TIDE
Tidal River Development

Project part-financed by the European Union (European Regional Development Fund)

The Interreg IVB North Sea Region Programme

‘Deployment of Mudbugs’

Measure analysis 32
in the framework of the Interreg IVB project TIDE

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Part 1: Measure description

Measure category: hydrology/morphology
Estuary: Humber
Salinity zone: polyhaline
Pressure: maintenance dredging

Responsible Authority: Associated British Ports Humber Estuary Services
Specific location: Humber Estuary
Costs:
Country: United Kingdom
Downloads:
Links:http://www.engineerlive.com/Hydrographic-Seismic/Hydrographic_Survey/Mud_density_measurement_saves_dredging_costs/22030/
http://dev.engineerlive.com/Mining-Engineer/Hydrographic_Survey/Fluid_mud_density_measurement_saves_harbour_dredging_costs/22329/

Figure 1: Photo of the Mudbug

1.1 Description of the issue and measure

The deployment of the Mudbug is a new technique in the Humber Estuary and is used to determine the navigable depth in ports, harbours and estuaries by measuring the density of fluid mud[1]. It is an easy-to-use "plug-and-play" system consisting of a rugged, towable transducer connected by an umbilical cable to DataPod Connection Unit on the surface.

The heavy-duty device is made from stainless steel, uses all-welded construction and is robust enough to withstand being towed through marine sediments. Importantly, the sensing element consists of a single short probe around which fluid can flow easily with no risk of material entrapment. Unlike some other types of density meter, the Mudbug uses no radioactive materials,

[1] Mud with a density of 1240-1250 kg-1m^3 - the maximum density through which a ship can safely navigate.

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so there are no environmental hazards involved. A further advantage is that with no moving parts, maintenance is minimal.
This technique is still in its infancy on the Humber Estuary, but with accuracies of +/- 1% being quoted, the ability to have real-time density data versus depth profiling and the ability to minimise maintenance dredging on the Humber Estuary, the implications may be huge. This measure is also not limited to the Humber Estuary and can be used in both shallow and deep water.
There is still a lot to learn to maximise the potential to reduce the needs for dredging, which have both economic and ecological benefits and can reduce hydromorphological impact within the estuary.

In one outing, the Mudbug mud density probe saved Associated British Ports (ABP) over £70,000 in dredging costs and enabled the ABP survey team quickly and accurately to detect the depth at which the mud reached the density of fluid mud.

The Mudbug was rigged on a davit and towed through the waters of the river Humber at Immingham Outer Harbour. The bathymetric survey produced by running the Mudbug simultaneously with a standard 33 kHz echo sounder showed an average 0.5m difference between the results from the Mudbug and those obtained from the echo sounder.

The Mudbug also enabled the survey to be completed much more quickly than was possible with earlier density measurement methods. Using the Mudbug, it took no more two hours to gather the data for the chart and another two hours to process it, compared to the previous method of density probing, which would have taken two days to collect that amount of data.

The Mudbug's multifunctional transducer incorporates density, temperature and pressure (depth) sensors plus all interface electronics. The unit is calibrated at the factory, so on-site calibration is not necessary. Once at the desired location the transducer is deployed using a support line, and measurement can start as soon as the probe is submerged. The weight of the transducer ensures that it will easily sink into silt layers. Readings are taken approximately five times a second and, as a large number of measurements can be made very quickly, it is possible to cover a wide area in a short time.
Density is measured in the range 800 to 1600 kg/m³ with an accuracy of ±1% at depths up to 100 metres. The Mudbug uses its own pressure sensor to determine the depth of the transducer, thus allowing real-time density versus depth profiling.

Density, depth and temperature measurements are output by the Mudbug as serial data which can be imported directly by third-party hydrographic surveying software such as HYPACK. Alternatively, the DataPod Connection Unit can be connected to a USB port on a PC or laptop, in which case no separate power supply is required as the instrument is powered simply through the USB connection. The proprietary NaviTrend software supplied with the system shows real-time measurements in both tabular and graphic form on the PC/laptop, while logged data can be exported to Microsoft® Excel™ for further analysis.

Easily integrated into existing survey equipment, the Mudbug can be deployed in minutes and provides reliable data straightaway, with minimal setup and no risk to the environment.

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1.2 Status of the Measure

Implemented in 2010 and onwards.

1.3 Monitoring

Unknown, other than to determine the reduction in dredging possible by deploying this technology.

1.4 Monitoring results

No monitoring results available as monitoring proposals have not been developed or implemented.

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Part 2: Execution of main effectiveness criteria

2.1 Effectiveness according to development targets of measure

Effectiveness of this measure may be classified by cost-effectiveness by ABP, however the potential ecological benefits of reduced maintenance dredging should also be captured.

There was an average 0.5m difference between the results from the Mudbug and those obtained from the echo-sounder, reducing the volume of dredging required at a given time.

2.2 Impact on ecosystem services

Targeted Ecosystem services

This section will need to be produced at a later date, once any ecosystem services benefits from the deployment of the Mudbug are determined.

Table 1: Targeted ecosystem services

Measure	
Food: animals	
Water for industrial use	
Water for navigation	
Climate regulation: carbon sequestration	
Regulation extreme events or disturbance: flood water storage	
Regulation extreme events or disturbance: water current reduction	
Regulation extreme events or disturbance: Wave reduction	
Water quantity regulation: drainage of river water	
Water quantity regulation: dissipation of tidal and river energy	
Water quantity regulation: landscape maintenance	
Water quantity regulation: transportation	
Water quality regulation: transport of pollutants and excess nutrients	
Water quality regulation: reduction of excess loads coming from the catchment	
Erosion and sedimentation regulation by water bodies	x
Erosion and sedimentation regulation by biological mediation	
"Biodiversity"	
Aesthetic information	
Opportunities for recreation & tourism	
Inspiration for culture, art and design	
Information for cognitive development	

Involved habitats

It is not likely that the deployment of the Mudbug will result in the creation of any marsh habitat, intertidal habitat, subtidal habitat or adjacent land, as given the potential reduced volume of dredged material, it may not be necessary to dredge and relocate the arisings within the estuary to create any additional habitat.

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Table 2: Ecosystem services analysis for Hydromotion Mudbugs: Indication of habitat surface and quality change, i.e. situation before versus after measure implementation

MEASURE		before		after	
		surface (%)	Quality (1-5)	surface (%)	quality (1-5)
Marsh habitat	above mean high water, floods at spring tide	**0**	**0**	**0**	**0**
Intertidal steep habitat	floods every tide, mainly steep zones at marsh edges	**0**	**0**	**0**	**0**
Intertidal flat habitat	floods every tide, flat zones	**0**	**0**	**0**	**0**
Subtidal shallow habitat	never surfaces, less deep than 2m	**0**	**0**	**0**	**0**
Subtidal moderatily deep habitat	never surfaces, 2m-5m	**0**	**0**	**0**	**0**
Subtidal deep habitat	never surfaces, deeper than 5m	**0**	**0**	**0**	**0**
ADJACENT LAND	NON FLOODED LAND	**0**	**0**	**0**	**0**

Quality
1 = very high quality
2 = high quality
3 = medium quality
4 = low quality
5 = very low quality

100 100

The measure Hydromotion Mudbug in the polyhaline zone of the Humber estuary was about determining the density of 'fluid' mud to determine the depth of the navigable channel, improving the habitat quality of the subtidal deep habitat.

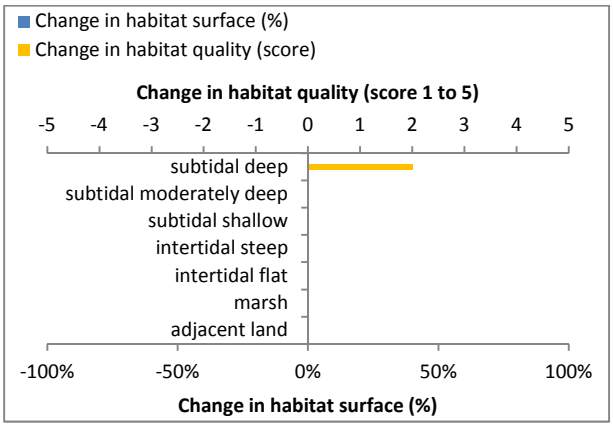

Figure 2: Ecosystem services analysis for Hydromotion Mudbug: Indication of habitat surface and quality change, i.e. situation before versus after measure implementation.

From the ES assessment it is concluded that this measure generates overall a slightly positive expected impact for many ES, mainly for:

- "biodiversity"
- Cultural services
- Some regulating services: Erosion and sedimentation regulation (by water bodies); Water quality regulation: transport of pollutants and excess nutrients

The expected impact for the different beneficiary groups is slightly positive for indirect and future use and for local and region use.

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Table 3:Ecosystem services analysis for Hydromotion Mudbug: (1) expected impact on ES supply in the measure site and (2) expected impact on different beneficiaries as a consequence of the measure

Hydromotion MudBug – determine the density of 'fluid' mud to determine the depth of the navigable channel (1250 kg/m³)

Cat.	Ecosystem Service	Score
S	"Biodiversity"	1
R1	Erosion and sedimentation regulation by water bodies	1
R2	Water quality regulation: reduction of excess loads coming from the catchment	0
R3	Water quality regulation: transport of polutants and excess nutriënts	1
R4	Water quantity regulation: drainage of river water	0
R5	Erosion and sedimentation regulation by biological mediation	0
R6	Water quantity regulation: transportation	0
R7	Water quantity regulation: landscape maintenance	0
R8	Climate regulation: Carbon sequestration and burial	0
R9	Water quantity regulation: dissipation of tidal and river energy	0
R10	Regulation extreme events or disturbance: Wave reduction	0
R11	Regulation extreme events or disturbance: Water current reduction	0
R12	Regulation extreme events or disturbance: Flood water storage	0
P1	Water for industrial use	0
P2	Water for navigation	0
P3	Food: Animals	0
C1	Aesthetic information	1
C2	Inspiration for culture, art and design	1
C3	Information for cognitive development	1
C4	Opportunities for recreation & tourism	1

Beneficiaries:	
Direct users	0
Indirect users	1
Future users	1
Local users	1
Regional users	1
Global users	0

X Targeted ES

Legend: expected impact*	
3	very positive
2	positive
1	slightly positive
0	neutral
-1	slightly negative
-2	negative
-3	very negative

*: Indicative screening based on ES-supply surveys and estimated impact of measures on habitat quality and quantity. Quantitative socio-economic conclusions require local supply and demand data to complement this assessment.

2.3 Degree of synergistic effects and conflicts according to uses

Further monitoring of the deployment of the Mudbug will be required to determine is effectiveness.

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