

**DISTRIBUTION AND BEHAVIOUR OF
PHOSPHATE AND SILICATE BASED
NUTRIENTS WITH RESPECT TO TIDAL
VARIATIONS IN THE SURFACE WATER OF
THE TERENGGANU RIVER ESTUARY**

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**Thesis Submitted in Fulfilment of the Requirement for the
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*To the pillars of my life: Allah, my parents and my late grandma.
Without you, my life would fall apart.*

***ALLAH:** I might not know where life's road will take me, but walking with you, through this journey has given me strength.*

***Baba and Mama:** You used to tell me that "It always seemed impossible until it's done". Undoubtedly, I have been able to attain a second level of my academic life. Thanks for your love and your faith in me.*

***Bibi:** It was so sad to leave me in the middle of this journey. Even though we could not meet as we wished, no matter how far you are I would like to tell you that I made it. I made it sincerely and safely as you always wished for me.*

Together we made it.....

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DISTRIBUTION AND BEHAVIOUR OF PHOSPHATE AND SILICATE BASED NUTRIENTS WITH RESPECT TO TIDAL VARIATIONS IN THE SURFACE WATER OF THE TERENGGANU RIVER ESTUARY

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Estuaries can be considered as vital natural resources and are a unique ecosystem at the interface between terrestrial and marine environments. The increase in population density centred on the coastal features and associated anthropogenic activities, such as trade, industry, agriculture and recreation can diversely affect these sensitive environments. The Terengganu River estuary, located on the East Coast of Peninsula Malaysia, is one such estuarine environment that experiences large supplies of contaminants along its passages and within its wider catchment. This thesis investigates the distribution and behaviour of nutrients (P and Si) and chlorophyll (chl-a) over the tidal cycle of the surface water of Terengganu River estuary, as essential parameters for addressing the widespread problem of estuarine eutrophication. In particular, the

concentration of chlorophyll a (chl-a), Dissolved Inorganic Phosphate (DIP), Dissolved Organic Phosphate (DOP), Particulate Phosphate (PP), Dissolved Inorganic Silicate (DISi), Dissolved Organic Silicate (DOSi) and Particulate Silicate (PSi) were in the range of 0.2 – 42 mg/L, 0.38 – 2.83 μM , 0.38 – 3.2 μM , 0.5 – 3.34 μM , 20.28 – 324.5 μM , 33.72 – 375.0 μM and 43.94 – 488.5 μM , respectively. The particulate forms of nutrients were observed to be the most abundant, contributing to about 28 % to 51 % and 26 % to 53 % in the total P and Si pool, respectively. The significant negative correlation obtained between salinity and nutrients signifies the riverine nature of these nutrients, whereas chl-a seemed to be contributed by both river and coastal water. Further observation revealed the important influence of rainfall, and freshwater inflow over the tidal cycle in the estuary. Regardless of the tides, all the parameters show non-conservative behaviour along the salinity gradients, which are controlled by the river discharge, mineralization process, and exchange with suspended particles, and, superimposed on these processes, is the tidal influence of coastal upwelling on the biogeochemical process within the estuary. The overall results presented, suggested that the surface water of the Terengganu River estuary was slightly polluted. This underscores the necessity of temporal sampling in evaluating the estuary health and the coastal ocean for the catchment alleviation process.

Abstrak tesis yang diserahkan kepada Senat Universiti Malaysia Terengganu untuk memenuhi keperluan bagi mendapatkan Ijazah Sarjana Sains.

TABURAN DAN PELAKUAN NUTRIEN BERASASKAN FOSFAT DAN SILIKAT BERHUBUNG VARIASI PASANG SURUT BAGI PERMUKAAN AIR DI MUARA SUNGAI TERENGGANU

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Julai 2015

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Muara boleh dikatakan sebagai sumber alam semula jadi yang penting, dan ia merupakan suatu ekosistem yang unik kerana ia merupakan pertemuan antara kawasan daratan dan kawasan perairan. Peningkatan kepadatan populasi yang berpusat di kawasan pantai dan aktiviti antropogenik berkaitan, contohnya perdagangan, perindustian, pertanian, dan rekreasi, boleh menjejaskan persekitaran yang sensitif ini dengan amat buruk. Muara Sungai Terengganu yang terletak di Pantai Timur Semenanjung Malaysia merupakan kawasan muara yang turut terjejas kerana di situ terdapat banyak sumber bahan cemar di sepanjang laluanannya dan di kawasan tadahannya yang lebih luas. Tesis ini menyelidik taburan dan ragam nutrien (P dan Si) dan klorofil (chl-a) ketika kitaran pasang surut pada permukaan air di muara Sungai Terengganu sebagai parameter yang diperlukan bagi menyelesaikan masalah pengeutrofikatan

muara. Lebih khusus lagi, kepekatan chl-a, Fosfat Bukan Organik Terlarut (FBOT), Fosfat Organik Terlarut (FOT), Fosfat Zarah (FZ), Silikat Bukan Organik Terlarut (SiBOT), Silikat Organik Terlarut (SiOT), dan Silikat Zarah (SZ) masing-masing berada dalam julat 0.2 – 42 mg/L, 0.38 – 2.83 μ M, 0.38 – 3.2 μ M, 0.5 – 3.34 μ M, 20.28 – 324.5 μ M, 33.72 – 375.0 μ M, dan 43.94 – 488.5 μ M. Nutrien dalam bentuk zarah didapati paling banyak, iaitu masing-masing menyumbang lebih kurang 28 % hingga 51 % dan 26 % hingga 53 % pada keseluruhan takungan P dan Si. Korelasi negatif ketara antara kemasinan dan nutrien menunjukkan keadaan nutrien-nutrien ini di sungai berkenaan, manakala chl-a mungkin muncul daripada sungai dan air pantai. Pemerhatian lanjut menunjukkan pengaruh penting yang disebabkan oleh curahan hujan dan aliran masuk air tawar ke dalam kitaran pasang surut di muara tersebut. Tanpa mengira keadaan air pasang surut, semua parameter menunjukkan ragam yang tidak konservatif di sepanjang cerun kemasinan yang dikawal oleh aliran sungai, proses pemineralan, dan pertukaran dengan zarah terampai; selain itu, ada juga pengaruh pasang surut julang air pantai terhadap proses biogeokimia di muara berkenaan. Hasil keseluruhan menunjukkan bahawa permukaan air di muara Sungai Terengganu sedikit tercemar. Dapatan ini menunjukkan bahawa pensampelan temporal perlu dijalankan untuk menilai keadaan kesihatan muara dan lautan pinggir laut bagi mengurangkan kawasan tadahan.