

**JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)  
MINISTRY OF AGRICULTURE FORESTRY AND WATER ECONOMY (MAFWE)  
THE FORMER YUGOSLAV REPUBLIC OF MACEDONIA**

**THE STUDY ON CAPACITY DEVELOPMENT  
FOR SOIL CONTAMINATION MANAGEMENT  
RELATED TO MINING  
IN THE FORMER YUGOSLAV REPUBLIC OF  
MACEDONIA**

**FINAL REPORT  
VOLUME III  
APPENDICES**

**MARCH 2008**

**MITSUBISHI MATERIALS NATURAL RESOURCES  
DEVELOPMENT CORPORATION**

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## **FORMATION OF THE FINAL REPORT**

The Final Report is comprised of the following volumes:

Volume I	:	SUMMARY
Volume II	:	MAIN REPORT
Volume III	:	APPENDICES
Volume IV	:	DATA REPORT
Volume V	:	ACTION PLAN OF RISK MITIGATION FOR SOIL CONTAMINATION IN THE PILOT PROJECT AREA
Volume VI	:	SUMMARY (in Japanese)

Volume I, SUMMARY, contains background information of the study, brief information of the Pilot Project and summary of the Master Plan for soil contamination management related to mining in Macedonia.

Volume II, MAIN REPORT, contains information of the overall study and its results; that is the background information of this study, results of the Pilot Project and the Master Plan for soil contamination management related to mining in Macedonia.

Volume III, APPENDICES, contains figures related to the main report and some explanation materials.

Volume IV, DATA REPORT, contains various material supporting the report, such as sampling methods, methods of chemical analysis, descriptions of soil and drilling core, results of chemical analysis, calculation and distribution of environmental risk in the Pilot Project Area and minute of the steering and technical committees and working groups.

Volume V, ACTION PLAN OF RISK MITIGATION FOR SOIL CONTAMINATION IN THE PILOT PROJECT AREA, contains the action plan for the soil contamination in the Pilot Project Area.

Volume VI, Summary in Japanese



# **Appendices**

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**Appendix 2: Histogram and Cumulative Frequency  
Curve of 400m Grid Samples**

**Appendix 3: Distribution of Heavy Metal Concentration  
of 400m Grid Survey**

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of 400m to 50m Grids Surveys**

**Appendix 5: Distribution of Elution Concentration of  
Surface Soil**

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**Appendix 7: Vertical Chemical Variation along the  
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**Appendix 8: Vertical Chemical Variation of Drill Hole**

**Appendix 9: Results of Monitoring Bore Holes**

**Appendix 10: Cross Sections of Groundwater Profile**

**Appendix 11: Sample List of Additional Groundwater  
Survey**

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**Appendix 15: Soil Contamination Survey Method**



# **Appendix 1**

## **Laboratory of Chemical Analysis**



Laboratory name	St. Cyril and Methodius University Faculty of Mining and Geology-Stip	MEPP Central laboratory	St. Cyril and Methodius University Institute of Agriculture
Address Tel Fax E-mail:	Goce Delcev 89, Stip, Republic of Macedonia Tel: Fax: E-mail:	16ta Makedonska Brigada br 18, Skopje Republic of Macedonia Tel: +389 2 3287904 Fax: +389 2 3287904 malkovlab@yahoo.com	Bulevar "Aleksandar Makedonski" bb Tel: +389 2 3230-910 Fax: +389 2 3114-283 s.bandzo@zeminst.edu.mk
Manager	Prof. Blazo Boev	Katica Vasilevska	Julijana Cvetkovic
Establishment	1977	1980	1927
Whole staff Num.	45	25	130
Num of the analysis engineers	5	17	7
Num of soil analysis engineers	2	2	2
Possession analytical instrument	-Inductively Coupled Plasma : 1 -Absorption Spectrophotometer : 2 -Flame Photometric Detector : 1	- Inductively Coupled Plasma : 1 - Atomic Absorption Spectrometric : 3 - Mass Spectrometry : 1 -Gas Chromatograph - Mass Spectrometry : 1 - Absorption Spectrophotometer : 2 - HPLC : 1 - TOC : 1	-Atomic Absorption Spectrometric : 1 - Gas Chromatograph : 1 - Gas Chromatograph - Mass Spectrometry : 1 - Absorption Spectrophotometer : 1 -Flame Photometric Detector : 1
Standard sample			
Pure water production device			

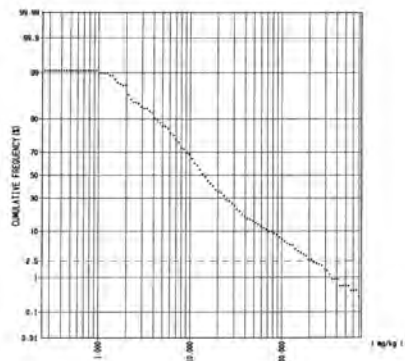
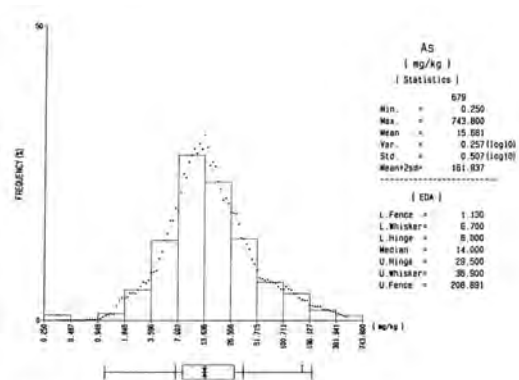
Laboratory name	Republic Institute for Health Protection	St. Cyril and Methodius University Faculty of Veterinary Medicine	St. Cyril and Methodius University Faculty of Technology and Metallurgy
Address	50 <sup>th</sup> Divizija br. 6 Skopje	Lazar Pop-Trajkov 5-7 Skopje	Ruger Boskovich 16 1000 Skopje
Tel	Tel: +389 2 3125-044	Tel: +389 2 3115-125	Republic of Macedonia
Fax	Fax: +389 2 3223-354	Fax: +389 2 3114-619	phone: + 389 2 3063 167
E-mail:	Blagoja_al@yahoo.com	dekanfvm@fvm.ukim.edu.mk	fax: + 389 2 3064 389
Manager	Dr. Vlado Spirkovski	Pavle Sekulovski	info@ian.tmf.ukim.edu.mk
Establishment	1924	1927	Prof. Todor Anovski
Whole staff Num.	160	98	1958
Num of the analysis engineers	70	9	98
Num of soil analysis engineers	7	4	20
Possession analyzer	-Atomic Absorption Spectrometric : 3 - Ion chromatograph : 1	-Atomic Absorption Spectrometric : 3 -Gas Chromatograph : 1 -Gas Chromatograph - Mass Spectrometry : 2 - High Performance Liquid Chromatography : 1 -Absorption Spectrophotometer : 1	- EAAS : 2 - Mass Spectrometry : 1 - Absorption Spectrophotometer: 4 -High Performance Liquid Chromatography : 1 - TOC : 1 - Flame Photometric Detector : 1
Standard sample			
Pure water production device			

## **Appendix 2**

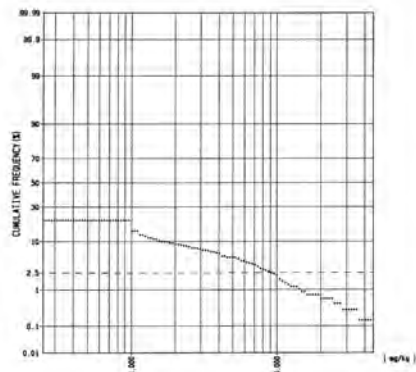
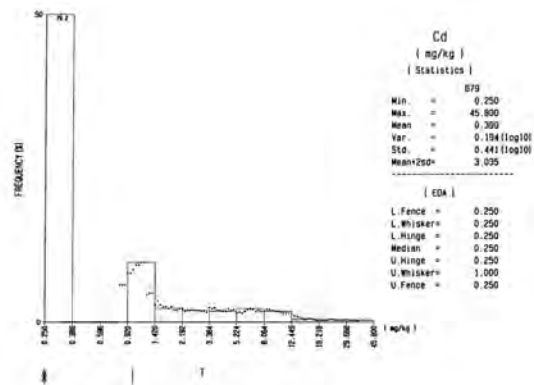
### **Histogram and Cumulative Frequency Curve of 400m Grid Samples**



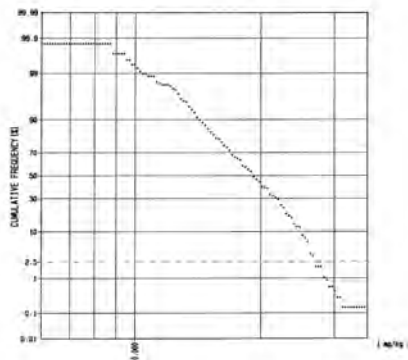
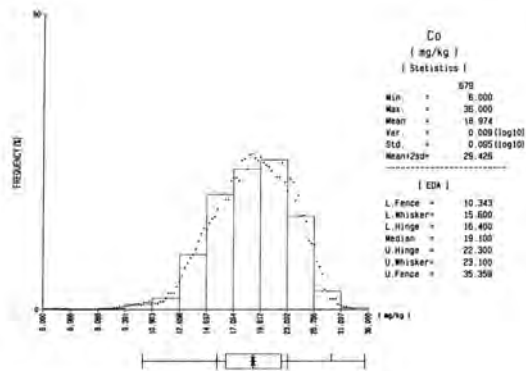
As



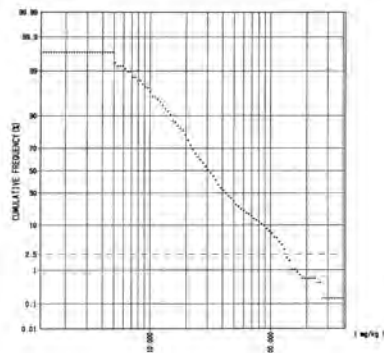
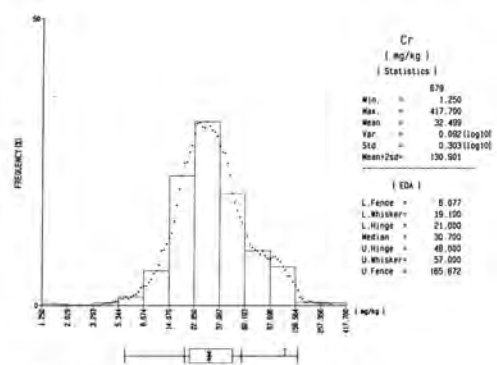
Cd



Co

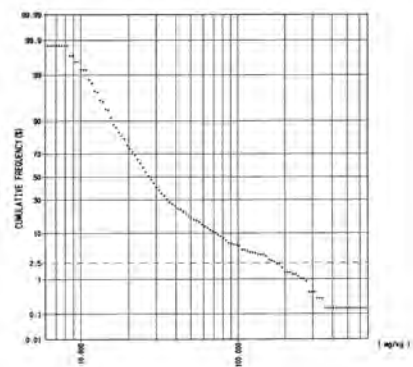
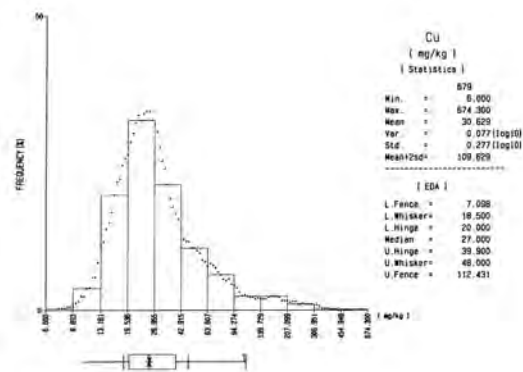


Cr

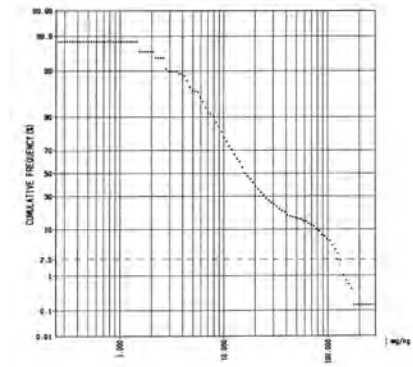
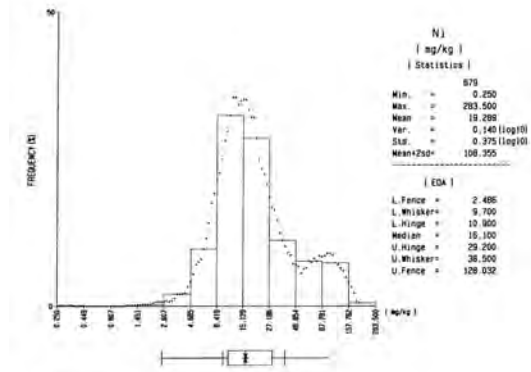


Histogram and Cumulative Frequency Curve of 400m Grid Samples (1)

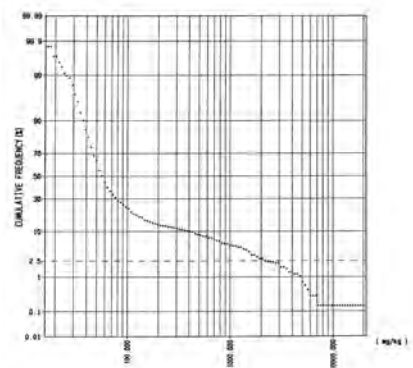
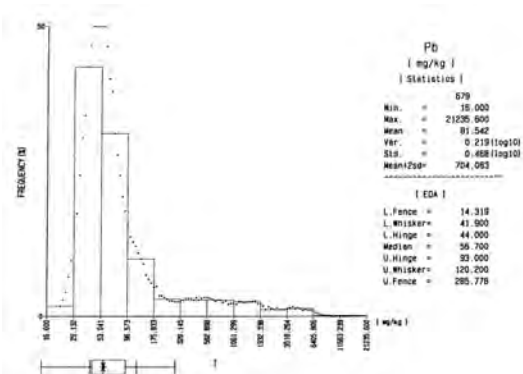
Cu



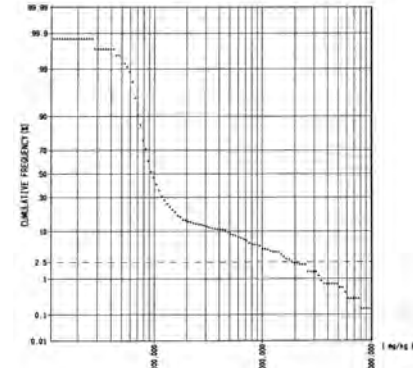
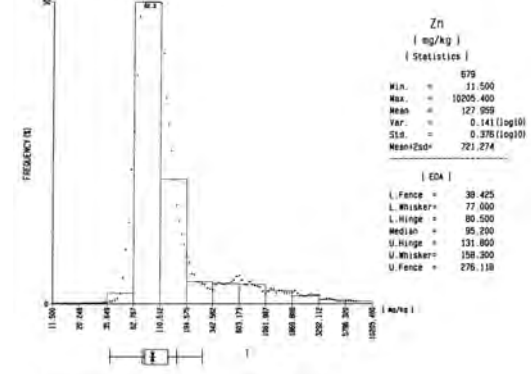
Ni



Pb

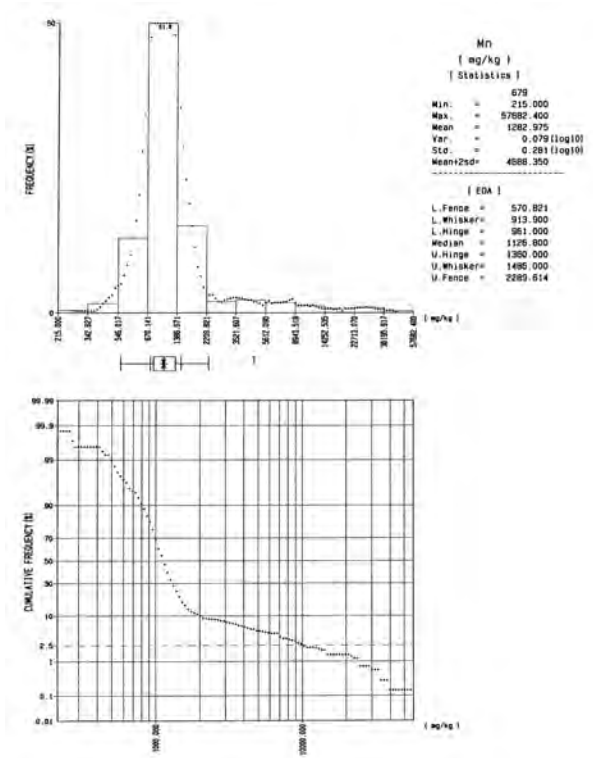


Zn



Histogram and Cumulative Frequency Curve of 400m Grid Samples (2)

Mn



Histogram and Cumulative Frequency Curve of 400m Grid Samples (3)

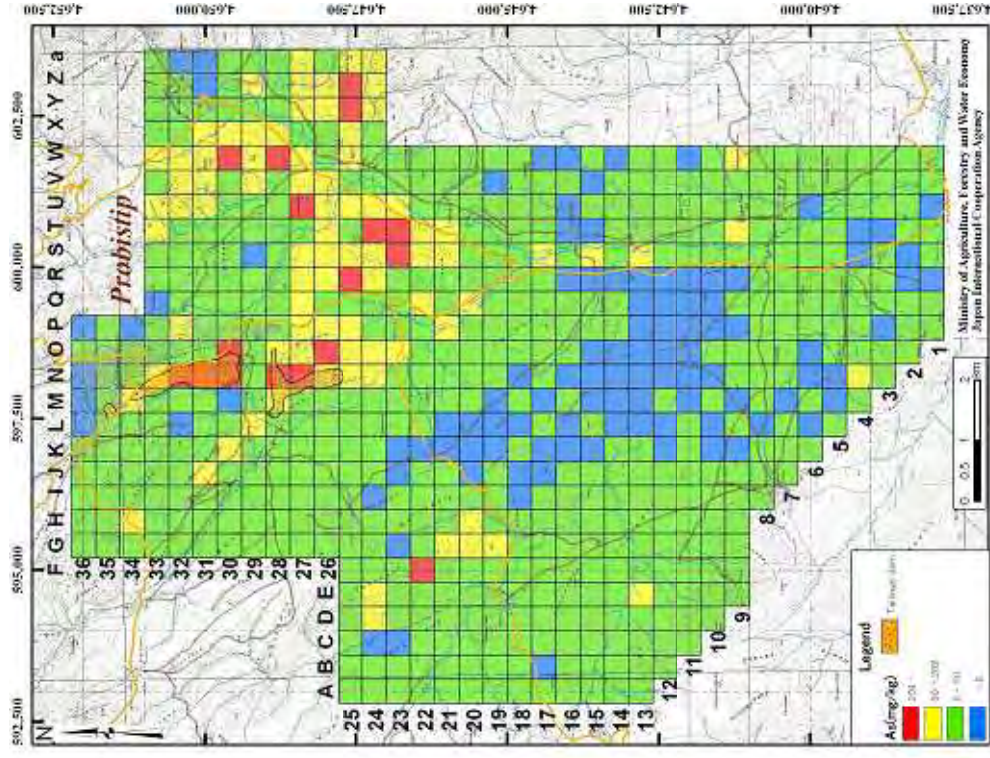


**Appendix 3**

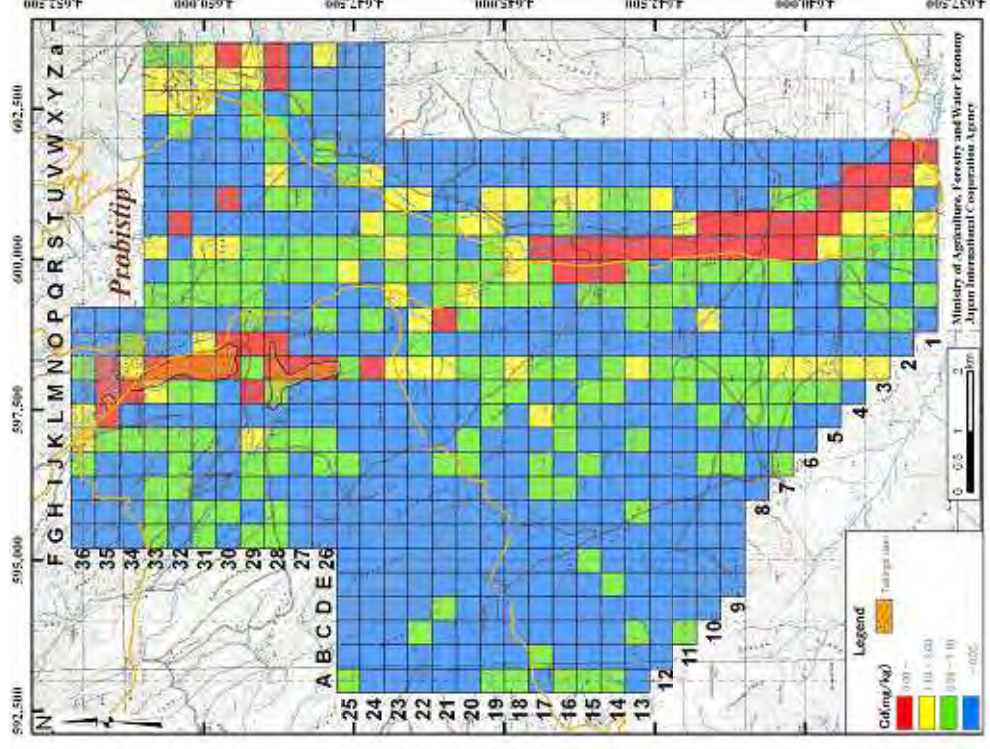
**Distribution of Heavy Metal Concentration of**

**400m Grid Survey**



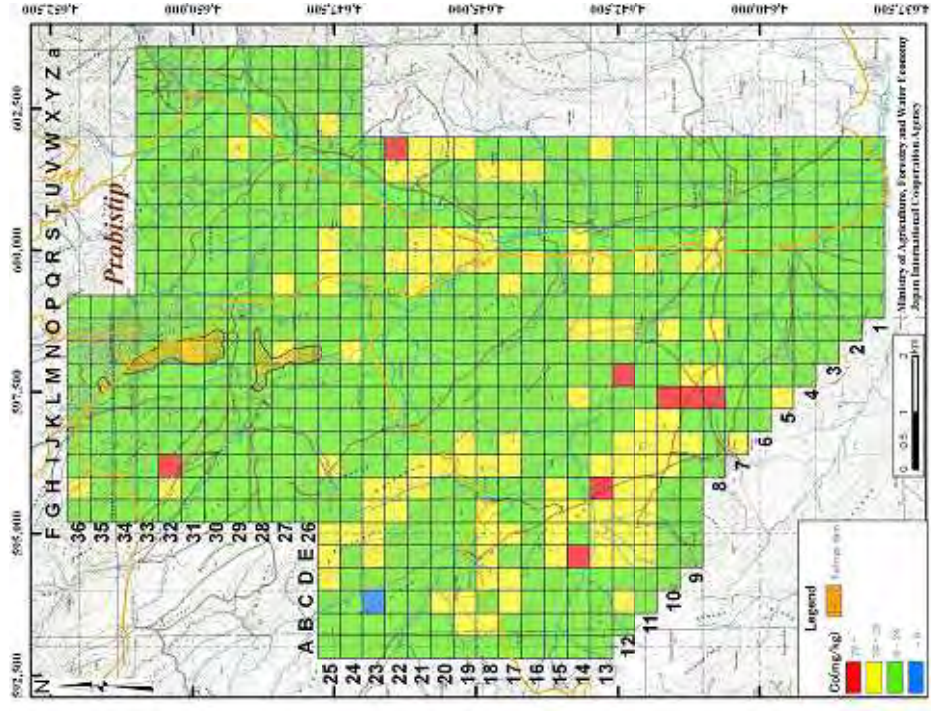


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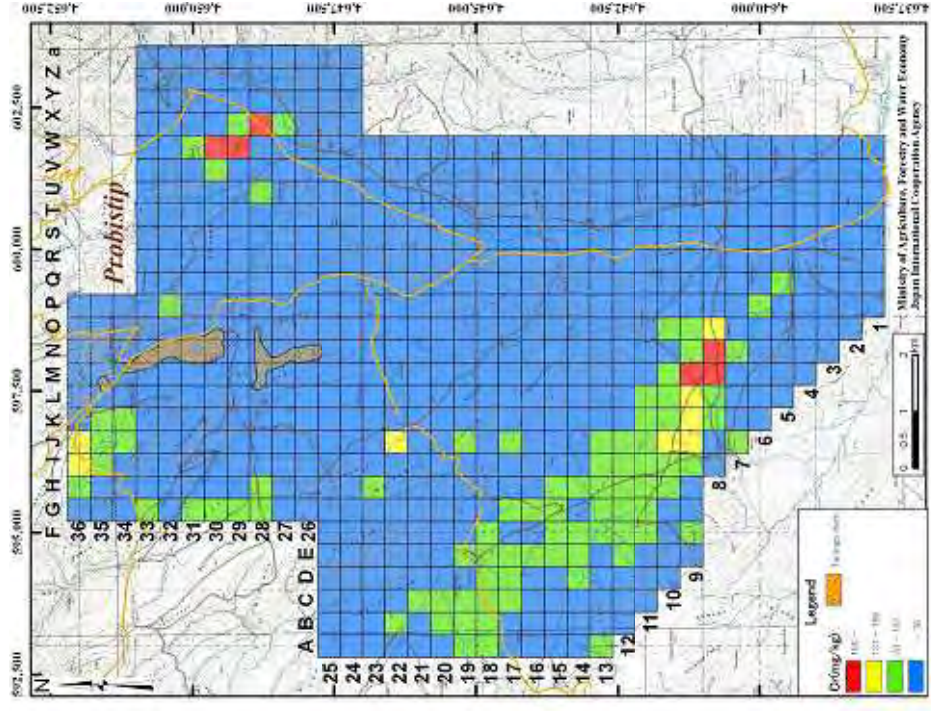


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Distribution of Heavy Metal Concentration of 400m Grid Soil Samples (1)

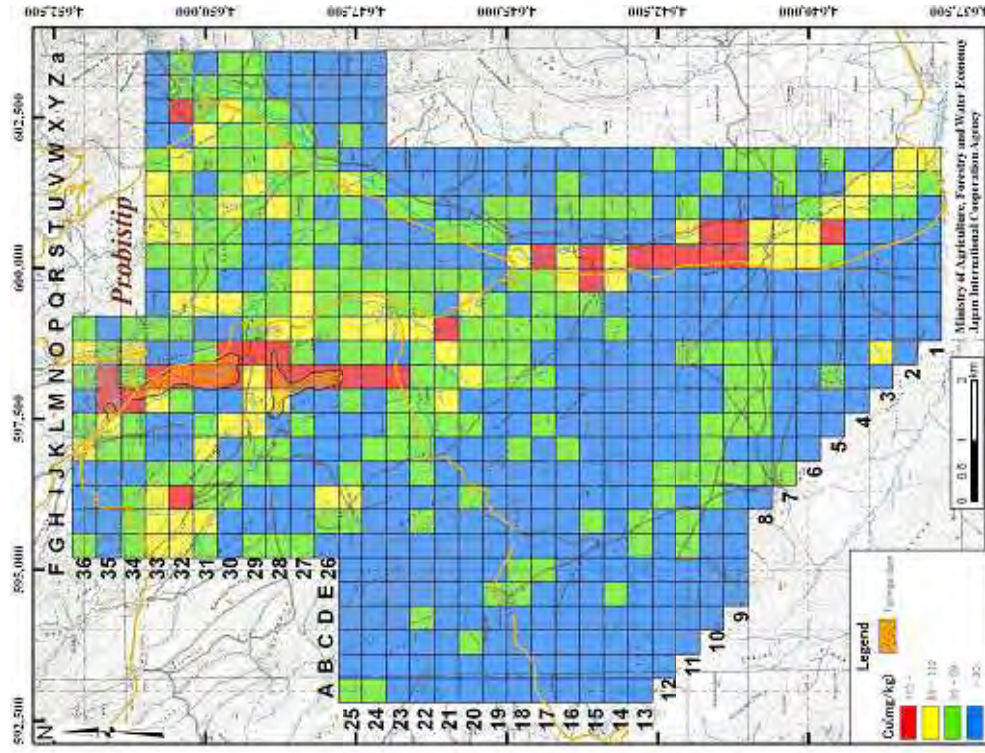


Co

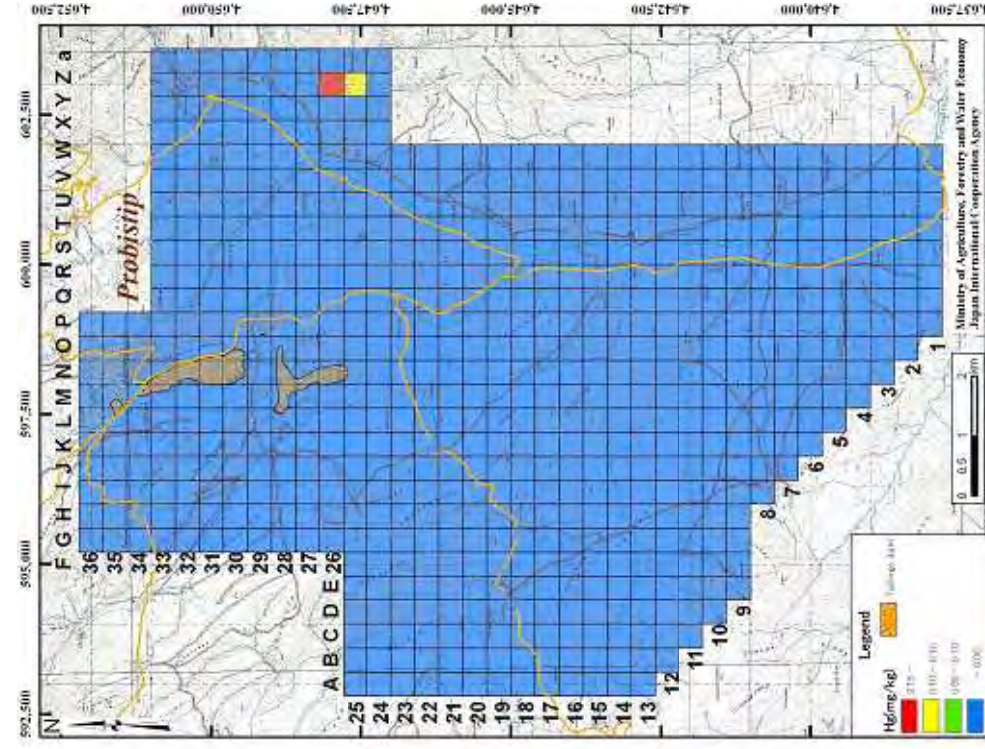


Cr

Distribution of Heavy Metal Concentration of 400m Grid Soil Samples (2)

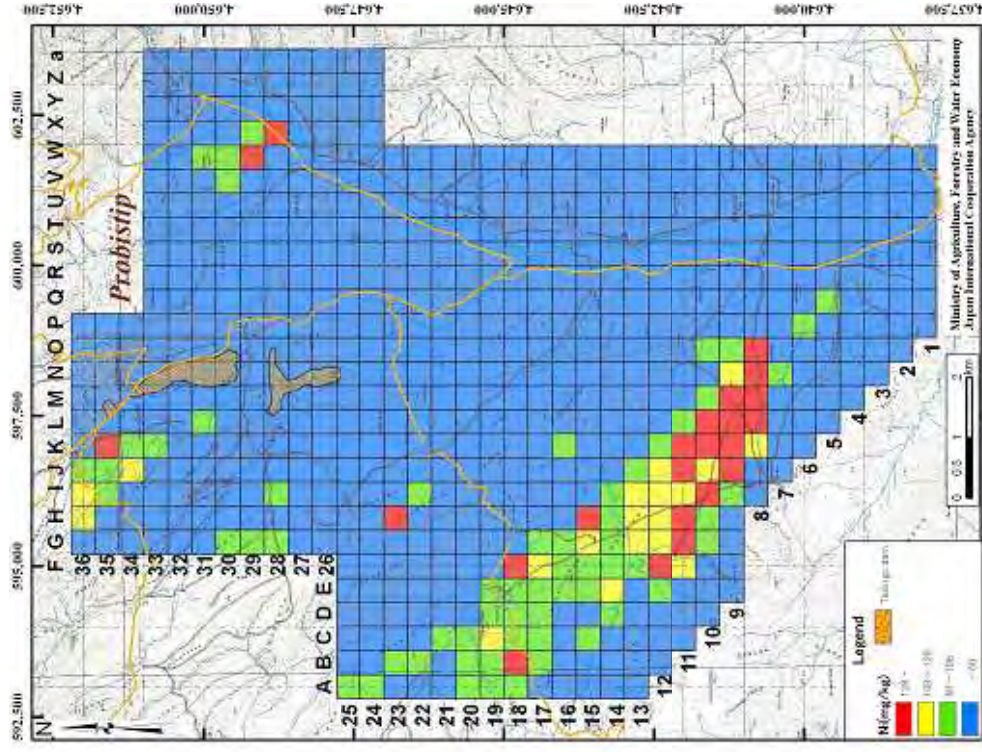


Cu

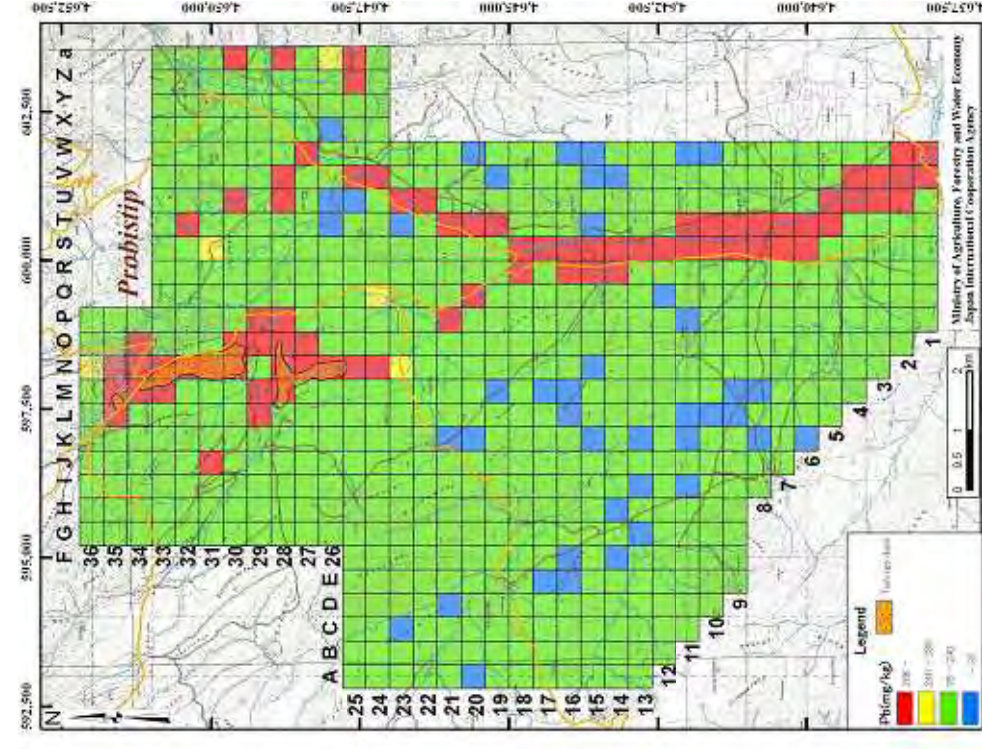


Hg

Distribution of Heavy Metal Concentration of 400m Grid Soil Samples (3)

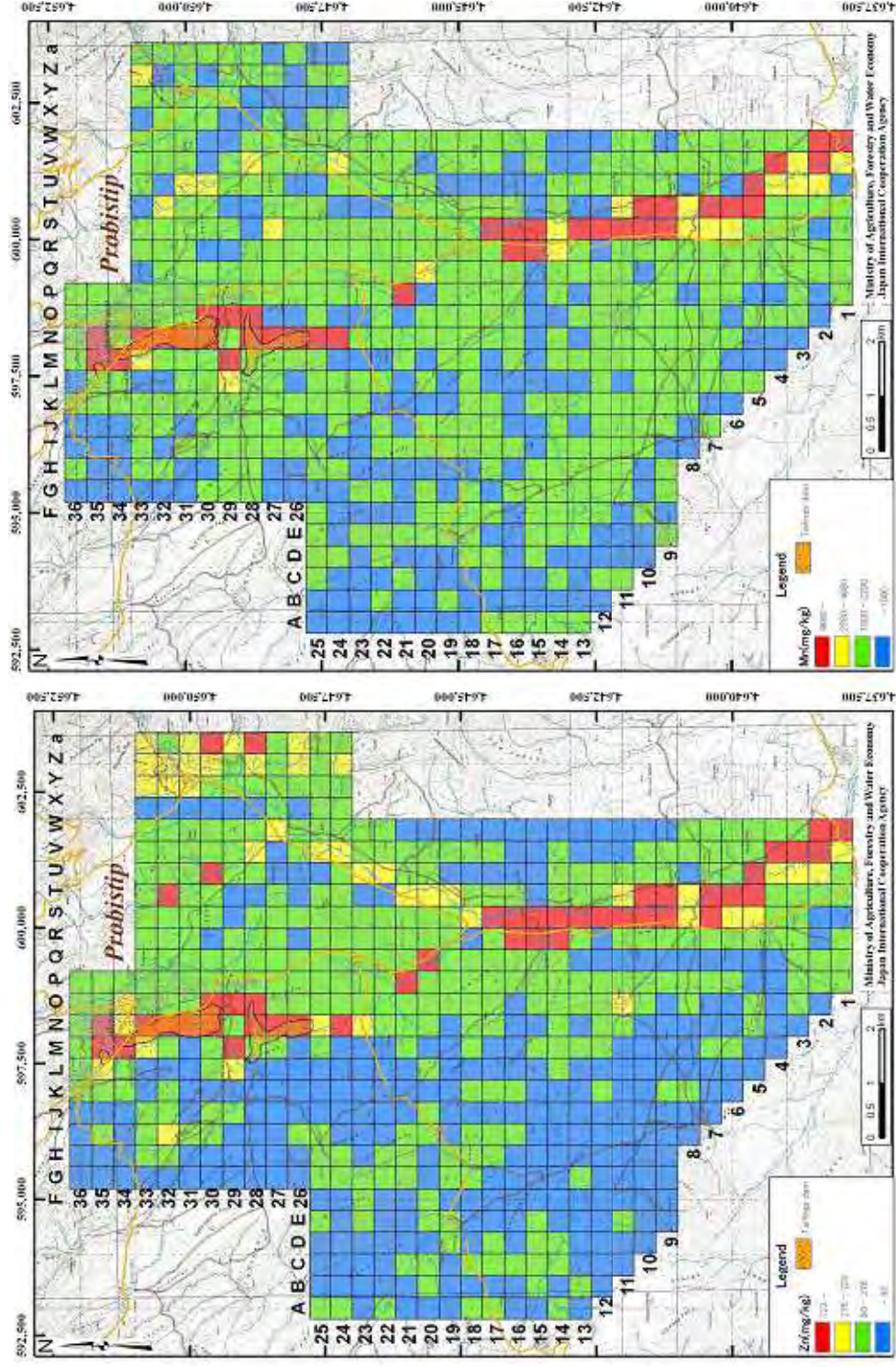


Ni



Pb

Distribution of Heavy Metal Concentration of 400m Grid Soil Samples (4)



Zn

Mn

Distribution of Heavy Metal Concentration of 400m Grid Soil Samples (5)

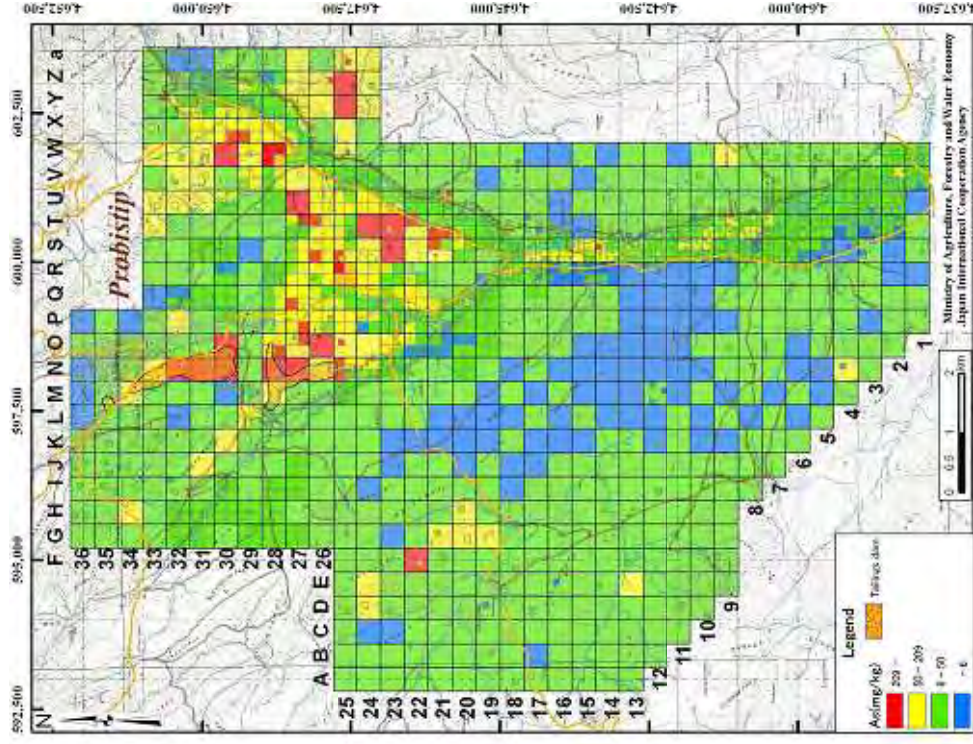


**Appendix 4**

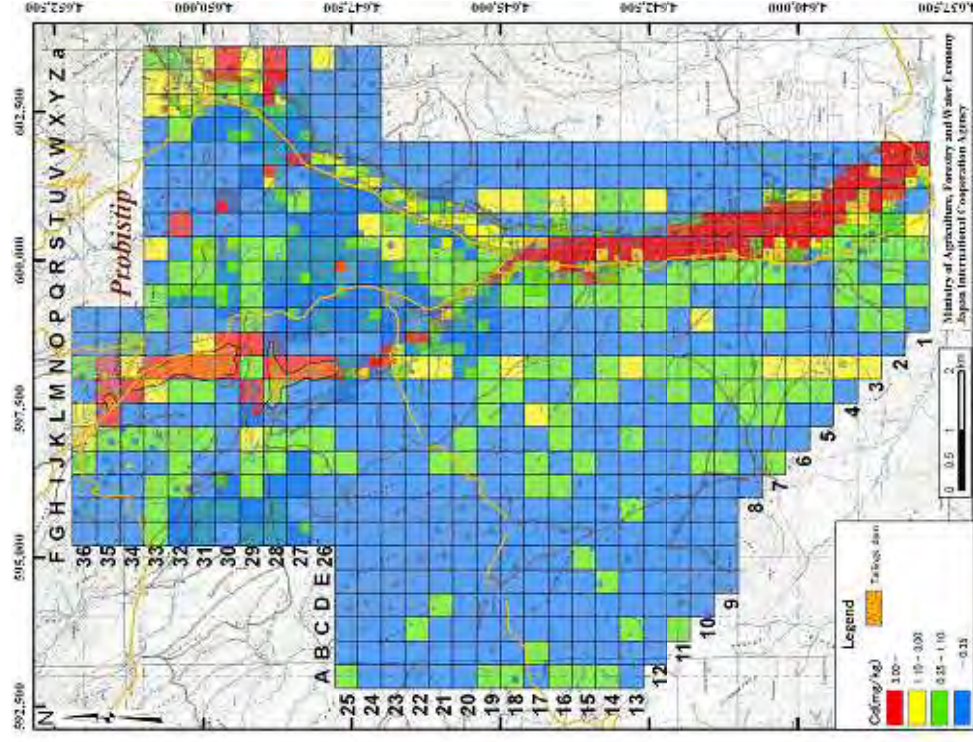
**Distribution of Heavy Metal Concentration of**

**400m to 50m Grids Surveys**



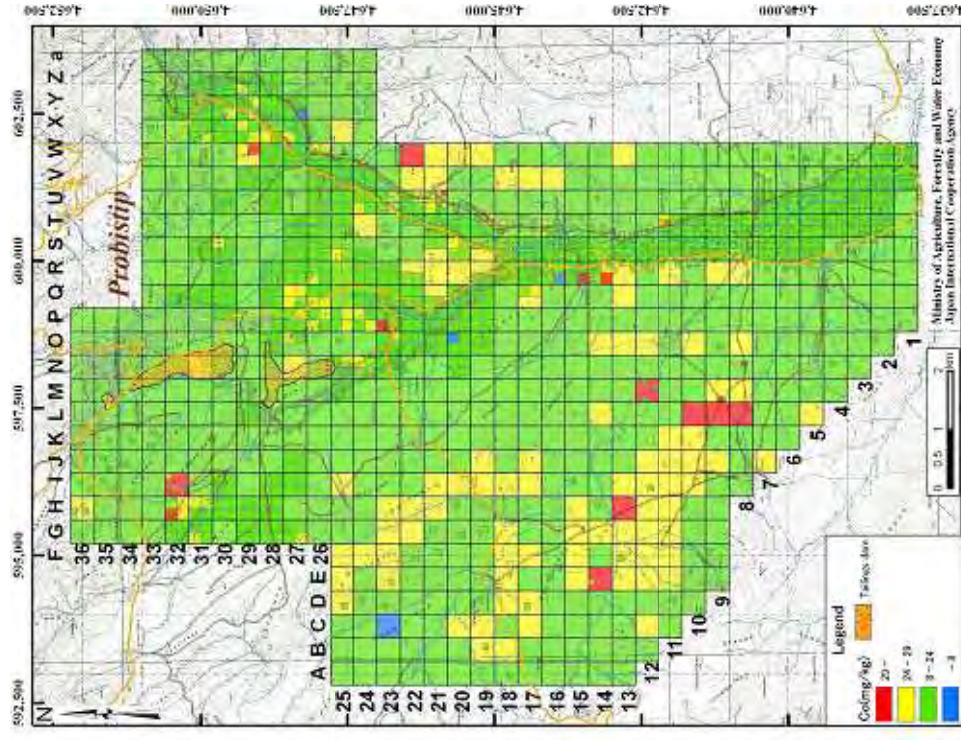


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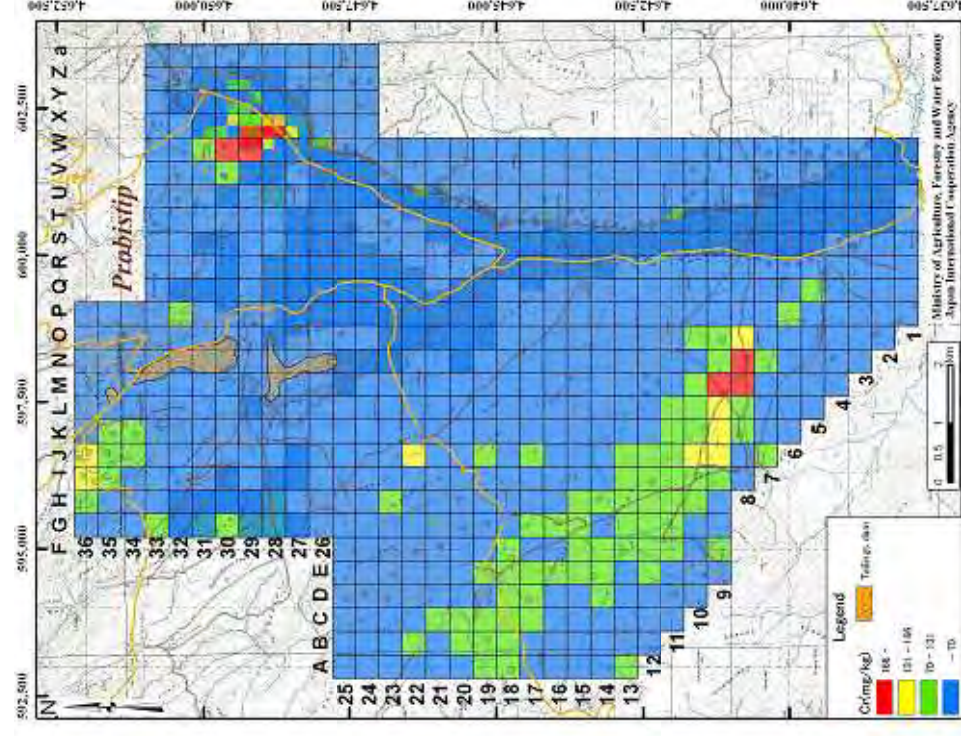


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Distribution of Heavy Metal Concentration of 400m to 50m Grids Surveys (1)

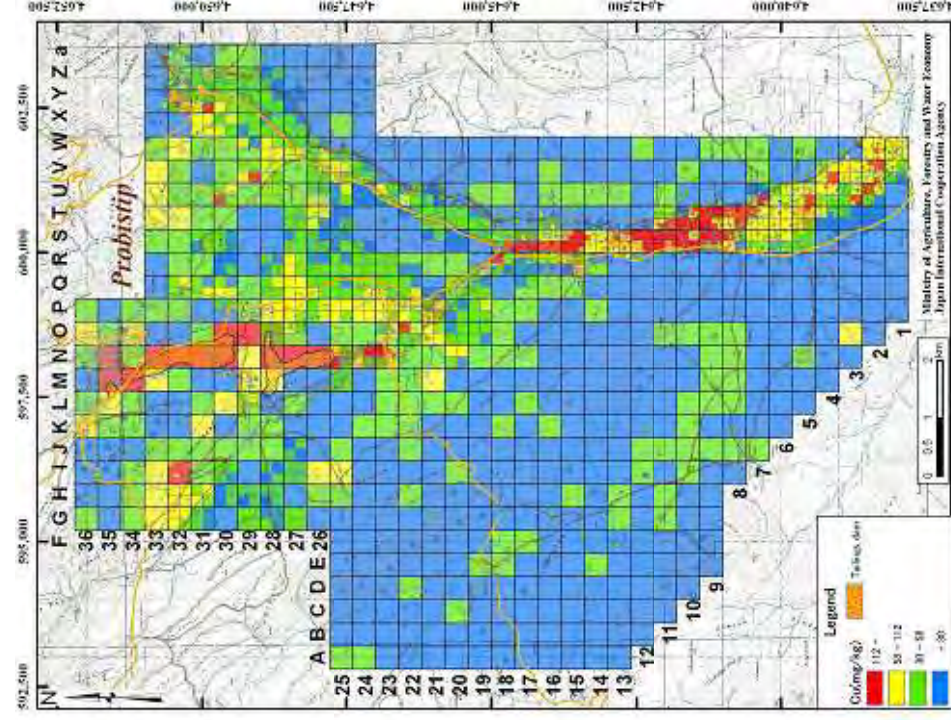


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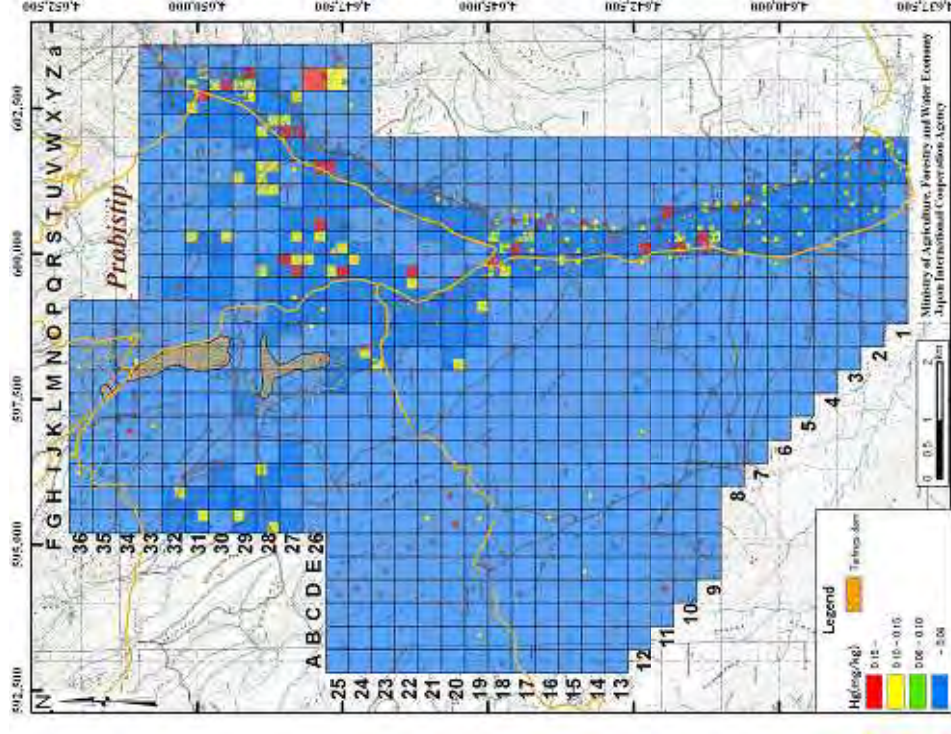


Cr

Distribution of Heavy Metal Concentration of 400m to 50m Grids Surveys (2)

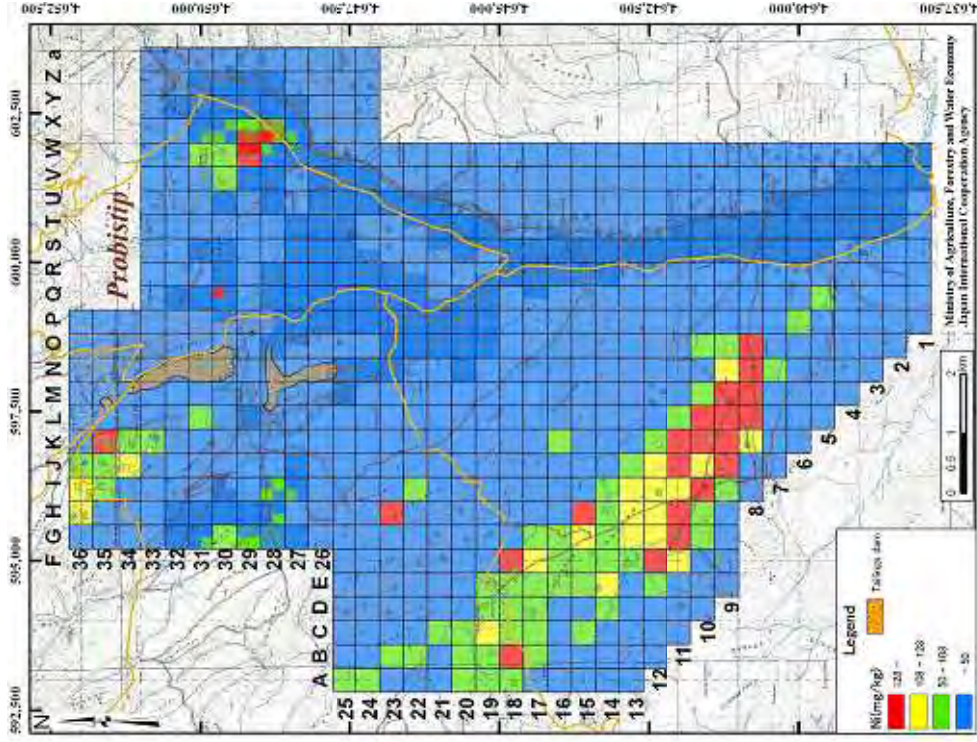


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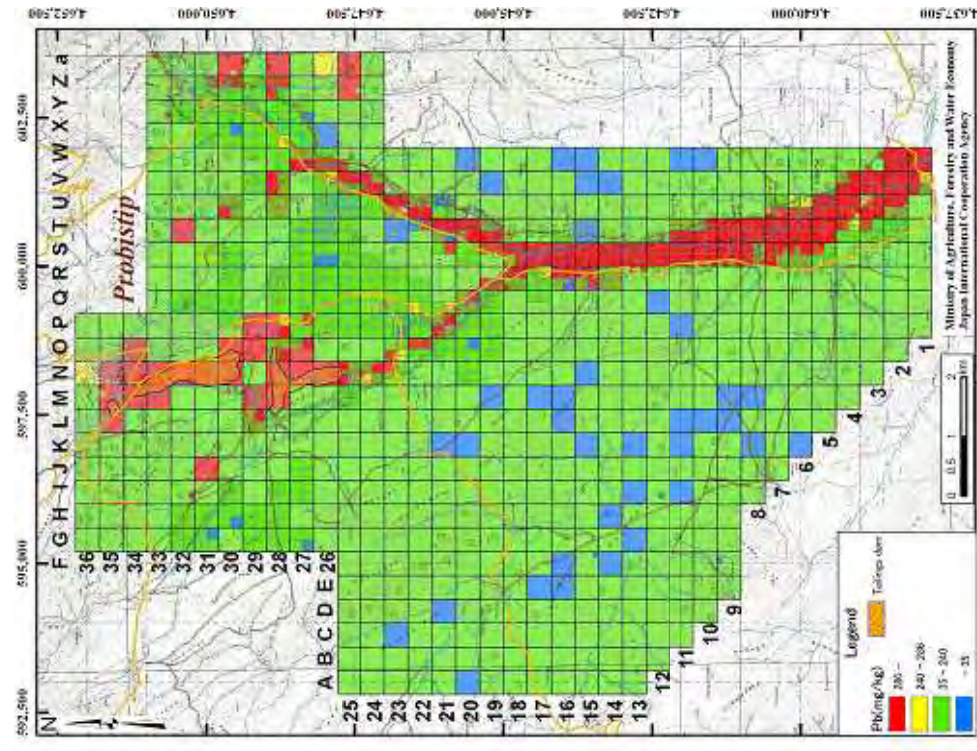


Hg

Distribution of Heavy Metal Concentration of 400m to 50m Grids Surveys (3)

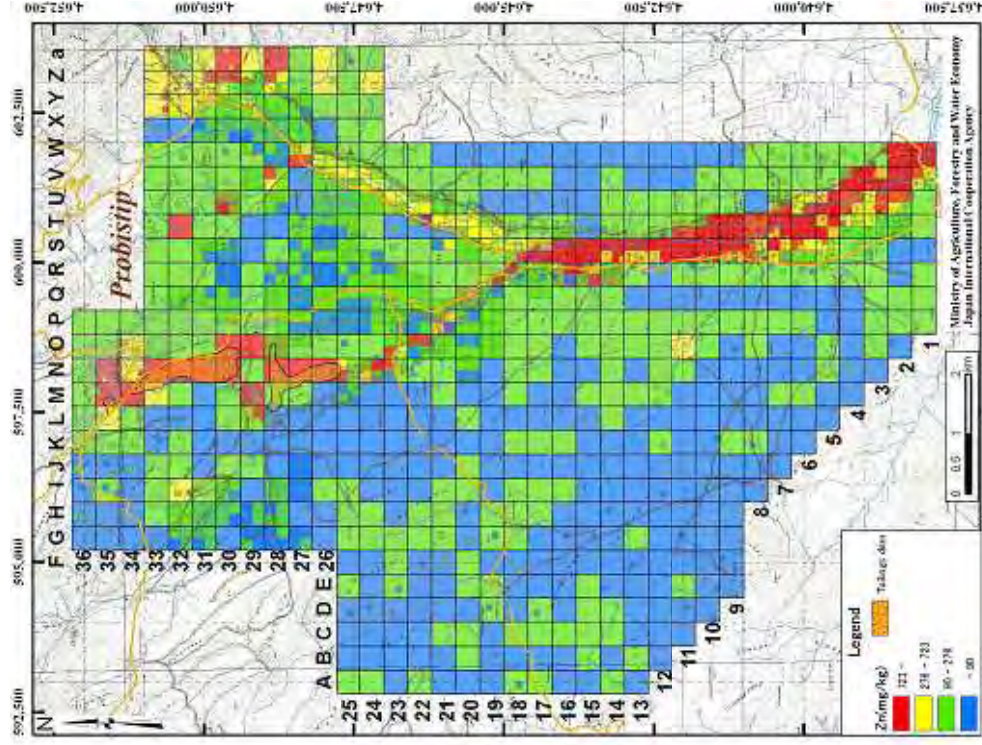


Ni

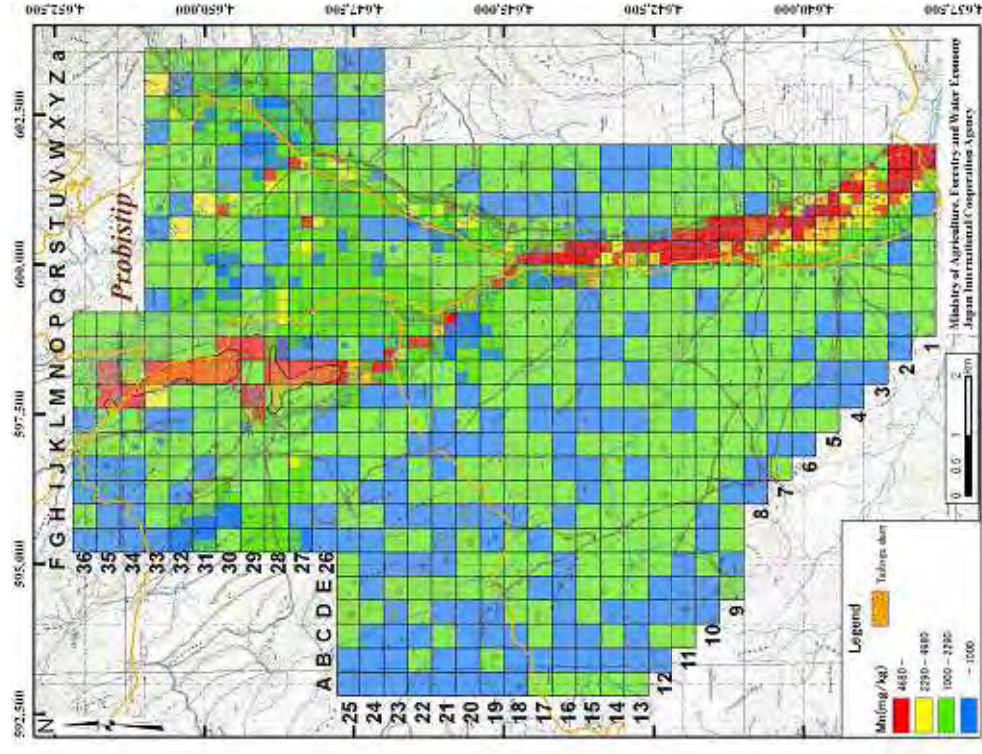


Pb

Distribution of Heavy Metal Concentration of 400m to 50m Grids Surveys (4)



Zn



Mn

Distribution of Heavy Metal Concentration of 400m to 50m Grids Surveys (5)

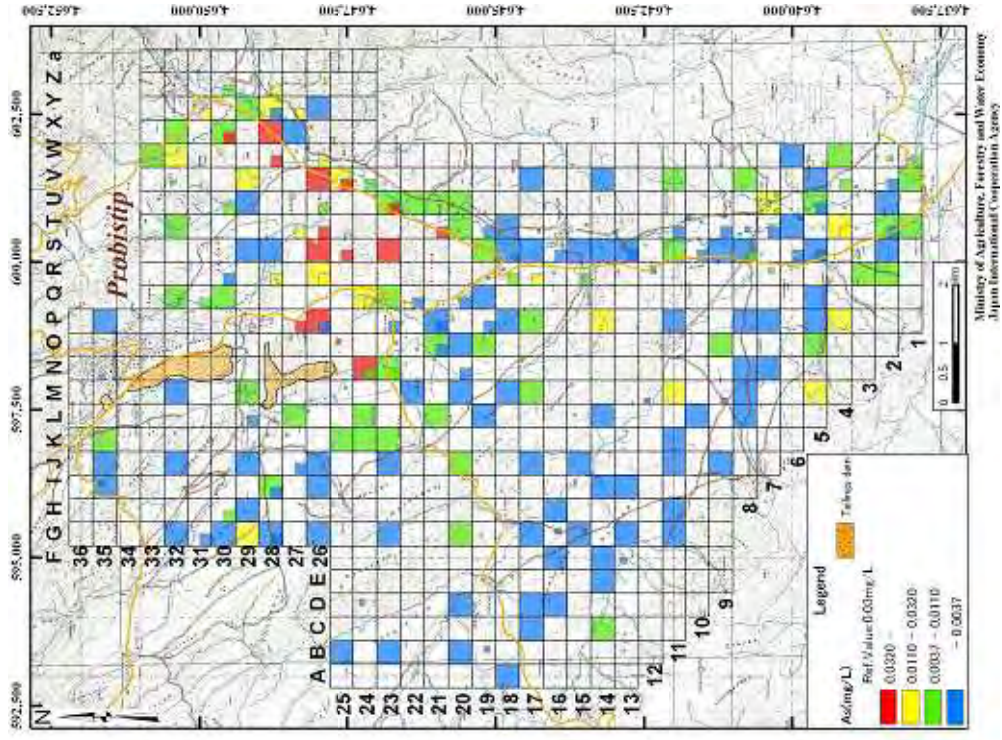


**Appendix 5**

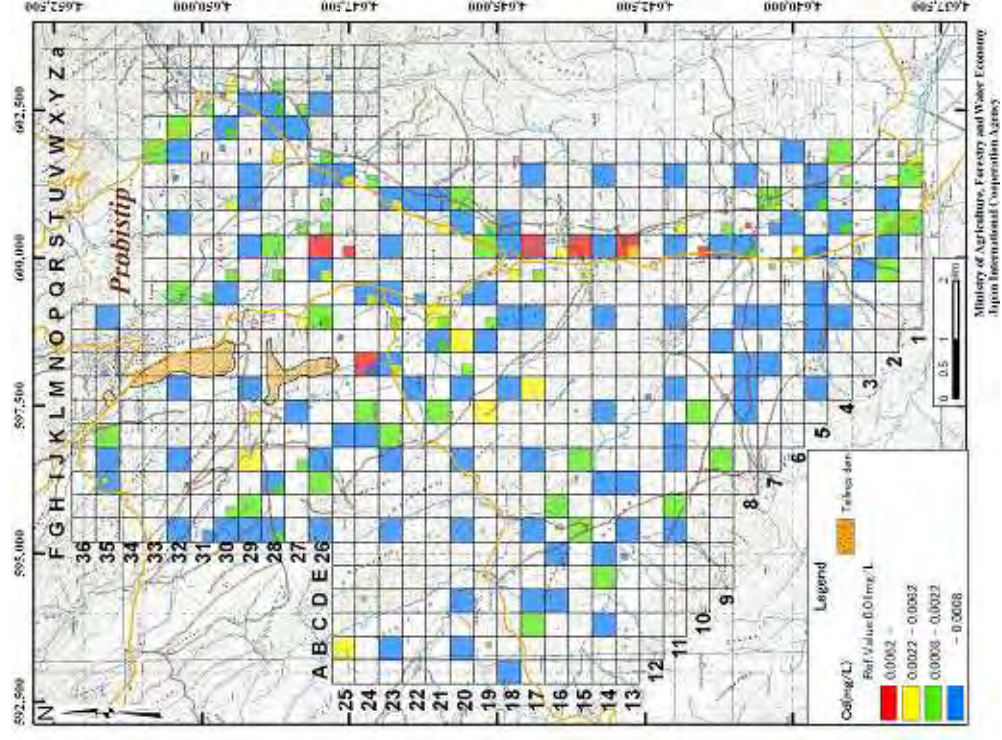
**Distribution of Elution Concentration of**

**Surface Soil**



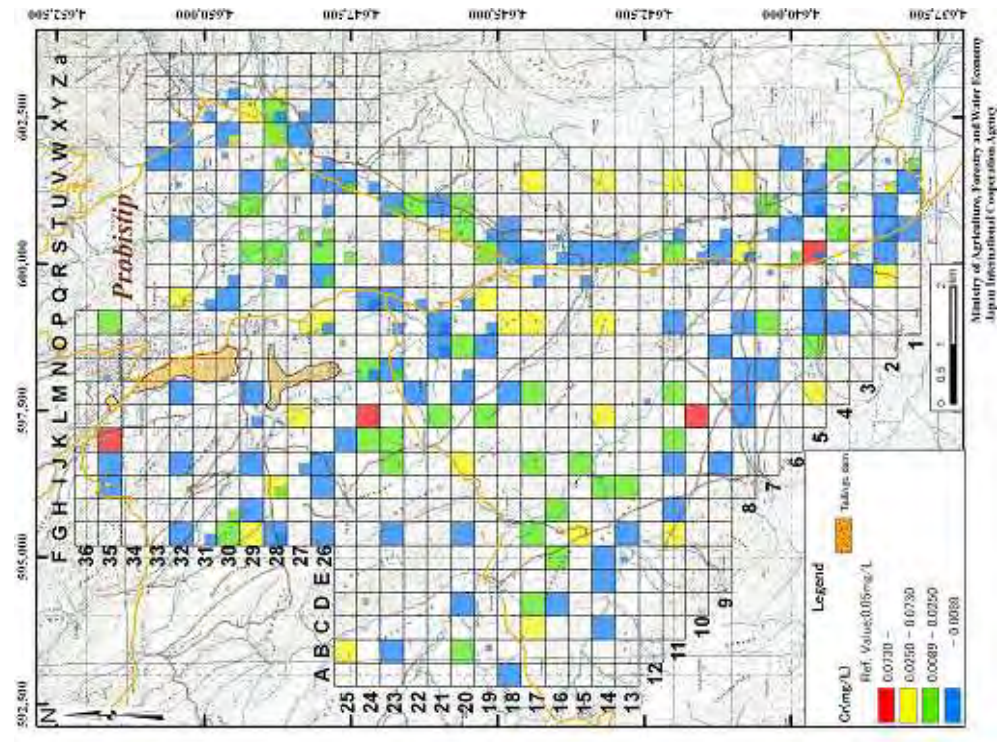
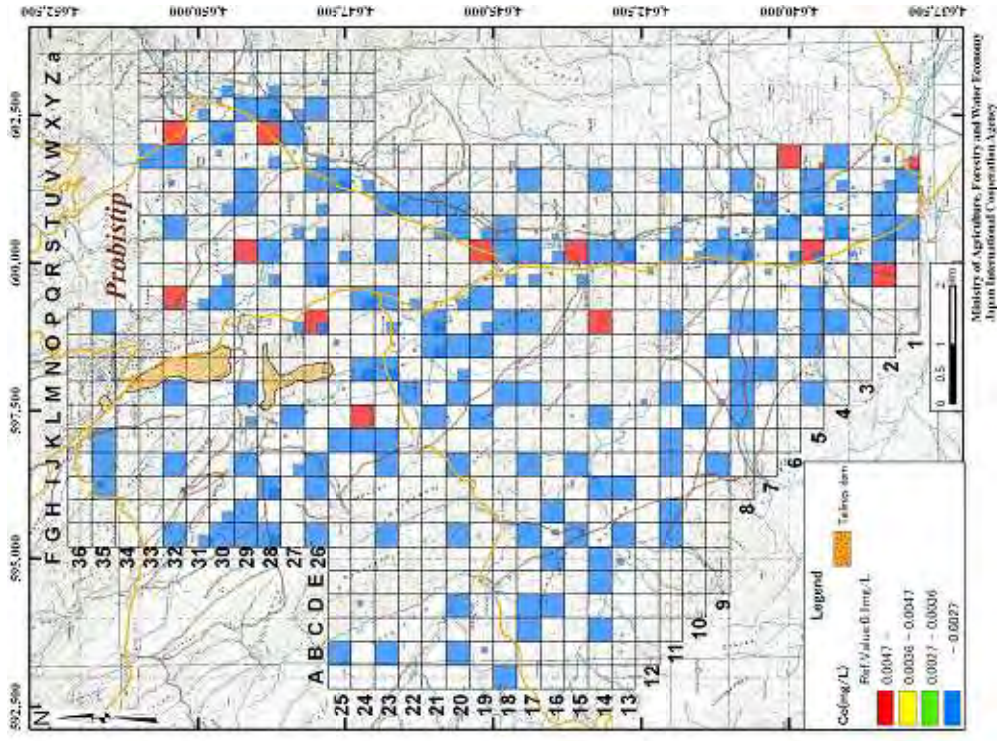


As



Cd

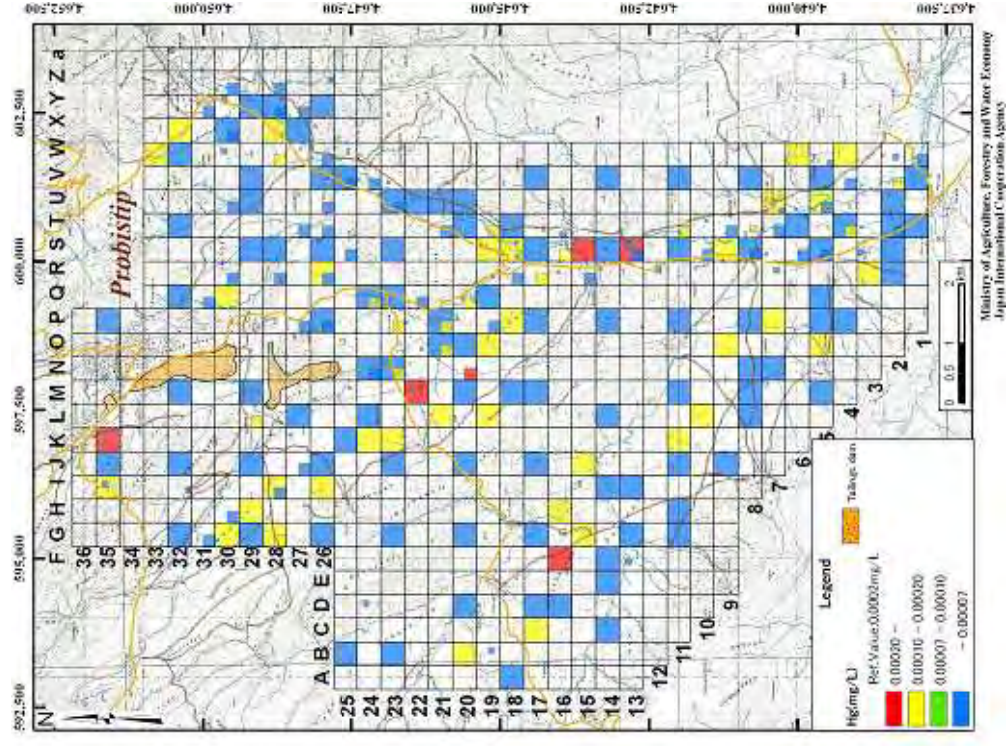
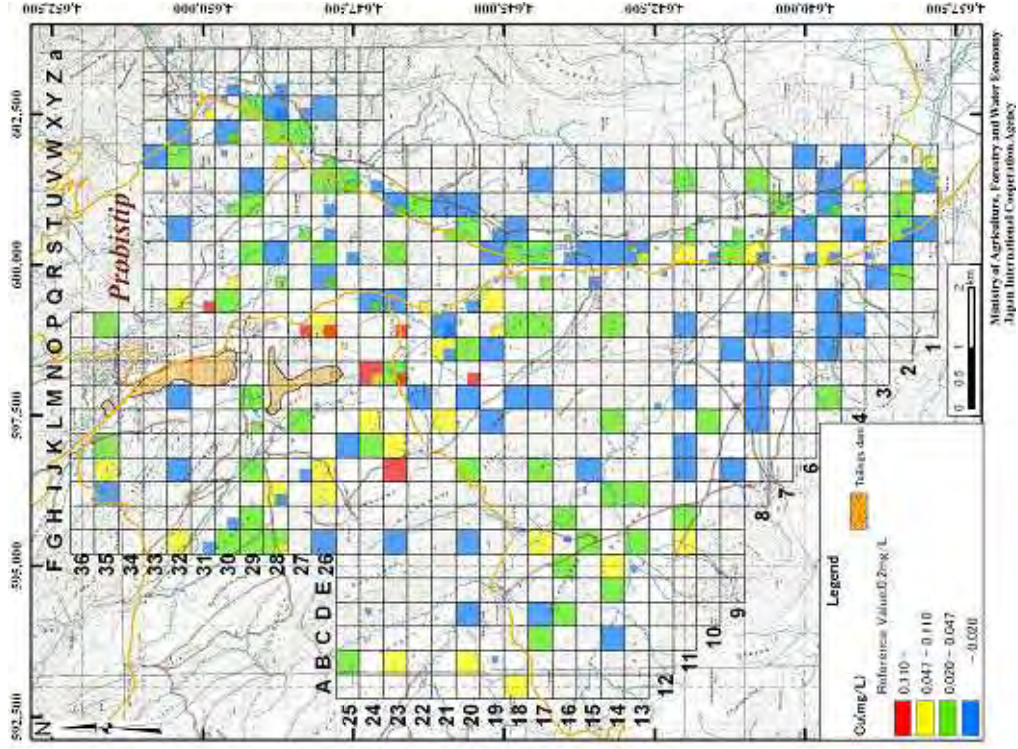
Distribution of Elution Concentration of Surface Soil (1)



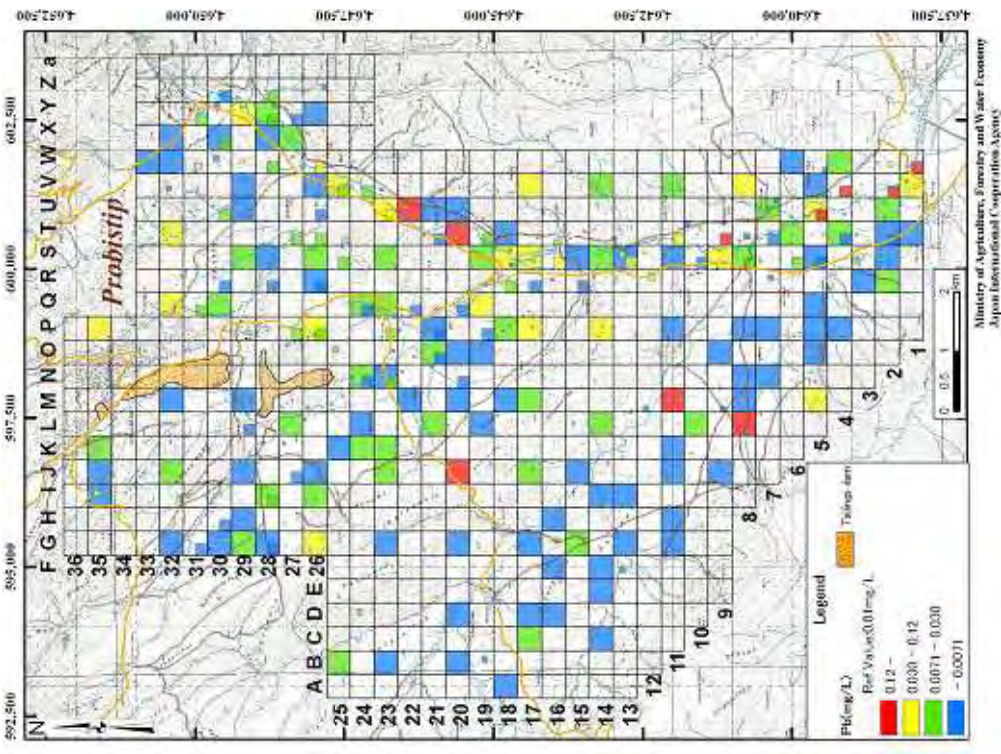
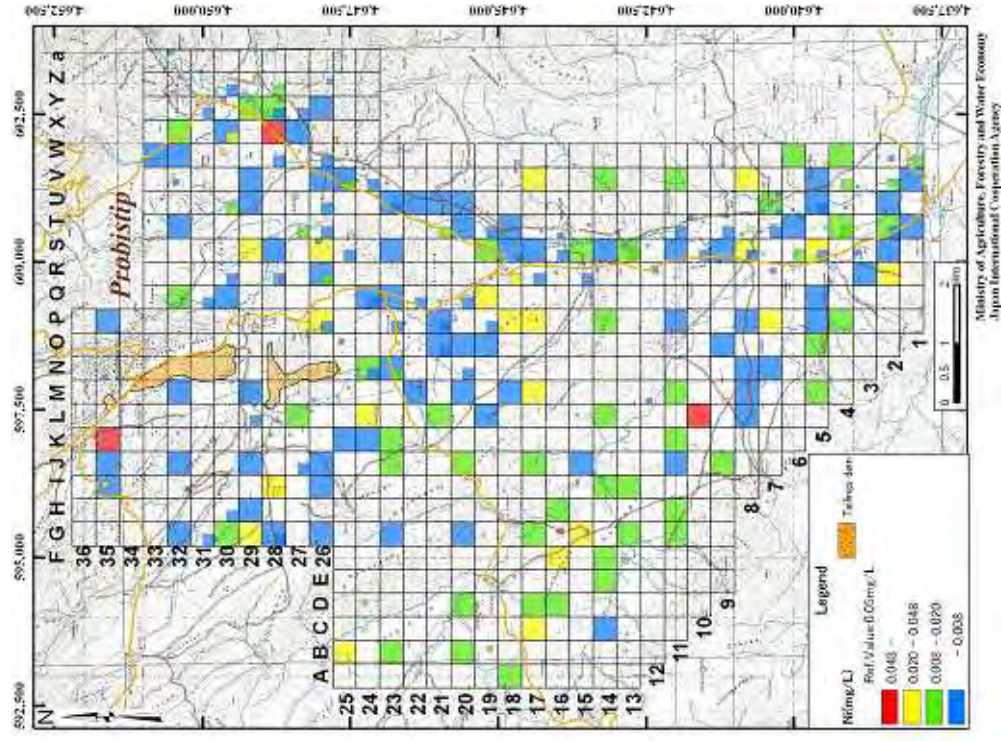
**Cd**

**Cr**

Distribution of Elution Concentration of Surface Soil (2)



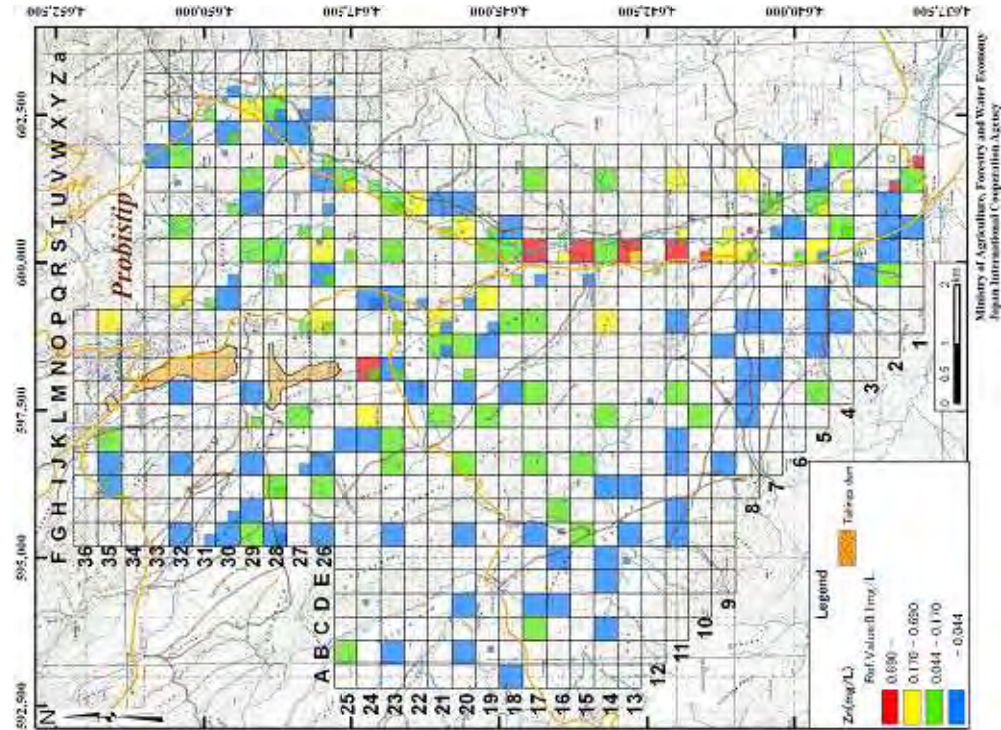
Distribution of Elution Concentration of Surface Soil (3)



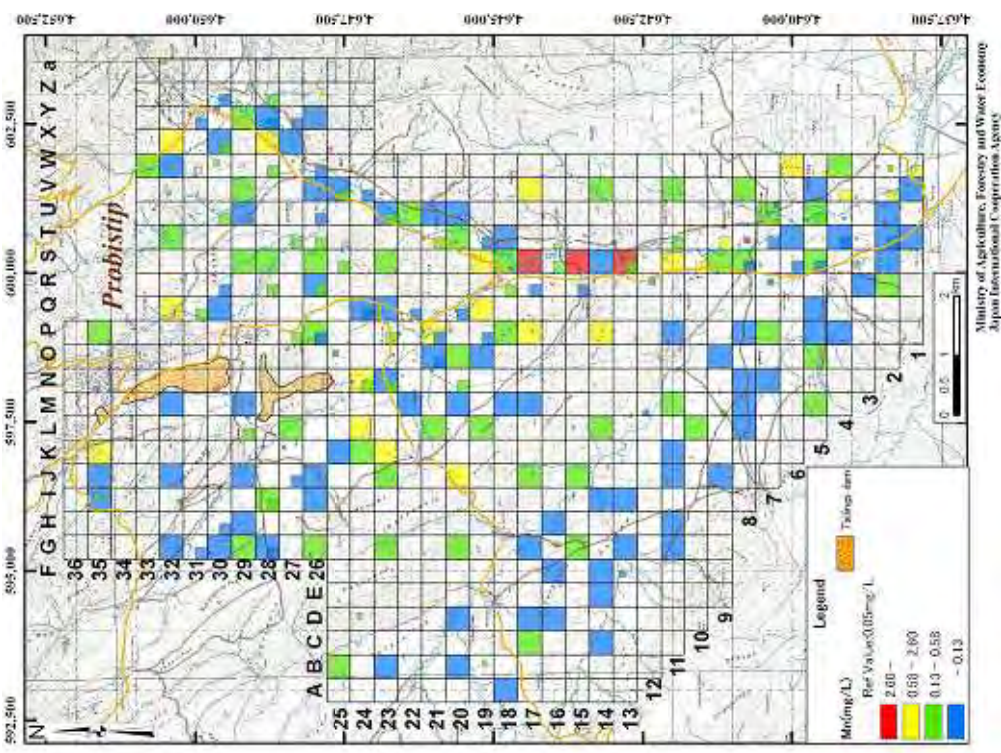
Ni

Pb

Distribution of Elution Concentration of Surface Soil (4)



Zn



Mn

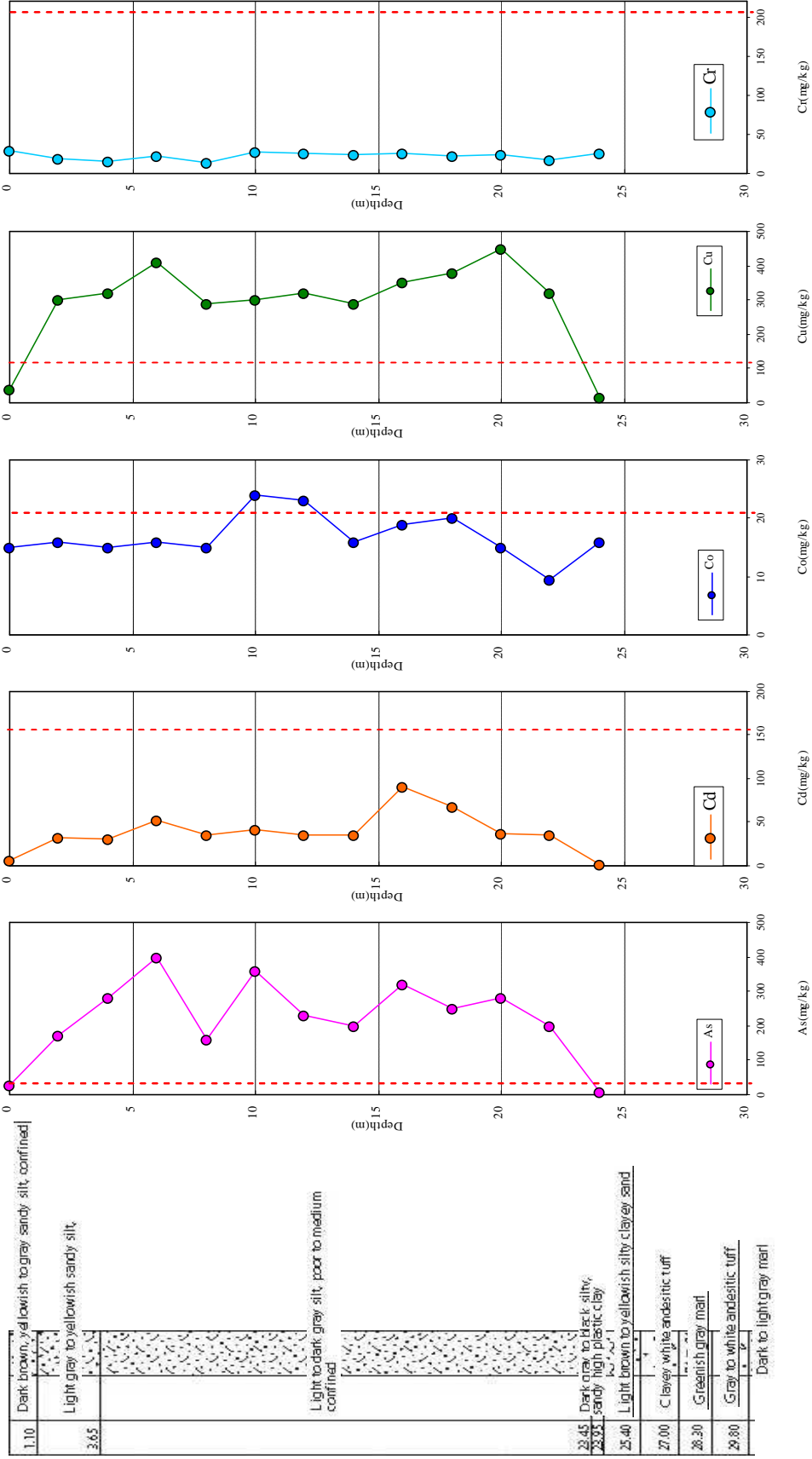
Distribution of Elution Concentration of Surface Soil (5)



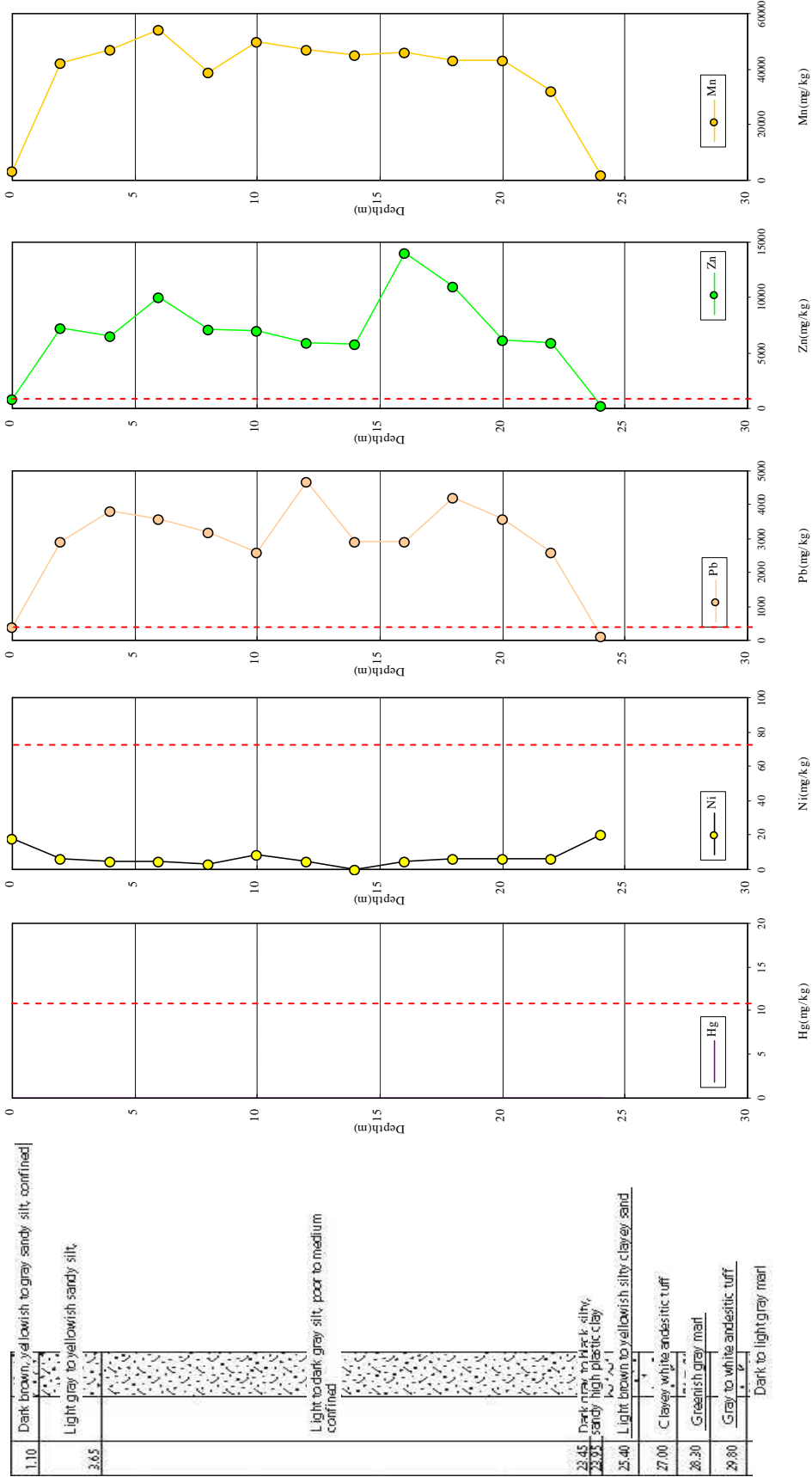
**Appendix 6**

**Distribution of heavy metals of the Tailings Dam**

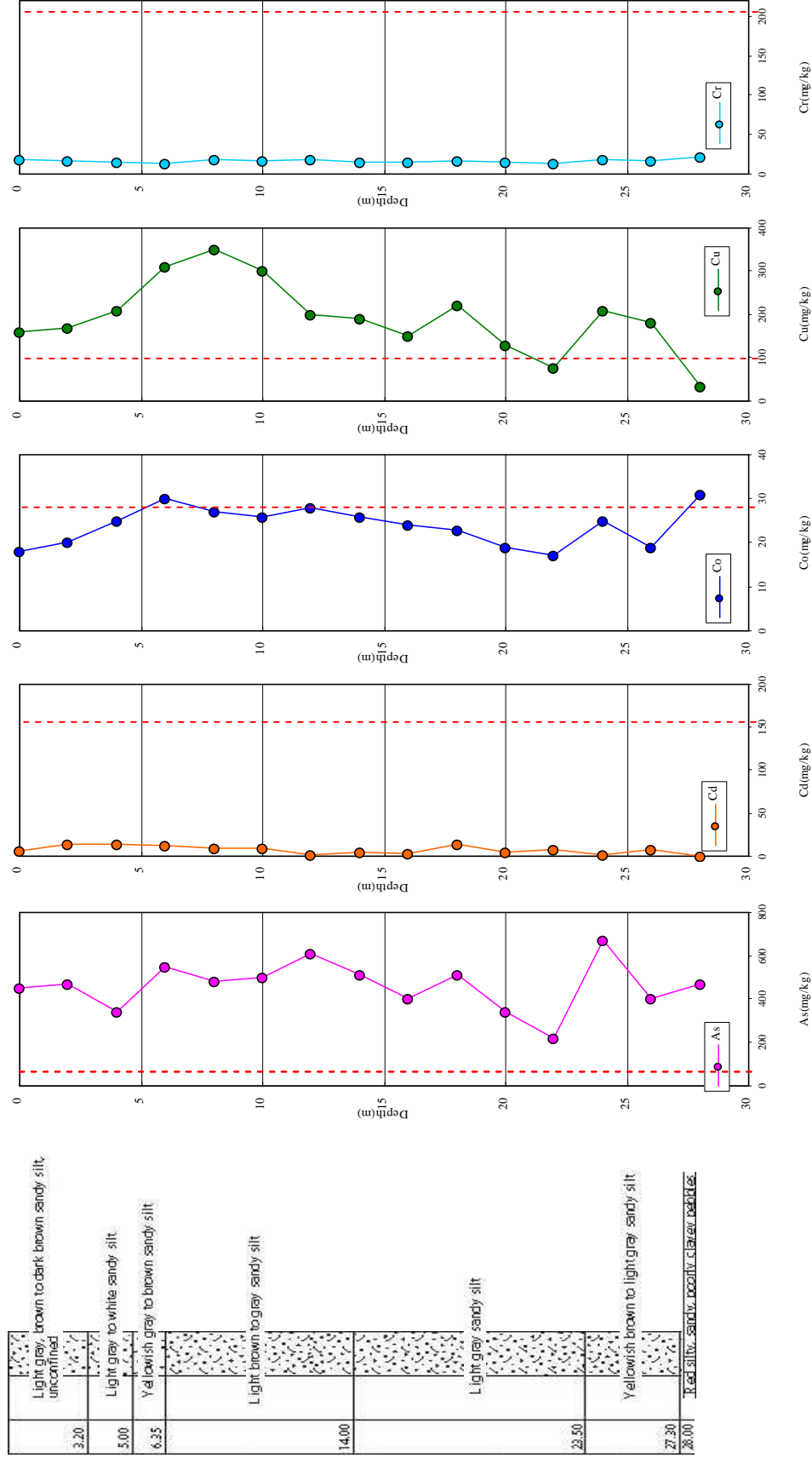




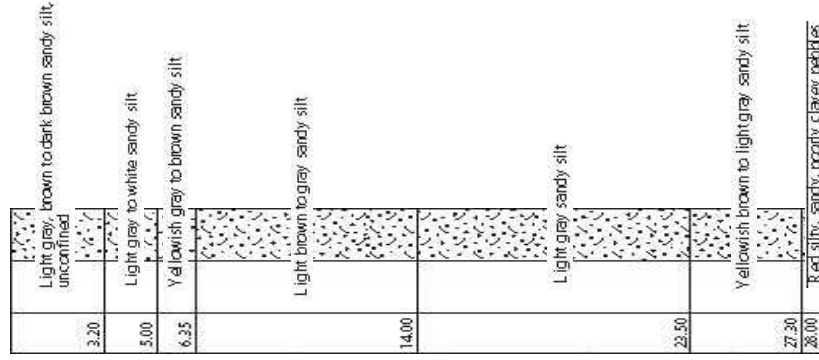
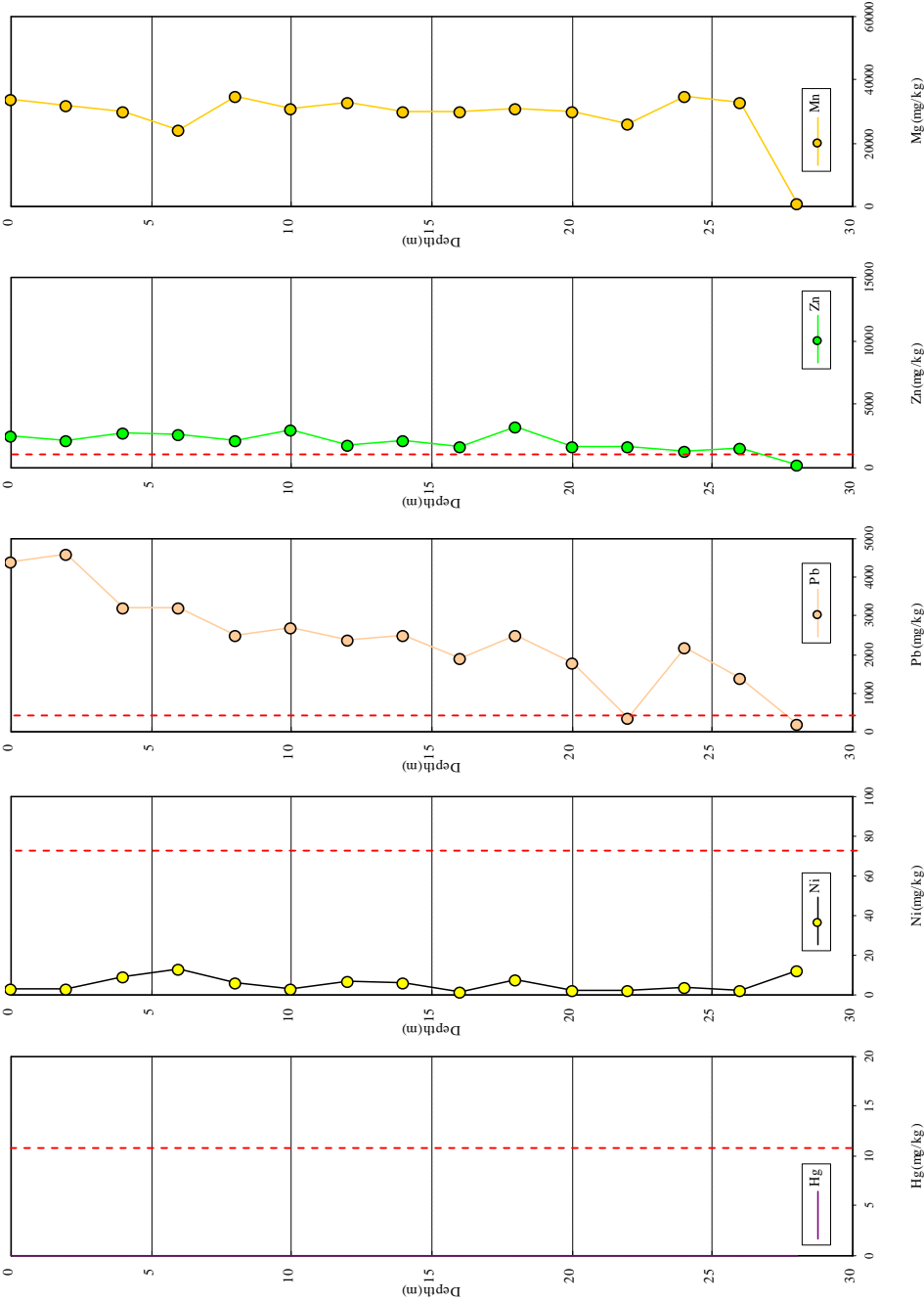
Distribution of Heavy Metals Concentration in the Old Tailings Dam (1)



Distribution of Heavy Metals Concentration in the Old Tailings Dam (2)



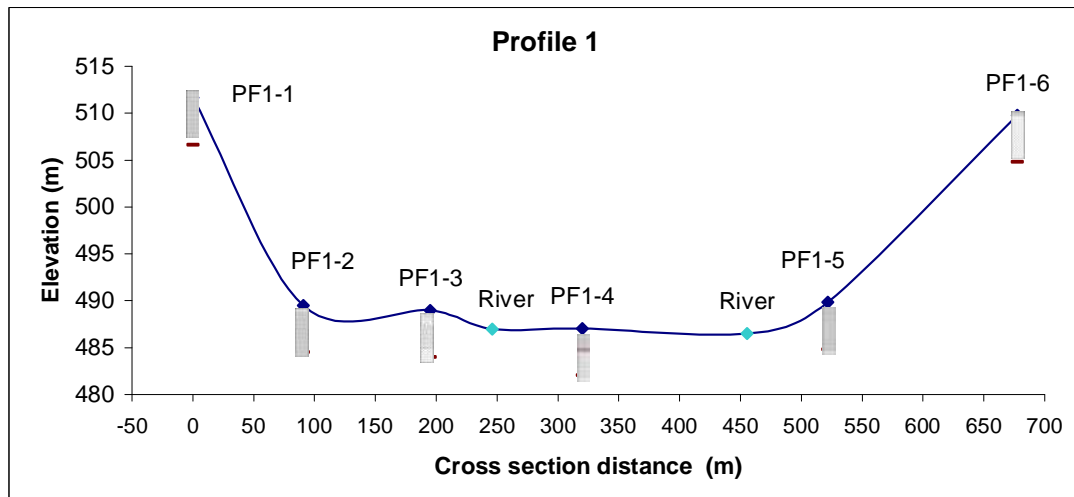
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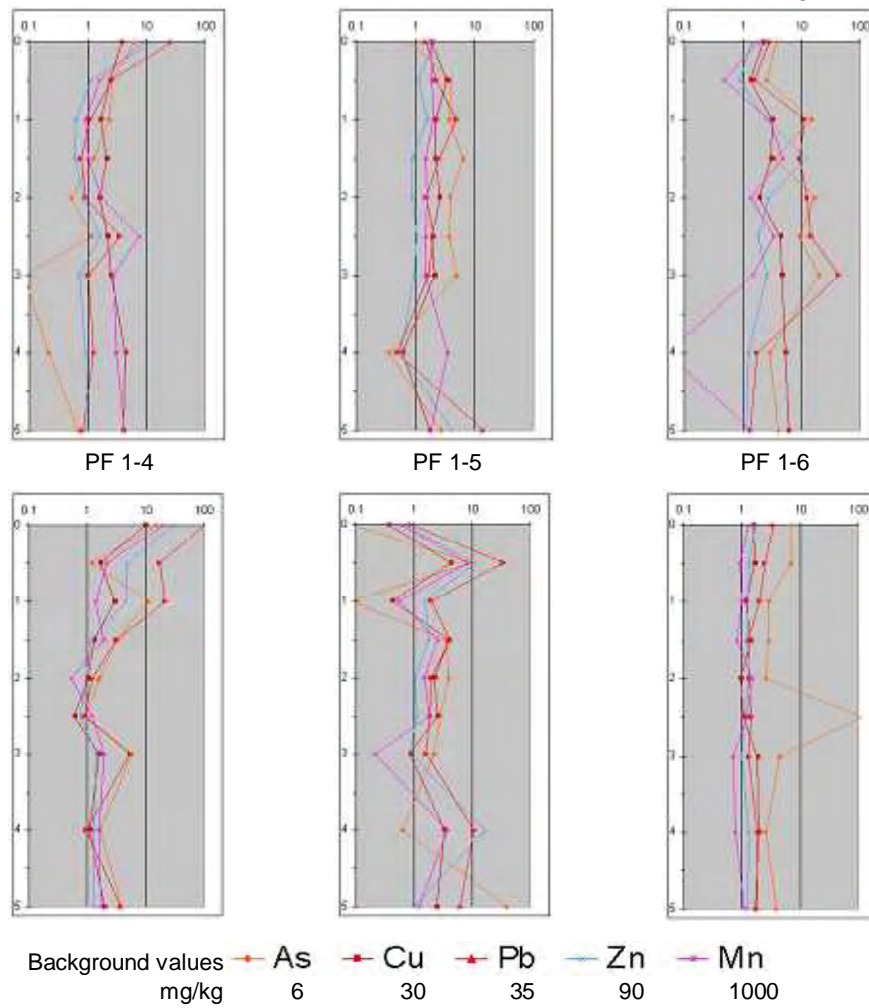
Distribution of Heavy Metals in the New Tailings Dam (2)

**Appendix 7**  
**Vertical Chemical Variation**  
**along the Profile Line**  
**of Soil Drilling Survey**



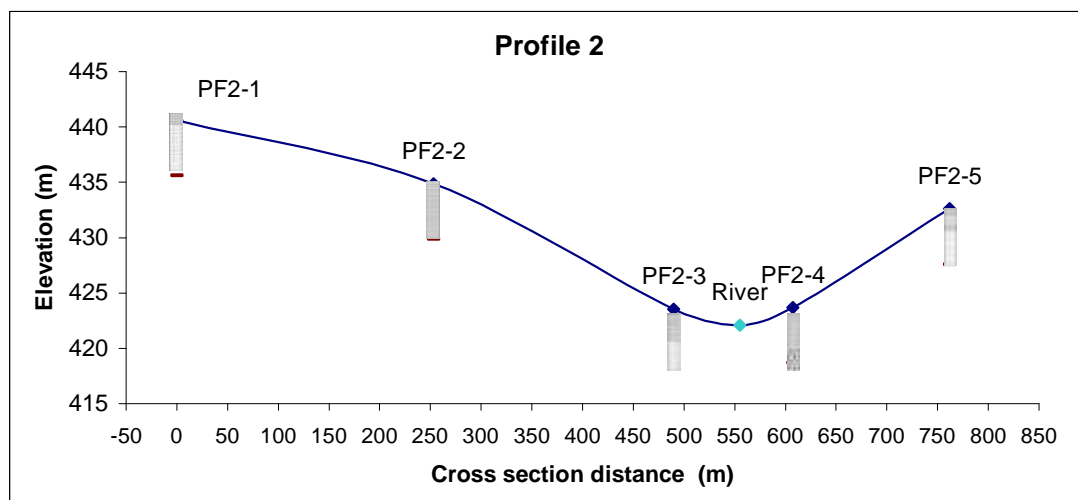


Heavy metal concentration relative to Background Value of soil

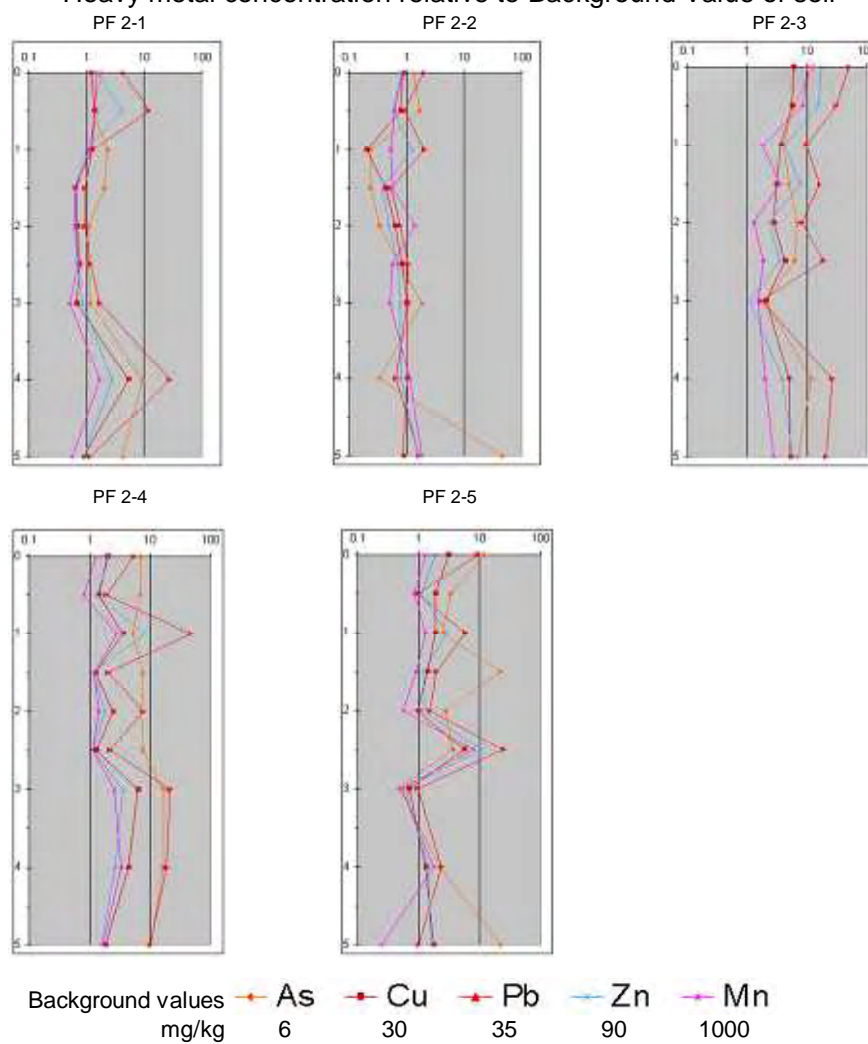


LEGEND

### Vertical Chemical Variations along the Profiles Lines (1) (Profile 1)

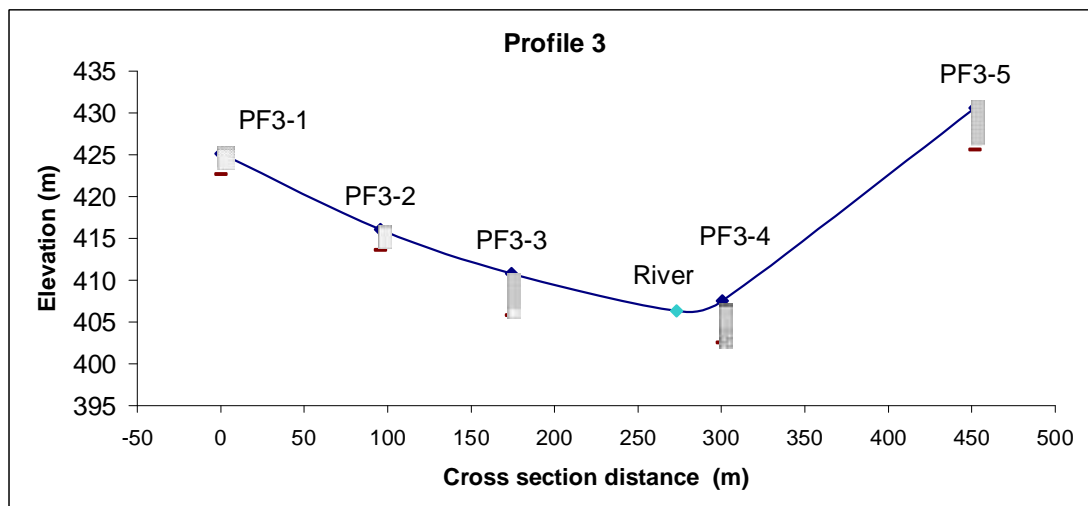


Heavy metal concentration relative to Background Value of soil

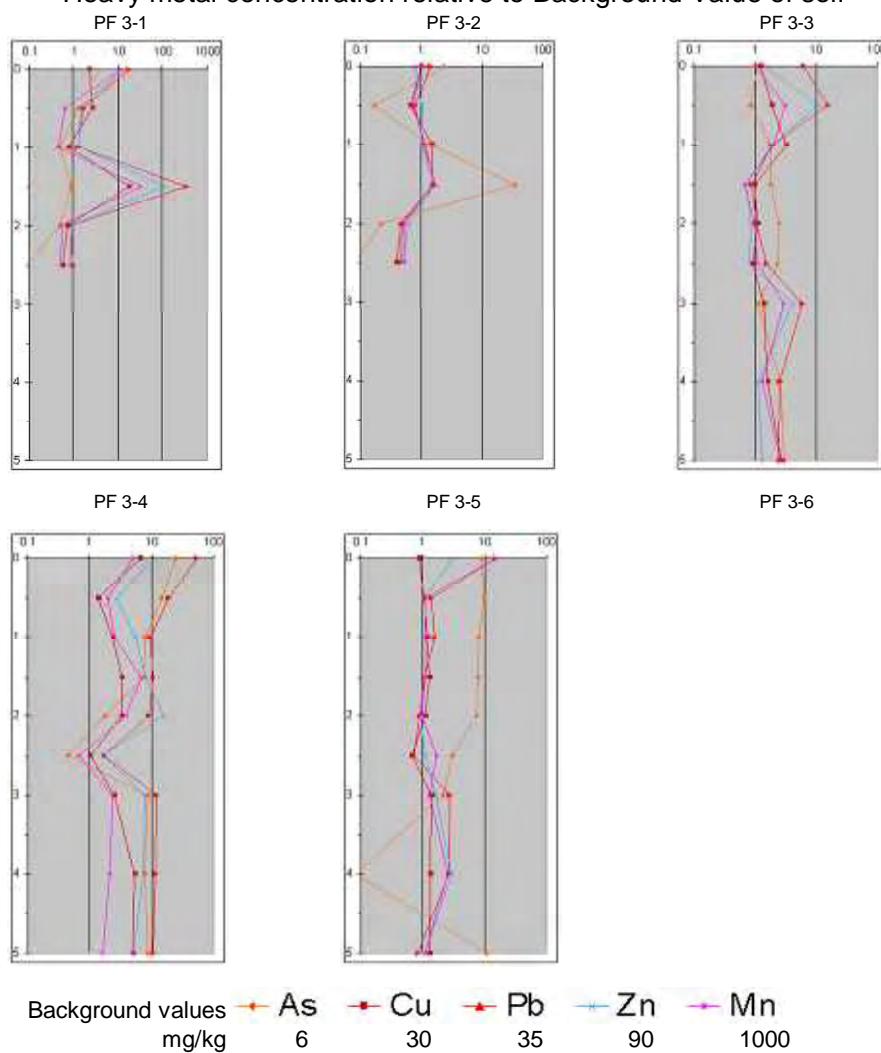


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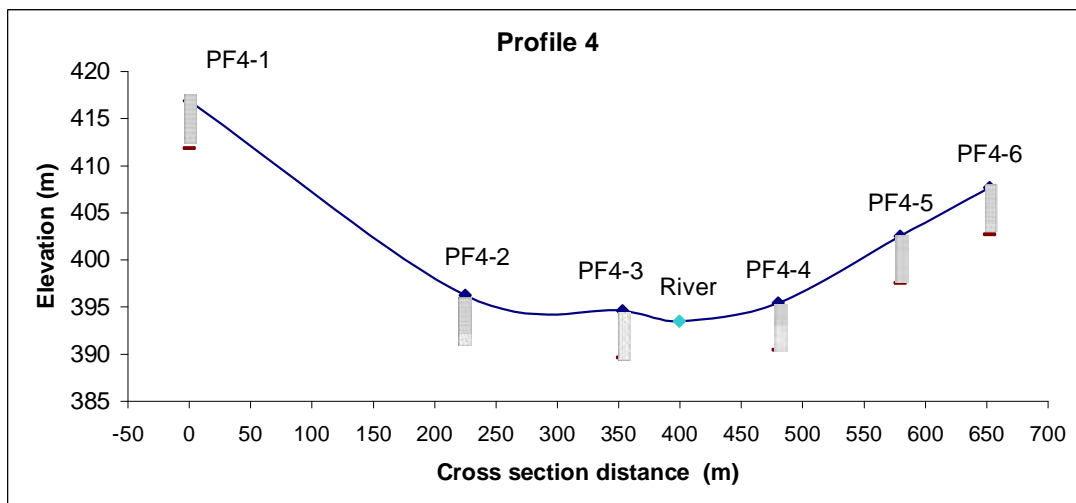


Heavy metal concentration relative to Background Value of soil

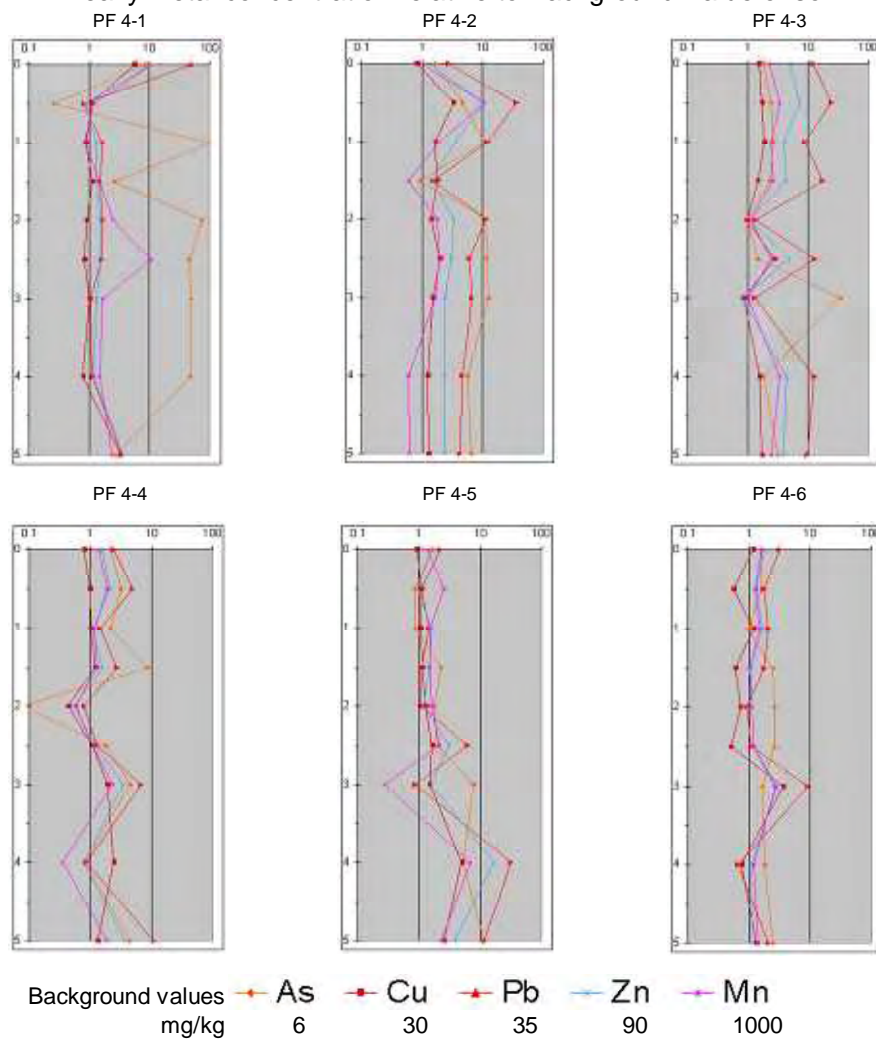


LEGEND

**Vertical Chemical Variations along the Profiles Lines (3) (Profile 3)**

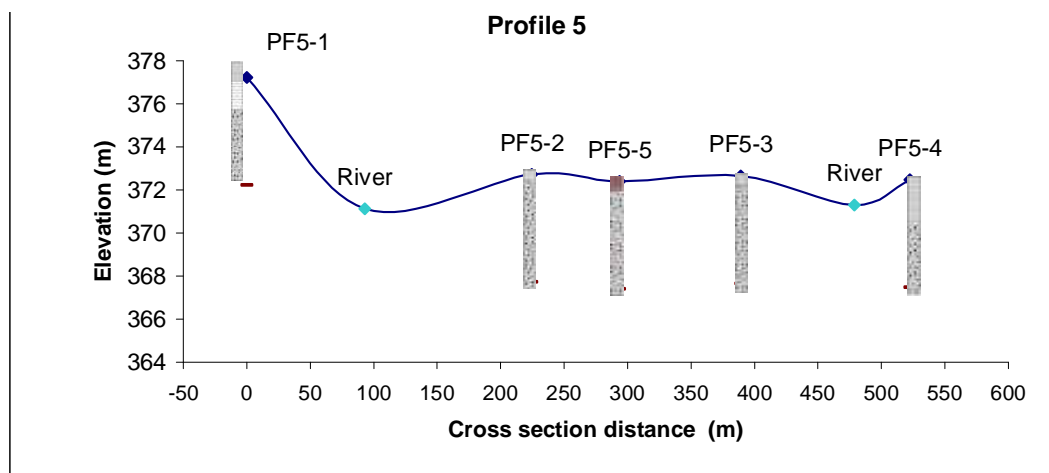


Heavy metal concentration relative to Background Value of soil

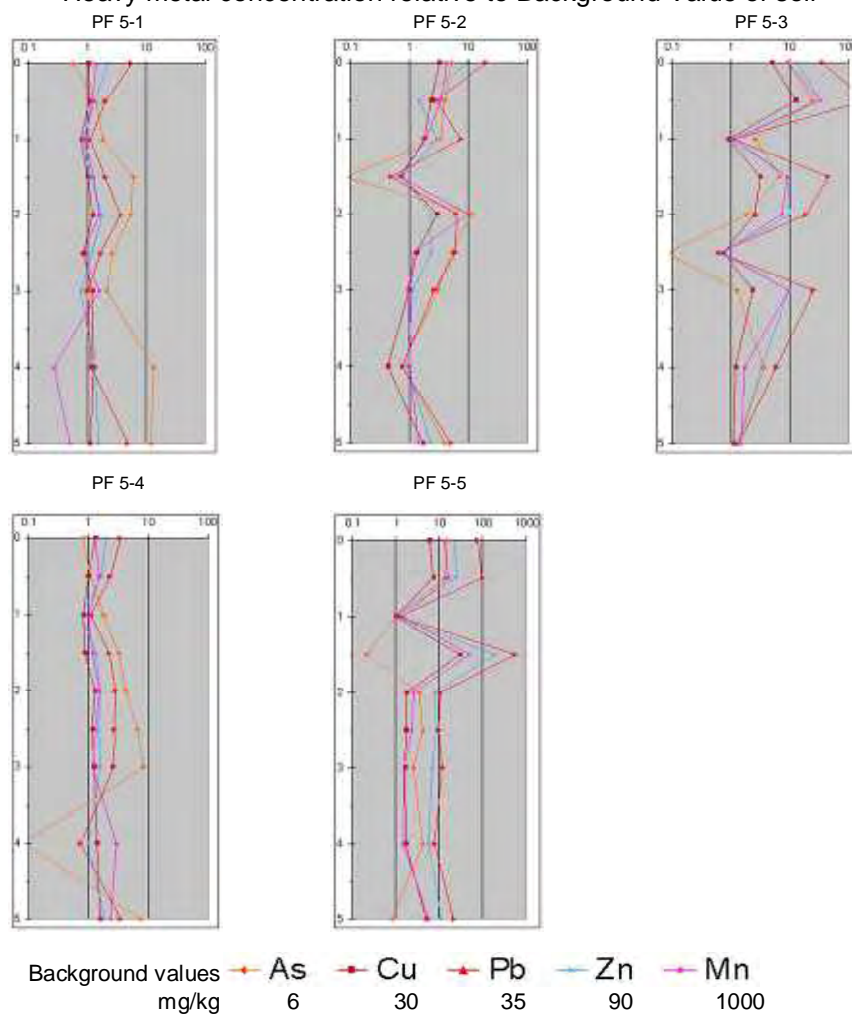


LEGEND

### Vertical Chemical Variations along the Profiles Lines (4) (Profile 4)

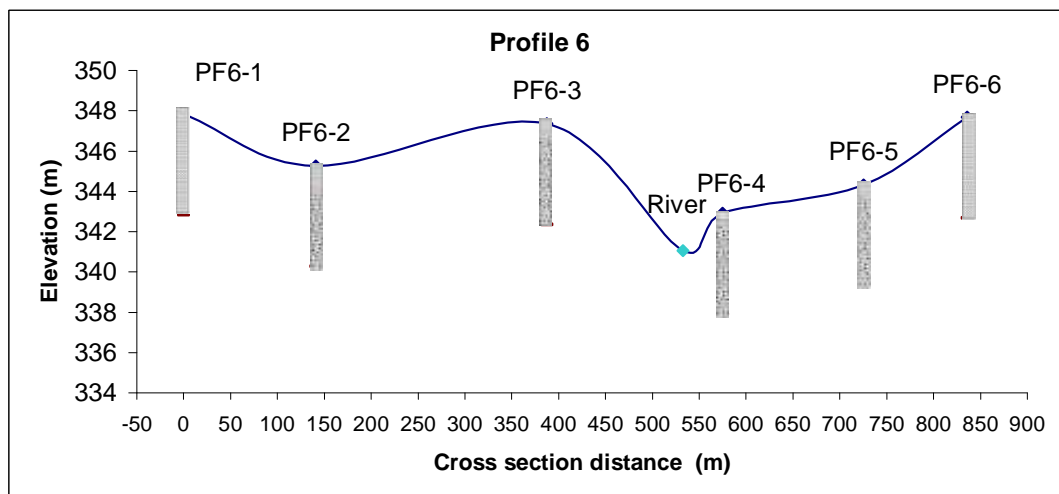


Heavy metal concentration relative to Background Value of soil

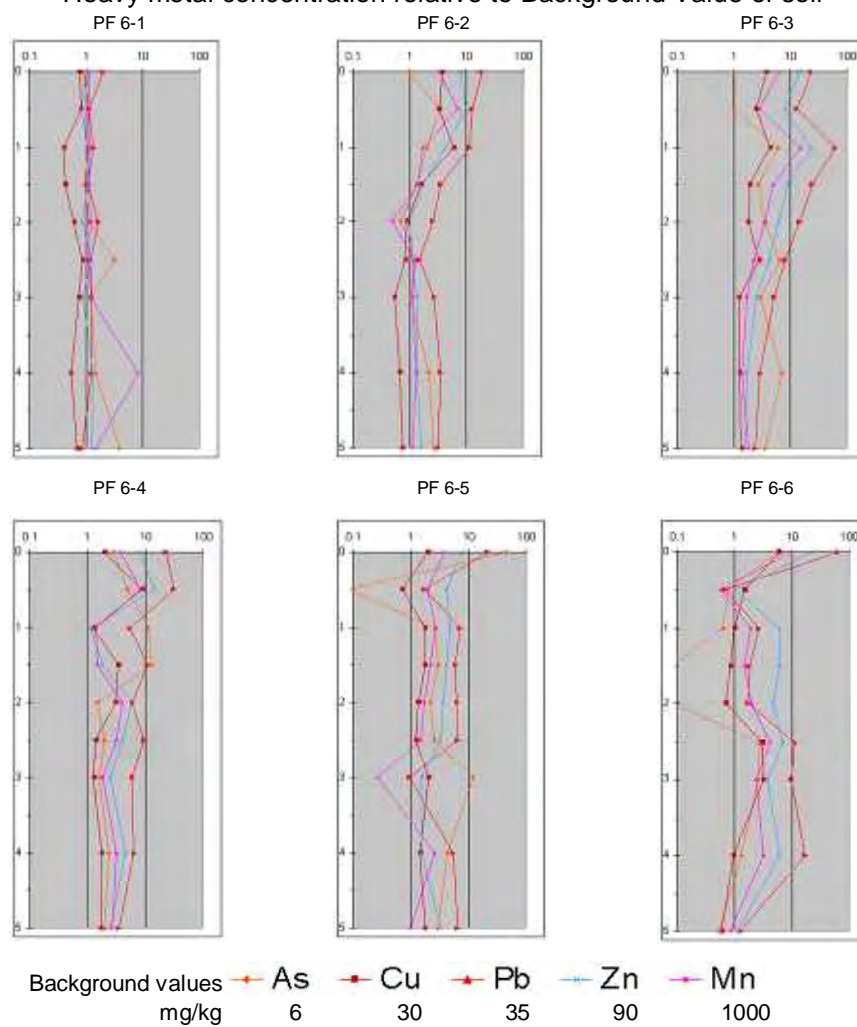


LEGEND

### Vertical Chemical Variations along the Profiles Lines (5) (Profile 5)



Heavy metal concentration relative to Background Value of soil



LEGEND

### Vertical Chemical Variations along the Profiles Lines (6) (Profile 6)