SUPPORTING INFORMATION: Legacy Iron and Steel Wastes in the UK: Extent, Resource Potential, and Management Futures.

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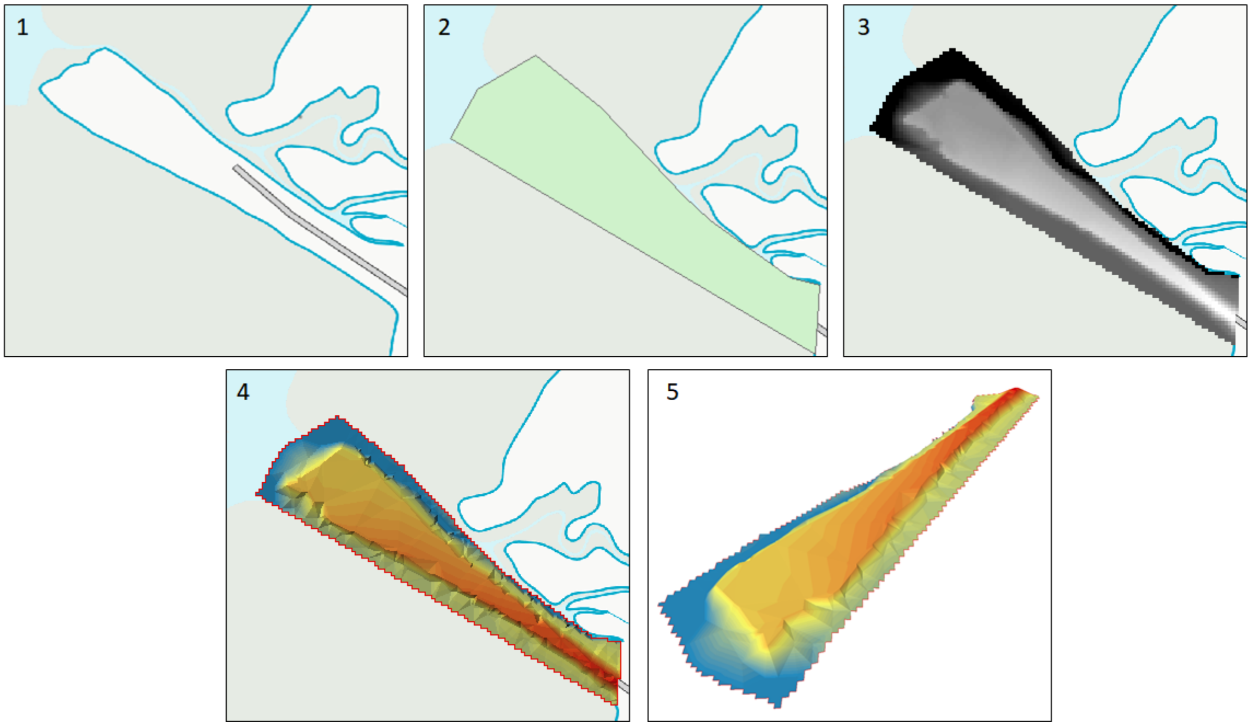
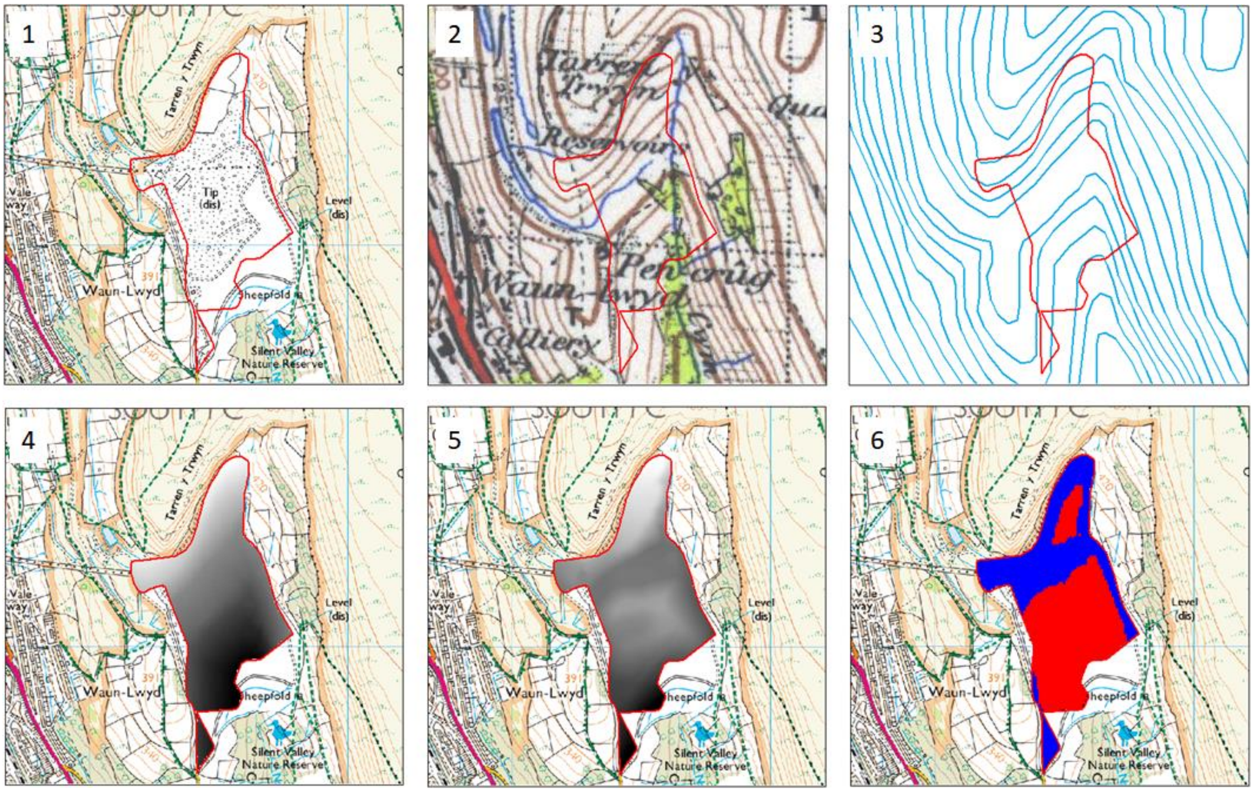
Figure S1: Slag volume estimation method for littoral (coastal) slag deposits with constant baseline. Askam-in-Furness slag pier used as an example. (1: Basemap of known slag deposit, 2: Shapefile of region of interest, 3: Clipped digital terrain model (DTM), 4 and 5: 2-D and 3-D triangular irregular network (TIN) model of slag deposit).



For coastal deposits, where slag was heaped directly on the littoral zone, volume estimation was achieved as follows. First, the boundary of the slag deposit was identified using either the Environment Agency/Natural Resources Wales Historic Landfill Databases, British Geological Survey data, or hand-digitised from current or historical OS maps (Panels 1 and 2 in Figure S1). Using a 5-m resolution digital terrain model (DTM) of the site, the surface profile of the deposit was extracted (panel 3), and used to generate a triangular irregular network (TIN) model of the deposit (panels 4 and 5), which were used for subsequent volume calculation. Volume calculations were made using the Surface Volume tool of ArcMap 10.7.1, using a baseline characteristic of the surrounding surface (e.g. in the example above, the elevation of sand deposits/water surrounding the pier). This method proved reliable for such coastal deposits where underlying terrain was constant, although it will underestimate volumes of material tipped below mean low water mark.

Figure S2: Slag volume calculation for terrestrial environments with complex underlying terrain. Ebbw Vale used as an example (1: OS Map and extent of slag deposit, 2: 1920s OS Map of area, 3: Digitised contour lines from 1920s OS map, 4: digital terrain model (DTM) of historical elevation, 5: DTM of present-day elevation, 6: regions of increased elevation (i.e. slag deposition) in red).



Where slag was deposited in terrestrial settings, a different approach to volume estimation was taken to account for the complex terrain beneath the deposit. Using the contour lines of historical OS maps prior to slag disposal, a TIN model was generated of the historical surface and converted to a terrain raster dataset. Comparison of this historical surface with modern terrain models (clipped to slag extent) was completed using the Cut Fill tool of ArcMap to identify differences in elevation, with volume tabulated as layer attribute. While this method yielded reasonable results, it is possible for over estimation of volume to occur in, for example, heavily wooded areas where modern surface elevation may be overestimated. Similarly, the resolution of data generated by historical contour line mapping has potential for introducing error into volume calculations. However, this method was deemed appropriate for such a national-scale assessment of iron and steel slag inventory, but detailed geophysical surveys are recommended for future site-specific investigations in priority areas. For comparative purposes, estimates of slag heap volume at Consett, County Durham when derived from geophysical estimates (Mayes et al., 2018; Pullin et al., 2019) are roughly 10% higher than those derived from GIS here. This may reflect the difficulty in identifying shallow layers of slag where material has been tipped over undulating underlying topography.

Table S1: Review of UK blast furnace (BF) and basic oxygen furnace (BOF) slag composition. Values presented as wt.% of metal oxides. [1] Pullin et al. (2019), [2] Poh et al. (2006), [3] Schrama et al. (2020), [4] Tyrer (1991), [5] Bougara et al. (2010), [6] Lee (1974), [7] Hamilton (1999), [8] Juckes (2003), [9] Hobson et al. (2017), [10] Hobson et al. (2018), [11] Ghatoara et al. (2015), [12] Ghatoara et al. (2004), *unpublished data by authors, - = not analysed for.

Type	**Ref**	**Location**	**Age**	**CaO**	**FeO**	**SiO_2**	**MgO**	**MnO**	**Al_2O_3**	**P_2O_5**	**V_2O_5**	**TiO_2**	**Cr_2O_3**	**SO_3**	**K_2O**	**Na_2O**	**SrO**	**ZrO_2**	**BaO**	**NiO**	**ZnO**	**CoO**
BF	[1]	Consett	1950s	34	0.86	38.05	19	0.61	6.3	0.005	-	0.17	-	1.5	0.26	0.38	0.16	0.002	0.24	-	-	-
BF	[2]	Llanwern	2000<	40.43	0.38	35.41	8.71	0.57	13.64	-	-	0.61	-	0.1	-	-	-	-	-	-	-	-
BF	[3]	Port Talbot	2000<	38	-	37	8.9	0.14	14	-	-	0.6	-	-	0.45	0.32	-	-	-	-	-	-
BF	[4]	Scunthorpe	1990s	42.3	0.4	36.7	6.4	0.3	10.1	-	-	0.3	-	2.2	0.6	0.5	-	-	-	-	-	-
BF	[5]	Scunthorpe	2000<	39.72	0.86	35.8	8.55	0.69	13.19	-	-	0.63	-	0.56	0.41	0.28	-	-	0.09	-	-	-
BF	[6]	UK	1960s	36	0.3	28	4	-	12	-	-	-	-	1	-	-	-	-	-	-	-	-
BF	[6]	UK	1960s	43	1.7	36	11	-	22	-	-	-	-	2	-	-	-	-	-	-	-	-
BOF	NA*	Consett	1960s	31.1	22.3	28.4	1.2	3.9	3.8	-	0.26	0.7	0.13	0.8	0.248	0.82	0.04	-	0.17	0.05	0.3	0.002
BOF	[7]	Allonby	>1970	-	42.5	-	-	-	-	-	-	-	0.04	-	-	-	-	-	0.11	-	0.12	0.015
BOF	[8]	Llanwern	2000<	36.45	31.13	12.11	4.15	-	2.22	1.12	-	-	-	0.25	-	-	-	-	-	-	-	-
BOF	[12]	Port Talbot	2000<	41.44	22.7	15.26	8.06	5.2	4.35	1.15	-	0.72	-	0.1	0.42	0.05	-	-	-	-	-	-
BOF	[8]	Port Talbot	2000<	45.83	29.98	10.74	6.65	-	2.1	1.19	-	-	-	0.23	-	-	-	-	-	-	-	-
BOF	[9]	Scunthorpe	2000<	40	32	14	5.2	4.5	1.2	1.3	0.81	0.3	0.24	0.23	0	0	0	0.02	0	0.02	0	-
BOF	[10]	Scunthorpe	2000<	19	16	11	28	2.1	18	0.87	0.33	0.86	3.3	0.33	0.12	0.18	0.14	0.14	0.01	0	0.02	-
BOF	[8]	Scunthorpe	2000<	43.54	26.2	11.99	7.76	-	0.99	1.15	-	-	-	0.35	-	-	-	-	-	-	-	-
BOF	[11]	Teesport	2000<	38.8	21.34	16.3	8.2	3.44	1.28	0.6	-	0.6	-	0.08	-	0.42	-	-	-	-	-	-
BOF	[12]	Teesport	2000<	38.8	21.34	16.29	8.15	3.44	1.28	0.63	-	0.61	-	0.08	-	0.42	-	-	-	-	-	-
BOF	[8]	Teesside	2000<	41.86	26.84	11.92	6.51	-	3.43	1.47	-	-	-	0.53	-	-	-	-	-	-	-	-
BOF	[2]	UK	2000<	52.19	27.3	10.78	5.04	2.45	1.34	1.28	-	0.55	-	-	0.07	0.07	-	-	-	-	-	-
BOF	[2]	UK	2000<	40.98	26.2	11.98	7.5	3.78	2.82	0.89	-	0.58	-	-	1.23	0.2	-	-	-	-	-	-
BOF	[8]	Ravenscraig	2000<	44.42	25.04	15.19	6.88	-	1.4	1.01	-	-	-	0.18	-	-	-	-	-	-	-	-
BOF	[6]	UK	1970s	40	12	10	2	-	-	-	-	-	-	0.2	-	-	-	-	-	-	-	-
BOF	[6]	UK	1970s	50	20	20	9	-	-	-	-	-	-	0.9	-	-	-	-	-	-	-	-

Table S2: Summary of ecological and cultural designated areas screened against in this study, adapted from Crane et al. (2017).

Designation	**Type**	**Summary**
Site of Special Scientific Interest (SSSI)	Ecological	Designated under the Wildlife and Countryside Act (1981) for biological and/or geological interest. Often overlap other designated areas, including SACs and SPAs. Planning permission within SSSIs facilitated through Natural England.
Special Protected Area (SPA)	Ecological	Designated under the 1979 Birds Directive and the Conservation of Habitats and Species Regulations (2010) to protect threatened and endangered international bird species.
Special Area of Conservation (SAC)	Ecological	Contain internationally significant habitats and/or species. Protected under the 1992 Habitats and Species Directive, and the Conservation of Habitats and Species Regulations (2010). All terrestrial SACs are also SSSIs.
Ramsar Site	Ecological	Protected under the Convention on Wetlands (1971) (aka Ramsar Convention) for conservation of wetlands of international importance, especially those providing waterfowl habitat.
Area of Outstanding Natural Beauty (AONB; England/Wales) / National Scenic Area (NSA; Scotland)	Cultural	Designated for their landscape qualities under the National Parks and Access to the Countryside Act (1949).
National Park	Cultural	Also designated under the National Parks and Access to the Countryside Act (1949) to promote education, recreation, and conservation of landscapes, wildlife, and cultural heritage.
World Heritage Site (WHS)	Cultural	Designated by the United Nations Educational, Scientific and Cultural Organisation (UNESCO) for natural and/or cultural features of international significance.
Listed Building (LB)	Cultural	Buildings and structures of special historical interest which are protected by Historic England, Historic Environment Scotland, Cadw (Wales), or the Northern Ireland Environment Agency.

Table S3: Slag disposal sites with the highest maximum carbonation potential under three management regimes, and the date of closure of the associated works (DC = direct carbonation, EW = enhanced weathering, PC = passive carbonation, *= works still operational).

Site	**Town**	**Easting**	**Northing**	**Works Closed**	**Mass Slag**	**CO_2 Sequestration Potential**		
					Mt	**DW (Mt)**	**EW (Mt)**	**PC (Kt)**
Workington South	Workington	298878	527962	2006	31 - 38	13.0	22.5	0.5
Consett Heaps	Consett	409735	550606	1980	15 - 18	6.2	10.8	0.2
Workington North	Workington	299640	530352	2006	10 - 13	4.3	7.5	0.2
Barrow Slag Bank	Barrow-in-Furness	318883	470850	1963	9 - 12	4.0	6.9	0.1
Quarry Infill	Scunthorpe	493123	411079	NA*	9 - 11	3.7	6.3	0.1
Normanby Slag Bank	Scunthorpe	488033	414122	NA*	7 - 9	3.0	5.1	< 0.1
Ravenscraig Heaps	Ravenscraig	277208	657704	1992	7 - 8	2.8	4.9	< 0.1
Margam Burrows	Port Talbot	278460	183702	NA*	7 - 8	2.8	4.8	< 0.1
Reduction Works	Cardiff	321422	176048	1987	6 - 8	2.7	4.6	< 0.1
Maryport Coastal	Maryport	302906	535909	1927	5 - 7	2.3	4.0	< 0.1

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