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## Using geostatistics and local Moran's I to identify pollution hotspots of rare earth elements in urban soils of London

### Introduction research

potential toxicity and long-term effects on human health. Up to now, there is little information about the spatial patterns of REEs and their influencing factors in urban soils

#### Attention

1

#### London soils data

Data from the Greater London Area (GLA)  
British Geological survey and  
A total a set of **6467** samples and **7** REEs contained in the data.

2

**LREE** : Sc (Scandium) La (Lanthanum)  
Ce (Cerium) Sm (Samarium)  
Nd (Neodymium)

**HREE** : Y (Yttrium) Yb (Ytterbium)

#### REEs data

3

#### Hotspots analysis

Spatial clusters and spatial outliers were detected with the index of local Moran's I  
And influencing factors

4

## Materials and methods

### 1. Local Moran's I

It was calculated for every sampling location to reveal the degree of spatial autocorrelation (Anselin, 1995). It is computed as follows:

$$I_i = \frac{z_i - \bar{z}}{\sigma^2} \sum_{j=1, j \neq i}^n [w_{ij} (z_j - \bar{z})]$$

### 2. Inverse Distance Weighted

The inverse distance weighted (IDW) interpolation estimates values at un-sampled points using weighted average of the sampled points within a selected number of neighbours of the un-sampled location (Robinson and Metternicht, 2006).

$$w_i = \frac{1/d_i^p}{\sum_{i=1}^n 1/d_i^p}$$

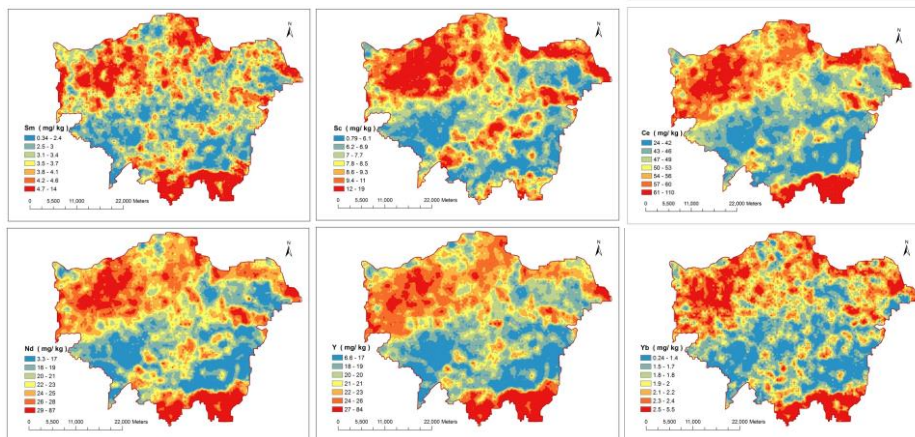
### 3. Data transformation

Due to the influence of large sample sizes (e.g.,  $n > 1000$ ), the Box-Cox transformation for the 7 REEs was effective in pushing the data sets towards normality, with their skewnesses and kurtoses close to 0.

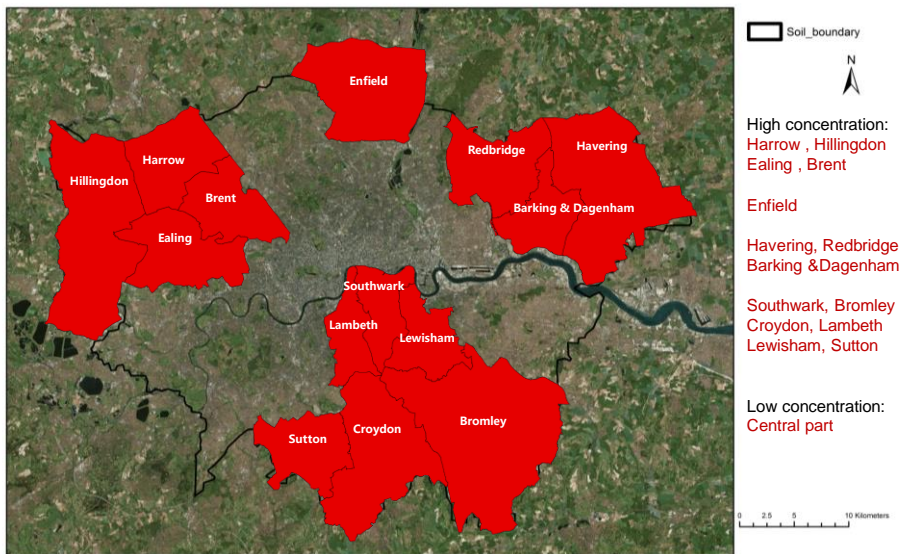
## Results : IDW Inverse Distance Weighted

IDW (Inverse Distance Weighted) to illustrate the spatial distribution of REEs.

The spatial pattern of Y, Yb, Sc, La, Ce, Sm and Nd values in London soils are illustrated in IDW maps.



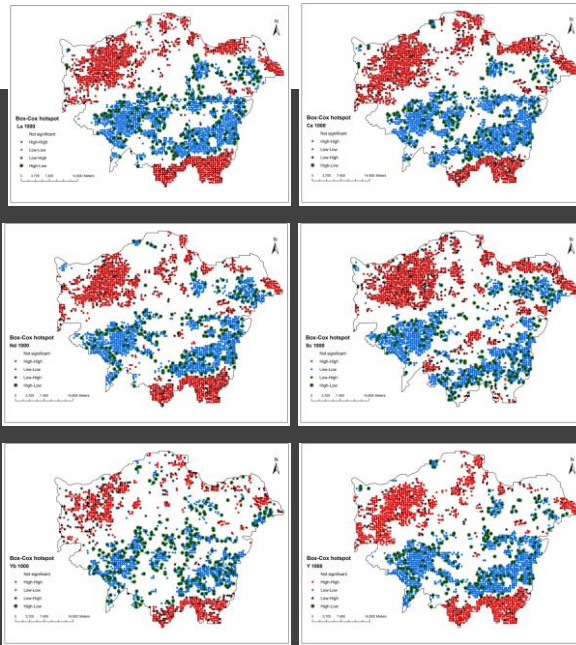
## Information from the IDW maps



## local Moran's I

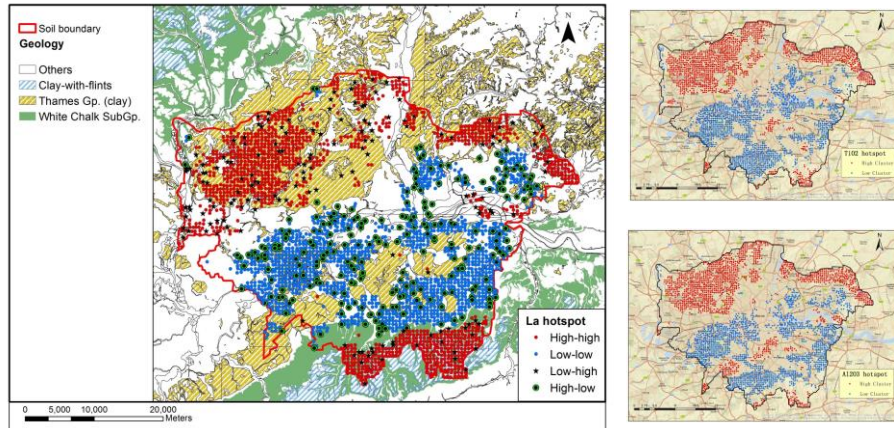
### Box-Cox Data as example Distance band 1000 m

1. while all the 7 REEs exhibited generally similar spatial patterns
2. A larger area of **high-high** spatial cluster was found in the northwest and northeast, south part of area.
3. The **Low-Low** area was located in the centre of London.
4. **So** show H-H cluster in centre part



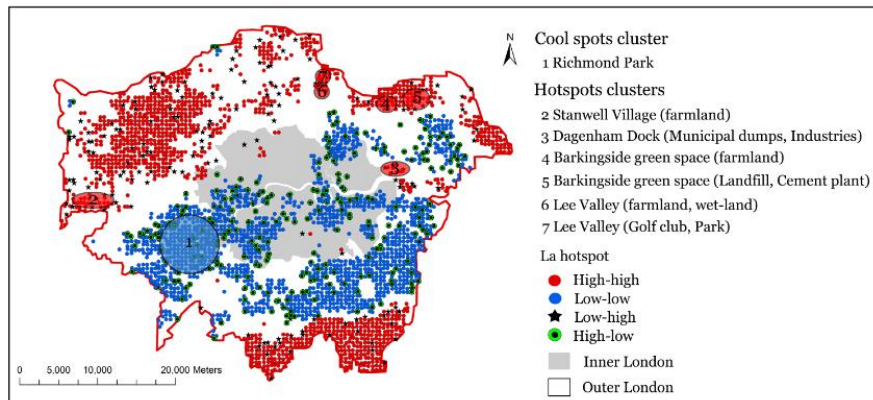


## Discussion : Geogenic factors



All 7 REEs had very similar spatial patterns, with a large number of hotspots simultaneously located in the northwest and south parts. Soils from the White chalk subgroup, Clay-with-flints and Thames Group (clay) areas displayed the highest REE concentrations among all the rock types, followed by Alluvium and Brickearth areas. Therefore, soil parent material and weathering process are a natural factor leading to enrichment of REEs in soils of this district.

## Anthropogenic factors



Landfill



Metal recycling

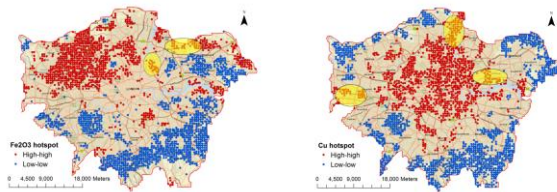


Farmland



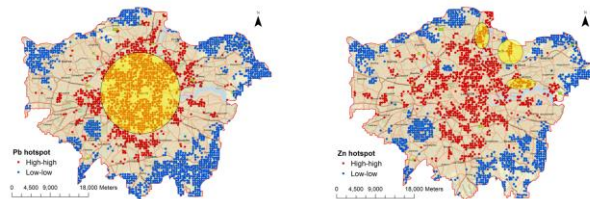
Municipal dumps

## Anthropogenic factors



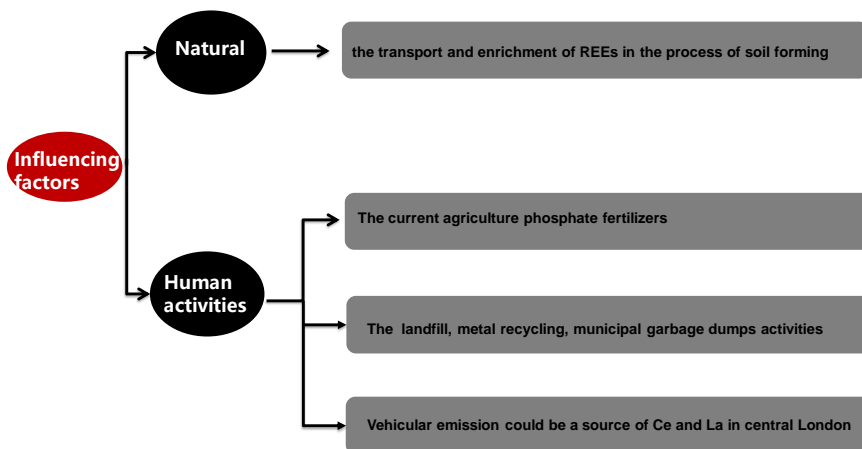
Relatively high concentration of Ce, La, Nd, Sc and Y hotspots in parks, greenbelts and agricultural lands especially in Brent, Harrow, Croydon, Bromley Dagenham, Rainham, Redbridge and Barking could be attributed to the application of phosphate fertilizers, landfill, municipal dumps and small scale metal recycling.

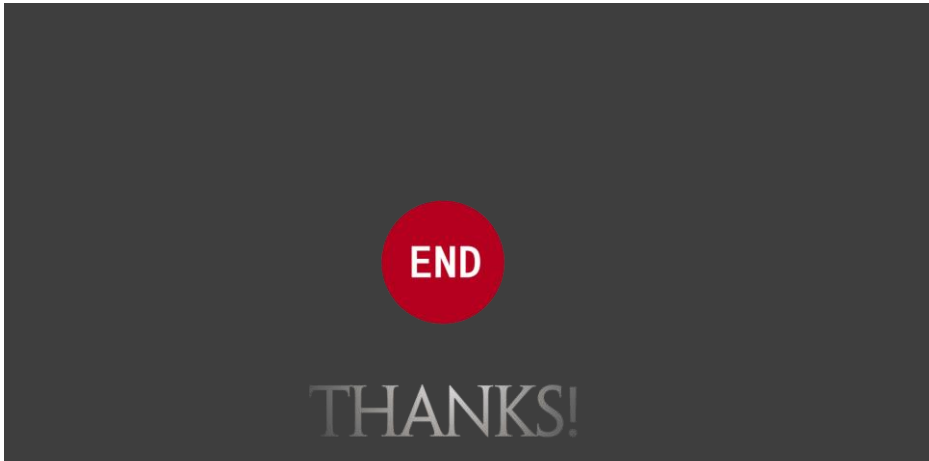
The LISA maps, high-high clusters were evident for Cu, Pb and Zn in areas of high traffic density in the city centre and are probably associated with vehicular emission. High-low outliers of 7 REEs are also seen in central London suggesting that REEs are also associated with vehicular emissions.



## Conclusions

The value of using Local Moran's I for the identification of pollution hotspots in urban soils





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