IDENTIFICATION OF FISHING GROUND USING LOCAL KNOWLEDGE AND REMOTE SENSING DATA

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DEDICATION

As with everything I do,

I dedicate this,

To my beloved parents,

Your unconditional love has made me gone through the tough times in my life,

The faith you have in me makes me stronger,

And yet I have so much to learn,

To learn from you,

You are the aspiration in my life,

Love you always,

As to my dear siblings, colleagues and friends,

My lecturers and supervisors,

Thanks for always be there for me.

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ABSTRACT

Accurate identification of potential fishing ground is very important to help local fishermen carrying out fishing activities. Objectives of this study are, i) to identify the potential fishing ground using fishermen's local knowledge, ii) to identify the potential fishing ground using information derived from remote sensing satellite data, and iii) to compare results obtained from first and second objectives. This study has been carried out in east coast of Johor. The data used in this study consist of the local knowledge used by the fishermen in carrying out fishing activities. This information can be obtained from questionnaires survey that have been carried out at eleven fishing villages around the district of Mersing and Kota Tinggi. Seventy samples (10% the total number of local fishermen) were chosen randomly. Moderate Resolution Imaging Spectroradiometer (MODIS) data were utilized to derive two marine environmental parameters; Sea Surface Temperature (SST) and Chlorophyll-a concentration (Chl-a), which were used to identify the potential fishing ground. Fishing ground identified using both local knowledge and remote sensing technique were then analyzed qualitatively and quantitatively. Correlation analysis between SST and Chl-a with distance and total catch as identified by local fishermen were carried out. SST has a correlation coefficient, R = -0.6378 with the distance and R = 0.4511 with the total catch, while Chl-a has a correlation coefficient, R = -0.1523 and R = 0.4195 with the distance and total catch respectively. These results show that fishing grounds identified by local fishermen were mostly near to coastal area and having high value of SST and Chl-a distribution which is favorable condition for a fishing ground.

ABSTRAK

Penentuan kawasan penangkapan ikan yang berpotensi secara tepat adalah sangat penting untuk membantu nelayan tempatan menjalankan aktiviti penangkapan ikan. Objektif kajian ini adalah, i) untuk menentukan kawasan penangkapan ikan yang berpotensi dengan menggunakan pengetahuan setempat nelayan, ii) untuk menentukan kawasan penangkapan ikan yang berpotensi dengan menggunakan maklumat yang diperoleh dari data satelit penderiaan jarak jauh, dan iii) untuk membandingkan hasil keputusan daripada objektif pertama dan kedua. Kajian ini dijalankan di pantai timur Johor. Data yang digunakan dalam kajian ini terdiri daripada pengetahuan setempat yang telah digunakan oleh nelayan dalam menjalankan aktiviti penangkapan ikan. Maklumat ini telah diperoleh melalui kajian soal selidik yang telah dijalankan di sebelas buah kampung nelayan di sekitar daerah Mersing dan Kota Tinggi. Tujuh puluh sampel (10% daripada jumlah keseluruhan nelayan setempat) telah dipilih secara rawak. Data *Moderate Resolution Imaging Spectroradiometer* (MODIS) digunakan untuk memperoleh dua parameter alam sekitar marin iaitu suhu permukaan laut (SST) dan kepekatan klorofil-a (Chl-a) yang digunakan untuk menentukan kawasan berpotensi untuk penangkapan ikan. Kawasan penangkapan ikan yang dikenal pasti menggunakan pengetahuan setempat dan teknik penderiaan jarak jauh telah dianalisis secara kualitatif dan kuantitatif. Analisis korelasi di antara SST dan Chl-a dengan jarak dan jumlah tangkapan seperti yang dikenal pasti oleh nelayan tempatan telah dijalankan. SST mempunyai pekali kolerasi, R = -0.6378 dengan jarak dan R = 0.4511 dengan jumlah tangkapan, manakala Chl-a mempunyai pekali kolerasi, R = -0.1523 dan R = 0.4195 masing-masing dengan jarak dan jumlah tangkapan. Hasil kajian ini menunjukkan bahawa kawasan penangkapan ikan yang dikenal pasti oleh nelayan tempatan kebanyakannya adalah berhampiran dengan kawasan pantai dan mempunyai nilai taburan SST dan Chl-a yang tinggi, di mana ia merupakan keadaan yang baik untuk sesebuah kawasan penangkapan ikan.

TABLE OF CONTENT

CHAPTER	TITLE	PAGE
	DECLARATION	ii
	DEDICATION	iii
	ACKNOWLEDGEMENTS	iv
	ABSTRACT	v
	ABSTRAK	vi
	TABLE OF CONTENTS	vii
	LIST OF TABLES	xi
	LIST OF FIGURES	xii
	LIST OF ABBREVIATIONS	xiv
	LIST OF APPENDICES	xv
1	**INTRODUCTION**	**1**
	1.1 Background of the study	1
	1.2 Problem Statement	3
	1.3 Aim of the Study	4
	1.4 Objectives of the Study	4
	1.5 Scope of the study	5
	1.5.1 Study Area	5
	1.5.2 Data	6
	1.6 Significant of the Study	7
2	**LITERATURE REVIEW**	**9**
	2.1 Introduction	9
	2.2 Bottom-up Approach: Utilization of Local Knowledge	9

		2.2.1 Local Knowledge for Fishing	11
	2.3	To-down Approach: Remote Sensing Technique	13
		2.3.1 Oceanographic Remote Sensing	13
		2.3.1.1 Sea Surface Temperature (SST)	14
		2.3.1.2 Chlorophyll-a Concentration (Chl-a)	16
		2.3.2 Remote Sensing for Marine Application	17
		2.3.2.1 Remote Sensing for Fish Forecasting	18
		2.3.2.2 Remote Sensing for Predicting Fish Spawning Aggregation	20
		2.3.3.3 Remote Sensing for Marine Conservation	21
	2.4	Integration of Local Knowledge and Remote Sensing for Fishing	22
	2.5	Summary	26
3	**METHODOLOGY**		**27**
	3.1	Introduction	27
	3.2	Type and Sources of Data	28
	3.3	Techniques of Data Acquisition	30
		3.3.1 Techniques of Obtaining Background Information	30
		3.3.2 Techniques of Data Collection using Questionnaire Survey	31
		3.3.3 Techniques of Derivation from Remote Sensing Satellite Data	35
		3.3.3.1 MOD 28 – Sea Surface Temperature (SST)	37
		3.3.3.2 MOD 21 – Chlorophyll-a Concetration (Chl-a)	39
	3.4	Remote Sensing Data Processing and Analysis	40

4	**RESULT AND ANALYSIS**		**42**
	4.1	Introduction	42
	4.2	Result of Local Knowledge	42
		4.2.1 Respondent Information	42
		4.2.2 Fishing Operation	45
		4.2.2.1 Fishing Method	45
		4.2.2.2 Fishing Equipment	46
		4.2.3 Fishing Location	47
		4.2.3.1 Distance	47
		4.2.3.2 Depth	48
		4.2.3.3 Marking Method	49
		4.2.3.4 Factor Selecting Fishing Location	50
		4.2.4 Fishing Time	51
		4.2.4.1 Frequency per Month	51
		4.2.4.2 Time Spent	52
		4.2.4.3 Factor Affecting Fishing Time	53
		4.2.4.4 Month with Highest Catch	54
		4.2.5 Total Catch	55
		4.2.5.1 Species with Highest Catch	55
		4.2.5.2 Catch Rate	56
		4.2.6 Regression Analysis of Catch Rate and Distance	57
	4.3	Result of Remote Sensing Data Processing	58
		4.3.1 Sea Surface Temperature Distribution	59
		4.3.1.1 Relation between SST and Month	62
		4.3.1.2 Regression Analysis of SST, Distance and Catch Rate	63
		4.3.2 Chlorophyll-a Concentration Distribution	64
		4.3.2.1 Relation between Chl-a and Month	67
		4.3.2.2 Regression Analysis of Chl-a, Distance and Catch Rate	68
5	**CONCLUSION**		**70**
	5.1	Introduction	70

5.2 Conclusion 70

5.3 Recommendations 72

REFERENCES **73**

Appendices A – C 82-91

LIST OF TABLES

TABLE NO.	TITLE	PAGE
2.1	Oceanographic variables information	14
3.1	Summary of the data used and their resources	29
3.2	Background information of the respondents	30
3.3	MODIS specification	35
3.4	MODIS spectral bands specification	36
3.5	Detail of MODIS data product used	37
3.6	R_{rs} value and coefficients, a_0-a_4 for multiple sensors	40
4.1	Species with highest catch	56

LIST OF FIGURES

FIGURE NO.	TITLE	PAGE
1.1	Location of the study area	6
2.1	Plot of radiance from blackbody against wavelength, with temperature as a variable	15
3.1	Flowchart of research methodology	28
3.2	Aspect carried out in questionnaire survey	31
3.3	Location of villages	32
4.1	Respondents' age	43
4.2	Years of involvement	44
4.3	Fishing method	46
4.4	Fishing equipment	47
4.5	Fishing location distance	48
4.6	Fishing location depth	49
4.7	Fishing location marking method	50
4.8	Factor selecting fishing location	51
4.9	Fishing frequency per month	52
4.10	Times spent for one fishing activity	53
4.11	Factor affecting fishing time	54

4.12	Month with highest catch	55
4.13	Catch rate	57
4.14	Correlation between catch rate and distance	58
4.15	Correlation between SST and Chl-a	59
4.16	SST distribution in 2005	60
4.17	SST distribution in 2014	61
4.18	Relation between SST with month in 2014	62
4.19	Correlation between SST and distance	63
4.20	Correlation between SST and catch rate	64
4.21	Chlorophyll-a concentration distribution in 2005	65
4.22	Chlorophyll-a concentration distribution in 2014	66
4.23	Relation between Chl-a with month in 2014	67
4.24	Correlation between Chl-a and distance	68
4.25	Correlation between Chl-a and catch rate	69

LIST OF ABBREVIATIONS

NO	ABBREVIATIONS	DESCRIPTION
1	FAO	Food and Agriculture Organization
2	GDP	Gross Domestic Product
3	DOF	Department of Fisheries Malaysia
4	MSY	Maximum Sustainable Yield
5	EEZ	Exclusive Economic Zone
6	FRI	Fish Research Institute
7	SST	Sea Surface Temperature
8	AVHRR	Advanced Very High Resolution Radiometer
9	NOAA	National Oceanic and Atmospheric Administration
10	SeaWiFS	Sea-Viewing Wide Field-of-View Sensor
11	ERS	European Remote Sensing Satellite
12	R&D	Research and Development
13	CZCS	Coastal Zone Color Scanner
14	MODIS	Moderate Resolution Imaging Spectroradiometer
15	MERIS	Medium Resolution Imaging Spectrometer
16	FAD	Fish Aggregating Device
17	PFZ	Potential Fishing Zone
18	CPUE	Catch per Unit Effort
19	ETM	Enhanced Thematic Mapper
20	NASA	National Aeronautics and Space Administration
21	OBPG	Ocean Biology Processing Group

LIST OF APPENDICES

APPENDIX	TITLE	PAGE
A	Sample of Questionnaire	81
B	Fishing Zone	87
C	Site Visit at Belukar Juling, Mersing	88

CHAPTER 1

INTRODUCTION

1.1 Background of the Study

Fishing industry is one of the most important economic sector for developing countries such as Malaysia. Globally, the fishing industries give major contribution to the livelihoods of many rural and coastal communities. In terms of economic contribution, the export revenues from fishing activities are greater than those of other agricultural commodities. In 2010, fishing industries provided employment for 54.8 million people around the world which supplied the world with 154 million tons of fish. 131 million tons of these fish have been utilized to provide food for people (FAO, 2012). Products from fishing industries are one of the most widely traded agricultural commodities. Preliminary estimates in the second half of 2011 indicate that the amount of exports have exceeded USD 125 billion (FAO, 2011).

In Malaysia, fishing industry is also one of the main economic sectors that supply sources of protein while contributing to the country's Gross Domestic Product (GDP), employment and development of fish-based industries (Raduan *et al.*, 2011). In 2011, fish production from this sector contributed RM 10,620.97 which is about 1.1% of the country's GDP. With regard to the contribution towards employment opportunity, fishing industries have benefited about 134,110 fishermen and 28,599 fish culturists (DOF, 2012). The development of this sector also helps to decrease importation of the nation's food supply. The rapid growth of the population in Malaysia led to an increasing demand for fish as one of the main food source for the people. According to DOF (2012), marine capture fisheries comprising of coastal and deep-sea fishing accounted for about 82% of the total landings in Malaysia.

The global ocean productivity for the past 40 years is however believed to be declining due to overexploitation, habitat degradation, pollution and climate change (Klemas, 2010). More than half of all the fish stocks are fully exploited, causing number of catches produced to be at or close to its maximum hold or usually known as Maximum Sustainable Yield (MSY). According to FAO (2011), MSY is the optimum level of effort that produces the maximum yield that can be sustained without affecting me long-term productivity of the stock. As the result of this, 19% were overexploited, 8% were depleted and 1% are recovering, yielding less than their allowed potential and only about 20% were moderately exploited or underexploited with a possibility of producing more (FAO, 2009). The percentage of overexploited, depleted and recovering stocks has tripled since the 1970s (MRAG, 2010).

Malaysia has also experienced the implication of this phenomenon. Although Malaysian sea territory has been extended due to the declaration of the Exclusive Economic Zone (EEZ), fishing sector is still concentrated in the inshore fisheries within 30 nautical miles of the coast. Based on annual reports by the DOF, 70 to 79 percent of the total fish landed in Peninsular Malaysia are from coastal fisheries, while the rest are from the deep sea fishing and aquaculture. However, marine resources in coastal waters are believed to decline due to overexploitation. According to research and statistics by Fisheries Research Institute (FRI), inshore fishing resources of Peninsular Malaysia has reached MSY, which means that any effort to increase the catch will destroy these resources.

Although landings in Peninsular Malaysia from 1955 to 2010 showed a significant growth, there has been a significant waste of fishery resources which can be identified by a four-fold increase of trash fish landings from the total landings within the last 55 years. Trash fish is a small fry that does not have any trade value as it is only used as feed or fertilizer. In 1955, trash fish landings in Malaysia was only 5% of total landings, while in 2010, it increased substantially to 22.39% (DOF, 2012). If there are no action to be taken to solve this problem, the country’s fish stocks may no longer fulfill the increasing demand of society in future. This concern plea for a more sustainable use of marine resources which requires effective monitoring and management of the entire ecosystems, not just exploiting the fish stocks (Klemas, 2010).

1.2 Problem Statement

Recently, scientists and decision makers have started to realize that fishing management is not all about extensive research, complicated models, a ton of data and well-trained experts (Grant & Berkes, 2004). They began to recognize some gaps with this kind of top-down approaches as they failed to address major problems such as coastal water pollution, erosion, overexploitation and habitat destruction (Freitas & Tagliani, 2009). On the other hand, local communities are also very skeptical towards these approach as they feel that it did not adequately reflects the fishing grounds as they knew (Bergmann *et al.*, 2004). Top-down approach is often criticized for its deep problems; 'out of line' to their targets and poor communication between the decision makers and local communities (Silitoe, 1998; Cochrane, 2000; Nor Hayati, 2011). It failed to utilize all available sources of information especially local knowledge (Anuchiracheeva *et al.*, 2003).

Local knowledge has been long ignored by scientific research for being subjective, anecdotal and of little value to today's fisheries studies (Ames, 2003). This is due to the unsystematic format of local knowledge collected (Anuchiracheeva *et al.*, 2003) and lack of published literature on local knowledge data collection and analysis methods (Hall & Close, 2007). However, there are still a lot of research carried out in remote, infrequently visited and unwell described regions with limited references (Drew, 2005). Due to their isolated areas, knowledge of indigenous people may be the only reliable source of information regarding those species or interactions that are not recorded in scientific literature (Heyman *et al.*, 2001). Johannes (1998) had also stated that, if scientific data on the past status of fish stocks or environmental conditions do not exist, older fishermen's knowledge may be the only source of information available.

Thus, it is important for top-down approach to be practiced together with bottom-up approach such as the utilization of local knowledge so that the development programs will be established up to the target. Recently, despite the increasing global interest of local knowledge, its integration with top-down approach such as remote sensing is still uncommon. There are still lacking in the form of study that have been carried out to compare fishermen local knowledge with remote sensing analyses for fisheries purpose. The main reason is maybe due to the large gap in point of views between the science and local people in this field. On one side, scientists tend to marginalize this kind of local perspective due to the equivocal evidence of these knowledge as most of them have not really been proved scientifically.

1.3 Aim of the Study

The main aim of this study is to identify the potential fishing ground using fishermen local knowledge and to compare the result with remote sensing satellite data.

1.4 Objectives of the study

The objectives of this study are:

i. To identify local knowledge from local fishermen regarding fishing ground.
ii. To compare the identified local knowledge with the Sea Surface Temperature (SST) and chlorophyll-a concentration (Chl-a) based on remote sensing data.

iii. To analyze the differences of fishing ground identified based on the local knowledge and remote sensing technique qualitatively and quantitatively.

1.5 Scope of the Study

The scope of this study consists of two parts which are data and study area. Data used for this study were questionnaires distributed to local fishermen, SST and Chl-a from remote sensing satellite image. While study area shows the region covered for the questionnaire distribution in obtaining the local knowledge information and the region of remote sensing subset image for the data processing.

1.5.1 Study Area

This research was carried out along the East Coast of Johor state, which includes two district; Mersing and Kota Tinggi. This coastal area is part of the country that is facing the South China Sea, at the latitude of 0°U to 23°U and longitude of 99°T to 121°T. It covers an area of about 3.5 million km^2. The coastal area of the region includes an area of 35 896 km^2 and 99 749 km^2 for Exclusive Economic Zone (EEZ). Beside Malaysia, South China Sea is surrounded by the mainland of Indonesia, Singapore, Brunei, Thailand, Vietnam, Philippines, Taiwan and China. Chapter 3 will show the detail description of the study area with specific focus on aspects related to fishing activities.

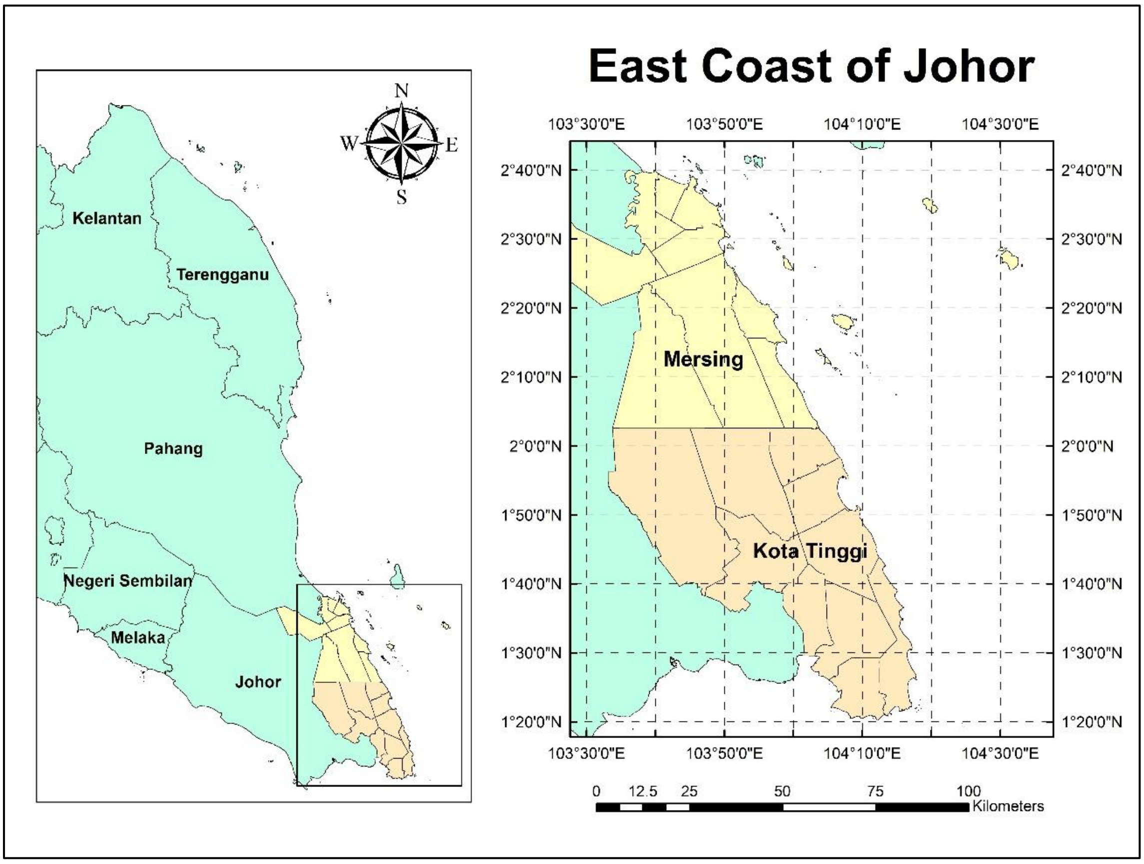

Figure 1.1 Location of the study area

1.5.2 Data

This study used both secondary and primary data. Primary data such as basic information of fishermen that include social and economic background, involvement in fishing activities and their knowledge in fishing were obtained through formal questionnaire surveys. Some of the related information were also obtained from secondary sources. Details on the collection of primary and secondary data will be explained in Chapter 3.

Briefly, the data used in this study consists of two types of data; local knowledge and remote sensing:

i. Local knowledge

Local knowledge is collected based on the interview and questionnaires distributed among the local community that had been carried out August 2014 along Mersing and Kota Tinggi coastal area.

ii. Remote sensing

Location of each identified fishing ground are analyzed using remote sensing technique based on two types of satellite images for each month in 2005 and 2014:

- MODIS SST: MOD28
- MODIS Chl-a: MOD21

1.6 Significance of Study

Based on present scenario of the fishing industry as a major contributor to the nation's economy and the sustainability of food supply, it is very important to give more attentions for the development of this sector. However the most important aspect related to the development of fishing activities is to identify strategies or ways of how to improve production and income of local fishermen. Among problems related to local fishermen are, (i) low catch, (ii) lack of knowledge in recent technologies, (iii) lack of knowledge in identifying potential fishing ground. Most of the local fishermen identify fishing ground based on traditional or local knowledge inherited from their ancestors.

High consistency of local knowledge with catch data and scientific data indicated that this knowledge could be a valuable input in assisting fisheries management (Zukowski et al., 2011). Although the integration of local knowledge and scientific knowledge such as remote sensing may not always appropriate, we cannot actually denied that this integration is indeed can help bridge the gap between the higher management such as decision makers and scientists with the local people.

Combination of these scientific and fishers' observation will boost our confidence in both approaches (Johannes et al., 2000), bridge some gaps in our knowledge (Mackinson, 2001) and produce scientifically valid and locally relevant information (Hall & Close, 2007). The integration between the practically local knowledge and scientifically remote sensing techniques can help fishermen in planning their fishing activities in a more proper and effective way. This will reduce their effort, cost and time spent on these activities.

Hence, this will eventually encourage a sustainable and socially acceptable fisheries management in the future. A better fishery management plan will ensure that marine stocks are enough for the coming years. For example, a fish conservation area can prevent overexploitation and source wastage while fish harvesting and hotspot area will optimum the fish catch in unexplored areas. Sufficient stock for the country will reduce the imported fish supply from other countries. Thus, there are significant needs for us to take into consideration regarding these local knowledge as part of fisheries study in addition to the scientific method, specifically remote sensing technique (FAO, 2011).

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