THE ECOSYSTEM CONSEQUENCES OF SEABED DISTURBANCE

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Introduction

Coastal marine sediments carry out important 'ecosystem functions' including the biogeochemical cycling of carbon, nitrogen, phosphorus, the storage of contaminants and providing a resting place for algal cysts. Disturbance of the sediments via natural or anthropogenic impacts can lead to undesirable consequences such as the impairment of biogeochemical function, increased bio-availability of contaminants and the wider distribution of algal toxicity problems. Human activities such as fishing, dredging and dredge spoil disposal, construction and sand and gravel extraction can have a deleterious impact on the quality and function of marine and estuarine ecosystems. These activities are subject to regulation in respect of their physical and macro-biological environmental impact, but the consequences for sediment function (e.g. storage and cycling of nutrient species, organic degradation, contaminant storage and transformation) are not considered.

CEFAS is currently conducting a four year project (04/01 to 03/04), funded by DEFRA, to assess the significance of the wider impacts of seabed disturbance taking account of the relative magnitude (space and time) of both natural (i.e. storms and tides) and anthropogenic activities. The overall aim is to provide a regional-scale assessment, using a combined GIS (Geographical Information System) and modelling approach. It is intedned that this new understanding will assist in the development of a management tool to support specific assessments of disturbance on environmental quality.

The first field survey of this project was undertaken in October 2001 and targeted several impact sites with the main aim of looking at the response of sediment biogeochemical processes (denitrification, sulphate reduction, oxygen uptake, nutrient fluxes, sediment oxygen profiles using microelectrodes and pore water profiles) and benthic epi- and infauna assemblages across disturbance gradients (trawling, dredge spoil dumping, natural). The results of this first survey were not available for this poster. Future plans include implementation of *in-situ* measurement techniques, especially in coarser substrates and in particular, involving utilisation of the CEFAS/Blackdown Sedflux lander.

Disturbance

Natural vs. anthropogenic

Spatial extent vs. intensity vs. frequency

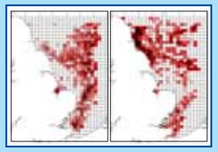
Individual vs. cumulative

Ecological sensitivity

Recovery timescales

Fishing

Fishing gears



Fishing effort

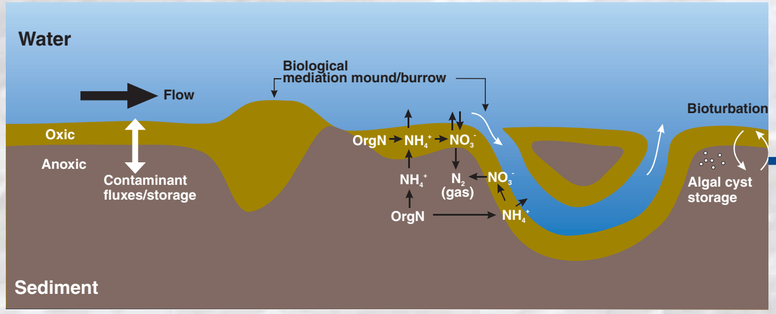
Side scan image of beam-trawl track scars

Aggregate extraction/dredging

Distribution of licensed extraction sites (CEFAS)

Disposal/dumping construction

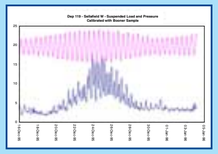
UK dredged material disposal sites and amounts deposited in tonnes for 1994 (from Jones and Franklin, 1994).



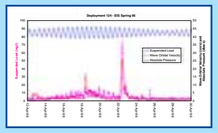
Conceptual diagram of undisturbed sediment: cycling of carbon and nutrients (including denitrification), and storage of contaminants and algal cysts.

Natural: waves/tides/storms/fronts

Spring tidal velocities round the UK (ms^{-1})



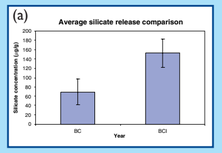
Sediment tidal resuspension



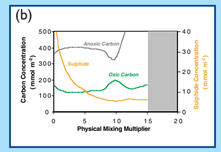
Resuspension due to wave activity

Sediment function:

- Resuspension/ploughing/oxidation
- Changes in substrate
- Nutrient release, links to water column production (a)
- Changes in biogeochemistry (redox, sediment cycling of nutrient species and carbon) (b)
- Timescales of recovery



Pulsed silicate release from resuspended cores from Botany Cut. Non-impacted sites (BC) and impacted (BCI)



Model simulation results showing steady state organic carbon + sulphide concentrations as a function of physical mixing (Duplisea et al., 2001)

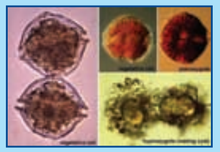
Contaminants

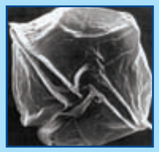
- Resuspension/oxidation/transport/fate
- Release upon resuspension, speciation changes, transformation/degradation
- Bioavailability
- Ecotoxicology
- Habitat impact, sediment biostructuring

Impact

Algal cysts

- Resuspension/oxidation/bloom/flocculation/transport/burial
- Salinity, oxygen, temperature, light
- Excystment
- Harmful algal blooms (HAB's).





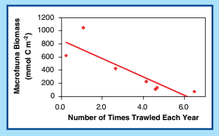
Alexandrium sp. life stages including resting cyst (dormant in anoxic sediment). (Y. Fukuyo)

Benthos interface

Undisturbed coarse deposits off the Isle of Wight, UK

Sandy substrates in area of high dredging intensity

- Physical impact/carbon inputs-mortality/competition
- Changes in size structure and community
- Impact on links to biogeochemistry via sediment structuring and bioturbation.



Impact of trawling on bioturbator biomass in Silver pit area of the southern North Sea

Conclusions

- Many disturbances directly impact the benthos and benthic interface.
- This can impact biogeochemical cycling, contaminant storage and algal cyst redistribution.
- The extent and intensity of impacts need to be rationalized on various time and spatial (small and regional) scales.
- *In-situ* measurements are the way forward to tackle these problems
- The regional function of coarse sediments (sands/gravels) needs to be integrated into this approach but is a challenge due to sampling limitations.

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References

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