Appendix 13. Seabed Mapping Methods and Data

DORIS HABITAT MAPPING – METHODS AND SOURCES

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1. Geophysical Datasets – Bathymetry and Backscatter

Swath bathymetry and co-registered backscatter data was collected across the DORIS area during 2008 and 2009, with a total coverage of c. 800 km^2 from the mean low water mark to c. 25 km offshore. Data was acquired and processed using a combination of QPS QINSY (V8), CARIS HIPS/SIPS (V6.1) and Fledermaus (V6.7) software. The data was acquired to IHO (S-44: 2008) Order 1a standard and was collected from four different survey vessels:

1. Fugro OSAE - MV Victor Hensen (Kongsberg EM710)
2. Fugro OSAE - MV Meridian (Reson SeaBat 7125)
3. Fugro OSAE - MV Jetstream (Kongsberg EM3002D)
4. Royal Navy - HMS Gleaner (Kongsberg EM3002)

Horizontal co-ordinates were referred to ITRF2000 Datum, GRS80 spheroid; grid coordinates are given in terms of the UTM (N) Projection, UTM grid zone 30 (CM 3°W). For vertical datum control OSAE Fugro acquired RTK-GPS tide which was then reduced to Chart Datum using VORF model values provided by the UKHO. These derived heights were calibrated against Tide Guage data from Sandown, Weymouth, West Bay and Swanage. The HMS Gleaner data was reduced to CD using the Proudman Oceanographic Laboratories Tide Guage installed at Weymouth. No co-tidal correction was deemed necessary for the latter survey area. The final data set was quality controlled and converted to OSGB36/Ordnance Datum Newlyn by the UKHO. The final bathymetric data was presented as 1 m bin size ASCII 'XYZ' files which were stitched together as a single non-interpolated ArcGIS10 raster dataset.

The bathymetric data were integrated into a single raster surface that was used to generate four inter-related layers: 1) Colour coded bathymetric raster; 2) Hill-shade raster that was obtained by setting a position for a hypothetical light source and calculating the illumination values of each cell in relation to neighbouring cells; 3) Slope raster which presents the maximum rate of change of slope between each cell and its neighbours, and presented as an angle in degrees; and 4) Aspect raster that identifies the down-slope direction (relative to north) of the maximum rate of change in value from each cell to its neighbours, as calculated in the slope raster.

Backscatter data was processed using the software programme PRISM and ERDAS. The datasets were sub-sampled from the original acquired bin size of 0.1m to 0.25m to reduce the large file sizes (total data volume still 21 Gb). The final image was added to the master GIS for integration with the derived bathymetric layers.

2. Hydrodynamic Modelling

The University of Southampton (Cazenave, 2012) has developed a shelf-scale 2D depth-averaged numerical model to better understand both shelf-scale sediment transport pathways and sediment transport on smaller subset scales comparable with individual tidal sand banks. A flexible triangular mesh provides the ability to selectively refine the model resolution from very coarse on the outer shelf (20 km) to very fine (100 m) over areas of particular interest. High quality coastline data with multibeam bathymetry of large parts of the north-west European continental shelf provide the most up-to-date shelf bathymetry data available as input to the hydrodynamic model. In the case of the DORIS run the UKHO 15 m sub-sampled bathymetry was used to support a nested model with a 150 m bin size.

Grain size data across the majority of the continental shelf has been collected from a range of sources (grab samples, extant distribution maps in the literature and national repositories) to provide a comprehensive grain size distribution map for use in sediment transport calculations on the shelf. This grain size data has also, in combination with the collated bathymetry and measurements of bedform parameters, been used to create the first shelf-scale, variable bed friction map.

The model boundaries, located off the continental shelf, are driven by a predicted tide surface elevation. Data sets of harmonic analysis of satellite altimetry provide eight deep-water diurnal and semi-diurnal tidal constituents from which water elevation has been predicted. The subsequent flows have been extensively calibrated against eighty-one tide gauges and sixty –two current meters across the shelf. This calibration has shown the model is able to reproduce tidal heights to within 20 cm and within 10 minutes in phase. Similarly, calibration of currents shows that current speeds are reproduced to within 7–10 cms^{-1}.

For habitat mapping of the DORIS data both hydrodynamic data (Maximum, Medium and Residual Flow) and sediment transport data (residual sediment transport direction and magnitude) for two grains sizes: 375 microns (medium sand) and 4 mm (cobbles) were calculated. These data outputs were used to define interpreted high energy, medium energy and low energy boundaries.

3. Ground Truthing Datasets

A total of 184 grab samples; 168 core samples; 3185 stills photographs and 119 video transects and seventeen dive records have been collated from a variety of sources in order to be calibrate the bathymetry and backscatter data. In addition, georectified aerial photographs and lidar topographic data were integrated with the bathymetry to further enhance the interpretation process. The datasets collated include:

a. SeaStar Grab Samples, Video Sledge and stills photography. The major calibration survey was undertaken by SeaStar Survey Ltd. during 2009. From this survey a total of 22 grab samples were acquired; 119 video transects; from which 3185 stills photos were acquired and visual descriptions of sediment were taken.

b. OSAE Fugro Grab Samples. As part of the deliverable to the DORIS contract a total of 82 grab samples were taken on a 5 km grid across the survey area. Sediment distribution was described following Folk sea bed sediment classification system (Folk, 1954).

c. Bastos et al., 2002. A total of 80 grab samples during undertaken in June and August 2000 for the PhD research project of Alex Bastos. Particle size analysis for all of these samples were given using the Wentworth scale and presented here following Folk sea bed sediment classification system (Folk, 1954).

d. Donvon and Stride, 1961: In 1959, Donovan and Stride surveyed a large part of Weymouth Bay and Purbeck Bay, using a combination of echo sounding and echo ranging (asdic – a side scan sonar precursor) on the RRS Discovery II. In addition they acquired a total of 125 core samples (and gained access to a further 36 samples from a survey in 1953) using a 8 cwt free-fall corer. In addition, 39 stations were dived in Weymouth Bay with additional sites being dived along the coasts of both Weymouth and Kimmeridge Bays. One hundred and sixty-eight of these cores and seventeen of the dive sites are reported in their 1961 paper and these have been translated into an appropriately formatted shapefile. These samples were focused towards interpreting the bedrock geology and not necessarily the seabed substrate and so have been used primarily to identify the nature of the geological substrate.

e. Coastal Aerial Photographs and Lidar Data: Fugro-BKS Limited, for the Environment Agency, acquired digital aerial photographs along the coastal strip from Portland Bill to Durleston Head, during May and June 2008. Full overlapping coverage was acquired, from a Piper Aztec PA23 survey aircraft, using a large format, Intergraph Digital Mapping Camera, with a T-AS gyro stablilised mount and electronic forward motion compensation system. Positioning was provided by a combination of an Airborne Global Positioning System and Rinex data from the nearest OS active stations. The final ortho-rectified image data was supplied as 24-bit RGB compressed ECW 500 m tiles, with a ground sample distance of 9 cm and a positional accuracy of ± 27 cm.

Lidar data was collected using an ALTM 3100 LiDAR in March 2008. These data are delivered as ArcView ASCII GRID & XYZ Delimited Text files at 2 m resolution and a maximum vertical error ± 0.15 m when compared against terrestrial base stations and cross-sections. The acquired WGS 84 co-ordinates were converted to the Ordnance Survey Grid and Newlyn Datum. These two datasets were used extensively to correlate the offshore bedrock exposures with the well mapped inter-tidal bedrock outcrops. Both of these datasets were made freely available via the Channel Coastal Observatory website.

4. Data Integration and Habitat Mapping Protocols

The results were integrated to derive the first fine-scale habitat map of the Dorset seabed based on the JNCC Marine Habitat Classification Hierarchy (version 04.05 - Connor et al. 2004). Slight modification was made based on the work of James et al., 2007, with the substratum divided into three categories: Rock, 'Rock and Thin Sediment' and Sediment rather than the conventional Rock and Sediment sub-division. The Infra-Littoral - Circa-Littoral divided for this area was taken as 18 mCD (Tinsley pers. comm.) note no Littoral habitats were identified. The final level of classification ranging included both Level 2 (Broad Habitat type) and Level 3 (Habitat complex) components.

The dataset as a whole was assessed using the MESH Confidence Assessment tool (http://www.searchmesh.net/confidence/confidenceAssessment.html) with the dataset achieving a score of 73%.

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References

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