Legacy Wastes in the Coastal Zone: Environmental Risks and Management Futures

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COASTAL LEGACY WASTES

UKRI Natural Environment Research Council

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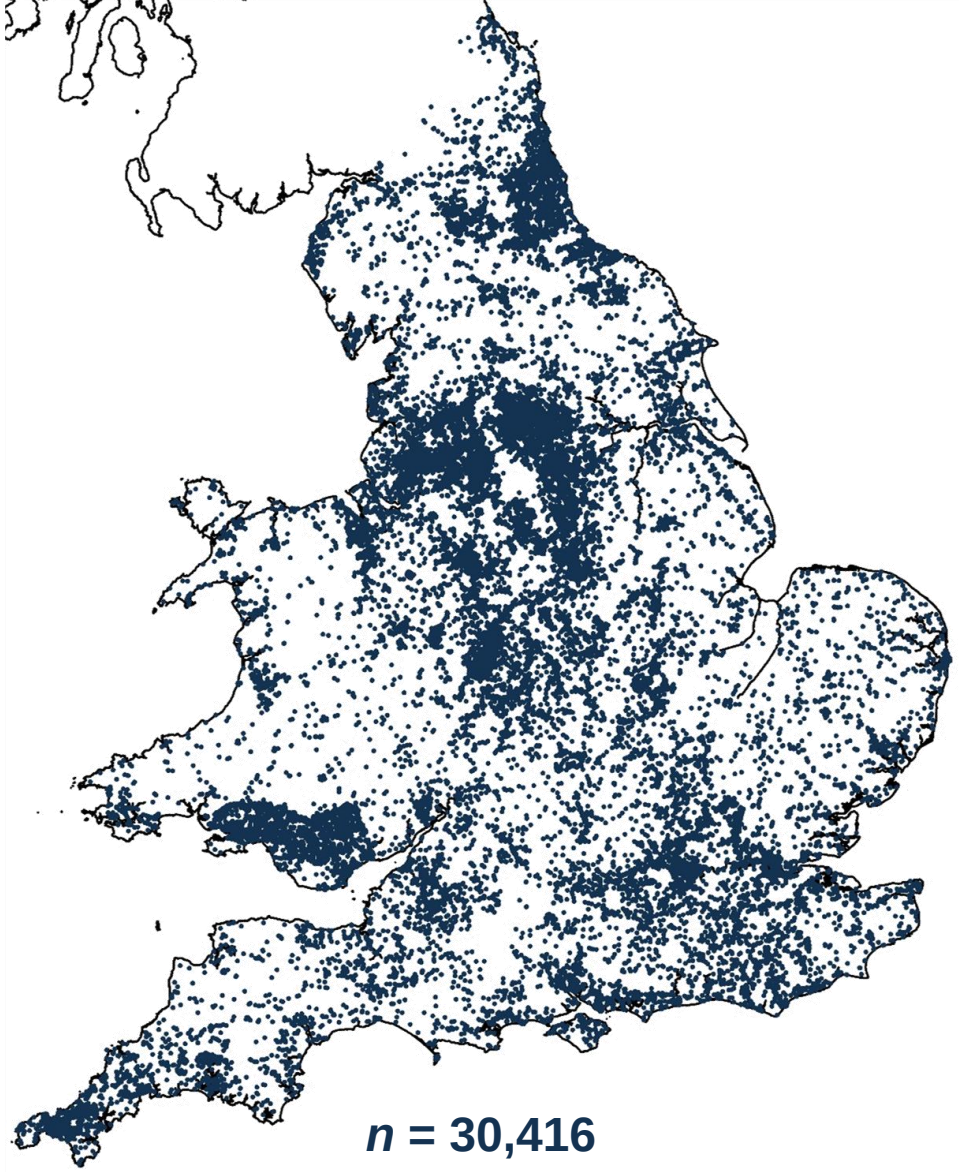
The Problem

- >30,000 legacy waste deposits identified throughout the UK
  - Coastal and low-lying areas historically used for deposition
- Most deposition pre-dates strict environmental regulations
  - Poor records kept of contents – unknown risks
- Coastal sites particularly at risk from climate change effects
  - Sea level rise
  - Increased severity of erosion
  - Increased storm activity
  - Increased likelihood of tidal flooding



A brief tour of the Great British coastline…

Mining waste on public beach

Leachates enriched in arsenic

Exposed plastics, glass – eyesore and hazard

Lynemouth Beach

- Mixed waste (municipal, commercial, mine spoil)
- Rapid erosion exposes wastes to beach.
- Is being actively managed – major works starting this year.

Slag “cliff” 40 m high

Duddon Estuary (SSSI, Ramsar, SAC)

Exposed waste – erosion; chromium, vanadium enriched

Barrow Slag Bank

- Extensive deposition of steel slag from local industries
  - 1860s-1960s
- 8.3 million m^3 waste
- Slag contains multiple potentially hazardous metals (e.g. Cr, V)

Eroding spoil

Spoil waste

Public beach; acidic pond pH 1.4

Seaham Blast Beach

- 2.5 million tonnes of coal spoil deposited per year over a century.
- Waste extended 7 km out to sea
  - Extensive regeneration in 1990s
- Legacy issues remain

Used by nesting birds – receptor

Retreat ~ 0.5m year

Multiple layers of deposition – 4m high

Flint, North Wales

- "Galligu" waste from Victorian alkali industries (sodium carbonate).
  - Common in Mersey/Dee estuaries
- Very soft material, subject to erosion and transportation.
- Reports of high Arsenic concentration

Overall Research Aim

- To investigate the ***spatial extent*, *characteristics*, and *physical and biogeochemical behaviour*** of legacy wastes, in order to evaluate;
  - The **environmental risks** and impacts of wastes in coastal zones, now and in future climate scenarios
  - The most appropriate **management policies** and interventions to address these risks

National Screening Exercise

Analysis separated based on existing/future management

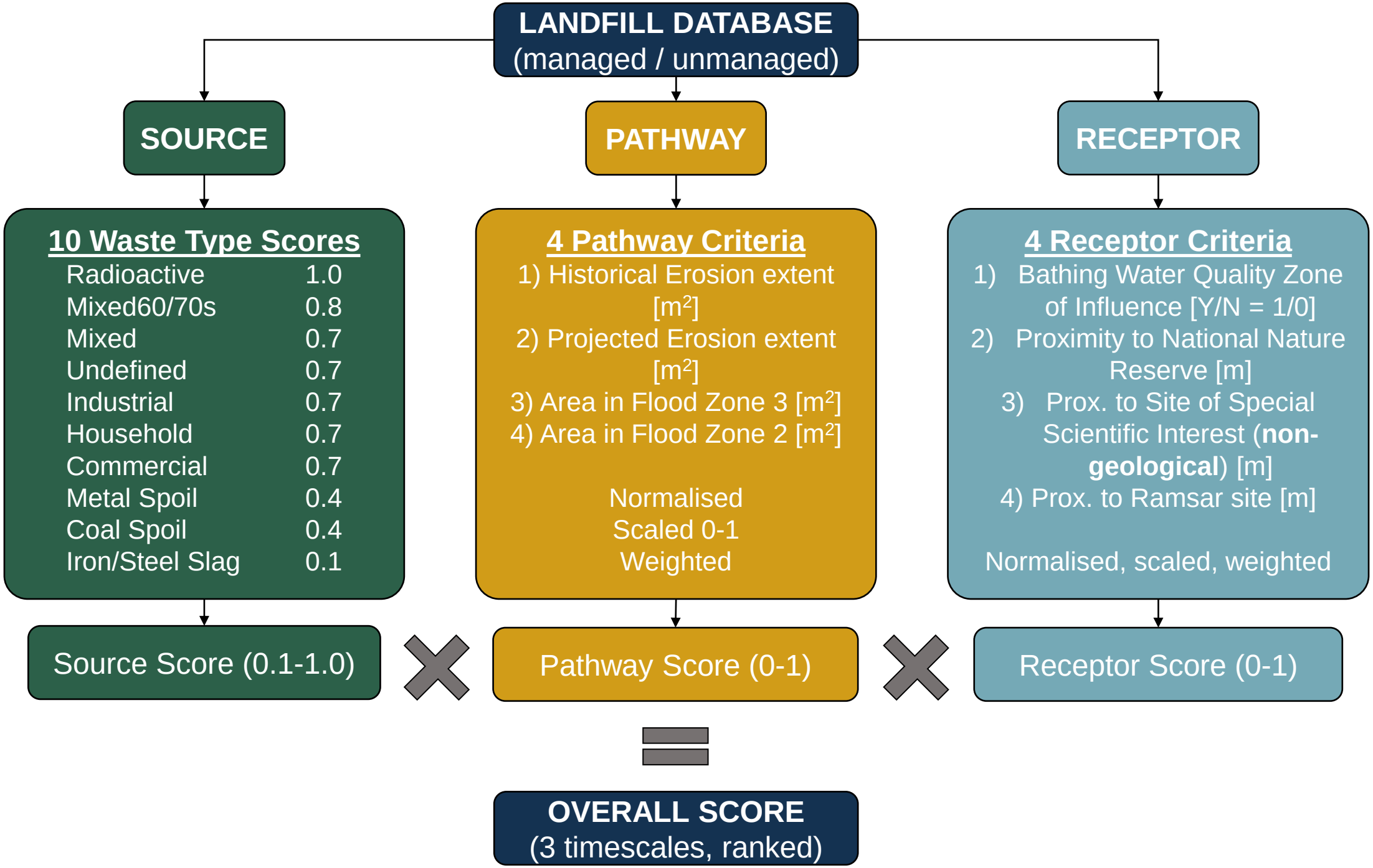
- **Managed**: sites behind flood (or tidal) defences and/or ‘hold the line’ shoreline management plans.
- **Unmanaged**: sites with no defences or HTL management plan.

CSM approach uses SPR framework, generating three sub-scores for each site

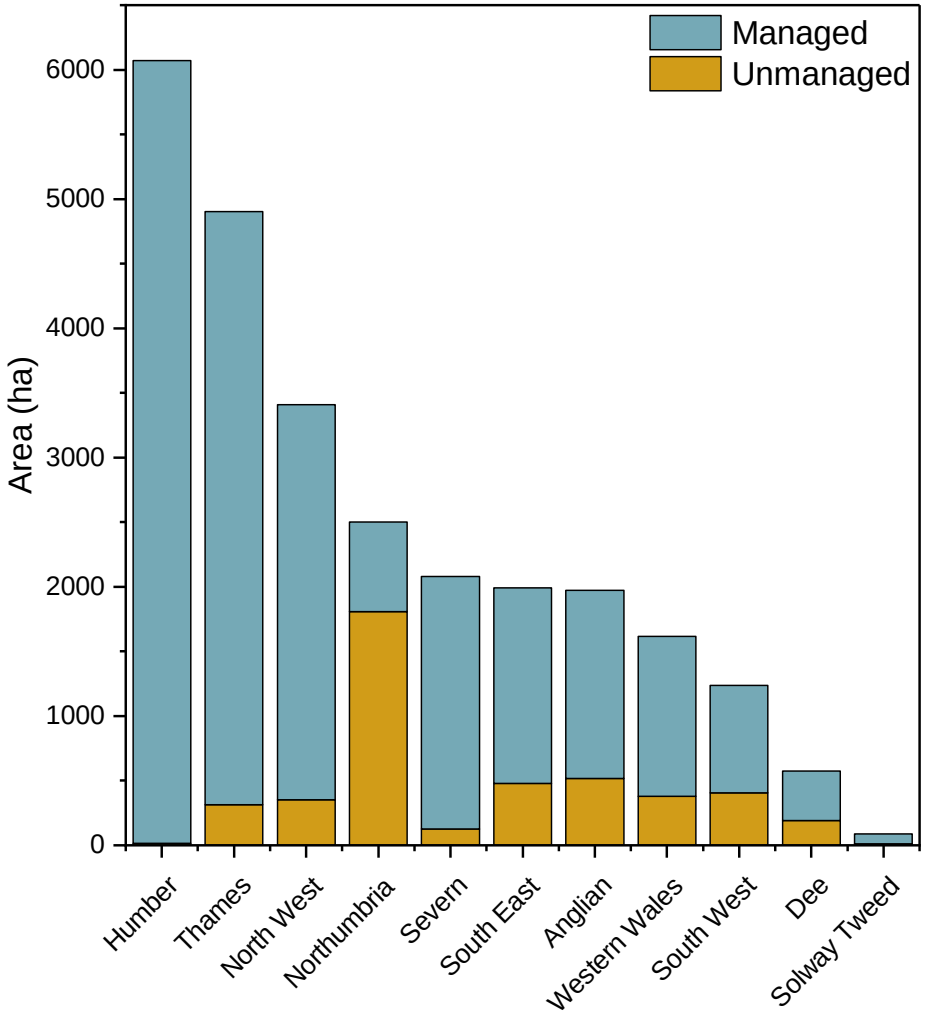
- **Source**: relative inherent risks of waste types based on likely contents.
- **Pathway**: relative likelihood of pollutant release.
- **Receptor**: risk of pollution affecting environmental and human receptors.

Scores are **multiplied** to generate overall risk score

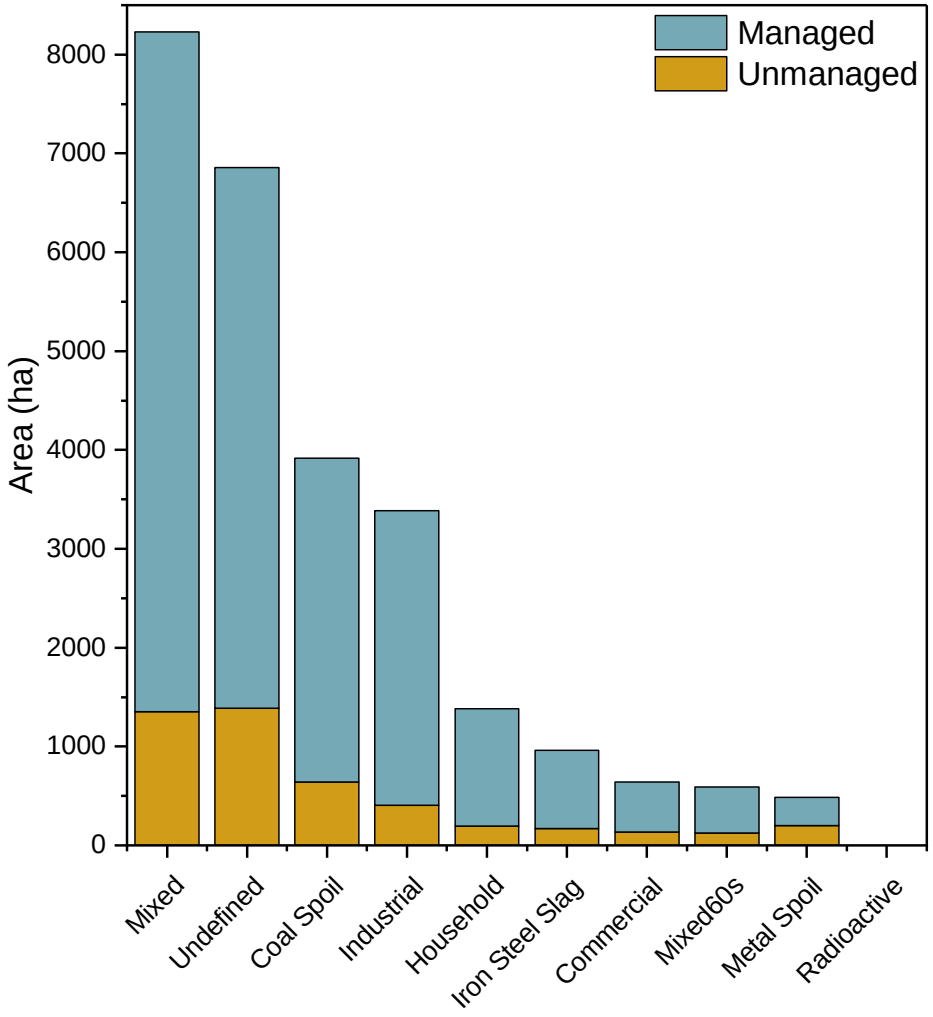
- A landfill must have a feasible pollutant transport pathway to a sensitive receptor to score highly.


LANDFILL DATABASE
(managed / unmanaged)
SOURCE
PATHWAY
RECEPTOR
10 Waste Type Scores
Radioactive 1.0
Mixed60/70s 0.8
Mixed 0.7
Undefined 0.7
Industrial 0.7
Household 0.7
Commercial 0.7
Metal Spoil 0.4
Coal Spoil 0.4
Iron/Steel Slag 0.1
4 Pathway Criteria
1) Historical Erosion extent [m²]
2) Projected Erosion extent [m²]
3) Area in Flood Zone 3 [m²]
4) Area in Flood Zone 2 [m²]
Normalised
Scaled 0-1
Weighted
4 Receptor Criteria
1) Bathing Water Quality Zone of Influence [Y/N = 1/0]
2) Proximity to National Nature Reserve [m]
3) Prox. to Site of Special Scientific Interest (non-geological) [m]
4) Prox. to Ramsar site [m]
Normalised, scaled, weighted
Source Score (0.1-1.0)
Pathway Score (0-1)
Receptor Score (0-1)
OVERALL SCORE
(3 timescales, ranked)

Key Outcomes – Coastal Distribution



Management Status by RBD



Management Status by Waste Type

Key Sites and Rankings

Filtered ~30,000 original legacy sites down to 669 unprotected at-risk sites; 2550 protected at risk sites

UNMANAGED

Mostyn Docks	#1	Mixed
Vange Marshes	#3	Mixed 60/70s
Millom Pier	#9	Iron Steel Slag
Blast Beach	#11	Coal Spoil
Blackhall	#27	Industrial
Withernsea	#31	Mixed 60/70s
Brickyard Lane	#45	Industrial

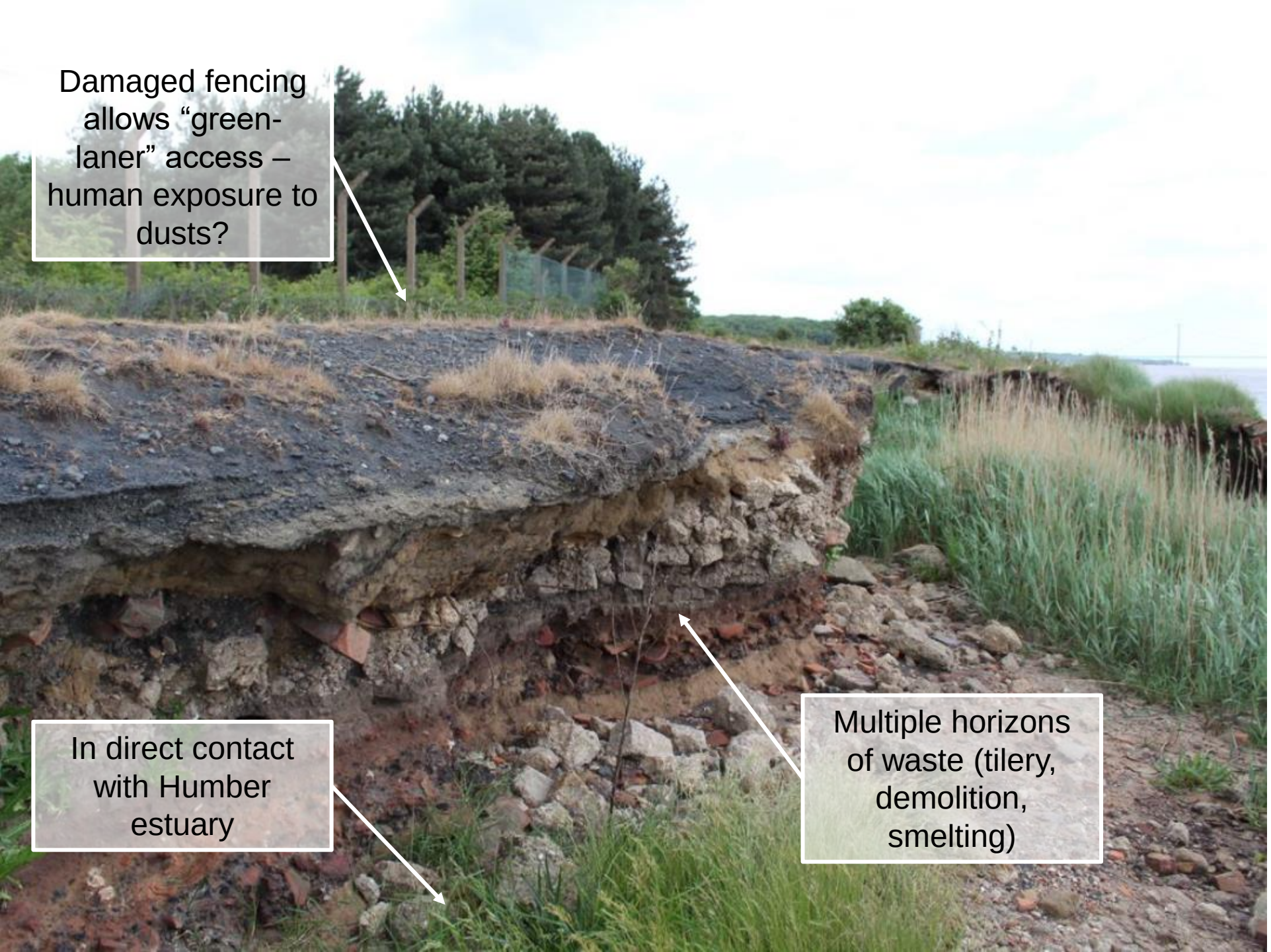
MANAGED

- **Lynemouth** #23 Mixed

Brickyard Lane (Capper Pass), Humber

- Site of former Capper Pass & Son Ltd tin smelter, North Ferriby
  - Produced 10% of world tin output at its peak
- Notorious pollution track record, including;
  - ~3 tonnes *per week* of lead and arsenic discharged to atmosphere
  - Largest point source of radiation in UK for a time (batch of ore containing Po-210 in 1984)
  - Links to childhood leukaemia clusters in West Hull and surrounding area

Active erosion of landfill frontage on Humber Estuary



North Ferriby

- Site comprised of metallurgical slag
- Enriched in Pb, Cu, Zn, Sn, As, Sb
- High leaching of toxic metals in seawater conditions

Metal(loid) flux

Scale 1:4000

0 50 100 150 200 250 300 350 400 450 500 m

Projection: British National Grid
20 March 2023 08:21

Direct water discharge:
- 164-204 kg/yr As
- 220-292 kg/yr Zn

Physical erosion
- <5 kg/yr As
- 250-295 kg/yr Zn

Flux from consented discharges within Humber:
- Industrial: 17-23 kg/yr As; 5050-10650 kg/yr Zn
- STW: 121-170 kg/yr As; 8551-12926 kg/yr Zn

Flux at tidal limits of major tributaries of Humber (Ouse, Wharfe, Derwent, Aire, Don, Trent, Hull, Ancholme)
- ~**8.5 tonnes/yr As**; **~290 tonnes/yr Zn**

Data source: OSPAR monitoring courtesy of EA

Conclusions & Future Work

- Large number of waste sites in coastal zone
- Range of pressures and issues
- Lack of data on composition (solids, affected waters / sediments) a key uncertainty
- GIS screening is first stage in focussing management efforts
- Detailed site studies useful in considering relative importance of legacy sites compared with contemporary sources

- Ongoing research on leaching behaviour, fate of pollutants and issues associated with accentuated wetting / drying cycles underway

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Natural Environment Research Council

Latest paper: https://doi.org/10.3389/fenvs.2022.1045482

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https://research.ncl.ac.uk/legacywastes/