

INTEGRATED COASTAL ZONE – DATA RESEARCH PROJECT **(ICZMap®)**

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Background

The coastal zone has, through its social, economic and environmental significance, become a focus of growing attention in the UK. It is a dynamic environment under constant pressure from human and economic activity as well as physical and environmental forces, some of which are associated with climate change and rising sea levels.

Currently, the UK coastline has formed the boundary of both Ordnance Survey & Ordnance Survey Northern Ireland (OSNI) terrestrial mapping down to mean low water (mean low water springs in Scotland) and United Kingdom Hydrographic Office (UKHO) chart data (up to mean high water).

Coastal zone geographic data in UK is only available in diverse terrestrial, geological, and marine geographic datasets and this is a major problem for policy makers. Until now, it has been the remit of the user to resolve any integration issues resulting from differing projections, datum, scale of capture and other specification issues. This is a time consuming and laborious process and may produce inconsistent data, which are difficult to maintain and hence a major barrier to the management of a particularly sensitive environmental zone.

About the Project

The Integrated Coastal Zone Mapping Research Project (ICZMap®) is a two-year applied research joint venture, started in May 2001, between Ordnance Survey, UKHO and British Geological Survey (BGS) to resolve projection, datum and specification issues and produce a consistent, useable dataset. The project has been supported by HM Treasury through its Invest to Save Budget (ISB) funding initiative.

The key stages of the project are to:

- establish user needs, priorities and service provision;
- draw up a Specification of Requirements for data integration;
- evaluate options for resolving technical differences;
- develop a Technical Specification for integrated coastal zone mapping;
- capture and integrate data for the defined “test” pilot areas;
- use the pilot test data to support innovative coastal management projects;
- present findings to the ICZMap® Steering Group and user community.
- derive post project options for electronic delivery of data & services

The overall aim of ICZMap® is to investigate the creation of an integrated and accessible coastal dataset built from existing data, and how this might be used to satisfy the diverse range of coastal applications and services. In doing so, incompatibilities between horizontal and vertical datums, as used by the three organisations and the resultant problems, are being investigated by producing a methodology for datum transformation. Ultimately, this methodology would produce an integrated height model with a consistent height datum. In the case of this research we specifically looked at the transformation of UKHO bathymetry (at Chart Datum) to Ordnance Datum Newlyn (ODN).

Three pilot areas around the UK coast were selected as test cases over a wide enough geographic area and that could be delivered within a timescale to be practical for potential pilot users. Nominal limits of 5km inland and 20km out to sea were set and vector datasets from each of the Agencies produced and amalgamated. The main test area for the project covers a stretch of coastline between Shoreham and Lyme Regis on the South Coast including the Isle of Wight. Additionally, smaller test areas have been defined in the Firth of Forth in Scotland and Milford Haven in South West Wales.

The project has involved staff from all three Agencies covering specialists in areas such as Geographic Information Systems, Geodesy, Research & Development as well as Business Management.

Horizontal datum and projections

Both Ordnance Survey and BGS data are issued on OSGB36 horizontal datum with British National Grid on the Transverse Mercator Projection, whereas UKHO use WGS84 compatible datum on the normal Mercator Projection. In order to create integrated datasets the UKHO, using SafeSoft’s Feature Manipulation Engine (FME), created parameter files containing ten 7-point parameter horizontal shifts for regions of the UK enabling UKHO to confidently transform its data to OSGB36. It is proposed that this transformation will be applied to UKHO test data prior to its dispatch.

The Vertical Datum integration problem

Within the Integrated Coastal Zone Mapping (ICZMap®) project there is a requirement to create a three dimensional height model integrating both terrestrial and marine geographic data held by Ordnance Survey (OS) and the United Kingdom Hydrographic Office (UKHO). This model is intended for use by scientific, research and coastal management and planning organisations and will not be used for navigation.

There is a fundamental factor currently preventing the creation of an accurate height model, that of the differing height datum’s used by Ordnance Survey and UKHO. On mainland Great Britain, Ordnance Survey use Newlyn (ODN), which is a land based

Assumptions

The final methodology will be based upon a number of assumptions, these are:-

- Due to the errors inherent in OS data ($\sim \pm 1.8\text{m}$) and UKHO data (variable depending on survey methodology), a rigorous correction method would not be beneficial.
- The connection between Mean Sea Level (MSL) and Chart Datum (CD) varies in proportion to the tidal range from the coast to seaward, thus the connection will vary across the pilot area, from the coast to 20km offshore.
- For the purpose of this research the difference between MSL and ODN remains constant seaward, although it is acknowledged that in reality this is not so.
- At the coast Mean High Water Springs (MHWS) is recorded above MSL and Mean Low Water Springs (MLWS) is below MSL. The difference between MHWS and MLWS is known as the Mean Spring Range (MSR) and reduces seaward.

Integration of onshore and offshore height data

By relating the co-tidal value offshore to the nearest appropriate Port and the use of an equation developed at the UKHO, an offshore value for the height correction relative to the OS height datum can be obtained. Interpolation techniques can then be employed to grid the derived values around the UK. The production of the geo-referenced grid provides a means for applying a correction to the observed UKHO soundings relative to OS datum. The resulting data set can be used to re-contour the bathymetric depths and hence produce on the same vertical datum, an integrated terrestrial and marine geographic model for the UK.

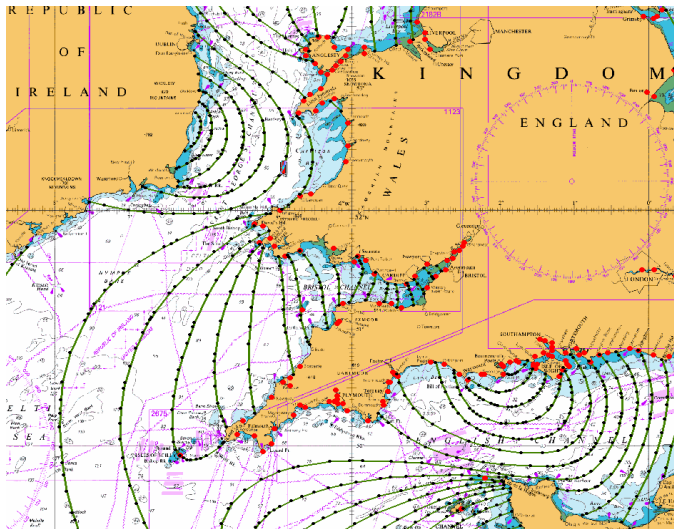


Fig 2 Co-tidal points, lines and ports

A series of points 20km offshore where the difference between ODN and Chart Datum is known was produced. This was achieved by locating positions on the 20km offshore line where a co-range line (lines through points of equal MSR) cut. These positions were then used in conjunction with the co-range MSR values offshore, MSR values at the nearest ports and differences between the datums at the nearest ports

to calculate the differences in datums. These points 20km offshore were then used in conjunction with the published differences in datums at locations along the coast to interpolate a 'transformation surface', which when applied to bathymetric data resulted in a consistent height model both onshore and offshore. Various interpolation algorithms were assessed as to their efficacy in producing an accurately modelled 'transformation surface'. Those algorithms assessed were, Inverse Distance Weighted (IDW), Spline Interpolator and Natural Neighbours.

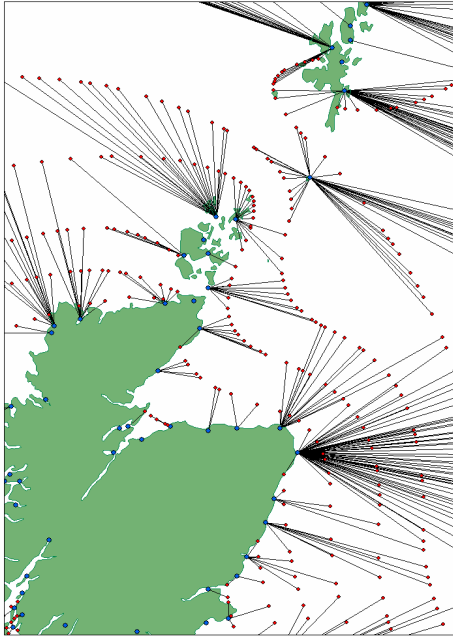


Fig 3 Co-tidal point related to nearest port

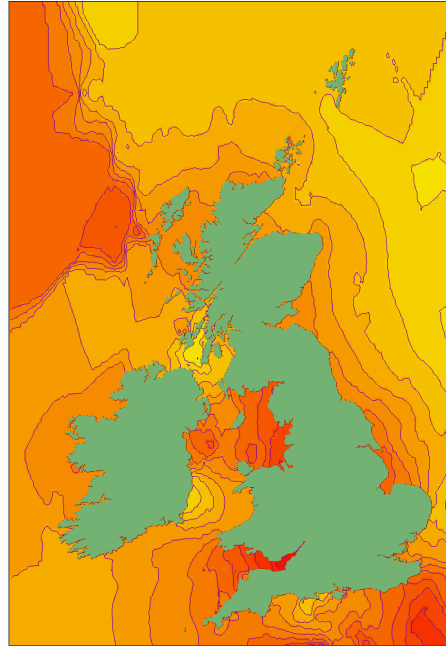


Fig 4: Contoured grid – red is 6m and yellow is 0m with 0.5m interval

Of those interpolators assessed it was found that the Natural Neighbours algorithm produced the best results. This algorithm and the method of calculating datum differences offshore was then incorporated in to the methodology for datum transformation.

3D soundings into attributed 2D soundings

UKHO Sounding data is supplied as x,y,z. In order to enable height (depth) modelling attributed 2D Sounding data were required, with the depth being assigned to the feature as an attribute (2D+1). FME functionality (ElevationExtractor) was used to obtain attributed 2D soundings

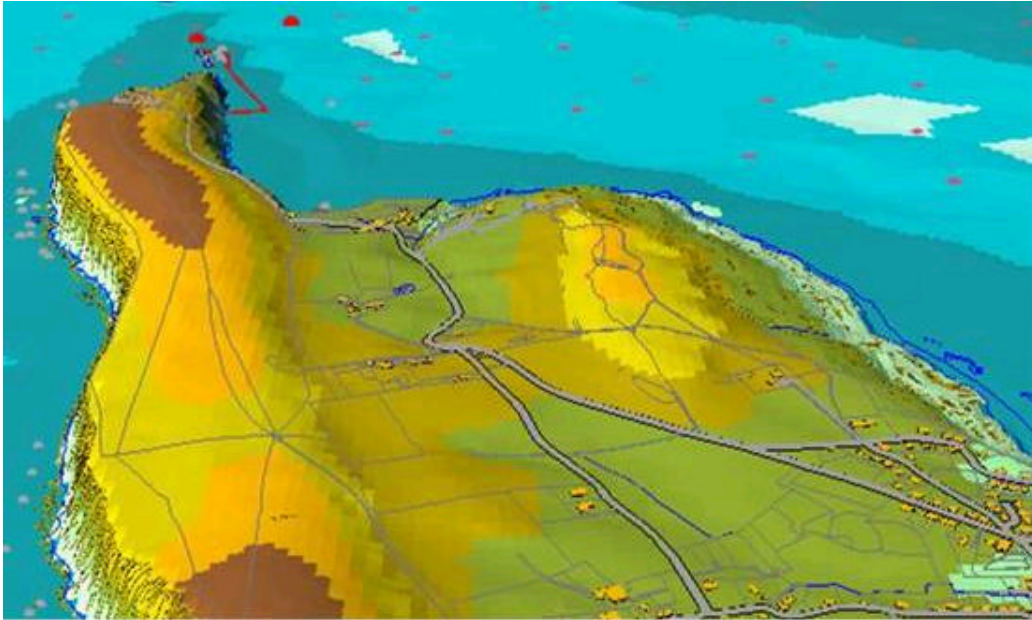


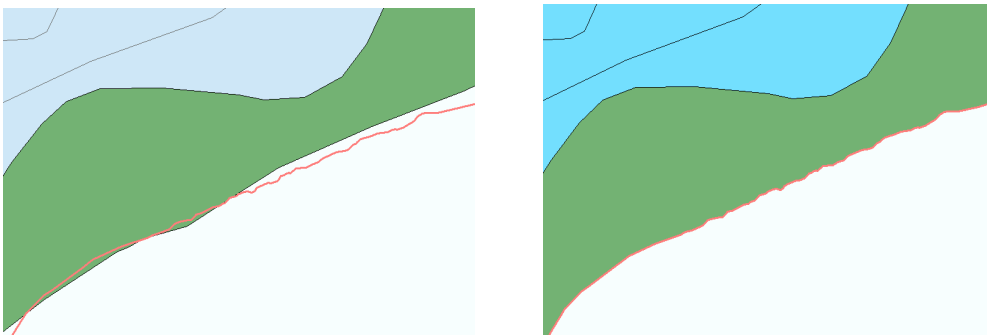
Fig 5. 3D Spatial model to common vertical and horizontal datum

Expanding integer values into meaningful text

UKHO data is in s57 format, whereby attribute values are coded (i.e. colour 1,6,1 equates to Red, Black, Red) in order that the data can be utilised across a range of ECDIS viewers, however this is meaningless to non-navigational end users. In order add value to the s57 data the attribute codes were decoded and converted to meaningful text. So in the example above the user will view the text rather than the integer values.

Foreshore representation

This project is investigating options available for the representation of the foreshore at the interface between these different datasets. At present Mean Low Water (MLW) marks the extent of Ordnance Survey data while the Mean High Water (MHW) marks the extent of the UK Hydrographic Office (UKHO) data. This creates an overlap in datasets and complications arise in their depiction due to conflicts between different datasets.



Figs 6 & 7 Incidence of Ordnance Survey and UKHO foreshore polygons before and after resolution

Resolution of this issue was to accept that the Ordnance Survey MHW line, due to capture scale, accuracy and frequency of surveying, as the primary source. The UKHO cut / extended its shoreward limit of the inter-tidal polygon to match the MHW as supplied by Ordnance Survey.

BGS use MLW as their limit to classify their data between onshore and offshore, and in order to achieve cartographically neat datasets BGS have cut their data to MLW as supplied by Ordnance Survey.

Symbology

A revised set of symbols for the UKHO element of ICZMap® has been created based on Chart 5011 (INT 1) symbol set so that features can be viewed in such a way so as to replicate those shown on UKHO navigational charts. The ENC s52 display standard (for use in ECDIS) is considered inappropriate for non navigational use.

Data formats

UKHO supply their data as S57 Ed 3 output format, Ordnance Survey supply their data in GML format and BGS in ESRI Shape or MapInfo TAB file formats. Two common data formats were agreed on for release in the test areas, namely ESRI Shape and MapInfo TAB files for the trial datasets.

Future initiatives – Global datums

The task to integrate onshore and offshore height data for the UK will deliver a cartographically robust seamless vertical reference surface on which modelling of the coastal zone can be undertaken. However, there is a need to begin investigating new methodologies to improve the positional accuracy of vertical datum planes relative to the new Geoid Model for UK (OSGM02) and possibly the creation of a European or Global reference system based on alternative technologies (such as altimetry). Whilst UK has a vision of this as a long term goal, cooperation between world geospatial organisations will be needed. I am sure that this will figure in future debates and become a hot topic.

User inputs

To date, over 500 organisations, ranging from nature conservation to mineral extraction companies, have expressed interest in ICZMap® through the website

www.iczmap.co.uk

The Inter-Agency Committee on Marine Science and Technology (IACMST) Marine Environmental Data Action Group (MEDAG) acts as the intelligent user group. This group forms the primary customers for the data. The membership of this group covers the wide range of users of coastal information within Central, Local Government and the commercial sectors.

The user group is assisting in defining the specification for the data and investigate practical use of the data in their applications and hence priorities. Additionally users will provide a key input to the project through the Coastal Groups involved in testing the datasets at present.

Success criteria

Specific criteria for measurement of project success include:

- users of ICZMap® are able to access, receive, integrate and use the data sets more easily
- users can develop their own applications using the coastal zone mapping
- data is widely used and integrated
- ICZMap® is recognised as an effective solution to user needs

ICZMap® trial data is currently with The Solent Coastal Forum, Forth Estuary Forum and the Pembrokeshire Coast Forum for trial and evaluation purposes. Results of testing the trial data in these areas are due in April 2003. If successful, plans will be put in place to consider how such data can be made available across the United Kingdom.