MODELLING MARINE DUNES INTERACTING WITH A WIND FARM OFFSHORE DUNKIRK

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INTRODUCTION

At the end of 2020, around 5,400 offshore wind turbines had been installed, or were under construction, in European waters (The Crown Estate, 2020). This number is set to grow steadily in the coming decades to help meet ambitious climate neutrality goals.

Current and future offshore wind farm (OWF) projects are likely to be deployed in shallow shelf seas due to the proximity to mainland and favourable depths. Shallow shelf seas are also home to large sedimentary bed forms called marine dunes (sometimes sand waves). Their scale and the continuous evolution of the seabed resulting from their dynamic behaviour are expected to pose challenges for the implementation and safety of OWF projects. However, the morphology and dynamics of dunes are still poorly understood in open marine environments.

Our interest is in an area offshore Dunkirk (northern coast of France), where marine dunes coexist with sandbanks. The area is subjected to relatively strong tidal flows, and waves originating from the Atlantic Ocean and the North Sea. Recurrent and detailed bathymetric surveys have been carried out in recent years (Figure 1). They indicate migration rates of up 30 m/year.

Figure 1 – Marine dune field observed offshore Dunkirk, November 2019 (Source of the data: France Energies Marines).

SEDIMENT TRANSPORT PROCESSES AND MARINE DUNE DYNAMICS

To date, data-driven methods are applied to predict future bathymetries and assess changes in seabed levels in the context of OWF projects. A complex process-based numerical model has been developed for Dunkirk. It is based on the open**TELEMAC** system and considers the interactions between currents, waves, and sediment transport processes.

The model has been calibrated against comprehensive in situ bathymetric and oceanographic data. In doing so, the relevance of sediment transport mechanisms (bedload vs. suspended load, tides vs. waves) was investigated. The importance of the formalism used in the sediment transport formulae (shear-stress or energy considerations) was highlighted. The reproduction of the observed evolution of the dune field over time scales ranging from 1 month to 2 years was examined and will be discussed.

INTERACTION BETWEEN THE OWF AND THE SEABED

It is common practice to parameterise OWF piles with a resistance term in large-scale coastal models (Lambkin et al., 2009). This approach has been widely used in simple and complex morphodynamic models alike. It can be extended to include a turbulence source term that represents the mixing effect of the obstruction on the flow.

This method and the explicit method of including the turbine piles as an array of islands in the computational mesh have been explored. Preliminary results will be presented and discussed, in the context of a marine dune environment.

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