Introducing a small-scale dynamic penetrometer for rapid geotechnical site assessment and monitoring in the field of ocean renewable energy

Nina Stark1,2, Alex E. Hay2, Achim Kopf3

1 now at: Virginia Tech, Dept. of Civil and Environmental Engineering, Blacksburg, VA, U.S.
2 Dalhousie University, Dept. of Oceanography, Halifax, NS, Canada.
3 MARUM-University of Bremen, Bremen, Germany.

Corresponding author: ninas@vt.edu

Standard offshore geotechnical in-situ testing in the field of ocean renewable energy is expensive and -- in the case of shallow water depths and strong hydrodynamics -- difficult. We present results using the small-scale penetrometer Nimrod for

(i) site characterization, scour and surficial sediment strength monitoring prior, during and after installation of offshore wind energy converters in the offshore wind energy test field Alpha Ventus (North Sea), and for

(ii) early site characterization of a proposed tidal energy converter site in Grand Passage, Bay of Fundy, Nova Scotia.

Conclusions:

• The Nimrod proved to be suitable for rapid geotechnical assessment of the seabed surface in these areas of difficult access, allowing up to 50 deployments per hour from small, easily maneuverable vessels, and in the direct vicinity of structures.

• In the vicinity of the wind energy converters (< 50 m), the results attest changes in surficial sediment strength, resulting from installation actions and scour.

• In Grand Passage, we mapped surficial sediment strength, layers of loose, potentially mobile sediment, and abundance of cobbles/shells in the upper layers of the seabed. This data set contributed to narrowing down the number of possible deployment sites to two preferred sites.

References


Acknowledgements

Measurements in the wind energy test field Alpha Ventus were funded by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety of Germany via the Federal Maritime Agency for Hydrography and Diga Marine (BMU) and MARUM-University of Bremen. The surveys benefited highly from the support by M. Zeiler and M. Lammers-Huesmann (both BMU) and the crew of the 55m operated research vessel WEGA. Surveys in Grand Passage were funded by the Offshore Energy Research Association of Nova Scotia, and the Natural Sciences and Engineering Research Council of Canada. We acknowledge field support by Dalhousie’s Dept. of Oceanography acoustic group, G. Trowe and Fundy Tribal Inc., and the crew of the survey vessel Excalibur XI. The deployment of the Nimrod was funded by the German Research Association via MARUM-University of Bremen, and was supported by H. Harff, C. Zoelker and M. Lange (all MARUM).

In Grand Passage, we mapped surficial sediment strength, layers of loose, potentially mobile sediment, and abundance of cobbles/shells in the upper layers of the seabed. This data set contributed to narrowing down the number of possible deployment sites to two preferred sites.

Small-scale dynamic penetrometers, or also called portable free-fall penetrometers have been introduced for the rapid geotechnical investigation of seafloor sediments (Stark and Achim, 2009; Stark et al., 2009). Particularly, they enable in-situ geotechnical seafloor assessments in areas of difficult access and areas of ongoing sediment dynamics (Stark and Kopf, 2011; Stark et al., 2014). For both of these reasons, they have been tested in the field of offshore renewable energies, when challenges such as testing close to sensitive structures, and deployment in areas of strong hydrodynamic and sediment dynamic activity might occur.

Example (i): Wind energy test field Alpha Ventus, German Bight, North Sea

Example (ii): Grand Passage, Bay of Fundy, proposed tidal energy site