APPENDICES

Appendix 1 *Concentration of standard calibration solutions*

C_2(ppm)	V_1(ml)	C_1(ppm)	*V_2(ml)
40	20	100	50
30	15	100	50
20	10	100	50
10	5	100	50
5	2.5	100	50
0	0	0	50**

V_1 = Volume of stock solution (ml)
C_1 = Concentration of stock solution (ppm)
*V_2 = Final volume of calibration solution * usually the volume of volumetric flask*
C_2 = Calibration solution concentration (ppm)
*** = Calibration blank - usually distilled water*

Appendix 2. ***Prompt-List in the Operation of the AAS Perkin Elmer 2380 at the Department of Geological Sciences, Faculty of Science, Chiang Mai University, Thailand.***

Starting Up

Input Fan (north window)
Extraction fan
Compressor (plug in, open air tap)
Plug in U.P.S.
Acetylene Supply
* N_2O Supply
* Plug-in valve-warmer
Hallow Cathode Lamp (e.g. Pb)
Choose Burner head (Spoiler or ***bead***)
" Lamp " anti-clockwise to stop
" Gain" anti-clockwise to stop
U.P.S. on
P.E. 2380 on
"Signal" at 'Lamp'
Lamp current
"Signal" at 'set-up'
Slitwidth
Coarse wavelength (283.3 nm for Pb)
Gain $\approx$20
Tune wavelength
Align lamp
Gain = 75
Oxidant flow
*Check N_2O/air swap
Acetylene flow
Drain & Tank
Ignite
* air $\rightarrow N_2O$
Signal at "ABS"
Aspirate water
AZ
Aspirate analyte giving absorbance $\approx$ 0.400
Nebulizer: oxidant flow
Align burner
Optimize C_2H_2 flow
Aspirate water
Aspirate analyte/samples

Closing down

* Compressor on
* White Flame
* N_2O air
Blue flame
Wash nebulizer
Extinguish flame
Taps off on gas cylinders & compressor
Bleed gas and air
" Gain" $\rightarrow$ 0
"Lamp" $\rightarrow$ 0
"Signal"$\rightarrow$ 'Lamp'
"Mode"$\rightarrow$ 'Cont'
"BG" $\rightarrow$ 'AA'
P.E. 2380 off
U.P.S. Off
Fuel & oxidant off
Relax cylinder-head valves
* Unplug valve warmer
Unplug U.P.S.
Unplug compressor
Bleed condensate
Extraction fan off
Input fan off
Remove hallow cathode lamp
Wipe burner chamber
Wash (& scrape) burner head
Record in logbook
Emplace covers

Appendix 3 ***Recommended methodology for finger probe textural analysis of soil***

(Soil Science: Methods and Applications , David L. Rowell, 1994)

This method was followed according to the recommended methodology and other considerations with the aid of diagram in Figure 11.

Materials, Equipment and Reagents

- Plate (porcelain), old cloth, trowel, plate, water

Method

* As much as possible use only one hand for soil sample, keeping the other hand clean or at least reasonably dry for writing down the results:
* Take about a handful of soil from the profile face.
* Remove "foreign bodies" such as roots, seeds and insects.
* Remove stones to leave the fine earth fraction. Although all particles > 2 mm should be removed, in practice very small stones may remain.
* Add a little water and then work (mould) the moist soil in the hand and then between the thumb first two fingers until the soil is uniformly moist and has been broken down into its individual particles. Clay soils initially dry need much working to satisfy these requirements.

Appendix 3. cont...

* Add more water or ore soil, working the soil until the sample is at its sticky point, i.e. the condition in which the soil being wetted just begins to stick to the fingers. Clay soils may seem to become drier as they are worked due to the continued absorption of water. More water may need to be added until the condition of the soil is stable.
* Follow the guidelines in Figure 11 and record a textural class.
* Wipe residual soil off hands thoroughly before taking another sample of soil for texture assessment

Appendix 4. ***Calibration data of Sept 16, 1996 analysis of lead in soil of Chiang Mai City***

Analyte Concentration	Transparency (%)	Optimized Absorbance	Beer-Lambert Absorbance
40	42.36	0.530	0.373
30	50.93	0.398	0.293
20	62.52	0.267	0.204
10	78.34	0.134	0.106
5	88.31	0.067	0.054
0	100.00	0.000	0.000
40	41.78	0.541	0.379
30	50.35	0.406	0.298
20	62.23	0.269	0.206
10	77.98	0.136	0.108
5	88.10	0.068	0.055
0	100.00	0.000	0.000

Regression Parameters:

Optical impurity as percentage of incidence beam	*18.28*
Intercept on optimized abs. (analyte conc. = 0)	*.0011738*
Slope of tangent where analyte conc. = 0	*0.013535*
S.D. on residuals of optimized absorbance Sy/x	*0.003466*

Appendix 5. ***Example of mathematical computation of the amount of lead (ppm) in soil with a given weight of soil sample Equation 4***

$$\text{Lead cont'n. } (\mu g/g \text{ soil}) = \frac{\text{Analyte cont'n. } (\mu g/mi) \times \text{Volume of sample(ml)}}{\text{Weight of soil. sample (g)}}$$

Taking for example the analysis of IAEA Soil 5.

Given:	Absorbance Reading of SOIL 5	=	0.093
	Analyte Concentration	=	8.485 μg/mL
	Volume of sample	=	50 mL
	Weight of soil sample	=	3 g

Solution: *Substituting values*

$$\text{Lead conc. } (\mu g/g) = \frac{8.45 \text{ ug/ml} \times 50 \text{ ml}}{3.00 \text{ g}}$$

$$= 141.42\ \mu g/g \text{ soil(ppm)}$$

Appendix 6. ***Lead level (ppm) in soil at different grids of Chiang Mai City.***

Grid No./ Site	Mean	Remarks/Location
G20	26.19	Airforce Mililtary Area
G14	32.17	Outside Chiang Mai Moat
G17	33.49	Along Mae Ping
G2	36.21	Outside Chiang Mai Moat
G5	36.58	Along Mae Ping
G3	37.03	Outside Chiang Mai Moat
G24	38.81	Along Mae Ping & Outside CM Moat
G6	38.92	Along Mae Ping & Outside CM Moat
G11	38.97	Along Mae Ping
G4	41.16	Outside Chiang Mai Moat
G23	41.97	Along Mae Ping
G8	42.79	Outside Chiang Mai Moat
G22	42.80	Outside Chiang Mai Moat
G12	46.45	Outside Chiang Mai Moat
G9	46.46	Within Chiang Mai Moat
G18	53.68	Outside Chiang Mai Moat
G21	55.00	Outside Chiang Mai Moat
G15	73.21	Within Chiang Mai Moat
G16	83.43	Within Chiang Mai Mote
G10	102.98	Within Chiang Mai Moat

Appendix 7. ***pH level in soil at different grids of Chiang Mai City.***

Grid No./Site	Mean	Remarks/Location
G18	6.78	Outside Chiang Mai Moat
G20	6.80	Military Air Field
G14	6.89	Outside Chiang Mai Moat
G6	6.95	Along Mae Ping & Outside CM Moat
G4	7.08	Outside Chiang Mai Moat
G24	7.11	Along Mae Ping & Outside CM Moat
G5	7.20	Along Mae Ping
G12	7.22	Outside Chiang Mai Moat
G22	7.22	Outside Chiang Mai Moat
G21	7.25	Outside Chiang Mai Moat
G17	7.26	Along Mae Ping
G10	7.29	Within Chiang Mai Moat
G11	7.32	Along Mae Ping
G2	7.35	Outside Chiang Mai Moat
G15	7.38	Within Chiang Mai Moat
G8	7.40	Outside Chiang Mai Moat
G9	7.42	Within Chiang Mai Moat
G23	7.47	Along Mae Ping
G16	7.48	Within Chiang Mai Moat
G3	7.49	Outside Chiang Mai Moat

Appendix 8. ***Organic matter content level (%) in soil at different grids of Chiang Mai City***

Grid No./ Site	Mean	Remarks/Location
G3	2.48	Outside Chiang Mai Moat
G17	2.74	Along Mae Ping
G22	2.77	Along Mae Ping
G20	2.80	Military Air Field
G16	3.15	Within Chiang Mai Mote
G14	3.22	Outside Chiang Mai Moat
G9	3.28	Within Chiang Mai Moat
G10	3.34	Within Chiang Mai Moat
G24	3.42	Along Mae Ping
G4	3.78	Outside Chiang Mai Moat
G21	3.79	Outside Chiang Mai Moat
G12	3.90	Outside Chiang Mai Moat
G2	3.94	Outside Chiang Mai Moat
G11	3.94	Along Mae Ping
G23	4.10	Along Mae Ping
G5	4.39	Along Mae Ping
G15	4.40	Within Chiang Mai Moat
G8	4.50	Outside Chiang Mai Moat
G6	5.07	Outside Chiang Mai Moat
G18	5.54	Outside Chiang Mai Moat

Appendix 9. ***Comparing means of clay content (%) in soil at different grids using LSD Test with significance level 0.05.***

Grid No./Site	Mean	Significant difference*	Remarks/Location
G2	12.5	a	Outside Chiang Mai Moat
G3	12.5	a	Outside Chiang Mai Moat
G6	12.5	a	Outside Chiang Mai Moat
G15	12.5	a	Within Chiang Mai Moat
G15	12.5	a	Within Chiang Mai Moat
G17	12.5	a	Along Mae Ping
G20	12.5	a	Military Air Field
G22	15.0	a	Along Mae Ping
G8	15.0	ab	Outside Chiang Mai Moat
G10	15.0	ab	Within Chiang Mai Moat
G14	15.0	ab	Outside Chiang Mai Moat
G21	15.0	ab	Outside Chiang Mai Moat
G24	15.0	ab	Along Mae Ping
G5	17.0	b	Along Mae Ping
G23	17.0	b	Along Mae Ping
G4	17.5	b	Outside Chiang Mai Moat
G9	17.5	b	Within Chiang Mai Moat
G11	17.5	b	Along Mae Ping
G12	17.5	b	Outside Chiang Mai Moat
G18	18.0	b	Outside Chiang Mai Moat

** Homogenous subsets (a,b,c), highest and lowest means are not significantly different*
*The difference between two means is significant if MEAN (J) - MEAN (I) > = 15.9794 * RANGE * SQRT (1/N(I) + 1/N(J) with the following value(s) for RANGE:2.95*

Appendix 10. ***Registered vehicles in Chiang Mai (1991-94).***

No.	Type of vehicle	1991	1992	1993	1994
1	Car more than 7 passengers	21042	25378	31839	39827
2	Car less than 7 passengers	9077	9652	10615	11338
3	Light truck	46464	56034	68814	81392
4	Tuk tuk	20	22	25	23
5	Taxi used for province	-	-	-	-
6	Taxi less than 7 passengers	-	-	-	-
7	Taxi used for municipal (cilo)	88	88	86	6
8	Taxi less than 8 passengers	1149	1149	1098	1098
9	Business cars	-	-	29	30
10	Motorcycles	276561	307643	355318	394493
11	Tractor	688	792	1416	861
12	Bulldozers	42	45	54	4
13	Big tractor	7	7	13	5
14	Heavy truck	30	26	31	29
15	Bicycle	3050	3040	3033	3033
	Total	358218	403876	472371	532219
	Rate of increase/year		11.30%	14.5%	11.24%

**Average rate of Increase/year: 12.4 %*

Source: Land Transportation Office of Chiang Mai

Appendix 11 ***High and low traffic density (number of vehicles/hr) of old Chiang Mai City as of Janauary1996.***

Type of Vehicle	**Traffic Density (Number of Vehicles/hr: Taken from 30 identified roads)**					
	Heavy	%	Low	%	Ave.	%
Motorcycles	28969	48.27	17916	42.97	23442	46.10
Pick-ups/Minibus	15451	25.74	13319	31.94	14385	28.29
Personal Cars	13238	22.06	7223	17.32	10230	20.19
Taxi(*Tuktuk*)	612	1.02	956	2.29	784	1.54
Buses	141	0.23	98	0.24	119	0.24
Trucks/Vans	1087	1.81	1567	3.76	1327	2.61
Trucks>10W	38	0.06	183	0.44	110	0.22
Others***	471	0.78	431	1.03	451	0.88

Note:** *Data were collected by the students of ERA Batch 1995 in the old Chiang Mai City (enclosed by Moat) from 30 roads in December 1995- January 1996 for the requirement in GIS Class and the formulation of Environmental Quality Map of Chiang Mai City*

*** *Others are bicycles, 3-wheeled bicycles, bulldozers, tractors*

Appendix 12. ***Definition of Terms***

Absorbance Fit (AF)

- computer software used to compute the analyte concentrations from given absorbance values.

Atomic Absorption Spectroscopy (AAS)

-refers to the absorption of energy from a light source, with a consequent decrease in the radiant power transmitted through the flame. The AAS makes use of the fact that the free atoms of an element absorb light at wavelengths characteristic of that element and that the extent of the absorption is a measure of the concentration of these atoms in the light path.

Attribute

- the attribute of that cell is the characteristic or quality we find in that location.

Attribute value files

- a non-spatial data file in which the attributes of numbered regions (or features) are listed.

Environmental Risk Assessment (ERA) -

- Refers to the analysis (identification and quantification) and evaluation of existing or potential (environmental) hazards to natural resources and to human health. This comprises the determination of the significance of effects on man, ecosystems or part of the ecosystems, including the assessment of the likelihood (or frequency) and severity of impacts and their consequences, especially with regard to stability and elasticity of ecosystems.

Geographic Information System (GIS)

- is one of the useful information technologies in handling, analyzing and modeling geographic information for resource management whose main purpose is to process spatial information and its strongest and most successful areas of applications are addressed to problems in the environment.

IDRISI-GIS Program

- is a grid- based geographic information and image processing system developed by the Graduate School of Geography at Clark University, USA which is a raster-based microprocessor GIS and image processing system.

IDRISI

- born in 1099 AD in the Spanish Colony of Ceuta on the North African coast (now Morocco), educated at the University of Cordova in Spain, and widely traveled throughout Europe, North Africa, the Middle East and Central Asia. Idrisi was a cartographer and geographer of major significance during the medieval period to whom this software was dedicated.

Image

-a representation of some rectangular portion of space. Images are stored in IDRISI as a collection of numeric attribute codes, arranged in raster format.

Georeferencing

-refers to the location of an image or vector file in space as defined by the known coordinate referencing system.

Scanner

-a devise used for the direct collection of raster data.

Vector

- is any variable quantity that can be described as having magnitude and direction and which can be resolved into components.

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