



# Spatial distribution patterns of phosphorus in top-soils of Greater London Authority area and their natural and anthropogenic factors

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6 May 2017

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# Introduction



Eutrophication in Mossops Creek Park, London (photos taken on 25. Jun. 2016)

With the worldwide rapid urbanization, urban soils are receiving considerable attention due to their associations with the life quality of human beings. Previous researches have revealed that phosphorus (P) enriched in the soils of a number of big cities, e.g. Beijing (China), Bangkok (Thailand) and Phoenix (USA).

Nilsson, 1995;  
Metson *et al.*, 2012;  
Xia *et al.*, 2013

# Introduction

London, is the capital of the United Kingdom with a two-thousand-year history as a major settlement. Geographical information system (GIS) and spatial analyses are helpful tools to investigate the complicated sources of P and identify the hotspots. Thus, the government can manage soil problem more efficient.

<b>Main input sources of P</b>	Sewage	Major in urban areas
	Septic tanks	
	Agriculture	Major in rural areas

Neal *et al.*, 2005;  
Foundation for Water Research, 2006

# Introduction

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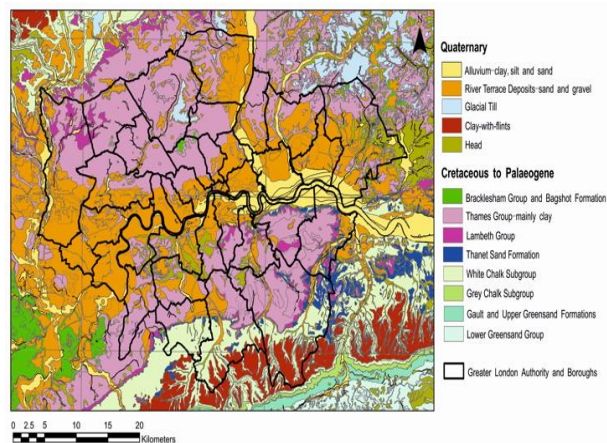
## The purposes of this study were to :

- (1) reveal P spatial distribution;
- (2) identify the locations of P accumulation and depletion;
- (3) explore the geogenic and anthropogenic factors causing the spatial patterns.

## Material

Top-soil samples were collected at a depth of ca. 5-20 cm and a sampling density of 4 samples per km<sup>2</sup> by British Geological Survey (BGS), totally 6467 samples.

A surface PM map with simplified geological types was adopted for investigating the influence of different parent materials (PMs) on the P distribution.

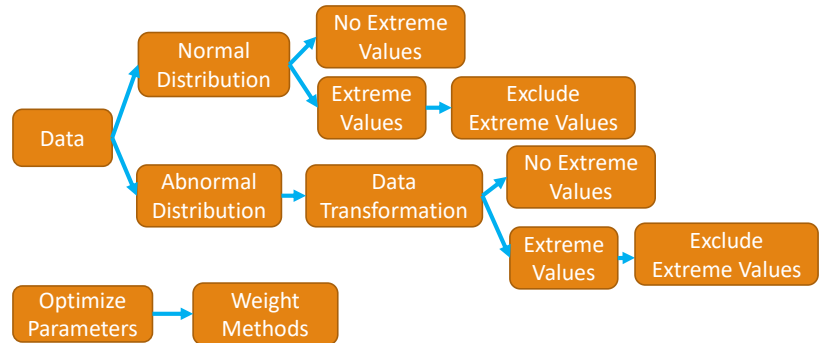


# Method (main): Anselin Local Moran's I

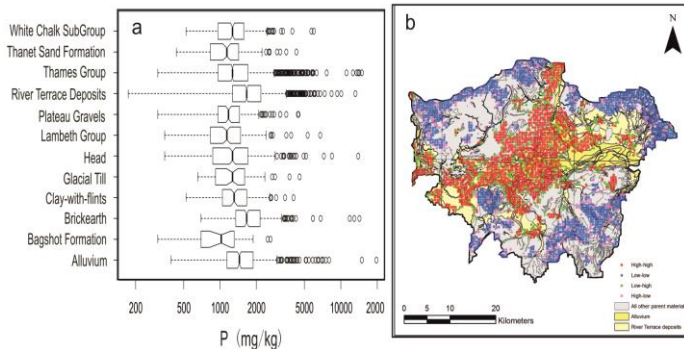
P concentration hotspots can be clustered (spatial clusters) or exist individually (spatial outliers). They can be identified using the local Moran's I index (Anselin, 1995; Getis and Ord, 1996; Levine, 2004):

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

What should you do before using local Moran's I?



## Results: Natural Factors Influence of PMs



(a) Notched boxplot of P in top-soils of different PMs; (b) Spatial distribution map of significant hotspots and cool spots overlaying on geology map

One-way ANOVA shows a significant difference among PMs ( $p < 0.05$ ). Tukey HSD analysis reveals that **alluvium**, river **terrace** deposit and brickearth had higher P than other PMs.

## Results: Natural Factors Influence of the Thames Estuary

The suspended sediment is mainly land-derived.

A zone of high suspended particulate matter (SPM) and much sedimentation exist.

Sedimentation is dominated by bed-load transport from the sea.

P along the lower Thames Estuary is diluted by the tidal effect. The majority of total P derived from the upstream as well as city sewages deposited in the upper estuary and the rest was exported to the coast.

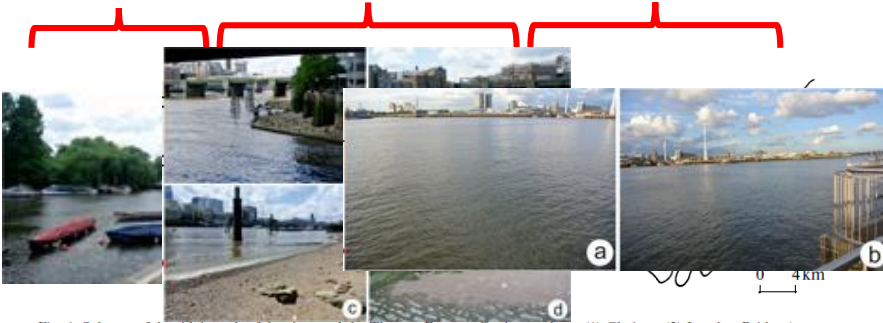
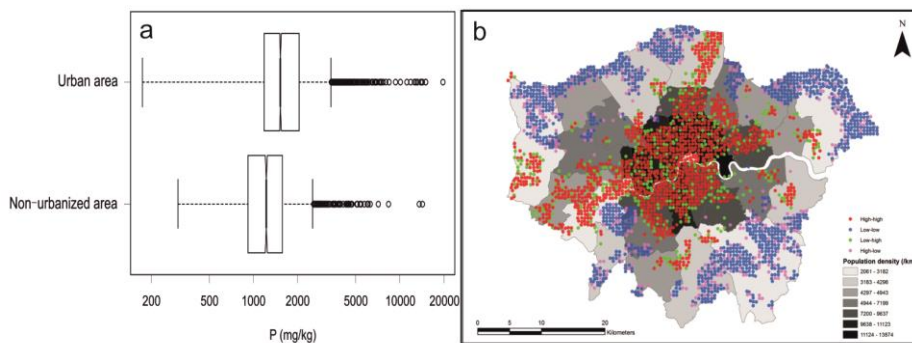


Fig. 1. Scheme of the tidal reach of the river and the Thames Estuary. Gaging stations: (1) Chelsea, (2) London Bridge (estuary head), (3) London Docks, (4) Tower Bridge, (5) Tower Pier, (6) North Woolwich, (7) Barking, (8) Tilbury, (9) Long Reach, (10) Southend; (11) Sheerness; Settlements: (12) Woolwich, (13) Jenningtree Point, (14) Gravesend, (15) Coryton, (16) Teddington Dam; Flood barriers: (17) Richmond, (18) Thames, (19) Barking, (20) Dartford, (21) Fobbing Horse, (22) Easthaven, (23) Benfleet, (24) Canvey Isl.

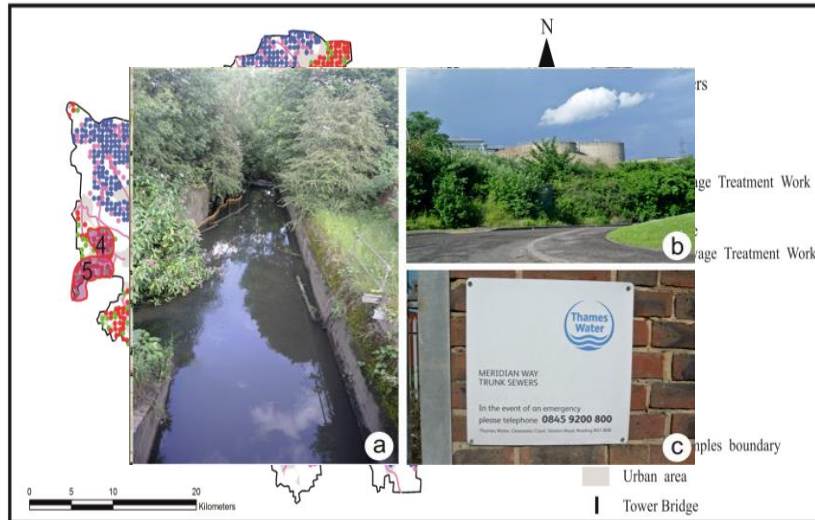
Fang, 2000;  
Uncles and Mitchell, 2011;  
Mikhailov and Mikhailova, 2012

## Results: Anthropogenic Factors Influence of urbanization



## Results: Anthropogenic Factors

### Influence of sewage treatment works (STWs)



## Conclusion

The variation of P in top-soils of GLA area was influenced by a combination of natural and anthropogenic controls. Natural factors, consisting of PM, the hydrology in the Thames Estuary, the distribution of Si and pH level in top-soils, were clearly associated with the P distribution. In addition, anthropogenic factors, such as population density, STWs and fertilizer application, also had an effect on the P concentration and spatial distribution, causing localised high concentrations.

### Acknowledge:

This study is sponsored by the Royal Society International Exchange Scheme of the UK (2015-2017).

The soil data used in this study were provided by the BGS from the London Earth Project.



Thank you for your attention

