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On simulating the impacts of in-stream tidal turbines on island-associated sandbanks

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In recent years marine renewable energy generation has attracted the interest of energy developers and stakeholders (EOEA, 2012). Amongst current interests, the tidal stream turbine technology is in the spotlight. Prior to considering large scale tidal turbines installations, a number of uncertainties linked to site specifications will determine the array location and operating characteristics. One such important factor is the altered tidal environment as a result of the energy extraction and how this will impact the natural sediment transport regime and hence the sea bed morphology and local coastal ecology. Due to limited availability of sediment data at potential sites, only a few studies have done so far to investigate the effects of tidal stream energy extraction on sediments and bed dynamics (Robins et al., 2014). In the work presented here, a 3D numerical modelling study has been carried out, to investigate the response of headland/island associated sandbanks to tidal energy extraction.

The Inner Sound channel located in Pentland Firth (Scotland, UK), between the Scottish Mainland and the Island of Stroma is used as the test site. Deep water depths and fast moving tidal flows in the Inner Sound channel provide a promising location for tidal stream energy harvesting (Easton et al., 2010). A proposed development plan will result in a 400MW turbine array installation in the channel in 2020. The seabed in the Inner Sound is mostly bedrock however, large scale sand deposits are found at numerous locations. In this present study, we focus on two large sandbanks located close to the Island of Stroma (Meygen Ltd, 2010). Any potential changes to these sandbanks as a result of tidal energy extraction may have some significant impacts on the marine ecology associated with them.

The open source Delft3D model (Lesser et al., 2004) was used for modelling. The hydrodynamic simulations covered two neap-spring tidal cycles (Chatzirodou et al., 2016). The model is used to investigate potential changes to existing hydrodynamic regime as a result of tidal stream energy harvesting and the resultant changes to sediment transport and sandbank morphology by a large scale turbine array. Horizontal in-stream porous disc (turbines) theory is used to implement turbines in the model. A staggered array with 200 generic turbines were implemented, with intra-row spacing of 2.5 times turbine diameter (D) and array-row spacing of 10D (D=20m). In the vertical column a minimum 5m top and bottom clearance was allowed.

As a result of tidal stream energy extraction, the natural tidal current regime presented notable changes over a tidal cycle. In addition, significant changes were found in the residual tidal currents, which indicate impacts on the sediment transport regime. The paper will present the details of the computational model, describe the undisturbed tidal regime and the results on the impacts of large scale energy harvesting on the hydrodynamic environment and, sediment transport and morphology of island-associated sandbanks in the Inner Sound channel.

References:

Chatzirodou, A., Karunarathna, H. and Reeve, D.E. 2016. Investigation of deep sea shelf sandbank dynamics driven by highly energetic tidal flows, Marine Geology, 380, pp.245-263

Easton, M.C., Woolf, D.K., Pans, S., (2010). An Operational Hydrodynamic Model of a key tidal-energy site: Inner Sound of Stroma, Pentland Firth (Scotland, UK). 3rd International Conference on Ocean Energy, Bilbao.

EOEA (European Ocean Energy Association), 2012. European Ocean Energy Roadmap 2010-2050.

Lesser, G., Roelvink, J.A., Van Kester, J.A.T.M., Stelling, G.S., 2004. Development and validation of a three dimensional morphological model, Coastal Engineering 51, 883 – 915.

Robins P.E., Neill S.P., and Lewis M.J. (2014). Impact of tidal-stream arrays in relation to the natural variability of sedimentary processes. Renewable Energy, 72, 311-321.

MeyGen Ltd. (2010). MeyGen Tidal Energy Project Phase 1 Environmental Statement.