Sea State Report

Chapel Point wave buoy, 2012-2013

RP037/L/2013

December 2013

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Anglian Coastal Monitoring programme

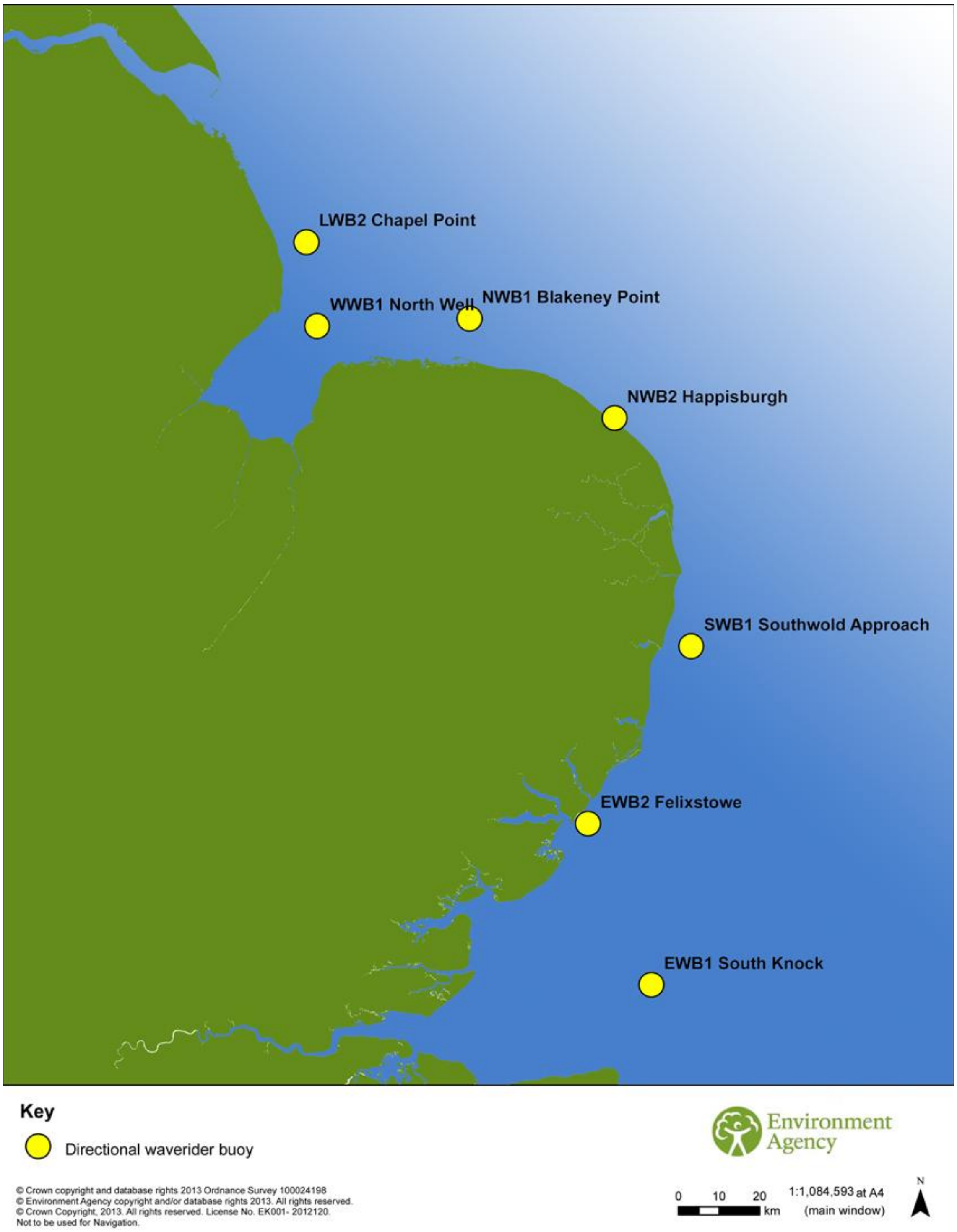

Figure 1.1: Map of instrument locations

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1.1 Wave & tide monitoring

The Shoreline Monitoring Group (SMG) based within the Flood & Coastal Risk Management function of the Environment Agency (EA) (Anglian Region) provides strategic monitoring of the Anglian coast through the Anglian Coastal Monitoring project. Phase VIII of this programme runs from 2011 to 2016. The hydrodynamics monitoring element of the programme consists of a network of Directional Waverider (DWR) buoys deployed off the Anglian coast. The DWR buoys provide real-time wave spectra and GPS positions via satellite link. The wave data are uploaded to the WaveNet[1] website maintained by the Centre for Environment, Fisheries and Aquacultural Science (Cefas) on behalf of the Department of Environment Food & Rural Affairs (Defra), allowing public access to the programme's real-time monitoring records.

1.2 Wave climate & sea state reports

The aim of the report is to present the nearshore wave conditions at the instrument location in order to feed into studies and management activities of the Anglian coast. The Sea State reports make use of the processed onboard instrument logged data from the wave buoy (Environment Agency, 2012). Logged data is processed and quality checked by our survey contractor, Gardline Environmental[2]. The wave buoys are fully calibrated before deployment and data translation and processing is carried out using the instrument manufacturer's software including Datawell's W@ves 21[3].

[1] Cefas WaveNet: www.cefas.co.uk/data/wavenet.aspx

[2] Gardline Environmental: www.gardlinemarinesciences.com/page/gardline-environmental

[3] Datawell W@ves 21: www.datawell.nl/

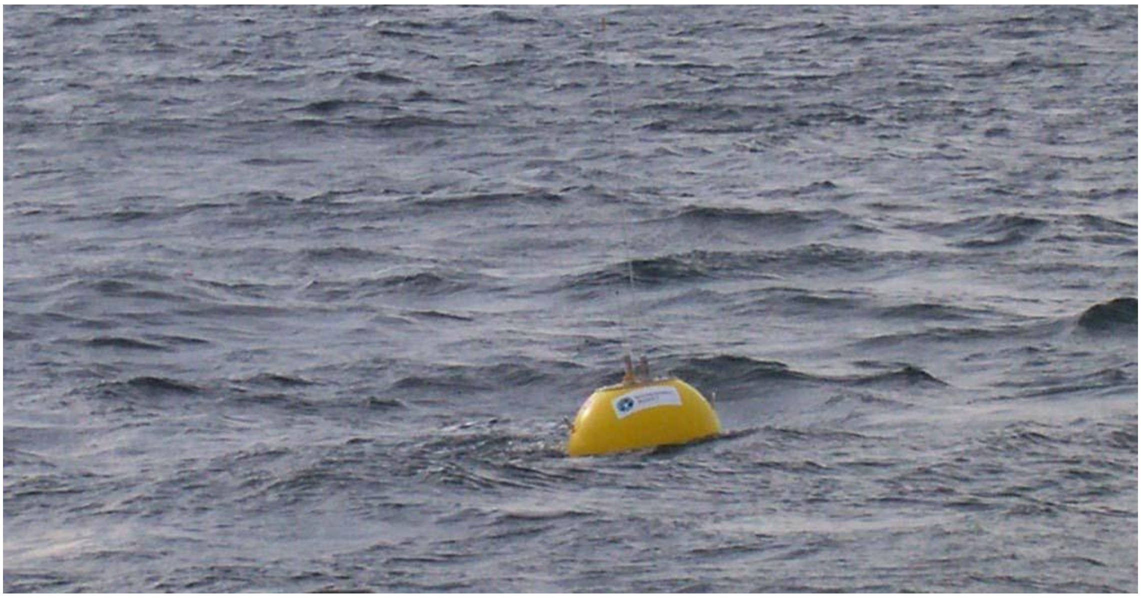

Photo 1: Deployed directional Waverider buoy (Photo: Environment Agency)

2 Chapel Point Directional Waverider Buoy

2.1 Instrument description

The DWR buoys provide real-time information on waves approaching the Anglian coast. The buoys are moored to the seabed by an elasticised line allowing them to float on the surface and record wave movements. The buoys measure the orbital motions of the water at the surface rather than the surface slope. These continuous measurements are then sent ashore through high frequency radio signals to base stations, such as RNLI Life Boat stations. We can then monitor and log these data streams through a broadband internet connection. Wave spectra and GPS positions are also sent via satellites. The real-time wave data are publically available on the WaveNet[1] website.

Every 30 minutes the DWR logs processed spectral data of 2304 samples measured over a 19.2 minute period. The logged spectra have a 64 frequency band energy density resolution. The first 30 minutes of each hour is processed and quality checked to give a representative value of the hour. DWR buoys are serviced and swapped over annually when they are re calibrated and the onboard logger data recovered.

2.2 Instrument location

The Chapel Point Waverider buoy (LWB2) is situated off Chapel Saint Leonards and Chapel Point on the Lincolnshire coast at 53° 14.707.494 N, 000° 26.763 E. It is moored in 12 mCD of water, just north of the Lincs offshore wind farm and inside of the Inner Dowsing Banks and Overfalls. The buoy is also about 20 km from North Ridge, Dudgeon Shoals and Race Banks. Despite the presence of these banks the Lincolnshire coast is particularly exposed with a trend of beach erosion and where annual sediment renourishment occurs. The buoy records the long fetch, north-easterly waves impacting on this stretch of the coast, On the Lincolnshire coast the flood tidal flow generally moves south and the ebb tidal current flows north (Haskoning, 2005). Along the coast, wave action dominates but the tidal current residuals become more significant in the nearshore and offshore. These currents regulate sediment transport and the development of sand banks in the area, such as the Skegness Middle. Interaction between the tidal currents and sandbanks creates areas of turbidity known as overfalls. The Saltfleet, Trusthorpe and Inner Dowsing Overfalls modify the waves approaching the Lincolnshire coast, with those passing over the latter being recorded by the wave buoy.

Onshore the Lincolnshire coast frontage is monitored through LiDAR, aerial photography and topographic surveys of the following monitoring cells; Grimsby – Cleethorpes, Donna Nook, Saltfleet – Theddlethorpe, Mablethorpe – Skegness and Gibraltar Point.

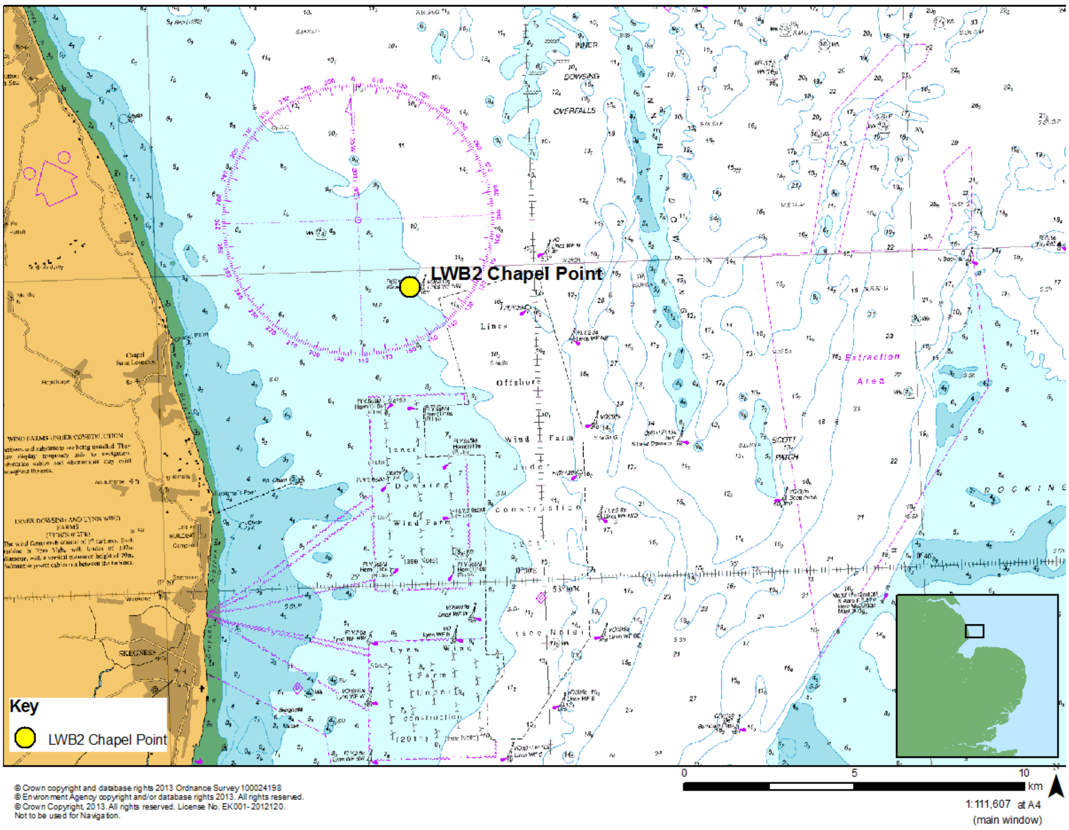

Figure 2.1: Chapel Point (LWB2) location map

2.3 Instrument deployment

The Chapel Point buoy is a new deployment as part of Phase VIII of the Anglian Coastal Monitoring. It was first deployed on the 23rd May 2012 and recovered on the 7th July 2013 (Gardline 2013).

Over the period July 2012 to June 2013 the data return of the logged records achieved was 100 %.

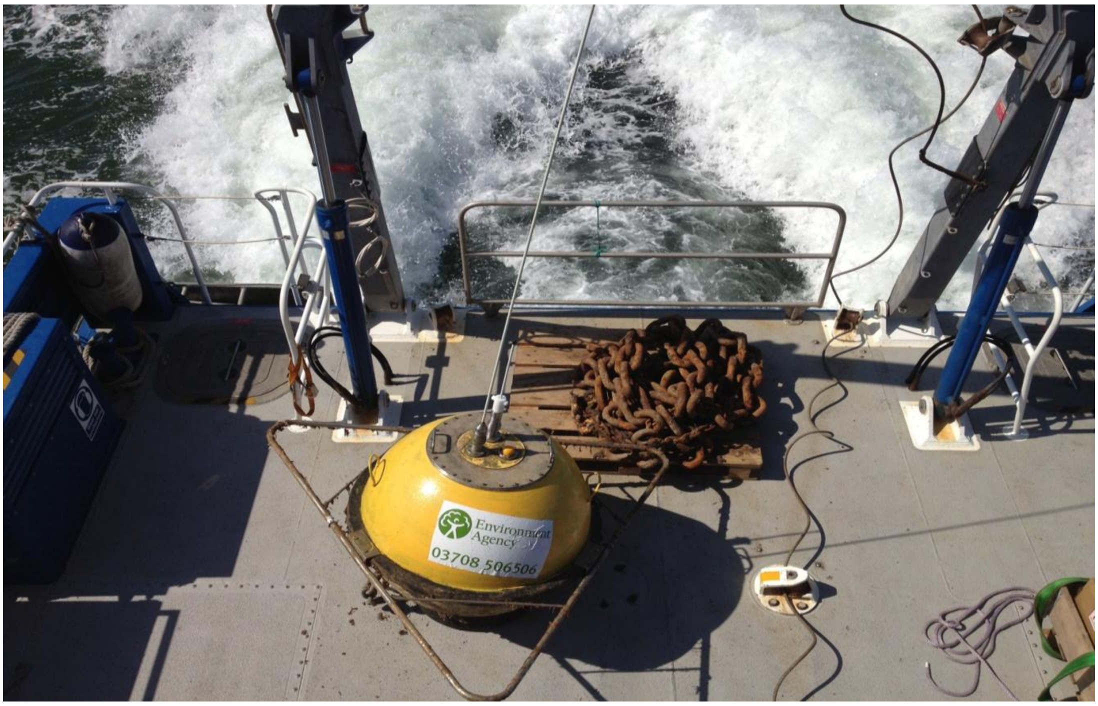

Photo 2: Chapel Point DWR in July 2013 on deck prior to the latest deployment (Photo: Gardline Environmental).

3 Wave statistics

This section presents the key wave parameters in the annual time series. In future reports this will also include all the observations over the instrument's extending deployment life to describe sea conditions at the instrument location. This shows the general pattern of waves represented by a spectrum of waves of different frequencies, heights and directions through statistical measurements, time series and averages over the duration of a year. A description of all of the parameters can be found in the glossary section at the end of this document.

3.1 Annual summary statistics 2012-13

Table 3.1 below details the statistical summaries of records logged over the last deployment from July 2012 to June 2013.

	Significant wave height Hs (m)	Peak period Tp (s)
Max:	3.16	25.0
Min:	0.09	1.72
Mean:	0.80	6.07

Table 3.1: Min, Max and Mean statistics (July 2012 – June 2013)

	2012						2013					
	Jul	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**
Hm0 (m)	0.56	0.57	0.68	0.82	0.78	0.94	0.81	1.00	1.31	0.80	0.77	0.61
Tp (s)	5.62	4.69	5.42	6.22	6.92	6.33	5.82	6.85	7.46	6.19	6.14	5.20
Tz (s)	3.47	3.30	3.39	3.78	3.69	3.90	3.72	4.09	4.63	3.73	3.74	3.64
Mdir (°)†	25	27	28	28	31	28	65	31	69	30	25	28
T (°C)	2.66	2.62	2.64	2.82	2.77	2.88	2.83	3.00	3.27	2.84	2.84	2.82

† Mdir is a monthly modal statistic

Table 3.2: Monthly mean statistics for the reporting period (July 2012 – June 2013)

3.2 Significant wave height

The annual mean wave height recorded at Chapel Point is 0.8 m. The nearshore acoustic wave and current meter (AWAC) deployed at Chapel Point, in a water depth of 5 mCD, from 2006 – 2009, logged an overall mean wave height of 0.65 m.

In comparison, the NWB1 buoy deployed off the North Norfolk coast also logged a mean height of 0.8 m for this year. The WWB1 buoy located in at North Well in the mouth of the Wash recorded 0.62 m (see Figure 1.1 for wave buoy deployment locations).

The highest waves are recorded in the winter months with the highest monthly mean values occurring during February and March. In March the mean significant wave height was 1.31 m.

As this is the first year of deployment no storm threshold level has been designated for the site. However for illustration, Figure 3.1 shows five occurrences of waves exceeding 2.75 m and a single storm event, at the end of October, where waves exceeded 3 m in height.

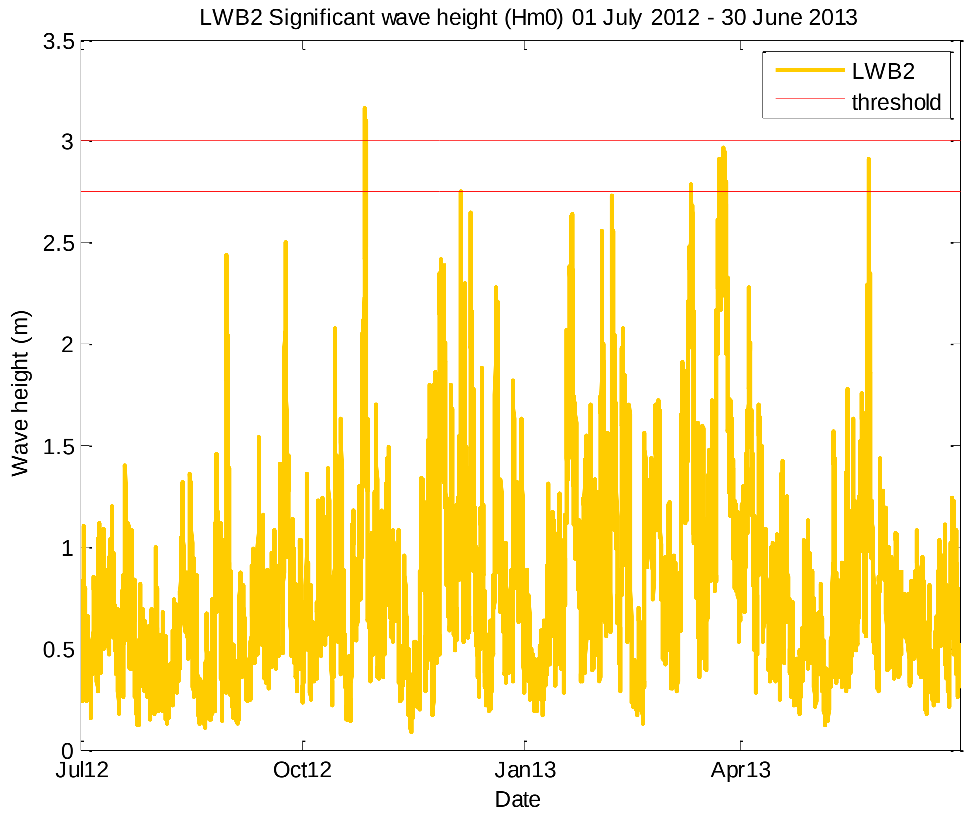

Figure 3.1: Significant wave height (Hm0) (2012-13)

	Annual Hs occurrences per height band (%)					
Year	0 – 0.5 m	0.5 – 1 m	1 – 1.5 m	1.5 – 2 m	2 – 3 m	3 – 4 m
2012	33.41	47.84	12.69	4.02	2.00	0.03
2013	24.06	43.87	19.99	6.60	5.49	n/a

Table 3.3: Annual significant wave height (Hm0) occurrences per height band (%)

3.3 Wave period

Peak period is also known as the dominant wave period and describes the frequency with the highest energy. The gentle slope of the nearshore bathymetry leads to wave shoaling on the Lincolnshire coast. Offshore the overfalls such as Inner Dowsing also modify the wave period and therefore wave heights. The presence of sandbanks can cause the offshore waves passing over the overfalls to slowly rise and even break. In addition to the bathymetry, interaction with the strong currents influences the incoming waves, and they are the most likely reason for the short wave periods and heights observed. The greatest concentration of waves passing the buoy location are wind generated, with a short period of 3 – 6 seconds (see Figure 3.2). There a number of longer period waves, associated with stormier periods and with swell waves with a peak period of over 20 seconds recorded.

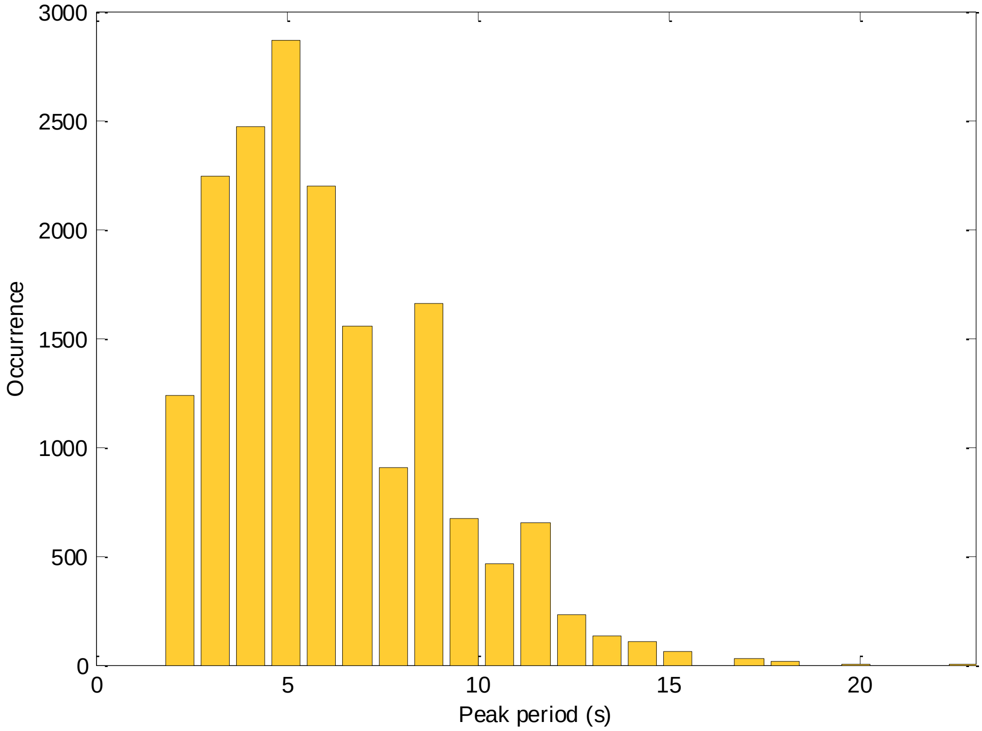

Figure 3.2: Peak period (July 2012 – July 2013)

Figures 3.3 and 3.4 show the joint distribution of significant wave height (Hm0 (m)) and wave period for July 2012 – June 2013. Figure 3.3 shows the peak wave period (Tp) against wave height and Figure 3.4 displays the mean wave period (Tz) against wave height. The peak period data presents several wave distributions of; waves generated locally by wind with short periods, the stormier, rougher conditions, where waves achieve moderate wave periods, and finally the lower wave heights but of longer period of over 15 seconds of the swell waves coming through the North Sea.

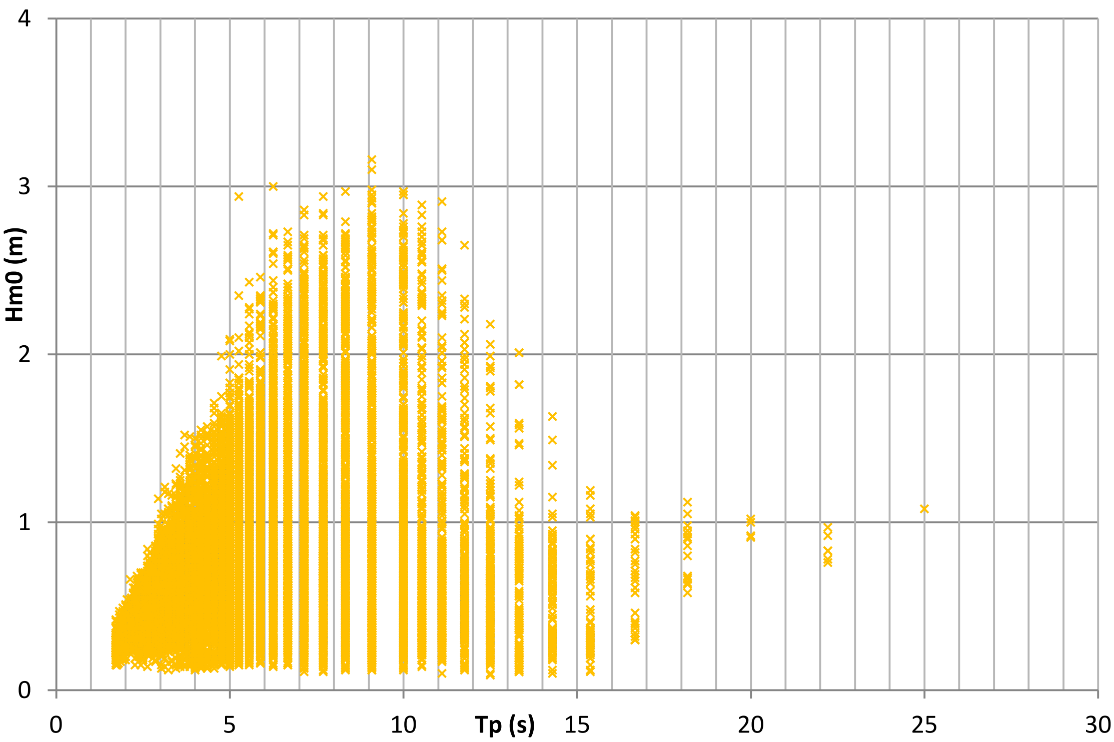

Figure 3.3: Significant wave height Hm0 (m) vs peak wave period Tp (s) (July 2012 – June 2013)

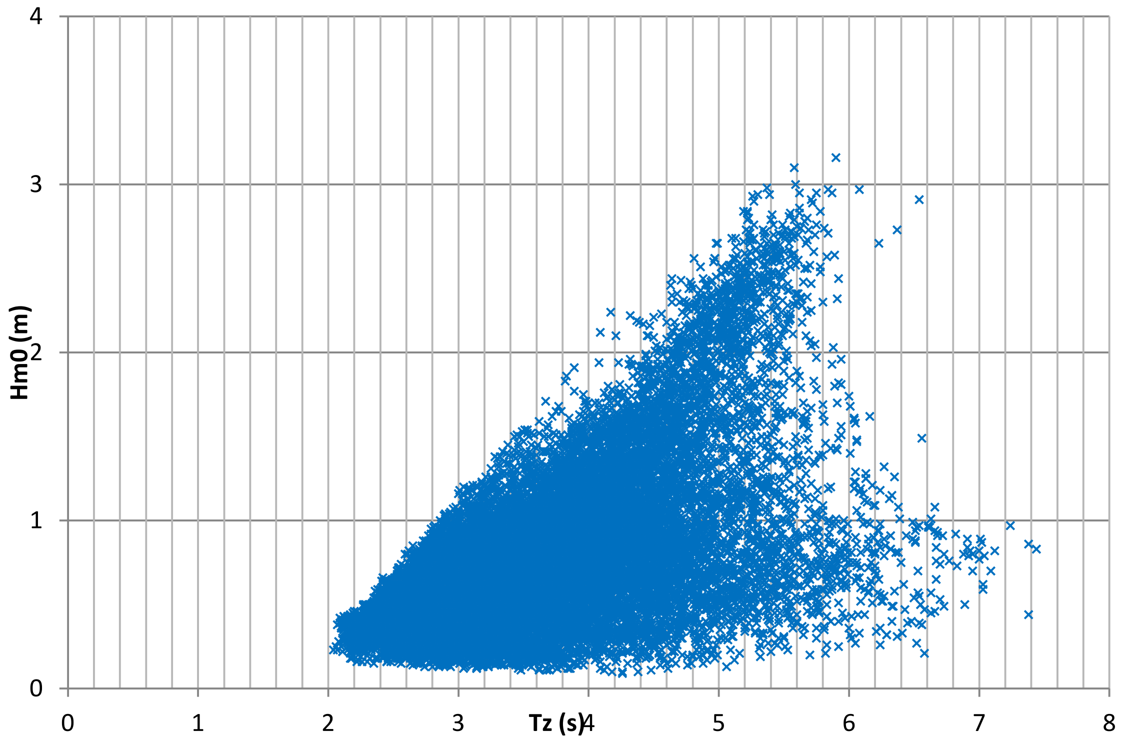

Figure 3.4: Significant wave height Hm0 (m) vs mean wave period Tz (s) (July 2012 – June 2013)

3.4 Wave direction

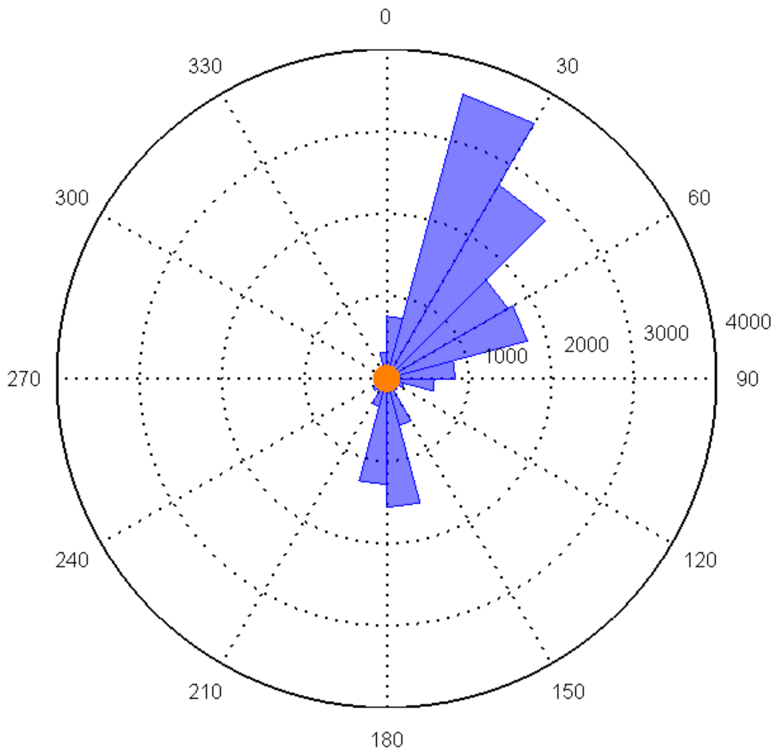

Figure 3.5: Wave direction (°) plot at LWB2 for 2012-13

There is a distinct and consistently prominent north-east wave direction recorded at the buoy. This record is consistent with the nearshore AWACs deployed at Chapel Point and Skegness in 2006 to 2009. There is a small number of waves approaching from the south and travelling along the east facing coastline. These waves may be associated with residual tidal flows.

4 Storm calendar

4.1 Storm events

The occurrence of high wave events is tracked through a storm calendar. The calendar allows seasonal characteristics and annual storminess to be monitored. In the first year of deployment there was one storm event where waves exceeded 3 m. This instance is detailed in Table 4.1, with statistics of the highest wave of the event shown. The wave was recorded on the morning of the 27th October 2012. Weather conditions were that of heavy showers on the east coast turning to sleet and snowfall in places. The coast experienced gusty winds with several low pressure troughs and winds travelling through the North Sea (UKHO1). At North Well a 2.58 m wave, the highest of 2012-13, was also logged by the wave buoy at this time.

Date	Hm0 (m)	Mdir (°)	Tp (s)	Tz (s)
05:30 27/10/2013	3.16	25	9.09	5.90

Table 4.1: Storm event statistics on 27th October, 2013

Figure 4.1 (overleaf) shows the occurrences when wave heights have crossed thresholds of 2.75 (blue) and 3 m (red). The storm calendar serves as a record of storminess and the frequency of storm waves at the buoy location each year.

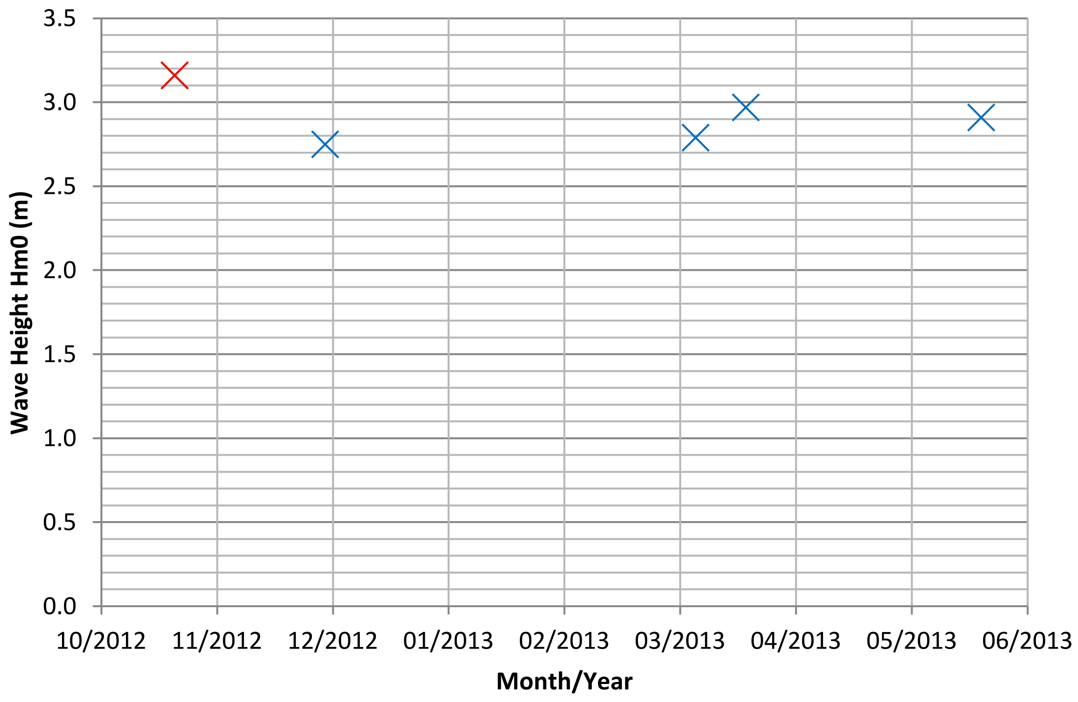

Figure 4.1: Storm events exceeding 2.75 m (blue) and 3 m (red) (1st July 2012 – 30th June 2013)

5 Summary

The east facing Lincolnshire coast has a gentle beach slope and a number of offshore overfalls and banks. The Chapel Point DWR is situated just west of the Inner Dowsing Overfall and banks. This bathymetry, in addition to strong currents interacting with incoming waves, results in the wave characteristics recorded over the year by the buoy. Waves are consistent throughout the year and come from a north-easterly direction. These waves have a significant fetch and the buoy has logged wave periods of over 20 seconds. The tidal regime is generally that of a southerly flow on the flood tide and northerly on the ebb. There is an erosion trend along most of the Lincolnshire coast south of Mablethorpe with sediment suspected to move south or offshore to the banks.

Wave heights are largest during the winter period, particularly February and March. The highest wave of the year was recorded in October. This occurred in the morning of the 27th October, and was the only storm event where waves were logged exceeding 3 m.

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Gardline 2013, Chapel Point and Northwell Waverider Service Report, Report for the Environment Agency. GELSR3. Gardline Environmental Oceanography Department, Great Yarmouth, July 2013.

Haskoning, 2005. Scoping study for wave and water level monitoring and analysis: Lincolnshire. Specialist Team Consultancy: Geomorphology, Project number: STCG/2004/89. Report for the Environment Agency, Anglian Region. Royal Haskoning Uk Ltd, Peterborough, March 2005.

UKHO1. www.metoffice.gov.uk/climate/uk/2012/october.html [Accessed 1st October, 2013].

List of abbreviations

ACM – Anglian Coastal Monitoring

AWAC – Acoustic Wave And Current meter

CD – Chart Datum

Cefas – Centre for Environment, Fisheries and Aquacultural Science

Defra – Department of Environment Food and Rural Affairs

DWR – Directional Waverider

EA – Environment Agency

GPS – Global Positioning System

ODN – Ordnance Datum Newlyn

QA – Quality Assurance

RNLI – Royal National Lifeboat Institution

SMG – Shoreline Monitoring Group

Glossary

Bathymetry – The measured shape and depth contours of the sea bed.

Fetch – The uninterrupted distance over water which the wind acts to produce waves.

Intertidal – The coastal area between the Lowest Astronomical Tide (LAT) and Highest Astronomical Tide (HAT).

Maximum wave height (Hmax) – Statistic of the maximum wave height recorded in a period of time.

Mean direction (Mdir) – The average or main direction from which waves have come, measured over a period of time.

Mean Sea Level - Generally refers to 'still water level' above a fixed datum (excluding wave influences), averaged over a period of time such that periodic changes in level (e.g. due to the tides) are smoothed out.

Mean wave period (Tz) – Also referred to as the zero crossing period, a description of the average wave period over a duration of time.

Neap Tide - The tide that occurs when the tide-generating forces of the sun and moon are positioned at right angles to each other. The neap tide has the lowest tidal range.

Ordnance Datum (OD) – A specific datum or plane to which depths or heights are referred to.

Peak period (Tp) – Also called dominant wave period and Tpeak, it is the wave period (time for two successive waves to pass a point) associated with the largest wave energy, obtained from the spectral "peak frequency" i.e. the frequency band that has the largest energy.

Sea (waves) – Waves generated at a storm system, under a height of 2 m.

Significant wave height (Hm0) – Statistical calculation taken from the spectral analysis to describe the average wave height.

Spring tide - The tide that occurs when the tide-generating forces of the sun and moon are in alignment and results in a higher than average tidal range.

Storm surge - A storm surge is the additional sea level accounted for by a storm. The rise in water level causes a propagating bulge of water on the open coast caused by the action of wind stress and atmospheric pressure on the sea surface.

Storm waves – Wind driven waves associated with a storm system, these waves have a higher frequency than swell waves and therefore can cause multiply frequency peaks in the spectra. In a multiple peaked spectrum the mean wave period (Tz) may not be a measure of the frequency where the peak energy occurs.

Swell (waves) – Waves that have travelled out of the area they were generated. Swell waves characteristically have a flatter shape and longer period. In spectral analysis swell waves have a low frequency, with a peak period (Tp) where energy decays in the frequencies either side.

Wave climate – The average condition of the waves at a location over a period of time, represented by wave statistics such as height, period and direction.

Wave spectra – The wave energy in a band of frequencies, describing the total energy transmitted by a wave-field.

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