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Flood and Coastal Erosion Risk Management
R&D Programme

R&D Science Summary W5B-014

Pollution of Managed Realignment: Sediment Geochemistry at Orplands and Tollesbury, Essex, UK April 1995 – April 1997

Background to R&D project

The term managed realignment refers to the realignment of the sea defences, be it either forward or backward form its original position. In this report, investigations of pollution, sediment and geochemistry have been carried out at two managed retreat sites on the Blackwater Estuary in Essex. The term managed retreat refers to the breaching of the sea defences to allow flooding of coastal agricultural land behind the original sea defence barrier. This technique allows the establishment of salt marshes which are now considered to be areas of both economic and environmental importance as well as action as hydraulic buffers to wave energy incidents on the coast.

In earlier studies of salt marsh sediments in the Blackwater Estuary, undertaken by Imperial College, for the former national Rivers Authority, a wide range of contaminants had been detected. While the concentration levels of the contaminants were not above pollutant criteria, it was evident from the surveys that some of the contaminants were not locally derived and hence were transported, either via atmospheric or hydrologic processes. The deposition of sediments with elevated levels of heavy metals and organic micropollutants is of concern in regard to the establishment of a healthy saltmarsh fauna and flora. Early establishment of salt marsh plants is essential to act as sediment traps to act in marsh accretion.

Since April 1995, Imperial College has undertaken annual sediment surveys at two managed retreat sites, one at Orplands and the other at Tollesbury, in the Blackwater Estuary, in order to assess the effects of saline inundation on sediment quality. These surveys, commissioned by the Environment Agency, include the analysis of metal partitioning in cored sediments collected before breaching and subsequent saline inundation and after saline inundation to determine how inundation affects partitioning and hence bioavailability of metals in the sediments. Results from this work will aid management decisions over such land-use where there may be concern on the geochemical interaction of inundated land with sea-water, and especially the effects on water quality and ecotoxicology where natural systems are utilised for human food production.

Results of R&D project

The geochemical development of the Orplands managed retreat site has been examined with reference to metals and nutrient anions. Soils and sediments at Orplands wre characterised as having low anthropogenic heavy metal contamination. Partitioning studies of metals in sediment accreting at the site revealed an increased percentage of zinc (Zn), copper (Cu), nickel (Ni) and lead (Pb) in more labile (week) associations with particulates, which may result from local pollution sources. The major change is metal concentration occurring at the site was the saturation of the soil with sodium (Na), calcium (Ca) and magnesium (Mg). Inundation of unvegetated soil led to homogeneous saturation in the surface layers of the soil. Inundation of vegetated soil led to the restriction of saturation to the top 10cm of the soil profile due to the development of a zone of anaerobic organic decomposition between 4 and 8cm. This zone was characterised by increases in the degree of labile associations with trace metals, indicating the potential for increased mobility. Increases in Ca concentration occurred only to the layer of accreting sediment indicating a solid phase import. Levels of Nitrate (NO_3^-) in soils were reduced as a result of inundation. The vegetated site was determined to be a source of NO_3^- to coastal waters.

Geochemical monitoring at Tollesbury and Orplands has also shown that the developing marshes are acting as a sink for heavy metals, particularly Pb, Cr and Cu. The effect of inundation has been the release of Cd to the water column which may be available for uptake by plants and other organisms. The use of geographical information systems (GIS) at Tollesbury made it possible to elucidate spatial changes that have occurred with respect to major and trace metal distributions on the site. A sediment transport analysis showed that sediment transport at Tollesbury is ebb tide dominated and that there is an accumulation of sediment developing just inside the breach. A constraint of the contract at Orplands was the use of minimal sampling locations, hence a modified W was used for sampling, this makes it difficult to do a thorough sediment transport survey or to use GIS in a meaningful way.

The establishment of a salt marsh environment at the managed retreat centre at Orplands has most assuredly been successful. The two sites, Sites A which had been used for grazing prior to breaching, and site B, with no vegetation, were both covered in salt marsh plants two years after inundation and sediment accretion is occurring. The difference in marsh development at Tollesbury and Orplands is due as much to pre-inundation preparation as to site dynamics. At Tollesbury, it is necessary to form a creek network and thus down cutting and erosion have been the dominant processes. Sediment reworking is evident by the change in metal cation distribution across the site. Furthermore, sediment flow models indicate that the primary direction of sediment movement at Tollesbury is outward toward the breach.

Identification of the most suitable site preparation is a key requirement of research into managed retreat as budgetary restrictions (the technique is favoured due to its low cost) may dictate against holistic site appraisal before implementation and best practice may require definition. On the basis of this study the site B at Orplands is the more preferable method due to the absence of labile metal associations in the soil profile and the import of nitrate (NO_3^-) determined in tidal flows. However, the potential for turbulent mixing of loose soil and mobilisation of sediment bound contaminants is a drawback to this approach.

These investigations revealed the need for a geochemical appraisal of managed retreat sites as part of the site selection process to determine the potential for mobilisation as well as immobilisation of contaminants.

R&D Outputs and their Use

The outputs from the project include this Technical Summary and an R&D Technical Report. The R&D Technical Report presents the materials and methods, results, discussions and conclusions around metal distribution, tidal exchanges, partitioning of metals, and changes in metal loading and distribution.
The document is aimed at all organizations and individuals involved with the development of salt marsh areas.

This R&D Technical Summary relates to R&D Project W5B-014 and the following R&D outputs:

- **R&D Technical Report** – ***Pollution of Managed Realingment, Sediment Geochemistry at Orplands and Tollesbury, Essex, UK, April 1995 – April 1997.***

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