

## COASTAL MAPPING AND DATA SOURCES IN SOUTH-WEST ENGLAND

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Chisholm, N.W.T. 1996. Coastal mapping and data sources in south-west England. *Proceedings of the Ussher Society*, 9, 021-024.



Whilst the Ordnance Survey and the Hydrographic Department discharge their statutory responsibilities with regard to national mapping and hydrography, there exists a need for bespoke mapping and survey data to define and monitor physical forms and processes. The study sets the availability of many aerial photography sorties covering the coastal areas of south-west England against the use to which these data sets are put by those with coastal interests and responsibilities. The problems of coastal site mapping and the derivation of quantitative data are related to factors which include costs, personnel, equipment and the adoption of alternative methods of collecting and portraying data.

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### INTRODUCTION

In terms of variety of landscape and susceptibility to geomorphological change, the coastal zone has much to offer. In south-west England in particular, a combination of wave regime dominated by the storm wave, high tidal ranges and geological variety render its coastal zones an excellent centre for the study of coastal processes and their impact on coastal zone management strategies.

Coastal environments may be hostile to ground-based survey techniques and are often subject to rapid change. Furthermore, some coastal areas have a high recreational or amenity value, are of economic or industrial importance and contain locations or sites that are regarded as being of great scientific significance. These attributes have the potential for creating a higher than usual demand for spatial information.

### SPATIAL DATA REQUIREMENTS

In addition to academic coastal research, bodies such as the legal profession, the industrial sector, local authorities, English Nature and those directly responsible for Areas of Outstanding Natural Beauty (AONB), National Parks, Heritage Coasts and National Nature Reserves all have remits which include the acquisition and use of coastal zone information apart from the national statutory requirements such as the Coast Protection Act 1949, Land Drainage Act 1976 and the Wildlife and Countryside Act 1985.

Observation or measurement is essential for understanding both the process and response variables operating to shape and alter the coastal zone. The differences between these two aspects of coastal study cause them to be measured in different ways and by different techniques. Some historical examples of observations made of dynamic phenomena include the instrumental measurement of flow processes over shingle beaches (Kirk, 1973), radioactive tracers to determine longshore movement (Kidson *et al*, 1958) and fluorescent dyes to monitor the movement of beach sand in the surf zone (Ingle, 1966). These types of study are aimed at gaining a better understanding of the mechanics of the processes involved as a means of explaining the derivation and development of existing and future landforms. In general, such studies are instrumentally-based and usually confined to specific sites.

Aerial photography has much to offer in the determination of coastal processes (Sonu, 1964) in both the appreciation of contemporary physical changes not readily determined by ground-based methods and in monitoring historical development of coastlines (Moffitt, 1969). Plan forms and profiles may be determined at one

moment in time and, by sequential aerial photography, useful data may be gathered on the changes taking place. Retrospective examination of the coastline may only be made by older aerial photography, generally the post-war RAF cover, or by recourse to examination of historical cartographic data, a course of action fraught with dangers because of generalisation problems and lack of knowledge of survey dates and accuracies (de Boer and Carr, 1969; Carr, 1969).

### SOURCES OF AIR PHOTO DATA

#### *The Hydrographic Department (Ministry of Defence)*

The Hydrographic Department supplies the following type of survey information:

1. The coastline as defined by Mean High Water Spring tides.
2. The drying line and inter-tidal detail and drying heights.
3. Underwater detail of interest to the safety of navigation and, where possible, photobathymetry of inshore waters.
4. Updating of mapping of topography of interest to the mariner.

The majority of the photography used to accomplish these tasks comes from the Ordnance Survey, flown under contract to the Hydrographic Department. This is 1:10,000 scale vertical black and white infrared photography and provides a record of the coastal zone extending approximately 1 km inland around the entire length of the British Isles. This photography is only acceptable if the height of the water shown on the photography is within +0.3 metres of MLW; this calculation is derived from the time of the photography and the data, supplied to the Ordnance Survey by the Hydrographer, on times and heights of tides at the Standard Port, plus time differences to the Secondary Ports "sandwiching" the photography. The majority of these flights have taken place between 1962 and 1974 from cover which spans the period 1955 to 1985 (Figure 1). Ordnance Survey sales show that this data source has been little used, or perhaps little known, as a potential information source.

#### *The Ordnance Survey*

Examination of the OS large-scale aerial photography taken since 1970 shows that there are around 1400 individual flight lines covering British coastal areas but these are often individual lines flown at

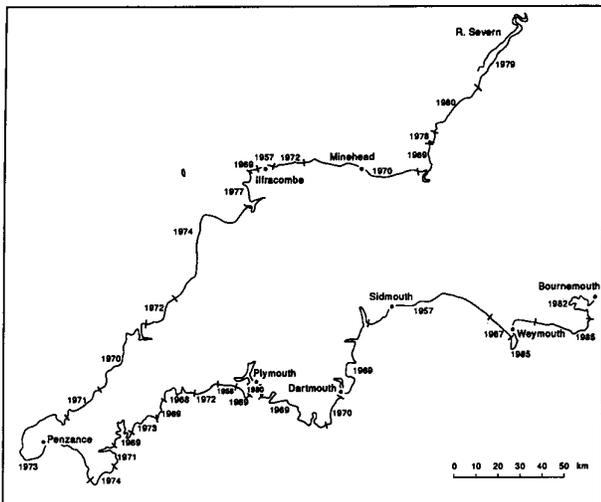


Figure 1. Dates of Ordnance Survey black and white infrared coastal air photo cover.

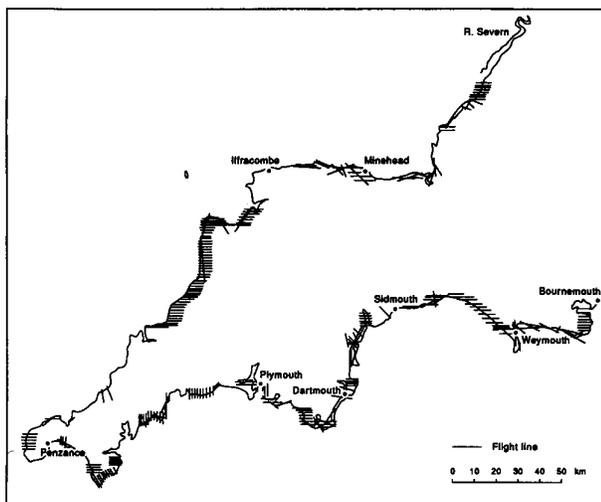


Figure 2. Ordnance Survey large-scale panchromatic coastal air photo cover.

different dates and scales and adjacent lines do not necessarily form "blocks" of photography. Individual lines have been plotted for south-west England (Figure 2).

Approximately 70% of this photography has been taken with a 12 in. focal length camera resulting in a scale of 1:7,500 whilst the remaining 30% (6 in. focal length) yields 1:10,000 - 1:12,000 scale cover depending on the flying height used. Particular sites have been flown at a larger 1:5,000 scale for the purposes of OS resurvey and/or revision. These include Weymouth, Dawlish, Newton Abbot, Brixham, Plymouth and Avonmouth.

*Royal Air Force*

In terms of completeness of national cover the RAF photography undertaken during the period 1945 to 1960 is the most extensive. However, unlike the OS, whose programmes include recognition of the need to supply some cover flown parallel to the coastline, this RAF photography was "blanket" cover which made no such provision. From the point of view of coastal interests, therefore, this air photo archive suffers from several deficiencies, amongst which is the fact that the general orientation of the flight lines is in an east-west direction. For those stretches of the coastline which do not happen to match this orientation, use of RAF cover involves examination of a

large number of photographs from adjacent strips. Furthermore, this air photo collection is of variable quality and scale and a substantial volume of it is non-vertical, fan or split-vertical i.e. tilted about 5 to 10 degrees from the vertical. The scale of much of this vast undertaking was a nominal 1:10,560 but it was flown by RAF pilots accustomed to reconnaissance standards and is not comparable in quality with the later survey photography flown to photogrammetric standards.

The more recent higher quality cover was flown in 1969 when the photography was again panchromatic but at a scale of 1:60,000 and again in the period 1976-1981 at a scale of 1:50,000. Because of the small scale of these photos and the flight line directions they are of limited value for larger scale coastal studies. However, together with the earlier sorties, they form an extremely valuable resource not least for their ability to provide a "base-line" and a time series against which changes can be measured.

*MAFF Air Photo Unit*

From its inception in 1974, the activities of the MAFF Air Photo Unit were to provide aerial photography and interpretation services to the Agricultural Development and Advisory Service (ADAS) branch of MAFF. Until 1980 these tasks were accomplished mainly with 70 mm Hasselblad photography, by which time the unit acquired a Wild RC5 survey camera. This development led to sales of the metric vertical photography to outside parties. From 1984 an increasingly commercial attitude was encouraged and there was greater emphasis placed on involvement in commercial air photo contracts rather than just being a service unit to MAFF. Although the ADAS interests predominate

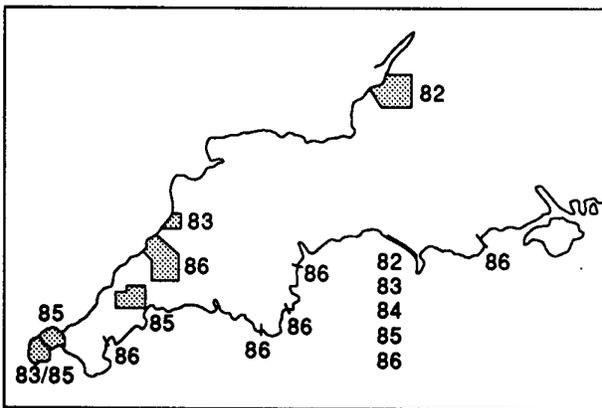


Figure 3. MAFF vertical air photo sorties including coastline. Numbers indicate the date flown.

and are mainly inland, the cover flown does indicate the potential of this air photo source in coastal studies (Figure 3).

*Cambridge University*

The Cambridge University Collection of Air Photographs contains over 400,000 oblique and vertical air photographs taken over the past 50 years. This air survey unit has its own aircraft based at Cambridge airport and although the primary purpose has been to serve academic needs it does undertake photography of many kinds by commission. This it accomplishes with a Wild RC8 survey camera for vertical photography and a hand-held Hasselblad 70 mm camera for obliques. Thus there are many parallels with the MAFF situation which the Cambridge University arrangement precedes by many years. A great number of the sorties flown have been on behalf of English Nature (formerly the Nature Conservancy Council).

Data relevant to coastal areas have been extracted from this extensive air photo archive - containing around 14,000 coastal prints nationally - and the extent of the coastal cover of south-west England plotted (Figure 4). The irregularity of most of the shapes depicting this

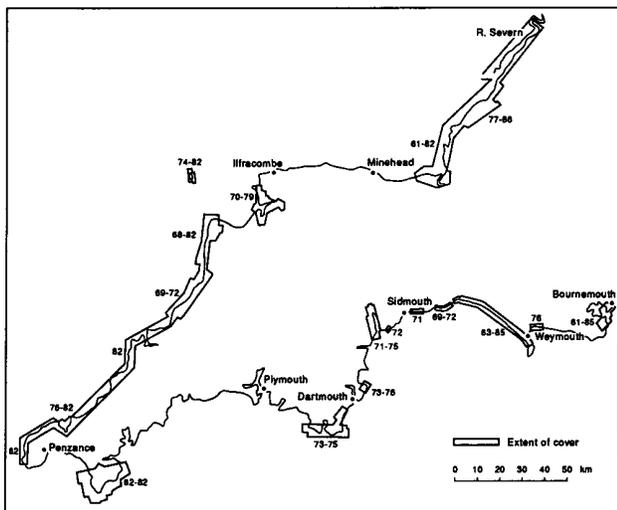


Figure 4. Coastal sorties with dates from the Cambridge University Air Photo Collection.

cover is indicative of the fact that they frequently delineate the limits of photography from many different sorties. The scales of photography vary but all tend to be larger than that to be found in most other sources, being in the range of 1:2,500 to 1:10,000, and most are panchromatic. An exception to this is the 1:15,000 scale North Cornwall (sic) coast cover, from Hartland Point to Land's End, flown at the end of July 1982. In addition to this, particular sites of interest which have been covered by vertical and/or oblique cover are listed in Table 1.

SITE	YEAR(S)	SITE	YEAR(S)
Sand Bay/Middle Hope	1964	Slapton Ley	1973
Lynmouth	1970	Berry Head	1962/73/76
Braunton Burrows	1970/74/75/80	Dawlish Warren	1973/75
Northam Burrows	1977	Exe Estuary	1966/75/80
Taw-Torridge Estuary	1978	Lyme Regis cliffs	1950/55/56/58 /66/70/72/82
Lundy Island	1974/82/83	Lyme Bay	1972
Isles of Scilly	1971/83	Chesil Beach	1963/65/70/72 /77/80/85
Marazion	1971	Portland	1965/72
Porthleven Sands	1971	Weymouth Bay	1976/83
Lizard Point	1971/82	Lulworth Cove	1971
Treleaver Cliff	1973	Studland Heath	1952/55/61/62 /70/81
Coverack	1973	Arne Bay/Heath	1952/56/58/60 /71/80/81
Plymouth	1983	Brownsea Island	1959/62

Table 1. Cambridge University coastal sorties.

### Commercial Air Survey Sources

The difference between aerial cover undertaken at the national level, and exemplified by Ordnance Survey and RAF photography where relative uniformity of specifications exist, and that flown by commercial organisations is normally the diversity of contracts. The maximum aerial coverage for any one contract is usually to provide county, or equivalent, cover often coincident with census years (Figure 5). On the other hand, over the years, and particularly in the 1960s and 1970s, commercial survey organisations like Hunting Surveys Ltd, Clyde (formerly Fairey) Surveys Ltd, J.A. Story and Partners, B.K.S. Surveys Ltd, Meridian Airmaps Ltd, Precise Surveys Ltd and Cartographical Services Ltd provided purpose-flown metric photography for a variety of users. The majority of such sorties was

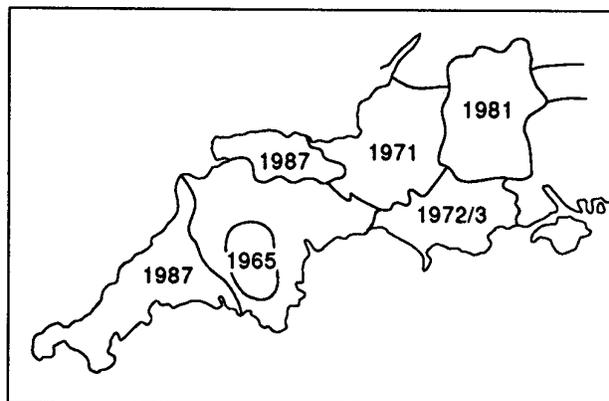


Figure 5. Commercially flown panchromatic air photo coverage to 1987.

commissioned by industrial organisations such as extraction, development and road construction industries and the contracts usually involved precise photogrammetric mapping. That is, the photography was a means to an end and not an end in itself.

The demise of the UK air survey industry resulted in only one company, Geonex UK Ltd, being active in a major way by the early 1990s in the air photo market. In 1994, however, Geonex's assets were acquired by the National Remote Sensing Centre (NRSC) and it has preserved the colour air photo archive which Geonex had established. The NRSC has also developed its own air photo capability and is continuing to expand the colour coverage by flying extensive areas of the country at 1:25,000 scale (Figure 6). A full suite of air photo interpretation and photogrammetric mapping services are also offered

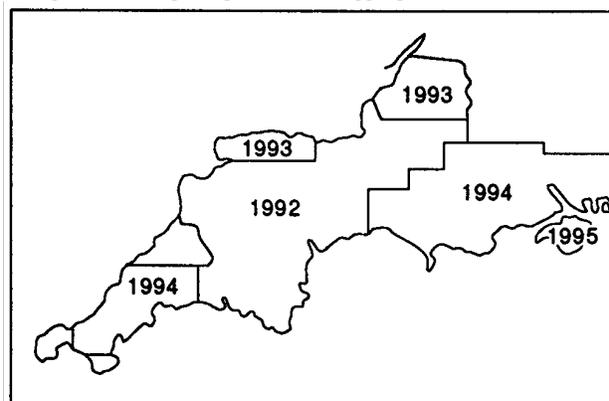


Figure 6. NRSC 1:25000 scale colour air photo archive to 1995.

and these, and the colour photography itself, can be supplied in digital form if required.

### AIR PHOTO USAGE

Research has shown that aerial photography is usually commissioned by a Chief Planning Officer or a committee of the planning and technical departments of county and district councils, or by the regional officer or Head of Policy in the case of English Nature and National Parks. These are usually distinct from the range of people who will be users of the photography and who may, or may not, be empowered to suggest the need for air photo cover as an essential data source.

Just under 90% of photography commissioned has been black and white (panchromatic) at a scale of 1:12,000 or larger whilst the only other significant (5%) cover has been oblique. This is true of the stock of existing air photos but it is undoubtedly true that since the mid-1980s the frequency of true colour photography has increased and that

increased and that at the present time it is the predominant film type. Near monopoly by Geonex and latterly by the NRSC has encouraged the demand for colour, due in part to advances in film /filter/camera technology, but also to the perceived usefulness of colour over panchromatic by the user population.

With the exception of the Highways Departments of County Councils, whose main requirement is that photography should meet Department of Transport specifications for photogrammetric mapping purposes, there is a general looseness in air photo specification. There is no apparent consensus on the time of year when photography should be taken although summer cover forms a small majority. Generally, too, there are no conditions, eg. regarding week-day, weekend or time of day, or, more importantly, accuracies, stipulated in commissioned sorties. Although English Nature, in acquiring photographic data for its coastal reserves, usually demands cover at low tide, this is not a common specification for the majority of other users for whom the state of the tide is seemingly unimportant. Surprisingly, this also applies to "ports and harbours" users.

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