CONCLUSIONS AND RECOMMENDATIONS

Conclusions:

The following conclusions have been drawn after doing chemical analysis, statistical analysis and geochemical analysis of the soil and plant samples collected:

1) The investigation of roadside and agricultural soil of Rohtak, Jhajjar and Faridabad cities indicated that the concentrations of Cu, Zn, Ni, Cd and Pb don’t exceed the calculated average mean for the world scale of unpolluted soil.

2) Pb followed by Cd was the most serious deposited heavy metals in the study area. Significant to extremely high values of contamination factors were recorded confirming an important role of anthropogenic pollution in the soil of the study area.

3) The distribution of the metal concentration of the roadside soil indicated that the traffic were mainly responsible for metal pollution. This form of pollution is attributed to emissions from motor vehicles. The amount of Pb deposited along the roads was variable, being dependent on factors such as traffic volume and distance from the road.

4) Mobility of heavy metals is mainly influenced by the soil properties such as pH, organic matter, ionic strength, cation exchange capacity, texture, temperature, addition of fertilizers, ligands, herbicides, organic pollutants, microbes and so on. The adverse effects of mobility are, they contaminate ground water and ultimately causes human health hazards. The heavy metals accumulated in soil transferred to food chain.

5) High concentration of metals in non-agricultural soil don’t affect human health directly as it could not enter the food chain but it can be transferred from non-agricultural soil to agricultural soil via water, airborne or soil erosion and then may enter in food chain which affect human health.

5) The presence of heavy metals in soils represents a significant environmental hazard, and one of the most difficult contamination problems to solve. There are two main reasons: firstly, the chemical character of heavy metals - they are not subjected to biodegradation processes, and keep on accumulating in the environment and secondly, the complexity of the soil matrix.
**Recommendations:**

1) Heavy metal pollution is a problem for cities. It has been found that the concentration of Pb in roadside soils is generally higher than that found in major urban areas. Consumption of Pb based gasoline and the higher overall traffic volume contributes to this trend. These data suggest the use of both electricity and alternative fuels like LPG (liquid petroleum gas) and CNG (compressed natural gas) to run vehicles which may decrease heavy metal pollution in urban areas.

2) In addition, with further demands on transport and lowering of permitted emission, automotive manufacturers and suppliers will continue to reduce emission from engines by cleaner combustion and by optimized catalyst systems.

3) It is clear that traffic plays the dominant role in metal pollution. Hyper accumulator plants which may extract excess amount of metals from the soil i.e. Phyto-remediation may be used for treatment of soil. Identification of plants which can accumulate more quantity of heavy metals in their tissues is the prime most important technique to clean the contaminated soil.

4) Bioremediation of soil may be done to remove heavy metals by growing microorganisms in the soil. However, the effectiveness of this process depends on several factors among which the most relevant are the types of contaminants and its concentration and the physiochemical, mineralogical and microbial characteristics of the host soil.
Summary

The work presented in this thesis is divided into six chapters.

CHAPTER 1: INTRODUCTION

This chapter deals with environmental pollution, different types of pollution and their harmful effects. It discusses about soil pollution, various pollutants responsible for soil pollution and their health hazard. It also discusses the term Heavy Metal and effect of heavy metal contamination of soil. It explains why heavy metals are more hazardous than any other pollutants.

A lot of work on soil pollution has been done in different countries. Review of this work is included under literature review. It also illuminates present work, its aim, objectives and further scope of work.

CHAPTER 2: METHODS AND MATERIALS

This chapter includes a brief description of Rohtak, Jhajjar and Faridabad districts which are selected to study heavy metal contamination of soil. It explains various methods used for sample collection, extraction and estimation of heavy metals from soil and plant samples. Heavy metals extracted by acid digestion method from soil and plants. Their quantity was estimated by Atomic absorption spectroscopy. This chapter gives details of principal, construction, working and conditions required for Atomic absorption spectrophotometer.

Some physicochemical properties of soil like conductance, TDS, pH and percentage of organic carbon were also measured. Details procedure and instrument used to determine these properties are also explained in this chapter.

CHAPTER 3: HEAVY METAL CONTAMINATION OF THE SOIL FROM ROHTAK

In this chapter physicochemical properties and heavy metal contamination of Rohtak soil was studied. In Rohtak two road of city selected to study contamination- Rohtak to Jind and Rohtak to Hisar road. Total 144 soil samples were collected from these two roads from four locations. Samples were collected from road soil and agricultural soil in consecutive two years 2013-2014 in the month of March, July and November. Grass samples were also collected from these locations. Different locations were designated as RR1, RR2, RR3, RR4,
RF1, RF2, RF3 and RF4. Concentration of Copper, Zinc, Cadmium, Lead and Nickel were determined in these samples.

In 2013 Average conductance of road side soil was measured as $0.59 \text{ mS cm}^{-1}$ having maximum value of $2.08 \text{ mS cm}^{-1}$ and minimum value of $0.18 \text{ mS cm}^{-1}$. TDS of the soil vary from maximum value of $1.35 \text{ ppt}$ to minimum value of $0.12 \text{ ppt}$ having average value of $0.38 \text{ ppt}$. pH of the soil vary between 8.15 to 6.05 with an average value of 7.28. Percentage organic carbon of soil lies between 0.25 % and 0.04 % with an average value of 0.14 %.

Conductance and TDS of road side soil were higher than agricultural soil. In agricultural soil average conductance was measured as $0.35 \text{ mS cm}^{-1}$ whereas maximum value was $0.75 \text{ mS cm}^{-1}$ and minimum value was $0.21 \text{ mS cm}^{-1}$. Average TDS of soil was 0.23 ppt having maximum value of 0.49 ppt and minimum value of 0.14 ppt. Agricultural soil was more basic than road side soil, maximum pH of soil was 8.51 and minimum was 6.82 with an average value of 7.59. Mean value of percentage organic carbon of soil was 1.89 % with maximum 3.37 % and minimum 0.24 %, it showed that agricultural land has more organic content.

In 2014 conductance of road side soil was in between $2.33 \text{ mS cm}^{-1}$ to $0.16 \text{ mS cm}^{-1}$ with an average value of $0.67 \text{ mS cm}^{-1}$. TDS of soil has maximum value of 1.52 ppt and minimum value of 0.10 with an average value of 0.44 ppt. pH has mean value of 7.22 with a maximum of 7.57 and minimum of 6.00. Percentage organic carbon has highest value 0.60 % and lowest value 0.10 % with a mean value of 0.24 %.

Conductance and TDS of this year were again higher for road side soil. Average conductance of agricultural soil was $0.48 \text{ mS cm}^{-1}$ with maximum value of $1.39 \text{ mS cm}^{-1}$ and minimum value of $0.23 \text{ mS cm}^{-1}$. TDS was measured in between 0.91 ppt to 0.15 ppt with average value of 0.31ppt. Average pH of soil was 7.73 having highest value 8.66 and lowest value 7.40. Agricultural soil was more alkaline than road side soil. Average percentage organic carbon was 1.58 % with maximum value of 2.60 % and minimum value of 0.61 %, it showed that agricultural land has higher organic content.

In 2013 average concentration of Copper in road side soil sample was 40.54 mg Kg$^{-1}$, maximum 78.02 mg Kg$^{-1}$ and minimum 23.05 mg Kg$^{-1}$. Average concentration of Zinc was 47.14 mg Kg$^{-1}$, maximum 78.46 mg Kg$^{-1}$ and minimum 19.15 mg Kg$^{-1}$. Average concentration of Cadmium was 1.20 mg Kg$^{-1}$, maximum 2.20 mg Kg$^{-1}$ and minimum 0.24 mg Kg$^{-1}$. Average concentration of Lead was 78.28 mg Kg$^{-1}$, maximum 121.61 mg Kg$^{-1}$ and
minimum 48.01 mg Kg$^{-1}$. Average concentration of Nickel was 42.25 mg Kg$^{-1}$, maximum 59.53 mg Kg$^{-1}$ and minimum 29.72 mg Kg$^{-1}$.

This year in agricultural soil concentration of copper vary from 36.60 mg Kg$^{-1}$ to 12.68 mg Kg$^{-1}$ with mean value of 22.53 mg Kg$^{-1}$; Zinc from 64.56 mg Kg$^{-1}$ to 14.55 mg Kg$^{-1}$ with mean value of 30.78 mg Kg$^{-1}$; Cadmium from 1.55 mg Kg$^{-1}$ to 0.36 mg Kg$^{-1}$ with mean value of 0.96 mg Kg$^{-1}$; Lead from 94.71 mg Kg$^{-1}$ to 24.48 mg Kg$^{-1}$ with mean value of 58.05 mg Kg$^{-1}$ and Nickel from 44.88 mg Kg$^{-1}$ to 20.50 mg Kg$^{-1}$ with mean value of 32.93 mg Kg$^{-1}$.

In 2014 average concentration of Copper in road side soil was measured 92.20 mg Kg$^{-1}$ having maximum value 115.70 mg Kg$^{-1}$ and minimum 69.10 mg Kg$^{-1}$. Concentration of Zinc was in between 137.47 mg Kg$^{-1}$ and 38.69 mg Kg$^{-1}$ with an average value of 84.39 mg Kg$^{-1}$. Cadmium has maximum value of 5.15 mg Kg$^{-1}$ and minimum value of 1.43 mg Kg$^{-1}$ with average concentration of 3.40 mg Kg$^{-1}$. Concentration of Lead varies from 293.07 mg Kg$^{-1}$ to 94.00 mg Kg$^{-1}$ with mean value of 147.01 mg Kg$^{-1}$. Nickel has maximum concentration of 63.07 mg Kg$^{-1}$ and minimum concentration of 36.48 mg Kg$^{-1}$ with mean value of 46.48 mg Kg$^{-1}$.

In agricultural soil concentration of copper vary from 95.43 mg Kg$^{-1}$ to 48.62 mg Kg$^{-1}$ with mean value of 73.50 mg Kg$^{-1}$; Zinc from 103.33 mg Kg$^{-1}$ to 17.03 mg Kg$^{-1}$ with mean value of 61.67 mg Kg$^{-1}$; Cadmium from 4.05 mg Kg$^{-1}$ to 0.87 mg Kg$^{-1}$ with mean value of 2.22 mg Kg$^{-1}$; Lead from 100.96 mg Kg$^{-1}$ to 55.16 mg Kg$^{-1}$ with mean value of 80.26 mg Kg$^{-1}$ and Nickel from 53.80 mg Kg$^{-1}$ to 25.35 mg Kg$^{-1}$ with mean value of 43.11 mg Kg$^{-1}$. Concentration of all these five metals was also determined in grass samples.

In statistical analysis Pearson’s correlation was studied between soil properties and metals concentration; Paired t test was applied between concentration of metals of 2013 and 2014 and two-way Anova with replication was studied for different metals. They give some significant relation between different metals and show their variation with soil properties, season and location.

In Geochemical Analysis, Geo accumulation index, Contamination Factor is used for assessment of soil quality. Potential ecological risk index was used to determine the overall contamination level of soil. It was assessed to know the toxic level of metal and response of environment. Transfer factor (TF) is determined to measure bioaccumulation of heavy metal in plants.
CHAPTER 4: HEAVY METAL CONTAMINATION OF THE SOIL FROM JHAJJAR

This chapter includes the study of heavy metal contamination of Jhajjar soil. Jhajjar to Gurgaon road was selected in Jhajjar city to study soil contamination. Total 108 soil samples were collected from three different locations. Samples were collected from road side soil and agricultural soil in consecutive two years 2013-2014 in the month of March, July and November. Grass samples were also collected to study effect on plants. Concentration of Copper, Zinc, Cadmium, Lead and Nickel were determined in these samples. Locations were designated as JR1, JR2, JR3, JF1, JF2 and JF3.

In 2013 Average conductance of road side soil was measured as 0.42 mS cm\(^{-1}\) having maximum value of 0.67 mS cm\(^{-1}\) and minimum value of 0.21 mS cm\(^{-1}\). TDS of the soil vary from maximum value of 0.44 ppt to minimum value of 0.14 ppt having average value of 0.27 ppt. pH of the soil vary between 8.29 to 6.75 with an average value of 7.54. Percentage organic carbon of soil lies between 0.79 % and 0.11 % with an average value of 0.29 %.

Conductance and TDS of road side soil were higher than agricultural soil. In agricultural soil average conductance was measured as 0.32 mS cm\(^{-1}\) whereas maximum value was 0.64 mS cm\(^{-1}\) and minimum value was 0.18 mS cm\(^{-1}\). Average TDS of soil was 0.21 ppt having maximum value of 0.42 ppt and minimum value of 0.12 ppt. Agricultural soil was less alkaline than road side soil, maximum pH of soil was 7.90 and minimum was 6.99 with an average value of 7.45. Mean value of percentage organic carbon of soil was 1.56 % with maximum 1.93 % and minimum 1.06 %, it showed that agricultural land has more organic content.

In 2014 conductance of road side soil was in between 0.75 mS cm\(^{-1}\) to 0.17 mS cm\(^{-1}\) with an average value of 0.39 mS cm\(^{-1}\). TDS of soil has maximum value of 0.49 ppt and minimum value of 0.11 with an average value of 0.26 ppt. pH has mean value of 7.46 with a maximum of 8.18 and minimum of 6.98. Percentage organic carbon has highest value 0.64 % and lowest value 0.12 % with a mean value of 0.44 %.

Conductance and TDS of this year were again higher for road side soil. Average conductance of agricultural soil was 0.38 mS cm\(^{-1}\) with maximum value of 0.83 mS cm\(^{-1}\) and minimum
value of 0.23 mS cm$^{-1}$. TDS was measured in between 0.55 ppt to 0.15 ppt with average value of 0.25 ppt. Average pH of soil was 7.52 having highest value 7.83 and lowest value 7.40. Agricultural soil was more alkaline than road side soil. Average percentage organic carbon was 1.93 % with maximum value of 2.49 % and minimum value of 1.38 %, it showed that agricultural land has higher organic content.

In 2013 average concentration of Copper in road side soil sample was 28.37 mg Kg$^{-1}$, maximum 40.21 mg Kg$^{-1}$ and minimum 20.70 mg Kg$^{-1}$. Average concentration of Zinc was 28.23 mg Kg$^{-1}$, maximum 40.54 mg Kg$^{-1}$ and minimum 16.93 mg Kg$^{-1}$. Average concentration of Cadmium was 0.82 mg Kg$^{-1}$, maximum 1.71 mg Kg$^{-1}$ and minimum 0.30 mg Kg$^{-1}$. Average concentration of Lead was 54.34 mg Kg$^{-1}$, maximum 75.25 mg Kg$^{-1}$ and minimum 37.01 mg Kg$^{-1}$. Average concentration of Nickel was 28.94 mg Kg$^{-1}$, maximum 37.55 mg Kg$^{-1}$ and minimum 15.59 mg Kg$^{-1}$.

This year in agricultural soil concentration of copper vary from 54.66 mg Kg$^{-1}$ to 17.00 mg Kg$^{-1}$ with mean value of 31.90 mg Kg$^{-1}$; Zinc from 37.03 mg Kg$^{-1}$ to 11.31 mg Kg$^{-1}$ with mean value of 20.70 mg Kg$^{-1}$; Cadmium from 0.94 mg Kg$^{-1}$ to 0.28 mg Kg$^{-1}$ with mean value of 0.58 mg Kg$^{-1}$; Lead from 74.11 mg Kg$^{-1}$ to 17.82 mg Kg$^{-1}$ with mean value of 47.70 mg Kg$^{-1}$ and Nickel from 31.90 mg Kg$^{-1}$ to 14.05 mg Kg$^{-1}$ with mean value of 22.88 mg Kg$^{-1}$.

In 2014 average concentration of Copper in road side soil was measured 60.45 mg Kg$^{-1}$ having maximum value 74.13 mg Kg$^{-1}$ and minimum 36.62 mg Kg$^{-1}$. Concentration of Zinc was in between 70.47 mg Kg$^{-1}$ and 31.55 mg Kg$^{-1}$ with an average value of 56.85 mg Kg$^{-1}$. Cadmium has maximum value of 4.08 mg Kg$^{-1}$ and minimum value of 0.89 mg Kg$^{-1}$ with average concentration of 2.09 mg Kg$^{-1}$. Concentration of Lead varies from 93.02 mg Kg$^{-1}$ to 65.43 mg Kg$^{-1}$ with mean value of 74.66 mg Kg$^{-1}$. Nickel has maximum concentration of 52.09 mg Kg$^{-1}$ and minimum concentration of 32.09 mg Kg$^{-1}$ with mean value of 42.31 mg Kg$^{-1}$.

This year in agricultural soil concentration of copper vary from 69.88 mg Kg$^{-1}$ to 31.73 mg Kg$^{-1}$ with mean value of 53.63 mg Kg$^{-1}$; Zinc from 71.93 mg Kg$^{-1}$ to 21.45 mg Kg$^{-1}$ with mean value of 46.72 mg Kg$^{-1}$; Cadmium from 2.94 mg Kg$^{-1}$ to 0.65 mg Kg$^{-1}$ with mean value of 1.68 mg Kg$^{-1}$; Lead from 93.25 mg Kg$^{-1}$ to 58.34 mg Kg$^{-1}$ with mean value of 72.29 mg Kg$^{-1}$ and Nickel from 52.87 mg Kg$^{-1}$ to 30.26 mg Kg$^{-1}$ with mean value of 40.07 mg Kg$^{-1}$. 
Pearson’s correlation, Paired t test and two-way Anova give some significant relation between different metals and show their variation with soil properties, season and location.

In geochemical analysis, Geo accumulation index ($I_{geo}$), Contamination Factor, Potential ecological risk index and Transfer factor were studied which help to determine the quality of soil.

**CHAPTER 5: HEAVY METAL CONTAMINATION OF THE SOIL FROM FARIDABAD**

This chapter deals with the study of heavy metal contamination of Faridabad soil. In Faridabad Mathura highway was selected to study contamination of soil. Total 108 soil samples were collected from three different locations. These locations were designated as FR1, FR2, FR3, FF1, FF2 and FF3. Samples were collected from road side soil and agricultural soil in consecutive two years 2013-2014 in the month of March, July and November. Grass samples were also collected to study contamination in plants. Concentration of Copper, Zinc, Cadmium, Lead and Nickel were determined in these samples.

In 2013 Average conductance of road side soil was measured as 0.52 mS cm$^{-1}$ having maximum value of 0.84 mS cm$^{-1}$ and minimum value of 0.25 mS cm$^{-1}$. TDS of the soil vary from maximum value of 0.55 ppt to minimum value of 0.16 ppt having average value of 0.34 ppt. pH of the soil vary between 8.14 to 6.96 with an average value of 7.47. Percentage organic carbon of soil lies between 0.22 % and 0.12 % with an average value of 0.17 %.

Conductance and TDS of road side soil were higher than agricultural soil. In agricultural soil average conductance was measured as 0.33 mS cm$^{-1}$ whereas maximum value was 0.47 mS cm$^{-1}$ and minimum value was 0.25 mS cm$^{-1}$. Average TDS of soil was 0.21 ppt having maximum value of 0.30 ppt and minimum value of 0.16 ppt. Agricultural soil was less basic than road side soil, maximum pH of soil was 7.50 and minimum was 7.10 with an average value of 7.27. Mean value of percentage organic carbon of soil was 1.49 % with maximum 2.26 % and minimum 0.73 %, it showed that agricultural land has more organic content.

In 2014 conductance of road side soil was in between 0.54 mS cm$^{-1}$ to 0.20 mS cm$^{-1}$ with an average value of 0.31 mS cm$^{-1}$. TDS of soil has maximum value of 0.35 ppt and minimum value of 0.13 with an average value of 0.20 ppt. pH has mean value of 7.08 with a maximum
of 7.46 and minimum of 6.51. Percentage organic carbon has highest value 0.37 % and lowest value 0.14 % with a mean value of 0.23 %.

Conductance and TDS of this year were again higher for road side soil. Average conductance of agricultural soil was 0.32 mS cm\(^{-1}\) with maximum value of 0.50 mS cm\(^{-1}\) and minimum value of 0.24 mS cm\(^{-1}\). TDS was measured in between 0.32 ppt to 0.15 ppt with average value of 0.21ppt. Average pH of soil was 7.24 having highest value 7.70 and lowest value 7.05. Agricultural soil was more alkaline than road side soil. Average percentage organic carbon was 1.13 % with maximum value of 2.29 % and minimum value of 0.51 %, it showed that agricultural land has higher organic content.

In 2013 average concentration of Copper in road side soil sample was 47.77 mg Kg\(^{-1}\), maximum 60.62 mg Kg\(^{-1}\) and minimum 34.30 mg Kg\(^{-1}\). Average concentration of Zinc was 64.67 mg Kg\(^{-1}\), maximum 78.21 mg Kg\(^{-1}\) and minimum 30.35 mg Kg\(^{-1}\). Average concentration of Cadmium was 1.86 mg Kg\(^{-1}\), maximum 4.68 mg Kg\(^{-1}\) and minimum 0.65 mg Kg\(^{-1}\). Average concentration of Lead was 100.42 mg Kg\(^{-1}\), maximum 154.37 mg Kg\(^{-1}\) and minimum 60.09 mg Kg\(^{-1}\). Average concentration of Nickel was 39.39 mg Kg\(^{-1}\), maximum 49.91 mg Kg\(^{-1}\) and minimum 27.65 mg Kg\(^{-1}\).

In 2014 average concentration of Copper in road side soil was measured 99.66 mg Kg\(^{-1}\) having maximum value 120.83 mg Kg\(^{-1}\) and minimum 62.75 mg Kg\(^{-1}\). Concentration of Zinc was in between 166.57 mg Kg\(^{-1}\) and 55.82 mg Kg\(^{-1}\) with an average value of 129.18 mg Kg\(^{-1}\). Cadmium has maximum value of 5.74 mg Kg\(^{-1}\) and minimum value of 2.69 mg Kg\(^{-1}\) with average concentration of 4.07 mg Kg\(^{-1}\). Concentration of Lead varies from 198.23 mg Kg\(^{-1}\) to 134.96 mg Kg\(^{-1}\) with mean value of 165.02 mg Kg\(^{-1}\). Nickel has maximum concentration of 68.05 mg Kg\(^{-1}\) and minimum concentration of 45.06 mg Kg\(^{-1}\) with mean value of 54.80 mg Kg\(^{-1}\).

This year in agricultural soil concentration of copper vary from 63.69 mg Kg\(^{-1}\) to 22.76 mg Kg\(^{-1}\) with mean value of 36.02 mg Kg\(^{-1}\); Zinc from 61.87 mg Kg\(^{-1}\) to 21.72 mg Kg\(^{-1}\) with mean value of 44.70 mg Kg\(^{-1}\); Cadmium from 2.83 mg Kg\(^{-1}\) to 0.53 mg Kg\(^{-1}\) with mean value of 1.04 mg Kg\(^{-1}\); Lead from 116.15 mg Kg\(^{-1}\) to 23.42 mg Kg\(^{-1}\) with mean value of 54.92 mg Kg\(^{-1}\) and Nickel from 64.76 mg Kg\(^{-1}\) to 23.65 mg Kg\(^{-1}\) with mean value of 37.52 mg Kg\(^{-1}\).

In 2014 average concentration of Copper in road side soil was measured 99.66 mg Kg\(^{-1}\) having maximum value 120.83 mg Kg\(^{-1}\) and minimum 62.75 mg Kg\(^{-1}\). Concentration of Zinc was in between 166.57 mg Kg\(^{-1}\) and 55.82 mg Kg\(^{-1}\) with an average value of 129.18 mg Kg\(^{-1}\). Cadmium has maximum value of 5.74 mg Kg\(^{-1}\) and minimum value of 2.69 mg Kg\(^{-1}\) with average concentration of 4.07 mg Kg\(^{-1}\). Concentration of Lead varies from 198.23 mg Kg\(^{-1}\) to 134.96 mg Kg\(^{-1}\) with mean value of 165.02 mg Kg\(^{-1}\). Nickel has maximum concentration of 68.05 mg Kg\(^{-1}\) and minimum concentration of 45.06 mg Kg\(^{-1}\) with mean value of 54.80 mg Kg\(^{-1}\). This year in agricultural soil concentration of copper vary from 129.77 mg Kg\(^{-1}\) to 37.91 mg Kg\(^{-1}\) with mean value of 64.42 mg Kg\(^{-1}\); Zinc from 155.14 mg Kg\(^{-1}\) to 19.36 mg Kg\(^{-1}\) with
mean value of 71.58 mg Kg\(^{-1}\); Cadmium from 4.68 mg Kg\(^{-1}\) to 1.15 mg Kg\(^{-1}\) with mean value of 2.51 mg Kg\(^{-1}\); Lead from 200.23 mg Kg\(^{-1}\) to 47.16 mg Kg\(^{-1}\) with mean value of 99.00 mg Kg\(^{-1}\) and Nickel from 65.39 mg Kg\(^{-1}\) to 26.96 mg Kg\(^{-1}\) with mean value of 41.14 mg Kg\(^{-1}\).

Pearson’s correlation, Paired t test and two-way Anova give some significant relation between different metals and show their variation with soil properties, season and location.

In geochemical analysis, Geo accumulation index (I_{geo}), Contamination Factor, Potential ecological risk index and Transfer factor were studied which help to determine the quality of soil.

**CHAPTER 6: COMPARATIVE STUDY OF CONTAMINATION OF SOIL AND PLANTS**

In this chapter result of three districts was compared to know the highly contaminated city among the three. Descriptive, statistical and geochemical studies were compared.
LIST OF PUBLICATIONS
List of publications


