

NUTRIENTS AND HEAVY METALS IN THE STRAITS OF JOHOR

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A project report submitted in partial fulfillment of the
Requirements for the award of the degree of
Master of Civil Engineering (Environmental Management)

Faculty of Civil Engineering
Universiti Teknologi Malaysia

JANUARI 2016

To my beloved mother and father...
Thank you for all the sacrifices, prayers and loves.

To my beloved family...
Thank you for the support and endless sacrifices...

To my colleagues and lecturers...
Thank you for the support and guidance that you gave,
I will keep all the kindness forever..

ACKNOWLEDGEMENT

In the name of Allah, Most Gracious and Most Merciful. All praise and thanks for the grace of Allah Almighty, I can prepare and complete my Master Project Report successfully as required for the award of a Master's degree in Civil Engineering.

On this occasion, I wish to express my deepest thanks and appreciation to my parents, Dato' Dr Yusof bin Ahmad and Datin Kamaliah binti Abdul Aziz, and the whole family for the endless support and encouragement for me to complete my study. I also want to thank Dr. Shamila binti Azman as my supervisor for giving trust, mentoring and guidance for me to prepare this report as good as possible. Thank you to the employees of Environmental Laboratory, Faculty of Civil Engineering, Universiti Teknologi Malaysia, especially to Mr. Razali and anyone involved directly or indirectly for the success of this research project. Not to forget to thank my beloved friends that continuously gives support and courage.

Finally, I want to apologize if there are any weaknesses and shortcomings in the preparation of this report. My hope is that this project report will be used as a reference and used by university students in and society.

ABSTRACT

In this study, marine water quality together with land use effect on Johor Straits along Kampung Pasir Putih was investigated. Changes in land use and increased discharge of domestic, agricultural and industrial waste into the coastal water have severely affected the water condition and threatened fishing and green mussel aquaculture activity. According to fisherman there are no more fish caught in the vicinity and only crabs and mussels survive. Sampling was conducted on 26th April 2015, 27th September 2015, 15th October 2015, 1st November 2015 and 23rd November 2015. Six sampling stations were identified for marine water quality analysis based on *in-situ* and laboratory analysis. Dissolved oxygen (DO) concentration was between 0.43 to 6.71 mg/L. The nitrogen concentrations studied were between 0.01 to 0.22 mg/L for NO₃⁻, 0.02 to 0.33 mg/L for NH₃-N, and 0.02 to 0.31 mg/L for TN. The phosphorus concentrations were between 0.02 to 0.31 mg/L for PO₄³⁻ and 0.17 to 0.89 mg/L for TP. Heavy metals concentration in marine water along Kampung Pasir Putih (in mg/L) were between 0.08 to 0.33 for Ni, 0.01 to 0.09 for Zn, 0.04 to 0.19 for Cd, and 0.21 to 1.39 for Pb. Based on the selected parameters conducted, Kampung Pasir Putih is classified as Class 3 according to Malaysia Marine Water Quality Standard (MMWQS).

ABSTRAK

Dalam kajian ini, kesan guna tanah ke atas kualiti air laut di Selat Tebrau khususnya di kawasan Kampung Pasir Putih telah dikaji. Perubahan guna tanah dan peningkatan pelepasan sisa domestik, pertanian dan perindustrian ke dalam air laut telah menyebabkan keadaan kualiti air di kawasan kajian terjejas serta mengancam aktiviti perikanan dan akuakultur kupang. Menurut nelayan di kawasan kajian, hanya ketam dan kupang yang hidup di kawasan kajian, tiada spesis ikan yang boleh ditemui. Persampelan telah dijalankan pada 26 April 2015, 27 September 2015, 15 Oktober 2015, 1 November 2015 dan 23 November 2015. Enam stesen persampelan telah dikenal pasti untuk menganalisa kajian kualiti air laut berdasarkan analisis *in-situ* dan makmal. Kepekatan oksigen terlarut (DO) adalah di antara 0.43-6.71 mg/L. Kajian kepekatan nitrogen adalah di antara 0.01-0.22 mg/L untuk NO_3^- , 0.02-0.33 mg/L untuk NH_3 , dan 0.02-0.31 mg/L untuk TN. Kepekatan fosforus adalah di antara 0.02-0.31 mg/L untuk PO_4^{3-} dan 0.17-0.89 mg/L untuk TP. Kepekatan logam dalam air laut di sepanjang Kampung Pasir Putih adalah di antara 0.08-0.33 mg/L untuk Ni, 0.01-0.09 mg/L untuk Zn, 0.04-0.19 mg/L untuk Cd, dan 0.21-1.39 mg/L untuk Pb. Berdasarkan parameter kualiti air laut yang diuji, Kampung Pasir Putih diklasifikasikan sebagai Kelas 3 mengikut Piawaian Kualiti Air Laut Malaysia (MMWQS).

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Green mussel, *Perna viridis*, is native to the Indo–Pacific region and currently they are being extensively cultured in many Asian countries; largely because of their value as a cheap source of animal protein for human consumption (Nicholson and Lam 2005). Besides being consumed as a protein rich food, they are also used as bio-monitoring agent for heavy metal contamination in various Asian countries (Monirith *et al.* 2003). Straits of Johor is the largest producer of green mussels in Malaysia, however its production has dwindle. It has been reported that by of what Datuk Seri Ismail Sabri Yaakob, The Minister of Rural and Regional Development said, the mussels' productivity level in the state has declined over the years from 20,000 tonnes in year 2000 to 2,100 tonnes in year 2014 (Utusan Online, 22 Mac 2015). One of the factors contributing to the reduction could be due to pollution at the aquaculture area.

P.viridis feeds on plankton and other microscopic creatures, which are free-floating in seawater. Thus, it removes large quantities of seston from seawater column and can be used for controlling phytoplankton abundance in coastal water (Chayarat, 2014). Green mussel is a remarkable species in terms of its ability to

reach very high biomass levels, to withstand environmental fluctuations, and to concentrate a variety of organic and inorganic environmental pollutants (Rajagopal, 2006).

Johor Straits is a narrow strait that separates Malaysia from Singapore by a causeway. It is also an important area for fishing and aquaculture activities (Ng, 2013). Furthermore, the existence of mangrove, sea grass, corals and mudflat ecosystems also make Johor Straits important (Zulkifli *et al.*, 2010). Oil pollution has been identified as the major contributor to the pollution of the water in the Straits of Johor (Ng, 2013). Shipping activities involving tankers and other vessels can easily be found in the Strait of Johor, while land-based industrial and urban sources have been recognised as the sources of pollutants for the strait (Abdullah *et al.*, 1996).

Most of the coastal areas of the world have been reported to be damaged from pollution, significantly affecting commercial coastal and marine fisheries. Therefore, control of aquatic pollution has been identified as an immediate need for sustained management and conservation of the existing fisheries and aquatic resources (Zain, 2015). Increased nutrient loading due to human activity has caused eutrophication of coastal ecosystems throughout the world. Eutrophication has become a widespread matter of concern especially in coastal and inland waters during the last 50 years. Eutrophication is one of the leading causes of pollution in ocean. Excess nutrient inputs can stimulate algal blooms leading to decreases in light penetration and hypolimnion oxygen levels, decreases in ocean aesthetics and shifts to algal taxa (i.e. cyanobacteria) that are associated with objectionable taste and odor events (Saadoun *et al.*, 2001; Smith, 2003).

Coastal eutrophication is a societal concern because anthropogenic nutrient enrichment can stimulate algal production and biomass accumulation, leading to events of anoxia and large-scale mortalities of fish and shellfish (James, 1999). Eutrophication has been defined as “the enrichment of water by nutrients, especially nitrogen, phosphorus and organic matter, causing an increased growth of algae and

higher forms of plant life to produce an unacceptable deviation in structure, function and stability of organisms present in the water and to the quality of water concerned, compared to reference conditions” (Andersen *et al.*, 2006)

1.2 Problem Statement

Anthropogenic activities increase as human population grows rapidly. The increase of anthropogenic activities has always caused pollution in coastal waters (Giarratano *et al.*, 2010). Human activities commonly affect the distribution, quantity, and chemical quality of water. The range in human activities that affect the interaction of ocean water is broad.

Over the years, changes in land use and increase discharge of domestic, agricultural and industrial waste into the coastal water has severely impaired the water condition and threatened the profitable green mussel aquaculture activity. The growths of green mussels in certain parts of Johor Straits have been affected with reduction of cultivation and production due to pollution, development and land use activities. Therefore, it is essential to study the causes that affect the reduction in production of mussels.

In Malaysia, Johor is the largest state producing *P.viridis* and produces approximately 92% of total mussel's production. The National Fisheries Institute of Malaysia has identified a large area in Johor Straits estuaries starting from the Singapore-Malaysia second link to Danga Bay as a suitable area for the expansion of mussels and caged-fish industry (Adnan, 2009). *P.viridis* thrive in estuarine or coastal water which are rich with plankton, warm water in range of 26 to 32°C with high salinity around 27-33 ppt (Power, 2004). Hence, the study of the environmental factors as well as the quality of the water along the study area is needed.

Kampung Pasir Putih coastal area serves as very important natural resources for the people living around the area. Due to rapid development and urbanization process around the area especially the industrial development there, the water quality of the coastal water on the study area has significantly been affected. Water pollution is obvious since it could be easily judged by the look of the sea. The residents around the area especially the fisherman also complained that Kampung Pasir Putih coastal water is being polluted by the land use surrounding the area. Therefore, it is important to study the level of pollution in the coastal water of Kampung Pasir Putih and determine the sources of pollutant that contribute to the pollution level.

1.3 Objectives

The aim of the study is to determine marine water quality in the study area. The main purpose this study was conducted is to achieve the objective as follows:-

- a) To study the nitrogen cycle and heavy metal concentration in Kampung Pasir Putih coastal area.
- b) To determine the environmental factors and land use that could affect *Perna viridis* distribution in the Straits of Johor.
- c) To identify sources of pollution to green mussels aquaculture at Kampung Pasir Putih.

1.4 Scope of The Study

The scope of this study is to study the nitrogen cycle and heavy metals concentration in the coastal water to determine the classes of water based on

Malaysia Marine Water Quality Standard (MMWQS), and the sources of pollution to the green mussels aquaculture area. The study area is located at Kampung Pasir Putih, where marine water quality monitoring was conducted from April to November 2015.

In this study, six sampling points were selected along the study area. The scope of this study focuses on physical, nutrients, heavy metals and biological parameters including dissolved oxygen (DO), pH and temperature, salinity, nitrate (NO_3^-), ammonia ($\text{NH}_3\text{-N}$), total nitrogen (TN), dissolved phosphorus (PO_4^{3-}), total phosphorus (TP), chlorophyll-a, nickel (Ni), cadmium (Cd), lead (Pb) and zinc (Zn). This study was conducted to determine the marine water quality by taking coastal water samples and the sample was analyzed using two methods experimentally in laboratory and in-situ. Sources of pollution were also identified along the study area.

1.5 Significance of the Study

Effects of land use changes are very significant contributor to the changes in water quality water in The Straits of Johor. This is because the replacement of the existing land use to other development land use which is mostly urban area will create large interference in term of pollutants such as organics, pesticides and chemical residues which lead to polluted coastal. Therefore, it is important to study the correlation between the land use changes due to the development and its impact on water quality as well as green mussel along Kampung Pasir Putih. The correlation can be used to monitor the water quality along the Straits of Johor which also may lead to other effects in environmental aspects and disturb the aquatic ecosystem. Green mussels are economically important seafood for Malaysian where it may lead to million in revenues in domestic consumption or exports. Among others, the main importance of this study is to ensure that sustainability of the environment is still maintained and controlled along with the development.

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