Developing an industrial-ecological model to remediate marine sediments

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Project Industry Partners - *Nystar, Flinders Ports, Environmental Protection Agency (SA)*
Location - Adelaide (and Port Pirie), South Australia

Summary
Coastal smelters and refineries can create serious pollution legacies in marine sediments that are often ignored until facilities close. This project will investigate opportunities to use industry's capacity to progressively remediate while operating and, potentially, recover resources from sediments. By understanding current contamination levels, dispersion pathways and interactions with ecological systems at Port Pirie, South Australia, this project will develop an industrial-ecological model to determine how to rectify historical heavy metal pollution and identify new ways of managing ongoing sediment contamination. In turn, the sustainability of smelters and refineries will be reimagined, potentially extending their working lives while improving environmental outcomes.

Background and Approach
Many coastal locations have a long history of industrial activities that have released metals into the marine environment, which can have long-term persistence and important environmental effects. Port Pirie is located on the eastern shore of the Upper Spencer Gulf in South Australia and hosts one of the world's largest lead and zinc smelters, in constant operation for more than 120 years. Although discharges and emissions have reduced from the plant in recent years, past studies found extremely elevated levels of metals including zinc, lead, arsenic, manganese and copper in the adjacent marine system. Recent smelter upgrades at Port Pirie should reduce future inputs, but it is unclear exactly what the existing metal loads are or their dynamics i.e. how contaminants are migrating and affecting the marine ecosystem, or how much (and where) metal is available biologically, and how much is sequestered into sediments and/or exported from the system into the rest of the Spencer Gulf. Without a better model of metals' fate in the marine environment, it is difficult to assess the cost-benefit of reduced discharges from future smelter upgrades or which sediment remediation options are viable. Similarly, likely impacts from future disturbances are hard to predict - for example, from dredging for port expansion or climate change. Such questions could be addressed by developing an industrial-ecological (systems) model that links an understanding of the fate of metals in the marine environment with ongoing smelter operation, as well as potential industrial processes for remediating sediments, including options that may involve the capacity of the smelter itself in metals recovery (Fig 1).

The project will also work towards assessing new remediation options for areas like Port Pirie that are often considered too contaminated for options other than 'do-nothing' or dredge and landfill disposal (as hazardous waste). Sediments contaminated with high concentrations of metals such as those at Port Pirie may in fact present opportunities for dual resource recovery/remediation works, depending on the concentrations (and total resource) present, particle size and chemistry, resuspension likelihood and metal availability. Indeed, although the (very high) concentrations previously reported for some metals in Port Pirie sediments are still below typical commercial mining grades, the potential energy savings associated with processing already fine sediment particles could mean recoveries might be economic at much lower concentrations. Additionally, any assessment should also consider what opportunities the onsite smelter processes and ancillary facilities (settling ponds etc.) might add to options to remediate progressively, and then also the opportunity costs of a 'do nothing' strategy where remediation is delayed until contamination ceases sometime in the future (when the smelter may also have stopped working).

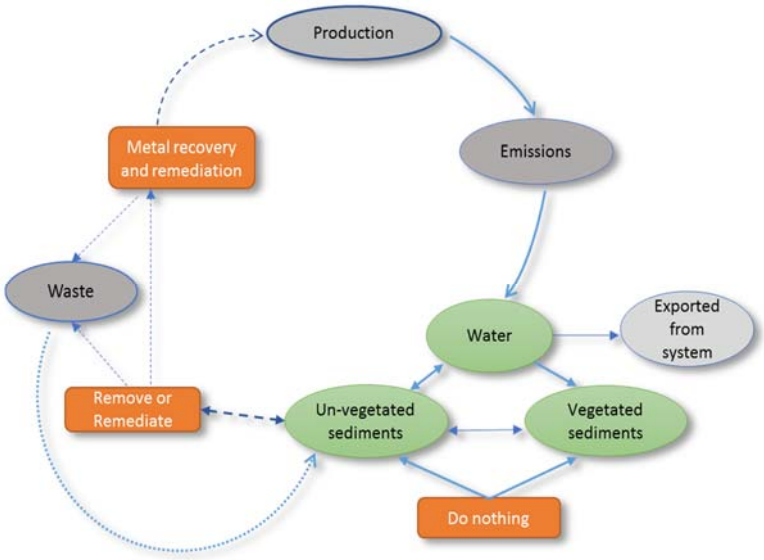

Figure 1: Industrial-ecological model of heavy metal contamination of marine sediments at Port Pirie

PhD Project Outline

Overall, the aim is to develop an industrial-ecological (systems) model of the dynamics of metal contamination at Port Pirie, incorporating both the receiving marine ecological system and changing smelter (input) and potential remediation processes. The model will be parameterised using environmental sampling (aged sediment coring) and field experiments to determine current/historical levels of metal contamination and their flows and effects in the marine ecosystem of Port Pirie. Field work to collect this data is underway but there will be opportunities to be involved in future field collections and chemical analysis of samples, potentially focussing on the resource recovery value of rare earth elements. The PhD student will also need to work closely with metallurgists at Nyrstar to incorporate current smelter operations into models and with their environmental scientists who collect extensive emissions monitoring data. We expect the student will spend some time based at the smelter, about 300km north of Adelaide. The goal is to then use the model to identify cost-effective and environmentally beneficial remediation options for the contaminated marine sediments at Port Pirie, accounting for both current opportunities provided by a working smelter as well as future scenarios such as dredging or climate change.

Project Team & Funding

This PhD project will be based in Craig Styan's lab in South Australia, at the Future Industries Institute (FII) at UniSA (see also www.ermeresearch.com), with a supervisory panel including Professor Peter Teasdale and Assoc. Prof. Albert Juhasz and a representative from industry. Support for the overall project is being provided by the industry partners but the PhD student will need to apply for a scholarship to cover tuition fees and living expenses. Although Craig is a Senior Lecturer at University College London, he is also an adjunct at UniSA and the broader research team on the supervisory panel are based at UniSA. Consequently, the most logical option is for the student enrol for a PhD at UniSA (see UniSA scholarships).

For international (non Australian) students there are a few options to cover fees and a stipend:

- Endeavour Awards (many countries)
- Australia Awards (developing countries)
- Britain-Australia Award (UK citizens)
- ATN-LATAM Research Scholarship Scheme (Sth American countries)
- UniSA Awards for International PhD students (many countries)

And for Australian students the most likely options are:

- UniSA-wide scholarships for Australian applicants
- (UniSA) William T Southcott Scholarship for Practical Engineering

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