

NATURAL HABITAT STATUS OF SOME SINGAPORE SOUTHERN ISLANDS BEFORE MAJOR LANDUSE CHANGES

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ABSTRACT

Some of Singapore's southern islands will be extensively modified for development purposes. Some will be merged through reclamation to create larger land areas for petro-chemical industries. Others designated for recreational purposes, will be linked by bridges. Still others will have their coastlines modified to accommodate a solid-waste dumping ground. These construction activities will inevitably cause major changes to the natural habitats of affected islands. This paper records the present status of natural resources of these islands before the expected changes, based on satellite images analysed by microBRIAN (a PC-based remote sensing software developed by CSIRO of Australia). The resource maps developed from this study provide baseline information for future comparison, especially for assessing the impact of development.

INTRODUCTION

The Republic of Singapore consists of the main island and about 58 islets within its territorial waters. It is approximately 136.8 km north of the equator, located between latitudes 1°09'N and 1°29'N and longitudes 103°38'E and 104°06'E. The main island of Singapore is about 42km from east to west, and 23km from north to south.

The land area of Singapore has been increasing since the 1960s due to foreshore reclamation at various parts, especially along the southern coastline of the main island (Chou, in press; Teo, 1993). For example, on the main island itself, 64ha was reclaimed for saw-milling industry between 1965 and 1970 at the Kranji Industrial Estate in the north. At the eastern coast, 663ha of land was reclaimed by 1976 to build the Changi International Airport. The reclamation project at Changi is still on-going in order to create another 500ha of land for the fourth terminal and a new runway by 1997. Also along the east coast, 1,525ha of land was created for recreation and housing purposes, after 22 years of reclamation between 1963 and 1985. On the southern coast, a former ship anchorage area was transformed into the present Marina South, a 600ha landfill for entertainment and recreation centres, including a large field for kite-flying. On the western front, more than 1,000ha has been reclaimed for the marine industry at the Tuas area. Many of these areas are still under additional reclamation for all sorts of development.

With its continuing land reclamation, Singapore is literally growing in size all the time. From an area of 581 km² in 1966, the combined total land area of the Republic has increased to 625.6km² in 1989 (Ng, 1989) and by 1992, the area was 641.0km² (Law et al., 1993). Future reclamation plans will add a further increase of 15% to the land area (Yong *et al*, 1991).

Besides the main island, some of Singapore's southern islands will also be extensively modified for development purposes. For example, Pulau (=island) Ayer Chawan and its surrounding islets will be merged into a single land mass to support a massive multibillion-dollar petroleum and chemicals complex within 10 to 15 years (Anon., 1991). These islets will then become a 2,000ha industrial area by the year 2010 (Teo, 1993). In 1989, the eastern sea of Pulau Semakau was designated as a solid-waste dumping ground (Anon., 1989) and is expected to handle garbage disposal through to the year 2045 (Nathan, 1993). Recently, a plan to link the St John's and Lazarus islands and Pulau Renget was announced, the aim being to transform these islands into a marine village for residential and recreational use (Dhaliwal, 1994).

All these activities will inevitably cause major changes to the natural habitats of the islands. In order to keep a record of the status of these islands' natural resources, and to provide some baseline information for future

references, especially for assessing the impact of development, an analysis was made of some of these islands based on satellite images taken before development commenced.

MATERIALS AND METHODS

Image Data

The images used in this study were taken by SPOT MSS on 18 June 1986 and Landsat Thematic Mapper (TM) on 24 May 1989. All three channels of data from the SPOT imagery were used for analysis but for the Landsat TM data only channels 1, 2, 3 and 5 of the seven channels were used.

Image processing

The images were classified using the microBRIAN, a PC-based remote sensing software developed by CSIRO of Australia. The two main areas that were classified included the Ayer Chawan group of islands, and the Pulau Semakau area. The methods of processing the images were carried out as reported in Loo et al, 1991, 1992. In this study, the analyses were concentrated on the reef flats of the various southern islands. Some of the results were taken from a previous study (Loo et al., 1991).

RESULTS

Pulau Ayer Chawan Area

There are seven islets in this group, viz., Pulau Merlimau, Pulau Seraya, Pulau Ayer Merbau, Pulau Ayer Chawan, Pulau Pesek, Pulau Pesek Kecil and Pulau Sakra. These islets are to be merged by the year 2010 to create 2,000 ha for petro-chemical industry. The combined land area before reclamation was 657.5 ha.

Figures 1 and 2 show the classified resource maps of the reef flats surrounding the seven islets generated from the 1986 SPOT and the 1989 Landsat TM data, respectively. The 1986 data were classified into 6 classes (Fig. 1) while the 1989 data resulted in 8 classes of reef resources (Fig. 2). The total area of reef flats calculated from the SPOT data was 442.08 ha while the area calculated from the TM data was 486.72 ha. These differences could be due to the different intrinsic nature of the two satellite images in terms of the resolution of the imagery and the band wavelengths used for sensing. However, both maps show very similar patterns in the size and spatial distribution of the reef flats. There was no significant change in the reef configurations between 1986 and 1989.

Pulau Semakau area

This area includes Pulau Semakau, Pulau Sakeng and several patch reefs, viz., Terumbu Semakau, Terumbu Raya, Terumbu Jerat, Terumbu Pernalang Besar, and Beting Bemban Besar. Based on our previous analysis using the 1989 TM data (Loo et al., 1991) this region had an area of 395.19 ha of reef resources, comprising 7 clustered classes (classified map not shown).

Other southern islands

The remaining of the southern islands include the Pulau Hantu region, the Pulau Sudong region and the Sentosa Island region. Based on the 1989 TM data (Loo et al., 1991), Pulau Hantu had 221.13 ha of reef flat, Pulau Sudong 341.94 ha and Sentosa Island 136.88 ha (classified maps not shown).

DISCUSSION

The various components commonly found on a reef flat in Singapore include coral rocks, live corals, sand patches, seagrass and algae. As ground truthing was not carried out during 1986 or 1989, the components of resources classified from the satellite images cannot be confirmed. However, these results show that the reef flats of the southern islands were extensive and rich. Based on field surveys, reef life, particularly in the

shallow zones, was diversified (Lim et al., 1990). Chou (in press) showed that there was a significant difference in the life coral cover on the upper reef slopes between reefs which had the reef flats reclaimed and those with intact reef flats.

The reef flats off Pulau Ayer Chawan and the surrounding islets (Fig.1 and 2) will be totally buried when the proposed reclamation work is completed. The loss of about 440 to 480 ha of reef resources will be significant in view of the limited amount of the resource in Singapore.

An area of 350 ha at the eastern part of Pulau Semakau will be used as a dumping ground. In order to prevent or minimise pollution affecting the marine environment, a 7-km-long rock wall will be constructed around the site. The site will be used for infilling in 1999 (ST, 1993). At present, the area is used for the dumping of earth spoils. The reef resources between Pulau Semakau and Pulau Sakeng are now affected by heavy sedimentation from the earth spoils and will be completely lost when infilling begins. Extensive seagrass beds and mangroves present in the area will mostly be destroyed in the process.

Since the early 1960s, reclamation work along the southern coast and southern islands of Singapore has smothered many reef flats. As there were no quantitative documentation of natural reef resources in the past, it is difficult to assess the extent of damage to the natural communities. Surveys since the 1980s indicate that coral life is diverse in terms of species richness, especially along the upper part of the reef slopes.

The extent and rate of reclamation in the past paid little attention to coastal and marine habitats. More recently, some of these habitats have been designated for protection and satellite imagery together with field surveys provide valuable information towards the management of these resources.

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Fig. 1. Classified image showing six classes of reef flat components around Pulau Ayer Chawan area based on a 1986 SPOT imagery.

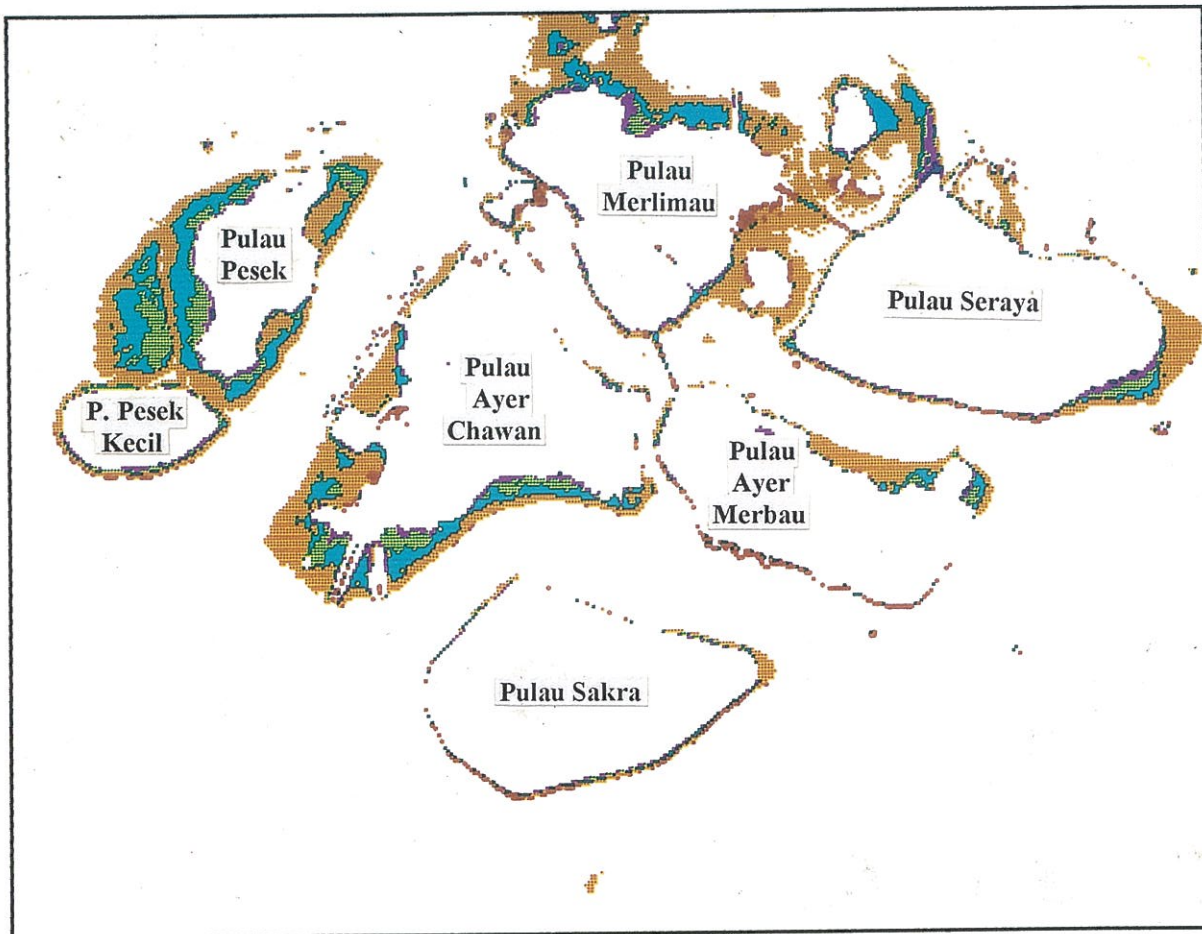


Fig. 2. Classified image showing eight classes of reef flat components around the Pulau Ayer Chawan area based on a 1989 Landsat TM imagery. The overall class distribution are similar to that derived from the 1986 SPOT data.

