Queen Mary
University of London

Effect of dry-wet cycles on the release of metals and herbicides from soil and sediment in coastal managed realignment sites



M. Kadiri, K. Spencer, K. Heppell

Geography Department, Queen Mary
University of London, UK

Background

- Extensive land reclamation in the UK
- Affected inter-tidal wetlands – mudflats and saltmarshes
- Saltmarshes and mudflats:

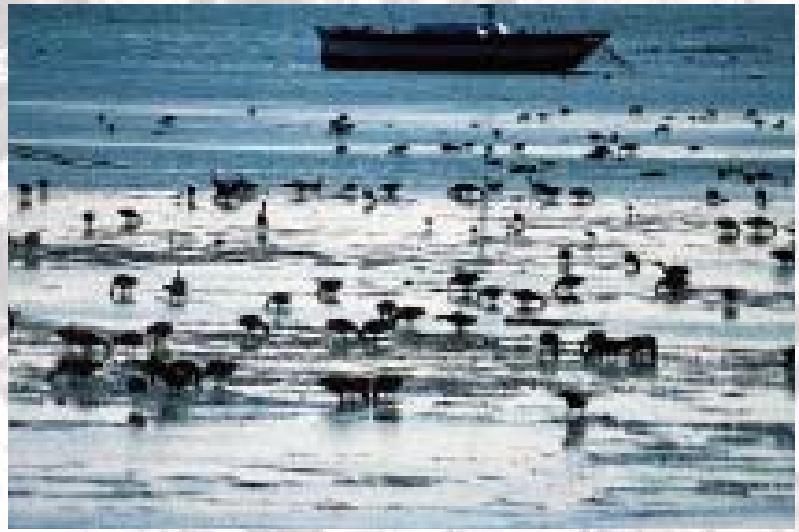
- between land and sea

- equivalent of mangroves

- periodically inundated by seawater

Importance of inter-tidal areas in wetland ecosystem functioning

- Protects the mainland from coastal flooding
- Biogeochemical store and reactor
- Highly productive ecosystems – 930 to 7600 g m^{-2} yr^{-1} (Koretsky et al., 2005)
- Rich bird and fish feeding area – conservation significance



Drivers for managed realignment

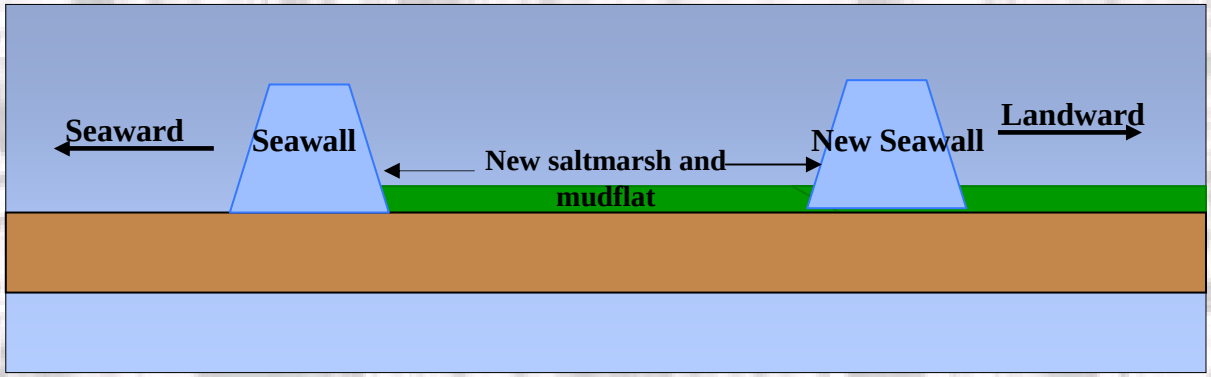
- Inter-tidal wetland under threat from erosion due to sea level rise

-Saltmarsh erosion in SE England – 40ha y^{-1} (Hughes and Paramor, 2004)

- UK committed to restore lost saltmarsh and mudflat habitats (EU Habitat Directive)

- Planned wetland creation – managed realignment

What does managed realignment involve?



'realignment'- setting new seawall further inland, breaching the old seawall to inundate land and re-create a new saltmarsh and mudflat.

Different approaches for managed realignment:

- Flooding agricultural farmland
- Flooding beneficially reused dredged sediment sites

Wallasea Island Managed Realignment site, Essex, UK

Uncertainty associated with managed realignment

Agricultural soil and dredged sediment – potential to act as contaminant source

Exposure to repeated drying and wetting cycles

- Promote transformations in organic matter
- Alter soil and sediment geochemistry
- Implications for contaminant mobilization

While it is necessary to recreate inter-tidal wetlands, the critical question is:

➡ 'In the short-term, will the soil and sediment be a source of contaminants to the estuarine water?'

Objectives

- To evaluate the impact of dry-wet cycles on the release of heavy metals and herbicides from soil and sediments.
- To examine the relationship between metals and herbicides release characteristics and dissolved organic carbon release.
- To assess the impact of dry-wet cycles on microbial biomass activity in soil and sediment.

- Studied contaminants:

Metals- Copper, Nickel and Zinc
Herbicides- Simazine and Atrazine
These contaminants bind to organic matter

Experimental set-up and conditions

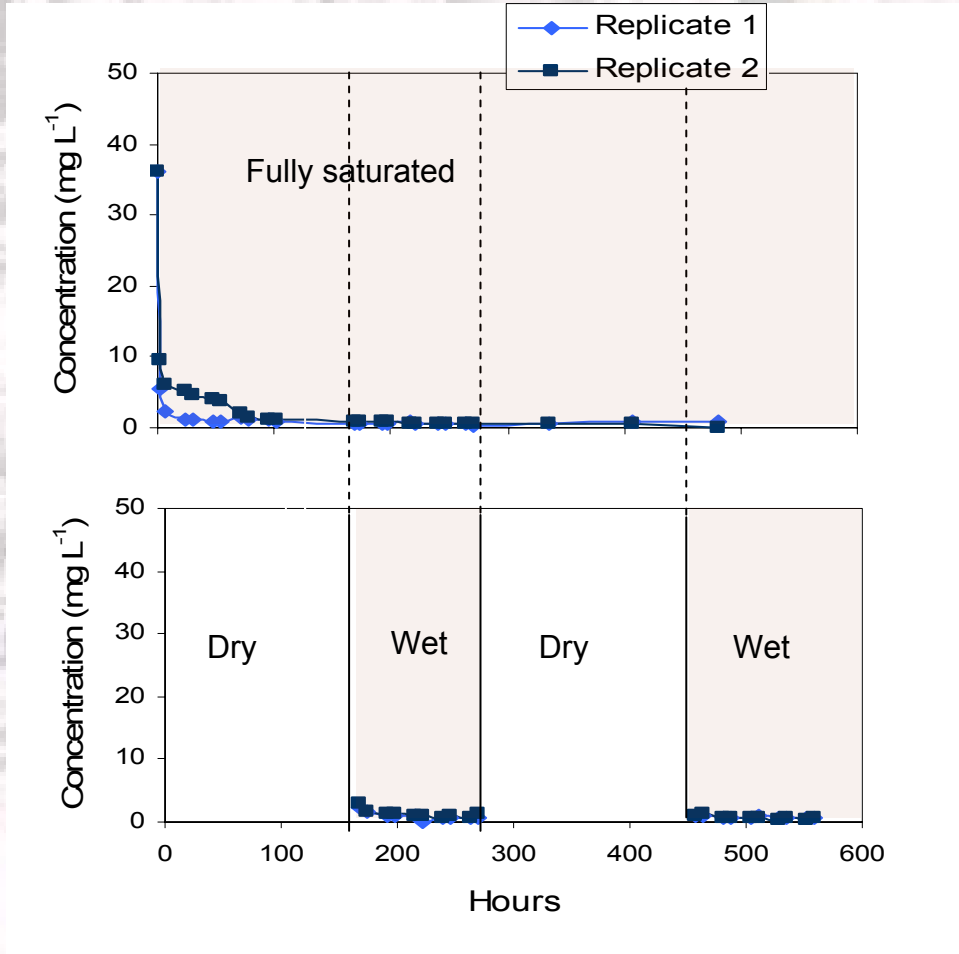
- Laboratory simulation experiments
  - Glass column microcosms
  - spiked sediment and soil

- Two wetting regimes
  - fully saturated
  - alternating dry-wet cycles

- Substrate Induced Respiration (SIR)

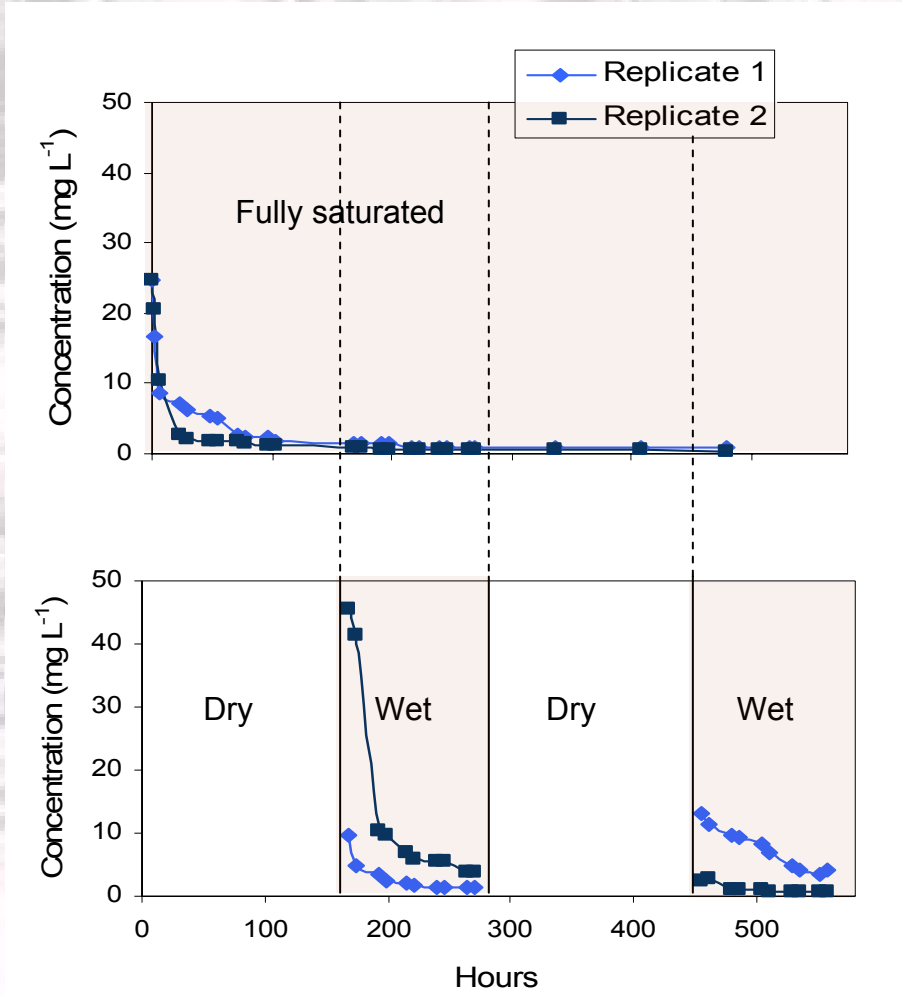
- Analytical techniques
  - ICP-OES
  - on-line SPE-LC-UV
  - GC-FID
  - TOC Analyser

Zinc concentration from fully saturated and dried-rewet dredged sediment



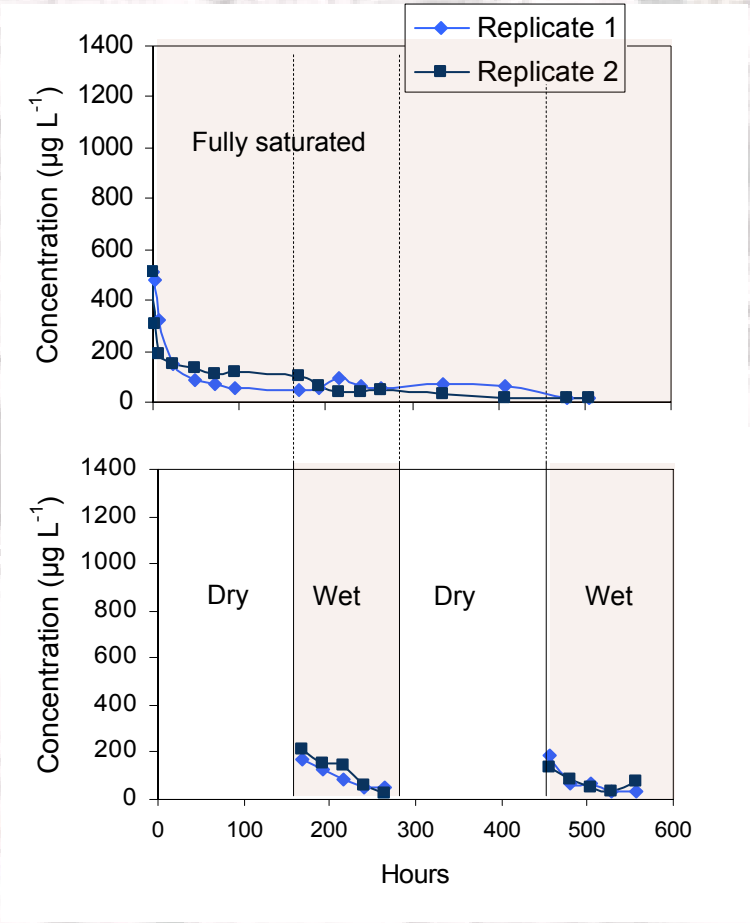
- Initial pulse in the fully saturated sediment but not the dried–rewet sediment
- No influence of repeated drying and drying temperature on release (p=0.29)

Zinc concentration from fully saturated and dried-rewet agricultural soil



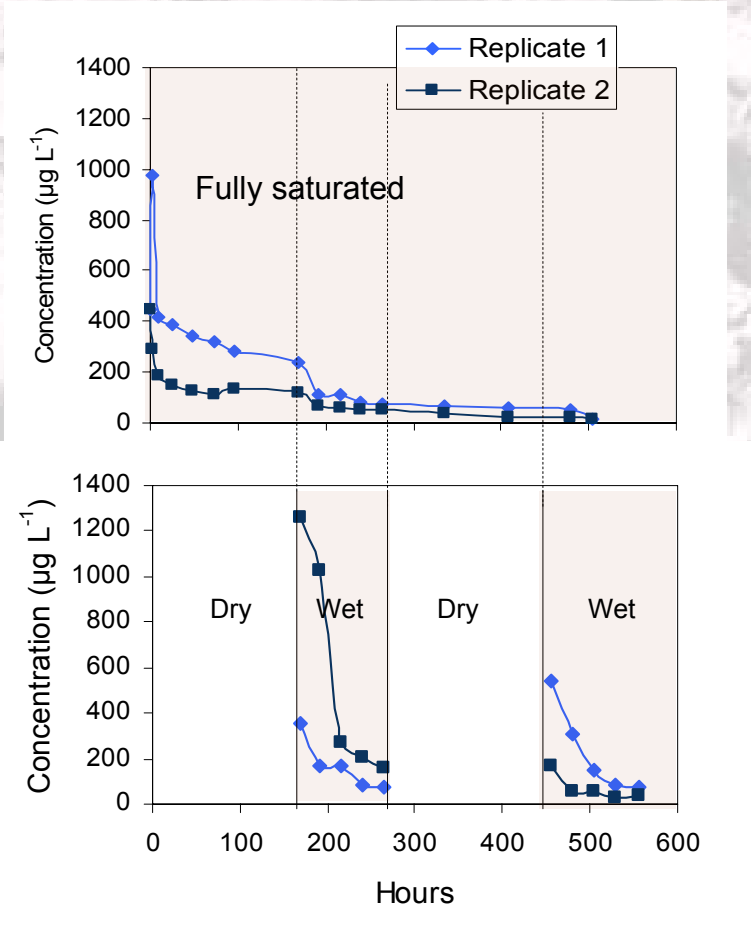
- Initial pulse in both fully saturated and dried-rewet soil
- Influence of repeated drying and drying temperature on release
- Significant difference between release from sediment and soil ($p<0.05$)

Simazine concentration from fully saturated and dried-rewet dredged sediment



- Initial pulse in the fully saturated sediment but not in dried-rewet sediment
- No influence of repeated drying and drying temperature on release (p=0.89)

Simazine concentration from fully saturated and dried-rewet agricultural soil



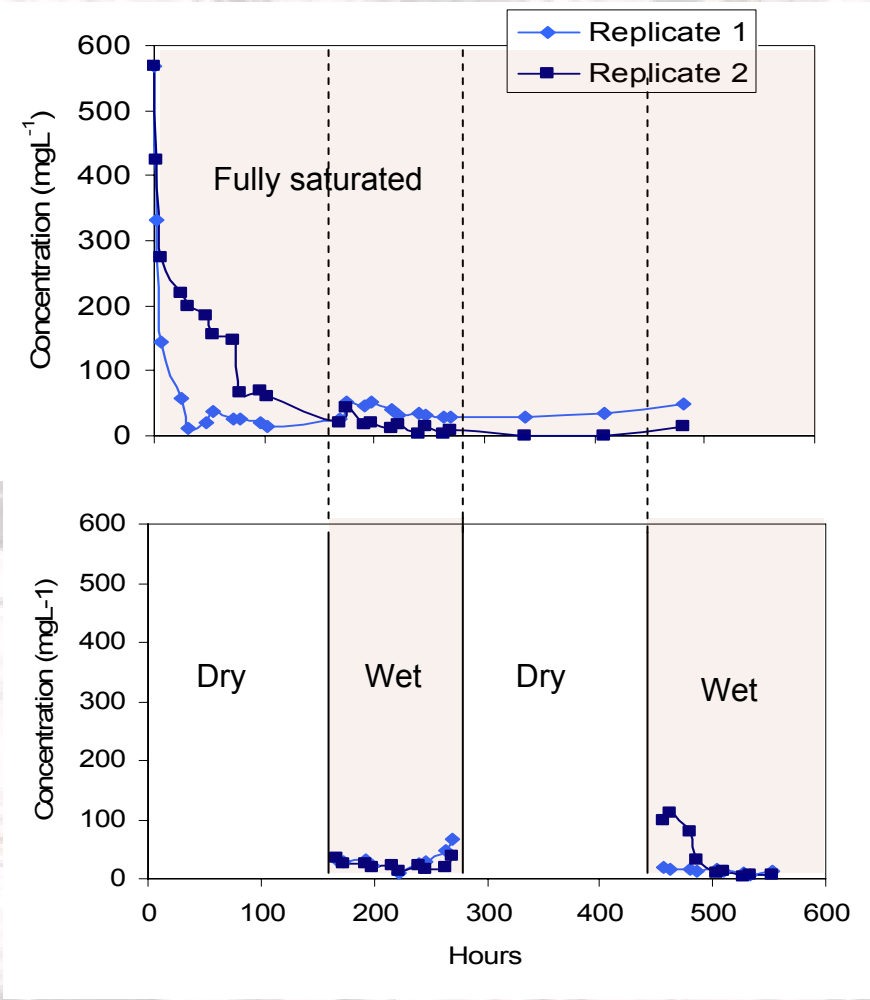
- Initial pulse in both fully saturated and dried-rewet soil
- Repeated drying and drying temperature had an influence on release
- Significant difference between release from soil and sediment ($p<0.05$)

Impact of dry-wet cycles on DOC release from agricultural soil and dredged sediment

Dry-wet cycle in soil and sediment => comparable release characteristics for metals and herbicides

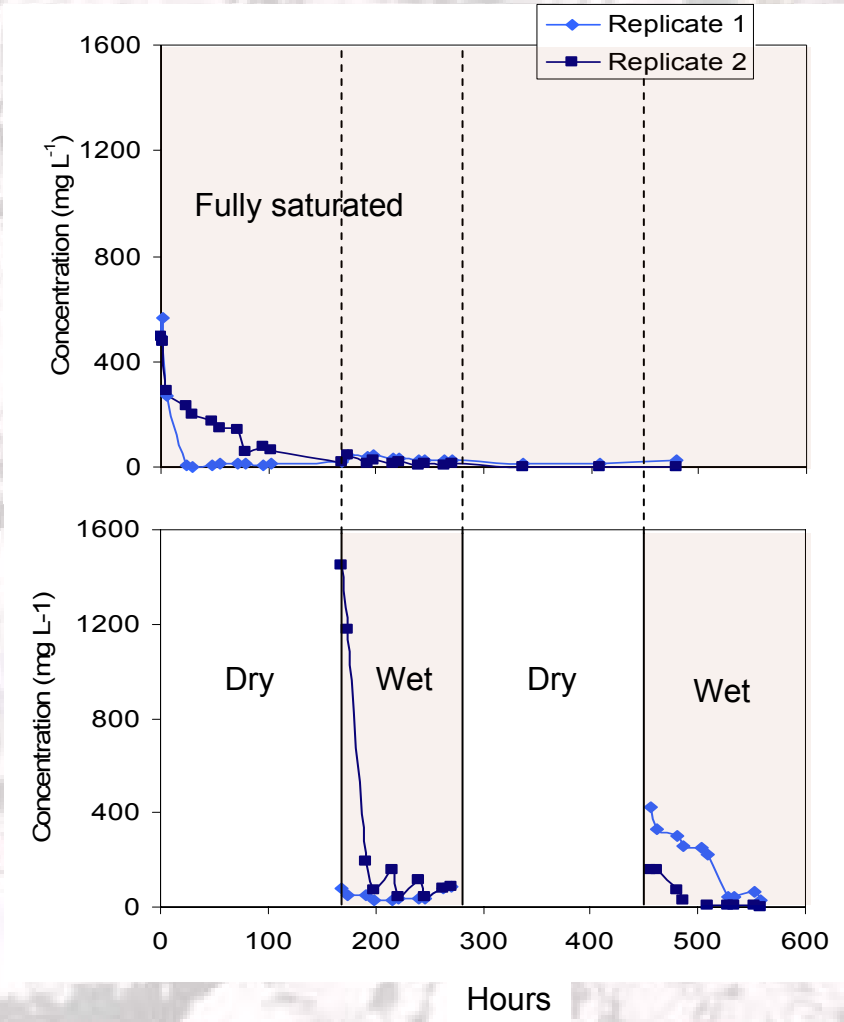
- Studied metals and herbicides bind to organic matter
- Dry-wet cycles promote transformations in organic matter
  - disruption of organic matter
  - stimulation of microbial activity
  - enhanced mineralisation of organic matter
- influences the DOC release

DOC concentration from fully saturated and dried-rewet dredged sediment



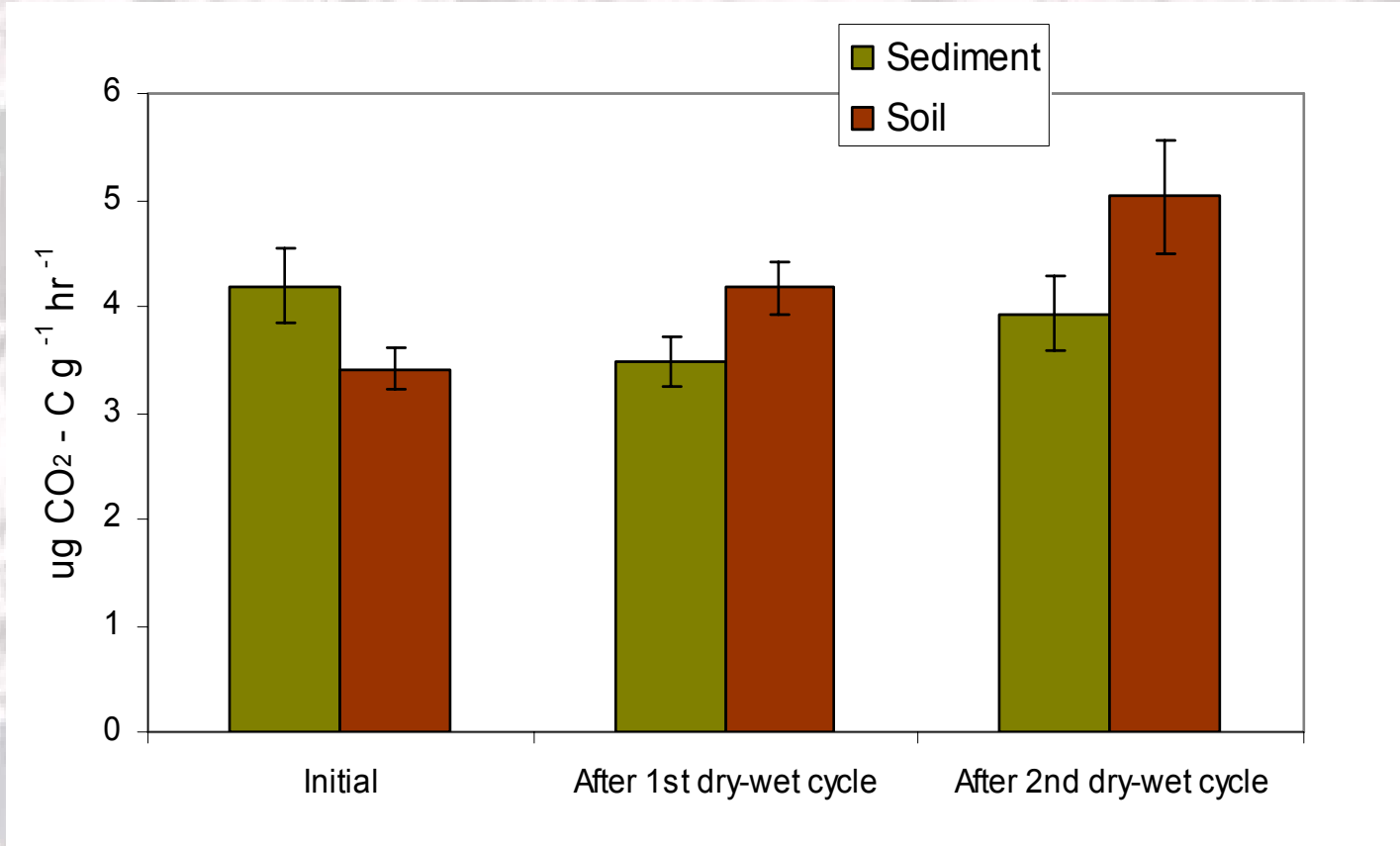
- Initial pulse due to the instantaneous release of readily available carbon
- Release characteristics similar to that of metals and herbicides

DOC concentration from fully saturated and dried-rewet agricultural soil



- Pulse in dry-wet regime due to drying and rewetting of soil
- Release characteristic similar to that of metals and herbicides

Respiration Potential (SIR) after dry-wet cycles



- Increase in respiration in soil due to higher labile organic matter fraction in soil than in sediment

Conclusions

- Similar release characteristics from metals, herbicides and DOC
- An initial pulse in the release from soil but not from sediment
- Repeated drying and drying temperature affects the release from soil but not sediment

MANAGEMENT IMPLICATIONS:

- Need for dredged sediment to dewater and dry-out
- Higher potential for release of metals and herbicides from agricultural soil than from dredged sediment.

Acknowledgements

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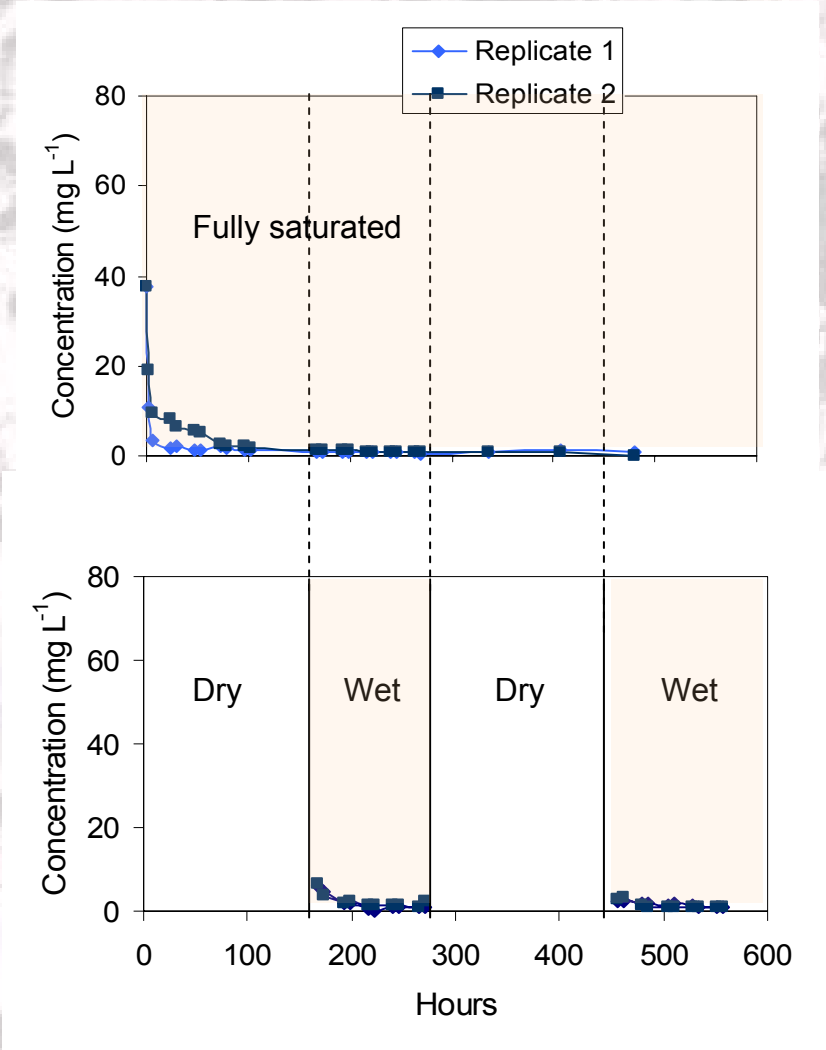
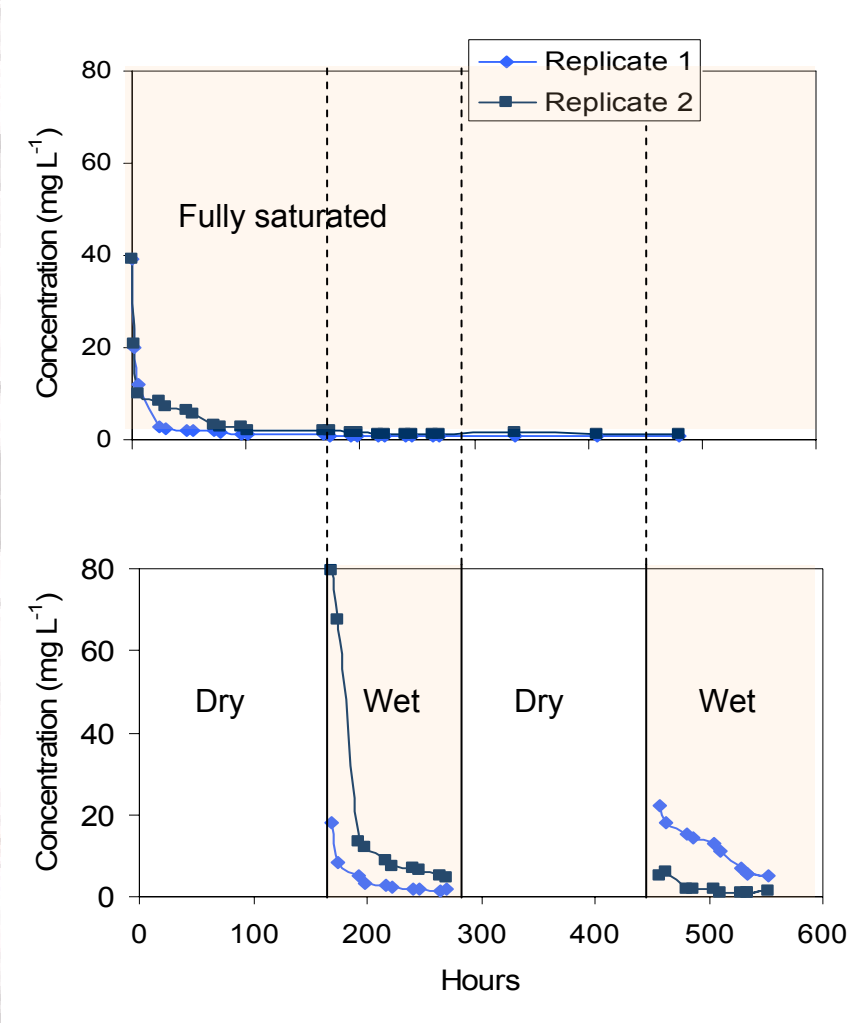
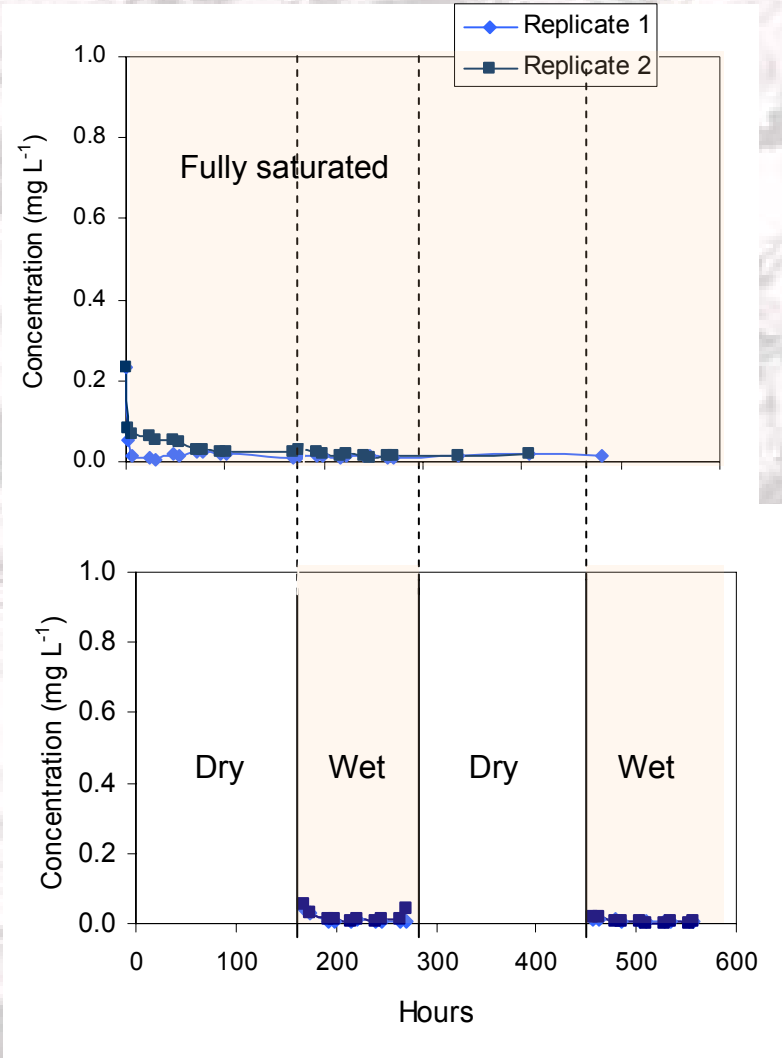
Nickel concentration from saturated and dried-rewet sediment



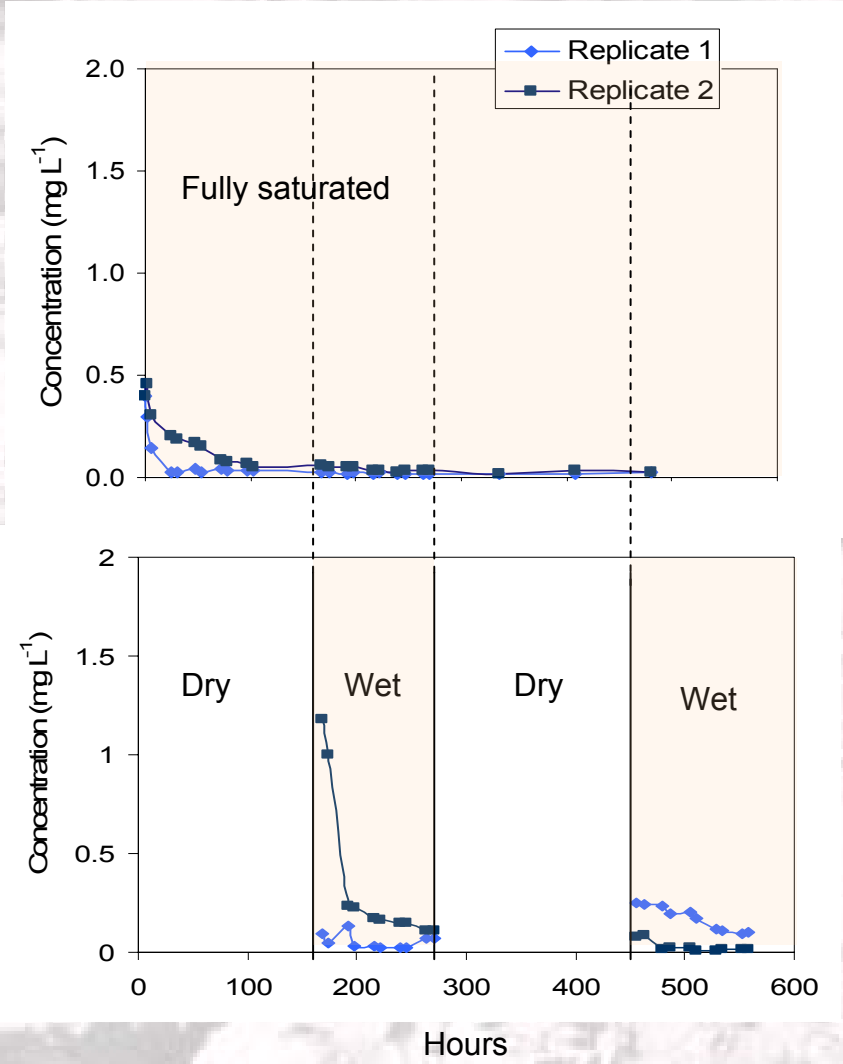
Nickel concentration from saturated and dried-rewet soil



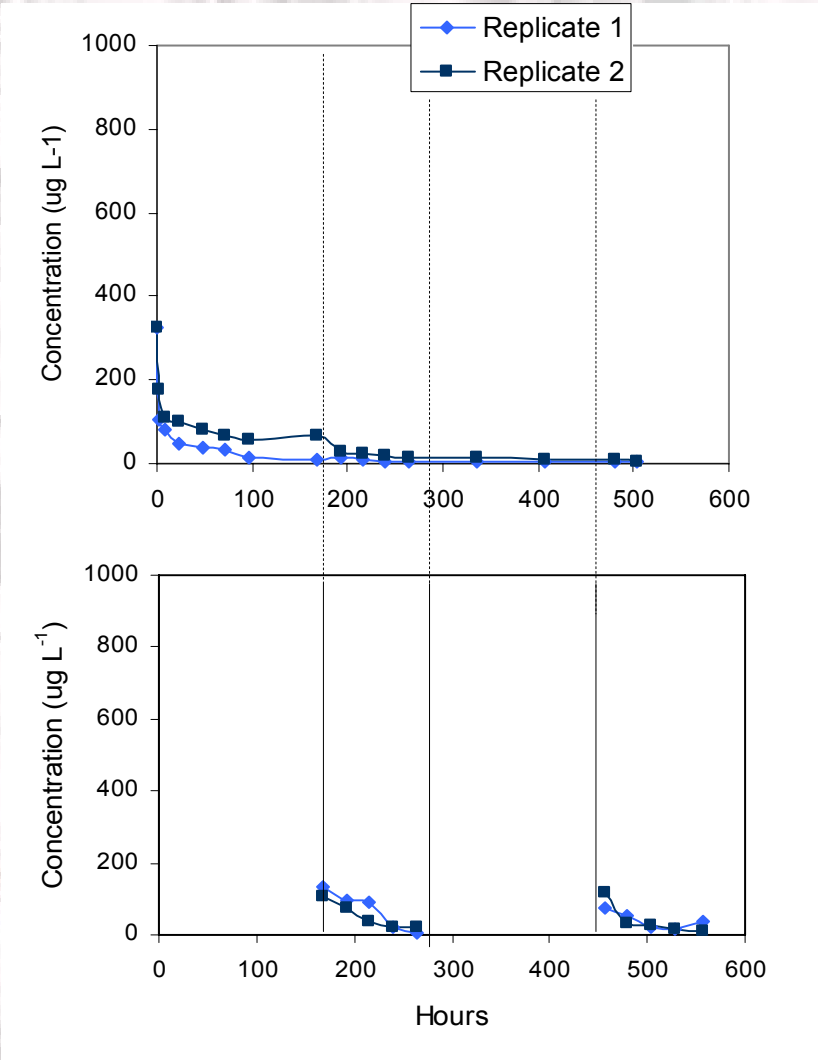
Copper concentration from saturated and dried-re-wet sediment



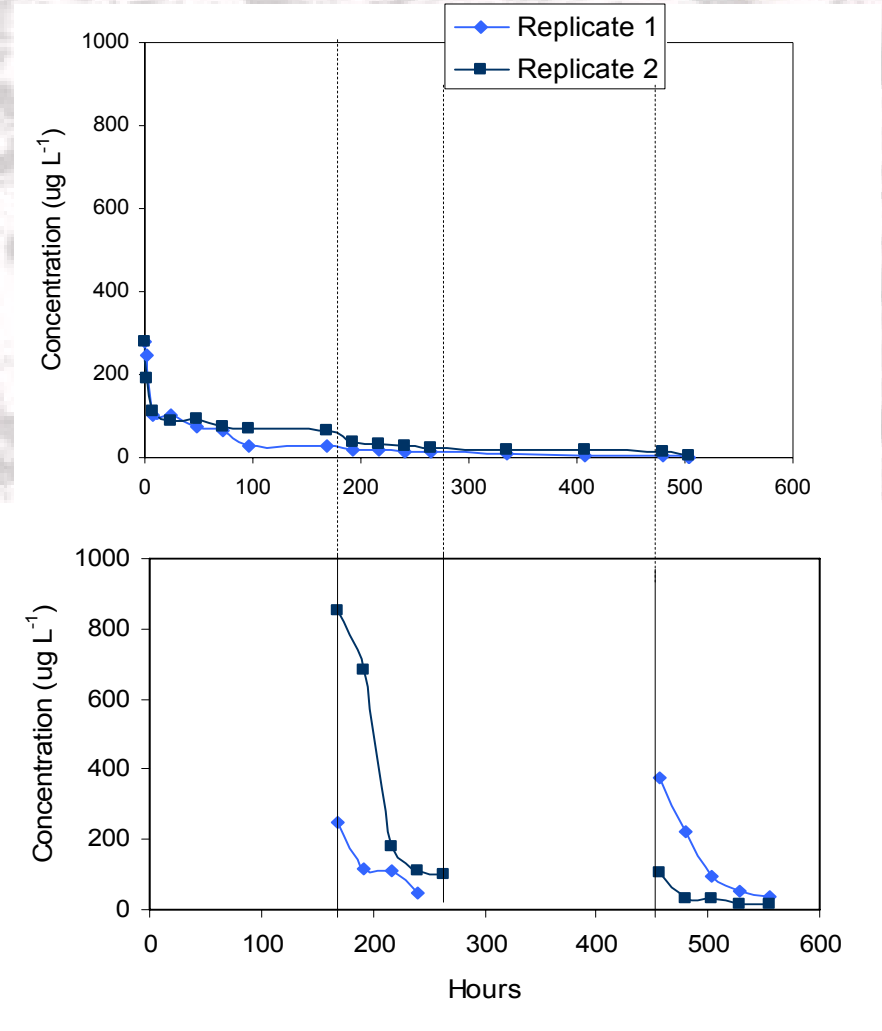
Copper concentration from saturated and dried-re-wet soil



Atrazine concentration from saturated and dried-re-wet sediment



Atrazine concentration from saturated and dried-re-wet soil



Basal Respiration after dry-wet cycle