

Developing an evidence base for in situ contaminated sediment hazards in England

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In situ contaminated sediments

In this context:

Chemically contaminated sediment within the water column, bed, banks and floodplain of a surface water body that has been transported alongside the normal sediment load and deposited by fluvial and coastal processes

- Project objective:
 - Provide a sound evidence base on in situ contaminated sediments in England
 - Underpin the development of tools to help regulators make evidence-based decisions



Project structure



Conceptual model



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- GIS-based approach
 - 1km grid squares
 - Likelihood x Consequence = Hazard
 - Confidence based on uncertainties
- Use existing national datasets
 - Contaminant sources
 - Sediment quality
 - WFD classification
 - Catchment characteristics (hydrology, geomorphology)



- Three assessments
 - Potential hazards to aquatic receptors
 - Potential hazards to terrestrial receptors
 - Potential hazards from historical contamination (all receptors)



Assessment	Likelihood	Consequence	
Aquatic receptors	 Sediment type (grain size) Contaminant concentrations (compared to Cefas & Canadian SQGs) 	 WFD classification (benthic invertebrates & fish) Protected area status 	
Terrestrial receptors	 Contaminants in surface soils Contaminants in stream sediments 	 Grazing intensity (land use) 	
Historical contaminants	 Likelihood of erosion (river bank type, coastal erosion risk, presence of defences) Likelihood of historical contamination (urbanisation & mining) 	 Response to rainfall (time to peak flow) Climate change (UKCP09 median projection) 	

	Severe	Substrate all/nearly all ocarse grained All sediment quality concentrations' below SOGIower <10% catchment/ocastline urban/industrial, mineralisationimine assets. No disorbarge consents present Benthic Invertebrates' Fish Classification Poor SSSI/SPA/SAC habitat destroyed permanently or part destroyed. Favourable condition unachievable	Substrate all/nearly all coarse grained Contaminant concentrations not confirmed by data 25%-48.9%catchment/coastline urban/industrial, immerialisation/mine assets or 1 pressure present at 10%-34.5%. Only surface water discharge consents present. Benthic Invertebrates/ Fish Classification Poor SSSI/SPA/SAC habitat destroyed permanently or part destroyed. Favourable condition unachievable	Some sits present but prained At least one sediment of SOG _{Source} and SOG _{Source} of SOW-75% catchment/or mineralisation/mine ass 25%-40-9%. Low densis effluent/combined sewe Benthic Invertebrates / SSSISPA/SAC habitat destroyed. Favourable	majority of substrate coarse utality concentration" between bastline urban/industrial, sets or 1 pressure present at ty of industrial/trade or sewage er overflow discharge consents. "Sich Classification Poor destroyed permanently or part condition unachievable	Fine silt present in over half/nearly all the water body area. At least one sediment quality concentration * between SQGs _{win} and SQG _{wine} >75% catchment/coastline urban/industrial, mineralisationhime assets, or 1 pressure present at 50%- 75%. Medium density of nubutahitrade or sewage effluent/combined sever overflow discharge consents. Benthic Invertebrates/FSA Classification Poor SSSI/SPA/SAC habitat destroyed permanently or part destroyed. Favourable condition unachievable	 Fine sitt present in all/nearly all of water body At least one sediment quality concentration' greater than SQG_{use} >75% catchment/coastine urban/industrial, micrafisationtimic assets, high density of industrial/trade or sewage effluent/combined sever overflow discharge consents Benthic Invertebrates/Fish Classification Poor SSS/SPA/SAC habitat destroyed permanently or part destroyed. Favourable condition unachievable
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		Remote	Very Low	Low		Medium	High

Likelihood

Results (national scale)

- Potential hazards to aquatic receptors
 - Large areas with at least one SQG failure, but hazards generally low
 - Hazards greater in urban areas and historically mined catchments
- Potential hazards to terrestrial receptors
 - Potential hazards where contaminants in stream sediments > floodplain soils
 - Urban areas and mined catchments
- Potential hazards from historical contamination
 - Hazards generally low
 - Higher in urban areas and mined catchments with medium (or greater) risk of erosion



Results (catchment scale)

- Examined results in more detail in selected catchments with detailed data
- River Swale, North Yorkshire
 - Long history of metal mining
 - High concentrations of Pb, Zn and Cd in stream and floodplain sediments
 - WFD failures in mined tributaries
- Potential hazards to aquatic and terrestrial receptors
 - High hazard in mined tributaries expected
 - Lower hazard along main river not expected
 - Reflects lack of evidence of biological harm (limited WFD failures)





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Limitations

- Data limitations
 - Datasets do not always have national coverage
 - Inconsistent coverage of contaminants
 - Different analytical methods
 - Some data not available (historical contamination, industrial sites, landfills)



- Lack of suitable SQGs
 - Cefas Action Levels for dredging in marine environment
 - BUT no values for freshwater sediments
 - Canadian SQGs may not be suitable



Canadian Sediment Quality Guidelines for the Protection of Aquatic Life

Evidence of harm – is there a real hazard?

- National datasets do not consistently show that there is a significant hazard
 - WFD failures in some catchments
 - No failures in areas where database shows significant contamination
 - Data does not pick up on nuances, e.g. contamination in Swale not bioavailable due to pH buffering
- Literature does clearly demonstrate that contaminated sediments can be a hazard
 - Livestock grazing on contaminated floodplains
 - Ingest contaminated sediments following flooding
 - Metals in blood, PCBs in milk



Conclusions

- National assessment identified potential problem
 - Major urban centres and mined catchments
 - Low hazard levels elsewhere
- BUT no definitive evidence of harm or environmental impacts at a national scale
 - Extensive evidence of harm for some sources (e.g. historical metal mining, urban pressures)
 - Very little evidence for others
 - Data quality is a problem
- Hazards likely to be site specific and localised
 - Further investigations in catchments with uncertain or unacceptable hazard
 - Improved data to further refine and test the national hazard assessment process



Recommendations

- Develop specific environmental quality guidelines or standards for sediments
 - Consistent "baseline" against which contaminant levels can be assessed
- Develop a standardised contaminated sediment assessment process
 - Consistent approaches to sampling and analysis
 - Improved data coverage
- Produce practical, user-friendly guidance
 - Consistent approaches to assessing and managing hazards
- Assess climate change risks
 - Increased cycling of contaminants
 - Long term problem



What next?

- Currently working on a guidance document for CIRIA
 - CIRIA Research Project 1037
 - Contaminated sediments: A guide for risk assessment and management
 - Due for publication early 2018



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