Quantifying "exposure" with Cost Effective Wave Resource Measurements

Robert Beharie, John Side

Work stream 4: Arrays, Wakes and near field effects

Introduction

This aim of this research is to develop new concepts and methodologies to reduce costs of environmental information gathering. This is to be achieved by identifying new measurement parameters through the development of shore based and near shore low cost devices and instrumentation, which will provide metrics for the evaluation of environmental disturbance resulting from the installation of wave energy converter arrays. A series of field studies to investigate the data acquired from the deployment of these devices against the biological communities corresponding to the habitat and biotope classification system underpinning Special Areas of Conservation (EEA, 2008) will also be undertaken.

Background

Although modern wave data measurements using buoys and Acoustic Doppler Current Profilers (ADCP's) is currently the most accurate available, these require on site installation which is expensive. This way is also a notoriously hazardous exercise when installed within high energy environments where marine renewable energy resource assessments are the prime focus of research. The loss of floating devices through mooring failure results not only in the loss of data continuity but can also lead to the loss of the equipment with subsequent cost implications for insurance premiums and indeed un-insurable equipment.

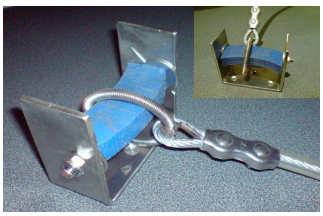
Acoustic characteristics of the air/water boundary interactions in the surf zone using hydrophones has shown that the ratio of noise power spectral density to surface wave energy flux is proportional at certain frequencies (Deane, 2000). This method has not been used as yet to establish resource assessments. Modelling techniques are becoming increasingly sophisticated with regards to near-shore wave parameters but remain limited due to the highly complex nature of the littoral zone. Remote sensing brings its own difficulties among which, is the issue of how to transmit accurate data with increasing distance from the location of study. Radar based wave mapping systems can be used to a higher degree of accuracy but are orders of magnitude more costly.

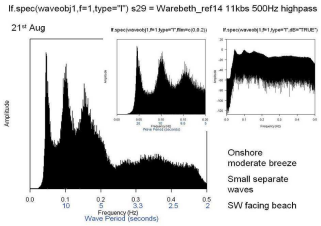
At present there are no commercially available devices that can measure wave energy acting directly upon the coastline. This study will develop such a device/s for the "accurate quantification of the environmental consequences of large scale energy extraction" an important factor in SuperGen Workstream 4. Further, no studies that have attempted a measurement of "exposure" that can be understood in terms of biotope classification systems, and this lack of quantitative measurement causes difficulty in developing general theories through the inability of integrating other studies (Lindegarth and Gamfeldt, 2005), particularly for environmental impact assessments.

It is essential that where change (environmental, etc) is observed in the proximity of MEC deployments that there is confidence that such a change is as a consequence of alteration of the 'energy regime' and does not result from natural variation or any other source of disturbance (e.g. climate change). During monitoring programme planning, surveillance procedures and procedural guidelines recommended by the UK Joint Nature Conservation Committee (JNCC) will be implemented to identify normal background variations as a baseline so that any abnormal changes can be identified. The identification of such sentinels and metrics will prove invaluable to stakeholders and investors in marine renewable energy technologies.

Technology

Most previous research into attempting to quantify water currents using simple devices has been conducted with regards to biological communities in the littoral zone and has been used to examine measurements of maximum water velocities (Denny, 1995 and Galley, 1991). Recently, a more informative shore-based method includes a design that uses a non-reactive sacrificial material to provide an aggregate measure of wave energy over a prolonged period with a degree of directional indication (Beharie, 2007) and this study will develop it further.





It is intended to incorporate advanced electronic instrumentation including miniature data storage devices where increased capacity / low cost units are becoming increasingly available. Compatibility issues are almost eliminated with the widespread use of universal connection standards such as USB, Bluetooth and WiFi. The utilisation of shore based audio transducers to analyse the frequency spectrum of the surf zone can accurately determine wave periodicity (Beharie, 2007). From this metric alone we may have the ability to calculate mean values of near shore wave energy due to the wave period being proportional to the strength of the winds in the generating area, the distance traveled from that area and also waves of a given steepness.

Future Research

Prototype installations – A shore trial of a second-generation prototype device is on going at Billia Croo, Orkney, the nearest shoreline location to the European Marine Energy Centre (EMEC) WEC test berths. The information from this trial will be incorporated into a series of multiple deployments at strategic locations in and around Orkney for the corroboration of wave action determination.

Environmental Survey – A monitoring programme of habitat and biotopes within the research areas related to this study to determine the natural background variation.

Remote measurements – A shore based stand-alone audio recording measurement device will be developed using PC based hardware to provide 24hr wave periodicity data.

References

Beharie, R.A. (2007). Methods for the measurement of "exposure" in marine environments. *International Centre for Island Technology, Heriot Watt University. MSc Dissertation.*

Deane, G.B. (2000) Long time-based observations of surf noise. *J. Acoust. Soc. Am. 107(2)758-770*

Denny, M.W. (1995). Predicting physical disturbance: Mechanistic Approaches to the Study of Survivorship on Wave-Swept Shores. *Ecological Monographs* 65(4):371-418

EEA (2008). About the EUNIS Database. *European Environment Agency, Copenhagen, Denmark.* http://eunis.eea.europa.eu/about.jsp [Accessed 18th Sept 2008]

Galley, D.J. (1991) The Ergopod: A simple device to measure on-shore wave action. *Field Studies 7 (1991), 719-729*

Lindegarth, M. and Gamfeldt, L. (2005). Contrasting analyses of qualitative and quantitative ecological models: the effects of 'exposure' on rocky shore assemblages. *Ecology.* 86(5): 1346–1357

International Centre for Island Technology
Heriot Watt University – Orkney Campus
Institute of Petroleum Engineering
Academy Buildings
Back Road
Stromness Orkney **KW16 3AW**

Engineering and Physical Sciences Research Council