Can Dredged Canal Sediments Be Used For Flood Defences As Part Of The Scottish Circular Economy?

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Overview

The vision of a circular economy is to limit environmental damage through waste elimination. This is only possible through intensive recycling and the elimination of waste streams via beneficial reuse, with a corresponding reduction in the estimated 10.7 Mg CO_2 emissions per capita in Scotland (Pratt, Lenaghan *et al*. 2016). Sediments dredged from Scotland's four operating canals represent a waste stream that can be potentially utilized, providing its geotechnical properties can be optimised and any residual environmental concerns, such as sediment contamination, can be addressed. Scottish Canals currently remove around 4,000 tonnes of material per year to maintain canal depth and navigability through the canal network. Over 99% of EU marine sediment is dumped at sea, representing a lost opportunity to reuse or recycle materials for use in engineering works to prevent flood risk or erosion under climate change scenarios.

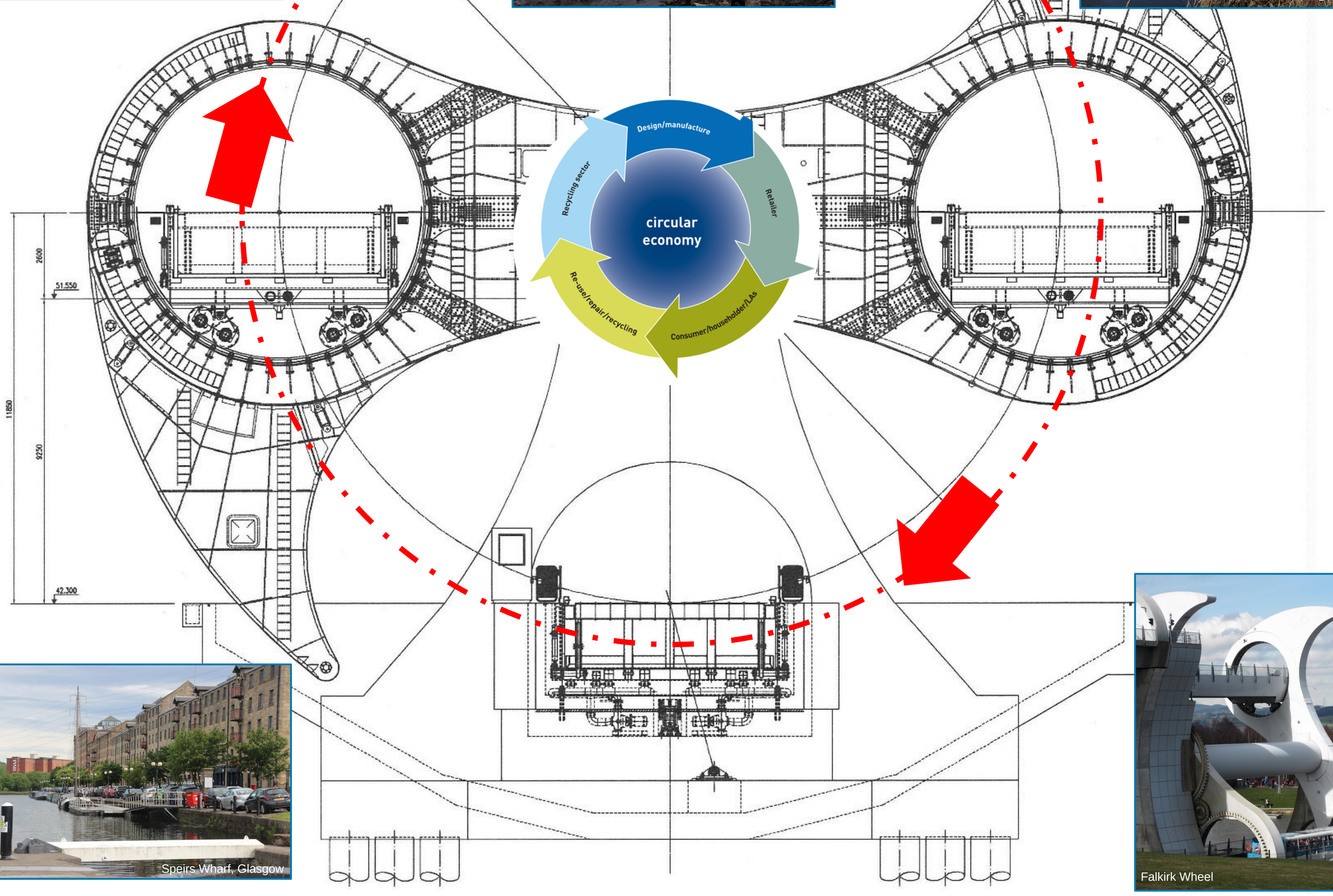
Scottish Canals and the University of Strathclyde have joined a consortium of 7 key European academic and industrial partners as part of the EU-funded Interreg NWE SURICATES Project - Sediment Uses as Resources in Circular And Territorial Economies. Using a series of pilots and trials the SURICATES consortium will demonstrate the potential for safe and effective reuse options of this potential resource, including sediment nourishment, use in concrete, pozzolanic mixtures, or phyto-conditioning and bio-engineering of soil for restoration and reclamation.

Following a protracted decline in usage due to competition with railway transport, the Forth & Clyde Canal finally closed in 1962, but was rehabilitated and reconnected to the Union Canal via the Falkirk Wheel as a millennium project. An important economic benefit of the canal system was the provision of water to the industries that grew up along its banks and as a convenient sewer for the disposal of waste. The geochemistry of canal sediments is often reflective of the types of industries adjacent to a section of canal, with gas works, chemical works, foundries, and tanneries contributing to elevated levels of lead, arsenic, chromium, and cadmium.


Derelict canal 1980s Clydebank


Rejuvenation


Dredging



Speirs Wharf, Glasgow

Falkirk Wheel

What are the geotechnical characteristics of dredged canal sediment?

Sedimentation in Scottish Canals is influenced by four main factors:

- Sediments derived from natural erosion within the watersheds draining into the canal, which are in turn controlled by the local geology, topography and hydrology.
- Inputs of vegetation and other organic materials, including reeds and other aquatic plants.
- Anthropogenic inputs within urban areas, including run-off, pollution and the erosion of contaminated land.
- Historical pollution related to industries that discharged waste directly into the canal.

The table below shows the properties of sediment at selected canal locations.

Ref	Canal	Description	Latitude	Longitude	LOI	Water content
21052019SS2	Union Canal	Dark brown organic clayey SILT	55.970629	-3.610024	19.0%	74.0%
21052019SS5	Union Canal	Dark brown organic CLAY	55.975939	-3.586418	13.0%	35.0%
SC/069/001	Forth and Clyde Canal	Dark brown organic CLAY	55.929765	-4.478279	47.0%	71.0%
SC/070/001	Forth and Clyde Canal	Very clayey SAND	55.880881	-4.2680475	30.0%	70.0%
SC/070/003	Forth and Clyde Canal	Sandy CLAY	55.877191	-4.2639793	35.0%	60.0%
SC/072/003	Caledonian Canal	Brown very gravelly SAND	57.037504	-4.812766	1.0%	15.0%
SC/072/006	Caledonian Canal	Brown slightly clayey, very sandy GRAVEL	57.03615	-4.810129	2.0%	12.0%

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Scottish Canals

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Other contaminants, such as tributyltin and mercury fulminate originate from specific point sources. Maintenance of antifouling paint on barge hulls has impacted sediments at Bowling Basin (Bangkedphol, Keenan *et al*. 2009). Explosives manufacture at the former Nobel Westquarter factory in Reddingmuirhead has impacted sediments with mercury compounds over a large stretch of the Union Canal (Cavoura, Brombach *et al.* 2017). Consequently, any beneficial reuse of canal sediments is predicated on screening for potentially toxic elements and compounds.

Dredged sediments for flood prevention

More frequent extreme rainfall events and flash flooding is an expected manifestation of Scotland's changing climate. Flooding can be mitigated to some extent by engineering controls which are resource intensive, with a correspondingly high carbon footprint for mined aggregates and cement. While dredged canal sediments do not have the required engineering characteristics for flood barriers, they have potential in pozzolanic mixtures or additives to concrete and as clean fill.

Sediment treatment for beneficial re-use

Some processing of dredged sediments will be required prior to use. Firstly, the saturated sediments must be dewatered, ideally at the point of dredging, to reduce transportation costs. In-situ dewatering must be engineered to collect and monitor water discharges to meet regulatory standards.

Further soil conditioning may be required to address such properties as soil texture and organic carbon content which might impair soil stability. The SURICATES consortium is investigating the viability of phyto-conditioning and bio-engineering in pilot to achieve this goal using sediment dredged at three locations.

References

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