Managing European Shorelines and Sharing Information on Nearshore Areas

messina

A Case Study Documenting The UK SOUTH-EAST REGIONAL STRATEGIC COASTAL MONITORING PROGRAMME

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SOUTH-EAST REGIONAL STRATEGIC COASTAL MONITORING PROGRAMME

1. INTRODUCTION

The south-east coast of England is characterised by low-lying land susceptible to both flooding and erosion as a result of rising sea levels and soft sedimentary geology. This combined with extensive coastal development, means that the management of the coastal zone is essential. Shoreline Management Plans and coastal strategy studies have highlighted the need for a more standard approach to coastal monitoring in order maximise the use of data and to provide best value.

The coastline of England and Wales is subdivided into coastal cells for the purposes of shoreline management planning (Motyka and Brampton, 1993) of which the South-East Strategic Regional Coastal Monitoring Programme covers approximately 1000km within Coastal Cells 4 and 5 between Portland Bill and the Isle of Grain (Figure 1).

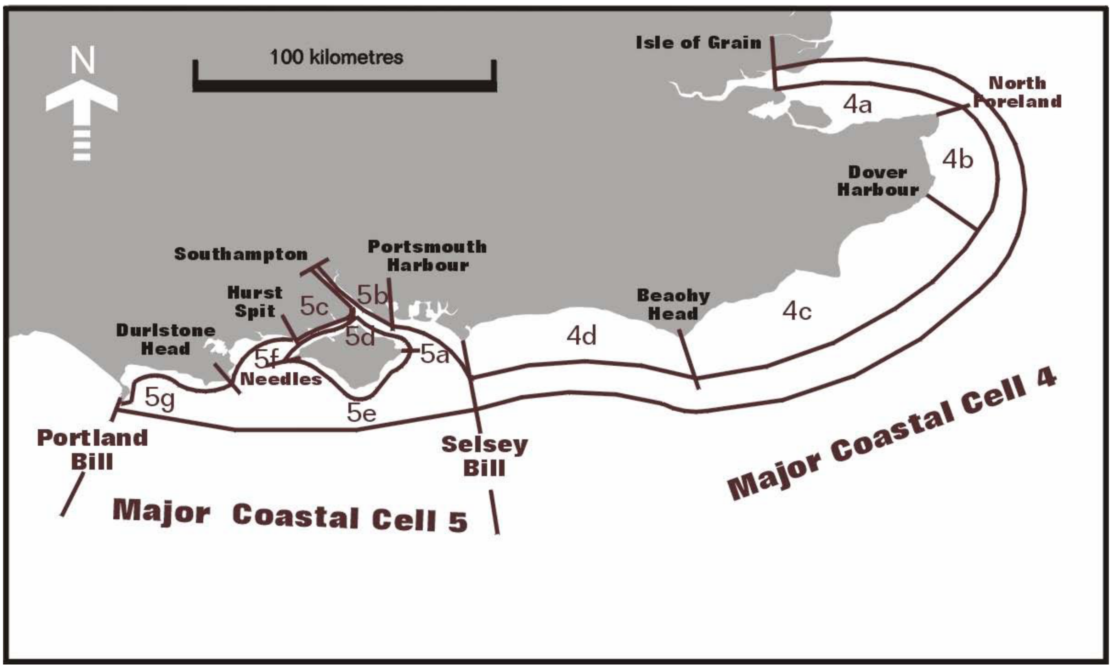

Figure 1. Major Coastal Cell and Sub-cell boundaries (Bradbury, McFarland, Horne and Eastick, 2001)

The recent approach to coastal monitoring has been both ad-hoc and unsatisfactory within the southeast of England, and elsewhere in the UK; this is evident at both regional and local scales. Data collection and analysis methodologies have been inconsistent, and coordination has been poor.

Region wide monitoring costs have been estimated at between £700,000 and £1.4m per year however. Although several region-wide monitoring programmes have been managed in isolation, results have not been integrated; either in context with each other, or with relation to regional aspects of shoreline management; this is contrary to best practice shoreline management principles.

The South-East Strategic Regional Coastal Monitoring Programme was introduced as a means of providing a standard, repeatable and cost-effective method of monitoring the coastal environment. It provides information for development of strategic shoreline management plans, coastal defence strategies and operational management of coastal protection and flood defence.

1.1 AIMS

- Promote a standard, repeatable and cost-effective method of monitoring of the coastal environment.
- Promote, inform and integrate the operational monitoring requirements of: a regional overview; shoreline management plans; coastal strategies, and individual schemes, between the limits of the boundaries of regional cells 4 and 5 (Figure 1) (Bradbury, Beck, McFarland and Curtis, 2001).

1.2 **OBJECTIVES** (Bradbury, Beck, McFarland and Curtis, 2001)

- Examine the need for a hierarchy of tiers for coastal data collection and management
- Provide proposals for a co-ordinated regional hierarchy, including methods of integration of the various tiers.
- Define appropriate monitoring cells for each of the tiers. The extents of the regional scoping study area are major coastal cells 4 and 5. (Isle of Grain to Portland Bill).

- Examine the range of types of data collected within the coastal zone, on both defended and undefended coasts.
- Determine whether any further types of data should be collected which might benefit the understanding and management of the coastal zone.
- Discuss the range of spatial and temporal coverage required, for the various data types.
- Examine the range of operational survey techniques in current use.
- Provide guidance for regional baseline monitoring, at each of the defined levels.
- Examine current and best practice methods for data management, analysis and dissemination, and identify opportunities for regional collation and management of data
- Investigate methods of maintaining continuity and quality of monitoring programmes
- Examine techniques, which might provide regional best value benefit, through economies of scale.
- Discuss methods of procurement and packaging of the monitoring programmes.
- Discuss options for the management of monitoring programmes and data.
- Discuss how the regional initiatives might be extended to a national level.

2 BACKGROUND

Prior to the development of the South-East Strategic Regional Coastal Monitoring Programme, data collection programmes were seen as unsatisfactory both regionally and at a local scale. Although there are a number of extremely good local monitoring programmes in place in areas such as Bournemouth, North Kent and Christchurch Bay, it was identified that a region-wide approach was necessary offering a standard and repeatable means of coastal monitoring.

The Environment Agency Annual Beach Management Survey (ABMS); an annual aerial survey programme generating beach profiles (approx. six per km) by photogrammetry, over 440km of coast, was, until now the most comprehensive regional monitoring programme. A detailed review of the ABMS identified a regional consensus that it could be improved, to provide a product which could be used with some confidence, to inform both a regional overview and for strategic decision-making within SMPs and strategy studies.

The South-East Strategic Regional Coastal Monitoring Programme encompasses the older ABMS programme along with an extensive Geographical Positioning System (GPS) survey schedule and wave and tidal data. The programme is expected to cost approx £1.5m per year based on a five year funding period, but with an expectation that the programme will continue indefinitely. Funding commenced in August 2002 with the main funding source being DEFRA, Local Authorities and the Environment Agency. The programme will act as a regional pilot model that may later be used within other regions of England and Wales. Data is collected via a series of contracts and also by in-house local authority teams.

A specialist team has been established at the Channel Coastal Observatory within the National Oceanographic Centre, Southampton, to manage the programme and develop the data analysis, storage and dissemination procedures. Large quantities of data are currently being made freely available from the survey and analysis programme via the Channel Coastal Observatory website (www.channelcoast.org). It is hoped that this data will be useful to Local Authorities within the region, the Environment Agency, consultants in coastal defence, conservation management, academic research and for educational purposes.

3 PROGRAMME DESIGN (taken from www.channelcoast.org 2005).

A risk-based design approach has been adopted for the regional programme (Bradbury *et al* 2001), in order to optimise expenditure. Ideally, regular surveys of the various variables should be conducted at consistent (dense) spatial and (frequent) temporal scales. This idealistic approach cannot be sustained or justified financially however, and a reasoned method of sampling must be designed to provide best value for money. Coastal characteristics including geomorphology, shoreline composition and defence type, management strategy, exposure to wave attack and tidal range have all been considered within a weighted design framework developed from a conceptual model of data requirements. More data is generally required at those sites that are most vulnerable or heavily managed. Although the spatial and temporal coverage of data collection varies across the region, the risk-based approach has been applied consistently across the region (www.channelcoast.org, 2005).

The risk categories considered in programme design are:

- Exposure to wave attack
- Vulnerability to flooding
- Management strategy
- Coastal geomorphology and geology
- Defence type
- Application of GIS to development of risk model
- Limitations of risk model

Each of the risk categories has been considered separately, before drawing the data together within a weighted risk model. Extensive use has been made of a review of existing local and long-term programmes, to determine weightings. The well-developed programmes have been fine-tuned over a period of many years and demonstrate best value through their long-term development and use of the data in practical management of the coast.

The basic risk assessment model is very simple, but provides a clear separation of management risks and the relative need for monitoring at different sites. When considered together, the risk categories can be analysed in various combinations to determine those types of frontage where monitoring is most needed. A weighted approach, based upon the numerical indices derived for each category, was used to determine the most effective programme. Thresholds have been determined for each index category, and the required level of monitoring defined. The model has been validated against the existing long-term local programmes and has been further refined by consultation with each of the programme partners.

Examples of this risk-based approach are illustrated in the following examples. Exposed sites with active beach management and vulnerable features e.g. Medmerry (Sussex) shingle beach may require frequent and intensive monitoring. Low exposure, hard-cliff sites, with a do-nothing strategy e.g. Beachy Head (Sussex) need less intensive coverage, but some strategic data is needed to support other down-drift sites within the process unit e.g. Eastbourne (Sussex). Bathymetric surveys may be needed annually in areas of low tidal range and active submerged surficial sediments e.g. Bournemouth (Dorset), whilst areas that have a beach toe that dries at low water on a hard rock platform e.g. Hythe (Kent) will not benefit from frequent bathymetric surveys. Each site has been reviewed on the basis of exposure and the general dynamics of the local system.

4 SURVEY TECHNIQUES

The survey programme consists of a number of different survey techniques including both land-based and bathymetric surveys. In addition, the programme also undertakes airborne remote sensing topographic surveys.

4.1 CONTROL NETWORK

The wide range of survey techniques used within the programme requires a robust position-control network within which the surveys can be conducted. A single control network has been developed that will provide a framework for land surveys, aerial surveys, LIDAR and hydrographic surveys. Although the specific requirements for each element differ, the coordinate system and transformation methods must be consistent for all data to be integrated accurately and directly comparable. The basis for the network will be an ETRS89 GPS network transformed using standard OSTN02 and OSGM02 transformations to provide Ordnance Survey coordinates. This process is already standard practice for EA LIDAR surveys and some local surveys. The historical ABMS programme and many other local systems require some modification to be relatively compatible. The figure below illustrates the locations of the control points for the Isle of Wight. In addition to the control points there are a number of less accurate Real Time Kinematic (RTK) points which allow checks to be made to ensure the base station is set up correctly and that surveys are measured in relation to this fixed point.

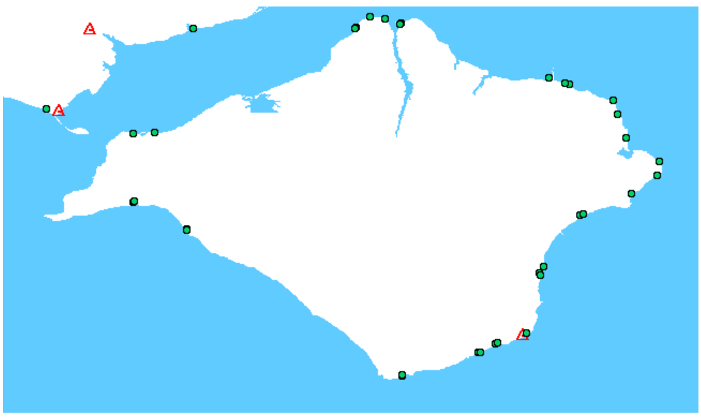

Figure 2. Isle of Wight Control Network (www.channelcoast.org, 2005)

4.2 LAND BASED TOPOGRAPHIC BEACH SURVEYS

In the past, the majority of land based topographic surveys were carried out by levelling using an automatic level or by total station theodolite (usually in conjunction with a data logger). The technology associated with the total station theodolite is well proven and is still an efficient and appropriate method for collection of beach data. However, kinematic global positioning system (GPS) technology has advanced rapidly during the past few years. Kinematic GPS provides the opportunity to capture data with a vertical accuracy of approximately +/-2-3cm and horizontal positioning at approximately double the accuracy making it ideal for beach surveys. A minimum of two GPS receivers linked by a radio is required. One receiver acts as a base station, providing corrections, the other is a mobile station used for collection of data. The main advantage of GPS over other techniques is in the speed of data capture. Kinematic GPS is particularly well suited to repetitive surveys, since fairly long stretches of coastline can be surveyed from a single base station set up. The system is well suited to low light conditions and can be used in complete darkness. It is well suited to measurements of slope stability in areas of unstable terrain, since no control is required within the zone of instability. Control surveys can be conducted considerably more efficiently than using optical techniques. The same system can also be used in conjunction with bathymetric surveys (www.channelcoast.org, 2005).

Techniques in current use include both profiling and also continuous data collection of spot height data. Once every five years a baseline survey is carried out on all beaches within the South-East Strategic Regional Coastal Monitoring Programme area. These surveys provide a detailed topographical map of the beach through a combination of profile lines spaced at 50m intervals and continuous data taken every two seconds from shore parallel lines at 5m spacing. This combination allows a digital ground model (DGM) to be produced allowing profiles to be drawn at any location indicating changes in beach levels in comparison to previous surveys.

Subsequent surveys are determined by spatial and temporal factors. The profile interval varies from 100m-500m depending on the risk-based analysis of the area. Profiles spaced at 100m are generally in areas where barrier beaches run parallel to hold the line frontages at high exposure sites or where the beach has coastal structures where a high risk hold the line beach management plan sites exists. Profile lines spaced at 500m are likely to be where a ‘do nothing’ option exists on a low-risk/low-exposure site.

Thousands of beach profiles will be collected during the course of the programme with some sites being surveyed as many as 4 times per year. Where possible data from historical programmes is incorporated within the data sets to provide information on longer-term changes in beach levels. Figure 3 below is taken from a profile line within Colwell Bay on the northwest coast of the Isle of Wight. Survey data here dates back to 1998 and illustrates clearly how beach levels have changed over the years.

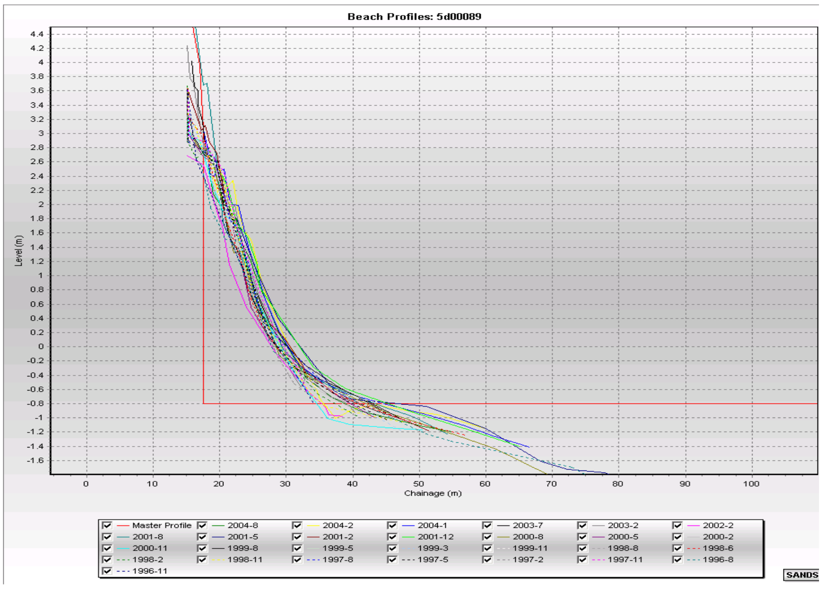

Figure 3. Beach profile graph for Colwell Bay (Southeast Strategic Regional Coastal Monitoring Programme Annual Report – Isle of Wight, 2004)

Provision has also been made for post-storm surveys. These surveys provide information on short-term changes as a result of storm events and allow for the effects of such an event to be measured.

4.3 AIRBORNE REMOTE SENSING

Airborne remote sensing techniques are used to capture data at a variety of sites, to provide coverage of special features, or where these techniques are either more practical or efficient than land based methods. Surveys for a total of 530km frontage are monitored exclusively by remote sensing techniques. The whole of the programme area is also surveyed by airborne remote sensing methods to provide supplementary data to the land based techniques (www.channelcoast.org, 2005).

Digital aerial photographs (Figure 4) are also taken as part of the programme. Both orthorectified and georectified images are provided in order to allow measurements of shoreline position to be gained in inaccessible areas. Georectified images, once transformed to the local co-ordinate system can be viewed or plotted within a Geographical Information System (GIS).

Digital georeferenced aerial photographs provide an excellent analytical medium, which can be used conveniently in combination with other types of georeferenced survey information. In particular, the images provide the opportunity for valuable interpretation of morphodynamic changes measured by reference to georeferenced profile data in combination with geomorphology (www.channelcoast.org, 2005).

4.4 BATHYMETRIC SURVEYS

Bathymetric surveys are carried out in line with the topographic surveys with similar baseline and interim surveys being carried out. The majority of lines are measured at 50m spacing although in ‘do nothing’ frontages the spacing increases to 100m. The use of differential GPS enables survey points to be

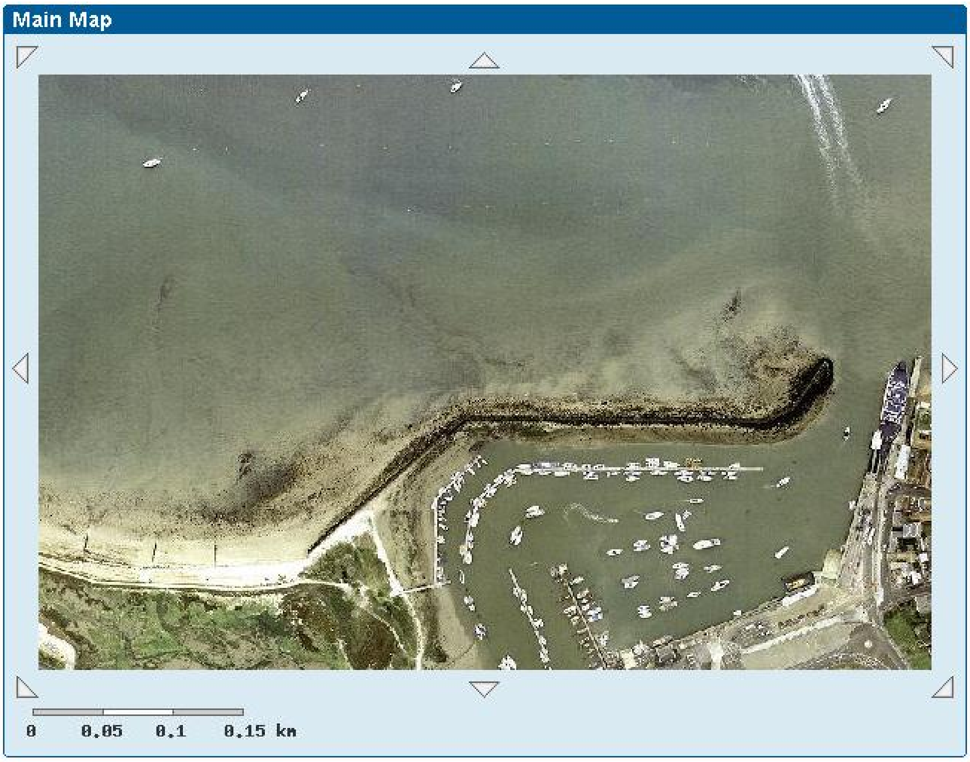

Figure 4. Aerial photo of Yarmouth Harbour (www.channelcoast.org, 2005)

coordinated to within approx. +/-1m. This is generally considered to be sufficiently accurate. Kinematic GPS can be used to improve plan position, but such systems are not widely used yet. The alignment of the survey vessel track is also significant. Straight profiles can rarely be steered to an accuracy of better than 1-2m. The use of DTMs to produce profiles is advantageous in these circumstances, since survey error will be reduced. Vertical accuracy varies enormously, depending upon sea state, but is typically no better than +/-0.15m on the open coast. Bathymetric surveys tend to produce more scattered results across areas of irregular rocky seabed, by comparison with regular seabed (www.channelcoast.org, 2005).

4.5 ENVIRONMENTAL MITIGATION MONITORING

In addition to the survey programme, a recent application has been made by the Isle of Wight Council for the South-East Strategic Regional Coastal Monitoring Programme to incorporate monitoring of Environmental Mitigation sites. DEFRA consents and planning consents require ongoing monitoring of flora and fauna for the lifetime of the project and it is hoped that this can be incorporated in to the monitoring programme.

5 ANALYSIS PROGRAMME – ANNUAL REPORT

On the 30th September 2004 the first Annual Report was produced for each of the areas within the Regional Monitoring Programme. Analysis presented in this interim report provided an overview of beach changes and wave and tidal measurements since the commencement of the Southeast Strategic Regional Coastal Monitoring Programme.

On the Isle of Wight the first beach surveys took place during the winter of 2002 and changes are reported until spring 2004. This provides a short time base over which beach changes have been monitored. Detailed interpretation and decision-making is not advisable on the basis of short-term changes, since the changes may not be representative of longer-term trends.

Data was presented at four levels:

- Process cell summary of aggregated change over one year
- Management Unit overview of one year's beach changes
- Plotted time series of beach profiles
- Trend analysis of beach cross-section area

The Management Unit overview (see Figures 5 and 6) provides an at-a-glance summary of changes during the past year. Colour-coded lines highlight areas of maximum change with the arrows representing the average accretion, no change or erosion for each Management Unit.

Analysis was conducted for those sites where a minimum of four surveys were recorded. Where possible, changes are measured relative to the Mean Low Water Springs level, although this is not possible at many sites for a variety of reasons. Where possible, longer-term records from earlier programmes are also presented in the profile analysis, although historical data were often collected using significantly different survey techniques, specifications and even datums.

With regards to the topographic survey data no significant change is shown for the majority of units in the north of the Isle of Wight. There is however notable accretion at Alum Bay and also between Cliff End and Sconce Point, whilst Totland Bay shows considerable erosion. The analysis indicated no net change in the units analysed in the south of the Isle of Wight.

The first baseline bathymetric survey of the Isle of Wight was completed in May 2003. No further analysis will be carried out until after the next baseline survey in 2006.

The Southern Half of the Isle of Wight (sub-cell 5e) shows no notable change in beach cross sectional area. In the northern half of the Island (sub-cell 5d) most change is at the western point. TOT 2 and NEW 1 show substantial accretion, while TOT 3, which lies between these two bays, shows significant erosion. On the eastern side of the island there is little change apart from slight erosion in RYD10 and accretion in RYD6. The northern tip of the Island shows no net change.

A full time series of plotted beach profiles are shown superimposed and relative to a master profile for each profile location (see Figure 7 as an example). The master profile provides the basis for calculation of beach cross-section area changes. Where possible, identical depth boundaries have been used for all profiles within a Management Unit. However, even where this has not been possible, direct comparisons can be made for the beach cross sectional area at one profile over time, since the master profile is constant for each profile. The trend in cross sectional area is presented as a graph for each profile.

Condition of individual Management Units is also provided in the report detailing specific movement for each unit.

6 CONCLUSIONS

The South-East Strategic Regional Coastal Monitoring Programme offers a standard and repeatable approach to coastal monitoring which has been lacking in the past. Although the programme is still in its early stages there have already been significant advances made in data collection and management as a result of the programme. It is hoped that approval will be granted in the next 6 months for funding for the next five years of the project. General consensus is that this should be the case as the programme is already offering significant advantages to previous methods of monitoring and that a long-term programme is essential for the effective management of the coastal zone.

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