Sediment pathways and bedform mobility: considerations for offshore construction from the Pentland Firth, northeast UK

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The Pentland Firth’s eastern approach hosts intricate sediment transport pathways. Time-averaging the modelled flow field revealed the recirculatory nature of the residual flow also reflected by the inferred sediment transport field identified via timeseries bathymetric analysis.

@CarmSeas

The full abstract should be submitted to masts@st-andrews.ac.uk, in an editable format, by 16:00 Monday 23rd August 2021.

The Pentland Firth (PF), located between mainland Scotland and Orkney, is an area of the UK continental shelf (UKCS) that experiences extreme tidal flows. These are demonstrated partly by the occurrence of mobile sedimentary bedforms (e.g. dunes). This study presents a timeseries bathymetric dataset coupled with a tidal flow model to examine the hydrodynamics and bedform response at the eastern approach to the PF. These observations were additionally augmented by sediment grain type and flow data to validate the numerical flow model. Tidal flows of the PF result from a tidal phase difference between the east and west approaches to the channel. A resulting barotropic pressure gradient leads to flow accelerations that locally exceed 5m/s. The extreme tidal setting of the PF’s eastern approach was found to promote distinct bedforms that are spatially varied in geomorphology with distance from the PF. Sediment analysis also showed a decreasing grain size trend also with distance from the PF. The modelled residual tidal current (RTC) shows strong agreement with the sediment transport pathways, supported by the bedform migration direction. The energetic tidal flows of the PF’s eastern approach interact with the highly irregular coastline, generating residual tidal counter currents leeward of flow obstructions. These counter currents (i.e. RTC vortices) were reflected in bedform migrations and thence the sediment transport pathways. As the PF is considered as a bedload parting site (BLP), the RTC vortices are expected to influence the rate of erosion at the BLP, by recirculating sediment back upstream as a counter current inshore of the main flow. The modification of sediment transport pathways by RTC vortices may affect the development of nearshore and offshore engineering and should be considered in any initial site assessment. This study in the PF demonstrates how methods can be applied by offshore industries to better understanding local sediment transport pathways and mobile bedform features, and how they may interact with proposed infrastructure projects.

Acknowledgements

The research here was funded by the Scottish Universities Partnership for Environmental Research (SUPER) DTP in partnership with the University of the Highlands and Islands (UHI) and Scottish Association for Marine Science (SAMS). Additionally, many thanks to SHE Transmission Plc who provided high resolution timeseries bathymetric datasets along with survey reports, making this research possible.
Practical approaches for characterising prey assemblages and predator behaviour in tidal channel environments

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Twitter abstract: A first look at results of a combined fish trap and shore-based observation approach in tidal channel environments in Shetland @ShetlandUHI @BangorUni @jjwaggitt #MASTSasm2021

Practical approaches are required to address persisting data gaps related to prey fields and predator behaviour in tidal channel environments. These uncertainties cause high costs and risks for Marine Renewable Energy (MRE) projects during consenting. The trend in recent years towards increasingly sophisticated technological approaches to environmental monitoring in such sites often fails to provide all necessary data. For example, results from expensive active acoustic studies on prey and predator distributions are often interpreted without the most basic biological information such as species identity. Similarly, survey efforts designed to monitor seabirds and marine mammals, whilst informative, often do not provide the information required to assess key risks such as collision. Likewise, tagging approaches which depend on animals travelling precisely to areas of interest can also be impractical.

In April 2021 a new data collection approach was trialled in sites in Shetland including at Bluemull Sound. This approach was based on the use of modified fish traps deployed and recovered from a vessel and combined with data from shore-based observation.

The fish traps were adapted from a commercially available design and trialled in both seabed and floating configurations. A variety of fish species were successfully sampled in areas of very strong currents without any losses of gear. Various crustaceans and echinoderms were also observed in the seabed traps. The resulting data provide insights into the abundance and distribution of prey species across the study sites.

Shore-based observations were made before and during the fish trap deployments using a rangefinder binoculars and video camera system to record animal positions and dives. These observations focused on the most abundant seabird species foraging in the sites that could potentially interact with submerged MRE devices. Hundreds of tracks of up to 10 minutes duration were recorded, allowing dive duration and location to be estimated and providing a comparison of feeding behaviour within and amongst tidal stream environments.

The combined use of these methods allows for the rapid identification of areas of consistent foraging activity by the shore-based observations which can then inform the targeted deployment of fish traps to provide complementary data on associated prey assemblages. This approach provides much needed empirical ground-truth data to support active acoustic methods and for improving existing collision risk models. This trial demonstrates that these methods are viable as a low-cost data collection approach which is reliable in the challenging physical environments currently under MRE development.

Acknowledgements

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An Integrated Subsea Electrolytic Hydrogen Production, Storage, and Transmission System Powered by Floating Offshore Wind and Ocean Energy

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The presentation describes an integrated approach to gigawatt subsea green hydrogen production powered by offshore wind. Pressure-balanced subsea electrolyzers anchored at the seafloor leverage ambient cold water and hydrostatic pressure for cooling and first-stage H2 compression.

The presentation describes an integrated approach to large-scale subsea green hydrogen production powered by offshore wind and ocean energy. Fig. 2 shows pressure-balanced subsea electrolyzers anchored at the seafloor are powered by floating overhead offshore wind turbines. Hydrogen stored safely at the seafloor, in the absence of combustible oxygen, may be used for utility grid-balancing, sold as a commodity chemical, and as a fuel for the emerging hydrogen fuel cell electric vehicle transportation market. The proposed technology expands the current form and function of offshore wind and ocean energy. For example, electricity from a floating nameplate 10 MW wind turbine is rectified and used to power a subsea 10 MW electrolysis system that is anchored at the seafloor beneath the turbine.

As shown in the table, a GTA Technology Readiness Level 4 (TRL 4) prototype\(^1\) was validated at the National Renewable Energy Laboratory-NREL, under a Cooperative Research and Development Agreement between GTA and the U.S. Department of Energy’s Hydrogen and Fuel Cells Technology Office. The native hydrogen purity is 99.65%. A single oxygen scrubbing step elevated the purity to <10 ppm oxygen.

The work shows: (1) An offshore wind farm dedicated to subsea electrolytic hydrogen production, combined with subsea hydrogen gas pipeline collection and transmission, has the potential to eliminate large power transformers, floating platforms, and high-voltage cables that are large CAPEX and OPEX items. (2) GTA electrolyzers contain no moving parts and are constructed from relatively inexpensive and robust commodity materials, such as polyethylene, that exclude platinum group metals. (3) Cold deep-water hydrostatic pressure is leveraged for cooling and first stage hydrogen compression without mechanical compressors. (4) Subsea hydrogen production is shielded from extreme weather, ice floes, falling ice, and EMP events.

Reference

1. E. Greenbaum, “Electrolyzer Apparatus and Method of Making It”, European patent 2 917 386, issued April 1, 2017, assigned to GTA, Inc. The electrolysis cell for the validation work performed at NREL was constructed according the method described in this reference.
Cross-sectoral perspectives on improving data tools and knowledge resources for marine renewable energy consenting

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Tweet:
Data tools & knowledge bases provide essential information for MRE consenting. But are they authoritative & accessible & "approved"? Who decides? Industry stakeholders from the UK, Europe and N America agreed that all parts of the sector have a role to play in generating trust in data, knowledge, & information for the sector.

Twitter handle: @AquateraLtd @RaeGMiller

Issues around data, metadata, and knowledge availability and accessibility are frequently highlighted as challenges throughout the marine renewable energy consenting process by all parties involved. Numerous tools and resources have been designed to facilitate common access to environmental data and knowledge to support a proportionate and streamlined decision-making process, including online knowledge bases, data portals, and impact assessment tools. However, recent studies have highlighted that there continues to be a lack of awareness of or hesitancy across in using publicly available resources and tools across the sector, and that this stems from uncertainty around how they should be best used and around the quality of data they contain.

In a series of four international focus groups, marine renewable energy developers, regulators and government organisations, statutory nature conservation bodies and NGOs, and consultants discussed their perspectives on the appropriate use and implementation of the consenting tools and resources that were available to them, as well as any barriers preventing them from using the tools and resources effectively.

Although participants perceived that regulators and government bodies had the greatest role in curating, resourcing, or providing guidance on the use of consenting tools and resources, all parts of the sector were noted as having a role to play. Participants stressed that there was no established or consistent way to access information on the environmental impacts of marine renewable energy installations, which led to a precautionary approach in decision-making. Generating trust in information through the provision of authoritative data and standardisation of data collection methods, analysis methodologies, and metadata provision would help to improve confidence in decision-making across the sector. Here, we highlight specific actions that each part of the sector can take to improve the implementation of data portals, knowledge bases, impact assessment tools, and other resources throughout the marine renewable energy consenting process.

Acknowledgements

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References


How might very large scale offshore wind deployment in the North Sea look?

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(Peter Munro is a student and will be presenting. Simon Waldman is handling correspondence)

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Peter Munro of @uniofhull has been investigating the available space in the North Sea. If all of the nations with North Sea EEZs build offshore wind to their stated ambitions, how much room will be left for other activities? #MASTSasm2021

Abstract

The UK is planning 40 GW of offshore wind in its sector of the North Sea by 2030, and perhaps 75 GW by 2050. Other North Sea nations have similar ambitions.

At these scales of deployment, the space occupied will be significant and this may impact on other sea users.

In this talk we report on ongoing work in understanding the national ambitions of all the North Sea nations, identifying areas in which the resulting wind farms are likely to be built, and suggesting plausible array locations, both fixed and floating, taking account of projected increases in turbine size between now and 2050. We then briefly discuss implications for offshore wind ambitions and for other sea users.