On the Tidal Resource of the Rathlin Sound

Alberto Pérez Ortiz
Alistair Borthwick
James McNaughton
Acknowledgements
Content

- Research Background
- Rathlin Sound
- Numerical Methodology
- Domain Spatial Discretization
- Calibration of Numerical Model
- Natural State at Rathlin Sound
- Rathlin Sound Resource Assessment
- Conclusions
Characterization of tidal resource of idealised coastal site in the vicinity of an island near a landmass

Validity assessed of outcomes from idealised study by Pérez-Ortiz et al. [1] when applied to an actual coastal site

The Rathlin Sound is a very good example of an island near a landmass
Rathlin Sound
Numerical Methodology

Numerical model based on Fluidity [2] solver of shallow water equations

Site bathymetry data from HydroSpatial One Gridded Bathymetry [3]

Sea surface elevation at open boundary conditions derived from the Oregon State University European shelf solution [4]

Power extraction by tidal turbines modelled through additional absorption term $k_f$ in the momentum equations applied at footprint of tidal farm

Power extraction methodology neglects turbine and farm scale mixing losses, thus representing an upper limit to power extraction
Domain Spatial Discretization

Domain divided into four mesh regions with mesh resolution specified in each region

Model forced solely with $M_2$ tidal signal at open boundaries

Solution convergence assessed at transects at entrance and exit of Rathlin Sound, and 10 km downstream from entrance and exit of Rathlin Sound
Calibration of Numerical Model

Two measured field datasets: 3 ADPs deployed south-east of Rathlin Sound [5] and 3 UK tidal gauge stations [6]: Portrush, Bangor and Portpatrick

Model forced by 8 constituents at open boundaries, and 15 days’ data used for calibration process

Calibration performed by altering seabed friction coefficient $C_d$ between 0.001 and 0.005

Measured free surface and velocity data best approximated with $C_d = 0.0025$
Natural State at Rathlin Sound

Mean and maximum speeds at the site are ~2 and 3 m/s respectively when model is forced with $M_2$ tidal signal.
Rathlin Sound Resource Assessment (1/2)

Upper limit to power extraction east of Rathlin Sound: 298 MW

Power figures agree with outcomes of island-landmass idealised study

Analytical channel model [7] underpredicts by 51% the numerical results
Substantial reduction in mean speed flows in Rathlin Sound and offshore east and south-east at maximum power extraction

Mean difference in sea surface elevation of 10 % and 1 % in the near and far-field respectively
Conclusions

Calibrated model captures main flow features in vicinity of Rathlin Sound

Upper limit to power extraction at Rathlin Sound: ~298 MW

Comparison with results from idealised strait between island and landmass

Analytical channel model underpredicts by 51% the numerical results

At maximum power extracted, substantial reduction occurs in mean speed flows in the Rathlin Sound, offshore east and south-east of Rathlin Sound
References


