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The effects of sea-level rise on water quality in coastal floodplain sediments

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Sea level has risen approximately 1.2 mm/year over the last 100 years (Hennessy et al. 2004) and is predicted to rise up to 80 cm by 2100 relative to 1990 sea levels (IPCC 2007). The number of extreme events related to sea level such as higher sea levels and increased inter-annual variability have also increased in frequency in the same time period (Hennessy et al. 2004).

Globally, large areas of coastal and estuarine floodplains are underlain by sulfidic sediments and acid sulfate soils (ASS). These sediments frequently contain high concentrations of acidity and trace metals. A significant portion of the stored acidity occurs in the form of exchangeable and hydrolysable acidic metal cations such as Al and Fe. Watertables in these environments are often close to the surface and intercepted by relatively shallow drains. Due to their low elevation and locations, these floodplains are highly susceptible to pulses of saline water caused by saltwater intrusion, storm surge and rising sea levels. Construction of extensive drainage systems has further increased the susceptibility of the floodplain to seawater inundation by increasing connectivity to the estuarine channel. This risk is likely to increase in the future with predicted increases in sea level and extreme events due to climate change.

This study uses both batch experiments to determine the effects of increasing ionic strength on exchange processes and trace metal desorption in oxidised floodplain sediments and sulfidic drain sediments, and intact soil cores to determine the surface water-porewater interactions over the short term following seawater inundation in coastal floodplain sediments.

We found that that saline inundation of oxidised ASS floodplain sediments, even by relatively brackish water may cause rapid, shorter-term water quality changes and a pulse release of acidity due to desorption of acidic metal cations (Wong et al. 2010). We also found that trace metals can be mobilised from sulfidic estuarine drain sediments at near-neutral pH values without oxidation as a result of increased ionic strength and competitive desorption of metal cations (Wong et al. in press). Rapid seawater incursion in CASS drainage networks is likely to adversely impact drain water quality by increasing trace metal mobilization. Drainage networks on ASS floodplains are highly susceptible to rapid seawater inundation through storm surge, seasonal salt wedge migration, floodgate failure or floodgate opening. The experimental results show that the initial addition of marine derived salts will result in a decrease in pH and increase in trace metals, even at low salt concentrations such as that found in brackish waters in estuarine environments.

References

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