**Ministry of Higher Education**
**And Scientific Research**
**University of Baghdad**
**College of Science**
**Department of Geology**

# Environmental Assessment Using Remote Sensing Techniques At (Al-Nahrawan Area, East Baghdad)

**A Thesis Submitted to the College of Science**
**University of Baghdad in Partial Fulfillment**
**of the Requirement for the Degree of**
**Master of Science in Geology**

**BY**

**ROSE M. ABDUL SATTAR**
B.SC. in Geology (2007)

**SUPERVIED BY**

**Dr. SALEH M. ALI** **Dr. BALSAM S. Al-TAWASH**

**2013**

# Dedication

***To the pure soul of my father, the first to teach me …***

***To the tree that shaded my path and provided me with shelter, my mother …***

***To my brothers and sisters for their endless love and constant support …***

***To my husband Ahmed, for his love, patience, support and encouragement…***

***To all my friends who cared for me…***

Rose

# ***ACKNOWLEDGMENT***

In the name of Allah, the most gracious, the most merciful all the praise and thanks be to Allah, the almighty who gave me the ability to successfully complete this study. I am all full of admiration and gratitude to my supervisors **Dr. Saleh Mahdi Ali** and **Dr. Balsam Al- Tawash** for their guidance and assistance throughout all stages of this work.#My sincere gratitude to the Department of Earth Science staff, College of science, University of Baghdad for their support during my courses of study.

Special thanks go to Dr. khaldoun Al-Bassam not only for his tremendous support, but also for giving me so many wonderful opportunities.# would like to express my deepest gratitude to Younus Al-Saady for his valuable assistance throughout this work. I express my thanks to Dr. Safaa Fakhri for his support.

I would like also to express my deep gratitude and respect to Dr. Waleed Jaboury and Dr. Georgis Micho Paulos in Mineral and Investment Department for their support and encouragement. This project would not have been possible without the support of my dearest friend Mariam Albert, thank you so much. I am very thankful to my friends: Bashier Hasson, Asmaa Akram, Ghasaq Abdul Rahman, Adian Arkan, Rita Talaat, Tharaa Aamer, Hala Ali, Sawsan Abdul Rahman and Rand Mahdi for their support and encouragement. My great thanks go to Ahmed Fayek and Ahmed Tariq for their help. I also thank Ahmed Adeeb and Ghassan faisal for their support through field work. Thanks are also extended to Omar Hamid and Abdul Alnaser Abdul Sattar for their help. I would also like to show my genuine appreciation to Dr. Maitham Al- Maliki and Mohammed Khalil in the Ministry of Science and Technology for his help in air sampling and analysis. Iam also grateful to Dr. Thair J. Benni for his help in the first stages of the work.

I further owe my sincere gratitude to my family who stood by me during some tough moments in my life, especially my mother who has been a pillar of strength, love and support without whom I would never have been able to do the project. I further owe my sincere gratitude to my sister Saja I will never know how to repay the sacrifices you made for me.

I am grateful to all the people who made this work to be something. Finally I would like to express my gratitude to all whom I forget to mention them.

***Rose***

# Abstract

The study area lies about 65 km in the eastern part of Baghdad city at Nahrawan area, and it is located in the Mesopotamian Plain which is covered by Quaternary deposits (Pleistocene & Holocene). It can be considered as a hot spot for pollution whereas different point source pollution can be distinguished within this area represented by many brick factories, which burns heavy oil leading to emission of different types of contaminants released in the environment (air, water, soil) such as toxic gases and fly ash (fallout).

The use of supervised classification technique on Landsat TM 5 , of 2007 to prepare landuse / landcover map have shown different landuse classes which represented by: urban or built up land, water, smoke, vegetated land, agricultural land non-vegetated and barren land which are considered as the main land use - land cover units in the study area.

Change detection results of Normalized Difference Vegetation Index (NDVI) have shown that vegetation cover for three periods (1990, 2002, 2007) almost very close to each other with little change toward decreasing in 2002, and again little increase in 2007 as compared with the year 1990, because of lack or shortage of water resources caused by climate changes and drought conditions which has led to increasing in soil salinity.

The results of change detection for salinity index for the three periods have shown that soil salinity has increased due to drought conditions that had prevailed over the country for the last few decades beside the unsuitable practices of agriculture and irrigation systems and waste water influenced by tannery factories that use high concentrations of salt in the tanning industry. Water levels have increased sharply in 2002 as compared with the year 1990 while it dropped again significantly in 2007. The visual interpretation of the repaired image satellite ETM+ 2011 shows that smoke released from brick factories has increased

throughout the last four years as compared with TM image of 2007 and that means increasing the pollution at the study area.

For air pollution detection the contaminant concentrations of air (TSP, Pb, Cr, Ni, $NO_2$, $SO_2$, $H_2S$) are measured for nine air samples. The results have shown that TSP average reaches 1820.08 ($\mu g/m^3$). Heavy metals (Pb, Ni, Cr) showed high concentrations exceeding the Iraqi and international standards of pollution. There is high concentration of ($NO_2$, $SO_2$, $H_2S$) gases in some locations of the study area and this increase might be due to burning of fuels (heavy oil) at brick factories as well as other industrial activities.

The hydrochemical analysis for eleven water samples (two surface and nine ground water samples) showed that water is contaminated with high concentration of heavy metals (Pb, Cr, Cd, Ni) with high concentrations of major and minor ions ($Ca^{+2}$, $Na^{+1}$, $Cl^{-1}$, $SO_4^{-2}$) with the exceptional case of very high concentration of ($NO_3^{-2}$) at location (W2). Industrial waste water released from tanneries has shown very high concentration of (T.D.S, major and minor ions) and heavy metals especially (Cr). Hydrogen sulfide is measured for water samples and shows high values which are mainly due to burning of heavy oil at the brick factories.

Geochemistry and mineralogy for soil samples showed high value of heavy metals (Pb, Cr, Cd, Ni and V) and their concentration has exceeded the allowable limits. The percentage of major oxides ($SO_3$, $K_2O$, $Al_2O_3$, $Na_2O$ and CaO) have shown little changes compared with previous studies.

Total carbon percentage for five selected soil samples ranged from (3.63 -5.27 %), whereas sulphur percentage ranged from (0.107-6.57%).

The main clay minerals in the soil of the study area are montmorillonite, kaolinite, palygorskite and illite, and the calcite is the highest in content among the non-clay minerals.

# The Supervisor Certification

I certify that this thesis (**Remote Sensing Techniques for Study the Environmental Effects of Brick Factories Products At (Al-Nahrawan Area, East Baghdad) was** prepared under my supervision at the Department of Geology, College of Science, University of Baghdad, in partial fulfillment of requirement for the degree of Master of Science in Geology (Remote Sensing).

| | |
|---|---|
| **Signature:** | **Signature:** |
| **Scientific degree:** | **Scientific degree:** |
| **Dr. Saleh M. Ali** | **Dr. Balsam S. Al-Tawash** |
| **Date:** / / 2013 | **Date:** / / 2013 |

# Recommendation of the Head of Committee of Postgraduate Studies in Geology Department

In view of the available recommendation I forward this thesis for debate by
the examination committee.

**Signature:**
**Name:** *Dr. Ahmad Shehab Al-Banna*
**Scientific *degree:*** *Professor*
**Address:** *University of Baghdad (Head of Geology Department)*
**Date:** / / 2013

# TABLE OF CONTENTS

## CHAPTER ONE
## Introduction

## CHAPTER TWO
## Methodology and Techniques

## CHAPTER THREE
## Land Use – Land Cover and Change Detection

## CHAPTER FOUR
## Environmental Assessment of Air, Water and Soil

## CHAPTER FIVE
## Conclusions and Recommendations

# LIST OF TABLES

# LIST OF FIGURES

# LIST OF SYMBOLS AND ABBREVIATIONS

| Abbreviations | Descriptions |
|---|---|
| LULC | Landuse Landcover |
| TM | Thematic Mapper |
| ETM+ | Enhanced Thematic Mapper |
| SLC | Scan Line Corrector |
| MLC | Maximum Likelihood Classifier |
| NDVI | Normalized Difference Vegetation Index |
| WI | Difference Water Index |
| SI | Salinity Index |
| TSP | Total Suspended Particles |
| T.D.S | Total Dissolved Solids |
| TH | Total Hardness |
| TC | Total Carbon |
| TS | Total Sulphur |

# Chapter One
# Introduction

## 1.1. Preface

During the visits to the study area it is found that the infection of most of the residents and workers with various diseases, especially respiratory diseases (Pulmonology) is quite common. Eight cancer cases are found in (Shmessan village) located near the brick factories and infertility disease near the sanitary landfill. It is also found that the age of workers in the study area do not exceed 50 years. All of the above indicates that the study area is highly polluted.

Remote sensing is the acquisition of information about an object or phenomenon, without making physical contact with the object. In modern usage, the term generally refers to the use of sensor technologies to detect and classify objects on Earth (both on the surface and in the atmosphere and oceans) by means of propagated signals (e.g. electromagnetic radiation emitted from aircraft or satellites emitted). It can be defined as a technique for collecting information about the earth without touching the Earth`s surface, using sensors placed on a platform at a distance from it. The major applications of remote sensing include environmental pollution, land cover / use mapping, urban planning and the earth management, etc (Lim, *et al.,* 2010). It has been widely used for environmental application such as for air quality, and water quality studies (Penner, *et al.* 2002).

In fact, modern remote sensing began in 1858 when first aerial photographs took for Paris from a hot air balloon, as shown in figure (1-1).

Figure (1-1):Illustrates Gasper Felix Tournachon in 1858, taking the first aerial photograph from a captive balloon from an altitude of 1,200 feet over Paris. (Lithograph published in Le Boulevard, 1862).

Remote sensing continued to grow from there; one of the first planned uses of remote sensing occurred during the U.S. Civil War when messenger pigeons, kites, and unmanned balloons were flown over enemy territory with cameras attached to them. Today, small remote sensors or cameras are used by law enforcement and the military in both manned and unmanned platforms to gain information about an area. However, remote sensing imaging, today, includes infra-red, conventional air photos, doppler radar, and so on. In addition to these tools, satellites were developed during the late 20th century and are still used today to gain information on a global scale and even information about other planets in the solar system. For example, the Magellan probe is a satellite that has used remote sensing technologies to create topographic maps of Venus.

[http://geography.about.com/od/geographictechnology/a/remotesensing.htm ]

Land use is the result of a continuous field of tension created between available resources and human needs and acted upon by human efforts (Vink, 1975). Remote sensing has been used to investigate differences in vegetation structure, cover, and species composition as a result of varying land uses (communal, commercial and conservation) and management strategies (Palmer & van Rooyen, 1998; Dube & Pickup, 2001).

Environmental pollution is the contamination of air, water and soil in such a manner as to cause real or potential harm to human health or well-being, or to damage or harm nonhuman nature without justification (Peirce et al, 1998).

Environmental pollution may occur naturally like gases and dust resulting from volcanic eruptions, forest fires, storms, cyclones, drought and other natural factors that cause defect in the natural balance of the environmental components may continue for a long or short period and occurs sporadically or seasonally depending on controlling the geographical, geological and climatic factors, or environmental pollution may occur artificially as a result of human activities on the earth surface. And this source has emerged with the arrival of the industrial age that brought the world today to the present level of civilization, scientific and technological development, but the tax of this development comes at the cost of the environment, Among the most important of these sources is: the use of fossil fuels in industry, transport and electricity generation, and factories waste, mining, mines, opening of transportation roads, nuclear reactors and other products and requirements that are necessary to maintain human life (Landis & Yu, 1999).

## 1.2. Location of the study area

Nahrawan area can be considered as a hot spot for pollution where different points source pollution can be distinguished represented by many brick factories (more than 200 factory) which work with heavy oil as a fuel consequently leading to emission different types of contaminates such as toxic gases and dust. The study area is located (65) km east of Baghdad city, (Al-Sultani, 2006). It is bounded between latitudes ( $33^0$ 45" 00 " - $33^0$ 17" 00") and longitudes (4 $5^0$ 55" 00 - $44^0$ 35" 00 " ) as shown in figure (1-2).

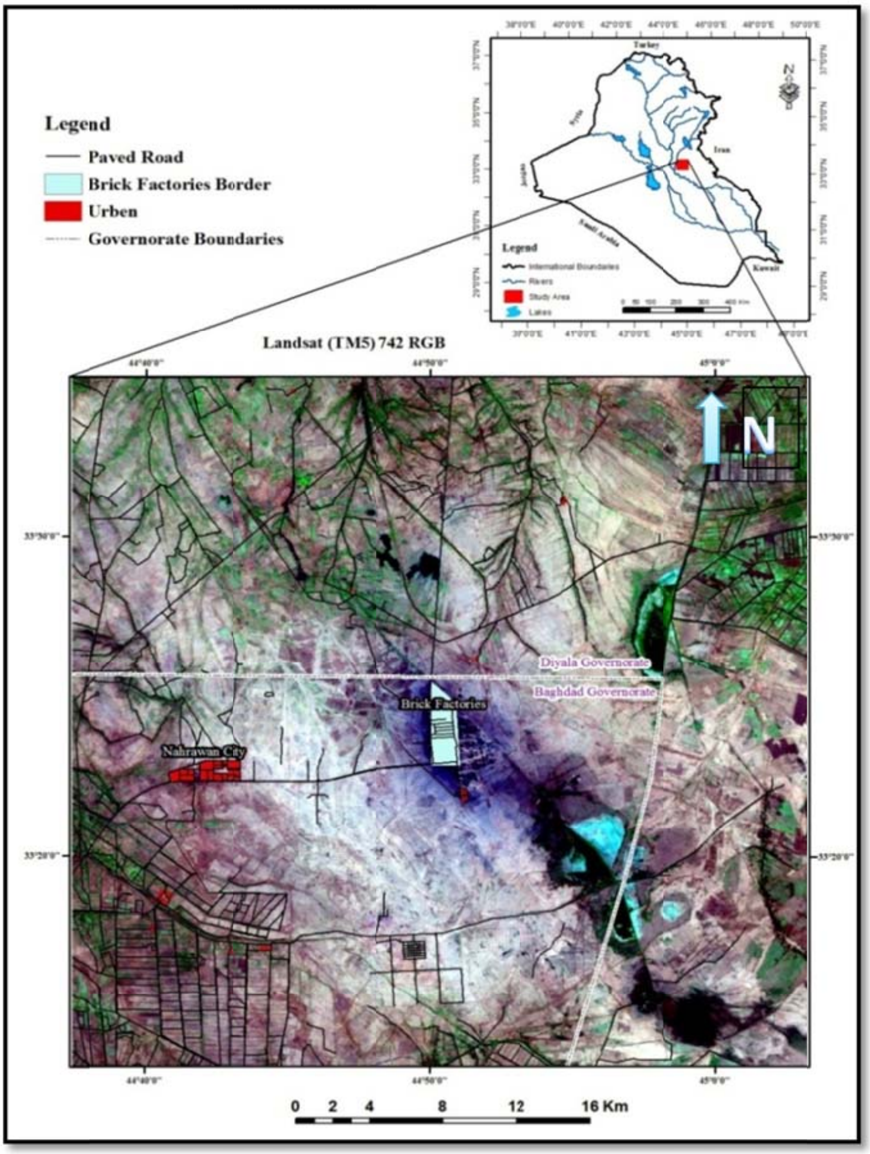


Figure (1-2): Location map of the Study area (TM5 in 2007, RGB 742)

## 1.3. Project aim and objectives

The project will concentrate on studying;

- Environmental change detection for three periods (1990, 2002, 2007) of vegetation, water and salinity by using remote sensing and GIS techniques.
- Performing landuse / cover map for the study area by using Remote Sensing and GIS techniques.
- Study the environmental effects caused by brick industries on the soil, air, and water.

## 1.4. Literature review

In fact many studies have been published concerning the effects of industrial units on the environment. This review will focus on those considered the case of Iraq with emphasis on Baghdad city.

- Al-Bayati, (1980) studied on pollution of the Tigris River sediments (the muddy part) in Baghdad city and he concluded that the rate of heavy elements such as chromium, nickel and lead is greater in muddy part.
- Al Hilali , (1980) studied on the clays of Baladroz area and its suitability for brick industry and how its polluted with heavy elements, which showed the presence of high concentrations of these elements (nickel, zinc and lead) in the muddy part.
- Khalid *et,al.*, (1981) studied on the pollution of Baghdad with lead as samples were collected from 36 locations and has been shown that the concentration of element lead on the outskirts of Baghdad is more than the concentration in industrial areas, this indicates that the soil pollution in non-industrial areas result mainly from modes of transport, The study also showed that wind direction has no effect in the distribution element of lead in those locations.
- Jabbar, (1983) studied the geochemical and sedimentological of alluvial plain from Mahmudiya to Mandali, the study showed high concentrations of the elements cadmium, lead and nickel in the muddy part of the deposits.
- Kanbour, *et.al*, (1985) collected suspended particles sample in the air in different parts of Baghdad city and they calculated the amount of suspended particle in the air, also they calculated the concentrations of the following elements: Hg, Co, Cd, Cr, Mn, Pb, Zn, Cu, Fe as well as sulphate and chlorite. They found that major components of these suspended particles in Baghdad city is composed of mineral dust due to industrial activities.

- Shaker, (1992) studied on the effect of human activities on water quality of Diyala River, this study showed high concentrations of heavy metals like nickel, lead, chrome and cadmium in the muddy sediments in Diyala River.
- Al-Saadi, (1999) studied air pollution in Baghdad city and its surroundings with carbon monoxide and heavy metals; it showed an increment in heavy elements concentrations due to increasing of particulate concentrations, also showed that the climate elements (temperature, wind speed, relative humidity and rainfall) have their effect on concentrations of these pollutants in air.
- Afaj *et,al,*(2000) Studied the concentrations of toxic pollutants in the air include (suspended particles, lead, and gas CO ) in stations distributed over different parts of Baghdad city , and found high concentrations of these pollutants exceeded the nationally and internationally allowed limits , and they attributed this increase to the transportation and industrial activities such as: power stations and factories.
- Fadhil, (2001) studied the environmental changes by geoinformation technology for Baghdad and its neighboring areas and the results of his study showed an increase in an increase in the vegetation cover, farm lands, soil moisture, and the built up areas, while the water bodies has gained a significant decrease in some studied counties during the period from 1990 to 2001.
- Al-Azzawi, (2002) studied on mineral content of heavy metals in the sediments of Diyala River (Baquba) where it showed the presence of high concentrations of heavy elements like (chromium, nickel, lead, copper and zinc) in the fine part of the sediment.
- Shanshal,( 2004) Found high concentrations of heavy metals (Cd, Ni, Pb, Cr) in the soil of Nahrawan area (tannery), also found high

concentrations of heavy metals in the Tartia plants in the same area and attributed this increase to the presence of tanneries and brick factories.

- Al- Maliki, (2005) studied the air, water and soil pollutants in Baghdad city using geographic information system (GIS), he measured the pollutants concentrations of air, water and soil and found that these concentration exceeded the international and Iraqi standard levels.
- Al Sultani, (2006) studied the Pollution of air and soil in Al- Nahrawan area East Baghdad by heavy metals produced from brick factories, showed that the total suspended particles exceeded the nationally and internationally allowed limits, also the concentration of trace element were high compared with international limits, he concluded that brick factories are the main source of the pollution in the area.
- Fadhil, (2009) studied the land degradation detection using geo-information technology for some sites in Iraq; it showed a clear deterioration in vegetative cover, an increase of sand dune accumulations, and a decrease in soil/vegetation wetness. In addition, a decrease in the water bodies area.
- Hisham, (2010) study air pollution by using remote sensing data and GIS and their relationship with land cover land use in Baghdad city. They show a relationship between the concentration of air pollutants and land surface temperature with the land cover and land use classification for Baghdad city. The results of the research gives evidence of a link between air pollutants derived from the measurement stations of ground and satellite data within the range of Thermal IR.
- Saleh, (2011) studied the air quality over Baghdad city using earth observation and Landsat thermal data, the study showed significant linear relationships between grounds based measurements of air pollution parameters with temperatures from Landsat satellite data. Also, this study

indicated that satellite imagery was capable for mapping of the pollution parameters concentrations.

- Ali, (2012) studied the hydrochemistry of water and mineralogy and geochemistry of soil of Baghdad area, the study showed that soil have anomalous concentration of Pb, Zn, Co, Cu, and Sr and negative anomalous of Mn, Cr, and Ni, and that Baghdad area is free from radioactive pollution. Also there is a great variation in the hydrogeological parameters of shallow aquifer. Hydrochemical parameters of ground water showed significant spatial and temporal variations in major and minor elements, whereas trace elements showed no temporal variation.

## 1.5. Geological setting

### 1.5.1. Stratigraphy

The area is covered by Quaternary sediments which consist of the following sediments based on the study of Deikran & Yacoub, (1993) as shown on figure (1-3):

- Sheet run – off deposits (Pleistocene – Holocene)

Consist of silty clay, brownish red, with some grains of sand and silt.

- Flood Plan deposits (Holocene)

These sediments represents most of the Holocene deposits of the Mesopotamian plain, consist of silty clay and clayey silt with lenses and thin layers of sand.

- Depressions or Fill Deposits (Holocene)

Consist of flood plains or small depression that forms small salty lakes filled with water periodically. They are characterized by their gray color with organic materials like shells remains. As result to the continued moisturizing leads to the formation of mud cracks in these depressions.

- Eolian Deposits

Consist of fine to medium sand with some silt and clay, the sand generally consist of quartz, chert and carbonate with some heavy mineral. (Yacoub & Hussian, 1996).

- Galgia

A succession of microbasins and microknolls in nearly level areas of microvallies and microridges parellal with the slope. Typically, the microreleif of clayey soil that shrinks and swells considerably with changes in moisture content, (Hawley and Parsons, 1980).

### 1.5.2. Structure

Structurally the area is located in the Unstable Shelf within the Tigris subzone that belongs to the Mesopotamian Basin (Al-Kadhimi *et al.*, 1996). While (Fouad, 2010) Considered the area within the Mesopotamia Foredeep, and mentioned that there is no shallow geological structures in the area but there is a deep geological structures under the surface, represented by faults and folds that lies down the cover of Quaternary deposits and there is a reflection of it on the surface.

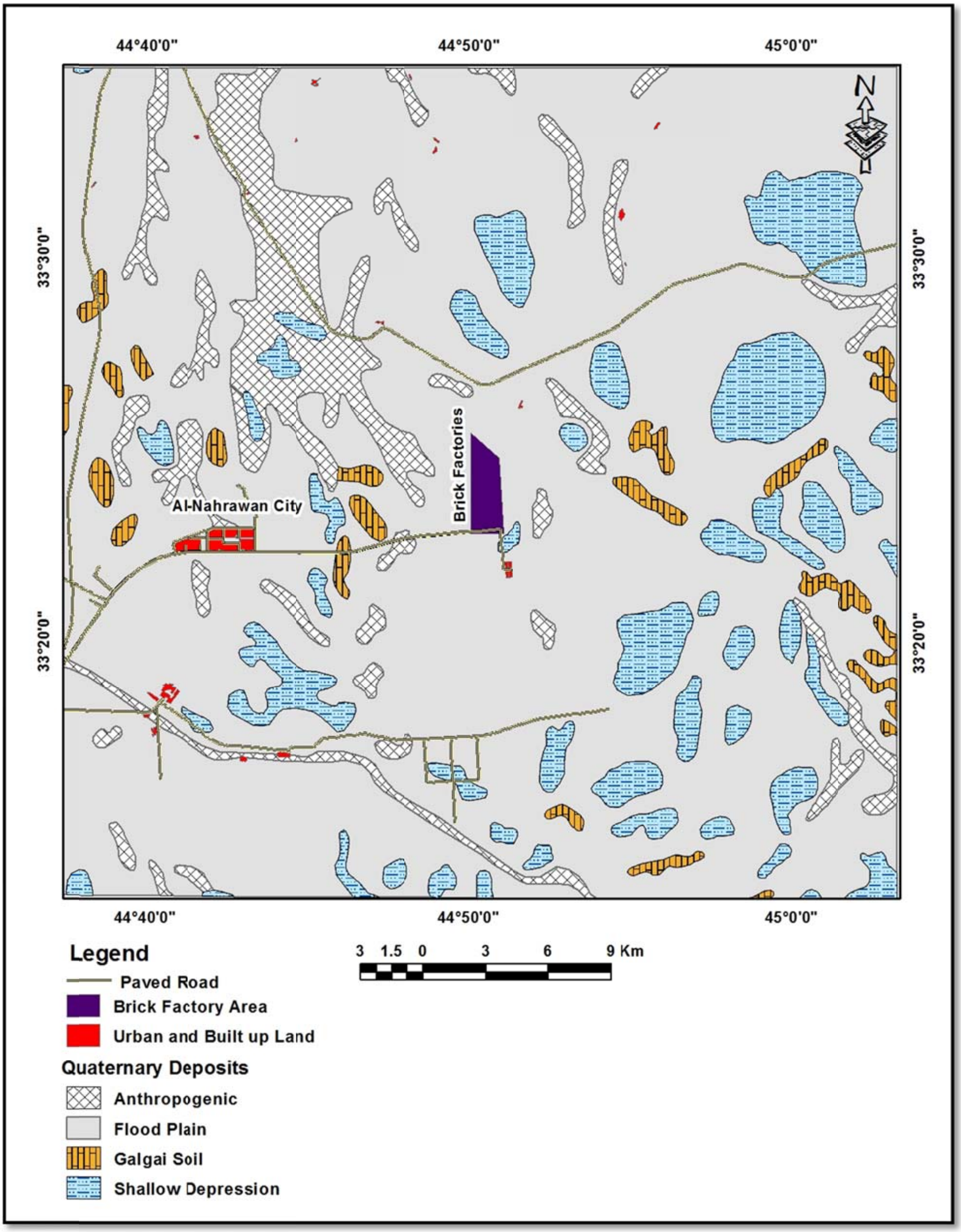


Figure (1-3): Geological map of the study area

(Modified after Dikran and Yacoub, 1993)

### 1.5.3. Topography

According to Yacoub & Hassan, (1996) the study area is located within the Mesopotamian plain. The alluvial plain has a simple slope from the north to the south where the elevation is reduced to (50) meters above sea level near Khalis, to (15) meters above sea level south of Kut city.

The study area is a flat area and rises nearly about 34 meters above sea level, and the sediments that cover the area is a flood plain sediments resulting from the floods of Tigris and Diyala rivers, and these sediments are one of the units of fluvial origin. There is salt flat in some depressions that consist of alluvial clayey materials mixed with a high content of salts. Formed as a result of groundwater leakage near the surface or due to the accumulation of salty water, which was carried by old irrigation channels (Benni, 2011).

### 1.5.4. Hydrogeology

Alluvial plain is characterized by a thick sequence of stratified deposits of river origin, which is made up of gravel, sand, silt and clay. The layers that contain water belong mainly to the Quaternary. It also characterized by sudden changes in both directions vertical and horizontal for these deposits the basin is considered a complex Hydrogeological system. The ground water depth ranges in general from (2-18) meters and it is almost (15) meters in the flood plain (study area).

The shallow reservoirs for groundwater are of sulfate type in the whole alluvial plain (Parsons, 1957).

## 1.6. Climate

The climate is considered one of the important factors that affect the quality of air, water and soil, due to fact that if the climate is humid then the concentrations of pollutants in the air will be reduced despite the change of air pollutants case, especially gases, Furthermore the increase in the amount of falling rain leads to water infiltration within the soil layers and thus raise the groundwater levels as well as reduces the concentrations of some chemical elements in water and soil. If the temperature increases in the summer season it will lead to the evaporation of water and dry the soil and then lowers the groundwater levels and increases salinity, (Moses, 2000).

The climate of the study area is characterized by large changes throughout the year. Long hot summer with occasional dust storms prevails as well as short winter with limited and seasonal rainfall. The Meteorological data is collected from Baghdad Meteorological Station No. (650) during the period (1971 – 2000) except the rainfall data up to (2005).The main meteorological parameters are:

### 1.6.1. Temperature (°C)

The maximum temperature reaches to 47 °C in summer season especially in the July and August, sometimes a cold period control on this area in winter, which leads to a conspicuous decrease in the temperature and reaches to 4 °C. The mean of the monthly maximum temperature °C in the study area during three periods is shown in table (1-1) and figure (1-4).

Table (1-1): Monthly mean of maximum temperature (°C) for three periods from (1971 −2000) Baghdad Meteorological Station No. (650)

| **Periods** | | **Months** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **JAN.** | **FEB.** | **MAR.** | **APR.** | **MAY** | **JUN.** | **JUL.** | **AUG.** | **SEP.** | **OCT.** | **NOV.** | **DEC.** |
| **Period (1971-1979)** | **Min.** | 12.4 | 15 | 20.6 | 26.2 | 33.1 | 39.6 | 41.8 | 41 | 38.4 | 19.8 | 20.7 | 14.2 |
| | **Max.** | 18.3 | 22.3 | 24.7 | 31.1 | 37.2 | 41.5 | 44.7 | 44.8 | 42.6 | 35.9 | 26.9 | 19.6 |
| | **Mean** | 15.2 | 18.6 | 23.1 | 29.1 | 35.7 | 40.7 | 43.2 | 42.9 | 40.3 | 32.5 | 23.9 | 16.5 |
| **Period (1980-1989)** | **Min.** | 12.3 | 14.5 | 21.3 | 28.4 | 33.6 | 39.4 | 43 | 40.2 | 38.7 | 30.4 | 20 | 14.6 |
| | **Max.** | 18.6 | 21.9 | 24.1 | 33.3 | 38 | 42.3 | 45.3 | 45.3 | 42.3 | 32.4 | 26.8 | 19.5 |
| | **Mean** | 15.7 | 18 | 22.6 | 30.1 | 36 | 40.8 | 44.1 | 43 | 40.1 | 32.2 | 23.3 | 16.9 |
| **Period (1990-2000)** | **Min.** | 12.9 | 14.7 | 19.2 | 28.3 | 34.1 | 40.2 | 42 | 41.1 | 38.8 | 31.7 | 20.9 | 13.9 |
| | **Max.** | 18.3 | 21.4 | 25.3 | 33.1 | 39.2 | 44 | 47 | 47.7 | 40.6 | 34.9 | 27.2 | 21.1 |
| | **Mean** | 15.4 | 18.2 | 22.8 | 30.4 | 36.9 | 41.8 | 44.2 | 44 | 39.9 | 33.3 | 24 | 17.7 |

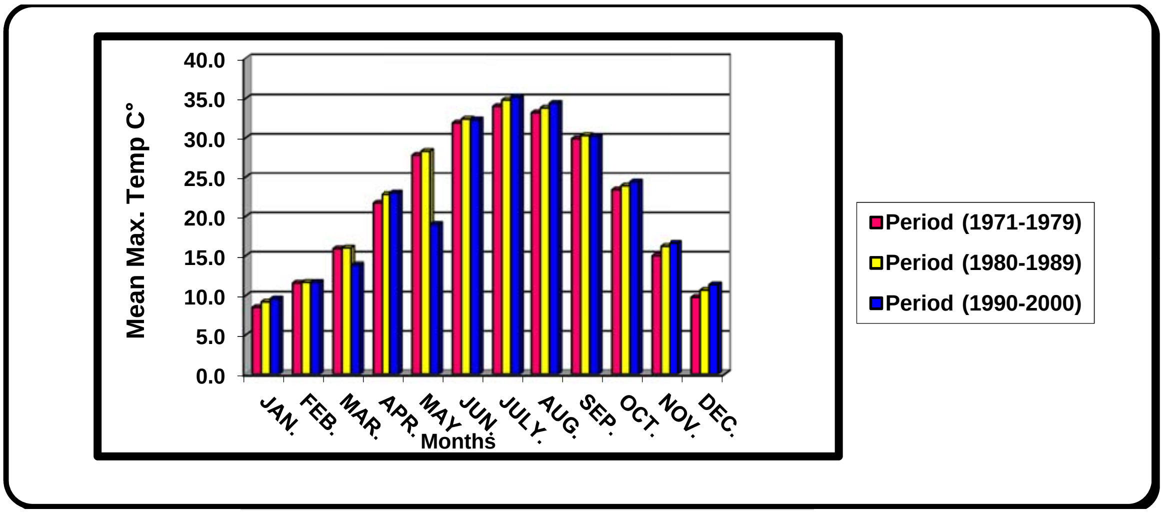


Figure (1-4): Monthly mean of maximum temperature (°C) for three periods from (1971 – 2000)

The minimum temperature recorded through the period (1990-2000) ranged between (4.5 º C) in January to (25.9 º C) in July, as shown in table (1-2) which shows that temperature is increased through these periods. Figure (1-5) shows the monthly mean for minimum temperatures for the period above.

Table (1-2): Monthly mean of minimum temperature (°C) for three periods from (1971 – 2000) Baghdad Meteorological Station No. (650)

| **Periods** | | **Months** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **JAN.** | **FEB.** | **MAR.** | **APR.** | **MAY** | **JUN.** | **JUL.** | **AUG.** | **SEP.** | **OCT.** | **NOV.** | **DEC.** |
| **Period (1971-1979)** | **Min.** | 1 | 1.6 | 6.8 | 12.8 | 18 | 21.1 | 22.9 | 21.6 | 18.5 | 12.4 | 3.8 | 2 |
| | **Max.** | 6.2 | 7.8 | 10.5 | 16.3 | 20.8 | 24 | 25.6 | 25.1 | 22.3 | 17.2 | 10.5 | 6.9 |
| | **Mean** | 3 | 4.9 | 8.8 | 14.3 | 19.1 | 22.3 | 24.2 | 23.2 | 19.9 | 14.5 | 7.5 | 4.4 |
| **Period (1980-1989)** | **Min.** | 0.1 | 2.8 | 6.7 | 13.4 | 17.6 | 21.6 | 23.9 | 21.5 | 18.7 | 13.6 | 7.1 | 2.9 |
| | **Max.** | 5.9 | 8 | 11.2 | 17.4 | 21.5 | 23.6 | 25.9 | 25.5 | 22.1 | 18.2 | 12.8 | 8.1 |
| | **Mean** | 3.5 | 5.3 | 9.4 | 15.3 | 19.9 | 22.8 | 25.1 | 24 | 20.2 | 15.8 | 9.9 | 5.2 |
| **Period (1990-2000)** | **Min.** | 1.5 | 0.7 | 6.1 | 13 | 18.7 | 22.4 | 24.7 | 23.4 | 19.3 | 13.7 | 7.3 | 3.3 |
| | **Max.** | 6.7 | 7.8 | 11.8 | 17.8 | 21.9 | 25.2 | 27.8 | 26.2 | 22 | 20.1 | 12.3 | 8.6 |
| | **Mean** | 4.5 | 5.2 | 9 | 15.1 | 20.1 | 23.4 | 25.9 | 24.5 | 20.5 | 16.1 | 9.8 | 5.7 |

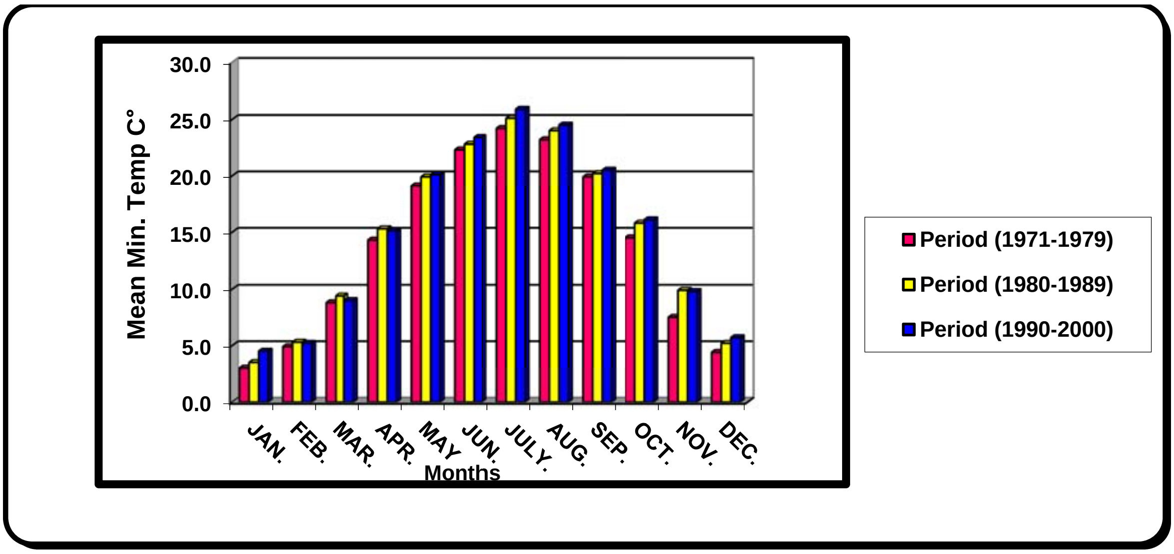


Figure (1-5): Monthly mean of minimum temperature for three periods (°C) from

(1971 – 2000)

### 1.6.2. Relative Humidity

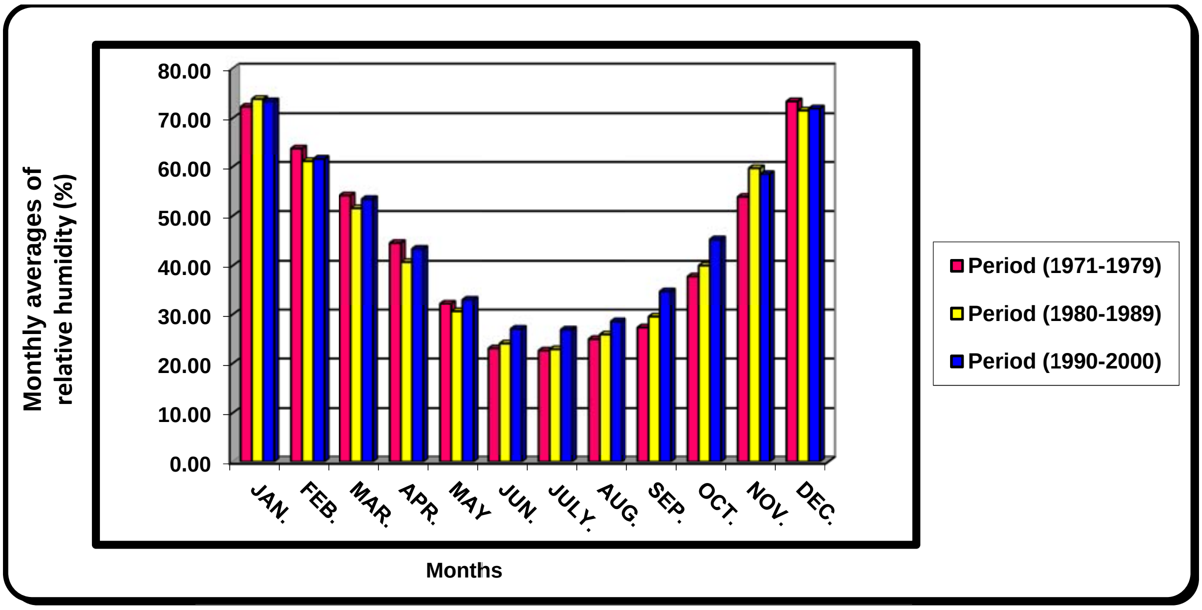
Representing the amount of water vapor in a mixture of air and water vapor. It is defined as the ratio of the partial pressure of water vapor in an air-water mixture to the saturated vapor pressure of water at a prescribed temperature (i.e. saturated vapor pressure at the certain temperature). The relative humidity of air depends not only on temperature but also on the pressure of the system of interest. Normally, the relative humidity as a percentage and is calculated by using the following equation (Wallace and Hobbs, 1977):

$$RH = \frac{\text{Partial pressure of water vapor } (H_2O)}{\text{Saturated vapor pressure of water}} \text{ x } 100\% = \frac{p_{p-water}}{P_{s-water}} \text{ x } 100\% \qquad (1\text{-}1),$$

There is a large disparity in the mean of relative humidity between the summer and winter seasons where the maximum mean of the relative humidity reaches to 73.46 %, in January, and minimum relative humidity 26.92% in July, during the period (1990–2000) as shown in table (1-3) and figure (1-6).

Table (1-3): Monthly mean of relative humidity (%) for three periods from (1971 – 2000) Baghdad Meteorological Station No. (650)

| **Periods** | | **Months** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **JAN.** | **FEB.** | **MAR.** | **APR.** | **MAY** | **JUN.** | **JUL.** | **AUG.** | **SEP.** | **OCT.** | **NOV.** | **DEC.** |
| **Period (1971-1979)** | **Min.** | 59 | 56 | 39 | 33 | 24 | 20 | 21 | 21 | 24 | 32 | 47 | 68 |
| | **Max.** | 84 | 76 | 74 | 54 | 40 | 27 | 26 | 27 | 31 | 46 | 62 | 78 |
| | **Mean** | 72.36 | 63.82 | 54.18 | 44.64 | 32.27 | 23.09 | 22.64 | 25 | 27.36 | 37.82 | 53.91 | 73.45 |
| **Period (1980-1989)** | **Min.** | 56 | 50 | 46 | 34 | 25 | 20 | 21 | 21 | 28 | 35 | 50 | 64 |
| | **Max.** | 96 | 70 | 57 | 50 | 39 | 27 | 25 | 29 | 32 | 50 | 73 | 77 |
| | **Mean** | 73.92 | 61.17 | 51.57 | 40.75 | 30.67 | 24.08 | 22.92 | 25.92 | 29.58 | 40.05 | 59.75 | 71.58 |
| **Period (1990-2000)** | **Min.** | 62 | 54 | 42 | 36 | 26 | 22 | 22 | 21 | 29 | 39 | 38 | 62 |
| | **Max.** | 80 | 72 | 66 | 56 | 41 | 31 | 31 | 34 | 42 | 54 | 75 | 82 |
| | **Mean** | 73.46 | 61.62 | 53.46 | 43.46 | 33.08 | 27.08 | 26.92 | 28.62 | 34.77 | 45.38 | 58.54 | 72 |



### 1.6.3. Rainfall

The rainfall data for the period (1990 − 2005) shows that the rainfall period is concentrated during the months January , February , March , April, May, October, November and December while the dry period is during June to September. The maximum mean of the rainfall in the years above was in January 19mm and March 19.12 mm, while the minimum mean of the rainfall in July 0.0 mm as shown in table (1-4) and figure (1-7).

Table (1-4): Monthly mean of rainfall (mm) for three periods from (1970−2005)
Baghdad Meteorological Station No. (650)

| Periods | | Months | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | JAN. | FEB. | MAR. | APR. | MAY | JUN. | JUL. | AUG. | SEP. | OCT. | NOV. | DEC. |
| Period (1970-1979) | Min. | 8.5 | 2.9 | 5.7 | 3 | 24 | 20 | 0 | 0 | 0 | 0 | 0.6 | 8.3 |
| | Max | 79.8 | 68.6 | 148.7 | 63.9 | 16 | 0.8 | 0 | 0 | 0 | 14.4 | 24.9 | 53.7 |
| | Mean | 35.21 | 23.1 | 37.16 | 22.23 | 5.4 | 0.1 | 0 | 0 | 0 | 3.7 | 7.9 | 29.1 |
| Period (1980-1989) | Min. | 0 | 3.5 | 4.4 | 0.4 | 0.1 | 0 | 0 | 0 | 0 | 0 | 1.5 | 4.2 |
| | Max. | 49.6 | 44.5 | 40.9 | 45.1 | 24.4 | 0.8 | 0 | 0 | 0.1 | 14.1 | 56.7 | 50.2 |
| | Mean | 24.27 | 19.61 | 19.97 | 14.46 | 5.64 | 0.1 | 0 | 0 | 0 | 4.35 | 14.47 | 20.95 |
| Period (1990-2005) | Min. | 2.4 | 0.6 | 1.2 | 0.8 | 0.1 | 0 | 0 | 0 | 0 | 0 | 0.6 | 0.7 |
| | Max. | 42.4 | 48 | 60.6 | 59.1 | 7 | 0.6 | 0 | 0 | 0.9 | 7.3 | 44 | 35.3 |
| | Mean | 19 | 15.38 | 19.12 | 16.1 | 2.1 | 0.1 | 0 | 0 | 0.2 | 4.1 | 17.6 | 17.8 |

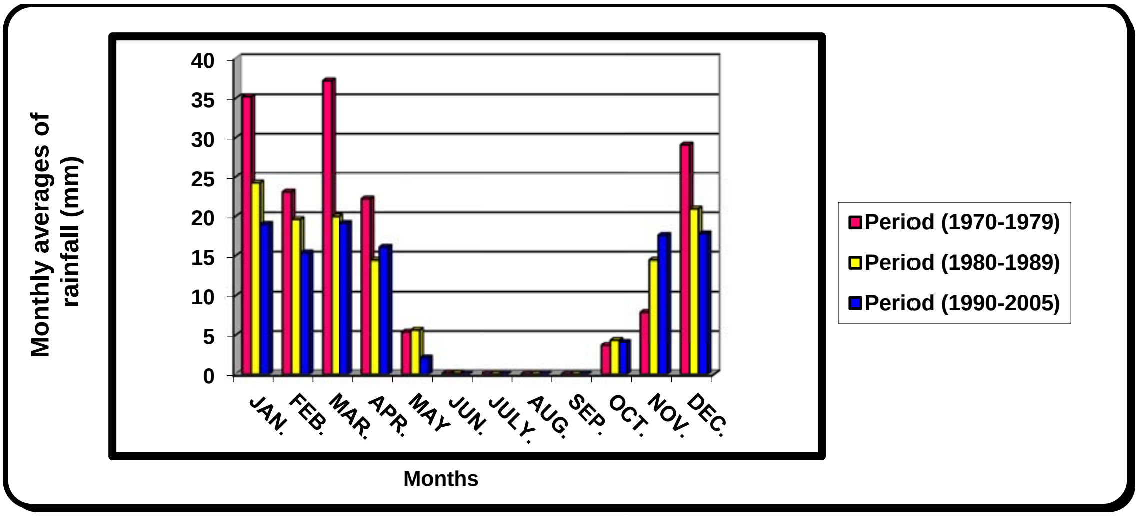


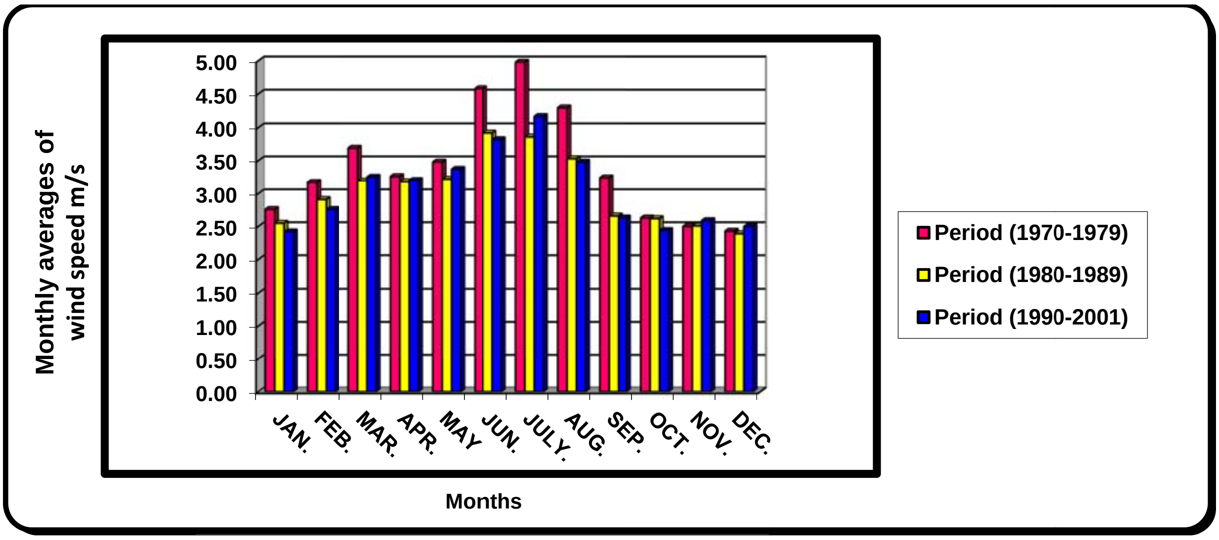
Figure (1-7): Monthly mean of rainfall for three periods from (1970−2005)

### 1.6.4. Wind Speed

The prevailing wind, which is called locally ‘‘Shamal’’ is from north and northwest; this is a very dry steady wind. The eastern and southern wind, locally called ‘‘Sharji’’, is a dry dusty wind often accompanied by dust storms is considered the main source of rainfall in the area. The maximum monthly wind speed mean during the period (1970-2001) was (3.82 m \ sec) in June and (4.17 m \ sec) in July, the minimum was (2.5 m \ sec) in December and (2.42 m \ sec) in January as shown in table (1-5) and figure (1-8).

Table (1-5): Monthly mean of wind speed (m/s) for three periods from (1970 – 2001)
Baghdad Meteorological Station No. (650)

| Period | | Months | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | JAN. | FEB. | MAR. | APR. | MAY | JUN. | JUL. | AUG. | SEP. | OCT. | NOV. | DEC. |
| Period (1970-1979) | Min. | 2.1 | 2.8 | 2.8 | 2.1 | 3 | 3.7 | 4.3 | 3.6 | 2.9 | 1.9 | 2 | 1.6 |
| | Max. | 3.3 | 3.7 | 4.4 | 4.1 | 3.9 | 5.1 | 6.1 | 5.8 | 3.8 | 3.5 | 3.2 | 2.9 |
| | Mean | 2.76 | 3.17 | 3.69 | 3.26 | 3.48 | 4.58 | 4.98 | 4.3 | 3.24 | 2.63 | 2.5 | 2.43 |
| Period (1980-1989) | Min. | 1.7 | 2.4 | 2.2 | 2.1 | 1.5 | 3.1 | 3 | 2.1 | 1.8 | 1.5 | 1.4 | 1.2 |
| | Max. | 3.2 | 3.7 | 3.7 | 4.3 | 4.1 | 4.7 | 4.4 | 4.5 | 3.4 | 3.4 | 3.2 | 3.7 |
| | Mean | 2.55 | 2.91 | 3.19 | 3.18 | 3.22 | 3.92 | 3.86 | 3.53 | 2.66 | 2.62 | 2.51 | 2.39 |
| Period (1990-2001) | Min. | 1.8 | 1.4 | 2.8 | 2.5 | 2.5 | 3 | 2.9 | 2.2 | 2.2 | 1.8 | 1.7 | 1.4 |
| | Max. | 3.3 | 4 | 4.2 | 3.7 | 4 | 5 | 5.2 | 34.9 | 3.4 | 3 | 3.5 | 3 |
| | Mean | 2.42 | 2.76 | 3.25 | 3.2 | 3.37 | 3.82 | 4.17 | 3.48 | 2.63 | 2.44 | 2.59 | 2.5 |



01)

### 1.6.5. Evaporation

The monthly mean of evaporation ranging between 66 mm, in January to 540 mm, in July. The variation of evaporation for the period from (1966-1990) illustrated in figure (1-9). The evaporation fluctuates and has greater effect in the increase of dry land area and then contributes to the increase of desertification. Evaporation rates of this magnitude encourages the formation of salt crusts on the surface of areas, where the groundwater depths are shallow and the capillary fringe reaches the surface; such crusts occur over large areas on the Mesopotamia Plain,(Al-Saady,2010).

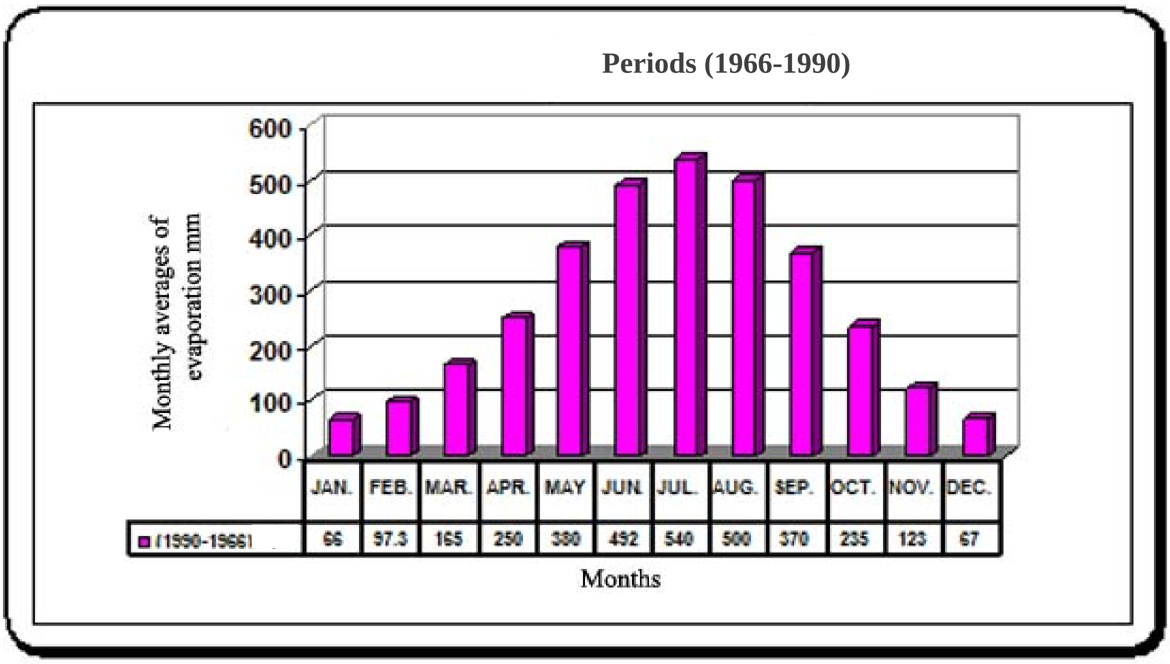


Figure (1- 9): Monthly mean of evaporation (mm) from (1966 – 1990)

### 1.6.6 Climatic Classification

Morphogenic regions have been identified in relation to rainfall and temperature by Peltier (1950). This scheme of classification applicable in global scale defines morphogenetic region as a region in which a distinctive complex of erosional, transportational and depositional processes is responsible for landform development. The climate of the study area can be classified according to Peltier (1950) as arid region as shown in figure (1-10).

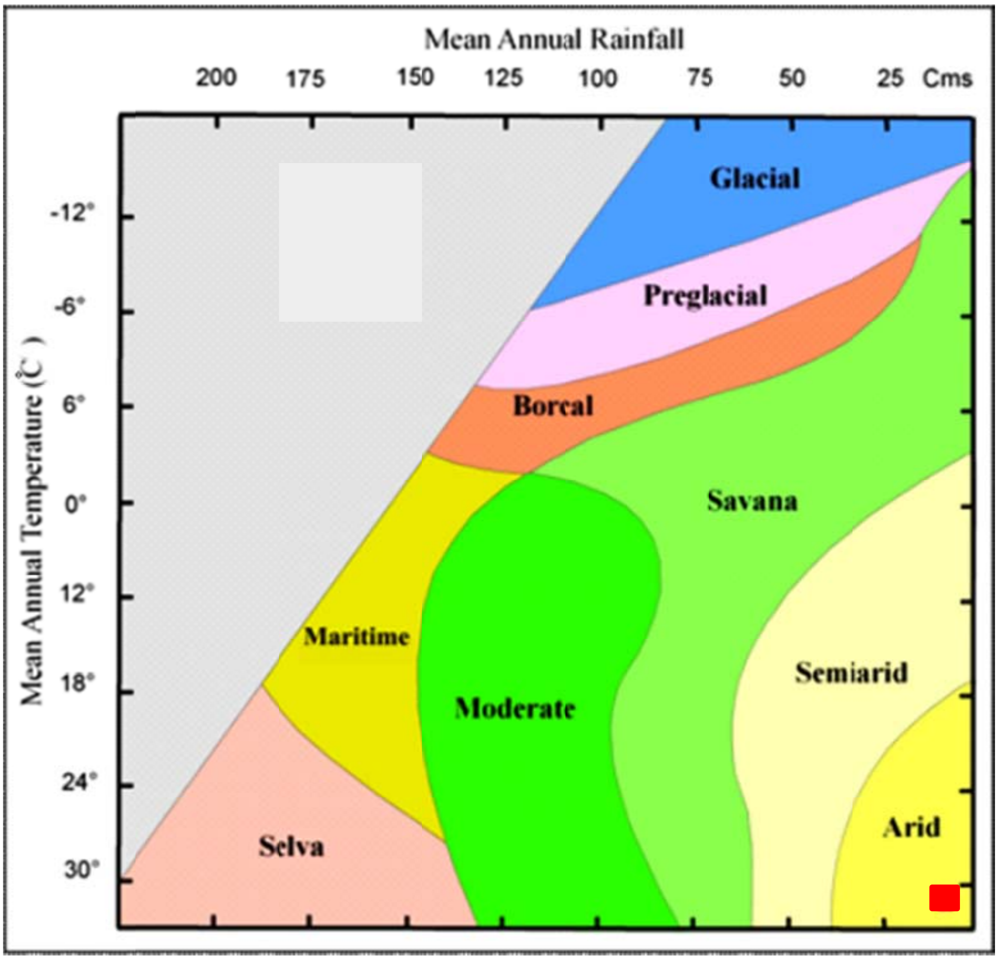


Figure (1-10): Climatic boundaries of the morphogenetic regions (Peltier, 1950)

## CHAPTER TWO

# Methodology and Techniques

## 2.1. Preface

After collecting the information, data and maps concerning the study area the field work started in December 2011 and ended in July 2012. It included site visits to brick factories and then collecting air, water, and soil samples from different sites in the study area and fixing the land use/cover classes located on the map at the field. Afterward the collected samples have been analyzed in the laboratories, the results then discussed and compared with previous studies and international standards. GPS device has been utilized to verify the selected sites on the study area to collect samples and navigation. The procedures involved in the project can be summarized by the following steps:

- Pre-fieldwork,
- Field and laboratory work,
- Preparing land Use / Cover map and decide changes in water, soil, and vegetation cover, and
- Finally, enriching and discussing the obtained results as a prelude to end the project.

## 2.2. Pre-fieldwork

This step includes:

- Preparation of necessary satellite image data, topographic and geologic maps and essential information about the study area from previous works.
- Collecting other ancillary data as reports and scientific articles.

## 2.3. Fieldwork: includes;

### 2.3.1. Air samples: this step mainly includes:

- Ten samples sites have been selected (well distributed over different locations of the studied area) to measure the concentrations of air pollutants, one sample has been taken from Al-Jaderyia / University of Baghdad Campus area to compare with the polluted samples of the studied region. The ten selected locations are illustrated in figure (2-3).
- Special equipment was used to determine the concentrations of air pollutants in the study area.
- Small-sized samples of air were collected (sniffer) to estimate the suspended particles in the air. These equipments were set on different places of the studied area, at a height of one meter, to avoid the dust from the sidewalks caused by wind movement on distance of one meter from the street. This process was accompanied the measuring of the gases concentration of the suspended particles, using a Triple plus+.

### 2.3.2 Equipment used in the air sampling:

1. Triple plus+: manufactured by Crowcon Detection Instrument Ltd. American (Issue 4, oct. 2000).It is used to measure ($SO_2$, $NO_2$, $H_2S$) components. It consists of the following components, as shown in figure (2-1):
    - Digital Display,
    - Power Switch,
    - Calibration Switch, and
    - Alarm Receptacle.

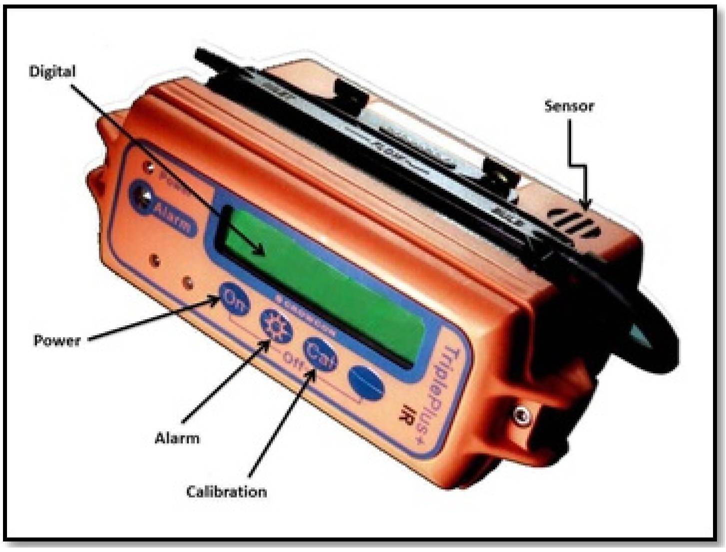


Figure (2-1): (Triple Plus+) device for measuring air components

2. Low Volume Sampler (Sniffer): device type L60 manufactured by Rotheroe and Mitchel Ltd. (English company ) 1989.It is used for collecting suspended particles in the industrial and commercial areas and its consist from the following components, as shown in figure (2-2):
   - Filter Holder with circular shape and diameter of (6 cm).
   - Air Flow Recorder.
   - Time meter.
   - Air Flow Motor.
   - Glass fiber filter (Whitman type) and diameter of (6cm).

Figure (2-2): Low Volume Sampler (Sniffer)

### 2.3.2 Laboratory Analysis Work for Air Samples:

Laboratory analysis work for air samples was performed in the Ministry of Science and technology.

### 2.3.3.1. The Digestion Procedure

1. Drying filters to temperature (60 C?) for one hour to get rid of the moisture and then weighed it.

2. After completing the withdrawn sample process, the suspended particle's concentrations are calculated according to the following equation: [Schilling, 1997]

$$SP = W2 - W1 / VT * 106 \qquad (2\text{-}1),$$

Whereas:

"SP" suspended particle's concentrations measured with mg / m3,
"W2" Weight filters after drawing measured with gram unit,
"W1" Weight filters before drawing measured with gram unit, and
"VT" Volume of drawn air measured with per cubic meter unit.

The volume of drawn air is calculated by the following equation: [Schilling, 1997].

$$VT = V1 + V2 * t / 1000 \qquad (2\text{-}2),$$

"V1" Volume of air in the beginning of the drawing measured with liter,
"V2" Volume of air in the end of the drawing measured with liter, and
"t" The period of time for the drawing process measured with minute.

3. After that the digestion procedures conducted to the filters that contain the suspended particles by adding 3 ml of nitric acid ($HNO3$)and then heating it at a temperature of (60 C?) to get rid of ($NO2$) gases and then leave to cool down.

4. Adding (2) ml of Hydrofluoric acid (HF) then covering the sample and leave it to the next day so that the sample completely digested.

5. Filtering the sample and then put it in a volumetric bottle with (50) ml capacity and dilute the volume of the measurement by distilled water.

Measuring the concentrations of heavy elements using (Atomic Absorption Spectrophotometer), after that the concentrations of these elements is calculated by the following: [OSHA, 2006].

$$\text{Metal Conc. } (\mu g/m^3) = C * Vi / VT \qquad (2\text{-}3),$$

"C" Concentration of element in the sample measured by (ppm) unit.

"$V_i$" Volume of sample measured by (ml) unit.

"$V_T$" Total volume of drawn air measured by cubic meter.

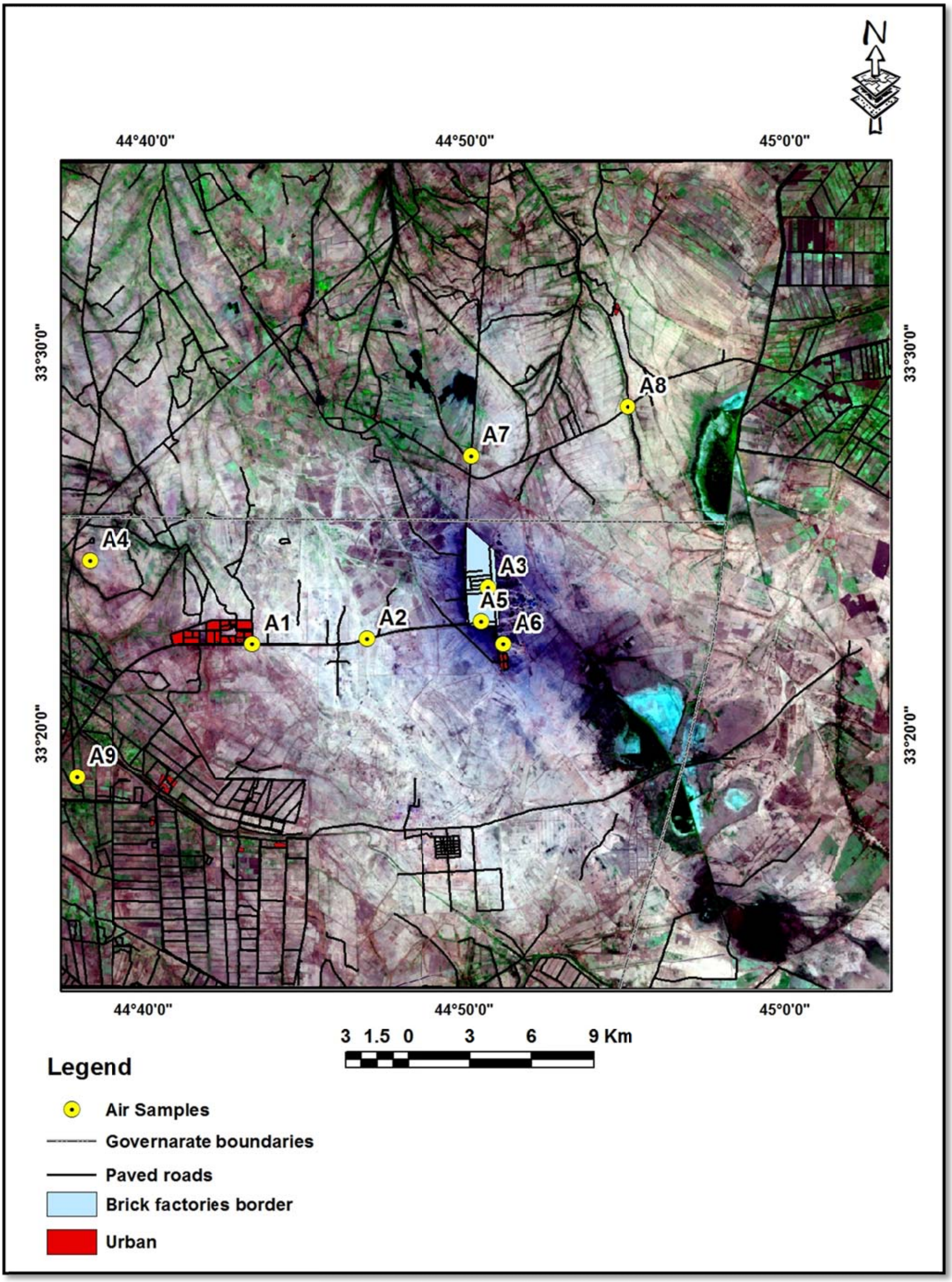


Figure (2-3): Location map of air samples, (Landsat TM5 in 2007, 742 RGB)

### 2.3.4. Water Sampling

- Eleven water samples were selected in the study area and located on base maps using GIS software, one of them was taken from irrigation canals (IW11), other was taken from quarry water (QW6), one was taken from waste water from tannery factories (WW7) and the rest were ground water samples (W) collected from shallow ground water hand dug well.
- Special equipment was used to measure the physical properties of water (pH) meter.
- Water level was recorded at sample locations that were taken from shallow water hand dug well using (sounder equipment). Water temperature of each sample were measured on site using portable instrument conductivity meter standardized to 20 $^0$C.
- Water quality samples were obtained by taking water using a 0.5 liter plastic bottle with three bottles for each sample one for determine major components , second for hydrogen sulfide and the third for heavy metals . Before taking the sample, they first take a little bit of water and rinse the bottle and throw that water out. 50 ml of zinc acetate was added to the hydrogen sulfide bottle with concentration (10%) while the heavy metals sample was acetated by one drop of nitric acid with concentration 0.7.
- Water samples were collected from different sites in the study area to cover the main water resources in the area, as shown in figure (2-4).

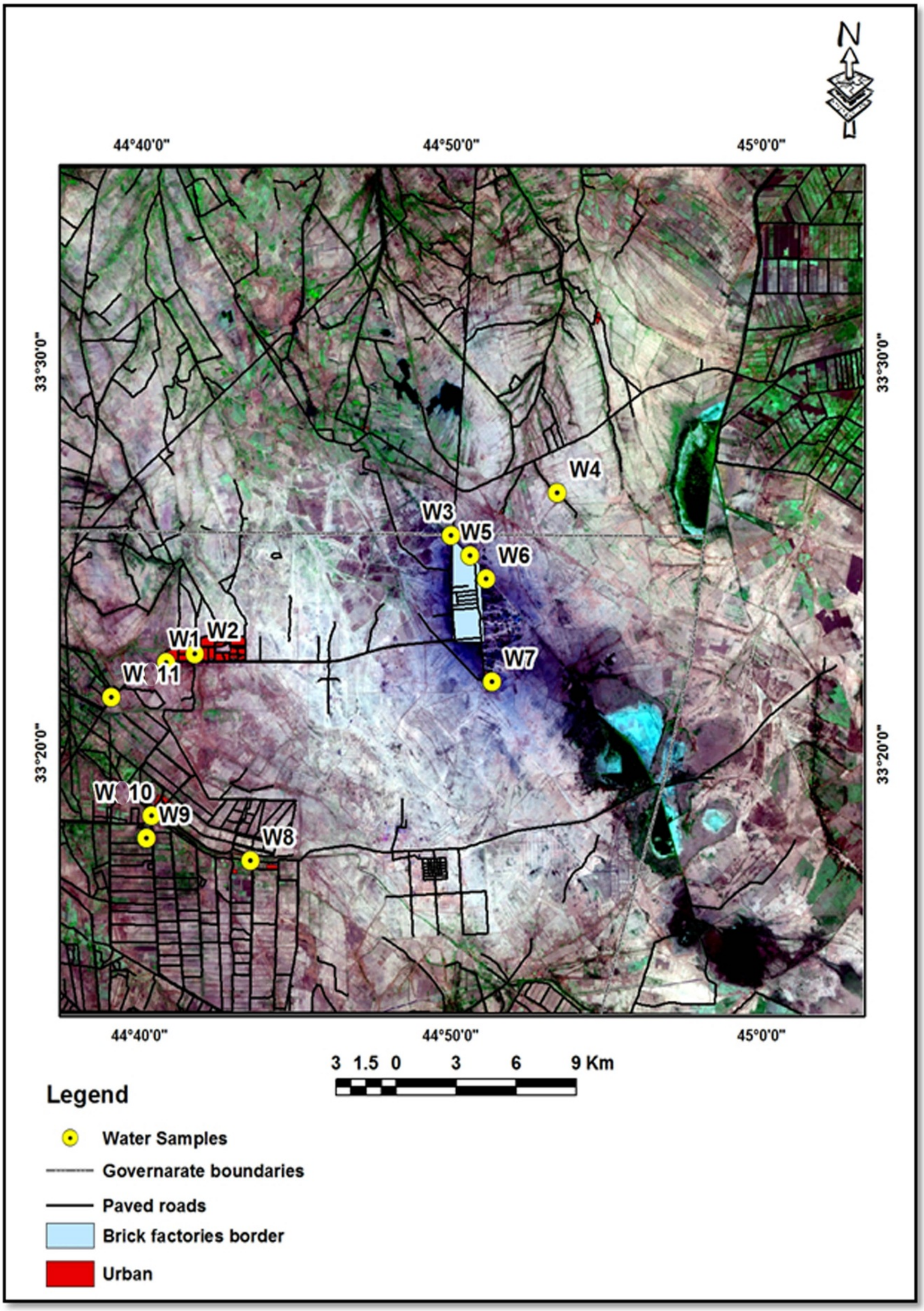


Figure (2-4): Location map of Water samples (Landsat TM5 in 2007, 742 RGB)

### 2.3.5. Laboratory Work for Water Samples

Water samples were analyzed in the laboratories of (Iraqi Geological Survey).

#### 2.3.5.1. Total Dissolved Solids (T.D.S):

Some dissolved solids come from organic sources such as, silt, plankton, and industrial waste and sewage. Other sources come from runoff, fertilizers and pesticides used on lawns and farms, (Hem, 1989).The total dissolved solids were measured by using (Water Quality Tester).

#### 2.3.5.2. Major Elements:

Major elements were measured by using Ion Chromatograph (IC) produced by (Metrohm Company). Standard methods had been followed according to (Iraqi Geological Survey) procedure.

#### 2.3.5.3. Trace (Heavy) Elements

The term heavy metal or (trace metals) is applied to the group of metals and semimetals (metalloids) that have been associated with contamination and potential toxicity , it usually refers to common metals such as copper, lead, or zinc,(Duffus, 2002). Heavy elements were analyzed for water samples with Atomic Absorption Spectrometer after preparation of standard solutions for these elements. The elements that have been analyzed in this study are: (Cr), (Ni), (Pb) and (Cd).

#### 2.3.5.4 Hydrogen Ion Concentration (pH):

The pH of water samples was measured by (pH) meter. An electronic pH meter is used for more precise measurements. A pH meter determines pH from the electrical potential between two electrodes in a solution. The potential varies with pH and activates an analog or digital meter calibrated to read pH directly to the nearest 0.01 or 0.001 unit, (Buck, et al, 2002).

### 2.3.5.5 Total Hardness

Hardness is expressed as the equivalent quantity of calcium carbonate (Who, 2006). Hardness caused by calcium and magnesium is usually indicated by precipitation of soap scum and the need for access use of soap to achieve cleaning. Depending on the interaction of other factors, such as PH and alkalinity (Faure, 1998, Ljungberg, 2004).Total hardness was measured in laboratory by taking (25) ml of the sample and completing the size to (50) ml by distilled water and then adding (1-2) ml from (Buffer Solution)so that the pH of the solution up to 10, Then adding (1-5) ml powder indicator(T-Erichrome Black) until the solution colored red and adding EDTA until the red color disappeared and the light blue color appears, the volume of the spent EDTA is recorded, then the following equation was applied, (APHA, 1985) :

$$\text{Hardness } (CaCo_3) \text{ ppm} = (A*N*1000) / V \qquad (2\text{-}4),$$

*Where: "A" EDTA spent volume, and*

*"V" Volume drawn from the sample.*

### 2.3.5.6 Hydrogen Sulfide ($H_2S$):

The standard method according to (APHA, 1998) were followed to determine ($H_2S$) in water samples.

### 2.3.6. Soil sampling:

Eighteen samples of soil were collected from the topsoil at different locations in the study area (0-25 cm) as shown in figure (2-5). Each sample was placed in a storage bag and labeled.

**2.3.6.1. Laboratory Work for Soil Samples:** includes;

### 2.3.6.1.1. Grain size analysis for soil samples:

Grain size analysis was applied to five samples that were chosen from the collected soil samples using pipette analysis following Folk (1974).

### 2.3.6.1.2. XRD Analyses:

To identify the minerals (especially clay minerals), five soil samples were chosen to be analyzed by X-ray diffraction. The procedures of (Gibson, 1966; Gibbss, 1968) and (Carroll, 1970) for the preparation of oriented samples was used. The procedure followed for clay mineral analysis was followed after Carroll (1970). Procedure for the separation of the less than (2) micron size fraction were followed after Carver (1971) and Folk (1974). Procedures for the different treatment (heating, and ethyl glycolation) of these samples were followed after Millot (1970); and Thoraz (1975). The general procedures that were followed in the clay minerals analysis are as follow:

1- Oriented clay samples were prepared; the less than (2) micron clay fraction was taken from the dispersed sediments by sedimentation method, and mounted on glass slides. Three slides for each sample were prepared.

2- The samples were then allowed to dry at room temperature.

3- The samples were studied by X-Ray Diffraction as follow:

A- Normal (untreated) samples were scanned from $2\theta = 5^o$-$50^o$

B- Ethyl glycolated samples were scanned from $2\theta = 5^o$-$15^o$

C- Heated samples (550C° for two hours) were scanned from $2\theta = 5^o$-$15^o$

Using Shiamatzu XRD 6000**,** vertical goniometry, cupper tube, (30 MA), (40 KV), and speed (0.05 degree / min) conditions.

### 2.3.6.1.3. Determination of Soil Major Oxides:

(18) Samples of soil were chemically analyzed for major oxides in the laboratories of (Iraq Geological Survey), which are:($SiO_2$, $Al_2O_3$, $Fe_2O_3$, CaO , MgO, $K_2O$, $Na_2O$, $SO_3$ and L.O.I),according to (AL-Janabi *et al,* 1992).

### 2.3.6.1.4. Determination of the Trace Elements:

Five elements were determined due to their environmental importance (Cr, Ni, Pb, Cd, V) in the laboratories of (Iraq Geological Survey) for (18) soil samples using (Atomic Absorption Spectrophotometer)according to (Forsther and Muller, 1973) .

### 2.3.6.1.5. Determination of Total Carbon (TC):

Total carbon (TC) includes both organic and inorganic sample constituents, (Bernard, 2009).

Total carbon content is determined in dried sediments and total organic carbon is determined in dried and acidified sediments using a LECO CR-412 Carbon Analyzer.

Percent of Total Carbon (TC) is calculated by the following equation, (Bernard, 2009):

$$TC(\%) = \frac{C\ (\mathrm{g})}{W\ (\mathrm{g})} \qquad (2\text{-}4),$$

Where: TC (%) is the percent of Total Carbon (TC).

C (g) is the carbon weight (g).

W (g) is the dry sediment analysis weight (g).

### 2.3.6.1.6. Determination of Total Sulfur (TS):

The proportion of organic and inorganic sulfur in a soil sample, however, varies widely according to soil type and depth of sampling, (Beaton, *et al*, 1968). Total sulfur was measured in laboratory according to (APHA, 1998).

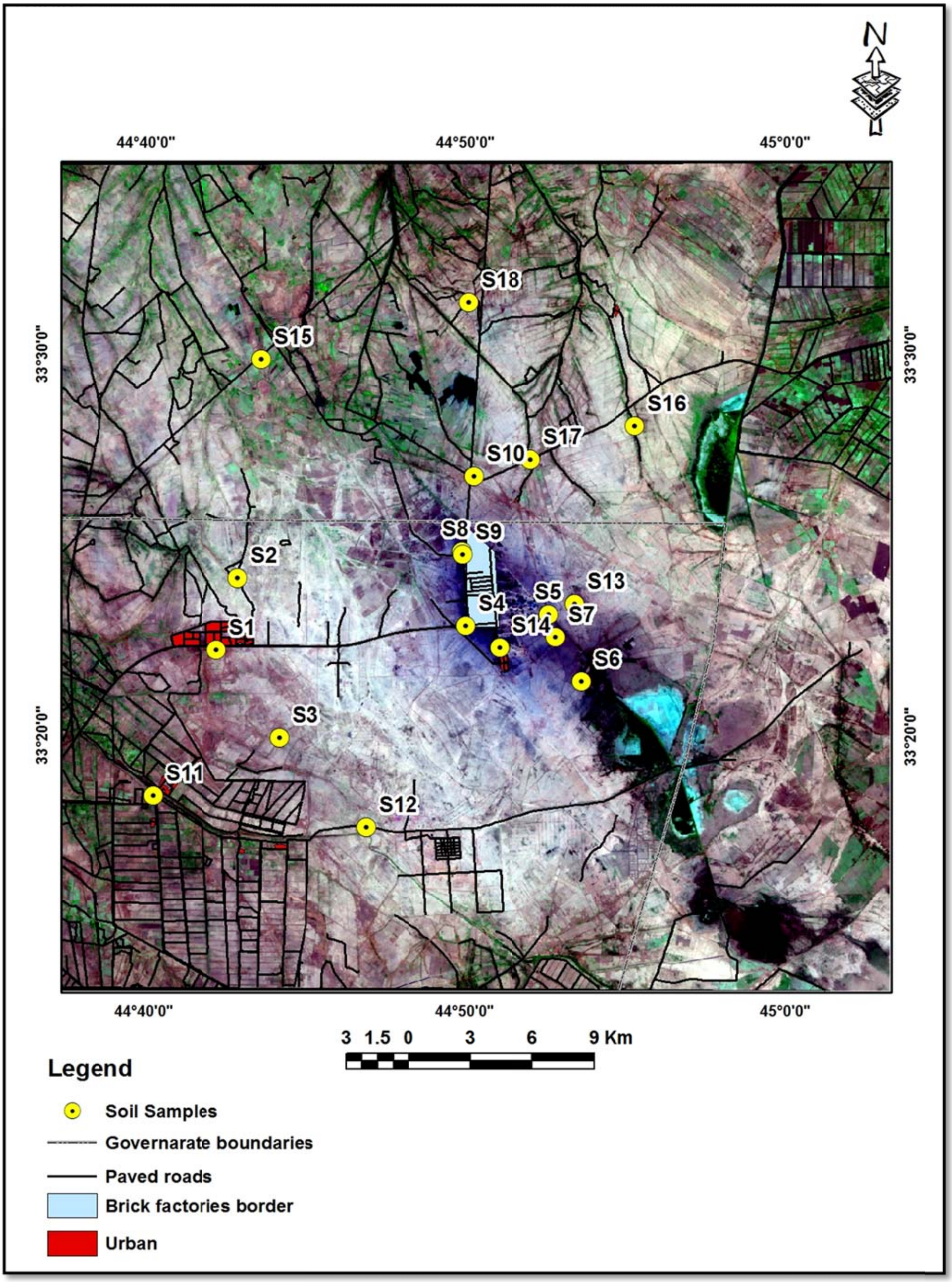


Figure (2-5): Location map of soil samples, (Landsat TM5 in 2007, 742 RGB)

## 2.4. Land Use Land Cover Change Detection Techniques:

Change detection techniques for the study area is achieved for three periods (1990 TM, 2002 ETM+, 2007 TM).

### 2.4.1 Material Sand Methods:

#### 2.4.1.1 Data and Software

Landsat satellite imagery was ordered with the aim to reach back as far as possible as well as to cover the time period at regular intervals. The achieved time series encompasses three time (1990, 2002, 2007). The data of the three time (1990, 2002, 2007) originate of Landsat -TM 5 (Thematic Mapper), and Landsat 7 - ETM+ (Enhanced Thematic Mapper).

#### 2.4.1.2 Adopted Methodology and Tools

The adopted methodology followed in land use land cover (LULC) change detection consists of four Steps:

- Preparing data of Landsat satellite images for three periods (1990, 2002, 2007) and ancillary data acquisition which includes geological and topographic maps are also necessary to be used in the process of registration and integration with satellite imagery and/or to cover the periods, which are not covered by Satellite imagery.
- Digital image processing such as: Salinity index, Water index and Normalized Difference Vegetation Index (NDVI) by using Landsat image for three times (TM 1990, ETM+ 2002, TM 2007) and detect the variation between these period depended on (LULC) changes detection.
- Field work to check the results.
- Final processing, discussion results and preparing final research.

### 2.4.2. Tools:

#### 2.4.2.1. Data Analysis and Interpretation Using ERDAS

ERDAS Imagine v. 11.2 is used for digital image processing, data analysis, interpretation of the satellite image ETM+ 2011.The process consists of digitizing representing different (LULC) classes, based on image characteristics such as tone, texture, color and pattern, which are translated into (LULC) attributes by using Arc GIS v. 11.

#### 2.4.2.2. Data Analysis and Interpretation Using GIS

ArcGIS v. 11 software is used for analyzing and layout the classification results. The results of the image processing by ERDAS technique are reprocessed by ArcGIS as a digital coverage layer, in which polygons represent different land use classes. Full database is attached to this coverage, in which every polygon is characterized by many attributes such as, category number, area and perimeter of polygons. The (LULC) map produced at thematic classes or categories, depending on the characteristics and objectives of the study area.

First: the comparison of the image indices results is realized, as well as their statistical results, in order to detect changes in terms of area also the geographic location of these changes.

Second: through the identifying and assessing results in order to produce the evolution map between three periods and detect the variation in categories between these period. Then the impact of urbanization and other changes are investigated.

Third: the “final matrix” is built-up for three periods, taking in account all possible changes involved and the corresponding areas in terms of extension, regression and net evolution for all categories.

#### 2.4.2.3. Land Use and Land Cover Changes Detection Methods:

One prerequisite for successful change detection is an accurate registration of satellite imagery, so the overlaid pixels represent the same location. There is a wide range of techniques used for (LULC) change detection. These techniques can be subdivided into many categories which include Composite Image, Image Comparison, Comparison of the Classified Images, etc.

### 2.4.2.4. Multi-Date Composite Image Method:

Images of different periods can be combined to form a new composite single image, in which changes may be inferred from variations in gray tone or color hue. Enhancement procedure most frequently employed for change detection includes image overlay, image differencing, image rationing, and vegetation index.

The role of the enhancement procedure is to suppress areas of no change and enhance areas containing changes. The composite image is then classified. Enhancement procedures can be described as follows (Fung and Zhang, 1989):

- Image Overlay is a combination of 2 images, which are assigned to different colors.
- Image Differencing involves subtraction of two images or two bands pixel by pixel.
- Image Rationing is based on the division of bands to generate the rationed image.
- Vegetation Index serves to discriminate between vegetation and soil background.

### 2.4.2.5. Field Data Collection

Field data collection was carried out for accuracy assessment of the supervised classification results with the field results to determine the accuracy of the supervised classification of the map area. The random sampling method was used for data collection in the map area depending on the variation of surface terrain sediment's properties. The field work was performed in July 2012. The total number of ground check points is shown in figure (2-6).

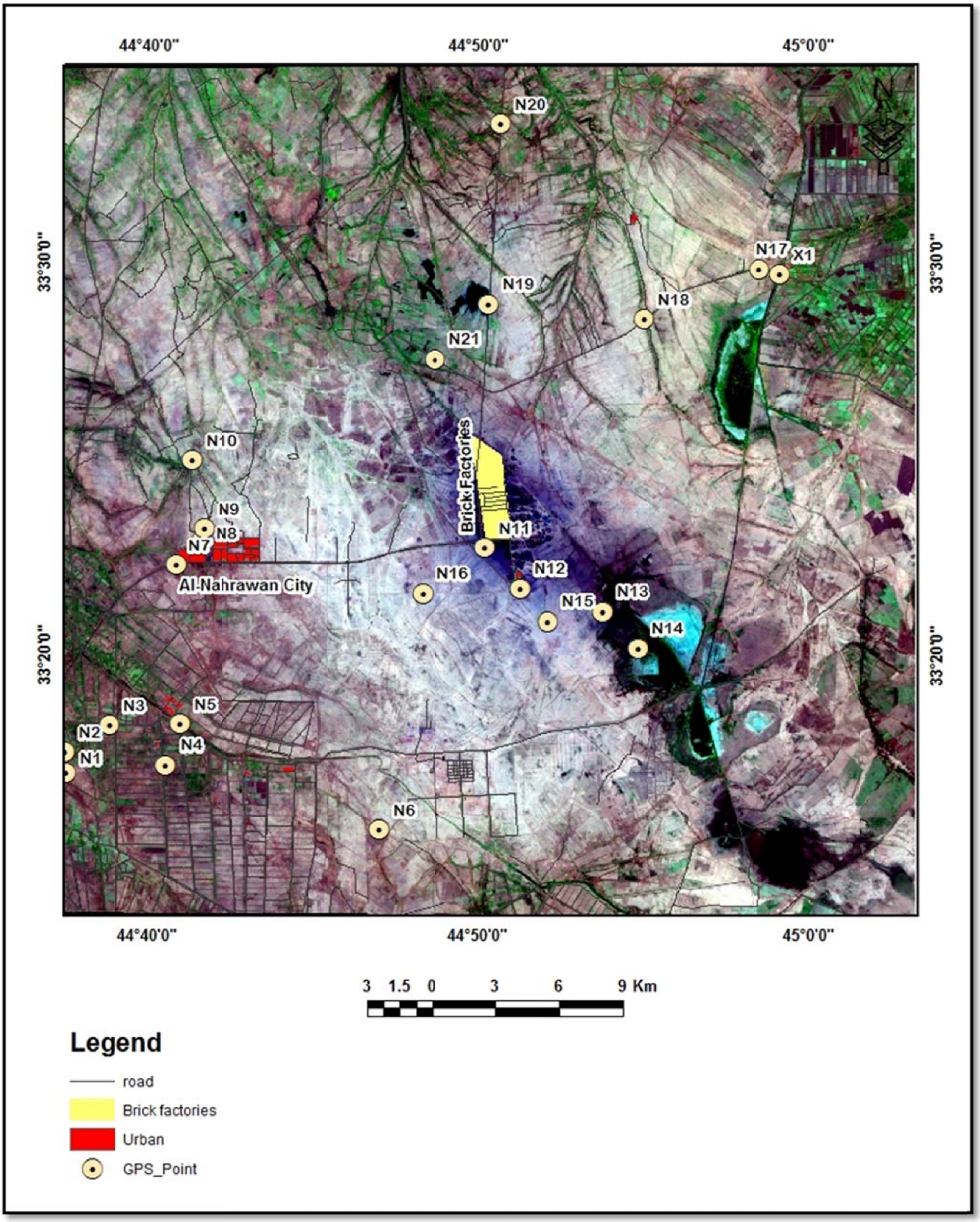


Figure (2-6): Distribution of check points in the study area (TM 2007 RGB 742)

#### 2.4.2.6. Image Comparison Method

A comparison can be made between separate satellite images for different dates. These images may be single band gray tone or multiple band color composite images. Image variation between dates signals the occurrence of land cover change (Martin, 1989).

Image comparison is done for three satellite images of the study area in different dates (TM 1990, ETM+ 2002, TM 2007).

# Chapter Three

# Land Use Land Cover and Change Detection

## 3.1. Preface

Land cover is a term, which often refers to vegetation, natural or man-made features on the earth's surface at a specific time of observation (Campbell, 2002). Generally, land cover shows the visible evidence of land use, to include both vegetated and non-vegetated features. Although land cover is used interchangeably with land use land cover refers to all land, for example; dense forest, grasslands, urban structures and others (Campbell, 2002).

Because ecosystems are ever changing, land cover changes are therefore categorized in two ways, namely; "land cover modifications" and "land cover conversions" (Henebry and Goodin, 2006). Coppin and Nackaerts (2004) defined land cover conversions as "the complete replacement of one cover type by the other" and land cover modifications as "the subtle changes that affect the character of land cover without changing its overall classification". In fact, land cover conversions are as a result of urban expansion, wildfires, agricultural expansion, whereas land cover modifications are mainly due to climatic variability, pollution, intra-annual cycles (Lunetta *et al.*, 2006).

Different remote sensing tools are used to prepare Land Use and Land Cover *"LULC"* map of the study area and determine change detections for the main factors that responsible for land degradation like: Water, Vegetation, Salinity and Agricultural Land.

## 3.2. Preparation of Landsat Satellite Image Data

Landsat satellite images were prepared during four periods, these are; Landsat-TM (Thematic Mapper) during 1990, Landsat-ETM+ 7 (Enhanced Thematic Mapper) during 2002, Landsat-TM 5 (Thematic

Mapper) during 2007 and Landsat-ETM+ 7 (Enhanced Thematic Mapper) during 2011 repaired. The details of TM and the ETM+ description are shown in table (3-1).

Table (3-1): Details information of used remote sensing data

| **Sensors** | **Row/Path** | **Bands** | **Acquisition Date** | **Projection/Earth Ellipsoid** | **Resolution (m)** |
|---|---|---|---|---|---|
| **TM 5** | **168/037** | **B1:- 0.45-0.52 µm**<br>**B2: 0.52-0.60 µm**<br>**B3: 0.63-0.69 µm**<br>**B4: 0.76-0.90 µm**<br>**B5: 1.55-1.75 µm**<br>**B7: 2.08-2.35** | **28-08-1990** | **UTM / WGS84** | **30.00** |
| **ETM+7** | **168/037** | **B1: 0.45-0.52 µm**<br>**B2: 0.52-0.60 µm**<br>**B3: 0.63-0.69 µm**<br>**B4: 0.76-0.90 µm**<br>**B5: 1.55-1.75 µm**<br>**B7: 2.08-2.35** | **06-09-2002** | **UTM / WGS84** | **30.00** |
| **TM 5** | **168/037** | **B1:- 0.45-0.52 µm**<br>**B2: 0.52-0.60 µm**<br>**B3: 0.63-0.69 µm**<br>**B4: 0.76-0.90 µm**<br>**B5: 1.55-1.75 µm**<br>**B7: 2.08-2.35** | **11-08-2007** | **UTM / WGS84** | **30.00** |
| **ETM+7** | **168/037** | **B1: 0.45-0.52 µm**<br>**B2: 0.52-0.60 µm**<br>**B3: 0.63-0.69 µm**<br>**B4: 0.76-0.90 µm**<br>**B5: 1.55-1.75 µm**<br>**B7: 2.08-2.35** | **01-10-2011** | **UTM / WGS84** | **30.00** |

* Other unused bands are excluded from TM and ETM+ sensor.

## 3.3. Gap Filling of Strip in ETM+ Image for study area 2011

Gapping is a typical phenomenon with remote sensing imagery, it could have dynamic and diverse characteristics thus there are a variety of techniques that could be applied to recover it. Removing gapped areas from satellite imagery is of high interest for visual image interpretation and digital image classification purposes, (Lillesand et al., 2007). The Scan Line Corrector (SLC) of the Landsat-7 Enhanced Thematic Mapper Plus (ETM+) sensor failed in 2003, resulting in about 22% of the pixels per scene not being scanned. The SLC failure has seriously limited the scientific applications of ETM+ data. While there have been a number of methods developed to fill in the data gaps, each method has shortcomings, especially for heterogeneous landscapes, (Chen *et al.*, 2011).In this research, two gap-filling methods will be proposed to restore the ETM+ image malfunctions using different techniques.

**1. Selection of neighboring similar pixels of the same ETM+ image**

This method is based on the assumption that the same land cover class pixels in close proximity to the gaps have similar spectral characteristics and temporal patterns of change with the target missing pixel, it is necessary to search for similar pixels near the gaps. It is assumed that no major land cover changes occurred during the period between acquisitions of the input image and target image. Assuming that the time interval between input and target scene acquisitions is short, that this assumption will generally be valid. Accordingly, the similar pixels from the input image can be selected and assume that these pixels are also spectrally similar with the target missing pixel at the target image, (Chen *et al.,* 2011). ENVI software package was used in this method by calculating the average of neighboring pixels to the known pixel. This method is useful for showing purposes but it's inappropriate for digital processing to assess the change detection for environmental studies with good accuracy as shown in figure (3-1), (3-2).

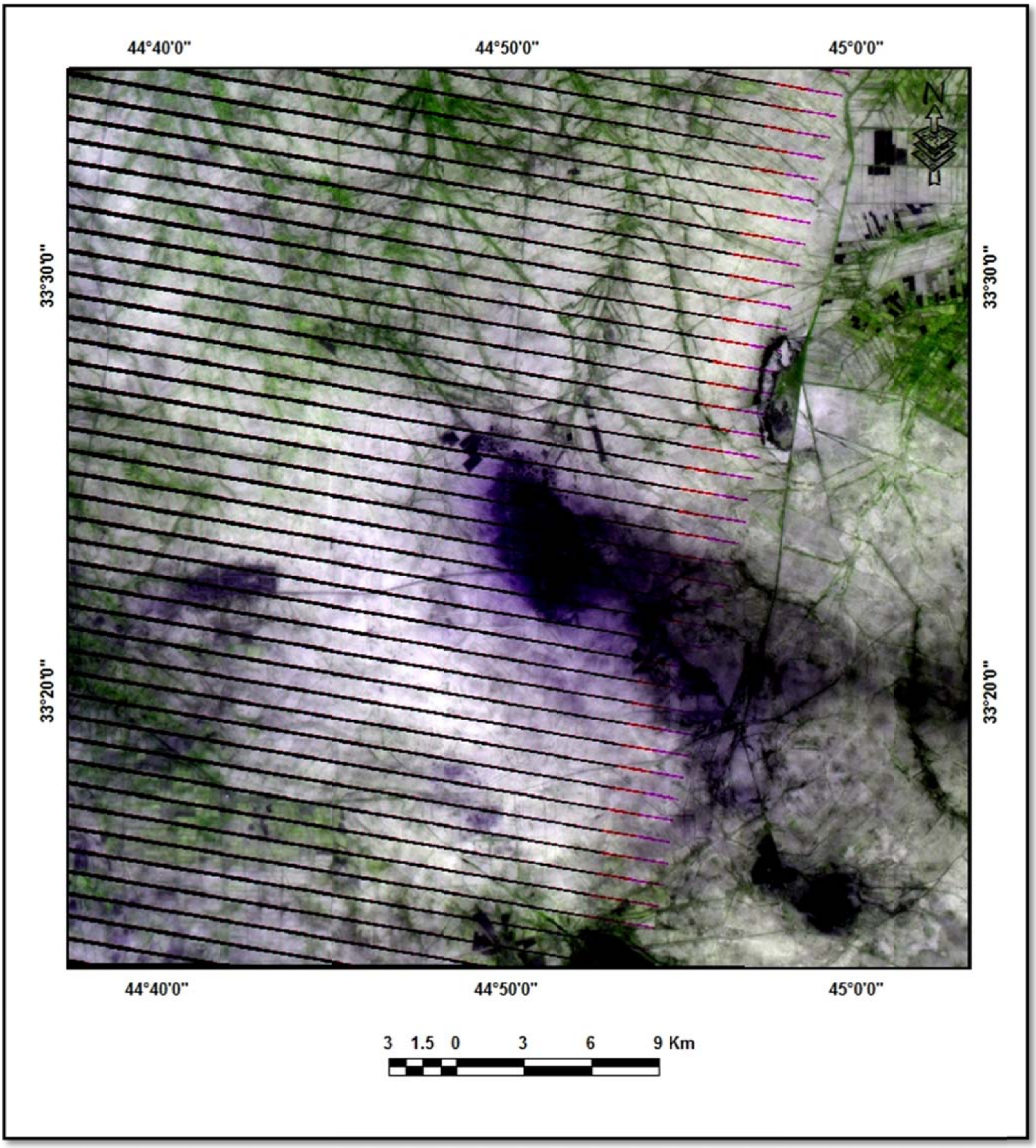


Figure (3-1): The RGB color scene for ETM+ image before gap filling acquired in October1st, 2011

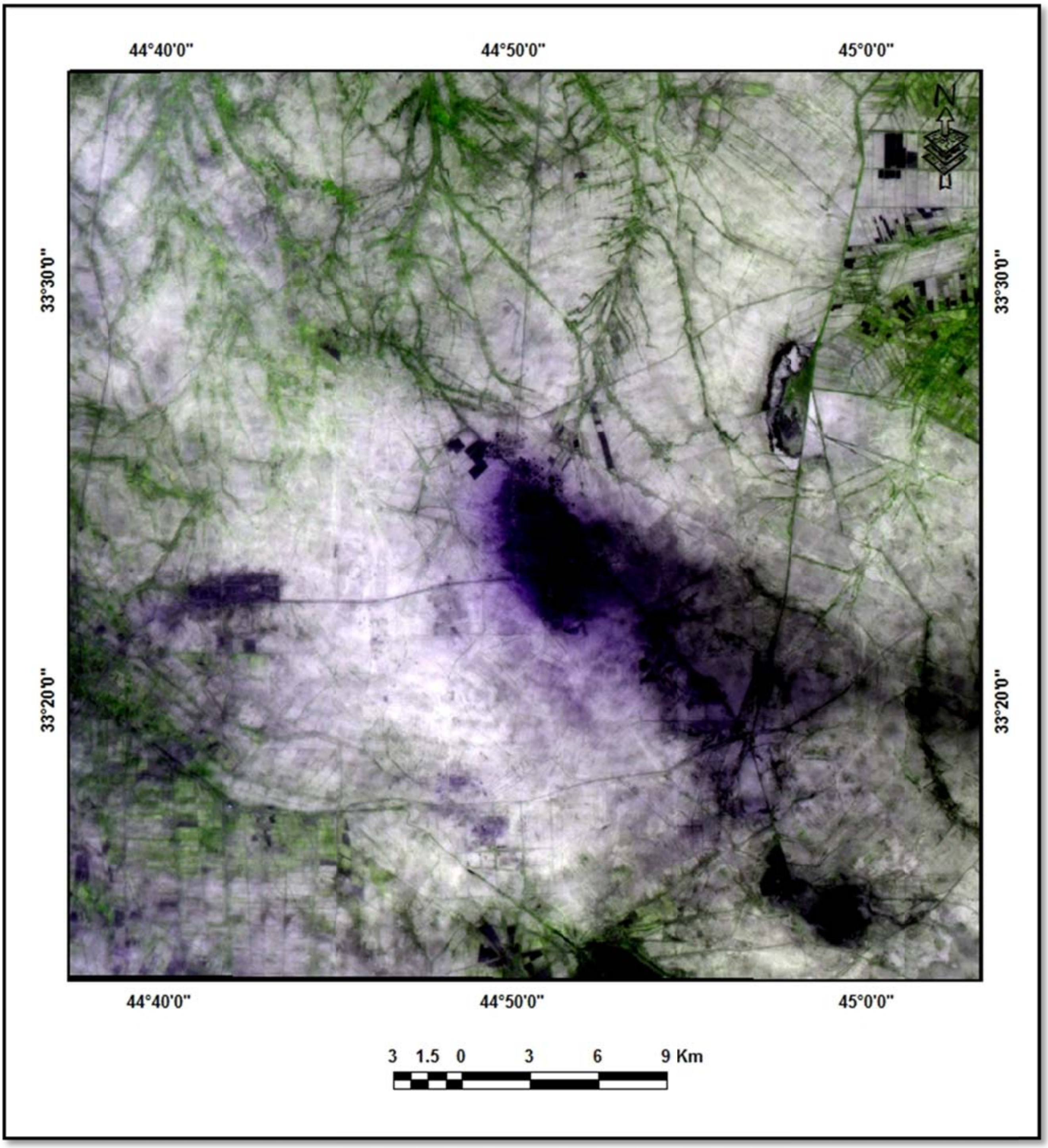


Figure (3-2): Gap filled ETM+ color scene, using selection of neighboring similar pixels

## 2. Using Multiple SLC-off ETM+ Images

It is possible to fill gaps using multiple SLC- off ETM+ images because the gaps in these images do not overlap completely among scenes. The criteria for selecting the input images are: (1) their acquisition dates are close to that of the target image. (2) they are mostly free of cloud contamination or snow cover. The number of necessary input images can be determined by the degree of gap overlapping. If gaps in input and target images do not overlap, then fewer input images are needed. The input image acquired closest in time to the target image is given first priority, and is the first one used in the process. Images acquired further from the target image acquisition date are used correspondingly later in the process, (Chen *et al.,* 2011) this method depends on the replacement of miss data or unknown pixel using scene of other different acquisition date within the same period or the shorter period between acquisition date. This method is very useful for scientific interpretation where there is no big change could occur within shorter period additionally this method gives us appropriate explanation for the distribution of each class. One flaw in this method is the absence of harmony between the original tone and the tone that filles the stripe in spite of the efforts used to fix this problem the variation in tone is caused by different factors (atmospheric ,satellite conditions) as shown in figure (3-3) , (3-4) and (3-5).

The two used methods are useful for roughly estimating or visual interpretation and also very useful in field work checking.

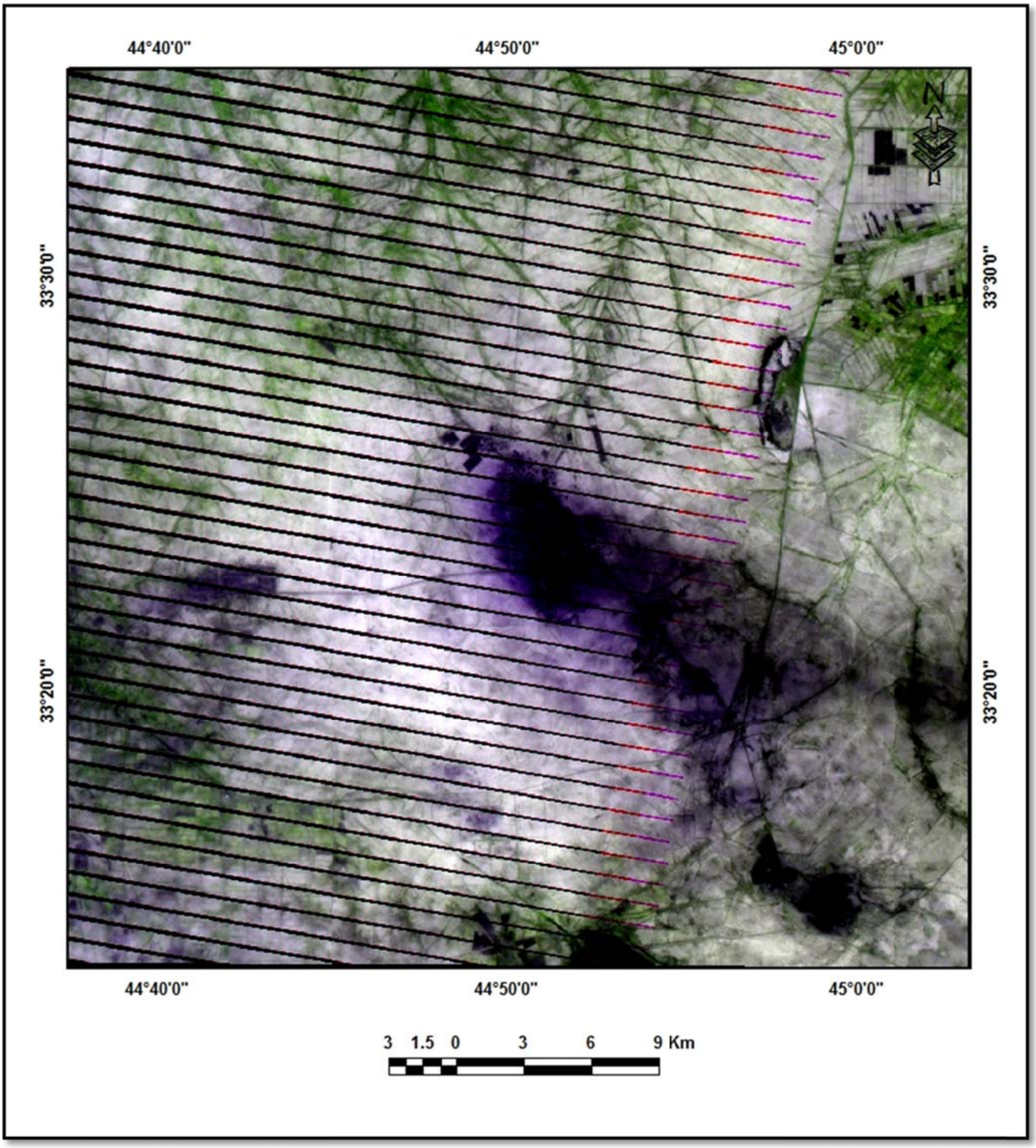


Figure (3-3): The RGB color scene before gap filling for ETM+ image acquired in September 14th2011

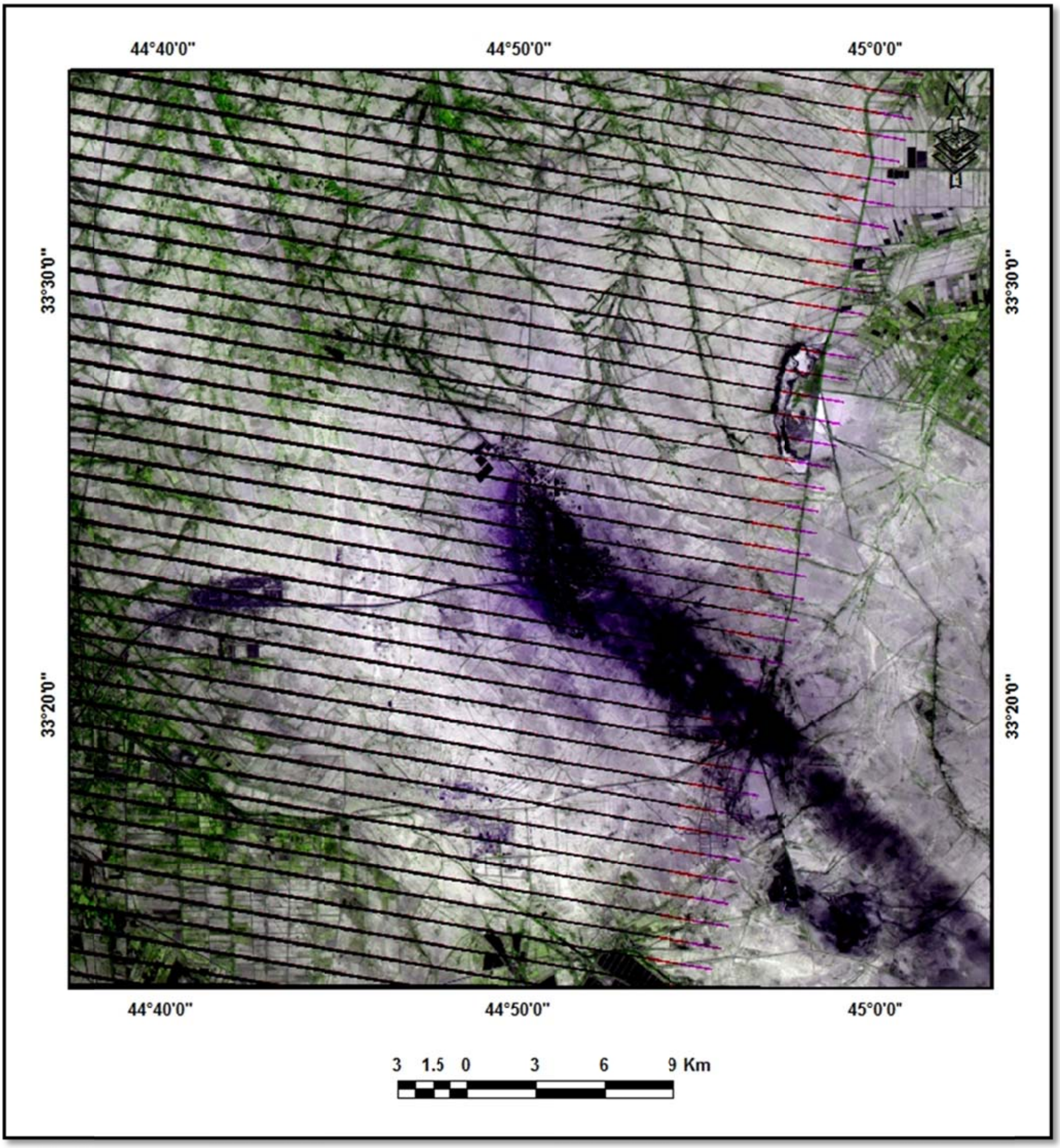


Figure (3-4): The RGB color scene before gap filling for ETM+ image acquired in September 30 2011

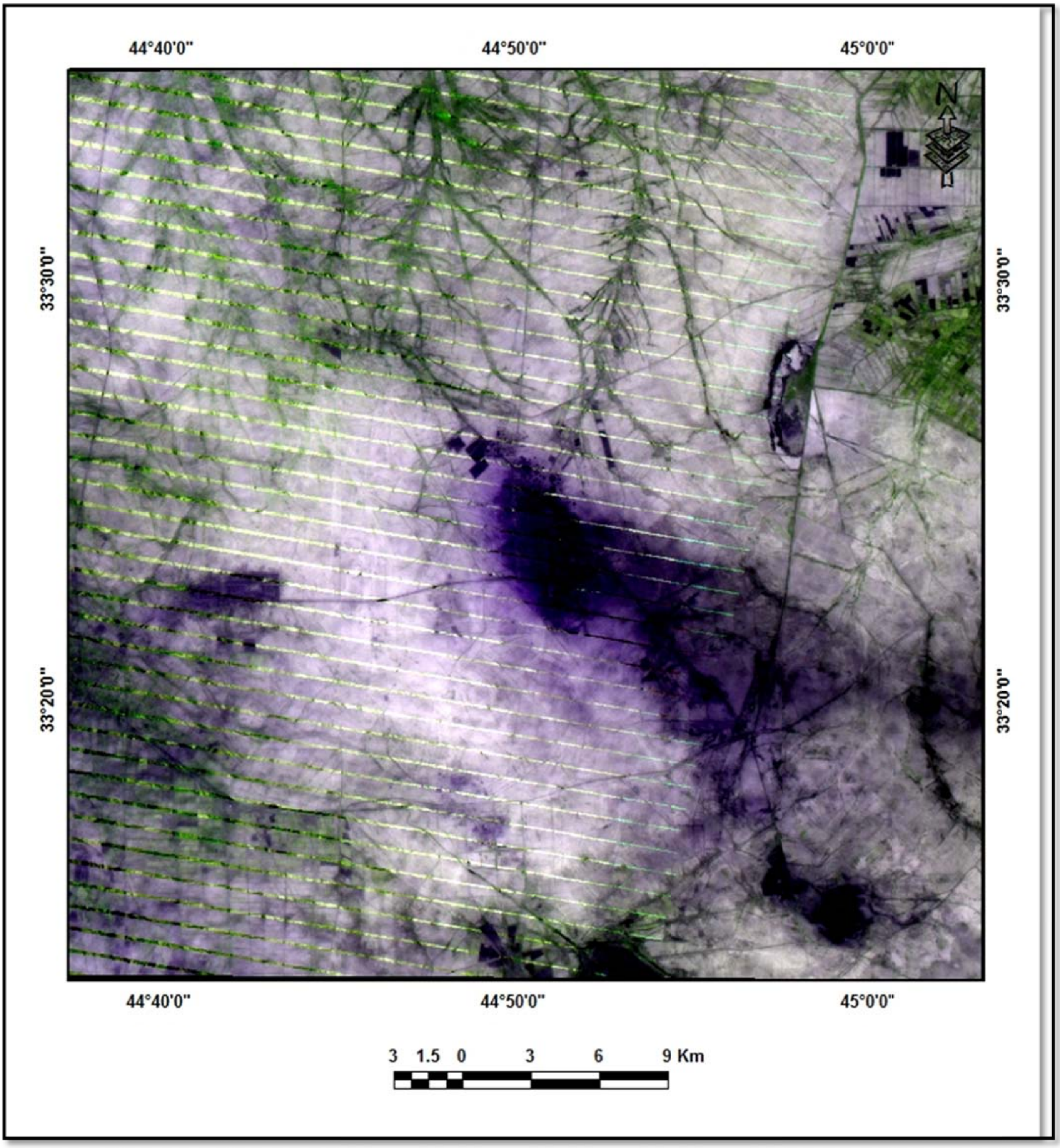


Figure (3-5): Gap filled ETM+ color scene using multiple SLC-off ETM+ images

From the visual interpretation of the repaired image satellite of ETM+ 2011 by comparing it with TM image 2007 it is noticed that the smoke resulting from brick factories has increased during the last four years and that indicates increasing in the pollution in the study area as shown in figures (3-6) and (3-7).

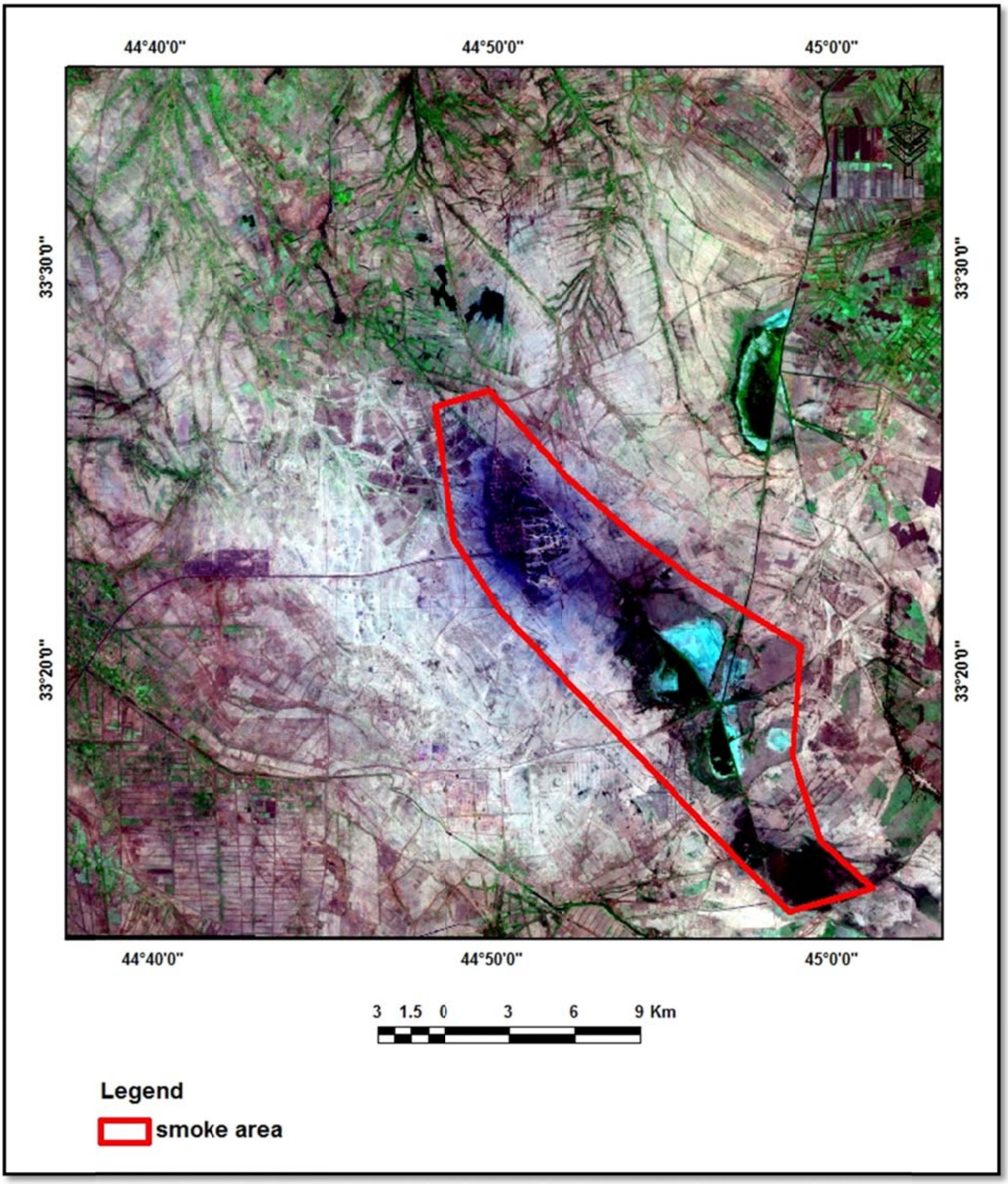


Figure (3-6): Smoke area in the study area for TM image 2007 RGB 742

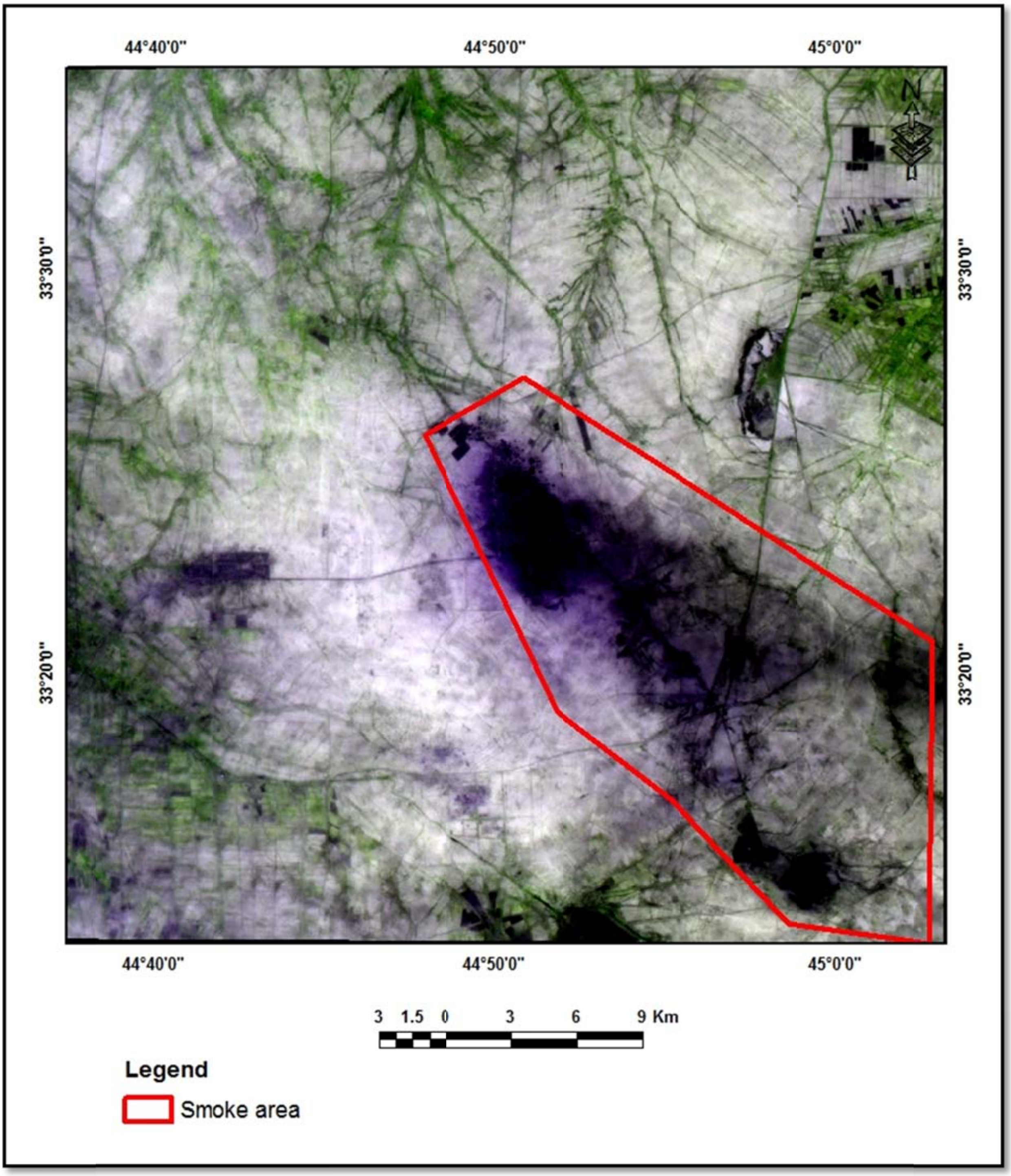


Figure (3-7): Smoke area in the study area for ETM+ image (2011) RGB 742

## 3.4. Image Classification Method Using ERDAS 2011

Supervised classification is used to prepare LULC map while image indices as (water index, normalized differential vegetation index, salinity index) are used to determine the change detection.

### 3.4.1. Supervised Image Classification

Supervised classification technique using maximum likelihood (MLC) algorithm is used in this study. The maximum likelihood classifier quantitatively evaluates both the variance and covariance of the category spectral response patterns, when classifying an unknown pixel (Lillesand *et al*., 2004). The success of the method depends on the accuracy of training data as well as field investigation (Richards and Jia, 1999).

#### 1. Spectral Signature Classes

Creating spectral signature classes is an iterative process and its objective to aggregate a set of statistical data that describe the spectral signature of each informat\ion class, Lillesand *et al*. (2004) described the determination of training sites as art and science, since it needs a close interaction between user and the image, as well as adequate reference data. The result of spectral signatures in this study for TM-2007 produced seven classes; i.e. urban or built up land, bare soil, salt flat, water, vegetated land, agricultural land non vegetated and smoke class. Table (3-2) shows the results of signatures for TM image, while figure (3-8) shows the results of mean plot for TM image.

Table (3-2) The results of signature for TM image 2007

| Class # | Signature Name | Color | Red | Green | Blue | Value | Order | Count | Prob. | P | I | H | A |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Smoke | 🟨 | 1.000 | 1.000 | 0.000 | 1 | 1 | 69 | 1.000 | ✓ | ✓ | ✓ | ✓ |
| 2 | Water | 🟦 | 0.000 | 0.000 | 1.000 | 2 | 2 | 501 | 1.000 | ✓ | ✓ | ✓ | ✓ |
| 3 | Salt flat | 🟪 | 0.933 | 0.510 | 0.933 | 9 | 54 | 296 | 1.000 | ✓ | ✓ | ✓ | ✓ |
| 4 | Urban or built up land | ⬛ | 0.000 | 0.000 | 0.000 | 7 | 64 | 11 | 1.000 | ✓ | ✓ | ✓ | ✓ |
| 5 | Vegetated land | 🟩 | 0.000 | 0.392 | 0.000 | 21 | 76 | 56 | 1.000 | ✓ | ✓ | ✓ | ✓ |
| 6 | Agricultural land non vegetated | 🟥 | 1.000 | 0.714 | 0.757 | 6 | 79 | 41 | 1.000 | ✓ | ✓ | ✓ | ✓ |
| 7 | Bare soil | 🟫 | 0.761 | 0.563 | 0.039 | 26 | 86 | 23 | 1.000 | ✓ | ✓ | ✓ | ✓ |

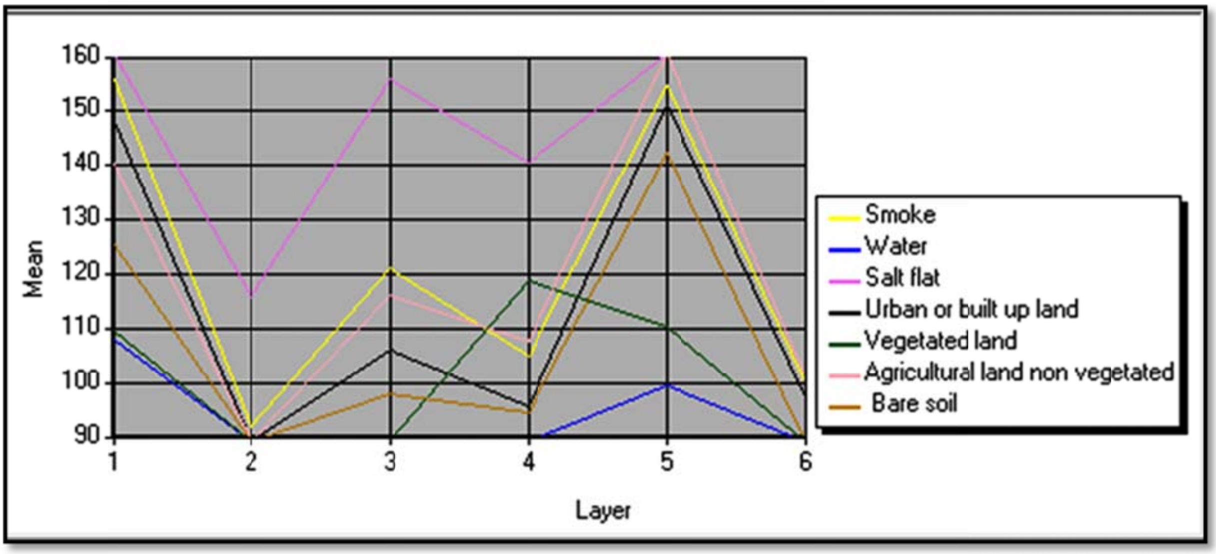


Figure (3-8) The results of mean plot for TM image 2007

## 2. Accuracy Assessment of Supervised Classification

No classification is completed until its accuracy is assessed. The “accuracy” means the level of agreement between labels assigned by the classifier and the class allocations on the ground collected by the user as test data (Lillesand and Kiefer, 2004). Accuracy assessment is performed on classified image, the achieved classification accuracy such as producer accuracy, user accuracy as well as overall accuracy and kappa will be illustrated hereinafter.

## 3. Producer’s Accuracy

The producer accuracy is a probability of a reference points being correctly classified and it is derived by dividing the total number of the correctly classified pixels in a category or a class by total point numbers in the corresponding row or column (Congalton, 1991). The results of producer accuracy for all classes are shown in table (3-3).

## 4. User’s Accuracy

The user's accuracy is the probability that a randomly chosen points on the map that have the same location on the ground, which is derived by dividing the total number of correctly classified points in a category or class by the total number of pixels classified on the same category

(Congalton, 1991). The results of User's accuracy for all classes are showing in table (3-3).

## 5. Signatures Evaluation

The following tools for evaluating of the signatures were used**.**

## 6. Accuracy Assessment

The following is the detailed description about the accuracy and its calculation methods.

### A. Overall Accuracy

Overall accuracy is the proportion of all reference pixels, which are classified correctly. It is computed by dividing the total number of correctly classified pixels (the sum of the elements along the main diagonal) by the total number of reference pixels (Congalton, 1991). The overall accuracy result of supervised classification for TM image of the study area is 92.00% as shown in table (3-3).

Table (3-3): Accuracy assessment of TM 2007 Image

| Class Name | Reference Totals | Classified Totals | Number Correct | Producers Accuracy | Users Accuracy |
|---|---|---|---|---|---|
| **Urban or Built up Land** | **1** | **1** | **0** | **0.00%** | **0.00%** |
| **Water** | **2** | **2** | **2** | **100.00%** | **100.00%** |
| **Smoke** | **16** | **14** | **13** | **81.25%** | **92.86%** |
| **Salt Flats** | **4** | **3** | **3** | **75.00%** | **100.00%** |
| **Idle Agricultural Land** | **56** | **62** | **53** | **94.64%** | **85.48%** |
| **Vegetated Land** | **65** | **65** | **58** | **89.23%** | **89.23%** |
| **Cultivated Land** | **2** | **2** | **2** | **100.00%** | **100.00%** |
| **Bare soil** | **150** | **148** | **142** | **94.67%** | **95.95%** |
| **Moist Bare soil** | **3** | **2** | **2** | **66.67%** | **100.00%** |
| **Totals** | **300** | **300** | **276** | | |
| **Overall Classification Accuracy = 92.00%** | | | | | |

### B. Kappa Statistics

Kappa is a measure, which expresses to what degree the pixels in the interpreted map (satellite data) differ from a class category taken by chance. The calculation follows Congalton (1991). Kappa Statistic for TM 2007 image is presented in table (3-4).

Table (3-4): Kappa Statistic for TM-2007 image

| **Overall Kappa Statistics = 0.8797** | |
|---|---|
| **Conditional Kappa for each Category** | |
| **Class Name** | **Kappa** (K^) |
| **Urban or Built up Land** | **0.0033** |
| **Water** | **1** |
| **Smoke** | **0.9245** |
| **Salt Flats** | **1** |
| **Idle Agricultural Land** | **0.8215** |
| **Vegetated Land** | **0.8625** |
| **Cultivated Land** | **1** |
| **Bare Soil** | **0.9189** |
| **Moist Bare Soil** | **1** |

## 3.5. Post Classification Processing

In order to exclude the scattered pixels, post classification smoothing can be applied using majority filter. The standard majority filter assigns the main value or class name to the central pixel in the output map. Majority function in Post-super classification is used in this study with filter (3×3) kernel.

## 3.6. Data Analysis and Interpretation Using GIS

The results of images processed by ERDAS software package and then reprocessed by ArcGIS are viewed as a digital coverage layers, whereas each polygon represents different LULC categories.

## 3.7. Land Use Land Cover (LULC) map

The produced LULC map is dominated by barren land (the main class in the study area), moreover the class Barren Land is divided into two sub-classes (salt flat and bare soil) as shown in figure (3-10). The followed procedure to derive Land Use – Land Cover map of the study area is modified after Anderson *et al.* (1976). The classes of LULC map are urban or built up land, vegetated land, agricultural land non-vegetated, water and smoke which are classified according to Level I, while Barren Land is classified according to Level II into two sub-classes, which are salt flat and bare soil. The extraction of LULC map for TM 2007image is represented by six major types of classes demonstrated as follow:

### 1. Urban or Built up Land

Urban or built-up land is comprised of areas of intensive use with much of the land covered by structures. Included in this category are cities, towns, villages, (Anderson *et al.*, 1976).

This class involves all city, town, village and factories in the study area. Whereas the Nahrawan city represents the main town in addition to scattered villages distributed in different places such as: (Abu-Toyor, Al-Seaedatt and Shmessan village) as shown in figure (3-5).

There is no large urbanization in the map area, which can be clearly distinguished using landsat satellite images, due to low spatial resolution of these images, and because most of the villages are built by clay. Most of the urban and built-up land are represented by small villages and scattered houses distributed on the majority parts of the map area. The urban land was added from another data (HIC, 2004) and updating using Quick Bird and field checking, therefore, the change detection of this class is uncounted through this study.

The Urban and Built-up Land cover 5.83 Km$^2$ with percentage of 0.36 %, as shown in table (3-5). The pie chart, figure (3-11) shows the percentage of this class. The scattered houses in the map area are uncounted within this percentage.

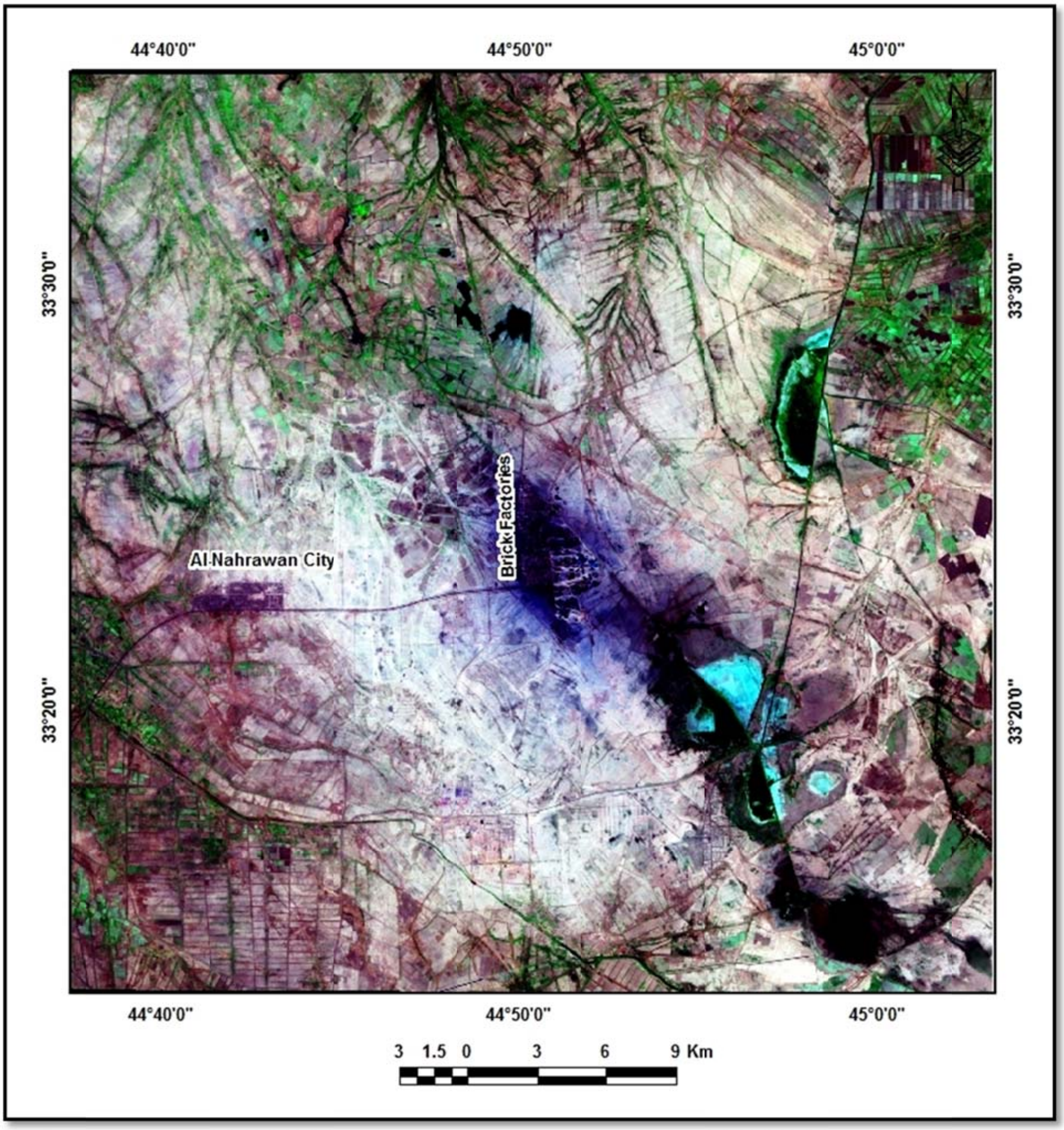
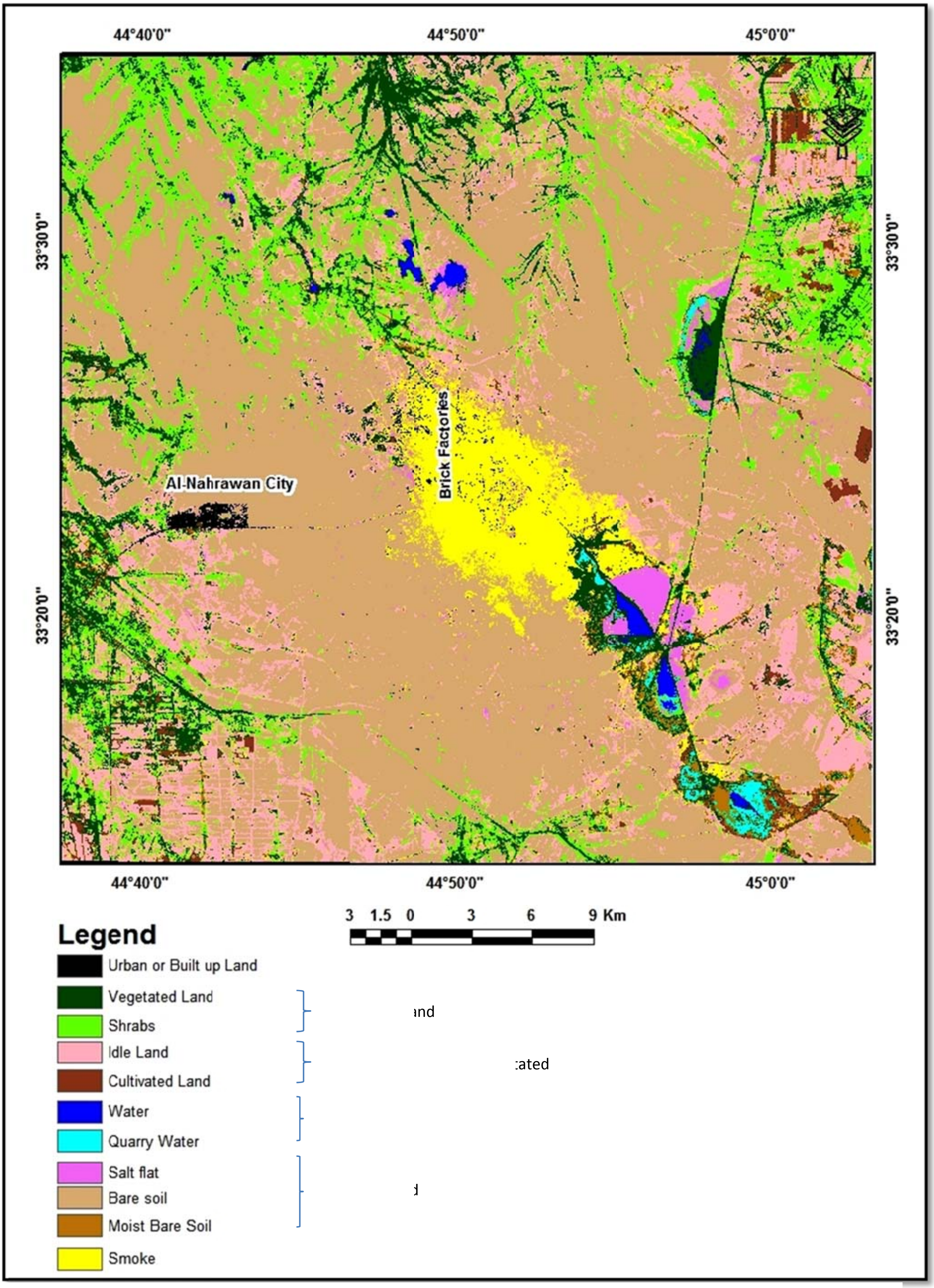


Figure (3-9): Satellite image TM-2007 RGB (742) of the study area


44°40'0"
44°50'0"
45°0'0"
33°30'0"
33°20'0"
Al-Nahrawan City
Brick Factories
3 1.5 0 3 6 9 Km
Legend
Urban or Built up Land
Vegetated Land
Shrabs
Idle Land
Cultivated Land
Water
Quarry Water
Salt flat
Bare soil
Moist Bare Soil
Smoke
nd
ated

The urban land has reddish brown to bluish pink color in 742 RGB for Landsat TM image as shown in figure (3-9).

Table (3-5): Land Use–Land Cover classification results of TM 2007 image

| **Class Name** | | **Area Km$^2$** | **Area%** |
|---|---|---|---|
| **Barren Land** | **Salt Flats Class** | **21.59** | **1.35** |
| | **Bare Soil Class** | **868.09** | **54.37** |
| **Total Barren land** | | **889.67** | **55.72** |
| **Agricultural Land non-Vegetated Class** | | **275.56** | **17.26** |
| **Vegetated Land Class** | | **332.74** | **20.84** |
| **Smoke Class** | | **78.06** | **4.89** |
| **Water Class** | | **14.88** | **0.93** |
| **Urban and Built-up Class** | | **5.83** | **0.36** |
| **Total** | | **1596.75** | **100** |

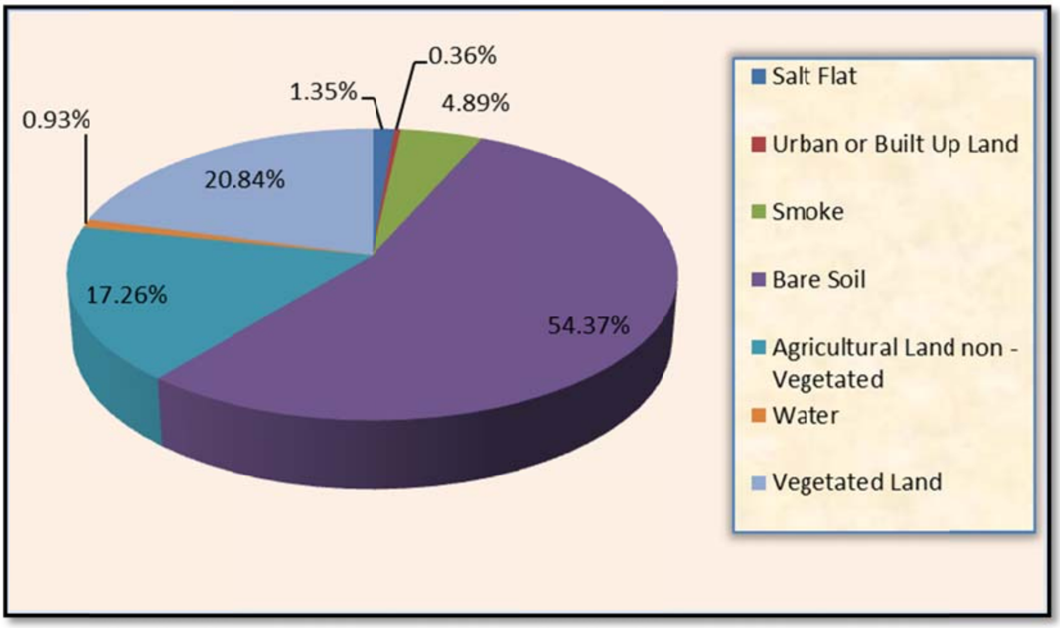


Figure (3-11): The percentage of LULC classes in TM 2007 image

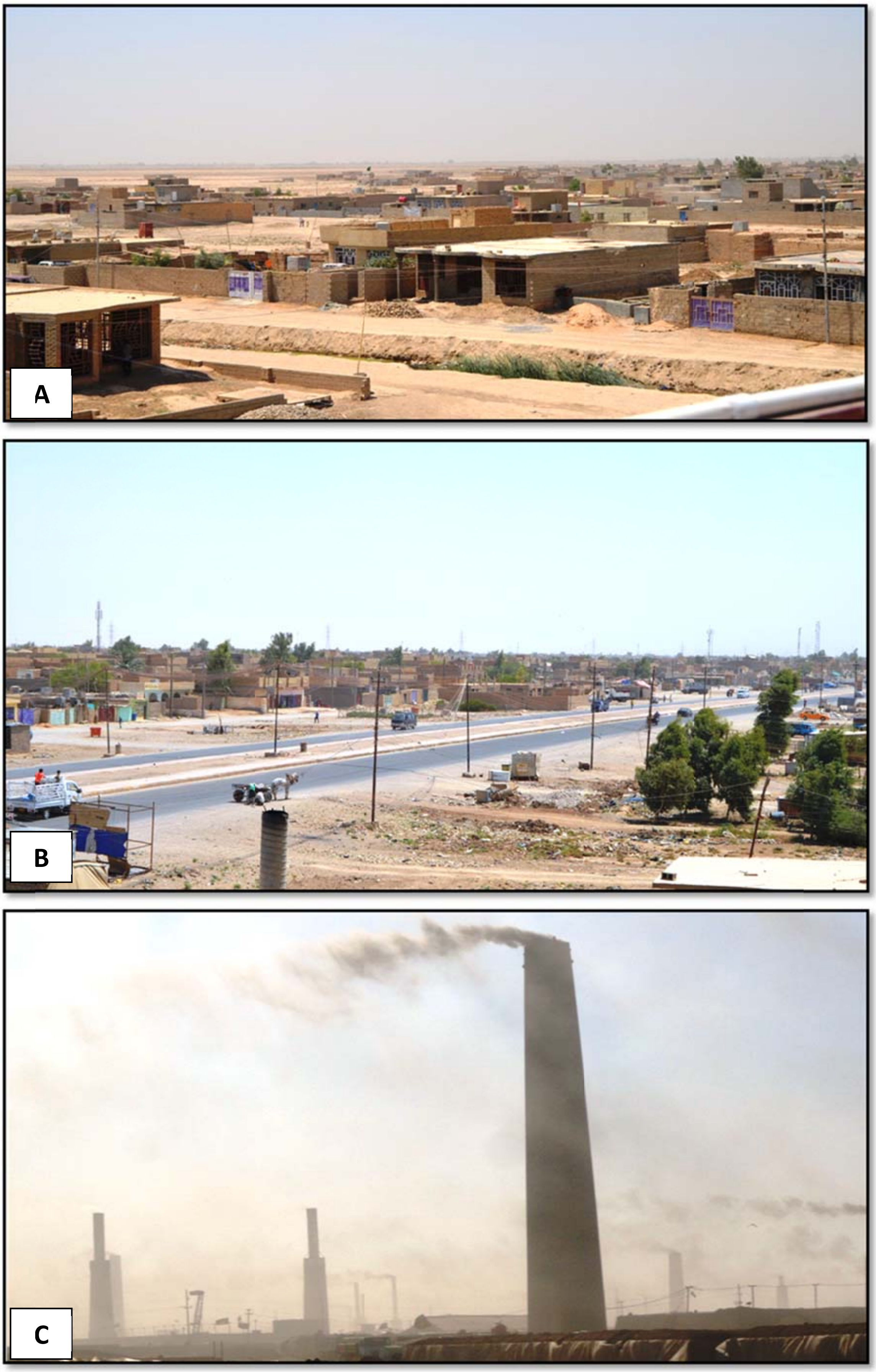


Figure (3-12): Side view for urban class; A: Village, B: Nahrawan city, C: Brick factories

## 2. Vegetated Land Class

Vegetated land includes all vegetation cover, which grow naturally or by human activates in agricultural land. Agricultural Land may be defined broadly as land used primarily for production of food and fiber, (Anderson et al., 1976).This class is represented by agricultural for cereal crops like wheat and barley aside from some small date palms orchards and other types of trees, there is also reed aquatic vegetation grew in small ponds and along irrigation canals like: reed and sedge. Shrubs and shrubbery land are also included within this class because there is no ability with this type of data to distinguish between different type of vegetation cover as a result of low spectral resolution of TM , ETM+ data in spite of the agricultural land can be recognized depending on visual interpretation because most of these are characterized by specific geometric shape for detailed plant studies, as shown in figure (3-13).This class covers an area of up to (332.74) km$^2$ and represent (20.84 %) from LULC map as shown in table (3-5) figure (3-11), and has green color in 742 RGB for Landsat TM image.

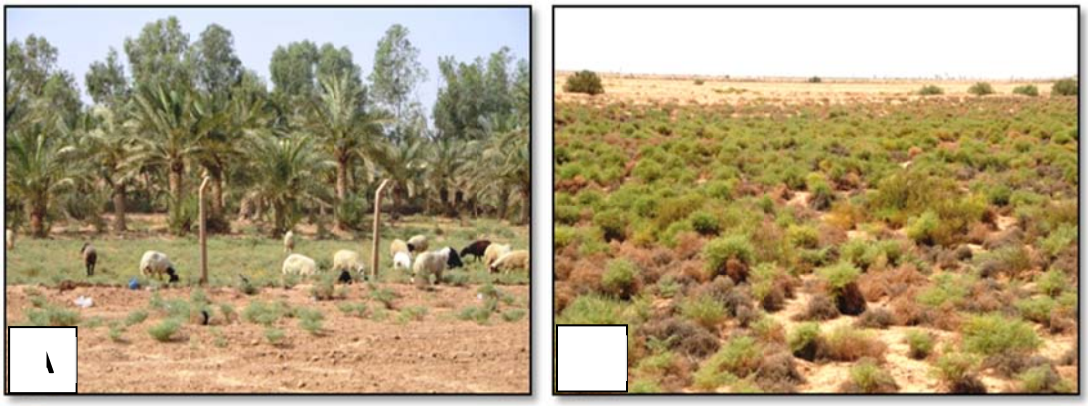
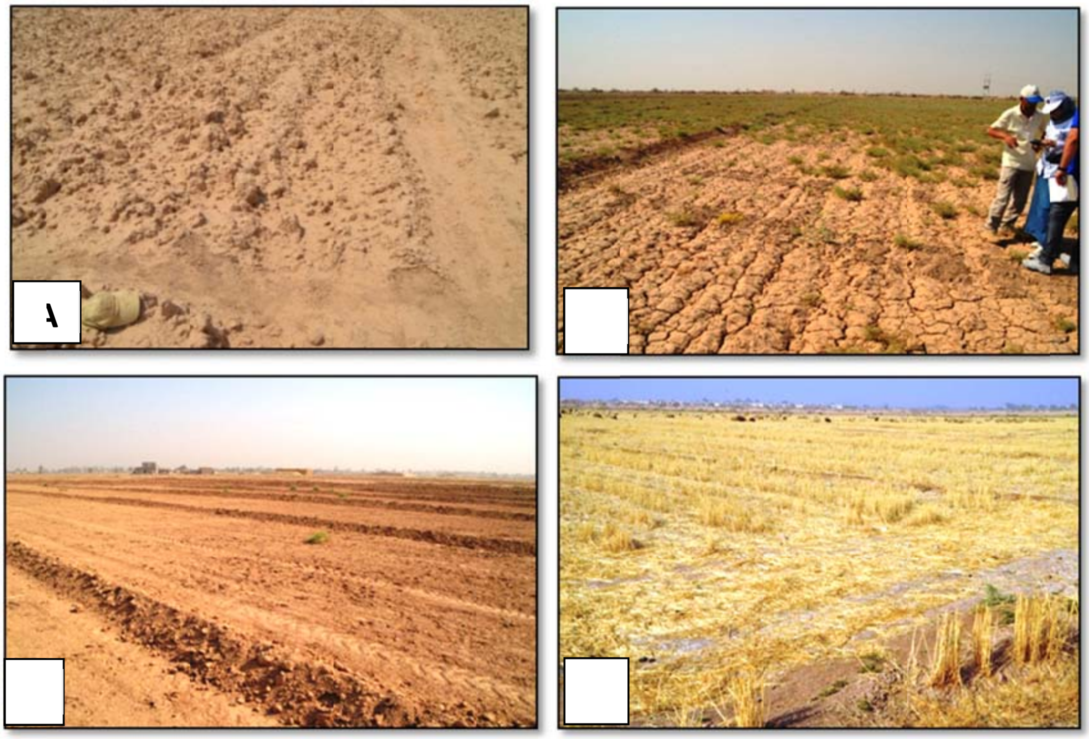


Figure (3-13): Agricultural lands of different types in the study area; A: Date palm orchards, B: Shrubs

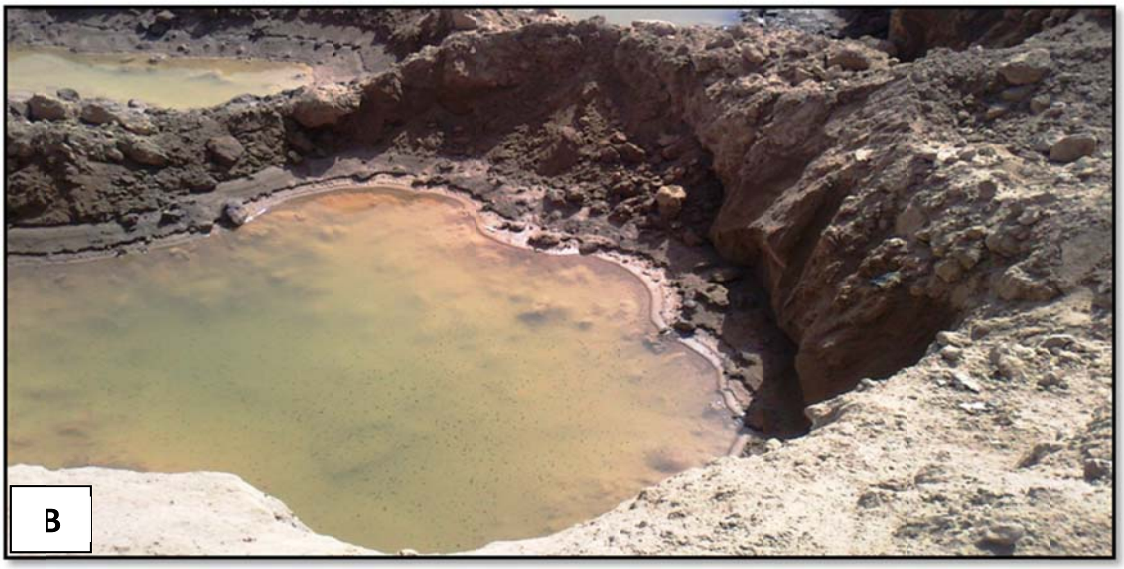
## 3. Agricultural Land non-Vegetated Class

This category includes non-vegetated idle cropland agricultural land, which has been left idle, either tilled or untilled, during the whole or greater portion of the growing and harvesting season (Anderson *et al.*, 1976). There are three types of non-vegetated agricultural land in the studied area; e.g. harvested cropland, cultivated land, water in irrigation consequently increasing the salt content. Cultivated fields consist of patches of land recently harvested and cultivated for the growing season. Crops in this class are typically wheat and barley as shown in figure (3-14) and LULC map figure (3-10). The non-vegetated agricultural land class occupies (275.56) Km$^2$, of percentage (17.26 %) in TM image 2007, as listed in table (3-5) and shown in figure (3-11). This class has gray to light brown color in the 742 RGB Landsat TM image. These subclasses (cultivated, idle and harvested) are merged together throughout calculating the area of each class because there is huge interface between these subclasses in some places.



### 4. Water Bodies Class

Water areas are one of LULC categories comprising water bodies and streams that are permanently running. They include; streams, canals, lakes, reservoirs, bays and estuaries. The delineation of water areas depends on the type of the utilized images (i.e. image resolution) which is based on the characteristics of the sensors used to interpret of landuse and landcover, (Anderson et al., 1976). The surface water in the study area is represented by irrigation canals fed from Dayala river and small swamp formed in the brick quarry because of shallow water table and small pond located south of tannery factories formed by discharge polluted water from tannery factories as shown in figure (3-15) and LULC map figure (3-10). The Water class occupies an area of 14.88 Km$^2$; i.e. ≅ 0.93% in TM image 2007, as listed table (3-5) and illustrated figure (3-11). The water bodies in the study area appeared in black to dark color within 742 RGB image.



ry

### 5. Barren Land Class

Barren land is one of LULC category; used to classify lands with limited capacity to support life and having ≤ 5% of vegetative cover; i.e. vegetation if present is widely scattered. Generally, the surface of Barren Land is salt flats; sand dunes; mud flats; beaches; bare exposed rocks, bare soils, or salt-affected soils (Anderson *et al.*, 1976).

The total area of barren land covers 889.67 km$^2$, representing about 55.72% in TM 2007, as listed in table (3-5), and as illustrated in figure (3-11). This presentation represents a good indicator for land degradation extent and actual size of desertification problems. Subcategories of barren land in the studied area also include; salt flat and bare soil each one of these sub-categories will be described later as shown in LULC map figure (3-10).

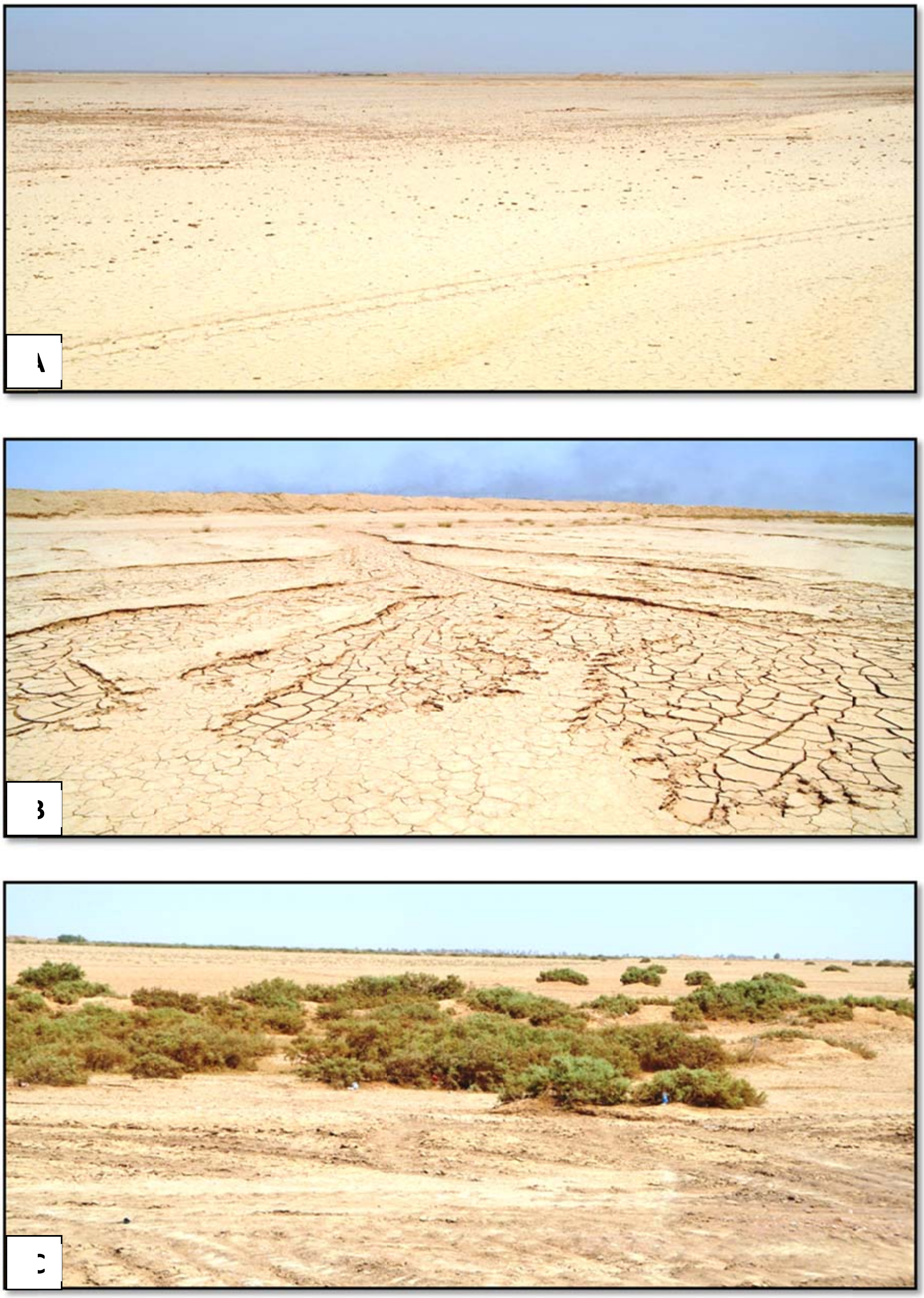
#### A. Dry Salt Flats (Sabkha) Sub-Class

The area of salt flat is locally known as "Sabkha", which is an Arabic word referring to soil salinization it is one of major land-degradation problem in arid and semi-arid environments (Dwivedi and Sreenivas, 1998). Dry salt flats occurring on the flat-floored bottoms of interior desert basins which do not qualify as wetland included in this category. On satellite images , dry salt flats tend to appear white or light tone because of the high concentrations of salts at the surface as water being evaporated, resulting in a higher albedo than other adjacent desert features,(Anderson et al., 1976). Figure (3-16) refers to soil of high salt content or covered by white salt crust. This class is mainly formed with low relief from surrounding area where the discharge of excessive water from agricultural land and also the rainfall contribute to accumulate water with high (T.D.S) (salt content) in these land consequently after dryness this soil become saturated in salt content . The salt flat appears with white to light gray colors in TM image with band combination (RGB 742). The salt flat occupied an area of 21.59 Km$^2$ ≅ 1.35 %, in TM image 2007, as listed in table (3-5), and illustrated in figure (3-11).

This class is distributed mainly in the central and south east of the study area as shown in figure (3-9).

**B. Bare Soil Sub - Class**

The soil covered most of the study area. The composition is sand, silt and clay with light brown color. Some soil is covered by shrubs or dense herbaceous that have dark olive color. Galgia soil appears in some places of the study area with mud cracks as shown in figure (3-17).The soil is moist and it is distributed in a small limited area on the surface of the studied area, which is covered by sparse shrubs, in some places. This class appear with light brown to gray color in RGB 742 TM satellite image, shown in figure (3-9), and occupied an area of 868.09 Km$^2$ ≅ 54.37% in TM image 2007, as listed in table (3-5), and shown in Figure (3-11).



y shrubs

### 6. Smoke class

This class represents the area covered by emissions from the brick factories (figure 3-10), located to the south and southeast of mainly brick factories, where there are usually winds blowing in this direction; i.e. northwest winds. The soil in this class is covered by veneer of dark to dark gray colors of carbonate materials with thickness of (2-4) cm as shown in figure (3-18). The Smoke class occupied an area of 78.06 $Km^2$; representing about 4.89 % in TM image 2007, as listed in table (3-5). Figure (3-11) shows the smoke as dark grey to black color, using 742 bands for coloring TM satellite image as shown in figure (3-9).

By reviewing the satellite images of different sensors, one can conclude that this class is extended abruptly or rapidly which refer to the increasing of pollution in the study area. It is in fact, a good sign for the absence of any environmental monitoring of the quantities of smoke emitted from brick factories.

## 3.8. Image Indices and Change Detection

### 3.8.1. Image Indices

Indices are used to create output images by mathematically combining the digital number values of different bands, (Chang, 2008).

### 3.8.1.1. Normalized Difference Vegetation Index (NDVI)

Vegetation indices derived from satellite data are one of the primary sources of information for operational monitoring of the earth's vegetative cover (Gilabert *et al.,* 2002). Typically, the normalized difference vegetation index NDVI is mainly used for mapping land cover changes (Los *et al.*, 2002).Vegetation indices combine reflectance measurements from different portions of the electromagnetic spectrum to provide information about vegetation cover on the ground (Campbell 1996). NDVI is represented by dividing the difference between infrared and red reflectance measurements by their sum which provides the effective measure of photosynthetic active biomass (Lunetta *et al.*, 2006). It is an effective indicator to show the surface coverage condition of vegetation; given as [Lunetta *et al.*, 2006]

$$NDVI = \frac{NIR - R}{NIR + R} \tag{3-1}$$

Where;

NIR refer to near infrared band (band 4 in TM and ETM+ satellite images)

RED refer to red band (band 3 in TM and ETM+ landsat satellite images).

#### A. Changes Detection Using NDVI

Change detection is the process of identifying differences in the state of an object or phenomenon by observing it at different times (Singh, 1989). Many change detection techniques have been developed (Moran et al., 2004).The landsat TM 1990, and ETM+ 2002 and 2007 images have been applied for monitoring vegetation changes in the study area. The distribution of vegetation covers, which is extracted by the

NDVI of the three images, are shown in figures. (3-20, 3-21 and 3-22). Table (3-6) represent the areas which occupied by vegetation in three acquisition date. The result showed that vegetation is decreased in 2002 as compared with 1990, and increased again in 2007 but still less than 1990 because of lack or shortage of water resources due to climate changes and droughts conditions which has led to increasing in salinity, also due to soil compaction which are both responsible for decreasing vegetation cover, inspite of the increased moisture during 2002. The groundwater resources is a hand-dug wells characterized by high levels of TDS ranging from (1832.09) ppm to (33424.13) ppm. The comparison between vegetation cover of these three dates are shown in figure (3-19).

Table (3-6): Image indices of TM 1990, ETM+ 2002 images and TM 2007

| **Date** / **Images Indices** | **Area in Km²** | | |
|---|---|---|---|
| | **TM 1990 image** | **ETM+ 2002 image** | **TM 2007 image** |
| **NDVI** | **437.51** | **410.20** | **418.24** |
| **SI** | **54.98** | **57.87** | **66.44** |
| **WI** | **69.15** | **232.71** | **27.52** |

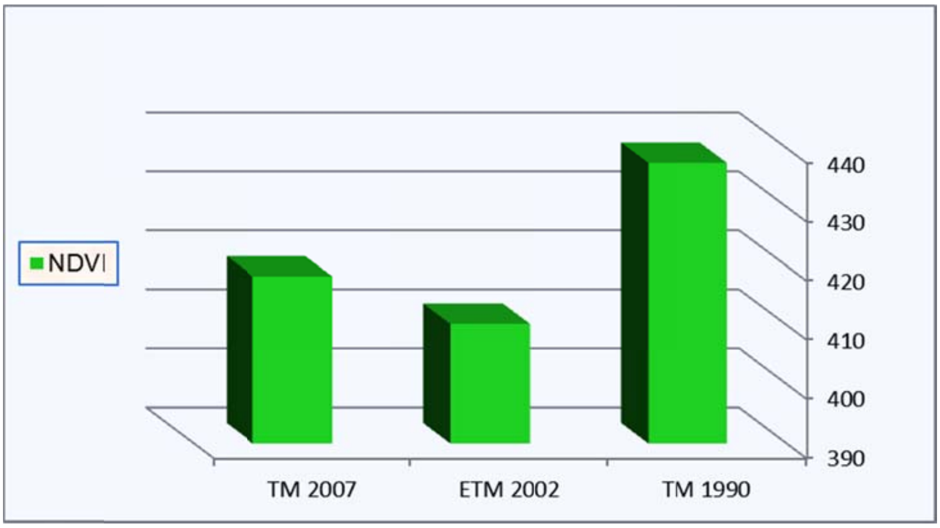


Figure (3-19): Variation in NDVI area of TM 1990, ETM+2002 and TM2007 images

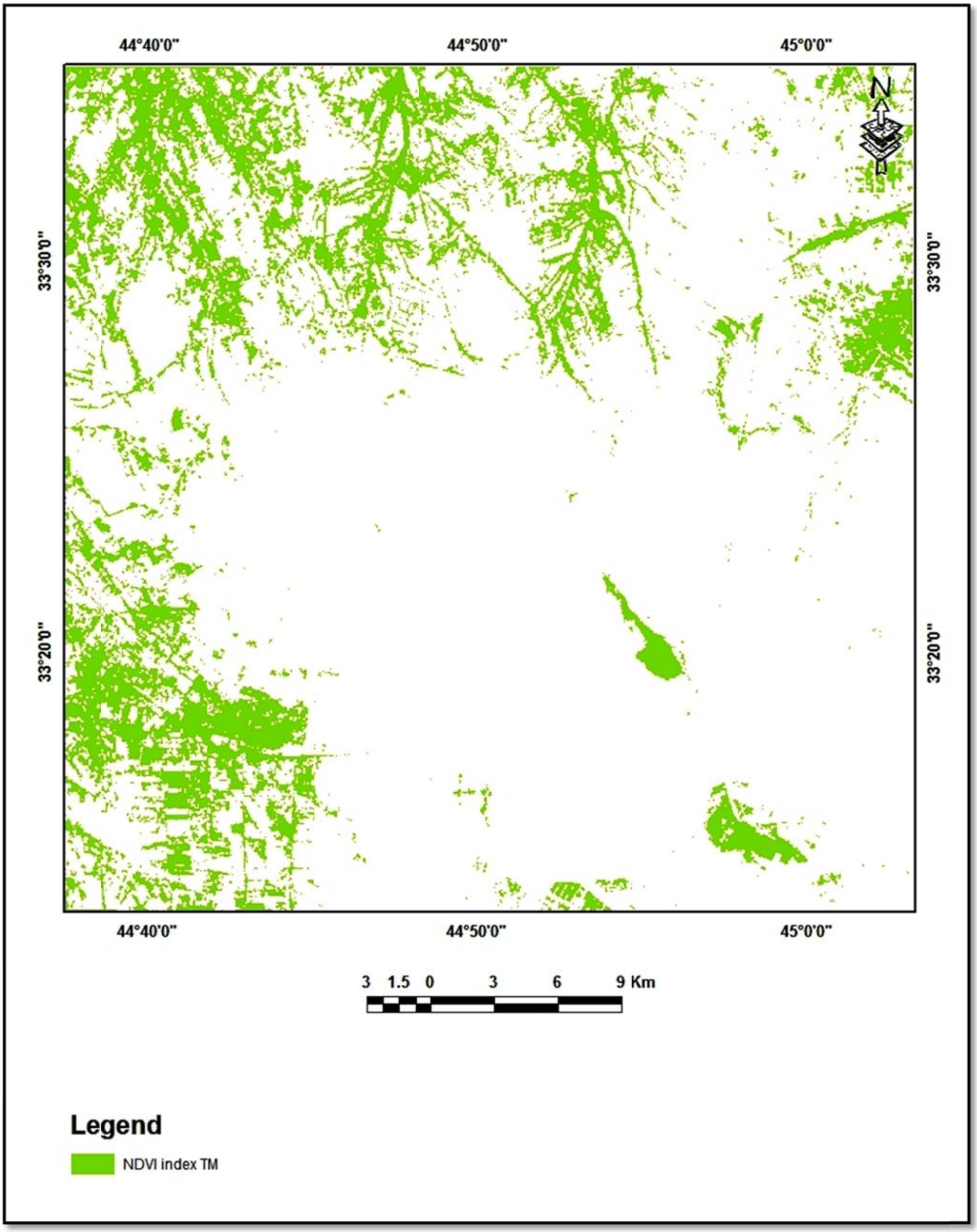


Figure (3-20): NDVI of TM 1990 image

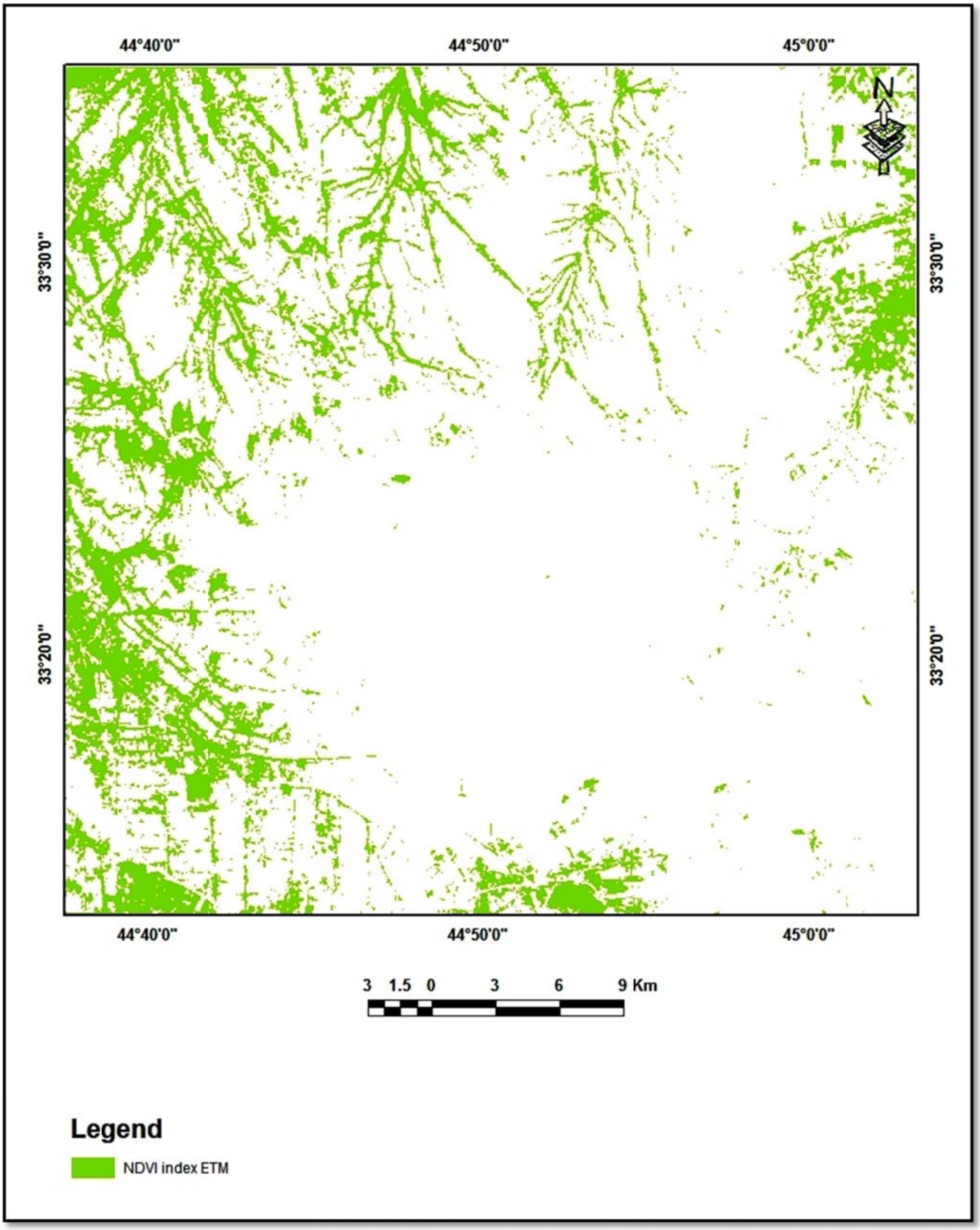


Figure (3-21): NDVI of ETM+ 2002 image

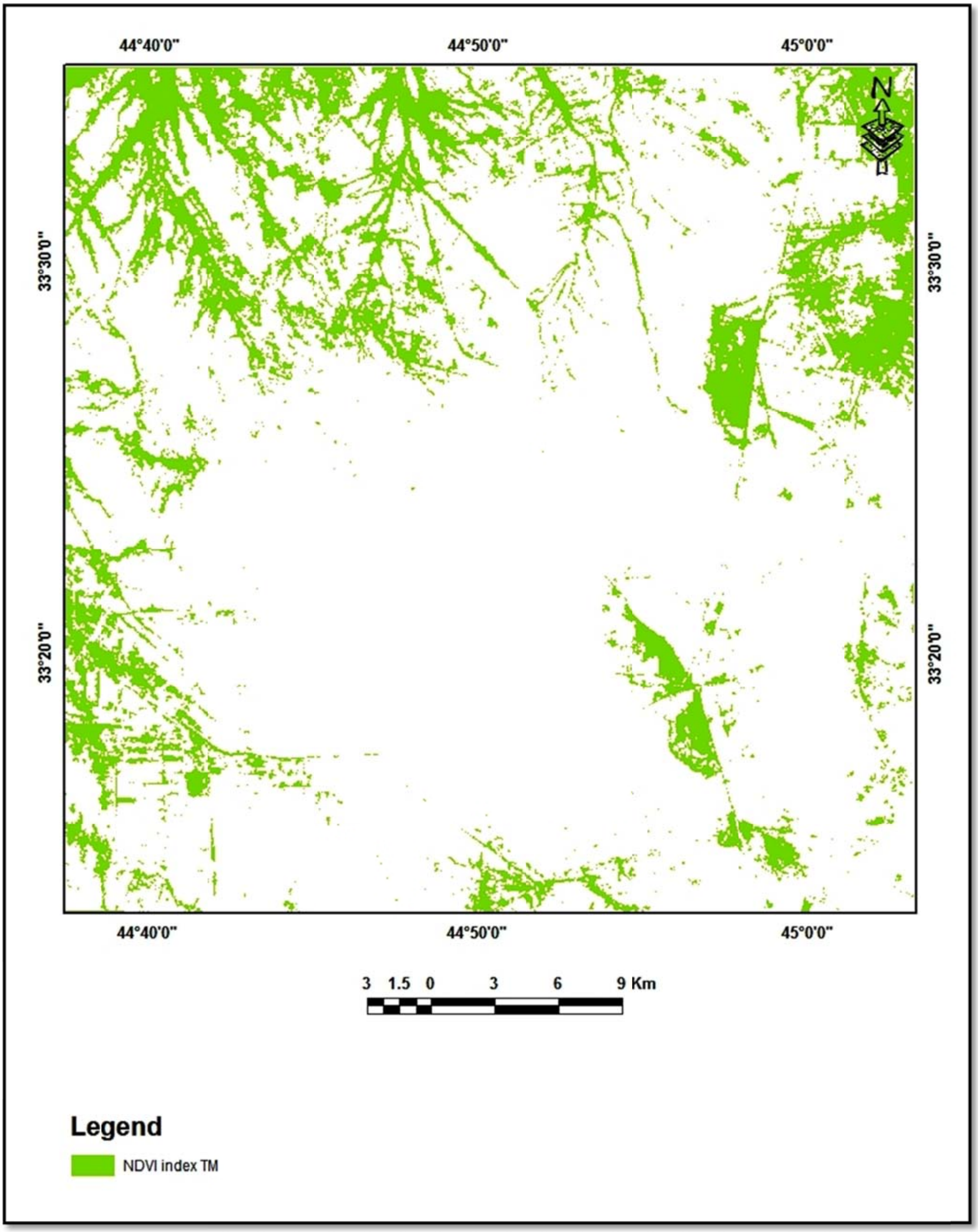


Figure (3-22): NDVI of TM 2007 image

### 3.8.1.2. Difference Water Index (WI)

The Difference Water Index is used to oversee the situation of water in the map area. It is computed as the average of summing the NIR and SWIR bands (Al-Jaf and Al-Saady, 2009) as shown in equation below: [Al-Jaf and Al-Saady, 2009]

$$WI = \frac{NIR + SWIR}{2} \qquad (3\text{-}2),$$

SWIR: indicating short wave infrared

### A. Changes Detection Using Difference Water Index (WI)

The lowest values in the spectral range in this index represent water class. Water area covered by water is roughly 69.15Km ² in the image of TM-1990 and about 232.71Km² in ETM+ - 2002, while water levels drops significantly in 2007, as illustrated in table (3-6) and figure (3-23). The distribution of surface water in three images are illustrated in figures (3-24), (3-25) and (3-26).

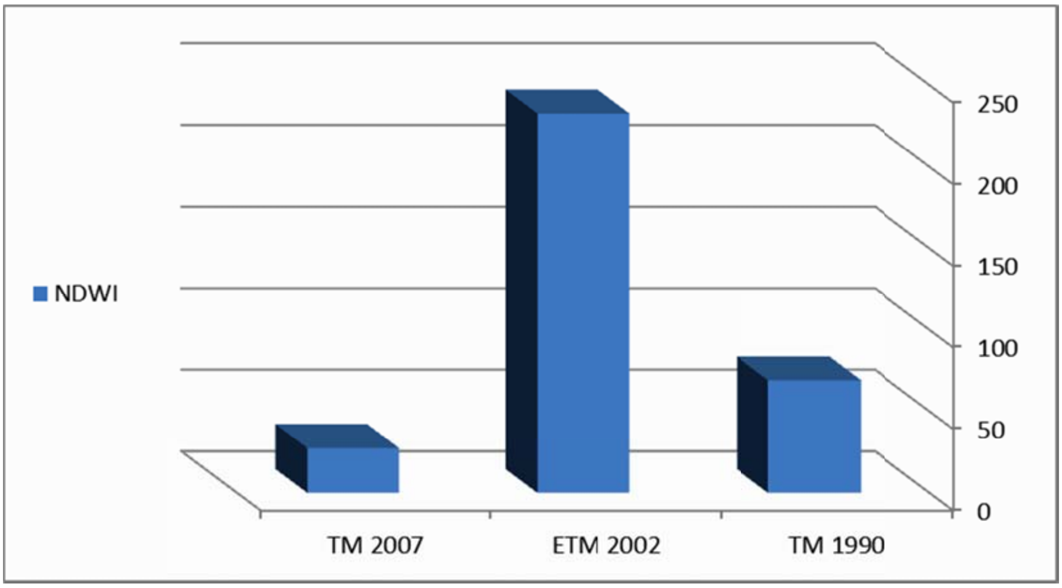


Figure (3-23): Variation in water area of TM 1990, ETM+ 2002 and TM 2007 images

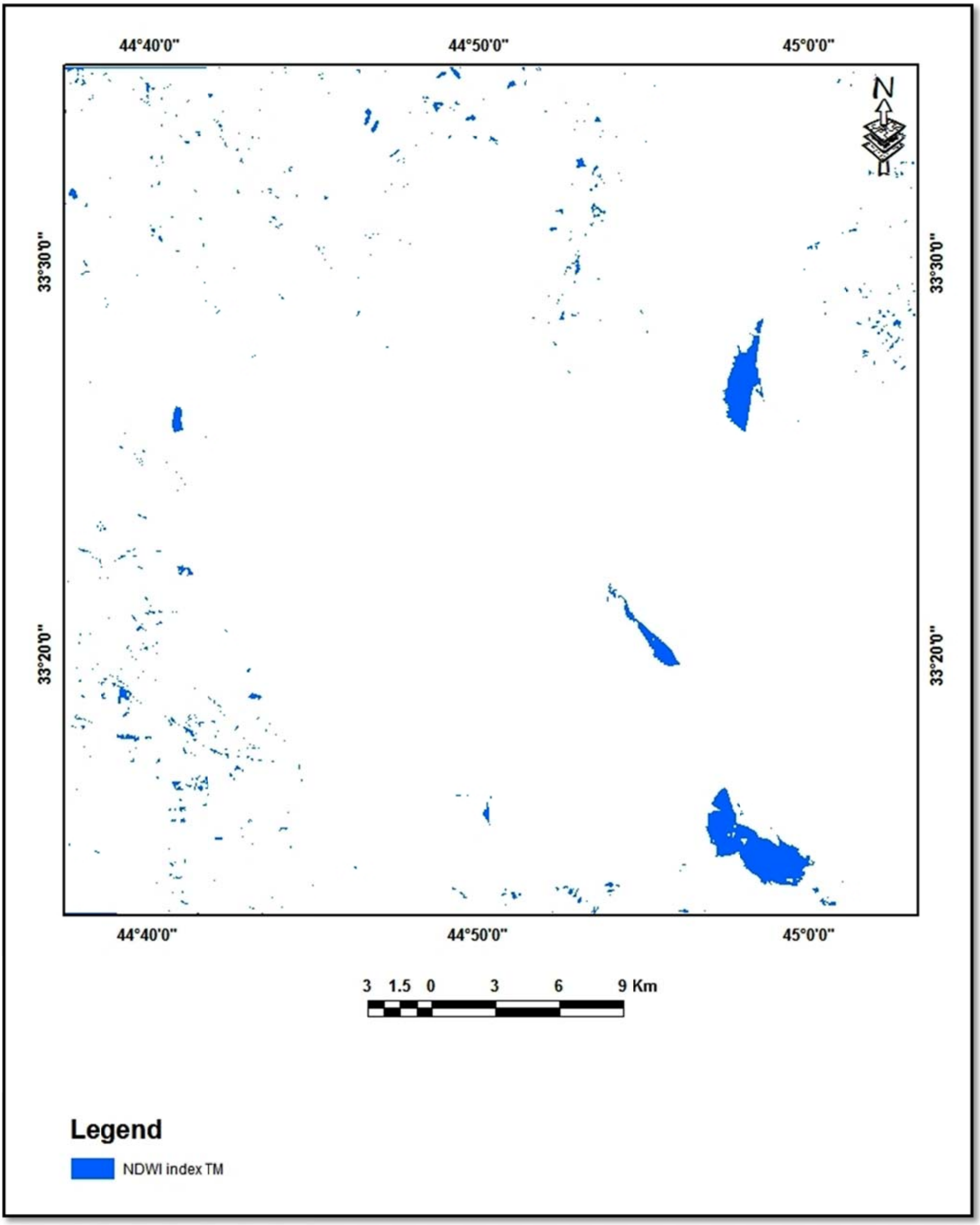


Figure (3-24): NDWI of TM 1990 image

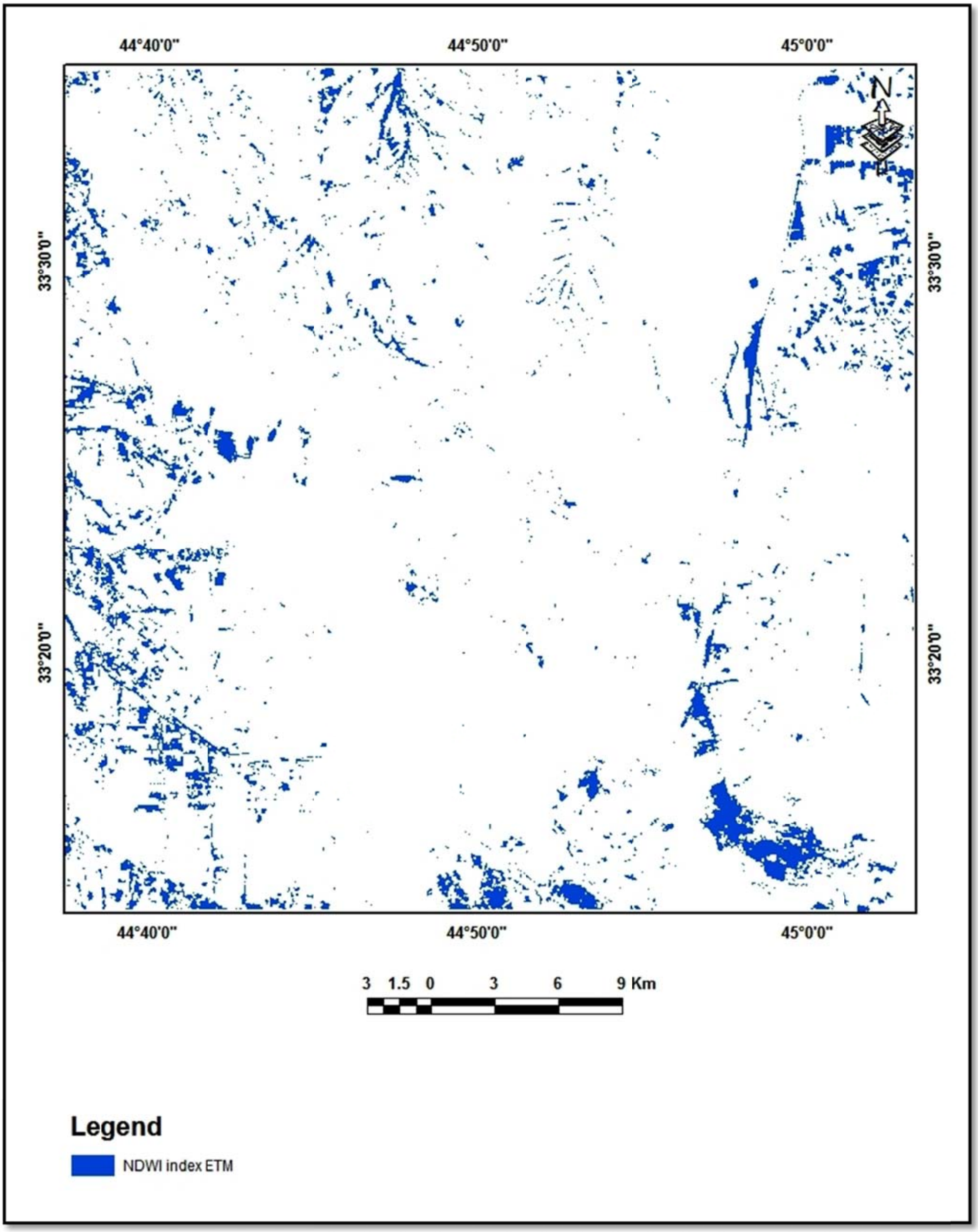


Figure (3-25): NDWI of ETM+ 2002 image

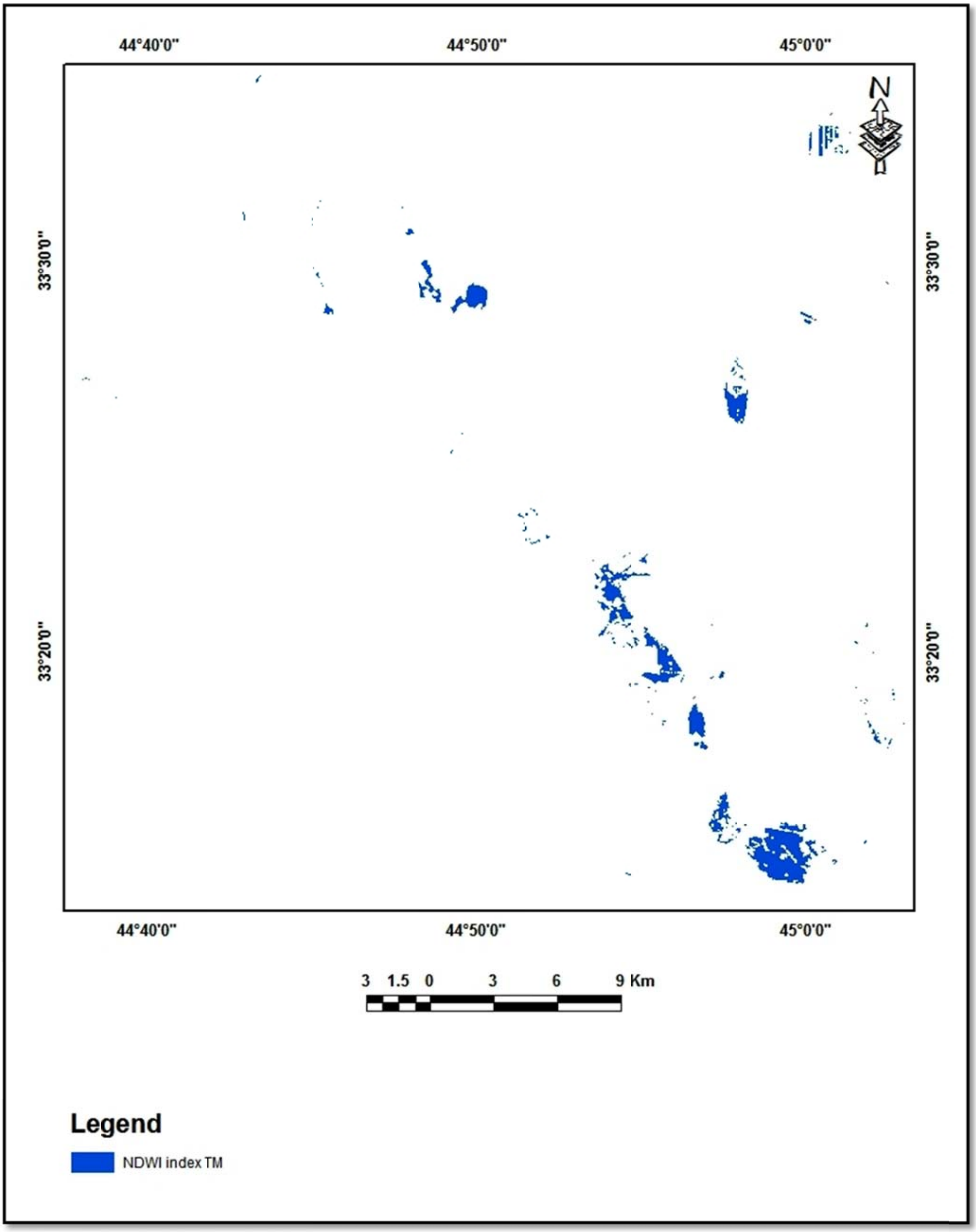


Figure (3-26): NDWI of TM 2007 image

### 3.8.1.3. Salinity Index (SI)

Salinity index represents the ability to detect the level of salinity using TM-1990, ETM+ -2002 and TM 2007 images. The equation that was used to measure the salinity index (Al-Jaf and Al-Saady, 2009) in the relationship below to determine saline soils in the map using remote sensing data,[ Al-Jaf and Al-Saady, 2009 ]:

$$S\,I = \frac{Green + \mathrm{Re}\,d}{2} \qquad (3\text{-}3),$$

The higher spectral reflection represents high saline soil. The areas covered by saline soil is 54.98 Km$^2$ in TM-1990 image, 57.87 Km$^2$ in ETM+-2002 image and 66.44 Km$^2$ TM 2007, as listed in table (3-6), and illustrated figure (3-27). The results of saline soil distribution in TM-1990, ETM+-2002 and ETM+-2007 images are shown in figures (3-28), (3-29) and (3-30).

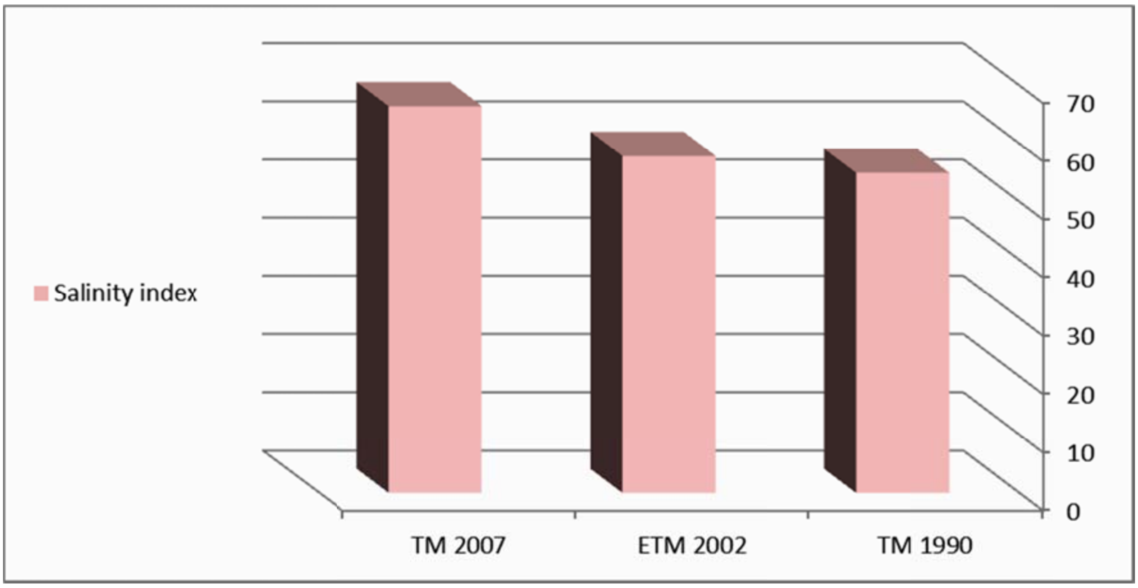


Figure (3-27): Variation of (SI) area of TM 1990, ETM+ 2002 and TM 2007 images

Figure (3-28) Salinity index (SI) of TM 1990 image

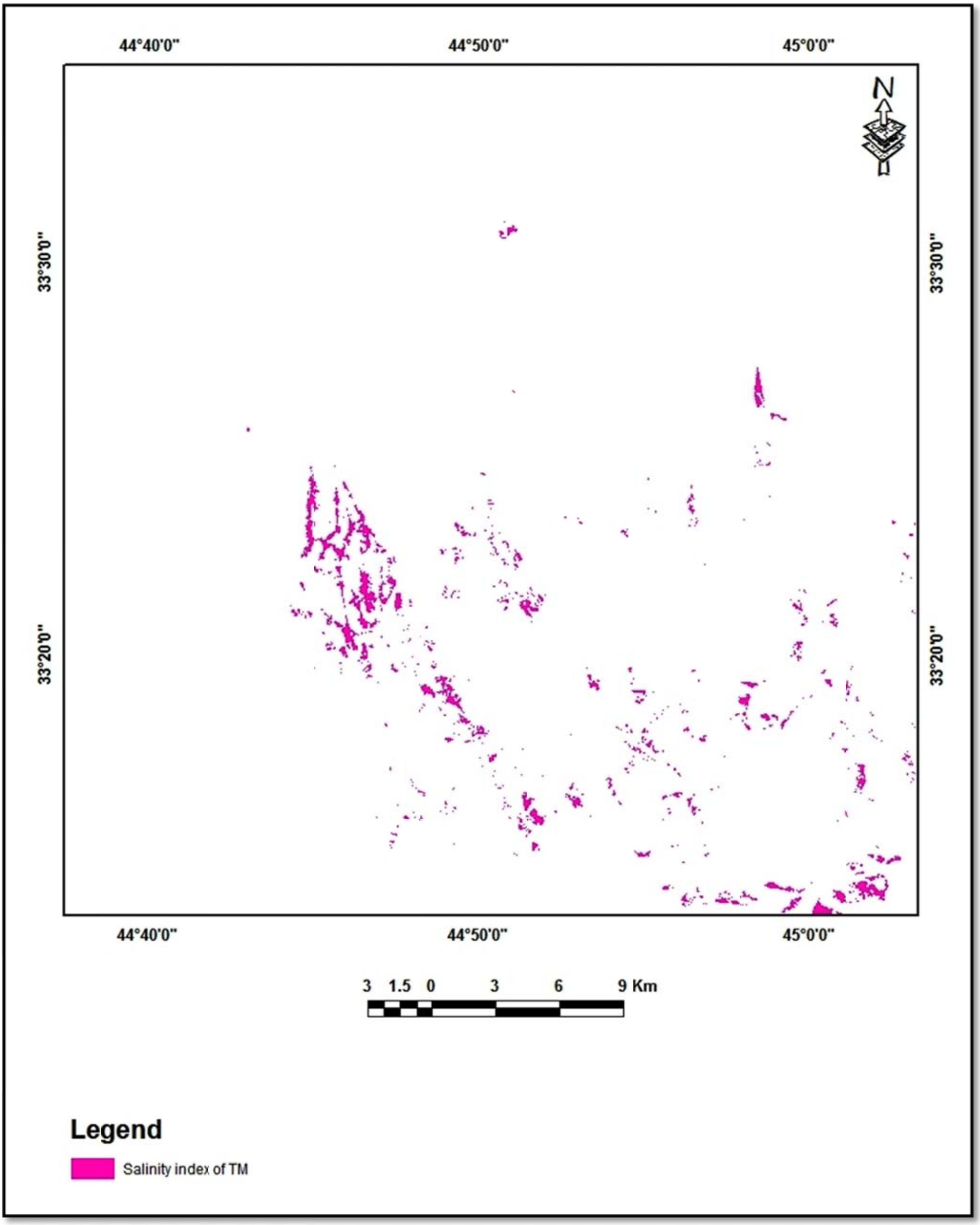


Figure (3-28) Salinity index (SI) of TM 1990 image

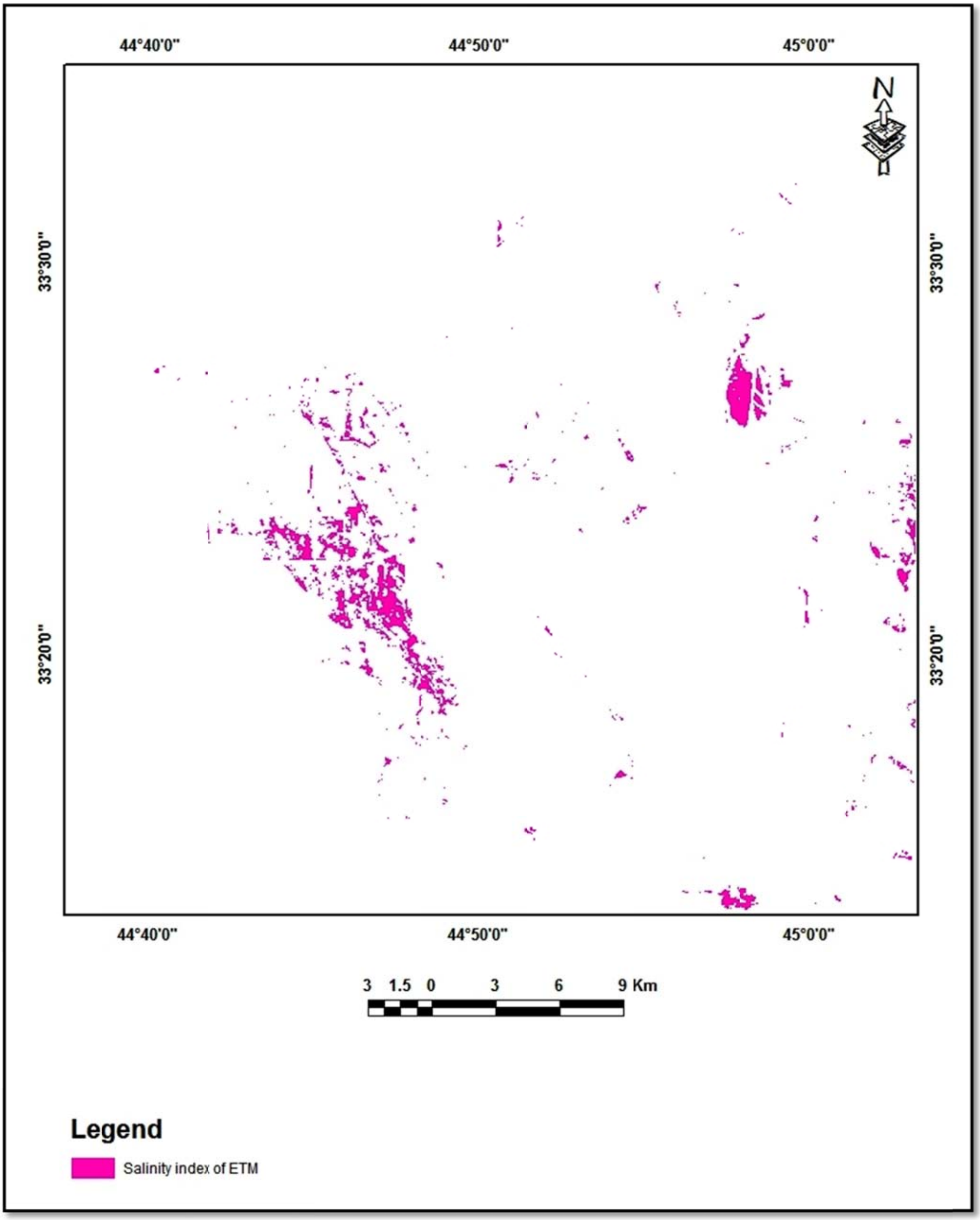


Figure (3-29): Salinity index (SI) of ETM+ 2002 image

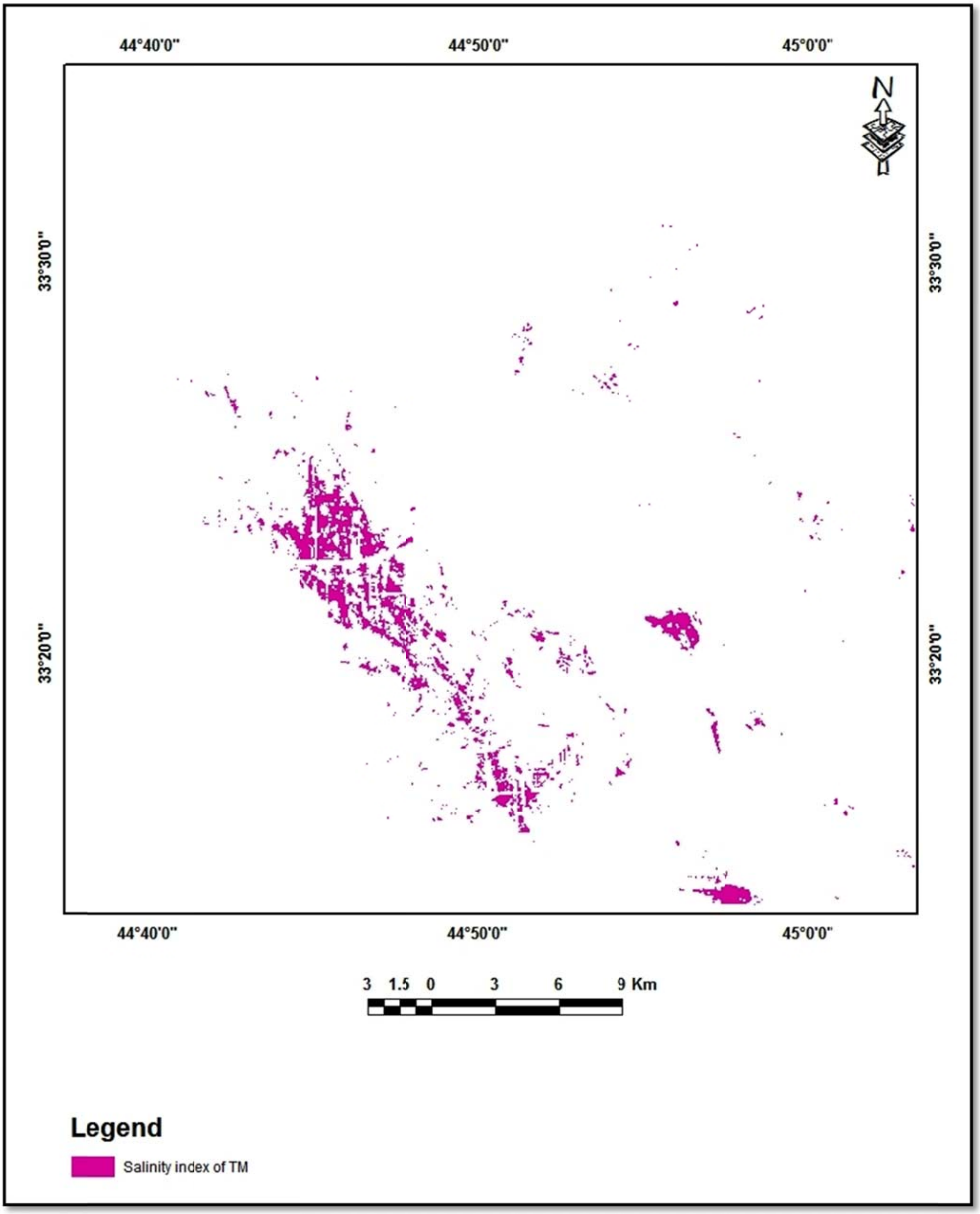


Figure (3-30): Salinity index (SI) of TM 2007 image

# Chapter Four

# Environmental Assessment of Air, Water and Soil

## 4.1. Preface

Environmental assessment for air, water and soil has been carried out by analyses of (air, water and soil) of the study area, in order to investigate the potentiality of the presence of contaminants.

Firstly: The concentrations of (total suspended particles) gases ($NO_2$, $SO_2$, $H_2S$) and heavy metals (Pb, Cr, Ni) in the air.

Secondly: Water quality is determined, including determine the concentrations of major ions and trace elements in groundwater, irrigation canals water, waste water produced by tannery factories and quarry water.

Thirdly: Investigating the soil of the study area and the concentration of major oxides and trace elements and type of clay minerals are determined by using X.R.D. . The results of these parameters are compared with previous studies and international standards.

## 4.2. Air Pollution

Air pollution includes anything introduced by humans into the atmosphere with a damaging effect. The main cause of air pollution is the burning of fossil fuels in cars, planes, industrial factories and in the production of electricity. Pollutants in the air include carbon dioxide, carbon monoxide, sulphur dioxide, nitrogen dioxide and small particles that are a result of burning different materials, especially coal. These pollutants not only harm individuals by causing diseases, but also harm the environment by adding to global warming (James, 2011). Temperature inversions that remain over an industrial area for a long time usually result in episodes of severe smog (a combination of smoke and fog) that can cause respiratory problems, (Borrero, 2008).

### 4.2.1. Air Quality of the study area

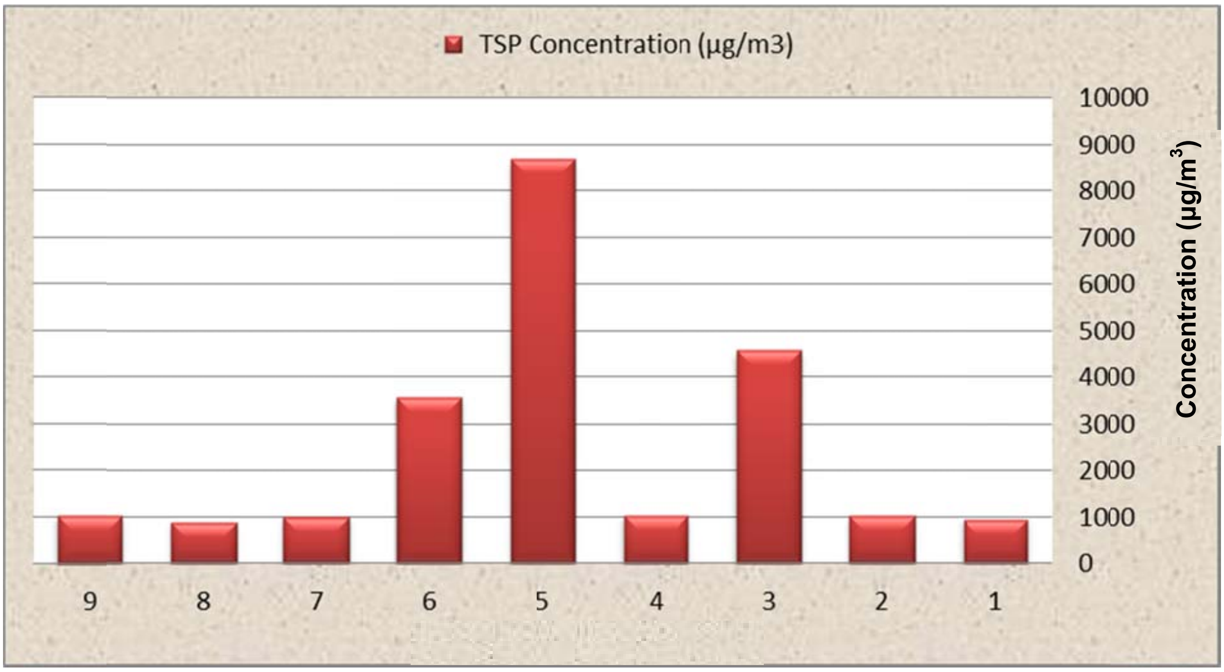
#### 4.2.1.1. Total Suspended Particles (TSP)

Total Suspended Particles (TSP) are small solid or liquid particles suspended in air. Major sources of TSP are diesel vehicles and coal-burning power plants. Dust is also a major source of TSP especially during the dry months. Dust can come from unpaved roads and construction activities, (EMB, 2004).

The mean of the total suspended particles in the air of the study area has reached (1820.08 µg/m$^3$) and the concentration ranges from (880.12 µg/m$^3$) at location number (8) which located at an agricultural land to (8687.5 µg/m$^3$) at location number (5) which located near the brick factories as shown in table (4-1) and figure (4-1). This mean is higher than the total suspended particles value that had recorded in Al-Jadria area in order to compare these concentrations with general environment situation. Comparing the total suspended particles concentrations in the selected locations of the study area with the allowable limits in the standards of the World Health Organization (WHO,2000) which range between (35-220µg/m$^3$) show that all of these concentrations have exceeded the allowable limits especially in locations (5 and 6) figure (2-3) page 25. The concentrations of (TSP) in the current study were compared with the concentrations of the (TSP) of previous studies for the air of the study area and Baghdad city in order to check any variation in concentration and explain the main cause for such variation and this comparison has shown high increase in the (TSP) of the air of the study area. The industrial processes in the study area represented by brick factories are considered as the main cause for this increase.

udy area

| Locations | TSP $(\mu g/m^3)$ | $NO_2$ (ppm) | $SO_2$ (ppm) | $H_2S$ (ppm) | Pb $(\mu g/m^3)$ | Ni $(\mu g/m^3)$ | Cr $(\mu g/m^3)$ |
|---|---|---|---|---|---|---|---|
| **1** | 947.09 | 0 | 0.2 | 0 | 15.1 | 3.91 | 1.53 |
| **2** | 1013.22 | 0 | 0.3 | 0 | 20.6 | 4.05 | 1.73 |
| **3** | 4567.7 | 0 | 0.5 | 0.1 | 85.3 | 25.23 | 2.9 |
| **4** | 1036.90 | 0 | 0 | 0 | 6.5 | 1.52 | 1.15 |
| **5** | 8687.5 | 0.2 | 0.7 | 0.2 | 125.7 | 52.54 | 3.01 |
| **6** | 3561.76 | 0.1 | 0.9 | 0.1 | 63 | 33.12 | 3.5 |
| **7** | 994.52 | 0.2 | 0 | 0.1 | 9.6 | 2.13 | 1.63 |
| **8** | 880.12 | 0.3 | 0 | 0 | 15.3 | 1.7 | 1.51 |
| **9** | 1021.98 | 0 | 0.1 | 0 | 11.9 | 1.38 | 1.24 |
| **Mean** | 2523.42 | 0.09 | 0.3 | 0.06 | 39.22 | 13.95 | 2.02 |
| **10 (Al-Jadria area)** | 1119.266 | 0 | 0 | 0 | 0.42 | 0.31 | 0 |
| **(WHO, 2000)** | 35-220 | - | - | 0.05 | 0.5 | 0.2 | $4x10^{-2}$ |
| **(NAAQS),1997** | - | 0.053 | 0.14 | - | - | - | - |
| **(Al-Sultany,2006)** | 2391.80 | - | - | - | 26.1 | 8.72 | 1.81 |
| **(Al- Maliky,2005)** | 390.3 | - | 0.98 | - | 2.52 | - | - |

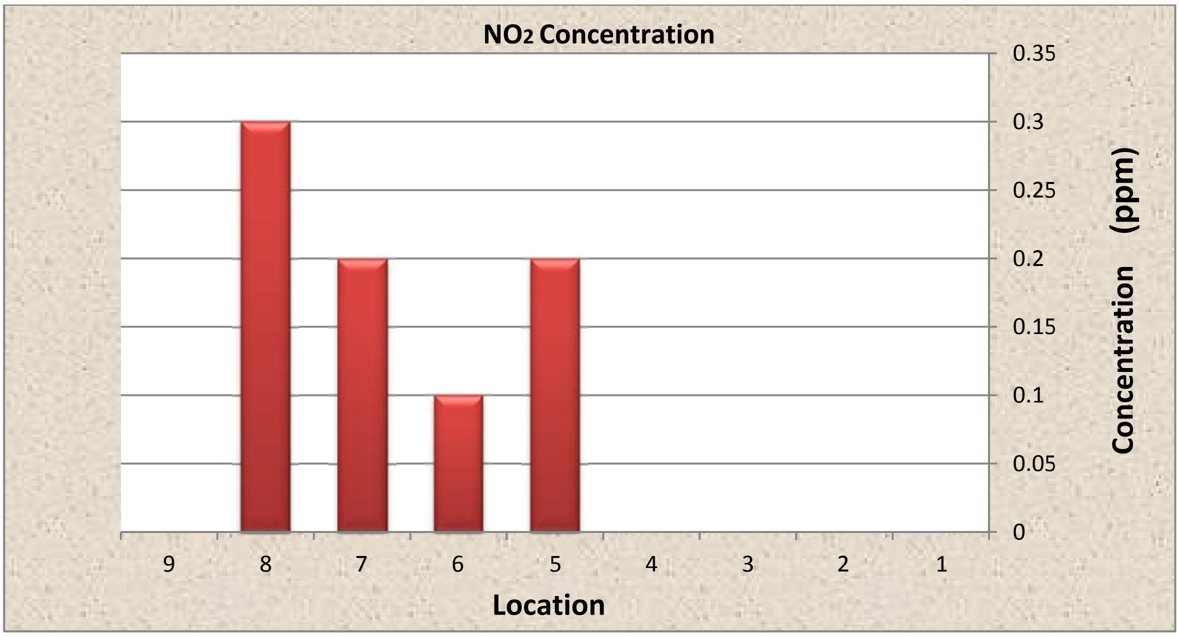


ir of the

### 4.2.1.2. Nitrogen dioxide ($NO_2$)

Nitrogen dioxide is one of the most important air pollutants in urban areas. Urban concentrations of nitrogen oxides are frequently higher than in other areas and near emission sources. Short and long term exposure to $NO_2$ can induce health effects. The health effects related to the two types of exposure are often different in character, (Berglund *et al*, 1993).

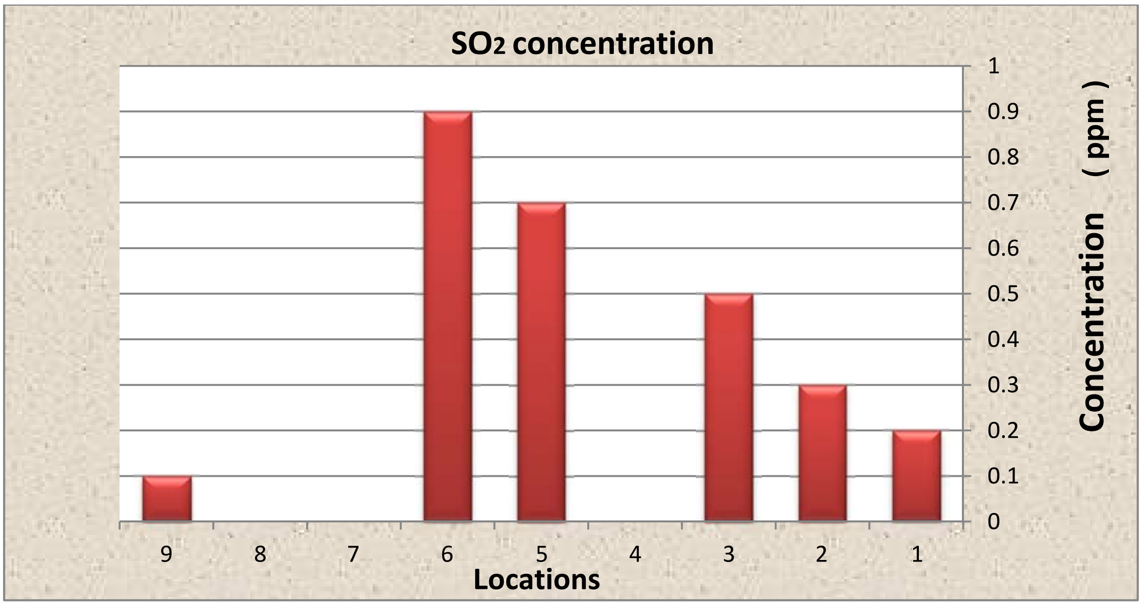
The result of table (4-1) and figure (4-2) show that the mean of nitrogen dioxide in the air of the study area (0.09 ppm) has exceeded the allowable limits of the (National Ambient Air Quality Standard, 1997) (0.053 ppm) .It can be concluded from this that the air of the study area is polluted with nitrogen dioxide resulting from burning of heavy oils at brick factories products.



### 4.2.1.3. Sulfur Dioxide ($SO_2$)

Sulfur dioxide ($SO_2$), a colorless, reactive gas, is produced during the burning of sulfur-containing fuels such as coal and oil, during metal smelting, and by other industrial processes. Generally, the highest concentrations of sulfur dioxide are found near large industrial sources. Long-term exposure to both sulfur dioxide and fine particles can cause respiratory illness, alter the lung's defense mechanisms, and aggravate existing cardiovascular disease, (EPA, 2000).

Table (4-1) and figure (4-3) show that the highest concentration of sulfate dioxide at the study area is recorded at location number (6) located near tannery factories and the lowest concentration is recorded in locations (4,7,8) are (zero) as these are located far from the brick factories. The mean of $SO_2$ concentrations (0.3 ppm) which is above the allowable limits of (0.14 ppm) but it has decreased in general as compared with previous study by Al- Maliki, (2005) which was (0.98 ppm). This decrease in concentrations may be related to seasonal or economic factors, most of the constant source varies in concentrations with time.



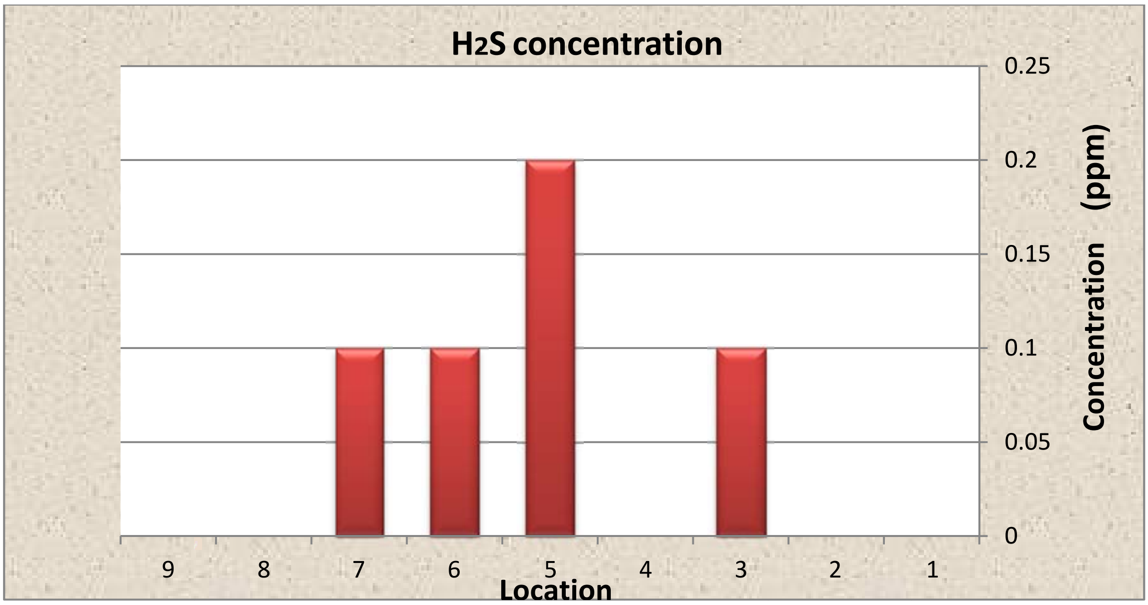
study

#### 4.2.1.4 Hydrogen sulfide ($H_2S$)

It occurs naturally in crude petroleum, natural gas, and hot springs. In addition, hydrogen sulfide is produced by bacterial breakdown of organic materials and human and animal wastes (e.g., sewage). Industrial activities that can produce the gas include petroleum/natural gas drilling and refining, wastewater treatment, coke ovens, tanneries, and Kraft paper mills. Hydrogen sulfide can also exist as a liquid compressed gas, (OSHA, 2005).

Its health effects can vary depending on the level and duration of exposure. Repeated exposure can result in health effects occurring at levels that were previously tolerated without any effect. High concentrations can cause shock, convulsions, inability to breathe, extremely rapid unconsciousness, coma and death. Effects can occur within a few breaths, and possibly a single breath, (OSHA, 2005).

The highest concentration of ($H_2S$) in the air of the study area is recorded at location number (5) which is (0.2 ppm) and the lowest is recorded at locations (1,2,4,8,9) which is (zero) ($H_2S$) as shown in table (4-1) and figure (4-4), and the mean of ($H_2S$) is (0.06ppm). By comparing this mean with the allowable limits of the (World Health Organization, 2000) (0.05 ppm) it is found that this mean has exceeded these limits and that indicates that the air of the study area is polluted with ($H_2S$) gas.



ıe study

### 4.2.1.5. Heavy Metals

The combustion of fossil fuel contributes heavily to the release of heavy metals in the environment, especially into the atmosphere. The deposition of fly ash from fossil fuel combustion leads to the mobilization of heavy metals into surface waters, soils, and ground waters (Adriano, 2001).

### 1. Lead (Pb)

Lead is the most abundant of the heavy metals in the earth's crust. Exposure to and uptake of this element have consequently increased. At high levels of human exposure there is damage to almost all organs and organ systems, most importantly the central nervous system, kidneys and blood, culminating in death at excessive levels, (WHO,2000).

The most common ways of contact with Pb is through the air and exposure to dust, and dig ingestion of food and water. The most significant source of Pb poisoning in children is considered to be dust contaminated by Pb – based paint, (Bradl, 2005).

The concentration of (Pb) in the air of the study area ranges from (6.5µg/m$^3$) at locations number (4) to (125.7 µg/m$^3$) at the location number (5) and the mean is (39.22µg/m$^3$) as shown in table (4-1) and figure (4-5). Comparing this mean with the concentration that recorded in Al-Jadria area and previous studies during (2005 and 2006) show that its much higher and also has exceeded the allowable limits (0.5µg/$m^3$) all that indicates that the air of the study area is highly polluted with Pb at exceeding levels comparing with previous years , table (4-1).

The cause of the high concentrations of (Pb) at the sites number (3,5,6) was due to its location at the center of the brick factories, and the more farther the distance from the brick factories (the most polluted locations) the less the concentrations have become at locations number (1,2,4,7,8) and also because these factories were located at the north and north - west direction of the study area that means that the products (smoke) released from brick factories is carried away by the prevailing winds in the study area and Iraq in general to the southwest.

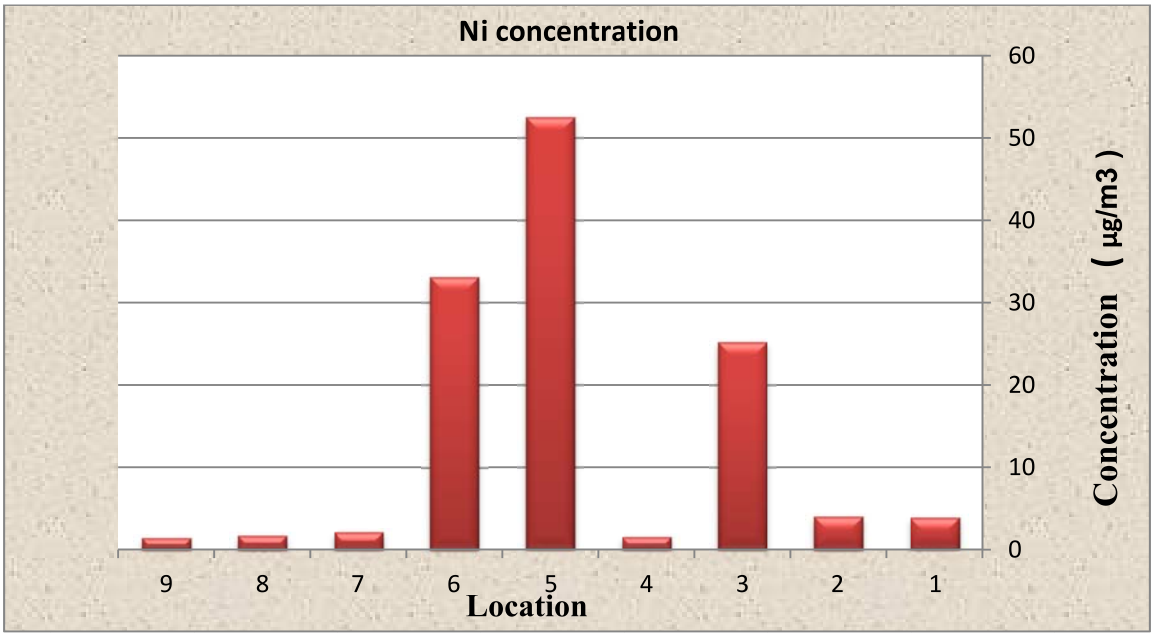
rea

**2. Nickel (Ni)**

The anthropogenic sources of nickel to the atmosphere are primarily from fossil fuel (oil and coal) combustion, high-temperature metallurgical operations, and nickel primary production operations (European Communities, 2001).

Contact dermatitis is one of the most common effects reported by people exposed to Ni compounds via other exposure routes (ATSDR, 1997).

Table (4-1) and figure (4-6) showed that the highest concentrations of (Ni) were in locations number (5, 6, and 3) and the lowest concentrations were at location number (1, 2, 4, 7, 8, and 9), the mean is (13.95µg/m$^3$). All the locations have exceeded the allowable limits (0.02 µg/m$^3$) according to (the World Health Organization, 2000). By comparing the mean of (Ni) in the air of the study area with the concentration recorded in Al – Jadria area and previous study in 2006 so that mean the pollution of (Ni) in the air of the study area has increased in last six years. The increase in concentrations in the last years belong to expanding in the industrial activities within the area which represented by brick factories, which is responsible for most of the increasing in other contaminants.



rea

## 3. Chromium (Cr)

Chromium has released into the environment primarily as a result of industrial activity. Chromium is not an essential nutrient. High air levels (2 µg/m$^3$) may cause irritation of nasal mucosa, nose bleeds, ulcers and holes in the nasal septum. High exposure levels may also cause skin ulcers. The main cause for concern with chromium (VI) is induction of lung cancer after long-term exposure to this toxicant, (ATSDR, 1993).

The results in table (4-1) and figure (4-7) showed that all concentrations of (Cr) in the air of the study area have exceeded the allowable limits of (the World Health Organization, 2000) (0.02µg/m$^3$), whereas the mean in the current study is (2.02µg/m$^3$) and the concentration of (Cr) ranges from (1.15 µg/m$^3$) at location number (4) to (3.5 µg/m$^3$) at location number (4) and the high concentration at location (6) is because this sample was taken near the tannery factories which uses chromium in the tanning industry. But in general (Cr) concentration levels show high levels more than the allowable limits, which of course has related to the burning of heavy oil at brick factories.

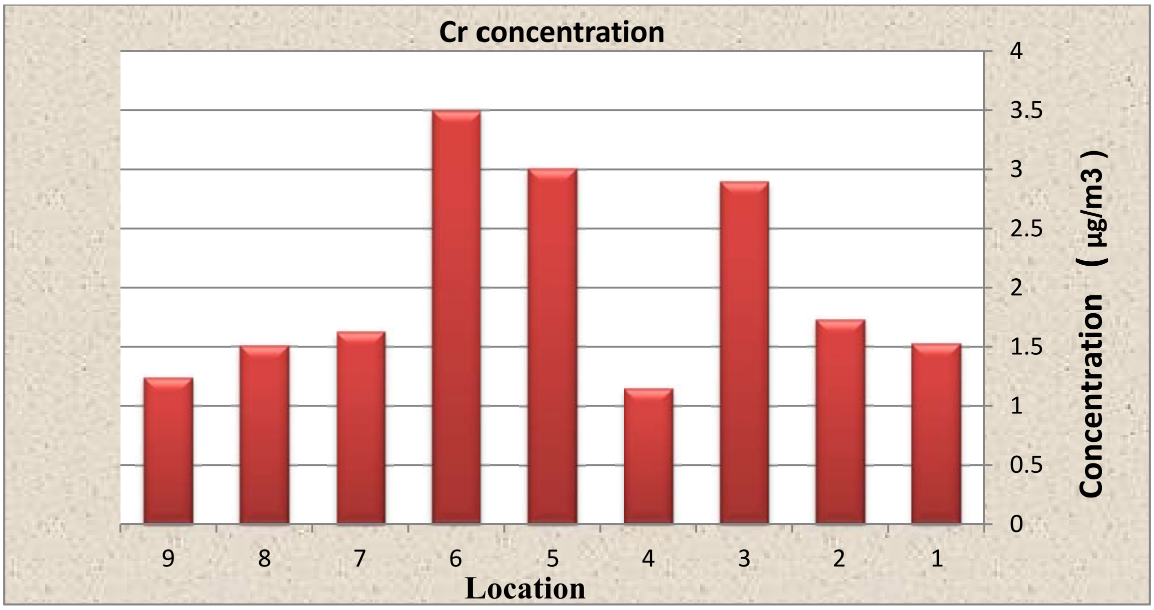


Figure (4-7): Distribution of chromium (Cr) concentrations in the air of the study area

## 4.3. Water pollution

Water pollution is a qualitative term that describes the situation when the level of contaminants impedes an intended water use. Major sources of surface water contamination are construction, municipalities, agriculture, and industry. The pollution of groundwater can occur in many forms, including hazardous industrial organic compounds, fuel components, heavy metals and salinity, (Peper *et al*.,2006).

### 4.3.1. Surface and groundwater quality of the study area

Eleven water samples were collected, figure (2-5) page 27.

#### 4.3.1.1. Physical properties

The main cause of studying the physiochemical characteristics of surface and groundwater are to determine water quality and the degree of pollution, (Detay, 1997).

#### 1. Temperature

Temperature has impact on the acceptability of a number of other of inorganic constituents that may affect taste, (Who, 2006). Temperature affects the geochemical and chemical reactions (Mather in Seather, 1997). The temperature of water samples shown in table (4-2) below:

Table (4-2) Temperature recorded in the field for surface and groundwater samples

| **Sample No.** | **Temperature ($C^o$)** |
|---|---|
| **W1** | **24** |
| **W2** | **22** |
| **W3** | **23** |
| **W4** | **22** |
| **W5** | **22** |
| **QW6** | **22** |
| **WW7** | **25** |
| **W8** | **23** |
| **W9** | **23** |
| **W10** | **22** |
| **IW11** | **22** |
| **Mean** | **23** |

## 2. Hydrogen Ion Concentration (pH)

The pH defined as the negative, base 10, logarithm of the hydrogen ion activity. Most reaction in gas, water, rock systems involve or are controlled by the pH of system (Lungmuir, 1997).

The pH values ranges from (7) at location (2) to (8.2) at both locations (4 and 6) were recorded in the spring season. Comparing the values of (pH) for the study area with the Iraqi allowable limits show that the values within the normal range as shown in table (4-3).

Table (4-3): Physical properties of surface and ground water at the study area

| Sample NO. | Depth (m) | pH | T.D.S (mg/l) | Hardness (ppm) |
|---|---|---|---|---|
| **W1** | 12 | 7.15 | 1830 | 849.42 |
| **W2** | 6 | 7 | 5460 | 5177.38 |
| **W3** | 8.5 | 7.31 | 1998 | 1017.95 |
| **W4** | 12 | 8.2 | 2110 | 1291.57 |
| **W5** | 25 | 7.32 | 2470 | 1091.05 |
| **QW6** | 8 | 8.2 | 26624 | 7975.94 |
| **WW7** | surface | 7.2 | 33386 | 10051.23 |
| **W8** | 10 | 7.67 | 2502 | 1156.42 |
| **W9** | 28 | 7.7 | 4850 | 776.25 |
| **W10** | 8 | 7.9 | 2320 | 1002.33 |
| **IW11** | surface | 7.8 | 2520 | 1118.43 |
| **Mean** | - | 7.58 | 7824.54 | 2864.36 |
| **Iraqi limits (2009)** | - | 6-8.5 | 1500 | 160-480 |

## 3. Total Dissolved Solids (T.D.S)

The concentration of (T.D.S) in the water of the study area ranges from (1830 mg/l) at location (1) to (33386 mg/l) at location (7) and the mean is (7824.54mg/l) as shown in table (4-3). All concentrations of

(T.D.S) in the study area have exceeded the allowable limits (1500mg/l). According to (Altoviski, 1962), (Gorrel, 1968) and (Drever, 1997) classification of water depending on the concentration of (T.D.S) the water is classified as brackish water table (4-4).The high (T.D.S) values are related to the high soil salinity and to natural occurrence of gypsum.

Table (4-4): Classification of water by total soluble salts (TDS)

| **Water class** | **Gorrel, 1968** | **Atovisk, 1962** | **Drever, 1997** |
|---|---|---|---|
| **Fresh water** | **0-1000** | **0-1000** | **<1000** |
| **Slightly brackish** | **-** | **1000-3000** | **-** |
| **Brackish water** | **1000-10000** | **10000-100000** | **-** |
| **Saline water** | **-** | **-** | **35000** |
| **Brine water** | **>100000** | **>100000** | **>35000** |

## 4. Total Hardness (TH)

The results of table (4-3) show that the concentration of total hardness during this study is variable; the concentration of (TH) ranges from (776.25 ppm) at location number (9) to (10051.23 ppm) at location number (7) and the mean is (2864.36ppm).

All concentrations of total hardness in the water of the study area have exceeded significantly the allowable limits as shown in table (4-3). The excessive increasing in the (TH) value at location (7) belongs to waste water influenced by the tannery factories as these factories use huge amount of salt as requirements for the tanning industry.

The high value of (TH) at (QW6) which represent quarry water that and old quarries lying at low land areas (20) m below the land surface) allow water to accumulate.

### 4.3.1.2. Major Elements

#### 4.3.1.2.1. Cations

#### 1. Sodium ($Na^{+1}$)

Sodium is a common element in the environment and occurs widely in soils, plants, water, and foods. Sodium chloride is the most economically and industrially important form of sodium, with an estimated 14,000 direct and indirect uses. Sodium ion is ubiquitous in water, owing to the high solubility of its salts and the abundance of Sodium-containing mineral deposits (Kostick 1993).

The concentration of (Na) in the water of the study area ranges from (196.88 ppm) at locations (4) to (8294.49 ppm) at location (7) and the mean is (1727.13 ppm) as shown in table (4-5). Comparing this mean with the Iraqi allowable limits show that it has exceeded significantly the allowable limits. High sodium values were related to high (T.D.S) value which attributed to the influence leached from agricultural land and some small sabkha in the study area and also for high salt content within the soil, high salts that used in tannery industry.

#### 2. Potassium ($K^{+1}$)

Although potassium is an abundant element and its common salts are highly soluble, it seldom occurs in high concentrations in natural waters because of the high degree of stability of potassium-bearing aluminosilicate minerals (Hem, 1989).

The concentration of ($K^{+}$) in the study area ranges from (1.69) ppm at location (1) to (27.37) ppm at location (7) with mean of (8.22) ppm and this mean is within the allowable limits as shown in table (4-5).

Table (4-5): Concentrations of cation, anion and $H_2S$ gas in the water of the study area measured

| Locations | $Ca^{+2}$ | $Mg^{+2}$ | $K^{+1}$ | $Na^{+1}$ | $HCO_3^{-1}$ | $Cl^{-1}$ | $NO_3^{-2}$ | $SO_4^{-2}$ | $H_2S$ |
|---|---|---|---|---|---|---|---|---|---|
| **W1** | 216.43 | 75.09 | 1.69 | 290.49 | 202.52 | 477.48 | 0 | 572.64 | 21.42 |
| **W2** | 1485.36 | 356.85 | 2.35 | 894.93 | 85.40 | 3463.74 | 474.30 | 1708.80 | 20.10 |
| **W3** | 244.29 | 99.14 | 3.91 | 293.02 | 212.28 | 481.03 | 0 | 744.96 | 20.40 |
| **W4** | 301.20 | 131.10 | 5.87 | 196.88 | 100.04 | 380.92 | 0 | 990.72 | 20.40 |
| **W5** | 291.38 | 88.33 | 3.52 | 360.18 | 185.44 | 176.08 | 0 | 1384.32 | 19.70 |
| **QW6** | 641.28 | 1549.13 | 20.72 | 6042.79 | 122.00 | 5502.50 | 0 | 12672.00 | 18.70 |
| **WW7** | 8411.68 | 1931.85 | 27.37 | 8294.49 | 244.00 | 13312.50 | 0 | 8780.64 | 20.40 |
| **W8** | 237.27 | 137.05 | 10.56 | 406.87 | 280.60 | 486.25 | 0 | 1055.04 | 19.70 |
| **W9** | 139.88 | 103.76 | 5.87 | 1388.28 | 309.88 | 967.38 | 0 | 2047.68 | 20.40 |
| **W10** | 185.17 | 131.22 | 4.30 | 404.11 | 153.72 | 473.57 | 0 | 1003.20 | 19.70 |
| **IW11** | 235.67 | 128.79 | 4.30 | 426.42 | 261.08 | 478.54 | 0 | 1066.08 | 20.40 |
| **Mean** | 1217.31 | 430.21 | 8.22 | 1727.13 | 196.08 | 2381.81 | 43.11 | 2911.46 | 20.12 |
| **Iraqi limits (2009)** | 200 | 50 | 15-20 | 200 | 170 | 200 | <50 | 400 | - |

## 3. Magnesium ($Mg^{+2}$)

Sedimentary forms of magnesium include carbonates such as magnesium, hydromagnesium and mixtures of magnesium with calcium carbonate (Helstrup et al; 2007).

Table (4-5) showed that the concentration of (Mg ) in the water of the study area ranged from (75.09 ppm) at location number (1) to (1931.85 ppm) at location number (7) and the mean is (430.21ppm). All concentrations of (Mg) in the water of the study area have exceeded the Iraqi allowable limits.

### 4. Calcium ($Ca^{+2}$)

Calcium is the most abundant of the alkaline – earth metals and is a major constituent of many common rock minerals. It is an essential element for plant and animal life form, and is a major component of solutes in most natural water (Hem, 1989).

The concentration of (Ca) in the water of the study area ranges from (139.88) ppm at location (9) to (8411.68) ppm and at location (7) the mean is (1217.31 ppm) as shown in table (4-5). Most of the concentrations of (Ca) have exceeded the Iraqi allowable limits.

## 4.3.1.2.2. Anions

### 1. Chloride ($Cl^{-1}$)

Chloride is the anion of the element chlorine. Chlorine seldom occurs in nature, but is usually found as chloride. The chlorides of alkali and alkaline earth metals are all highly soluble in water, for example, sodium, potassium, calcium, and magnesium (Hem, 1992,).

The concentration of (Cl) in the water of the study area ranges from (176.08) recorded at location number (5) to (13312.50) ppm recorded at location number (7) and the mean is (2381.81 ppm). Table (4-5) show that most of the concentrations have exceeded significantly the allowable limits.

### 2. Bicarbonate ($HCO_3^{-1}$)

Bicarbonate and carbonate are the producer of alkalinity which is the capacity for solutes it contains to react with and neutralize acid. The principle source of carbon dioxide species that produce alkalinity in surface or ground water is the $CO_2$ gas fraction of the atmosphere, or the atmospheric gases present in the soil or in the unsaturated zone lying between the surface of the land and the water table (Ljungberg, 2004).

The concentration of ($HCO_3^{-1}$) in the water of the study area ranges from (85.40ppm) at location number (2) to (309.88 ppm) at location number (9) and the mean is (196.08 ppm). Comparing these concentrations with the Iraqi allowable limits table (4-5) show that most of these concentrations have exceeded the allowable limits.

### 3. Sulfate ($SO_4^{-2}$)

The natural sources of sulfate are from (dissolution of evaporated rocks), or may be derived from chemical fertilizers, detergents, pesticides and tannin (WHO, 2006).The presence of sulfate in drinking water can cause noticeable taste, and very high levels might cause a laxative effect in unaccustomed consumers, (WHO, 2006).

The concentrations of ($SO_4$) in the water of the study area ranges from (572.64) ppm at location (1) to (12672.00) ppm at location (6) and the mean is (2911.46 ppm). Table (4-5) show that all concentrations of ($SO_4$) have exceeded the allowable limits. The high value of ($SO_4$) related to high salt content in the soil and because of sabkha, also to the natural occurrence of gypsum.

## 4.3.1.3. Minor compounds

### 1. Nitrate ($NO_3^{-2}$)

Nitrate ions ($NO_3$) found in freshwater samples result from a variety of natural and manmade sources. Nitrate levels in freshwater are usually less than 1 mg/l but manmade sources of nitrate may elevate levels above 3 mg/l. Levels above 10 mg/l in drinking water can cause a potentially fatal disease in infants called methemoglobinemia, or Bluebaby Syndrome (nitrate converts hemoglobin into a form that can no longer transport oxygen, (WHO, 1999).

Table (4-5) show that the mean of nitrate in the water of the study area is within the allowable limits except the concentration that recorded at location number (2) has value of (474.30 ppm) which highly has exceeded the allowable limits and that high value might be related to agricultural land and fertilizer, might be (W2) located within the leaching field of the septic system for natural water treatment, then led to the ground water contamination of (W2) by the raw sewage, because of oxygen levels in the saturated soil of the leaching field are often too low to permit rapid aerobic break down of organic matter.

#### 4.3.1.4. Hydrogen Sulfide ($H_2S$)

When the concentration of ($H_2S$) exceeds (0.05 mg/l) in drinking water it irritates mucous and cause nausea, vomiting and epigastric pain following ingestion, and when inhaled, hydrogen sulfide is highly acutely toxic to human, it formed a complex with ($Fe^{+3}$) of the mitochondrial, herby blocking oxidative metabolism, (WHO,2006).

The rotten-egg odor of hydrogen sulfide can be detected by most people in water that have only a few tenths of milligram per liter of this material in solution. ($H_2S$) is generated in natural water by sulfide reduction, all plants, animals, and bacteria metabolize sulfur in order to synthesize amino acid such as cysteine and methionine, (Langmuir,1997).

Most people can detect hydrogen sulfide ($H_2S$) in water by the “rotten egg” smell at concentrations of (0.5 to 1.0mg/l). Although in very rare circumstances hydrogen sulfide gas released from water into closed spaces can buildup to toxic or flammable levels, (WHO,2006).

Test results shows the presence of hydrogen sulfide gas in all water samples of the study area ranges from (18.7 – 20.42 ppm) with mean of (20.12) as shown in table (4-5) and these high values were mainly due to burning of heavy oil.

#### 4.3.1.5. Trace (heavy metals) elements in water of the study area

Metals in our water supply may occur naturally or may be the result of contamination. Naturally occurring metals are dissolved in water when it comes into contact with rock or soil material. Other sources of metal contamination are corrosion of pipes and leakage from waste disposal sites, (WHO, 2000). Table (4-6) show the examples of metal pollutants commonly released in wastewaters from various industries.

Table (4-6): Principal trace metals in industrial wastewaters (Montgomery, 2006)

| Industry | Metals |
|---|---|
| Fertilizers | Arsenic, cadmium, chromium, copper, lead, mercury, manganese, nickel, zinc |
| Petroleum refining | Arsenic, cadmium, chromium, copper, lead, nickel, vanadium, zinc |

### 1. Lead (Pb)

Lead is a cumulative general poison, with infants, children up to 6 years of age, the fetus and pregnant women being the most susceptible to adverse health effects. Its effects on the central nervous system can be particularly serious, (WHO, 2011).

The concentrations of the (Pb) in all locations were less than (1.25 ppm) comparing the current results with that of previous studies for (Pb) in (Shanshal, 2004) and (Ali, 2012); (< 0.25), (0.001) ppm respectively, show that the concentrations has increased in the last nine years; also these concentrations have exceeded the allowable limits (0.07ppm) of (EPA, 2005). This increase in (Pb) in the last nine years related to increasing of industrial activities and vehicles within the area.

### 2. Nickel (Ni)

Nickel enters groundwater and surface water by dissolution of rocks and soils, from atmospheric fallout, from biological decays and from waste disposal. Many nickel compounds are relatively soluble in water, especially at pH values less than 6.5, and generally exist as nickel ions in aqueous systems; water-soluble nickel compounds are more acutely toxic than the less soluble ones, (PHG, 2001).

Table (4-7) shows that the concentration of nickel in all water samples of the study area are less than (0.5 ppm) which is higher than its concentration in the Tigris River (0.02 ppm), (Maliki, 2005) and higher than its concentration in the Euphrates River (0.03 ppm), (Al- Sultani, 2006). Comparing these concentrations with the previous study for the water of the study area by (Shanshal, 2004) and (Ali, 2012); (< 0.2), (0.002) ppm respectively, show that the concentrations of (Ni) has increased in the last nine years, also these concentrations have exceeded the Iraqi allowable limits (0.1ppm).

Table (4-7): Concentration of heavy metals in water samples of the study area and mean concentration of previous studies

| Sample No. | Cr (p.p.m) | Ni (p.p.m) | pb (p.p.m) | Cd (p.p.m) |
|---|---|---|---|---|
| W1 | < 0.75 | < 0.5 | < 1.25 | < 0.15 |
| W2 | < 0.75 | < 0.5 | < 1.25 | < 0.15 |
| W3 | < 0.75 | < 0.5 | < 1.25 | < 0.15 |
| W4 | < 0.75 | < 05 | < 1.25 | < 0.15 |
| W5 | < 0.75 | < 0.5 | < 1.25 | < 0.15 |
| QW6 | < 0.75 | < 0.5 | < 125 | < 0.15 |
| WW7 | 4.0 | < 0.5 | < 1.25 | < 0.15 |
| W8 | < 0.75 | < 0.5 | < 1.25 | < 0.15 |
| W9 | < 0.75 | < 0.5 | < 1.25 | < 0.15 |
| W10 | < 0.75 | < 0.5 | < 1.25 | < 0.15 |
| IW11 | < 0.75 | < 0.5 | < 1.25 | < 0.15 |
| (Shanshal, 2004) Al- Nahrawan area | < 0.5 | < 0.2 | < 0.25 | < 0.01 |
| (Ali, 2012) Baghdad city | 0.001 | 0.002 | 0.001 | 0.13 |

* Detection limit of the device read for (Cr = < 0.75, Ni = < 0.5, Pb = <1.25, Cd = < 0.15)

### 3. Cadmium (Cd)

The major sources of cadmium in water are corrosion of galvanized pipes; erosion of natural deposits; discharge from metal refineries; runoff from waste batteries and paints. Some people who drink water containing cadmium well in excess of the maximum contaminant level (MCL) for many years could experience kidney damage, (EPA, 2011).

In humans, Cd interferes with the metabolism of Ca, vitamin D, collagen, and causes bone degenerations such as osteomalachia. Long term inhalation and oral exposure to Cd affects the kidneys and lungs, leading proteinuria, decreased glomerular filtration rate, and emphysema, (Friberg *et al,* 1971 in Bradl, 2005).

Table (4-7) show that the concentration of cadmium in all water samples of the study area were less than (0.15 ppm) which is higher than its mean in the Tigris River (0.05 ppm), (Al-Maliki, 2005) and is higher than its mean in the Euphrates River (0.01 ppm), (Al- Sultani, 2006).Also it was higher than its mean in Water River (0.005 ppm) according to the Iraqi standards, (Salman, 2007). Comparing this mean with previous study mean of (Shanshal, 2004) and (Ali, 2012); (<0.01), (0.13) ppm respectively show that the concentrations of (Cd) were increased the last nine years.

### 4. Chromium (Cr)

Metallic chromium is used mainly for making steel and other alloys. Chromium compounds in either the chromium-3 or chromium-6 forms are used for chrome plating, dyes and pigments, leather and wood preservation.Chromium-3 has relatively low toxicity and would be a concern in drinking water only at very high levels of contamination; Chromium-6 is more toxic and poses potential health risks. People who use water containing total chromium in excess of the maximum contaminant level (MCL) over many years could experience allergic dermatitis, (EPA, 2011).

Cr is used in a wide variety of applications, e.g. in the paper industry, chemical industry, in fertilizers, metal works and foundries, leather tanning and finishing, and power plants, (Bradl, 2005).

Table (4-7) show that the concentration of chrome in water samples of the study area are all less than (0.75 ppm), except sample (W7) (4 ppm) which was taken from waste water resulted from tannery factories and all these concentrations are higher than the mean of Cr in

Euphrates River (0.11 ppm), (Al-Sultani, 2006). Also it was higher than its mean in Freshwater (0.02 ppm) according to (EPA, 2005). Comparing these results with that deduced by (Shanshal, 2004) and (Ali, 2012); (< 0.5), (0.001) ppm respectively, show that the concentrations of (Cr) has increased in the last nine years.

The increment in trace element as a whole could be related to waste water, tannery factories, industrial activities including brick factories, and sanitary land fill sites all these parameters contribute significantly in the increasing of concentrations of these elements.

## 4.4. Soil pollution

Soil pollution is defined as the build-up in soils of persistent toxic compounds, chemicals, salts, radioactive materials, or disease causing agents, which have adverse effects on plant growth and animal health, (EPA,2009).

### 4.4.1. Geochemistry and mineralogy of soil

Geochemistry and mineralogy of soil have been investigated, the results involve determine the concentrations of major oxides and trace elements for all samples. Whereas five soil samples from different locations representing different land use classes are chosen to determine clay minerals by using (X-ray Diffraction), figure (2-7) page 34.

### 4.4.1.1. Major Oxides

### 1. Silica ($SiO_2$)

Silica percentage in the soil samples of the study area ranged from (37.89 -44.77) % and with an mean of (40.31 %) as shown in table (4-7), This content of silica in the soil of the study area is higher than the rate of global silica in the soil which (33.0)% (Rosler,1972)and this due to the presence of silica content within the crystalline structure of clay minerals in addition to its presence in the form of metal quartz (Quartz), as shown the results of X-ray diffraction(X. R. D.) in the studied samples figure (4-10) and table (4-8).

### 2. Iron oxide ($Fe_2O_3$)

Iron oxide percentage in the soil samples of the study area ranges from (3.71-4.73) % and with mean of (4.34%) as shown in table (4-8).Iron oxides play an important role in adsorption reactions and are found in almost all soils, even if it was in low and affecting the color of the soiland the absorption of ions, (Silviera et al., 2003).

Table (4-8): Percentage of major oxides concentrations in the selected soil samples of the study area

| Sample No. | $SiO_2$% | $Fe_2O_3$% | $Al_2O_3$% | CaO% | MgO% | $SO_3$% | L.O.I% | $Na_2O$% | $K_2O$% | TC% | TS% |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **S1** | 38.95 | 3.71 | 8.62 | 16.92 | 4.08 | 3.08 | 19.7 | 2.99 | 1.31 | - | - |
| **S2** | 42.29 | 4.41 | 10.29 | 15.92 | 4.27 | 0.53 | 18.99 | 1.2 | 1.38 | - | - |
| **S3** | 40.86 | 4.68 | 10.98 | 15.15 | 4.55 | 0.8 | 19.42 | 1.1 | 1.47 | 3.861 | 0.324 |
| **S4** | 41.11 | 4.31 | 10.29 | 17.69 | 3.79 | 1.05 | 19.26 | 0.54 | 1.28 | - | - |
| **S5** | 39.07 | 3.95 | 9.59 | 17.33 | 3.92 | 2.4 | 20.23 | 1.85 | 1.09 | - | - |
| **S6** | 37.89 | 4.55 | 11.02 | 15.57 | 5.33 | 3.03 | 19.51 | 1.34 | 1.44 | 3.632 | 1.22 |
| **S7** | 37.89 | 4.65 | 11.36 | 14.91 | 5.24 | 1.5 | 20.38 | 1.98 | 1.38 | - | - |
| **S8** | 40.59 | 4.61 | 11.34 | 16.7 | 4.45 | 0.33 | 19.34 | 0.41 | 1.31 | 4.654 | 0.107 |
| **S9** | 40.28 | 4.37 | 10.87 | 16.99 | 3.94 | 1.24 | 19.36 | 1 | 1.27 | - | - |
| **S10** | 39.45 | 4.12 | 10.34 | 16.31 | 4.3 | 0.86 | 20.55 | 2.15 | 1.24 | - | - |
| **S11** | 40.18 | 4.36 | 11.1 | 16.95 | 3.77 | 1.07 | 19 | 1.6 | 1.29 | - | - |
| **S12** | 44.77 | 3.96 | 9.8 | 17.33 | 3.14 | 0.33 | 18.26 | 0.55 | 1.15 | - | - |
| **S13** | 40.21 | 4.73 | 9.56 | 15.37 | 5.57 | 0.55 | 20.39 | 1.52 | 1.39 | - | - |
| **S14** | 41.14 | 4.13 | 8.8 | 19.05 | 3.71 | 1.1 | 19.65 | 0.5 | 1.21 | - | - |
| **S15** | 40.32 | 4.41 | 9.56 | 16.63 | 4.34 | 0.89 | 20.12 | 1.7 | 1.34 | - | - |
| **S16** | 41.23 | 4.56 | 10.39 | 16.44 | 5.04 | 0.08 | 19.5 | 0.51 | 1.36 | 4.291 | 4.95 |
| **S17** | 39.16 | 4.31 | 9.79 | 16.91 | 4.7 | 0.78 | 20.82 | 1.5 | 1.35 | - | - |
| **S18** | 40.27 | 4.42 | 9.98 | 17.71 | 4.29 | 0.09 | 20.45 | 0.42 | 1.43 | 5.271 | 6.57 |
| **Mean** | 40.31 | 4.34 | 10.20 | 16.66 | 4.35 | 1.09 | 19.71 | 1.27 | 1.31 | 4.34 | 2.63 |

### 3. Alumina ($Al_2O_3$)

Alumina percentage in the soil samples of the study area ranges from (8.62-11.36) % and with mean of (10.20%) as shown in table (4-8).The alumina content in the sediments of the study area is due to the presence of clay minerals rich in aluminum such as Kaolinite and Illite, as shown by the results of the X-ray diffraction (X. R. D.) in the studied samples figure (4-8).

### 4. Calcium Oxide (CaO)

Calcium percentage in the soil samples of the study area ranges from (14.91-19.05) % with mean of (16.66%) as shown in table (4-8).The calcium content in the study area is due to that calcite mineral ($CaCO_3$) which constitute an essential mineral in the sample and as shown in results of the X-ray diffraction.

### 5. Magnesium oxide (MgO)

Magnesium percentage in the soil samples of the study area ranges from (3.71-5.57) % with mean of (4.35%) as shown in table (4-8).The magnesium content in the sediments of the study area is due to the fact that the fine part of deposits of the area is rich in montmorillonite, which usually contains high concentrations of magnesium. Also the presence of very low proportions of dolomite in the sediments of the study area can be a source for magnesium and as shown by the results of X-ray diffraction, figure (4 - 8).

### 6. Sulphate ($SO_4$)

Sulphate percentage in the soil samples of the study area ranges from (0.08-3.08) % with an average of (1.09%) as shown in table (4-8).The sulphate content in the soil is due to the presence of saline groundwater and salts reaching the surface by capillary and as a result of high evaporation the salts are deposited between soil particles, (Parsons, 1957).

### 7. Loss on Ignition (L.O. I.)

Loss on Ignition percentage in the soil samples ranges from (18.99 - 20.82) % with mean of (19.71%) as shown in table (4-8).

### 8. Sodium oxide ($Na_2O$)

Sodium oxide percentage in the soil samples of the study area ranges from (0.41-2.99) % with mean of (1.27%) as shown in table (4-8).Sodium oxide content in the soil is due to its association with clay parts located within the ions of clay minerals and especially montmorillonite found in the soil of study area, (Weaver & Pollard, 1975).

### 9. Potassium oxide ($K_2O$)

Potassium oxide percentage in the soil samples of the study area ranges from (1.09 -1.47) % and with mean of (1.31%) as shown in table (4-8).The content of potassium oxide in the soil is due to the fact that origin of potassium in the source rocks exist in the most important mineral phases such as feldspar (which is exist in the soil of the study area),(Al-Bassam *et al*, 2002) and that shown by the results of X-ray diffraction and shown in figure (4 - 9).

A comparison between the current chemical composition of the soil at the study area with the chemical composition of the soil of previous studies to study the possible changes due to Human and industrial activity, as shown in the table (4 - 9).

Table (4 - 9): Comparison between the current chemical compositions with the chemical composition of soil with previous studies in the study area

| | $SiO_2$% | $Fe_2O_3$% | $Al_2O_3$% | CaO% | MgO% | $SO_3$% | L.O.I% | $Na_2O$% | $K_2O$% |
|---|---|---|---|---|---|---|---|---|---|
| Nahrawan area (Shaker, 1983) | 39.87 | 4.6 | 9.13 | 18.48 | 4.19 | 0.92 | 18.49 | 0.40 | 0.02 |
| Nahrawan area (Shanshal,2004) | 39.09 | 3.74 | 8.43 | 18.23 | 4.65 | 1.21 | 20.07 | 1.49 | 1.22 |
| Nahrawan area (current study) | 40.31 | 4.34 | 10.20 | 16.66 | 4.35 | 1.09 | 19.71 | 1.27 | 1.31 |

### 4.4.1.2. Total Carbon (TC)

Soils with high clay and silt content have generally high organic matter content. This is attributed to restricted aeration in finer-textured soils, reducing the rate of organic matter decomposition. Additionally, plant growth is greater in fine textured soils, resulting in a larger return of residues to the soil, in the top soil rich in sand, it is likely that organic carbon less protected are easily transported with wind and water runoff, (Mc Cauley et al, 2003).

Total carbon percentage in the five selected soil samples ranges from (3.63 -5.27 %) with mean of (4.34 %) as shown in table (4-8).

### 4.4.1.3. Total Sulphur (TS)

Sulfur in the soil occurs in two basic forms, organic and inorganic S. Sulfur in the form of sulfate is readily available to plants, but organic S accounts for 95 % of all S in most soils, as indicated by the close relations between organic C, total N, and total S (Alvarez V. et al; 2001).

Total sulphur percentage in the five selected soil samples ranges from (0.107-6.57%) with mean of (2.63%) as shown in table (4-8).

### 4.4.1.4. Grain size analysis

Grain size and grain size distribution are key factors in sediment logy. These parameters determine the mechanical properties of sediment and provide information on the origin and history of the latter; they also determine by which agent sediment can be eroded (Goossens, 2008).Table (4-10) shows that silt is dominant in the soil .

Table (4-10) The grain size distribution analysis of Al – Nahrawan Soil

| Sample No. | Clay % | Silt % | Sand % |
|---|---|---|---|
| **S3** | 33 | 62 | 5 |
| **S6** | 29 | 68 | 3 |
| **S8** | 32 | 64 | 4 |
| **S16** | 39 | 57 | 4 |
| **S18** | 36 | 55 | 9 |

### 4.4.2. X- Ray results of Soil

The procedure followed for clay mineral analysis was followed after Carroll (1970); Gibbs (1968); Gipson (1966); and Kinter (1956).

#### 4.4.2.1. Clay minerals

Five soil samples were selected which distributed over the study area and the clayey part has been analyzed using (X-ray diffraction XRD) and the results shown in table (4-11), figure (4- 8) and (4-9). The present clay minerals in the soil of the study area are:

1. **Montmorillonite**

Montmorillonite is a member of the smectite group, (Grim, 1968). On XRD diffractograms of air-dried oriented samples, montmorillonite is characterized by its reflection, mainly 001 reflection and ranges between (12 – 13 Å). When saturated with ethylene glycol it will swell to about 16.6 Å, when it is heated to 550 ºC the 001 reflection will collapse to about (10 Å). This collapse is often reflected to the exchange cations present and to the smectite itself (Poope et al., 2002). As shown in figure (4-8) and (4-9).

2. **Kaolinite**

Kaolinite yield X-ray diffraction patterns and characterized by 001 reflection (7.1) Å, without treatment and when glycolated. This reflection disappears when heated to 550°C. Reflections of 002 and 003 hkl were (3.57 and 2.38) Å, respectively figure (4-8) and (4-9).

The importance of Kaoline appears from an environmental perspective because it is among widespread clay minerals as well as it is used in construction, ceramic and porcelain field and enter medicine field (Wallace et al., 1975 in WHO, 2005).

3. **Palygorskite**

The X-Ray results showed palygorskite with characteristic peaks at (10.5, 6.4, 5.4, 4.5, 3.6 and 3.2 Å) for (110, 200, 130, 040, 240 and 400 hkl), respectively, (Thorez, 1976). Glycolation had minor effect, where the 110 reflection became 10.7 Å. At 550C° the 10.5Å peaks were noticeably shifted to about 10.0Å and the peak suffered significant reduction in intensity as shown in figure (4-8) and (4-9), due to further dehydration and possible folding of the structure (Soong,1992).

Depending on the width of 110 peak in the midhigh, it is possible to determine the crystallization degree of the palygorskite mineral (Kubler, 1964 in Mohammed, 1993).

XRD Figures of the studied samples show clearly that the palygorskite peak appeared as a sharp peak and consequently reflected high degree of crystallization.

Table (4- 11): X- Ray results for soil of the study area

| Sample No. | XRD | |
|---|---|---|
| | **Clay** | **Non Clay** |
| **S3** | Montmorillonite, Kaolinite, Palygorskite, Illite | Calcite , Quartz, Fledspar , Dolomite, Gypsum |
| **S6** | Montmorillonite, Kaolinite, Palygorskite, Illite | Calcite, Quartz, Gypsum, Feldspar, Dolomite |
| **S8** | Montmorillonite, Kaolinite, Palygorskite, Illite | Calcite , Quartz, Feldspar, Dolomite |
| **S16** | Montmorillonite, Kaolinite, Palygorskite, Illite | Calcite, Quartz, Feldspar, Dolomite |
| **S18** | Montmorillonite, Kaolinite, Palygorskite | Calcite, Quartz, Feldspar, Dolomite |

## 4. Illite

The X-Ray results show that Illite characterized by (10, 5 Å) for (001, 002) reflection, respectively, (Thorez, 1976). Reflections for this mineral unaffected by glycolation and heating, and it might reach to (9.9 Å), (Brown, 1961) as shown in figure (4-8) and (4-9).

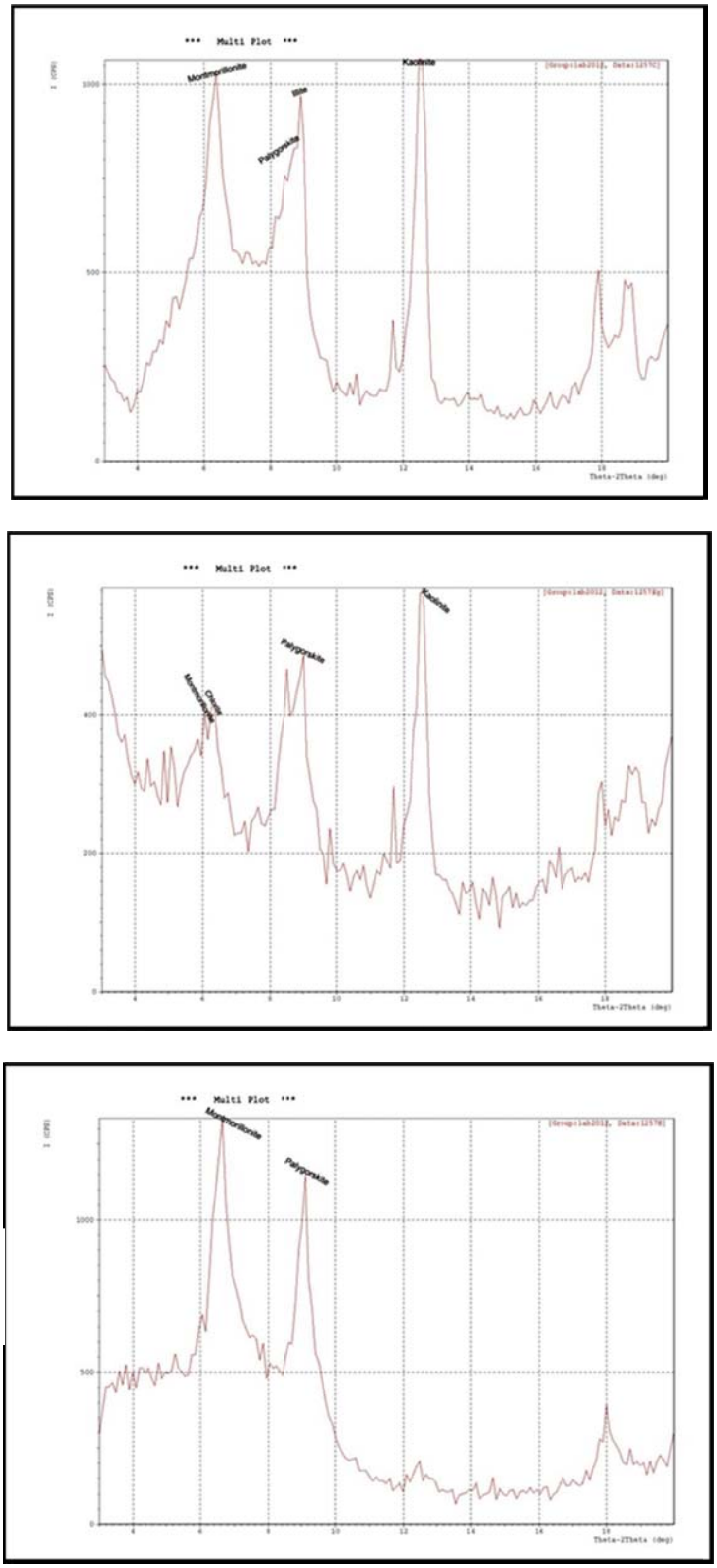


Figure (4-8): X-Ray diffractogram of clay minerals in soil sample (S3)

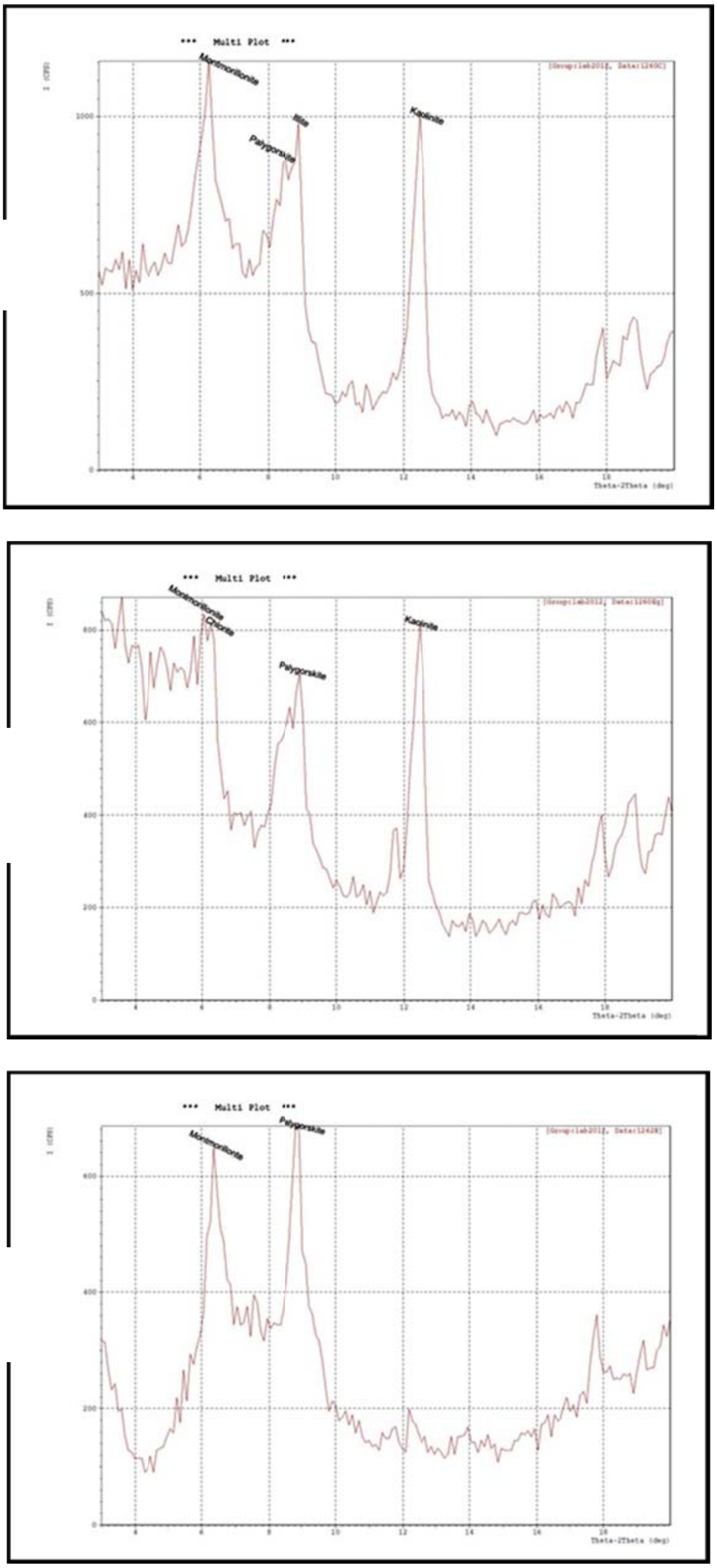


Figure (4-9): X-Ray diffractogram of clay minerals in soil sample (S6)

### 4.4.2.2. Non – Clay minerals

In addition to the above mentioned clay minerals, the following non-clay minerals were determined by XRD results. The procedures of (Gibson, 1966; Gibbss, 1968) and (Carroll, 1970) was used, as associated minerals with clay minerals:-

#### 1. Calcite

It is the most abundant non-clay mineral in the studied soil; According to the XRD results all selected samples contain Calcite. Calcite is characterized by the peak of 3.04 Å for 104 reflections figure (4- 10).

#### 2. Quartz

Quartz was characterized by the peaks (3.33 and 4.6 Å) for reflections (101 and 100), respectively figure (4- 10).

#### 3. Feldspar

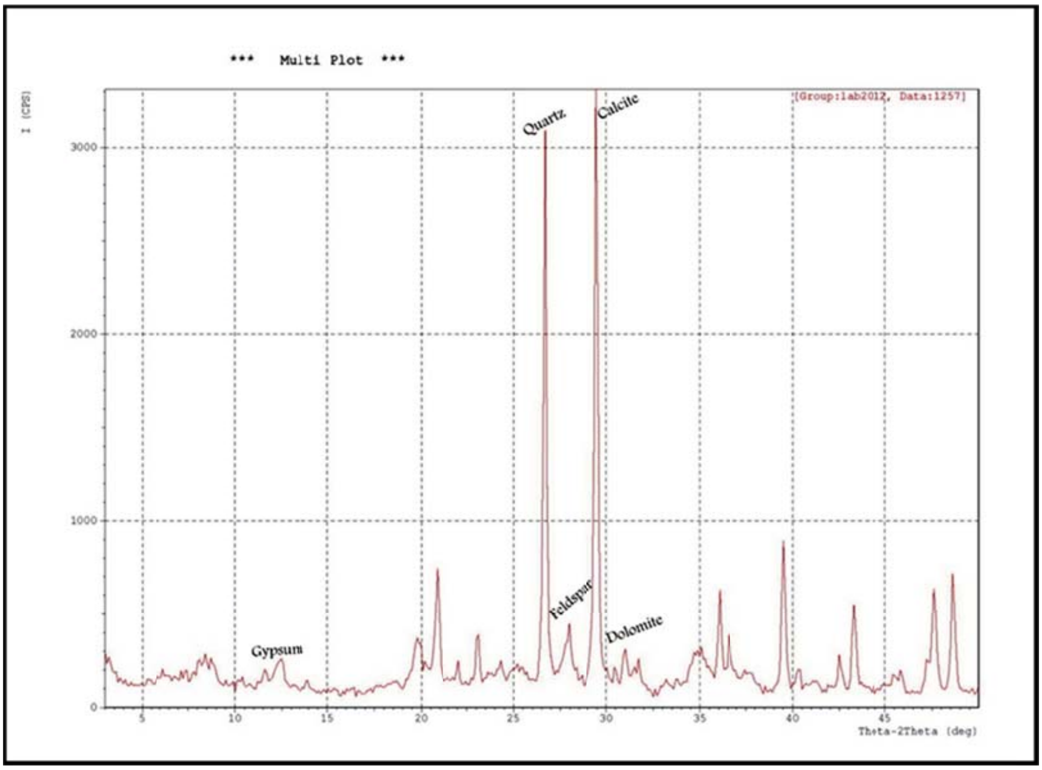
Nearly always less abundant than quartz, and plagioclase is believed to be more abundant than potash feldspar. It appears that even less is known about feldspar in shale than about quartz (Paul, 1970). Feldspar was determined as plagioclase which is characterized by the peak (3.2 Å) for (002) reflection figure (4- 10).

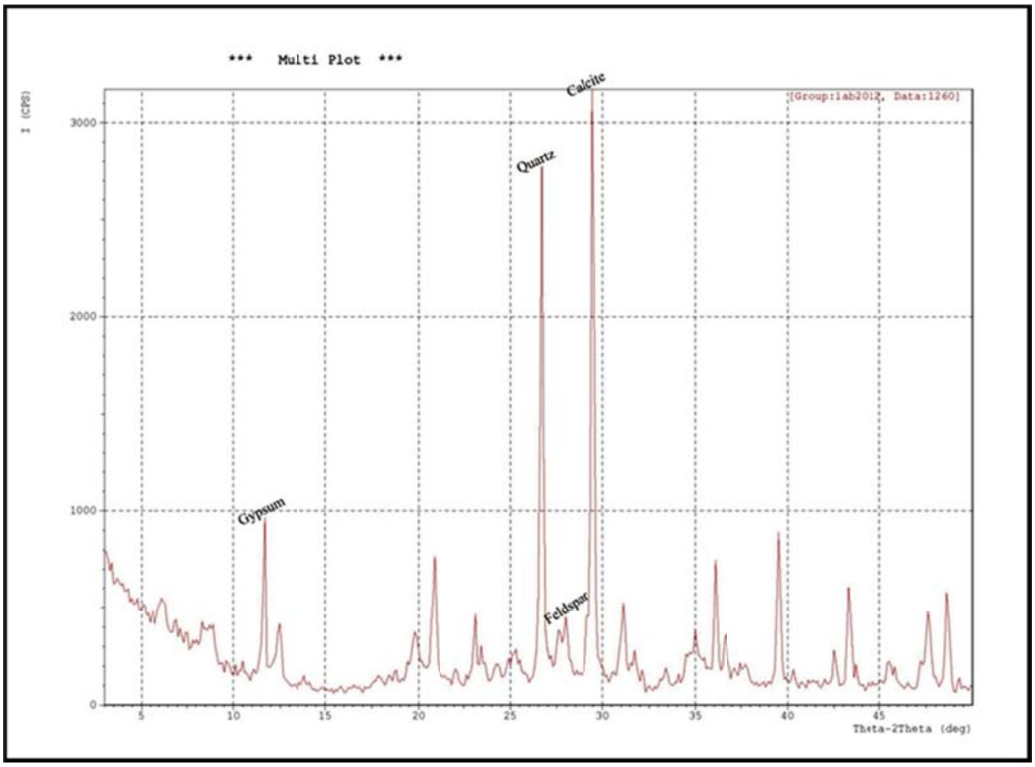
#### 4. Dolomite

Generally, it is present in a small amount. The X-ray scanning showed dolomite with characteristic peaks of (2.89 and 2.19) Å for (104 and 113) reflections figure (4- 10).

#### 5- Gypsum

X.R.D results showed small amount of gypsum as shown in figure (4- 10).


*** Multi Plot ***
I (CPS)
[Group:lab2012, Data:1257]
3000
2000
1000
0
5
10
15
20
25
30
35
40
45
Theta-2Theta (deg)
Quartz
Calcite
Feldspar
Dolomite
Gypsum


*** Multi Plot ***
I (CPS)
[Group:lab2012, Data:1260]
3000
2000
1000
0
5
10
15
20
25
30
35
40
45
Theta-2Theta (deg)
Calcite
Quartz
Gypsum
Feldspar

### 4.4.3. Heavy (Trace) Minerals in the soil of the study area

#### 1. Lead (Pb)

Under anoxic conditions Pb, which is a chalcophile element, forms distinct sulphide phases (Morse and Luther 1999), and also binds strongly to organic matter (Waaren & Haack, 2001).

As for livestock, fish, and wildlife, Pb is a nonspecific toxin, which inhabits many enzymatic activities nervous system, and reproduction function. As for humans, poisoning with Pb is a major environmental and public hazard, especially for infants and young children. The way by which Pb enters the body depends on its chemical and physical form. Inorganic Pb is mainly inhaled and ingested, and does not undergo biological transformation, while organic Pb such as tetraethyl Pb ( Which is used as an antiknock agent in gasoline) enters the body mainly by skin contact and inhalation, and is metabolized in liver, (Griffin *et al*, 1977 in Bradl, 2005). Table (4-12) gives the most commonly reported Pb values in various environmental media.

Table (4-12) Common values for Pb concentration (ppm) in various environmental media, (Bradl, 2005)

| Material | Average concentration | Range |
|---|---|---|
| **Coal** | **16** | **Up to 60** |
| **Fly ash** | **170** | **21 - 220** |
| **Soils (agricultural)** | **-** | **2 - 300** |
| **Fresh water** | **3** | **0.06 - 120** |

Table (4-14) and figure (4-11) shows that the concentration of lead in soil of the study area ranges from (26-110 ppm) the mean is (31.61 ppm).The highest concentration is recorded at location number (14) which exists near the tannery factories. Most concentrations of the selected soil samples have exceeded the global allowable limits as shown in table (4-15).

The increase in the concentrations of lead in the soil results from the increase of this mineral in the air due to brick factories smoke, also due to the impact of tannery factories near brick factories which in enriches the soil with this element.

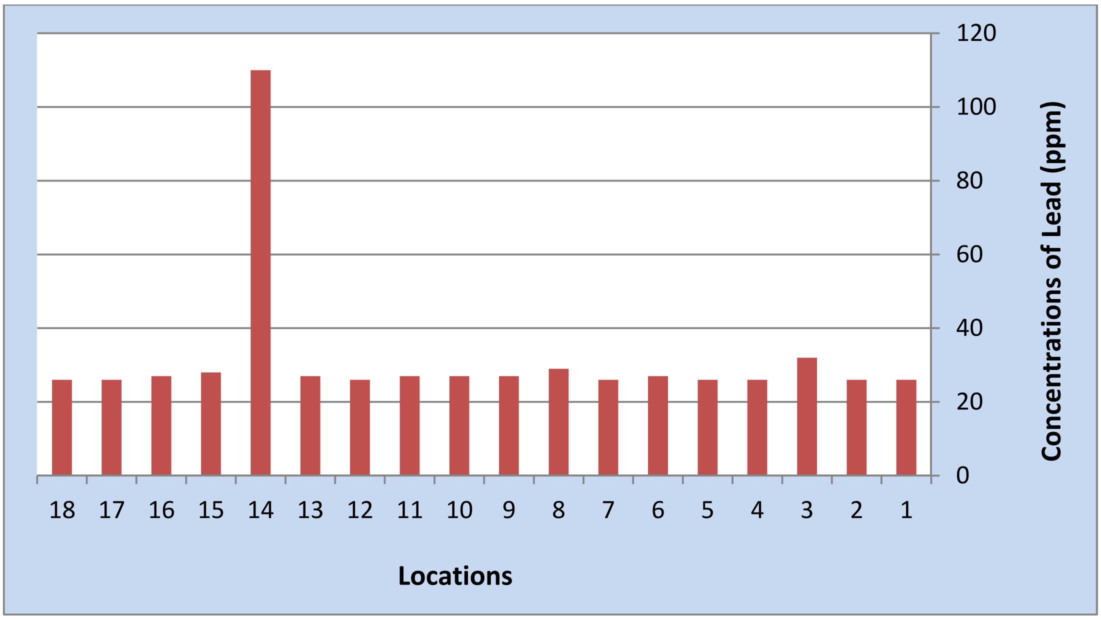


Figure (4-11): Concentrations of Lead in the soil of the study area

## 2. Nickel (Ni)

The main sources of nickel in the environment are from mining and smelting, sewage sludge and from fuel oil and coal combustion. The latter process is identified to be the primary source of Ni in the air, since petroleum contains Ni. There is also a high correlation between Ni and V in the air, (Schroeder, 1971 in Bradl, 2005). Table (4- 13) shows average Ni concentrations in various environmental media.

Wetland species, including Typha, Scirpus have been shown to take up Ni from soils or pore waters to different degrees, (Bhattacharyaet al. 2006).

Table (4-13): Commonly observed nickel concentrations (ppm) in various environmental media, (Bradl, 2005)

| Material | Average concentration | Range |
|---|---|---|
| **Coal** | **15** | **3 - 50** |
| **Fly ash** | **141** | **23 - 353** |
| **Fresh water( ug/ L)** | **0.5** | **0.02 - 27** |
| **Soils (world)** | **20** | **5– 500** |

Table (4-14) and figure (4-12) show that the concentrations of Nickel in soil ranges from (95-120 ppm) with mean of (110.05ppm). All concentrations of the selected soil samples exceed the allowable limits as shown in table (4-15).

The reason for the increased concentration of nickel in the soil is due to burning of heavy fuels and also to the adsorption of clay minerals especially montmorillonite which is a prevalent clay mineral in arid soil and semi-arid areas of the country, (Al-Obaidi, 2000).

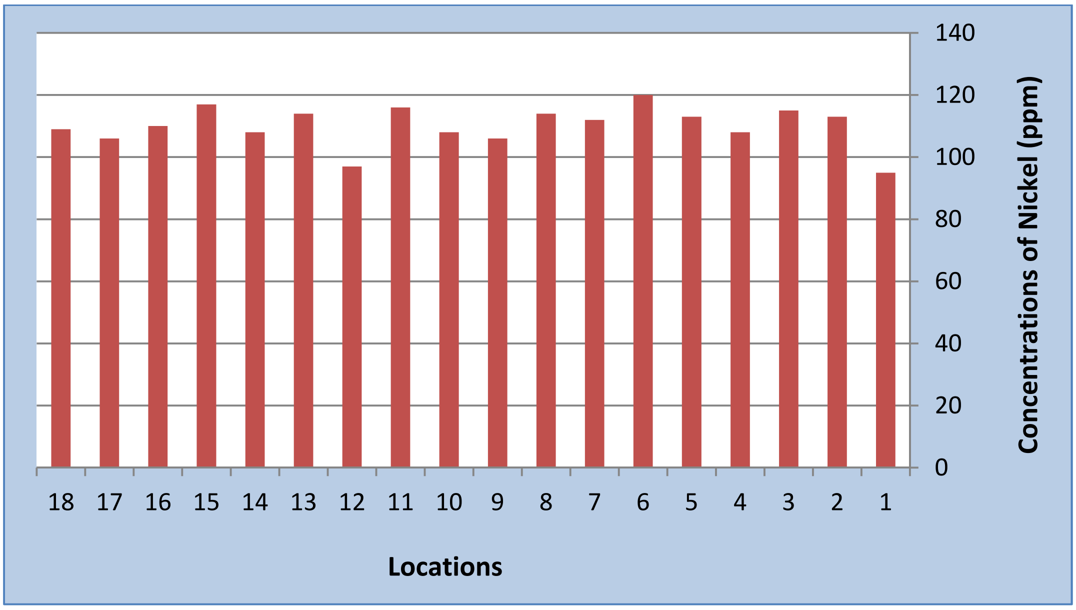


Figure (4-12): Concentrations of Nickel in the soil of the study area

Table (4-14): Concentrations of heavy metals in the soil of the study area

| Sample No. | Cr (ppm) | Ni (ppm) | Pb (ppm) | Cd (ppm) | V (ppm) |
|---|---|---|---|---|---|
| S1 | 80 | 95 | 26 | < 5 | 75.0 |
| S2 | 93 | 113 | 26 | < 5 | 89.0 |
| S3 | 99 | 115 | 32 | < 5 | 94.0 |
| S4 | 88 | 108 | 26 | < 5 | 86.0 |
| S5 | 95 | 113 | 26 | < 5 | 77.0 |
| S6 | 101 | 120 | 27 | < 5 | 92.0 |
| S7 | 97 | 112 | 26 | < 5 | 96.0 |
| S8 | 102 | 114 | 29 | < 5 | 96.0 |
| S9 | 88 | 106 | 27 | < 5 | 89.0 |
| S10 | 91 | 108 | 27 | < 5 | 88.0 |
| S11 | 93 | 116 | 27 | < 5 | 90.0 |
| S12 | 87 | 97 | 26 | < 5 | 82.0 |
| S13 | 99 | 114 | 27 | < 5 | 92.0 |
| S14 | 91 | 108 | 110 | < 5 | 85.0 |
| S15 | 100 | 117 | 28 | < 5 | 88.0 |
| S16 | 100 | 110 | 27 | < 5 | 92.0 |
| S17 | 87 | 106 | 26 | < 5 | 81.0 |
| S18 | 96 | 109 | 26 | < 5 | 90.0 |
| **Mean** | **93.72** | **110.05** | **26.32** | **<5** | **83.38** |

* Detection limit of the device for (Cd ) read < 5.

Table (4-15): Comparison between concentrations of heavy minerals in the soil of the study area with those of the local and global soils

| Country | Pb | Ni | Cd | Cr |
|---|---|---|---|---|
| **Current Study** | 31.61 | 110.05 | < 5 | 93.72 |
| **Baghdad<br>(Ali, 2012)** | 66.8 | 135.8 | <1 | 112.8 |
| **Baghdad<br>(Al- Maliki,2005)** | 153.7 | 111.4 | 5.25 | n.a |
| **USA<br>(Burt et al., 2003)** | 10.1 | 18.3 | 0.16 | 24.1 |
| **Brazil<br>(Deabreuet al., 2005)** | 50 | 30 | 3 | 100 |
| **Hungary<br>(Peter, 2004)** | 18 | 25 | n.a | 30 |
| **Global Average<br>(Lindsay, 1979)** | 10 | 40 | 0.06 | 100 |

**n.a= not analyzed**

### 3. Vanadium (V)

Vanadium occurs in many environmental materials; its source in the atmosphere being from fumes emitted from coal, thermal, or oil fired electric power stations, industrial plants, and ships. The compounds of vanadium may be highly toxic to man and animal. Vanadium has various biological and physiological roles to play in animal biochemistry (Campillo, 2002).

The mobility of vanadium in soils is affected by pH. Vanadium is fairly mobile in neutral or alkaline soils relative to other metals, but its mobility decreases in acidic soils, Vanadium is present in coal, crude oil, naturally occurring petroleum hydrocarbons, and all fuel oils where it remains in the residue after the more volatile fractions have been distilled (EPA,2005).

Major sources of environmental contamination of vanadium result from the combustion of fossil fuels, the burning of coal wastes, the disposal of coal waste and fly ash, and releases from metallurgical works and smelters, (Alloway, 1990).

Table (4-14) and figure (4-13) shows that the concentration of (V) in soil of the study area ranges from (75-96 ppm) with mean of (83.38ppm).

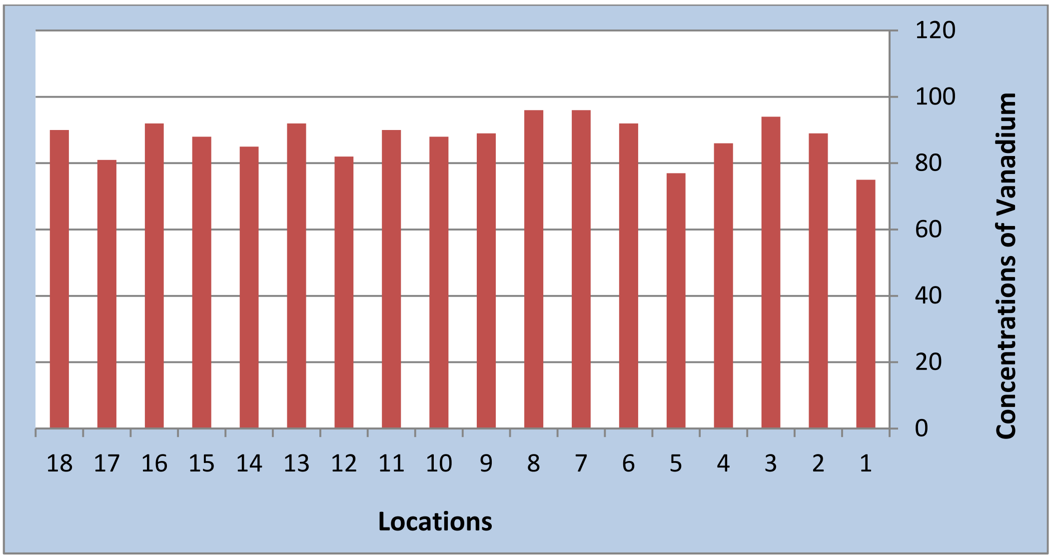


Figure (4-13): Concentrations of Vanadium in the soil of the study area

## 4. Cadmium (Cd)

Cadmium (Cd) is ranked 64 th in crustal abundance with an average concentration of 0.15 to 0.20 ppm. Cd is closely related to Zn and is therefore found mainly in Z, Pb-Zn, and Pb-Cu-Zn ores, (Bradl, 2005). Not only is it non-essential for life, it is highly toxic to most organisms, having a toxicity 2-20 times higher than many other heavy metals (Das, *et al,* 1998).

The main anthropogenic sources of Cd are the use of phosphate fertilizers, land application of municipal sewage sludge, atmospheric deposition. As ores containing Cd are used for the production of phosphate fertilizers, these products may contain Cd concentrations of up to 340 ppm. Long term studies showed significant increase in Cd uptake by plants growing on soils treated with these fertilizers, (McLaughlin and Tiller, 1994 in Bradl, 2005).

Cd adsorption is influenced by variable parameters, the most important being pH, ionic strength, and exchangeable cations, (Bradl, 2005).

Table (4-14) shows that the mean concentration of (Cd) in the soil to be less than 5 ppm. All concentrations of the selected soil samples have exceeded the allowable limits as shown in table (4-15).

The high concentrations of (Cd) in the soil is due to burning heavy fuel used in brick factories that comes out with black smoke and falls on the soil. It has high transition in soil and high toxicity, (Navrot *et al.*,1978).It is possible that tannery factories near brick factories contribute in rising the concentrations of (Cd) because of its industrial water (untreated ) which contain heavy elements such as Cadmium, (Shanshal, 2004). Table (4-16) shows the normal Cd concentration found in various environmental media.

Table (4-16): Normal Cd concentrations in (ppm) in various environmental media, (Bradl, 2005)

| Material | Average concentration | Range |
|---|---|---|
| **Recent sediments** | **0.53** | **0.02- 6.2** |
| **Crude oil** | **0.008** | **0.0003-0.027** |
| **Coal** | **0.10** | **0.07 – 0.18** |
| **Fly ash** | **11.7** | **6.5 - 17** |
| **Phosphate fertilizers** | **4.3** | **1.5 – 9.7** |
| **Sewage sludges** | **74** | **2 - 1100** |
| **Soils**<br>**(world, non-polluted)** | **0.35** | **0.001 – 2.0** |
| **Fresh water (µg/L)** | **0.10** | **0.01-3** |

## 5. Chromium (Cr)

Chrome is mostly found in the oxidation state III, which is the most stable, but also occurs in the oxidation state 0 and VI. In soils and sediments, two hexavalent forms (vis. the $Cr^{3+}$ cation and the anion $CrO_2^-$) and two hexavalent anions ($Cr_2O_7{}^{2-}$ and $CrO_4^{2-}$) occur. The hexavalent form is relatively toxic compared to the trivalent form, (Bradl, 2005).

The main anthropogenic sources of Cr are atmospheric deposition from electric furnaces, steel production and coal- fired power plants. Various industrial processes may release wastewater contaminated with Cr such as electroplating, leather tanning, metal processing, and textile. Fertilizers and sewage sludges may contain several hundred to thousand ppm of Cr, (Stoepler, 1994 in Bradl, 2005).

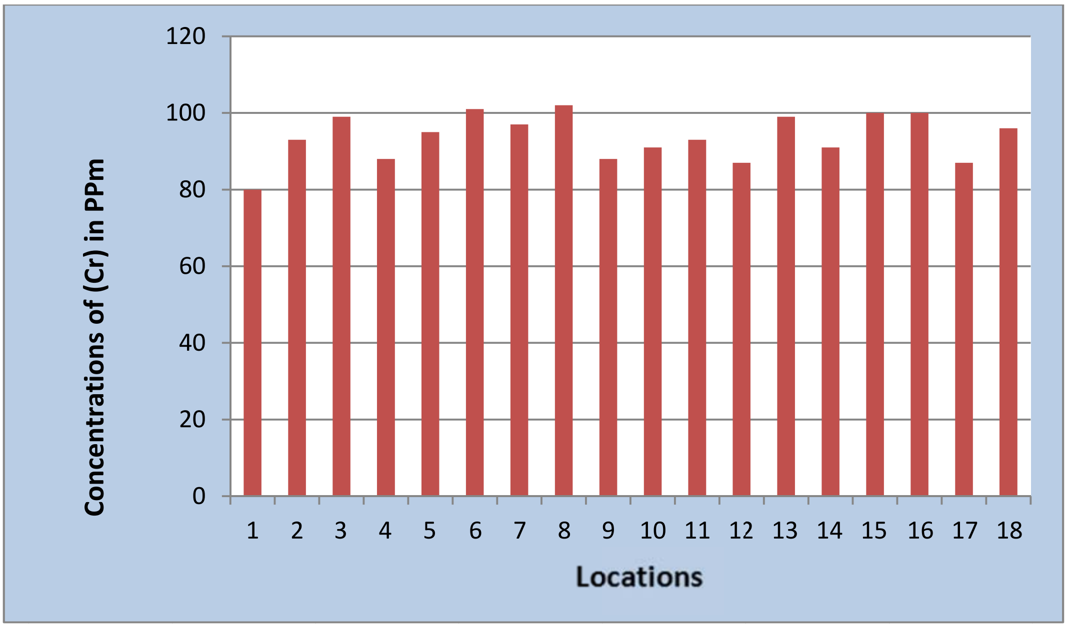
Table (4-14) and figure (4-14) shows that the concentrations of (Cr) ranges from (80-102 ppm) with mean of (93.72ppm). Some concentrations of the selected soil samples located near the tannery and brick factories exceed the allowable limits as shown in table (4-15).

The increase of (Cr) concentrations in these locations is due to the industrial activities in the study area represented by the brick and tannery factories, in which the products released from burning fossil fuel (heavy oil) in brick factories rising from chimneys into the air which has high concentrations of (Cr) and fall on the soil and cause soil contamination with this heavy element. While tannery factories used the chromium basically in leather tanning.

The low increase of chromium content in the soil of the study area is due to the adsorption of heavy metals by clay minerals especially montmorillonite which is a prevalent mineral in the soil of the study area, (Al- Sultani, 2006). Also is due to waste water influenced by tannery factories that use Cr in the tanning industry. Table (4-17) shows commonly observed chromium concentrations (ppm) in various environmental media.

Table (4-17): Commonly observed chromium concentrations (ppm) in various environmental media (Montgomery, 2006)

| **Material** | **Average concentration** | **Range** |
|---|---|---|
| **Continental crust** | **125** | **80 - 200** |
| **Coal** | **20** | **10 - 1000** |
| **Fly ash** | **247** | **37 - 651** |
| **Phosphate fertilizers** | **-** | **30 - 3000** |
| **Sewage sludges** | **74** | **2 - 1100** |
| **Soils** | **40** | **10 – 150** |


120
100
80
60
40
20
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
Concentrations of (Cr) in PPm
Locations

# Chapter Five

# Conclusions and Recommendations

## 5.1. Conclusions

1. The study area is highly polluted and has serious diseases.

2. The use of supervised classification (MXL) technique on Landsat TM, of 2007 indicate that the urban or built up land, water, smoke, vegetated land, agricultural land non-vegetated and barren land represent the main land use – land cover units at the study area.

3. The results of NDVI for three periods (1990, 2002, 2007) have shown that vegetation cover had decreased in 2002 compared with 1990, and increased again in 2007 but is still less than 1990, because of lack or shortage of water resources due to climate changes and drought conditions causing soil salinity, and soil compaction, being both responsible for decreasing vegetation cover, inspite of the increased moisture during 2002.Increasing desertification due to land degradation, soil salinity and other environmental problems observed at the study area.

4. The results of NDWI of the three periods (1990, 2002, and 2007) show that water level increased in 2002 and dropped significantly in 2007.

5. The results of SI of the three periods (1990, 2002, 2007) show that soil salinity has increased in the last thirty years due to climate changes and drought conditions that had prevailed in addition to the unsuitable practices of irrigation systems and waste water influenced by tannery factories that used high concentrations of salt in the tanning industry.

6. Visual interpretation of the repaired image satellite of ETM+ 2011 as compared with TM image 2007 concludes that the smoke released from

brick factories has increased during the last four years and increased the pollution.

7. Air pollution results of the current study showed that the concentrations of the total suspended particles in the air is high and exceeds the national and global allowable limits, with an increase in concentrations during the current study as compared with previous years (2005, 2006). The industrial processes represented by brick factories are considered as the main reason for this increase. It is also found that the concentrations of trace elements in the air have exceeded the allowable limit globally and nationally. The analysis of air filters contain suspended particles that has high concentrations of elements :(Pb, Cr, Ni) and this high increase in these heavy metals is due to industrial activities represented by a brick factories which uses the fossil fuel (heavy oil ) for burning. It contains high concentrations of elements that released into the air with black smoke outside of the chimneys. Also the air dust leads to increase of concentrations of these elements.

8. The study points out that concentration of sulfur dioxide gas in the air is higher than the allowable limits in most selected locations. The reason for this increase is due to the effect of industrial activities represented by brick factories and burning fossil fuels.

9. The study results indicate that concentrations of nitrogen dioxide gas and hydrogen sulfide gas in the air exceed the allowable limits in some studied locations. This increase might be due to burning fossil fuels in the brick factories as well other industrial processes.

10. The study shows that the industrial waste water from tanneries has high concentrations of total dissolved salts and major cations and anions they are all higher than the allowable limits of Iraqi and Global standards,

largely due to the use of salts significantly in the early productive stages of tanning processes.

11. Hydrochemical analysis of water samples shows that the water is contaminated with high concentrations of heavy metals (Pb, Cr, Cd, and Ni) which exceed the allowable limits and that increase is due to the ash and the effect of industrial waste products and waste water from tannery factories, beside the agricultural use of fertilizers.

12. Hydrochemical analysis of water samples show that one of the studied wells (W2) was drilled wrongly within the leaching field of the septic system for natural water treatment and that led to the ground water contamination of (W2) with ($NO_3$) by the raw sewage.

13. The results of soil analysis of soil samples of the study area show high value of heavy metals (Pb, Cr, Cd, Ni) and their concentrations exceed the allowable limits due to the impact of brick factories products as well as the influence of vehicles products results from burning fuel, beside other anthropogenic activities represented by fertilizers and sewage sludge that may contain high percentage of heavy metals.

## 5.2. Recommendations

1. Medical study is required for the residents and workers in the study area to determine the effect of brick factories on health and what diseases they cause such as respiratory diseases (Pulmonology), cancer and infertility disease, and the shortage of life span.

2. Use treatment units in brick and tanning factories because of its importance in getting rid of the heavy elements before releasing waste into the environment.

3. Environmental Monitoring should be imposed on industrial areas in general and put pollution monitoring stations permanently to know any increase in the concentration of pollutants.

4. Reducing the particles released from chimneys of brick factories as industrial wastes by using methods of collecting particles such chemical precipitators or the use of filters.

5. As a result of bad fuel (black oil) used in the burning processes which causes air pollution and soil with heavy metals and high levels of sulfur, improved fuel or electrical energy can be used instead to maintain a clean environment.

6. Attempting to treat the contaminated soils using one of the natural ways such as soil washing, evaporation and separation by gravity or by evaporation and burning, by chemical treatment such as oxidation and hydration, by biological methods or by applying phosphates to remediate soil contaminated with Pb and Cd.

7. Prevention of uncontrolled disposal of solid wastes and creating on infrastructure for environmentally-safe solid waste disposal.

8. Well (W2) should be abundant after studying the diseases that had caused in the area.

# References

- **Adriano, D. C., (2001):** Trace elements in Terretrial Environments, Springer, Berlin, Heidelberg, P.533.
- **Al- Saady, Y. I., and Ahmed, M. A., (2010):** Monitoring Of Eolian Deposits and Environmental Changes Detection of Ali Al-Gharbi Quadrangle NI-38-16 Using Remote Sensing and GIS Techniques, GEOSURV, Int. Report, P. 90.
- **Al-Bassam, K.S., (2000):** The Iraqi palygorskite: Geology, Mineralogy, Geochemistry, Genesis and Industrial Uses. (GEOSURV) Baghdad, Iraq, 237pp.
- **Al-Bayati, H. J., (1980):** Hydrochemical and Geochemical of the Tigris River and the potential contamination from Qayyarah to Baghdad, M. SC. Thesis (unpublished), College of Science, University of Baghdad, 211 p. (in Arabic).
- **Al-Jaf A. A. and Al-Saady Y. I., (2009):** Integration of remote sensing data and GIS application for land cover land use and environmental changes Al-Razzaza Lake − Bahr Al-Najaf area GEOSURV int. rep.no.3150.
- **Al-Sultani, A., R, (2006):** Air and Soil Pollution of Nahrawan Area - East of Baghdad, Heavy Metals Resulting from the Brick factories, M. SC Thesis (unpublished), College of Science - University of Baghdad, 119 pages. (in Arabic).
- **Al-Janabi, A.Y., Al-Saadi, N. A., Zainal, Y. M., Al-Bassam, K. S., and Al-Delaimy, M. R., (1992):** Work procedures of the S.E. of geological survey and mining (Geosurv.) part 21, No., B, pp 59-65.
- **Al-Obeidi, A. K.,( 2000):** The Impact of Kufa Cement Factory on Soil, Plant and Air of the Surrounding Areas, PhD. Thesis

(unpublished), College of Science, University of Baghdad, 166 pages. (in Arabic).

- **Al-Kadhimi, J.A.M., Sissakian, V.K., Fattah, A.S. and Deikran, D. B., (1996):** Tectonic Map of Iraq, 2nd edit., scale 1:1000 000. GEOSURV, Baghdad, Iraq.
- **Alloway, B.J. (1990):** Heavy Metals in Soils. John Wiley and Sons, Inc. New York, PP. 125-155.
- **Al-Azzawi, B. Gh., (2002):** Study and Metal Content of Heavy Metals in Diyala River Sediments (Baquba area), Mining and Geological Survey Company, 50 p. (in Arabic).
- **Altoviski, M., E., (1962):** Handbook of Hydrology. Gosgeolitzdat, Moscow, USSR (Russian), P. 416.
- **Alvarez V., V.H.; Dias, L.E.; Ribeiro JR., E.S.; Souza, R.B. & Fonseca, C.A., (2001):** Organic Sulfur Oxidation To Sulfate In Soil Samples For Total Sulfur Determination By Turbidimetry , MG, Universidad Federal de Viçosa**,** p.10-20.
- **Al-Hilali, M. A., (1980):** Study Some of the Geochemical and Physical Properties of Balad Ruz Clays Area _ Diyala Province, M.SC Thesis (unpublished), College of Science, University of Baghdad, 151 p. (in Arabic).
- **Al-Saadi, A. N., (1999):** Air Pollution in Baghdad City and its Environs With Carbon Monoxide and Heavy Metals, Unpublished, M.SC. Thesis, College of Science / Department of Earth Sciences / University of Baghdad, p 118. (in Arabic).
- **Al-Obeidi, A. K.,( 2000):** The Impact of Kufa Cement Factory on Soil, Plant and Air of the Surrounding Areas, PhD. Thesis (unpublished), College of Science, University of Baghdad, 166 pages. (in Arabic).

- **Al- Maliki, M. A., (2005):** Assessment of Air Pollutants, Water and Soil in Baghdad City, Using a Geographic Information System (GIS). Ph.D. Thesis (unpublished), College of Science, University of Baghdad, 170 p. (in Arabic).
- **Ali, S. M., (2012):** Hydrogeological Environmental Assesment of Baghdad Area, Ph.D. thesis, College of Science, University of Baghdad, P. 245.
- **Anderson, J., Hardy, E., Roach, J. and Witmer, R., (1976):** A Land Use and Land Cover Classification System for use With Remote Sensor Data, United States Government Printing Office, Washington. 41PP.
- **APHA. (1998):** Standard Methods for the Examination of Water and Wastewater. 20th Edition. American Public Health Association, Washington D.C, pp. 2-22.
- **Araim H. J., (1990):** Hydrogeological Map of Iraq. Scale 1: 1000000, GEOSURV, Baghdad, Iraq.
- **Araim H. J., (1993):** The Hydrogeological Map of Iraq Explanatory Brochure, Int . Report, GEOSURV, Baghdad, Iraq.
- **ATSDR,( 1993):** Toxicological profile for chromium. Update April 93. Agency for Toxic Substances and Disease Registry.
- **Afaj, A. H., Jabbar, A. , Rauf , Maythem A., (2000):** Air pollution in the Baghdad city - study of environmental pollution. The first national scientific conference in the pollution of the environment and protection methods, Baghdad, 5-6 November from 0.390 to 405. (in Arabic).
- **Beaton, J. D., Burns, G. R. and Platou, Jr (1968):** Determination of sulphur in soils and plant material. Tech. Bull., 14, The Sulphur Inst., Washington DC, 14-56 pp.

- **Berglund, M., Bostrom, E., Bylen, G., Ewerzt, L., Gustafssun, L., Norberg, S., Pershagen, G., Victorin, K., (1993):** Health Risk Evaluation of Nitrogen Oxides. Scandinavian Journal of Work, Environment and Health, vol. 19, suppl. 9, 14-20 pp.
- **Bernard, B., Bernard, H., and Brooks, M. (2009):** Determination of Total Carbon, Total Organic Carbon and Inorganic Carbon in Sediments, TDI-Brooks International/B&B Laboratories Inc. College Station, Texas77845.{online}available: http://www.tdibi.com/analytical_services/environmental/NOAA_methods/TOC.pdf
- **Bhattacharya, P., Ahmed, K.M., Hasan,M.A., Broms, S., Fogelström, J., Jacks, G., Sracek,O., von Brömssen,M., Routh, J., (2006):** Mobility of arsenic in groundwater in a part of Brahmanbaria district, NE Bangladesh. In: Naidu, R., Smith, E., Owens, G., Bhattacharya, P., Nadebaum, P. (Eds.), Managing Arsenic in the Environment: from Soils to Human Health. CSIRO Publishing, Collingwood, Australia, pp. 95–115.
- **Bassam, Kh., al-Dulaimi, Sallama, Mohammed and Ahmed, Maha, (2000):** Evaluation of the efficiency of bentonite and Alborslinaaat in the extraction of some heavy metals in industrial effluents of the Electrical Industries Company, Mining and Geological Survey Company, an internal report, 36 P. (in Arabic).
- **Borrero, J., C., (2008):** "Historical Assessment of tsunamis Affecting the southern coast of the Dominican Repuplic ", Vancuover, Canada, 2008.
- **Bradl, H., (2005):** Heavy Metals in the Environment, Origin, interaction and remediation. Interface Science and Technology Volume 6, Elsevier Academic Press, Amstedam, 269 p.

- **Briney, A., (2008):** An Overview of Remote Sensing,{online} available: http://geography.about.com/od/geographictechnology/a/remotesensing.htm .
- **Bonnie, Th. Z., Nayef, A. M., and Mohamed A. J., (2011):** Nomination of the landfill site in Nahrawan area within Baghdad boundaries, Company of Mining and Geological Survey, an internal report, 18 pages. (in Arabic).
- **Brown G. (1961):** The X-Ray identification & Crystal Structures of clay minerals, Min. Soc. (clay min. Group), London, 544 p.
- **Buck, R., P., Rondinin, S., Covington, A., K, Baucke, F., G., Brett, C., M., Milton, M., G., and Wilson G. S, (2002):** Measurement of pH. Definition, Standards, and Procedures, (IUPAC Recommendations), Pure Appl. Chem., Vol. 74, No. 11, pp. 2169–2200.
- **Burt, R.; Wilson, M.A.; Mays, M.D. and Lee, C.W., (2003)**: Major and trace elements of selected pedons in the USA, published in Journal of Environ. Quality, Vol. 32, No.6, 2109 – 2121 pp.
- **Campbell, J. B., (1996):** ‘Introduction to remote sensing. 2nd ed. (Guilford Press: New York.), 622 pp.
- **Campbell, J. B., (2002):** Introduction to Remote Sensing, London and New York (3rd), Taylor and Francis, 620 p.
- **Campillo, N., (2002):** Determination of vanadium, molybdenum and chromium in soils, sediments and sludges by electrothermal atomic absorption spectrometry with slurry sample introduction, Córdoba, Anal. At. Spectrom., PP. 1429-1433.
- **Carroll, H., (1970):** clay minerals, A Guide to Their X-ray Identification, The geological Society of America, Colorado.
- **Carver, R. E. (edits), (1971):** Procedures in Sedimentary

Petrology: John Wiley and Sons, 653P.

- **Chen, J., Xiaolin, Z., Vogelmann, J., Gao, F. and Jin, S., (2011):** A simple and effective method for filling gaps in Landsat ETM++ SLC-off images, Jour. Remote Sensing of Environment, V. 115, P. 1053–1064.
- **Chang, K. T. (2008).** Introduction to Geographical Information Systems. New York: McGraw Hill. p. 184.
- **Congalton, R. G., (1991):** A review of assessing the accuracy of classifications of remotely sensed data. Remote Sensing of Environment 37: p 35-46.
- **Coppin, J. and Nackaerts, (2004):** Digital change detection methods in ecosystem monitoring: a review. International Journal of Remote Sensing 25(9): p 1565-1596.
- **Das P, Samantaray S, Rout GR. (1998):** Studies on cadmium toxicity in plants: a review. Environmental Pollution 98(1): 29-36.
- **Datko,S., (2012):** Relative Humidity in Your Indoor Garden, {online} available: http://sdhydroponics.com/resources/articles/ gardening/relative-humidity-in-your-indoor-garden.
- **Dube, O. and Pickup, G. (2001):** Effects of rainfall variability and communal and semi-commercial grazing on land cover in Southern African rangelands. Climate Research, 17, 195–208.
- **Deabreu, C. A.; Raid, B. V.; Deabreu, M. F. and Gonzalez, A. P., (2005):** Routine soil testing to monitor heavy metals and Boron, Sci. Agric. (piracicaba, Braz.), Vol. 62, No. 6, pp. 564-571.
- **Deikran D. B. & Yacoub S. Y., (1993):** The geology of Baghdad Quadrangle, Sheet No. N1– 38–10. Scale 1: 250000, Int. Rep. GEOSURV, Baghdad, Iraq, P.21.
- **Detay, M., (1997):** Water Wells – Implementation, Maintenance and Restoration. Jhon Waley and Sons, London, P. 379.

- **Drever, J., I., (1997):** The geochemistry of Natural Water, Surface and Groundwater Environments, 3 rd ed., Prentice Hall, USA, P. 436.
- **Duffus, J. H., (2002)**: "Heavy metal" – a meaningless term? Pure Appl Chem V.74, P. 793–807.
- **Dwivedi, R. S. and Sreenivas, K., 1998**. Image transforms as a tool for the study of soil salinity and alkalinity dynamics. Int. J. Rem. Sens., no.19, P 605-619.
- **EMB (Environmental Management Bureau), (2004):**Air Quality Monitoring System. {Online} available: http://www.emb.gov.ph.
- **EC (1999)**: Integrated Pollution Prevention and Control (IPPC) Best available techniques reference document on the production of iron and steel. Publ: EC European IPPC Bureau 370 pp.
- **EPA (Environmental Protection Agency), (2000):** A Guide to Air Quality and Your Health, EPA-454/R-00-005,{online} available: http://www.epa.gov .
- **EPA (Environmental Protection Agency), (2009):** Urban Agriculture and Soil Contamination: An Introduction to Urban Gardening, Environmental Finance Center Region 4, Louisville, KY 40292.
- **EPA (Environmental Protection Agency), (2011):** Basic Information about Regulated Drinking Water Contaminants, EPA-454/R-00-005, {online} available:http://www.http://water.epa.gov /drink/contaminants/basicinformation/cadmium.
- **EPA (Environmental Protection Agency), (2005):** Current national recommended water quality criteria, pp. 1-18.
- **European Communities, (2001):** Ambient Air Pollution by As, Cd and Ni Compounds: Position Paper, Office for Official Publications of the European Communities, Luxembourg, 318 P.

- **Fadhil , M., A., (2009):** Land Degradation Detection Using Geo-Information Technology for Some Sites in Iraq, Journal of Al-Nahrain University, V. 12, pp. 94-108.
- **Fadhil, M., A., (2001):** Environmental Change Monitoring by Geoinformation Technology for Baghdad and its Neighboring Areas, Technical College, Ministry of Higher Education and Scientific Research, Baghdad, (GISdevelopment.net), 13 PP.
- **Faure, G., (1998):** Principles and Application of Geochemistry (2nd ed.). Prentice Hall Inc, USA, 600 P.
- **Folk, R. L., (1974):** Petrology of sedimentary Rocks, Hem phill publishing CO., Austin, 182p.
- **Forstner, U., and muller, G.,(1973):** Heavy metal accumulation in river sediments :aresponce to environmental pollution.geoform 14,pp 53-61.
- **Fouad**, **F., A., (2010):** Tectonic And Structural Evolution Of The Mesopotamia Foredeep, IRAQ, Iraqi Bulletin of Geology and Mining, V.6, p 41- 53.
- **Friberg, L.**, **Piscator, M., and Nordberg, G., 1971.** Cadmium in the Environment, CRC press, Cleveland, OH.
- **Fung, T. and Zhang, Q., (1989**): Land Use Change Detection with Landsat Digital Data in the Kitchener-Waterloo Area, Remote Sensing and Methodologies of Land Use Change Analysis, Waterloo, Department of Geography Publications Series, Occasional Paper No. 6, University of Waterloo, pp. 135-153.
- **Gibbs R. J., (1973):** Mechanisms of trace metals transport in river, science, Vol.180, pp. 71-73.
- **Gibbs, R. J., (1968):** Clay mineral mounting techniques for X-Ray diffraction analysis, J. S. P., . V.38, p.242-244.

- **Gilabert, M.A. J. Gonza´lez-Piqueras, F. J. Garcı´a-Haro, J. Melia., (2002):** A generalized soil-adjusted vegetation index. Remote Sensing of Environment 82, p 303–310.
- **Gipson, M., (1966):** preparation of oriented slides for X-Ray analysis of c clay minerals, jour.sed.pet. V.36, p.1143.
- **Goossens, D., (2008):** Techniques to measure grain-size distribution of Loamy sediments: a comparative study of ten instruments for wet analysis: Jour. Sedimentology, V. 55, P. 65-96.
- **Gorrell, H.A., (1968):** Classification of formation waters based on sodium chloride content, AAPG Bull. 42, p. 2513.
- **Grim, R. E., (edits), (1968):** Clay Mineralogy, 2nd Ed, McGraw-Hill, 596P.
- **Griffin, R. A., Au, A. K. and Prost, P.P., 1977.** Environment Science HealthA12, P. 431.
- **Hawley, J.W. and Parsons, R.B. (1980):** Glossary of selected geomorphic and geologic terms. Mimeo. U.S. Dept. Agric., Soil Cons. Serv., West Technical Center, Portland, OR; 30p.
- **Helstrup, T., Jorensen, N., O., and Yakubo, B., B., (2007):** Investigation of Hydrochemical Characteristics of Groundwater from the Cretaceous – Eocene Limestone Aquifer in Southern Ghana and Southern Togo using Hierarchal Cluster Analysis, Hydrology Journal, V. 15, PP. 977- 989.
- **Hem, J. D., (1989):** Study and interpretation of the chemical characteristics of natural water U.S. Geological Survey, Water supply paper 2254, 246p.
- **Hem, J.D., (1992):** Study and interpretation of the chemical characteristics of natural water (3d ed.): U.S. Geological Survey Water-Supply Paper 2254, 263 p.
- **Henebry, G. M. and Goodin, G. D. (2006):** Landscape Trajectory

Analysis: Toward Spatio-temporal Models of Biogeophysical Fields for Ecological Forecasting. Accessed on December 08, 2006, pp. 157–174.

- **HIC, (2004):** Humanitarian information centre of Iraq. Website: www.hiciraq.org.
- **Hisham, M., B., (2010):** Using remote sensing data and GIS to evaluate air pollution and their relationship with land cover and land use to Baghdad city, Ministry of Science and Technology/Baghdad-Iraq, International Applied Geological Congress, Department of Geology, Islamic Azad University, Iran. PP. 829 – 834.
- **James, F., (2011):** “In China, Time Is Not Ripe” for honest Air Pollution Readings, United States, P. 33.
- **Jabbar, S. SH., (1983):** Sedimentary and Geochemical Study of the Alluvial Plain from Mahmudiya to Mandali, M. SC Thesis (unpublished), Collage of Science, University of Baghdad, 161 pp. (in Arabic).
- **Kanbour, F.I; Kitto, A.N.; Yassein, S.; AL-Taie, F.A. and Ali, A. (1985):** Elemental analysis of Total Suspended Matter in the ambient air of Baghdad. Environmental International, Vol. 11, Pp. 459-463.
- **Khalid, B.Y.; Salih, B.M. and Issac, M.W., (1981):** Lead contamination of soil in Baghdad city, Iraq. Bull. Environm. Contam. Toxicol. 27, 634-638.
- **Kinter, E. P. and Diamond, S., (1956):** A new method for preparation and treatment of oriented aggregate specimens of soil and clays for XRay Diffraction analysis, Soil Sci., V. 81, P. 111-120.

- **Kostick D.S., (1993):** The material flow of salt. Information Circular 9343. Washington, DC: U.S. Department of the Interior, Bureau of Mines, p. 31.
- **Landis W. G. & Yu M. H., (1999):** Introduction to Environmental Toxicology, Impact of Chemicals upon Ecological System, 2nd ed., Lewis Bulb., M London, New York, 390 p.
- **Langmuir, D. (1997):** Aqueous environmental geochemistry. Prentice-Hall, Upper Saddle River, New Jersey.
- **Lillesand, T. M., Kiefer, R. W. and Chipman, J. W. 2004):** Remote Sensing and Image Interpretation, 5th edit, New York, John Wiley and Sons, 763 PP.
- **Lillesand, T. M., Kiefer R. W. and Chipman J. W.,(2007):** " Remote Sensing and Image Interpretation", 6th Ed., John Wiley & Sons, Inc., 612 P.
- **Lim H. S., MatJafri M. Z. and Abdulla, Wong C. J., (2010):** Air pollution determination using remote sensing technique , .{online} available:http://www.intechopen.com/books/advances-in-geoscience-and-remote-sensing/air-pollution-determination-using-remote-sensing technique.
- **Lindsay, W. L., (1979):** Chemical Equiliberia of Soils, John Wiley and sons, p 449.
- **Ljungberg, V., (2004):** Assessment of ground water flow and Pollutant Transport through Modeling. M.sc Thesis, Unpublished, Collage of Science, Stockholm. Sweeden.110 P.
- **Los, S. O., Anyamba, A., Cherlet, M., Collatz, G. J., Giglio, L. H., F.G. & Kendall, J. A. (2002):** The Biosphere: a global pespective. IN Skidmore, A. K. (Ed.) Environmental Modelling with GIS and Remote Sensing. London, UK,Taylor and Francis, PP. 70-96 .

- **Lunetta, R. S., Knight, J. F., Ediriwickrema, J., Lyon, J. G. and Worthy, L. D., (2006):** Land-cover change detection using multi-temporal MODIS NDVI data. Remote Sensing of Environment, 105, p 142-154.
- **Lungmiur, D., (1997):** Aqeous Environmental Geochemistry. Prentice Hall, USA, P. 600.
- **Martin, P.M. (1989):** Computer Processing of Remotely Sensed Images 3rd edn. John Wiley & Sons New Jersey, 632 P.
- **Mc Cauley A., Jones C., Jacobsen J., (2003):** Soil pH and Organic Matter. A self-study course from the MSU extension service continuing education series. Montana State University.12 pp.
- **McLaughlin, M. J. and Tiller, K. G., 1994.** Trans. 15th World Congress Soil Science, P., 195.
- **Milot, G., (1970):** Geology of clay, Springer-Verlag, New York, 429P.
- **Ministry of Health, the Department of protecting and improving the environment (2000)**: environmental legislation, relations department and environmental education / Baghdad. (in Arabic).
- **Musa, A. H., (2000):** Environmental pollution. Dar Al- fikr / Damascus, Dar Al- fikr Al-muaser/ Beirut, the first edition. (in Arabic).
- **Mohammed, I. Q., (1993):** Mineralogy, petrology and depositional environment of clays and siliceous rocks in the Maastrichian- Danian sequence in western desert. Unpublished Ph. D. Thesis, University of B Baghdad, 183 pp. (in Arabic).
- **Montgomery. W., C., (2006):** Environmental Geology. MC Grow-hill Companies Inc., Boston, 7 th ed., P. 346.

- **Moran, E., Brondizio, E., Mausel, P., and Lu, D., (2004):** Change detection techniques, Int: Journal of Remote Sensing, Vol 25, issues 12, p 2365-2401.
- **Morse, J.W., Luther III, G.W., 1999):** Chemical influences on trace metal-sulfide interactions in anoxic sediments. Geochim. Cosmochim. Acta 63, 3373–3378.
- **NAAQS (National Ambient Air Quality Standard), (1997):** Air and Radiation, U.S. Environmental Protection Agency, P. 66.
- **Navrot J, Singer A, Banin A. (1978):** Adsorption of cadmium and its exchange characteristics in some Israeli soils. J Soil Sci 29:505-511.
- **OSHA (Occupational Safety and Health Administration), (2005):** Hydrogen Sulfide (H2S), OSHA - 321 (800), {online} available: http://www.osha.gov.
- **OSHA (Occupational Safety and Health Administration), (2006):** Small Entity Compliance Guide for the Hexavalent Chromium Standards, OSHA 3320-10N, {online} available: http:// www.osha.gov.
- **Palmer, A.R. and van Rooyen, A.F. (1998):** Detecting vegetation change in the southern Kalahari using Landsat TM data. Journal of Arid Environments, 39, 143–153.
- **PAPA (Professional Aerial Photographers Association), (2001):** History of Aerial Photography, {online} available: http://www.profotos.com/education/referenedesk/masters/felixnadar/ felixnadar.shtml.
- **Parsons R. M., (1957):** Ground water Resources of Iraq, Vol. 11, Mesopotamian Plain, Ministry of Development Board, Baghdad, 157 P.

- **Parsons R. M., (1957):** Ground Water Resources of Iraq, Vol. 11, Mesopotamian plain, ministry of development Board, Baghdad, 157p.
- **Peirce J., Werner R. and Vesllmd P., (1998):** Environmental Pollution & Control, Butter Worth _ Heinemann, 264 PP.
- **Peltier, L., (1950):** The geographic cycle periglacial region as it is related to climatic geomorphology: Annuals of the Association of American Geographers,V. 40, No. 3, P214–236.
- **Penner J. E., Zang S. Y., Chin M., Chaung C. C., Feichter J., Feng Y., Geogdzhayev I. V., Ginoux P., Herzog M., Higorashi A, Koch D., Land C., Luhmann U., Mishchinko M., Nikajima T., Pitari G., Soden B., Tegen I., Stowe L.,(2002):** A comparison of model and satellite derived optical depth and reflectivity.{online} available: http://data.engin.umich.edu./penner/paper3.
- **Peper, L., Gerba, P., and Brusseau, L., (2006):** Environmental and Pollution Science, 2nd Ed., E.R. Loya, Inc. New York, P. 532.
- **Peter, S., (2004)**: Geochemical factors controlling the migration and immobilization of heavy metals as reflected by the study soil proiles from the Cserhat mts., Lab. For Geochemical research, Hungarian Academy of Sciences, Budapest, p17.
- **PHG (Public Health Goal), (2001):** Nickel in Drinking Water, Office of Environmental Health Hazard Assessment California Environmental Protection Agency, Joan E. Denton, Ph.D., P. 73.
- **Poppe, L.J., Paskevich, V.F., Hathaway, J.C. and Blackwood, (2002):** D D.S., A Laboratory Manual for X-Ray Powder Diffraction, U. S. G Geological Survey Open-File Report 01-041.
- **Pual, S., Dennis, P. and Daavid, R., (1970):** Geochemistry. U.S. Patent No. 6130179., 133 P.

- **Richards, J. A. and Jia, X., (1999):** Remote Sensing Digital Image Analysis: An Introduction. 2rd Edition, Springer, Berlin/Heidelberg/New York, 363 PP.
- **Rosler, H., J., (1972):** Geochemical Tables, Lange Elsevier, Amsterdam, 468 P.
- **Salah, A., H., (2011):** Air Quality Over Baghdad City Using Earth Observation And Landsat Thermal Data, Journal of Asian Scientific Research, V. 1, pp.291-298.
- **Salman, M., (2007):** A rapid Method for Measurement of Nickel and Chromium at Trace Level in Aqueous Samples, J., Mex. Chem. Soc. 2011, PP.200-217.
- **Seather, O., M., (1997):** Geochemical Processes, Weathering and groundwater Recharge In Catchment S. A.A. Balkama, Rotterdam, Brookfield, Holland, P. 400.
- **Singh, A., (1998):** Review Article: Digital change detection techniques using remotely-sensed data.Int. J. Remote Sensing, 10(6), 989-1003.
- **Shaker, M. M., (1983):** Clays land suitable for brick industry in Nahrawan area / Part II, Company of Mining and Geological Survey, an internal report, 19 pages. (in Arabic).
- **Shaker, A., (1992):** The Impact of Human Activities on Water Quality of Diyala River, M.SC (unpublished), College of Science, University of Baghdad, 180 p. (in Arabic).
- **Shanshal, S. M., (2004):** The impact of pollution resulting from tannery and brick factories on soil and water in Nahrawan area - east of Baghdad, M. SC Thesis (unpublished), College of Science, University of Baghdad, 135 p. (in Arabic).
- **Silveira. M. L.; Alleoni, L. R. and Guilherme, L. R. G., (2003):** Biosolids and Heavy Metals in soils, Sci. Agric. (piraicaba Braz.), Vol. 60, No-4, pp. 32.
- **Schroeder, H. G., 1971.** Environment, P., 13-18.

- **Schilling, G., H., 1997.** Modeling Aircraft Fuel Consumption With A Neural Network, M. SC. Thesis, Civil Engineering, Virginia Polytechnic Institute and State University, Blacksburg, Virginia, Unpublished, P. 123.
- **Stoepler, M., 1994.** Hazardous Elements in the Environment, Elsevier, Amsterdam.
- **Soong, R. (1992):** Palygorskite occurrences in northwest Nelson, South Island, New Zealand, Geol. Geoph. New Zealand, 35, 325–330.
- **Thoraz, J., (1975):** Phyllosilicates and clay minerals; Laboratory handbook for their X-Ray Diffraction analysis, G. Le lette (edits), Dison, Belgium, 578P.
- **Thorez J., (1976):** Practical Identification of Clay Minerals, G. Lellotte (ed.) Belgiun, P.89.
- **Vink, A.P.A. (1975):** Land Use: in Advancing Agriculture. Springer Verlag. Germany, 19-32 P.
- **Waaren L. A., Haack E. A. Biogeochemical controls on metal behavior in freshwater environments. *Earth Science Reviews*, (2001):** vol. 54, 261.-320.pp.
- **Waever C. E., & Pollard L., (1975):** The Chemistry of clay minerals, Elsavier, Amsterdam, 213P.
- **Wallace, J. M. and Hobbs P. V., (1977):** Atmospheric Science, an Introductory Survey. Chapters 7 and 9, Academic Press, New York. 467 PP.
- **World Health Organization (WHO), (1999):** Water quality assessments: a guide to the use of biota, sediments and water in environmental monitoring London, 615 PP. {online} available: http://www.waterresearch.net/ Watrqualindex/index.htm.

- **World Health Organization (WHO), (2005):** Bentonite, kaolin, and Selected Clay Minerals. (Environmental health criteria; 231), Geneva, Switzerland, ISBN 92 4 157231 0, 175p.
- **World Health Organization (WHO), (2006):** Guidelines for drinking water quality. (3rd ed.) , Vol. 1, Recommendations, Geneva, P.595.
- **World Health Organization (WHO), (2011):** Guidelines for drinking water quality, (2nd ed.), Ward, V. 2, P.32.
- **World Health Organization, (2000):** Environmental lead exposure: a public health problem of global dimensions, P. 1074, {online} available: http://www.scielosp.org.
- **Yacoub S. Y. & Hassan I. A. (1996):** The Geology of Baghdad Quadrangle, Sheet No. 427 C, Scale 1: 500000, Int. Rep. GEOSURV, Baghdad, Iraq, P.55.
- **Zinni, S. M., (2001):** Air pollution in some industrial facilities in the Baghdad city. (Unpublished) M. SC thesis, Engineering Department of Production and minerals / University of Technology, 156 pages. (in Arabic).

Appendix (1) : X- Ray diffractogram of clay minerals in soil sample

| **Peaks No.** | **2 Theta ( deg )** | **d (A)** | **I / I1** |
|---|---|---|---|
| 1 | 6.8373 | 12.91677 | 64 |
| 2 | 9.0182 | 9.79808 | 100 |
| 3 | 12.8640 | 6.87621 | 79 |
| 4 | 14.8440 | 5.96317 | 11 |
| 5 | 16.8180 | 5.26743 | 17 |
| 6 | 18.8907 | 4.69389 | 52 |

| **Peaks No.** | **2 Theta ( deg )** | **d (A)** | **I / I1** |
|---|---|---|---|
| 1 | 6.8926 | 12.8142 | 84 |
| 2 | 9.1557 | 9.65124 | 100 |
| 3 | 12.7959 | 6.91265 | 5 |
| 4 | 16.6206 | 5.32954 | 5 |
| 5 | 18.2825 | 4.84865 | 35 |

| **Peaks No.** | **2 Theta ( deg )** | **d (A)** | **I / I1** |
|---|---|---|---|
| 1 | 8.4285 | 10.48224 | 5 |
| 2 | 8.8233 | 10.01407 | 4 |
| 3 | 11.6033 | 7.62032 | 3 |
| 4 | 12.3443 | 7.16451 | 5 |
| 5 | 19.7944 | 4.48159 | 9 |

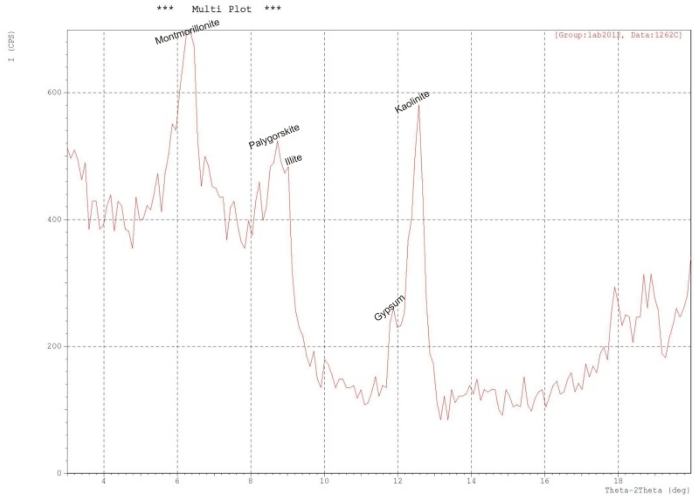
| Peaks No. | 2 Theta ( deg ) | d (A) | I / I1 |
|---|---|---|---|
| 6 | 20.8373 | 4.25958 | 19 |
| 7 | 22.0033 | 4.03642 | 3 |
| 8 | 23.0735 | 3.85157 | 8 |
| 9 | 26.6534 | 3.34182 | 84 |
| 10 | 27.8605 | 3.19971 | 9 |
| 11 | 29.4465 | 3.03088 | 100 |
| 12 | 30.9913 | 3.88323 | 6 |
| 13 | 31.5777 | 2.83102 | 5 |
| 14 | 34.9262 | 2.56688 | 7 |
| 15 | 36.0279 | 2.49088 | 15 |
| 16 | 36.5579 | 2.45597 | 9 |
| 17 | 37.4463 | 2.39972 | 3 |
| 18 | 39.4922 | 2.27999 | 25 |
| 19 | 40.2650 | 2.23799 | 4 |
| 20 | 42.4897 | 2.12582 | 5 |
| 21 | 43.2497 | 2.09021 | 15 |
| 22 | 45.4410 | 1.99438 | 3 |
| 23 | 45.8358 | 1.97811 | 4 |
| 24 | 47.1189 | 1.92719 | 4 |
| 25 | 47.5923 | 1.90912 | 19 |
| 26 | 48.5955 | 1.87203 | 22 |

| **Peaks No.** | **2 Theta ( deg )** | **d (A)** | **I / I1** |
|---|---|---|---|
| 1 | 3.2714 | 26.98596 | 3 |
| 2 | 5.5662 | 15.86443 | 30 |
| 3 | 6.1584 | 14.34015 | 28 |
| 4 | 8.7426 | 10.10633 | 47 |
| 5 | 9.4155 | 9.38551 | 9 |
| 6 | 11.5869 | 7.63107 | 10 |
| 7 | 12.4634 | 7.09631 | 100 |
| 8 | 13.7295 | 6.44462 | 7 |
| 9 | 14.4492 | 6.12520 | 4 |
| 10 | 15.1524 | 5.84248 | 4 |
| 11 | 15.831 | 5.59354 | 5 |
| 12 | 16.5219 | 5.36115 | 17 |
| 13 | 17.7929 | 4.98095 | 40 |
| 14 | 18.7618 | 4.72585 | 48 |
| 15 | 19.779 | 4.48504 | 51 |

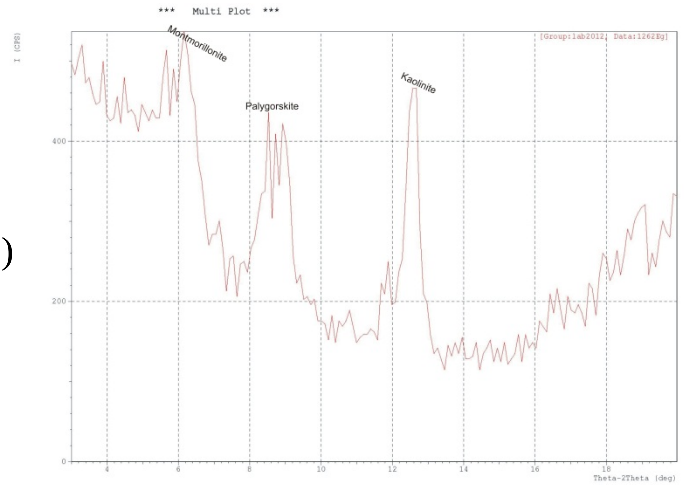
| **Peaks No.** | **2Theta ( deg )** | **d (A)** | **I / I1** |
|---|---|---|---|
| 1 | 4.5792 | 19.2814 | 12 |
| 2 | 5.0727 | 17.4067 | 21 |
| 3 | 5.5662 | 15.8644 | 31 |
| 4 | 6.2934 | 14.0328 | 2 |
| 5 | 7.2441 | 12.1932 | 32 |
| 6 | 8.3298 | 10.6062 | 49 |
| 7 | 8.7116 | 9.90351 | 78 |
| 8 | 9.7116 | 9.10001 | 6 |
| 9 | 10.5061 | 8.41356 | 3 |
| 10 | 11.7046 | 7.5546 | 15 |
| 11 | 12.5109 | 7.06947 | 100 |
| 12 | 17.2128 | 5.14749 | 4 |
| 13 | 17.8889 | 4.95444 | 33 |
| 14 | 18.7502 | 4.72875 | 34 |
| 15 | 19.4829 | 4.55254 | 11 |

| **Peaks No.** | **2 Theta (deg)** | **d (A)** | **I / I1** |
|---|---|---|---|
| 1 | 6.5861 | 13.40983 | 39 |
| 2 | 8.8715 | 9.95977 | 100 |
| 3 | 17.9037 | 4.95037 | 33 |
| 4 | 19.4829 | 4.55254 | 80 |

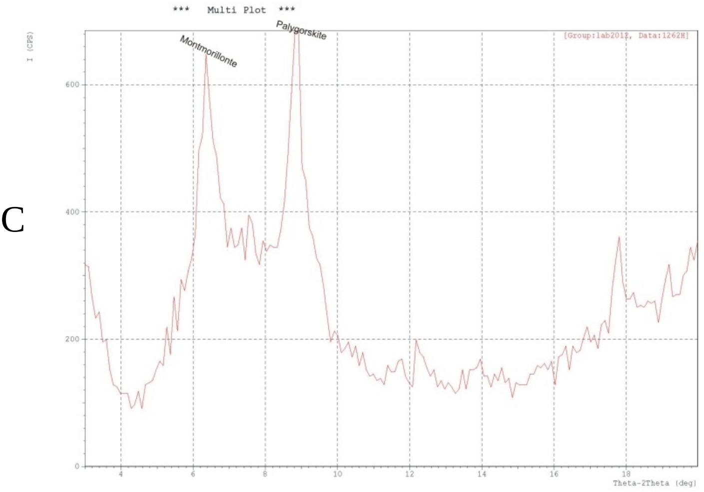
| **Peaks No.** | **2 Theta (deg)** | **d (A)** | **I / I1** |
|---|---|---|---|
| 1 | 6.1739 | 14.30418 | 5 |
| 2 | 8.3298 | 10.60622 | 5 |
| 3 | 8.8233 | 10.01407 | 6 |
| 4 | 11.6331 | 7.60087 | 21 |
| 5 | 12.4120 | 7.12558 | 11 |
| 6 | 19.3842 | 4.57549 | 3 |
| 7 | 19.7872 | 4.48320 | 9 |
| 8 | 20.8170 | 4.26369 | 21 |
| 9 | 23.0361 | 3.85774 | 8 |
| 10 | 23.5296 | 3.77793 | 3 |
| 11 | 25.1581 | 3.53695 | 5 |
| 12 | 26.6606 | 3.34093 | 81 |
| 13 | 27.5763 | 3.23204 | 9 |
| 14 | 27.9711 | 3.18730 | 10 |
| 15 | 29.4562 | 3.06047 | 12 |
| 16 | 29.0852 | 3.02991 | 100 |
| 17 | 31.0852 | 2.87474 | 14 |
| 18 | 31.7217 | 2.81849 | 5 |
| 19 | 34.4853 | 2.59869 | 5 |
| 20 | 34.9788 | 2.56314 | 9 |
| 21 | 35.3736 | 2.53544 | 4 |
| 22 | 36.0515 | 2.48930 | 20 |
| 23 | 36.5879 | 2.45403 | 8 |
| 24 | 37.5861 | 2.39112 | 3 |
| 25 | 39.4987 | 2.27963 | 27 |
| 26 | 42.4907 | 2.12577 | 6 |
| 27 | 43.2713 | 2.08922 | 18 |
| 28 | 45.5987 | 1.98784 | 5 |
| 29 | 47.1189 | 1.92719 | 4 |
| 30 | 47.5938 | 1.90907 | 15 |
| 31 | 48.6065 | 1.87163 | 18 |



Normal (N)

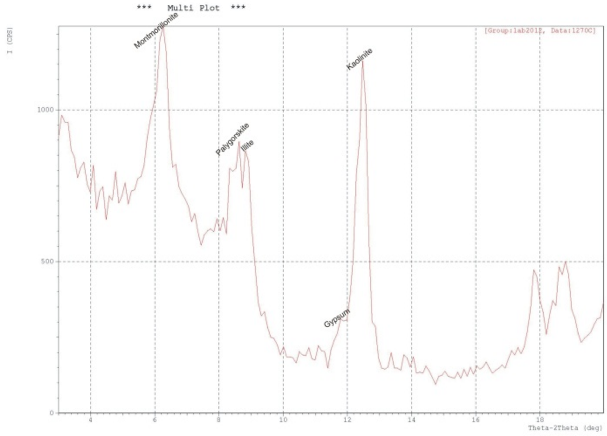


Ethylglycolated (EG)

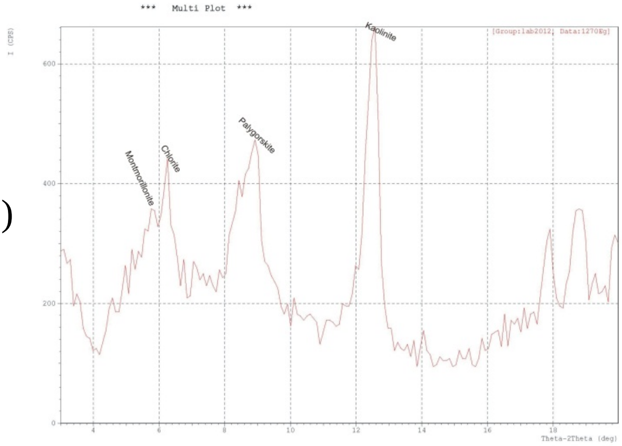


Heated at 550 °C

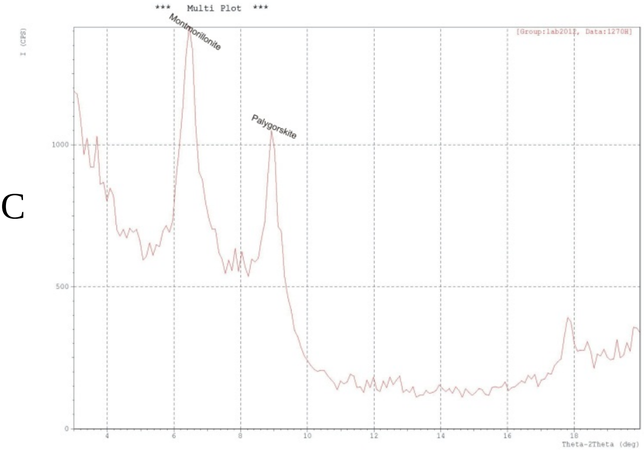
Normal (N)



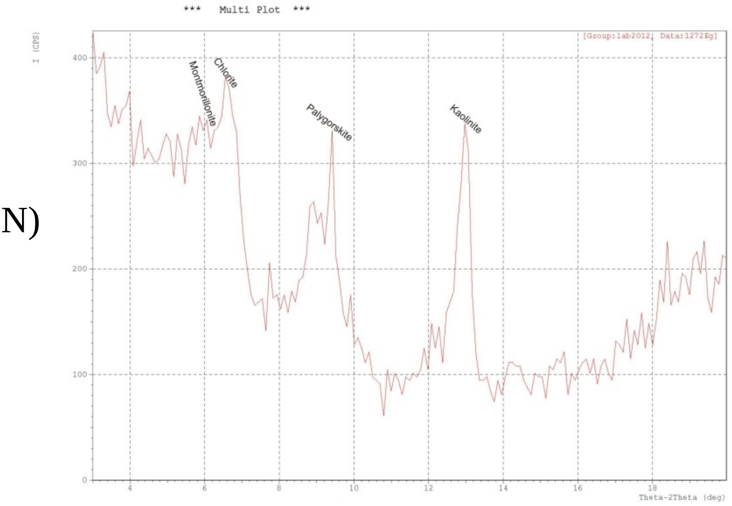
Ethylglycolated (EG)



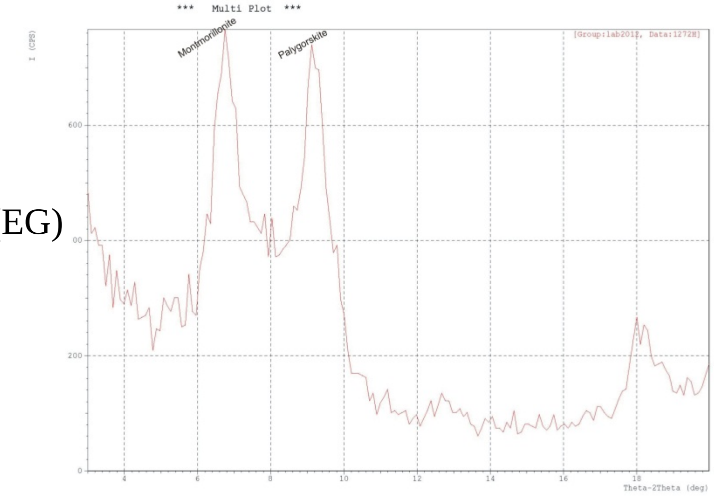
Heated at 550 °C



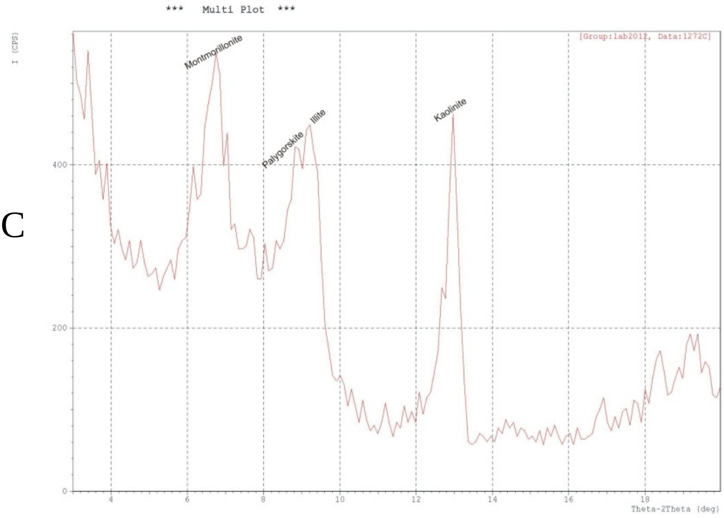
Normal (N)



Ethylglycolated (EG)



Heated at 550 °C



# المستخلص

تقع منطقة الدراسة حوالي 65 كم في الجزء الشرقي من مدينة بغداد في منطقة النهروان ، وهي واقعة ضمن نطاق السهل الرسوبي وتغطيها ترسبات العصر الرباعي، ويمكن اعتبارها نقطة ساخنة للتلوث حيث مختلف مصادر التلوث يمكن تمييزها ضمن هذه المنطقة المتمثلة بالعديد من معامل الطابوق والتي تعمل بواسطة حرق النفط الاسود بالتالي ادى الى انبعاث مختلف الملوثات الى البيئة (هواء ، ماء ، تربة) مثل الغازات السامة والرماد المتطاير.

استخدام التصنيف الموجه على المرئية الفضائية للقمر الصناعي Landsat (2007 , TM) لإعداد خارطة استخدامات غطاء الارض اظهرت مختلف وحدات غطاء واستخدامات الأراضي والمتمثلة ب : المناطق الحضرية ، الماء ، الدخان ، الغطاء النباتي ، الاراضي الزراعية غير المغطاة بالنباتات والاراضي الجرداء) ، والتي تعتبر الوحدات الرئيسية لاستخدامات غطاء الارض في منطقة الدراسة.

التغييرات البيئية تم تحديدها باستخدام دليل الغطاء النباتي (NDVI) لثلاث فترات (1990، 2002 ، 2007) والذي اظهر ان الغطاء النباتي قل خلال 2002 من ثم زاد بشكل طفيف خلال 2007 بسبب عدم وجود أو نقص في الموارد المائية بسبب التغيرات المناخية وظروف الجفاف مما أدى إلى زيادة في ملوحة التربة.

اما الملوحة فحددت بواسطة دليل الملوحة (SI) اظهرت النتائج للفترات الثلاث ان الملوحة زادت نتيجة للتغيرات المناخية وظروف الجفاف التي سادت البلد خلال العقود القليلة الأخيرة إلى جانب الممارسات غير الملائمة لأنظمة الزراعة والري ومياه الصرف المتأثرة بمصانع الدباغة التي تستخدم تراكيز عالية من الملح في صناعة الدباغة. أما مستويات المياه فقد زادت بشكل كبير في عام 2002 مقارنة مع عام 1990 في حين تراجع بشكل كبير مرة أخرى في عام 2007.

التفسير البصري للصورة الفضائية المصححة (2011, ETM ) أن الدخان المنبعث من معامل الطابوق زاد على مر السنين الأربع الماضية مقارنة مع عام (2007،TM) وهذا يعني زيادة التلوث في منطقة الدراسة.

للكشف عن تلوث الهواء تراكيز ملوثات الهواء (TSP, Pb, Cr, Ni, $NO_2$, $SO_2$, $H_2S$) تم قياسها لتسعة نماذج من الهواء، وقد أظهرت النتائج أن معدل TSP يصل الى 1820.08 ($\mu g/m^3$). اما المعادن الثقيلة (الرصاص، النيكل، الكروم) أظهرت تراكيز عالية تجاوزت المحددات العالمية والعراقية للتلوث. الغازات ($NO_2$، $SO_2$، $H_2S$) اظهرت النتائج نسبة عالية

في بعض المواقع في منطقة الدراسة وهذه الزيادة قد تكون بسبب حرق الوقود (الزيت الثقيل) في معامل الطابوق وكذلك الأنشطة الصناعية الأخرى.

أظهرت نتائج التحاليل الكيميائية لمياه منطقة الدراسة لأحد عشر نموذج اثنان منها سطحي وتسعة منها مياه جوفية ان المياه ملوثة بتراكيز عالية من المعادن الثقيلة ( Pb, Cr, Cd, Ni) بالإضافة الى تراكيز عالية الأيونات الرئيسية والثانوية ($Ca^{+2}$, $Na^{+1}$, $Cl^{-1}$, $SO_4^{-2}$) مع حالة استثنائية من تركيز عال جدا ل ($NO_3$) في موقع (W2). في حين أظهرت مياه الصرف الصناعية الناتجة من معامل الدباغة تراكيز عالية جدا من (TDS، الأيونات الرئيسية والثانوية) والمعادن الثقيلة وخاصة (الكروم). وقد تم قياس كبريتيد الهيدروجين لعينات المياه وأظهرت قيم عالية لهذا الغاز ويرجع ذلك أساسا إلى حرق الوقود في معامل الطابوق.

وأظهرت جيوكيميائية ومعدنية التربة لنماذج التربة تراكيز عالية من المعادن الثقيلة (الرصاص، الكروم، الكادميوم، النيكل والفناديوم) وتراكيزها تجاوزت المحددات المسموح بها. وقد أظهرت نسبة أكاسيد الرئيسية ($SO_3$، $K_2O$، $Al_2O_3$، $Na_2O$) تغييرات قليلة مقارنة مع الدراسات السابقة.

تراوحت نسبة الكربون لخمسة نماذج مختارة من التربة من (3.63 -5.27٪)، في حين تراوحت نسبة الكبريت من (0 ،107-57،6٪).

المعادن الطينية الرئيسية في تربة منطقة الدراسة هي مونتموريلونايت، الكاؤلينايت، وباليكورسكايت، الإليت، في حين ان الكالسيت هو أعلى محتوى من المعادن غير الطينية.

**وزارة التعليم العالي والبحث العلمي**
**جامعة بغداد**
**عمادة كلية العلوم**

# التقييم البيئي باستخدام تقنيات الاستشعار عن بعد في منطقة النهروان – شرق بغداد

أطروحة مقدمة الى
كلية العلوم - جامعة بغداد
وهي جزء من متطلبات نيل درجة ماجستير
في علوم الأرض

**من قبل**
**روز محمد عبد الستار**
**بكالوريوس علوم 2007**

**اشراف**

**د. صالح مهدي علي** **د. بلسم سالم الطواش**

2013