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Surface sediments of Richards Bay Harbour,

South Africa – potential pollutants (heavy metals, persistent organic pollutants, microplastics) and grainsize distribution

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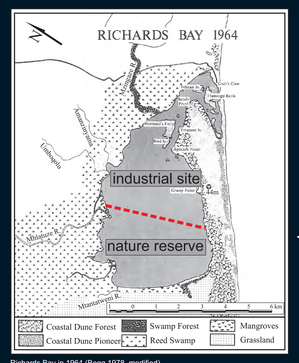
South Africa's rising population together with the developing industrial sector have resulted in vast pressures on its ecosystems (Department of Environmental Affairs, 2012). The influence of Port operations, Coal Terminal and nearby factories (Aluminium Smelter, Fertilizer plant, woodchip factory) are expected to imprint on Richards Bays ecosystem.



Richards Bay in 1964 (Begg 1978, modified)

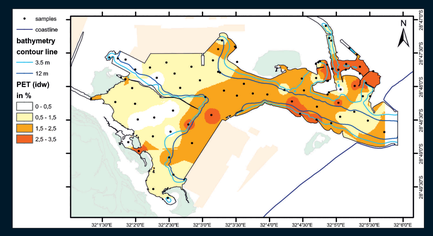
Study Area

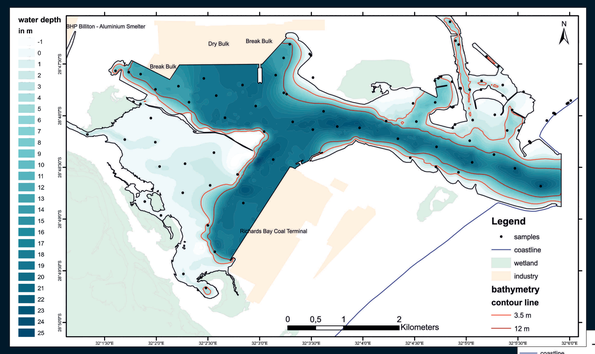
The facilities of Richards Bay opened in April 1976. Key to its establishment was the division of the original ecosystem into harbour and sanctuary by a 4 km long causeway. This created two separate systems.

Richards Bay today (GoogleEarth)

Hydrodynamic control

PET





Bathymetry

Richards Bay Harbour bathymetry features two extremes: the dredged inner basin (dark blue) and the less/undredged outer perimeter (light blue/white). Highlighted are the 3.5 m and 12 m contour line. These frame the steep margins created by dredging.

Granulometry

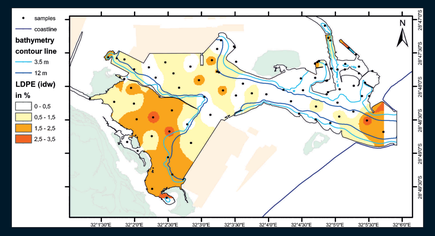
Grainsize distributions correlate strongly with water depth. The dredged harbour basin accumulates mainly silt, the port entrance accumulates medium - coarse sand.

PET* (Polyethylenterephthalat) distributions are linked to the hydrodynamic regime. Maximum percentages are found at shorelines. The high density of ~1.4 g cm^{-3} defines the PET particles sedimentational behaviour. It settles under higher energetic conditions.

LDPE* (Low Density Polyethylen) distribution correlates with shallow water and low energetic depositional areas. Particles of lower density ~0.9 g cm^{-3} are transported to regions where conditions are calmer (i.e., not influenced by marine traffic).

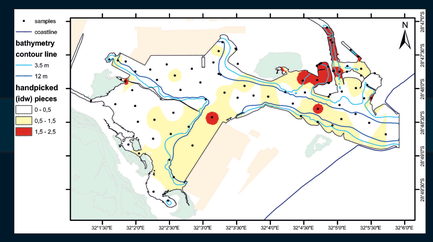
Plastic particles < 5 mm were **handpicked** for each sample. Their occurence is similar to PET distributions, but their highest occurence is concentrated around public ports and BBQ areas, identifying them as a source of pollution.

*Bulk sediment samples were analysed for microplastic using a method by Hahn et al. 2019.



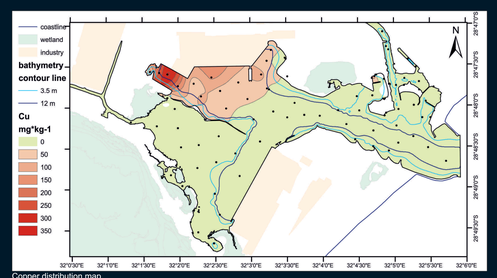
LDPE

handpicked plastic



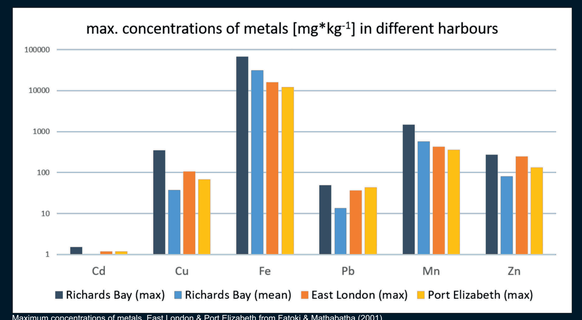
Point sources

Heavy metal distributions generally follow grainsize distribution patterns: metals are deposited within the finer fractions (silt to clay). However, some heavy metals are enriched in certain areas. Copper (Cu) reveals **highest concentrations in front of the industrial port**, indicating an anthropogenic point source. Copper levels ranging from 50 - 350 mg*kg^{-1} exceed London Dumping Convention Thresholds (DEA&T, 1998).



Copper distribution map.

Maximum concentration values exceed findings of other comparable studies on South African ports (e.g., max. Cu concentration in Fatoki & Mathabatha (2001) for Port Elizabeth: 68.5 mg*kg^{-1} and East London: 106 mg*kg^{-1}).



Maximum concentrations of metals. East London & Port Elizabeth from Fatoki & Mathabatha (2001).

Conclusions

Microplastic distributions - derived from bulk sediment analysis - depend on the **hydrodynamic regime** within the harbour. In contrast, larger, handpicked remains are found mainly close to their appearent source: public harbour areas.

The distribution of copper and other environmental pollutants, e.g., chromium or zinc, appear to be influenced by **point sources**, such as the main bulk port.

Richard Bays maxiumum metal concentrations also exceed comparable South African ports (e.g., Port Elizabeth, East London; Fatoki & Mathabatha, 2001).

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This study is incorporated in the project TRACES (Tracing Human and Climate impacts in South Africa), funded by the BMBF (German Ministry of Education and Research) and embedded within SPACES II (Science Partnerships for the Assessment of Complex Earth System Processes).

Funded by
Federal Ministry of Education and Research
Ref. No. 03F0798A

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