Buletin Geoinformasi, Jld. 1, No. 3, ms. 134 – 138, Disember 1997

Integration of Remote Sensing-GIS Techniques for Mapping and Monitoring Seagrass and Ocean Colour off Malaysian Coasts

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Abstract

This paper describes seagrass and ocean colour mapping off Peninsular Malaysia. The seagrass were extracted from visible bands of Landsat TM using the depth invariant index of the seabottom type. The ocean colour which much referred to plankton concentration is derived by regressing samples from known site collected at time of satellite overpass. Oth these information were then input into GIS database which were also being established to assist the Marine Fisheries Management and Development Centre in managing and monitoring coastal areas This paper also addresses the experience gained in building spatial database for coastal areas various data collected from various mapping environments were carried out.

INTRODUCTION

The ocean is an important asset for a country because of its varius valuables resources such as food, source of energy, tourism and as an entrance into the country. As a marine source of food, seagrass and planktons are two important parameters in fisheries. Seagrass are commonly found in shallow coastal marne locations, salt-marshes and estuaries, and in the topics they are often associated with mangroves. Seagrass ecosystems provide habitats for a wide variety of marine organisms, both plant and animal, these including fauna and flora, bethis flora and fauna, epiphytic organisms, plankton and fish, not to mention microbial and parasitic organisms. The relatively high rate of primary production of seagrass also drives detrius-based chains, which help to support many of these organisms.

Plankton, on the other hand, is an important part of these ocean, which often associated with the optical proeprties of water i.e. the ocean or sea colour (colourization of water due pigmentation found in plankton). Plankton, a unicell plants that floats in areas near the sea surface also plays an important part in the food cycle of fishery environment. The plankton populations are dependent on variety of factors, including ocean, temperature, availability of nutrient, amount of sunlight and ocean depth.

The importance of seagrass and plankton are that they are often correlated to the fish breeding grounds, hence, measuring these two factors can assist in indentifying both fish breeding and fishing grounds. In this paper, both ocean colour can seagrass mapping from satellite remote sensing data off eastern coast of Malaysia comprising of clustered islands priorily gazetted by the Malaysian Government as one of the 5 national marine parks.

MATERIAL & METHODS

Geographic Information System

Initiative and precious studies carried out at Centre for Remote Sensing (CRS), UTM has given high awarness and sentivity of the appropriate authority in using GIS for assisting marine parks management. Recently, CRS was given a research grant under Intensification of Research in Priority Areas (IRPA), Ministry of Science Technology & the Environment to undertake pilot study to establish an integrated remote sensing and GIS technology for mapping ocean and seagrass mapping. The whole project is breakdown into two phases;(1) extraction of seagrass and ocean colour, and (2) to fulfill develop full GIS system enabling al queries pertaining to management of the marine part. Presently, the project are emphasizing on phase 1 where only limited GIS manipulative functions available in the digital image processing software-PCI-Easi-Pace system.

SPATIAL DATABASE

To enable results of the study be tied to corresponding geometry of the area, aptial data base were generated. Topographic maps along the shoreline and hydrographic charts (navigational and approaches to estuaries) were used in the compilation of the spatial database. The digital data capture were carried out through digitizing process using AutoCad drafting software. The digital data captured by AutoCad were more generic to most available GIS and digital image processing softwares in the market.

DIGITAL IMAGE PROCESSING

Pre-Processing

Pre-processing were carried out to mainly to minise atmospheric and geometric distortions. As the ground-leaving radiance over water-covered body is mostly range of maximally less than 20 percent of available dynamic range in visible bands, slight effect to the information to extract from the these water covered area. Hence, atmospheric correction is one of the important correction carried out in this study. Input into this correction were those insitu measurement collected at the time of satellite overpass. Where information is not available, estimation through atmospheric model of the corresponding site sere used.

Seagrass Mapping

Seagrass mapping is extracted from substrate reflectance estimated based on algorithm proposed by Bierwith et. Al. (1992). Within this algorithm, the substance reflectance (Rbi) in band is estimated from digital number (DN) by :

$$DN = R_{bi}\, e^{2K_i \Delta z} \qquad (1)$$

Where

Ki is the attenuation coefficeient (can be estimated from satellite remote sensing data),

ΔZ is the water depth,

R_{bi} is the substrate refelectance in band I

The substrate reflectance for each band can be translated to substrate type known samples are calibrated against R_{bi} index computed. The effect water atenuaton on R_{bi} is taken account in (1). To further analysed the output of this study, a 1.5km transact situated at Telok Ewa of Langkawi Island was used in this study. Detail mapping of sea-bottom feautres along the 3.5 km transact line were identified, where each sample type and their position were recorded. The G00lobal Positioning System (GPS) was used in positioning , while the sea-bottom features were documented by the research team through diving at regular interval of every 100 meters along the transect where the sea bottom features are expressed as index (each bottom type is represented by one index). DII is determined from radiance values recorded in band 1, 2 and 3 which taking into account the effect of water attenuation. Over known substrate samples, these indices are the translated to sea bottom type.

OCEAN COLOUR MAPPING

Landsat band 1, 2 and 3 were used in extracting ocean colour mapping. The assumption made in this study is that each colour represent the different rate of plankton. Ocean colour manifest the microplankton distributions and concentration at the time of satellite overpass. To extract both the plankton distribution and concentration, plankton samples collected at near realtime (+ 15 minutes continuous period prior and after satellite overpass) using 56-micron sampling net. The vertical-haul micro-plankton sampling technique was employed in a random purposive manner covering the entire study area. The sampling net was dipped at depth of 3 m in the near-shore waters and 5 m in further away area, respectively.

Particulates might also influenced the ocean colour. Dua to this, samples for suspended sediment concentration (SSC) was also taken simulateneously at all corresponding points where microplankton samples were collected. In this phase of this study, plankton-refelectance relationship for TM data (Mayo, 1995) was examined , and result was shown in Figure 1. Mayo (1995) reported the reflectance-plankton concentration (ChlO) can be expressed as :

$$Chl = TM1 - TM3 / TM2 \quad (2)$$

Where

TM1, TM2 and TM3 are reflectance recorded by TM band 1, 2 and 3, respectively

Other measurements made during the samplings were : the wind speed and directions; water transparency using secchi-disk, water-depth; salinity; sea-surface and air temperatures. (These measurements used in explaining the analysis of results). Attempt is yet to be made on inputing these mesuarements as variables in relation to the reflectance recorded by hypothetical model of :

$$y = f \{ p, v, w, t, z, s, sst, at \} \quad (3)$$

where

y is the digital number,

p is microplankton concentration,

v is the wind speed,

w is the wind directions,

t is the water transparency measured by secchi disk,

z is the depth of the water column corrected for tide at time for satellite overpass,

s is the salinity

sst is the sea-surface temperature, and

at air temperature

Computed variables once determined (through regressing the known samples) were used to extract the plankton concentration pattern in the netire study area. In this paper, however, the sesults using (2) will be reported as insitu-measurements during satellite overpass has not adequately collected.

RESULTS AND DISCUSSION

The seagrass and ocean colour maps produced for the study sites were shown in plate 1. To analyse the these maps, an independent test samples were used. For the seagrass mapping, with a total of 15 samples gathered by diving at 100m transectline, only 4 bottom feature classes were able being defined. The depth invariant index is shown in Figure 2. Detailed accuracy analysis on broader area in South China Sea (off Kuala Terengganu up to EEZ area) and Northcn Malacca Straits surrounding Langkawi island is yet to be conducted using in independent satellite data with full deployment of sea-truth gathered with the south East Asia Fisheries Development Centre (SEAFDEC) team.

SUMMARY

In this paper, mapping sea-grass and plankton distribution using Landsat TM data have been described. Seagrass information is extracted based on depth invariant index where the attenuation corfficeint of water is estimated through satellite data while the index calibrated against field samples were used in identifying the sea-bottom features.

The initial results of this study also exhibit strong correlation of plankton concentration with the reflectance. Mayo et. Al (1995) reflectance-plankton concentration model shows a potential model to be fully exploited in the next phase of this study where hypotentical model to include all other influncing factors will be measured.

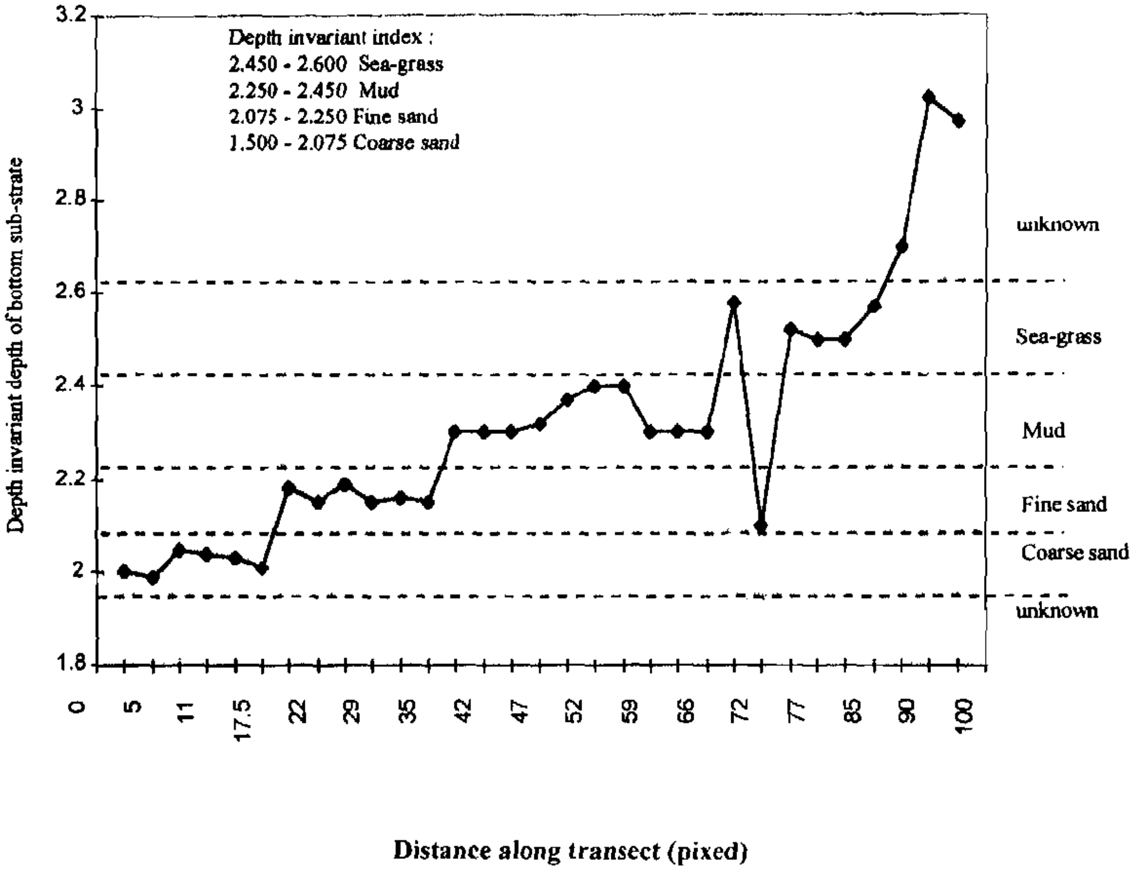

Figure 1 : Relationship of retioed TM band 1-band 2 against plankton concentrations. This relationship is adopted by Mayo et. Al. (1995)

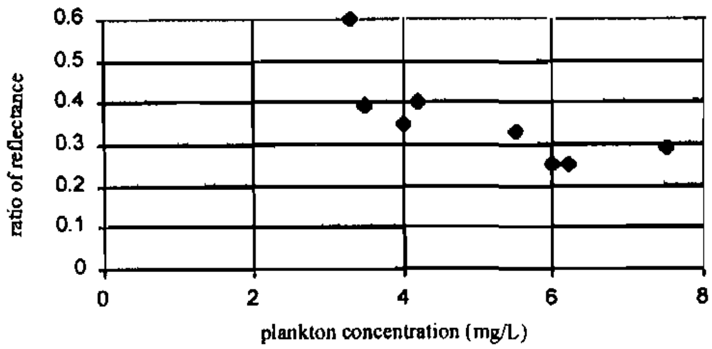

Figure 2 : Calibrating depth invariant index against 'pure' samples collected at selected point along the transect at Telok Ewa, Langkawi

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