Concepts and Science for Coastal Erosion Management

CONSCIENCE

Specific Targeted Research Project

Thematic priority: Forecasting and developing innovative policies for sustainability in the medium and long term

Data Set Inventory for Field Pilot Sites

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Executive Summary

This report summarises the data sets collected at six contrasting beaches as part of the EC-funded project Concepts and Science for Coastal Erosion Management (CONSCIENCE, contract number 044122). The six field pilot sites were:

1. Dutch Coast (between Den Helder and Cadzand) (NL)
2. Hel Peninsula, Gulf of Gdansk (Poland)
3. Black Sea coastal zone of the Danube Delta (Romania)
4. Costa Brava Bays, Mediterranean coast (Spain)
5. Pevensey Bay, English Channel coast (UK)
6. Inch Beach, Kerry Atlantic coast (Ireland)

The data sets were collected with the aim of identifying appropriate Coastal State Indicators for coastal erosion management. Cross-shore beach profile, and wave data were collected at all sites (although in one case the waves were simulated using a numerical model and in another case the wave measurements were offshore and needed to be transformed inshore using a numerical model). Bathymetric data was collected a lot less frequently then inter-tidal beach profiles at all sites. All sites had some information on sediment size and most sites had good records of water level, but this was not so important in the Baltic and Black Sea sites. Routine wind measurements were made at about half the sites. The four sites where beach or shoreface nourishment took place all kept records of this. LIDAR data was collected at two sites while the historic development of the coastline was studied using historic map data at three sites. The emphasis in data collection is on the short-term response of the beaches to storms, illustrated by the universal records of waves and cross-shore intertidal beach profiles.

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1 Introduction

Concepts and Science for Coastal Erosion Management (commonly known as CONSCIENCE) is an EC-funded research project being carried out by eight organisations, coordinated by Deltares (NL). The overall objective of CONSCIENCE is to define and validate through pilot applications a methodology to support the implementation of the concepts of coastal resilience, favourable sediment status, strategic sediment reservoirs and coastal sediment cells for the European coasts (European Commission, 2004)[1]. The project is developing a series of guidelines and tools in support of this approach to ensure that it can be effectively assimilated into a sustainable management strategy for erosion. More information on the project, the participants and the deliverables can be found on the project website http://www.conscience-eu.net/.

An important part of the decision-making procedure adopted in CONSCIENCE (Marchand, 2008) is the comparison between measured values of a Coastal State Indicator (van Koningsveld et al, 2005) and a previously developed threshold value (van Koningsveld and Mulder 2004). Coastal State Indicators are "a reduced set of parameters that can simply, adequately and quantitatively describe the dynamic-state and evolutionary trends of a coastal system" (van Koningsveld et al, 2005). CONSCIENCE has six pilot sites (Section 1.1) each of which has used one or more coastal state indicators. The quantification of the relevant physical parameters has required data to be acquired or collected.

This report is an inventory of data used by the project partners at their field sites. For further information on the data, please contact the pilot site leaders (Section 1.1). Further information about the use of coastal state indicators in CONSCIENCE and the data needed to produce them can be found in:

- Coastal processes and coastal state indicators. CONSCIENCE Deliverable D9, 2008.
- Assessment of data needs for coastal state indicators. CONSCIENCE Deliverable D10, 2009.

The results from this report have informed the development of CONSCIENCE deliverable D15 Guidelines on Monitoring. These deliverables are available from the project website.

1.1 Pilot Sites

The six pilot sites used in CONSCIENCE are:

1. Dutch Coast (between Den Helder and Cadzand) (NL)
2. Hel Peninsula, Gulf of Gdansk (Poland)
3. Black Sea coastal zone of the Danube Delta (Romania)
4. Costa Brava Bays, Mediterranean coast (Spain)
5. Pevensey Bay, English Channel coast (UK)
6. Inch Beach, Kerry Atlantic coast (Ireland)

The locations of the pilot sites used in CONSCIENCE are shown in Figure 1, while descriptions of the sites and the problems to be addressed there can be found on the

[1] These concepts were originally derived by the EUROSION project: www.eurosion.org

web-site (http://www.conscience-eu.net/). Contact details for the pilot site leaders are given in Table 1.

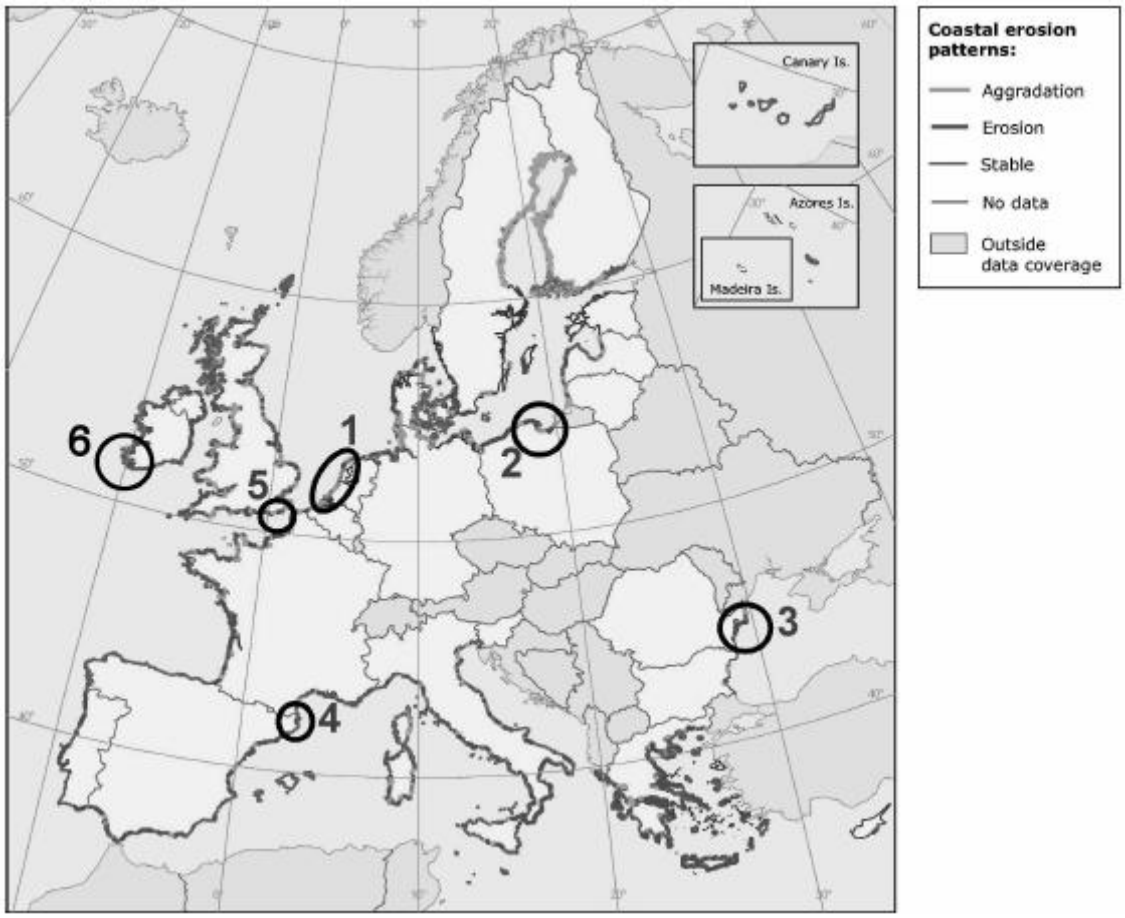

Figure 1 Pilot sites

Table 1 Contact details of the pilot site leaders

Pilot Site	**Leader**	**Email address**
Dutch Coast	Jan Mulder	Jan.Mulder@deltares.nl
Hel Peninsula	Wojciech Sulisz	sulisz@ibwpan.gda.pl
Black Sea coastal zone	Adrian Stanica	astanica@geoecomar.ro
Costa Brava Bays	Jose Jiménez	Jose.Jimenez@upc.edu
Pevensey Bay, UK	James Sutherland	J.Sutherland@hrwallingford.co.uk
Inch Beach	Jeremy Gault	J.Gault@ucc.ie

2 Data Set Inventory – Holland coast

2.1 Bathymetry

Since 1963 annual *profile measurement* have been carried out along the entire Dutch North Sea coast (echo sounding). These so called JARKUS transects are contained in the JARKUS dataset and cover the topography and bathymetry of the near shore zone. The JARKUS dataset is also gridded to a 20 x 20 m fixed map format (in Dutch the so called Kaartbladen). Additional to these yearly measurements, several nourishments are monitored more frequently (echo soundings of the surrounding area).

Less frequently (from 1926 to 2006 with varying intervals, for most areas a frequency of 5 years applies) the deeper part of the Dutch Coastal system is included in the echo sounding. Also included are the area of the Wadden Sea and the (former) estuaries in the Zeeuwsche Delta (Southern part of the Netherlands). This data (in Dutch the so called Vaklodingen) are also gridded to a 20 x 20 m fixed map format.

Beach line data were gathered on an annual basis from 1943 to 1963 (afterwards the JARKUS measurements started from which beach lines can be derived). The beach line data contains MLW, MHW and dune foot measurement at roughly 1 km alongshore resolution.

At five positions along the Dutch coast video monitoring technique (Argus) is available. The first Argus station has been operational since 1999. In contrast with the annual measurement, this video monitoring technique supplies continuous information on the bathymetry. This leads to more insight in the dominant processes (processes that determine the morphological development).

2.2 Hydrodynamics

Over more than 25 years, data concerning off shore and nearshore boundary conditions (consisting of tide, setup, wind and waves) is gathered. The National Measurement Network Water (in Dutch Landelijk Meetnet Water) provides continuously information on water levels and significant wave heights from a large number of stations along the coast. Also four offshore locations in the North Sea are included in the monitoring network: K13-alpha 1, Stroommeetpaal IJmond, Stroommeetpaal Maasmond and Lichteiland Goeree 1.

Hydraulic boundary conditions for testing the various sea defenses are issued by the Ministry of Transport, Public Works and Water management every 5 years.

2.3 Nourishments

A record of all nourishments carried out in the Dutch coastal zone is available containing information on location, type (beach nourishment, shoreface nourishment, dune enforcement), volume etc. In addition a record of dredging activities is available.

Most of the above mentioned data can be retrieved freely via internet.

3 Data Set Inventory – Hel Peninsula

Available measurements for the Polish Pilot Site at the Hel Peninsula.

3.1 Sediment

Sieve tests were conducted for sediment samples collected near Wladyslawow and Chalupy for the year 1985.

3.2 Bathymetry data 2004-2008

There are 73 profiles of sea bed available. The profiles were measured from the vicinity of the shoreline to the water depth of about 15 m on average. The profiles are in 500 m spacing and cover 36 km of the shoreline and were measured perpendicular to the shore. The length of the profiles varies from 800 m to 1500 m.

Other available data were collected in 1995 for the short parts of the shoreline at Kuznica and Jastarnia. Cross-shore profiles were measured also in 1985 near Kuznica, Wladyslawowo (1996), Chalupy (1996), Kuznica (1997).

3.3 Shoreline evolution 2002-2008

The data are available for years 2002, 2003, 2004, 2005 and 2008. The position of the shoreline was measured at least every 500 m and covers 36 km of the Hel Peninsula shore.

3.4 Artificial nourishment

The data is provided for every year of the period 1998-2007. The volumes are provided for two regions 0-10 km distance from Wladyslawowo harbour and 10-23 km from the harbour.

3.5 Winds

The measurements of wind velocities are available for the following sites and periods:

- Leba (30 km from Wladyslawowo, 1961-1977),
- Hel village (1952-1990),
- Kuznica (1.07-30.10.1985),
- Hel Peninsula 0-12.3km wind velocities (23.04-20.09, 1996).

3.6 Waves

The measurements were conducted in the vicinity of the Hel village 800 m offshore. The directional waverider buoy was deployed at a water depth of 20 m. The data cover the period between 3.11.2008 and 5.05.2009. Available data are records of free-surface elevation measured at a frequency of 1.28 Hz for 20 minutes.

Also the Baltic longterm forecast is available for the period 1958–2001. The WAM4 model was used. Parameters available are: significant wave height, mean wave direction, mean wave period, wave component period in spectrum peak, swell height, mean swell direction, mean wind wave direction.

4 Data Set Inventory – Danube Delta

For the Danube Delta pilot site the following measurements have been made:

4.1 Beach profiles

Morphological beach profiles (from the inland limit of the dune zone – to the water depth of 1.5m along the entire shoreline):

- 1984 – 2000 – annual field measurements (generally August) with classical topographic methods (theodolites, topographic gauge). Measurements made in the 4 main sectors of the coastal cell (Sulina, Canalul cu Sonda, Casla Vadanei, Sf. Gheorghe).
- 1994 – 1999 – seasonal field measurements on a pilot site with transverse profiles measured every 25 metres (beach of Sf. Gheorghe – southern part of the cell). Measurements performed every February, June, August, November.
- 2001 – 2003, 2006, 2007 – annual field measurements (August, except for 2002 and 2003 - June) with classical topographic methods (theodolites, topographic gauge). Measurements made only in the Sulina and Sf. Gheorghe beach sectors (the benchmarks from other sectors were lost due to erosion and storms).

4.2 Sediment samples

Superficial sediment sampling along the before-mentioned beach profiles. Sediment samples were collected for one profile for each beach sector. Seven characteristic points were sampled for each profile: inland limit of the dune zone, limit dune zone/backshore, berm crest, upper swash, runnel, first submerged bar (generally at 0,8 m), 1,5 m water depth.

Sediment samples were analysed for: grain size (always) and for mineralogy (heavy minerals and Calcium Carbonate contents – between 1984 and 2000, then for 2001 – 2003, 2007).

Complete sets of samples (seven samples per profile) exist for the 4 beach section between 1984 and 2000. Other data – Sulina and Sf. Gheorghe for 2001 – 2003, 2007.

4.3 Bathymetry

Bathymetry measurements:
- June 2002 – the entire area (border with the Ukraine – Sahalin Island) – single beam Interphase echosounder with Sercell GPS
- June 2003 - Sulina mouth and surrounding area – single beam echosounder with Sercell GPS
- July – August 2007 – the entire area (Sulina – Sahalin Island) – dual beam echosounder with incorporated GPS - Ceeducer.

4.4 Shoreline

Shoreline positions measured with GPS:
June 2002 – the entire shoreline between Sulina and Sf. Gheorghe – Sercell GPS
June 2003 – the shoreline up to 15 kilometres south of Sulina mouth – Sercell GPS
June 2007 – the entire shoreline between Sulina and Sf. Gheorghe – Ceeducer.

4.5 Maps

Maps (for the entire coast):
- 1857 – Map made by the UK Admiralty – Admiral Spratt (during the Crimean War) – the copy of the map can be used only for orientation.
- 1898 – Romanian Navy Directorate Map
- 1979 – Romanian Navy Directorate Map
- 1997 – Romanian Navy Directorate Map
- 2009 – Romanian Navy Directorate Map

4.6 Wind measurements

Data used for modelling originate from the meteo stations included in the official national meteorological network (National Administration for Meteorology).

Wind data are measured four times each day (every 6 hours) – and consist of direction and velocity.

From Sulina meteorological station, data are available for 1991 – 2000, 2002.
From Sfantu Gheorghe meteorological station, data are available for 2003 – 2008.
From the Gloria Oil Rig meteo station data are available only for 2002.

4.7 Waves

No measurements of the wave climate have been used, nor that have been made (at least that we are aware of). The wave climate in front of the Danube Delta, based on the wind regime and bathymetry, was computed using SWAN model.

5 Data Set Inventory – Costa Brava Bays

The Costa Brava Bays Pilot site consists of the s'Abanell and Lloret de Mar urban beaches on the north-east Mediterranean coast (Figure 2).

5.1 Wave Data

Two different data sources are available: recorded data by a buoy deployed at about 50 m depth off the Tordera delta and hindcasted data obtained within the HIPOCAS project (Guedes and Soares et al. 2002). Time series of significant wave height, Hs, spectral peak wave period, Tp and wave direction (from directional buoy and hindcast data) are available.

Instrumental data cover the period 1984 – present. From 1984 to 2006 the buoy was omnidirectional (scalar data) and since 2007 was substituted by a directional wave buoy.

Hindcasted data cover the period 1958 – 2001.

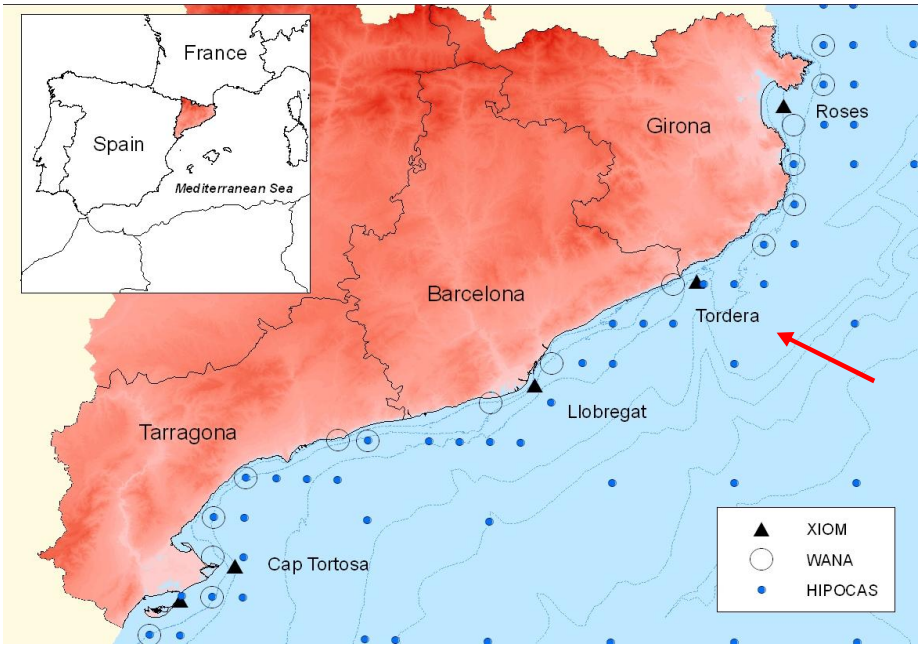

Figure 2 Study area. The arrow indicates the location of the wave buoy (adjacent to s'Abanell beach). HIPOCAS nodes are also shown.

5.2 Water levels

Water levels were obtained from the tide gauge on the Barcelona harbour (Puertos del Estado, Spanish Ministry of Public Works). Available data cover the period 1992 – present.

In addition to this, there is also available a time series of hindcasted water levels due to meteorological forcing which was included in the HIPOCAS analysis. These data cover the period 1958 – 2001.

5.3 Topographic data

Different topographic surveys have been done in both beaches since 2004 (11 surveys in s'Abanell beach and 8 in Lloret) by DGPS levelling. Only the subaerial beach was surveyed.

5.4 Bathymetries

Two bathymetries are available for the southern site (s'Abanell beach). These two campaigns were performed in 1995 and 1997 by the Ministry of Environment.

5.5 Shoreline data

Different shorelines extracted from aerial photographs are available for both beaches. The period covered extends from 1957 until present.

5.6 Sediment data

Textural parameters of the sediment in both beaches have been obtained from sediment samples taken at the beachface of each site.

5.7 Beach nourishment data

Data on artificial beach nourishment performed at the study area have been obtained from the Ministry of Environment (nourished volume, date, sediment type).

6 Data Set Inventory – Pevensey Bay

6.1 Introduction

The Pevensey Bay field site is situated on the English Channel coast of East Sussex between Eastbourne and Bexhill-on-Sea.. The area is covered by the Channel Coastal Observatory (http://www.channelcoast.org/) which is the data management centre for the Southeast Regional Coastal Monitoring Programme. Much of the data used at Pevensey was collected by the Channel Coastal Observatory or a link to it was provided from there. Meta-data on the data used and available is given below.

6.2 Wave Data

The Channel Coastal Observatory has deployed a Datawell Directional WaveRider Mk III wave buoy in Pevensey Bay since March 2003. Its location is at 50°46.96602´N, 0° 24.97493´E, although this has changed by small distances as the buoy has been redeployed several times after servicing or loosing its moorings. Its location is shown in Figure 3. Time series of wave data were downloaded from the Channel Coastal Observatory between 2003 and 2008 inclusive. The time series recorded the following observables every 30 minutes, unless interrupted:

- Date – day, month, year.
- Time (GMT)
- Latitude (WGS84)
- Longitude (WGS84)
- Flag
- Hs (m) – significant wave height defined as $H_{m0} = 4\sqrt{m_0}$, where m_0 is the zeroth order spectral moment of surface elevation.
- Hmax (m) – height of highest wave in record.
- Tp (s) – spectral peak wave period.
- Tm (s) mean wave period = $\sqrt{(m_0/m_2)}$ with m_2 the second order spectral moment of surface elevation.
- Dirp (degrees) – direction of peak of wave spectrum.
- Spread (deg) – spread at peak of wave spectrum.
- SST (deg C) – sea surface temperature.

Manufacturer's specified accuracy is 3% on wave height, 1.5° on wave direction, 0.2°C. Data were quality controlled for out-of-range values and spikes. Further meta-data is available on the Channel Coastal Observatory web site.

6.3 Water levels

Water levels were obtained from the tide gauge on the east side of the port entrance at Newhaven. The data were supplied by the British Oceanographic Data Centre as part of the function of the National Tidal & Sea Level Facility (http://www.pol.ac.uk/ntslf/) hosted by the Proudman Oceanographic Laboratory and funded by the Environment Agency and the Natural Environment Research Council.

Data was obtained from 2003 to 2008 to correspond to the period that wave data was available. The tide gauge is located at 50° 46' 54.4" N, 00° 03' 25.3" E and recorded data every 15 minutes. The equipment consists of an Ott pneumatic gauge and a

pneumatic bubbler system, which collected between 97% and 100% of the possible data records in each year.

All data refer to Admiralty Chart Datum (ACD). The relationship between ACD and Ordnance Datum Newlyn (ODN) ig given by ACD = ODN – 3.52m. All times are given to Greenwich Mean Time (GMT). The data was obtained in annual files in ascii format and consist of a header and time series of data. The header contains a port number (assigned by Proudman Oceanographic Laboratory) the site name, approximate latitude and longitude of the gauge, the start and end date of the data in the file, the name of the supplier of the data, the datum that the data refer to and a parameter code used by BODC to identify how the measurements were obtained.

The first two lines of the body of the file show how information is listed. Each subsequent line of the time series consists of:

- Cycle number (integer value);
- Date in format year / month / date;
- Time in format hour : minute : seconds;
- Sea level value (mACD);
- Flag channel identifying problems with the sea level values;
- Residual = observed sea level minus predicted sea level (m);
- Flag channel identifying problems with the residual values.

6.4 Topographic data

6.4.1 2003 survey by Channel Coastal Observatory

Fifty-eight cross-shore profiles of the shingle barrier, stretching from Sovereign Harbour almost to Cooden were also obtained from Channel Coastal Observatory. The 2003 baseline survey was conducted using a Leica SR530. The contract required accuracy in position of ±15mm and in elevation of ±30mm. An average of 24 points was measured at each profile. The vertical datum was ODN.

All 58 profiles were reported in a single file, which contained a single header line followed by the data. Each line of data contained:

- Eastings (m, OSGB36)
- Northings (m, OSGB36)
- Elevation (m, relative to ODN)
- Chainage (distance in m)
- FC = Feature Code (S = sand, G = gravel, SH = shell, etc (see http://www.channelcoast.org/data_management/online_data_catalogue/images/feature_codes.pdf for more details)
- Profile Reg_ID = profile registration number (allocated by CCO and different for each of the 58 profiles).

6.4.2 Environment Agency profiling

The Environment Agency monitors the beach management services provided by Pevensey Coastal Defence Limited by measuring a series of 52 cross-shore profiles at approximately 180m centres every four months using GPS stake-out surveys.

6.4.3 Monthly surveys by PCDL

Pevensey Coastal Defence (PCDL) undertakes a full beach survey every month, coinciding with the lowest spring tide of that period. This is always around 06:00 for the Sussex coast. Each survey is conducted using a GPS receiver mounted on a quad bike. The bike is driven along beach contours at the position of changes in beach slope. Typically a length of beach will be surveyed from the top of beach crest at +6.0m to MLWS at -3.0m. Generally only the active beach is surveyed every month, static sections only being re-surveyed after significant wave events have occurred. The entire 9km long beach can be surveyed from the crest of the shingle ridge to the low water mark by a single person within a single tide in summer, but may take two tides in winter. Observations are obtained every one second, meaning that a typical long-shore resolution is 5m in most places, stretching to 10m on the flat, sandy lower foreshore. Spatial resolution cross-shore depends on beach geometry at the time, but tends to lie within 5m to 20m.

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6.5 Hydrographic data

Inshore surveys of the local bathymetry have been conducted for the Channel Coastal Observatory using a Phillips DGPS system and a HydroTrac Echosounder, on a Hardy Fisher 34 boat. This provides an accuracy in the coordinates of ±1m. The OSGB coordinate system was used with elevations given to Ordnance Datum Newlyn. Depths are probably accurate to about 0.15m (depending on the wave conditions at the time of the survey).

6.6 Ordnance Survey Maps

Digital versions of 1:2500 scale Ordnance Survey (OS) maps from 1973 to 2004 were obtained so that the evolution of the contours of Mean High Water (of ordinary tides) and Mean Low Water (of ordinary tides) could be studied. OS maps come in different periods, referred to as epochs. The number of map tiles from each epoch and the range of dates of these maps is shown in the following Table. Each map was individually dated. The accuracy of the representation of tidelines on OS maps has been studied within the project but is not discussed here.

Epoch	Number of map tiles	Date range	
		from	to
1	6	1873	1876
2	6	1899	1899
3	6	1909	1910
4	5	1925	1930
A5	12	1955	1965
B6	3	1975	1976
SIM 1	9	1964	1989
SIM 2	3	1983	1989
SIM 3	1	1988	1988
SUSI A5	2	1973	1973
Mastermap		2004	2004

6.7 Additional data available

The following data is available from CCO but was not used:

- Filtered and unfiltered LIDAR data
- Aerial photographs

The following data was available from Pevensey Coastal Defence Limited

- Particle size distributions from beach sediment samples and from nourishment material.
- Records of beach nourishment and recycling activities, specifying volumes, locations and dates of activity.

6.8 Acknowledgements

The Southeast Regional Coastal Monitoring Programme is funded by Defra, in partnership with the Maritime Local Authorities and the Environment Agency Southeast Region, to whom we are grateful. The National Tidal & Sea Level Facility is hosted by the Proudman Oceanographic Laboratory and funded by the Environment Agency and the Natural Environment Research Council. Pevensey Coastal Defence Limited manages the beach under a contract from the Environment Agency.

7 Data Set Inventory – Inch Strand, Kerry

7.1 Introduction

Inch Strand and the adjacent Rosbeigh Spit are situated in Dingle Bay in Co. Kerry on the southern coast of Ireland. The Bay has a south-westerly aspect and is therefore exposed to the Atlantic Ocean and routinely subjected to high energy waves. The area is remote and there is limited monitoring or routine data available and therefore the majority of the data had to be collated from previous initiatives or collected as part of the project.

7.2 Wave Data

The nearest Wave Buoy (M3) is operated by the Irish Government through the Marine Institute and is located to the South West of the site at 51.2166°N 10.5500°W with the following data available in real time at hourly intervals:

- Time & Date
- Atmospheric. Press.(mb)
- Wind Speed (kn)
- Speed Maximum Gust (kn)
- Wind Direction (°)
- Dry Bulb Temperature (°C)
- Dew Point Temperature (°C)
- Relative Humidity (%)
- Wave Height (m)
- Wave Period (sec.)
- Sea Temperature (°C)

Given the distance from the permanent wave gauge to the site additional wave data was required and was derived by deploying wave gauges at two locations in Dingle Bay for discrete periods of time. The instruments deployed were Valeport Midas directional wave recorders with expected manufacturer's performance accuracy given as:

Sensor	Type	Range	Accuracy	Resolution
Pressure (high accuracy)	Piezo-Resistive	100dBar (90m water)	±0.01%	0.001%
Pressure (standard)	Strain Gauge	50dBar (40m water)	±0.04%	0.001%
Temperature	PRT	-5 to +35°C	±0.01°C	0.005°C
Compass	Fluxgate	0 to 360°	±1°	0.1°
Current	Valeport 2 axis EM	±5m/s	±1%	0.001m/s

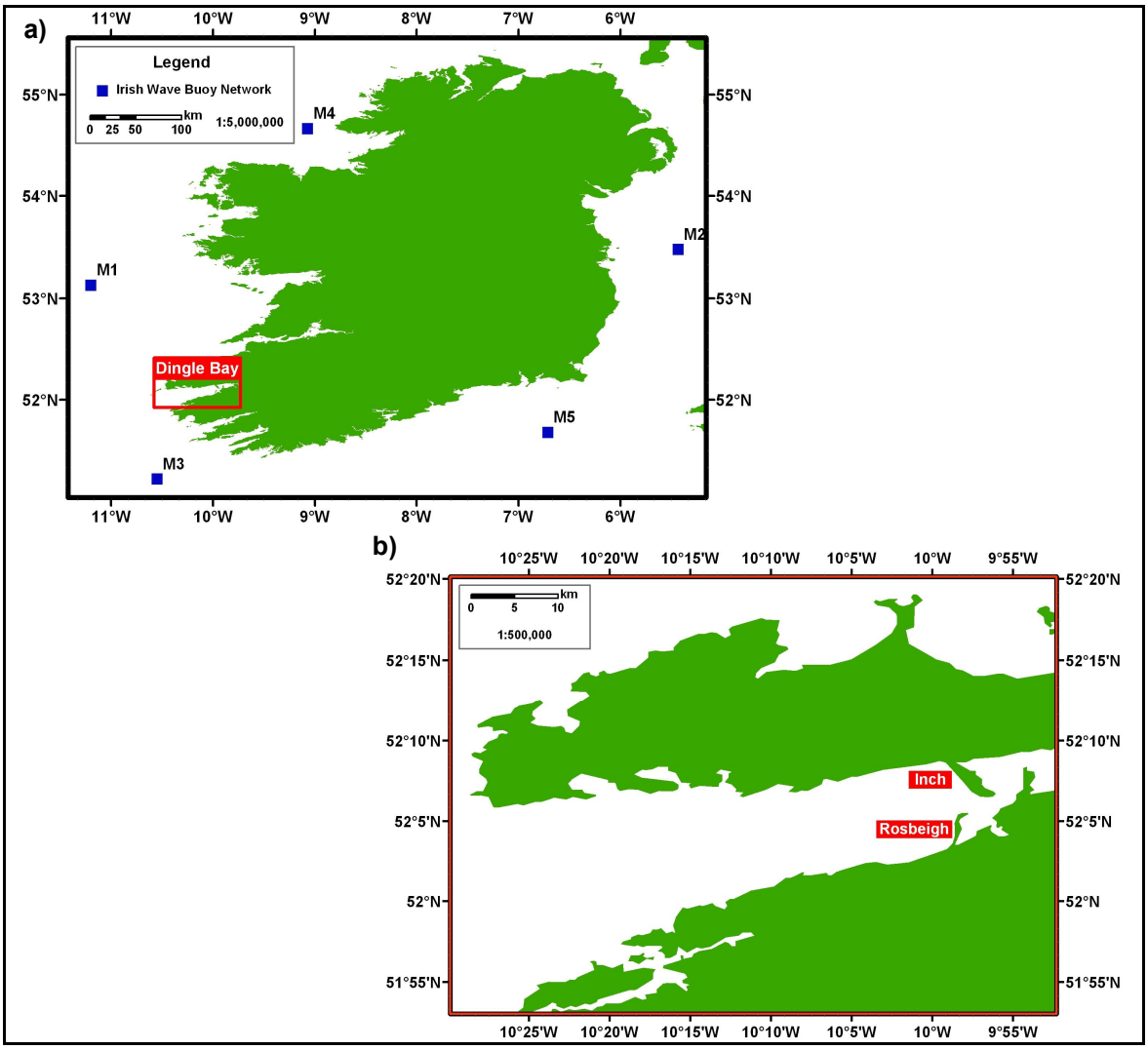

Figure 3 Map showing a) the location of Dingle Bay and M3 Wave Buoy and b) the location of Inch and Rosbeigh within Dingle Bay

7.3 Water levels

There are no accurate tide gauges in this area and any long term tidal data was derived from tide tables produced by the UK hydrographic office. Short term data was recorded during the wave gauge deployments and converted to Ordnance Datum (Malin).

7.4 Topographic data

Twenty-eight cross shore profiles were established from the northern end of Inch Strand to the distal point. These were surveyed over a six-month period using a Trimble Series 4400 differential Global Positioning System (*d*GPS) base and rover unit in conjunction with a six-wheel vehicle. The *d*GPS was operated in fine mode giving an expected accuracy of ±1cm (+2ppm × baseline length) in the horizontal and ±2cm (+2ppm × baseline length) in the vertical.

7.5 Hydrographic data

There is very limited hydrographic data available for Dingle Bay and therefore bathymetry was limited to reproduction of historical data from the UK Hydrographic Office.

7.6 Ordnance Survey Maps

A significant amount of research had been conducted into the position of Inch from historical mapping sources. Historical OS series maps from the nineteenth century and early twentieth century conducted by the UK Ordnance Survey were combined with more recent Ordnance Survey (Ireland) mapping and aerial photography using the GIS software, ArcMap 9.2.

8 References

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