Development of a risk assessment model for diffuse landfill pollution as a result of climate change.

F. T. O'Shea*[1], K. L. Spencer[1], C. L. MacLeod[2]

Vulnerable Coastal Landfills

- Historically, many landfill sites have been constructed adjacent to, or behind coastal defences in fluvial, estuarine and coastal environments, frequently within a few metres from the mean high water mark.
- There are over 10 sites within the river Thames estuary alone, constructed prior to engineering controls with unknown waste content and extent.
- Increasing sea level, and storm frequency and intensity over the next 50 years (IPCC, 2007), may result in increased defence failure and erosion of these landfills.
- Predicted increases in sea level will lead to saline inundation of such landfills sited in estuarine and lower river reaches, promoting diffuse pollutant release.
- Under current legislation contaminated land managers have a duty of care to the surrounding aquatic environment. Currently, these potential impacts are poorly understood and few tools exist for assessing the risk to surface waters and estuaries.

Research Aims

- The main aim of this research is to assess current contamination of the Newlands landfill. This will be achieved by:
  - A site walkover to assess geotechnical stability and identify potential sites of leachate release,
  - Determination of contamination concentrations within surrouding sediments to indicate whether the landfill is currently impacting the adjacent aquatic environment.

Study Site + Methods

- Newlands Landfill (landrise), Canvey Island, Essex, UK (Figure 1) was constructed as a flood defence in 1954, accepting 1,000,000m^3 municipal waste, prior to closure in 1989 (Caulmert, 2011).
- The site is surrounded by environmentally significant saltmarshes and mudflats, containing Lax-flowered sea-Lavender (*Limonium humile*), Golden Samphire (*Inula crithmoides*) and small Cord-grass (*Spartina maritima*).

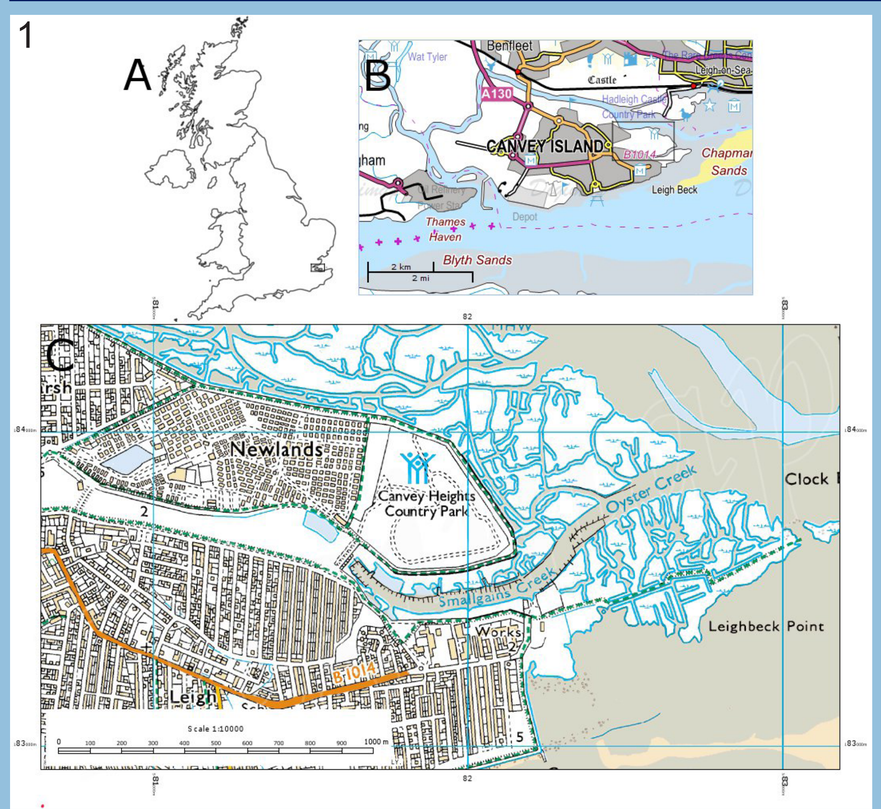


Figure 1:
A) The location of Canvey Island within the UK.

B) Canvey Island showing the location of Canvey Heights Country Park.

C) Location of Newlands Landfill site on Canvey Island.

(Edina, 2012)

A site walkover was conducted to identify visual evidence of:

- Wall failure and slumping
- Current leachate release

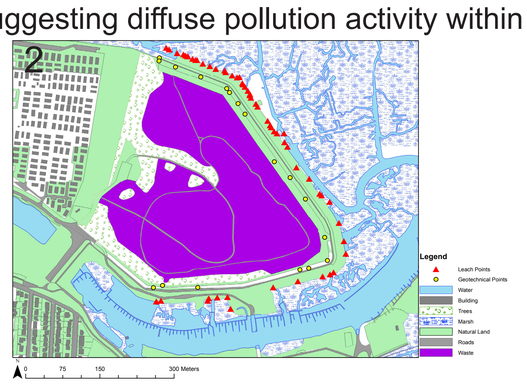
To assess current contamination, surface sediments were collected along transects from the landfill site boundary in triplicate and analysed for:

- Loss on ignition and Carbon content (Flash Elemental Analyser),
- Sediment pH,
- Sediments were digested and analysed for a full suite of heavy and trace metals using ICP-OES,
- Sediments will also be analysed for Total Petroleum Hydrocarbon Criteria Working Group organic contaminants (TPHCWG),
- Leachate monitoring will begin Summer 2012.

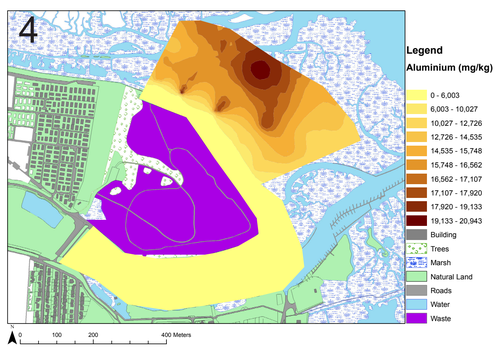
Results

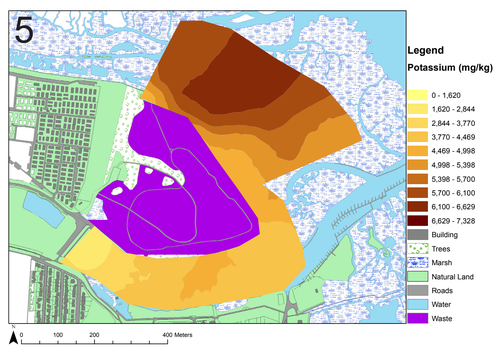
Site Walkover

Figure 2 shows areas of current geotechnical instability and potential leachate release. Figure 3 shows visual evidence of slumping and vegetation dieback, suggesting diffuse pollution activity within the site.

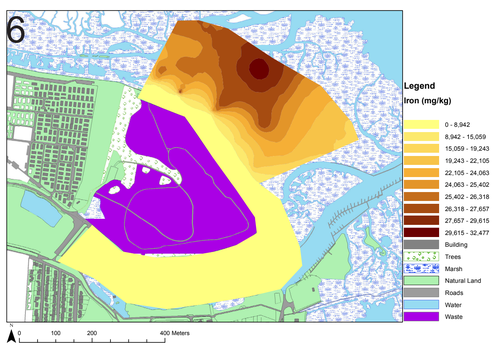


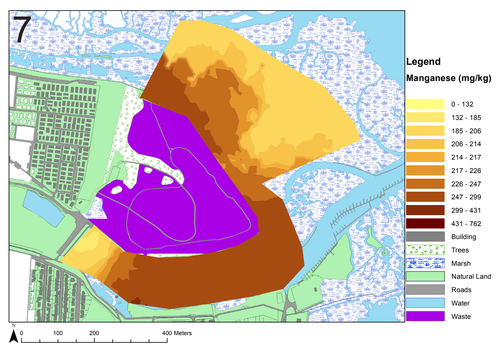
Geochemical Data



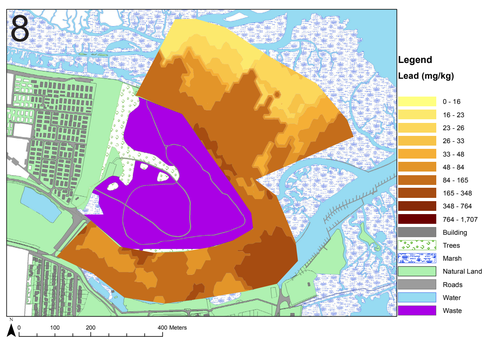


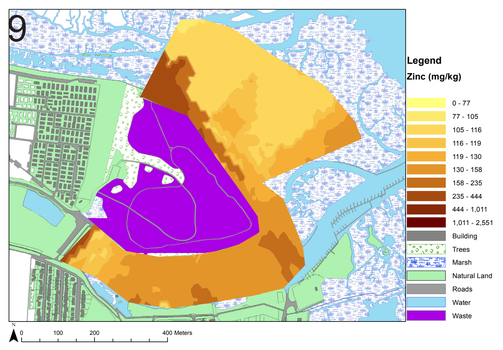
Figures 4 & 5 show modelled Al and K concentrations respectively. Al is used as a proxy for grain size, whilst K predictions show good correlation with saline inundation.





Fe (Figure 6) and Mn (Figure 7) are common indicators of redox conditions. Figure 7 shows Mn concentrations decreasing with distance from the waste and so may be waste contaminant components. Fe distributions are similar to Al, suggesting natural sources.





Pb and Zn (Figures 8 & 9) concentrations decline with distance from the site boundary with 'hotspots' to the north. 13% and 3% (respectively) of the samples contained Pb and Zn values above NOAA marine sediment Probable Effect Levels (PEL's) (NOAA, 2008).

Conclusions

- Although Al concentrations indicate that the distribution of Pb and Zn is not controlled by grain size effects, granulometric normalisation is required (Kersten and Smedes, 2002) because Al cannot be used as a proxy since it may also be a potential contaminant.
- There is evidence to suggest that the landfill site is impacting adjacent saltmarsh sediments with Pb and Zn potentially causing ecotoxicological effects.
- Further work will include batch testing within various media to simulate how partitioning coefficients and erosion levels will change with saline inundation and higher storm intensity scenarios.

References

- Caulmert Limited (2011). *Newlands Landfill, Annual Monitoring Report,* Bangor.
- Edina (2012). 'Edina Digimap Ordnance Survey', *[Online], available at: http://www.edina.ac.uk/digimap* [accessed 20th March 2012]
- IPCC (2007). Summary for Policymakers, Cambridge Univeirsity Press, Cambridge, United Kingdom and New York, NY, USA.
- Kersten. M., Smedes, F., (2002). Normalization procedures for sediment contaminants in spatial and temporal trend monitoring. *Journal of Environmental Monitoring,* **4,** p109-115.
- National Oceanic and Atmospheric Adminisration, (2008). Screening Quick Reference Tables (SQuiRTs). *[Online], available at*: *http://bit.ly/KnPGes.*

Acknowledgements

Supervisors: Dr. K. L. Spencer (QMUL)
Dr C. L. MacLeod (Arcadis N. V.)

This research is funded by an NERC open CASE studentship.

[1]School of Geography, Queen Mary, University of London, United Kingdom. [2]Arcadis N. V., United Kingdom.
*Corresponding author: f.t.oshea-brown@qmul.ac.uk