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Integration of remote sensing-GIS Techniques for mapping Seagrass and Ocean Colour off Malaysian Coasts

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Abstract

This paper describes seagrass and ocean colour mapping off Peninsular Malaysia . the seagras were extracted form visible bands of Landsat TM using the depth invariant index of the seabottom type. The ocean colour which is much referred to microplakton concentration is derived by regressing samples form known site collected at time of satellite overpass. Both these information were then input into GIS database which were also being established to assist the Marine Fisheries Management and Development Center in managing and monitoring coastal areas.

Introduction

The ocean is an important asset for a country because of its various valuable resources such as food, source of energy, tourism and as a mode of entrance into the country. As a marine source of food, sea grass and planktons are tow important parameters in fishers . seagrass are commonly found a shallow coastal marine locations, salt-marshes and estuaries, and in the tropics they are often associated with mangroves. Seagrass ecosystems provide habitates for a wide variety of marine organisms. The relatively high rate of primary pro9ductions of seagrass also detritus-based food chains which help to support many of these organisms.

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

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

Material & Methods

Geographic Information's System

Initiative and previous studies carried out at center for Remote sensing (CRS), UTM has given high awareness and sensitivity of the appropriate authority in using GIS for assisting marine parks management. Recently, CRS as 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 colour and seagrass mapping. The whole project is breakdown into tow phases : (i) extraction of seagrass and ocean colour, and (ii) a fully developed GIS system enabling all queries pertaining to management part, Presently, the project are emphasize on phase 1 where only limited GIS manipulative functions available in the digital image processing software.

Spatial database
To enable results of the study be tied to corresponding geometry of the are, spatial database were generated. Topographic maps along the shoreline and hydrographic charts (navigational and approaches to estuaries were used in the complications 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 software.

Digital Image Processing

Pre- processing
Pre-processing were carried out to mainly to minimize the atmosphere and geometric distortions. As the ground-leaving radiance over water -covered body is mostly ranged of maximally less than 20 percent of available dynamic range in visible bands. Hence, slight perturbation to the data recorded must be compensated. The atmospheric correction is one of the most important correction that was 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 atmosphere model of the corresponding site were used.

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

$$DN= R_{bi}e^{2KiDz} \qquad (1)$$

Where

Ki is attenuation coefficient (can be estimated from satellite remote sensing data),
Z is the water depth,
R_{bi} is the substrate reflectance in band I.

The substrate reflectance for each band can be translated to substrate type once the known samples are calibrated against RBI index computed. The effect water attenuation on RBBI is taken into account in (1). To further analysed the output of this study, a 350m transect situated at Telok Ewa of Langkawi island was used in this study. Detail mapping of sea bottom features along the transact line were identified, where each sample type and their. Detail mapping of sea-bottom features along the transact line were identified, where each sample type and their position were recorded . the global positioning system (GPS) was used in positioning, while the sea-bottom features were documented by research tem though diving at regular interval of 2m along the transact. Computing Rbi from (1) over known attenuation coefficient, the sea bottom features can be expressed as index (or priorily termed as depth invariant index by Lyzenga, 1981). Over known substrate samples, these indices can be translated to sea bottoms type. Calibration of these indices at Telok Ewa sample is shown in figure. 1.

Ocean colour mapping
Landsat band 1,2 and 3 were used in extracting ocean colour maping. The assumption made in this study is that each colour represented the different rate of plankton. Ocean colour manifests the microplankton distributions and concentration at the time of satellite overpass. To extract both the plankton distribution and concentration, plankton samples were collected at near-realtime (+ 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.

The ocean colour might have also influenced by particulates. Due to this, samples for suspended sediment concentration (SSC) was also taken simultaneously at all corresponding points where microplankton samples were collected. In this study, plankton concentration-reflectance relationship for TM data (Mayo et. Al., 1995) was examined, and the result was shown in figure 2. Mayo (1995) reported the reflectance-plankton concentration (Chl) can be expressed as :

$Ch1 = TM1-TM3/TM2$ (2)

Where
TM1, TN2, and TM3 are reflectance recorded by TM band 1,2, and 3, respectively .

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

$Y \underline{=} f\{p,v,w,t,z,s,sst,at\}$ (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,
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 concentrations pattern in the entire study area . in this paper, however, the results using (2) will be reported. Comprehensive hypothetical model given by (3) is yet to be examined once adequate in-situ measurements during satellite overpass are made.

Results & Discussion

The ocean colour and seagrass information extracted from Landsat TM were shown in Plate 1 and 2, respectively. 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 350m transect line, only 4 bottom features classes were able being defined. The depth invariant index is shown in figure 1. detailed accurate analysis on broader area in south Chine sea (off Kualal Terengganu up to EEZ area) and Northern Malacca Straits surrounding Langkawi islands is yet to be conducted using independent satellite data with full deployment of sea-truth gathered with the south east Asia fisheries Development center (SEAFDEC) team .

With regarded to the ocean, only relative analysis of the four concentrations identified (see plate 1) . the tagging of these four plankton categories to absolute plankton concentration when the samples collected were fully analysed later. Plankton analysis is still underway at SEADEC oceangraphic laboratory when this paper is made.

Summary

In this paper, mapping sea-grass and plakton distribution using satellite Landsat TM data have been described. Seagrass information in extracted based on depth invariant index where the attenuation coefficient of water is estimated through satellite data while the index calibrated fields 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 hypothetical model all other influencing factors will be measured.

Acknowledgement

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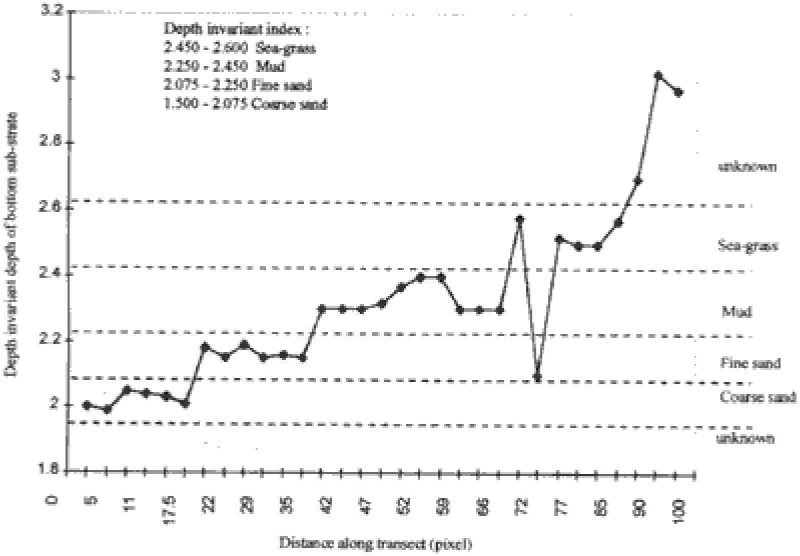


Figure 1: Calibrating depth invariant index against " Pure " samples collected at selected point along the transect at Telok Ewa, Langkawi.

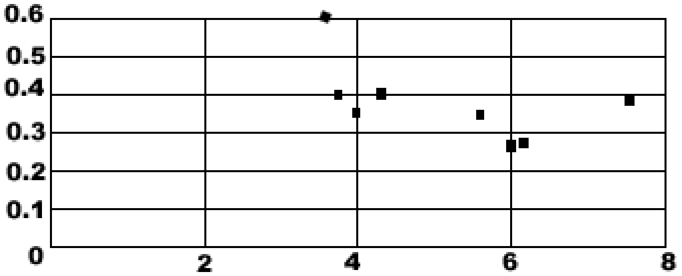
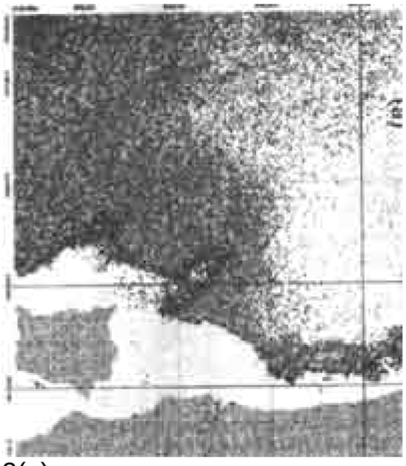


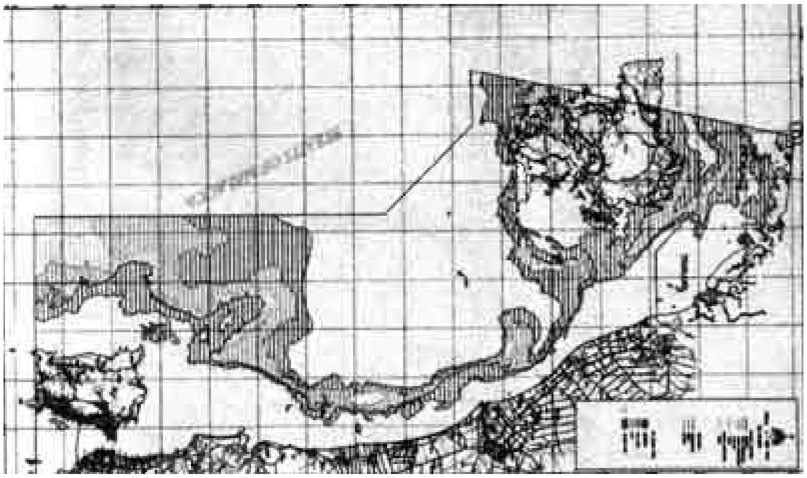
***Figure 2**: Relationship of ratioed TM band 1-band3/band 2 against plankton concentrations. This relationship is somewhat similar to the results obtained by Mayo et. al. (1995).*

(a) Ocean colour of Terengganu study site

(b) the line map derived from the raster-based ocean colour information as depicted in (a) which can directly input as one "layer" into GIS



2(a)



2(b)

Figure 2*: Calibrated depth invariant index (DII) at Langkawi test site using 350m transect collected at Telok Ewa. 2(a) the inset of DII surrounding Penang, and 2(b) the DII of one Landsat scene. Seagrass location is shown in red.*