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Supergen Offshore Renewable Energy

Industry guidance on the use of benthic landers for monitoring sediment mobility

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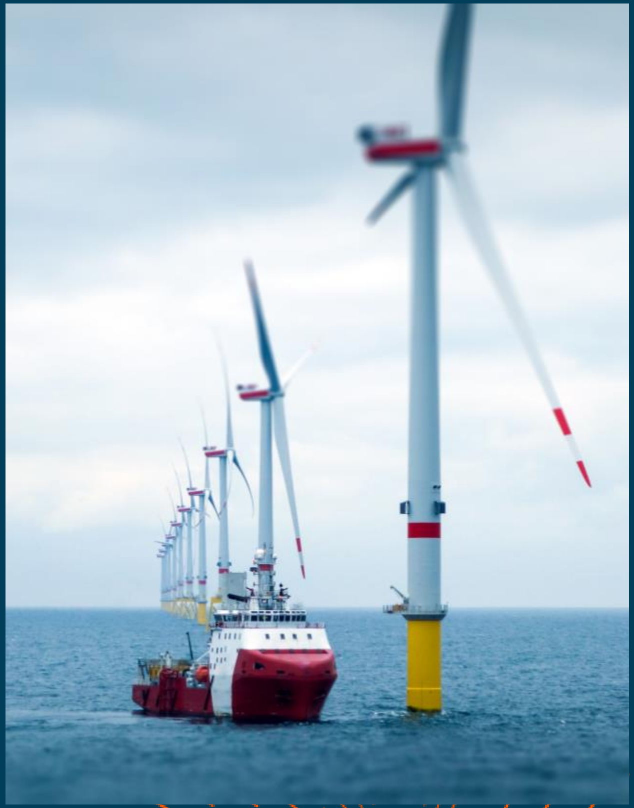
Aims



Before construction offshore can begin there is often a lengthy process to establish the present-day site conditions & the potential impacts that the development (e.g. a windfarm) may have on these conditions

Whilst landers/benthic frames are used in industry (OWF, tidal power etc.), the data collected are sometimes unfit for purpose and more value could be extracted with more appropriate methods

To address this, we have created guidance (as yet unpublished report)

The focus of the report is on the collection of data to observe sediment transport characteristics of a given coastal or offshore (< 100 m water depth) site

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Why landers?

Almost any type of sensor may be attached to a lander (e.g., ADCP, cameras, single-beam or multibeam bathymetry sensors, biochemical sensors etc).

By recording data over a long time landers can be used to provide time-series of longer scale processes

Most landers operate with an array of different sensors affixed. The data from each instrument can be stitched together to create a more complete picture.

Avoids scaling issues or simplifications/assumptions required in physical and numerical modelling

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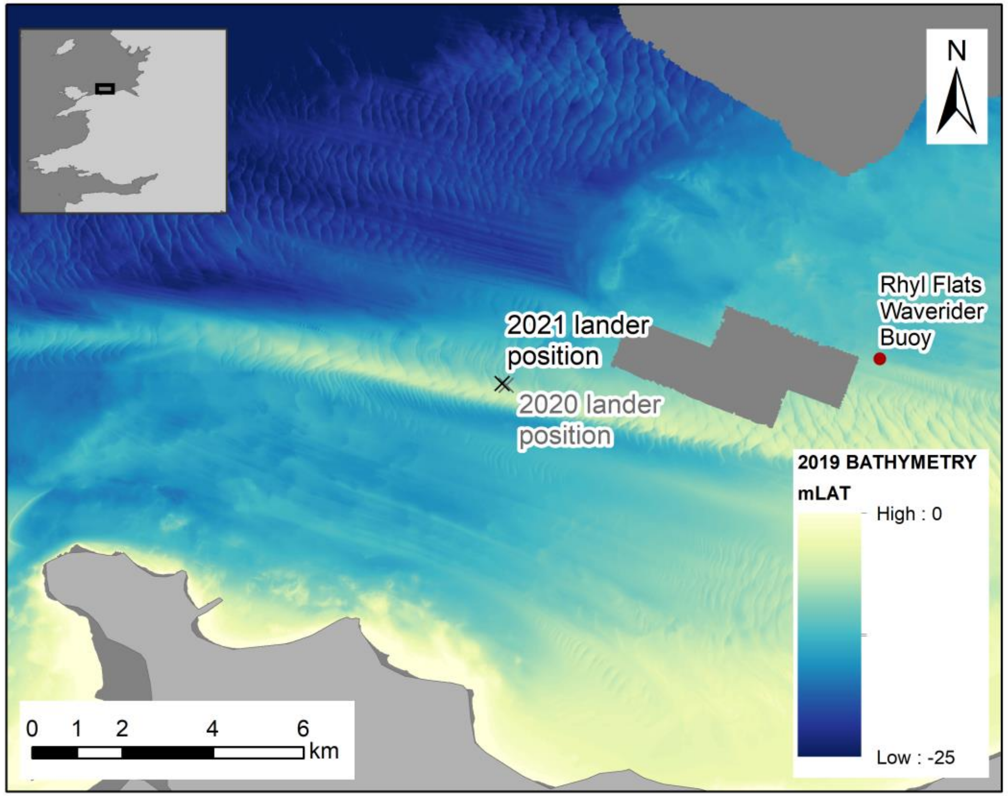
Case study

Since 2021 Bangor University have been leading a EPSRC Supergen project with collaborators from industry.

The aim of the Supergen project was to observe the seabed processes (scour and deposition) around a section of seafloor cable.

Unsworth, C.A., Austin, M.J., Van Landeghem, K.J., Couldrey, A.J., Whitehouse, R.J., Lincoln, B., Doole, S. and Worrall, P., 2023. Field measurements of cable self-burial in a sandy marine environment. Coastal Engineering, 184, p.104309.



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Case study

A section of electricity cable was attached to the lander so that on ebb tides turbulent wakes and sediment suspensions from interactions with the cable and frame were measured, and on flood tides a clear boundary layer flow was measured.

The lessons learned from this project are utilised to highlight important considerations in the planning, design, deployment and data-processing for a benthic lander mission.

Planning phase

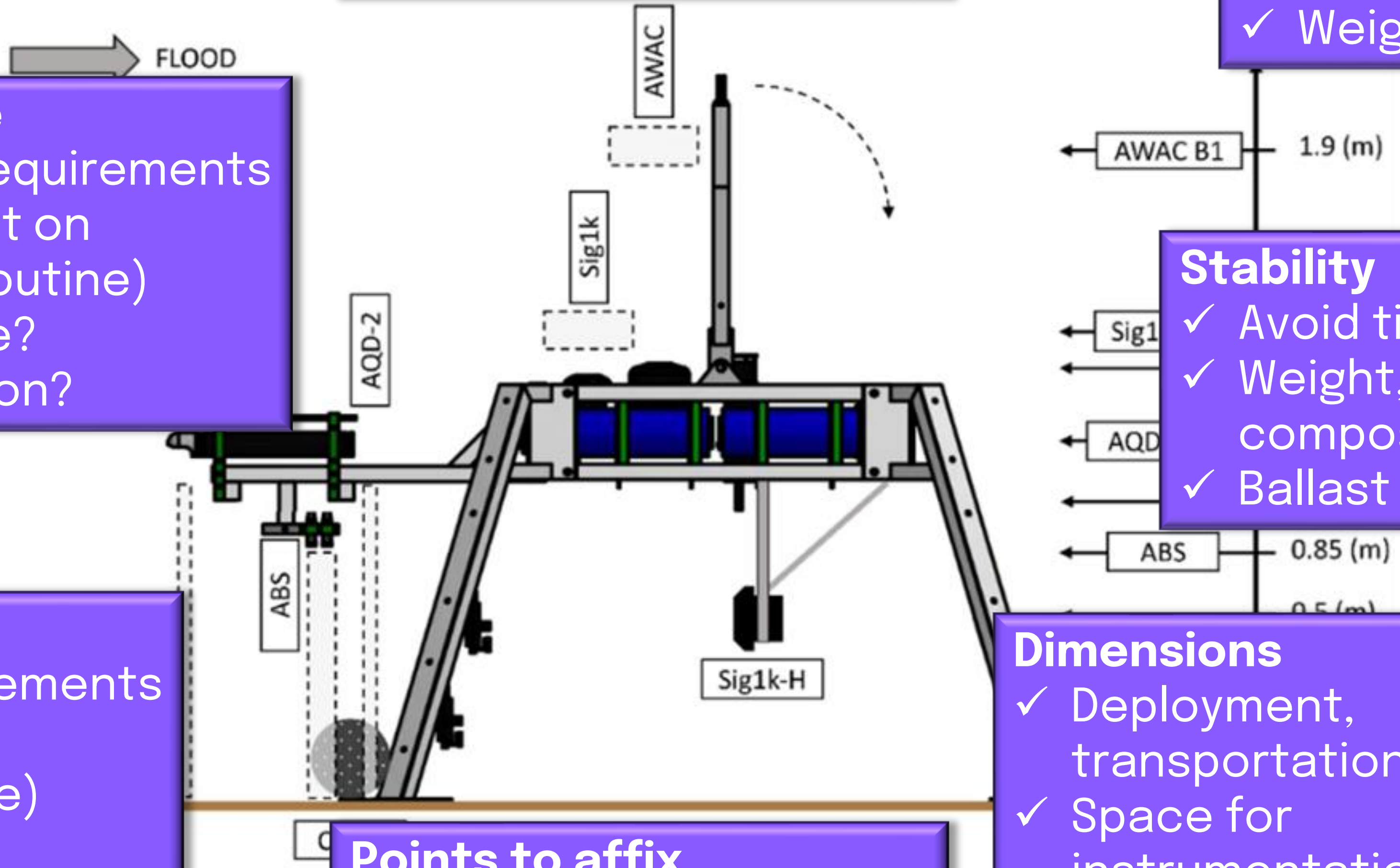
Aspect	Considerations
Selection of location	Most representative? Most extreme?
Time window	Tidally dominated: peak spring tide Wave dominated: peak storm activity
Duration & sampling rate	Set by requirements of the research question Battery endurance, data capacity, recovery windows and biofouling
Permissions	For UK deployments the following permissions must be attained: • Crown Estates seabed licence, • Trinity House navigation mark approval, • Maritime and Coastguard Agency notification and Notification to Mariners. Site of Special Scientific Interest (SSSI) require additional permissions

Frame design

Deployment/retrieval
- ✓ Surface marker buoy
- ✓ Acoustic release
- ✓ Backup

Materials
- ✓ Durability
- ✓ Rigidity
- ✓ Weight

Data storage
- ✓ Estimate requirements (dependent on sampling routine)
- ✓ Burst mode?
- ✓ Transmission?



Stability
- ✓ Avoid tilting
- ✓ Weight, footprint, composition seabed
- ✓ Ballast

Power supply
- ✓ Estimate requirements (dependent on sampling routine)
- ✓ Burst mode?
- ✓ Water temperature

Points to affix instruments
- ✓ Minimise drag

Dimensions
- ✓ Deployment, transportation
- ✓ Space for instrumentation

Interference

Acoustic

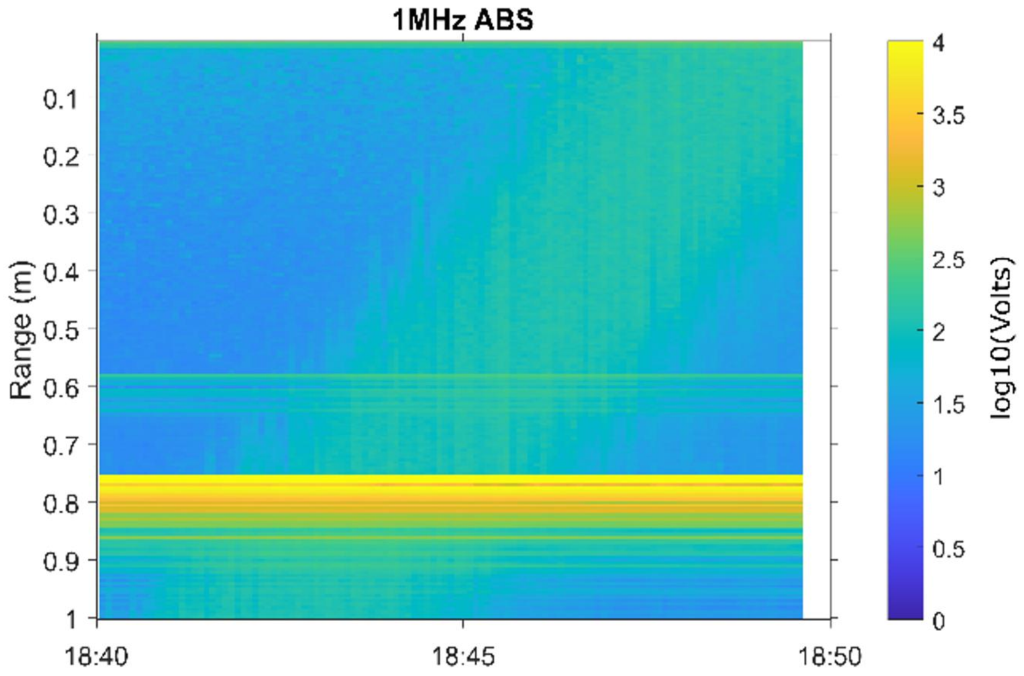
- Acoustic instruments may cause interference when their frequencies overlap or are close harmonics
- To reduce interference the sampling periods of the instruments may be setup to minimise spatial/and or temporal overlap.

Magnetic

- Calibrate instruments once all in place (inc. batteries)

Flow

- Protruding arm?
- Upstream + downstream instrumentation
- CFD model?



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Instrumentation: Currents

Most modern current sensors make use of the acoustic Doppler principle

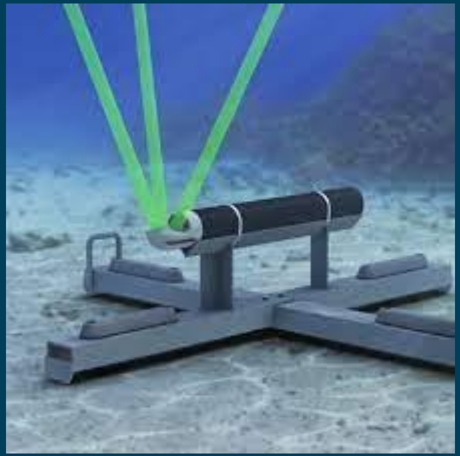
Water column profiling

Combination of upwards pointing and downwards pointing instrumentation. Profiles can then be stitched together to give a full water column profile.

Boundary layer scale

Turbulent velocities are, by their nature, highly variable in direction and strength

High sample rates and small bin sizes are required to observe these flows. As a result, higher frequency acoustics are required.



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Instrumentation: Sediment concentration & particle size

Optical and acoustic methods employ the same principles of transmission and scattering

Acoustic

Sediment concentration tends to be measured over a burst of time (a few minutes)

Auto gain changing required in environments with large sediment concentration ranges

Can provide an estimate of the mean particle size (requires calibration)

Optical

Detect infrared light scattered from suspended matter

Sensitive to grain size, composition and shape

Must be calibrated using the sediment from the intended field site

Sediment traps

Detail on the grain size, composition and shape

If not concerned with time varying change then simple sediment trap may be sufficient

Invasive

Instrumentation: Scour

Cameras

Use markings to provide quantitative data

Limited by visibility

Large battery and storage requirements

Acoustic methods

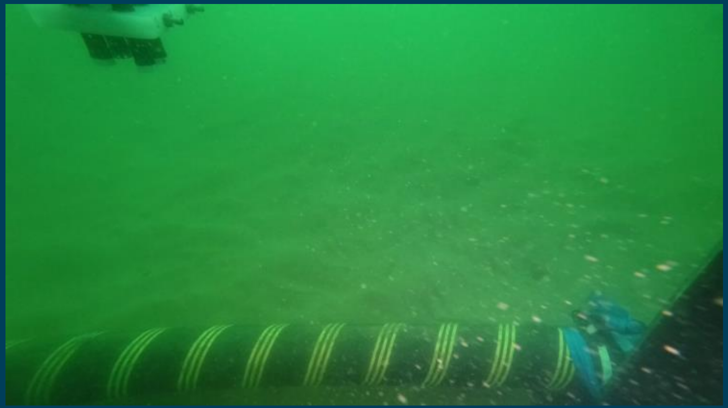
Single point (SBES) or swath, i.e. multibeam echosounders (MBES)

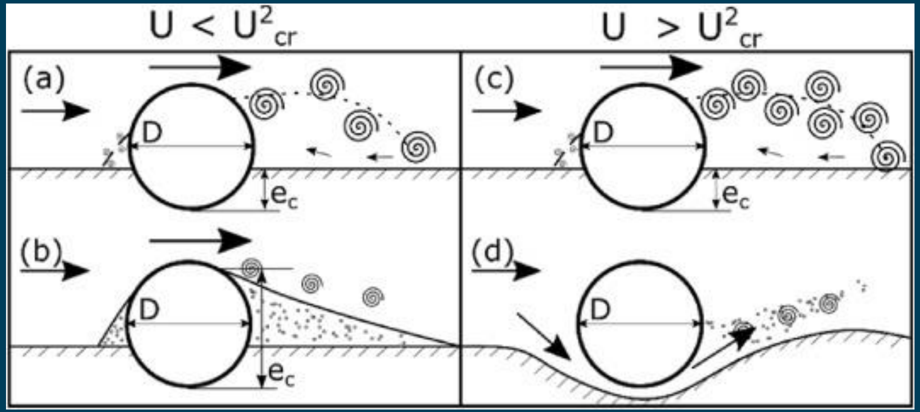
Backscatter can also give indication of composition

Optical

Optical scanners may not perform well in environments with high suspended load

May provide better resolution





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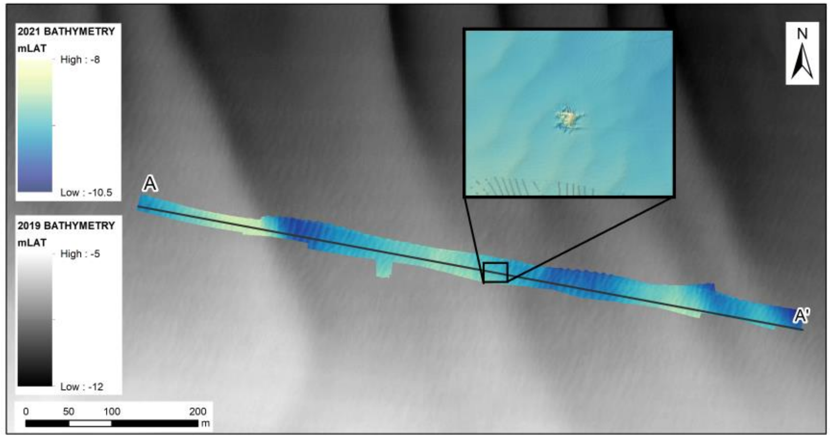
Supporting data

Multibeam bathymetry

Initial positioning of the lander

Record larger scale (e.g. bedform migration or scour wake) changes in the seafloor



Metocean observations

Locally acquired wave data may provide more context (e.g. extreme event return periods)

Grab samples

Useful for instrument calibration

Will disturb the soil layers

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Data processing

Once the lander mission is complete data will require cleaning and quality assessing.

Instruments should be calibrated both before and after the deployment so that any drift in signals can be quantitatively assessed and removed from the dataset.

A check should be performed to ensure that none of the signals between the various instruments have any interference and if required filtering for interference should be performed.

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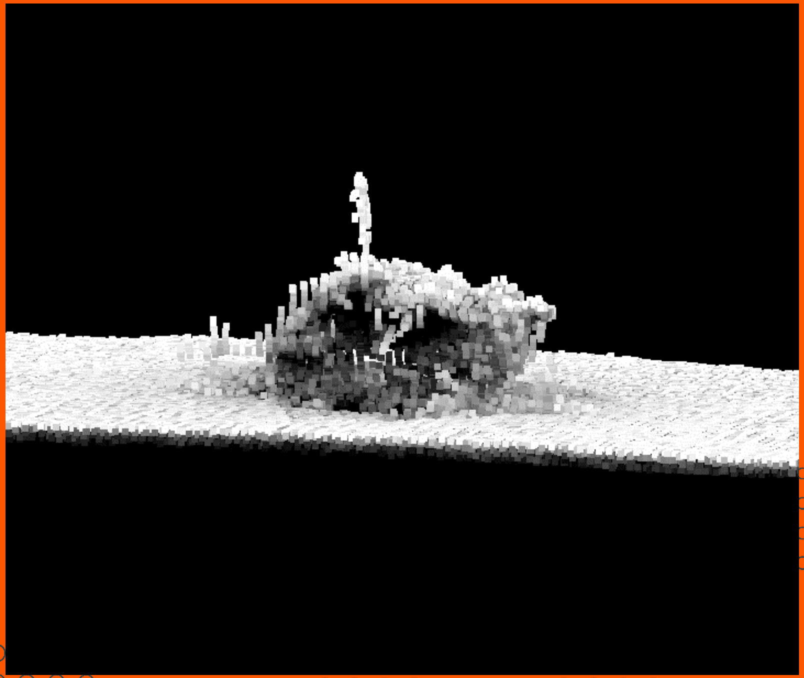
Other considerations

Biofouling

Spatial heterogeneity

Disturbance to the environment



Conclusions

Benthic landers are a powerful tool when used well.

The design of the lander and the deployment are critical to the success of the mission.

The duration of deployment mostly depends on the mission objective matching the research question(s).

The user must think carefully what data outputs are required and work backwards from this to design a lander and deployment that are fit for purpose.

It is hoped that the experiences drawn by previous deployments (specifically the 2020 and 2021 Supergen deployments) will be useful in refining future research and commercial missions.

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Thank you to….

Bangor University Innovation and Impact Award (BU-IIA),

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And

Supergen Offshore Renewable Energy

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