



UK Coastal Monitoring and Forecasting (UKCMF) Service: Service Definition

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1.0 DOCUMENT PURPOSE

Purpose: *This document defines the United Kingdom Coastal Monitoring and Forecasting (UKCMF) Service in its entirety and gives a descriptive summary of each of its component parts. The intention is to help ensure that partners and customers understand who is responsible for each part of the Service, and what the Service is able to deliver.*

Objective: *To ensure that the UKCMF has a distinctive identity to prevent conflict, confusion and overlap. This can be achieved through a shared understanding of the extent of the Service, how its component parts interact, how it delivers the outputs, and who its customers are.*

Clarification: *The Service Definition is intended to provide a detailed position statement, describing how the products and services of the partnering organisations are delivered. It is not intended to duplicate the contents of the UKCMF Strategy which sets out the vision, aims and strategic direction of the Service. It is also not intended to duplicate the detailed technical description held within the existing UKCMF contract documents.*

Service Definition Audience: *UKCMF partners and stakeholders*

2.0 INTRODUCTION TO UKCMF SERVICE

There are over 2.1 million properties at risk from river and coastal flooding across England and Wales (figures from Northern Ireland and Scotland unavailable) with 1.3 million of those located in coastal areas¹. The frequency of severe and extreme events is predicted to increase in the future due to the onset of global climate change. This will impact in particular those people living and working along the coast. The number of people affected and the value of property often makes coastal flooding more devastating and more costly than other sources of flooding.

It is neither technically feasible nor economically affordable to prevent all properties from flooding. This is why non-structural solutions such as flood forecasting and warning are an essential part of managing the consequences of floods. The UKCMF Service provides such a solution and ensures that those at risk of coastal flooding can be warned in good time to save lives and reduce the impact of flooding on homes, businesses, infrastructure and communities.

2.1 Core Service

The main function of the UKCMF Service is to deliver an **operational forecasting service** consisting of a suite of products to assist any operational authority that requires forecasting information. It is the primary coastal forecasting tool for the Environment Agency (EA), the Scottish Environmental Protection Agency (SEPA) and the Department of Agriculture and Rural Development Northern Ireland (DARDNI).

The UKCMF Service is a partnership of public bodies with expertise in specialist areas, who work together to provide a comprehensive UK-wide coastal monitoring, forecasting and consultancy service. The Service delivers the primary alert service for coastal flood risk around the UK to assist the emergency response community in planning and preparing for flood events. It provides operational users with early alerts needed to protect coastal communities from the threat of flooding, as well as supporting decisions to operate flood defences such as the Thames Barrier.

The Department of the Environment, Food and Rural Affairs (Defra), the Scottish Government and the Northern Ireland Assembly provide funding to the Environment Agency to manage the Service. The Environment Agency works alongside five key partners/suppliers to provide the Service;

- Flood Forecasting Centre (FFC) – operates the 24-hour UKCMF Tidal Alerts Forecast and Outlook Service on behalf of the Environment Agency, SEPA and DARDNI.
- The Met Office – hosts and runs the operational storm surge model and delivers the forecast output on behalf of the Environment Agency, SEPA and DARDNI. It also shares information and knowledge with all parties as part of its national overview remit.
- National Oceanography Centre (NOC) (formerly known as the Proudman Oceanographic Laboratory) - maintains and develops the national tide gauge network and the storm surge models, carries out related research and delivers tidal predictions for all coastal sites.
- Centre for Environment, Fisheries and Aquaculture Science (Cefas) - manages the WaveNet system on behalf of the Environment Agency, SEPA and DARDNI.

¹ <http://www.environment-agency.gov.uk>

- British Oceanographic Data Centre (BODC) – provides a national facility for all marine science data, and archives and disseminates the tide gauge data.

2.2 Strategy and Vision

In November 2009, a 10-year strategy and delivery plan for UKCMF² was published. The Strategy sets out the Vision for the UKCMF Service:

- *We will provide coastal forecasts to support the current and future needs of those who provide coastal warnings.*
- *We will secure the future of the monitoring networks that underpin those forecasts and provide evidence for a managed response to the potential impacts of rising sea levels and climate change on communities.*

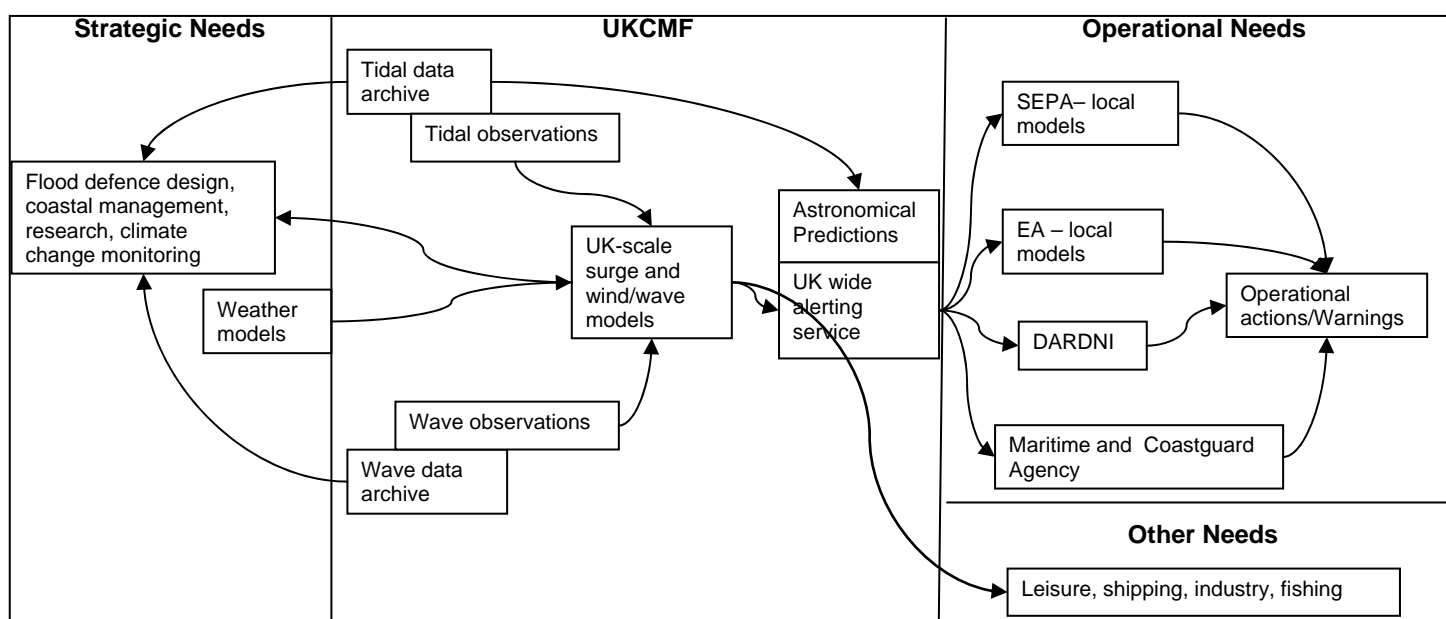
To achieve the Vision outlined above, the Strategy identifies five key aims. The first two address the core service with the third focusing on the wider benefits of the Service:

1. work together to provide a comprehensive coastal flood risk forecast service for the UK;
2. develop the skills and capacity in strategic coastal forecasting and monitoring networks to meet the needs of those using them both now and in the future;
3. provide the long-term evidence to develop forecast models to meet the environmental challenge of climate change and inform coastal flood risk management;

The final two aims cover the wider availability of knowledge, data and information to partners and customers across the UK and Europe.

4. work with European partners to share knowledge and forecast data;
5. encourage UKCMF data and information to be widely used by allowing it to be openly available.

Diagram of UKCMF Service



² <http://publications.environment-agency.gov.uk/pdf/GEHO1009BRFE-e-e.pdf>

2.3 Value of the Service

The storm surge of 1953, which caused disastrous flooding around the North Sea, along the east coast of England and the Thames Estuary, led to pioneering developments in numerical modelling and the beginning of the Storm Tide Warning Service. Since 1953 there have been other examples of devastating storm surges in the UK and beyond, for example:

- 1953: 1,835 deaths in the Netherlands, 307 people killed along the east coast of England and 28 deaths in Belgium. This was the worst natural disaster to affect Britain during the 20th Century
- 1978: people were evacuated in Kings Lynn, Norfolk and Herne Bay, Kent.
- 1990: 600m breach in sea defences in Towyn, North Wales, 5,600 people affected
- 2005: family of five died in Scotland,
- 2005: Hurricane Katrina in New Orleans claimed 1,300 lives and caused an estimated \$80 billion of damage.
- 2007: 7,500 people were evacuated in Great Yarmouth, Norfolk
- 2010: 53 people killed and €2.5 billion of damage during the Xynthia Storm off the west coast of France

Within the UK, assets worth an estimated £132 billion are at risk from flooding by the sea. These values are likely to grow significantly as the climate changes, with sea levels predicted to rise and storms possibly becoming more frequent and intense. The UK government spends around £325 million a year maintaining sea defences and on-shore protection along 4,300km of coastline³.

Protecting coastal communities relies on the ability to predict the impact of extreme storms on sea defences and to quantify and manage associated flood risks. UKCMF costs £2.3 million net a year to operate and is estimated to deliver benefits in the order of £23m per year in avoided flood damage⁴.

2.4 Summary of Products and Customers

UKCMF provides a suite of products to assist operational authorities that require coastal monitoring and forecasting information, such as the Environment Agency, SEPA and DARDNI. This includes:

- Forecasts of coastal water levels, wave conditions and flood risk
- Real time observations of wave and tide data
- Astronomical predications of tide levels (tide tables)
- Archived data and information
- Advice to support users of the Service

UKCMF does not provide forecasting information directly to the public.

Tidal alerts, together with forecast wave and tidal surge data, are disseminated to flood forecasting authorities and are used to activate local warning systems. Warning the public is not within the remit of the UKCMF Service, however, information and support are provided to partner organisations throughout storm surge events.

³ Modeling Water from Clouds to Coast - 9 September 2009

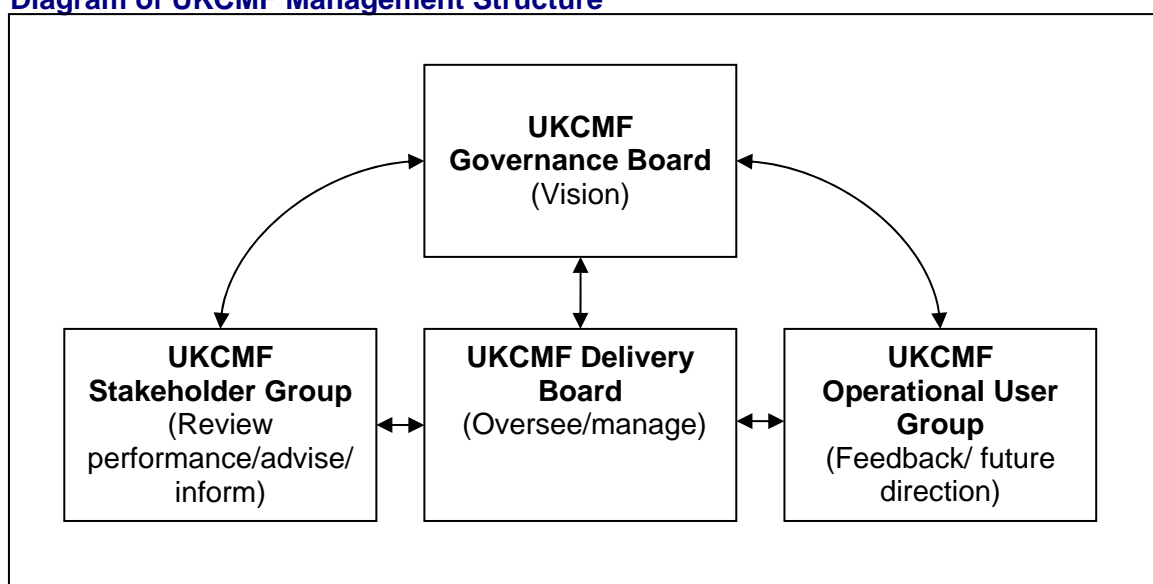
⁴ Environment Agency - UKCMF Position Statement 2010

UKCMF also provides advanced warnings of abnormally low tide levels that might prove hazardous to shipping. The details of this service are contained in the Annual Notices to Mariners⁵, published by the Hydrographic Office. This service is supported by the Maritime and Coastguard Agency.

UKCMF has a wide and varied customer base including other national flood warning authorities (such the Dutch organisation Rijkswaterstaat), forecasters, coastal authorities, academics, government bodies, local authorities, port authorities, emergency responders, commercial bodies, scientific organisations and the general public (who receive warnings via the EA and SEPA). In addition, knowledge, funding, data, research and forecasting techniques are also shared with European Partners.

3.0 MANAGEMENT OF THE UKCMF SERVICE

Diagram of UKCMF Management Structure



The diagram above describes the UKCMF management structure. The UKCMF Governance Board takes policy and direction from Government to shape and communicate the vision and aspirations of the Service. The Environment Agency, as the organisation managing the Service, chairs the Board, which is made up of executive managers from each of the key partnering organisations.

Three groups support the Governance Board. The Stakeholder Group, which aims to review the performance of the Service, is supported by the wider coastal risk management community. The Delivery Board, which sits within the Environment Agency, provides an overseeing and management role in relation to the delivery of service activities. The Operational User Group represents the operational needs for the Service.

3.1 Roles and Responsibilities

- The **Governance Board** is made up of senior members of the governmental departments and operating organisations and is chaired by the Environment Agency. The Board owns the UKCMF Vision, Strategy and its future direction,

⁵ <http://www.ukho.gov.uk/productsandservices/martimesafety/pages/nmpublic.aspx>

and ensures that the Service is compliant with government policy and legislation. The Board is supported by the following three groups:

- The **Stakeholder Group** is drawn from users, managers and providers of the Service and is chaired by the Environment Agency. It advises the Governance and Delivery boards on user interests and requirements and provides feedback on the operational running of the Service.
- The **Delivery Board** is drawn from users and providers of the Service and is chaired by the Environment Agency's Technical Manager for Detection and Forecasting. It oversees the delivery of the Service and identifies and oversees Service developments in accordance with the UKCMF Strategy.
- The **Operational User Group** is drawn from those who use, manage and monitor the Service on a day-to-day basis and is chaired by the Environment Agency's National Flood Risk Systems (NFRS) Manager. It provides feedback on the operation and future direction of the Service.

4.0 SERVICE DELIVERY

4.1 Service Overview

The coastal forecasting service is based on a suite of models for forecasting storm tides and a network of tide and wave gauges which provide real time data used to validate and support the forecasts. Information and alerts based on these forecasts are provided to the Environment Agency, SEPA and DARDNI to allow an appropriate response to any potential flooding situation.

4.2 Key Components of the UKCMF Service

4.2.1 Storm Surge Model Outputs

The operational storm surge model is run in real-time at the Met Office, producing forecasts up to 2 days ahead using wind and pressure forecasts from the Met Office. It comprises the CS3X domain model (which covers the continental shelf at 12km resolution) and nested finer resolution models, for example, the Bristol Channel Model at 4 km resolution and the Severn River Model at 1.3 km resolution.

NOC validate the surge model by regularly checking its performance against observations from tide gauges. This allows systematic errors to be identified and investigated so that model performance can be progressively improved.

The grib format data stream comprises the following;

- Storm surge residual height (m)
- Storm surge residual current speed (m/s)
- Storm surge residual current direction (degrees)
- Tide water level (M)
- Tide current speed (m/s)
- Tide current direction (degrees)

Primary Use

1) Operational Forecasting

The storm surge model output data, together with wind and wave observations, are used operationally by the Environment Agency and SEPA as input to flood forecasting models. The Flood Forecasting Centre uses storm surge model output to generate coastal forecasts. Information is also used locally for shipping control by Port Authorities and by other commercial users.

2) Planning and design purposes

Coastal engineers use the data for the justification, planning and design of coastal defence schemes, and for other coastal construction projects.

3) Scientific use

Storm surge residuals are used in climate change studies to calibrate the global climate models upon which government adaptation policy is based. The information is also used in modelling, identifying extremes, and in other oceanographic research.

Data Dissemination

- Data are available four times per day (every 6 hours).
- Data files are sent from the Met Office to the Environment Agency via its data distribution system. Files are automatically transferred into NFFS.
- Files are transferred to SEPA via the internet for automatic upload into FEWSS.
- Data are sent to other recipients such as Isle of Man and other European users via Met Office protocols.

Access to data and point of contact

- Access to the full data set is by arrangement with the Environment Agency and is available under license.
- Some data can be obtained free of charge from the NOC website (www.noc.ac.uk).

4.2.2 Storm Surge Ensemble

Storm surge predictions, like all forecasts, have a level of uncertainty. Small errors in weather predictions can produce significantly different storm surge forecasts. Storm surge ensemble is a prediction technique that is used to assess and quantify the level of uncertainty in surge forecasts.

Ensemble storm surge forecasts, emanating from a version of the CS3X model, are issued in a grib format file based on 24 different weather scenarios. The system forecasts 54 hours ahead.

The data stream comprises the following;

- Surge residual height (m) for all 24 ensemble members

Primary Use

Surge ensembles give forecasters greater confidence and result in more informed decision-making.

Data Dissemination

- Data are available twice per day
- Data files are sent from the Met Office to the Environment Agency via its data distribution system. Files are automatically transferred into NFFS.

Access to data and point of contact

- Access to the full data set is by arrangement with the Environment Agency and is available under license.

4.2.3 Wind/Wave Model Outputs

Wave and wind forecasts are generated by the Met Office's Wavewatch III model. The wind and wave forecast data are supplied by the Met Office who retain the intellectual property rights on the dataset.

Wavewatch III is a numerical wave model that calculates;

- Significant wave height (M)
- Significant wave period (S)
- Significant wave direction (degrees)
- Wind-sea height (M)
- Wind-sea period (S)
- Wind-sea direction (degrees)
- Swell height (M)
- Swell period (S)
- Swell direction (degrees)
- Wave peak period (S)
- Total current speed (m/s)
- Total current direction (degrees)

Primary Use

Primarily used by operational flood forecasting teams as a feed into flood forecasting models

Data Dissemination

- Data are available four times per day
- Data files are sent from the Met Office to the Environment Agency via its data distribution system. Files are automatically transferred into NFFS.
- Files are transferred to SEPA via the internet for automatic upload into FEWSS.

Access to data and point of contact

- Access to the full data set is by arrangement with the Met Office and is available under license.

4.2.4 Tide Gauge Data

As part of the UKCMF Service, the Environment Agency owns and funds the Strategic Tide Gauge Network (TGN). This consists of 44 gauges around the UK coastline which record tidal elevations every 15 minutes (see Appendix 2). These installations have been classified as strategic gauges (formerly Class A gauges) as they directly support the UKCMF Service and provide known accuracy and stability. The majority of tide gauges are sited in the still waters of shipping ports.

As well as the strategic gauges, there are a number of other gauges installed around the UK coastline which support the primary sites. These are owned and operated by various organisations such as Associated British Ports, Port of London Authority, Falmouth Harbour Commissioners, BODC, local councils, the Maritime Councils and SEPA. The Environment Agency has over 310 tide gauges which it uses for its own coastal monitoring and forecasting purposes in areas that are not covered by the Strategic TGN.

Primary Use

1) Operational Monitoring

Tide gauge data are collected in real-time and distributed to a range of interested parties, nationally and internationally, primarily for operational purposes. The information is used by UK national and regional forecasters to verify the Storm Surge Model during events.

NOC download the data on a weekly basis for quality control and long-term archiving purposes. This process involves liaison with NOC's Tide Gauge Inspectorate (who maintain the network on behalf of the EA) to resolve anomalies in data logging and the completeness of the data record.

2) Planning and design purposes

Coastal engineers use the data for the justification, planning and design of coastal defence schemes, and for other coastal construction projects.

3) Tidal Predictions

NOC use historic records from the 44 strategic tide gauges to calculate harmonic components of astronomical tides to predict tides at each location for the coming year.

4) Assessing and Improving the Performance of Storm Surge Models

NOC routinely undertake post-event evaluation and monitor the accuracy of the Storm Surge Model forecasts by comparing the model output with observed data from the strategic gauges. This helps to maintain and improve the accuracy of forecasts and to calibrate and enhance the forecasting model.

5) Use of tide gauge data in the scientific community

BODC is responsible for the retrieval of sea level data from the tide gauge network telemetry system. Daily checks are kept on the performance of the gauges.

Data Dissemination

- 15-minute data from the 44 gauges are distributed to the Flood Forecasting Centre, the Environment Agency and SEPA for flood forecasting and warning purposes. Forecasters at the FFC monitor the tide gauges on a continuous basis and advise all operational users (via an incident report from the FFC Service Desk) if data are lost or appear erroneous.
- Information is sent to BODC where it is quality controlled and archived. This includes 15-minute data from January 1993 onwards and hourly values prior to that date. Monthly mean, surge and extreme values are also available for some or all of the period.

Access to data and point of contact

- Data are made available (free of charge) for scientific use via the BODC and NOC websites (www.bodc.ac.uk/www.noc.ac.uk). There is a three month delay from the collection date until these data are available on the web site whilst the information is quality controlled.

- Customers can also gain access to the latest (unchecked) tidal elevation data via BODC and NOC. A charge may be made for these data.

4.2.5 Wave Observations

Wave conditions around the UK are measured by Cefas which operates the strategic network of 15 wave-measurement buoys. The network, which was established in 2001, provides real-time information. The WaveNet fleet of offshore buoys are located in flood risk areas around the UK coastline and each buoy is selected to represent the offshore wave conditions for approximately 100km of coastline. They are generally situated in relatively deep water (typically 25 to 30m).

Real time wave statistics shown on the WaveNet website include;

Significant wave height (Hm0):m
Maximum wave height: m
Dominant (peak) wave period: s
Average (zero crossing) wave period: s
Dominant (peak) wave direction: degrees
Average (mean) wave direction: degrees
Wave speed: degrees
Temperature: degrees C
Depth: m
Mean water level: m
Mean wave height: m
Significant wave height: m
Wind direction: degrees
Wind gust: knots
Wind speed: knots

Data from buoys owned and maintained by other parties (such as the Met Office, the Irish Marine Institute, Shell UK, Total UK and the Environment Agency) are also made available via the WaveNet website.

Primary Use

1) Wave observations for operational purposes

The Met Office uses the wave data to increase confidence in wave predictions by validating the operational forecasting model with wave observations. Data are used by the Environment Agency for wave modelling, forecasting and warning. SEPA/DARDNI may require these data in the future.

2) Planning and design purposes

Researchers use historic wave buoy data to quantify trends and variability in wave height and directions for commercial and non-commercial use. Coastal engineers use the data for the justification of coastal defence schemes and for other coastal construction projects.

3) Scientific use

Wave data are used in climate change studies to calibrate the global climate models, upon which government adaptation policy is based, and in other oceanographic research.

Data Dissemination

Live data are transmitted by satellite from the instrument directly to the Cefas data centre for onward transmission to operational users. Here it is quality assured, stored in a consistent format and uploaded onto the WaveNet website where it is

made freely available to the public. The latency (time between the data available at the buoy and display on the website) is controlled by satellite availability.

- Wave observations are produced on a continuous basis every 30mins.
- Cefas provides the Met Office with data at 30-minute intervals and receipt of the data is automatically monitored.
- The Met Office supplies Cefas with wave model predictions which are also displayed on the WaveNet website.
- The Environment Agency receive wave observations via a secure link to the Met Office and it is automatically transferred into the NFFS. SEPA also receive these data.

Access to data and point of contact

- The Cefas WaveNet website, funded by UKCMF, provides real-time and archived wave data for the UK for non-commercial purposes:
www.cefas.co.uk/data/wavenet

4.2.6 Tidal Alert Forecasts and 5 Day Tidal Outlook Service

The Flood Forecasting Centre (FFC) operates the UKCMF Tidal Alert Forecast and Outlook Service on behalf of the Environment Agency, SEPA and DARDNI. This service is based on storm surge, wind and wave forecasts supplied by the Met Office.

- **Tidal Alert Forecast Service**

This service provides forecasts of the possibility of tidal water levels exceeding pre-defined thresholds around the coastline of the UK. For the purposes of issuing forecasts, the coastline of Scotland, Northern Ireland and the west, east and south coasts of England are sub-divided and each sub-division is associated with a reference port. Forecasts are based on surge model outputs and monitored against data from individual tide gauge sites within each sub-division. Forecasters will highlight any model underperformance.

- **Tidal Outlook Service**

This service provides guidance for 5 days ahead and indicate when significant wave or surge activity is expected and there is a likelihood of Tidal Alert Forecast thresholds being exceeded. This is used for planning purposes within the Environment Agency to give an early indication of a significant event and the possible use of other forecasting products such as Storm Surge Ensembles. The Service is also available to other participants.

- **Consultancy Service**

An 'on demand' telephone consultancy service is provided by the FFC to participating operational authorities. It provides clarification and updates on issued products including guidance on the performance of models and adjustments if modelled data shows significant variation from observations.

Primary Use

This is the primary forecast service for coastal flood risk management for the Environment Agency and SEPA. UKCMF does not issue warnings directly to the public. The Tidal Alert Forecasts, together with forecast wave and storm surge data, help activate regional/local warning systems at the appropriate times. The UKCMF continues to provide information and support to forecasting authorities during storm surge events.

In the Environment Agency, regional forecasting teams use the data, along with their own local forecasts, to provide more detailed information to the Area Flood Incident Management teams who are responsible for issuing flood warnings to the public.

Data Dissemination

- The Tidal Alert Forecasts and Consultancy Service is available 24 hours per day.
- Tidal Outlooks are issued once a day by the FFC for the coasts of Scotland, England and Wales.
- Information is transferred to forecasting staff in the Environment Agency, SEPA and DARNI who are also supported by the consultancy service.

Access to data and point of contact

- The Tidal Alert Forecast and Outlook Services are only available via the FFC to operational users of the wider UKCMF Service.

4.2.7 Astronomical Predictions

Information is collected from the UK National Tide Gauge Network and analysed by NOC to give accurate harmonic constants – the basis of all tidal predictions. Tide Tables are generated to give daily predictions of the times and heights of high and low waters at Standard Ports around the UK coast. NOC also provide a commercial tidal analysis service for other tide gauge sites.

Primary Use

Tidal predictions are provided to the Flood Forecasting Centre, the Environment Agency, SEPA and DARDNI for operational and planning purposes (as the predictions take no account of weather conditions). These organisations also receive tidal predictions for specified sites using data collected from nominated tide gauges.

When combined with the modelled storm surge residuals, the predicted astronomic tides are used as the basis for flood forecasting

Data Dissemination

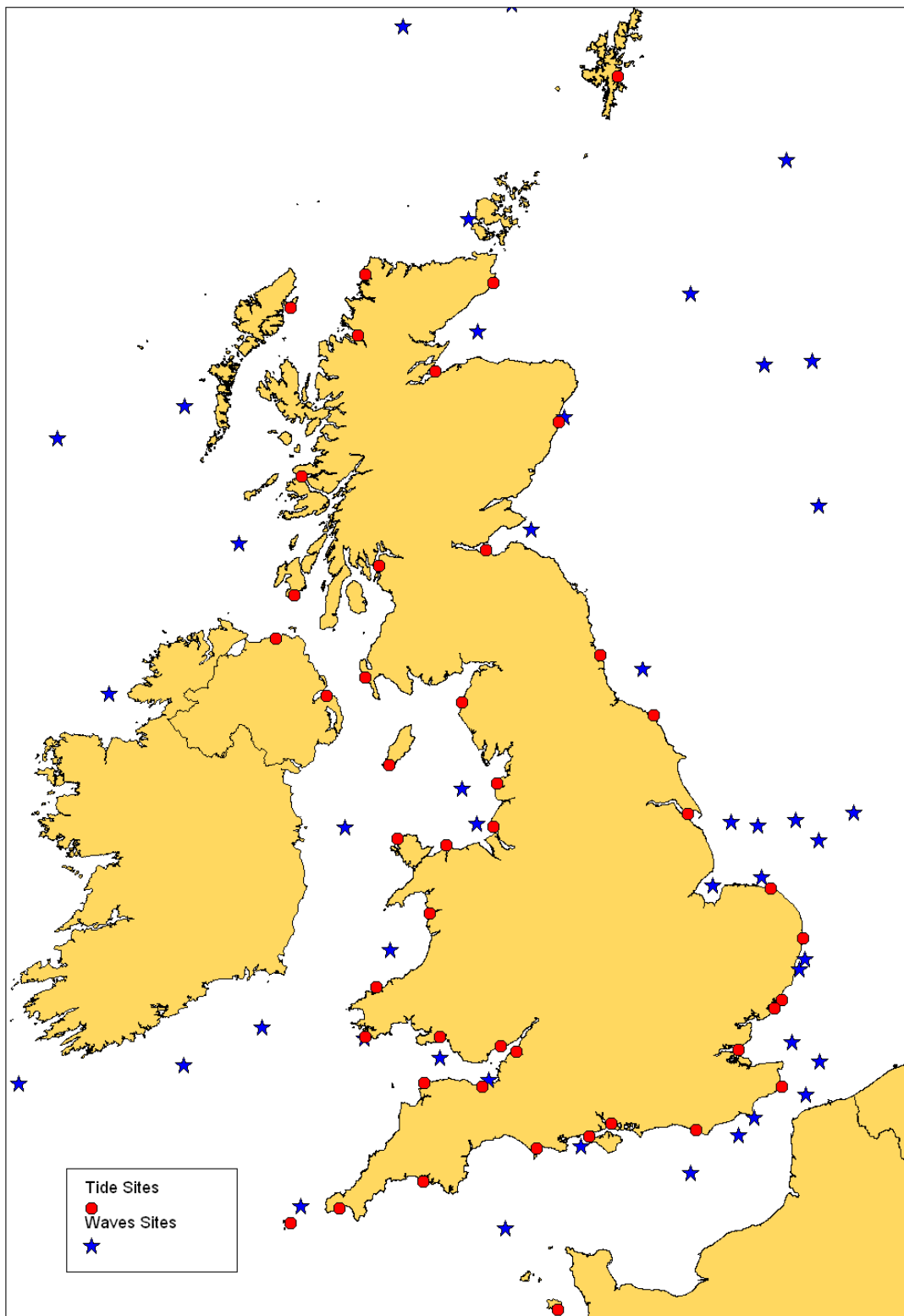
- Tide tables are published annually
- Astronomic tide predictions are also available on request

Access to data and point of contact

- Astronomic tide predictions for the current day and the next consecutive 6 days are available free of charge. Predictions and additional information for the past or future dates can be obtained at a small charge.
- Information is available via the NOC website: [**www.noc.ac.uk**](http://www.noc.ac.uk)

Appendix1: Glossary of terms

BODC	British Oceanographic Data Centre
CEFAS	Centre for Environment, Fisheries and Aquaculture
CS3X model	Continental shelf model - the current operational numerical storm surge model
DARDNI	Northern Ireland Department of Agriculture and Rural Development
DEFRA	Department for Environment, Food and Rural Affairs
EA	Environment Agency
FEWSS	Forecast Early Warning System Scotland (SEPA)
FFC	Flood Forecasting Centre
Grib format	A binary data format commonly used in meteorology to transmit bulk gridded data such as Numerical Weather Predictions
Harmonic constants	The amplitudes (height) and phase (time of occurrence) lags for each tidal curve
NFFS	National Flood Forecasting System (Environment Agency)
NOC	National Oceanography Centre (formerly Proudman Oceanographic Laboratory)
Residuals	The difference in water level between the predicted tide and that generated by meteorological effects
SEPA	Scottish Environment Protection Agency
UKCMF	United Kingdom Coastal Monitoring and Forecasting Service
Wavewatch III model	Operational numerical wave forecasting model



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