An-Najah National University
Faculty of Graduate Studies

# EVALUATION OF DAILY CHANGES IN AIR POLLUTANTS LEVELS ON THE INDUCTION OF RESPIRATORY SYMPTOMS IN SCHOOL CHILDREN: THE Y'ABED CHARCOAL PRODUCTION BASIN

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*TO*

*MY DEAR FATHER AND MOTHER FOR THEIR SUPPORT, TO MY WIFE JUMANA AND TO MY BROTHERS AND My FRIEND WITH LOVE AND RESPECT*

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# TABLE OF CONTENT

# LIST OF TABLES

## LIST OF FIGURES

**EVALUATION OF DAILY CHANGES IN AIR POLLUTANTS LEVELS ON THE INDUCTION OF RESPIRATORY SYMPTOMS IN SCHOOL CHILDREN: THE YABED CHARCOAL PRODUCTION BASIN**

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# ABSTRACT

The effect of charcoal production in Ya'bad area was studied by evaluation of gasses emitted from the process of carbonization. The study was carried out over 14-month period (May 1998 – August 1999). An ELE 8000/EMS 1417 Environmental Data Logger was used to measure the concentrations of CO, $CO_2$, $NO_2$, $SO_2$ and $H_2S$ in three different locations. These locations are: site A located at about 180 meter to the north east of the kilns, site B about 70 meter forward to the smoke comes out of the kilns in Ya'bad and site C in the site of the kilns. Other physical factors; wind speed, wind direction, temperature and relative humidity were measured by the Logger. The effect of gas production on respiratory symptoms on Ya'bad inhabitants was studied by a 14 questions questionnaire. Primary school children from the fifth grades living in four communities (supposed to be polluted). and in three communities (low polluted) answered the questionnaire .Our study has demonstrated that the concentrations of the gases measured were inversely correlated with distance from charcoal kilns, with the highest levels being encountered in site C (CO average concentration was 100.57ppm, $NO_2$ 11.7 ppm and $SO_2$ 1.75 ppm). In site A gases levels were very low (CO average concentration was 0.19ppm, $NO_2$ 0.29 ppm, $SO_2$ 0.26ppm, $CO_2$ 1.6%, and $H_2S$ 0.36ppm). In site B, the levels of gases were also lower than that of site C (CO average concentration was 37.9ppm, $NO_2$ 14.9 ppm, $SO_2$ 14.7 ppm, $CO_2$ 1.98%, and $H_2S$ 12.2 ppm). In sites C and B the gases levels exceeded the maximum standards limits and in site A the levels did not exceed the standards. Statistical analysis using ANOVA and F-tests ($p < 0.05$) showed significant difference in gases levels in the three locations. Our study showed also a considerable effect of charcoal production was significant (using ANOVA and t-tests) between school children close to the kilns and school children far from the kilns. Moreover, there was significant difference in respiratory symptoms between male and female students in schools closer to the kilns.

# CHAPTER ONE

# INTRODUCTION

# Chapter 1
# Introduction

## 1.1 Air Pollution

Air pollution is defined as substanses in the atmosphere that have harmfully effects on breathing (Nebel and Wright, 1993). The main sources of air pollution are energy production, transportation and industry.

One of the most problematic air pollutants in Israel as confirmed by air quality monitoring carried out, is sulfur dioxide (Gabbay, 1994). In 1993, over 11.5 million tons of crude oil and 5.8 million tons of coal were imported in to Israel (Gabbay, 1994).

In a study in Jordan there was an elevation in $SO_2$ and CO during the cold periods and exceeds the standard (Environmantal Research Center, 1990).

Industrial air pollution is made up largely of smog and sulpher dioxide from the burning of coal and generally occurs in winter.Exposure to carbon monoxide at high concentration some times encountered in heavy traffic can raise carbxyhemoglobin concentration in the blood of normal subjects, and can limit exercises tolerance in-patients with angina.

A small consistent association between standardized mortality and concentration of particulates in the environment particularly those below 2.5 micro meter in comparisons was found between similar cities with differing levels of pollution in the U.S.A. (Greef, 1995).

A significant association between daily $SO_2$ levels originated from a coal-fueled power plant in France and prevalence of upper and lower respiratory symptoms, in children was demonstrated (Charpin et al., 1988).

The evaluation of adverse health effects of exposure to air pollutants, even at relatively low concentrations, had become recently a major concern in many parts of the world. Significantly higher prevalence of respiratory symptoms in children were reported to be induced by moderate daily changes in $SO_2$ concentration in coal-basin area in France (Charpin et al., 1988).

Effects of air pollution have been mainly studied through examination of pulmonary function tests, whereas the association between air pollution and respiratory symptoms has been studied less extensively in sensitive subjects, e.g., children and asthmatic or bronchitic patients (Charpin et al., 1988).

## 1.2 Air pollution in the West Bank

There are no data available on air pollution in the West Bank due to the lack of air quality monitoring stations or programs so far. Quantification of air pollution has bean carried out based on the estimation of possible air pollution contributing factors such as industrial activities, transportation, energy consumption, open burning of solid waste, and transboudary air pollutants. Although West Bank houses have little heavy industry, it suffers from substantial air pollution especially in the main urban areas and vicinities. More than 90% of the pollution in the West Bank comes from: human activities; increase in population; expanding industrial activity; and transboundary air pollutants. These are probably the key factors of air quality deterioration in the West Bank. The lack of preventive legislation and codes and regulations to protect the environment; leads to an increase in human activities that affect air pollution. More over, climate and topography of the West Bank play a crucial role in transmitting air pollutants from one place to another (Applied Research Institute Jerusalem ARIJ, 1996).

The most expected common air pollutants in the West Bank are sulfur dioxide, suspended particulate matter, nitrogen dioxide, carbon monoxide, carbon dioxide and lead. Industrial activities with regard to air pollution are almost unregulated and their impact is heightened by the close proximity of the industrial facilities to populated areas. Quarries and stone cutting factories emit huge amounts of dust to the air (Shtayeh and Hamad, 1995). Charcoal production mainly found in Jenin area is a major contributor to air pollution. Considerable amounts of particulate, carbon monoxide, nitrogen oxides and VOC (volatile organic compounds) were expect to be emitted from charcoal production (ARIJ, 1996; Harris, 1978).

## 1.3 Charcoal production

Charcoal is an energy source in some areas of the world. It is considered as a clean energy source in comparison to coal and petroleum (Ballester et al., 1996). Charcoal by itself is a nontoxic material. However, it can be used to treat some digestive system problems (Baba, 1995). However, gases that are produced as a result of converting wood to charcoal may cause some adverse effects to humans, animals, plants and other organisms health. It is also a serious cause of air pollution (Charpin et al., 1988).

The process of charcoal production is known as "carbonization". This process occurs in kilns and consists essentially of burning some wood charges to carbonize the rest in the presence of limited controlled quantities of air (Harris, 1978).

The process may require from 5 to 15 days of continuous vigilance by the workers with burning materials like hay and dry branches until actual carbonization happened (Baba, 1995).

The temperature of wood is raised inside the kiln up to 100-120 $^0$C so that all of the free moisture will be driven off as steam, until wood become absolutely dry. Then the tempereature increased to 170 $^0$C at which wood will ignite in the presence of air. Decomposition of wood starts at 270 $^0$C and the tempereature continues to rise and may reach 400 $^0$C or more untill carbonization process is completed. This process results in: charcoal that contains 75-80% of fixed carbon, some ash and 20-25% volatile matter including tars and gases such as methane, carbon monoxide, carbon dioxide and others (Harris, 1978).

Production of charcoal using old kilns involves internal combustion of part of wood charged. These old kilns consume aproximatly twice as much wood per ton of charcoal as modern methods. In the ancient time charcoal was produced in earth pits or caves involving little or no capital. The process of charcoal burning requires days of continuous vigilance by the charcoal burner whose occupation was nevertheless regarded as lowly one, although it required a considerable skill (Harris, 1978).

After the industrial revolution more sophisticated kilns were developed using brick, concreat or even steel independently or in combination but with no essential change in the practices, The best results were given by the tranchant kiln which was made of steel and was portable which consists of two cylindrical sections and a lid, other kilns which are operated widely and successfully in Brazil, and especially in the state of Minas Gerais are internally heated fixed , batch type , the important iron and steel companies operate several thousand of them .

They are circular , with a domed roof and are built of ordinary fire bricks , the circular wall is totally in contact with the outside air , this type of kiln is referred as "Beehive Brick kiln, this type has many advantages such as the gases pass though the wood charge, the heat contained in the gases is partially used in the prosses of wood drying and carbonization. Good yeild of charcoal and low cost (Harris, 1978).

## 1.4 Health hazards during charcoal production

### 1.4.1 Particulates

During the process of charcoal production (wood carbonization), different suspended particles are emmited into the air breathed by the workers and the people living in the region surrounding the production area. In addition to that, these particulates affect the trees, buildings and transportation. These particles include pure CO and dust. Also as a result of carbonization and after the process is completed, a huge amount of ash is produced. When the burrning wood is cooled and washed with water, ash is mixed with the ground soil causing an increase in acidicty of the soil (Baba, 1995; Schwartz, 1993).

#### 1.4.1.1 Particles measuring

Particulate air pollution has been traditionally measured by drawing air through a filter paper and measuring the density of the black stain on the filter. This method is called black smoke method (Seaton et al., 1995).

Respirable particles, typically with a 4.5 micro meter aerodynamic diameter (50% cut-off point) are collected by the black smoke method and its variation; some particles up to 7-9 micrometer are also collected. Methods to measure total suspended particulate (by high volume sampler) have been used extensively in the USA. There are problems with this method, however in that the size range of particles sampled extends well beyond those particles that are able to penetrate the upper respiratory tract and in arid regions the method is liable to sample wind – entrained dust of non combustive origin, and this problem has been recognized by US EPA who recommended that particulate matter of less than 10 micro meter aerodynamic diameter (PM10) be measured, as a better indicator of health – related particles (WHO,1987).

The measurements of black smoke or PM10 are both expressed in micro gram per meter cubed, but they don not measure quite the same thing (Seaton et al., 1995).

### 1.4.2 Gases

#### 1.4.2.1 CO

Carbon monoxide is an invisible gas that is highly poisonous (Nebel and Wright, 1993). It is a colorless and odorless gas, very stable and has a life time of 2 to 4 months in the atmosphere (Wark and Warner, 1981). This gas comes from pilot lights, unwanted kerosene, gas space heaters, gasoline engines, wood burning and mostly from carbonization (Samet et al., 1987).

Carbon monoxide interferes with oxygen transport by avidly binding to hemoglobin to form carboxyhemoglobin and by shifting the oxyhemoglobin dissociation curve to the left, although it binds to myoglobin , but the physiologic significance of the formation of CO –myoglobin has not been established .

Carboxyhemoglobin reduce oxygen delivery to tissues as dose the hypoxia of altitude, the tissues with highly oxygen needs are myocardium, brain, and exercising muscle, are most affected by the formation of carboxyhemoglobin (Samet et al., 1987).

The relevant standard of CO is 35 ppm EPA 1-hour, 9 ppm EPA 8-hour. The risks of CO poisoning are greater for fetuses, infants, pregnant women and persons with underlying cardiovascular or pulmonary disease.

High concentrations of carbon monoxide can cause physiological and pathological changes and ultimately death. Carbon monoxide is a poisonous inhalant that deprives the body tissues of necessary oxygen (Wark and Warner, 1981).

Hypoxia caused by carbon monoxide leads to deficient function in sensitive organs and tissues like the brain, heart, the inner wall of blood vessels (WHO, 1987).

**1.4.2.2 $CO_2$**

Carbon dioxide $CO_2$ is a colorless gas without smell and has a role in the carbon cycle and is one of the greenhouse gases (Shtayeh and Hamad, 1995). It is emitted from all fossil fuels products. Coal generates 1.8 times as much $CO_2$ as does natural gas; large increases in atmospheric concentration of $CO_2$ could produce significant climatic changes mainly through the greenhouse effect. Further more if the rate of fossil fuel and coal were to continue increasing then the amounts of $CO_2$ could have severe impacts by the year 2025(The committee on Health and Environmental Effects of increased Coal Utilization, 1980).

**1.4.2.3 $NO_2$**

$NO_2$ has a stinging , suffocating odour and is composed of nitrogen–oxygen compounds (gases) that are converted to nitric acid in the atmosphere and they are a major source of acid deposition (Nebel and Wright, 1993). It plays an important role in formation of troposphere $O_3$ .$NO_2$ is often found at higher level indoors than outdoor, levels currently encountered in outdoor and indoors air, have been difficult to characterize.

Most studies of the relationship between residential exposure to $NO_2$ and health have focused on respiratory symptoms, illness and on level of pulmonary function. Because of its solubility, nitrogen dioxide penetrates into the lung periphery and about 60% of it is deposited there (Bascom, 1996).

$NO_2$ may damage the lung directly through its oxidant properties or indirectly by increasing susceptibility to respiratory infection (Bascom, 1996).

$NO_2$ can react with moisture present in the atmosphere to form nitric acid, which can cause considerable corrosion of metal surfaces. It absorbs visible light and at a concentration of 0.25 ppm will cause appreciable reduction in visibility. At a concentration of 0.5 ppm for a period of 10 to 12 days it suppresses growth of some plants. At a concentration found in the atmosphere it is only potentially irritating and potentially related to chronic pulmonary fibroses and some increase in bronchitis in children.

Nitrogen dioxide may trigger biochemical changes at relatively low concentration beginning after a 30-minute exposure to about 0.2 ppm. Long exposure leads to emphysema –like structural changes characterized by thickening of the alveolar capillary membrane. It has effect on the pulmonary function of normal, bronchitis and asthmatic humans (WHO, 1987).

### 1.4.2.4 $SO_2$

Sulfur dioxide is a poisonous gas to both plants and animals. It converts to sulfuric acid in the atmosphere and causes acid deposition (Nebeland Wright,1993). $SO_2$ is one of the most widespread pollutants in the world. It is emitted during the composition of most fuels (Khan and Gibbs, 1996). Domestic fires can produce emissions containing sulfur dioxide (WHO, 1987).

Sulfur dioxide is a nonflammable, nonexclusive, colorless gas that causes a taste sensation at concentrations from 0.3 to 1.0 ppm in air, at concentrations above 3.0 ppm the gas has pungent, irritating odor (Wark and Warner, 1981).

Exposure to sulfur dioxide is sensitive to asthmatics after vigorous exercise. Many of them show excess bronchoconstriction after only a few minutes. Studies have indicated that the bronchoconstrictive effect of $SO_2$ on asthmatics can be mitigated by anticholonergic drugs beta–adrenergic drugs (Linn et al., 1988).

Broncho constriction may be assessed in terms of slight increase in airway resistance ,most individuals will show are response to $SO_2$ at concentration of 5.0ppm and above, certain sensitive individuals show slight effects at 1to 2 ppm(Wark and Warner, 1981).

**1.4.2.5 $H_2S$**

It is a colorless gas, soluble in various liquids including water and alcohol. It can form under conditions of deficient oxygen in the presence of organic material and sulfate. Human activities can release naturally occurring hydrogen sulfide into ambient air. In industry, hydrogen sulfide could be formed whenever elemental sulfur or sulfur containing compounds come into contacts with organic materials at high temperatures.

In acute form, hydrogen sulfide intoxication is mainly the result of action on the nervous system, at concentration of 15 mg /$m^3$ and above. It causes conjunctiva irritation, it affects the sensory nerves in conjunctivae. If respiration can be maintained, the

Prognosis in a case of a cute hydrogen sulfide intoxication, even a severe one, it cause eye irritation (WHO, 1987).

#### 1.4.2.6 Methane

Methane emissions from agricultural activities in particular the report must include an inventory of activities in rice farming and livestock production and the intentional burning of agricultural waste grassland wood and forests (Ballester et al., 1996).

Methane is produced of microbial fermentation of organic matter in anaerobic environment. The percent of methane in the atmosphere is about 0.0002%. Increase in methane and other greenhouse gases are anticipated to affect global climate dynamics, increasing surface temperatures and altering the distribution of precipitation (Abu Omar and Shtayeh, 1995).

### 1.5 Charcoal production in Palestine

Charcoal continues to be used in different quantities as domestic fuel in the West Bank and Gaza. It is mainly used for cooking and heating in urban and rural areas. Charcoal was used in large quantities thirty years ago but it has faced competition from kerosene and liquefied gas. Until now there are no official statistics on the amounts of charcoal produced or consumed in the Palestinian areas, but it is estimated that 18,000 – 20,000 Tons of charcoal is produced annually less than 30% of this quantity is consumed locally (Baba, 1995).

Actually, more than 80% of charcoal produced locally in the West Bank and Gaza is exported to Israel. It is estimated that 18,000 tons of charcoal is produced in the Jenin area and around 2000 tons are produced in the Gaza strip, charcoal is used for cooking (barbecue), home heating, tobacco smocking (babbles) and for small industries. The quality of the produced charcoal is relatively low, and it is consumed locally without any type of processing, the studies shown that the carbonizing process of wood is not complete in more than 85% of the cases. The result of this is higher percentage of carbon monoxide production when burning the charcoal. Using such energy source for home heating in winter is a great danger to human health (Baba, 1995).

Charcoal production techniques used locally, are extremely poor, since much of the energy of wood is lost in the production process of charcoal. Thus the use of charcoal as a viable cooking and heating fuel can be developed and expanded, but this should be on the basis of technology and management that lead to low priced, reliable and sustainable supply. Present methods of cutting the trees and burning the wood in kilns are predatory and waste of energy and can not be sustained beyond a low threshold. More efficient pit kilns would improve the economics of charcoal but not the long term output or validity of the forests (Baba, 1995).

If charcoal, as indigenous sources of energy, is to be reliably supplied to customers, it must come from plantations that are regularly cut and replanted. Energy plantations have generally been promoted for land unfit for agriculture but the availability of such land varies from region to region (Baba, 1995).

In Palestine, old-fashion kilns are used for the production of charcoal. Most of these kilns are located in Y'abad Area near Jinin.

The process of charcoal production used in Palestine is as follows; (Figures 1.1,1.2,1.3), wood pieces are organized together to form a coned shape. A small hole is left at the top of the cone to put the small dry branches and hay to be used as fuel to start the fire. Next, all sides of the cone excluding the top are covered with soil and sand so that smoke can not escape from the cone. After starting the fire by burning the hay and small dry branches at the top the whole cone is closed and covered completely with soil. After that from time to time, the top of the cone is opened to add more wood and hay to keep the fire on inside the cone.

### 1.5.1 kilns in Y'abed

The charcoal Kilns are mostly located in Y'abed and the surrounding villages see (Figure 1.4). A population of about 35,000 people lives in Y'abed area (Y'abed, Zabadah, Dhahr Al 'abed, Barta'a, Tourah and Nazlet Zeid). Many of these people

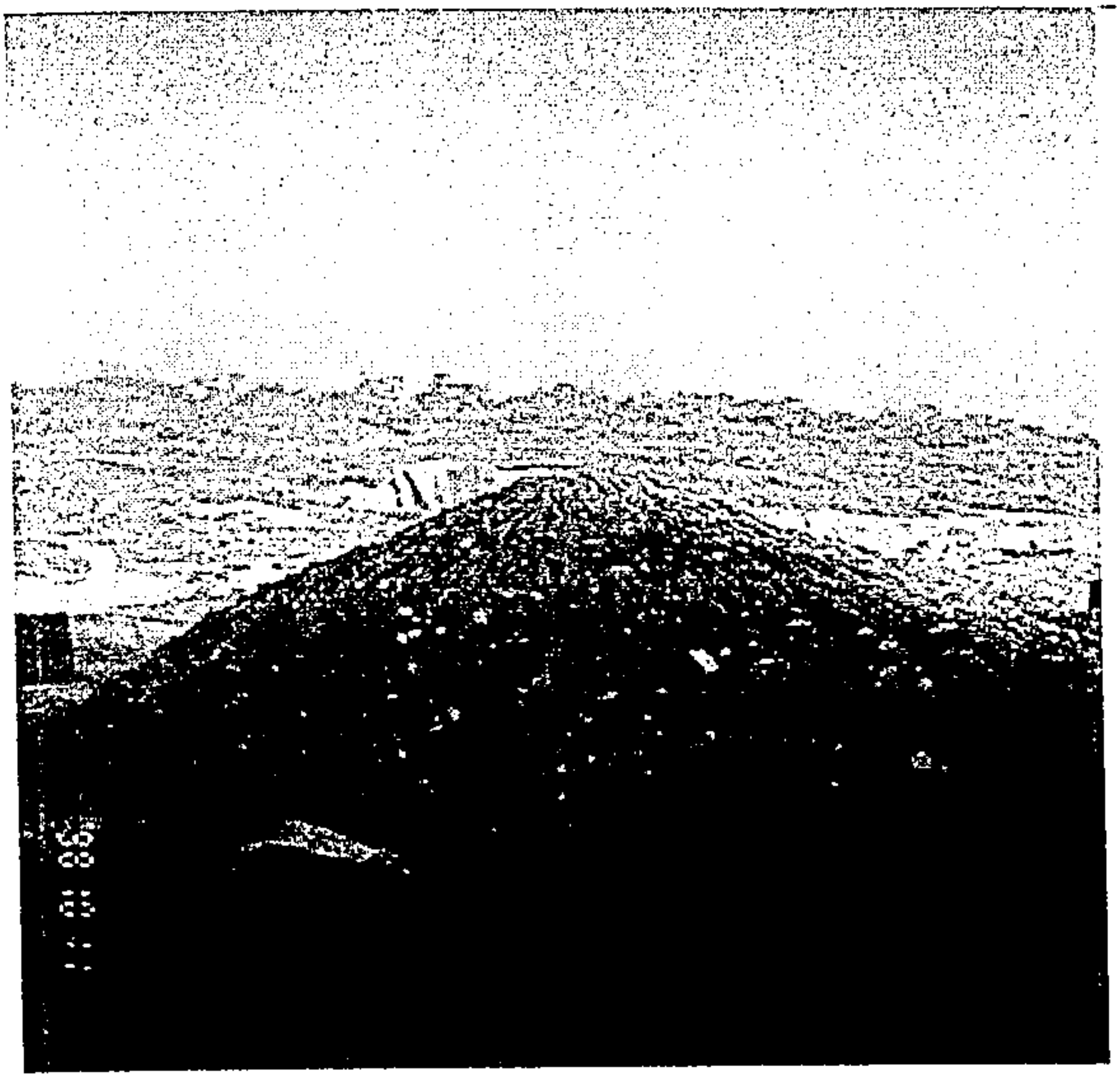


Figure 1. 1 The fist step in charcoal production: wood is arranged in a cone shape heep.

Figure 1. 2 The second step in charcoal production: covering wood with a layer of hay (7-10cm) thick

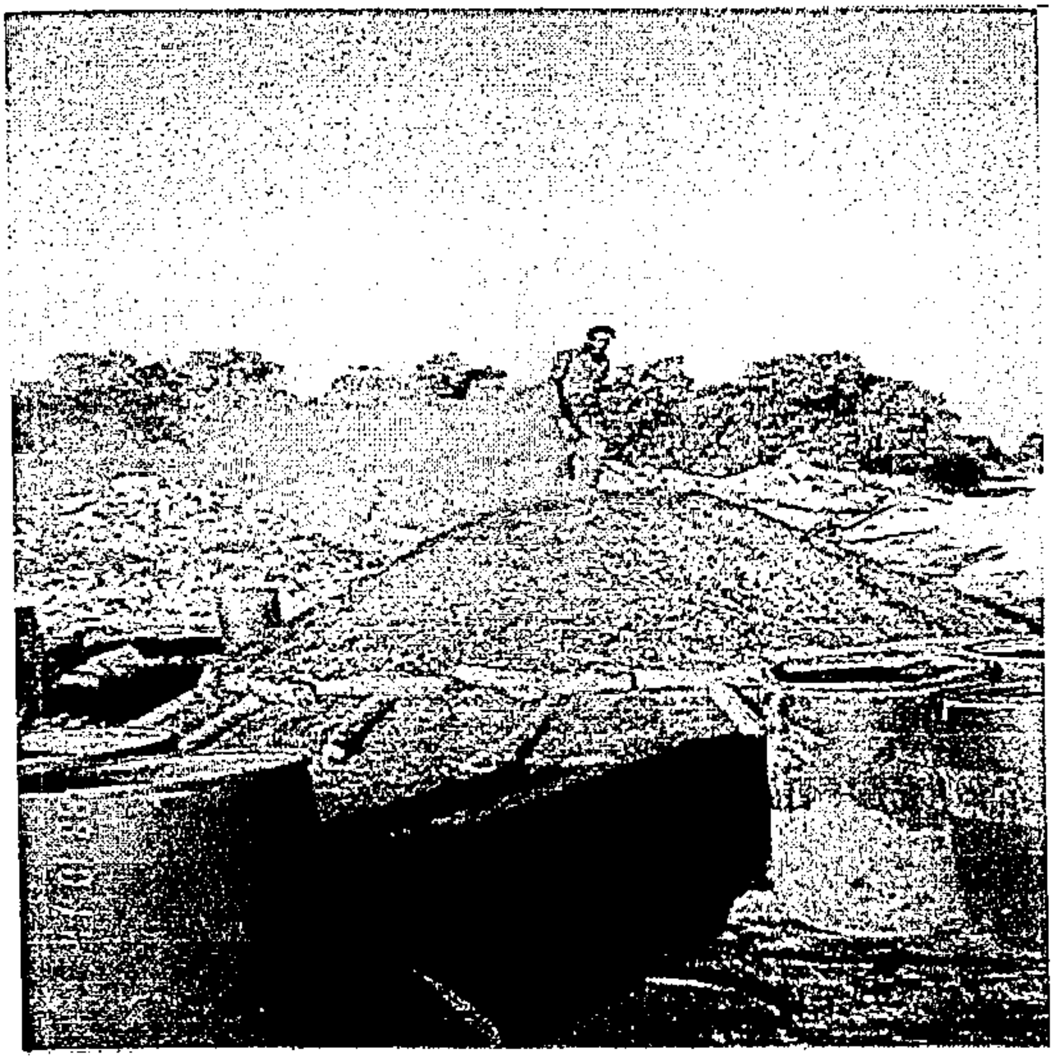


Figure 1.3
Charcoal kiln covered with sand and the worker on the top to see the fire.

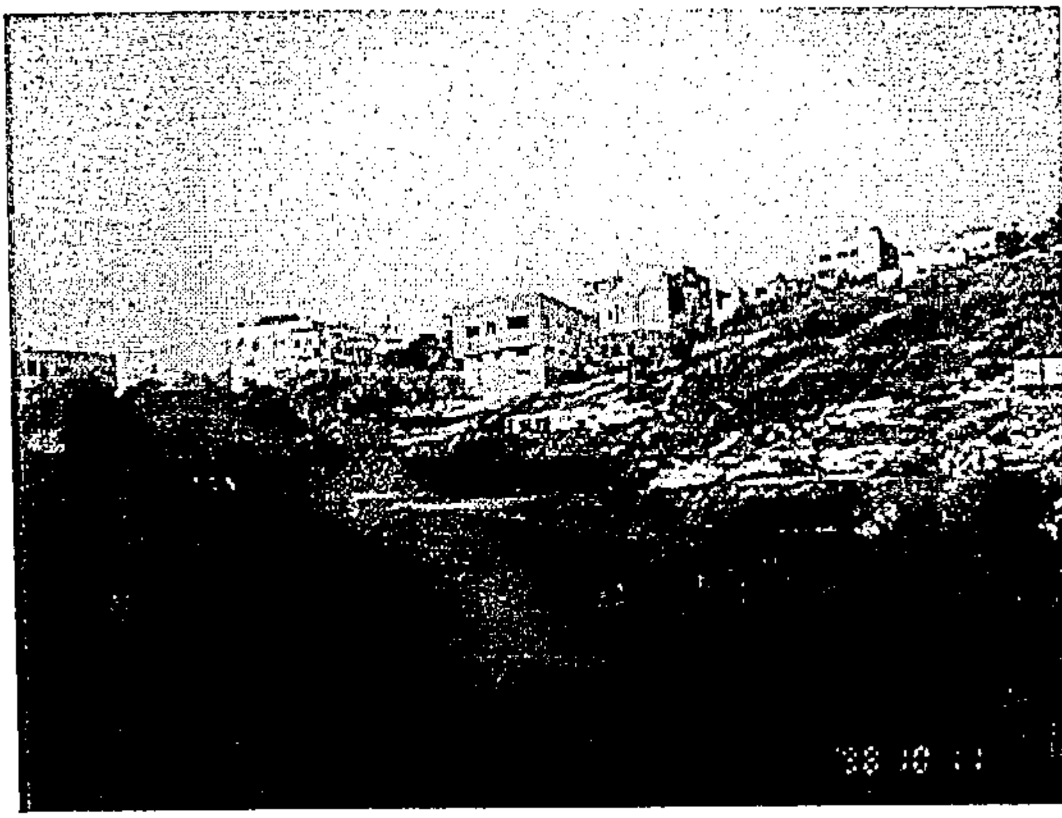


Figure 1. 4 charcoal kiln close to houses in Ya'bad

depend, in their living, on olive and tobacco farming, and on charcoal production.

More than 75,000 tons of wood is used annually for charcoal production resulting in about 18,000 tons of charcoal the majority of which is exported to Israel. About 600 workers supporting about one third of Y'abed. The charcoal kilns are located in the agricultural land and not far from the living area, and some of them are very close to houses (Figure1.5), and closer to the main road (Figures 1.6, 1.7).

Figure 1.6 man work in a charcoal kiln

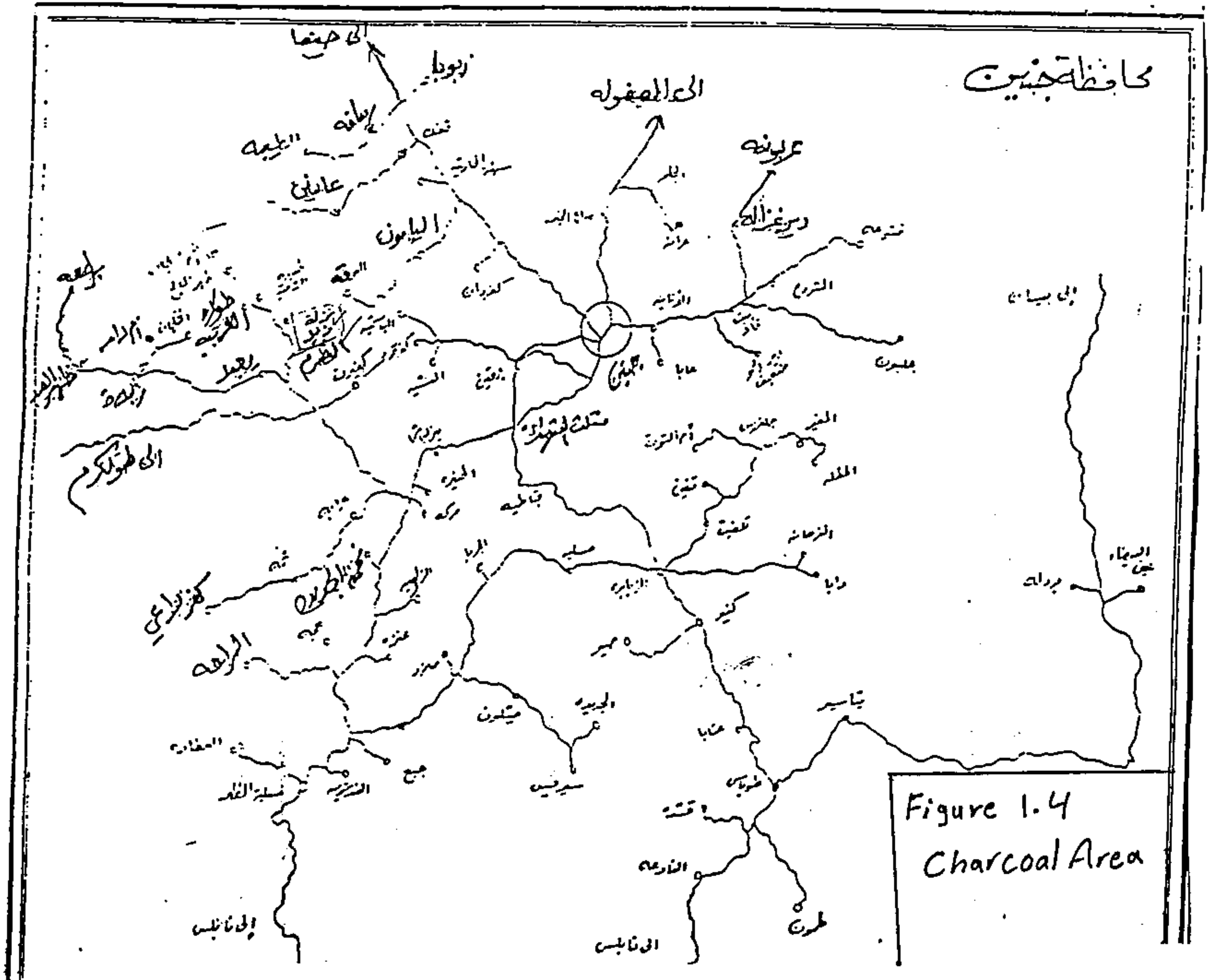



Figure 1.4
Charcoal Area

Figure 1.7 Charcoal kilns located near the main road in the vicinity of Y,abed village

## 1.6 Objectives

This study was aimed at:

1. Providing data on air pollution levels resulted from charcoal kilns in Ya'bed area.
2. Studying the relationship between air pollutants and climate (e.g., temperature, humidity, wind speed and direction).
3. Evaluating the adverse health effects of exposure to air pollutants resulting from charcoal production in Ya'bed area.

# CHAPTER TWO

# MATERIALS AND METHODS

# Chapter 2

## Materials and Methods

### 2.1 Study area: The Y'abed charcoal production basin

The charcoal kilns are located around Y'abed and surrounding villages. A bout 200 location for charcoal production existed in the year 1996.

Y'abed, located about 17-Km south west of Jenin, comprises an area of approximately 35 $Km^2$, with a population of 18000 inhabitants. Several other villages with a total population of about 17,000 have charcoal kilns. These villages are: Zabada, Theher Al-abed, Bartaah, Tourah and Nazlet Zaed. Charcoal kilns have been operating there for long time, and many people of the area work in the kilns.

In the year of 1995 more than 75,000 tons of wood were used annually for charcoal production resulting in about 18,000 tons of charcoal the majority of which was exported to Israel. About 600 workers supporting about one third of Yabed. Actually, more than 80% of charcoal produced locally in the

West Bank and Gaza were exported to Israel. It was estimated that 18,000 tons of charcoal were produced in the Jenin area and less than 30% of this quantity is consumed locally (Baba,1995).

## 2.2 Study sites

Three sites expected to have different air pollution levels that been, in Y'abed town.

**Site A:**

Located at about 180m to north east of the charcoal production area near Y'abed town on a house in side the town, and expected to have moderate or low air pollution level.

The site was studied in the periods of March 19-April 22,1999 and May 2-11,1999.

**Site B:**

Which was on a house near the charcoal, kilns near Y'abed town. About 70m from the charcoal kilns and for ward to the smoke comes out of the kilns, we expect this place to be polluted so we took readings in the year 1998 and 1999.

The site was studied in the periods of May 28- June 9-1998,Agust 17-24-1998, September 1-8-1998,April22-29-1999, May 12-20-1999, and June16-21-1999.

**Site C:**

Was closer to the charcoal kilns near Y'abed town in the field to see the effect on the workers, and we expect that the concentration could be high or heavy polluted, and that was during the period of July 2-5 -1999.

The charcoal kilns are located in an agricultural land mainly planted with olives, many of them are not far from the living area . Soil in the area is a mudy soil.

## 2.3 Environmental monitoring system

An ELE 8000/EMS 1417 Environmental automatic pollution monitoring station was used throughout this sort. The system is a computerized station that use a computer program called (DEMS) from which the data logger can be set up and programmed.

Dialog 900/EMS Management Software has been developed in conjunction with the MM900/950 series of data loggers and runs on IBM PC or compatible. The software provides the means to set up and operate the data loggers. Once an experiment has been defined, and the relevant sensors connected the logger can be quickly and easily configured. When the logger has been configured it will run independently from the computer until data has to be collected.

Dialog is a menu driven program with pull down menus, which lead logically through the normal operational sequences. The user interface is intuitive, with context sensitive help available. Dialog is supplied with a database containing the configuration data for standard sensors.

All information about a logging task can be saved in a configuration file, separate configuration files can be created for each experiment, and can be retrieved when required. Dialog can be set up to automatically retrieve a predefined configuration file when the program is first run.

Dialog downloads data from the MM900 via the RS232 serial link and saves it to a data file. The downloading procedure does not interfere with the operation of the logger. Dialog can be configured to start the download from the end of the last downloaded record in the logger's memory and to append the information to the data file, the data in the files can subsequently be viewed or converted to different formats for export to other programs like Lotus 123, or can be output to a printer.

The data logger depends on a chemical and physical sensors. The chemical sensors are very sensitive to the gases, each sensor is sensitive to one gas, and the sensors are:

**Carbon monoxide gas sensor**: This sensor uses an electrode, a reference electrode and a counter electrode, the gas diffusing into the sensor reacts with special catalyzed sensing electrode to produce electrons. A built-in circuit amplifies the signal into a millivolt output. Calibration can be checked by exposing the sensor to a known gas construction or by using a cylinder of span gas.

**Carbon dioxide sensor**: for the estimation of $CO_2$ gas concentration, the concentration is in (%).

**Nitrogen dioxide sensor**: This sensor uses an electrode, a reference electrode and a counter electrode, the gas diffusing into the sensor reacts with special catalyzed sensing electrode to produce electrons. A built-in circuit amplifies the signal into a millivolt output. Calibration can be checked by exposing the sensor to a known gas construction or by using a cylinder of span gas.

The concentration unit is ppm, the reading was recorded on a 10-min. basis.

**Sulfur dioxide sensor**: This sensor uses an electrode, a reference electrode and a counter electrode, the gas diffusing into the sensor reacts with special catalyzed sensing electrode to produce electrons. A built-in circuit amplifies the signal into a millivolt output. Calibration can be checked by exposing the sensor to a known gas construction or by using a cylinder of span gas.

The concentration unit is ppm, the reading was recorded on a 10-min. basis.

**Hydrogen Sulfide sensor**, This sensor uses an electrode, a reference electrode and a counter electrode, the gas diffusing into the sensor reacts with special catalyzed sensing electrode to produce electrons. A built-in circuit amplifies the signal into a millivolt output. Calibration can be checked by exposing the sensor to a known gas construction or by using a cylinder of span gas.

The other sensors are:

**Wind speed sensor**: this sensor measure wind run and average wind speed.

Measurement method: The wind causes the cups to rotate.

A magnet turns with the rotor spindle and the resulting varying field causes two mercury wetted reed switches to make and break contact each revolution. The unit is m/s.

**Relative Humidity sensor**: This sensor measures the relative humidity of air.

The measurement method: The water is absorbed according to the relative humidity of the air. This causes a change in the capacitance of the sensor, which the electronics convert, into a linear voltage.

**Wind direction sensor**: for determining the wind direction.

A wire wound potentiometer system is used to indicate the wind direction. Increased wind angels produce larger resistance's, which can be measured, the sensor gives a smooth rotation through 360 degree.

## 2.4 Experimental design

The study was carried out over a 14-month period (May - 1998 to August -1999). Monitoring periods are shown in table 2.1 and 2.2

Table 2.1: Air pollution monitoring periods during the year 1998

| | May<br>28-31 | June<br>1-11 | July<br>1-31 | August<br>17-24 | September<br>1-8 |
|---|---|---|---|---|---|
| CO | | ++ | | | |
| $CO_2$ | | | | ++ | ++ |
| $NO_2$ | ++ | ++ | | ++ | ++ |
| $SO_2$ | ++ | ++ | | ++ | ++ |
| $H_2S$ | ++ | ++ | | ++ | ++ |

Table 2.2: Air pollution monitoring periods during the year 1999

| | March<br>19-31 | April<br>1-30 | May<br>2-20 | June<br>16-21 | July<br>2-5 |
|---|---|---|---|---|---|
| CO | | | ++ | ++ | ++ |
| $CO_2$ | ++ | ++ | ++ | | |
| $NO_2$ | ++ | ++ | ++ | | ++ |
| $SO_2$ | ++ | ++ | ++ | | ++ |
| $H_2S$ | ++ | ++ | ++ | ++ | |

2.5 **Data collection**

The data were collected every three days and some times every one-week by a computer.

In our study the gases collected were CO, $CO_2$, $NO_2$, $H_2S$ and $SO_2$. Some environmental factors were studied such as humidity, temperature, wind direction and wind speed

### 2.5.1 Statistical study

The data were statistically done for the averages every 8-hour, because the national standards concern with the 8-hour standard. The maximum and minimum concentrations were found for each period. F-test was done for each gas to see if there was significant difference between the location then statistical test done between each two locations to see the difference between which location and toward which location.

### 2.5.2. Graphics

Graphs were done for the average data. In the graphs the concentration of gases were put on the main axis and on the secondary axis we put the environmental factors to see if theirs a relation between the concentration of the deferent gases and the environmental factors. We took two axes because of the difference in the unit.

## 2.6 Questionnaire

The study was including a questionnaire for respiratory symptoms, which was reported at the morning by the help of the teacher. The questionnaire contains 14 questions and information about the place and the sex, the questions where divided into two parts some of the questions, at the morning had you 1- cough 2- eye irritation 3- a runny nose 4-any sneezing 5- sore throat 6-wheezing in the chest 7- fever (Appendix.B.1).

The symptoms such as eye irritation, runny nose, and sneezing have been considered together under the heading E.N.T symptoms and morning cough and wheezing in the chest appear as pulmonary symptoms.

The questionnaire was answered by primary school children from the fifth grades living in four communities supposed to be polluted ( Ya'bed, Zabdeh, Kferet , Nazlet Zeid) and in three low polluted communities (Anin , Arabeh, Am alrehan ). In each community all children attending the fifth grade were enrolled in the study.

Children were chosen because they do not smoke, not exposed to occupational hazards and spend the day in homogeneous air environment. The children will give indication on the people living in these areas.

Aims of the questionnaire:

To give us indications about respiratory and pulmonary symptoms in different villages in Jenin area.

To see if there was relation ship between air pollution from the charcoal production and respiratory and pulmonary symptoms through the statistical analysis of questionnaire in the area expected to be polluted and the villages expected to be non polluted.

To see if there was relation between the data obtained from the environmental station and the questioner.

The effect of the place and sex on the results.

Statistical analysis was done for the data obtained from the questionnaire between all the villages to see the effect of place and between the polluted and non-polluted villages.

# CHAPTER THREE

# RESULTS

# Chapter 3

## Results

### 3.1 Air pollutant levels in the Y'abed area

Means of concentrations of $CO$, $CO_2$, $NO_2$, $SO_2$ and $H_2S$ in the air determined at 8-h intervals in relation to relative humidity, temperature and wind speed are presented in Tables A.1-A.13 and Figures 3.1-3.11.

#### 3.1.1 CO monitoring

The 8-hour U.S.A. maximum is 9ppm and the Canadian standard is 13ppm.

Sampling sites (Locations A, B, C) differed significantly at ($p < 0.05$) in CO concentration with location C showing higher CO levels being closer to charcoal kilns.

Location A

During the period of May 2-11,1999 the concentration of CO ranged between 0.01- 0.5 ppm; with an average of 0.19 ppm. In this period there was an increase in the concentration of CO as temperature increased. The correlation with RH was not clear (Figure 3.1.A,D and Table A.1).

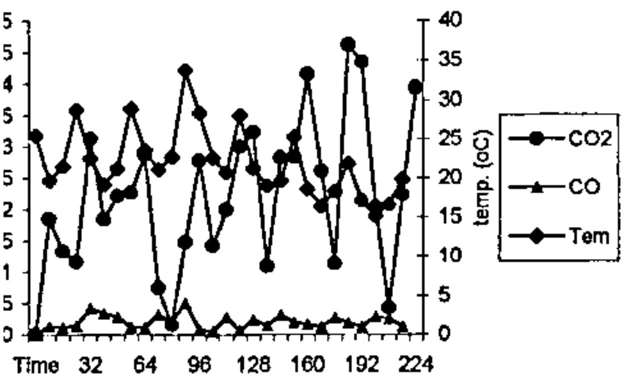



Figure 3.1.A Percent concentration of CO2 in relaton to tempreature during the period of May 2-11, 1999 (site A)

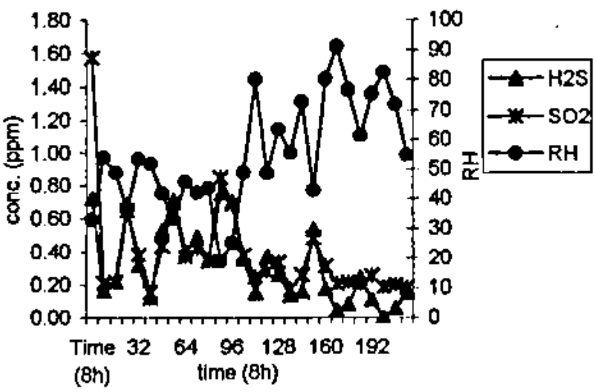



Figure 3.1.B Concentration of H2S and SO2 in relation to RH during the period of May 2-11, 1999 (site A)

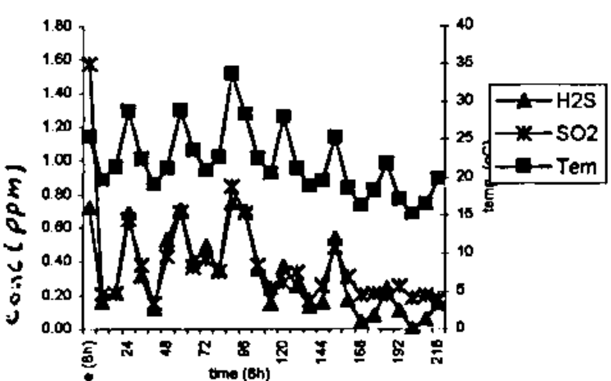



Figure 3.1.C Concentration of SO2 and H2S in relation to tempreature during May 2-11, 1999 (site A)

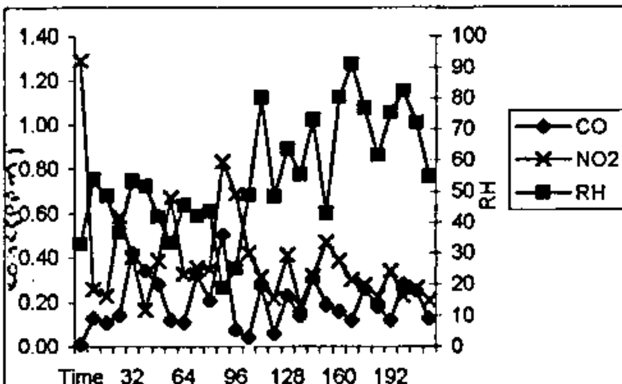



Figure 3.1.D Concentration of CO and NO2 in relation to RH during the period of May 2-11, 1999(site A)

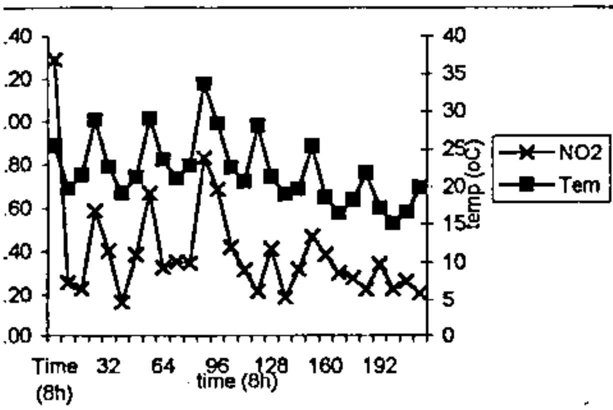



Figure 3.1.E Concentration of NO2 in relation to tempreature during the of May 2-11, 1999(site A)

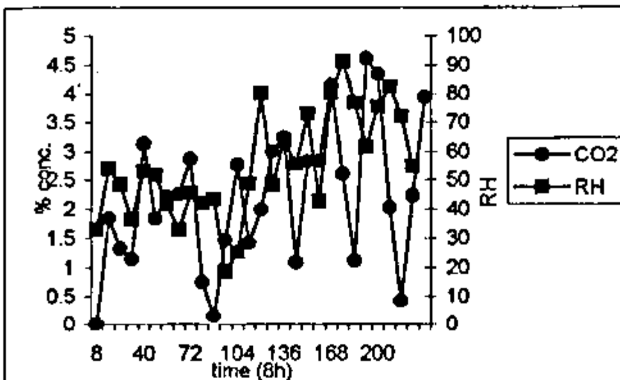



Figure 3.1.F Concentration of CO2 in relation to RH during the of May 2-11,1999(site A)

Location B

During the period of May31-June9, 1998 CO concentration ranged between 2.12-15.47 ppm; and the average was 10.2-ppm concentration increased with increasing temperatures (Figure 3.2.C, D and Table A.2).

During the period of September 27-29,1998 the concentration was ranged between 9.8-13.8 ppm; with an average of 11.55 ppm (Table A.3).

During June 16-21, 1999 the concentration of CO ranged between 31.65- 50.48 ppm; and the average was 37.9 ppm (Figure 3.3.A, Table A.4).

Location C

During the period of July 2-5,1999 the concentration of CO ranged between (20.86-167.75ppm) and the average was 100.57ppm. The concentration decreased with increasing in relative humidity (Figure 3.4.A and Table A.5).

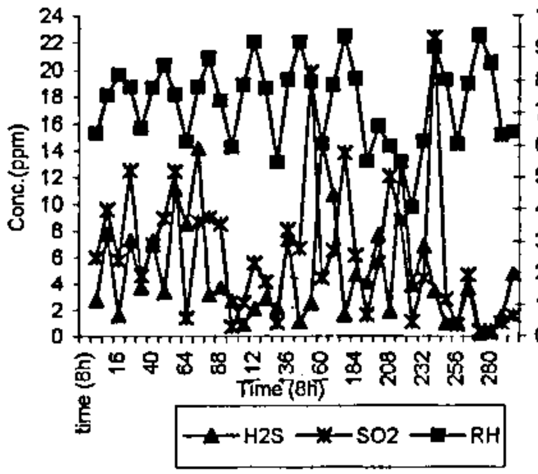



Figure 3.2.A H2S and SO2 Concentration in relation to RH during the period of May 31-June 9, 1998 (site B)

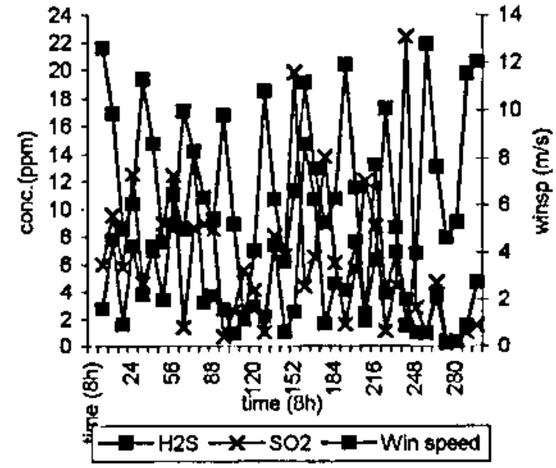



Figure 3.2.B H2S and SO2 concentration in related to wind speedduring the period of May 31-June 9, 1998 (site B)

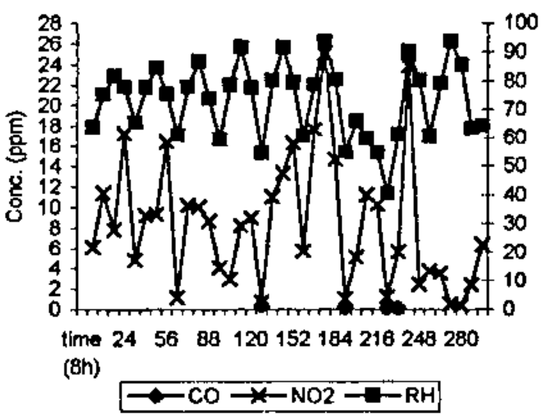



Figure 3.2.C CO and NO2 concentrations in related to RH during May 31- June 9, 1998 (site B)

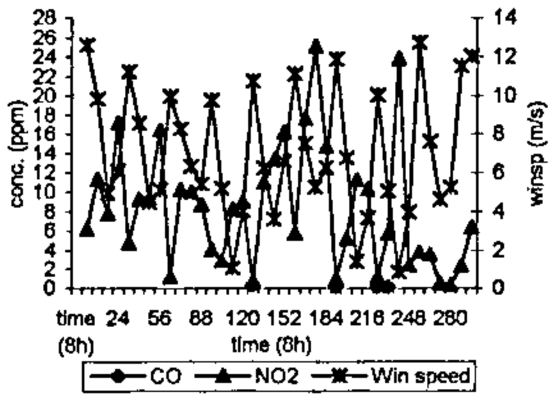



Figure 3.2.D CO and NO2 conc. in related to wind speed during the period of May 31-June 9, 1998 (site B)

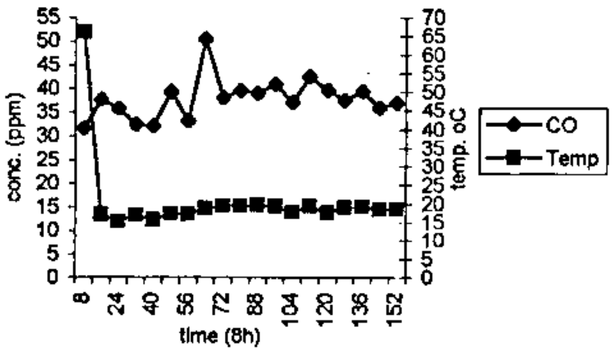



Figure 3.3.A Concentration of CO gas in relation to Tempreature during the period of JUne 16-21, 1999.(site B)

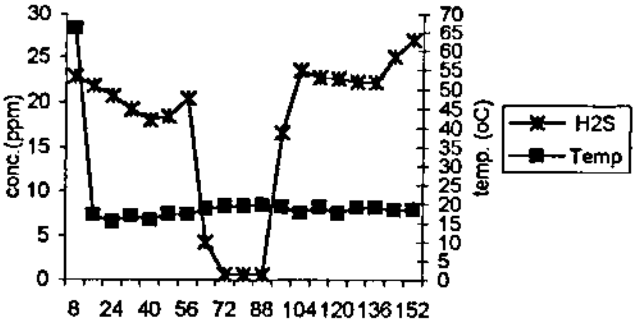



Figure 3.3.B Concentration of H2S in relation to tempreature during June 16-21, 1999(site B)

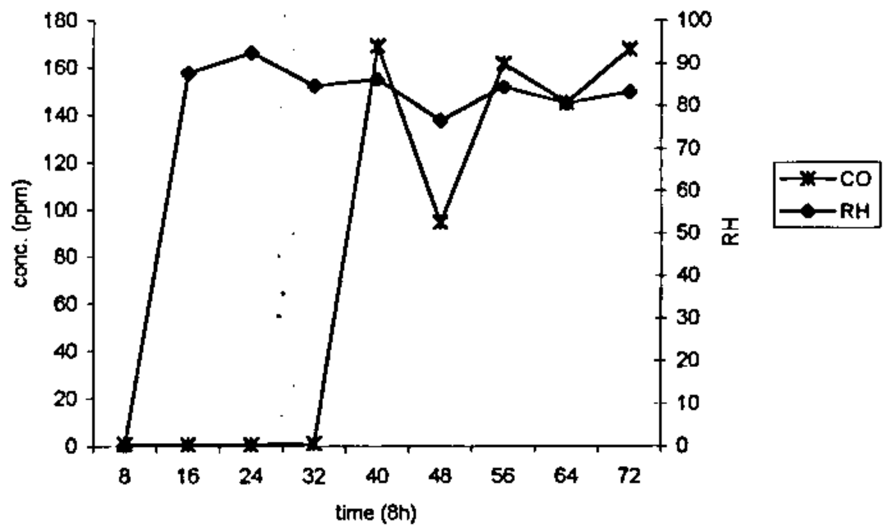



Figure 3.4.A Concentration of CO in relation to RH during July 2-5, 1999 (site C)

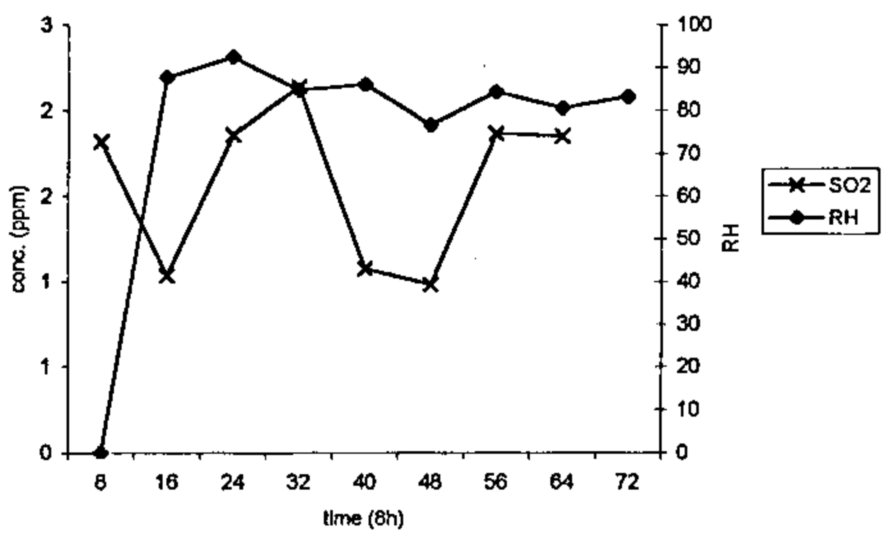



Figure 3.4.B Concentration of SO2 in relation to RH during July 2-5, 1999 (site C)

### 3.2.2 $NO_2$ monitoring

Sampling sites (locations A,B,C) differed significantly at ($p<0.05$) in $NO_2$ concentration with location C showing higher $NO_2$ level being closer to charcoal kilns.

**Location A**

During the period of March 19-April 22, 1999 the concentration of $NO_2$ ranged between 0.1- 1.51 ppm; with an average of 0.29 ppm. In most of the reading as the temperature increased the concentration increased, correlation with humidity was not clear (Figure 3.5.A,B, Table A.6).

During the period of May 2-11,1999 the concentration of $NO_2$ lies between 0.16-1.29ppm; and the average was 0.40 ppm, there was no large change in the concentration during this period. The concentration of $NO_2$ was increased as the temperature increase, the correlation with humidity increased as the humidity decreased (Figure 3.1.D,E, Table A.1).

**Location B**

During the period of May 28-30,1998 the concentration of $NO_2$ ranged between 1-15.29 ppm; the average was 8.57ppm.

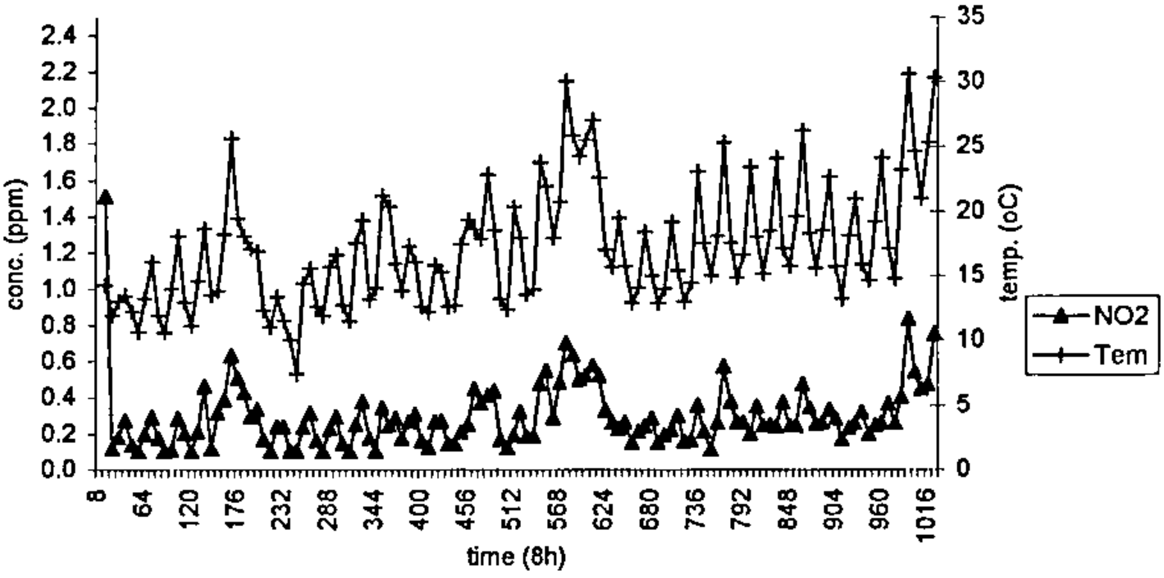



Figure 3.5.A concentrations of NO2 in relation to tempreature during the period of March 19 - April 22, 1999 (site A)

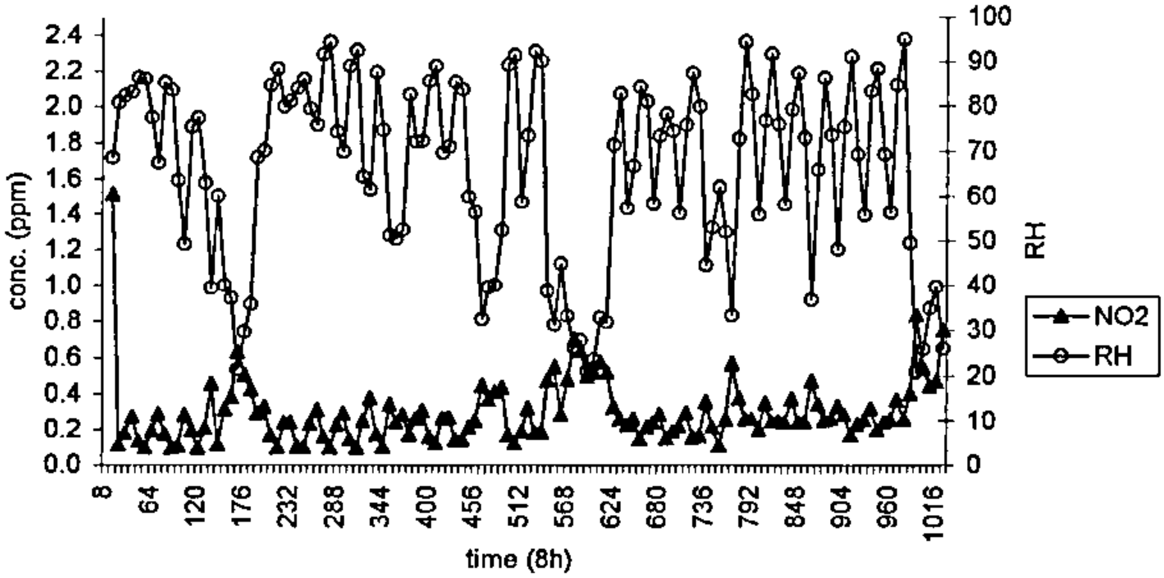



Figure 3.5.B concentrations of NO2 in relation to RH during the period of March 19- April 22, 1999 (site A)

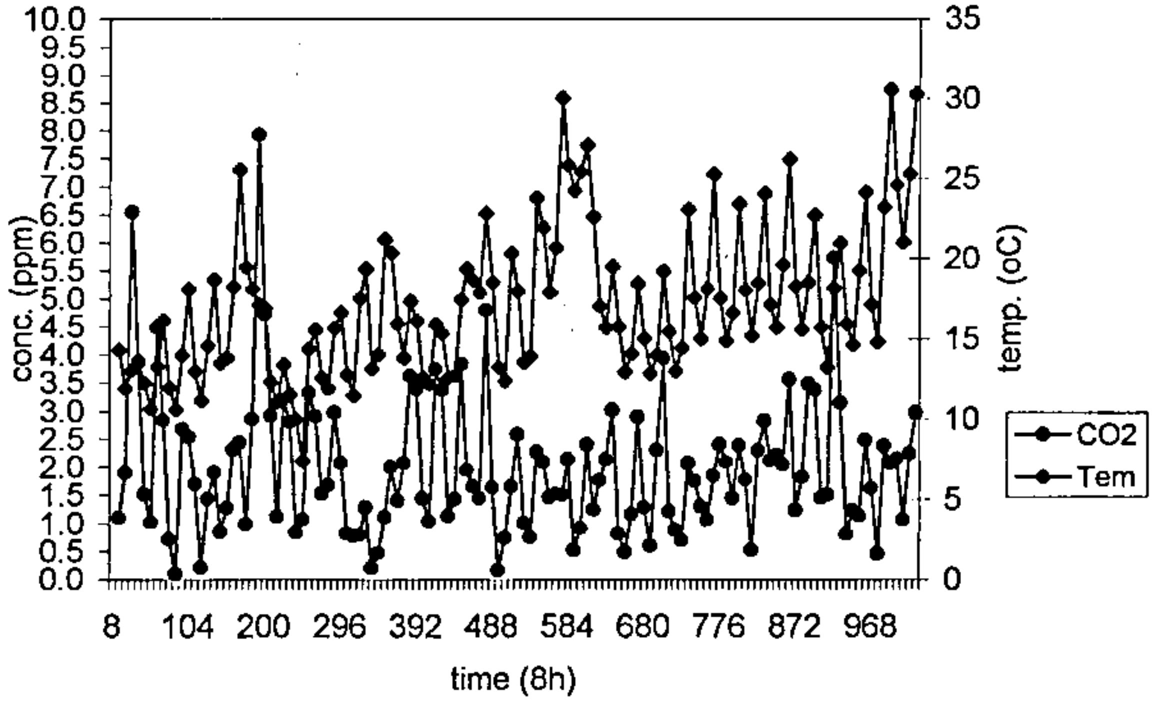



Figure 3.5.C concentrations of CO2 in relation to tempreature during the period of March 19 - April 22, 1999 (site A)

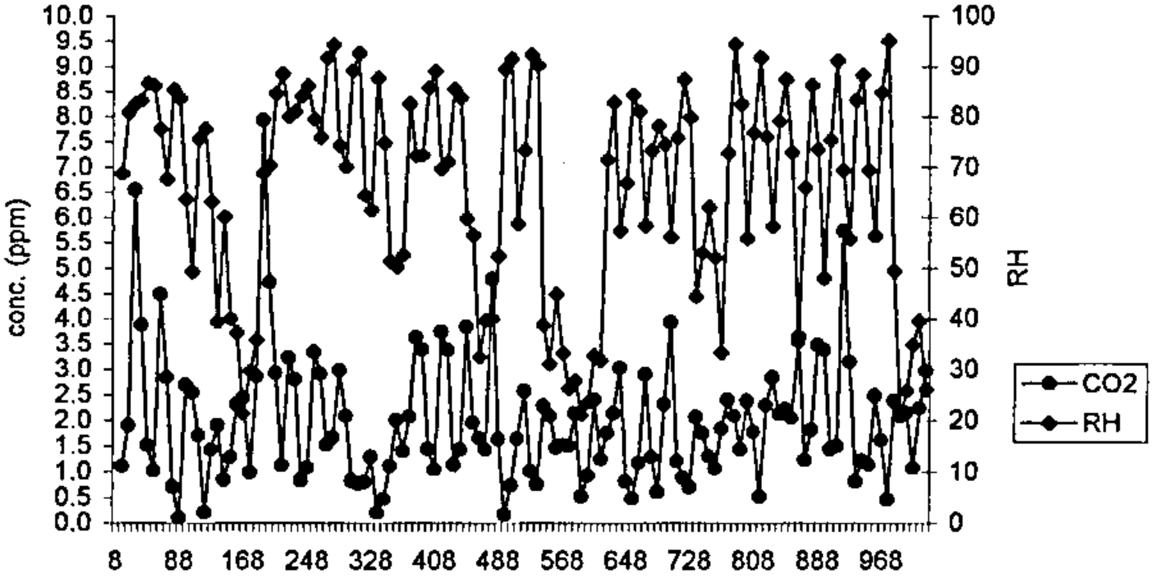



Figure 3.5.D concentrations of CO2 in relation to RH during the period of March 19- April 22, 1999 (site A)

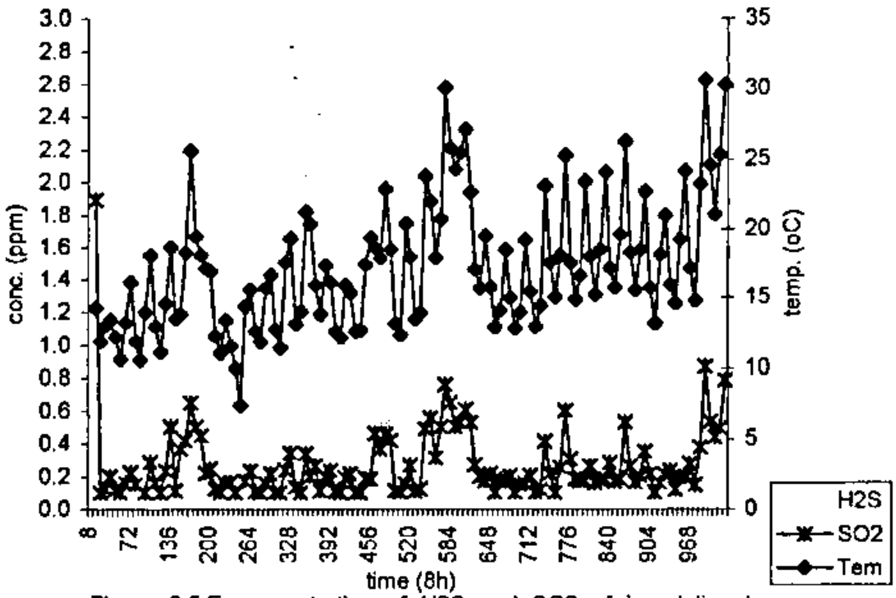


Figure 3.5.E concentration of H2S and SO2 of in relation to tempreature during the period of March 19 - April 22, 1999 (site A)

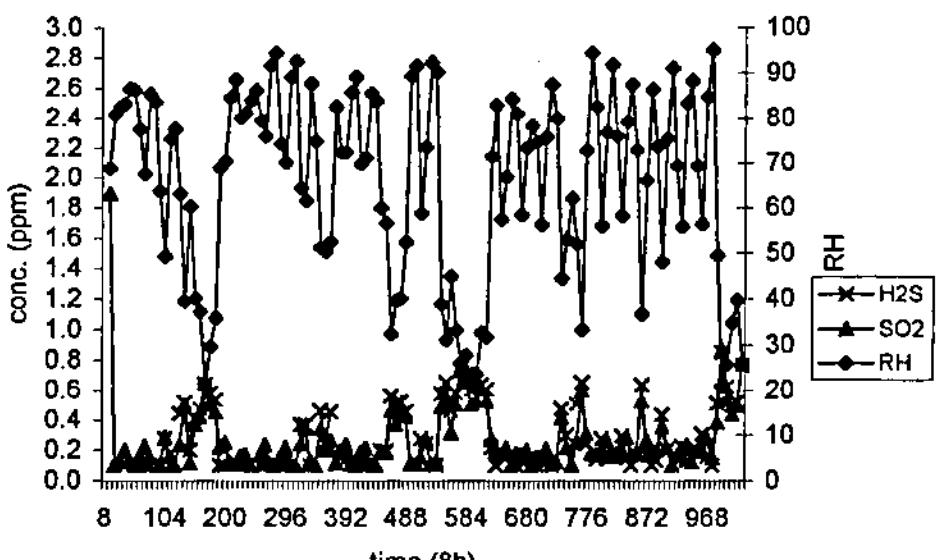


Figure 3.5.F concentrations of H2S and SO2 in relation to RH during the period of March 19- April 22, 1999

In this period when the humidity increased the concentration of $NO_2$ increased, (Figure 3.6.A,D , Table A.7).

During the period of May 31-June 9, 1998 the concentration of $NO_2$ ranged between 0.34-25.03 ppm and the average was 8.37 ppm .The relation with relative humidity the concentration of $NO_2$ increased as the humidity increased, according to wind speed the concentration decreased as the wind speed increased (Figure 3.2.C,D and Table A.2).

During the period of September 27-29,1998 the concentration ranged between 5.70-12.76 ppm with an average of 8.99-ppm (Table A.3).

During the period of August 17-24,1998 $NO_2$ concentration ranged between 2.6-28.5 ppm; the average was 14.9 ppm . The relation to relative humidity as the humidity increased the concentration of $NO_2$ increased (Figure 3.7.C,D and Table A.8) .

During the period of September 1-8, 1998 the concentration of $NO_2$ was ranged between 3.42-29.09 ppm; with an average of 15.66 ppm. According to humidity as the

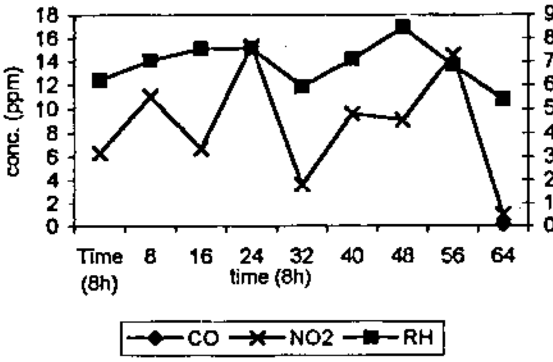



Figure 3.6.A CO and NO2 concentrations inrelated to RH during the period of May 28-30, 1998(site B)

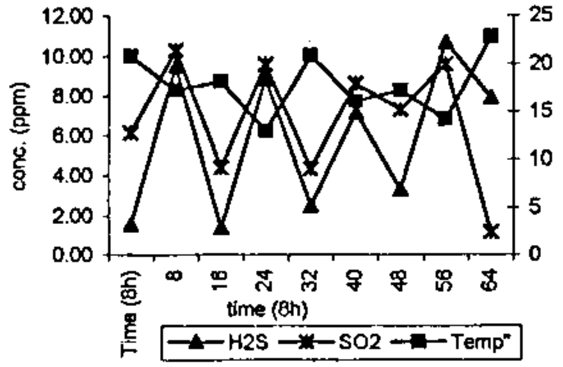



Figure 3.6.B concentrations of H2S and SO2 in relation to tempreature during the period of May 28-30, 1998 (site B)

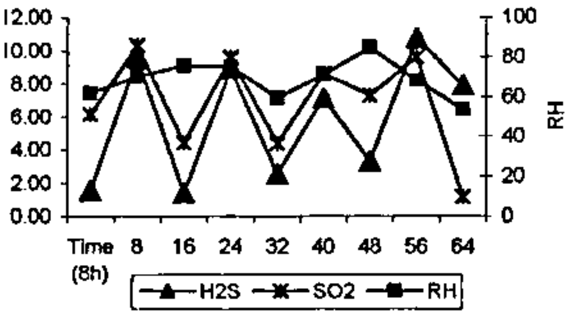



Figure 3.6.C H2S and SO2 concentrations in related to RH during the period of May 28-30, 1998 (site B)

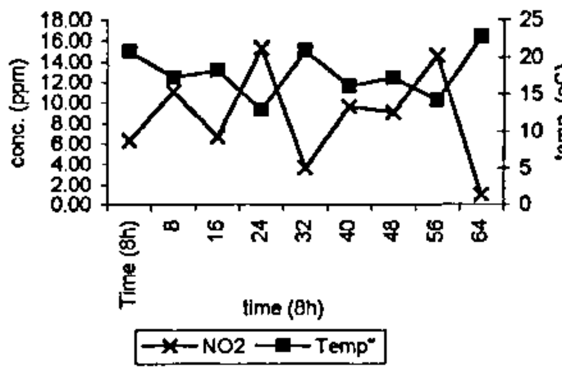



Figure 3.6.D concentration of NO2 in relation to tempreature during the period of May 28-30, 1998 (site B)

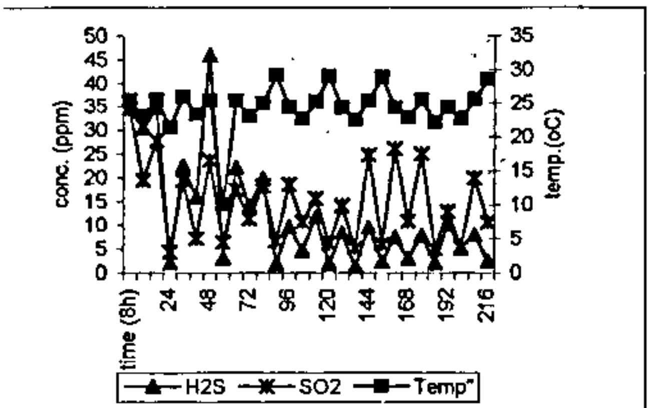



Figure 3.7.A concentration of H2S and SO2 in relation to tempreature during the period of Aug. 17-24, 1998.(site B)

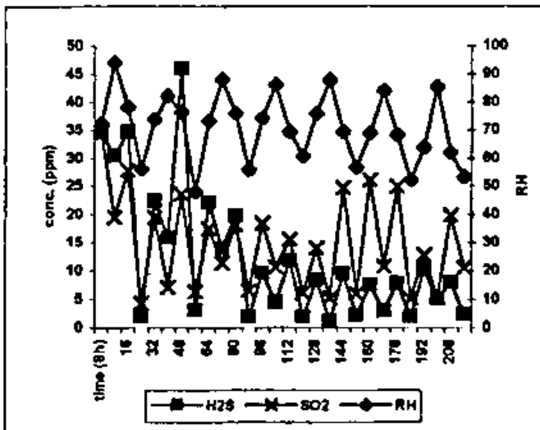



Figure 3.7.B concentrations of H2S and SO2 in relation RH during the period Aug. 17-24, 1998 (site B)

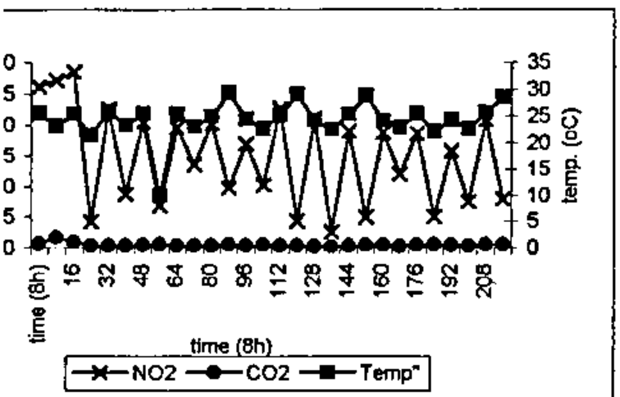



Figure 3.7.C concentration of CO2 and NO2 in relation to tempreature during the period of Aug 17-24, 1998 (site B)

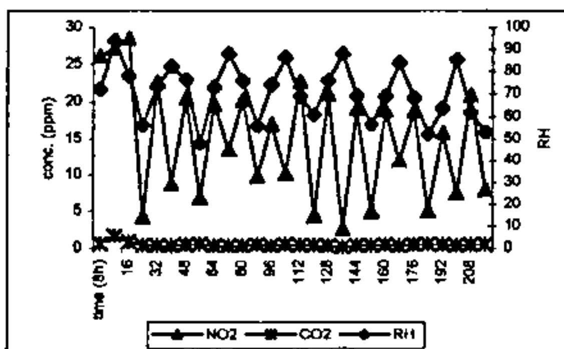



Figure 3.7.D concentrations of CO2 and NO2 in relation to RH during the period of Aug. 17-24, 1998 (site B)

humidity increased the concentration of $NO_2$ increased, and as temperature increased the concentration of $NO_2$ increased, there was correlation with wind speed as wind speed increased the concentration decreased (Figure 3.8.C,D and Table A.9) .

During the period of April 22-29,1999, the concentration of $NO_2$ ranged between 0.23-50.04ppm; the average was 14.58 ppm, (Figure 3.9.A,B and Table A.10).

During the period of May 12- 19,1999, the concentration of $NO_2$ was low during the first 5days, on the sex day there was an increased in the concentration of $NO_2$ the concentration ranged between 0.10-25.16 ppm; the average was 6.7 ppm (Figure 3.10.A,B and Table A.11).

During the period of September 28-October 5, 1999 the concentration ranged between 0.1-22.3 ppm; and average of 12.34 ppm.(Figure 3.11.C,D and Table A.12).



Location **C**

During the period of July 2-5,1999 the concentration of $NO_2$ ranged between 7.10-15.7 ppm the average concentration was 11.7 ppm. (Table A.5).

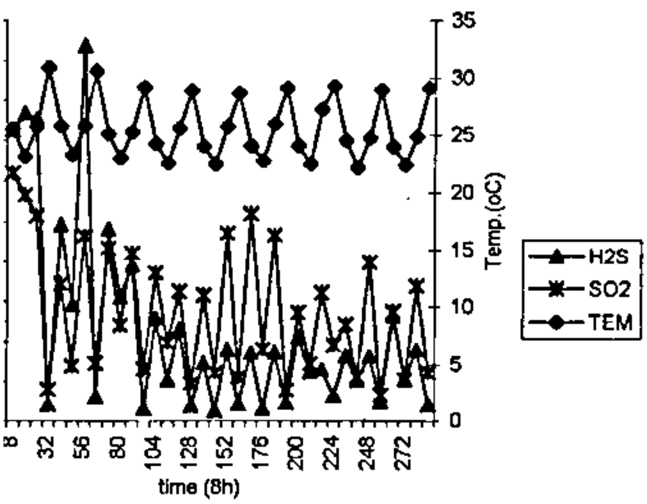



Figure 3.8.A H2S and SO2 concentrations in relation to temp. during the period of Sept 1-8, 1998(site B)

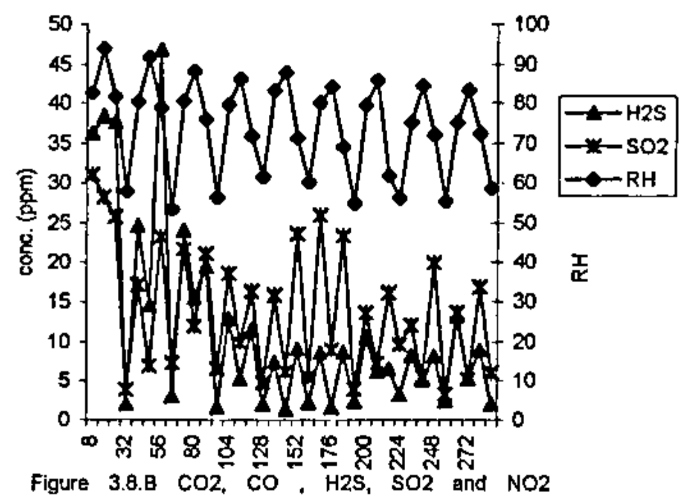
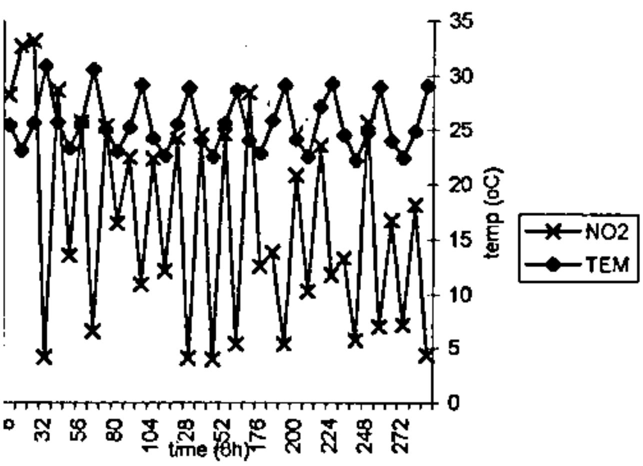



Figure 3.8.B CO2, CO , H2S, SO2 and NO2 concentrations in relation to RH during the period of Sept 1-8, 1998(site B)




igure 3.8.C NO2 concentrations in relation to tempereature uring the period of Sept 1-8, 1998(site B)

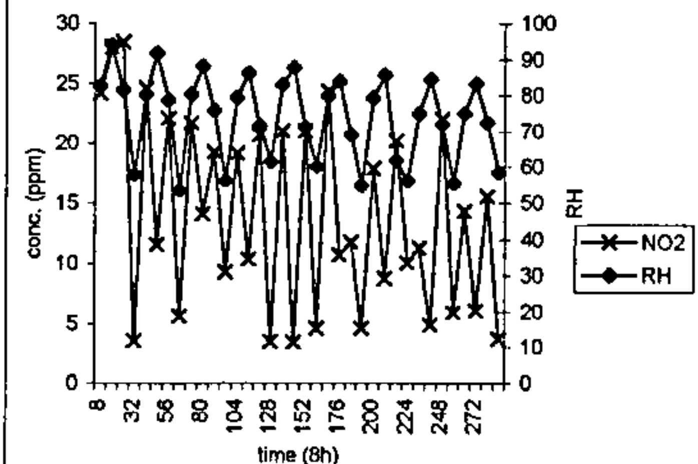
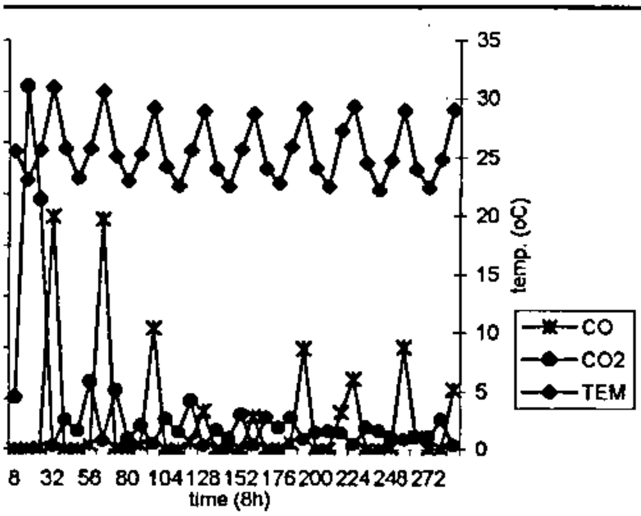



Figure 3.8.D NO2 concentrations in relation to RH during the period of Sept 1-8, 1998 (site B)




3.8.E CO2 and CO concentrations in relation to ature during the period of Sept 1-8, 1998(site B)

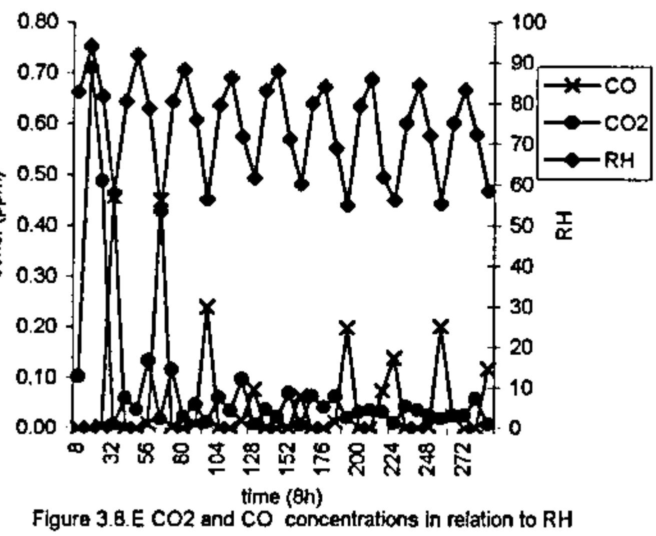



Figure 3.8.E CO2 and CO concentrations in relation to RH during the period of Sept 1-8, 1998 (site B)

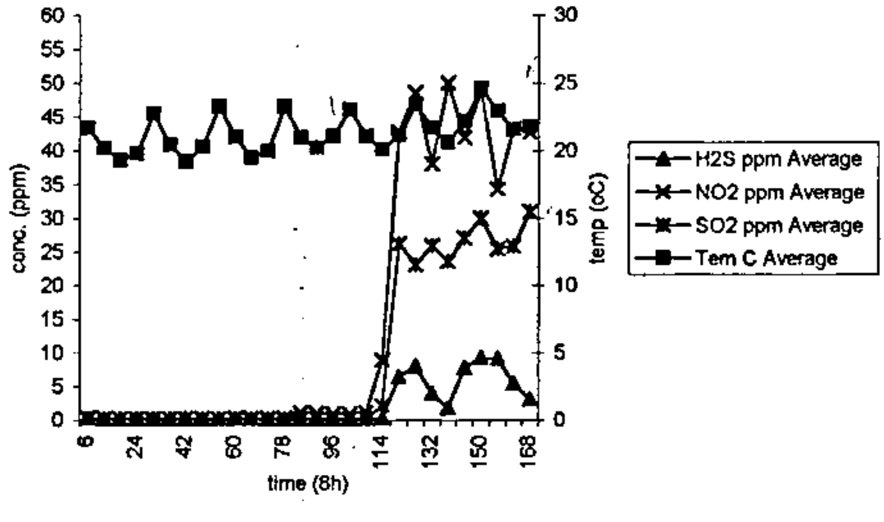



Figure 3.9.A Concentration of H2S , SO2 and NO2 in relation to tempreature during Apri 22 -29, 1999 (site B)

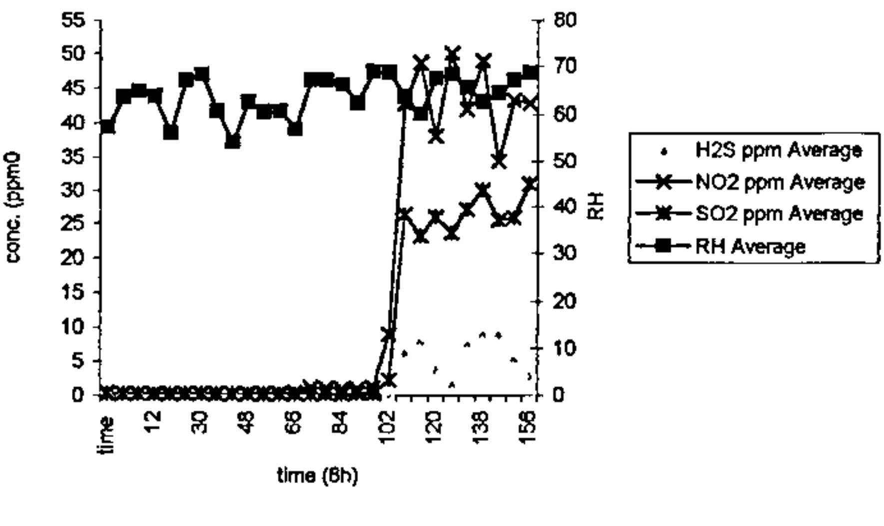



Figure 3.9.B Concentration of H2S, SO2 and NO2 in relation RH during the period of April 22-29, 1999 (site B)

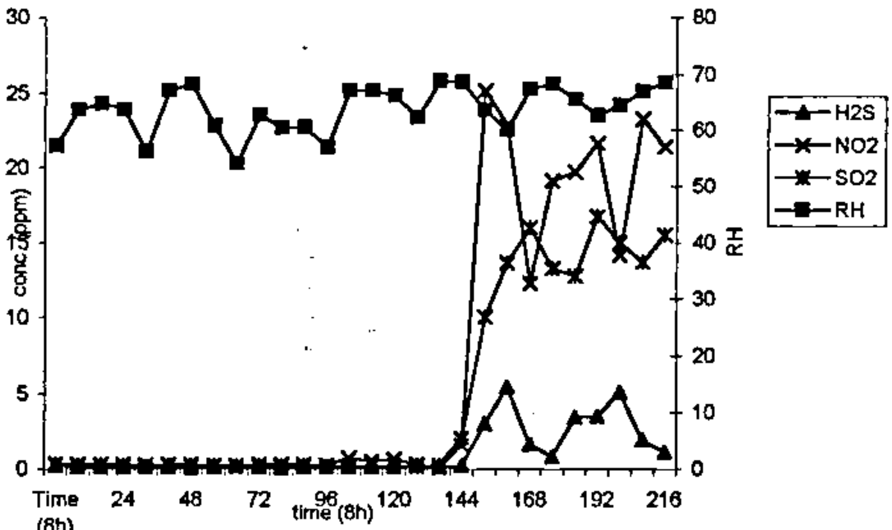



Figure 3.10.A Concentration of SO2, H2S and NO2 in relation to RH during May 12-19, 1999 (site B)

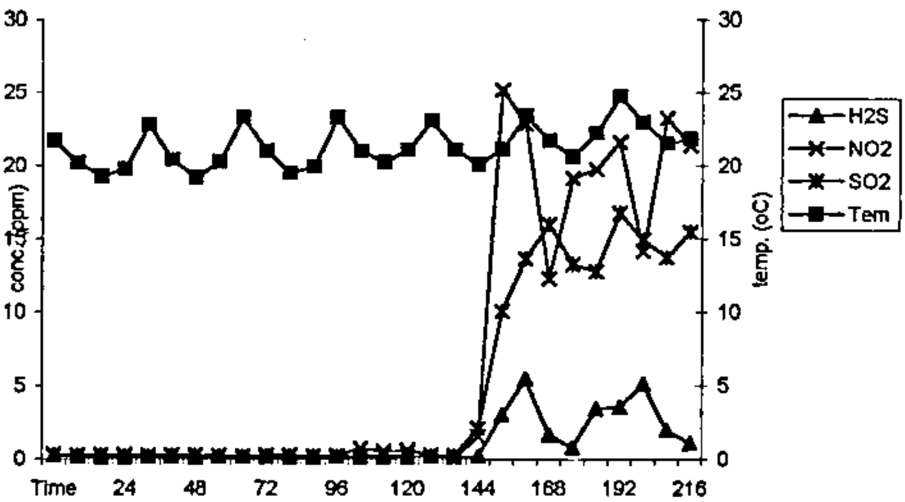
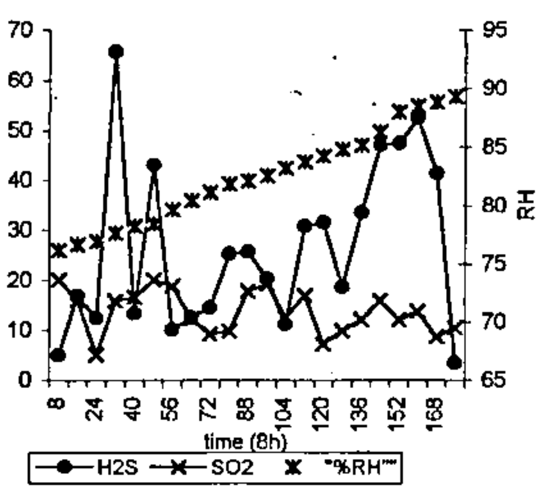



Figure 3.10.B Concentration of SO2 , H2S and NO2 in relation to termpreature during May 12-19, 1999 (site B)




e 3.11.A Concentration of H2S and SO2 in relation
midity during the period of September 28-October
99 (site B)

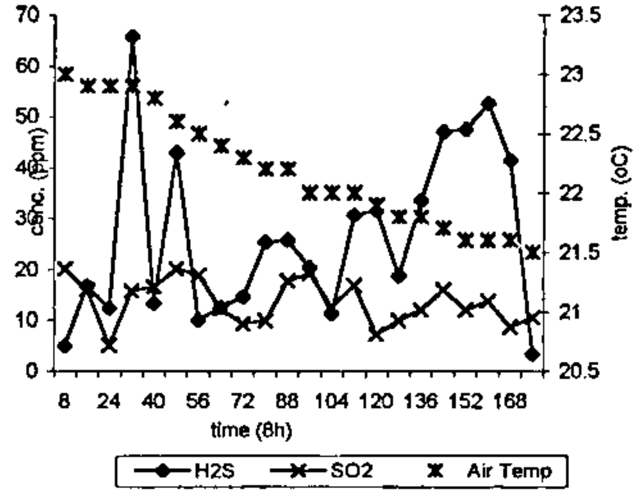



Figure 3.11.B Concentration of H2S and SO2 in relation to tempreature during September 28- October 5, 1999(site B)

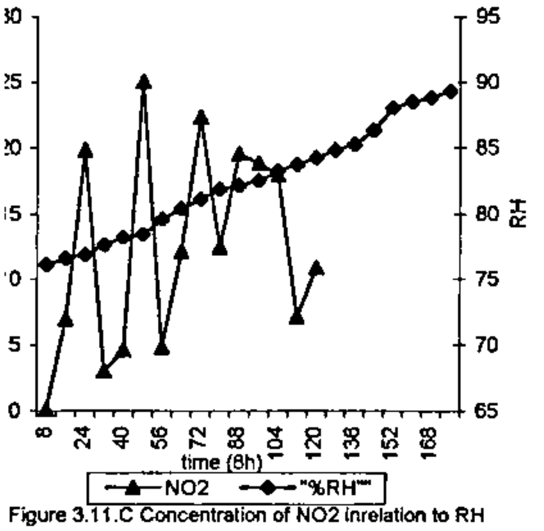



Figure 3.11.C Concentration of NO2 inrelation to RH during the period of September 29 - October 5, 1999 (site B)

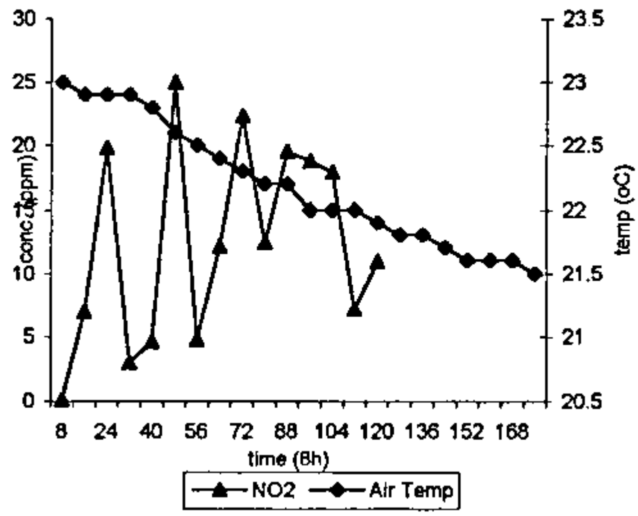



Figure 3.11.D Concentration of NO2 in relation to air tempreature during the period of september 28 - October 5, 1999.(site B)

### 3.2.3 $SO_2$ monitoring

The British allowable maximum is 2 ppm , and the American standard is 5 ppm .WHO for quality of air $SO_2$ must be 0.134 ppm.

Sampling sites (Locations A, B, C) differed significantly at ($p < 0.05$) in $SO_2$ concentration with location B showing higher $SO_2$ levels and location A showing lower $SO_2$ levels.

Location **A**

During the period of March 19-April 22, 1999 $SO_2$ concentration was ranged between 0.1- 1.89 ppm with an average of 0.26 ppm. In most of the reading as the temperature increased the concentration increased, the correlation with humidity was not clear (Figure 3.5.E,F, and Table A.6).

During the period of May 2-11,1999 the concentration of $SO_2$ lies between 0.15-1.57 ppm; the average concentration was 0.38 ppm. The concentration increased as the temperature increased, correlation with humidity the concentration increased as humidity decreased (Figure 3.1.B,C and Table A1).

Location **B**

During the period of May 28-30,1998 the concentration of $SO_2$ was arranged between 1.16-10.29 ppm; the average was 6.81 ppm, In this period as the humidity increased the concentration of $SO_2$ decreased, (Figure 3.6.B,C and Table A.7).

During the period of May 31-June 9, 1998 the concentration of $SO_2$ ranged 0.37- 22.4 ppm with an average of 6.34 ppm, according to wind speed the concentration decreased as the wind speed increased (Figure 3.2.A,B and Table A.2).

During the period of September 27-29,1998 the concentration of $SO_2$ ranged between 7.73-23.37 ppm; the average was 12.3 ppm. (Table A.3).

During the period of August 17-24,1998, the concentration ranged between 4.37- 34.8 ppm; the average was 14.7 ppm. In relation to relative humidity as the humidity increase the concentration of $SO_2$ increased (Figure 3.7.A,B and Table A.8).

During the period of September 1-8, 1998 the concentration of $SO_2$ was ranged between 3.9-37.98 ppm with an average of 15.18 ppm. According to relative humidity as the humidity increased the concentration of $SO_2$ increased, according to temperature as the temperature increased the concentration of $SO_2$ increased, in correlation to wind speed as wind speed increased the concentration decreased (Figure 3.8.A,B , Table A.9) .

During the period of April 22-29,1999, the concentration of $SO_2$ ranged between 0.18-30.92 ppm; the average was 8.73 ppm. $SO_2$ concentration stay low during the first four days in which the concentration don't exceed 1 ppm after that the concentration increased, the temperature ranged between 17- 25 $^0$C. (Figure 3.9.A, B and Table A.10).

During the period of May 12- 19,1999, the concentration $SO_2$ was ranged between 0.18-16.2 ppm; the average was 4.73 ppm. The concentration was low during the first 5days, on the sex day there was an increased in the concentration of $SO_2$ (Figure 3.10.A,B and Table A.11).

During the period of September 28-October 5, 1999 the concentration ranged between 5.1-20.1 ppm; the average was 13.7 ppm.(Figure 3.11.A,Band Table A12).

Location C

During the period of July 2-5,1999 the concentration of $SO_2$ ranged between 1.03-2.2 ppm; with an average of 1.75 ppm. (Figure 3.4.B and Table A.5) .

**3.2.4 $CO_2$ monitoring**

The concentration of $CO_2$ in the air is (0.0325%).

Sampling sites (Locations A, B) different significantly at ($p < 0.05$) in $CO_2$ concentration with location A showing higher $CO_2$ levels.

Location A

The concentration of $CO_2$ was between 0.1-4.79% with an average of 1.98% during the period of March 19-April 22, 1999, in correlation to temperature there was no constant relation, According to the humidity there was a differentiation according to the humidity changes (Figure 3.5.C,D and Table A.6).

During the period of May 2-11,1999 the concentration of $CO_2$ was between 0.16-4.61%; the average was 2.27%. In most the reading as the temperature increased the concentration increased (Figure 3.1.A,F and Table A.1).

Location **B**.

During the period of September 27-29,1998 the concentration of $CO_2$ was between 0.01-0.28% with an average of 0.15% (Table A.3).

During the period of August 17-24,1998 the concentration of $CO_2$ was between 0.18-1.66%; the average was 0.43%. The relation with temperature and humidity was not clear (Figure 3.8.C,D and Table A.8) .

During the period of September 1-8,1998 the concentration was arranged between 0.03- 1.69% with an average of 0.19% (Figure 3.8.E,F and Table A.9) .

During the period of April 22-29,1999 the concentration of $CO_2$ was ranged between 0.35- 4.10%; the average was 1.6% (Table A.10).

### 3.2.5 $H_2S$ monitoring

The USA maximum is 10 ppm and the Canadian maximum concentration is 10-ppm .The National ambient air quality standard for $H_2S$ is 0.07 ppm.

Sampling sites (Locations A, B) differed significantly at ($p< 0.05$) in $H_2S$ concentration with location B showing higher $H_2S$ levels being not far from charcoal kilns.

Location **A**

During the period of March 19-April 22, 1999 $H_2S$ concentration was between 0.1- 5.43 ppm; with an average of 0.36 ppm. In about 90% of the reading as the temperature increased the concentration increased, the correlation with humidity was not clear (Figure 3.5.E, F and Table A.6).

During the period of May 2-11,1999 the concentration of $H_2S$ was ranged between 0.06-0.75 ppm; the average was 0.32 ppm. In this period as the temperature increased the concentration of $H_2S$ increased, in correlation to humidity as the humidity decreased the concentration increased (Figure 3.1.B,C and Table A.1).

Location **B**

During the period of May 28-30,1998 the concentration of $H_2S$ was ranged between 1.36-10.7 ppm; the average was 5.9 ppm. In this period as the humidity increased the concentration of $H_2S$ increased , in relation to temperature the concentration decreased as the temperature increased (Figure 3.6.B,C and Table A.7).

During the period of May 31-June 9, 1998 the concentration of $H_2S$ was ranged between 0.18-14.15 ppm; the average was 4.74 ppm. In related to relative humidity the concentration of H2S increased as the humidity decreased, according to wind speed the concentration decreased as the wind speed increased (Figure 3.2.A,B and Table A.2).

During the period of September 27-29,1998 the concentration of $H_2S$ ranged between 10.44-12.22 ppm. (Table A.3).

During the period of August 17-24,1998, the concentration of $H_2S$ ranged between 1.23 - 45.94 ppm; the average concentration was 12.2 ppm. The relation with temperature was not clear, in related to relative humidity as the humidity increased the concentration of $H_2S$ increased (Figure 3.7.A,B, Table A.8).

During the period of September 1-8, 1998 the concentration of $H_2S$ was ranged between 1.55-46.83 ppm; the average was 13.06 ppm. According to relative humidity as the humidity increased the concentration of $H_2S$ increased, in related to temperature as temperature increased the concentration of $H_2S$ increased and when the temperature decreased the concentration decreased, during this period as wind speed increased the concentration decreased (Figure 3.8.A,B and Table A.9) .

During the period of April 22-29,1999, the concentration of $H_2S$ ranged between 0.1-9.19 ppm; with an average of 2.05 ppm. $H_2S$ concentration stay low during the first four days in which the concentration don't exceed 1 ppm after that the concentration increased, (Figure 3.9.A,B and Table A.10).

During the period of May 12- 19,1999. The concentration $H_2S$ was low during the first 5 days, the concentration of $H_2S$ ranged between 0.1- 5.99 ppm; (Figure 3.10.A,B, Table A.11).

During the period of June 16-21,1999 the concentration of $H_2S$ ranged between 0.54-26.97 ppm; the average was 17.32 ppm (Figure 3.3.B and Table A.4).

During the period of September 28-October 5, 1999 the concentration ranged 3.4-65.7 ppm; the average was 26.47 ppm (Figure 3.11.A,B and Table A.12).

**3.3 Effect of Charcoal Production on School Children:**

The effect of charcoal production on school children was obvious in areas where the kilns are close to the schools. Statistical analysis of the questionnaire showed that some children were suffering from respiratory tract diseases (asthma, breathing problems or difficulty and pulmonary symptoms). Using t- and F- tests (at $P< 0.05$), it was shown that there was a significant difference of charcoal production on children between schools that are close to the kilns and those that are far away from the kilns (Tables C.1.A, C.1.B, C.2.A, C.2.B, C.3and C.4).

The questionnaire also showed that there was significant difference between male and female students in schools of the polluted areas (Table C.5) shows the effect on sex as revealed by statistical analysis using F-test at $P<0.05$. It is clear from the table   that males are more affected by charcoal production in the above-mentioned areas.

# CHAPTER FOUR
# DISCUSSION

# Chapter 4
# Discussion

## 4.1 CO

The results have demonstrated that CO air pollution level was inversely correlated with distance from charcoal kilns with the highest levels being encountered in site **C.** In sites **A** and **B**; CO levels were very much lower than that in site C. In location C the concentration of CO (100.7 ppm) exceeded the maximum standard of USA and WHO (9ppm). In location A, the concentration (0.5-ppm) did not exceed the standards. In location B the concentration (50.48 ppm) exceeded the standards but it did not reach the levels of location C. In some periods the concentration in location B was close to the maximum and in other periods it was very high but don not reach that in location C.

The above results indicate that CO gas is emitted from charcoal klins. Since the environmental station had recorded the concentrations of CO in places that are close to the kilns. Iris 1975 mentioned that CO gas is one of the gases that produced by carbonizing process of wood.

School children living in areas with higher air pollution levels suffered significantly more frequent respiratory disease symptoms than these living in non polluted areas. High concentration of carbon monoxide has been reported to cause certain types of blood poisoning and respiratory diseases (Ellegard 1997). Statistical analysis (using ANOVA F and T tests at $P<0.05$) of the questionnaire showed that there was a significant effect of CO pollution from the kilns.

The relation between temperature and CO concentrations varies between locations. It was not clear in location C in most of the readings. In locations A and B. it was noticed that CO concentration increase as the temperature increase. These two locations are far from the kilns and it can be said that: as the temperature increases the wind weight decrease and it raise up carrying the CO.

**4.2 $NO_2$**

The results indicate that there was an increase in the concentration of $NO_2$, as the station becomes closer to the charcoal kilns so location C contains the highest concentration

The 8-hour concentration of $NO_2$ gas in location A was elevated but less than the standard. The maximum concentration does not exeeds.51ppm

In location B the concentration of $NO_2$ was high and exceeds the maximum standard in all the periods. The most elevation was during the period of April 22-29,1999 in which the maximum concentration reaches 50.04 ppm, which indicate that there was $NO_2$ pollution in that area.

In location C there was an indication that the concentration of $NO_2$ was high which gives indication that most of the $NO_2$ comes out from charcoal kilns. Its known that $NO_2$ formed by the oxidation of both the nitrogen in the air and particles, which are the result of, unburned materials. (The Committee on Health and environmental Effects, 1980).

$NO_2$ concentration was high in place B and C exceeds all the maximum standards. The statistics shoes significant different in the three locations with location C showing the highest concentration.

$NO_2$ is known to show more spatial heterogeneity than the other pollutants and hence the central monitoring site may be a poorer proxy for exposure, $NO_2$ was associated with reduction in pulmonary function.

$NO_2$ to nitrate ion, this can occur up to hundreds of miles away from the coal burns plant. (The Committee on Health and environmental Effects, 1980).

The USA maximum for $NO_2$ is 5ppm and the British maximum is 3 ppm,

**4.4 $CO_2$**

At sea level the air ordinary contains about 0.03% $CO_2$, To be safe a level of no more than 1% should be maintained.

In our study the concentration of $CO_2$ was in location A the concentration of $CO_2$ reaches a maximum of 4.79%, in this location there was an increasing in $CO_2$ concentration in some parts of the period this may comes from more than one sours the charcoal production and Combustion of all fossil fuels produces emissions of $CO_2$, for fossil fuels.

The Committee on Health and environmental Effects ,1980 mentioned that identical energy outputs coal generates 1.8 times as much $CO_2$ as dose natural gas and 1.2 as much as fuel oil.

.In location B $CO_2$ concentration reaches 4.10% which is high and gives indication that $CO_2$ comes out from charcoal kilns.

**4.5 $SO_2$**

In this study there was moderate changes in SO2 levels between the different locations

The maximum concentration of $SO_2$ in location A was 1.89ppm this less than the maximum standard but more than the WHO quality of air.

In location B the maximum concentration was 37.98ppm and this was during the period of September 1-8,1998 which is very dangerous and exceeds all the maximum standard, in this location the concentration of $SO_2$ was high during all the periods ,this indicate that $SO_2$ gas may come out from the carbonization process increase of $SO_2$ have effects on the people and the building. The workers are the most imposed to the gasses come out from the charcoal kilns, $SO_2$ has an effect on the teeth it cause teeth damage and this was seen in the mouth of most of the workers. Inhalation studies performed on human volunteers under controlled short-term exposure conditions show that Sulfur Dioxide alone at a concentration of 0.75ppm slightly affects the respiratory function (Saric, et al,. 1978). Timonen and Pekanen, 1997 mentioned that among the children the increase in $SO_2$ levels was associated with an increase in the incidence of upper respiratory symptoms. Asthmatics tend to be atypically sensitive to Sulfur dioxide exposure, Bronchodilator medication block the brunt-constrictive effects of $SO_2$ and provide a quantitative estimate of degree of protection that can be expected in typical mild asthmatics (Linn et al,. 1988).

The British allowable maximum is 2ppm, and the American standard is 5ppm .WHO for quality of air $SO_2$ must be 0.134ppm

**4.6 $H_2S$**

The maximum U.S.A. standard 10PPM, and the Canadian standard is 10PPM, the national ambient air quality standard is 0.07ppm. In location A maximum concentration of $H_2S$ was 5.43 during one period and this less than the standard. In location B there was an increasing in the concentration of $H_2S$ it reaches 46.83ppm during the period of Septemper1-8, 1998 its very high concentration.

In our study the 8-hour average concentration was high in some period and low in other.

In our study we see that when the temperature increases the average concentration increases and this may be related to the place of the environmental station on the houses which is high so when the temperature is high the gasses goes up.

When the humidity increases the gas concentration decreases ship was not clear between RH. and the concentration of the gases when the RH increase the average concentration of most of the gasses decreases .

The wind direction has an effect on the pollution of the gases we study. When the wind direction is toward the houses and toward the station the concentration of the gases were high. And when the wind direction is to the opposite side the concentration was less, and when we asked the people in the village of Yabad they said; that when the wind is toward the Village the smell was strong.

**4.1 Effect of Charcoal Production on School Children**

Our study proved that a considerable effect of charcoal production was significant between children of schools close to the Kilns. Those children had defects in respiratory system, and some disease like asthma was severely common between those children. In the results of the questionnaire there was heath problems for the people living near the charcoal kilns. The questions give the indication on the upper respiratory symptoms like asthma, and other pulmonary symptoms problems which comes from air pollution or gas pollution like eye irritation at the morning and cough. In the present study males were more affected by air pollution than females. This may be attribute study to longer exposure time for males than females the more affected was the male more than the female and this because the male or boys go out of the house but the girl stay in the house more than the boys.

The association between respiratory symptoms and air pollution, association between respiratory health and air pollution from coal combustion have been observed elsewhere, in across-sectional study of three areas of Beijing China, heating with coal was associated with reduce lung function in non smoking adults (Archives of Environmental Health). Schwartz, 1993 mentioned that acute respiratory symptoms or illness have also been associated with particulate air pollution.

Ellegard, 1997 mentioned that eye irritation has been used as an indicator of air pollution in developing country.

For lung function and disease incidence studies children are a particularly suitable population group because of there sensitive respiratory system. Children also represent a nonsmoking and non-professional group who have spent the greatest part of there lives in the same environment (Saric, 1978).

## Recommendation

1-Relocating the charcoal kilns from their current locations to new locations far from populated areas and traffic lines.

2- Promote plantation in areas surrounding the charcoal kilns, which will decrease the gas pollution that comes out from the charcoal kilns.

3- The workers must use safety clothes, shoes and masks must be needed as a mandatory safety means.

4- Modern techniques with higher efficiency and less hazards must be adopted.

5-Use big tanks for the production of charcoal instead of traditional ways, in this way we can use filters to decrease the pollution coming from the charcoal kilns.

6- Use oven for the production of charcoal.

7- Enforce legislative regulations and codes for plantation of forests to be used as wood source for charcoal production to prevent deforestation.

8- Water tanks in surrounded areas must be closed tightly to minimize pollution of soluble gasses and suspended particulate.

9- More research studies about the occupational health of the workers.

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# APPENDICES

# APPENDIX A

Table A.1 The concentration of CO, $H_2S$, $NO_2$, $SO_2$ and $CO_2$ . RH, temperature During the period of May 2-11,1999

| Time 8h) | CO ppm | RH | Tem $^0C$ | $H_2S$ ppm | $NO_2$ ppm | $SO_2$ ppm | $CO_2$ % |
|---|---|---|---|---|---|---|---|
| 8 | 0.01 | 32.94 | 25.36 | 0.72 | 1.29 | 1.57 | 1.84 |
| 16 | 0.13 | 53.76 | 19.72 | 0.16 | 0.26 | 0.21 | 1.33 |
| 24 | 0.11 | 48.65 | 21.42 | 0.22 | 0.23 | 0.21 | 1.16 |
| 32 | 0.14 | 36.45 | 28.72 | 0.69 | 0.59 | 0.65 | 3.12 |
| 40 | 0.42 | 53.21 | 22.54 | 0.31 | 0.40 | 0.38 | 1.84 |
| 48 | 0.34 | 51.62 | 19.15 | 0.12 | 0.16 | 0.15 | 2.21 |
| 56 | 0.28 | 41.78 | 21.23 | 0.53 | 0.39 | 0.43 | 2.26 |
| 64 | 0.12 | 32.97 | 28.86 | 0.71 | 0.67 | 0.69 | 2.86 |
| 72 | 0.11 | 45.45 | 23.58 | 0.40 | 0.33 | 0.37 | 0.75 |
| 80 | 0.32 | 41.96 | 21.02 | 0.49 | 0.35 | 0.41 | 0.16 |
| 88 | 0.21 | 43.38 | 22.68 | 0.35 | 0.35 | 0.34 | 1.47 |
| 96 | 0.50 | 18.84 | 33.66 | 0.75 | 0.83 | 0.85 | 2.77 |
| 104 | 0.07 | 25.18 | 28.33 | 0.70 | 0.69 | 0.69 | 1.42 |
| 112 | 0.04 | 48.76 | 22.48 | 0.35 | 0.42 | 0.38 | 1.99 |
| 120 | 0.27 | 80.05 | 20.61 | 0.15 | 0.31 | 0.24 | 2.99 |
| 128 | 0.06 | 48.44 | 28.00 | 0.37 | 0.22 | 0.28 | 3.23 |
| 136 | 0.23 | 63.51 | 21.21 | 0.26 | 0.41 | 0.33 | 1.09 |
| 144 | 0.14 | 55.51 | 18.93 | 0.13 | 0.19 | 0.17 | 2.83 |
| 152 | 0.31 | 72.84 | 19.59 | 0.16 | 0.32 | 0.26 | 2.84 |
| 160 | 0.19 | 42.79 | 25.27 | 0.53 | 0.47 | 0.48 | 4.14 |
| 168 | 0.16 | 80.18 | 18.56 | 0.17 | 0.39 | 0.31 | 2.60 |
| 176 | 0.12 | 90.98 | 16.36 | 0.04 | 0.30 | 0.20 | 1.13 |
| 184 | 0.26 | 76.69 | 18.22 | 0.08 | 0.28 | 0.21 | 4.61 |
| 192 | 0.18 | 61.38 | 21.74 | 0.24 | 0.23 | 0.20 | 4.34 |
| 200 | 0.12 | 75.33 | 17.11 | 0.11 | 0.34 | 0.25 | 2.03 |
| 208 | 0.28 | 82.27 | 15.14 | 0.00 | 0.23 | 0.18 | 0.42 |
| 216 | 0.25 | 71.95 | 16.50 | 0.06 | 0.26 | 0.20 | 2.23 |
| 224 | 0.13 | 54.61 | 19.80 | 0.15 | 0.21 | 0.18 | 3.94 |

Table A.2 The 8-hour concentration of CO, $H_2S$, $NO_2$ and $SO_2$ gas and the 8-hour reading of RH, air temperature and wind speed during the period of May 31-June 9,1998

| time (8h) | CO ppm | RH | Air Temp | $H_2S$ ppm | $NO_2$ ppm | $SO_2$ ppm | Win direction degree | Win speed M\s |
|---|---|---|---|---|---|---|---|---|
| 8 | 8.14 | 63.62 | 21.79 | 2.70 | 6.12 | 5.98 | 265.01 | 12.58 |
| 12 | 5.12 | 75.34 | 19.49 | 7.75 | 11.35 | 9.55 | 263.33 | 9.85 |
| 16 | 4.51 | 81.73 | 18.25 | 1.58 | 7.78 | 5.80 | 223.91 | 4.93 |
| 20 | 5.23 | 77.97 | 19.11 | 7.28 | 17.20 | 12.49 | 227.09 | 6.04 |
| 24 | 2.12 | 65.32 | 21.83 | 3.72 | 4.81 | 4.63 | 258.94 | 11.26 |
| 28 | 10.7 | 77.79 | 18.53 | 7.22 | 9.23 | 6.97 | 259.23 | 8.58 |
| 32 | 12.4 | 84.54 | 17.16 | 3.35 | 9.33 | 8.91 | 229.05 | 4.44 |
| 36 | 9.54 | 75.52 | 19.19 | 11.04 | 16.39 | 12.43 | 227.88 | 5.10 |
| 40 | 13.5 | 61.03 | 22.69 | 8.48 | 1.10 | 1.36 | 264.59 | 9.96 |
| 44 | 12.54 | 77.92 | 19.06 | 14.15 | 10.19 | 8.65 | 203.94 | 8.26 |
| 48 | 12.21 | 86.68 | 17.16 | 3.15 | 10.01 | 8.93 | 167.60 | 6.31 |
| 52 | 10.25 | 73.74 | 19.01 | 3.68 | 8.67 | 8.49 | 165.02 | 5.38 |
| 56 | 8.97 | 59.27 | 24.30 | 2.68 | 4.08 | 0.69 | 218.46 | 9.77 |
| 60 | 13.84 | 78.54 | 20.12 | 0.88 | 2.90 | 2.59 | 223.28 | 5.17 |
| 64 | 7.51 | 91.59 | 17.45 | 2.10 | 8.21 | 5.55 | 235.99 | 1.09 |
| 68 | 11.69 | 77.65 | 19.76 | 2.88 | 8.98 | 4.13 | 191.78 | 4.04 |
| 72 | 6.52 | 54.59 | 24.70 | 2.16 | 0.68 | 1.00 | 226.72 | 10.77 |
| 76 | 14.2 | 80.09 | 19.88 | 7.35 | 11.01 | 8.05 | 216.07 | 6.21 |
| 80 | 12.5 | 91.59 | 18.01 | 1.03 | 13.30 | 6.67 | 226.94 | 3.59 |
| 84 | 15.47 | 79.55 | 20.35 | 2.47 | 16.23 | 19.82 | 227.33 | 6.57 |
| 88 | 13.85 | 60.42 | 24.81 | 14.70 | 5.73 | 4.43 | 236.14 | 11.14 |
| 92 | 14.25 | 78.58 | 21.04 | 10.66 | 17.61 | 6.54 | 227.98 | 7.53 |
| 96 | 12.54 | 93.37 | 18.43 | 1.60 | 25.03 | 13.79 | 233.43 | 5.24 |
| 100 | 10.25 | 80.46 | 20.09 | 4.62 | 14.64 | 6.14 | 185.96 | 6.25 |
| 104 | 6.25 | 54.84 | 25.08 | 4.10 | 0.97 | 1.62 | 220.78 | 11.89 |
| 108 | 8.36 | 65.81 | 21.69 | 7.60 | 5.15 | 5.64 | 225.51 | 6.75 |
| 112 | 8.98 | 59.53 | 19.71 | 1.84 | 11.19 | 12.03 | 148.58 | 1.40 |
| 116 | 13.28 | 54.64 | 21.48 | 13.19 | 10.25 | 8.73 | 231.58 | 3.66 |
| 120 | 7.96 | 40.50 | 26.82 | 3.87 | 1.16 | 1.10 | 222.70 | 10.05 |
| 124 | 9.85 | 61.07 | 21.98 | 6.83 | 5.71 | 4.49 | 228.03 | 5.04 |
| 128 | 15.27 | 90.10 | 18.24 | 3.42 | 23.84 | 22.40 | 180.44 | 0.85 |
| 132 | 13.68 | 80.09 | 20.06 | 0.97 | 2.43 | 2.80 | 231.94 | 3.95 |
| 136 | 12.47 | 60.39 | 24.88 | 0.96 | 3.79 | 0.87 | 242.27 | 12.73 |
| 140 | 9.97 | 78.92 | 21.04 | 3.63 | 3.53 | 4.68 | 246.25 | 7.61 |
| 144 | 8.65 | 93.62 | 18.11 | 0.18 | 0.52 | 0.37 | 214.27 | 4.62 |
| 148 | 9.67 | 85.29 | 19.46 | 0.29 | 0.34 | 0.37 | 170.78 | 5.25 |
| 152 | 6.19 | 63.06 | 24.24 | 1.47 | 2.34 | 1.02 | 228.33 | 11.51 |
| 156 | 7.91 | 64.04 | 24.03 | 4.71 | 6.36 | 1.53 | 224.89 | 11.99 |

Table A.3 The 8-hour concentration of CO, $H_2S$, and $NO_2$, $SO_2$ and $CO_2$ in addition to RH, temperature and wind speed. During the period of September 27-29,1998

| Time (8h) | CO ppm | RH | Tem $^0C$ | $H_2S$ ppm | $NO_2$ ppm | $SO_2$ ppm | Win Sp. M\H | $CO_2$ ppm |
|---|---|---|---|---|---|---|---|---|
| 8 | 10.2 | 74.41 | 23.06 | 12.14 | 12.76 | 23.45 | 2.37 | 0.28 |
| 16 | 13.8 | 78.75 | 21.84 | 11.06 | 5.70 | 7.73 | 1.16 | 0.01 |
| 24 | 9.8 | 78.82 | 20.1 | 10.44 | 8.21 | 8.37 | 1.78 | 0.11 |
| 32 | 12.4 | 79.12 | 19.22 | 12.22 | 9.32 | 9.71 | 2.11 | 0.20 |

**Table A.4** The concentration of CO and $H_2S$ gases and Temperature during the period of June 16-21,1999

| Time 8 (h) | CO ppm | Temp $^0C$ | $H_2S$ ppm |
|---|---|---|---|
| 8 | 31.65 | 16.02 | 22.85 |
| 16 | 37.65 | 17.03 | 21.79 |
| 24 | 35.79 | 15.31 | 20.67 |
| 32 | 32.44 | 16.94 | 19.17 |
| 40 | 32.21 | 15.68 | 18.06 |
| 48 | 39.35 | 17.44 | 18.44 |
| 56 | 33.24 | 17.27 | 20.37 |
| 64 | 50.48 | 18.72 | 4.25 |
| 72 | 38.09 | 19.45 | 0.54 |
| 80 | 39.57 | 19.46 | 0.56 |
| 88 | 39.09 | 19.71 | 0.55 |
| 96 | 40.94 | 19.26 | 16.65 |
| 104 | 37.15 | 17.78 | 23.54 |
| 112 | 42.53 | 19.32 | 22.75 |
| 120 | 39.74 | 17.57 | 22.59 |
| 128 | 37.53 | 19.02 | 22.23 |
| 136 | 39.50 | 19.11 | 22.20 |
| 144 | 35.97 | 18.49 | 25.03 |
| 152 | 37.03 | 18.61 | 26.97 |

Table A.5 The concentration of CO, $NO_2$ and $SO_2$ gases and RH and wind speed During the period of July 2-5,1999

| time (8h) | RH | CO ppm | $NO_2$ ppm | $SO_2$ ppm | Wind. S. M\S |
|---|---|---|---|---|---|
| 8 | 85.40 | 20.86 | 10.32 | 1.82 | 1.88 |
| 16 | 87.57 | 35.60 | 9.15 | 1.03 | 1.01 |
| 24 | 92.30 | 50.55 | 11.12 | 1.86 | 2.32 |
| 32 | 84.60 | 60.20 | 8.47 | 2.13 | 2.16 |
| 40 | 86.03 | 169.17 | 14.98 | 1.07 | 1.31 |
| 48 | 76.49 | 94.35 | 7.10 | 1.98 | 2.42 |
| 56 | 85.40 | 161.66 | 13.2 | 1.87 | 1.18 |
| 64 | 80.40 | 144.99 | 15.7 | 1.85 | 2.52 |
| 72 | 83.07 | 167.75 | 15.2 | 2.2 | 2.37 |

**Table A.6** The concentration of $H_2S$, $NO_2$, $SO_2$ and $CO_2$ gases in addition to RH, temperature during the period of March 19-April 22,1999

| Time (8h) | RH | Tem. °C | $H_2S$ ppm | $NO_2$ ppm | $SO_2$ ppm | $CO_2$ % |
|---|---|---|---|---|---|---|
| | | | | | | |
| 8.00 | 68.70 | 14.29 | 5.43 | 1.51 | 1.89 | 1.10 |
| 16.00 | 80.81 | 11.91 | | 0.12 | 0.10 | 1.89 |
| 24.00 | 82.45 | 13.02 | | 0.18 | 0.13 | 6.55 |
| 32.00 | 83.17 | 13.44 | 0.10 | 0.27 | 0.20 | 3.88 |
| 40.00 | 86.54 | 12.23 | | 0.14 | 0.12 | 1.51 |
| 48.00 | 86.15 | 10.66 | | 0.10 | 0.10 | 1.02 |
| 56.00 | 77.55 | 13.23 | 0.10 | 0.19 | 0.16 | 4.48 |
| 64.00 | 67.55 | 16.10 | 0.10 | 0.29 | 0.22 | 2.84 |
| 72.00 | 85.32 | 11.94 | 0.10 | 0.18 | 0.15 | 0.71 |
| 80.00 | 83.59 | 10.61 | | 0.10 | | 0.10 |
| 88.00 | 63.65 | 13.96 | | 0.11 | 0.10 | 2.68 |
| 96.00 | 49.29 | 18.08 | 0.27 | 0.28 | 0.28 | 2.54 |
| 104.00 | 75.48 | 12.96 | 0.10 | 0.20 | 0.16 | 1.70 |
| 112.00 | 77.48 | 11.15 | | 0.10 | 0.10 | 0.20 |
| 120.00 | 63.06 | 14.56 | 0.44 | 0.21 | 0.23 | 1.43 |
| 128.00 | 39.42 | 18.66 | 0.52 | 0.46 | 0.50 | 1.90 |
| 136.00 | 60.08 | 13.49 | 0.20 | 0.12 | 0.11 | 0.85 |
| 144.00 | 39.95 | 13.81 | 0.41 | 0.32 | 0.37 | 1.28 |
| 152.00 | 37.21 | 18.25 | 0.48 | 0.38 | 0.42 | 2.31 |
| 160.00 | 21.41 | 25.56 | 0.64 | 0.63 | 0.65 | 2.43 |
| 168.00 | 29.55 | 19.47 | 0.58 | 0.51 | 0.50 | 0.99 |
| 176.00 | 35.84 | 18.10 | 0.53 | 0.43 | 0.45 | 2.86 |
| 184.00 | 68.69 | 17.13 | 0.10 | 0.29 | 0.22 | 7.92 |
| 192.00 | 70.29 | 16.90 | 0.10 | 0.33 | 0.25 | 4.72 |
| 200.00 | 84.63 | 12.31 | | 0.17 | 0.13 | 2.91 |
| 208.00 | 88.49 | 11.05 | | 0.10 | 0.10 | 1.12 |
| 216.00 | 80.05 | 13.37 | 0.10 | 0.24 | 0.16 | 3.21 |
| 224.00 | 81.08 | 11.54 | 0.10 | 0.24 | 0.16 | 2.80 |
| 232.00 | 83.93 | 10.02 | | 0.10 | 0.10 | 0.83 |
| 240.00 | 86.12 | 7.39 | | 0.10 | | 1.06 |
| 248.00 | 79.51 | 14.36 | 0.10 | 0.23 | 0.17 | 3.32 |
| 256.00 | 75.94 | 15.54 | 0.10 | 0.31 | 0.23 | 2.91 |
| 264.00 | 91.74 | 12.59 | | 0.16 | 0.11 | 1.53 |
| 272.00 | 94.31 | 11.89 | | 0.10 | 0.10 | 1.67 |
| 280.00 | 74.33 | 15.67 | 0.10 | 0.22 | 0.15 | 2.97 |
| 288.00 | 70.06 | 16.62 | 0.13 | 0.29 | 0.21 | 2.08 |
| 296.00 | 89.02 | 12.72 | | 0.14 | 0.11 | 0.82 |
| 304.00 | 92.49 | 11.47 | | 0.10 | 0.10 | 0.77 |
| 312.00 | 64.36 | 17.53 | 0.37 | 0.25 | 0.24 | 0.79 |
| 320.00 | 61.52 | 19.32 | 0.37 | 0.38 | 0.34 | 1.27 |
| 328.00 | 87.59 | 13.13 | 0.10 | 0.17 | 0.14 | 0.20 |
| 336.00 | 74.81 | 14.01 | | 0.10 | 0.10 | 0.47 |
| 344.00 | 51.26 | 21.20 | 0.46 | 0.34 | 0.34 | 1.11 |
| 352.00 | 50.36 | 20.38 | 0.25 | 0.24 | 0.20 | 1.99 |
| 360.00 | 52.51 | 15.92 | 0.46 | 0.29 | 0.26 | 1.40 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 368.00 | 82.53 | 13.82 | | 0.17 | 0.11 | 2.07 |
| 376.00 | 72.31 | 17.32 | 0.16 | 0.26 | 0.20 | 3.63 |
| 384.00 | 72.42 | 16.09 | 0.14 | 0.31 | 0.23 | 3.39 |
| 392.00 | 85.68 | 12.59 | | 0.16 | 0.11 | 1.44 |
| 400.00 | 88.96 | 12.18 | | 0.12 | 0.10 | 1.04 |
| 408.00 | 69.66 | 15.86 | 0.10 | 0.26 | 0.19 | 3.74 |
| 416.00 | 71.08 | 15.31 | 0.10 | 0.27 | 0.21 | 3.37 |
| 424.00 | 85.38 | 12.59 | | 0.14 | 0.10 | 1.13 |
| 432.00 | 83.70 | 12.71 | | 0.14 | 0.10 | 1.42 |
| 440.00 | 59.81 | 17.43 | 0.20 | 0.21 | 0.19 | 3.84 |
| 448.00 | 56.52 | 19.35 | 0.19 | 0.25 | 0.18 | 1.95 |
| 456.00 | 32.42 | 18.63 | 0.56 | 0.45 | 0.46 | 1.65 |
| 464.00 | 39.57 | 17.87 | 0.52 | 0.37 | 0.36 | 1.44 |
| 472.00 | 39.96 | 22.84 | 0.52 | 0.41 | 0.46 | 4.79 |
| 480.00 | 52.36 | 18.51 | 0.46 | 0.44 | 0.42 | 1.63 |
| 488.00 | 89.27 | 13.20 | | 0.17 | 0.11 | 0.16 |
| 496.00 | 91.46 | 12.38 | | 0.12 | 0.11 | 0.73 |
| 504.00 | 58.71 | 20.34 | 0.27 | 0.19 | 0.15 | 1.65 |
| 512.00 | 73.48 | 17.94 | 0.24 | 0.32 | 0.26 | 2.57 |
| 520.00 | 92.28 | 13.52 | | 0.18 | 0.11 | 1.01 |
| 528.00 | 90.16 | 13.94 | 0.10 | 0.19 | 0.12 | 0.75 |
| 536.00 | 38.70 | 23.78 | 0.58 | 0.48 | 0.49 | 2.27 |
| 544.00 | 31.10 | 21.96 | 0.65 | 0.55 | 0.55 | 2.09 |
| 552.00 | 44.85 | 17.93 | 0.46 | 0.29 | 0.31 | 1.46 |
| 560.00 | 33.16 | 20.70 | 0.58 | 0.48 | 0.50 | 1.51 |
| 568.00 | 26.18 | 30.06 | 0.74 | 0.70 | 0.76 | 1.50 |
| 576.00 | 27.65 | 25.82 | 0.71 | 0.63 | 0.65 | 2.14 |
| 584.00 | 21.08 | 24.26 | 0.61 | 0.50 | 0.50 | 0.52 |
| 592.00 | 23.48 | 25.45 | 0.62 | 0.52 | 0.53 | 0.92 |
| 600.00 | 32.69 | 27.05 | 0.64 | 0.57 | 0.61 | 2.40 |
| 608.00 | 31.72 | 22.62 | 0.61 | 0.52 | 0.53 | 1.25 |
| 616.00 | 71.43 | 17.03 | 0.22 | 0.33 | 0.27 | 1.76 |
| 624.00 | 82.72 | 15.68 | 0.10 | 0.26 | 0.20 | 2.13 |
| 632.00 | 57.33 | 19.48 | 0.19 | 0.23 | 0.17 | 3.01 |
| 640.00 | 66.83 | 15.75 | 0.15 | 0.26 | 0.21 | 0.81 |
| 648.00 | 84.21 | 12.91 | | 0.15 | 0.10 | 0.49 |
| 656.00 | 80.99 | 14.08 | 0.10 | 0.21 | 0.18 | 1.17 |
| 664.00 | 58.36 | 18.44 | 0.13 | 0.24 | 0.16 | 2.89 |
| 672.00 | 73.34 | 14.98 | 0.13 | 0.28 | 0.20 | 1.27 |
| 680.00 | 78.18 | 12.84 | | 0.15 | 0.10 | 0.60 |
| 688.00 | 74.54 | 13.96 | 0.10 | 0.19 | 0.15 | 2.31 |
| 696.00 | 56.19 | 19.19 | 0.14 | 0.22 | 0.15 | 3.93 |
| 704.00 | 75.79 | 15.41 | 0.12 | 0.30 | 0.20 | 1.21 |
| 712.00 | 87.33 | 12.99 | | 0.16 | 0.10 | 0.88 |
| 720.00 | 79.89 | 14.42 | | 0.16 | 0.12 | 0.70 |
| 728.00 | 44.46 | 23.06 | 0.47 | 0.36 | 0.41 | 2.07 |
| 736.00 | 53.02 | 17.54 | 0.30 | 0.21 | 0.22 | 1.75 |
| 744.00 | 61.96 | 15.01 | | 0.11 | 0.10 | 1.30 |
| 752.00 | 51.99 | 18.11 | 0.51 | 0.26 | 0.25 | 1.06 |
| 760.00 | 33.27 | 25.26 | 0.65 | 0.57 | 0.60 | 1.84 |
| 768.00 | 72.75 | 17.54 | 0.24 | 0.38 | 0.30 | 2.39 |
| 776.00 | 94.37 | 14.88 | | 0.26 | 0.18 | 2.09 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 784.00 | 82.49 | 16.60 | 0.14 | 0.26 | 0.17 | 1.45 |
| 792.00 | 55.95 | 23.40 | 0.27 | 0.20 | 0.17 | 2.37 |
| 800.00 | 76.76 | 18.02 | 0.18 | 0.35 | 0.26 | 1.78 |
| 808.00 | 91.69 | 15.17 | | 0.25 | 0.16 | 0.52 |
| 816.00 | 75.98 | 18.49 | 0.16 | 0.25 | 0.18 | 2.29 |
| 824.00 | 58.22 | 24.03 | 0.29 | 0.24 | 0.18 | 2.83 |
| 832.00 | 79.15 | 17.13 | 0.15 | 0.37 | 0.28 | 2.12 |
| 840.00 | 87.32 | 15.72 | 0.10 | 0.24 | 0.17 | 2.22 |
| 848.00 | 72.97 | 19.60 | 0.17 | 0.24 | 0.18 | 2.05 |
| 856.00 | 36.69 | 26.19 | 0.63 | 0.47 | 0.53 | 3.56 |
| 864.00 | 65.97 | 18.26 | 0.17 | 0.34 | 0.26 | 1.23 |
| 872.00 | 86.23 | 15.57 | 0.10 | 0.25 | 0.16 | 1.82 |
| 880.00 | 73.57 | 18.52 | 0.13 | 0.26 | 0.20 | 3.48 |
| 888.00 | 48.09 | 22.68 | 0.43 | 0.33 | 0.35 | 3.38 |
| 896.00 | 75.41 | 15.69 | 0.21 | 0.28 | 0.21 | 1.45 |
| 904.00 | 91.02 | 13.21 | | 0.17 | 0.10 | 1.51 |
| 912.00 | 69.26 | 18.15 | 0.15 | 0.23 | 0.16 | 5.73 |
| 920.00 | 55.80 | 20.96 | 0.23 | 0.25 | 0.21 | 3.15 |
| 928.00 | 83.27 | 15.90 | 0.13 | 0.32 | 0.23 | 0.80 |
| 936.00 | 88.25 | 14.61 | | 0.20 | 0.12 | 1.22 |
| 944.00 | 69.29 | 19.21 | 0.20 | 0.24 | 0.20 | 1.13 |
| 952.00 | 56.35 | 24.12 | 0.30 | 0.26 | 0.19 | 2.47 |
| 960.00 | 84.69 | 17.13 | 0.16 | 0.37 | 0.28 | 1.62 |
| 968.00 | 94.99 | 14.78 | 0.10 | 0.26 | 0.15 | 0.45 |
| 976.00 | 49.50 | 23.22 | 0.51 | 0.40 | 0.38 | 2.37 |
| 984.00 | 20.86 | 30.59 | 0.85 | 0.83 | 0.86 | 2.07 |
| 992.00 | 25.72 | 24.59 | 0.63 | 0.54 | 0.53 | 2.15 |
| 1000.00 | 34.82 | 21.02 | 0.50 | 0.45 | 0.44 | 1.06 |
| 1008.00 | 39.55 | 25.28 | 0.53 | 0.47 | 0.49 | 2.24 |
| 1016.00 | 25.93 | 30.29 | 0.77 | 0.75 | 0.79 | 2.97 |

**Table A.7** The concentration of $H_2S$, $NO_2$ and $SO_2$ and the 8-hour average reading of RH, temperature wind speed and wind direction, during the period of May 28-30,1998 .

| Time (8) | RH | Tem.$^0$c | $H_2S$ ppm | $NO_2$ ppm | $SO_2$ ppm | Win sp m\s |
|---|---|---|---|---|---|---|
| 8 | 61.89 | 20.77 | 1.54 | 6.32 | 6.12 | 12.21 |
| 16 | 70.27 | 17.29 | 9.51 | 11.04 | 10.29 | 7.93 |
| 24 | 75.44 | 18.23 | 1.36 | 6.66 | 4.37 | 4.93 |
| 32 | 75.38 | 12.92 | 8.87 | 15.29 | 9.55 | 6.37 |
| 40 | 59.35 | 20.88 | 2.50 | 3.63 | 4.33 | 9.93 |
| 48 | 71.00 | 16.07 | 7.14 | 9.60 | 8.62 | 7.77 |
| 56 | 84.50 | 17.20 | 3.28 | 9.05 | 7.28 | 4.22 |
| 64 | 68.29 | 14.15 | 10.70 | 14.54 | 9.58 | 5.36 |
| 72 | 53.80 | 22.80 | 7.89 | 1.00 | 1.16 | 8.47 |

Table A.8 The concentration of $H_2S$, $NO_2$, $SO_2$ and $CO_2$ gases and RH, wind speed, temperature and wind direction during the period of Aug. 17-24,1998

| time (8 h) | RH | Temp $^0$c | $H_2S$ ppm | $NO_2$ ppm | $SO_2$ ppm | Wind W. Deg. | Wind.S.m\S | $CO_2$ % |
|---|---|---|---|---|---|---|---|---|
| 8 | 72.06 | 25.49 | 34.50 | 26.09 | 34.48 | 212.14 | 4.83 | 0.63 |
| 16 | 93.88 | 23.11 | 30.41 | 27.17 | 19.49 | 174.73 | 2.47 | 1.66 |
| 24 | 78.13 | 25.42 | 34.68 | 28.44 | 27.84 | 163.37 | 5.89 | 0.90 |
| 32 | 56.20 | 21.40 | 1.99 | 4.21 | 4.37 | 217.13 | 9.24 | 0.31 |
| 40 | 73.73 | 25.91 | 22.40 | 22.55 | 19.47 | 233.39 | 5.91 | 0.30 |
| 48 | 82.11 | 23.31 | 15.88 | 8.73 | 7.08 | 173.16 | 2.09 | 0.29 |
| 56 | 76.45 | 25.36 | 45.94 | 20.52 | 23.64 | 150.35 | 5.91 | 0.42 |
| 64 | 47.94 | 9.97 | 3.08 | 6.80 | 6.34 | 187.16 | 8.76 | 0.53 |
| 72 | 73.04 | 25.36 | 22.10 | 19.66 | 17.44 | 223.63 | 4.40 | 0.28 |
| 80 | 87.95 | 23.06 | 14.04 | 13.52 | 11.38 | 171.83 | 2.44 | 0.26 |
| 88 | 75.94 | 24.89 | 19.75 | 20.27 | 18.24 | 141.84 | 6.13 | 0.27 |
| 96 | 55.98 | 29.21 | 1.87 | 9.75 | 6.59 | 181.56 | 10.25 | 0.48 |
| 104 | 74.13 | 24.45 | 9.70 | 16.96 | 18.46 | 214.66 | 5.59 | 0.29 |
| 112 | 86.13 | 22.62 | 4.57 | 10.18 | 10.67 | 127.77 | 3.22 | 0.41 |
| 120 | 69.30 | 25.16 | 11.77 | 22.62 | 15.58 | 140.98 | 6.43 | 0.35 |
| 128 | 60.89 | 28.96 | 1.85 | 4.33 | 6.10 | 190.58 | 9.36 | 0.33 |
| 136 | 75.78 | 24.24 | 8.35 | 21.03 | 14.02 | 185.92 | 5.27 | 0.23 |
| 144 | 87.81 | 22.54 | 1.23 | 2.60 | 5.20 | 162.36 | 3.99 | 0.18 |
| 152 | 69.31 | 25.28 | 9.50 | 19.03 | 24.68 | 143.48 | 7.68 | 0.33 |
| 160 | 56.56 | 28.79 | 2.24 | 4.91 | 6.01 | 196.58 | 10.40 | 0.38 |
| 168 | 68.77 | 24.22 | 7.45 | 18.81 | 26.01 | 182.72 | 6.90 | 0.43 |
| 176 | 83.89 | 22.86 | 2.96 | 12.03 | 10.80 | 142.90 | 5.01 | 0.24 |
| 184 | 68.23 | 25.44 | 7.84 | 18.74 | 24.96 | 154.39 | 5.46 | 0.45 |
| 192 | 52.20 | 22.17 | 1.97 | 5.03 | 5.08 | 234.10 | 10.94 | 0.52 |
| 200 | 63.78 | 24.37 | 10.14 | 15.79 | 12.82 | 210.09 | 5.36 | 0.43 |
| 208 | 85.32 | 22.64 | 5.13 | 7.48 | 5.25 | 190.13 | 1.93 | 0.32 |
| 216 | 61.98 | 25.59 | 7.91 | 20.84 | 19.80 | 140.62 | 3.97 | 0.47 |
| 224 | 53.14 | 28.54 | 2.38 | 7.94 | 10.62 | 212.17 | 8.61 | 0.52 |

Table A.9 The 8-hour concentration of $H_2S$, $NO_2$, $SO_2$ and $CO_2$ gases and RH, temperature and wind speed during the period of Sept. 1-8,1998

| Time( 8h) | RH | Tem $^0$c | $H_2S$ ppm | $NO_2$ ppm | $SO_2$ ppm | $CO_2$% | WinSp.m\S |
|---|---|---|---|---|---|---|---|
| 8 | 82.65 | 25.49 | 36.30 | 29.09 | 37.98 | 0.28 | 4.96 |
| 16 | 93.95 | 23.10 | 38.31 | 28.05 | 27.46 | 1.69 | 5.10 |
| 24 | 81.58 | 25.64 | 39.15 | 28.44 | 27.22 | 0.83 | 6.09 |
| 32 | 57.92 | 30.91 | 2.02 | 3.56 | 3.94 | 0.03 | 11.50 |
| 40 | 80.39 | 25.74 | 24.56 | 24.61 | 18.87 | 0.13 | 6.45 |
| 48 | 91.76 | 23.25 | 14.52 | 11.62 | 7.20 | 0.16 | 2.07 |
| 56 | 78.77 | 25.71 | 46.83 | 22.10 | 23.21 | 0.23 | 6.04 |
| 64 | 53.46 | 30.55 | 3.18 | 5.58 | 7.28 | 0.05 | 11.54 |
| 72 | 80.44 | 25.06 | 24.03 | 21.73 | 21.61 | 0.20 | 8.60 |
| 80 | 88.11 | 23.01 | 15.49 | 14.11 | 12.00 | 0.08 | 2.50 |
| 88 | 75.95 | 25.24 | 19.44 | 19.25 | 20.98 | 0.13 | 6.46 |
| 96 | 56.34 | 29.14 | 1.55 | 9.33 | 6.59 | 0.05 | 11.53 |
| 104 | 79.48 | 24.17 | 12.86 | 19.14 | 18.46 | 0.15 | 5.59 |
| 112 | 86.17 | 22.58 | 5.17 | 10.40 | 9.21 | 0.15 | 3.19 |
| 120 | 71.75 | 24.77 | 11.50 | 20.74 | 16.18 | 0.17 | 7.35 |
| 128 | 61.54 | 28.86 | 1.91 | 3.64 | 4.72 | 0.03 | 11.47 |
| 136 | 83.02 | 23.99 | 7.69 | 21.03 | 15.70 | 0.09 | 5.54 |
| 144 | 87.86 | 22.49 | 1.30 | 3.42 | 6.12 | 0.11 | 3.88 |
| 152 | 71.19 | 25.69 | 8.94 | 21.06 | 23.57 | 0.15 | 8.09 |
| 160 | 60.25 | 28.66 | 2.13 | 4.59 | 5.49 | 0.04 | 11.99 |
| 168 | 79.96 | 24.03 | 8.58 | 25.93 | 25.99 | 0.10 | 6.63 |
| 176 | 84.00 | 22.79 | 2.06 | 11.68 | 8.97 | 0.09 | 4.92 |
| 184 | 69.06 | 25.91 | 9.44 | 18.15 | 23.28 | 0.15 | 5.77 |
| 192 | 55.00 | 29.08 | 2.28 | 4.59 | 3.90 | 0.06 | 11.80 |
| 200 | 79.36 | 24.07 | 10.57 | 17.84 | 13.56 | 0.08 | 4.58 |
| 208 | 85.75 | 22.52 | 6.37 | 8.80 | 7.26 | 0.11 | 1.85 |
| 216 | 61.88 | 27.20 | 6.51 | 20.17 | 18.95 | 0.06 | 6.11 |
| 224 | 56.22 | 29.24 | 3.19 | 10.06 | 9.59 | 0.05 | 10.71 |

**Table A.10** The concentration of $H_2S$, $NO_2$, $SO_2$ and $CO_2$ gases .RH, and temperature during the period of April 22-29,1999

| time (8h) | RH | Tem. $^0C$ | $H_2S$ ppm | $NO_2$ ppm | $SO_2$ ppm | $CO_2$ (%) |
|---|---|---|---|---|---|---|
| 8 | 57.23 | 21.69 | 0.27 | 0.36 | 0.29 | 4.10 |
| 16 | 63.63 | 20.17 | 0.11 | 0.30 | 0.26 | 3.2 |
| 24 | 64.75 | 19.28 | 0.10 | 0.29 | 0.26 | 2.4 |
| 32 | 63.68 | 19.76 | 0.10 | 0.30 | 0.20 | 3.1 |
| 40 | 56.21 | 22.75 | 0.16 | 0.26 | 0.19 | 1.5 |
| 48 | 67.08 | 20.41 | 0.13 | 0.31 | 0.24 | 1.2 |
| 56 | 68.33 | 19.18 | 0.10 | 0.30 | 0.25 | 1 |
| 64 | 60.76 | 20.28 | 0.11 | 0.27 | 0.20 | 0.15 |
| 72 | 54.08 | 23.26 | 0.16 | 0.23 | 0.19 | 0.35 |
| 80 | 62.68 | 21.01 | 0.12 | 0.30 | 0.22 | 0.91 |
| 88 | 60.45 | 19.45 | 0.10 | 0.29 | 0.21 | 1.2 |
| 96 | 60.54 | 19.93 | 0.11 | 0.28 | 0.20 | 0.85 |
| 104 | 56.99 | 23.26 | 0.16 | 0.35 | 0.18 | 0.86 |
| 112 | 67.06 | 20.96 | 0.13 | 1.16 | 0.22 | |
| 120 | 67.02 | 20.23 | 0.19 | 1.06 | 0.26 | |
| 128 | 66.16 | 21.08 | 0.12 | 0.96 | 0.20 | |
| 136 | 62.30 | 23.05 | 0.22 | 0.94 | 0.23 | |
| 144 | 68.86 | 21.06 | 0.20 | 1.10 | 0.26 | |
| 152 | 68.63 | 20.08 | 0.29 | 8.90 | 2.18 | |
| 160 | 63.59 | 21.13 | 6.36 | 42.77 | 26.27 | |
| 168 | 60.01 | 23.40 | 8.02 | 48.59 | 23.14 | |
| 176 | 67.38 | 21.68 | 3.97 | 38.02 | 25.91 | |
| 184 | 68.29 | 20.59 | 1.81 | 50.04 | 23.65 | |
| 192 | 65.48 | 22.19 | 7.73 | 41.91 | 27.08 | |
| 200 | 62.62 | 24.64 | 9.19 | 48.89 | 29.98 | |
| 208 | 64.35 | 22.93 | 9.11 | 34.34 | 25.45 | |
| 216 | 66.92 | 21.52 | 5.48 | 43.25 | 25.86 | |
| 224 | 68.52 | 21.77 | 3.08 | 42.74 | 30.92 | |

**Table A.11** The concentration of $H_2S$, $NO_2$, and $SO_2$ gases and RH, temperature During the period of May 12-19,1999

| Time (8h) | RH | Tem. °C | $H_2S$ ppm | $NO_2$ ppm | $SO_2$ ppm | Win.Dir. Degree |
|---|---|---|---|---|---|---|
| 8 | 57.23 | 21.69 | 0.26 | 0.34 | 0.29 | 189.48 |
| 16 | 63.65 | 20.17 | 0.11 | 0.30 | 0.26 | 72.19 |
| 24 | 64.75 | 19.28 | 0.09 | 0.29 | 0.26 | 8.01 |
| 32 | 63.68 | 19.76 | 0.09 | 0.30 | 0.20 | 96.89 |
| 40 | 56.21 | 22.75 | 0.16 | 0.26 | 0.19 | 157.53 |
| 48 | 67.08 | 20.41 | 0.13 | 0.31 | 0.24 | 160.72 |
| 56 | 68.33 | 19.18 | 0.10 | 0.30 | 0.25 | 160.72 |
| 64 | 60.76 | 20.28 | 0.11 | 0.27 | 0.20 | 266.42 |
| 72 | 54.08 | 23.26 | 0.17 | 0.23 | 0.19 | 295.49 |
| 80 | 62.68 | 21.01 | 0.12 | 0.30 | 0.22 | 293.19 |
| 88 | 60.45 | 19.46 | 0.10 | 0.29 | 0.21 | 293.17 |
| 96 | 60.54 | 19.93 | 0.11 | 0.28 | 0.20 | 293.17 |
| 104 | 56.99 | 23.26 | 0.16 | 0.27 | 0.18 | 269.94 |
| 112 | 67.06 | 20.97 | 0.12 | 0.71 | 0.21 | 200.54 |
| 120 | 67.02 | 20.23 | 0.11 | 0.50 | 0.26 | 190.39 |
| 128 | 66.16 | 21.08 | 0.12 | 0.62 | 0.20 | 216.82 |
| 136 | 62.30 | 23.05 | 0.21 | 0.30 | 0.19 | 275.59 |
| 144 | 68.86 | 21.07 | 0.14 | 0.10 | 0.25 | 275.58 |
| 152 | 68.63 | 20.11 | 0.23 | 1.57 | 2.05 | 275.55 |
| 160 | 63.61 | 21.13 | 2.99 | 25.16 | 10.04 | 247.28 |
| 168 | 60.02 | 23.40 | 5.42 | 22.86 | 13.62 | 245.56 |
| 176 | 67.39 | 21.69 | 1.64 | 12.30 | 16.00 | 245.52 |
| 184 | 68.29 | 20.61 | 0.80 | 19.13 | 13.24 | 245.52 |
| 192 | 65.48 | 22.19 | 3.41 | 19.72 | 12.74 | 204.19 |
| 200 | 62.62 | 24.71 | 3.51 | 21.61 | 16.76 | 175.12 |
| 208 | 64.35 | 22.93 | 5.09 | 14.14 | 14.97 | 175.14 |
| 216 | 66.94 | 21.52 | 1.94 | 23.23 | 13.69 | 175.15 |
| 224 | 68.48 | 21.81 | 1.09 | 21.38 | 15.46 | 175.14 |

Table A.12 The concentration of $H_2S$, $NO_2$, and $SO_2$ gases and wind direction, temperature and wind speed during Sep. 28- Oct. 5,1999

| Time 8 (h) | Air Temp °C | $H_2S$ ppm | $NO_2$ ppm | $SO_2$ ppm | win s. m/s |
|---|---|---|---|---|---|
| | | | | | |
| 16 | 23 | 5 | 0.1 | 20.1 | 4.7 |
| 24 | 22.9 | 16.8 | 6.9 | 16 | 3.2 |
| 32 | 22.9 | 12.4 | 19.8 | 5.1 | 1.6 |
| 40 | 22.9 | 65.7 | 3 | 15.8 | 1.8 |
| 48 | 22.8 | 13.4 | 4.6 | 16.6 | 2 |
| 56 | 22.6 | 43 | 25 | 20.1 | 3.8 |
| 64 | 22.5 | 10.1 | 4.8 | 18.9 | 5.2 |
| 72 | 22.4 | 12.5 | 12.1 | 12.3 | 1.5 |
| 80 | 22.3 | 14.6 | 22.3 | 9.3 | 2.4 |
| 88 | 22.2 | 25.3 | 12.4 | 9.9 | 1.3 |
| 96 | 22.2 | 25.7 | 19.5 | 17.8 | 2.4 |
| 104 | 22 | 20.4 | 18.8 | 19.2 | 2.4 |
| 112 | 22 | 11.3 | 17.9 | 12.7 | 2.3 |
| 120 | 22 | 30.7 | 7.1 | 16.9 | 0.4 |
| 128 | 21.9 | 31.5 | 10.9 | 7.2 | 0.5 |
| 136 | 21.8 | 18.7 | | 9.9 | 0.3 |
| 144 | 21.8 | 33.5 | | 12.1 | 0.9 |
| 152 | 21.7 | 47.1 | | 16 | 1.9 |
| 160 | 21.6 | 47.5 | | 12.1 | 0.4 |
| 168 | 21.6 | 52.5 | | 13.8 | 1.1 |
| 176 | 21.6 | 41.4 | | 8.7 | 1 |
| 184 | 21.5 | 3.4 | | 10.5 | 0.3 |

**Table A.13** The concentration of CO, $H_2S$, $NO_2$ and $SO_2$ and the 8-hour concentration of RH, temperature Wind direction and Wind speed during the period of May 19-20,1999

| Time (8h) | CO ppm | RH | Tem. $^0C$ | $H_2S$ ppm | $NO_2$ ppm | $SO_2$ ppm | Win.Dir. degree | Win.Sp. M\S |
|---|---|---|---|---|---|---|---|---|
| 8 | 6.24 | 53.85 | 27.66 | 0.33 | 0.25 | 0.29 | 203.98 | 2.64 |
| 16 | 3.41 | 66.01 | 23.52 | 12.71 | 6.53 | 0.31 | 129.79 | 3.65 |

# APPENDIX B

## B.1

بسم الله الرحمن الرحيم

## استبانه

يقوم الطالب ياسر كايد طالب الماجستير في برنامج العلوم البيئية في جامعة النجاح الوطنية بإجراء بحث حول تلوث الهواء الناجم عن المفاحم و أثره على سكان المنطقة .

لدى يرجى تعبئة هذه إلا ستبانة علما بان المعلومات التي تعطى سوف تستخدم لأغراض البحث العلمي فقط.

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التاريخ : ............................ المدرسة: .............................. البلدة: ......

الاسم: .............................. تاريخ الميلاد : ..............................

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. الجنس : ا – ذكر ب – أنثى......................مكان السكن:

---

ضع / ضعي دائرة حول رمز الإجابة المناسبة:

١. عدد مرات زيارة الطبيب في الأربعة أسابيع الأخيرة ا- لم أقم بذلك ب- مرة واحدة ج مرتان د-ثلاث مرات أو أكثر

٢. هل تشعر بلهثه عند المشي ا- لا ب- خفيفة ج – متوسطة د- قوية

٣. هل تخرج بلغم عند السعال ا- لا ب- خفيف ج – متوسط د- قوي

٤. هل شعرة بخشخشة في الصدر ا- لا ب- خفيفة ج – متوسطة د – قوية

٥. هل شعرت بضيق تنفس على شكل ضغط على الصدر ا- لا ب- أحيانا ج- عند المشي القصير د – عند المشي لمسافات

٦. هل شعر بإعياء أو تعب عند المشي ا- لا ب- تعب خفيف ج – تعب متوسط د – تعب شديد

في صباح اليوم:

٧. هل سعلت ا- لا ب- مرة واحدة ج – مرتان د – ثلاث مرات أو اكثر

٨. هل عطست ا – لا ب – مرة واحدة ج مرتان د- ثلاث مرات أو اكثر

٩. هل عانيت من سيلان المخاط ا- لا ب – خيف ج- متوسط د- قوي

١٠. هل شعرت بحرقة في العين : ا- لا ب – بشكل خفيف ج – متوسطة د- قوية

١١. هل شعرت بحكة في الأنف ا- لا ب – حكة خفيفة ج- حكة متوسطة د- حكة قوية

١٢. هل شعرت بألم في الحلق ا – لا ب – بشكل خفيف ج – متوسط د – قوي

١٣. هل شعرت بالحمى : ا- لا ب –حمى خفيفة ج– حمى متوسطة د –حمى مرتفعة

# APPENDIX C

## Table C.1.A Effect of Place ,F-Test when Alpha =5%
## Variable I (Q 1-7)

| Source of variation | D.F | S.S | M.S.S | F-values |
|---|---|---|---|---|
| Due to places | 6 | 21.0014 | 3.5 | 11.4816 |
| Due to Errors | 909 | 277.1156 | 0.3049 | |
| Total | 915 | 298.117 | | |

Fc > Fprop.

There is a different in the respiratory symptoms due to place

Table C.1.B F-test To know the difference between which place

| Mean | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|---|
| 2.0485 | Nazlet Zead | (1) | | | | | | | |
| 1.8235 | Zabadeh | (2) | | | | | | | |
| 1.6167 | Yabed | ( 3) | * | | | | | | |
| 1.3839 | Arabeh | (4) | * | * | * | | | | |
| 1.5238 | Anen | (5) | * | | | | | | |
| 1.7532 | Kferet | (6) | | | | | | | |
| 1.3839 | Am archan | (7) | * | | | | | | |

*= There is a difference to the greater mean

## Table C.2.A Effect of Place ,F-Test when Alpha =5%
## Variable II (Q 8-14)

| Source of variation | D.F | S.S | M.S.S | F-values |
|---|---|---|---|---|
| Due to places | 6 | 47.4525 | 7.9088 | 28.4199 |
| Due to Errors | 909 | 252.9586 | .2783 | |
| Total | 915 | 300.4111 | | |

Fc > Fprop.

There is a difference in the respiratory symptoms due to place

## Table C.2.B F-test To know the difference between which place

| Mean | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|---|
| 2.3208 | Nazlet Zead | (1) | | | | | | | |
| 1.4020 | Zabadeh | (2) | * | | | | | | |
| 1.5027 | Yabed | ( 3) | * | | | | | | |
| 1.2606 | Arabeh | (4) | * | | * | | * | | |
| 1.7222 | Anen | (5) | * | | | | | | |
| 1.4949 | Kferet | (6) | * | | | | | | |
| 1.4479 | Am archan | (7) | * | | | | | | |

* = there is a difference to the grater mean

**Table C.3 T-test** between polluted and non polluted villages
Group I (Q 1-7)

| Area | Number of cases | mean | SD | T-calculated | D.F | T-table |
|---|---|---|---|---|---|---|
| Polluted | 685 | 1.6669 | 0.588 | 5.61 | 914 | 1.96 |
| Non polluted | 231 | 1.4273 | 0.475 | | | |

T-calculated is greater than T-table there is a difference toward the polluted villages

**Table C.4 T-test** between polluted and non polluted villages
Group II (Q 8-14)

| Area | Number of cases | mean | SD | T-calculated | D.F | T-table |
|---|---|---|---|---|---|---|
| Polluted | 685 | 1.5606 | 0.586 | 3.58 | 914 | 1.96 |
| Non polluted | 231 | 1.4055 | 0.516 | | | |

T-calculated is greater than T-table there is a difference toward the polluted villages



**Table C.5** Effect of sex, F-Test at alpha = .05

| Variable | Hypoth. ss | Error ss | Hypoth.MS | Error MS | F Sig | |
|---|---|---|---|---|---|---|
| I | 2.22694 | 283.63610 | 2.22694 | 0.31100 | 7.16048 | |
| II | 1.52475 | 292.57704 | 1.52475 | 0.32081 | 4.75284 | |

There was difference between the sex factor

# قياس التغيرات اليومية في تراكيز ملوثات الهواء وعلاقة ذلـــك بانتشار أمراض الجهاز التنفسي لدى أطفال المدارس في منطقة المفاحم في يعبد

ياسر عمر حافظ كايد

المشرف

بروفيسور محمد سليم علي اشتية

و

دكتور معتصم بعباع

في هذه الدراسة تمت دراسة تأثير إنتاج الفحم النباتي في منطقة يعبد وذلك بقيـاس تركـيز الغــازات المنبعثــة مــن عمليــة الكربنــة(التفحــم) والغــازات هــي $CO, CO_2, NO_2, SO_2, H_2S$ وذلك علـــى مـدى ١٤ شـــهرا (أيــار ١٩٩٨ - آب١٩٩٩)، باســتخدام محطـــة رصــد بيئـــي ELE 8000/EMS 1417 Environmental Data logger ، حيث تم اختيار ثلاثة مواقع لقياس تراكـــيز الغازات فيها وكانت المواقع كما يلي الموقع الأول يبعد حوالي ١٨٠م عن تجمـــع المفاحم القريب من بلدة يعبد إلى الشمال الشرقي منه ، والموقع الثاني يبعد حوالـي ٧٠م ،مقابل للمفاحم وللأدخنة الصادرة منها، أما الموقع الثالث كان فـــي تجمـــع المفاحم ،هناك عوامل فيزيائية أخرى تم قياسها مثل سرعة الرياح، اتجاه الريـــح، درجة الحرارة والرطوبة،أما دراسة تأثير الغازات المنبعثة عـــن المفـــاحم علـــى

الجهاز التنفسي للسكان في منطقة يعبد فقد تمت من خلال استبانه مكونة من ١٤ سؤال وزعت على طلاب الصف الخامس في أربعة تجمعات سكنية يعتقد أنـــها ملوثة وثلاثة مجتمعات سكنية يعتقد أنها اقل تلوثا، ومن نتائج الدراســة وجـود ارتفاع في تراكيز الغازات في المواقع الثلاث، و أنّ تركيزَ الغازاتِ يرتبط بشكل معكوس مع المسافةِعن المفاحم ، وكان أعلى تركيز في الموقع الثالث حيث كـــان تركـيز الغـازات (CO100.57ppm, $NO_2$11.7 ppm and $SO_2$1.75ppm) أما في الموقع الأول فقد كانت تراكيز الغازات منخفضة جـــدا حيث كان معدلها (CO 0.19ppm, $NO_2$ 0.29 ppm, $SO_2$ 0.26ppm, $CO_2$ 1.6% and $H_2S$ 0.36ppm) بينما كانت التراكيز في الموقع الثـــاني اقـل مـــن الموقع الثالث أعلى من الموقع الأول: CO 37.9ppm, $NO_2$ 14.9ppm, $SO_2$ 14.7ppm, $CO_2$ 1.98% and $H_2S$ 12.2ppm). في الموقعين الثاني والثـــالث تجاوزت التراكيز الحدود القصوى المسموح بها دوليا بينما لم تتجاوزها في الموقع الأول .كما أوضحت التحليلات الإحصائية باستخدام ANOVA and F-test أن هناك فرق واضح في تراكيز الغازات في المواقع الثلاثة،كما أظهرت التحليـــلات الإحصائية في هذه الدراسة تأثير واضح لعملية إنتاج الفحم على طلاب المـــدارس القريبة من المفاحم، كما أظهرت أن هناك فرق واضح بين تاثر الفتيـــات والأولاد في المدارس القريبة من المفاحم حيث تبين أن الأولاد اكثر تأثرا من الفتيات.