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CORAL REEF MAPPING USING HIGH SPATIAL RESOLUTION SATELLITE IMAGERY (QUICKBIRD) AT REDANG ISLAND MARINE PARK, TERENGGANU, MALAYSIA

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Thesis Submitted in Fulfillment of the Requirement for the Degree of Master of Science in the Institute of Oceanography and Environment Universiti Malaysia Terengganu

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DEDICATION

To my parents,

Father, Ah Too & mother, Ah Ying.

To my beloved husband, Jaw Chuen.

I couldn't have done this without you.

Thank you for all of your love, support and encouragement along the way.

ABSTRACT

Abstract of thesis presented to the Senate of Universiti Malaysia Terengggganu in fulfillment of the requirements of degree of Master of Science

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Main Supervisor : Razak Bin Zakariya, Ph. D.

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Institute : Institute of Oceanography and Environment (INOS)

Coral reefs are among the most diverse ecosystems on the earth, but most of the world reefs are highly susceptible to degradation due to anthropogenic activities and climate change. Coral reef benthic communities are mosaic of several bottom types that are distinguishable by their optical spectral reflectance characteristic allows effective identification and mapping using the technologies of remote sensing. Therefore, *in-situ* radiometric measurement play an important role in bridging the gap between field and remotely sensed data in the improving the accuracy of remote sensing. Briefly, this study is aimed to determine the *in-situ* benthic hyperspectral reflectance and then

examine their characteristic and separability. Additionally to evaluate the performance of density slice and maximum likelihood algorithm for coral reef classification and developed a baseline map.

Field measurements were carried out to collect ground training, ground truth point and benthic reflectance. Satlantic HyperOCR Underwater Sensor was used to measure the upwelling radiance, L_u and downwelling irradiance, E_d of nine individual benthic communities and mixed benthic substrate in one m^2 quadrate. High resolution QuickBird satellite imagery acquired on 22nd July 2009 integrated with *in-situ* hyperspectral reflectance measurements were used to develop a coral reef baseline map of Redang Island.

All the benthic hyperspectral reflectance in this study was successfully determined regardless of variations in biogeography region, different spectroradiometric underwater sensors or measurement procedure. Ultimately, *in-situ* coral reflectance was mainly determined by the spectral absorption and the fluorescence properties from the chlorophyll pigment concentration. The results from separability analysis in this study were capable to discriminate and separate among the general reef communities (corals, algae & sand) with some degree of confusion. Demonstrated from this study, both classification techniques of maximum likelihood and density slicing algorithms were applicable for assessing the benthic types. Maximum likelihood classification produced a slightly higher (80.3 %) overall accuracy than using green band density slicing which has a lower (62.2 %) overall accuracy. These results confirm the potential of an effective combination of high spectral and spatial resolution sensor with *in-situ* data for accurate benthic habitat mapping.

ABSTRAK

Abstrak tesis yang dikemukakan kepada pihak Senat Universiti Malaysia Terengggganu sebagai memenuhi keperluan untuk ijazah Master Sains.

PEMETAAN TERUMBU KARANG MENGGUNAKAN SATELIT IMAJA (QUICKBIRD) YANG BERESOLUSI RUANG TINGGI DI TAMAN LAUT PULAU REDANG, TERENGGANU, MALAYSIA

KHOO SIAO JEAN

Ogos 2015

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Terumbu karang adalah ekosistem yang paling kepelbagaian di bumi ini, akan tetapi kebanyakan batu karang manghadapi kemerosotan disebabkan oleh aktiviti antropogenik dan juga perubahan iklim. Komuniti bentik terumbu karang adalah dibentukan daripda beberapa jenis golongan di bahagian dasar yang boleh dibezakan daripada segi ciri-ciri optik pantulan spektrum. Ini membolehkan pengenalpastian dan pemetaan secara cekap dengan menggunakan teknologi penderian jarak jauh. Oleh itu, pengukuran radiometrik di lapangan memainkan peranan yamg penting dalam menghubungkan jurang di antara data lapangan dan juga penderiaan jarak jauh untuk meningkatkan ketepatan penderiaan jauh. Secara ringkas, kajian ini bertujuan untuk

menentukan pantulan spektrum pada terumbu karang dan mengenal pasti ciri-ciri perbezaan antara komuniti bentik. Seterusnya, *maximum likelihood* dan *density slice* algoritma digunakan untuk pengkelasan terumbu karang dan hasilnya akan dinilai.

Pengukuran lapangan telah dijalankan untuk mengumpul data bagi titik sampel, titik kawalan dibumi dan pantulan bentik. Pengesan Satlantic HyperOCR dalam air digunakan untuk mengukur *upwelling radiance,* L_u dan *downwelling irradiance,* E_d untuk sembilan individu komuniti bentik dan bentik substrat dalam satu m^2 kuadrat. Imej satelit QuickBird yang beresolusi tinggi diperolehi pada 22^{hb} Julai 2009 dan ukuran pantulan spektrum digunakan sebagai data penanda aras di Pulau Redang.

Kajian ini menunjukkan semua spektrum pantulan dapat ditentukan tanpa dipengaruhi oleh perbezaan dari segi geografik, alat pengesan mahupun tatacara pengukuran. Secara umumnya, pantulan terumbu karang dapat ditentukan oleh penyerapan dan pandafluor daripada pigmen klorofil. Kajian ini dapat membezakan dan memisahkan antara komuniti terumbu karang (batu karang, alga & pasir) dengan tahap kekeliruan yang tertentu. Selain itu, kedua-dua teknik klasifikasi iaitu *maximum likelihood* dan *density slice* algoritma digunakan untuk penilaian terhadap jenis bentik di lapangan. Klasifikasi *maximum likelihood* menunjukkan ketepatan keseluruhan yang lebih tinggi (80.3 %) bagi beta yang dihasilkan berbanding jalur hijau *density slice* (62.2 %). Keputusan ini telah menunjukkan kombinasi efektif antara imej yang beresolusi ruang tinggi dan pantulan spektrum untuk menghasikan pemetaan habitat dengan lebih tepat.