**Numerical Modeling for Marine Renewable EIA**

Joanna Lester from Xodus gives the practitioner’s view on using numerical modeling for environmental impact assessment for marine renewables.

### Introduction

Marine renewable energy is a relatively young industry compared with offshore wind farms. Most wave and tidal energy developers are working towards commercialisation, at demonstration and commercial testing sites.

The marine environment into which these devices are deployed is highly energetic, dominated by physical processes including waves and currents. It is the interaction of these processes which form the beaches and other features around our coastline.

However, the complexity of these interactions can make it difficult to assess the impact a renewable device will have on the coast during the environmental impact assessment (EIA) process. Therefore, it may be necessary to use numerical modeling as an assessment tool.

### When is a Model Necessary?

While many physical processes associated with the introduction of man-made structures into the coastal environment are well understood, larger-scale processes, such as the modification of the flow field caused by the installation of a tidal stream array are harder to predict without a numerical model.

### Modeling Methods

If a numerical model is deemed necessary for marine renewable EIA, a baseline model capable of replicating the wave, current and sediment behaviour at the project site should be established. Good quality field data must be used as a starting point, which would typically include:

- water depths (see Figure 1) either from a dedicated survey or best available data from Admiralty charts;
- surveyed or purchased water levels, to drive the model boundaries;
- surveyed current speed and direction at the site, to help characterise general flow patterns and the overall hydrodynamic regime;
- characterisation of the wave regime from either long-term wave buoys or more likely, commercially available wave model data;
- geophysical survey data which will give information about the depth of sediment at site and details of local bedforms;
- sediment grab samples which can ground-truth the geophysical data, and give some information on sediment particle size distributions; and
- bedload samples which give information about how much sediment is typically in suspension.

Ultimately, it is important that numerical modeling is used on a site-specific basis, following a desk study to assess the complexity of the oceanography at site, and the sensitivity of the surrounding seabed and coastline.
Once all data has been collected and the study area selected, a suitable model can be built and calibrated using one of the commercially available flow software packages, and used to quantify the magnitude of changes to the physical processes brought about by the installation of marine energy devices.

**Impact Assessment**

There are not yet any specific EIA guidelines for assessing the effects on coastal processes from marine renewable devices, but existing guidelines for offshore wind farms (CEFAS, 2004; COWRIE, 2009) state that assessments should consider the construction and installation, operations and maintenance, and decommissioning of any project, and both the near-field and far-field effects.

Likewise, the guidelines advise investigating the magnitude and significance of change to the following coastal processes:

- Changes to current regime, which may have an effect on navigation channels, the mooring conditions at local piers and anchorages;
- Changes in wave regime, which can lead to beach accretion/erosion or impacts to recreational users such as surfers;
- Changes in water quality caused by the release of drill cuttings from piling operations or by the disturbance of existing sediment bedforms, which can impact benthic communities and habitats;

- Erosion/accretion of the coastline, which can have a negative impact if the coastline is protected or provides habitat for rare species; and
- Displacement of sediment resulting in alteration or loss of bedforms, which can impact on marine archaeological receptors and the navigability of shipping channels.

Notice that the concept of a receptor is not entirely conventional for physical processes, because they do not typically have any intrinsic sensitivity associated with them but they require study in order to understand secondary effects on the ecosystem which they underlie.

**Conclusion**

Work is ongoing at present to find the best ways of modeling the removal of wave and tidal energy from the sea. Optimising these methods will enable better prediction of the overall impact of each device on the marine environment and the ecosystems within which they are placed.

Standardisation of methodologies through the development of industry specific EIA guidelines would help streamline the process and reduce the costs associated developing a new model for each new development.

In summary, numerical models can be used to assess the impacts of marine renewable devices on complex physical processes with a much greater spatial and temporal resolution than is possible via survey and desk study alone.
Most importantly, these results can be used to provide valuable information about the likely impacts to many other important indirect receptors.

Figure 1: Example of numerical model bathymetry domain (refimage courtesy: EMEC website)

For access to more EIA articles, case studies and hundreds of non-technical summaries of Environmental Statements visit:
www.iema.net/qmark