

**THERMAL FRONTAL ZONE AND ASSOCIATED  
COASTAL UPWELLING ALONG THE EAST  
COAST OF PENINSULAR MALAYSIA**

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**MASTER OF SCIENCE  
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**THERMAL FRONTAL ZONE AND ASSOCIATED COASTAL UPWELLING  
ALONG THE EAST COAST OF PENINSULAR MALAYSIA**

**KOK POH HENG**

**Thesis Submitted in Fulfillment of the Requirement for the  
Degree of Master of Science in the School of Marine and Environmental Sciences  
Universiti Malaysia Terengganu**

**June 2015**

## DEDICATION

I dedicate this thesis to my beloved mother

*Lim De Suan*

And

The loving memory of my father

*Kok Ting Sing*

You have successfully made me the person I am today

You will always be remembered

## ABSTRACT

Abstract of thesis presented to the Senate of Universiti Malaysia Terengganu in fulfillment of the requirement for the degree of Master of Science

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**Main Supervisor : Mohd. Fadzil Mohd. Akhir, Ph.D.**

**School : Marine and Environmental Sciences**

The main aim of this study is to investigate the thermal fronts and coastal upwelling along the east coast of Peninsular Malaysia (ECPM). In view of that, monthly sea surface temperature (SST) climatology data were used to achieve this goal. The factors responsible for the formation of thermal fronts and coastal upwelling were determined. In addition to SST, chlorophyll-*a* concentration, sea surface height (SSH) and marine fish landing data were used to examine the implications of coastal upwelling on the marine environments. Besides that, in order to provide and to compare the *in-situ* vertical structure of the water column between the upwelling and non-upwelling events, *in-situ* hydrographic cruises during the both periods were conducted.

In general, the formation of thermal fronts along the ECPM is dependent on the monsoon system. During the northeast monsoon, the formation of thermal fronts along the ECPM is a result of the southward advection of cooler water tongue near South Vietnam and its' location is influenced by the speed of southward flowing western boundary current in that region. As the speed of this current increase from November until January, the cooler water tongue moves closer to the ECPM and its recedes when the current moves at a slower rate between January and inter-monsoon.

During the southwest monsoon, the presence of thermal fronts along the ECPM are a result of coastal upwelling combine with the northward cooler water advection from the southwestern coast of Kalimantan; however, coastal upwelling is a major contributor to the formation of thermal fronts. The analysis of wind-driven upwelling processes (wind stress curl and Ekman transport) suggested that upwelling commences starting from June and the intensity of upwelling reaches its' peak in August before coming to a decline in September and inter-monsoon. The chlorophyll-*a* concentration, SSH, and marine fish landing are found in response to the variations of upwelling intensity. The hydrographic cruises conducted during the southwest monsoon show the isoline of temperature, salinity, dissolved oxygen (DO) and fluorescence are shoaled towards the coast and surface (upwelling) but not during the inter-monsoon (non-upwelling).

## ABSTRAK

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

### ZON KEDEPANAN HABA DAN KENAIKAN JISIM AIR SEPANJANG PANTAI TIMUR SEMENANJUNG MALAYSIA

KOK POH HENG

Jun 2015

**Penyelia Utama : Mohd. Fadzil Mohd. Akhir, Ph.D.**

**Pusat Pengajian : Sains Marin dan Sekitaran**

Tujuan kajian ini adalah untuk menyiasat zon ke hadapan haba dan kenaikan jisim air (*upwelling*) yang berkaitan dengannya di sepanjang pantai timur Semenanjung Malaysia. Sehubungan itu, suhu permukaan laut bulanan klimatologi data telah digunakan untuk mencapai matlamat kajian ini. Faktor yang bertanggungjawab untuk pembentukan zon ke hadapan haba dan *upwelling* yang berkaitan dengannya telah ditentukan. Selain daripada suhu permukaan laut, data konsentrasi klorofil-*a*, ketinggian permukaan laut dan pendaratan ikan laut telah digunakan untuk mengkaji implikasi *upwelling* dalam persekitaran marin. Selain itu, dalam usaha untuk membekal dan membandingkan struktur menegak air semasa berlakunya *upwelling* dan bukan *upwelling*, pelayaran oseanografi dalam kedua-dua tempoh ini telah dijalankan.

Secara umum, pembentukan zon ke hadapan haba di pantai timur Semenanjung Malaysia adalah bergantung kepada musim tengkujuh. Semasa monsun timur laut, zon ke hadapan haba di pantai Semenanjung Malaysia adalah hasil daripada olahan lidah air sejuk ke arah selatan yang muncul berhampiran dengan Vietnam Selatan dan lokasi lidah air sejuk tersebut dipengaruhi oleh kelajuan arus sempadan barat yang mengalir ke arah selatan di rantau itu. Apabila kelajuan arus sempadan tersebut meningkat dari

November hingga Januari, lidah air sejuk bergerak lebih dekat dengan Semenanjung Malaysia dan ia semakin menghilang apabila arus sempadan barat bergerak dengan perlahan antara Januari dan monsun peralihan.

Semasa monsun barat daya, pembentukan zon kedepanan haba adalah hasil gabungan daripada *upwelling* serta olahan air sejuk ke arah utara dari pantai barat daya Kalimantan. Walaubagaimanapun, *upwelling* merupakan penyumbang utama pembentukan zon kedepanan haba. Analisis proses *upwelling* yang didorong angin (*curl* tekanan angin dan pengangkutan Ekman) mencadangkan bahawa *upwelling* adalah bermula dari Jun dan keamatan *upwelling* mencapai kemuncaknya pada bulan Ogos sebelum menurun pada bulan September dan monsun peralihan. Konsentrasi klorofil-*a*, ketinggian permukaan laut dan pendaratan ikan laut bertindak balas dengan perubahan keamatan *upwelling*. Pelayaran oseanografi yang dijalankan semasa monsun barat daya (*upwelling*) menunjukkan isoline suhu, kemasinan, oksigen terlarut dan pendarfluor beting ke arah pantai dan permukaan laut (*upwelling*) tetapi tidak semasa musim peralihan (bukan *upwelling*).