A PREDICTIVE FUZZY LOGIC MODEL TO BIMODAL WAVE PARTITIONING IN WELSH COASTLINE

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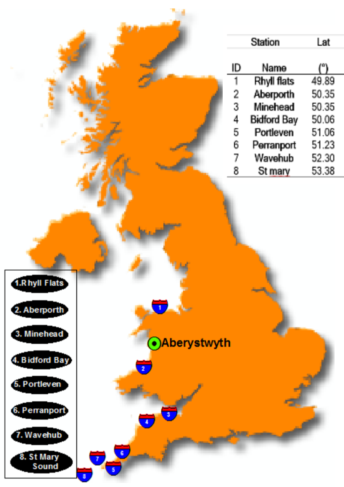
INTRODUCTION

Bimodal seas are usually characterised by the combination of swell and locally generated wind energy. Understanding the percentage of the swell component (SC) and the wind component (WC) partitioned from the energy content of a Wave System (WS) is important in coastal defense design and management. The South Wales and southwest England wave climate is mostly characterised by bimodal wave spectra because they are directly facing the North Atlantic Ocean. In this paper, we describe the application of fuzzy logic to develop an efficient wave partitioning system for bimodal wave energy separation that can be used to characterise the percentage of swell and wind waves in a measured sea state.

METHODS

The modified recursive approach proposed by Hanson and Philip (2001) was used to partition measured directional spectra obtained from approximately five hundred thousand historical waves captured in 8 stations in and around Wales with data spanning between 2006 to the early half of 2017 (Figure 1).



ID	Station Name	Lat (°)	Long (°)	Water Depth (m)	Wave Height Min (m)	Wave Height Max (m)	Wave Period Min (s)	Wave Period Max (s)	Years of Data Availability
1	Rhyll flats	49.89	-6.31	53.20	0.11	6.72	2.20	22.30	2011 to 2017
2	Aberporth	50.35	-5.62	50.00	0.22	10.03	1.90	25.00	1998 to 2012
3	Minehead	50.35	-5.18	15.00	0.18	22.69	1.70	25.00	2011 to 2017
4	Bidford Bay	50.06	-5.31	15.00	0.04	10.14	1.70	28.60	2011 to 2017
5	Portleven	51.06	-4.28	11.00	0.07	10.13	1.70	25.60	2011 to 2017
6	Perranport	51.23	-3.47	10.00	0.06	7.34	1.70	26.30	2006 to 2017
7	Wavehub	52.30	-4.50	15.00	0.05	7.20	1.60	22.30	2015 to 2017
8	St mary	53.38	-3.60	10.00	0.04	8.60	1.70	26.40	2014 to 2017

Figure 1 - Descriptions and Geographical Coordinates of Wave Buoy Stations used in the analysis.

The directional spectral at each station were separated into wind and swell components from different sources. These swell components were then recombined to create a single swell component. The components of the swell and the wind were integrated over frequency to develop the bimodal spectrum from where the characteristics significant wave heights H_{m0} and $T_{m-1,0}$ for each component of the swell and the wind were derived.

RESULTS AND ONGOING WORK

One of the wave partitioning results is presented in Figure 2. Note that this process allows a frequency overlap between the two components, unlike the traditional frequency cut-off approach (Reeve et al., 2015).

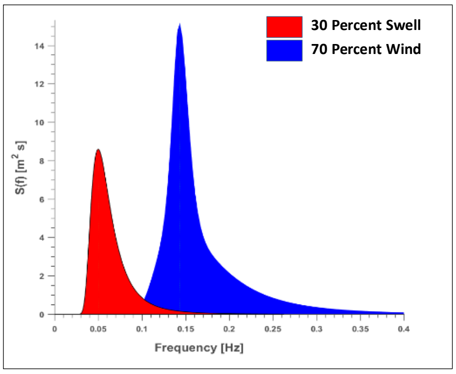


Figure 2: A snapshot of a partitioned 2-D plot of an energy density spectrum partitioned for WC (@70%) and SC (@ 30%) Train at St Mary's Sound (Channel Coastal Observatory buoy (CCO, 2017), with VM Code 6201053) at 01:00 UTC on December 24, 2014.

These percentages vary as the swell component grows in December 2014 as observed in St. Mary Sound (Figure 3).

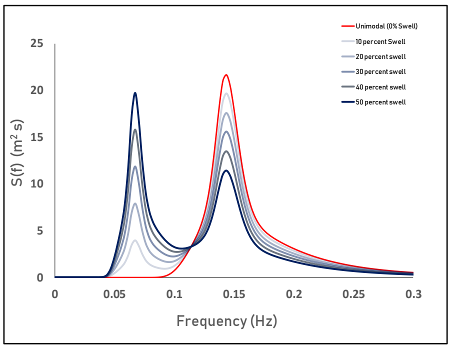


Figure 3: A snapshot of differently partitioned percentages of Swell energy built-up observed in St. Mary Sound at different dates in December 2014 (CCO, 2017).

The analyses of the swell growth over time in relation with the seasonal variation with large storms in the winter and spring months are still ongoing and will be incorporated into a fuzzy set to develop a predictive model for swell to wind combination for bimodal seas approaching Wales.

The full paper will identify the wave bimodality behaviour amongst the eight sites, as well as comparisons of the fuzzy partitioning method with other partitioning methods (e.g. the CCO method - see CCO, 2017).

REFERENCES

CCO (2017), 'Channel Coastal Observatory - Real time data', Online, assessed 20 August 2017, available at: http://www.channelcoast.org/.
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