KEMENTERIAN TENAGA, SAINS, TEKNOLOGI, ALAM SEKITAR DAN PERUBAHAN IKLIM

NUKLEAR MALAYSIA

'Teknologi Nuklear Pemacu Wawasan Negara'
'Nuclear Technology Propels The Nation Vision'

Spatial Distribution of Soil Elemental Pollution in the vicinity of Kapar Industrial Area

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1.0 Introduction

- Heavy metal, major, trace, actinide and rare earth elements (REEs) contamination has been a major concern due to it's capability to transfer through the food web that consequently will give an adverse effects to human health.

- In Malaysia, elemental pollution of heavy metal, major and trace elements, actinides (U & Th) and REEs in soil was given attention nowadays due to it's relation to the rapid industrial development.

- Kapar and Shah Alam (Selangor state), Senawang – (Negeri Sembilan state), Gebeng (Lynas – Pahang state), Prai – (Penang state) and Pasir Gudang - (Johor state) of industrial area in Malaysia.

1.0 Introduction

- Description related to the status of contamination.

Table 1 Degree of trace metal contamination according to different indices: enrichment factor (EF), geoaccumulation index (Igeo), and potential ecological risk index (RI)

Index	Value	Degree of contamination
EF	<2	Depletion to minimal enrichment
	2–5	Moderate enrichment
	5–20	Significant enrichment
	20–40	Very high enrichment
	>40	Extremely high enrichment
Igeo	<0	Uncontaminated
	0–1	Uncontaminated to moderately contaminated
	1–2	Moderately contaminated
	2–3	Moderately to strongly contaminated
	3–4	Strongly contaminated
	4–5	Strongly to extremely contaminated
	>5	Extremely contaminated
RI	<150	Low ecological risk
	150–300	Moderate ecological risk
	300–600	Considerable ecological risk
	>600	Very high ecological risk

Sources: Ayari, et al., 2016.

1.0 Introduction

Enrichment factor (EF)

- The enrichment factor (EF) is a common approached in estimating the anthropogenic impact for metal concentration over natural or background level concentration.

$$EF = \frac{(El)_{sample} / (X)_{sample}}{(El)_{crustal} / (X)_{crustal}}$$ Equation ------- (1)

Where: $(El)_{sample}$ concentration of interest element in sample.

$(X)_{sample}$ concentration of reference element for normalization in sample.

$(El)_{crust}$ concentration values of interest element from literature.

$(X)_{crust}$ concentration value of reference element for normalization from literature.

Sources: Zahra, et al., 2014.

1.0 Introduction

- Enrichment factor (EF) index classifications.

EF value	Description of sediment classification
> 40.0	Extremely enrichment
20.0 < EF ≤ 40.0	Very high enrichment
5.0 < EF ≤ 20.0	High enrichment
2.0 < EF ≤ 5.0	Moderate enrichment
≤ 2.0	No to minor enrichment

1.0 Introduction

Geoaccumulation index

- geo-accumulation index (I_{geo}) – is define the degree of anthropogenic pollution by comparing current concentration of elemental in soil over earth's crust.

$$I_{geo} = \log_2\left(\frac{Cn}{1.5 \bullet Bn}\right)$$

Equation ------- (2)

Where: C_n - concentration of interest element.

B_n - background value of interest reference element concentration from earth's crust (literature).

1.5 - correction factor for the variation of the background values due to lithogenic effects.

Sources: Müller (1969); Ayari, et al., 2016

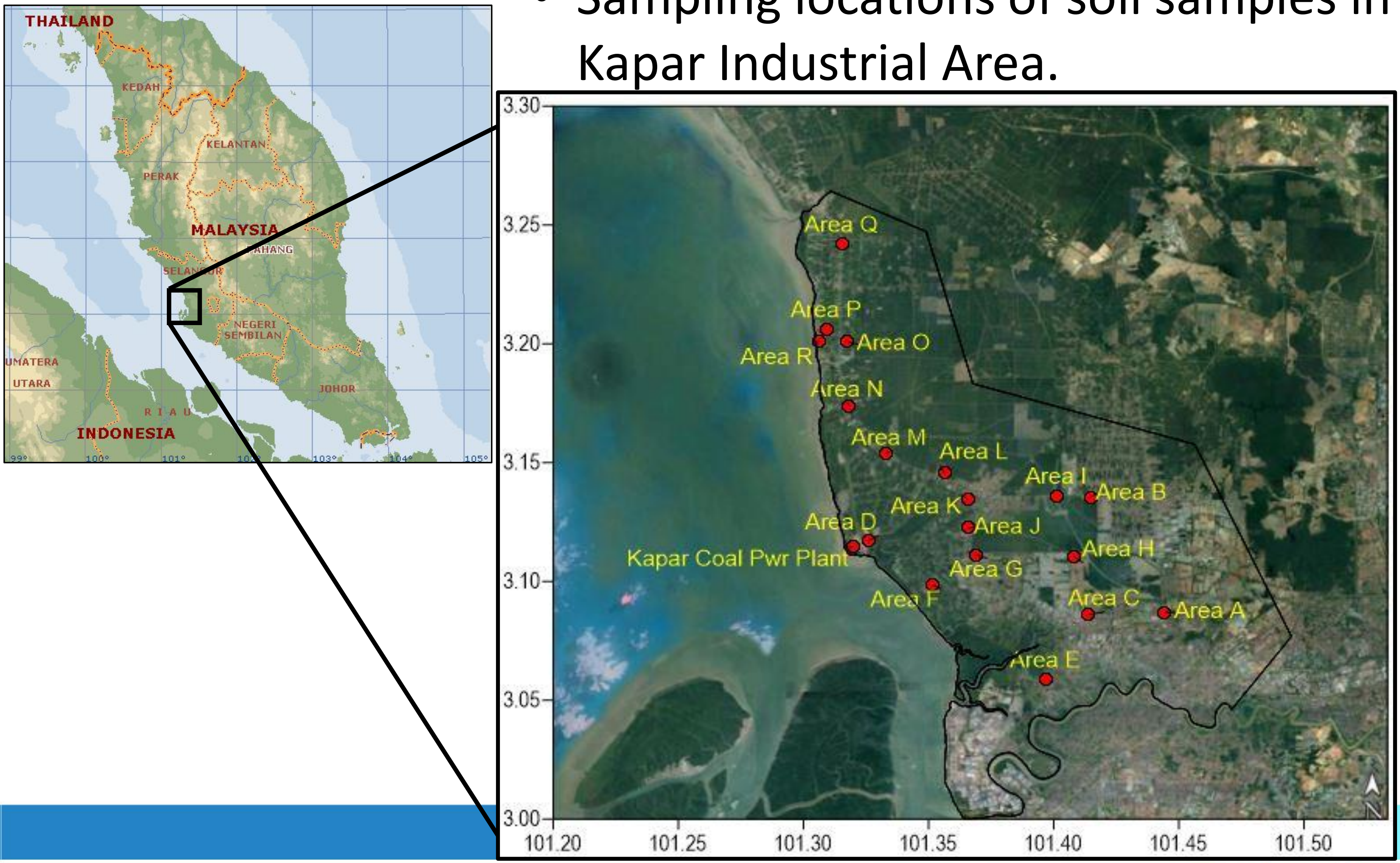
1.0 Introduction

- Geo-accumulation index categorised.

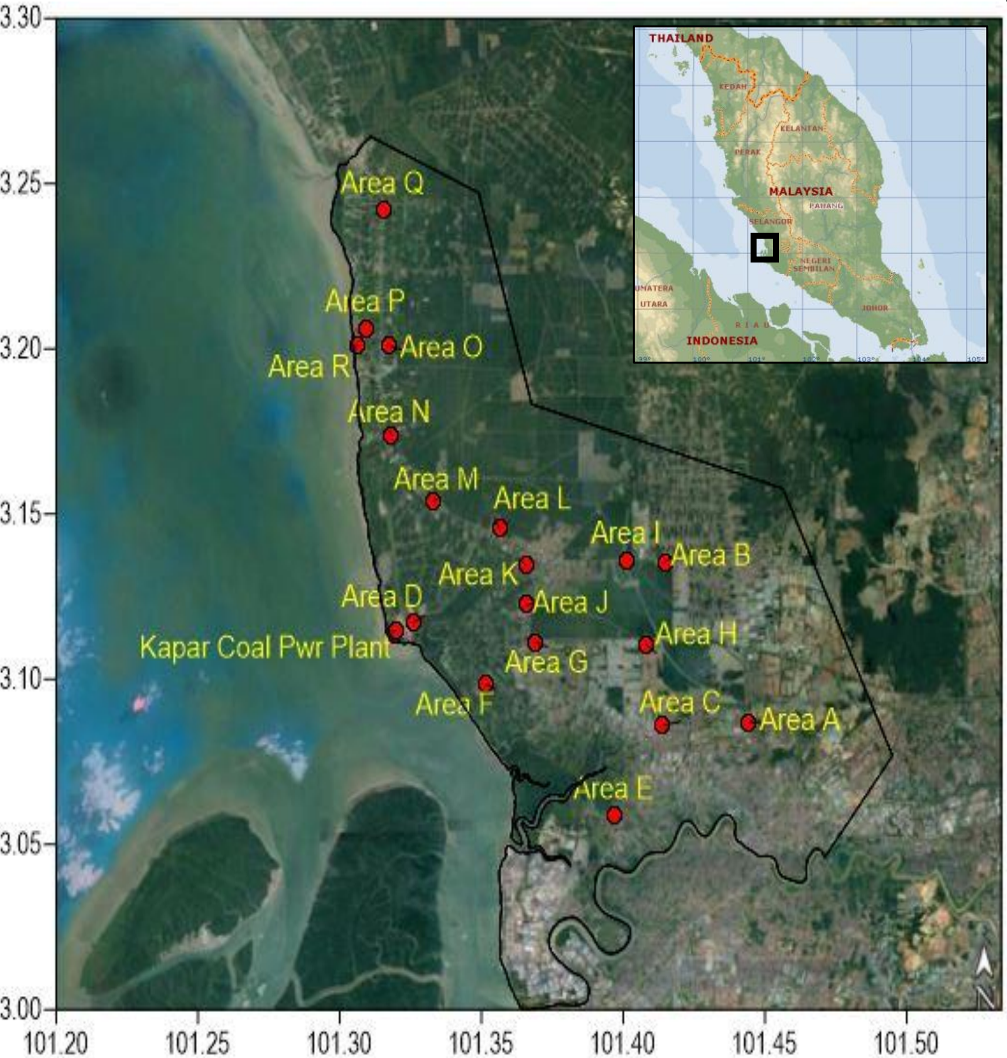
I_{geo} value	I_{geo} class	Description of sediment contamination
> 5	6	Very strongly contaminated
> 4 – 5	5	Strong to very strong contaminated
> 3 – 4	4	Strongly contaminated
> 2 – 3	3	Moderately to strongly contaminated
> 1 – 2	2	Moderately contaminated
> 0 – 1	1	Uncontaminated to moderately contaminated
< 0	0	Uncontaminated

2.0 Methodology – Kapar Industrial Area

- Sampling locations of soil samples in Kapar Industrial Area.

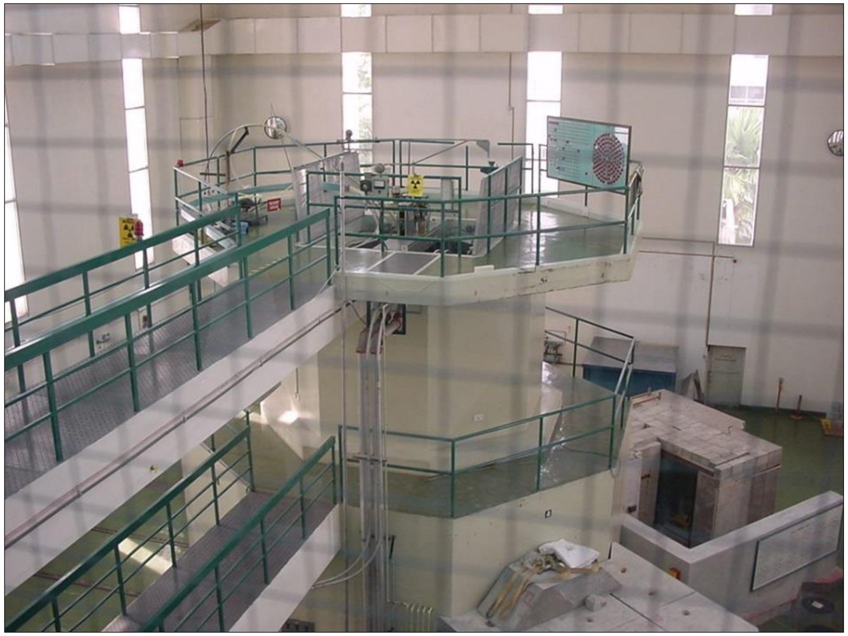


2.1 Methodology - Kapar Industrial Area (18 locations)



Location	Activities description
Area A	Residential area
Area B	Meru South Industrial Park – Electrical , cable, aluminium, smelter, glove and steel industries.
Area C **Area H**	Sg. Kapar Industrial Park – automotive, plastic, glove, wood, steel, costing industries
Area D	Close to Kapar coal power plant, agriculture area
Area E	Agriculture area
Area F	Agriculture area
Area G	Residential area, and shop lot
Area I **Area J** **Area K**	Kapar Industry Park – Manufacturing, coating, plastic and wood industries.
Area L	Residential area, small agriculture activities
Area M	Residential area, small agriculture activities
Area N	Kg. Tambak Jaya - Food, manufacturing, wood, furniture, plastic and coating industries.
Area O	Agriculture area, residential area
Area P	Agriculture area, residential area
Area Q	Residential area, small agriculture activities
Area R	Agriculture area, residential area

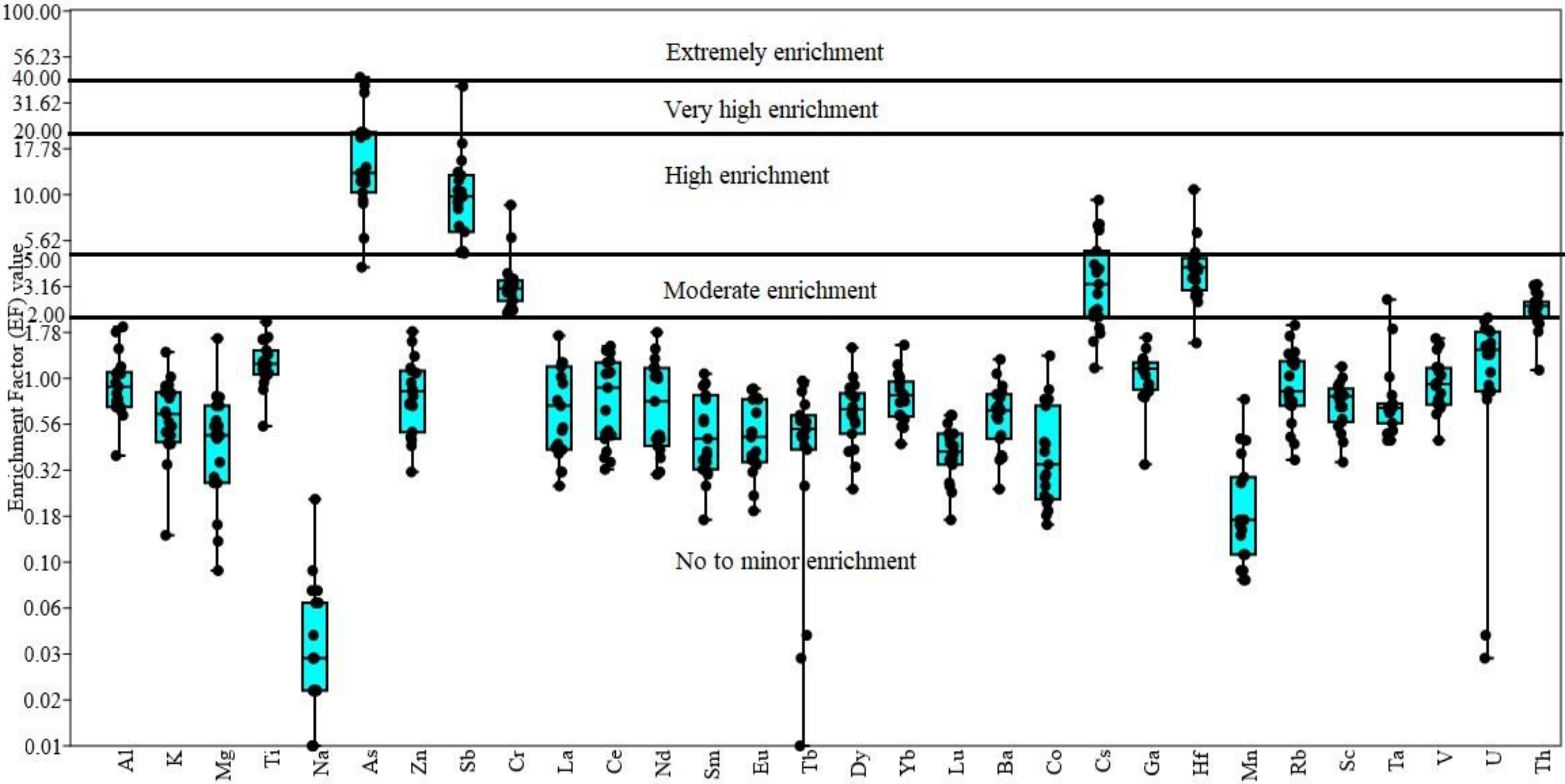
2.2 Methodology – Analysis of soil by using NAA Technique



- PUSPATI Triga Mark II Research Reactor at Malaysian Nuclear Agency
- Max power 1MW
- Average neutron flux 1.0 to 2.0 X 10^{12} $n.cm^{-2}.s^{-1}$
- Normal operational 750kW
- Soil sample weight – 0.1 to 0.2 g
- Analysis process
  - **Short half-life radionuclide** such as Al, Ca, K, Na, Ti - 1 minute irradiation, 20 minutes cooling and 10 minutes counting (gamma spectrometry)
  - **Long half-life radionuclides** such as As, Cr, Zn, Sb and Rare Earth Elements (REEs) – 6 hours irradiation, 2- 4 days cooling, 1 hour for counting.

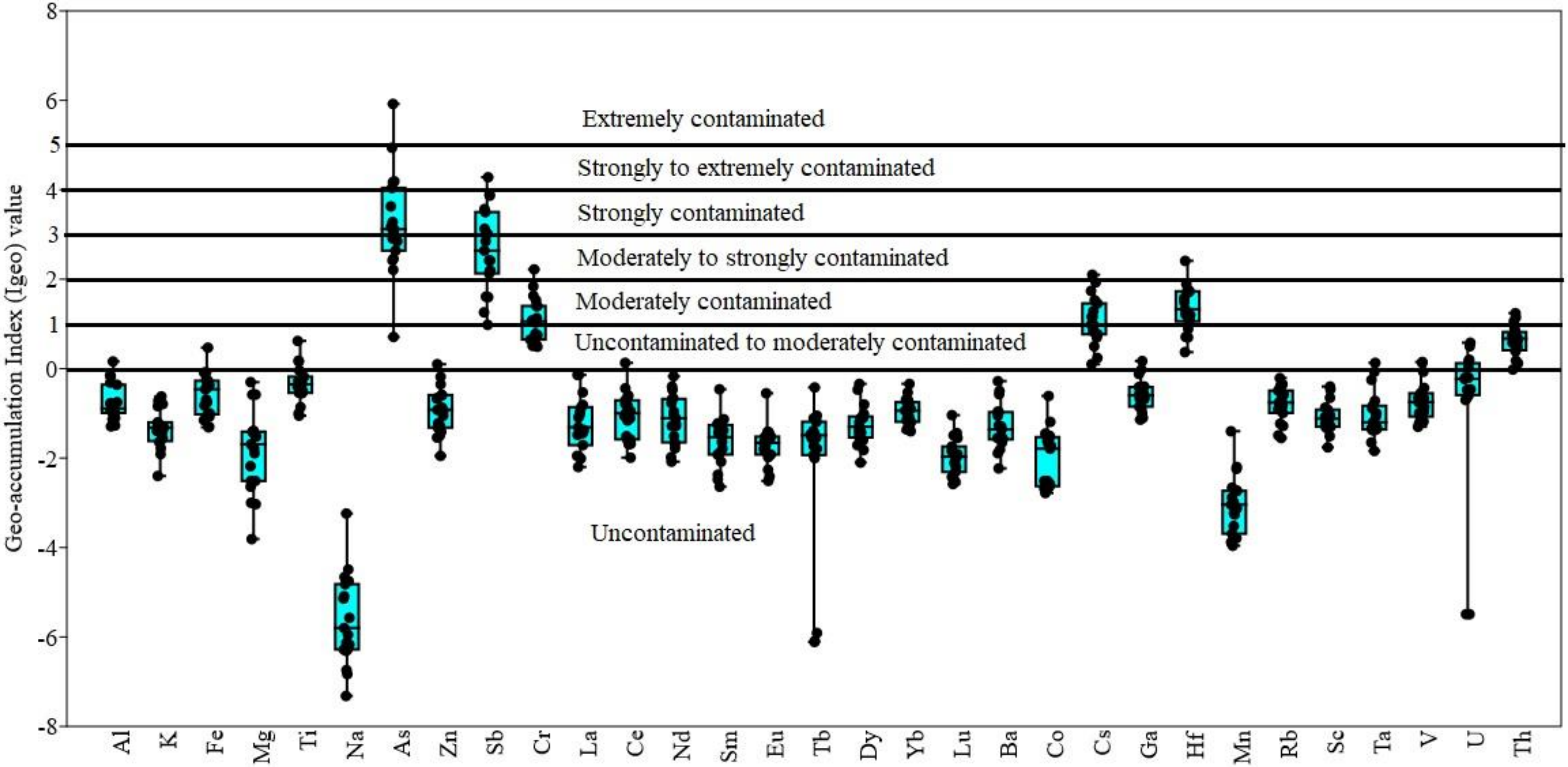
3.0 Results and Discussion

- Enrichment Factor (EF) of Elements in Soil of the Kapar Industrial Area



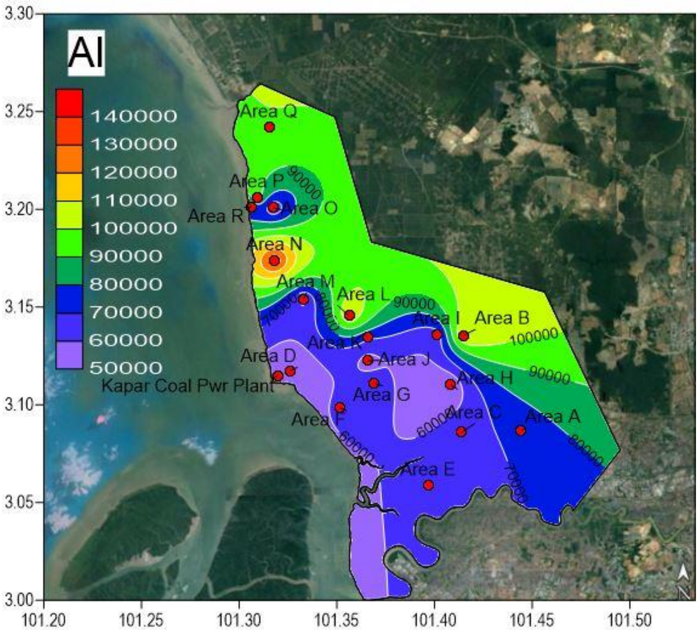
3.0 Results and Discussion

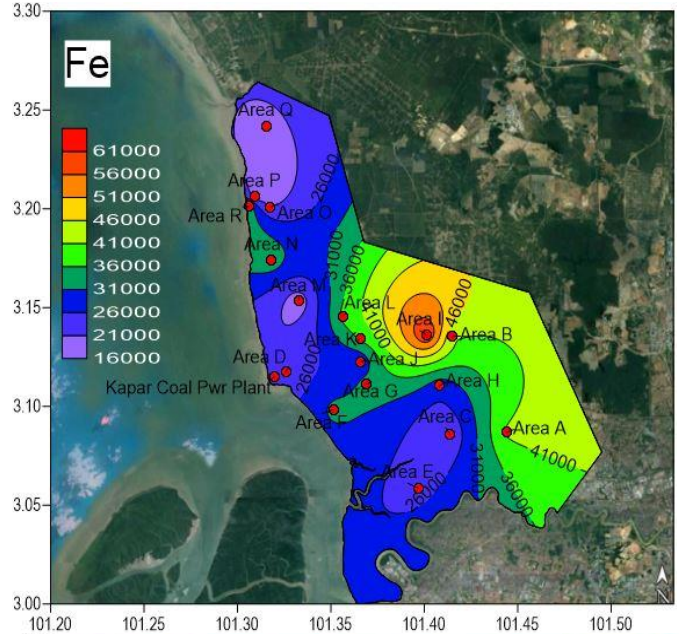
- Geo-accumulation Index (Igeo) of Elements in Soil of the Kapar Industrial Area

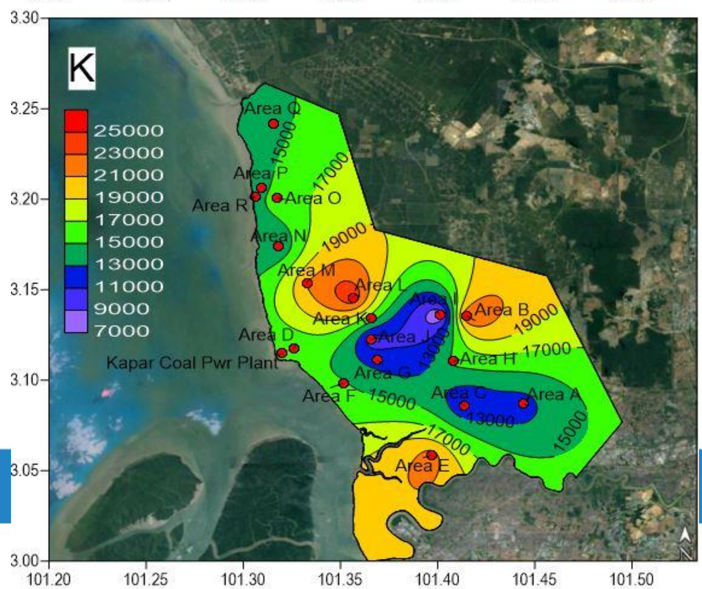


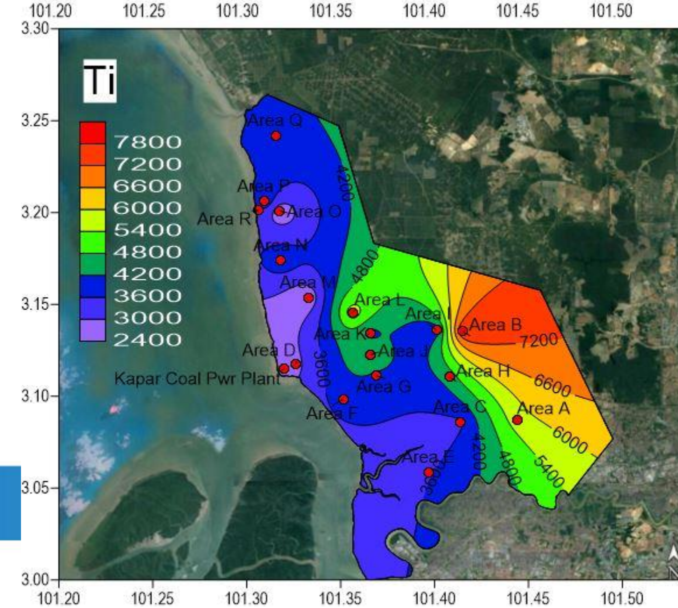
3.0 Results and Discussion

❑ Distribution of Major Elements in Soil of the Kapar Industrial Area



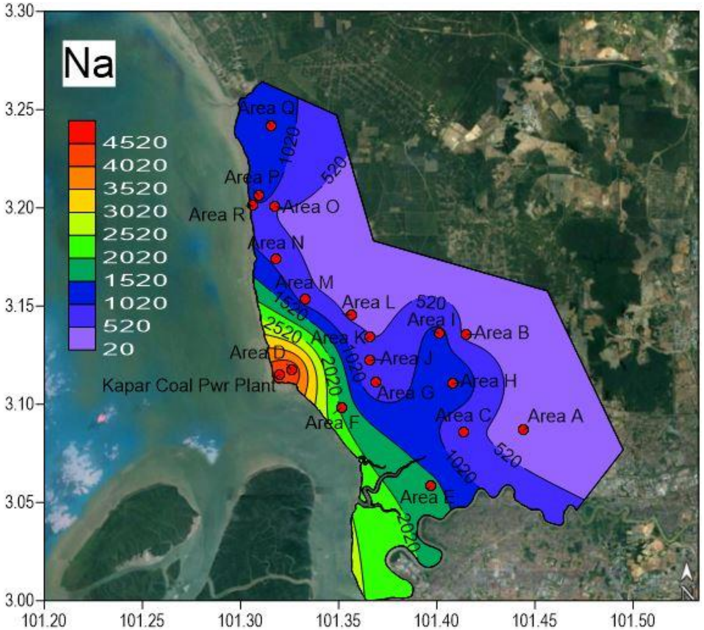


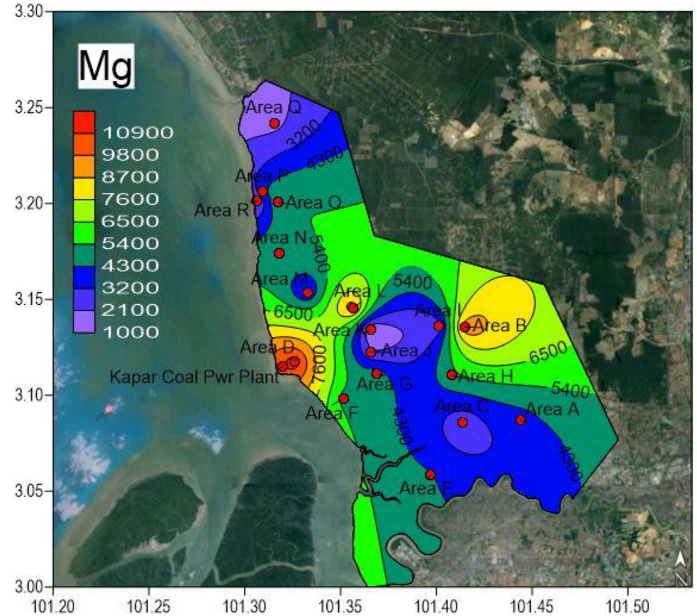


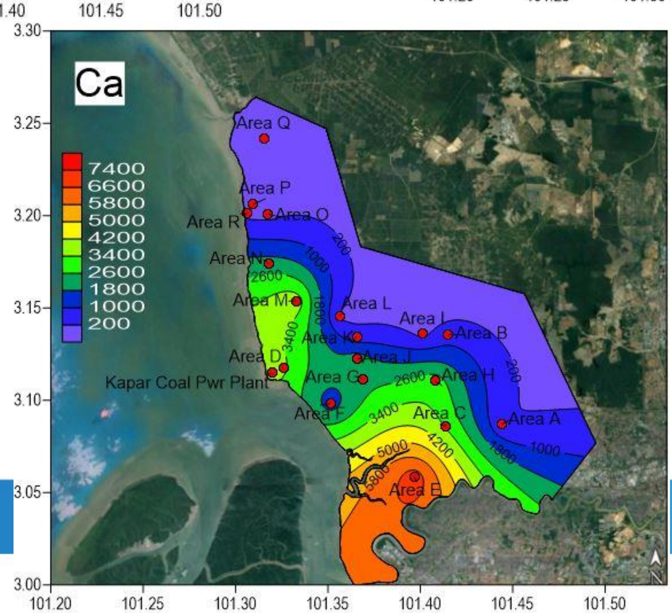


3.0 Results and Discussion

- Distribution of Major Elements in Soil of the Kapar Industrial Area

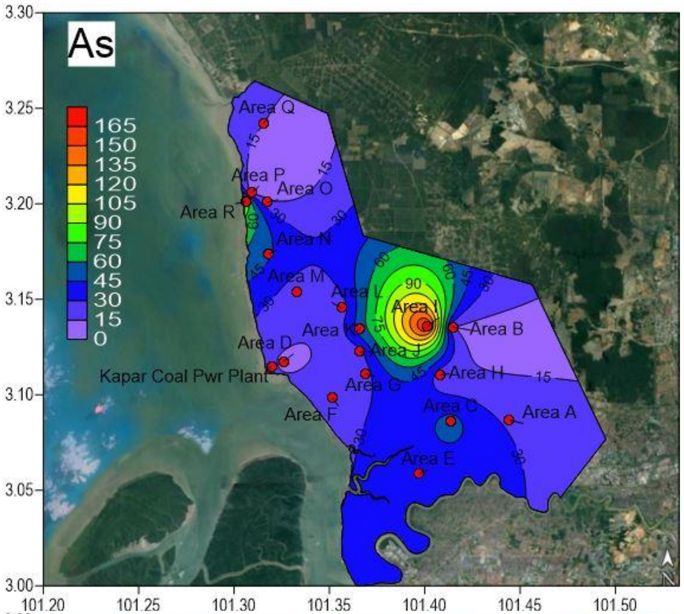


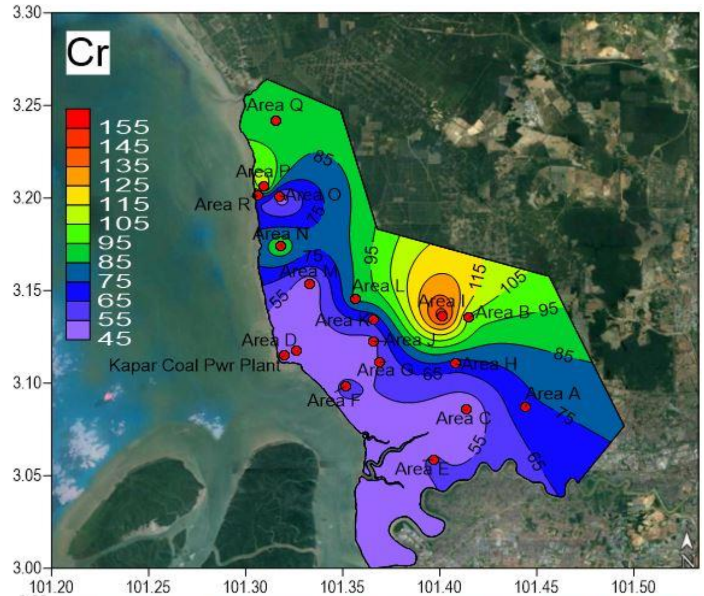


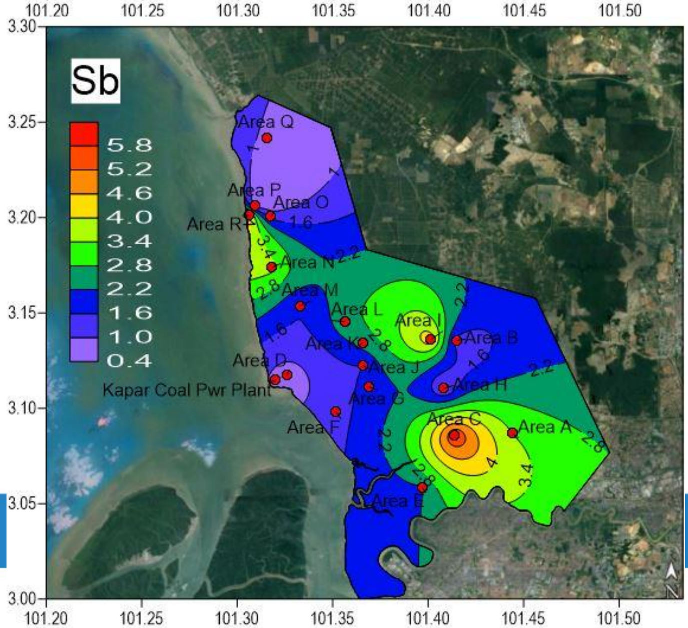


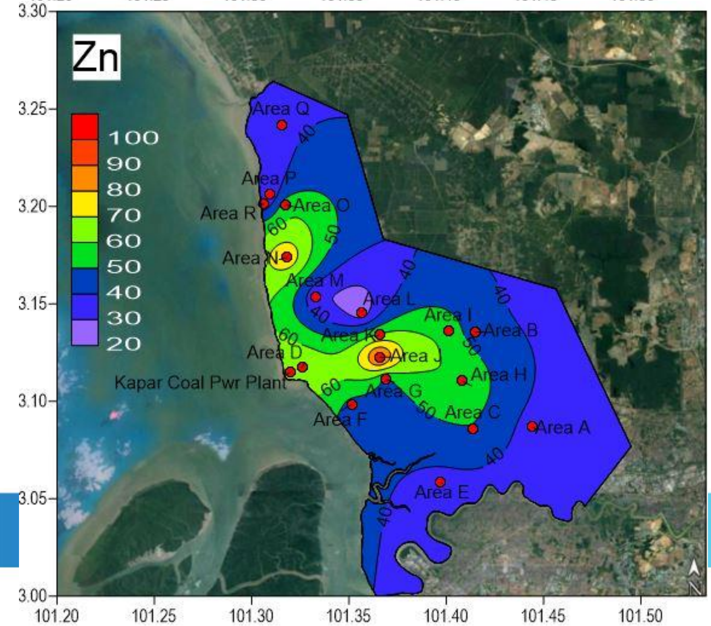
3.0 Results and Discussion

❑ Distribution of Heavy metals in Soil of the Kapar Industrial Area



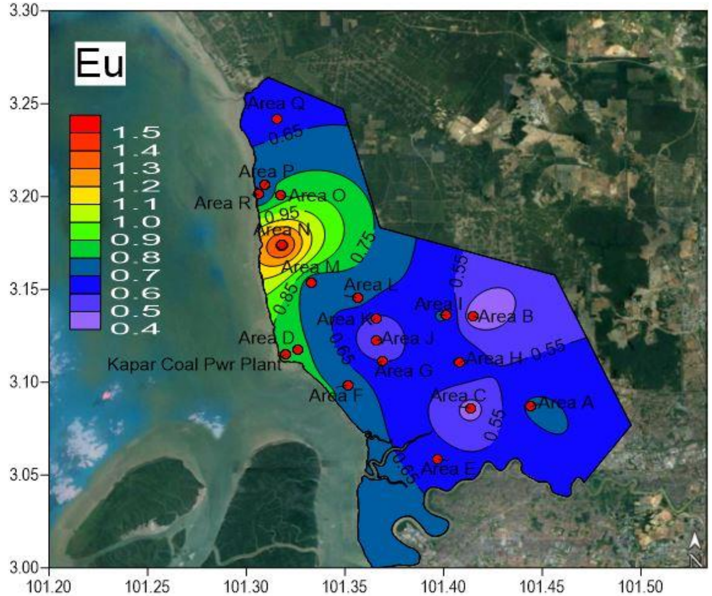


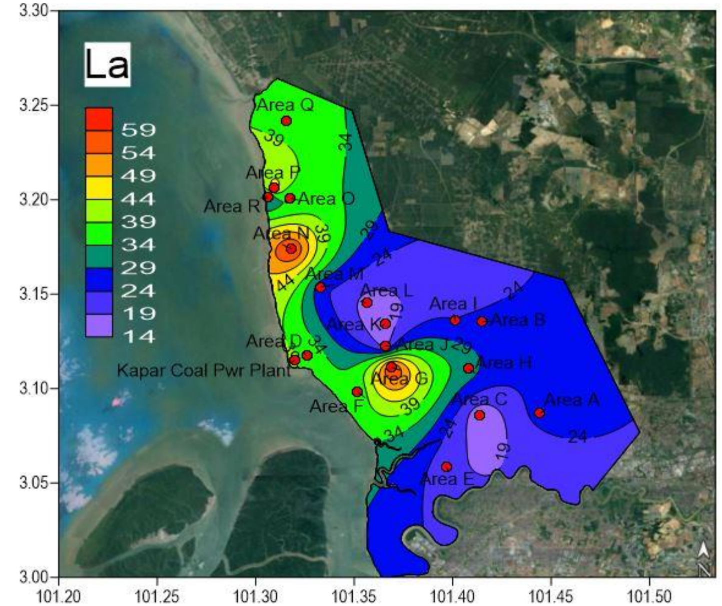


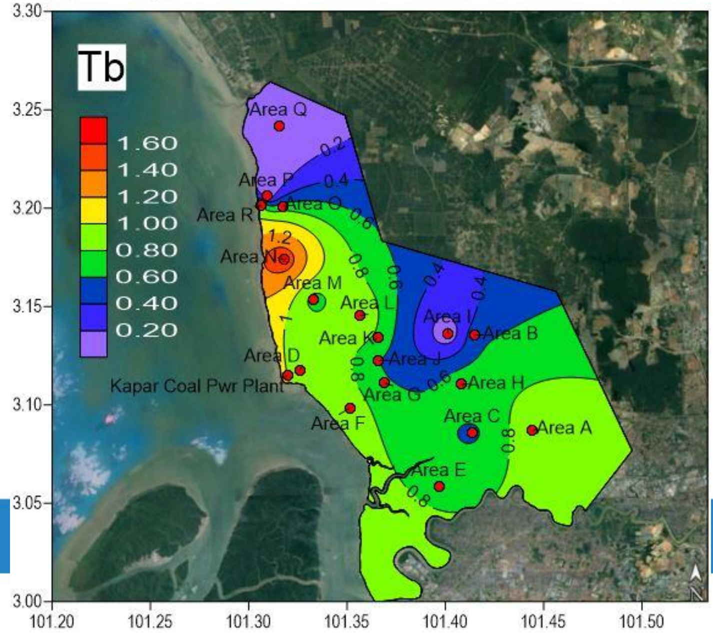


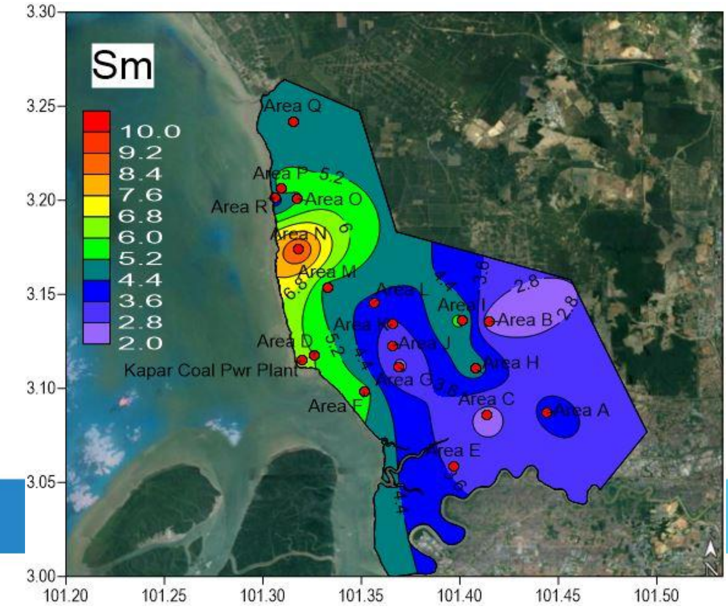
3.0 Results and Discussion

- Distribution of REEs in Soil of the Kapar Industrial Area



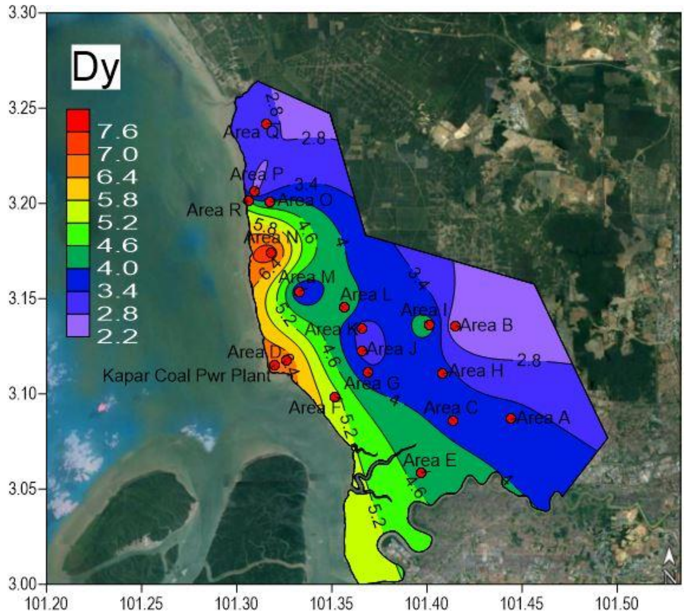


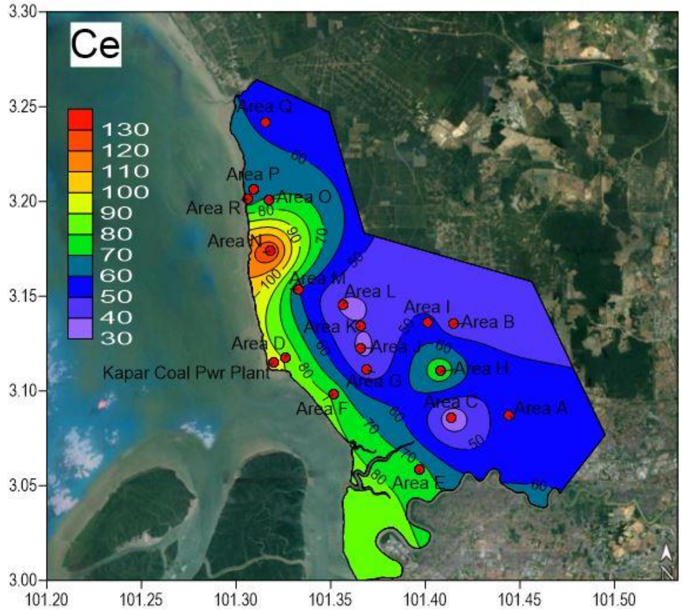


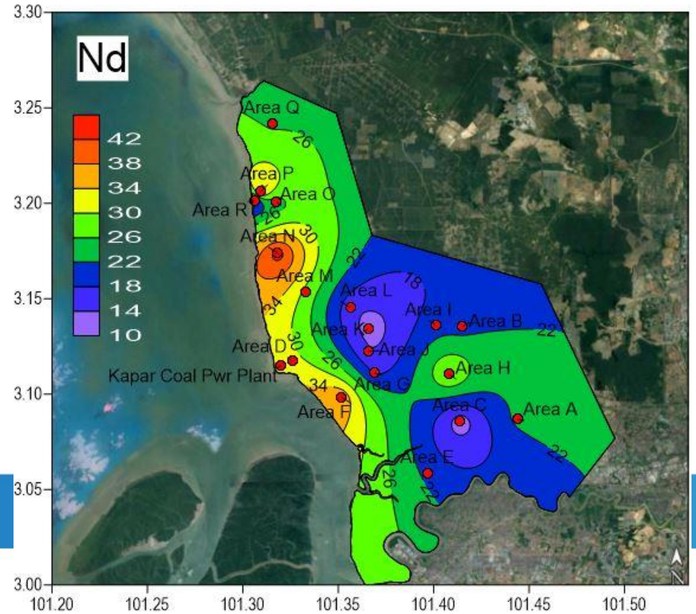


3.0 Results and Discussion

- Distribution of REEs in Soil of the Kapar Industrial Area

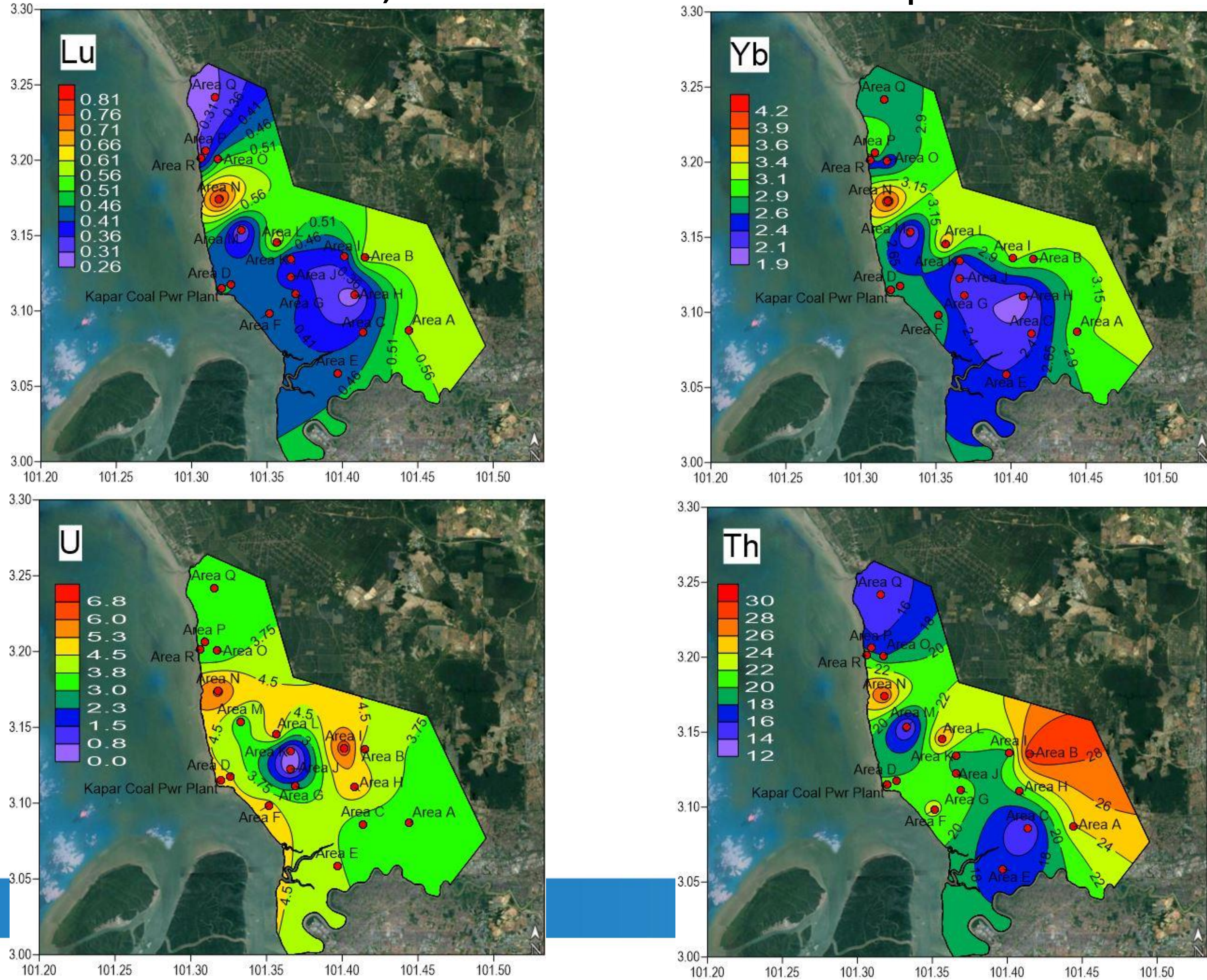






3.0 Results and Discussion

- Distribution of REEs, U and Th in Soil of the Kapar Industrial Area



4.0 Conclusion

- The source of Fe, K and Ti were probably originated from geogenic processes (weathering and terrestrial runoff)
- Heavy metal pollutions such as As, Cr, Sb, and Zn were most likely originated from the industrial activities.
- The REEs concentration such as Eu, La, Sm, Tb, Dy, Ce, Nd, Lu and Yb in Area N located near the food, manufacturing, wood, furniture, plastic and coating industries were relatively higher compare to other areas .
- The U element concentration in Area N and Area I were relatively higher compare to other areas.
- The Th element concentration in Area N and Area B, both located near the industrial activities were relatively higher compare to other areas.

4.0 Conclusion

- The element of As can be categorised as uncontaminated to moderately contaminated, and as extremely contaminated.

- Sb element can be categorised as moderately contaminated and as strongly to extremely contaminated.

- The elements of Cr, Cs and Hf can be categorised as uncontaminated to moderately contaminated and as moderately to strongly contaminated

- Other elements can be categorised as uncontaminated and as uncontaminated to moderately contaminated.

Thank You