SALTMARSH ANALYSIS

Method Indicator		
Bottom-Up	Hybrid	Top-Down
		YES

Summary of key issues

Issue	Description
Description	Analysis of changes in saltmarsh distribution, including erosion / accretion studies, and functioning of saltmarsh systems.
Temporal Applicability	Medium to long-term dependent on data availability.
Spatial Applicability	Estuary-wide, or specific areas of saltmarsh.
Links with Other Tools	Can be an important component of Historical Trends Analysis and EGA.
Data Sources	• Aerial photography; • Satellite imagery; • LIDAR; • CASI; • Historic and current maps and charts; • Geological maps; • Ground-truthing.
Necessary Software Tools / Skills	Software for image analysis; appropriate ground-truthing knowledge; GIS.
Typical Analyses	Erosion / accretion studies, through analysis of movement of the saltmarsh edge and changes in the saltmarsh elevation.
Limitations	Data availability, cost.
Example Applications	Saltmarsh vegetation classification and changes in saltmarsh extent in Southampton Water.

The study of saltmarsh is, in part similar to historical trend analysis, in that it can involve the analysis of maps, charts and other archives to establish how the marsh may have changed over time, and this analysis can form an important component of historical trend analysis. However, saltmarsh analysis can also entail mapping the flora and studying aspects of saltmarsh dynamics and community. Aspects such as hydrodynamics, hydrology, geochemistry and biochemistry can all influence the ecological functioning of the marsh (Gray, 1992; Packham and Willis, 1997). The marsh stability may therefore be a function of biological, chemical and physical factors, which in combination can influence how the saltmarsh interacts with the estuary geomorphology.

Aerial photographs and appropriate analysis software can be used to obtain vector datasets of attributes such as the marsh edge, notional shoreline, cheniers (crescentic accumulations of shell material sometimes present on the front of the marsh), pans (localised depressions in the march surface) and creeks. In this type of analysis errors can arise from a number of sources including:

- Misinterpretation of the marsh frontage, either due to poor quality coverage or poor contrast;
- Omission of areas that are marsh;
- Inclusion of marsh that is reclaimed (i.e. at least partially behind a seawall);
- Areas where there is lateral shift demarked in the data but, given the known stability of the creek system, is considered unlikely to have occurred;
- Poor resolution of photographs; and
- Decisions on how to close off features (e.g. the width towards the head of a creek that is used to end the feature).

Many of these problems relate to the quality of the early photographic coverage and the ability to determine the marsh front due to its varying morphology and different levels of algal cover. For more recent years it is increasingly possible to obtain CASI imagery, which helps delineate the vegetated areas and even classify the different types of flora (Figure 1). Such data sets can now be combined with detailed elevation maps, obtained using techniques such as LiDAR, to further improve the extent and confidence in the vegetation classification. Even so, some ground truthing is usually required to help train the classification software and provide a quality check from one survey to the next, requiring the identification of the different saltmarsh plants (Burd, 1991).

Given a series of images, it is possible to carry out a change analysis (Burd, 1992). With aerial photographs as the source, this is likely to focus on movements of the marsh edge, see further information in Historical Trends Analysis (Figure 1). However, using the photographs themselves, it is possible to also look at percentage vegetation cover and identify any internal dissection of the marsh surface. With classified vegetation maps (as obtained using CASI) it is possible to look for changes in the community structure of the marsh as well as the overall area.

Detailed, ground-based surveys (such as those undertaken by Burd, 1989; Hemphill & Whittle, 2002; Stark *et al.*, 2002) can be used to show saltmarsh change. Changes may be quite small (a few mm change in level), but nonetheless significant. However, such surveys are resource intensive and expensive to undertake on an estuary-wide scale. Remote sensing can provide the opportunity for more frequent observations, albeit at a coarser scale. Satellite imagery is currently under-utilised as a source of information on change in coastal habitats. However, satellites can cover large areas and record cumulative and significant effects, although they are less useful for measuring more rapid or small-scale change. Until recently, only a very coarse scale of resolution could be obtained (10 to 20 m, limiting the level of detail available), but recent improvements in periodicity and resolution have reduced this (in some cases to about 1 m) and thus, at a strategic level, the need for more traditional forms of spatial survey might be reduced. However, for this to be achieved there must be a clear relationship established between the satellite imagery and the situation 'on the ground'. This rectification is achieved by comparison with direct land measurements, which becomes more appropriate the larger the area to be covered and the greater the frequency between surveys (Royal Haskoning, 2005).

LIDAR can also be used, in conjunction with other remotely sensed data, for the production of cost-effective terrain maps, which can then be used to assess coastal erosion and geomorphology. The information can also be used to define or characterise land to be set aside for managed realignment or habitat re-creation. The combination of a terrain map and vegetation coverage can be used to determine if vegetation is at the right niche level in relation to the tidal frame, and can also be used to indicate the way the saltmarsh at a location is functioning.

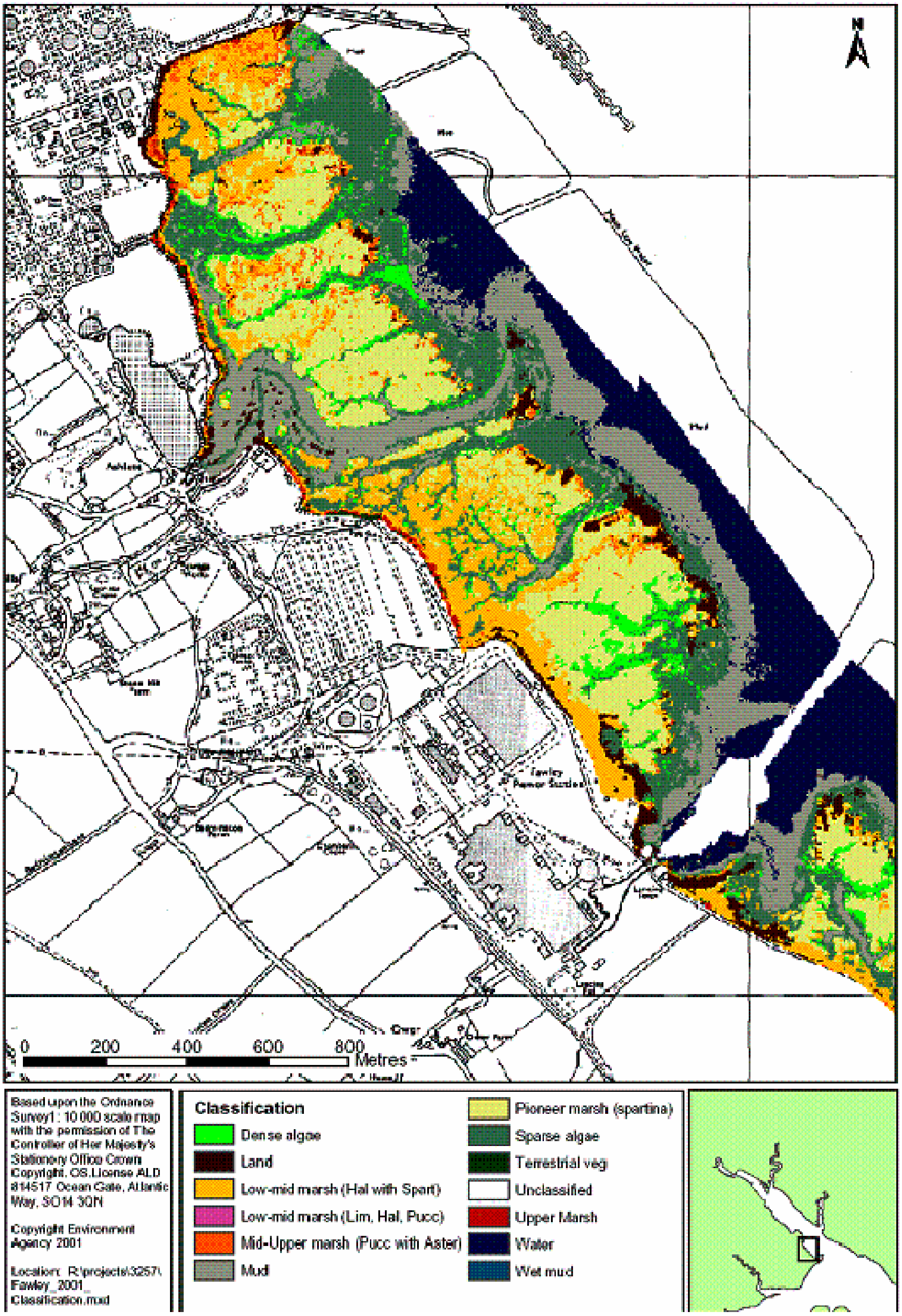

Figure 1. **Example of saltmarsh vegetation classification from CASI imagery taken in 2001**

It is also possible to generate routines to allow for the removal of surface features from the datasets, including vegetation, such that it may be possible to measure gross change in saltmarsh surface levels using successive surveys. Successful measurement of erosion or accretion helps to identify areas that show a net decrease in the area of saltmarsh. It also provides a means of assessing the effectiveness and long-term evolution of those areas currently subject to management, particularly where re-creating or restoring saltmarsh is a key component.

Ground-based measurements of saltmarsh vegetation reflectance, using a portable spectroradiometer, can also be used in combination with remote sensing data to inform saltmarsh management (through the provision of a spectral signature), for example, in relation to grazed and non-grazed saltmarshes. This approach can also, with expert interpretation, distinguish different (assemblages of) vegetation, although again ground-truthing is probably required (Royal Haskoning, 2005).

Further information on saltmarsh ecology, and management issues, particularly where they are considered as part of the coastal defences, can be found in the literature (Allen and Pye, 1992; Toft and Maddrell, 1995; Packham and Willis, 1997; Friedrichs and Perry, 2001; Royal Haskoning, 2005).

Example of previous applications of the approach

Historical saltmarsh area changes in Southampton Water

To quantify changes in saltmarsh coverage at Calshot in Southampton Water, aerial photograph analysis was used by ABP Research (2000a) to obtain the spatial distribution of saltmarsh boundaries. These were captured between 1946 and 1999 at approximately decadal intervals (Figure 2). A complete coverage of the estuary was limited by data availability. Due to the land reclamation in the area, the changes in saltmarsh coverage are confined to the area seaward of the present day sea defences in Southampton Water. Aerial photographs were analysed to provide digital datasets using analytical stereoplotting instruments. Furthermore, specialist training was provided for the intertidal zone feature identification. Ground controls were established from a number of reference points collected from the most recent 1:10,000 OS maps. The purpose of the aerial sequence was to take advantage of the recent high quality colour photographs and where marsh features were clear, before commencing analysis of older and black and white prints.

In addition to the marsh front, water line and notional shoreline, two other vector datasets, were digitised; cheniers (crescentic accumulations of shell material on the front of the marsh) and areas of indistinct marsh (areas which potentially represented areas of previous die-back of saltmarsh plants). The delimitation of the cheniers was limited to the morphological ridge which appears on the front of some marsh areas.

Most of the problems in interpreting change related to the quality of early photographic coverage and the determination of the extent of the marsh due to varied marsh frontage morphology and different levels of algal cover:

- The misinterpretation of the consistent marsh frontage, either due to poor quality coverage or poor contrast;
- The omission of areas that are marsh;
- The inclusion of marsh that is reclaimed - where the marsh structure appears intact but the marsh is at least partially reclaimed and behind a sea wall; and
- Areas where there is lateral shift demarked in the data, but where such apparent movement of marsh creeks is thought to be very unlikely, since creeks are usually very stable morphological features.

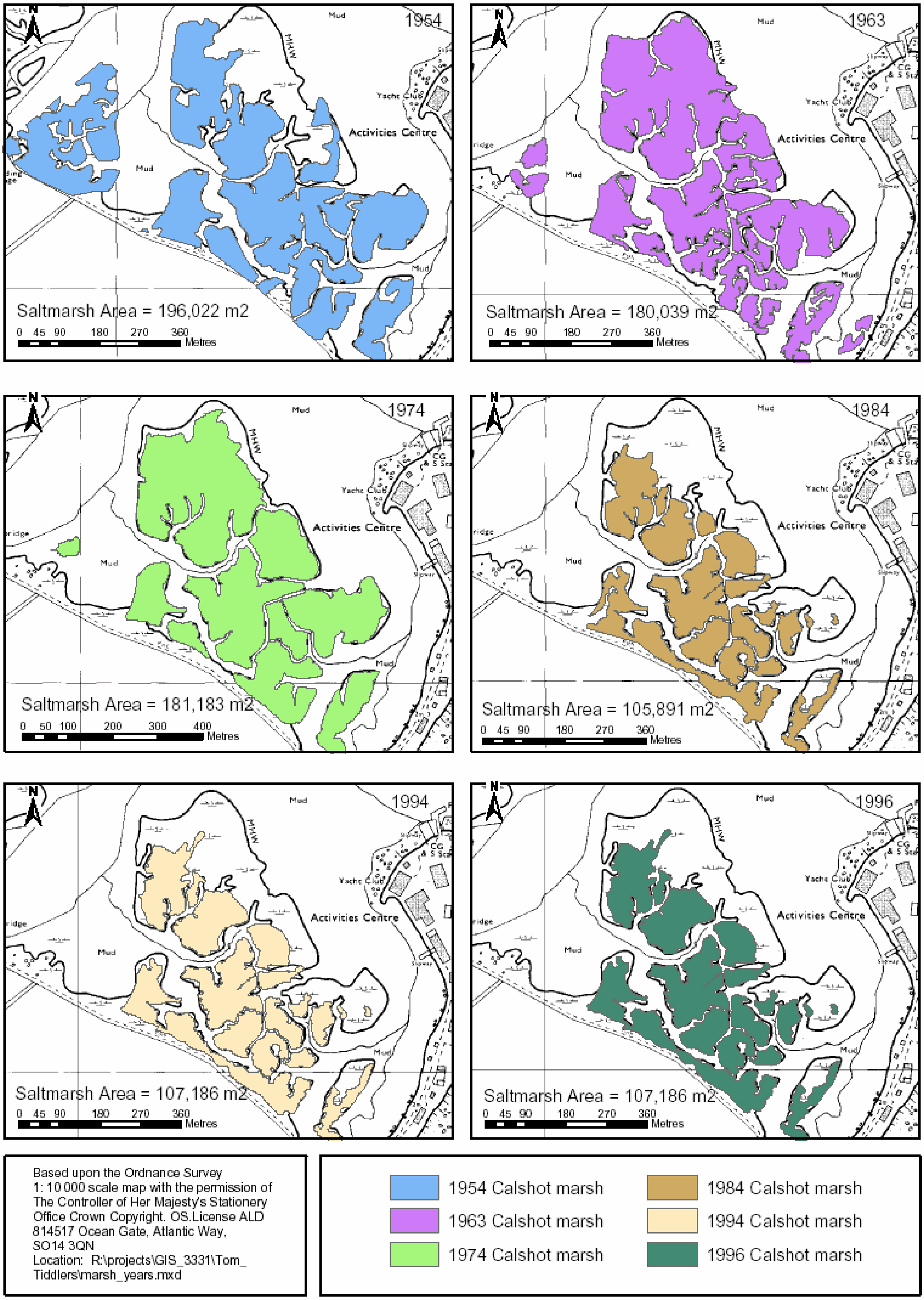

Figure 2. **Changes in saltmarsh coverage at Calshot between 1946 and 1999, ABP Research (2000a)**

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