Yarmouk University

Faculty of Science / Chemistry Department

Relationship Between Air Mass Back Trajectories and Levels Of Pollutants In The Fine Particle Fraction In Ajlune Air, Jordan

By:
Manal Husni Tashtoush

Supervised By:
Prof. Dr. Idrees F. Al-Momani

May 2, 2012
Relationship between Air Mass Back Trajectories and Levels of pollutants in the fine particle fraction in Ajlune Air, Jordan

By:

Manal Husni Tashtoush

Thesis submitted in partial Fulfillment of the requirements for the Master Degree of Science in the department of Chemistry, Yarmouk University, Irbid, Jordan

Approved by:

Prof. Dr. Idrees Al-Momani (Chairman)
Professor of analytical chemistry, Yarmouk University

Dr. Mufeed Awawdeh (Member)
Assistant Professor of Environmental Science, Yarmouk University

Dr. Safwan Obaidat (Member)
Assistant Professor of analytical chemistry, Yarmouk University
Dedication

This Work Is Dedicated To My Mother, Father, Brothers And Sisters.

To Whom I Love

Manal
ACKNOWLEDGEMENTS

It is an honor to express my deep appreciation and heartfelt thanks to many people who has facilitated my work on this dissertation.

First of all, I am extremely grateful to my supervisor Prof. Idrees Al-Momani who spared no efforts in encouraging and supporting me to develop this work.

I would like to thank him for his thoughtful remarks and constant guidance throughout the work on this study.

I would like to offer my thanks and gratitude to the members of the discussion committee Dr. Safwan Obeidat and Dr. Mufeed Awawdeh

I wish to acknowledge the help of my colleagues especially Nora Maghirea, Asalaa and Majida al-omari.

Finally, I would like to offer great thanks to my parents for their encouragement, patience and support.

Manal
LIST OF CONTENTS

Dedication ................................................................. iii
Acknowledgements ................................................... iv
List of contents ........................................................... v
List of tables ............................................................... ix
Lists of figures ............................................................ x
Abstract ................................................................. xiv
Chapter One

Introduction

1.1. Air pollution .............................................................. 1
1.2. Classification of pollutants ........................................ 2
1.3. Particulate Matter ....................................................... 3
1.4. Long range transport of pollutants ............................... 5
1.5. Definition of Heavy metals ......................................... 6
1.6. Biochemical proprieties of trace elements ...................... 7
   1.6.1. Essential Trace Elements .................................... 7
   1.6.2. Non-Essential Trace Elements ............................... 7
   1.6.3. Toxic Elements ................................................ 8
1.7. Sources of heavy metals ............................................. 9
   1.7.1. Natural Sources ............................................... 9
   1.7.2. Anthropogenic Sources .................................... 9
1.8. Analytical Technique for Atmospheric Trace Elements ...... 9
1.9. Back Trajectory ....................................................... 11
1.10. Potential Source Contribution Function ......................... 12
1.11. Literature Review .................................................. 13
1.12. Objectives ........................................................... 18
Chapter Two

Experimental Part

2.1. Sampling Site ...................................................... 19

2.2. Sample Collection .................................................. 19

2.3. Sample Preparation ................................................. 22

2.3.1 Reagents and Solutions......................................... 22

2.3.2. Instrumental and equipments................................. 23

2.3.3. Preparation of samples for heavy metals analysis..... 23

2.4. Elemental Analysis by ICP-OES................................. 24

2.5. Quality Control and quality Assurance of the measurement. 25

2.5.1. Blank measurement.............................................. 25

2.5.2 Accuracy of measurement ....................................... 25

2.6. Back Trajectory .................................................... 26
Chapter Three

Result and Discussion

3.1. Ambient concentration of elements in Ajlune Atmosphere.. 32
3.2. Metal distribution in different size fractions ............... 35
3.3. Comparison of trace metal concentration with literature data .................................................... 40
3.4. Seasonal variation of elements ........................................ 43
3.5. Enrichment factors of elements ....................................... 47
3.6. Potential source contribution function .......................... 58
3.7. Factor analysis .............................................................. 66

Chapter Four

Conclusion and recommendation

4.1. Conclusion ................................................................. 72
4.2. Recommendation ....................................................... 75
References ................................................................. 76
List of Tables

Table 2.1: The standard operational conditions of the ICP-OES… 24

Table 2.2: Measurements wavelength, Average blank, limit of detection and sample-to-sample ratio for measured elements …… 29

Table 2.3: Accuracy checked by standard reference material……… 30

Table 2.4: Model parameter used for all samples………………… 31

Table 3.1: Statistical summary for the measured elements in ultra-fine fraction of aerosol samples (ng/m$^3$).…………………………… 33

Table 3.2: Statistical summary for the measured elements in fine fraction of aerosol samples (ng/m$^3$) ………………………. 34

Table 3.3: Comparison with Literature…………………………… 42

Table 3.4: Statistical summary (Average and standard deviation) for all fractions ……………………………………………………………… 46

Table 3.5: Varimax rotated matrix with 5 factors ……………... 69
List of Figures

Figure 1.1: Typical dose-response curve for essential trace elements (a) and non-essential and toxic trace elements (b) ................................................................. 8

Figure 1.2: A typical Inductively Coupled Plasma layout .................. 10

Figure 2.1: A map for sampling site ........................................... 20

Figure 2.2: Picture of used High-Volume Sampler a: Mass Flow controlled TSP High Volume Air Sampler b: the sample holder c: High Volume Cascade Impactor ................................. 21

Figure 2.3: Calibration curves for some measured elements by ICP-OES ................................................................. 28

Figure 3.1: Percentage of elements in Coarse, Fine and Ultra-fine Fractions ................................................................. 38

Figure 3.2: Ultrafine to fine ratio for all elements ......................... 39

Figure 3.3: Winter-to-summer ratio for Coarse, Fine and Ultra-fine Fractions ................................................................. 45

Figure 3.4: Enrichment factor of the elements in the ultra-fine fraction ........................................................................... 51

Figure 3.5: Winter-to-summer Enrichment factor ratio of measured elements ................................................................. 52

Figure 3.6: HYSPLIT 120 hr- Back trajectory for sample 52, 9 March 2008 ................................................................. 53

Figure 3.7: HYSPLIT 120 hr- Back trajectory for sample 53, 25 54
March 2008 ……………………………………………………………..

Figure 3.8: HYSPLIT 120 hr- Back trajectory for sample 25, 12 55

August 2008 …………………………………………………………….

Figure 3.9: HYSPLIT 120 hr- Back trajectory for sample 37, 11 56

November 2008 ………………………………………………………

Figure 3.10: Annual wind rose of Jordan (USAID and water 57
authority of Jordan (2005) ………………………………………..

Figure 3.11: PSCF of Al based on 120 hr back trajectory 61
(h=500m) ……………………………………………………………

Figure 3.12: PSCF of Co based on 120 hr back trajectory 62
(h=500m) ……………………………………………………………

Figure 3.13: PSCF of Fe based on 120 hr back trajectory 62
(h=500m) ……………………………………………………………

Figure 3.14: PSCF of Ca based on 120 hr back trajectory 63
(h=500m) ……………………………………………………………

Figure 3.15: PSCF of K based on 120 hr back trajectory 63
(h=500m) ……………………………………………………………

Figure 3.16: PSCF of Na based on 120 hr back trajectory 64
(h=500m) ……………………………………………………………

Figure 3.17: PSCF of Hg based on 120 hr back trajectory 64
(h=500m) ……………………………………………………………

Figure 3.18: PSCF of Cr based on 120 hr back trajectory 65
(h=500m) ……………………………………………………………
Figure 3.19: PSCF of Cd based on 120 hr back trajectory (h=500m) ……………………………………………………………………….

Figure 3.20: PSCF of Zn based on 120 hr back trajectory (h=500m) ……………………………………………………………………….