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Intertidal Sediments and Geomorphology Characterisation - Methodology Report

Marine, Coastal and Hydrocarbons Programme

Internal Report OR/09/012

BRITISH GEOLOGICAL SURVEY

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Intertidal Sediments and Geomorphology Characterisation - Methodology Report

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Summary

This report describes the characterisation of beach sediment type and morphology for a trial area on Suffolk and Norfolk coast, from Orford Ness (637500 243900) to Winterton Ness (648500 321900).

1 Introduction

A method for classifying beach sediment type and morphology has been devised and tested along a section of coast in East Anglia, from Orford Ness (637500 243900) to Winterton Ness (648500 321900) (Figure 1). All data were acquired remotely, i.e. no fieldwork took place.

This section will join with other work offshore to create a seamless map to be displayed at 1:50,000 scale.

Figure 1 Extent of study area

2 Classifications

A new system for classifying beach sediment and morphological features has been developed.

Due to budgetary constraints within the project, it was not possible to carry out a field survey hence the classification has utilised aerial and oblique aerial photographs as the primary data source. To account for this lack of field survey ground-truthing, Confidence and Provenance fields have been included as meta data in the classification, which could be modified to reflect the quality of data available to surveyors in the future.

2.1 BEACH SEDIMENT CLASSIFICATION

The most accurate way to classify beach sediment is to sample and sieve it and to give the results as a particle size distribution. For this project, fieldwork was not possible so a new method of visually classifying the sediment was required.

The sediment classification adopted is a qualitative visual assessment of the sediment and is based on a judgement of the sediment components and their approximate proportion from remote data. It does not involve quantitative assessment of grain size and, for the purposes of this project, is designed to give the surveyor only an overview of what sediments are on the beach and their broad spatial distribution.

End member types are:
MUD (clay and silt = mud. It is not possible to differentiate between clay and silt remotely)
SAND
GRAVEL
BOULDERS
ROCK (denoting exposed rock platform)
Combinations of these end members give the overall sediment type.

Table 1 summarises this new sediment classification:

Table 1 Sediment classification

Quantity of sediment type 1	Quantity of sediment type 2	Quantity of sediment type 3	Example description
Major component	-	-	*Sand*
Major component	Minor component	-	*Sand with gravel*
Equal components	Equal components	-	*Sand and gravel*
Major component	Equal minor component	Equal minor component	*Sand with gravel and boulders*
Equal component	Equal component	Equal component	*Sand and gravel and boulders*
Equal component	Equal component	Minor component	*Sand and gravel with boulders*

2.2 BEACH MORPHOLOGY CLASSIFICATION

In order to classify beach morphology within the remit of this project, a qualitative visual assessment of beach form was developed. The basis for this assessment is presented in table 2 with published definitions of coastal geomorphology. These features could be readily identified from oblique aerial photographs and digitised on the vertical aerial photograph sets.

Table 2 (definitions adapted from Thomas & Goudie, 2000, Simm *et al.* 1996, USACE 2002)

Intertidal Morphological Feature	Definition	Example
Beach Ridge/Berm	Ridge: an accumulation of sediment running parallel to the coastline shaped by wave or other action. May occur singularly or as a series of approximately parallel deposits. Berm: commonly formed by deposition at the upper limit of the swash zone, near horizontal in form and marked by a break of slope at the seaward edge. Some beaches have no berms, others have one or several.	
Cusp	A three-dimensional, scallop-shaped beach form commonly occurring in regularly spaced sets along the coast.	

Supratidal Morphological Feature	Definition	Example
Storm Ridge	A shore-parallel accumulation of coarse sediments deposited on the beach above the high-water mark by high water levels brought about by storm action. This accumulation often forms a ridge or beach berm.	

2.3 CONFIDENCE SCALES AND PROVENENCE FIELD

Confidence and Provenance fields have been added to the beach sediment and morphology attribute tables. As it was not possible to ground truth the mapped polygons, this will help to ensure that future interpretations of this dataset are undertaken at an appropriate level.

These fields take into account the different types of data available to the survey, and therefore give a more accurate overview of the quality of data produced during the survey. These can be adapted and applied to other datasets.

For example, it was not possible to classify accurately beach sediment size from aerial photographs taken at more than about 1:300 scale. A visual field assessment would be more accurate but relies on the judgement of the surveyor. A sieved sample is the only method that would provide an accurate result.

2.3.1 Confidence

The Confidence Scale applied for this classification is as follows:
<u>How confident are we that the sediment type is correct?</u>

1. Low – external interpretation (e.g. map)
2. Small-scale oblique or aerial photo >1:300k scale
3. Large-scale oblique or aerial photo ≤1:300k scale
4. Field observation, visual only (not sieved)
5. High – sieved sample

<u>How confident are we that the morphology type is correct?</u>

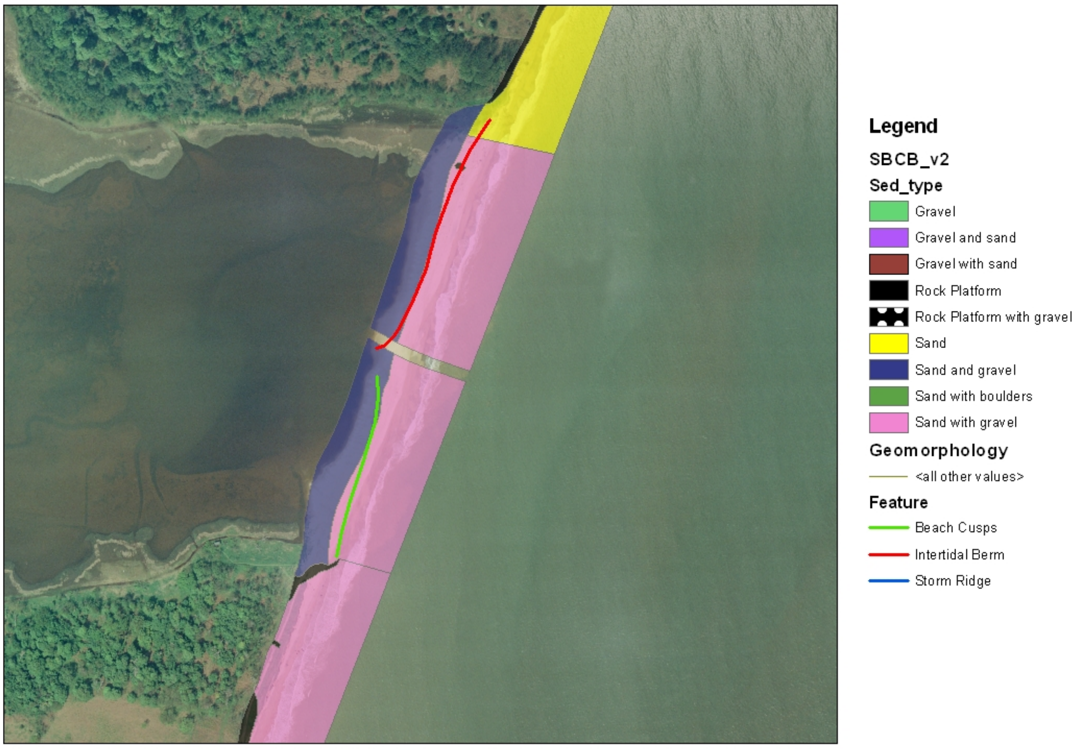
1. Low – external interpretation (e.g. map)
2. Small-scale oblique or aerial photo >1:300k scale
3. Large-scale oblique or aerial photo ≤1:300k scale
4. Field observation, visual only
5. High – surveyed (measured)

<u>How confident are we that the shape of the polygon is correct?</u>

1. Low – oblique photo
2. Map - >1 year old >1:10k scale
3. Map - <1 year old ≤1:10k scale
4. Aerial photo (vertical) >1 year and/or >1:300k scale
5. Aerial photo (vertical) <1 year old ≤ 1:300k scale

2.3.2 Provenance

The Provenance field is the full reference to the dataset giving details of date and scale.



3 Methodology

The sedimentological and morphological classifications described above were applied by delineating features seen on a series of oblique aerial photographs, and drawn as polygons in a GIS against georeferenced vertical aerial photographs and topographic maps.

3.1 DATA SOURCES AVAILABLE FOR THIS PROJECT

3.1.1 Oblique Aerial Photographs

A sequence of oblique aerial photographs were taken at approximately 1:300 scale. These were flown by a light aircraft and taken in January 2007 by Mike Page (Norfolk SkyView) as close to low tide as possible so as to maximise the beach exposure (Figure 2). These images are the main source of sedimentological and geomorphological information for this project.

Figure 2 Example of the oblique aerial photograph

3.1.2 BGS Aerial Photographs

These images were used as a guideline and as additional information and to fill in areas where the oblique aerial photographs did not give complete coverage. These photographs are georectified, approximately 1:2000 scale but were not flown with respect to the state of the tide.

3.1.3 Comparison of aerial photographs

The aerial and oblique aerial photographs used in this survey vary in scale so the confidence in sediment and morphology description varies. Figure 3 is a comparison of the amount of detail visible in both data sources.

3.2 NATURAL CHANGES IN BEACH SEDIMENT AND MORPHOLOGY

This classification does not take into account the natural variation and, in some cases, dramatic changes in beach sediment and morphology on various temporal scales. Accompanying the classification is metadata regarding the date the aerial photographs were flown, for example. This means the mapped polygons have a 'date stamp' and can therefore be compared to other data captured at a different time or season.

Figure 3 Example of the difference of best resolution and quality between the aerial and oblique aerial photographs.

3.3 DEFINITION OF UPPER LIMIT OF BEACH SEDIMENT

The landward limit of ‘beach sediments’ is difficult to define. MHW line could not be used. There was a lot of debate about where to draw this line. For example, the whole of Orford Ness could be considered to be composed of beach sediment, but much of this is relict beach material, is built upon, or is densely vegetated.

The concluding decision was to use the limit of non-vegetated sediment as a proxy for the limit of “active” beach sediment. This line was difficult to determine where very sparse vegetation gradually merges into dense vegetation. In other areas the base of cliffs or edge of man-made ‘hard’ defences were used which formed a more obvious demarcation.

3.4 DEFINITION OF LOWER LIMIT

The lower limit is drawn arbitrarily below low tide level. It is not implied that the sediment type represented immediately above the low tide mark, extends to the outer limit of the polygon, although further interpretation could be made if evidence were available of nearshore sediment characteristics.

4 Limitations and recommendations

4.1 SCALE.

In order to classify the sediments, the photographs were analysed between 1:300 and 1:1,000 scale. The aim of this project is to display the data at 1:50,000 scale. This will not show many of the classification features and the geomorphology will be lost entirely. It is suggested that the final product has schematic line work.

4.2 NATURAL CHANGES IN BEACH SEDIMENT AND MORPHOLOGY

As previously discussed, this classification does not take into account the natural variation in beach sediment and morphology. Several surveys over different seasons and year intervals and a layer of ‘changeability’ using the Futurecoast data may be useful.

4.3 DIFFICULTY IN MATCHING OBLIQUE AND AERIAL PHOTOGRAPHS

The best source of information available for this project was the oblique aerial photographs. The line work was taken from the oblique photographs and transferred onto the georeferenced vertical aerial photographs. A great deal of time was spent pinpointing features, especially where changes have occurred in the time between aerial surveys. There are some gaps in the oblique photo coverage. The digitising work took much longer than expected due to the difficulty in selecting features seen in the oblique photographs, and drawing them in the correct place on the vertical images. These difficulties were twofold:

(i) lack of distinctive points in areas of few landmarks such as sand dunes

(ii) substantial changes in the coast in the intervening period between vertical and oblique aerial photographs (over a decade in places)

Using georeferenced images would solve this problem; ideally high resolution, stereo pairs.

4.4 AVAILABILITY OF OBLIQUE AERIAL PHOTOGRAPHS ELSEWHERE

Without another flight survey, it is very unlikely that aerial photographs such as the oblique aerial photographs used in this survey will be able available for other parts of the coast in Britain.

4.5 RESOLUTION OF VERTICAL PHOTOS

The resolution of the vertical aerial photographs was not sufficient to pinpoint features. Due to their age and low resolution, it would not be possible to work from the existing vertical aerial photographs alone. As mentioned above, georeferenced, high resolution stereo images would be ideal. Some other form of remote sensing e.g. hyperspectral survey could be considered.

4.6 INCLUSION OF DEFENCES?

Man-made defences have not been digitised in this survey. Anthropogenic changes such as movement of beach sediment by bulldozers cannot be distinguished from natural features. Man-made defences could be mapped.

4.7 THE NEED FOR FIELDWORK FOR THIS TYPE OF SURVEY

This survey could have been completed in far fewer days if a fieldwork component had been built into the project. Given the difficulties explained above, the project team agree that it would be more efficient, and give a much greater level of confidence, if the data were acquired by field survey or as desk study complimented by ground truthing.

By creating a map of polygons from remotely collected data of varying quality and despite the confidence and provenance fields, there is a danger that other parties will use these data assuming they have been captured with a more reliable methodology than was the case.

It is strongly recommended that an obvious caveat is applied, should this map be used by anyone else in the future.

4.8 FUTURE WORK

Recommendations for further work could include a comparison with the Futurecoast data.

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