Hydrodynamic monitoring

Anglian Coastal Monitoring

May 2016
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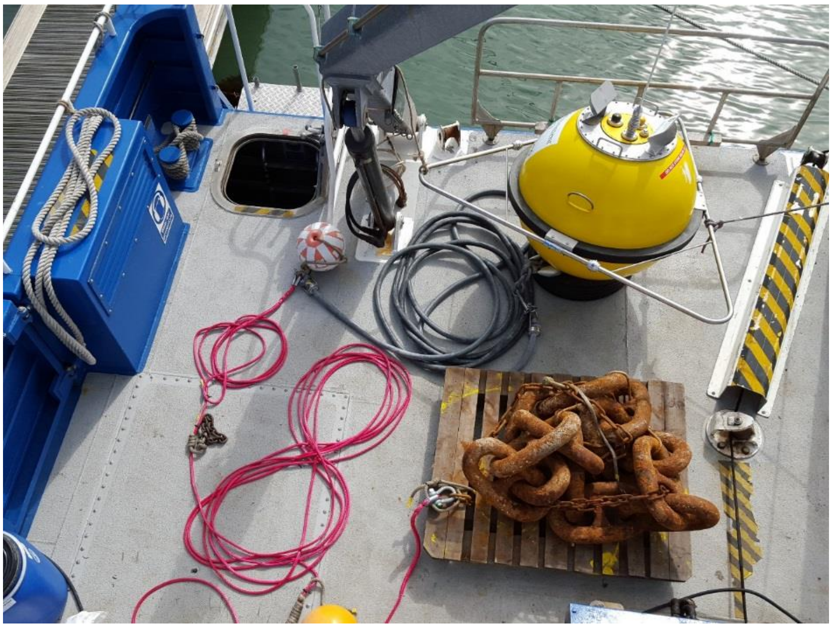
This document describes the network of wave buoys deployed off the east coast and the data collected by the Anglian Coastal Monitoring project.

The Survey

How we collect hydrodynamic data

The Environment Agency uses Datawell Mark III Directional Waverider buoys (DWRs) to measure waves approaching the east coast. The buoys are deployed in 10 – 30 m of water a few kilometres offshore and provide real-time information on waves along our coast.

We use a shallow water mooring, with the buoys moored to the seabed by an elasticised line allowing them to float freely without tension on the surface and record water movements. They measure the orbital motion 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, located at EA buildings or RNLI Life Boat stations. Wave spectra and GPS positions are also sent via an Iridium satellite service allowing us to monitor and log these data streams. The real-time wave data are publically available on the Defra WaveNet website (http://wavenet.cefas.co.uk/Map/).



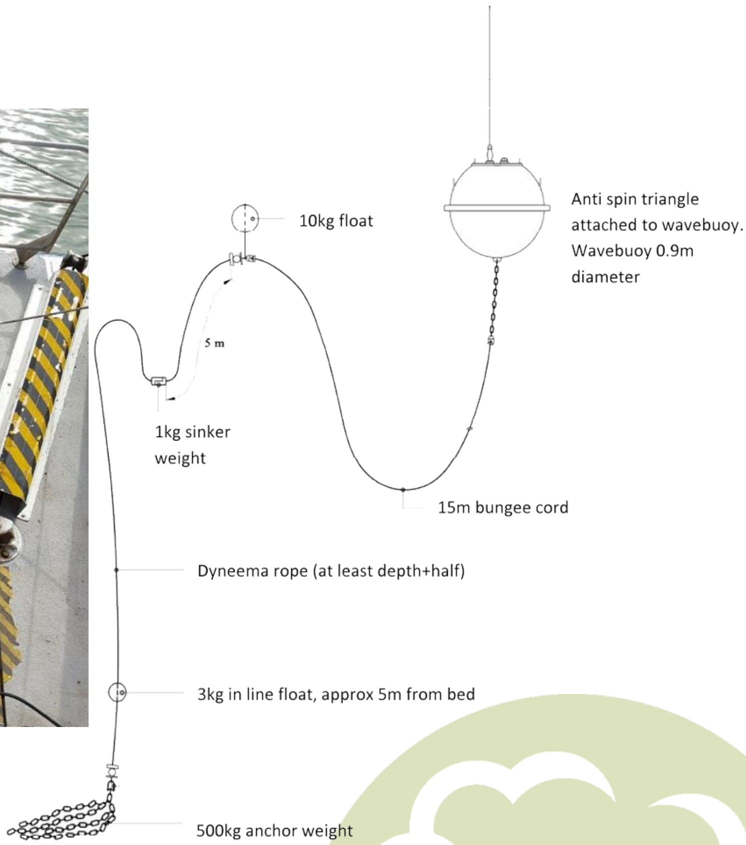


Figure 1: Wavebuoy and mooring on deck ready for deployment (left). Diagram of a wave buoy shallow water mooring (right) (image: Gardline Environmental)

Figure 2: Chapel Point DWR deployed off the Lincolnshire coast.

There are six wavebuoys deployed off the east coast as part of the project. The first being deployed in September 2006, with Happisburgh and Chapel Point deployments following 6 years later. A further 4 years later in April 2016 we deployed a new wavebuoy at Lowestoft.

Site ID	Position	Depth	Deployment	Data (find on map)
Chapel Point (LWB2)	53°14.7609'N 00°26.8930'E	10 m	2012 – present	http://wavenet.cefas.co.uk/Map?ZoomTo=0.4470%2C53.2448
North Well (WWB1)	53° 03.295'N 00° 28.538' E	31 m	2006 - present	http://wavenet.cefas.co.uk/Map?ZoomTo=0.4755%2C53.0582
Blakeney Overfalls (NWB1)	53° 03.4495'N 001°06.2132'E	18 m	2006 - present	http://wavenet.cefas.co.uk/Map?ZoomTo=1.1035%2C53.0575
Happisburgh (NWB2)	53° 49.5066'N 001°32.9724'E	9 m	2012 - present	http://wavenet.cefas.co.uk/Map?ZoomTo=1.5495%2C52.8263
Lowestoft (SWB2)	52° 28.551'N, 001° 49.027' E	20 m	April 2016 - present	http://wavenet.cefas.co.uk/Map?ZoomTo=1.8172%2C52.4758
Felixstowe (EWB2)	51°56.292'N 001°23.627'E	8.5 m	2012 - present	http://wavenet.cefas.co.uk/Map?ZoomTo=1.3940%2C51.9383

Buoy measurements

On board microprocessors process wave energy spectra and store definitive wave parameters and spectral estimates. High capacity logger stores 'raw' data of heights (displacements) along 3 directional axes collected each second (1.28 Hz). Three accelerometers measure the oscillatory forces in 3D to output vertical, north-south and east – west accelerations and which are scaled to wave height. Every 30 minutes the DWR logs processed spectral data of 2048 samples measured over 27 minutes. 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 replaced annually, when the on-board logger data are recovered. The recovered buoys are then tested and the compass checked, every 5 years the buoy is fully re-calibrated by the manufacturer.

Wave parameters

Key wave parameters in the annual time series are used to describe the sea conditions at the instrument location. This is 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. Below details and defines the outputted wave parameters.

Significant wave height (Hm0) – A statistical calculation from the spectral analysis to describe the mean wave height. This is very similar to Hs, which is the mean wave height of the highest one third of waves in a record.

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

Wave direction (Mdir) – The prominent wave direction (also known as Pdir), or main wave direction at the peak frequency from which waves have come, measured over a period of time. In sea state reporting a modal statistic showing the most frequent wave direction is used.

Directional spread (Sprd) – The directional spread of waves at the peak frequency.

Peak period (Tp) - Also known as the dominant wave period or Tpeak, it describes the frequency with the highest energy. This is the wave period (time for two successive waves to pass a point) associated with the largest waves, obtained from the spectral 'peak frequency'.

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

Temperature (°C). A measurement of sea surface temperature (SST).

Wave spectra

The buoy records the energy of waves in a band of frequencies, the spectra describes the total energy observed and its spread across a wave field.

Specification

Surveys are conducted according to the latest version of the Environment Agency's *National Standard Contract and Specification For Surveying Services, Standard Technical Specificat*ions.

Analysis

Wavebuoy data are used for flood forecasting and modelling, design statistics for management activities and to inform operational works. They also provide information on sea conditions, storm frequency and severity, and feed into research and studies such as sediment mobility. The wave parameters and spectral data are presented through plots such as wave roses. Parameters are also considered together in joint probabilities analysis. Plotting parameters such as wave period (Tp) and wave height (Hs) together is of value in determining heights that can be expected for various distributions of waves, and applied to defence overtopping studies and in determining beach response to wave loading.

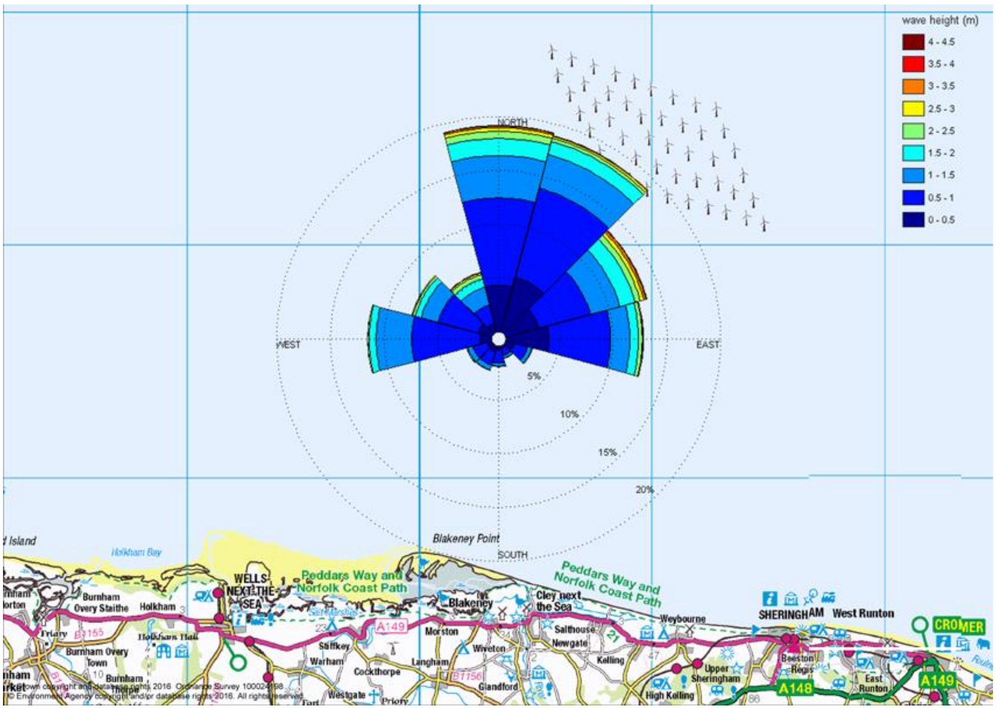


Figure 3: Wave rose plot for Blakeney Overfalls DWR off the Norfolk coast, for waves recorded from October 2011 to August 2015.

Storm analysis and frequency are a long term check on climate change. The occurrence of high wave events is tracked through a storm calendar. The calendar allows seasonal characteristics and annual storminess to be monitored. From analysis of extreme values we can determine how wave characteristics in calm waters, may change during storm conditions.

Data use considerations

Some of the wavebuoys have now been deployed for ten years, however these deployment periods are not sufficient to draw long term conclusions regarding sea and climate trends. The main purpose of the buoys is to enable an assessment of the current sea state influencing the Anglian coast, seasonal variation and comparison with previous years to give a picture of the wave climate and storminess. *Return periods* are an indicator of the frequency a wave can be expected from a certain height and direction sector. This is useful to know over a long period of time but requires a long dataset for accurate calculations. The datasets are continuous but do contain data gaps, following collisions, buoys being cut adrift, servicing or instrument failure.

Recorded wave characteristics at each buoy location are influenced by the bathymetry of the area. In addition waves are modified by their interaction with currents and tidal conditions. Currents regulate sediment transport and the development of sand banks in the area. Interaction between the tidal currents and sandbanks creates areas of turbidity, known as overfalls, in turn impacting incoming waves. A buoy located landwards or inside a bank will be relatively sheltered with lower energy waves expected. Wave height is a function of depth, a greater depth of water, such as the High Water of a Spring tide, or when there is a positive surge present, enables greater wave heights. Increased water depth will also allow waves to travel closer to the coast before bed friction will affect the surface wave, therefore changing breaking points.

The coastline and landmass also impact waves in terms of defining the fetch and open expanse of water that a wave can develop and travel over. Land masses can create sheltered sections of coast. However the orientation and exposure of a coastline can also make it more vulnerable to coastal erosion. Headlands and hardpoints and the shape of a bay will modify and refract waves focussing energy on certain sections of a coast.

It should also be remembered that waves will continue to be modified after passing a buoy site. Characteristics such as direction of travel may vary across an area of sea, and on their approach to the coast after being recorded by the wavebuoy especially if there is a change in wind conditions.