Sea State Report

Felixstowe wave buoy, 2012-2013

RP036/E/2013

December 2013

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Shoreline Monitoring Group
Environment Agency
Kingfisher House, Goldhay Way
Orton Goldhay, Peterborough PE2 5ZR
Email: enquiries@environment-agency.gov.uk
www.environment-agency.gov.uk

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Anglian Coastal Monitoring programme

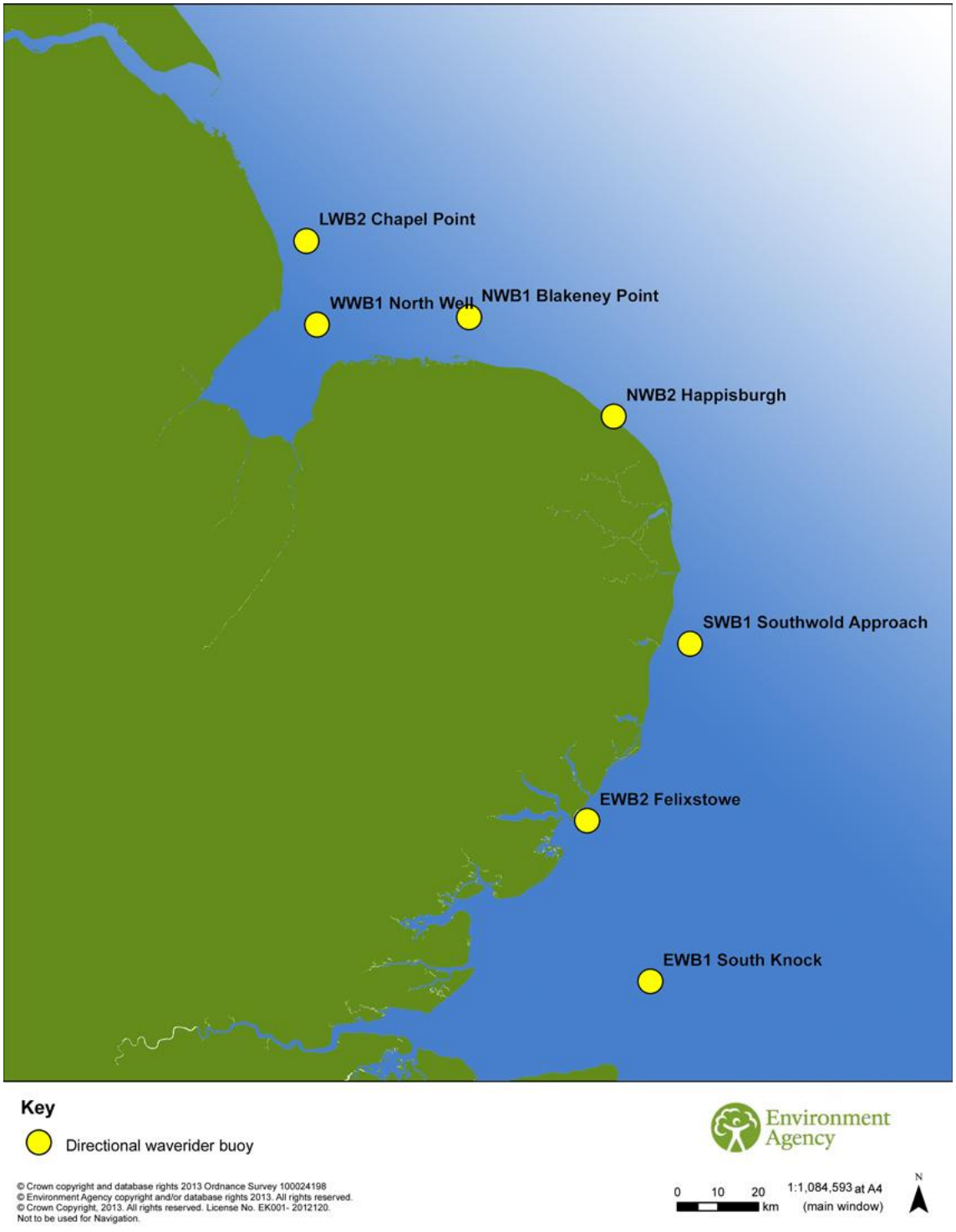

Figure 1.1: Map of instrument locations

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1 Anglian Coastal Monitoring

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, 2011). 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].

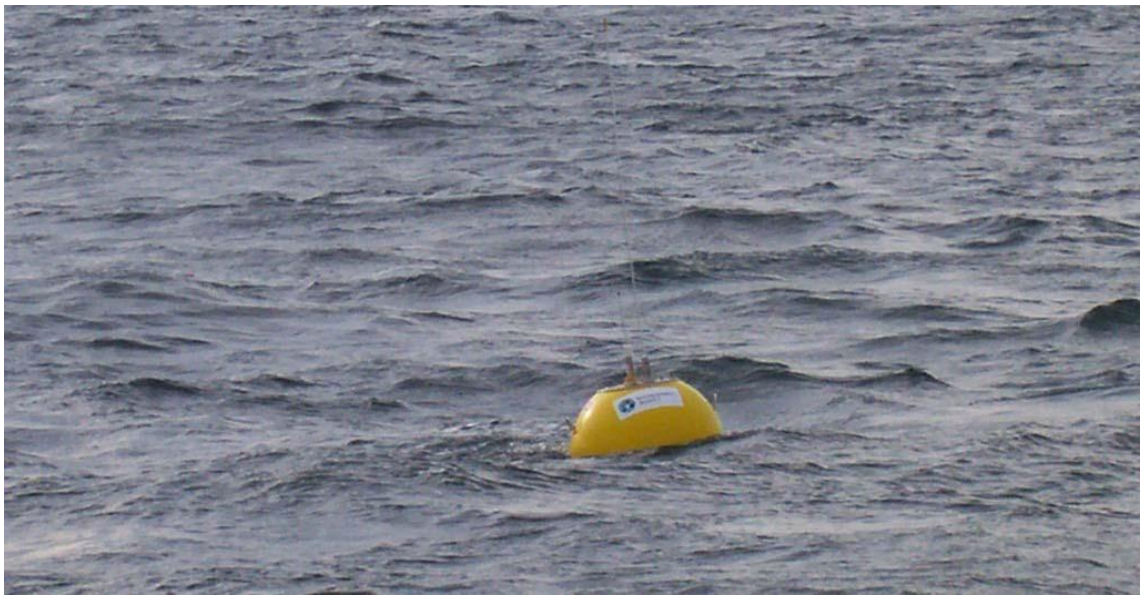

Photo 1: Deployed directional Waverider buoy (Photo: Environment Agency)

[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/

2 Felixstowe 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 Felixstowe Waverider buoy (EWB2) is located just off the Felixstowe coast at 51° 56.15' N, 001° 23.31' E. It is situated just north of the Harwich Deep Water Channel that flows out from where the River Orwell and River Stour converge at Harwich. The buoy is moored in 7.5 mCD of water off the Wadgate and Felixstowe Ledge. On the southern side of the channel and 2 km south-east of the buoy is Cork Sand. Around 14 km east is the long Shipwash bank that runs from north to south, further still is the Inner Gabbard banks. To the north-east and further up the coast off Hollesley Bay is Bawdsey Bank. The Harwich Channel is considered a natural drift break with no significant feed of sediment from Felixstowe to Harwich or Suffolk to Essex (H R Wallingford, 2002).

On land the frontage has a number of coastal towns and ports; these are generally fronted with shingle and sandy beaches and concrete and London Clay coastal defences. To the south there are large areas of environmentally designated coastal mudflats and saltmarsh, such as Hamford Water. The Essex frontage is generally low lying, and a sediment supply of fine grains and low wave energy has allowed steady saltmarsh development. To the north (at Bawdsey) and to the south (at Walton-on-the-Naze) there are soft cliffs consisting of the London Clay that underlies this coastline.

The on land coastline is monitored through LiDAR, aerial photography and topographic surveys of the following monitoring cells; Orford Ness, Hollesley Bay, Bawdsey, Felixstowe Ferry, Felixstowe, Harwich and Walton-on-the-Naze.

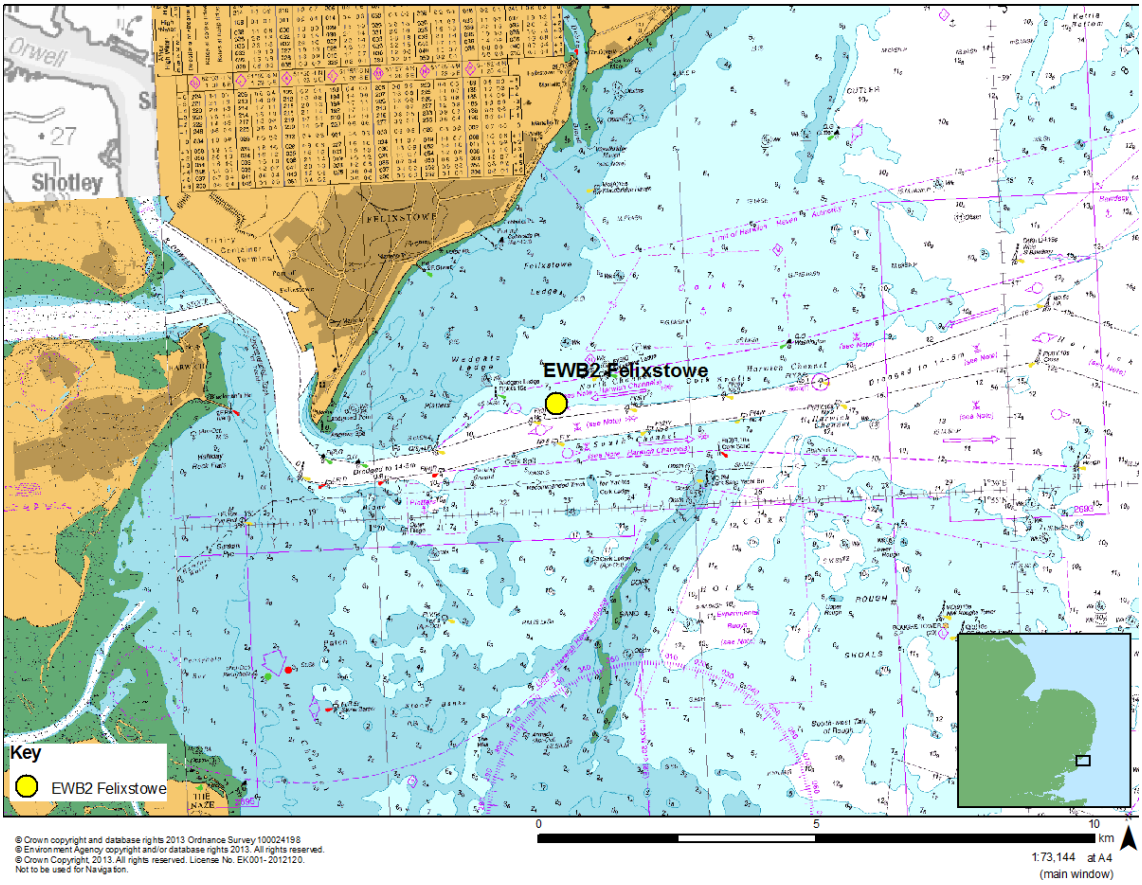

Figure 2.1: Felixstowe DWR (EWB2) location map

2.3 Instrument deployment

The Felixstowe DWR buoy is a new deployment as part of Phase VIII of the Anglian Coastal Monitoring. It was first deployed on the 13th May 2012 and recovered on the 5th July 2013 (Gardline 2013). However data are only available up till the start of June 2013, so this report will report on the period of 1st June 2012 to 31st May 2013. Over this annual period the data return of the logged records was 100 %.

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 June 2012 to May 2013.

	Significant wave height Hm0 (m)	Peak period Tp (s)
Max:	2.67	18.18
Min:	0.11	1.72
Mean:	0.62	4.81

Table 3–1: Min, Max and Mean statistics (June 2012 – May 2013)

	2012							2013				
	Jun	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**
Hm0 (m)	0.68	0.43	0.48	0.50	0.62	0.57	0.62	0.65	0.75	0.98	0.68	0.54
Tp (s)	4.57	4.00	4.04	4.33	4.84	4.73	5.15	4.75	5.48	6.44	4.69	4.78
Tz (s)	3.35	3.05	3.02	3.16	3.44	3.33	3.49	3.49	3.74	4.23	3.41	3.35
Mdir (°)†	82	83	86	84	83	82	83	80	83	83	83	82
T (°C)	2.74	2.54	2.53	2.57	2.72	2.66	2.70	2.78	2.86	3.11	2.75	2.67

† Mdir is a monthly modal statistic

Table 3–2: Monthly mean statistics for the reporting period (June 2012 – May 2013)

3.2 Significant wave height

The annual mean wave height (Hm0) at Felixstowe is 0.62 m. The nearshore acoustic wave and current meter (AWAC) deployed at Felixstowe, in a water depth of 4 mCD on the Felixstowe Ledge, from 2006 to 2009, logged an overall mean wave height of 0.49 m. Over the 2012 -13 period the buoys off the Lincolnshire coast and North Norfolk coast recorded an annual mean wave height of 0.8 m.

The highest waves are recorded in the winter months with the highest monthly mean values occurring during February and March. The individual highest waves and storm incidents are described in Section 4.1.

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 two occurrences of waves exceeding 2.5 m, both occurring in March. While throughout the year there have been 20 instances of waves exceeding 1.75 m.

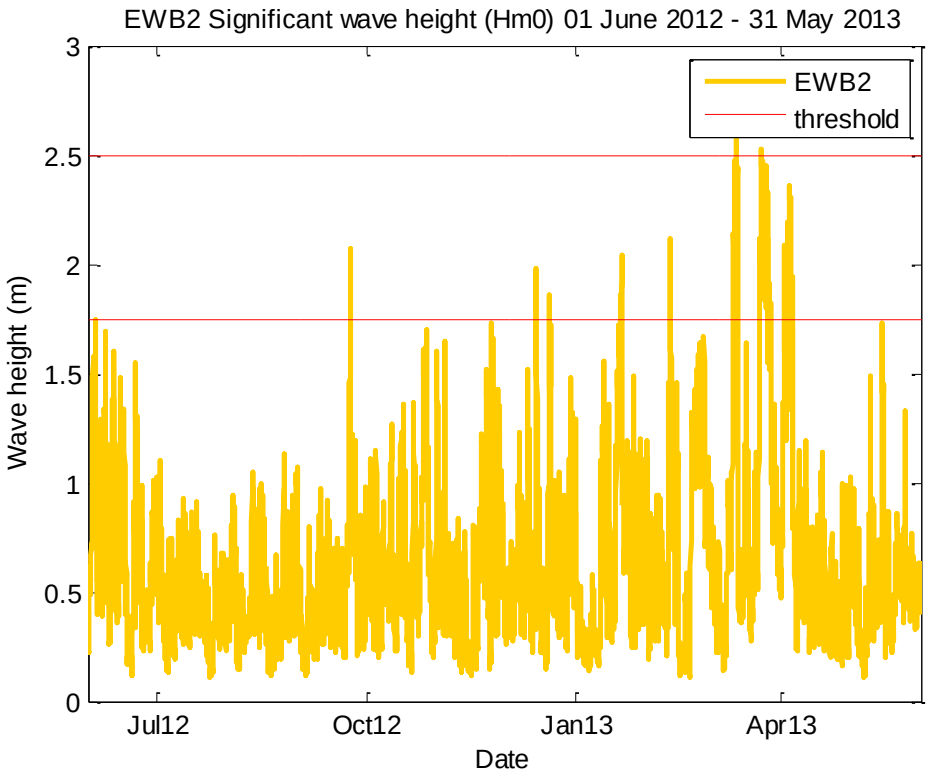

Figure 3.1: Significant wave height (Hm0) (June 2012 – May 2013)

	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
2012	51.15	40.01	7.57	1.24	0.03
2013	39.96	38.25	13.41	5.37	3.02

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 gradual sloping shallow nearshore is dominated by short period, local wind-driven waves. The greatest concentration of waves passing the buoy location have a period of 3 – 4 seconds (see Figure 3.2). In Figure 3.2 the occurrences of waves with periods of over 5 seconds can be seen to taper off, and there are few storm generated or swell waves recorded. The mean peak period is slightly higher during the winter months, with the maximum wave period recorded in the year being 18.18 s, but the average across all months in the year being 4.81 s.

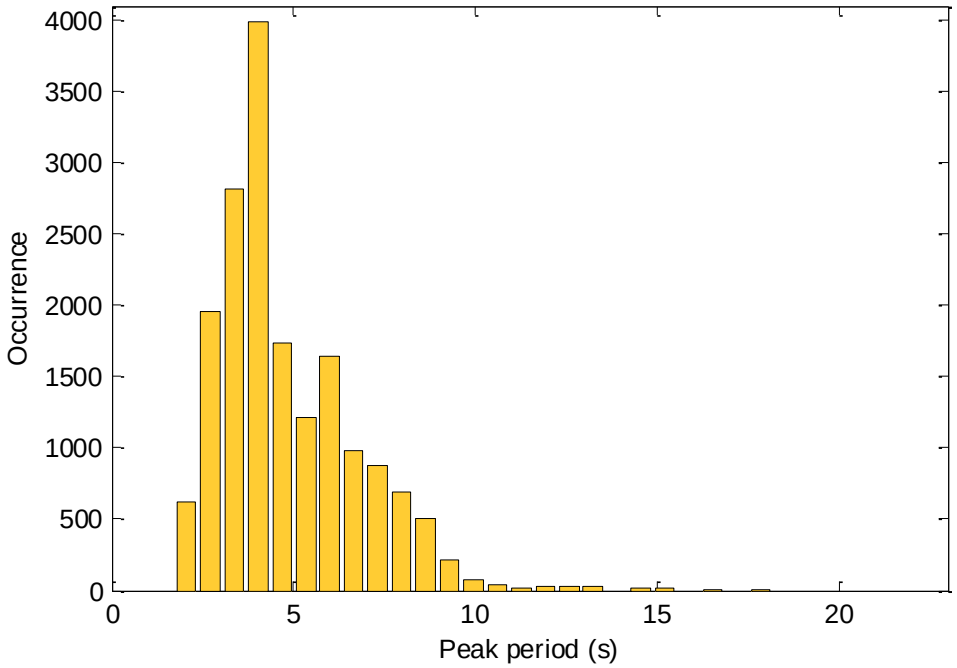

Figure 3.2: Peak period (Tp) (June 2012 – May 2013)

Figures 3.3 and 3.4 show the joint distribution of significant wave height (Hm0 (m)) and wave period for June 2012 – May 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.

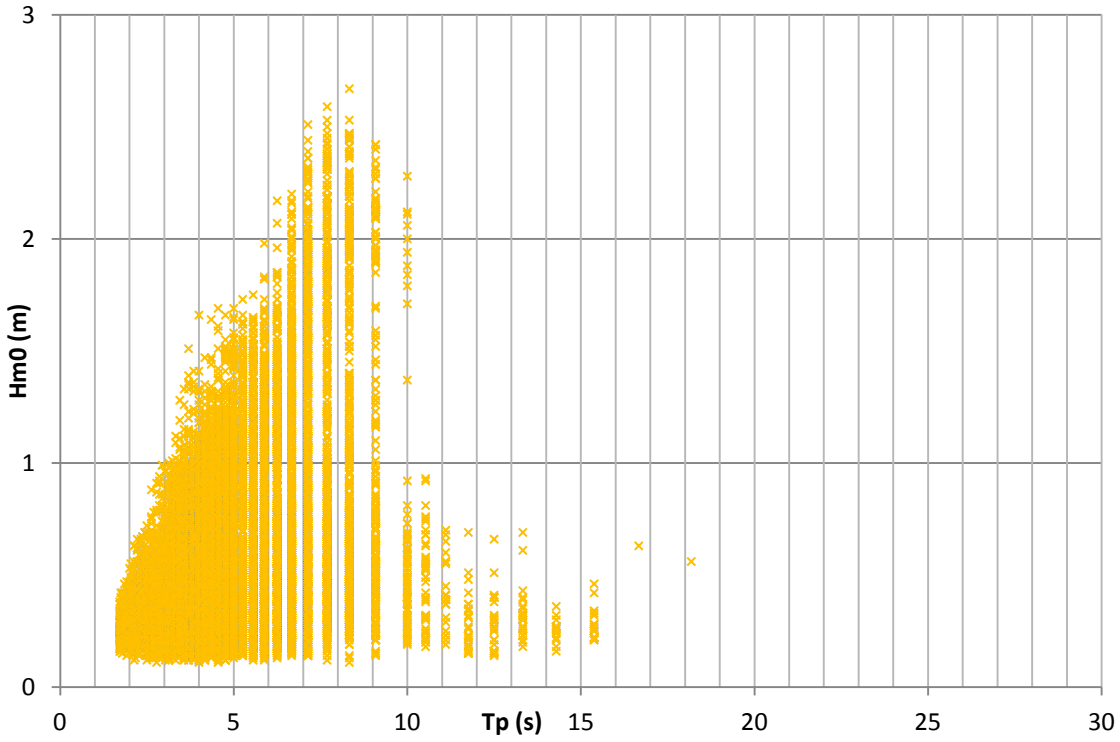

Figure 3.3: Significant wave height Hm0 (m) vs Peak wave period Tp (s) (June 2012 – May 2013)

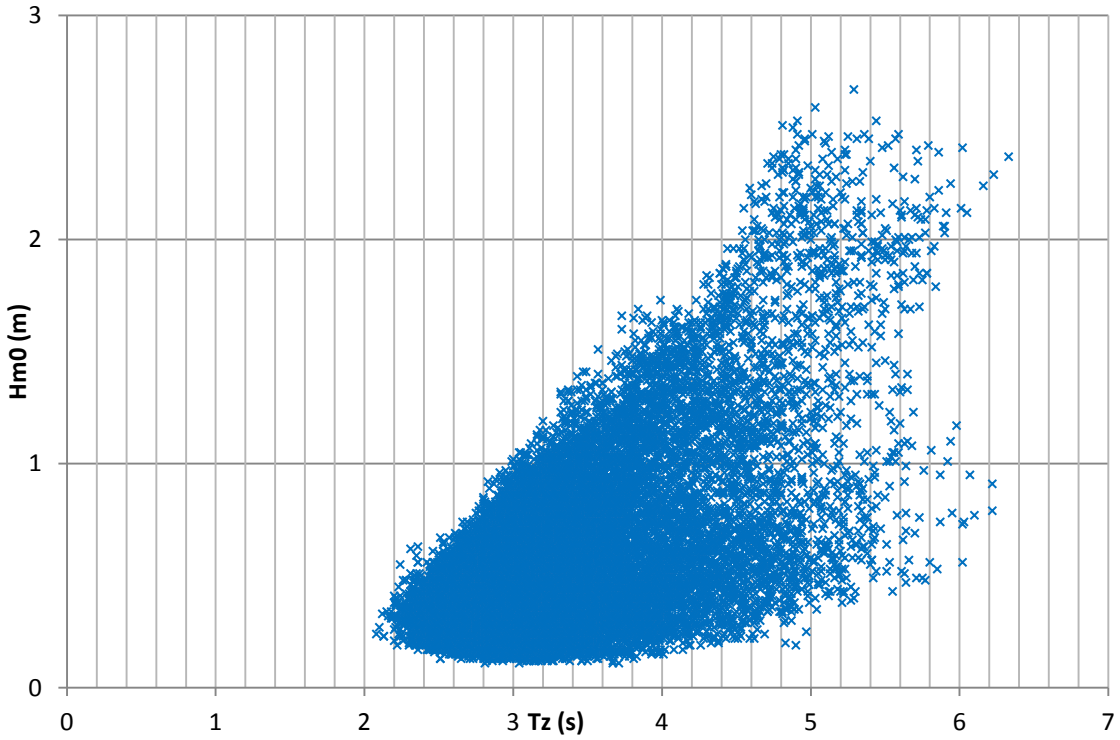

Figure 3.4: Significant wave height Hm0 (m) vs Mean wave period Tz (s) (June 2012 – May 2013)

3.4 Wave direction

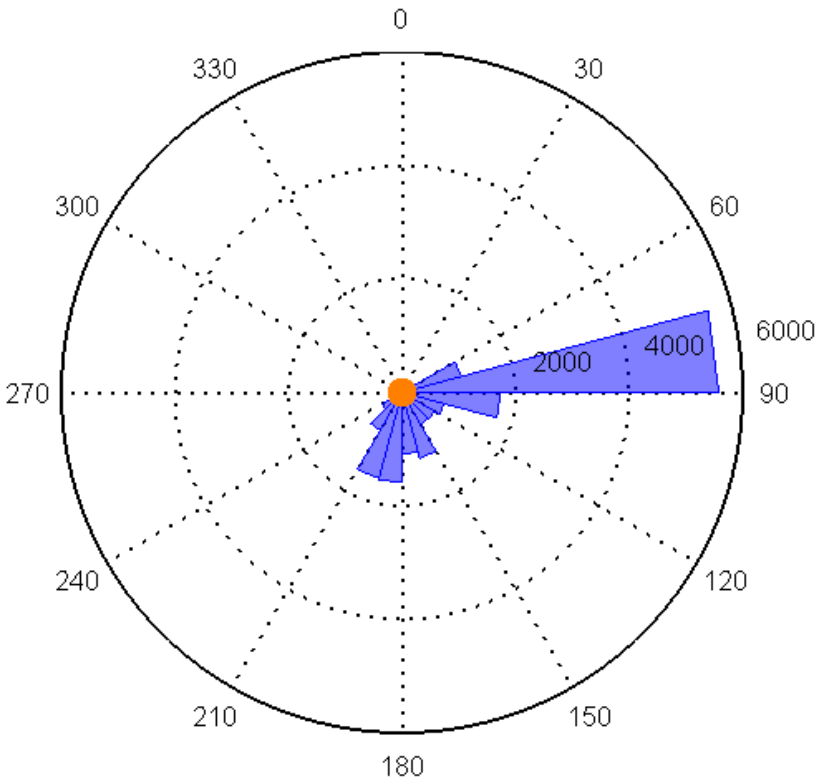

Figure 3.5: Wave direction (°) plot at EWB2 for 2012 - 13

The prominent wave direction at the buoy is from the east. This is consistent with the nearshore AWAC deployed from 2006 - 2009. The AWAC instrument was located

closer to the coast and is therefore more sheltered; it recorded fewer waves in the 80 - 90° sector but more in the 90 - 100° east south-east range. The land mass offers protection from northerly waves, making the southerly waves more significant, especially south westerly storm waves. This is shown by the offshore wave buoy at South Knock (EWB1) that is located far away enough from the land to be exposed to north easterly waves.

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 were two storm events where waves exceeded 2.5 m. Throughout the year, 20 storm waves exceeded a 1.75 m threshold. The stormiest month was March, with the highest wave of the year being logged at 23:30 on the 11th. Table 4.1 provides summary statistics for this event. Weather conditions were that of very cold air, and snowfall in the country with strong to gale-force north-easterly winds in the south-east of the UK.

Date	Hm0 (m)	Mdir (°)	Tp (s)	Tz (s)
23:30 11/03/2013	2.67	83	8.33	5.29

Table 4–1: Storm event statistics on 11th March, 2013

Figure 4.1 (overleaf) shows the occurrences when wave heights have crossed the preliminary threshold of 1.75 m. The storm calendar serves as a record of storminess and the frequency of storm waves at the buoy location each year.

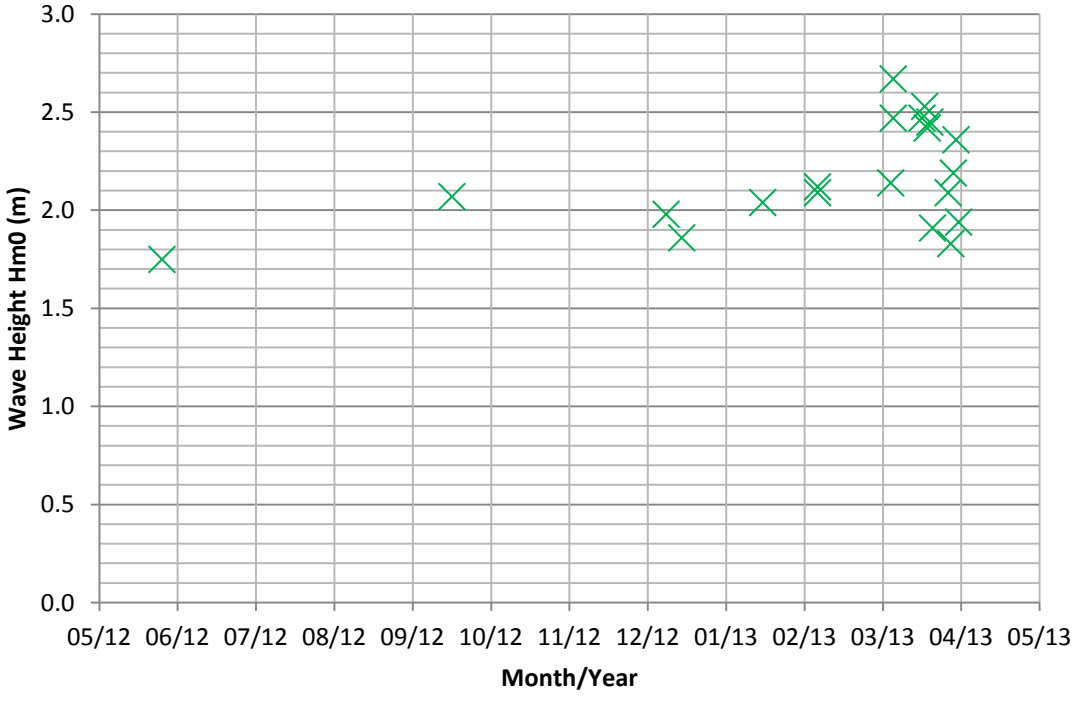

Figure 4.1: Storm events exceeding 1.75 m (1st June 2012 – 31st May 2013)

5 Summary

The Suffolk and Essex coast is sheltered from many long fetch north easterly waves by the UK land mass. The highest waves, and those that cross the threshold levels, are from an east north-east direction. However this is the overall prominent wave direction, with majority of waves coming from this direction in the year throughout most conditions.

The orientation of the coast, a relatively gentle beach slope and the presence of nearshore banks such as the Shipwash and Bawdsey Bank, result in relatively short wave periods and low wave heights. The mean wave height for the reported year is 0.6 m. There were a number of instances of waves over 1.75 m, especially in March and the first few days of April. The highest wave of the year occurred on the 11th March 2013, during a period of strong north-easterly winds.

References

Environment Agency, 2011. Sea State Report, Essex, Year 2 Oct 2007 – Sept 2008. RP021/E/2011, Shoreline Monitoring Group, Environment Agency, Peterborough, January 2011.

Gardline 2013, Felixstowe Waverider Service Report, Report for the Environment Agency. GELSR3. Gardline Environmental Oceanography Department, Great Yarmouth, June 2013.

H R Wallingford, 2002. Southern North Sea Sediment Transport Study (SNSSTS), 2002. Phase 2, Sediment Transport Report. Appendix 11 Report on Southern North Sea Longshore sediment transport. Report EX4526, Report for Great Yarmouth Borough Council. HR Wallingford.

UKHO1. http://www.metoffice.gov.uk/climate/uk/summaries/2013/march [Accessed 18th December, 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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