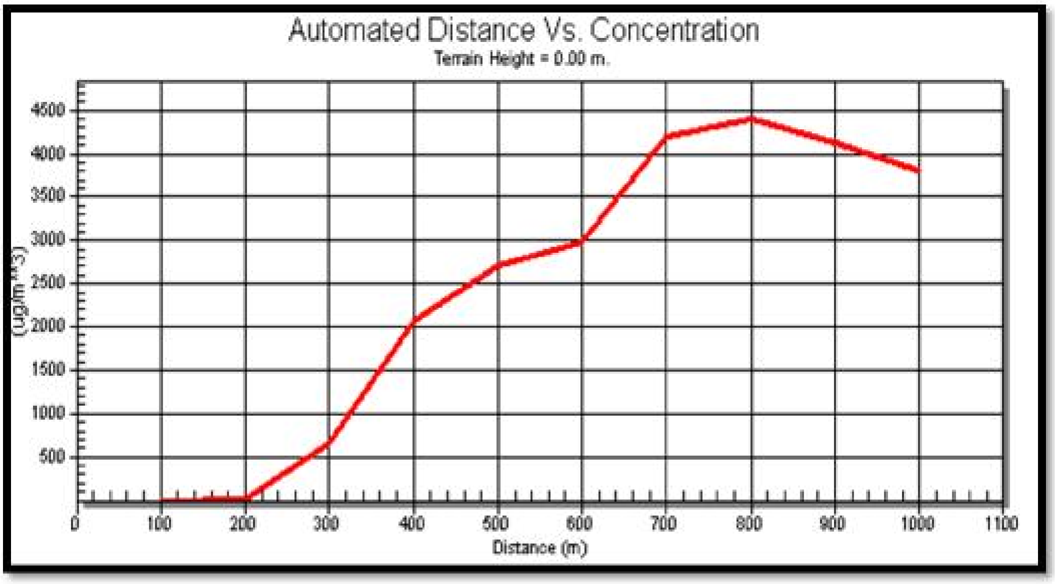

Figure (4.25): Carbon dioxide (CO_2) emission model

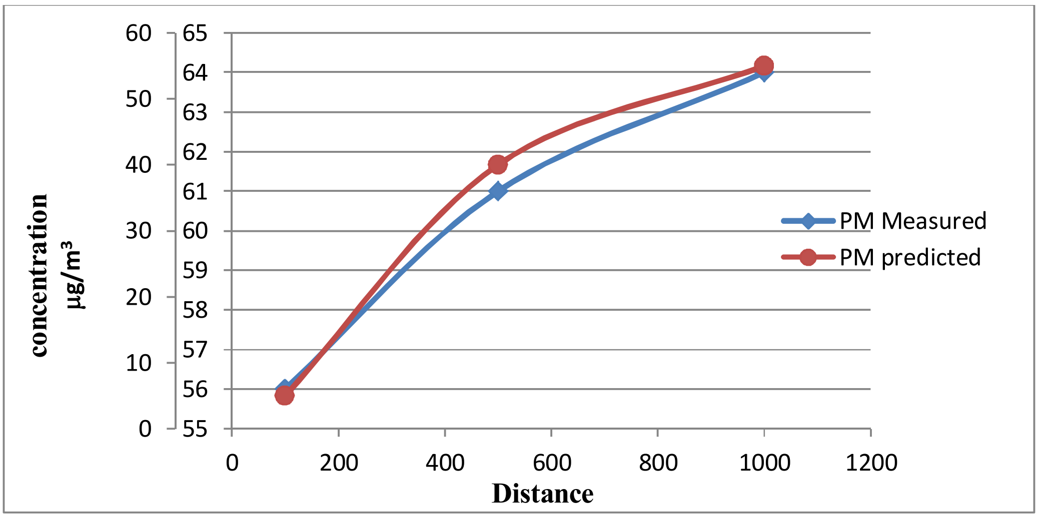

Figure (4.26): Measured and predicted particulate matter

According to the figure (4.26) that shows the measured and predicted particulate matter. It was found that the measured particulate matter had good correlation with predicted particulate matter.

4.5 Meteorological Data

Table 4.1 summaries the meteorological data during the monitoring period.

Table (4.1): Mean values of Air Temperature, Humidity, Weather Conditions and Wind Direction during the whole monitoring period.

Day- Date	Air Temperature	Humidity %	Weather Condition	Wind Direction
Wednesday 14/8/2012	35C	59%	Sunny	North
Thursday 15/8/2012	34C	55%	Sunny	North-West
Friday 16/8/2012	34C	55%	Sunny	North
Tuesday 27/8/2012	28C	49%	Clear	North-West
Wednesday 28/8/2012	30C	51%	Sunny	North-West
Wednesday 4/9/2012	29C	50%	Clear	North-West
Thursday 5/9/2012	30C	60%	Sunny	North-West
Monday 26/11/2012	21C	72%	Sunny	North
Wednesday 28/11/2012	23C	60%	Sunny	North-West
Thursday 29/11/2012	22C	50%	Sunny	North

Sunday 2/12/2012	21C	58%	Sunny	North
Monday 3/12/2012	21C	50%	Cloudy & Windy	North-West South-West

Based on table 4.1, the variation of air temperature values for power plant site during the whole monitoring periods is high. These values oscillated from 21 to 35 C, the lowest value of temperature recorded was 21 C at monitoring dates 26/11/2012, 2/12/2012, and 3/12/2012, while the highest was 35 C at sampling date 14/8/2012.

Humidity values varied during the monitoring periods, these values oscillated from 49 to 72 %, the lowest value of humidity recorded was 49 % at monitoring date 27/8/2012, while the highest was 72 % at monitoring date 26/11/2012. In addition, a weather condition during the monitoring periods is sunny and clear. The wind direction during the monitoring period is north to northwest direction. Figure 4.27 illustrate temperature and humidity during measurement process.

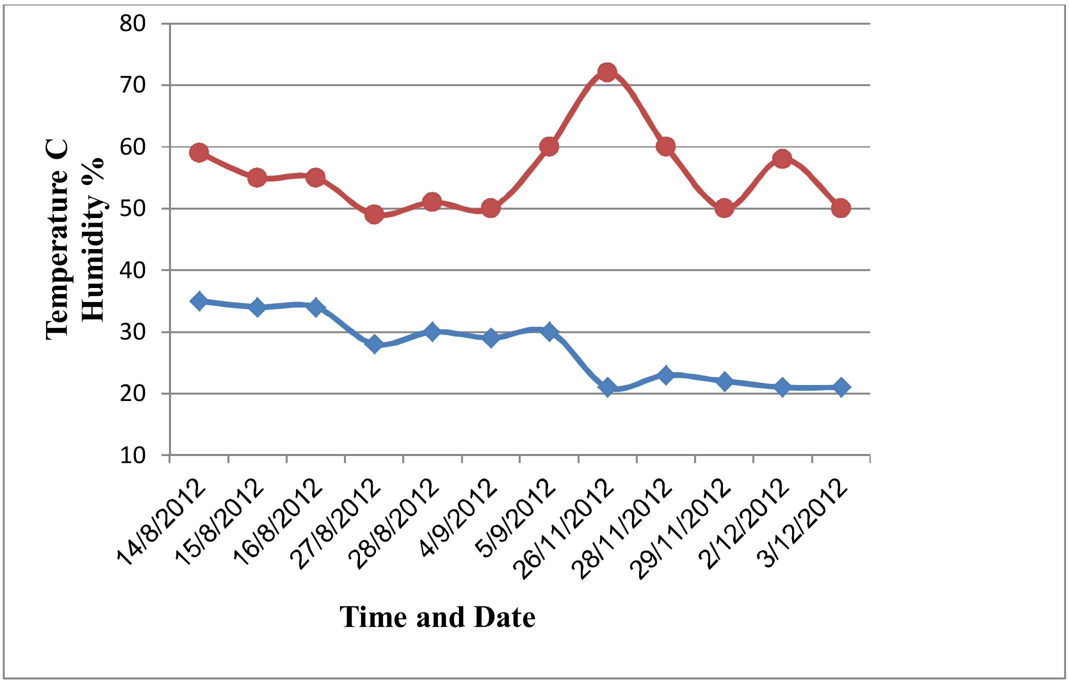

Figure (4.27): Temperature and humidity during monitoring

4.6 Air Quality and Health Impact Assessment

This section presented the results of conducted questionnaire for residents around power plant. The health impact of air pollution and level of awareness about the hazards of air pollution were assessed.

4.6.1 Air Quality Evaluation

To evaluate the air quality in the study area, researcher used the questionnaire and compared between monitoring results of particulate matter, carbon monoxide, and carbon dioxide during the monitoring period with WHO standards. Table 4.2 illustrates WHO air quality standard for $PM_{2.5}$ and CO.

Table (4.2): WHO air quality standard for $PM_{2.5}$ and CO

Pollutant	Level	Average time
Particulate matter $PM_{2.5}$	10 microgram/ m^3	Annual
	25 microgram/ m^3	24-hour
Carbon monoxide CO	10 ppm	8-hour
	25 ppm	1-hour

Based on WHO standard for particulate matter $PM_{2.5}$, the level of $PM_{2.5}$ in the study area was exceeded, the highest level was 79µg/m^3 (high reading in field at all monitoring day) and lowest level was 49µg/ m^3 (low reading in field at all monitoring day). The level of CO in the study area was less than WHO standard, the highest level was 2.18 ppm(high reading in field at all monitoring day), while the lowest level was 0.1 ppm(low reading in field at all monitoring day). According to literature review, the acceptable level of CO_2 must be less than 350ppm. The level of CO_2 around power plant oscillated from 254 ppm to 514 ppm, Turney and Fthenakis, 2011 proved that Carbon dioxide emissions also pose risks to human health.

Table 4.3 shows the resident opinions about air quality in the study area. It shows that 3.8% from the sample evaluate the quality of the atmosphere in the region “Excellent”. And 13.5% from the sample evaluate the quality of the atmosphere in the region “Very good" and 60.6% from the sample evaluate the quality of the atmosphere in the region

"Good". And 22.1% from the sample evaluate the quality of the atmosphere in the region "Bad".

Table (4.3): resident opinions about air quality in the study area.

Evaluate the quality of the atmosphere in the region	**Percentages**
Excellent	3.8
Very good	13.5
Good	60.6
Bad	22.1
Total	100.0

4.6.2 Questionnaire Data Analysis

A questionnaire was distributed to resident who lives around power plant to evaluate the health impacts of air pollution from power plant. Researcher visited fifty house around power plant and random sample were selected consist from 108 participants and 104 participants are received. Three persons were involved in the distribution of questionnaire in a week.

4.6.2.1 Age and Sex Distribution

One hundred and eight participants were interviewed and one hundred and four questionnaires were completed and received. Table 4.4 showed the age and sex distribution of the study population. Males were higher than females and the highest count was in the age group of 26-40 years. From the table 4.16, the highest percentage age group recorded was 30.8% at group (26-40 years), the lowest percentage age group recorded was 16.3% at group (less than 15 years).

Table (4.4): distribution of age and sex group in study population at study area

	Sex		**Age Group**			
	Male	Female	Less than 15 year	From16-25 years	From26-40 years	More than 40 years
	60.6%	39.4%	16.3%	26.9%	30.8%	26%
Total	100%		100%			

4.6.2.2 Location and Distance of Houses from Power Plant

Table 4.5 shows the location and distance of the study population. Population at west of the plant is the highest 57.7%, while the lowest at east 2.9%. It shows that 2.9% from the sample the house location for the power plant from " East " , and 57.7% from the sample the house location for the power plant from " West " , and 23.1% from the sample the house location for the power plant from " North " , and16.3% from the sample the house location for the power plant from " South " .

There are no statistical differences between the health effects of air pollutants emitted from the GPP and location and distance of house from power plant because of the proximity of the power plant from the sea, which makes the air continuously renewed.

Table (4.5): location and distance of study population at study area

	Location				**Distance**			
	East	West	North	South	300 meter	500 meter	800 meter	More than 800 meter
	2.9 %	57.7 %	23.1 %	16.3 %	51.9 %	38.5 %	6.7 %	2.9 %
Total	100%				100%			

Table 4.6 shows that 49.0 % from the sample live in another place before he lives beside the power plant, but 51.0% from the sample not live in another place before this place.

Table (4.6): population percentage live in another place before current place

Do you live in another place before this place?	**Yes**	**No**
	49%	51%
Total	100%	

Table 4.7 shows that 70.6% from the sample live in another place (49%) feel a change in air quality for the worst and slightly worst and it is mean that the pollutants emitted from GPP affected on air quality around power plant.

Table (4.7): population percentage feels a change in air quality

A change in air quality?	For the better	Slight change	For the worst	There is no change	Total
	15.7%	39.2%	31.4%	13.7%	100%

4.6.2.3 Public Awareness Level of Air Pollution and Health Status

Table 4.8 shows 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.

Table (4.8): population percentage has awareness of impact of air pollution on health

The impact of air pollution on health	Significantly	Moderately	little	no effect	Total
	14.4%	35.6%	33.7%	16.3%	100%

Table 4.9 shows that that 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 4.10 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.

Table (4.9): population feels difference between indoor & outdoor

Feel difference between indoor & outdoor	Yes	No	Total
	65.4 %	34.6 %	100 %

Table (4.10): population percentage for better air quality

which is better quality	Indoor	Outdoor	Total
	73.5 %	26.5 %	100 %

Table 4.11 shows that 61.5% of the population around the power plant is not affected by noise from the plant during the operation, which means that the degree of noise so low that the hearing was not affected by them and this shows that the proportion of noise generated by the plant is acceptable.

Table (4.11): population percentage suffer from lack of hearing

Lack of hearing	Significantly	Moderately	little	no effect	Total
	2.9 %	13.5 %	22.1 %	61.5 %	100 %

Although the noise level around the power site was less than 65 dB, but there are 2.9% of the population suffers from a lack of hearing. Many researchers support this finding (Atmaca et al, 2005; Basrur, 2000; Suter, 1991).
Table 4.12 shows that 40.4% from the sample are visited the hospital before" Two months", and 8.7% from the sample are visited the hospital before" Three months", and 4.8% from the sample are visited the hospital before “Four months", and 46.2% from the sample are visited the hospital before "More than four". Curtis et al, 2006 proved that air pollution is associated with large increases in medical expenses and morbidity.

Table (4.12): Hospital admission

Hospital admission	Two months	Three months	Four months	More four months	Total
	40.4 %	8.7 %	4.8 %	46.2 %	100 %

The 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; Tarmuto et al, 2011; Carbonell et al, 2007). The results also 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. 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. Table 4.13 show the percent of sample suffer from diseases.

Table (4.13): 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 (2.5-3Kg)	12.2	2.4	85.4

By using one way ANOVA, there are statistical differences between the health effects of air pollutants emitted from the GPP and the impact of air pollution on health status for citizens and the surrounding population (p-value 0.004).

CHAPTER (5)

CONCLUSION AND RECOMMENDATIONS

Air pollutants emitted from the power plant caused many environmental and health problems in the long term, to our knowledge, this was the first study done in Gaza Governorates demonstrating the level of air pollutants around the power plant and the impact of air pollution on human health. From the present study, the following conclusions and recommendations were drawn.

5.1 Conclusions

1. Air pollutants emitted from power plant are considered a large hazardous to public health in the long term. In addition, the west side had the highest level of carbon dioxide and carbon monoxide and the north side had the highest level of particulate matter ($PM_{2.5}$).

2. 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 North of the power plant was the highest concentration of the other sides.

3. The concentration of carbon dioxide CO_2 around plant (300 to 500ppm) was high. The West and the south of the power plant had the highest level because of the other pollution sources.

4. The level of carbon monoxide CO around power plant (0.1 to 2.3ppm) was low concentrated, but the concentration at west and south sides were sometimes higher.

5. The level of noise around power plant was low and near to the standards (70 dB).

6. 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.
7. 40% of population sample visited the hospital because of a disease that infects the respiratory tract.

8. No statistical differences between the health effects of air pollutants emitted from power plant and location and distance of house from power plant because of the proximity of the power plant from the sea, which makes the air continuously renewed.

5.2 Recommendation

Based on the results and findings of the current research, the researcher recommended the following:

1- Periodic maintenance for power plant and take advantage of modern technology techniques to reduce the emission of air pollutants.

2- The provision of modern devices to monitor air pollutants emitted from the power plant, and training technical staff to carry out the monitoring process.

3- Establish a continuous monitoring program of pollutants emitted from power plant and modeling of this data and made possibility to serve the public and researchers.

4- Sampling power plant chimneys to be tested and find out their components and conduct scientific studies.

5- Increase the public awareness about the risks of air pollutants on health and environment, and made periodic medical examinations of the population around the power plant.

6- Provide financial support for scientific research in the air pollution field. More specialized studies to study other pollutants such as sulfur and nitrogen oxides and volatile organic compound.

REFERENCE

Abrutzky, R., Dawiidowski, L., Matus, P., and Lankao, P.R., 2012, **Health effects of climate and air pollution in Buenos Aires: a first time series analysis**, Journal of Environmental Protection, V3:262-271

Atmaca, E., Peker, I., and Altin, A., 2005, **Industrial noise and its effects on humans**, Polish Journal of Environmental Studies, V14(6):721-726

Aziz, sh., Soomro, S.A., Tunio, A.H., Nazir, I., Qureshi, K.M., and Begum, R., 2010, **Environmental and health hazards of fly ash and SOx from FBC power plant at Khanote,** Pakistan journal analytical and environmental chemistry, V11 (2):56-62.

Bandyopadhyay, A., 2010, **Dispersion modeling in assessing air quality of industrial projects under Indian regulatory regime**, International Journal of Energy and Environment, V1 (1):97-112

Basrur, Sh.V., 2000, **Health effects of noise**, Toronto Public Health, Health Promotion and Environmental Protection Office.

Bhinder, F.S., Calay, R., Mustafa, M.Y., Al-zubaidy, S., and Holdo, A., 2011, **Ahybrid power plant to moderate carbon emissions**, Internatinal Journal of Research and Reviews in Applied Sciences, V6 (2):124-131

Bochenczyk, A., and Mokrzycki, E., 2007, **Emissions from the polish power industry**, Energy, V32:2370-2375

Blackman, A., Chandru, S., Mendoza-Domingues, A., and Russell, A.G., 2012, **Health impacts of power-exporting plants in Northern Mexico**, Energy Policy, V44:34-45

Bovensmann, H., Buchwitz, M., Burrows, J.P., Reuter, M., Krings, T., Gerilowski, K., Schneising, O., Heymann, J., Tretner, A., Erzinger, J., 2010, **A remote sensing**

technique for global monitoring of power plantCO_2 emissions from space and related applications, Atmospheric measurement techniques, V3:781-811

Chakraborty, N., Mukherjee, I., Santra, A.K., Chowdhury, S., Chakraborty, S., Bhattacharya, S., Mitra, A.P., and Sharma, C., 2008, **Measurement of CO_2, CO, SO_2 and NO emissions from coal-based thermal power plants in India**, Atmospheric Environment, V42:1073-1082

Curtis, L., Rea, W., Smith-Willis, P., Fenyves, E., and Pan, Y., 2006, **Adverse health effects of outdoor air pollutants**, Environment International, V32:815-830

Chatenoud, L., Mosconi, P., Malvezzi, M., Colombo, P., Lavecchia, C., and Apolone, G., 2005, **Impact of a major thermoelectric plant on self-perceived health status**, Preventive Medicine, V41:328-333

Carbonell, L., Ruiz, E., Gacita, M., Oliva, J., and Rivero, N., 2007, **Assessment of the impacts on health due to the emissions of Cuban power plants that use fossil fuel oils with high concentration of sulfur. Estimation of external costs**, Atmospheric Environment, V41:2202-2213

Celik, M., Donbak, L., Unal, F., Yuzbasioglu, D., Aksoy, H., and Yilmaz, S., 2007, **Cytogenetic damage in workers from a coal-fired power plant**, Mutation Research, V627:158-163

Corea, F., Silvestrelli, G., Baccarelli, A., Glua, A., Previdi, P., Siliprandi, G., and Murgia, N., 2012, **Airborne pollutants and lacunar stroke: a case cross-over analysis on stroke unit admissions**, Neurology International, V4:44-48

Dimitrova, R., Lurponglukana, N., Fernando, H.J.S., Runger, G.C., Hyde, P., Hedquist, B.C., Anderson, J., Bannister, W., and Jhonson, W., 2012, **Relationship between particulate matter and childhood asthma-basis of a future warning system for central Phoenix**, Atmospheric Chemistry and Physics, V12:2479-2490

Electric Power Research Institute, 2007, **Frequently asked questions about power plants, particulate matter and health**.

EPA, 2011, **Review of national ambient air quality standards for carbon monoxide: Final rule**, Federal Register, V76 (169):54294-54343

Goodarzi, F., 2006, **The rates of emissions of fine particles from some Canadian coal-fired power plants**, Fuel, V85:425-433

Ghosh, Subhodip, 2010, **Status of thermal power generation in India- perspectives on capacity, generation and carbon dioxide emissions**, Energy Policy, V38:6886-6899

Garcia-Perez, J., Pollan, M., Boldo, E., Perez-Gomez, B., Aragones, N., Lope, V., Ramis, R., Vidal, E., and Lopez-Abente, G., 2009, **Mortality due to lung, laryngeal and bladder cancer in towns lying in the vicinity of combustion installations**, Science of the Total Environment, V407:2593-2602

Guo, Y., Tong, Sh., Li, Sh., Barnett, A.G., Yu, W., Zhang, Y., and Pan, X., 2010, **Gaseous air pollution and emergency hospital visits for hypertension in Beijing, China: a time stratified case-crossover study**, Environmental Health, V9 (57)

Genc, S., Zadeoglulari, Z, Fuss, S.H., and Genc, K., 2011, **The adverse effects of air pollution on the nervous system**, Journal of Toxicology.

Hao, J., Wang, L., Shen, M., Li, L., and Hu, J., 2007, **Air quality impacts of power plant emissions in Beijing**, Environmental Pollution, V147:401-408

Hammons, T.J., 2006, **Impact of electric power generation on green house gas emissions in Europe: Russia, Greece, Italy and views of the EU power plant supply industry-a critical analysis**, Electrical Power and Energy Systems, V28:548-564

Kumar, K., Saroja, Ch., and Mahesh, K., 2011, **Reduction of carbon dioxide emission in thermal power plants using fire fly optimization technique**, International Journal of Computer Applications, V25(6):29-33

Kariman, N., Araban, M., Motesadi, S.Z., and Alavi, H.M., 2011, **The relationship between CO ambient and low birth weight**, Qom University of Medical Sciences Journal, V5

Laden, F., Neas, L.M., Dockery, D.W., and Schwarts, J., 2000, **Association of fine particulate matter from different sources with daily mortality in six U.S. Cities**, Environmental Health Perspectives, V108 (10):941-947

Levy, J.I., Spengler, J.D., Hlinka, D., Sullivan, D., and Moon, D., 2002, **Using CALPUFF to evaluate the impacts of power plant emissions in Illinois: model sensitivity and implications**, Tmospheric Environment, V36:1063-1075

Lopez-Cima, M.F., Garcia-Perez, J., Perez-Gomez, B., Aragones, N., Lopez-Abente, G., Tardon, A., and Pollan, M., 2011, **Lung cancer risk and pollution in an industrial region of northern Spain: a hospital-based case-control study**, International Journal of Health Geographics, V10 (10)

Mazandarani, A., Mahlia, T.M.I., Chong, W.T., and Moghavvemi, M., 2011, **Fuel consumption and emission prediction by Iranian power plants until 2025**, Renewable and Sustainable Energy Reviews, V15:1575-1592

Morello-Frosch, R., Jesdale, B.M., Sadd, J.L., and Pastor, M., 2010, **Ambient air pollution exposure and full-term birth weight in California**, Environmental Health, V9 (44)

Morata, Th.C., Dunn, D.E., Kretschmer, L.W., Lemasters, G.K., and Keith, R.W., 1993, **Effects of occupational exposure to organic solvents and noise on hearing**, Scandinavian Journal of Work, Environment and Health, V19 (4):245-254

Nenadovic, S.S., Matovic, L. LJ., Melanovic, M.M., Janicevic, S.V., Novakovic, J.D., and Ljesevic, M.A., 2010, **Impact of some meteorological parameters on the SO_2 concentrations in the city of Obrenovac, Serbia**, Journal of the Serbian Chemical Society, V75 (5):703-715

Natusch, D.F.S., 1978, **Potentially carcinogenic species emitted to the atmosphere by fossil-fueled power plants**, Environmental Health Perspectives, V22:79-90

Nazari, S., Shahhoseini, O., Kashani, A., Davari, S., Paydar, R., Moghadam, Z., 2010, **Experimental determination and analysis of CO_2, SO_2, and NO_x emission factors in Irans thermal power plants**, Energy, V35:2992-2998

Nastos, P.T., Paliatsos, A.G., Anthracopoulos, M.B., Roma, E.S., and Priftis, K.N., 2010, **Outdoor particulate matter and childhood asthma admissions in Athens, Greece: a time-series study**, Environmental Health, V9 (45)

Peled, R., Friger, M., Bolotin, A., Bibi, H., Epstein, L., pilpel, D., and Scharf, S., 2005, **Fine particles and meteorological conditions are associated with lung function in children with asthma living near two power plants**, Journal of the Royal Institute of Public Health, V119:418-425

Rozpondek, Maciej, and Siudek, Marian, 2009, **Pollution control technologies applied to coal-fired power plant operation**, MontanisticaSolvaca, V2:156-160

Senthil, K., Manikandan, K., Herman, I., and Saravanan, L., 2010, **Reduction of carbon dioxide emission in thermal power plants by using particle swarm optimization technique**, International Journal of Computer Applications, V3 (1):1-5

Shindell, D., and Faluvegi, G., 2010, **The net climate impact of coal-fired power plant emissions**, Atmospheric Chemistry and Physics, V10:3247-3260

Stankovic, A., Mitrovic, V., and Zivadinovic, R., 2011, **Influence of air pollution on birth weight**, SrpArhCelokLek, V139 (9):651-656

Stankovic, A., Mitrovic, V., and Zivadinovic, R., 2011, **Influence of air pollution on pregnant women's health and pregnancy outcomes,** Med Pregal, V5:279-284

Sajjadi, SA., and Bridgman, HA., 2011, **Respiratory hospital admissions before and after clouser of a major industry in the lower Hunter Region, Australia**, Iranian Journal of Public Health, V40(3):41-54

Saranta, S.E., Suh, H.H., Coull, B.A., Schwartz, J., Stone, P.H., and Gold, D.R., 2006, **Ambient particulate air pollution and cardiac arrhythmia in a panel of older adults Stebenville, Ohio**, Occupational and Environmental Medicine, V63:700-706

Salnikov, V.G., and Karatayev, M.A., 2011, **The impact of air pollution on human health: Focusing on the Rudnyi Altay Industrial area**, American Journal of Environmental Sciences, V7 (3):286-294

Suter, A.H., 1991, **Noise and its effects**, Report, Administrative Conference of the United States.

Syla, A.M., Veliu, A.H., and Berisha, K., 2008, **Air Pollution with Particulate Matter and Heavy Metals of Kosovo Thermal Power Plant**, BALWOIS-Ohrid, Republic of Macedonia.

Tainio, M., Sofiev, M., Hugo, M., Tuomisto, J., Loh, M., Jantunen, M., Karppinen, A., Kangas, L., Karvosenoja, N., Kupiainen, K., Porvari, P., and Kukkonen, J., 2009, **Evaluation of the European population intake fractions for European and Finnish anthropogenic primary fine particulate matter emissions**, Atmospheric Environment, V43:3052-3059

Tsilingiridis, G., Sidiropoulos, C., and Pentaliotis, A., 2011, **Reduction of air pollutant emissions using renewable energy sources for power generation in Cyprus**, Renewable Energy, V36:3292-3296

Turney, D., and Fthenakis, V., 2011, **Environmental impacts from the installation and operation of large-scale solar power plants**, Renewable and Sustainable Energy Reviews, V15:3261-3270

Tramuto, F., Cusimano, R., Cerame, G., Vultaggio, M., Calamusa, G., Maida, C.M., and Vitale, F., 2011, **Urban air pollution and emergency room admissions for respiratory symptoms: a case-crossover study in Palermo, Italy**, Environmental Health, V10 (31):1-11

The Environmental Integrity Project, 2011, **Getting Warmer: US CO_2 Emissions from Power Plants Emissions Rise 5.6% in 2010.**

Tahirsylaj, S., Latifi, L., 2010, **Quality of air in urban and suburban area's of the Prishtina's and meteorological impact conditions in distribution of pollution**, BALWOIS-Ohrid, Republic of Macedonia.

The Palestinian central bureau of statistics, 2012, **Gaza Strip Governorates Statistical Yearbook 2011**, Ramallah, Palestine. http://www.pcbs.gov.ps/DesktopDefault.aspx?tabID=1&lang=ar-jo. accessedin 5 July. 2013.

Vujic, J., Antic, D.P., and Vukmirovic, Z., 2012, **Environmental impact and cost analysis of coal versus nuclear power: The U.S. case**, Energy

Villeneuve, P.J., Chen, Li, Rowe, B.H., and Coates, F., 2007, **Outdoor air pollution and emergency department visits for asthma among children and adult: a case-crossover study in northern Alberta**, Canada, Environmental Health, V6 (40)

Velazco, V.A., Buchwitz, M., Bovensmann, H., Reuter, M., Schneising, O., Heymann, J., Krings, T., Gerilowski, K., and Burrows, J.P., 2011, **Towards space based verification of CO_2 emissions from strong localized sources: fossil fuel power plant emissions as seen by a CarbonSat constellation,**Atmospheric measurement techniques, V4:2809-2822

Win Lee, S., 2010, **Fine particulate matter measurement and international standardization for air quality and emissions from stationary sources**, Fuel, V89:874-882

White, S., and Kulcinski, G., 2000, **Birth to death analysis of the energy payback ratio and CO_2 gas emission rates from coal, fission, wind, and DT-fusion electrical power plants**, Fusion Engineering and Design, V48(248):473-481

Wang, X., and Mauzerall, D.L., 2006, **Evaluating impacts of air pollution in China on public health:Implications for future air pollution and energy policies**, Atmospheric Environment, V40:1706-1721

Wong, Ch., Vichit-Vadakan, N., Kan, H., Qian, Z., and the PAPA project teams, 2008, **Public health and air pollution in Asia (PAPA): a multicity study of short-term effects of air pollution on mortality**, Environmental Health Perspectives, V116(9):1195-1202

Yi, H., Hao, J., Duan, L., Tang, X., Ning, P., and Li, X., 2008, **Fine particle and trace element emissions from an anthracite coal-fired power plant equipped with a bag-house in China**, Fuel, V87:2050-2057

Yamazaki, Sh., Shima, M., Ando, M., Nitta, H., Watanabe, H., and Nishimuta, T., 2011, **Effect of hourly concentration of particulate matter on peak expiratory flow in hospitalized children: A panel study**, Environmental Health, V10 (15)

Yi, H., Hao, J., Duan, L., Li, X., and Guo, X., 2006, **Characteristics of inhalable particulate matter concentration and size distribution from power plants in China**, Journal of the air and waste management association, V56:1243-1251.

Zhou, Y., Levy, J.I., Evans, J.S., and Hammitt, J.K., 2006, **The influence of geographic location on population exposure to emissions from power plants throughout China**, Environmental Internatinal, V32:365-373

Zhao, Yu., Wang, Sh., Duan, L., Lei, Y., Cao, P., and Hao, J., 2008, **Primary air pollutant emissions of coal-fired power plants in China:Current status and future prediction**, Atmospheric Environment, V42:8442-8452

Zhang, F., Li, L., Krafft, Th., Lv, J., Wang, W., and Pei, D., 2011, **Study on the association between ambient air pollution and daily cardiovascular and respiratory mortality in an urban district of Beijing**, International Journal of Environmental Research and Public Health, V8:2109-2123

Zhao, Q., Liang, Zh., Tao, Sh., Zhu, J., and Du, Y., 2011, **Effects of air pollution on neonatal prematurity in Guangzhou of China: a time-series study**, Environmental Health, V10 (2)

Zanobetti, A., and Schwartz, J., 2009, **The effect of fine and coarse particulate air pollution on mortality: anational analysis**, Environmental Health Perspectives, V117 (6): 898-903

(http://www.chm.bris.ac.uk/motm/co/coh.htm 5:30) Wednesday 31/10/2012
(http://www.esrl.noaa.gov/gmd/ccgg/trends/#mlo5:50)Wednesday 31/10/2012

APPENDIX I

PARTICULATE MATTER MONITORIG RESULTS

THE FIRST DAY

Location	distance	PM2.5	Temp.T	Humidity	Wind.V	Wind.D
North	30 m	49	35	57	1.5	north
West	30 m	56	35	57.7	1.5	north
South	30 m	52	34	54.5	2.5	north
East	30 m	48	34	48.7	2	north
North	500 m	58	35	52.5	2	north
West	500 m	65	34	55.2	2.5	north
South	500 m	62	33	56	1.5	north
East	500 m	64	33	56	1.5	north
North	1000 m	69	32	61	1.5	north
West	1000 m	88	32	61	1.5	north
South	1000 m	84	32	68.4	1.5	north
East	1000 m	74	33	59	1.5	north

THE SECOND DAY

Location	distance	PM2.5	Temp.T	Humidity	Wind.V	Wind.D
North	30 m	56	34	58.7	1m/s	north
West	30 m	56	34	48.5	2.5m/s	north
South	30 m	57	35	60	2m/s	north
East	30 m	54	35	50	2.5m/s	north
North	500 m	59	35	50	1.5m/s	west
West	500 m	59	35	47	1m/s	west
South	500 m	61	35	52	1.5m/s	N-W
East	500 m	63	36	51	2.5m/s	N-W
North	1000 m	63	35	50	2.5m/s	west
West	1000 m	64	33	50	1.5m/s	west
South	1000 m	64	34	48.5	1.5m/s	west
East	1000 m	63	35	53	2.5m/s	west

THE THIRD DAY

Location	distance	PM2.5	Temp.T	Humidity	Wind.V	Wind.D
North	30 m	56	34	58.7	1m/s	north
West	30 m	56	34	48.5	2.5m/s	north
South	30 m	57	35	60	2m/s	north
East	30 m	54	35	50	2.5m/s	north
North	500 m	59	35	50	1.5m/s	west
West	500 m	59	35	47	1m/s	west
South	500 m	61	35	52	1.5m/s	N-W
East	500 m	63	36	51	2.5m/s	N-W
North	1000 m	63	35	50	2.5m/s	west
West	1000 m	64	33	50	1.5m/s	west
South	1000 m	64	34	48.5	1.5m/s	west
East	1000 m	63	35	53	2.5m/s	west

THE FOURTH DAY

Location	distance	PM2.5	Temp.T	Humidity	Wind.V	Wind.D
North	20m	31	28.9	50%	3.5Km/h	N-W
	40m	31	28.9	50%	3.2	N-W
	60m	33	28.7	50%	3	N-W
	80 m	36	28.7	50%	0.5	N-W
	100m	36	28.6	50%	0.5	N-W
East	20 m	48	28.5	50%	2.5	N-W
	40 m	48	28.5	50%	2	N-W
	60m	49	28.5	49.50%	0.5	N-W
	80 m	53	28.5	49.50%	0.5	N-W
	100m	51	28	49%	0.5	N-W
South	20 m	53	27.9	49%	0.5	N-W
	40 m	53	27.8	49%	1	N-W
	60m	52	27.8	49%	0.5	N-W
	80m	50	27.8	49%	zero	
	100m	51	27.8	49%	zero	
West	20m	68	27.5	49%	zero	
	40m	75	27.5	49%	zero	

	60m	62	27.5	49%	zero	
	80m	60	27.5	49%	zero	
	100m	64	27.5	49%	zero	

THE FIFTH DAY

Location	distanc	PM2.5	Temp.T	Humidity	Wind.V	Wind.D
North	20m	58	29	49%	0.5Km/h	N-W
	40m	58	29	49	0.5	N-W
	60m	59	28.5	49	0.5	N-W
	80 m	56	28.5	49	0.5	N-W
	100m	55	28	49	0.5	N-W
East	20 m	60	31	50	3.5	N-W
	40 m	59	31	50	3.5	N-W
	60m	58	31	50	3.5	N-W
	80 m	61	31	50	3.5	N-W
	100m	60	31	50	3.5	N-W
South	20 m	64	31	49	5	N-W
	40 m	63	31	49	5	N-W
	60m	61	30	49	4.5	N-W
	80m	61	30	49	5	N-W
	100m	61	29.5	49	5	N-W
West	20m	70	30.5	52.8	3.5	N-W
	40m	70	30.5	52.8	3.5	Nr-W
	60m	77	30.5	52.8	3.5	N-W
	80m	72	30.5	50	3.5	N-W
	100m	64	30	50	3	N-W

APPENDIX II

CARBON DIOXIDE, CARBON MONOXIDE AND NOISE MONITORIG RESULTS

THE FIRST DAY

Location	**distance**	**CO2**	**CO**	**Noise**	**Temp.**	**Humidity**	**Wind.V**	**Wind.D**
North	20m	239	0.1	40dB	28.9	50%	3.5Km/h	N-W
	40m	252	0.1	33.1	28.9	50%	3.2	N-W
	60m	248	0.1	32.8	28.7	50%	3	N-W
	80 m	215	0.1	32.8	28.7	50%	0.5	N-W
	100m	200	0.1	32.7	28.6	50%	0.5	N-W
East	20 m	133	0.1	39	28.5	50%	2.5	N-W
	40 m	308	0.1	39	28.5	50%	2	N-W
	60m	305	0.1	39	28.5	49.50%	0.5	N-W
	80 m	335	0.1	39	28.5	49.50%	0.5	N-W
	100m	325	0.1	38	28	49%	0.5	N-W
South	20 m	307	0.1	41	27.9	49%	0.5	N-W
	40 m	306	0.1	40	27.8	49%	1	N-W
	60m	307	0.1	40	27.8	49%	0.5	N-W
	80m	328	0.1	39	27.8	49%	zero	
	100m	348	0.1	39	27.8	49%	zero	
West	20m	370	0.3	41	27.5	49%	zero	
	40m	361	0.8	41	27.5	49%	zero	
	60m	371	1.1	40	27.5	49%	zero	
	80m	360	0.6	39	27.5	49%	zero	
	100m	353	0.5	39	27.5	49%	zero	

THE SECOND DAY

Location	distance	CO2	CO	Noise	Temp	Humidity	Wind.V	Wind.D
North	20m	316	0.1	46.5dB	29	49%	0.5Km/h	N-W
	40m	331	0.1	46	29	49	0.5	N-W
	60m	336	0.1	45.5	28.5	49	0.5	N-W
	80 m	331	0.1	45.5	28.5	49	0.5	N-W
	100m	333	0.1	45	28	49	0.5	N-W
East	20 m	271	0.1	43.2	31	50	3.5	N-W
	40 m	304	0.1	43.2	31	50	3.5	N-W
	60m	292	0.1	43.2	31	50	3.5	N-W
	80 m	312	0.1	43.2	31	50	3.5	N-W
	100m	329	0.1	43.2	31	50	3.5	N-W
South	20 m	402	0.7	49	31	49	5	N-W

	40 m	395	0.2	47	31	49	5	N-W
	60m	406	0.3	46.5	30	49	4.5	N-W
	80m	401	0.6	46.5	30	49	5	N-W
	100m	391	0.6	46.5	29.5	49	5	N-W
West	20m	380	0.4	43.5	30.5	52.8	3.5	N-W
	40m	396	1	43	30.5	52.8	3.5	N-W
	60m	444	0.8	43	30.5	52.8	3.5	N-W
	80m	348	0.4	43	30.5	50	3.5	N-W
	100m	368	0.9	43	30	50	3	N-W

THE THIRD DAY

NORTH OF POWER PLANT

Distance	CO_2	CO	Noise	Humidity	Temp
20	226	0.1	43	50	29
40	237	0.1	45	50	29
60	217	0.1	50	49	29
80	211	0.1	43	49	29
100	222	0.1	43	49	29

WEST OF POWER PLANT

Distance	CO_2	CO	Noise	Humidity	Temp
20	265	0.1	45	44	28
40	268	0.1	45	44	28
60	273	0.1	43	44	28
80	285	0.1	43	44	28
100	298	0.1	43	44	28

SOUTH OF POWER PLANT

Distance	CO_2	CO	Noise	Humidity	Temp
20	296	0.6	50	45	29
40	291	0.5	50	45	29
60	284	0.1	49	45	29
80	278	0.4	47	45	29
100	255	0.1	45	45	29

EAST OF POWER PLANT

Distance	CO_2	CO	Noise	Humidity	Temp
20	255	0.5	43	45	29
40	246	0.5	43	45	29
60	240	0.5	43	45	29
80	288	0.5	43	45	29
100	262	0.1	43	45	29

THE FOURTH DAY

NORTH OF POWER PLANT

Distance	CO_2	CO	Noise	Humidity	Temp
20	273	0.1	45	60	30
40	240	0.1	45	60	30
60	238	0.1	44	60	30
80	235	0.1	43	60	30
100	219	0.1	43	60	30

WEST OF POWER PLANT

Distance	CO_2	CO	Noise	Humidity	Temp
20	284	0.3	50	55	30
40	320	1.1	50	55	30
60	307	1.9	47	55	30
80	318	1.6	45	55	30
100	323	1.5	45	55	30

SOUTH OF POWER PLANT

Distance	CO_2	CO	Noise	Humidity	Temp
20	281	0.1	65	58	30
40	272	0.1	63	58	30
60	270	0.1	60	58	30
80	261	0.1	59	58	30
100	257	0.1	57	58	30

EAST OF POWER PLANT

Distance	CO_2	CO	Noise	Humidity	Temp
20	240	0.1	43	60	30
40	243	0.1	43	60	30
60	253	0.1	43	60	30
80	270	0.1	43	60	30
100	262	0.1	43	60	30

THE FIFTH DAY

NORTH OF POWER PLANT

Distance	CO_2	Co	Noise	Humidity	Temp
20	449	1.2	50	70	21
40	468	0.4	55	70	21
60	529	2.9	57	70	21
80	466	1.6	56	67	21
100	418	0.9	55	67	21
120	402	0.4	52	67	22
140	408	1.1	50	67	22
160	410	1	47	67	22
180	386	0.6	47	67	22
200	409	1.6	45	67	22
220	428	2.3	45	67	22
240	412	1.5	43	67	22
260	390	0.4	43	67	22
280	386	0.2	43	67	22
300	409	1.3	42	67	22

WEST OF POWER PLANT

Distance	CO_2	Co	Noise	Humidity	Temp
20	458	0.9	57	56	21
40	464	1.2	56	56	21
60	471	1.9	56	56	21
80	511	2.5	56	56	21
100	545	2.3	50	56	21
120	489	1.9	47	56	21
140	478	1.1	47	56	21
160	503	1.8	47	56	21
180	497	1.4	47	56	21
200	498	1.4	43	56	21
220	520	2.7	43	56	21
240	552	3.1	43	56	21
260	521	2	43	56	21
280	529	2.4	43	56	21
300	527	2.4	43	56	21

SOUTH OF POWER PLANT

Distance	CO_2	Co	Noise	Humidity	Temp
20	424	0.3	56	57	22
40	442	1.5	55	57	22
60	408	1	55	57	22
80	431	1.6	55	57	22
100	424	0.9	52	57	22
120	456	2.8	50	57	22
140	413	0.5	50	57	22
160	420	0.5	50	57	22
180	452	2.4	49	57	22
200	464	2.6	49	57	22
220	443	1.7	47	57	22
240	428	1.2	45	57	22
260	423	1.1	45	57	22
280	464	2.5	45	57	22
300	460	2.3	43	57	22

EAST OF POWER PLANT

Distance	CO_2	Co	Noise	Humidity	Temp
20	394	1	55	62	22
40	395	1.1	55	62	22
60	445	2.8	53	62	22
80	405	1.2	53	62	22
100	403	1.1	53	62	22
120	403	1	51	62	22
140	437	2.8	50	62	22
160	422	2.5	50	60	22
180	388	0.5	48	60	22
200	401	1.1	47	60	22
220	432	2	47	60	22
240	407	0.6	45	60	22
260	439	2.2	45	60	22
280	419	1.4	45	60	22
300	402	0.5	43	60	22

THE SIXTH DAY

NORTH OF POWER PLANT

Distance	CO_2	Co	Noise	Humidity	Temp
20	512	1.1	50	61	23
40	507	0.9	54	60	23
60	504	2.1	51	60	23
80	477	0.9	48	60	23
100	514	2.4	46	60	23
120	503	1.6	46	60	23
140	480	0.9	45	60	23
160	493	1.5	43	60	23
180	482	1.1	43	60	23
200	479	0.7	43	60	23
220	487	0.9	43	60	23
240	491	1.7	43	60	23
260	489	1.1	43	60	23
280	479	1.4	43	60	23
300	475	0.8	43	60	23

WEST OF POWER PLANT

Distance	CO_2	Co	Noise	Humidity	Temp
20	395	0.4	58	53	21
40	413	0.6	57	53	21
60	399	0.1	54	53	21
80	398	0.4	54	53	21
100	460	1.8	53	53	21
120	433	1.5	53	53	21
140	425	1	50	53	21
160	401	0.5	48	53	21
180	410	0.9	47	53	21
200	422	1.1	46	53	21
220	395	0.2	46	53	21
240	413	0.4	45	53	21
260	435	0.7	43	53	21
280	489	2.6	43	53	21
300	495	2.6	43	53	21

SOUTH OF POWER PLANT

Distance	CO_2	Co	Noise	Humidity	Temp
20	470	1.2	48	55	22
40	499	2	48	55	22
60	486	1.8	48	55	22
80	501	1.5	45	55	22
100	509	1.1	45	55	22
120	508	1.3	45	55	22
140	517	0.7	45	55	22
160	538	1.6	45	55	22
180	535	1.5	43	55	22
200	524	1	43	55	22
220	526	0.8	43	55	22
240	535	2	43	55	22
260	541	2.3	43	55	22
280	538	2.1	43	55	22
300	538	2	43	55	22

EAST OF POWER PLANT

Distance	CO_2	Co	Noise	Humidity	Temp
20	497	3	45	57	23
40	499	1.6	45	57	23
60	507	1.1	45	57	23
80	502	1	45	57	23
100	494	1.6	45	57	23
120	523	1.6	45	57	23
140	511	1.5	45	57	23
160	517	1.4	43	57	23
180	510	2.1	43	57	23
200	510	1.6	43	57	23
220	505	1.7	43	57	23
240	522	1.2	43	57	23
260	517	1.2	43	57	23
280	529	1.7	43	57	23
300	547	1.9	43	57	23

THE SEVENTH DAY

NORTH OF POWER PLANT

Distance	CO_2	Co	Noise	Humidity	Temp
20	376	2.2	55	57	23
40	295	0.3	55	57	23
60	305	0.1	55	57	23
80	324	0.8	55	57	23
100	342	1.7	54	57	23
120	310	0.7	54	57	23
140	341	2	52	57	23
160	301	0.7	50	57	23
180	308	0.6	49	57	23
200	312	0.6	48	56	23
220	273	0.1	47	56	23
240	318	1	46	56	23
260	309	0.8	45	56	23
280	297	0.6	45	56	23
300	310	0.8	45	56	23

WEST OF POWER PLANT

Distance	CO_2	Co	Noise	Humidity	Temp
20	372	0.2	54	52	22
40	382	0.4	54	52	22
60	337	1	52	52	22
80	368	0.7	52	52	22
100	381	1.4	52	52	22
120	375	0.8	50	52	22
140	379	0.8	50	52	22
160	377	0.2	49	52	22
180	376	1	48	52	22
200	351	0.5	48	52	22
220	349	0.2	47	52	22
240	361	1.3	47	52	22
260	380	1.1	47	52	22
280	400	1.2	46	52	22
300	374	0.5	45	52	22

SOUTH OF POWER PLANT

Distance	CO_2	Co	Noise	Humidity	Temp
20	339	0.1	55	52	22
40	342	1.4	55	52	22
60	345	1.7	55	52	22
80	338	1.8	55	52	22
100	329	0.7	55	52	22
120	307	0.4	55	52	22
140	321	0.7	55	52	22
160	328	0.4	54	52	22
180	347	1.4	53	52	22
200	351	1.5	53	52	22
220	347	1.1	52	52	22
240	319	0.1	51	52	22
260	330	0.2	50	52	22
280	338	0.1	50	52	22
300	345	0.1	50	52	22

EAST OF POWER PLANT

Distance	CO_2	Co	Noise	Humidity	Temp
20	315	1	45	55	22
40	313	0.5	45	55	22
60	309	0.4	45	55	22
80	340	1.5	45	55	22
100	330	2	45	55	22
120	296	0.1	43	55	22
140	317	0.6	43	55	22
160	319	0.4	43	55	22
180	308	0.3	43	55	22
200	308	0.3	43	55	22
220	345	1.4	43	55	22
240	332	0.9	43	55	22
260	342	1.4	43	55	22
280	318	0.2	43	55	22
300	346	1.6	43	55	22

THE EIGTH DAY

NORTH OF POWER PLANT

Distance	CO_2	Co	Noise	Humidity	Temp
20	375	1.2	55	60	21
40	382	1.5	55	60	21
60	348	0.3	55	60	21
80	343	0.2	55	60	21
100	331	0.2	55	60	21
120	326	0.3	54	60	21
140	310	0.7	54	60	21
160	320	0.2	49	60	21
180	319	0.2	48	60	21
200	323	0.1	47	60	21
220	325	0.2	47	60	21
240	318	0.1	46	60	21
260	317	0.1	46	60	21
280	319	0.2	45	60	21
300	336	0.2	45	60	21

WEST OF POWER PLANT

Distance	CO_2	Co	Noise	Humidity	Temp
20	489	0.9	45	54	20
40	487	0.8	45	54	20
60	512	1.9	45	54	20
80	562	2.3	45	54	20
100	550	2.1	45	54	20
120	566	1.7	43	54	20
140	558	1.8	43	54	20
160	598	2.3	43	54	20
180	542	1	43	54	20
200	550	1.9	43	54	20
220	577	2.2	43	54	20
240	576	2.2	43	54	20
260	553	1.8	43	54	20
280	602	1.6	43	54	20
300	596	1.7	43	54	20

SOUTH OF POWER PLANT

Distance	CO_2	Co	Noise	Humidity	Temp
20	411	1	44	55	21
40	412	0.6	44	55	21
60	431	1.3	44	55	21
80	450	1.9	44	55	21
100	439	1.1	44	55	21
120	482	2.3	44	55	21
140	462	1.2	43	55	21
160	489	1.9	43	55	21
180	494	1.8	43	55	21
200	483	2	43	55	21
220	482	2	43	55	21
240	478	0.7	43	55	21
260	489	1	43	55	21
280	499	1.8	43	55	21
300	497	1.8	43	55	21

EAST OF POWER PLANT

Distance	CO_2	Co	Noise	Humidity	Temp
20	332	1	49	58	21
40	349	0.8	49	58	21
60	343	0.6	48	58	21
80	355	0.7	48	58	21
100	354	0.5	48	58	21
120	362	0.4	48	58	21
140	356	0.2	48	58	21
160	378	1.1	48	58	21
180	349	0.2	47	58	21
200	364	0.3	47	58	21
220	404	1.4	47	58	21
240	386	2.8	46	58	21
260	395	0.7	46	58	21
280	382	1	45	58	21
300	401	0.5	45	58	21

THE NINTH DAY

NORTH OF POWER PLANT

Distance	CO_2	Co	Noise	Humidity	Temp
20	362	0.1	56	40	22
40	351	0.1	55	40	22
60	353	0.1	54	40	22
80	336	0.1	54	40	22
100	345	0.1	54	40	22
120	370	0.1	52	40	22
140	350	0.1	52	40	22
160	400	1.9	51	40	22
180	381	1.5	50	40	22
200	359	0.2	47	40	22
220	366	0.5	45	40	22
240	361	0.2	44	40	22
260	385	0.7	44	40	22
280	354	1	44	40	22
300	349	0.7	44	40	22

WEST OF POWER PLANT

Distance	CO_2	Co	Noise	Humidity	Temp
20	417	0.1	45	42	21
40	428	0.1	45	42	21
60	416	0.1	45	42	21
80	424	0.1	45	42	21
100	423	0.1	45	42	21
120	422	0.1	45	42	21
140	418	0.1	44	42	21
160	400	0.1	44	42	21
180	405	0.1	44	42	21
200	390	0.1	44	42	21
220	395	0.1	43	42	21
240	380	0.1	43	42	21
260	376	0.1	43	42	21
280	378	0.1	43	42	21
300	372	0.1	43	42	21

SOUTH OF POWER PLANT

Distance	CO_2	Co	Noise	Humidity	Temp
20	429	0.1	62	42	21
40	417	0.1	60	42	21
60	424	0.1	60	42	21
80	412	0.1	60	42	21
100	399	0.1	60	42	21
120	391	0.1	58	42	21
140	394	0.1	58	42	21
160	388	0.1	58	42	21
180	396	0.1	55	42	21
200	395	0.1	55	42	21
220	418	0.1	55	42	21
240	324	0.1	55	42	21
260	425	0.1	52	42	21
280	434	0.1	52	42	21
300	437	0.1	52	42	21

EAST OF POWER PLANT

Distance	CO_2	Co	Noise	Humidity	Temp
20	397	0.4	44	40	22
40	362	0.4	44	40	22
60	399	0.5	44	40	22
80	426	1.7	44	40	22
100	324	1.6	44	40	22
120	427	1.6	44	40	22
140	415	0.1	44	40	22
160	416	0.2	43	40	22
180	457	1.7	43	40	22
200	431	1.2	43	40	22
220	441	1.2	43	40	22
240	420	0.7	43	40	22
260	444	1.8	43	40	22
280	427	0.6	43	40	22
300	440	0.9	43	40	22

APPENDIX III-A

ENGLISH TRANSLATION OF QUESTINNAIRE

Islamic University-Gaza
Deanship of Graduate studies
Environmental Sciences
Master program
Environmental Health

الجامعة الإسلامية- غزة
عمادة الدراسات العليا
برنامج ماجستير العلوم البيئية
الصحة البيئية

Study questionnaire

Dear citizen:
The environment healthy and clean free of contaminants in all its forms is a prerequisite and important for every citizen, and aims of this questionnaire to study the health effects of pollutants air emitted from the GPP to the citizens and the surrounding population, and come this study complement the requirements for obtaining a master's degree in environmental health at the Islamic University -Gaza.
So we would like you to help mobilize this questionnaire with the knowledge that the information you give us is of great importance to us in this study appreciating you to your effort and your time that you will spend filling in the questionnaire.
Please answer the questions quite frankly and accurately as possible, knowing that your answers will be treated confidentially and will only be used for the purposes of scientific research.

Thank you for help me

Researcher/ Mosab Majid Matar
Phone No. / 0599568346

Basic information

1. Age

A. Less than 15 years B. From16-25 C. From 26-40 years D. More than 40 years

2. Gender

A. Male B. Female

3. House location for the power plant.

A. East B. West C. North D. South

4. How far is the house for the power plant?

A. 300 meter B. 500 meter C. 800 meter D. More than 800 meters

5. Your job

A. Employee B. Student C. Worker D. Housewife

6. If the answer is A or C specify the nature of the work…………………………………………………………….

7. Your education level

A. Preparatory B. Secondary C. Academic D. uneducated

8. Do you live in another place before this place?

A. Yes B. No

9. If the answer is yes, did you feel a change in air quality?

A. For the better B. Slight change c. For the worst d. There is no change

10. Do you smoke

A. Yes B. No

11. Do you suffer from a chronic disease

A. Yes B. No

12. If the answer is yes, specify the type of disease

……………………………………………………………………………………………

13. You are taking any drugs since a certain period

A. Yes B. No

14. Evaluate the quality of the atmosphere in the region

A. Excellent B. Very good C. Good D. Bad

15. The impact of air pollution on your health

A. Significantly B. Moderately C. little D. no effect

16. Evaluate your health status in the last six months

A. Excellent B. Very good C. Good D. Bad

17. Do you feel difference between the quality of the air inside and outside the house

A. Yes B. No

18. If the answer is yes, which is better quality?

A. Indoor B. Outdoor

19. Did you notice any noise from the power plant?

A. All the time B. Often C. Rarely D. No

20. to what extent the hassle of noise

A. Very annoying B. Annoying C. Little D. No

21. Do you suffer from lack of hearing?

A. Significantly B. Moderately C. Little D. No

22. Last time you visited the hospital before

A. Two months B. Three months C. Four months D. More than four

23. The reason for the visit………………………………………………………………

24. Have you visited the hospital in one day because of a disease that infect the respiratory tract
A. Yes B. No
25. If the answer is yes, type the name of the disease…………………………………...

Health information
26. Have you ever felt or been exposed to a disease and the following symptoms

No.	Items	Yes	Sometim e	No
1	Inability to focus			
2	Feeling lazy			
3	Feeling sudden drowsiness			
4	Feeling sleepiness			
5	Feeling dizziness and nausea			
6	Feeling short of breath and rapid breathing			
7	Sense of pain in the chest			
8	Feeling a burning sensation in the eyes			
9	Feeling tired and severe fatigue			
10	Feeling of dryness in the throat			
11	Feeling throat infection			
12	Feeling pain in the nose and difficulty in breathing			
13	The desire to scratch the skin			
14	Feeling suffocation and discomfort and tension			
15	Cough frequently occur when waking from sleep			
16	The occurrence of high blood pressure			
17	The occurrence of stroke			
18	The occurrence of cancer			
19	The occurrence of asthma			
20	Feeling bronchial infection			
21	Exposure to birth prematurely			
22	The birth of a child and weighed less than normal			
23	Inflammation of the trachea			
24	Snore during sleep			
25	Sensitivity in the chest			
26	Sinus infection			
27	Suffer from pneumonia			
28	Suffer from colds and flu			
29	Suffer from a sore throat			
30	Suffer from infections in the middle ear			
31	Occurrence of heart problems			
32	Suffer from seizures			
33	Vascular bleeding in blood vessels			
34	Difficult controlling nerves(Parkinson)			
35	Occurrence meningitis			
36	Suffer from excessive nervousness			

37	Feeling insomnia and lack of sleep				

Other add………………………………………………………………………………………

Thank you for your cooperation

APPENDIX III-B

ARABIC TRANSLATION OF QUESTINNAIRE

Islamic University-Gaza
Deanship of Graduate studies
Environmental Sciences
Master program
Environmental Health

الجامعة الإسلامية- غزة
عمادة الدراسات العليا
برنامج ماجستير العلوم البيئية
الصحة البيئية

استبانة الدراسة

أخي المواطن، أختي المواطنة .... السلام عليكم ورحمة الله وبركاته

إن البيئة الصحية والنظيفة الخالية من الملوثات بكافة أشكالها مطلب أساسي وهام لكل مواطن، ويهدف هذا الاستبيان لدراسة التأثيرات الصحية للملوثات الهوائية المنبعثة من محطة توليد كهرباء غزة على المواطنين والسكان المحيطين بها، وتأتي هذه الدراسة استكمالا لمتطلبات الحصول على درجة الماجستير في الصحة البيئية بالجامعة الإسلامية- غزة.

لذا نود منك المساعدة في تعبئة هذا الاستبيان مع العلم أن المعلومات التي ستزودنا بها ذات أهمية كبيرة لنا في هذه الدراسة مقدرين لك جهدك ووقتك الذين ستقضيهما في تعبئة الاستبيان.

الرجاء الإجابة على الأسئلة بصراحة تامة وبدقة قدر الإمكان، مع العلم أن إجاباتك ستعامل بسرية تامة ولن تستخدم إلا لأغراض البحث العلمي.

وبارك الله فيكم

الباحث / مصعب ماجد مطر
جوال
0599568346/

المعلومات الأساسية

1. العمر

أ. أقل من 15سنة ب. من 16-25سنة ج. من26-40سنة د. أكثر من 40سنة

2. الجنس

أ. ذكر ب. أنثى

3. موقع السكن بالنسبة لمحطة الكهرباء.

أ. شرق ب. غرب ج. شمال د. جنوب

4. كم يبعد مكان السكن عن محطة الكهرباء؟

أ. 300 متر ب. 500 متر ج. 800 متر د. أكثر من 800 متر

5. العمل الذي تقوم به.

أ. موظف ب. طالب ج. عامل د. ربة منزل ه. عاطل عن العمل

6. إذا كانت الإجابة أ أو ج حدد طبيعة العمل..

7. المستوى التعليمي.

أ. إعدادي ب. ثانوي ج. جامعي د. غير متعلم

8. هل كنت تسكن في مكان آخر قبل هذا المكان؟

أ. نعم ب. لا

9. إذا كانت الإجابة نعم هل أحسست بتغيير في جودة الهواء.

أ.للأفضل ب. تغيير طفيف ج. للأسوأ د. لا يوجد تغيير

10. هل تدخن؟

أ. نعم ب. لا

11. هل تعاني من مرض مزمن؟

أ. نعم ب. لا

12. إذا كانت الإجابة نعم حدد نوع المرض..

13. هل تتعاطى أي أدوية منذ فترة؟

أ. نعم ب. لا

14. ما تقييمك لجودة الهواء الجوي في المنطقة؟

أ. ممتاز ب. جيد جدا ج. جيد د. سيء

15. مدى تأثير تلوث الهواء على صحتك.

أ. يؤثر بدرجة كبيرة ب. بدرجة متوسطة ج. بدرجة قليلة د. ليس له تأثير

16. ما تقييمك لحالتك الصحية في آخر ستة أشهر؟

أ. ممتاز ب. جيد جدا ج. جيد د. سيء

17. هل تشعر بفرق بين جودة الهواء داخل البيت وخارجه؟

أ. نعم ب. لا

18. إذا كانت الإجابة نعم أيهما أفضل جودة.

أ. داخل البيت ب. خارج البيت

19. هل لاحظت أي ضجيج من محطة توليد الكهرباء؟

أ. في كل وقت ب. كثير من الأحيان ج. نادرا د. لا يوجد

20. مدى انزعاجك من الضجيج.

أ. مزعج جدا ب. مزعج ج. قليل الإزعاج د. لا يوجد

21. هل تعاني نقصا في السمع؟

أ. بدرجة كبيرة ب. بدرجة متوسطة ج. بدرجة قليلة د. لا يوجد

22. آخر مرة زرت فيها المشفى قبل.

أ. شهرين ب. 3أشهر ج.4أشهر د. أكثر من4

23. سبب الزيارة...

24. هل زرت المشفى في احد الأيام بسبب أحد الأمراض التي تصيب الجهاز التنفسي؟

أ. نعم ب. لا

25. إذا كانت الإجابة نعم اكتب اسم المرض..

المعلومات الصحية

26. هل سبق أن أحسست أو تعرضت لأحد الأمراض والأعراض التالية؟

التسلسل	الفقرات	نعم	أحيانا	لا
1	عدم المقدرة على التركيز			
2	الشعور بالكسل			
3	الشعور بالخمول			
4	الشعور بالنعاس المفاجئ			
5	الشعور بالدوخة والغثيان			
6	الشعور بقصر في التنفس وسرعة التنفس			
7	الإحساس بآلام في الصدر			
8	الإحساس بحرقان في العيون			
9	الإصابة بتعب وإرهاق شديدين			
10	الشعور بجفاف في الحلق			
11	الشعور بالتهابات في الحلق			
12	الشعور بآلام في الأنف وصعوبة التنفس			
13	الرغبة في حك الجلد			
14	الشعور بالاختناق وعدم الراحة والتوتر			
15	حدوث سعال متكرر عند الاستيقاظ من النوم			
16	حدوث حالات ارتفاع ضغط الدم			
17	الإصابة بسكتة دماغية			
18	الإصابة بمرض السرطان			
19	الإصابة بأزمة(الربو)			
20	الإصابة بالتهابات الشعب الهوائية			
21	التعرض للولادة المبكرة			
22	ولادة طفل وزنه أقل من المعدل الطبيعي			
23	التهابات القصبة الهوائية			
24	شخير أثناء النوم			
25	حساسية في الصدر			
26	التهابات الجيوب الأنفية			
27	الالتهاب الرئوي			
28	الرشح والزكام			
29	التهابات الحنجرة			
30	التهابات في الأذن الوسطى			
31	حدوث مشاكل في القلب			
32	الإحساس بنوبات صرع			
33	حدوث نزف وعائي في الأوعية الدموية			
34	صعوبة التحكم في الأعصاب (الشلل الرعاش)			
35	الإصابة بالتهاب السحايا			
36	أعاني من العصبية المفرطة			
37	الشعور بالأرق وقلة النوم			

إضافات أخرى...

وشكرا لحسن تعاونكم