Contamination of Coastal Sediments from Historic Landfills: A ticking time-bomb

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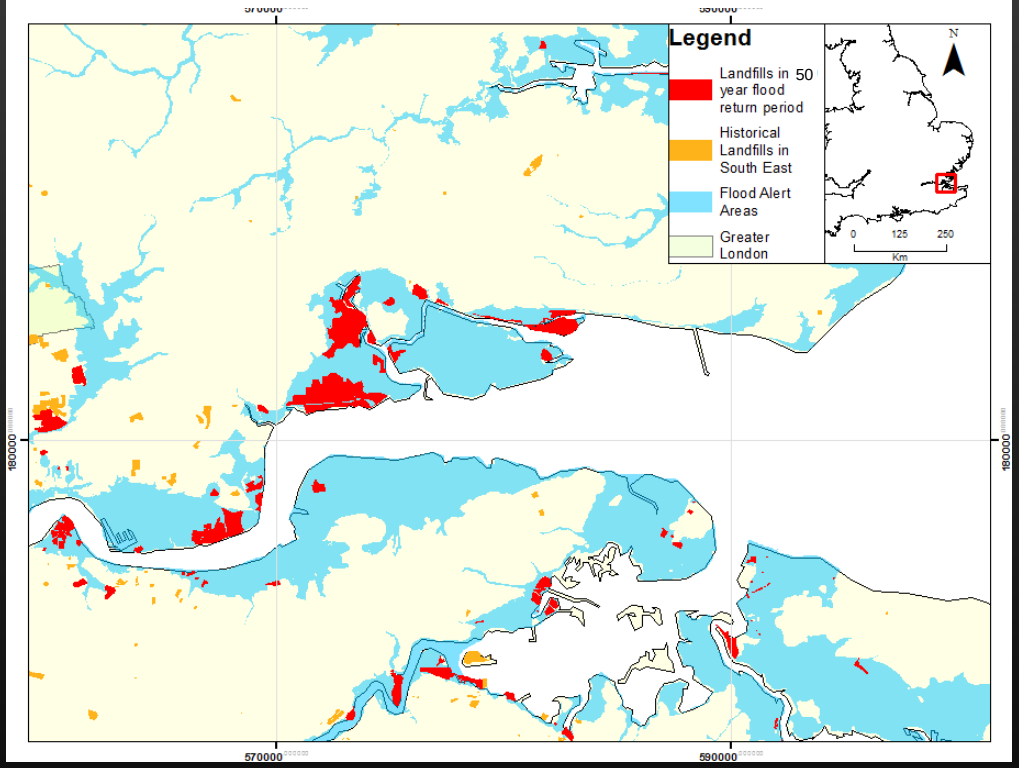
Historic Coastal Landfills - Context

- Waste was historically placed within the coastal zone
- Historical landfills closed prior to 1994 WMLR (Cooper, 2012)
- Unmanaged, unmonitored waste
- No basal or side wall protection
- Unprotected waste disposal

- 70 sites within the Thames Estuary
  - 50 % within the EA flood alert area
  - 1 in 50 year flood return period

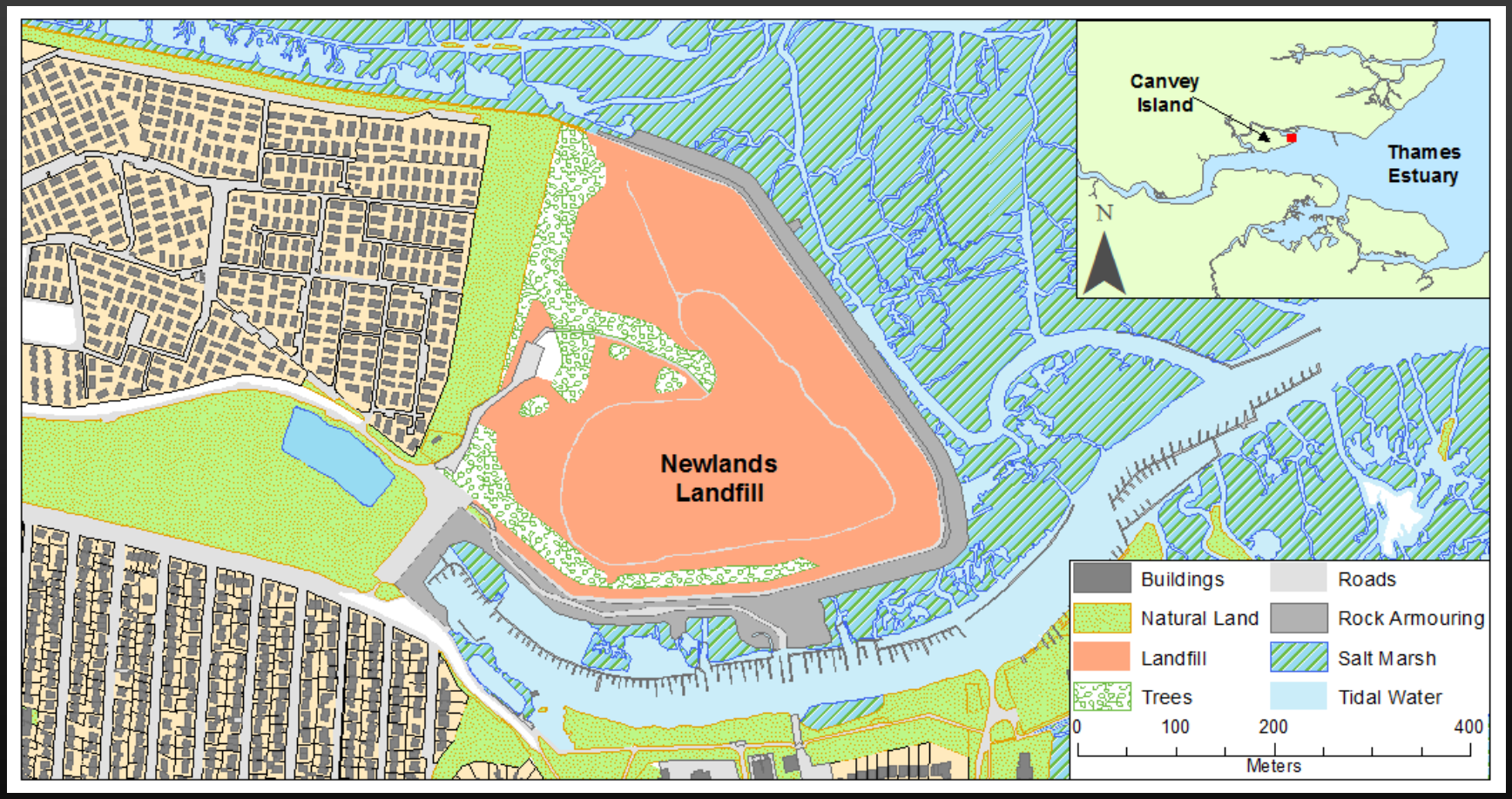
- Hazards are unquantified, yet there are potential problems for stakeholders and site managers.

Vulnerable Coastal Landfills within the EA Flood Alert Area: Thames Estuary



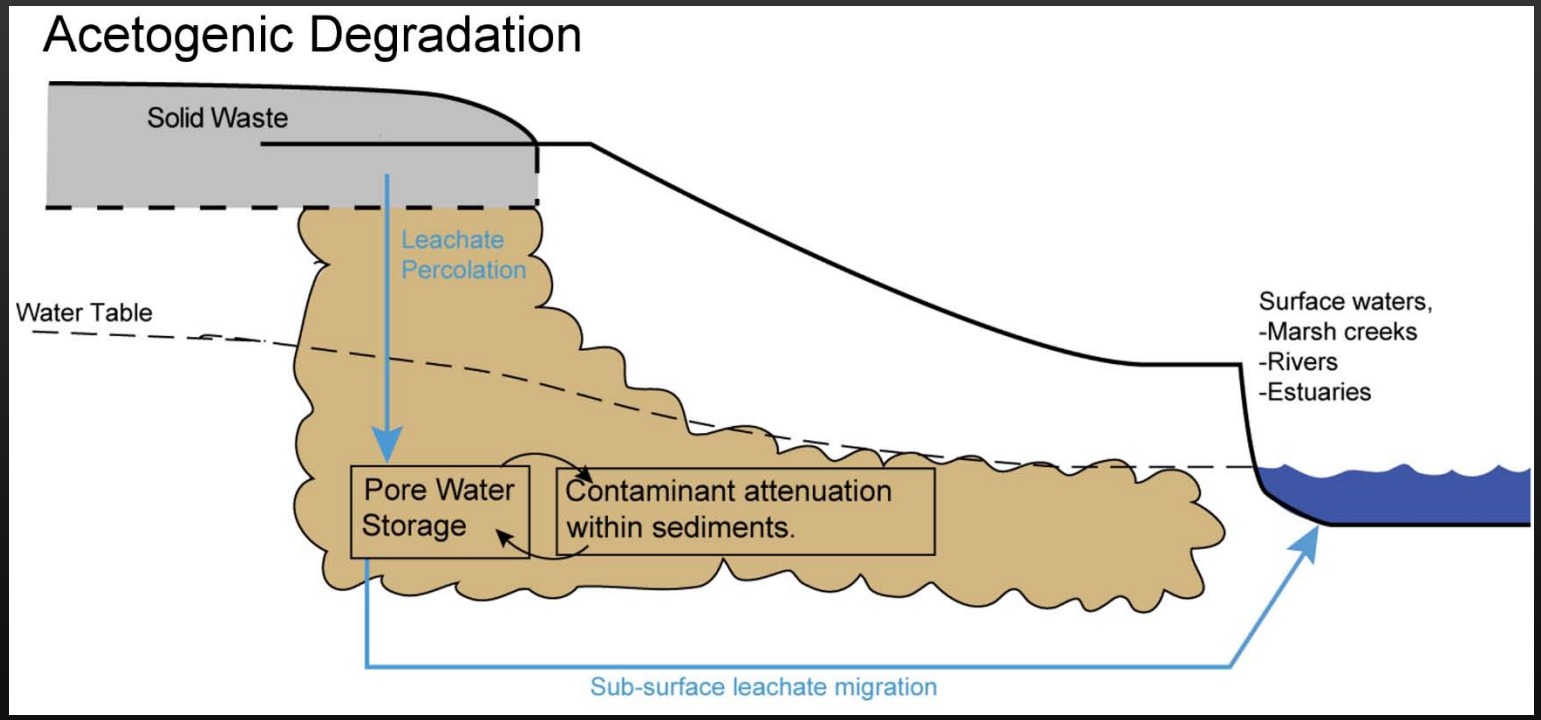
Previous Work

- Intensive study of dated sediment cores surrounding Newlands landfill, Essex, indicates the presence of a contaminant plume at 1.50 to 2 m (O'Shea *et al.*, 2015).

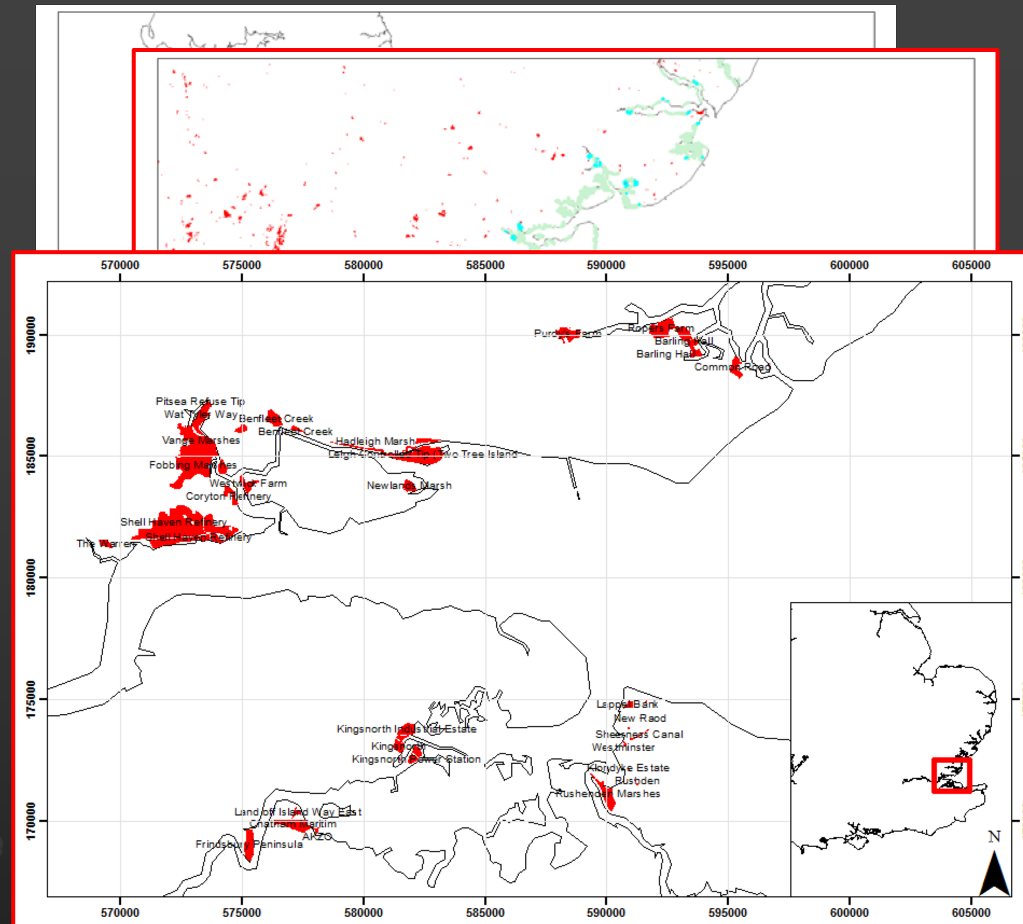


Previous Work

- Intensive study of dated sediment cores surrounding Newlands landfill, Essex, indicates the presence of a contaminant plume at 1.50 to 2 m (O'Shea *et al.*, 2015).
- Enrichment factors elevated at depth due to natural attenuation
- Objective: **To use XRF to rapidly screen historical landfills in the Thames Estuary**



Methods

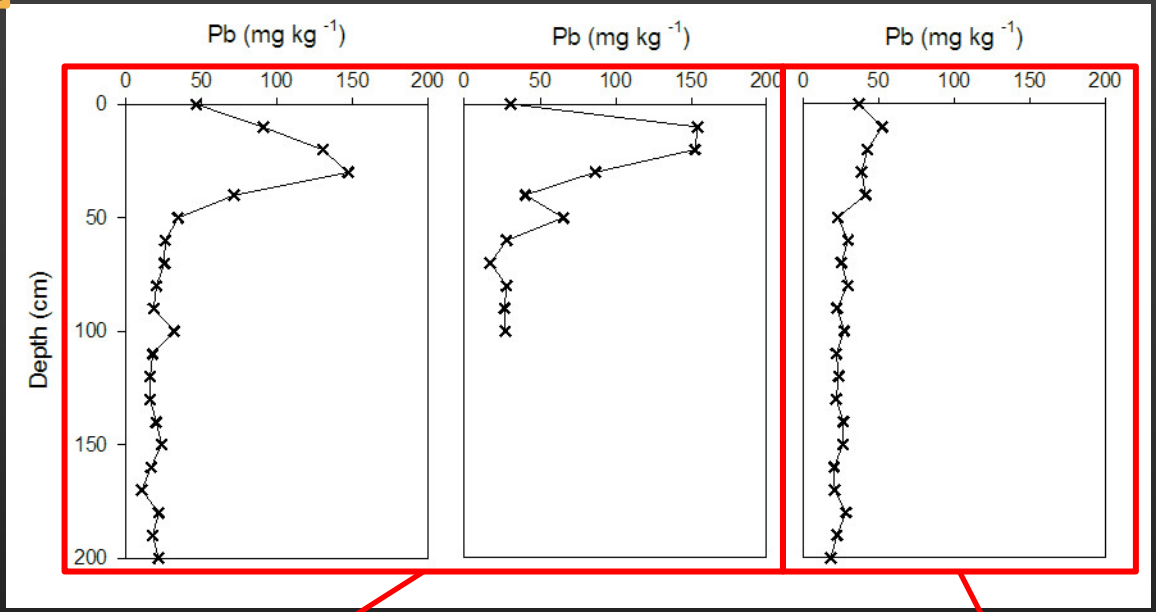


- GIS based site selection method used to identify sites with similar attributes to Newlands, e.g.
  - Waste Age
  - Waste type
  - Geographical setting
  - Situated in the coastal zone
- 20000 sites reduced to c. 40.
  8 were chosen at random
  - 5 sites with hazardous, commercial and industrial waste
  - 3 inert sites (as control)
- 3 cores were extracted at each site (2 m depth)
- Each core was analysed at 10 cm increments *in-situ* with XRF producing screening level data for Pb (Industrial source, immobile in sediment).
- Sediments were returned to the laboratory to measure moisture content.
- Sediment accumulation rate assumed 0.23 cm a^{-1} (1,2,3)

Results and Discussion (Typical Inert Profile)

Landfill

Increasing distance



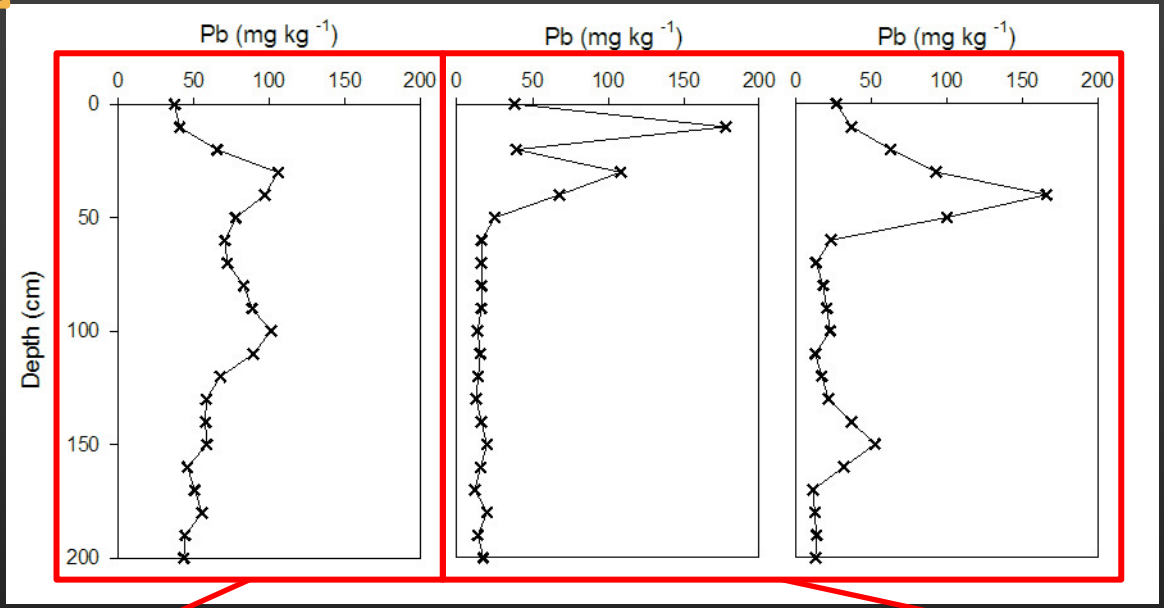
Concentration spike is reflective of industrial inputs into the sediment. Declines at depth represent pre-industrial ages.

Only a slight peak due to industrial activity.

Results and Discussion (Typical Hazardous Profile)

Landfill

Increasing distance



Industrial spike within the top layers. Concentrations do not reduce at depth. Similar to distributions at Newlands.

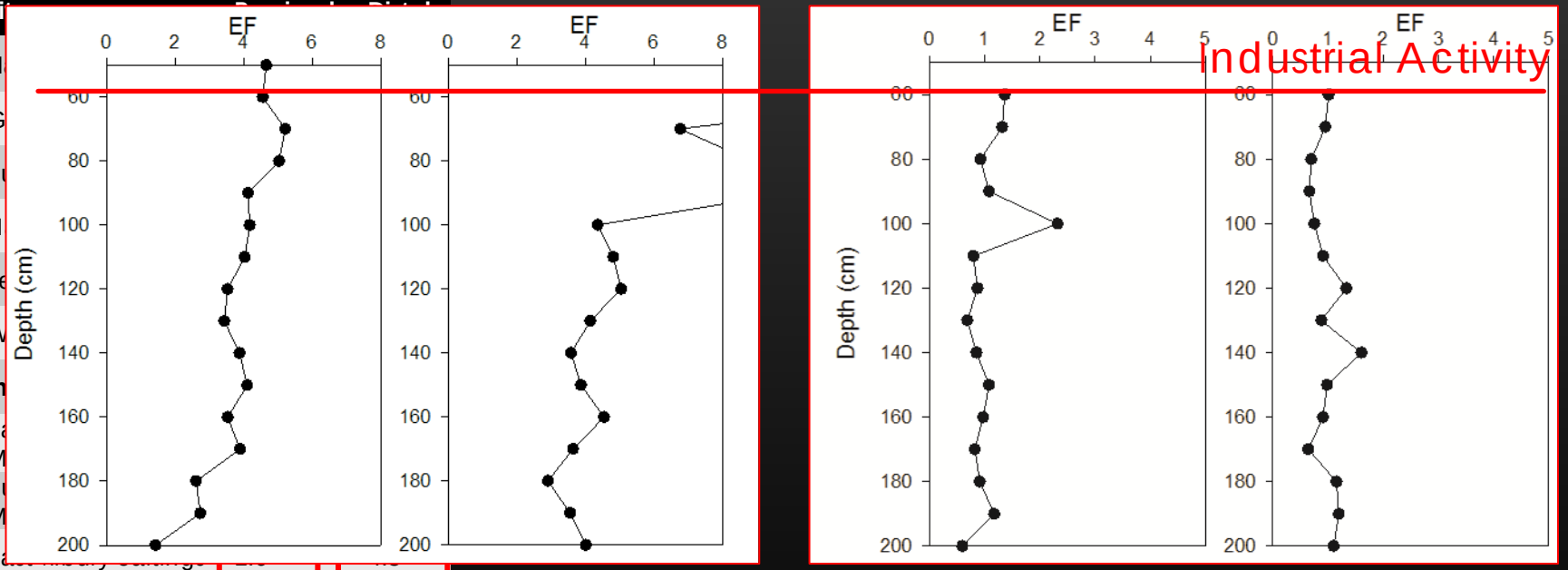
Concentration spike is reflective of industrial inputs into the sediment. Declines at depth represent pre-industrial ages.

Enrichment Factors

- Normalised Enrichment factors for **pre-industrial sediments** were calculated to assess anthropogenic impacts(4)
- At Hazardous sites, EFs decrease with distance from the landfill, whilst inert sites show no consistent pattern
- EF is also higher for hazardous than inert sites
- This suggests that there is an enrichment due to the landfill plume

Hazardous

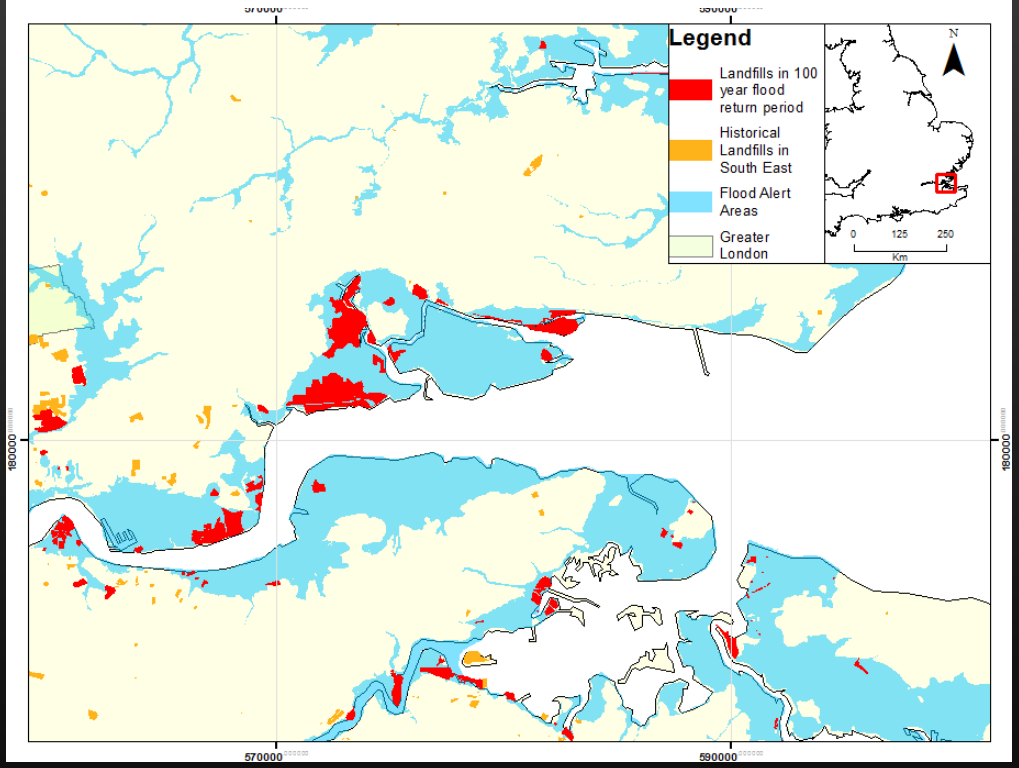
Inert



Impact

- Sediments exceeded PEL for Pb (225 mg kg^{-1}) and Zn (495 mg kg^{-1}).
- These locations are at risk from flooding within the next 50 years, which is likely to erode the contamination.
- 55 sites within the Thames represent 60000 kg Pb.
  - Annual dredge 5600 kg (5)
- 5000 sites on the UK coast
  - 4.8 x 10^6 kg Pb
- However, this study focused on screening level *in-situ* XRF, omitting further metals. It is likely they are also contaminated with As, Cu, Hg, Zn etc.

Vulnerable Coastal Landfills within the EA Flood Alert Area: Thames Estuary



Conclusions

- GIS / secondary data site selections advantageous.
- Cost effective XRF analysis allows broad scale data to be acquired.
- Hazardous sites exhibit contamination reflective of landfill pollution.
- Historic landfills represent a widespread issue.
- Significant contamination inventory (60000 kg).
- These sites are not currently managed, however there are implications under WFD, EIA under changing climate.
- Next steps:
  - Distributed qualitative risk assessment framework.
  - Improving parameterisation (organic contaminants, partitioning, different environments)

Thank you.
Any questions?

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Reference List

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