NUTRIENT CONCENTRATION AND LOAD ANALYSIS AT LANGAT RIVER BASIN

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Abstract

Water is one of the most important elements required by all living organisms. However, uncontrolled developments and human activities have significantly affected the water quality in the river. Excessive nutrient discharge into the river will lead to many problems such as eutrophication, apart from disturbing the water supply. This study has been conducted to determine the nutrient concentration and nutrient loads in the Langat River Basin in terms of total phosphorus (TP) and total nitrogen (TN), as well as their relationship with the rainfall. Four stations from the Langat River Basin upstream have been selected for this study. The water samples were collected weekly for six months spanning both dry and wet seasons. Two standard methods for examination of water and wastewater were chosen to determine the TN and TP concentration in the water sample. Method 8190 was used for TP while, TN was measured using Method 10071. The results showed that the nutrients in the water bodies generally were influenced by the land use, climate and stream flow of the river. The TN concentration for all four stations were within the USEPA limit. On the contrary, the TP concentration for all stations exceeded the USEPA limit, indicated that limiting nitrogen condition might happen and triggered algae bloom.

Keywords: Nutrient, Total Phosphorus, Total Nitrogen, Langat River Basin
I. Introduction

Water is one of the most important elements required by all living organisms. Generally, human needs at least 1.5 liter of water per day for drinking only, and more for daily consumption. Water is also essential for other activities such as industrial, agricultural and aquaculture activities. History has shown that water is important in carving our civilizations.

Recently, world climate change and unpredictable weather condition cause the demand of water supply to increase rapidly. The high growth rates of population over the years not only has increased the water demand, but also the level of water pollution. Pollution in the river is divided into several categories, namely physical, chemical, biological and in some cases, excessive nutrient may also consider as one of the types of pollution. Excessive nutrient discharged into the river will cause algae to grow rapidly, thus pollute the river and not suitable for human consumption. In view of this, it is important to study and determine the nutrient concentration in the river, for the sake of managing, maintaining, and restoring water quality, as well as the ecological health and sustainability.

In Selangor, major problem affecting Langat River Basin is surface water pollution, due to population expansion and uncontrolled developing activities within and around the river basin. According to the research conducted by [III], more than two third of the Selangor population live in the floodplain, which provide land for agricultural, development and recreation activities. Thus, this study has been conducted to determine the nutrient concentration of water in the Langat River Basin in terms of TP and TN, as well as to develop their relationship with the rainfall. In addition, this study also aims to evaluate the trend of the nutrient load in the water body in the Langat River Basin.

II. Nutrients

All living creature feeds on nutrient to survive. There are two types of nutrient in general, namely micronutrient and macronutrient, classified based on the amount of requirement. As pollutant, nutrient also comes from point and non-point sources and nutrient in river generally refers to nitrogen and phosphorus content in the water. Primarily, plants and animals are composed of carbon (C), hydrogen (H) and oxygen (O), but they still need other nutrient elements which necessary as a component of their structural tissue or as a participant in biochemical reactions [I]. All aquatic life depends on their surrounding water to provide them nutrients. Nutrient in water is referred to nitrogen and phosphorus and it is essential components of structural proteins that capture and utilize light and chemical energy to support life.

Based on previous related studies reported in [IX], nutrient is an important indicator of water quality. Unfortunately, a few centuries of industrial revolution and uncontrolled human activities have caused strong alteration to the basic structure and function of the environment.

A principle of aquatic science is those marine and estuarine phytoplankton tends to be nitrogen limited while freshwater phytoplankton tends to be phosphorus limited.

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As shown in Table 1, a significantly lower N: P ratio indicates potential nitrogen limitation, while a higher N: P ratio indicates a potential phosphorus limitation [V]. The ratio of nitrogen to phosphorus compounds in a water body will be the limiting factor, and consequently which one must be controlled in order to reduce a bloom.

Table 1: Nitrogen/Phosphorus ratios for various limiting conditions [XI].

| Type                | N-limiting (Ratio N/P) | Intermediate (Ratio N/P) | P-limiting (Ratio N/P) |
|---------------------|------------------------|--------------------------|------------------------|
| Freshwater          | ≤ 4.5                  | 4.5 - 6                  | ≥ 6                    |
| Estuarine/ Coastal water | ≤ 5                   | 5 - 10                   | ≥ 10                   |

Nutrient sources may come from agricultural, urban point and non-point source pollution, derived from external sources or internal sources [IV]. External nutrient sources include rainfall, biological nitrogen fixation, sewage discharges and river runoff. Besides that, uncontrolled industrial discharge and atmospheric deposition also contribute to the increase in the amount of nutrient in the river [VIII]. Changed in land use activities within the area also will contribute directly to the increase of load pollutants discharging into the river. Since 1950, human population has been increasing rapidly, associated with the increase in sewage, urban storm water and industrial discharges. Of particular concern, nutrient loading from seepage may also affect the nutrient in the study area. According to [XII], nutrient loading of TN and TP in seepage water was 11 to 17 times the TN and 14 to 23 times the TP of surface water discharged from drainage areas surrounding the river.

Nutrient pollution plays a prominent role in previous revealed preference studies and is a leading cause of water quality impairment throughout the world. Elevated nitrogen loads appear to be related to increase of phytoplankton populations apart from deterioration of the water quality [XII]. This has a profound impact on the ecosystem, such as mass mortalities of wild and farmed fish, human poisonings from contaminated fish, alterations of marine food webs or other life stages of commercial fisheries species, and death of marine mammals, seabirds, etc. [II] and [VI]. These problems not only affect the environment, but also the economy of the country in terms of money spent in water treatment and management purposes.

III. Methodology

This study was conducted at the Langat River Basin, which passes through 3 distinct administrative regions which are Federal Territory of Putrajaya and Cyberjaya, Selangor and Negeri Sembilan. Since the River was too long to be covered, only the upstream of the river was covered and the area is slightly less than 400 sq.km. Four sampling stations were chosen within this area which located at Pangsun, Sg. Lui, DusunTua and the last one at Kajang. They were chosen based on their characteristics, accessibility apart from to represent the upstream, middle and downstream of the river.

The sampling was conducted for three months, between September and November with one or two weeks interval, over both sunny and rainy seasons in order to get the pattern of the TN and TP content for both conditions. There are several methods to
collect water sample and one of them is it can be either grab or composite and collected in the bottle from well mixed areas so that they will represent the total flow. For this sampling, the water samples were collected from the center of the river’s cross section since it represents the real flow of the river.

Nutrient analysis for TP and TN was carried out according to the methods outlined in Standard Methods for the Examination of Water and Wastewater. In this study, test for TP was conducted according to Method 8190 PhosVer3 with Acid Per sulfate Digestion Method where Total Phosphate Test ‘N Tube Reagent Set was used for this test. While, test for TN was conducted using Method 10071 Persulfate Digestion Method. This test was a little bit complex since it involved many substances where TN Hydroxide Reagent Set and TN Acid Solution Reagent Set were required for this test.

**Fig. 1:** Locations of sampling points.

**IV. Results and Discussion**

Table 2 shows the nutrient concentration data in terms of TP and TN for all stations involved in this study. All results were obtained from the laboratory experiments.

**Table 2: Nutrient concentration**

| Station/Location  | TP (mg/L) | 0.77 | 0.80 | 0.91 | 1.27 | 1.39 | 1.93 |
|-------------------|-----------|------|------|------|------|------|------|
| (Pangsun)         | TN (mg/L) | 0.97 | 1.01 | 1.31 | 1.55 | 1.89 | 2.00 |
| Station 2 (Sg. Lui) | TP (mg/L) | 0.70 | 0.71 | 0.88 | 1.20 | 1.31 | 1.78 |
| (DusnTua)         | TN (mg/L) | 1.01 | 1.10 | 1.33 | 1.41 | 1.59 | 1.91 |
| Station 3 (Kajang)| TP (mg/L) | 1.13 | 1.56 | 1.91 | 1.83 | 2.07 | 2.59 |
| (Kajang)          | TN (mg/L) | 1.66 | 1.93 | 2.19 | 2.71 | 2.48 | 3.08 |
|                   |           | 1.99 | 2.32 | 2.09 | 2.64 | 2.77 | 3.34 |
|                   |           | 4.41 | 4.92 | 4.69 | 5.28 | 5.53 | 5.90 |
Fig. 2 shows the relationship of TP and TN concentration with rainfall. The data show that there are slight fluctuations in the reading, but generally the TN and TP increase with the increase of the rainfall. It shows that the amount of rainfall influenced the concentration of TN and TP in the river. High rainfall will increase the surface runoff thus more sediment will be carried into the river. Apart from that, human activities such as cooking and washing activities, also contribute to the increase of nutrient in the river. This can be seen from ‘Lubuk Manggis’ recreational area, Sg. Lopoh Chalet, and residential area surrounding the station.

![Total Phosphorus vs Rainfall](image1)

![Total Nitrogen vs Rainfall](image2)

**Fig. 2:** Relationship between TP and TN with rainfall for Pangsun station.

Fig. 3 shows the TN and TP relationship with the rainfall. The graph patterns for the first and second stations are similar, due to similar human activities in the two areas. However, Sg. Lui station is not densely populated, the values are slightly lower compared to the Pangsun station.

![Total Phosphorus vs Rainfall](image3)

![Total Nitrogen vs Rainfall](image4)

**Fig. 3:** Relationship between TP and TN with rainfall for Sg. Lui station.

Fig. 4 shows the trend for both TP and TN in Dusun Tua station. From both graphs, it shows that the concentration of TP and TN at this station does not totally depend on the amount of rainfall in that area, but also influenced by the activities and conditions upstream. Since the water in the Dusun Tua station is flowing from Pangsun and Sg. Lui station, the readings for this station is higher due to the accumulation of nutrient from both stations. Other sources of nutrient in Dusun Tua station have come from the villages, hawker stalls and National Youth Skills Institute nearby.

![Total Phosphorus vs Rainfall](image5)

![Total Nitrogen vs Rainfall](image6)

**Fig. 4:** Trend for both TP and TN in Dusun Tua station.
Fig. 4: Relationship between TP and TN with rainfall for Dusun Tua station.

Fig. 5 shows the trend of nutrient concentration for the Langat River at Kajang station. Generally, Kajang River has highest nutrient concentration. This is due to the station is located in a densely populated area packed with development and economic activities.

According to [X], an acceptable range for TN is 2 mg/L to 6 mg/L. From all the data obtained, the highest concentration of TN is 5.90 mg/L from Kajang station. Therefore, TN for all stations in this study are within the acceptable range. However, extra care has to be given to Kajang area to control the TN pollution. On the other hand, the TP for all locations has exceeded the 0.1 mg/L limit set by the USEPA standard. This could be due to the industrial and/or self-treat plant that discharged their waste without proper treatment.

The monthly averaged TN and TP loads in each station are presented in Table 3 and illustrated in Fig. 6. The results show that the TP and TN loads for the Kajang station is the highest which is almost one million kilograms per month compared to other stations in this study. Similar to the nutrient concentration, the nutrient loads also increase from upstream to downstream, on top of the original amount of nutrient loads contained in the sample soil. The ratio of Nitrogen and Phosphorus is 2.03 the highest and the lowest is 1.19. Generally, the ratios are significantly lower than the
WHO limits (see Table 1). Hence, the nitrogen sources need to be controlled in order to reduce or avoid algae bloom.

**Table 3: TP and Nitrogen Load per month.**

| Station      | TP load (kg/month) | TN load (kg/month) | N/P |
|--------------|--------------------|--------------------|-----|
| Pangsun (S1) | 31,104             | 38,800             | 1.25|
| Sg. Lui (S2)| 25,920             | 31,104             | 1.20|
| DusunTua (S3)| 121,824           | 145,152            | 1.19|
| Kajang (S4) | 331,776            | 673,920            | 2.03|

**Fig. 6:** Nutrient load at each station.

V. Conclusions and Recommendation

This study was conducted in order to determine the nutrient concentration of water in Langat River Basin in terms of TP and TN. In general, the nutrient concentration in the river is influenced by many factors such as climate condition and streamflow. Besides that, the land use within the sampling stations also contributes to the increasing amount of TP and TN in this river. Out of the four sampling stations, Kajang station has the highest nutrient concentration. However, TN concentration of all four stations are still within the standard limit recommended by USEPA. TP concentration for all stations, on the other hand, have exceeded the USEPA limit. From the results obtained, there is a strong relationship between the rainfall and concentration of TN and TP.

The nutrient concentration in the water bodies increases as the amount of rainfall increases within the sampling stations. This study was also conducted to analyze the nutrient loads in the water. Similar trends for nutrient concentration have been observed. The output of this work can be served as a guideline for the local authorities to give extra precautions for the affected areas.

This work can be further improved by extending the number of nutrients involved. To further improve the accuracy and precision, future work may consider increasing the number of sampling stations and reduce the distance between each station.
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