



## Baseline

## A baseline study of tropical coastal water quality in Port Dickson, Strait of Malacca, Malaysia

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## ABSTRACT

Tidal variation in tropical coastal water plays an important role on physicochemical characteristics and nutrients concentration. Baseline measurements were made for nutrients concentration and physicochemical properties of coastal water, Port Dickson, Malaysia. pH, temperature, oxidation reduction potential, salinity and electrical conductivity have high values at high tides. Principal Components Analysis (PCA) was used to understand spatial variation of nutrients and physicochemical pattern of Port Dickson coastal water at high and low tide. Four principal components of PCA were extracted at low and high tides. Positively loaded nutrients with negative loadings of DO, pH and ORP in PCA outputs indicated nutrients contribution related with pollution sources. This study output will be a baseline frame for future studies in Port Dickson involving water and sediment samples. Water and sediment samples of future monitoring studies in Port Dickson coastal water will help in understanding of coastal water chemistry and pollution sources.

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Productivity potential of coastal water depends on nutrients distribution and behavior. Tidal variation in tropical coastal water greatly affects their physicochemical characteristics and nutrients concentration (Liu et al., 2011). Mixing of freshwater and seawater at high and low tides on hourly time scale determines strong changes of nutrients as well as physicochemical properties. Extent of changes will depend on tidal state and amplitude of coastal water (Gavio et al., 2010). A growing number of coastal water monitoring programs is crucial to collect huge datasets. Huge datasets are important to obtain a better understanding on how anthropogenic activities effect the coastal water environment. Huge datasets obtained from such monitoring programs require multivariate statistical methods. Principal Component Analysis (PCA) is one of multivariate statistical methods that used in interpretation and explanatory of huge datasets (Praveena et al., 2011a).

In the last 20 years, studies pertaining to nutrients (nitrate, phosphate, ammonia) have been reported along Port Dickson coastline, giving further impetus to studies on interactions between tidal and coastal water. Praveena et al. (2011b) concluded that comparison between dissolved organic phosphorus and ortho-phosphate levels indicated an increased in its concentration which clearly shows that major inputs of phosphorus sources occur in Strait of Malacca directly contribute to phosphorus concentration in Port Dickson water. Review done by Praveena et al.

(2011b) also concluded that huge datasets on continuous and systematic of nutrients in Port Dickson coastal water have not been reported so far. Most of the investigations conducted on nutrients of Port Dickson coastal water were based as a single station in research projects. Thus, there is lack of understanding exists on tidal variations influence in nutrients and physicochemical properties in Port Dickson coastal water.

Here, this study aims to detect spatial variation of nutrients and physicochemical pattern of Port Dickson coastal water. In order to understand spatial variation of nutrients and physicochemical pattern of Port Dickson coastal water due to tidal variation (high and low tides), well known exploratory data analysis tool (Principal Component Analysis, PCA) was used. Output obtained in this study will provide baseline information on nutrient enrichments that can be used to identify hotspots which can direct future contaminants monitoring and management programs. Such baseline information can lead to reduce monitoring costs while simultaneously provide a better understanding of poor water quality causes.

This study took place in Port Dickson coastal stretch from north Tanjung Gemuk to south Tanjung Tuan facing the Strait of Malacca. Six sampling locations were selected where each sampling location has three transects parallel to the shoreline at 200 m, 500 m and 500 m to the sea (Fig. 1). Coastal water samples were collected from 18 sampling locations along Port Dickson coastline stretch facing the Strait of Malacca at high and low tides. Coastal water samples were collected in acid cleaned polyethylene bottles by using Van Dorn water sampler. In situ parameters (pH, oxidation

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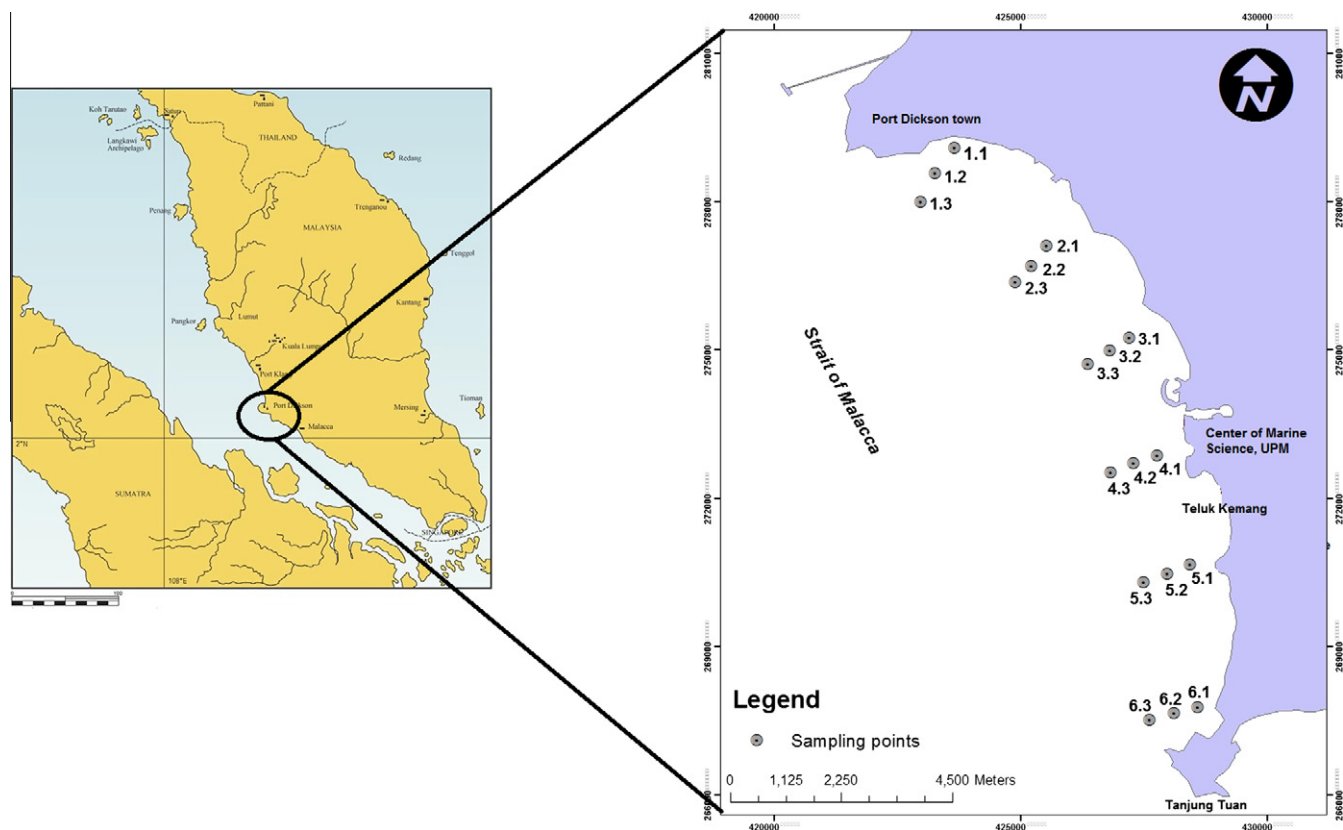


Fig. 1. Study area showing the sampling location.

reduction potential, temperature, salinity and electrical conductivity, Dissolved oxygen) were measured using WTW pH330i, YSI Model 32 and dissolved oxygen meter, YSI Model 52. All the meters were calibrated prior to sampling campaign. Turbidity measurement was done using a Secchi disk. Dissolved nutrients (nitrate, phosphate and ammonia) and major ion (sulfate) were estimated using standard methods (APHA, 1995) by means of Hach – DR 2700 Portable Spectrophotometer. In order to obtain greater data confidence regarding bias and variability, appropriate quality control and assurance measures were implemented. Triplicate samples were collected to estimate variability resulting from the sampling and analytical procedures (APHA, 1995). Laboratory equipments were pre-cleaned with concentrated nitric acid (5%; v/v) and rinsed with distilled water. Equipment blank was used to test for bias from possible contamination of blank water which consists of distilled water. Equipment blank include total field and laboratory sources of contamination. Mean and standard deviation values were used as an indication of accuracy and precision of each parameter measured as well as analytical errors.

Statistical analysis (descriptive statistics) and principal component analysis were carried out for coastal water samples at high and low tides using SPSS ver. 17.0 statistical packages. Principal Component Analysis (PCA) using Varimax rotation was selected to understand spatial variation of the nutrients and physicochemical pattern of coastal water in Port Dickson due to tidal variation. PCA components above 0.60 were taken after Varimax rotation was performed.

Table 1 shows descriptive statistics of all 18 locations in six transects to express spatial variation on nutrients distribution and physicochemical properties at high and low tides. Behavior of different variables in each transect was studied by considering mean value of all location in each transect due to high hydrodynamism of coastal area. Generally, pH, temperature, oxidation reduc-

tion potential, salinity and electrical conductivity values more or less followed tidal cycle with high values at high tides. Seawater buffering capacity causes a very narrow limit and responsible for the observed limited variation (Moresco et al., 2012; Riley and Chester, 1971). Dissolved oxygen (DO), turbidity, sulfate and all the nutrients (ammonia, nitrate, phosphate) values were highest at low tide. In tropical aquatic systems, oxygenation is the result of an imbalance between photosynthesis, degradation of organic matter, reaeration processes and physicochemical properties of water (Hernández-Romero et al., 2004).

Next, PCA was used to discover spatial variation of nutrients and physicochemical patterns of coastal water due to tidal effect. Measure of Sampling Adequacy (MSA) scored for PCA was 0.643 which according to Kaiser's empirical confirmation of sampling adequacy classification as mediocre. Communalities scores for each parameter summarized in Tables 2 and 3 were above 0.6, indicating that parameters share variances. PCA components of high and low tides accounted of 76.08% and 75.46%, respectively. Four principal components were extracted at low and high tide. High load of salinity and electrical conductivity at high tide explained characteristics of fully ionized ions contributed by seawater which contains 90% fully ionized ions (Church, 1989). O'Boyle et al. (1999) has suggested that positively loaded nutrients with negative loadings of DO, pH and ORP in PCA outputs indicated that nutrients contribution related with pollution sources. According to Radojevic and Bashkin (2006) increased of ammonia levels are indicative of pollution which sewage is a major source of ammonia (ammonia is results of urea breakdown by urease bacteria). At typical pH values between 6 and 8 and temperature of 5–30 °C, relative part of ammonia can be detected in coastal water. PCA supported this finding with positive loadings at high and low tides. Presence of nitrate is mainly due to processes such as nitrification. Oxidation of ammonia ions to nitrate by bacteria species is under aerobic

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