The Hidden Threat of Historical Landfills on Eroding and Low-lying Coasts

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Historical Landfills

Historically we have always used our estuaries and coasts to dispose of waste. Estuarine waters offered efficient removal and dilution of our sewage and industrial effluents, whilst low-lying coastal land was often prone to tidal flooding with low economic and agricultural value providing suitable locations for waste disposal. Hence, there is a legacy of industrial contamination in our estuarine sediments and there are tens of thousands of historical landfills and other contaminated sites along our coastlines. The term 'historical landfill' is used to identify those sites that were developed prior to current waste management or pollution prevention legislation such as the EU Groundwater Directive or EU Landfill Directive. As a result, these sites are usually un-lined, with incomplete or non-existent records of the waste that was disposed within them and with no legal requirements for their management or monitoring. A recent report by CIRIA (Construction Industry Research and Information Association) (Cooper et al. 2012) suggests that there are at least 20000 of these sites in England and Wales alone, and this number is likely to be an under-estimate due to incomplete records and a large number of un-recorded illegal sites.

When these sites were developed, often in the early 20th Century, this seemed like a sensible option. For example, domestic waste could be easily and cheaply transported out of London on River Thames barges. It could then be disposed in pits left behind by the extraction of Thames Gravel, or on low-lying marshland, where fine-grained sediments with poor hydraulic conductivity would provide natural attenuation of any leachate, protecting the adjacent Thames Estuary. However, all this happened in an era not only when we had far less understanding of the impacts of pollution on our aquatic environment and little pollution prevention legislation, but also before we had the vaguest inkling that anthropogenic climate change may have real and significant impacts on our coastlines.

Threats to the coastal zone

Climate change is likely to have wide-ranging impacts on our coasts and projections state that precipitation, surface runoff, sea level, sea temperature, salinity, storm frequency and storm magnitude are to increase within the next 50 years (Soloman et al. 2007). The most significant consequences for historical coastal landfills are likely to come from tidal flooding and/or erosion. Of the 20000 historical landfill sites recorded in England and Wales, 25% are within the Environment Agency's flood alert area, being at risk of a 1 in 100 year return period flood event (Environment Agency, 2012). For example, in south east England on the lower Thames Estuary there are > 50 landfills that are considered at risk of flooding and/or erosion (Figure 1) (Environment Agency, 2012). In many instances, rainwater and surface run-off will have already percolated through these waste materials for many decades, however inundating the sites with saline waters may have additional and un-quantified impacts on contaminant release. Of

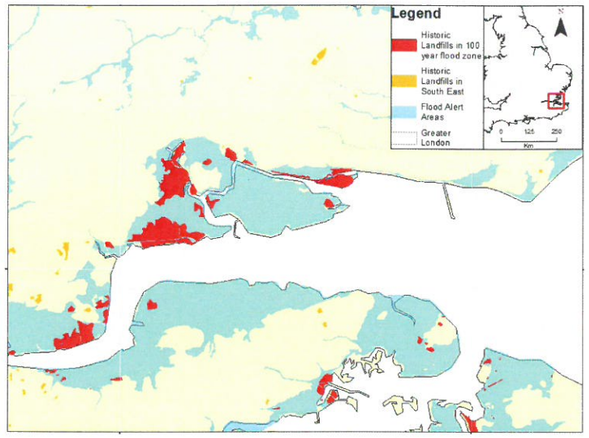

Figure 1: Vulnerable coastal landfills within the Environment Agency flood alert area in the Thames Estuary.

perhaps more significant consequence is the impact of erosion. Many of these sites are on vulnerable coastlines which are already actively eroding and there have been some well-publicised examples of waste material being released to the coastal environment during landslips and coastal erosion (BBC 2012). This presents a very clear visual pollutant and may also have impacts for local water quality, sediment quality and the invertebrate community that inhabits these environments. In addition, this is a long-term, un-quantified, diffuse input of contaminants to the coastal zone. Figure 2 provides an example of material collected from the foreshore at the eroding margin of an estuarine landfill in SE England operational from c. 1930s to 1950s, as well as material excavated from a seawall constructed from waste in the 1980s. The objects can be clearly dated to the 1940s and include glass and ceramics, food cans and ash from domestic coal fires. There is also the potential for the large-scale physical redistribution of waste from these sites as the result of a major storm surge or failure of an existing defence, this is of particular concern where waste materials have been used to backfill or infill sea defences.

There is also the real possibility that sediments surrounding these sites have been contaminated by landfill leachate. Figure 3 shows a conceptual model of the potential pathways by which contaminants can be

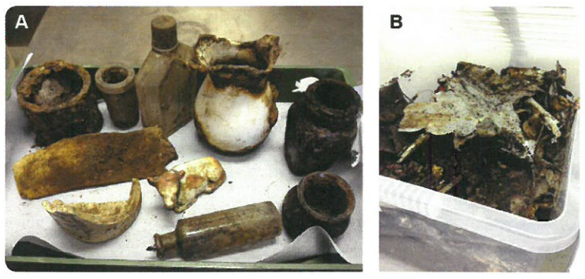

Figure 2: a) Material collected from the estuary foreshore from the eroding edge of a 1940s landfill, the material is predominantly glass or ceramic food and cosmetic containers including medicine bottles, haircare products, animal bones and a solitary tin can; and - b) Material excavated from a waste-filled coastal defence that was constructed in the 1980s and includes large amounts of paper and plastic waste.

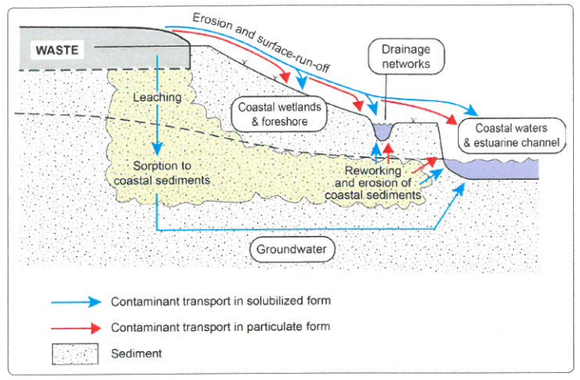

Figure 3: A conceptual model for sources, pathways and fate of contaminants in vulnerable coastal landfills.

transported from the waste body to the surrounding environment. Many of these sites were engineered without basal or side wall liners, and they relied on the natural attenuation capacity of surrounding fine-grained sediments to sorb contaminants before the leachates interacted with saline groundwater or surface waters. Therefore, surrounding sediments may be contaminated and the spatial extent of this contamination will depend on the flux and chemical behaviour of the contaminants released, physico-chemical characteristics of the sediment and local hydrological conditions. Whilst efforts might be made to defend the waste body itself from erosion using hard engineering, re-working of these surrounding sediments could contribute a secondary and diffuse source of contamination to estuarine and coastal waters.

What to do next?

The historic landfill sites situated on actively eroding and low-lying coasts clearly present a significant risk and the potential for diffuse discharge of pollutants to estuarine and coastal waters has not been quantified and is poorly understood. Those currently responsible for managing these sites have a duty of care towards the adjacent aquatic environment. Yet, currently there are few tools for assessing the risks associated with climate change and the erosion/inundation of these sites. Research is needed to understand; 1) the extent and magnitude of diffuse pollution from landfills; 2) the likelihood for failure and/or erosion of contaminated foreshore sediments and 3) the impacts on water quality and ecosystem health.

CIRIA's current guidelines (Cooper, 2012) adopt a 'source-pathway-receptor' approach and recommend removing the pathways identified within the site's conceptual model, effectively intercepting the contamination and preventing it from reaching vulnerable, sensitive receptors. This can include regular cleaning up of material visible at the surface and constructing cut-off walls and coastal defences providing a physical barrier between waste and the surrounding environment. These options are all site and cost dependant.

For more information on our current projects working with the Environment Agency, Essex County Council and Arcadis to assess diffuse pollution from coastal landfill sites see http://www.geog.qmul.ac.uk/staff/spencerk.html.
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