ROADSIDE HEAVY METAL POLLUTION OF SULAIMANI-ARBAT, SULAIMANI-MERGAPAN AND SULAIMANI-KARKUK ROADS

Dler Mustafa MOHAMMAD

MASTER THESIS

Department of Soil Science and Plant Nutrition

Supervisor: Assoc. Prof. Dr. Abdulkadir SÜRÜCÜ

2016

T.R.
BINGOL UNIVERSITY
INSTITUTE OF SCIENCE

ROADSIDE HEAVY METAL POLLUTION OF SULAIMANI-ARBAT, SULAIMANI-MERGAPAN AND SULAIMANI-KARKUK ROADS

MASTER OF SCIENCE THESIS

Dler Mustafa MOHAMMAD

Department Institute : SOIL SCIENCE AND PLANT NUTRITION

Supervisor of Thesis : Assoc. Prof. Dr. Abdulkadir SURUCU

December 2016

T.R.
BINGOL UNIVERSITY
INSTITUTE OF SCIENCE

ROADSIDE HEAVY METAL POLLUTION OF SULAIMANI-ARBAT, SULAIMANI-MERGAPAN AND SULAIMANI-KARKUK ROADS

MASTER THESIS

Dler Mustafa MOHAMMAD

Department Institute : SOIL SCIENCE AND PLANT NUTRITION

This thesis was unanimously approved by the following jury on 26.12.2016

Assoc.Prof. Dr.	**Assoc.Prof. Dr.**	**Prof. Dr.**
Abdulkadir SURUCU	**Veli UYGUR**	**Alaaddin YUKSEL**
President of the Jury	**Member**	**Member**

I confirm the results above

Prof. Dr. brahim Y. ERDO AN
Director of the Institute

PREFACE

To begin with, I thank (Allah) for his blessing who made me able to complete and perform this study with success. I would like to thank my supervisor, Assoc. Prof. Dr.Abdulkadir SÜRÜCÜ for his patience and guidance throughout the project. I would like to acknowledge and thank the presidency of Bingol University, the Deanery of Faculty of Agricultural Sciences and the Department of Soil Sciences and Plant Nutrition for giving me the chance and providing the available facilities to achieve this proposed project. I am also grateful to Prof. Dr. Alaaddin YUKSEL, to Assoc. Prof. Dr Ali Riza DEMIRKIRAN, Assist. Prof. Dr. Veysal TURAN, and Assist. Prof. Dr. Yasin DEMIR from Staff of Soil Science Department in Faculty of Agriculture of Bingol University. Special thank to Assoc. Prof. Dr. Veli UYGUR in suleyman demirel university.

Deepest gratitude to Prof. Dr. Nawroz Rashid ABDULRAZAQ in Sulaimani University, Faculty of Agriculture, Department of Field Crops for his scientific advices for doing static analysis to data of my thesis. I have special thank to As.Te. Ardalan Jalal MAJEED who checked and design style my dissertation. I am also grateful to Dr. Salih Najeb MAJED for his valuable remarks, also I thinks full to all of persons whose help me during my MSc study.

Last but not least, I express my sincere gratitude to my family for their support, cheerfulness, patience, and encouragement. Finally, I thank all those who assisted me in doing my work.

Dedication

I dedicate this work to my family, especially my wife for her patience and encouragement.

Dler Mustafa MOHAMMED

Bingöl 2016

CONTENTS

PREFACE ii

CONTENTS iii

LIST OF FIGURES v

LIST OF TABLES vii

LIST OF SYMBOLS ix

ÖZET xi

ABSTRACT xii

1. INTRODUCTION 1

2. LITERATURE REVIEWS 7
- 2.1. General Introduction to Environmental Pollution 7
- 2.2. Heavy Metals Pollution in the Environment 8
- 2.3. Traffic-Related (Vehicular) Heavy Metals Contamination in Roadside Soil 10
- 2.4. An Overview on Heavy Metal Concentration of Roadside and Farmland Soils 11

3. MATERIALS AND METHODS 17
- 3.1. Description of the Study Area 17
- 3.2. Meteorological Conditions 18
- 3.3. Motor Vehicle Growth in Sulaimani City 19
- 3.4. Soil Sampling 19
- 3.5. Soil Analysis 26
  - 3.5.1. Soil pH and EC 26
  - 3.5.2. Total Lime 26
  - 3.5.3. Olsen Phosphorus 27
  - 3.5.4. Organic Matter 28
  - 3.5.5. Soil Texture 29
  - 3.5.6. Extractable Calcium and Magnesium: 30
  - 3.5.7. Heavy Metals 32
- 3.6. Static Analysis 33

4. RESULT AND DISSCUTION 34
4.1. pH 34
4.2. EC 34
4.3. Organic Matter 35
4.4. Sand% 37
4.5. Silt% 37
4.6. Clay% 37
4.7. $CaCO_3$% 40
4.8. P_2O_5 Concentration 40
4.9. Ammonium Acetate Extractable Ca Concentration 40
4.10. Ammonium Acetate Extractable Mg Concentration 43
4.11. Ammonium Acetate Extractable K Concentration 43
4.12. Ammonium Acetate Extractable Na Concentration 43
4.13. Cation Exchange Capacity 45
4.14. Total Zn Concentration 45
4.15. Total Mn Concentration 48
4.16. Total Cu Concentration 52
4.17. Total Fe Concentration 54
4.18. Total Cr Concentration 57
4.19. Total Co Concentration 61
4.20. Total Pb Concentration 63
4.21. Total Cd Concentration 66
4.22. Total Ni Concentration 70
4.23. Total Na Concentration 73
4.24. Total K Concentration 73

CONCLUSION 77

REFERENCES 78

LIST OF FIGURES

Figure 1. Map of Iraq Showing Sulaimani Governorate 18

Figure 2. Average Temperature, Relative Humidity and Wind Speed for the Studied Area During the Years 1973 to 2006 (Muhammad 2009). 19

Figure 3. The Maps of Three Main Roads of Research Area 20

Figure 4. The Maps of Arbat Road of Soil Sampling 21

Figure 5. The Maps of Tasluja Road of Soil Sampling 21

Figure 6. The Maps of Mergapan Road of Soil Sampling 22

Figure 7. Microwave Accelerated Reaction System 32

Figure 8. Atomic Absorption Spectrophotometer 33

Figure 9. The Average Total Zn Concentration at Arbat 47

Figure 10. The Average Total Zn Concentration at Tasluja 47

Figure 11. The Average Total Zn Concentration at Mergapan 48

Figure 12. The Average Total Mn Concentration at Arbat 49

Figure 13. The Average Total Mn Concentration at Tasluja 50

Figure 14. The Average Total Mn Concentration at Mergapan 50

Figure 15. The Average Total Cu Concentration at Arbat 53

Figure 16. The Average Total Cu Concentration at Tsluja 53

Figure 17. The Average Total Cu Concentration at Mergapan 54

Figure 18. The Average Total Fe Concentration at Arbat 55

Figure 19. The Average Total Fe Concentration at Tasluja 56

Figure 20. The Average Total Fe Concentration at Mergapan 56

Figure 21. The Average Total Cr Concentration at Arbat 58
Figure 22. The Average Total Cr Concentration at Tasluja 58
Figure 23. The Average Total Fe Concentration at Mergapan 59
Figure 24. The Average Total Co Concentration at Arbat 61
Figure 25. The Average Total Co Concentration at Tasluja 62
Figure 26. The Average Total Co Concentration at Mergapan 62
Figure 27. The Average Total Pb Concentration at Arbat 64
Figure 28. The Average Total Pb Concentration at Tasluja 65
Figure 29. The Average Total Pb Concentration at Mergapan 65
Figure 30. The Average Total Cd Concentration at Arbat 67
Figure 31. The Average Total Cd Concentration at Tasluja 68
Figure 32. The Average Total Cd Concentration at Mergapan 68
Figure 33. The Average Total Ni Concentration at Arbat 71
Figure 34. The Average Total Ni Concentration at Tasluja 72
Figure 35. The Average Total Ni Concentration at Mergapan 72

LIST OF TABLES

Table 1. Sampling Nodes at Arbat Locat 23

Table 2. Sampling Nodes at Tasluja Location 24

Table 3. Sampling Nodes at Mergapan Location 25

Table 4. Side- and Distance-Induced Averages of pH, EC and OM at Sampling Locations (Arbat, Tasluja, and Mergapan)..... 36

Table 5 . Side- and Distance-Induced Averages of Sand%, Silt%, and Clay% at Sampling Locations (Arbat, Tasluja, and Mergapan) 39

Table 6. Side- and Distance-Induced Averages of $CaCO_3$, P_2O_5, and Ca at Sampling Locations (Arbat,Tasluja, and Mergapan) 42

Table 7. Side - and Distance-Induced Averages of Mg, K, and Na at Sampling Locations (Arbat,Tasluja, and Mergapan)..... 44

Table 8. Side- and Distance-Induced Averages of CEC, Total Zn, and Total Mn at Sampling Locations (Arbat, Tasluja, and Mergapan) 51

Table 9. Side- and Distance-Induced Averages of Total Cu, Total Fe, and Total Cr at Sampling Locations (Arbat, Tasluja, and Mergapan) 60

Table 10. Side- and Distance-Induced Averages of Total Co, Total Pb, and Total Cd at Sampling Locations (Arbat, Tasluja, and Mergapan)..... 69

Table 11. Side- and Distance-Induced Averages of Total Ni, Total Na, and Total K at Sampling Locations (Arbat, Tasluja, and Mergapan) 74

Table 12. Comparison of Mean Contents (mg kg^{-1}) of Heavy Metals in Roadside Soil From other Cities in the World. (Malkoc et al., 2010) 75

Table 13. The Boundary, Alerting and Critical Values of Heavy Metal in Soil, Values are in mg kg^{-1} of Dry Soil Cited from (Plesničar and Zupančič 2005)..... 76

LIST OF SYMBOLS

SYMBOL	: DESCRIPTION
Pb	: Lead
Cu	: Copper
Ni	: Nickel
Cd	: Cadmium
Cr	: Chromium
Zn	: Zinc
Fe	: Iron
Mn	: Manganese
As	: Arsenic
Hg	: Mercury
Se	: Selenium
Co	: Cobalt
Ag	: Silver
Sb	: Antimony
Al	: Aluminium
Mg	: Magnesium
P	: Phosphorus
K	: Potassium
Na	: Sodium
V	: Vanadium
C	: Carbon
Ca	: Calcium
HCl	: Hydrochloric Acid
H_2SO_4	: Sulfuric Acid
HNO_3	: Nitric Acid
$CaCO_3$	: Calcium Carbonate
NaOH	: Sodium Hydroxide
$NaHCO_3$	: Sodium Bicarbonate
KH_2PO_4	: Monopotassium Phosphate
$K_2Cr_2O_7$	: Potassium Dichromate
P_2O_5	: Diphosphorus Pentoxide
$MgCl_2$	: Magnesium Chloride
K_2SO_4	: Potassium Sulfate
BC	: Black Carbon
NH4OH	: Ammonium Hydroxide
$C_8H_8N_6O_6$	: Ammonium Purpurate

$(NH_4)6Mo7O_{24}.4H_2O$	: Ammoniumheptamolybdate
EDTA	: Ethylenediamine Tetra-acetic Acid
NH_4Cl	: Ammonium Chloride
EC	: Electric Conductivity
OM	: Organic Matter
TOC	: Clay% in One Gram of Oven Dry Soil
CEC	: Cation Exchange Capacity
pH	: Power of Hydrogen
D.W.	: Distilled Water
GPS	: Global Positioning System
GSP	: Generalised System of Preferences
MARS	: Microwave Accelerated Reaction System
AAS	: Atomic Absorption Spectrophotometer
LSD	: Least Significant Difference
EU	: European Union
IPI	: Integrated Pollution Index
kg	: Kilogram
g	: Gram
mg	: Milligram
ml	: Milliliter
µg	: Milliequivalent
m	: Meter
m/s	: Meter per second
mm	: Millimeter
MJ/m2 /day	: Mega joules per square meter per day
M	: Molarity
N	: Normality
N.	: North
E	: East
°C	: Degree Celsius
ND	: Not Detected

SÜLEYMANIYE-KERKÜK, SÜLEYMANIYE-ARBAT, VE SÜLEY-MANIYE-MERGAPAN KARAYOLU KENARINDA TRAFIKTEN KAYNAKLI AĞIR METAL KIRLILIĞI

ÖZET

Artan araç yoğunluğu nedeniyle son yıllarda trafik kökenli çevre kirliliği araştırıcıların ilgisini çekmektedir. Bu nedenle kuzey Irakta önemli yerleşim yerlerinden olan Arbat, Tasluja ve Mergapan ana yollarında trafik etkisiyle oluşan ağır metal kirliliği bu araştırmada incelenmiştir. Bu maksaktla 5 tekerrürlü ana yolların her iki tarafından yoldan 1, 15, 25 ve 50 mesafede yüzey toprak örnekleri (0-20 cm) alınmıştır. Örneklerde toprakların tanımlayıcı fizikokimyasal özelliklerinin yanında toplam ağır metal konsantrasyonları belirlenmiştir. Araştırma alanı topraklarının genelde hafif alkali, kireç içeriklerinin yüksek, organik madde açısından fakir, kil tekstürlü ve P, K ve Na konsantrasyonlarının düşük olduğu tespit edilmiştir. Toprakların ağır metal konsantrasyonlarının yoldan olan mesafe ile ters orantılı olarak değiştiği belirlemiştir. Bu etki Arbat yolunun her iki tarafında Pb, Cd, Co, Cu, Ni ve Fe, sadece yolun sağında Zn, sol tarafında Cr ve Mn için belirgindir. Aynı şekilde Tasluja yolunda Pb ve Cd konsantrasyonu her iki tarafta ve Cr, Ni ve Fe yolun solunda gözlenmiştir. Mergapan yolunda ise Pb ve Cd konsantrasyonu yolun her iki tarafında, Co ise yolun solunda mesafe ile ters orantılı olarak azalmıştır. Yolların sağında ve solunda bazı elementlerin davranışında değişkenlik belirlenmiştir. Bu değişimin yolların eğiminden kaynaklanan yüzey akışı ile ilişkili olduğu değerlendirilmiştir. Her üç örnekleme noktasında da Zn ve Cu sınır değerin üzerinde iken; Mergapan'da Pb, Arbat'ta Cd'nin kritik seviyeye yakın konsantasyonlara sahip olduğu belirlenmiştir. Ni metali Arbat'ta yolun sol tarafında, Tasluja ve Mergapan'da ise yolun sağ tarafta sınıra yakın bulunmuştur. Bazı ağır metallerin konsantrasyonunun kritik seviyelere ulaşmış olması nedeniyle kirliliğin önlenmesi ve ya temizlenmesi için çalışmaların yapılması gerektiği sonucuna varılmıştır.

Anahtar Kelimeler: Kirlilik, ağır metal, bulaşma, toprakların fizikokimyasal özellikleri.

. **ROADSIDE HEAVY METAL POLLUTION OF SULAIMANI ARBAT, SULAIMANI- MERGAPAN AND SULAIMANI-KARKUK ROADS**

ABSTRACT

In recent years has attracted interest from researchers due to increased vehicle density traffic pollution. For this reason, was investigated in this research heavy metal pollution caused by traffic on the main roads of Arbat, Tasluja and Mergapan which are the important settlements of northern Iraq. Soil samples (0-15cm) were taken from both sides of main roads that 5 repetitive and were collected at 1, 15, 25 and 50 m. distances. In the samples, were determined the total heavy metal concentrations addition to the descriptive physicochemical properties of the soil. The research area has been found to be slightly alkaline, high in lime content, poor in organic matter, clay texturized, and low in P, K and Na concentrations. It has been determined that the heavy metal concentrations of soils change inversely with the distance from the road. Concentration change of the elements are apparent Pb, Cd, Co, Cu, Ni and Fe on both sides of the Arbat road, only for Zn on the right side and Cr and Mn on the left side. Likewise, the concentration of Pb and Cd on the Tasluja road was observed on both sides and to the left of the road of Cr, Ni and Fe. In Mergapan road concentration of Pb and Cd on the decreased on both sides of the road and Co was inversely proportional to the distance on the left of the road. Behavior of some elements has been determined of variability in the on the left and right of the roads. This variation is considered to be related to surface flow originating from the slope of the roads. At all three sampling points, Zn and Cu are above the limit value; Pb in Mergapan, and Cd in Arbat have concentrations close to the critical level. Ni metal is found on the left side of Arbat, while Tasluja and Mergapan are on the right side of the road. The concentration of some heavy metals has reached critical levels, resulting in the need to work to prevent or clean up pollution.

Key words: Pollution, heavy metal, contamination, physicochemical properties of soils.

.

1. INTRODUCTION

Negative impacts of human activities are not the issues of the 20th century but it has begun since the appearance of human being on the Earth.

The Population growing rapidly and consequent urbanization and manufacturing are the main cause of air pollution. The fast increase in the use of transportations means in most developing countries, coupled with a lack of emission criterion in these countries, has contributed a great deal of concern over vehicular pollution.

Vehicular emission is at its top when there is a rise in population, with increase in the number of transportation means on the roads together. Potentially hazardous particulate emissions occurs either from the vehicles or road surfaces. Fine particles are produced mainly by combustion of fuels, and coarse particles which are formed mechanically by the abrasion of road materials, tires and brake linings (Palmgren Fet al. 2003).

Unlike the developed countries, the developing countries are not able to minimize or control vehicular emissions under the pressure of rapid population increase. This was as a result of stricter standards imposed on the rates of emissions from various types of vehicles, the use of alternative or cleaner fuels such as ethanol, improved technology, and transportation regulations.

As transport , and rapid urbanization has occurred the risk of roadside pollution is to increase and became a critical issue to be dealt with.

In fact, the number of motor vehicles per capita in big cities is rapidly growing due to increasing income and cheaper and outdated vehicle models introduction into the market.

As a result dust polluted with heavy metals become a potential risk for human beings and soils alongside highways or intercity roads (Onianwa and Adoghe 1997; Möller et al. 2005). The most important source of heavy metals pollution is human activities (Duong and Lee 2011; Sezgin et al. 2004).

The worldwide high vehicular traffic intensity has led to quicken to reach potentially risky levels of the contaminants (Modrzewska and Wyszkowski 2014; Kummer et al. 2009). Heavy metals emitted from vehicles transportation stay (Yu et al. 2014).

The intensity and type of traffics and the topographic and geographical position of the road will affect the enrichment and allocation rate of heavy metals in soils (Chen et al. 2010; Wiseman et al. 2013).

Road transportation is one of the most significant sources of heavy metal pollution and have important role in the biogeochemical cycles of trace metals (Liu et al. 2009; Khan and Kathi 2014).

It is important to obtain precise information on the allocation of heavy metals before implement a specific pollution remediation (Chen et al. 2009). The problem worsens as daily traffic rises (WHeeLer et al. 1979).

Sundry studies have reported on health hazard of heavy metals contaminations in soils and road dusts (Chen et al. 2015; Wei et al. 2015; Wu et al. 2015).

Nowadays heavy metals are main environmental concern in the world. They are causing damage to animals, humans and are susceptible to bioaccumulation in the food chain. In urban areas heavy metals come from many different sources. Atmospheric deposition is a main contributor to heavy metal contamination in surface soils (Kelly et al. 1996).

Since 1970s the possible health entanglement of chronic lead exposure has been discussed (Mahaffey 1982). As well as several industrial activities, and vehicle exhausts emit heavy metals so that soils, plants and even residents along roads with heavy traffic loads are subjected to increasing levels of contamination with heavy metals (Ghrefat and

Yusuf 2006). Metal emission into the atmosphere as a result of vehicular traffic and its disposition on nearby roadside soils (Panichayapichet et al. 2007).

Field studies have been shown that soil pollution by heavy metals is generally concentrated in the first few meters to tens of meters on either side of the road pavement and showed decreases with distance from the road by (Olajire and Ayodele 1997; Blok 2005).

However, soil permeation of metals may increase when the soil is disturbed due to tillage processes or traffic (Panichayapichet et al. 2007). Heavy metals exposure can cause many diseases like malformation, cancer, kidney damage, and abortion (Alomary and Belhadj 2007).

Pb in roadside environments was of large worry in the 1970s as an outcome of the use of leaded fuels (Chow 1970; Motto et al. 1970). In addition to Pb, the heavy metals Cu, Ni, Cd, Cr, and Zn were latter recognized as potential risky metals in roadside environments (Münch, 1993; Viard et al. 2004).

Automobile-emitted metals can be dispersed up to 100-200 m from roadsides, although the majority is deposited in 0-20 m of the road brink (Dan-Badjo et al. 2008; Trombulak and Frissell 2000).

The sources of heavy metals in roadside soils are related to vehicular traffic, road surfaces, as well as road traffic control and maintenance operations. These contain: road surface wear, vehicle wear of tires, road paint degradation, body and brake linings, lubricating oils, erosion of galvanized surfaces of crash barriers and road mark, as well as particulate emissions (Sutherland and Tolosa, 2000; Thorpe and Harrison, 2008; Werkenthin et al. 2014).

The intensive traffic and the fast movement of automobiles can produce a great amount of road-deposited particles contaminated with heavy metals that are finally incorporated in the roadside soil (Christoforidis and Stamatis 2009; Huber et al. 2016; Nazzal et al. 2013).

(Folkeson et al. 2009) classified the sources of road traffic pollution into five main groups: traffic and cargo, maintenance and operation, pavement and embankment material, road equipment, and external sources.

Automobiles emissions have been found to be one of the main sources of soil pollution (Olukanni and Adebiyi 2012). So, roadside soils predominantly contain high concentrations of heavy metals. These heavy metals are emitted from fuel combustion, worn-tires, seepage of oils, and corrosion of car metal parts (Dolan et al. 2006).Vehicle exhaust is considered as a first emitter of heavy metal pollutants (Poszyle-Adamaska and Czerniak 2007). Heavy metals contain a relatively great series of elements with specific density over 5 g/cm^3 and relative atomic mass above 40.

Heavy metals are non-biodegradable pollutants. They are not easily detoxified and removed by metabolic activities once they are present in the environment. This may then lead to their build up to toxic grade or bioaccumulation in ecosystem. Bioaccumulation of these heavy metals in plants, animals, and human result in different degrees of toxicity (Audu et al ; Lawal 2005).

Contamination of roadside soils with heavy metals engender from different sources like road wear, vehicles, and salts. Heavy metal concentrations, such as Cu, Zn, Cd and particularly Pb in surface soils have been focused by many investigations. Accumulation of these heavy metals in surface soil is highly influenced by motor vehicles and traffic density, which put in a number of toxic metals into the atmosphere (Lonati; 2006 Ciçek et al. 2008).

Traffic pollution also contributes significantly to the pollution levels because emission rate varies for several kinds of automobile (Nirjar et al. 2002).

It is not simple to remove heavy metals from the soils because of their irreversible immobilization within various soil components (Gülser et al. 2008). The use of unleaded petrol has caused a subsequent reduction in fuel based Pb emissions, it may still come from exhaust gas and come from worn metal alloys in the engine (Winther et al . 2010).

Road maintenance and road traffic are the origin of different types of environmental pollution. Vehicle exhaust, tire wear, brake lining wear, corrosion of galvanized crash barriers are all responsible for the emission of pollutants, especially heavy metals (Brinkmann. 1985).

Potential hazards of Cd, Cr, Pb, Zn, Fe and Cu and occurrences in contaminated soils have frequently reported in literature (Akoto et al. 2008).

Kibria et al., (2007) studied Cd and Pb uptake by plants grown in three different textured soils and they found that Cd and Pb concentration in different type plant tissues were highly correlated with soil Cd and Pb concentration.

Zinc and cadmium come from lubricants, tiers and galvanized parts of vehicles, whereas the lead from petrol (Andrade et al. 2007).

In the soil, the mobility of the heavy metals in soils were Cd > Pb> Zn (Lu Y et al. 2007).

The metals which come from the fuels are (Mn, Ni, As, Cd, Cr, Hg, Pb, Se and Zn), motor oil (Ni, Cd, Cr, Zn and W), tyre wear (Pb, Cr, Cd, Co, Cu, Ni, Se and Zn), brake wear (Cd, Cu, Cr, Ag, As, Ni, Pb, Sb and Zn) and vehicular exhaust catalysts (Rh, Pt, and Pd) (Hjortenkrans et al. 2006, 2007; Li et al. 2001; Ravindra et al. 2004; Whiteley and Murray 2003; Wichmann et al. 2007; Winther and Slento 2010; Zereini and Alt 2006).

A recently-analysis of roadside soils for heavy metals found a strong connection between traffic intensity and Cr and Cd moderate correlation for Cu and Zn, and no correlation for Pb (Werkenthin et al. 2014). Heavy metal concentrations in soils can be used as a good indicator of environmental quality (Dneasino 2009).

The most known and studied heavy metals in roadside environments are Pb, Ni, Cd, Cr, Cu, and Zn (Münch 1993; Folkeson et al. 2009; Kayhanian et al. 2012). use tire or tire throughout the entire text wear contributes the most important emission for Zn, and brake wear is the most important exporter of emissions for Cu and Pb, engine oil consumption is responsible for the greatest release for Cd (Winther 2010 ; Slent 2010).

Suleymaniyah city was chosen for this study because of the dramatically increase in the car number in the last decade. We therefore focused on the three major roads close to the city of Sulaimani, Arbat, Tasluja, and Mergapan to determine the effect of traffic induced changes in heavy metal concentrations in soil on the roadsides soil. These places used in agriculture and then the absorption of these elements by the cultivated plants and then enters into the human diet, it is known for these minerals have negative effects on human health. Therefore the goal of current study is traffic-induced pollution especially in roadside soil to introduce detailed reviews on soil pollution topics in Sulaimani city in order to inform other scientific endeavors, authorities and the decisions makers about the factual appraisal or rating of the risks of soil pollution on human health and environment. Because roadside soil pollution in Sulaimani city has not been given a required attentiveness and no action and strategies were so far taken for protecting the quality of agricultural lands and products.

As well as this study is the first milestone for future pollution study in the Sulaimani district and the results of this study is to increase the public awareness and possibly health.

2. LITERATURE REVIEWS

2.1. General Introduction to Environmental Pollution

Environmental pollution is the introduction of contaminants into the physical and biological components of the biosphere to such an extent that causes adverse effects on the ongoing environmental processes. Environmental pollution is one of the Challenges facing the World since the start of the industrial revolution. In recent years world's pollution problems has increased to a large extent and becoming worse day by day due to the increasing of population and the anthropogenic activities such as; agricultural activity, trade activity, transportation and fossile fuel combustion by motor vehicles, industrial activities and power plants. According to (Pimentel et al. 2007) pollution likely affects over a billion people around the world, with millions poisoned and killed each year.

In modern industrialized societies, combustion of fossil fuels (oil, gas, and coal) by power-generating plants and trasport produces extremely high levels of pollutants such as; organic and inorganic gases, particulate matter and heavy metals so it is widely recognized as a main source for air pollution.

Air pollution is currently one of the major problems in developing countries and it is a release into the atmosphere of any substances, which are harmful to organisms as well as the environment. It has bad effects on human life causing diseases in respiratory system and chronic illnesses (McCubbin and Delucchi 1999), on soils and plants (El Desouky and Moussa 1998) and on the forest (Zhang and Pouyat 2000).

Air pollutant can include almost any natural or artificial composition of matter capable of being airborne-solid particles, liquid droplets, gases, or a combination of them.

There are many factors that cause dispersion of air pollution, including weather condition such as temperature, wind speed and direction, humidity, topography of the area, relief of the area such as flat or hilly, or the local situation of the area such as whether the area is covered by buildings or there is ventilation in traffic corridors (Ocak and Turalioglu 2008).

Some heavy metals, form part of vehicle emission and those metals are also released by other sources, such as industrial processes, electric power generation, and home heating. Therefore, the motor of vehicles act as main source of contamination of soil roadsides as well as the grown plants at the farms along the roadsides affected from contamination of roadside soil all over the world.

2.2. Heavy Metals Pollution in the Environment

Heavy metal pollution is a problem associated with areas of intensive urbanization and industry, and their effect depends on the mobility of each metal through environmental compartment and the pathways by which metals reach humans and the environment. Heavy metals can be defined as any chemical elements having an atomic weight greater than of sodium (23) and forms soaps on reaction with fatty acids (e.g. mercury, chromium, cadmium, arsenic and lead), (Lewis 2007). But (Lenntech 2004) has defined the term of "heavy metals" as any metallic element that has a relatively high density and is toxic or poisonous even at low concentration.

Heavy metals cannot be degraded or destroyed and to a small extent they enter our bodies via food, drinking water and air (UNEP/GPA 2004; Kantor 2006). As trace elements, some heavy metals are essential to maintain the metabolism of the human body. However, at higher concentrations they can lead to poisoning (Renge et al. 2012). Heavy metals occur in the environment both as a result of natural processes and as pollutants from human activities. Environmental contamination and exposure to heavy metals such as Hg, Cd and Pb are a for whom throughout the world. Human exposure to heavy metals has risen dramatically in the last 50 years as a result of an exponential increase in the use of heavy metals in industrial processes and products (Dhundasi 2009). Heavy metals can localize and lay dormant. Unlike organic pollutants, heavy metals do not decay and thus pose a different kind of challenge for remediation (Zevenhoven and Kilpien 2001). The

levels of heavy metals contamination were increased in the environment due to the various human activities. As extra information to be mentioned, due to atmospheric transport and other pathways, the Arctic region, including the Canadian Arctic, is a major receptor of some heavy metals such as Hg, Cd and Pb released from sources in other regions of the world (AMAP 2002).

Metal pollution accumulates in the street dust, soil, and surface water samples and influences the ecosystem heath (Al-Radady et al. 1994).

Contamination of agricultural soil by heavy metals is becoming a significant environmental problem with the rapid industrialization and urbanization in developing countries and they pose a high risk to food safety, therefore, heavy metals became a great concern to governments and society in many countries (Wei and Yang 2010). Moreover, those metals can degrade soil quality, reduce crop yield and the quality of agricultural products, and though impact negatively the health of human, animals, and the ecosystem as a whole (Nagajyoti et al. 2010), because most of the heavy metals are toxic to the living organisms and even those considered as essential can be toxic if present in excess. It has been reported by (Kelly et al. 1996) that atmospheric is a major contributor to heavy metal contamination in topsoil's. Environmental contamination by heavy metals through polluted water, soil and air became an important issue partly because of the potential accumulation in biosystems and they can directly harm public health by entering the body via soil and dust, dermal contact or breathing (Abrahams 2002).

Nowadays, heavy metal pollution from motor vehicles and its effect on roadside soil, vegetation and crops are considered to be one of the important issues and likewise in Kurdistan Region of Iraq and namely Sulaimani Governorate the same case is occurring daily due to the intense driving conditions on the main roads. Therefore, the current study aimed to assess the impact of air pollution by traffic on the accumulation of some heavy metals in some roadside soil samples in Sulaimani Governorate because little previous research has been conducted to investigate heavy metal concentrations of roadside farmland. But, in many cities all over the world monitoring studies have been conducted to investigate the roadside heavy metal contamination, including; Hilla City-Iraq (Al-Fatlawi and Al-Alwani 2012), Bagdad-Iraq (AL- jibury and Essa 2016), China's Hong

Kong (Li et al. 2004), Beijing (Chen et al. 2010), Mexico City (Morton-Bermea et al. 2002), Turkey's Elazig (Bakirdere and Yaman 2008), England's Yorkshire (Akbar et al. 2006), Jordan's Amman (Qasem and Momani 1999), etc.

2.3. Traffic-Related (Vehicular) Heavy Metals Contamination in Roadside Soil

Motor vehicles have a significant impact on air quality, heavy metal pollution, greenhouse gases, ozone depletion, water quality, natural resources, agriculture product, habitat destruction/disturbance, noise and many economic, social and political issues of every country. One detrimental environmental effect of road transport is its contribution to atmospheric pollution, because automobile traffic is one of the important sources of air pollution (Gramer and Chevreuil 1991). Traffic activities are one of the major sources leading to heavy metal contamination in roadside soils due to their long-term accumulation. Therefore, the local contamination resulting from transportation activities is receiving increasing attention in the Third Pole countries.

Heavy metal release from vehicles is a serious worldwide environmental problem and it will occur by different mechanisms during the transport process such as fuel consumption, engine oil consumption, tire wear, fluid leakage, metal corrosion, brake wear, and road abrasion (Markus and McBratney 1996; Wilcke et al. 1998; Winther and Slento 2010). Some metals like, Pb, Cd, Cu and Zn are the major metal pollutants of the roadside environments and are released from burning of fuel, wearing out of tires, leakage of oils, and corrosion of batteries and metallic parts such as radiators etc. (Akbar et al. 2006; Yoshinori et al. 2010), because the metals of Fe, Cu and Zn are essential components of many alloy, pipes, wires and tires in motor vehicles and are released into the roadside environment as a result of mechanical abrasion (Jaradat et al. 2005). Researchers have reported that the contamination of roadsides by specific metals are due to the following sources; leaded gasoline fuel which is still used in some country is a main source for the Pb pollution at roadsides (Chen et al. 2005), while wearing and abrasion of tires and also the safety fences of the road side cause to contaminate by Zn (Blok 2005). Cu metal is mainly released from the wear of brake linings, which is also an important source of Pb and Zn. All three metals are deposited in the form of particulate

matters and can form suspended aerosols in the atmosphere (Han et al., 2007). Corrosion of vehicular bodys parts lead Ni and Cr pollution (Lu et al. 2009).

The concentration of heavy metals at roadsides due the vehicular pollution is influenced by multiple factors, including traffic properties, highway characteristics, roadside terrain, roadside distance, wind direction, etc.(Zhang et al. 2012).

In fact, releasing of heavy metals from traffic activities and subsequently roadside soil pollution is an important issue that should be taken into consideration in Sulaimani Governorate. (Majid 2010) has reported that the population in Sulaimani Governorate has increased suddenly in the last two decades, so the demands and needs for vehicles, transportation facilities and road establishment were also increased dramatically. Currently, almost about 1.5 million vehicles are running alone on the roads of Iraqi Kurdistan Region and day by day this number will increase geometrically. However, little previous research has been conducted to investigate heavy metal concentrations of roadside soil in the Governorate.

2.4. An Overview on Heavy Metal Concentration of Roadside and Farmland Soils

Traffic activities are one of the major sources leading to heavy metal contamination in roadside soils due to their long-term accumulation. Therefore, the local contamination resulting from transportation activities is receiving increasing attention in many countries. Vehicular emission has been found to constitute one of the major sources of soil pollution (Akbar et al. 2006; Olukanni and Adebiyi 2012). So, roadside soils often contain high concentrations of heavy metals contamination, since heavy metal is considered as first line source of the vehicles exhaust (Poszyler-Adamska and Czerniak 2007). Heavy metal concentrations and distribution patterns in roadside soils by traffic activity could be reagarded location-dependent due to the effect of many factors such as; complexity of roadside environment, predominant climatic conditions, intensity of driving or traffic volume, type and models of the vehicles, etc. Roadside soils often prone to high concentrations of metallic contamination. The bioavailability and environmental mobility of the metals are dependent upon the form in which the metal is associated with the soil. Normally, the concentration of heavy metals in roadsides is being higher if the usage history of the road or highway would be longer because it is positively related to the

intensity of driving and traffic volume (Bai and Wang 2009; Chen et al. 2010). The distribution pattern of heavy metals in roadside soil take normally a belt-shaped in accordance to the distance from the road edge and it decrease exponentially with increasing the distance from the road edge (Saeedi et al. 2009). Based on comparing the deposited metals with the background level of heavy metal content, the influential distance can be up to 50 m far from the road edge for a long distance of 100 m (Brady and Weil 1996; Fakayode and Olu-Owolabi 2003). Moreover, most of the accumulated metal can reach to a depth of 5 cm deep at roadside surface soils (Ward et al. 1997).

In recent years, many research studies have been conducted on heavy metal concentration of roadside and farmland soils, since heavy metal pollution in surface soil of roadside poses a significant aspect of pollution problem and human health concern, therefore monitoring heavy metal focus in roadside soil is an important task. Also, the degree of concern about human and environmental health varies with each metal.

In a study by (Aslam 2013) on heavy metals contamination in roadside soil in Dubai-United Arab Emirates near different traffic signals (i) locations which have more than two traffic signals, (ii) roads which have only one traffic signal and (iii) roads which have no traffic signals, the following concentration ranges were found; Cd (0.17–1.01), Ni (13.3–98.1), Pb (259–2784), Cu (15.5–65.9), Fe (325–5136), Mn (57.9–166), and Zn (91.3–166) mg kg^{-1} respectively. Similarly, the range of metals analyzed in soil samples collected from the roadside which have only one traffic signal were Cd (nd–0.80), Ni (18.3–59.4), Pb (146–308.1), Cu (0.82–18.1), Fe (88.5–3649), Mn (25.8–147.3) and Zn (8.97–106 mg kg^{-1}) respectively. However, the range of metals at roads which have no traffic signals were Cd (0.0–0.6), Ni (3.34–73.8), Pb (8.34–58.2), Cu (2.88–5.81), Fe (55.3–333), Mn (2.98–98.7) and Zn (1.23–46.6 mg kg^{-1}) respectively.The metals of Cd, Cu, Ni, Fe, Mn and Zn were present within the normal range of background levels in the studied soil, whereas lead was reported in high concentration. (AL- Jibury1and Essa 2016) have investigated the effect of distance interval from Pollution Source Pollution as well as the concentration status of the heavy metals Cd, Pb, Zn and Ni and in soil surrounding highway of Baghdad city. It has been found the concentration range of the studied metals were as follows; Cd (0.21– 3.93), Pb (36 – 129), Zn (240 – 380), and Ni (95 – 248) mg kg^{-1} .The results also showed that heavy metals concentrations in soil

samples along highway showed the following order Ni > Zn > Pb > Cd. Moreover, the highest concentrations of the metals were recorded within the distance 1.5 to 10 m away from the highway edge. The concentration of Cu, Pb, Cd and Zn levels were measured by (Jaradat and Moman 1999) in surface soil, plants, and air samples taken from both sides of the major highway connecting Amman with the southern parts of Jordan. Higher levels of the studied metal were reported in both soil and plants on both east and west side of the road as compared with the background values. The higher levels of heavy metals east of the road were due to the westerly prevailing wind at the sampling sites. The contamination of the investigated metals decreased exponentially with distance from the edge of the road and dropped to the background level at about 60 m. In soil samples, the average concentrations, 1.5 m east of the highway, were 29.7, 0.75, 188 and 122 mg kg^{-1} for Cu, Cd, Pb, and Zn, respectively.

Contamination of roadside soil and farmland with the metals of Ti, Mn, Fe, Zn, Sr and Zr due to traffic activities have been studied by (Sripathy et al. 2015) across the National highway 4 from Nelamangala to Dabaspet in the periphery of Bangalore city with contrasting traffic densities. The samples were taken from 35 sites at 10 and 200 m distance from the main road. The results indicated considerable heavy metal accumulations in the soils at 10 m and 200 m from the edge of the road on both sides and their concentration in the soil were in the order of Fe >Ti >Zr >Mn >Zn >Sr and the soils across the highway have shown significant differences in the concentration of all the heavy metals studied.

(Adedeji et al. 2013) determined the concentration of seven critical heavy metals (Cd, Cr,Cu, Fe, Mn, Pb, and Zn) in 36 soil samples of the roadside selected urban centers at three different traffic volumes (low, medium and high) in Ijebu-North Local Government Area of Ogun State, SW, Nigeria. The samples were collected at two depths (0-10 and 10-20 cm) along the roadside at varied distances of 0, 5, 10 and 15 meters from the side of the selected roads, additional, samples were taken at 500 m away from the edge of the road side and they considered them as background or control samples. Results showed that accumulation of heavy metals in top soils was greatly influenced by traffic volume and all the heavy metals exhibited a significant reduction in the roadside soils with increasing distance from the road. They found also that metals concentrations in the

roadside soils followed order of Zn> Pb> Fe> Cu> Mn> Cd> Cr and the mean concentrats were as follow; Cd (0.1, 0.3 and 0.0), Cr (0.1, 0.04 and 0.001), Cu (49.3, 3.68 and 1.41), Fe (64.3, 7.27 and 1.54), Mn (13.8, 2.72 and 1.23) Pb (61.0, 8.42 and 1.37) Zn (76.7, 7.71 and 1.67) mg Kg^{-1} for the traffic volumes of high, medium and low respectively. Moreover, the concentration of all the examined heavy metals was below the EU regulation, and Zn, Pb, Cu, Mn, and Fe were the most abundant element particularly in the topsoil.

Roadside soils were analyzed for Pb, Cd and Zn in 34 soil samples along Alexandria-Marsa Matruh highway, Egypt by contamination (Elnazer et al. 2015). The contamination status was evaluated by applying the indices of geoaccumulation (Igeo), contamination factor (CF), pollution load index (PLI), the single ecological risk index (Ei), and the potential ecological risk index (PERI). The obtained results for the average concentration of the investigated metals were 38.2, 2.3 and 43.4 mg Kg^{-1} for Pb, Cd and Zn, respectively. Igeo indicated the pollution of soil with Pb and Cd as opposed to Zn. Ei showed that the roadside soils had low risk from Pb and Zn and had considerable to high risk from Cd. Most of the samples (62%) presented low PERI risk associated with metal exposure and the rest of the samples (38%) are of moderate PERI. The bioavailable fraction (EDTA-Extract method) was 72.5 and 37.5% for Pb and Cd contents, respectively. Additionally, the obtained results indicated a remarkable effect of vehicular and agricultural activities on Pb and Cd contents in soils.

The role of traffic emissions in the pollution of Wien soil by Cu, Pb, and Zn was pointed out by (Simon et al. 2013). Increasing levels of soil contamination with heavy metals may be transformed and transported to plant and from plants they pass on to animals and human being (Atayese et al. 2010). Pb, Cd, Zn and Ni are the most metal pollutants from heavy traffic owing to their presence in fuel as antiknock agent (Atayese et al. 2010; Suzuki et al. 2009).

Akbar et al. (2006) determined four heavy metals (Cd, Cu, Pb and Zn) in 35 samples of roadside soils of different road verge zones (border, verge, slope, and ditch) in northern England. Results showed that Pb concentration was the highest in the soil and varied from 25.0 to1198 mg kg^{-1} (mean, 233 mg kg^{-1}), but Zn concentration ranged from 56.7 to

480 mg kg^{-1} (mean, 175 mg kg^{-1}) and Cu concentration ranged from 15.5 to 240 mg kg^{-1} (mean, 87. 3 mg kg^{-1}). While the concentration of Cd was the lowest in the soil and ranged from 0.3 to 3.8 mg kg^{-1} (mean, 1.4 mg kg^{-1}). It was found that the levels of heavy metals in the studied roadside soils were higher as compared to their natural background levels in British soils, and their concentrations were below the 'critical trigger concentrations for the contaminated soils. The investigated metals exhibited a significant decrease in the roadside soils with the increasing distance from the road. The border zone had the highest mean concentration of the four heavy metals whereas the ditch zone exhibited the lowest mean concentration. (Chen et al. 2010) noted that the extremely contaminated soils were situated near the roads which have highest traffics volume, Pb was found to be significantly correlated with traffic volume, whereas the other studied metals (Cd, Zn, and Cu) were not. Also, (Garcia and Millan 1998) and (Nabulo et al. 2006) noted that there were no significant relationships between traffic volume either Cr or Zn.

The surface soils and grass herbage in roadside of Mangshi–Ruili and Dali–Baoshan highways in China were analyzed by (Zhao et al. 2010) for the distribution of the following heavy metals; Cd, Cr, Cu, Ni, Pb and Zn at two adjacent sites (slopes) with distances of 5, 10, 20, 50, 100, and 200 m away from the highway. The results showed an enrichment of heavy metals in the surface soils and plants along the road was caused by the highway, and it decreased with the increasing distance from the road. Metal concentrations in the soils and plants along the downslope are higher than those in the upslope along the road. The asymptotic distributions of the examined six metals were mainly within 200 m from the highway. Four types of relationships between metal uptake by plants from soils and the distance were found and their clear distinctions of Cr, Cu, Pd, Ni and Zn uptake by plants were also investigated.

(Abdullateef et al. 2014) studied the levels of nine heavy metals (Mn, Ni, Co, Cr, Cd, Cu, Fe, Zn and Pb) in soils at distances of 50 m and 100 m from the main roads, and 250 m to serve as control site. The goal of the study was to use the results of the metal levels as an indicator of environmental pollution at three different locations (Bama station, Bulumkutu and Post office areas designated as S1, S2 and S3, respectively). Results showed the increasing trend of the metals were in the order as; Fe > Mn > Pb > Cr > Zn >

Cd > Co > Ni > Cu. The total concentration ranges were as follow: 1.04±0.06- 2.53 ± 0.03 Mn; 2.11±0.05-8.70 ± 0.30 Fe; 0.34±0.01-1.40±0.03 Zn; 0.01±0.01-0.46 ± 0.01 Co; 0.09±0.09-0.80 ± 0.02 Pb and 0.08±0.01-1.19 ± 0.13 mg kg^{-1} for Cr whereas the concentrations of Ni and Cd were not detected at S3 (control) and Cu at S1(50 m) and S2 (50 m) of the studied areas. ANOVA analysis confirmed significant differences ($p<0.05$) between the levels of heavy metals within the soils from the three sampling points, but the concentrations of some of the metals in the three sampling points were lower than that of their corresponding control. Thus, the soil didn't indicate pollution due to vehicular traffic activities. This could be interpreted by; either the control soils got much more metals from other origins such as lithogenic and pedogenic or the control soil was much affected by other factors such as; fertilization process or wind direction which led to more accumulation of heavy metals in the control soil rather than roadside soil.

Monitoring studies in many cities and regions on roadside soil pollution have been conducted on total emission loads of heavy metals into open grassland and agricultural areas (Harrison 1981; Ward et al. 1990; Viard et al. 2004; Hjortenkrans et al. 2006; Nabulo et al. 2006). Generally, total heavy metal contents in roadside soils were found to be strongly dependent on traffic density and showed an exponential decrease with distance from the road, reaching background levels at 10-100 m way from the road.

The objective of this study was to assess the extent of roadside soil pollution by heavy metals due to vehicular traffic activities in Sulaimani Governorate, Iraq, because little previous research has been conducted to investigate heavy metal concentrations of roadside soil in the Governorate. The roadside soils have examined for the following heavy metal contents; Cd, Pb, Co, Ni, Cr, Zn, Cu, and Fe along three main roads and motorway at four distance ranges (D1 = 0, D2 = 15, D3 =25, D4 =50 m). The distance ranges were perpendicular to the direction of the following main roads;

- Sulaimani – Karkuk (Tasluja),
- Sulaimani – Arbat ,and
- Sulaimani – Mergapan .

3. MATERIALS AND METHODS

3.1. Description of the Study Area

The northern region of Iraq includes three important governments; Erbil, Sulaimani, Duhok with the population about four million peoples. The Kurdistan region of Iraq is located approximately between the N. latitude 34º 30′ and 37º20′; and the E longitude 42º20′ and 46º20′ its borders with Iran to the east, Turkey to the north, and Syria to the west (Bilbas 2014).

Sulaimani is a governorate in Iraq, Iraqi Kurdistan region and located far north east of Iraq and southeast of the Iraqi Kurdistan Region (Figure 1). Sulaimani has a borders from north and north-west Erbil Governorate, from west by Karkuk Governorate and Salahaddin Governorate, and from southwest and south by Diyala Governorate, the international border with Iran represent the eastern border of the Governorate. Sulaimani city is the capital of Sulaimani Governorate, 35º 33′14.99″ N. and 45º 26′ 58.68″ E has an elevation of 864 m above the sea level (Google Earth; Cited from Majid 2011) .

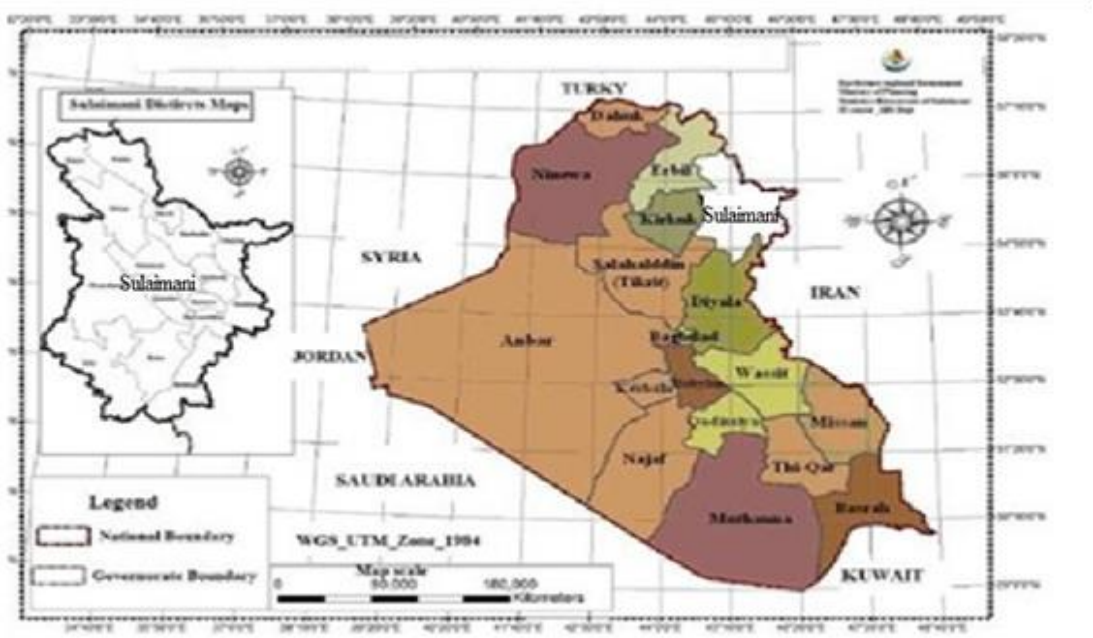

Figure 1. Map of Iraq Showing Sulaimani Governorate

3.2. Meteorological Conditions

Sulaimani, a harsh continental climate is dominant, the summer is very hot and dry, but the winter is cold. According to the meteorological station in the city center, the hottest month average is 26.9 degrees, the coldest month average 7 degrees. The mean average monthly temperature during the winter months varies between (4-10) °C and (22-32) °C during revise the data. The solar radiation density or total solar energy for a day-time in Sulaimani may reach (6-11) MJ m^{-2} / day (mega joules per square meter per day), during winter and increase up to (21-29) MJ m^{-2} /day in summer (Amin 2006). The annual precipitation 791.2 millimeters in 2015, but the overall average annual precipitation of Sulaimani center is 687.09 mm during the period extending from 1942 to 2005 seasons (64 years) (Mohamed-Ali 2008). Natural vegetation is generally outweigh create steppe plants of herbaceous plants. It blooms in spring in a short time, but they dry early summer with the cessation of rainfall. The daily temperature range may vary between (8-16)°C (Figure 2), but for the relative humidity, the highest average value of 69.67% was recorded in January and the lowest average value is 20.74% was recorded in July (Figure 2), (Muhammad 2009).

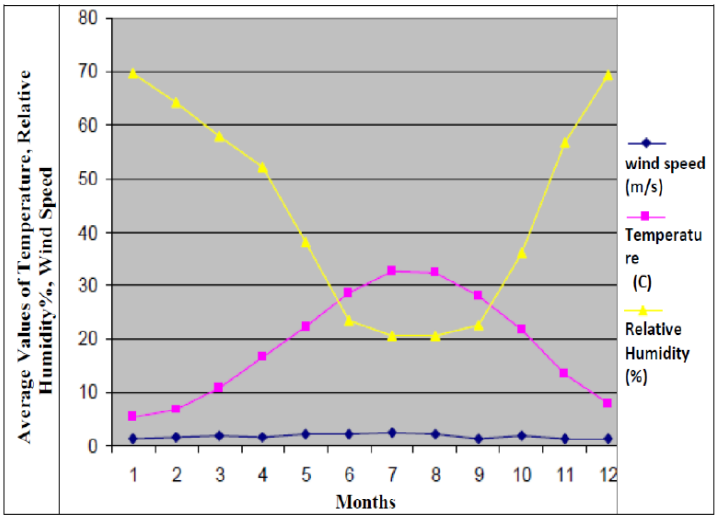

Figure 2. Average Temperature, Relative Humidity and Wind Speed for the Studied Area During the Years 1973 to 2006 (Muhammad 2009).

3.3. Motor Vehicle Growth in Sulaimani City

The number of motor vehicles in Sulaimani Governorate (Sulaimani Identification Numbering) has increased sharply from 32468 in 1999 to 373044 in 5/10/2016, in addition to 64614 vehicles registered with information cards and 10921 motorcycles. (Directorate of Traffic in Sulaimani City, 2016). Therefore, the number of vehicles in Sulaimani Governorate increased by 11.49%. This dramatically increase of vehicle number in Sulaimani caused increase of using fuel, then raising in air and roadside soil pollution.

3.4. Soil Sampling

Three locations near Sulaimani city were selected to collect roadside soil samples, these locations are main roads of Sulaimani - Karkuk (Tasluja) with 10 km 0.76 % slope at, Sulaimani- Arbat at 7 km with 0.82 % slope, and Sulaimani-Mergapan at 10 km with 0.46 % slope as shown in Figure 3. The samples were taken from roadside of agricultural land. The soil samples were taken at the distance (1,15, 25, 50 m) as shown in Figure 4, 5, and 6 from the soil surface (0-15 cm). Soil samples were taken by means of steel auger. The exact location for soil sampling nodes was determined by GPS reading as it is

shown in Table 1,2,3. Soil samples were dried at room temperature, and then were cleaned to be free from plant roots and rocks, gently crushed and sieved to pass through a 2 mm stainless-steel sieves and then stored in a plastic bags for subsequent analyses. The total of one hundred twenty samples from three locations. The all soil samples were taken to Turkey to do were collected at soil laboratories of Soil Science and Plant Nutrition Department, and central laboratory.

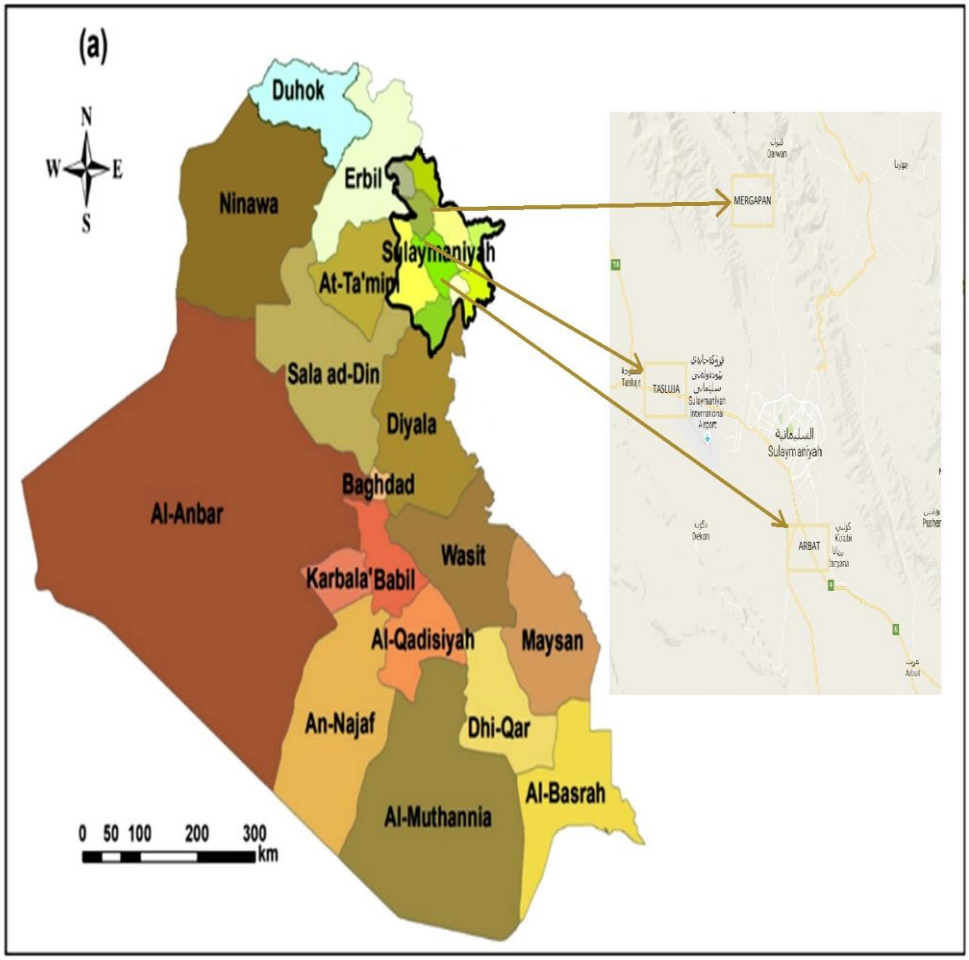

Figure 3.The Maps of Three Main Roads of Research Area

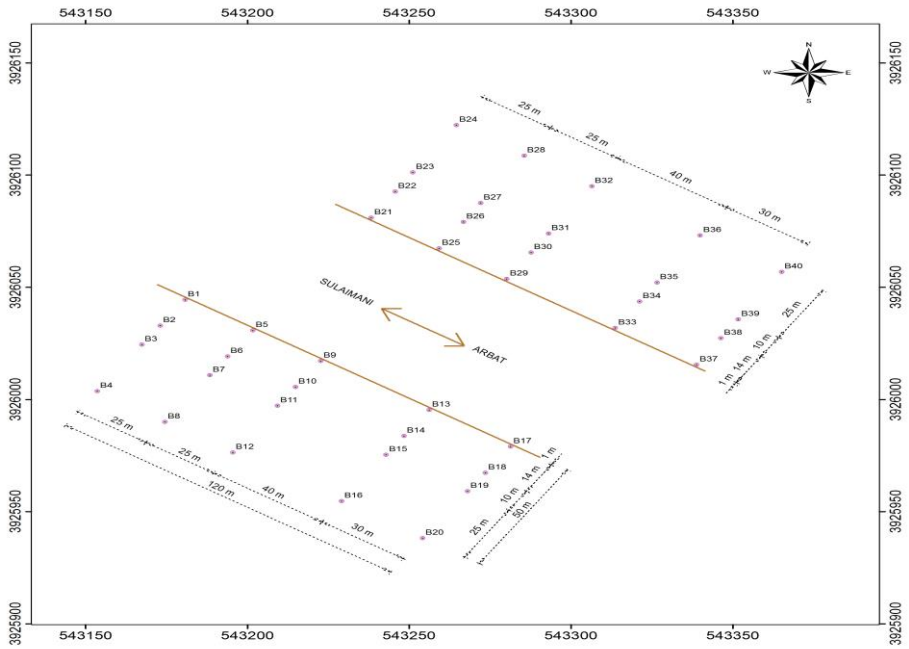

Figure 4.The Maps of Arbat Road of Soil Sampling

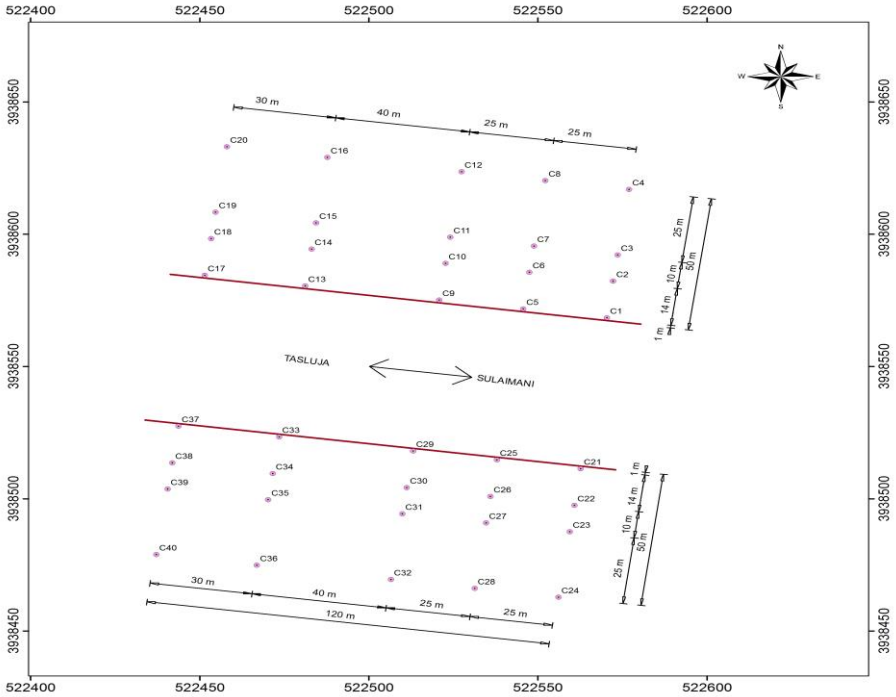

Figure 5.The Maps of Tasluja Road of Soil Sampling

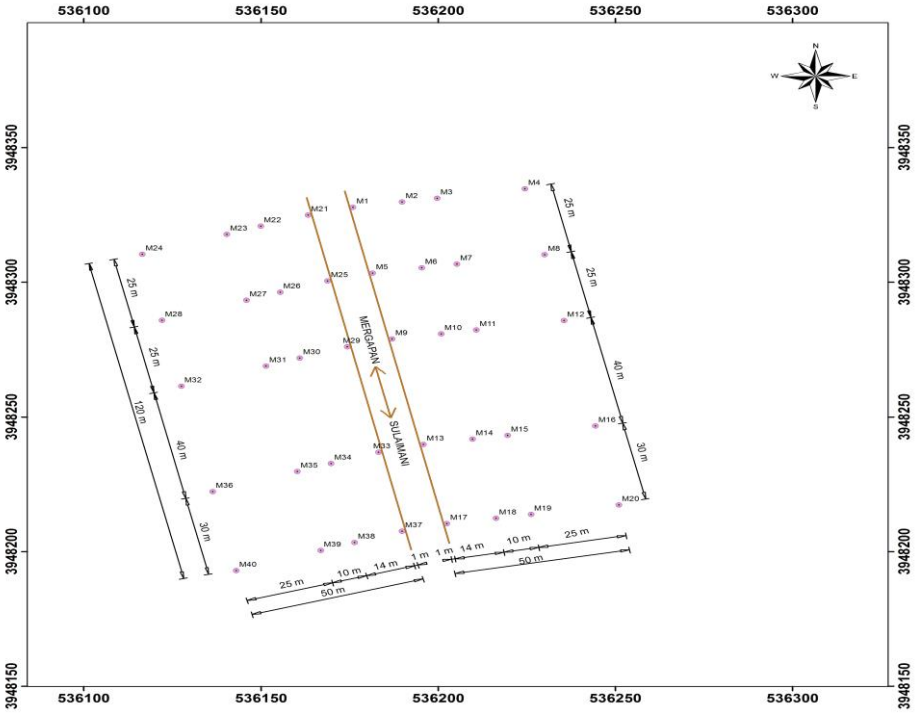

Figure 6.The Maps of Mergapan Road of Soil Sampling

Table 1.Sampling Nodes at Arbat Locat

Points	E	N	Zone
B1	543180.79	3926044.45	38 S
B2	543173.11	3926032.92	38 S
B3	543167.49	3926024.48	38 S
B4	543153.63	3926003.67	38 S
B5	543201.74	3926030.82	38 S
B6	543193.98	3926019.16	38 S
B7	543188.44	3926010.84	38 S
B8	543174.58	3925990.03	38 S
B9	543222.70	3926017.17	38 S
B10	543214.94	3926005.52	38 S
B11	543209.39	3925997.20	38 S
B12	543195.54	3925976.39	38 S
B13	543256.22	3925995.36	38 S
B14	543248.46	3925983.70	38 S
B15	543242.92	3925975.38	38 S
B16	543229.14	3925954.69	38 S
B17	543281.37	3925979.01	38 S
B18	543273.60	3925967.34	38 S
B19	543268.09	3925959.05	38 S
B20	543254.20	3925938.20	38 S
B21	543238.33	3926080.98	38 S
B22	543245.76	3926092.67	38 S
B23	543251.21	3926101.23	38 S
B24	543264.63	3926122.33	38 S
B25	543259.28	3926067.34	38 S
B26	543266.79	3926079.16	38 S
B27	543272.16	3926087.59	38 S
B28	543285.58	3926108.69	38 S
B29	543280.23	3926053.70	38 S
B30	543287.75	3926065.52	38 S
B31	543293.11	3926073.95	38 S
B32	543306.54	3926095.05	38 S
B33	543313.76	3926031.88	38 S
B34	543321.27	3926043.70	38 S
B35	543326.64	3926052.13	38 S
B36	543339.98	3926073.11	38 S
B37	543338.89	3926015.50	38 S
B38	543346.41	3926027.33	38 S
B39	543351.75	3926035.73	38 S
B40	543365.20	3926056.86	38 S

Table 2. Sampling Nodes at Tasluja Location

Points	E	N	Zone
C1	522570.37	3938568.37	38 S
C2	522572.25	3938582.24	38 S
C3	522573.60	3938592.15	38 S
C4	522576.95	3938616.92	38 S
C5	522545.60	3938571.72	38 S
C6	522547.48	3938585.60	38 S
C7	522548.82	3938595.50	38 S
C8	522552.18	3938620.28	38 S
C9	522520.83	3938575.08	38 S
C10	522522.71	3938588.95	38 S
C11	522524.05	3938598.86	38 S
C12	522527.41	3938623.63	38 S
C13	522481.19	3938580.45	38 S
C14	522483.07	3938594.32	38 S
C15	522484.41	3938604.23	38 S
C16	522487.77	3938629.00	38 S
C17	522451.46	3938584.48	38 S
C18	522453.34	3938598.35	38 S
C19	522454.68	3938608.26	38 S
C20	522458.04	3938633.03	38 S
C21	522562.64	3938511.28	38 S
C22	522560.76	3938497.41	38 S
C23	522559.42	3938487.50	38 S
C24	522556.06	3938462.73	38 S
C25	522537.87	3938514.64	38 S
C26	522535.99	3938500.77	38 S
C27	522534.65	3938490.86	38 S
C28	522531.29	3938466.08	38 S
C29	522513.09	3938518.00	38 S
C30	522511.21	3938504.12	38 S
C31	522509.87	3938494.21	38 S
C32	522506.52	3938469.44	38 S
C33	522473.46	3938523.37	38 S
C34	522471.58	3938509.49	38 S
C35	522470.23	3938499.58	38 S
C36	522466.88	3938474.81	38 S
C37	522443.73	3938527.39	38 S
C38	522441.85	3938513.52	38 S
C39	522440.51	3938503.61	38 S
C40	522437.15	3938478.84	38 S

Table 3. Sampling Nodes at Mergapan Location

Points	E	N	Zone
M1	536175.98	3948327.84	38 S
M2	536189.84	3948329.81	38 S
M3	536199.74	3948331.21	38 S
M4	536224.49	3948334.72	38 S
M5	536181.50	3948303.38	38 S
M6	536195.36	3948305.34	38 S
M7	536205.26	3948306.74	38 S
M8	536230.01	3948310.25	38 S
M9	536187.02	3948278.91	38 S
M10	536200.88	3948280.87	38 S
M11	536210.78	3948282.28	38 S
M12	536235.53	3948285.78	38 S
M13	536195.85	3948239.76	38 S
M14	536209.71	3948241.72	38 S
M15	536219.61	3948243.13	38 S
M16	536244.36	3948246.63	38 S
M17	536202.47	3948210.40	38 S
M18	536216.33	3948212.36	38 S
M19	536226.23	3948213.77	38 S
M20	536250.98	3948217.27	38 S
M21	536163.30	3948324.98	38 S
M22	536149.93	3948320.81	38 S
M23	536140.39	3948317.82	38 S
M24	536116.53	3948310.37	38 S
M25	536168.82	3948300.51	38 S
M26	536155.45	3948296.34	38 S
M27	536145.91	3948293.36	38 S
M28	536122.05	3948285.90	38 S
M29	536174.33	3948276.05	38 S
M30	536160.97	3948271.87	38 S
M31	536151.43	3948268.89	38 S
M32	536127.57	3948261.43	38 S
M33	536183.16	3948236.90	38 S
M34	536169.80	3948232.72	38 S
M35	536160.26	3948229.74	38 S
M36	536136.40	3948222.28	38 S
M37	536189.79	3948207.54	38 S
M38	536176.42	3948203.36	38 S
M39	536166.88	3948200.38	38 S
M40	536143.02	3948192.92	38 S

3.5. Soil Analysis

3.5.1. Soil pH and EC

pH was measured by means of calomel electrode in 1:1 soil waster mixture after equilibrating overnight. The pH meter was calibrated prior to measurement by using buffer solutions (pH 4, 7 and 9) (Apha, 2012). The electrical conductivity of the same mixture was measured with a EC meter (Black 1965).

3.5.2. Total Lime

The calcium carbonate equivalent of the soils were determined by means of a manometric method. A Scheibler calcimeter was used for the analysis. Then the calcium carbonate equivalent of the soils was calculated from the evolving CO2. The real gas volume (V0, at 0°C and 760 mmHg) was calculated by using Boyle-Mariotto formula (Gülçur 1974) .

$$VO = \frac{V_t \times (b - e) \times 273}{760 \times (273 + T)}$$

$$CaCO3\ \% = \frac{V_0 \times 0.4464}{A}\ 100$$

Where:

V_0 = Gas volume converted at normal condition (cm^3)

V_t = Gas volume read on calcimeter (cm^3)

b= Recovered Barometer pressure (mmHg)

e = vapor pressure of water at "t" °C (mmHg)

T= Temperature

A= Soil Sample weight (g)

3.5.3. Olsen Phosphorus

Plant available soil phosphorus was extracted with 0.5 M $NaHCO_3$ at pH 8.5, and determined it with ascorbic acid method using a Spectrophotometer (Olsen et al. 1954) and **(**Stone 1971).

Reagents:

a.0.5 M Sodium Bicarbonate ($NaHCO_3$): Weigh 42.0 g sodium bicarbonate ($NaHCO_3$), and dissolve it in a 1000 ml volumetric flask with distilled water and adjust the pH to 8.5 with either 0.05 N sodium hydroxide (NaOH) or 0.5 N hydrochloric acid (HCl).

b. Stock Solution A (working solution): Dissolve 12 g of ammoniumheptamolybdate [(NH4)6 Mo7024.4H20] in 250 ml distilled water and 0.2908 g of potassium antimony tartarate with 100 ml distilled water and put it in (a volumetric flask 2000 ml). Add 138.9 ml of concentrated H_2SO_4 (d: 1.84 g cm^{-3}) gradually with stirring, allow to cool and dilute to 2000 ml with distilled water. Store in a dark bottle.

c. Solution B: Prepare this solution B daily as required, it is only stable for 24 hours. Dissolve 0.265 g L-ascorbic acid in each 50 ml of solution A required, and store in a dark bottle. Color become light yellow.

d. The P Standard: Dilute 0.4393 g of oven dry KH_2P0_4 in a liter volumetric flask with distilled water. The concentration is 100 mg/ l. Add 5 drops toluene to diminish microbial activity. Prepare a set of standards in a range of 0-5 pg./ml made up of $NaHC0_3$ solution.

Extraction procedure: 2 g of soil and 1/2 teaspoon of carbon black were put into an erlenmeyer flask (125 ml) put into a (Erlenmeyer flask 125ml). Using a calibrated scoop add 1/2 teaspoon of carbon black. Add 40 ml of the extracting solution (0.5M $NaHCO_3$ pH 8.5) to the sample. Stopper tightly and shake for 1/2 hours on an appropriate shaker (160 oscillation per minute). Para film may be used instead of rubber stoppers. At completion of shaking time immediately filter the suspensions through Whatman No. 40 filter paper. If the filtrates are dark colored add more carbon black and filter again to obtain a clear filtrate. Save the filtrate in plastic vials and analyze within a few days.

Determination of phosphor by conventional calorimetry: Take 5 ml from extracted solution put it in 25 ml volumetric flask then add 5 ml from color reagent, and then make up the volume to 25 ml with distil water and read absorbance at 880 nm after stable color development (10 min), by using Optima SP - 3000 Spectrophotometer.

3.5.4. Organic Matter

Organic carbon was determined by wet oxidation method of (Nelson and Sommers 1996).

Reagents:

a. Potassium Dichromate, 1 N: Weigh 49.04 g of potassium dichromate ($K_2Cr_2O_7$) (dried at 100°C for two hours), dilute it to 1000 ml with distilled water.

b. 0.5 N Ferrous Ammonium Sulfate:

1. Slowly add 20 ml sulfuric acid to 1 liter volumetric flask containing 800 ml distilled water.
2. Add 196.1 g ferrous ammonium sulfate. Dissolve, and make up the volume with distilled water, and mix well. Prepare daily or determine the absolute normality before the analysis.
3. Diphenylamine indicator 0.16%: Weigh 0.16 g of the indicator and dilute it to 100 ml with distilled water.

Procedure:

Weigh 0.5 g of air dry soil sample into a 500 ml Erlenmeyer flask, add 10 ml of 1N potassium dichromate solution, and the flask was gently swirled to accelerate the reaction. Then, add 20 ml of concentrated H_2SO_4, and heated for 1 minute on 200°C. The flask was allowed to cool down to the room temperature for about 30 minute, later add 200 ml of distilled water and 13 drops of barium diphenylaminesulfonate as indicator. At the final stage, the solution was titrated with 0.5 N ferrous ammonium sulfate until the color of solution changes from dull green to a turbid blue (light green), then add the

titrating solution drop by drop until the end point was reached, the color of solution changed to brilliant green. A blank was also carried out without soil, but without soil to do blank.

Calculation:

$$\text{Organic matter} = \frac{(A - (B \times NK) \times 0.581}{T}$$

A: Amount of potassium dichromate used.
B: Amount of iron sulfate used in titration.
T: Weight of soil.
Nk: Absolute normality of iron sulfate.
NK=10/V
10: Means amount of potassium dichromate used.
V: used of iron sulfate in titration in blank.
0.581: Is equation number (constant equation).

3.5.5. Soil Texture

The fraction of different textural sizes were determined a hydrometer method (Bouyoucos 1951/1962)

Reagents:

5% Calgon solution: weigh 50 g. of Calgon dissolve it in 1 liter of distilled water.

Procedure:

Weigh 50 g of dry soil (use 100 g for sandy soils) into a 250 ml beaker, add 20 ml 5% Calgon solution, then add 200 ml distilled water, stir the soil and water to mixed well and let stand overnight, transfer to a mechanical dispersion cup, and place the dispersion cup on the Humbolt mixer, and mix for 5 minutes, then transfer to a graduated cylinder which

has volume of 1130 ml and add distilled water in to cylinder then complement the volume to 1130 ml, and stir thoroughly using the weighted disc shaped bar, immediately place the hydrometer and the thermometer into the suspension, then record the hydrometer reading and the temperature at 40 seconds and also after 2 hours. Analyze a blank in the same manner without soil. For temperature correction use a value of 0.4 for each degree temperature difference from 20°C. Add or subtract this factor if the temperature is more or less than 20 °C, respectively.

Calculation:

40th Second Reading:

Silt% + Clay% = ((A –B) / wt. of oven dry soil) × 100

Sand% = 100 – (Silt+ Clay)%

2 Hour Reading:

Clay% = ((A –B) / wt. of oven dry soil) × 100

Determination of Silt%:

Silt% = 100 - (Sand+ Clay)%

A = Sample hydrometer reading + temperature correction

B = Blank hydrometer reading + temperature correction

3.5.6. Extractable Calcium and Magnesium:

Reagents:

a. Ammonium Acetate : Dissolve 77.08 g of ammonium acetate in one liter distilled water and adjust the pH to 7.0.

b. (EDTA) Ethylene di Amine Tetra Acetic Acid Solution 0.01 N : weigh 2 g from (EDTA), and 0.05 g from magnesium chloride ($MgCl_2$) dissolve in water, and complement to volume for one liter.

c. Ammonium Purpurate Indicator ($C_8H_8N_6O_6$) : Mix 0.5 g of ammonium purpurate with 100 g of potassium sulfate (K_2SO_4).

d. Buffer Solution (NH_4Cl-NH_4OH): Dissolve 67.5 g of NH_4Cl in 570 ml of concentrated NH_4OH, and put the solution to a 1 liter flask, let it cool, and complete the volume by adding distilled water.

e. Eriochrome black Indicator: Dissolve 0.5 g of eriochrome black with 4.5 g of hydroxylamine hydrochloride in 100 ml 95% ethyl alcohol.

f. Sodium Hydroxide Solution (NaOH), 2 N: Dissolve 80 g of NaOH in about 800 ml of distilled water, put the solution to a 1- liter flask, cool, and complete the volume by adding distilled water.

Procedure:

Weigh 3 g air-dry soil (< 2-mm), and add 25 ml of ammonium acetate, then shak it for 10 minutes, do filtration and put extract in tubes with cover.

Measurement:

- **Calcium:**

5 ml of the extract is combined with 25 ml of distilled water, then add 10 drops of NaOH (2N), and 0.1g of ammonium purpurate, then titrate with (EDTA 0.01N) until the color changes from red to purple. Near the end point, EDTA should be added one drop every 10 second because the color does not change immediately. Prepare the Blank by repeating same procedure, with distilled water instead of the extract.

- **Calcium plus Magnesium :**Take from extract 5 ml, add 25 ml distilled water, add 10 drops of buffer solution (NH_4Cl-NH_4OH), and add 3 drops of eriochrome black indicator, then titrate with (EDTA 0.01N).

Calculation:

Soluble Ca or Ca + Mg(meq/L) = ((V – B) × N × 1000) / V1

Soluble Mg(meq/L) = Soluble (Ca +Mg) – Soluble Ca

Where:
V = Volume of EDTA consumed for the sample titration (ml)
B = Blank titration volume (ml)
V1= Volume of soil extract used for titration (ml)
N= Normality of the EDTA solution

3.5.7. Heavy Metals

Soil samples were digested with aqua-reggia mixture (HNO_3:HCl mixture, 3:1 V/V) by means of microwave oven (MARS 6, Microwave Accelerated Reaction System, CEM Analytical) for the determination of pseudo-total concentration of heavy metals (Figure 7). For analysis, selected the temperature on (200) °C ramp time of 25 minutes, 30 minutes, Pressure which selected is 800 bar and microwave power was 1030-1800 for ashing and 15 minutes for cooling. After this time the vessel taken out and filtered through Whatman No. 40 filter paper and diluted to 50 ml, then the pseudo-total concentrations of heavy metals in the digests were determined by using Atomic Absorption Spectrometer Perkin almer 8800 (Figure 8).

Figure 7. Microwave Accelerated Reaction System

Microwave acid digestion is a mechanism to dissolve metals bound within a sample matrix into liquid. This is accomplished by exposing a sample to a strong acid in a closed container and raising the temperature and pressure through microwave radiation. Both the speed of thermal decomposition of the sample, and the solubility of heavy metals in solution are increased. After the time of process is finished these heavy metals are release in solution, they can be quantified through elemental techniques. The MARS 6 acid digestion process takes approximately 40 minutes depending on the sample kind.

Figure 8.Atomic Absorption Spectrophotometer

3.6. Static Analysis

Finally the result was analyzed by using Jump 5 to determine significant between different treatment and least significant diffraction (LSD) .

4. RESULT AND DISSCUTION

4.1. pH

According to (ANOVA Table) the statistical analysis of the data displayed that locations had a significant ($p<0.05$) effect on pH, while the side of roads, distances, and their interaction were non-significant, only effect of side of road on pH content at Mergapan location according of (LSD 0.05=0.06) is significant. Among interactions between locations, and side of roads, maximum pH (8.02) was observed in Arbat on the right side of the road and the lowest pH (7.92) was observed in Tasluja on the left side of the road (Table 4). In the case of locations x side of roads x distances interaction, maximum pH (8.07) was noted at Arbat on the left side of road at a distance of (25m) and minimum pH (7.81) was observed in Tasluja on the left side of road at a distance of the 1m. Similarly, it commonly recognized that at a pH of 6.5, nutrient availability to plants is at highest (Harris et al. 1996). The mobility of metals in roadside soils are affected strongly by soil pH and organic matter (Ramakrishna and Somashekar 2005; Turer and Maynard 2003; Kocher et al. 2005; Kluge and Wessolek 2012). The mean pH value of soils in the studied locations (Arbat, Tasluja, and Mergapan) were (8.02-8.01, 8.01-7.92 and 7.99-7.93) respectively. Thus the soils can be classified as slightly alkaline to alkaline reaction.

4.2. EC

Table 4 summarizes the statistical analysis of the data. Locations had a significant ($p<0.05$) effect on EC, while the side of roads, distance, and their interaction were non-significant (ANOVA Table), but Arbat and Mergapan locations had significant distance dependent EC changes at $P<0.05$ and 0.01 confidence levels, respectively. As location vs. side of road interaction considered, the maximum EC was observed on the left side of Arbat and the minimum on the right side of Mergapan (Table 4). In the case of locations x side of the roads x distances interaction, maximum EC was noted on the left side of

Arbat (672 dS cm^{-1}) at 15 m distance whereas the minimum EC (323 dS cm^{-1}) was observed on the left side of Mergapan at 1 m away the road.

4.3. Organic Matter

Table 4 summarizes the statistical analysis of the data. Locations had a significant ($p<0.05$) effect on organic matter, while the side of roads, distance, and their interaction were non-significant (ANOVA Table), but Mergapan locations had significant distance dependent organic matter changes at 0.01 confidence levels. As location vs. side of road interaction considered, the maximum organic matter was observed on the left side of Tasluja and the minimum on the left side of Arbat (Table 4). In the case of locations x side of the roads x distances interaction, maximum organic matter was noted on the left side of Tasluga (1.88%) at 15 m distance whereas the minimum organic matter (0.46%) was observed on the right side of Mergapan at 1 m away the road.

In the present study, for all location the organic matter had a mean values ranged from (1.88 to 0.46%), generally this mean that level of organic matter in soils from these locations were low. This moderate amount of organic matter in the present study is supported by the fact that pH will be higher where organic matter is well decomposed and incorporated into the surface mineral horizon (Craul 1992; Turer and Maynard 2003; Kocher et al. 2005; Kluge and Wessolek 2012). Turer and Maynard (2003) found that there are a strong positive correlation between soil organic matter and certain metal concentrations. They also show that a large proportion of metals combined with organic matter to an insoluble form organic matter that is probably of anthropogenic origin.

Table 4. Side- and Distance-Induced Averages of pH, EC and OM at Sampling Locations (Arbat, Tasluja, and Mergapan)

Locations	**Side of Road**	**Distance (m)**	**Soil Properties**					
			pH		**EC (µS cm^{-1})**		**O.M(%)**	
Arbat	Right	1	8.04	8.02	554	570	0.76	0.87
		15	8.00		606		0.86	
		25	8.02		554		0.88	
		50	8.02		568		0.96	
	Left	1	7.98	8.01	485	595	0.70	0.82
		15	7.96		672		0.92	
		25	8.07		589		0.90	
		50	8.05		636		0.76	
LSD 0.05			NS	NS	84.11	NS	NS	NS
LSD 0.01			NS	NS	NS	NS	NS	NS
Tasluja	Right	1	8.05	8.01	440	496	1.36	1.41
		15	7.99		470		1.36	
		25	8.00		504		1.32	
		50	8.02		573		1.58	
	Left	1	7.81	7.92	469	510	1.58	1.59
		15	7.89		547		1.88	
		25	7.98		519		1.48	
		50	7.99		508		1.42	
LSD 0.05			NS	NS	NS	NS	NS	NS
LSD 0.01			NS	NS	NS	NS	NS	NS
Mergapan	Right	1	8.04	7.99	337	367	0.46	1.05
		15	7.98		349		0.96	
		25	8.04		407		1.38	
		50	7.89		377		1.38	
	Left	1	8.00	7.93	323	411	0.74	1.23
		15	7.94		381		1.00	
		25	7.89		455		1.56	
		50	7.90		485		1.62	
LSD 0.05			0.06	NS	-	NS	-	NS
LSD 0.01			NS	NS	54.77	NS	0.34	NS

4.4. Sand%

Table 5 summarizes the statistical analysis of the data. Locations had a significant ($p<0.05$) effect on sand%, while the side of roads, distance, and their interaction were non-significant (ANOVA Table), but Arbat locations had significant distance dependent sand% changes at 0.01 confidence levels. As location vs. side of road interaction considered, the maximum sand% was observed on the right side of Mergapan and the minimum on the left side of Tasluja (Table 5). In the case of locations x side of the roads x distances interaction, maximum sand% was noted on the left side of Tasluga (37.42%) at 1 m distance whereas the minimum sand% (14%) was observed on the left side of Tasluja at 50 m away the road.

4.5. Silt%

Table 5 summarizes the statistical analysis of the data. Locations had a significant ($p<0.05$) effect on silt% while the side of roads, distance, and their interaction were non-significant (ANOVA Table), but Arbat locations had significant distance dependent silt% changes at 0.05 confidence levels. As location vs. side of road interaction considered, the maximum silt% was observed on the left side of Arbat and the minimum on the right side of Mergapan (Table 5). In the case of locations x side of the roads x distances interaction, maximum silt% was noted on the left side of Arbat (34.70%) at 25 m distance whereas the minimum silt% (22.86%) was observed on the left side of Tasluja at 1 m away the road.

4.6. Clay%

Table 5 summarizes the statistical analysis of the data. Locations had a significant ($p<0.05$) effect on clay% while the side of roads, distance, and their interaction were non-significant (ANOVA Table), but Arbat locations had significant distance dependent clay% changes at 0.01 confidence levels. As location vs. side of road interaction considered, the maximum clay% was observed on the left side of Arbat and the minimum on the right side of Mergapan (Table 5). In the case of locations x side of the roads x distances interaction, maximum clay% was noted on the left side of Tasluja (53.74%) at

50 m distance whereas the minimum clay% (38.20%) was observed on the right side of Mergapan at 50 m away the road.

The mean Clay% content for all location ranged from (43.46 - 49.45%), generally this mean soil in all locations were contain a high ratio of Clay%. Farther more, in support to this study (Kabata Pendias 1986) found that heavy metals could be adsorbed in investigated samples by clay minerals, Fe-oxides and / or organic matter.

Table 5 . Side- and Distance-Induced Averages of Sand%, Silt%, and Clay% at Sampling Locations (Arbat, Tasluja, and Mergapan)

Locations	**Side of Road**	**Distance (m)**	**Chemical Parameter**					
			Sand%		**Silt%**		**Clay%**	
Arbat	Right	1	32.96	21.88	27.18	31.07	39.86	47.04
		15	19.98		31.74		48.30	
		25	19.98		31.96		47.76	
		50	19.98		33.40		52.22	
	Left	1	30.16	22.37	28.84	32.19	41.02	45.43
		15	22.44		33.88		43,68	
		25	19.94		34.70		45.32	
		50	16.92		31.34		51.70	
LSD 0.05			-	NS	3.71	NS	NS	NS
LSD 0.01			6.22	NS	NS	NS	5.47	NS
Tasluja	Right	1	28.50	26.70	26.56	26.15	44.98	47.17
		15	28.36		25.04		46.62	
		25	29.06		26.36		44.58	
		50	20.88		26.62		52.50	
	Left	1	37.42	20.23	22.86	30.33	39.70	49.45
		15	14.08		33.02		52.92	
		25	15.40		33.16		51.42	
		50	14.00		32.26		53.74	
LSD 0.05			NS	NS	NS	NS	NS	NS
LSD 0.01			NS	NS	NS	NS	NS	NS
Mergapan	Right	1	32.90	30.95	24.16	25.60	42.96	43.46
		15	27.08		26.82		46.10	
		25	28.06		25.36		46.58	
		50	35.76		26.04		38.20	
	Left	1	35.78	28.39	24.60	27.72	39.62	43.88
		15	28.14		27.56		44.30	
		25	23.98		29.44		46.56	
		50	25.64		29.28		45.02	
LSD 0.05			NS	NS	NS	NS	NS	NS
LSD 0.01			NS	NS	NS	NS	NS	NS

4.7. $CaCO_3$%

Table 6 summarizes the statistical analysis of the data. Locations had a significant ($p<0.05$) effect on $CaCO_3$% while the side of roads, distance, and their interaction were non-significant (ANOVA Table), but Tasluja and Mergapan locations had significant distance dependent $CaCO_3$% changes at 0.01 confidence levels, respectively. As location vs. side of road interaction considered, the maximum $CaCO_3$% was observed on the right side of Mergapan and the minimum on the left side of Tasluga (Table 6). In the case of locations x side of the roads x distances interaction, maximum $CaCO_3$% was noted on the right side of Mergapan (38.78%) at 15 m distance whereas the minimum $CaCO_3$% (19.94%) was observed on the right side of Tasluja at 25 m away the road.

According to these results the soil at all locations contain high ratio of %$CaCO_3$. Previously reported that the high $CaCO_3$% comes from Quaternary sediments of the area which are characterized by limestone facies (Ibrahim 2013).

4.8. P_2O_5 Contcentration

Table 6 summarizes the statistical analysis of the data. Locations had a significant ($p<0.05$) effect on P_2O_5, while the side of roads, distance, and their interaction were non-significant (ANOVA Table), but Arbat location had significant distance dependent P_2O_5 changes at 0.05 confidence levels. As location vs. side of road interaction considered, the maximum P_2O_5 was observed on the left side of Tasluja and the minimum on the right side of Arbat (Table 6). In the case of locations x side of the roads x distances interaction, maximum P_2O_5 was noted on the left side of Tasluga (6.31) at 25 m distance whereas the minimum P_2O_5(2.30) was observed on the left side of Arbat at 15 m away the road.

4.9. Ammonium Acetate Extractable Ca Concentration

Table 6 summarizes the statistical analysis of the data. Locations had a significant ($p<0.05$) effect on Ca concentration while the side of roads, distance, and their interaction were non-significant (ANOVA Table), but Mergapan location had significant distance dependent Ca concentration changes at 0.01 confidence levels. As location vs. side of road interaction considered, the maximum Ca concentration was observed on the

left side of Mergapan and the minimum on the right side of Tasluja (Table 6). In the case of locations x side of the roads x distances interaction, maximum Ca concentration was noted on the left side of Mergapan (42.78) at 25 m distance whereas the minimum Ca concentration (28.9) was observed on the right side of Mergapan at 15 m away the road.

These results show that soil samples in three locations contain high level of Ca. It is well-known that Pb and certain other metals form very stable complexes with functional groups of humid substances and Fe and Mn oxides / oxhydroxides because of the high adsorption capacities of these compounds (Jordan et al. 1997; Hassellov and von der Kammer 2008). Previously (Kretzschmar and Sticher 1997) have shown that humid-coated Fe oxide colloids were facilitated the transport of Pb and Cu in the presence of high Ca concentrations, which often occurs in road runoff.

Table 6. Side- and Distance-Induced Averages of $CaCO_3$, P_2O_5, and Ca at Sampling Locations (Arbat,Tasluja, and Mergapan)

Locations	**Side of Road**	**Distance (m)**	**Chemical Parameter**					
			$CaCO_3$ (%)		**P_2O_5 (kg/da)**		**Ca (meq/100g)**	
Arbat	Right	1	24.96	24.76	2.94	2.92	37.20	37.18
		15	24.32		2.92		36.88	
		25	24.82		3.04		38.26	
		50	24.92		2.78		36.38	
	Left	1	25.42	25.40	2.70	3.05	36.32	36.37
		15	25.42		2.30		36.06	
		25	24.86		2.55		36.52	
		50	25.88		4.66		36.58	
LSD 0.05			NS	NS	0.74	NS	NS	NS
LSD 0.01			NS	NS	NS	NS	NS	NS
Tasluja	Right	1	29.78	23.37	4.77	4.45	30.98	32.10
		15	23.62		3.85		28.90	
		25	19.94		4.46		35.22	
		50	20.14		4.75		33.30	
	Left	1	26.36	23.02	5.21	5.65	30.14	32.97
		15	21.74		5.07		34.16	
		25	22.16		6.31		31.84	
		50	21.80		6.07		35.72	
LSD 0.05			-	NS	NS	NS	NS	NS
LSD 0.01			4.43	NS	NS	NS	NS	NS
Mergapan	Right	1	35.30	33.35	5.43	4.82	35.42	37.67
		15	38.78		4.20		35.86	
		25	31.16		4.83		39.26	
		50	28.14		4.84		40.14	
	Left	1	37.34	30.89	4.07	4.26	32.72	38.51
		15	34.30		3.46		38.00	
		25	25.40		4.41		42.78	
		50	26.30		5.12		40.54	
LSD 0.05			-	NS	NS	NS	-	NS
LSD 0.01			6.58	NS	NS	NS	3.92	NS

4.10. Ammonium Acetate Extractable Mg Concentration

Table 7 summarizes the statistical analysis of the data. Locations had a significant ($p<0.05$) effect on Mg concentration while the side of roads, distance, and their interaction were non-significant (ANOVA Table), only Arbat location had significant side of road dependent Mg concentration changes at 0.05 confidence levels. As location vs. side of road interaction considered, the maximum Mg concentration was observed on the left side of Tasluja and the minimum on the right side of Arbut (Table 7). In the case of locations x side of the roads x distances interaction, maximum Mg concentration was noted on the right side of Tasluga (8.6) at 50 m distance whereas the minimum Mg concentration (4.4) was observed on the right side of Arbat at 15 m away the road.

4.11. Ammonium Acetate Extractable K Concentration

Table 7 summarizes the statistical analysis of the data. Locations had a significant ($p<0.05$) effect on K, while the side of roads, distance, and their interaction were non-significant (ANOVA Table), but Arbat and Mergapan locations had significant distance dependent K changes at $P<0.05$ and 0.01 confidence levels, respectively. As location vs. side of road interaction considered, the maximum K was observed on the left side of Arbat and the minimum on the right side of Tasluja (Table 7). In the case of locations x side of the roads x distances interaction, maximum K was noted on the right side of Arbat (0.77) at 50 m distance whereas the minimum K (0.02) was observed on the right side of Tasluja at 25 m away the road.

4.12. Ammonium Acetate Extractable Na Concentration

Table 7 summarizes the statistical analysis of the data. Locations had a significant ($p<0.05$) effect on Na, while the side of roads, distance, and their interaction were non-significant (ANOVA Table), but Arbat location had significant distance dependent Na changes at $P<0.05$ confidence levels. As location vs. side of road interaction considered, the maximum Na was observed on the left side of Tasluja and the minimum on the right side of Arbat (Table 7). In the case of locations x side of the roads x distances interaction, maximum Na was noted on the left side of Tasluja (0.30) at 25m distance whereas the minimum Na (0.06) was observed on the right side of Arbat at 50 m away the road.

Table 7. Side - and Distance-Induced Averages of Mg, K, and Na at Sampling Locations (Arbat,Tasluja, and Mergapan)

Locations	**Side of Road**	**Distance (m)**	**Chemical Parameter**					
			Mg (meq/100g)		**K (meq/100g)**		**Na (meq/100g)**	
Arbat	Right	1	5.05	5.27	0.57	0.65	0.09	0.072
		15	4.40		0.56		0.07	
		25	5.85		0.68		0.07	
		50	5.77		0.77		0.06	
	Left	1	6.37	6.06	0.56	0.68	0.08	0.073
		15	6.68		0.69		0.07	
		25	5.69		0.74		0.07	
		50	5.51		0.73		0.07	
LSD 0.05			1.2	NS	-	NS	1.28	NS
LSD 0.01			NS	NS	0.1	NS	NS	NS
Tasluja	Right	1	4.55	6.30	0.20	0.15	0.20	0.15
		15	6.25		0.14		0.14	
		25	5.78		0.12		0.12	
		50	8.60		0.14		0.14	
	Left	1	6.90	7.77	0.20	0.23	0.20	0.23
		15	7.93		0.20		0.20	
		25	8.55		0.20		0.30	
		50	7.68		0.22		0.22	
LSD 0.05			NS	NS	NS	NS	NS	NS
LSD 0.01			NS	NS	NS	NS	NS	NS
Mergapan	Right	1	6.33	6.15	0.38	0.39	0.09	0.11
		15	4.57		0.34		0.13	
		25	6.89		0.42		0.12	
		50	6.84		0.41		0.08	
	Left	1	4.930	5.46	0.32	0.42	0.124	0.08
		15	6.150		0.34		0.064	
		25	5.150		0.51		0.084	
		50	5.600		0.50		0.064	
LSD 0.05			NS	NS	0.1		NS	NS
LSD 0.01			NS	NS	NS		NS	NS

4.13. Cation Exchange Capacity

Table 8 summarizes the statistical analysis of the data. Locations had a significant ($p<0.05$) effect on CEC, while the side of roads, distance, and their interaction were non-significant (ANOVA Table), but Tasluja and Mergapan locations had significant distance dependent CEC changes at $P<0.05$ and 0.01 confidence levels, respectively. As location vs. side of road interaction considered, the maximum CEC was observed on the left side of Mergapan and the minimum on the right side of Tasluja (Table 8). In the case of locations x side of the roads x distances interaction, maximum CEC was noted on the left side of Mergapan (48.52) at 25 m distance whereas the minimum CEC (35.96) was observed on the right side of Tasluja at 15 m away the road.

4.14. Total Zn Concentration

Table 8 summarizes the statistical analysis of the data. Locations had a significant ($p<0.05$) effect on Zn, while the side of roads, distance, and their interaction were non-significant (ANOVA Table), but Mergapan location had significant distance dependent Zn changes at 0.01 confidence levels. As location vs. side of road interaction considered, the maximum Zn was observed on the left side of Arbat and the minimum on the left side of Mergapan (Table 8). In the case of locations x side of the roads x distances interaction, maximum Zn was noted on the left side of Arbat (385.8) at 1m distance whereas the minimum Zn (234.8) was observed on the left side of Mergapan at 15 m away the road.
Mean concentration of Zn for worldwide soils is calculated as 64 μg/g (Kabata and Pendias 2001). The traffic situation in locations of Arbat, Tasluja, and Mergapan might be regarded as a source of Zn in the roadsides soils. Wear and corrosion of vehicle parts (brakes, tires, radiators, bodies, and engine parts) might also be one of the potential sources of Zn in these locations. Zn is used in the process of vulcanization of tires as Zn oxide as reported by (Adachi and Tainosho 2004), and used as antioxidant in the engine oil. As a result of the tire wear and leaks of engine oil and emission of the exhaust fumes, Zn is accumulated on the roadside soils (Councell 2004). The mean concentration of total Zn at locations ranged from (290.75 to 352.65 mg kg^{-1}). Generally the mean concentration value of Cu for all locations were higher than the value of Zn in the (Table 13) which was 300 mg kg-1 (the alerting value). It was seen that the maximum

concentration of total Zn in this study was lower than the value of mean concentration of Zn which was 506.43 mg kg^{-1} recorded at (Denizli, Turkey 4), and 354.80 mg kg^{-1} recorded at (Kavala, Greece 10), and it was higher than 183 mg kg^{-1} recorded at (Hong Kong 1), 91.05 mg kg^{-1} recorded at (Islamabad, Pakistan 11), and other cities (Table 12), and minimum concentration of total Zn in this study was higher than all mean concentration of Zn which was given in Table 12, except the values of 506.43 mg kg^{-1} recorded at (Denizli, Turkey 4), 354.80 mg kg^{-1} recorded at (Kavala, Greece 10), and 301.40 mg kg^{-1} recoded at and (Shanghai, China 9) (Table 12). Figure 9 show that the mean concentration of total Zn at Arbat location at right side of the road decreased with distance from the edge of the road. This high mean concentration of total Zn in roadside soil indicated the role of vehicular traffic. At the left side of the road the mean concentration of total Zn at a distance of 1m from the road which was 385.8 mg kg^{-1} higher than the mean concentration of total Zn at a distance of 15m, and 25m. This result indicated same reason of right side of the road, while mean total Zn concentration at distance of 50m from the road had concentration of 383.2 mg kg^{-1}. This might come from the reason of slope of the soil in the land, or runoff. Figure 10 illustrates the mean concentration of total Zn at Tasluja location at the left side of the road at distance of 15m from the edge of the road was 344.2 mg kg^{-1}, it was higher than the mean concentration of total Zn at a distances of 25m which was 314.4 mg kg^{-1} and at a distance of 50m was 322 mg kg^{-1} these results indicated that the concentration of total Zn at this side of the road decreased with the distance from the edge of the road. At the right side of the road, the distance had no effect on the mean concentration of total Zn . Figure 11 show that the mean concentration of total Zn at Mergapan location exhibited a high decrease in the roadside soil with the increasing distance from the edge of the road. These results are agreement with field studies that have shown that soil pollution by heavy metals is generally concentrated in the first few meters to tens of meters on either side of the road pavement and show decreases with distance from the road (Olajire and Ayodele 1997; Blok 2005). Since no major industry exists in the study area it may assume that the primary sources of concentration of Zn are probably attributed to motor vehicle tire rubber exacerbated by poor road surface, and the lubricating oils. This was indicated that Zn and Cd might come from lubricants, tires and galvanized parts from vehicles, whereas the lead from petrol (Andrade et al. 2007).

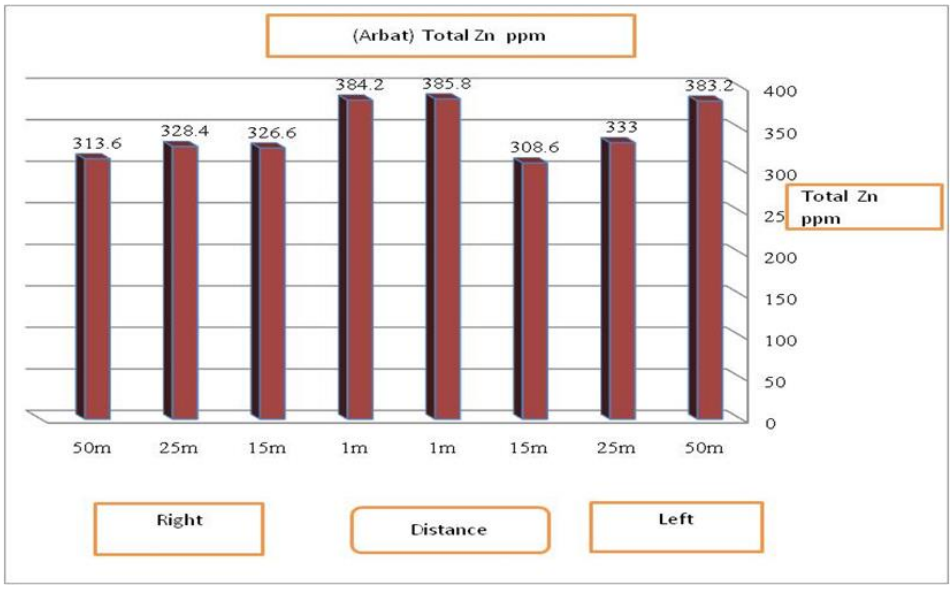

Figure 9. The Average Total Zn Concentration at Arbat

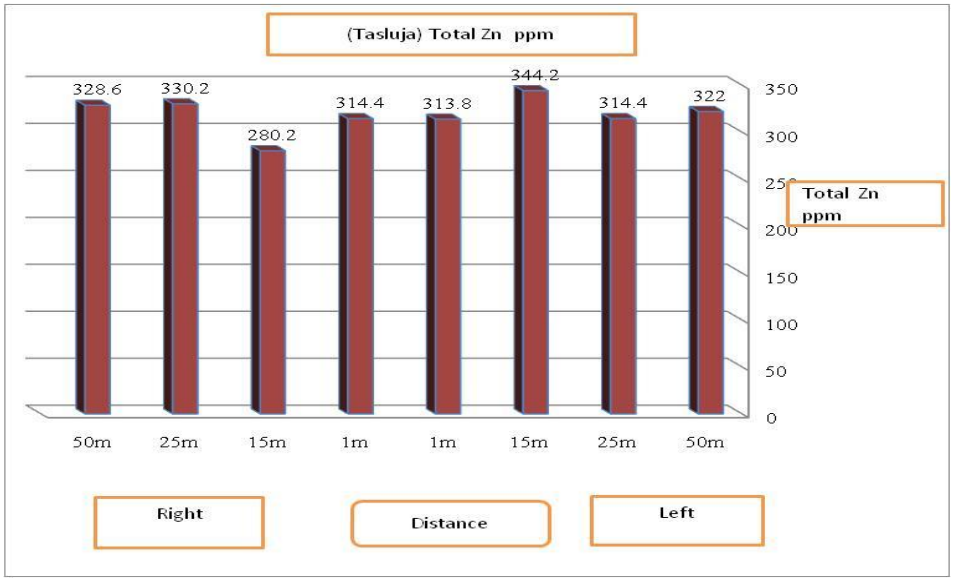

Figure 10. The Average Total Zn Concentration at Tasluja

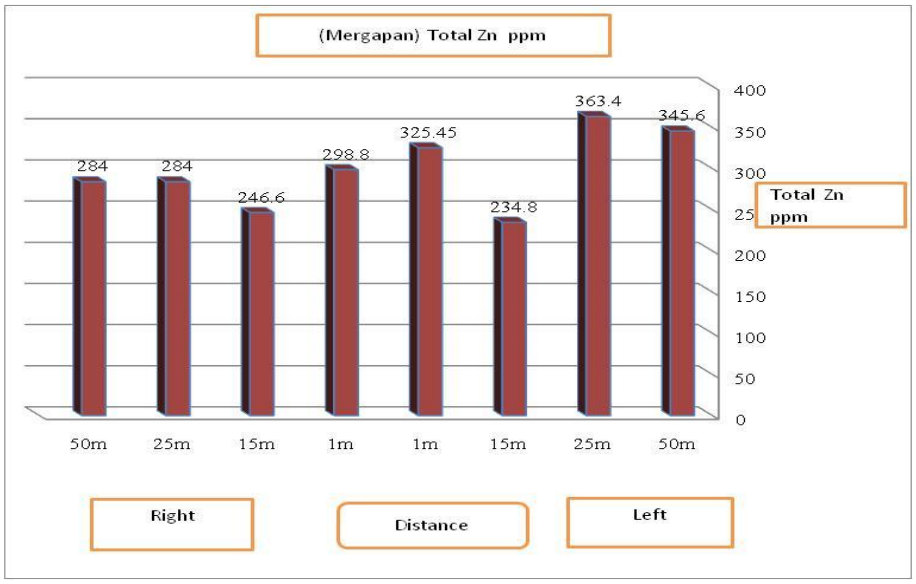

Figure 11.The Average Total Zn Concentration at Mergapan

4.15. Total Mn Concentration

Table 8 summarizes the statistical analysis of the data. Locations had a significant ($p<0.05$) effect on Mn, while the side of roads, distance, and their interaction were non-significant (ANOVA Table), but Mergapan locations had significant distance dependent Mn changes at $P<0.05$ confidence levels. As location vs. side of road interaction considered, the maximum Mn was observed on the right side of Arbat and the minimum on the left side of Mergapan (Table 8). In the case of locations x side of the roads x distances interaction, maximum Mn was noted on the left side of Arbat (829.4) at 1 m distance whereas the minimum Mn (607.6) was observed on the right side of Mergapan at 15 m away the road. Generally soil contains (200 – 3000 mg kg-1) of Mn with an average value equal to 600 mg kg-1 (Lindsay and Norvell 1978). Mn and Ni are connected with traffic related sources such as erosion of metallic part, concrete materials, and tire and wear of tires and engine parts (Fergusson and Nicholas 1991). The mean concentration of total Mn ranged from 717.40 to 781.90 mg kg^{-1} in all locations. In this study, the levels of Mn in soils were relatively high. The lowest level of Mn obtained in this study was higher than the value of Mn which they were 428.5, 566, 659.9 mg kg-1 respectively recorded at (Denizli, Turkey 4), (Palermo, Italy 8), (Galicia, Spain15) as it shown in Table 12. When the highest value of mean concentration of Mn obtained from

this study was compared with the levels in similar studies elsewhere. The mean concentration of Mn is lower than the concentration recorded in the United States 2532 mg kg-1^{-1} (Shacklette, et al. 1984) and Poland 1122 mg kg-1^{-1} (Dudka, et al. 1992). Figure 12 show that mean concentration of Mn at the left side of the road at Arbat decreased with increased distance from the road, this indicated that concentration of Mn might come from emission of vehicular traffic. Figure 13 shows that the mean concentration of Mn at left side of the road at location of Tasluja decreased with distance from the edge of the road this was shown the effect of emission of vehicular on concentration of Mn at this side of location of Tasluja. Mn is relatively harmless, when it enter to human body: the body absorbs it and excretes the excess (Habeck 2011).

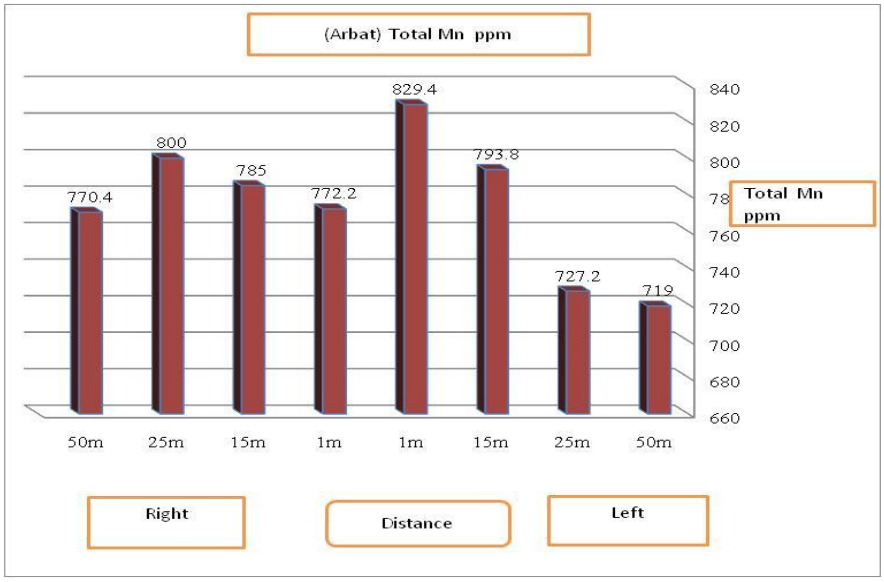

Figure 12.The Average Total Mn Concentration at Arbat

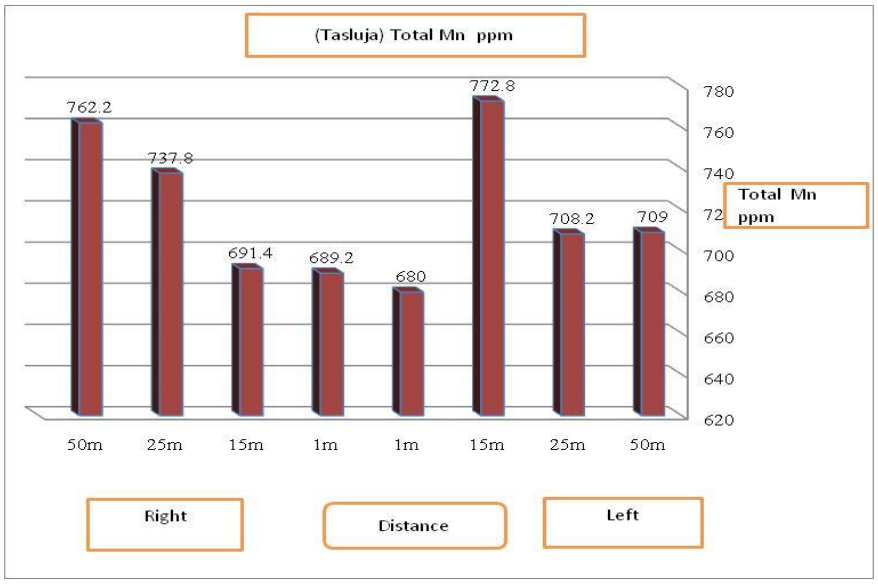

Figure 13. The Average Total Mn Concentration at Tasluja

Figure 14. The Average Total Mn Concentration at Mergapan

Table 8. Side- and Distance-Induced Averages of CEC, Total Zn, and Total Mn at Sampling Locations (Arbat, Tasluja, and Mergapan)

Locations	**Side of Road**	**Distance (m)**	**Chemical Parameter and Concentration of Heave Metals**					
			CEC meq/100 g		**Total Zn (mg kg^{-1})**		**Total Mn (mg kg^{-1})**	
Arbat	Right	1	42.90	43.17	384.2	338.2	772.2	781.9
		15	41.92		326.6		785	
		25	44.86		328.4		800	
		50	42.98		313.6		770.4	
	Left	1	43.34	43.18	385.8	352.7	829.4	767.4
		15	43.48		308.6		793.8	
		25	43.02		333.0		727.2	
		50	42.88		383.2		719	
LSD 0.05			NS	NS	NS	NS	NS	NS
LSD 0.01			NS	NS	NS	NS	NS	NS
Tasluja	Right	1	36.22	39.12	314.4	313.4	689.2	720.2
		15	35.96		280.2		691.4	
		25	41.68		330.2		737.8	
		50	42.60		328.6		762.2	
	Left	1	37.80	41.58	313.8	323.6	680.0	717.5
		15	42.96		344.2		772.8	
		25	41.34		314.4		708.2	
		50	44.22		322		709.0	
LSD 0.05			4.4	NS	NS	NS	NS	NS
LSD 0.01			NS	NS	NS	NS	NS	NS
Mergapan	Right	1	42.24	44.32	298.8	325.5	730.8	717.4
		15	40.88		246.6		607.6	
		25	46.70		284.0		721.2	
		50	47.46		284.0		810.0	
	Left	1	38.08	44.47	325.5	290.8	638.4	747.2
		15	44.58		234.8		729.8	
		25	48.52		363.4		816.6	
		50	46.70		345.6		804.0	
LSD 0.05			-	NS	-	NS	104.44	NS
LSD 0.01			4.35	NS	97.12	NS	NS	NS

4.16. Total Cu Concentration

Table 9 summarizes the statistical analysis of the data. Locations had a significant ($p<0.05$) effect on Cu, while the side of roads, distance, and their intraction were non-significant (ANOVA Table). As location vs side of road interaction considered, the maximum Cu was observed on the left side of Mergapan and the minimum on the right side of Tasluja (Table 9). In the case of locations x side of the roads x distances interaction, maximum Cu was noted on the left side of Mergapan (40.58) at 50 m distance whereas the minimum Cu (16.18) was observed on the right side of Tasluja at 1 m away the road.The range of mean concentration of Cu in this study was 18.26 to 36.21 mg kg-1. These values were lower than the official limits of range (50-114 mg $kg\text{-}1^{-1}$) recorded by the European Union regulatory standard for Cu in soil (Mushtaq et al.,2010). The mean concentration value of Cu for all locations were lower than the value of Cu in the (Table 13) which was 60 mg kg-1 (the boundary value). This mean that soil in all locations were not polluted with Cu. When the concentration range was compared with the levels in similar studies elsewhere, the concentration of Cu was lower than the concentration that recorded for those conducted in the 445.6 mg kg-1 reported at (Seoul city Korea 5), 115.07 mg kg-1 reported at (China 17), 49.4 mg kg-1 reported at (Aberdeen city Scotland UK 7) (Table 12), but they were higher than those (23.3, 9.3, and 0.85 mg kg-1) recorded in (Hong Kong6), (Murcia City-Spain 13), and (Karak-Jordan 2) respectively (Table 12). The implication of excess Cu through the food chain when taken by human may come that causes gastrointestinal irritation as (World Health Organization 2011).

Figure 15 show that at location of Arbat at both side of the road the mean concentration of total Cu showed a distance-dependent decrease, this was shown that concentration of total Cu in soil samples at this location may come from the vehicular emission.

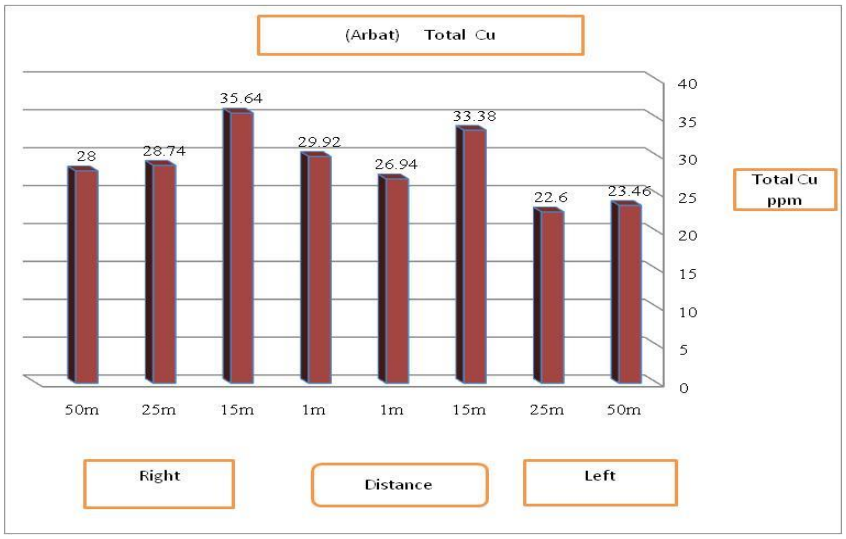

Figure 15. The Average Total Cu Concentration at Arbat

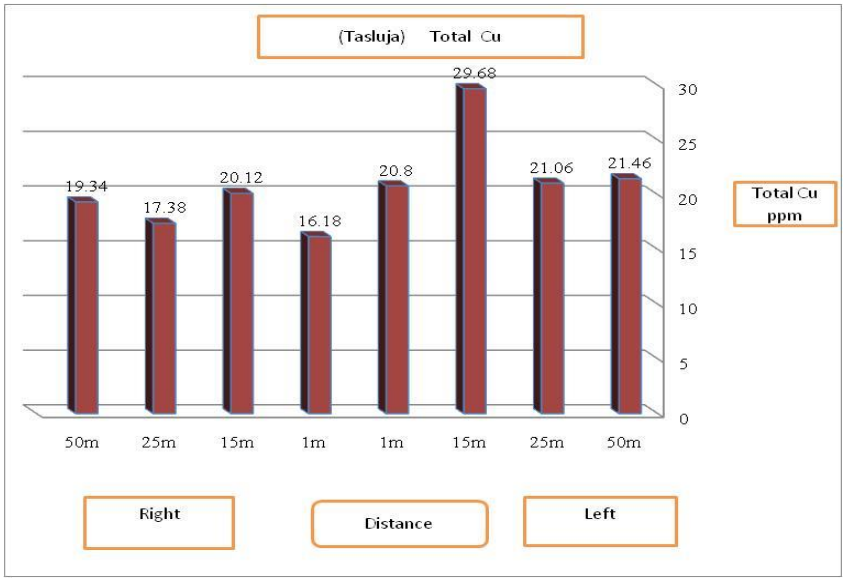

Figure 16. The Average Total Cu Concentration at Tsluja

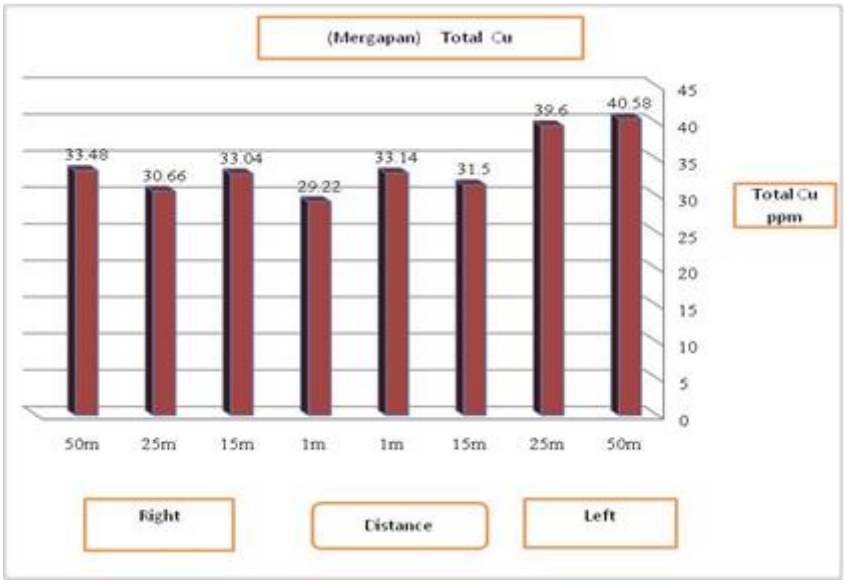

Figure 17. The Average Total Cu Concentration at Mergapan

4.17. Total Fe Concentration

Table 9 summarizes the statistical analysis of the data. Locations had a significant ($p<0.05$) effect on Fe, while the side of roads, distance, and their interaction were non-significant (ANOVA Table), but Arbat and Tasluja locations had significant distance dependent Fe changes at $P<0.05$ confidence levels, respectively. As location vs. side of road interaction considered, the maximum Fe was observed on the right side of Mergapan and the minimum on the right side of Arbat (Table 9). In the case of locations x side of the roads x distances interaction, maximum Fe was noted on the right side of Mergapan (4.42) at 50 m distance whereas the minimum Fe (3.24) was observed on the right side of Arbat at 15 m away the road.

The mean concentration of total Fe in all locations in this study ranged from (3.451 to 3,911 mg kg-1). When the mean concentration range of total Fe obtained in this study was compared with the levels in similar studies elsewhere. The concentration of total Fe was lower than the concentration of 22.7, 3554.5, and 35.26 mg kg-1 recorded for those conducted in the (Karak- Jordan 2), (Denizli- Turkey 4), and (Galicia- Spain 15) respectively (Table 12). The mean concentration of total Fe at Arbat at each right and left side of the road was found to be highest in the soil at the road edge, and then decreased

with increasing distance from the edge of the road in Figure 18. This might come from the vehicular emissions. While vehicle emission is one of the most important sources of air pollution. This is similar to that reported by (Jaradat et al. 2005) in his study found that heavy metals such as Zn, Fe, and Cu are essential components of many alloy, wires, pipes, and tires in motor vehicles and are released as a result of mechanical abrasion into the roadside environment.

Figure 19 shows that the mean concentration of total Fe at Tasluja location at left side of the road was decreased with increasing distance from the edge of the road. Generally for this reason the concentration of total Fe at this location might come from vehicular emission. But concentration of total Fe at location of Mergapan, the distance had no significant effect as it was shown in Figure 20.

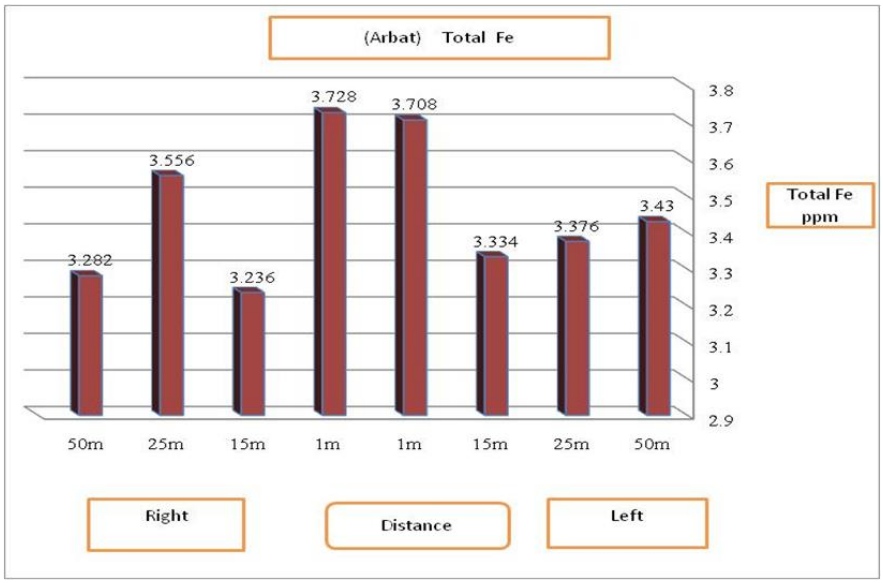

Figure 18. The Average Total Fe Concentration at Arbat

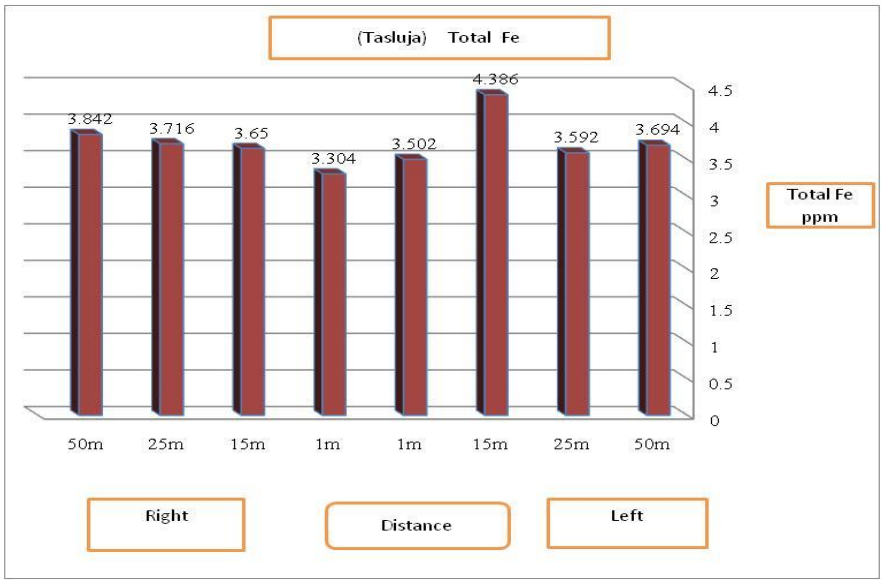

Figure 19. The Average Total Fe Concentration at Tasluja

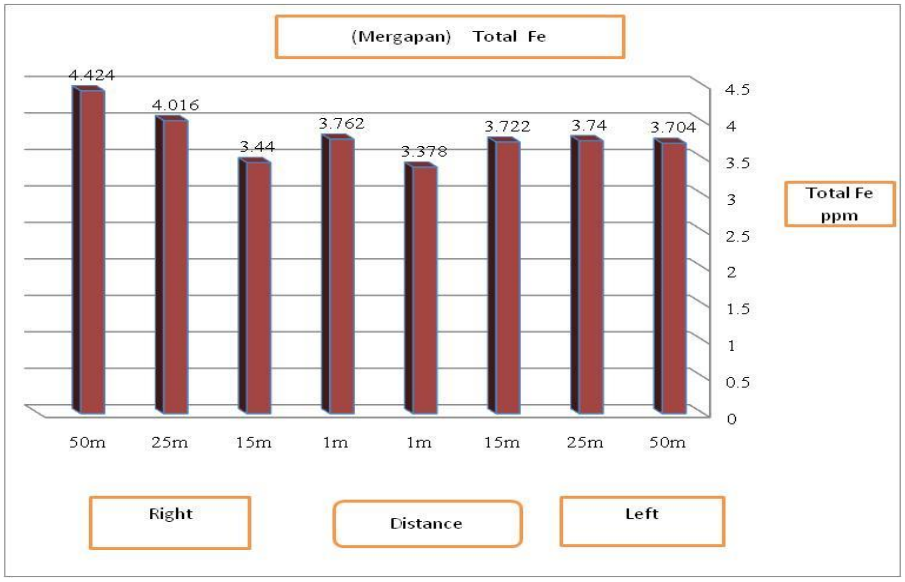

Figure 20. The Average Total Fe Concentration at Mergapan

4.18. Total Cr Concentration

Table 9 summarizes the statistical analysis of the data. Locations had a significant ($p<0.05$) effect on Cr, while the side of roads, distance, and their interaction were non-significant (ANOVA Table). As location vs. side of road interaction considered, the maximum Cr was observed on the left side of Tasluja and the minimum on the right side of Mergapan (Table 9). In the case of locations x side of the roads x distances interaction, maximum Cr was noted on the left side of Tasluja (268.6) at 1 m distance whereas the minimum Cr (107.4) was observed on the right side of Mergapan at 1 m away the road. The mean concentration of total Cr of soil samples in this study ranged from 139.16 to 241.48 mg kg-1 which indicates a fairly high level in all location. When the minimum mean concentration of Cr obtained was compared with the levels in similar studies elsewhere, the concentration of total Cr was lower than the concentration of 182.1, 232.4 mg $kg\text{-}1^{-1}$ recorded for (Seoul City- Korea 5) and (Kavala- Greece 10) respectively (Table 12), but it was higher than (23.1,107.9,21.6, and 54.1 mg kg-1) reported for (Hong Kong 1), (Shanghai, China 9), (Murcia City, Spain 13), and (Galicia, Spain 15) respectively (Table 12).

Figure 21 shows that the mean concentration of total Cr at left side of Arbat road decreased with increasing distance from the road, and the clearly higher levels of Cr concentration at left side of the road was observed due to direction of wind which blows from right to the left of the road. Therefore it can be concluded that traffic is likely to be responsible for high levels of Cr concentration. Figure 22 shows that unlike right side, total Cr concentration at Tasluja was inversely related to distance on the left side of the road. This could be an indication of traffic induced Cr pollution at this site. Figure 23 shows there is no effect of distance on Cr concentration buy the excessive Cr concentration may be related to automobile emission.

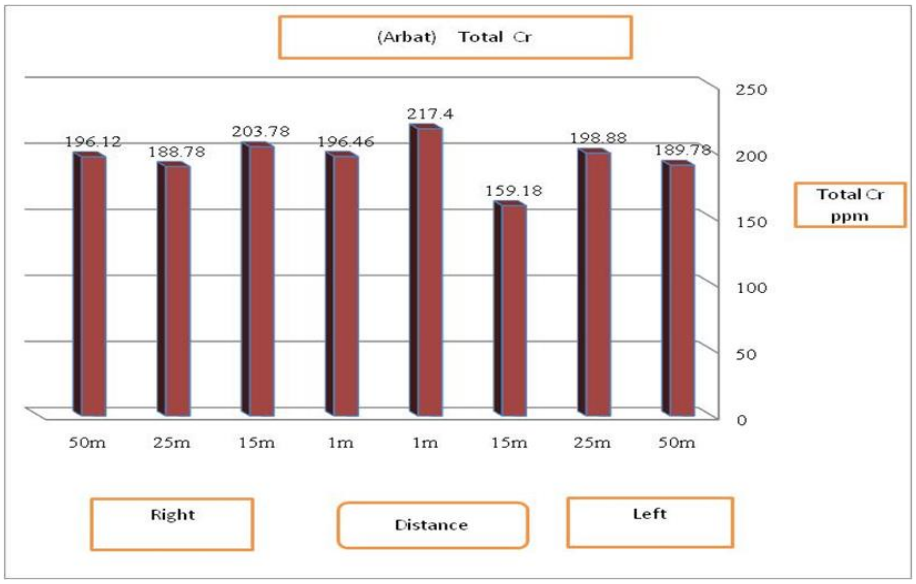

Figure 21. The Average Total Cr Concentration at Arbat

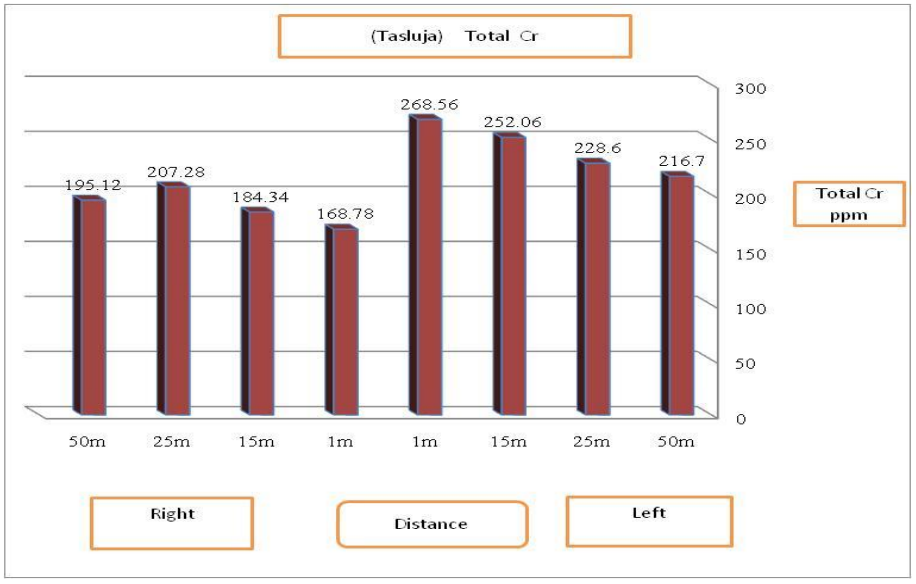

Figure 22. The Average Total Cr Concentration at Tasluja

Figure 23. The Average Total Fe Concentration at Mergapan

Table 9. Side- and Distance-Induced Averages of Total Cu, Total Fe, and Total Cr at Sampling Locations (Arbat, Tasluja, and Mergapan)

Locations	**Side of Road**	**Distance (m)**	**Concentration of Heavy Metals**					
			Total Cu (mg kg^{-1})		**Total Fe (mg kg^{-1})**		**Total Cr (mg kg^{-1})**	
Arbat	Right	1	29.92	30.58	3.73	3.45	196.5	196.3
		15	35.64		3.24		203.8	
		25	28.74		3.56		188.8	
		50	28.00		3.29		196.1	
	Left	1	26.94	26.60	3.71	3.46	217.4	191.3
		15	33.38		3.34		159.2	
		25	22.60		3.38		198.9	
		50	23.46		3.43		189.8	
LSD 0.05			NS	NS	0.31	NS	NS	NS
LSD 0.01			NS	NS	NS	NS	NS	NS
Tasluja	Right	1	16.18	18.26	3.30	3.63	168.8	188.9
		15	20.12		3.65		184.3	
		25	17.38		3.72		207.3	
		50	19.34		3.84		195.1	
	Left	1	20.80	23.25	3.50	3.79	268.6	241.5
		15	29.68		4.39		252.1	
		25	21.06		3.60		228.6	
		50	21.46		3.69		216.7	
LSD 0.05			NS	NS	0.37	NS	NS	NS
LSD 0.01			NS	NS	NS	NS	NS	NS
Mergapan	Right	1	29.22	31.60	3.76	3.91	107.4	139.2
		15	33.04		3.44		162.9	
		25	30.66		4.02		139.1	
		50	33.48		4.42		147.3	
	Left	1	33.14	36.21	3.38	3.64	139.4	156.4
		15	31.50		3.72		161.9	
		25	39.60		3.74		152.2	
		50	40.58		3.70		172	
LSD 0.05			NS	NS	NS	NS	NS	NS
LSD 0.01			NS	NS	NS	NS	NS	NS

4.19. Total Co Concentration

Table 10 summarizes the statistical analysis of the data. Locations had a significant ($p<0.05$) effect on Co, while the side of roads, distance, and their interaction were non-significant (ANOVA Table), but Arbat and Mergapan locations had significant distance dependent Co changes at $P<0.05$ confidence levels, respectively. As location vs. side of road interaction considered, the maximum Co was observed on the left side of Mergapan and the minimum on the right side of Arbat (Table 10). In the case of locations x side of the roads x distances interaction, maximum Co was noted on the left side of Mergapan (9.56) at 15 m distance whereas the minimum Co (4.95) was observed on the right side of Arbat at 1 m away the road.

Figure 24 revealed a Co a distance induced decrease on both sides at Arbat. with distance from the edge of the road. This indicate that the main source of Co concentration at this location was traffic related. Figure 25 revealed that distance had no effect on concentration of Co at Tasluja. Figure 26 shows there was a distance dependent distribution of Co concentration on the left side of the Mergapan road due to slope and runoff effects.

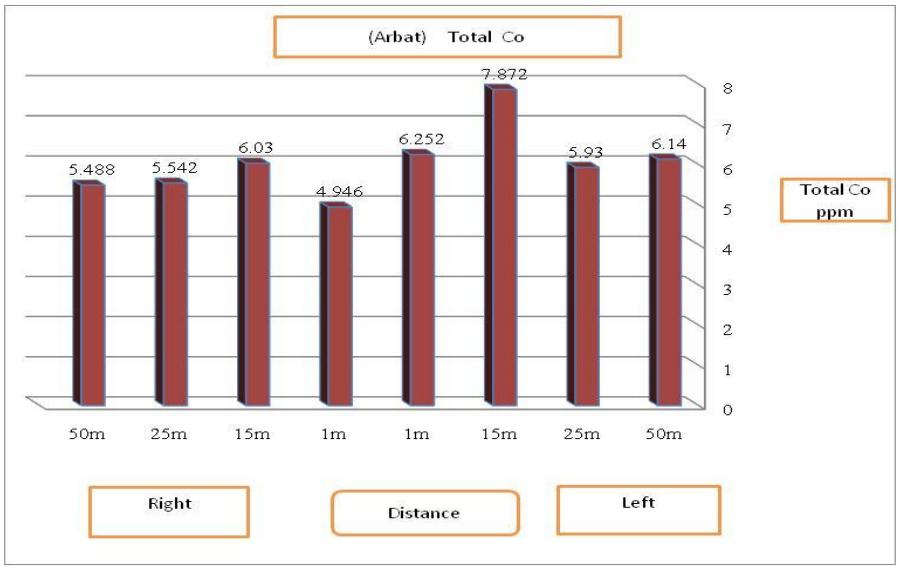

Figure 24. The Average Total Co Concentration at Arbat

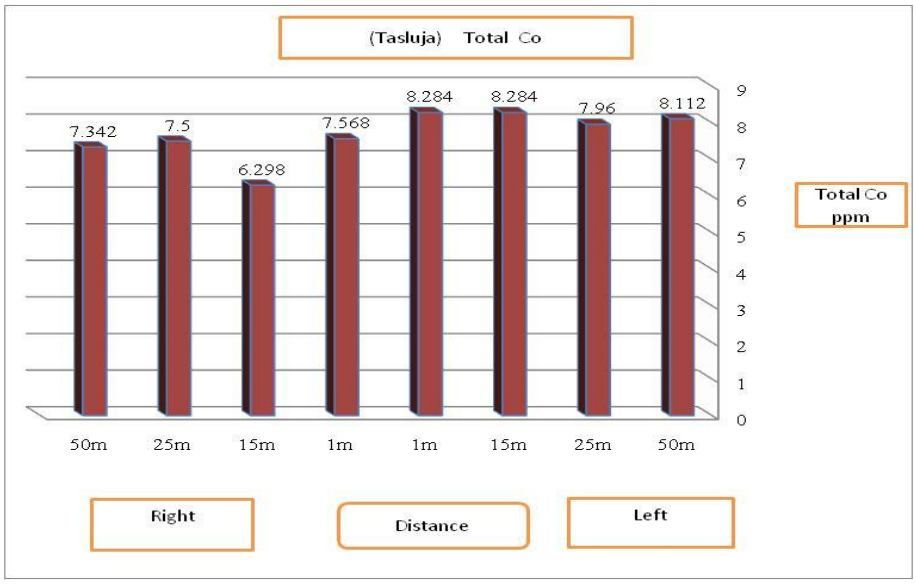

Figure 25. The Average Total Co Concentration at Tasluja

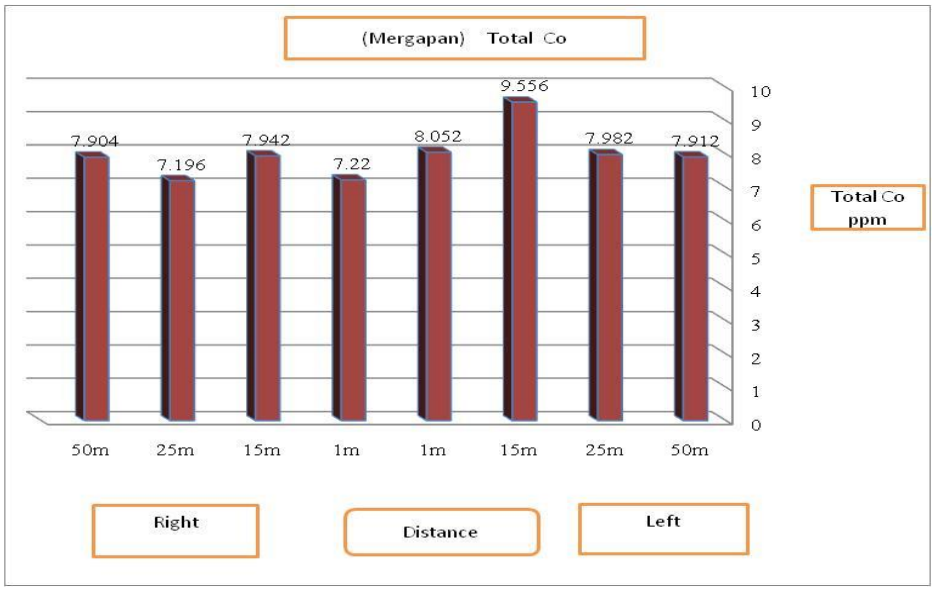

Figure 26. The Average Total Co Concentration at Mergapan

4.20. Total Pb Concentration

Table 10 summarizes the statistical analysis of the data. Locations had a significant ($p<0.05$) effect on Pb, while the side of roads, distance, and their interaction were non-significant (ANOVA Table), but Arbat and Mergapan locations had significant distance dependent Pb changes at 0.01 confidence levels, respectively, and Tasluja locations had significant distance dependent Pb changes at 0.05 confidence levels. As location vs. side of road interaction considered, the maximum Pb was observed on the right side of Mergapan and the minimum on the right side of Tasluja (Table 10). In the case of locations x side of the roads x distances interaction, maximum Pb was noted on the right side of Mergapan (141.6) at 1 m distance whereas the minimum Pb (39.1) was observed on the right side of Tasluja at 50 m away the road.

The high concentration of total Pb near the road show the role of vehicle exhaust as the use of alkyl-lead compounds as antiknock additives in petrol (Gratani et al. 1992). When the mean concentration of total Pb ranged from 43.34 -124.29 mg kg-1, and the maximum total Pb obtained from this study was compared with the levels in similar studies in other places, was higher than the concentration (94.6, 53.6, and 11.7 mg kg-1) recorded for (Hong Kong 3), (Jeddah City- Saudi Arabia 14), and (Galicia- Spain 15) respectively (Table 12), but it was lower than the ones obtained for (1351, 294, and 181 mg kg-1) (China 17), (Hong Kong1), (Aberdeen City, Scotland 7) respectively (Table 12). Even the minimum Pb concentration was higher than the ones reported for minimum mean concentration of total Pb in this study, was higher than the concentration (40.8, 18.7, and 5.35 mg kg-1) (Galway, Ireland 16), (Murcia City, Spain 13), and (Karak-Jordan 2), and lower than (88.1, 64.93, and 53.6 mg kg-1) (Hong Kong 6), (Eskisehir, Turkey 18), and (Jeddah City, Saudi Arabia 14) respectively (Table 12). The mean concentration Pb on Arbat and Tasluja was (58.9-67.5, 43.3-47.3 mg kg^{-1}) respectively it was lower than 85 mg kg^{-1} (Table 13), this mean these locations was not contaminated with Pb and had safety level, but on Mergapan mean concentration Pb was 116.3-124.1 mg kg^{-1} it was higher than 100 mg kg^{-1} (Table 13), this means it had alerting value of Pb. Lead can be very toxic to human health. For children, it could cause mental retardation, hyperactivity, and hearing loss and for adults increased blood pressure and liver, kidney, and fertility damage (Okorie et al. 2010). Due to growing concerns about the problems

linked with Pb, the using of leaded gasoline has been decreasing globally at an annual rate to % 7 (Faiz et al. 1996). The maximum level of Pb in leaded gasoline has been set to be less than 0.15 g/L since July 1989 (Nriagu et al. 1990), but till now there are many counties that use of leaded gasoline with Pb content about 0.4 g/L (Faiz et al. 1996, Kaysi et al. 2000). Although the use of leaded gasoline decreased during this time period, but day by day increasing automobile number, compensated its effect despite substantial decrease in Pb emission per vehicle. In addition, wearing down of vehicle tires can also introduce Pb (Giannouli et al. 2007) to the roadside soil. The mean concentration of total Pb in locations of Arbat and Tasluja was ranged from (43,34 - 67.51mg kg-1). Pb concentrations of all three locations' soils exerted an distance dependent distribution on both side which can be treated as traffic induced pollution (Figure 27-29). This high mean concentration of total Pb in soil near the road indicates the role of vehicle exhaust as the use of alkyl- lead compounds as antiknock additives in petrol (Gratani et al. 1992).

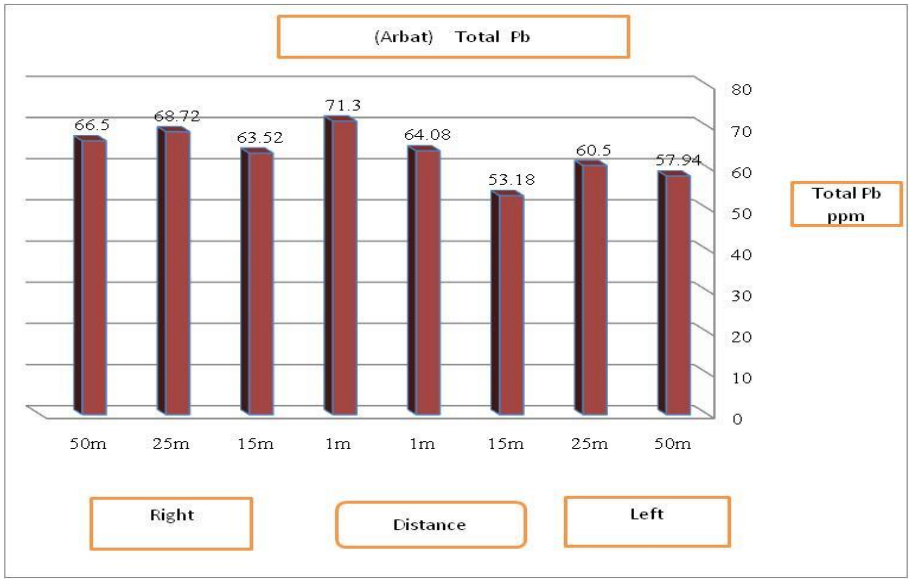

Figure 27. The Average Total Pb Concentration at Arbat

Figure 28. The Average Total Pb Concentration at Tasluja

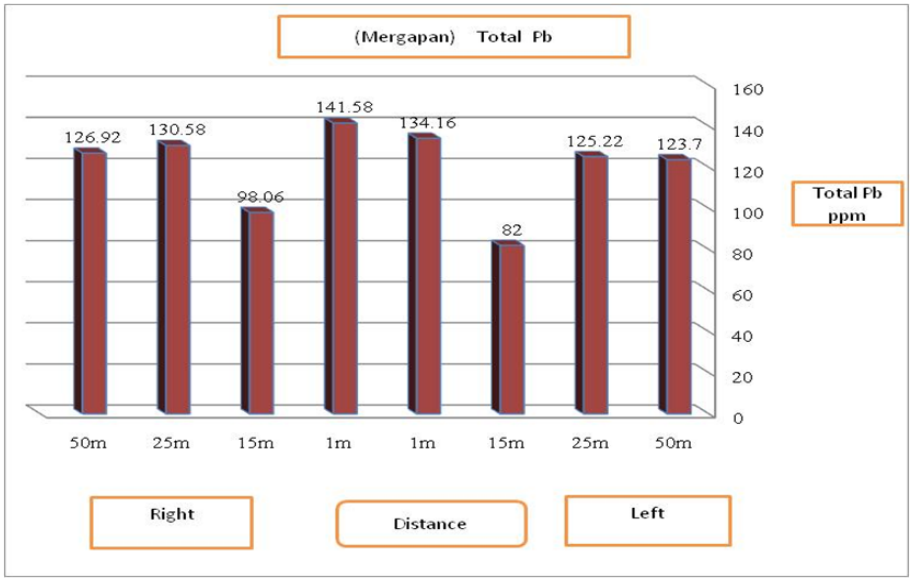

Figure 29. The Average Total Pb Concentration at Mergapan

4.21. Total Cd Concentration

Table 10 summarizes the statistical analysis of the data. Locations had a significant ($p<0.05$) effect on Cd, while the side of roads, distance, and their interaction were non-significant (ANOVA Table), but Arbat and Mergapan locations had significant distance dependent Cd changes at 0.01 confidence levels, respectively. As location vs. side of road interaction considered, the maximum Cd was observed on the left side of Tasluja and the minimum on the right side of Arbat (Table 10). In the case of locations x side of the roads x distances interaction, maximum Cd was noted on the right side of Mergapan (3.99) at 15 m distance whereas the minimum Cd (1.66) was observed on the right side of Arbat at 1 m away the road.

The mean concentration of total Cd ranged from (1.943- 3.992 mg kg-1), when compare these results with previous studies given in Table 12. Cd concentration determined in this study were much higher than those reported for (1.58,0.85, and 0.2mg kg-1) (China 17), (Palermo- Italy 8), and (Kavala- Greece 10) respectively. But the maximum mean concentration of total Cd in this study was lower than the ones reported for (5.95, 4.29, and 4.3 mg kg-1) (Islamabad- Pakistan 11), (Denizli- Turkey 4), and (Seoul City- Korea 5) respectively. A total Cd concentration below 1 mg kg-1 is regarded "non polluted" (Table 13). 1-2 mg kg-1 Cd concentration is indication of slight contamination and a concentration over 2 mg kg^{-1} is classified contamination trend (Table 13). The concentration of total Cd in location of Arbat was ranged from (1.943 -1,965 mg kg-1), this mean that contamination of soil in Arbat was slightly contaminated, whereas Tasluja and Mergapan soils can be classified as contaminated soils with Cd concentration range of 2.98-3.73 mg kg^{-1}. Considering the absence of any industry in the sampling sites, the levels of Cd could be due to lubricating oils and the wearing of tires, where Cd in car tires has been found to range from 20 to 90 mg kg^{-1} (Zhongren et al. 2006). Cd is a toxic element for humans because it easily moves from soil to food plants through roots by absorption, and great amounts can accumulate in their tissues without showing stress (Oliver et al., 1997). 83% of Cd emission comes from engine oil consumption (Winther et al. 2010).

Figure 30 show that the mean concentration of total Cd on both sides of the road at studied locations apparently decreased with the distance from the edge of the road, this

indicate that the main source of Cd in the soil was vehicular traffic on this road. Figure 31 show that the mean concentration of total Cd on both sides of the road at Tasluja apparently decreased with the distance from the edge of the road. This indicated that the concentration of Cd in this location was coming from vehicular emission. Figure 32 show that the mean concentration of total Cd on both sides of the road at Mergapan decreased with increasing distance from the edge of the road.

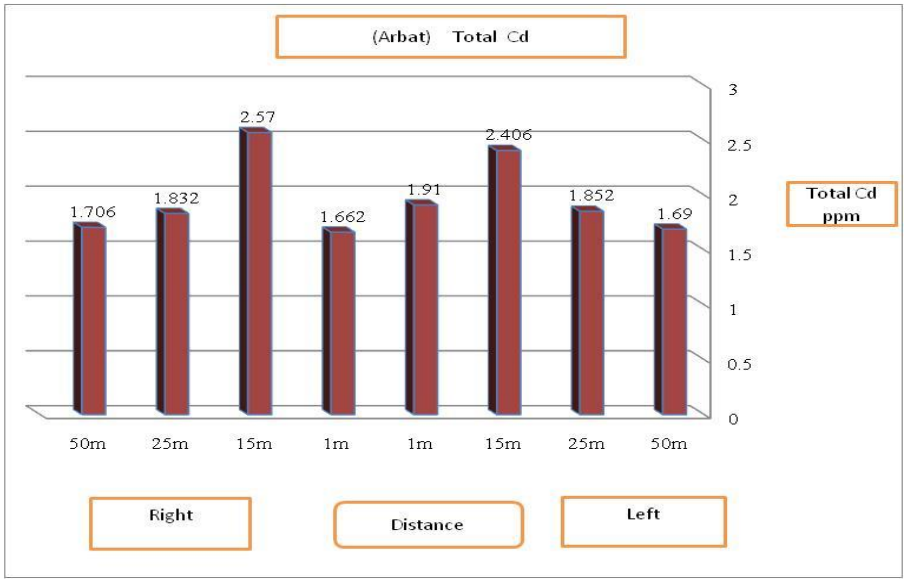

Figure 30. The Average Total Cd Concentration at Arbat

Figure 31. The Average Total Cd Concentration at Tasluja

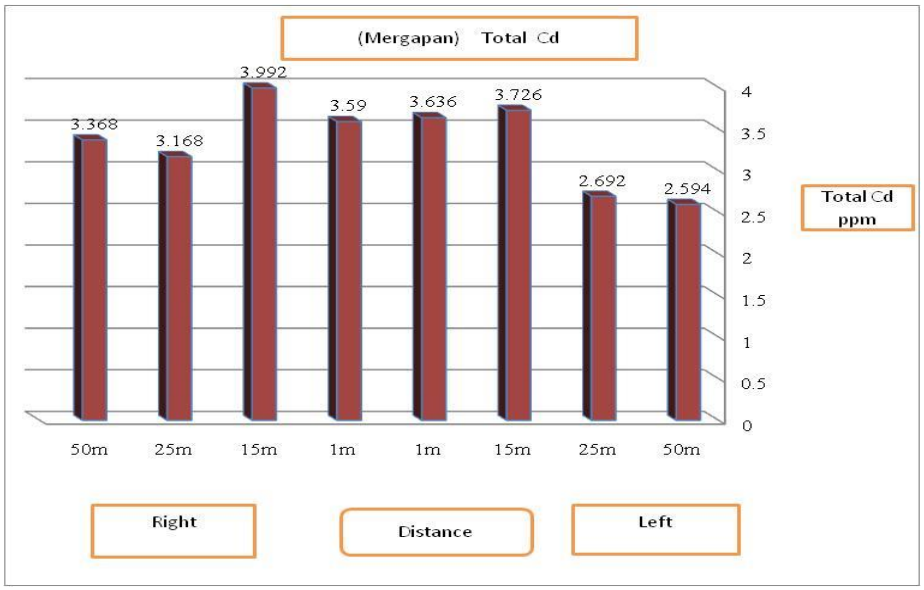

Figure 32. The Average Total Cd Concentration at Mergapan

Table 10. Side- and Distance-Induced Averages of Total Co, Total Pb, and Total Cd at Sampling Locations (Arbat, Tasluja, and Mergapan)

Locations	**Side of Road**	**Distance (m)**	**Concentration of Heavy Metals**					
			Total Co(mgkg^{-1})		**Total Pb (mgkg^{-1})**		**Total Cd (mgkg^{-1})**	
Arbat	Right	1	4.95	5.50	71.3	67.5	1.66	1.94
		15	6.03		63.5		2.57	
		25	5.54		68.7		1.83	
		50	5.49		66.5		1.71	
	Left	1	6.25	6.57	64.1	58.9	1.91	1.97
		15	7.87		53.2		2.41	
		25	5.93		60.5		1.85	
		50	6.14		57.9		1.69	
LSD 0.05			0.91	NS	-	NS	-	NS
LSD 0.01			NS	NS	3.77	NS	0.58	NS
Tasluja	Right	1	7.57	7.17	45.2	43.3	3.23	2.98
		15	6.30		46		3.10	
		25	7.50		43.1		2.73	
		50	7.34		39.1		2.86	
	Left	1	8.28	8.16	50.7	47.3	3.90	3.73
		15	8.28		47.7		3.95	
		25	7.96		46		3.57	
		50	8.11		44.7		3.50	
LSD 0.05			NS	NS	3.95	NS	NS	NS
LSD 0.01			NS	NS	NS	NS	NS	NS
Mergapan	Right	1	7.22	7.57	141.6	124.1	3.59	3.53
		15	7.94		98.1		3.99	
		25	7.20		130.6		3.17	
		50	7.90		126.9		3.37	
	Left	1	8.05	8.38	134.2	116.3	3.64	3.16
		15	9.56		82.0		3.73	
		25	7.98		125.2		2.69	
		50	7.91		123.7		2.59	
LSD 0.05			0.58	NS	-	NS	-	NS
LSD 0.01			NS	NS	25.1	NS	0.48	NS

4.22. Total Ni Concentration

Table 11 summarizes the statistical analysis of the data. Locations had a significant ($p<0.05$) effect on Ni, while the side of roads, distance, and their interaction were non-significant (ANOVA Table), but Arbat location had significant distance dependent Ni changes at 0.01 confidence levels. As location vs. side of road interaction considered, the maximum Ni was observed on the left side of Tasluja and the minimum on the right side of Mergapan (Table 11). In the case of locations x side of the roads x distances interaction, maximum Ni was noted on the left side of Tasluja (179) at 1 m distance whereas the minimum Ni (57.1) was observed on the right side of Mergapan at 15 m away the road.

Nickel plays an fundamental role in metabolic processes of higher plants as it (Brown et al. 1987). (Ward et al. 1977) noted that motor vehicles are responsible for accumulation of Cd and Ni in soils and vegetation along a motorway in New Zealand. When the mean concentration of total Ni at all location obtained in this study were compared with the levels in similar studies elsewhere, the lowest concentration of Ni (66.78 mg kg-1) obtained in this study is higher than the concentration reported for in the (Mexico City, Mexico 12) (39 mg kg-1), (Galway, Ireland 16) (22.1 mg kg-1), and (Hong Kong 6) (3.65 mg kg-1) (Table 12), and maximum concentration of total Ni in this study (142.99 mg kg-1) was higher than the concentration reported for those conducted in the (China 17) (99.48 mg kg-1), (Seoul City, Korea 5) (89.6 mg kg-1), and (Kavala, Greece 10) (67.9 mg kg-1) (Eskisehir, Turkey 18) (161.53 mg/km) (Table 12). The mean concentration of total Ni in Arbat at right side of the road was (66.78 mg kg-1), when compared with the value given in Table 13. It was higher than 50mg kg-1, this mean that this side of the road had a boundary value of Cd, but the concentration of Tasluja and Mergapan and the left side Ni of Arbat road was higher than 70mg kg-1 (table 13), this indicate that these locations had a alerting value.

Figure 33 show that the mean concentration of total Ni on both sides of the road at studied locations had not affected by distance from the edge of the road.

Figure 34 show that the mean concentration of total Ni at the left side of the road at location of Tasluja was decreasing with the distance increase from the edge of the road, this indicate that the main source of Ni in the soil was vehicular traffic on this road.

Figure 35 show that the mean concentration of total Ni at the left side of the road at Mergapan was decreasing with the distance increase from the edge of the road, this indicate that the main source of Ni in the soil was vehicular traffic on this road.

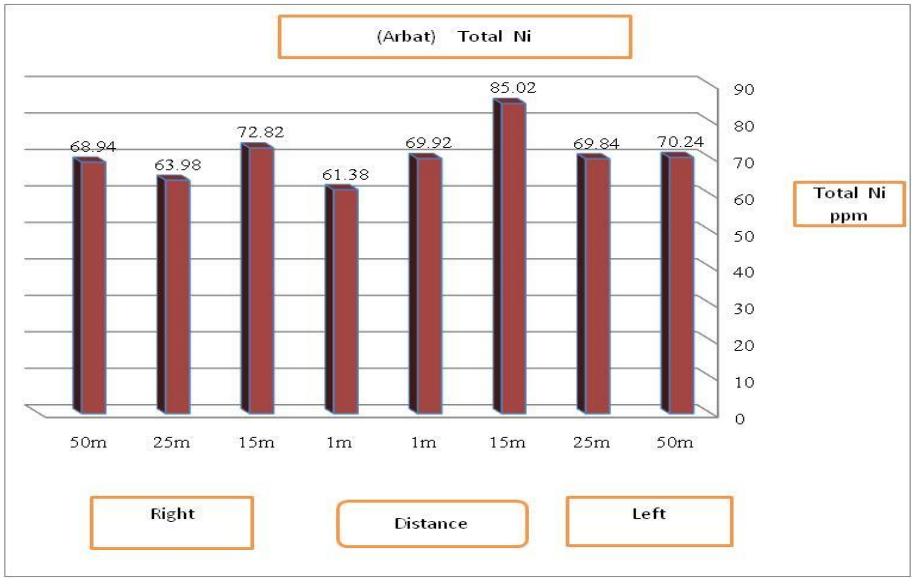

Figure 33. The Average Total Ni Concentration at Arbat

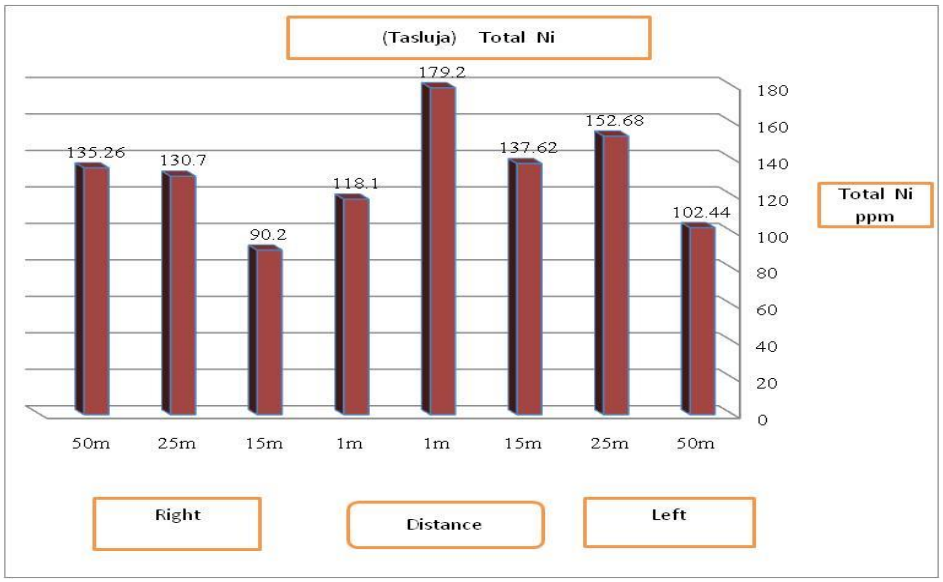

Figure 34. The Average Total Ni Concentration at Tasluja

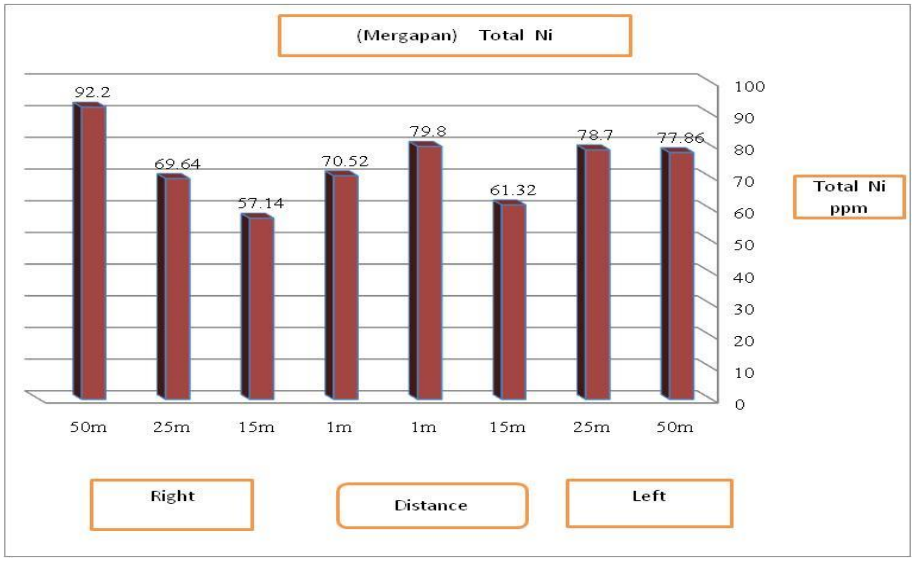

Figure 35. The Average Total Ni Concentration at Mergapan

4.23. Total Na Concentration

Table 11 summarizes the statistical analysis of the data. Locations had a significant ($p<0.05$) effect on total Na, while the side of roads, distance, and their interaction were non-significant (ANOVA Table), but Arbat location had significant distance dependent total Na changes at $P<0.05$ confidence levels. As location vs. side of road interaction considered, the maximum total Na was observed on the right side of Arbat and the minimum on the left side of Tasluja (Table 11). In the case of locations x side of the roads x distances interaction, maximum Na was noted on the left side of Arbat (252) at 1 m distance whereas the minimum total Na (171.8) was observed on the left side of Tasluja at 50 m away the road.

4.24. Total K Concentration

Table 11 summarizes the statistical analysis of the data. Locations had a significant ($p<0.05$) effect on total K, while the side of roads, distance, and their interaction were non-significant (ANOVA Table), but Arbat and Tasluja locations had significant distance dependent total K changes at 0.01 confidence levels, respectively. As location vs. side of road interaction considered, the maximum total K was observed on the left side of Arbat and the minimum on the left side of Tasluja (Table 11). In the case of locations x side of the roads x distances interaction, maximum total K was noted on the left side of Arbat (0.48) at 25 m distance whereas the minimum total K (0.30) was observed on the left side of Tasluja at 1 m away the road.

Table 11. Side- and Distance-Induced Averages of Total Ni, Total Na, and Total K at Sampling Locations (Arbat, Tasluja, and Mergapan)

Locations	**Side of Road**	**Distance (m)**	**Chemical Parameter and Concentration of Heavy Metals**					
			Total Ni (mg kg^{-1})		**Total Na (mg kg^{-1})**		**Total K (mg kg^{-1})**	
Arbat	Right	1	61.4	66.8	239.6	220	0.37	0.40
		15	72.8		210.8		0.36	
		25	64		222.6		0.42	
		50	68.9		207		0.47	
	Left	1	69.9	73.8	252	219.8	0.37	0.44
		15	85.0		212.4		0.43	
		25	69.8		210.8		0.48	
		50	70.2		204		0.46	
LSD 0.05			-	NS	25.78	NS	-	NS
LSD 0.01			7.25	NS	NS	NS	0.05	NS
Tasluja	Right	1	118	119	210.4	199.4	0.33	0.37
		15	90.2		206		0.40	
		25	131		194.2		0.36	
		50	135		187		0.37	
	Left	1	179	143	176.6	175.4	0.30	0.35
		15	138		180.8		0.40	
		25	153		172.4		0.35	
		50	102		171.8		0.37	
LSD 0.05			NS	NS	NS	NS	NS	NS
LSD 0.01			NS	NS	NS	NS	0.04	NS
Mergapan	Right	1	70.5	72.4	212.6	217.3	0.43	0.40
		15	57.1		232.4		0.38	
		25	69.6		216		0.41	
		50	92.2		208.2		0.39	
	Left	1	79.8	74.4	205.2	202.8	0.35	0.39
		15	61.3		190.2		0.34	
		25	78.7		204.2		0.44	
		50	77.8		211.4		0.44	
LSD 0.05			NS	NS	NS	NS	NS	NS
LSD 0.01			NS	NS	NS	NS	NS	NS

Table 12. Comparison of Mean Contents (mg kg-1) of Heavy Metals in Roadside Soil From other Cities in the World. (Malkoc et al., 2010)

City/Country	Heavy Metals (mg kg-1)							
	Cd	**Cr**	**Cu**	**Fe**	**Mn**	**Ni**	**Pb**	**Zn**
Hong Kong (1)	1	-	73	-	-		294	183
Karak, Jordan (2)	-	-	0.85	22.7	-	3.15	5.35	4.95
Hong Kong (3)	0.62	23.1	23.3	-	-	12,4	94.6	125
Denizli, Turkey (4)	4.29	-	69.71	3554.5	428.5	-	336.6	506.4
Seoul City, Korea (5)	4.3	182.1	445.6	-	-	89.6	214.3	2.665
Hong Kong (6)	0.33	16.8	10.4	-	-	3.65	88.1	103
Aberdeen City, Scotland,UK (7)	0.41	-	49.4	-	-	18.3	181	111
Palermo, Italy (8)	0.84	39	77	-	566	19.1	253	151
Shanghai, China (9)	0.52	107.9	59.25	-	-	31.14	70.69	301.4
Kavala, Greece (10)	0.2	232.4	172.4	-	-	67.9	386.9	354.8
Islamabad, Pakistan (11)	5.95	-	25	-	-	32	62.5	91.05
Mexico City, Mexico (12)	-	116	54	-	-	39	82	219
Murcia City, Spain (13)	-	21.6	9.3	-	208	13.5	18.7	26.9
Jeddah City, Saudi Arabia(14)	-	57	-	-	-	33.1	53.6	91
Galicia, Spain (15)	0.31	54.1	20.5	35.26	659.9	23.5	11.7	98.7
Galway, Ireland (16)	-	-	16.6	170	650	22.1	40.8	81.8
China (17)	1.58	78.43	115.07	-	-	99.48	1351	266.4
Eskisehir, Turkey (18)	1.28	97.65	39.33	19150	395.2	161.53	64.93	31.5

Where the soures are :- (1) Li et al . 2001 , (2) Al-Khashman 2004 (3) Li et al. 2004 , (4) Celik et al. 2005 , (5) Lee et al . 2005 , (6) Lee et al . 2006 , (7) Yang et al . 2006 , (8) Manta et al . 2002 , (9) Shi et al . 2008 ,(10) Christoforidis et al. 2009 , (11) Faiz et al. 2009 , (12) Morton-Bermea et al. 2009 , (13) Acosta et al. 2009 , (14) Kadi 2009 ,(15) Franco-Uria et al. 2009 , (16) Dao et al. 2010 , (17) Wei et al. 2010 , (18) Malkoc et al. 2010

Table 13. The Boundary, Alerting and Critical Values of Heavy Metal in Soil, Values are in mg kg-1 of Dry Soil Cited from (Plesničar and Zupančič 2005).

	The Boundary Value	**The Alerting Value**	**The Critical Value**
Pb	85	100	530
Zn	200	300	720
Cu	60	100	300
Ni	50	70	210
Cd	1	2	12

CONCLUSION

This study dealt with the concentration of heavy metals Pb, Cd, Cr, Co, Cu, Zn, Mn, Ni, and Fe in roadside soils along three main road at Arbat, Tasluja, and Mergapan in Sulaimani, in north of Iraq. Soil samples on both sides of the road at these locations were collected and analyzed. The results were indicated that on Arbat road the concentration of Pb, Cd, Cu, Ni, Co, and Fe on both roadside soil, Zn on right side of the road, and Mn and Cr on left roadside of the road was increased at first near the edge of road and then decreased with distance from the edge of the road. The concentration of Pb and Cd in the soil at both sides of the road and Fe, Cr, and Ni in soil on left side on Tasluja road was increased at first and then decreased with the distance increases from the edge of the road, also on Mergapan road the concentration of Pb and Cd on both side of the road, Co on left side of the road was decreases with increasing distance from edge of the road. Behavior of some elements has been determined of variability in the on the left and right of the roads. This variation is considered to be related to surface flow originating from the slope of the roads. At all three sampling points, Zn and Cu are above the limit value; Pb in Mergapan, and Cd in Arbat have concentrations close to the critical level. Ni metal is found on the left side of Arbat, while Tasluja and Mergapan are on the right side of the road. The concentration of some heavy metals has reached critical levels, resulting in the need to work to prevent or clean up pollution.

.

REFERENCES

Andrade, JM., Kubista, MA., Carlosena, PD., "3-Way characterization of soils by Procrustes rotation, matrix-augmented principal components analysis and parallel factor analysis." analytica chimica acta 603, no. 1: 20-29, 2007.

Alomary, AA., Belhadj, S., "Determination of heavy metals (Cd, Cr, Cu, Fe, Ni, Pb, Zn) by ICP-OES and their speciation in Algerian Mediterranean Sea sediments after a five-stage sequential extraction procedure." Environmental Monitoring and Assessment 135, no. 1-3: 265-280, 2007.

Audu, AA., Lawal, AOl., "Variation in metal contents of plants in vegetable garden sites in Kano metropolis." Journal of Applied Sciences and Environmental Management 10, no. 2: 105-109, 2005.

Akoto, O., Bruce, TN., Darko, D., "Heavy metals pollution profiles in streams serving the Owabi reservoir." African Journal of Environmental Science and Technology 2, no. 11: 354-359, 2008.

Akbar, FK., Hale, WH., Headley, AD., Athar, MHD., "Heavy metal contamination of roadside soils of Northern England." Soil Water Res 1, no. 4: 158-163, 2006.

Abdullateef, B., Kolo, BG., Waziri, I., Idris, MA., "Levels Of Heavy Metals in Soil as Indicator Of Environmental Pollution in Maiduguri,Borno State, Nigeria." Bull. Env. Pharmacol. Life Sci. 1, no. 3: 133-136, 2014.

Abrahams, PW., "Soils their implications to human health." Science of the Total Environment 291, no. 1: 1-32, 2002.

Adedeji, OH., Olayinka, OO., Oyebanji, FF., "Assessment of Traffic Related Heavy Metals Pollution of Roadside Soils in Emerging Urban Centres in Ijebu-North Area of Ogun State, Nigeria." Journal of Applied Science & Environmental Management 17, no. 4: 509-514, 2013.

AL- jibury1, DA., Essa, SK., "Heavy Metals Pollution in the Highway- Side Soil around Baghdad City." Journal of Environment and Earth Science, 6, no.9: (www.iiste.org),2016.

Al-Fatlawi, SMG., Alwani, MA., "Heavy metal pollution of roadside dust samples with different traffic volumes at Hilla city." Iraqi J. Mech. Mater. Eng 12, no. 4: 660-672, 2012.

Al-Radady, AS., Davies, BE., French, MJ., "Distribution of lead inside the home case studies in the north of England." Science of the Total Environment 145, no. 1-2: 143-156, 1994.

AMAP, A., (Arctic Monitoring and Assessment Programme)., "heavy metals in the Arctic." Available at; http://www.amap.no/documents/doc/amap-assessment-2002-heavy-metals-in-the-arctic 97, 2002.

Aslam, J., Khan, A., Khan, SH., "Heavy metals contamination in roadside soil near different traffic signals in Dubai, United Arab Emirates." Journal of Saudi Chemical Society 17, no. 3 : 315-319, 2013.

Atayese, MO., Eigbadon, AI., Oluwa, KA., Adesodun, JK., "Heavy metal contamination of amaranthus grown alongmajor highways in Lagos, Nigeria." African Crop Science Journal, 16, no. 4: 225–235, 2010.

Amin, AM., (2006)., "Policy dialog model for the future of agriculture development." Cited from Mohamed-Ali, JJ "Natural Resources and its Utilization for Agricultural development in Sulaimani Governorate." A Dissertation Submitted to the Council of Agriculture College/ Sulaimani University in partial fulfillment for the Degree of Doctor of Philosophy in Crop Science (Natural Resources). Regional Government of Iraqi Kurdistan, 2008.

Apha, AWA., "WEF " Standard methods for the examination of water and wastewater 22, 2012.

Adachi, K., Tainosho, Y., "Characterization of heavy metal particles embedded in tire dust." Environment international 30, no. 8: 1009-1017, 2004.

Al-Khashman, OA., "Heavy metal distribution in dust, street dust and soils from the work place in Karak Industrial Estate, Jordan." Atmospheric environment 38, no. 39: 6803-6812, 2004.

Acosta, JA., Cano, AF., Arocena, J., Debela, MF., Martínez, S., "Distribution of metals in soil particle size fractions and its implication to risk assessment of playgrounds in Murcia City (Spain)." Geoderma 149, no. 1: 101-109, 2009.

Brinkmann, WLF., "Urban stormwater pollutants: sources and loadings." GeoJournal 11, no. 3: 277-283, 1985.

Blok, J., "Environmental exposure of road borders to zinc." Science of the Total Environment 348, no. 1: 173-190, 2005.

Bai, J., Cui, B., Wang, Q., Gao, H., Ding, Q., "Assessment of heavy metal contamination of roadside soils in Southwest China." Stochastic Environmental Research and Risk Assessment 23, no. 3: 341-347, 2009.

Bakirdere, S., Yaman, M., "Determination of lead, cadmium and copper in roadside soil and plants in Elazig, Turkey." Environmental Monitoring and Assessment 136, no. 1-3: 401-410, 2008.

Brady, NC., Weil, RR., "The nature and properties of soils." No. Ed. 11. Prentice-Hall Inc, 1996.

Bilbas, A., "Ecosystem Health Assessment of Dukan Lake, Sulaimani, Kurdistan Region of Iraq." Ph. Dr. Thesis.Univ.of Salahaddin, Erbil, 2014.Cited from Rabar Mohammed Hussein Master Thesis. "Hyco-ecological study on two major parks water body in province (noryh Iraq)". Bingol universtiy Biology Department, (2016).

Black, AC., Evans, DD., Dinauer, RC., "Methods of soil analysis." Vol. 9. Madison, WI: American Society of Agronomy, 1965.

Bouyoucos, JG., "Directions for making mechanical analyses of soils by the hydrometer method." Soil Science 42, no. 3 : 225-230, 1936.

Begum, A., Ramaiah, M., Khan, I., Veena, K., "Analysis of heavy metals concentration in soil and litchens from various localities of Hosur Road, Bangalore, India." Journal of Chemistry 6, no. 1: 13-22, 2009.

Brown, PH., Welch, RM., Cary, EE., "Nickel A micronutrient essential for higher plants." Plant Physiology 85, no. 3: 801-803, 1987.

Chen, H., Teng, Y., Sijin, L., Wang, Y., Wang, J., "Contamination features and health risk of soil heavy metals in China." Science of the Total Environment 512: 143-153, 2015.

Chow, TJ., "Lead accumulation in roadside soil and grass." Nature 225: 295-296, 1970.

Chen, X., Xia, X., Zhao, Y., Zhang, P., "Heavy metal concentrations in roadside soils and correlation with urban traffic in Beijing, China." Journal of hazardous materials 181, no. 1: 640-646, 2010.

Christoforidis, A., Stamatis, N., "Heavy metal contamination in street dust and roadside soil along the major national road in Kavala's region, Greece." Geoderma 151, no. 3: 257-263, 2009.

Chen, T., Liu, X., Li, X., Zhao, K., Zhang, J., Xu, J., Shi, J., Dahlgren, RA., "Heavy metal sources identification and sampling uncertainty analysis in a field-scale vegetable soil of Hangzhou, China." Environmental Pollution 157, no. 3: 1003-1010, 2009.

Cicek, A., Koparal, AS., Aslan, A., Yazici, K., "Accumulation of heavy metals from motor vehicles in transplanted lichens in an urban area." Communications in soil science and plant analysis 39, no. 1-2: 168-176, 2007.

Cicek, N., Çakırlar, H., "Effects of salt stress on some physiological and photosynthetic parameters at three different temperatures in six soya bean (Glycine max L. Merr.) cultivars." Journal of Agronomy and Crop Science 194, no. 1: 34-46, 2008.

Chen, TB., Zheng, YM., Lei, M., Huang, ZC., Wu, HT., Chen, H., Fan, KK., Yu, K., Wu, X., Tian, QZ., "Assessment of heavy metal pollution in surface soils of urban parks in Beijing, China." Chemosphere 60, no. 4: 542-551, 2005.

Craul, PJ., "Urban soil in landscape design." John Wiley & Sons, New York. Craul, 1992.

Councell, TB., Duckenfield, KU., Landa, ER., Callender, E., "Tire-wear particles as a source of zinc to the environment." Environmental science and technology 38, no. 15: 4206-4214, 2004.

Celik, A., Kartal, AA., Akdoğan, A., Kaska, Y., "Determining the heavy metal pollution in Denizli (Turkey) by using Robinio pseudo-acacia L" Environment International 31, no. 1: 105-112,2005.

Duong, TT., Lee, BK., "Determining contamination level of heavy metals in road dust from busy traffic areas with different characteristics." Journal of Environmental Management 92, no. 3: 554-562, 2011.

Dan, B., Tankari, A., Rychen, G., Ducoulombier, CM., "Pollution maps of grass contamination by platinum group elements and polycyclic aromatic hydrocarbons from road traffic." Agronomy for sustainable development 28, no. 4: 457-464, 2008.

Danesino, C., "Environmental indicators for heavy metals pollution soils and higher plants." Sci Acta 3: 23-26, 2009 .

Dhundasi, SA., "Metal Toxicity A Least Explored Environmental Problem." Al Ameen Journal of Medical Sciences 1, no. 2: 1-1, 2009.

Dudka, S., "Factor analysis of total element concentrations in surface soils of Poland." Science of the total environment 121: 39-52, 1992.

Dao, L., Morrison, L., Zhang, C., "Spatial variation of urban soil geochemistry in a roadside sports ground in Galway, Ireland." Science of the total environment 408, no. 5: 1076-1084, 2010.

El-Desouki, HI., Mousqia, KF., Hassona, HH., "Impact of automobile exhaust on roadside soils and plants in Sharkiya Governorate [Egypt]." Egyptian Journal of Soil Science (Egypt) 38,no.1-4: 137-151, 1998.

Elnazer, AA., Salman, A., Seleem, EM., Ella, EMAE., "Assessment of Some Heavy Metals Pollution and Bioavailability in Roadside Soil of Alexandria-Marsa Matruh Highway, Egypt." International Journal of Ecology, 2015.

Folkeson, L., Bækken, T., Brenčič, M., Dawson, A., Frančois, D., Kuřímská, P., Leitão, T., Ličbinský, R., Vojtěšek, M., "Sources and fate of water contaminants in roads." In Water in Road Structures, pp. 107-146. Springer Netherlands, 2009.

Frieden, JA., Lake, DA., Lake, DA., "International political economy perspectives on global power and wealth." Routledge, 2002.

Fakayode, SO., Owolabi, BIO., "Heavy metal contamination of roadside topsoil in Osogbo, Nigeria Its relationship to traffic density and proximity to highways." Environmental Geology 44, no. 2: 150-157, 2003 .

Fergusson, JE., Kim, ND., "Trace elements in street and house dusts: sources and speciation." Science of the total Environment 100: 125-150, 1991.

Faiz, A., Weaver, CS., Walsh, MP., "Air pollution from motor vehicles standards and technologies for controlling emissions." World Bank Publications, 1996.

Faiz, Y., Tufail, M., Javed, MT., Chaudhry, MM., "Road dust pollution of Cd, Cu, Ni, Pb and Zn along Islamabad Expressway, Pakistan." Microchemical Journal 92, no. 2: 186-192, 2009.

Franco, U., Amaya, Mateo, CL., Roca, E., Marcos, MLF., "Source identification of heavy metals in pastureland by multivariate analysis in NW Spain." Journal of hazardous materials 165, no. 1: 1008-1015, 2009.

Gülser, F., Erdoğan, E., "The effects of heavy metal pollution on enzyme activities and basal soil respiration of roadside soils." Environmental monitoring and assessment 145, no. 1-3: 127-133, 2008.

Ghrefat, H., Yusuf, N., "Assessing Mn, Fe, Cu, Zn, and Cd pollution in bottom sediments of Wadi Al-Arab Dam, Jordan." Chemosphere 65, no. 11: 2114- 2121, 2006.

Garcia, R., Millan, E., "Assessment of Cd, Pb and Zn contamination in roadside soils and grasses from Gipuzkoa (Spain)." Chemosphere 37, no. 8: 1615-1625, 1998.

Granier, L., Chevreuil, M., "Automobile traffic a source of PCBs to the atmosphere." Chemosphere 23, no. 6: 785-788, 1991.

Google, E., Najeb, S., "Valuation of ambient air pollution a study of some urban areas in Sulaimanicity and its surrounding/ Kurdistan region of Iraq." University of Sulaimani, Faculty of Agriculture Sciences, 2011.

Gülçur, F., "Topragın Fiziksel ve Kimyasal Analiz Metodları, İstanbulÜniversitesi Orman Fakültesi Yayınları." İÜ Yayın No, OE Yayın No: 201, Kutulmuş Matbaası, İstanbul, 1970.

Gratani, L., Taglioni, S., Crescente, MF., "The accumulation of lead in agricultural soil and vegetation along a highway." Chemosphere 24, no. 7: 941-949, 1992.

Giannouli, M., Haan, Pd., Keller, M., Samaras, Z., "Waste from road transport development of a model to predict waste from end-of-life and operation phases of road vehicles in Europe." Journal of Cleaner Production 15, no. 11: 1169-1182, 2007.

Hjortenkrans, D., Bergbäck, B., Häggerud, A., "New metal emission patterns in road traffic environments." Environmental Monitoring and Assessment 117, no. 1-3: 85-98, 2006.

Hjortenkrans, DS., Bergbäck, BG., Häggerud, AV., "Metal emissions from brake linings and tires: case studies of Stockholm, Sweden 1995/1998 and 2005." Environmental Science & Technology 41, no. 15: 5224-5230, 2007.

Huber, M., Welker, A., Helmreich, B., "Critical review of heavy metal pollution of traffic area runoff Occurrence, influencing factors, and partitioning." Science of The Total Environment 54: 895-919, 2016.

Han, L., Zhuang, G., Cheng, S., Wang, Y., Juan, Li., "Characteristics of re-suspended road dust and its impact on the atmospheric environment in Beijing." Atmospheric Environment 41, no. 35: 7485-7499, 2007.

Harrison, RM., Laxen, DP., Wilson, SJ., "Chemical associations of lead, cadmium, copper, and zinc in street dusts and roadside soils." Environmental Science & Technology 15, no. 11: 1378-1383, 1981.

Hui, Z., Cui, B., Zhang, K., "The distribution of heavy metal in surface soils and their uptake by plants along roadside slopes in longitudinal range gorge region, China." Environmental Earth Sciences 61, no. 5: 1013-1023, 2010.

Harris, JA., Birch, P., Palmer, JP., "Land Restoration and Reclamation, Principles and Practice," Addison.Wesley Longman Ltd., Singapore, p.230, 1996.

Hassellöv, M., Kammer, FD., "Iron oxides as geochemical nanovectors for metal transport in soil-river systems." Elements 4, no. 6: 401-406, 2008.

Habeck, M., "Toxicological Profile for Manganese Agency for Toxic Substances and Disease Registry." United States Public Health Service, (1992) http://www. ecousa. net/toxics/chemicals/disclaimer. shtml, 2011.

Ibrahim, E., "Geoelectric resistivity survey for site investigation in east Matruh area, north western desert, Egypt." World Applied Sciences Journal 21, no. 7: 1008-1016, 2013.

Ikenaka, Y., Nakayama, SM., Muzandu, K., Choongo, K., Teraoka, H., Mizuno, N., Ishizuka, M., "Heavy metal contamination of soil and sediment in Zambia." African Journal of Environmental Science and Technology 4, no. 11: 729-739, 2010.

Jaradat, QM., Momani, KA., "Contamination of roadside soil, plants, and air with heavy metals in Jordan, a comparative study." Turkish Journal of Chemistry 23, no. 2: 209-220, 1999.

Jaradat, QM., Masadeh, A., Zaitoun, MA., Maitah, BM., "Heavy metal contamination of soil, plant and air of scrapyard of discarded vehicles at Zarqa City, Jordan." Soil & Sediment Contamination 14, no. 5: 449-462, 2005.

Jordan, RN., Yonge, DR., Hathhorn, WE., "Enhanced mobility of Pb in the presence of dissolved natural organic matter." Journal of Contaminant Hydrology 29, no. 1: 59-80, 1997.

Jintun, Z., Pouyat, R., "Effects of urbanization on the concentrations of heavy metals in deciduous forest floor in a case study of New York City." Scientia Silvae Sinicae 36, no. 4: 42-45, 2000.

Kummer, U., Pacyna, J., Pacyna, E., Friedrich, R., "Assessment of heavy metal releases from the use phase of road transport in Europe." Atmospheric Environment 43, no. 3: 640-647, 2009.

Khan, AB., Kathi, S., "Evaluation of heavy metal and total petroleum hydrocarbon contamination of roadside surface soil." International Journal of Environmental Science and Technology 11, no. 8: 2259-2270, 2014.

Kayhanian, M., Fruchtman, BD., Gulliver, JS., Montanaro, C., Ranieri, E., Wuertz, S., "Review of highway runoff characteristics Comparative analysis and universal implications." Water research 46, no. 20: 6609-6624, 2012.

Kelly, CJ., Connolly, PL., Bracken, JJ., "Maturity, oocyte dynamics and fecundity of the roundnose grenadier from the Rockall Trough." Journal of Fish Biology 49, no. sA: 5-17, 1996.

Kibria, MR., Jamalipour, A., "On designing issues of the next generation mobile network." IEEE Network 21, no. 1: 6-13, 2007.

Kantor, D., "Guillain-Barre Syndrome." The Medical Encyclopedia, National Library of Medicine and National Institute of Health,2006.

Kelly, J., Thornton, I., Simpson, PR., "Urban geochemistry a study of the influence of anthropogenic activity on the heavy metal content of soils in traditionally industrial and non-industrial areas of Britain." Applied geochemistry 11, no. 1: 363-370, 1996.

Kocher, B., Wessolek, G., Stoffregen, H., "Water and heavy metal transport in roadside soils." PEDOSPHERE 15, no. 6: 746-753, 2005.

Kluge, B., Wessolek, G., "Heavy metal pattern and solute concentration in soils along the oldest highway of the world–the AVUS Autobahn." Environmental Monitoring and Assessment 184, no. 11: 6469-6481, 2012.

Kabata P., Pendias, H., "Heavy metals could be absorbed in investigated samples by clay minerals, Fe-oxides and / or organic matter, 1986.

Kretzschmar, R., Sticher, H., "Transport of humic-coated iron oxide colloids in a sandy soil: Influence of Ca^{+2} and trace metals." Environmental Science & Technology 31, no. 12: 3497-3504, 1997.

Kabata, A., Pendias, H., "Trace elements in soils and plants." CRC, Washington, 2001.

Kaysi, I., Mahmassani, H., Kattan, L., "Phasing out lead in automotive fuels conversion considerations, policy formulation, and application to Lebanon." Transportation Research Part D: Transport and Environment 5, no. 6: 403-418, 2000.

Kadi, MW., "Soil Pollution Hazardous to Environment." A case study on the chemical composition and correlation to automobile traffic of the roadside soil of Jeddah city, Saudi Arabia. Journal of hazardous materials 168, no. 2: 1280-1283, 2009.

Lu, Y., Zhu, F., Chen, J., Gan, H., Guo, Y., "Chemical fraction of heavy metals in urban soils of Guangzhou, China." Environmental Monitoring and Assessment 134, no. 1-3: 429-439, 2007.

Liu, H., Chen, LP., Ai, YW., Yang, X., Yu, YH., Zu, YB., Fu, GY., "Heavy metal contamination in soil alongside mountain railway in Sichuan, China." Environmental Monitoring and Assessment 152, no. 1-4: 25-33, 2009.

Li, X., Poon, CS., Liu, PS., "Heavy metal contamination of urban soils and street dusts in Hong Kong." Applied geochemistry 16, no. 11: 1361-1368, 2001.

Lawal, AO., Idem, RO., "Effects of operating variables on the product distribution and reaction pathways in the oxidative degradation of CO2-loaded aqueous MEA-MDEA blends during CO2 absorption from flue gas streams." Industrial & engineering chemistry research 44, no. 4: 986-1003, 2005.

Lewis, RJ., "Hawley's Condensed Chemical Dictionary." CD-ROM. John Wiley & Sons, 2007.

Lonati, G., Giugliano, M., Cernuschi, S., "The role of traffic emissions from weekends' and weekdays' fine PM data in Milan." Atmospheric Environment 40, no. 31: 5998-6011, 2006.

Li, X., Lee, Sl., Wong, SC., Shi, W., Thornton, I., "The study of metal contamination in urban soils of Hong Kong using a GIS-based approach." Environmental Pollution 129, no. 1: 113-124, 2004.

Lu, X., Wang, L., Lei, K., Huang, J., Zhai, Y., "Contamination assessment of copper, lead, zinc, manganese and nickel in street dust of Baoji, NW China." Journal of hazardous materials 161, no. 2: 1058-1062, 2009.

Lindsay, WL., Norvell, WA., "Development of a DTPA soil test for zinc, iron, manganese, and copper." Soil science society of America journal 42, no. 3: 421-428, 1978.

Lee, KP., Yu, YH., Yun, ST., Mayer, B., "Metal contamination and solid phase partitioning of metals in urban roadside sediments." Chemosphere 60, no. 5: 672-689, 2005.

Lee, CS., Li, X., Shi, W., Cheung, SC., Thornton, I., "Metal contamination in urban, suburban, and country park soils of Hong Kong: a study based on GIS and multivariate statistics." Science of the Total Environment 356, no. 1: 45-61, 2006.

Mahaffey, KR., Annest, JL., Roberts, J., Murphy, R.S., "National estimates of blood lead levels: United States, 1976–1980 association with selected demographic and socioeconomic factors." New England Journal of Medicine 307, no. 10: 573-579, 1982.

Möller, A., Müller, HW., Abdullah, A., Abdelgawad, G., Utermann, J., "Urban soil pollution in Damascus, Syria concentrations and patterns of heavy metals in the soils of the Damascus Ghouta." Geoderma 124, no. 1: 63-71, 2005.

Modrzewska, B., Wyszkowski, M., "Trace metals content in soils along the state road 51 (northeastern Poland)." Environmental monitoring and assessment 186, no. 4: 2589-2597, 2014.

Motto, HL., Daines, RH., Chilko, DM., Motto, CK., "Lead in soils and plants: its relation to traffic volume and proximity to highways." Environmental Science & Technology 4, no. 3: 231-237, 1970.

Münch, D., "Concentration profiles of arsenic, cadmium, chromium, copper, lead, mercury, nickel, zinc, vanadium and polynuclear aromatic hydrocarbons (PAH) in forest soil beside an urban road." Science of the Total Environment 138, no. 1: 47-55, 1993.

Majid, SN., "Valuation of ambient air pollution" a study of some urban areas in Sulaimani city and its surrounding/Kurdistan Region of Iraq. A Dissertation Submitted to the Council of Agricultural Faculty/ Sulaimani University in partial fulfillment for the Degree of Doctor of Philosophy in Environmental Pollution (Air Pollution). Regional Government of Iraqi Kurdistan, 2011.

Markus, JA., Mcbratney, AB., "An urban soil study heavy metals in Glebe, Australia." Soil Research 34, no. 3: 453-465, 1996.

McCubbin, DR., Delucchi, MA., "The health costs of motor-vehicle-related air pollution." Journal of Transport Economics and Policy: 253-286, 1999.

Morton, BO., Álvarez, EH., Gaso, I., Segovia, N., "Heavy metal concentrations in surface soils from Mexico City." Bulletin of environmental contamination and toxicology 68, no. 3: 383-388, 2002.

Mohamed, AJJ., "Natural Resources and its Utilization for Agricultural development in Sulaimani Governorate." A Dissertation Submitted to the Council of Agriculture College/ Sulaimani University in partial fulfillment for the Degree of Doctor of Philosophy in Crop Science (Natural Resources). Regional Government of Iraqi Kurdistan, 2008.

Muhammad, Ak., "The ties between the Geomorphology of Sulaimani City and its Land using for Residential purposes." A thesis Submitted to the Council of Human Sciences College /Sulaimani University as partial fulfillment of masters Degree in geography. Regional Government of Iraqi Kurdistan. (In Kurdish Language), 2009.

Mushtaq, N., Khan, KS., "Heavy metals contamination of soils in response to wastewater irrigation in Rawalpindi region." Pak. J. Agri. Sci 47, no. 3: 215-224, 2010.

Manta, SD., Angelone, M., Bellanca, A., Neri, R., Sprovieri, M., "Heavy metals in urban soils: a case study from the city of Palermo (Sicily), Italy." Science of the Total Environment 300, no. 1: 229-243, 2002.

Morton, BO., Álvarez, EH., Hernández, GG., Romero, F., Lozano, RLE., Orosco, B., "Assessment of heavy metal pollution in urban topsoils from the metropolitan area of Mexico City." Journal of Geochemical Exploration 101, no. 3: 218-224, 2009.

Malkoc, S., Berna, Y., Koparal, AS., "Assessment of the levels of heavy metal pollution in roadside soils of Eskisehir, Turkey." Environmental Toxicology and Chemistry 29, no. 12: 2720-2725, 2010.

Nazzal, Y., Rosen, MA., Al-Rawabdeh, AM., "Assessment of metal pollution in urban road dusts from selected highways of the Greater Toronto Area in Canada." Environmental monitoring and assessment 185, no. 2: 1847-1858, 2013.

Nirjar, RS., Jain, SS., Parida, M., Sharma, N., RBET, RV., Mittal, N., "Development of transport related air pollutants modelling for an urban area." In Journal of the Indian Roads Congress, vol. 63, no. 2, 2002.

Nabulo, G., Origa, HO., Diamond, M., "Assessment of lead, cadmium, and zinc contamination of roadside soils, surface films, and vegetables in Kampala City, Uganda." Environmental Research 101, no. 1: 42-52, 2006.

Nagajyoti, PC., Lee, KD., Sreekanth, TVM., "Heavy metals, occurrence and toxicity for plants: a review." Environmental Chemistry Letters 8, no. 3: 199-216, 2010.

Nelson, DW., Sommers, LE., Sparks, DL., Page, AL., Helmke, PA., Loeppert, RH., Soltanpour PN., Tabatabai MA., Johnston CT., Sumne, MER., "Total carbon, organic carbon, and organic matter." Methods of soil analysis. Part 3-chemical methods . 961-1010, 1996.

Nriagu, JO., "The rise and fall of leaded gasoline." Science of the total environment 92: 13-28, 1990.

Onianwa, PC., Adoghe, JO., "Heavy-metal content of roadside dust gutter sediments in Ibadan, Nigeria." Environment international 23, no. 6: 873-877, 1997.

Olajire, AA., Ayodele, ET., "Contamination of roadside soil and grass with heavy metals." Environment International 23, no. 1: 91-101, 1997.

Olukanni, DO., Adebiyi, SA., "Assessment of vehicular pollution of road side soils in Ota Metropolis, Ogun State, Nigeria." International Journal of Civil & Environmental Engineering IJCEE-IJENS 12, no. 4: 40-46, 2012.

Ocak, S., Turalioglu, FS., "Effect of meteorology on the atmospheric concentrations of traffic-related pollutants in Erzurum, Turkey." J. Int. Environmental Application & Science 3, no. 5: 325-335, 2008.

Olsen, SR., Dean, LA., "Phosphorus. Ed.: CA Black. Method of Soil Analysis. Part 2. American Society of Agronomy." Inc. Publisher: Madison. Wisconsin. USA, 1965.

Olsen, Sterling, R., "Estimation of available phosphorus in soils by extraction with sodium bicarbonate.", 1954.

Okunola, OJ., Uzairu, A., Ndukwe, G., "Levels of trace metals in soil and vegetation along major and minor roads in metropolitan city of Kaduna, Nigeria." African journal of Biotechnology 6, no. 14, pp. 17031709, 2007.

Oliver, MA., "Soil and human health: a review." European Journal of Soil Science 48, no. 4: 573-592, 1997.

Official, GR., "Uredba o mejnih, opozorilnih in kriticnih imisijskih vrednostih nevarnih snove v tleh" No. 68/69: [online].Cited from Accessible on Internet:< http://www.uradni -list.si/1/ ulonline. jsp? urlid= 199668&dhid=34442, 21.9.2004.

Palmgren, F., Wåhlin, P., Kildesø, J., Afshari, A., Fogh, CL., "Characterisation of particle emissions from the driving car fleet and the contribution to ambient and indoor particle concentrations." Physics and Chemistry of the Earth, Parts A/B/C 28, no. 8: 327-33, 2003.

Panichayapichet, P., Nitisoravut, S., Simachaya, W., "Spatial distribution and transport of heavy metals in soil, ponded-surface water and grass in a Pb-contaminated watershed as related to land-use practices." Environmental monitoring and assessment 135, no. 1-3: 181-193, 2007.

Poszyler, AA., Czerniak, A., "Biological and chemical indication of roadside ecotone zones." Journal of Environmental Engineering and Landscape Management 15, no. 2: 113-118, 2007.

Pimentel, D., Cooperstein, S., Randell, H., Filiberto, D., Sorrentino, S., Nicklin, KBC., "Ecology of increasing diseases: population growth and environmental degradation." Human Ecology 35, no. 6: 653-668, 2007.

Plesničar, A., Zupančič, N., "Heavy metal contamination of roadside soil along Ljubljana–Obrežje highway Onesnaženje tal s težkimi kovinami vzdolž avtoceste Ljubljana–Obrežje." RMZ-Materials and Geoenvironment 52, no. 2: 403-418, 2005.

Ravindra, K., Bencs, L., Grieken, RV., "Platinum group elements in the environment and their health risk." Science of the Total Environment 318, no. 1: 1-43, 2004.

Renge, VC., Khedkar, SV., Shraddha, VP., "Removal of heavy metals from wastewater using low cost adsorbents: a review." Siences Review Chemical Communications 2, no. 4, 2012.

Ramakrishna, DM., Thiruvenkatachari, V., "Environmental impact of chemical deicers–a review." Water, Air, and Soil Pollution 166, no. 1-4: 49-63, (2005).

Sezgin, NH., Ozcan, K., Demir, G., Nemlioglu, S., Bayat, C., "Determination of heavy metal concentrations in street dusts in Istanbul E-5 highway." Environment international 29, no. 7: 979-985, 2004.

Sutherland, RA., Tolosa, CA., "Multi-element analysis of road-deposited sediment in an urban drainage basin, Honolulu, Hawaii." Environmental pollution 110, no. 3: 483-495, 2000.

Saeedi, M., Hosseinzadeh, M., Jamshidi, A., Pajooheshfar, SP., "Assessment of heavy metals contamination and leaching characteristics in highway side soils, Iran." Environmental monitoring and assessment 151, no. 1-4: 231-241, 2009.

Simon, E., Vidic, A., Braun, M., Fábián, I., Tóthmérész, B., "Trace element concentrations in soils along urbanization gradients in the city of Wien, Austria." Environmental Science and Pollution Research 20, no. 2: 917-924, 2013.

Sripathy, L., Rao, P., Kumar, ANM., Yashwanth, S., Divya, JN., Sharada, KR., "Heavy metal contamination of soil due to vehicular traffic: a case study across Nelamangala-Dabaspet Segment of national highway." No. 4. Rasayan J. Chem. 8, no.2: 232 -236, 2015.

Suzuki, K., Yabuki, T., Ono, Y., "Roadside Rhododendron pulchrum leaves as bioindicators of heavy metal pollution in traffic areas of Okayama, Japan." Environmental monitoring and assessment 149, no. 1-4: 133-141, 2009.

Stone, B., "Effect of temperature and shaking rate on sodium bicarbonate soluble phosphorus." Canadian journal of soil science 51, no. 2: 312-313, 1971.

Shacklette, HT., Boerngen, JG., "Element concentrations in soils and other surficial materials of the conterminous United States." US Geological Survey Professional Paper. Vol. 1270, 105 p, 1984.

Shi, G., Chen, Z., Xu, S., Zhang, J., Wang, L, Chunjuan, B., Teng, J., "Potentially toxic metal contamination of urban soils and roadside dust in Shanghai, China." Environmental Pollution 156, no. 2: 251-260, 2008.

Trombulak, SC., Frissell, CA., "Review of ecological effects of roads on terrestrial and aquatic communities." Conservation biology 14, no. 1: 18-30, 2000.

Thorpe, A., Harrison, RM., "Sources and properties of non-exhaust particulate matter from road traffic: a review." Science of the total environment 400, no. 1: 270-282, 2008.

Treatment, WL., "Water Treatment Published by Lenntech." Rotterdamseweg, Netherlands, 2004.

Turer, DG., Maynard, BJ., "Heavy metal contamination in highway soils. Comparison of Corpus Christi, Texas and Cincinnati, Ohio shows organic matter is key to mobility." Clean Technologies and Environmental Policy 4, no. 4: 235-245, 2003.

UNEP G., (United Nations Environmental Protection/Global Program of Action)., "Why the marine environment needs protection from heavy metals." heavy metals 2004, UNEP/GPA Coordination Office, 2004.

Viard, B., Pihan, F., Promeyrat, S., Pihan, JC., "Integrated assessment of heavy metal (Pb, Zn, Cd) highway pollution: bioaccumulation in soil, Graminaceae and land snails." Chemosphere 55, no. 10: 1349-1359, 2004.

Wei, X., Gao, B., Wang, P., Zhou, H., Lu, J., "Pollution characteristics and health risk assessment of heavy metals in street dusts from different functional areas in Beijing, China." Ecotoxicology and environmental safety 112: 186-192, 2015.

Wu, S., Peng, S., Zhang, X., Wu, D., Luo, W., Zhang, T., Zhou, S., Yang, G., Wan, H., Wu, L., "Levels and health risk assessments of heavy metals in urban soils in Dongguan, China." Journal of Geochemical Exploration 148: 71-78, 2015.

Wiseman, CL., Zereini, F., Püttmann, W., "Traffic-related trace element fate and uptake by plants cultivated in roadside soils in Toronto, Canada." Science of the Total Environment 442: 86-95, 2013.

Whiteley, JD., Murray, F., "Anthropogenic platinum group element (Pt, Pd and Rh) concentrations in road dusts and roadside soils from Perth, Western Australia." Science of the Total Environment 317, no. 1: 121-135, 2003.

Wichmann, H., Anquandah, GA., Schmidt, C., Zachmann, D., Bahadir, M A., "Increase of platinum group element concentrations in soils and airborne dust in an urban area in Germany." Science of the Total Environment 388, no. 1: 121-127, 2007.

Winther, M., Slentø, E., "Heavy metal emissions for Danish road transport." National Environmental Research Institute, Aarhus University, 2010.

Werkenthin, M., Kluge, B., Wessolek, G., "Metals in European roadside soils and soil solution–A review." Environmental Pollution 189: 98-110, 2014.

Wheeler, GL., Rolfe GL., "The relationship between daily traffic volume and the distribution of lead in roadside soil and vegetation." Environmental Pollution (1970) 18, no. 4: 265-274, 1979.

Ward, NI., Brooks, RR., Roberts, E., Boswell, CR., "Heavy-metal pollution from automotive emissions and its effect on roadside soils and pasture species in New Zealand." Environmental Science & Technology 11, no. 9: 917-920, 1977.

Wei, B., Yang, L., "A review of heavy metal contaminations in urban soils, urban road dusts and agricultural soils from China." Microchemical Journal 94, no. 2: 99-107, 2010.

Wilcke, W., Müller, S., Kanchanakool, N., Zech, W., "Urban soil contamination in Bangkok: heavy metal and aluminium partitioning in topsoils." Geoderma 86, no. 3: 211-228, 1998.

World, HO., (1993)., Guidelines for drinking water quality recommendations. 2nd Ed.Geneva. WHO, Geneva., "Guidelines for drinking-water quality." World Health Organization 216: 303-4, 2011.

Yu, H., Ni, SJ., He, ZW., Zhang, CJ., Nan, X., Kong, B., Weng, ZY., "Analysis of the spatial relationship between heavy metals in soil and human activities based on landscape geochemical interpretation." Journal of Geochemical Exploration 146: 136-148, 2014.

Yahaya, MI., Ezeh, GC., Musa, YF., Mohammad, SY., "Analysis of heavy metals concentration in road sides soil in Yauri, Nigeria." African Journal of Pure and Applied Chemistry 4, no. 3: 022-030, 2010.

Yang, Y., Campbel, CD., Clark, L., Cameron, CM., Paterson, E., "Microbial indicators of heavy metal contamination in urban and rural soils." Chemosphere 63, no. 11: 1942-1952, 2006.

Zhao, H., Cui, B., Zhang, K., "The distribution of heavy metal in surface soils and their uptake by plants along roadside slopes in longitudinal range gorge region, China." Environmental Earth Sciences 61, no. 5: 1013-1023, 2010.

Zereini, F., Alt, F., "Palladium emissions in the environment." Analytical methods, environmental assessment and health effects, Springer, Berlin, Heidelberg. ISBN: 978-3-540- 29219-7; E-ISBN: 978-3-540-29220-3, 2006.

Zevenhoven, R., Kilpinen, P., "Control of pollutants in flue gases and fuel gases." Espoo, Finland: Helsinki University of Technology, 2001.

Zhang, F., Yan, X., Zeng, C., Zhang, M., Shrestha, S., Devkota, LP., Yao, T., "Influence of traffic activity on heavy metal concentrations of roadside farmland soil in mountainous areas." International journal of environmental research and public health 9, no. 5: 1715-1731, 2012.

Zhongren, N., Wenqing, X., Chuanyan, Z., "Spatial distribution of selected trace metals in urban soils of Lanzhou city, Gansu province, Northwestern of China." In 2006 IEEE International Symposium on Geoscience and Remote Sensing, pp. 3397-3400. IEEE, 2006.

CURRICULUM VITAE

Personal Identity

Name, Surname : Dler Mustafa Mohammad
Nationality : Iraqi
Date and place of birth : 01 Jul, 1954 Sulaymaniyah, Iraq
Marital Status : Married
Telephone : (+90) 536 600 37 33 - (+964)770 105 34 12
E-mail : dlermustafa28@yahoo.com

Educational Background

Degree	Place of Education	Date of Graduate
Bachelor's Degree	Sulaimani University College of Agriculture Department of Soil and Water	1978

Work Experience Year	Place	Position
1981-2009	Ministry of Agriculture	Engineer
2009-2015	Agriculture Technical Institute of Bakrajo	Engineer

Language Skills

Language	Reading	writing	speaking
Kurdish (Mother language)	Excellent	Excellent	Excellent
Arabic	Excellent	Excellent	Excellent
English	Very good	good	Good
Turkish	Minor	Minor	Minor