WATER QUALITY ASSESSMENT AND TROPHIC STATE CLASSIFICATION OF TASIK ILMU, UTM

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DEDICATION

This project report is dedicated to my parents, who taught me that the best kind of knowledge to have is that which is learned for its own sake. It is also dedicated to my husband, who taught me that even the largest task can be accomplished if it is done one step at a time.

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ABSTRACT

Freshwater lakes are valuable natural asset to humans for their significant functions. Unfortunately, exposure of the lakes with anthropogenic pollutants creates concern on the occurrence of enhanced eutrophication which further degrade the water quality. In this study, water quality of UTM's lake and river was characterized according the six water quality parameter of Malysian Department of Environment Water Quality Index (DOE-WQI), total phosphorus, fecal coliform, chl-a, transparency and turbidity. The impact of the oxidation pond (OP) on the lake water quality was also investigated and meanwhile, the trophic state of UTM's lake was evaluated using Carlson index. Water samples were collected at seven locations including river, OP and lake for three times. The samples were analyzed for DO, BOD, COD, AN, total phosphorus and fecal coliform. The study found that, the WQI calculated for the lake was ranging from 69.5 to 70 which falls under Class III indicating that the water is slightly polluted and unsuitable for recreational use with body contact. The Trophic State Index (TSI) of Tasik Ilmu revealed that mean values of TSI(SD), TSI(chl-a) and TSI (TP) were 71.6, 65.4 and 100.2 respectively which reflect the eutrophic condition of the lake water. From the removal profile of OP it was found that, the COD removal was 60%, ammonical nitrogen and fecal coliform were only ranging between 30-33%, the total phosphorus and BOD were significant with 70% of removal. The classification of river water quality before the OP effluent falls under Class II with WQI 78 while, after the effluent it falls under Class III. In conclusion, the two indices TSI and WQI used for water quality assessment process confirmed that Tasik Ilmu is in a deteriorating state and effluents from the OP contributed to its deterioration.

ABSTRAK

Tasik air tawar adalah aset semulajadi yang berharga dengan kepentingan fungsinya terhadap manusia. Malangnya, pendedahan tasik-tasik dengan bahan pencemar daripada kegiatan manusia menimbulkan kebimbangan terhadap kejadian eutrofikasi yang menjejaskan kualiti air. Dalam kajian ini, kualiti air tasik dan sungai UTM dikategorikan mengikut enam parameter kualiti air DOE-WQI, jumlah fosforus, fecal coliform, klorofil-a, kejernihan dan kekeruhan. Kesan kolam pengoksidaan (OP) pada kualiti air tasik juga disiasat dan sementara itu, status tropika tasik UTM dinilai menggunakan indeks Carlson. Sampel air diambil daripada tujuh lokasi termasuk sungai, OP dan tasik sebanyak tiga kali. Sampel dianalisis untuk DO, BOD, COD, AN, total fosforus dan fecal coliform. Kajian ini juga mendapati bahawa, WQI yang dikira untuk tasik adalah diantara 69.5 hingga 70 dan dikategorikan sebagai Kelas III yang menunjukkan bahawa air itu sedikit tercemar dan tidak sesuai untuk kegunaan riadah dengan hubungan badan. Indeks Status Tropik (TSI) Tasik Ilmu pula menunjukkan bahawa nilai TSI (SD), TSI (chl-a) dan TSI (TP) adalah 71.6, 65.4 dan 100.2 masing-masing yang mencerminkan status eutrofik air tasik. Daripada profil penyingkiran OP, didapati bahawa penyingkiran COD adalah 60%, ammonical nitrogen dan coliform fecal diantara 30-33%, jumlah fosforus dan BOD sebanyak 70% penyingkiran. Klasifikasi kualiti air sungai sebelum efluen OP jatuh di bawah Kelas II dengan WQI 78 sementara, air sungai selepas efluen termasuk dibawah Kelas III. Sebagai kesimpulan, indeks TSI dan WQI yang yang dikaji menunjukkan bahawa Tasik Ilmu berada dalam keadaan yang tidak baik dan efluen dari OP telah menyumbang kepada kemerosotannya.

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LIST OF ABBREVIATIONS

APHA	-	American Public Health Association
OP	-	Oxidation Pond
Chl-a	-	Chlorophyll-a
BOD_5	-	5-day Biological Oxygen Demand
COD	-	Chemical Oxygen Demand
DO	-	Dissolve Oxygen
OP	-	Oxidation Pond
UTM	-	Universiti Teknologi Malaysia
TSS	-	Total Suspended Solid
AN	-	Ammonical nitrogen
TP	-	Total Phosphate

LIST OF SYMBOLS

°C	-	Degree Celcious
%	-	Percent
L	-	Liter
m^2	-	Square Meter
mg	-	Miligram
NH_4-N	-	Ammonical Nitrogen
µg	-	Microgram
m^3	-	Cubic Meter

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CHAPTER 1

INTRODUCTION

1.1 Background of Research

Eutrophication is a very slow natural process, resulting from accumulation of nutrients in lakes or other water bodies that can contribute to excessive plant growth. Within the past 50 years, the over enrichment of water by nutrients such as nitrogen phosphorus has emerged as one of the leading causes of water quality impairment. However, human activities such as changing of land use pattern, excessive nutrient loading from both point and non-point sources greatly contributed to enhance eutrophication. Additional nutrients cause additional plant growth and poor water quality. As a result, lakes were found to loss the aesthetic beauty and become unsuitable for recreation.

Phosphorus play a vital role to accelerate inland water eutrophication. Internal recycling of phosphorus from sediments represents a significant long-term input that plays an important role to enhance eutrophication particularly in shallow lake (Shear and Anda, 2005). Past studies in tropical countries revealed that shallower lakes were observed to have higher nutrient concentration as compared to deeper ones due to distinctive physico-chemical character (Sharip *et al.,* 2018); complex biogeochemical process (Davidson *et al.* 2015); sediment resuspension (Deng *et al.,* 2018); respond remarkably to a variety of changed conditions (He *et al.,* 2015), nutrient loading from human activities (Le *et al.,* 2010) and climate related disturbance (Zhu *et al.,* 2014).

In recent years, lakes are being contaminated mainly due to residential or agricultural activities (Baharim *et al.,* 2016), industrial activities (Hasim *et al.,* 2018), clinic centers, restaurants; petrol pump stations that release discharge into streams, rivers and eventually to the lake (Aziz *et al.,* 2017). Therefore, to maintain the quality of surface water has become a big issue in many countries, especially due to the

unavailability of freshwater resource. So, water quality monitoring program is needed for the protection of freshwater resources (Pesce and Wunderlin 2000).

Malaysia can be considered as a wet country with an average amount annual rainfall of 2500 mm. A rainfall at one duration can enhance surface runoff that can carry the soil, sand and foreign substances direct into the river and reservoir (Hasim *et al.,* 2018) and subsequently, causes water quality degradation. In Malaysia, most of the studied lakes were under Class III of DOE Water Quality Index (DOE-WQI) (Sharip *et al.,* 2010) and >60% of the 90 major lakes studied in 2005 were eutrophic (Sharip & Yusop 2007).

1.2 Statement of Problem

Water quality has become a global issue. Everyday millions of tons of inadequately treated sewage and industrial and agricultural wastes are poured into the world's water increasingly threaten Water quality has become a global issue. Every day, millions of tons of inadequately treated sewage and industrial and agricultural wastes are poured into the world's waters. Every year, lakes, rivers, and deltas take in the equivalent of the weight of the entire human population-nearly 7 billion people-in the form of pollution. Every year, more people die from the consequences of unsafe water than from all forms of violence, including war-and the greatest impacts are on children under the age of five.

The economic losses due to the lack of water and sanitation in Africa alone is estimated at $U528.4 billion or about 5% of GOP (Chang *et al.,* 2013). Water contamination weakens or destroys natural ecosystems that support human health, food production, and biodiversity. Studies have estimated that the value of ecosystem services is double the gross national product of the global economy, and the role of freshwater ecosystems in purifying water and assimilating wastes has been valued at more than $U5400 billion. Most polluted freshwater is a great threat for fisheries sectors.

Lakes confer numerous functional roles that may include defence over flood, recharge and storage of groundwater, biodiversity hot spot and the social economic services. Lakes are often subjected to sudden environmental changes caused by various anthropogenic (industrial, agricultural, water supply, recreational, etc.) and touristic activities along their shores.

Nutrients loading from natural as well as anthropogenic sources may accelerate eutrophication and cause adverse impacts on lake water quality. Eutrophication can result in depletion of oxygen and odour problem due to decomposition of plant. The deterioration of the appearance of previously clear water and poor water quality can adversely affect the aquatic life. The removal of nutrients can limit the algal growth and eutrophication control. Thus, it is crucial to realize the contribution of water quality assessment for planning and management of sustainable aquatic ecosystem.

Currently, very little is known about the occurrence, fate, and impact of sewage treatment plant (STP) on water quality of UTM's river and lake. Practicing of discharging effluent from STP directly into water without proper treatment deteriorates river water quality. Consequently, the river water flows through the lake and as a result, the lake water quality loss the valuable properties and became unusable for recreational purpose day by day. This situation has raised concerns due to their potential effects to aquatic organisms as well as on aesthetic beauty of UTM campus. The study was conducted to characterize the water quality of both UTM's river and lake in terms of DOE-WQI and TSI and to investigate impacts of OP on water quality.

1.3 Objectives of Study

This study was carried out with the following objectives:

a) To characterize the water quality of the lake and rivers in terms of the six DOE-WQI parameters, phosphorus, faecal coliform, chlorophyll-a, turbidity and transparency.

b) To evaluate the trophic state of the lake using Carlson Index.

c) To investigate the impact of the oxidation pond's effluent on the water quality deterioration of the lake.

1.4 Scope of Study

The study was conducted at UTM's lake, upstream river of the lake and OP. The main scope of the study involves water quality monitoring work within river, lake and the OP. Water quality was assessed based on biological oxygen demand (BOD), chemical oxygen demand (COD), suspended solids (SS), turbidity, pH, ammonical nitrogen, fecal coliform; while the trophic state was evaluated using total phosphorus, chlorophyll-a, and transparency. The performance of OP was investigated, and its effluent was compared against Regulations in Environmental Quality (Sewage), 2009. The impact of OP on water quality was also discussed at the end of the study.

1.5 Significance of Study

Every living thing on earth needs water to survive. Human bodies are made up of more than 60% water. We use clean water to drink, grow crops for food, operate factories and for swimming and recreational activities. Monitoring the quality of water will help protect our water ways from pollution. Farmers, local government use monitoring information to help control pollution levels. Water is a vast networks of branching rivers, springs, estuaries etc. Water quality can be difficult to measure without knowing available information of physico-chemical process occurring in lake. Thus, monitoring of water helps to recognize and prevent contamination problems.

Lakes and ponds are part of a complex and dynamic ecosystem that are in a constant state of change. Parameters such as alkalinity and conductivity can maintain relatively stable values over times, while DO and pH typically fluctuate throughout

the day, but can stay constant from season to season. Factors such as nutrient load and secchi depths usually change with major physical events. A rain storm can introduce large amounts of nutrient rich sediment that can cause both parameters to go up, while a dry spell can allow sediment to settle out causing the parameter values to improve. It is important to regularly have the water quality tested in order to maintain an ecological balanced approach to any site-specific pond management plan created in these dynamic ecosystems.

Water quality sampling and testing allows the authority to establish baseline values, ultimately increasing the knowledge and understanding surrounding the specific issues of a waterbody. Parameters such as alkalinity and conductivity are analogous to the yearly "physical" each lake or pond is recommended to have. These values rarely change over time much like the height and weight of an adult human. They are typically established based on the chemistry of the source of the water for that specific lake or pond. Major swings in parameter values can signify that something may be imbalanced leading to an unhealthy lake or pond. Both factors can change if the health of the lake or pond is suffering and a treatment can be more effective as a result. Different aquatic products applied at different rates will not all work the same under varying water conditions, so the more information that can go into selecting a product, the better chances for its success

Regularly monitoring of water quality is a crucial part of identifying any existing problems, or any issues that could emerge in the future. When designing and developing pollution prevention and management strategies data collected from water quality monitoring efforts is hugely helpful. Today governments, communities and businesses are required to meet a range of water quality goals. Monitoring data is used to determine whether or not pollution regulations are being complied with.

Lack of continuous study and limited literature in evaluating the trophic state of UTM lake and impacts of OP. Therefore, research in this field is important for UTM's management team to identify the overall degree of pollution in terms of eutrophication and its impact on the aquatic environment as well as in aquatic species. The findings from the study can be used to take effective measures to control pollution

and maintain the water quality standard of the lake for assuring sustainable aquatic resources in UTM campus.

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