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Ponds in UTHM: Water Criteria and Quality

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Abstract: Invasive Aquatic Plants (IAP) in the river/stream or lake are typically grown. IAP was left along the river/stream/lake after maintenance and clearance, caused the unpleasant view. The excessive nutrients in the water can cause native plants to have unusually high growth rates, the natural density and distribution of aquatic plants in lakes and streams can become affected. Ammoniacal nitrogen is the most nutrients that can be found in a water body. Despite the significance of these nutrients for aquatic health, severe problems may also arise from overabundance of nutrient. This study is limited to several ponds in UTHM. The objectives of the research are to identify type of aquatic plant that exist in pond and to determine the water quality of the pond. The water quality measurements involved the ammonia nitrogen and total suspended solid by following Method 8038 Nessler's and Standard Method 2540, APHA. The water quality also be determined using subindex of ammoniacal nitrogen and total suspended solid. The result showed that water lily grows in two ponds. The ammoniacal nitrogen from three ponds are different, subsequently resulted in different class such Class II, III and IV. However, using total suspended solid as a reference, each pond was classified as Class 1. Pond B was consistently showing the clean water quality status as based on subindex of ammoniacal nitrogen and total suspended solid.

Keywords: Invasive Aquatic Plant, water quality, ammoniacal nitrogen, total suspended solid

1. Introduction

Lake and pond ecosystems are made up of the physical, chemical, and biological characteristics found in these waterways [1]. A lake is a large, contained body of water (typically freshwater) enclosed by land and has no direct access to the sea unless it is fed or drained by a river or stream. [2]. Lakes are excellent environments for studying ecosystem dynamics because interactions between biological, chemical, and physical processes are typically internally or externally unique from those on the ground or in the air [1]. Though lakes constitute 50.01 % of all liquid on the surface of the planet, they comprise 498 percent of all liquid surface freshwater [1]. Freshwater is essential for the

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survival of many species, and lakes provide a diverse range of "goods and services" to humans including drinking water, waste disposal, fishing, agricultural irrigation, industrial activity, and enjoyment [1]. However, these actions subject them to growing strain and stress from pollutants, resulting in most of them degrading [3].

Lakes are important ecosystems for several reasons. Lake ecosystems are impacted by their watersheds, which are the geological, chemical, and biological processes that occur on the land and in upland streams [1]. As a result, the quality of surface water is determined not only by natural environmental processes such as weathering, erosion, and precipitation, but also by the effect of human activities such as urban, agricultural, and industrial operations [4]. The transfer of chemicals, sediments, debris, and many species from the watershed to the lake is generally unidirectional, but fish may travel upstream and aquatic insects may emerge and spread on land [1].

Invasive Aquatic Plant (IAP) are non-native aquatic plants and other creatures that have a harmful impact on the environment, economy, and human health. IAP have an unpleasant visual effect on the rivers, serve as vector habitat, change food web connections, and impair recreation, flood management, and hydroelectricity. IAP may colonize both fresh water and marine ecosystems, including wetlands, lakes, rivers, estuaries, coastal zones, irrigation systems, hydropower systems, and aquaculture facilities [5]. IAP grow faster than native species even in low-resource settings [6]. The major cause of the uncontrollable proliferation of aquatic invasive plants was caused by human activities all over the world, which deteriorated the health of our environment [7].

The IAP have a short reproductive cycle, significant genetic diversity, the capacity to flourish in a variety of conditions, and the capacity to compete vigorously in order to evict other plants from a coastal waterway [5]. Although IAP might be viewed as a danger, freshwater macrophytes are valued for their important role in the structure of shallow aquatic habitats [8]. Macrophytes provide key ecological activities, such as nutrient retention, improving water clarity by trapping sediment, limiting algal blooms, providing food for herbivores, and providing habitat for fish, in native, multispecies macrophyte beds [8]. This loss of ecosystem services is expected to have the greatest impact on human well-being in instances where local economic systems are strongly linked to biological resource harvesting and/or subsistence agriculture is practiced [9].

Plants and animals require nutrients, which are chemical components contained in food, to develop and survive. Although there are many different types of nutrients, nitrogen and phosphorus are two of the most important and plentiful [8]. Nitrogen and phosphorus exist in a number of forms (NH_3, NH_4^+, NO_3^- and PO_4^{3-}) and its presence can vary as they travel through the atmosphere, water, and soil [1]. Algae that consume nutrients form unattractive scum on the water's surface, reducing recreational value and blocking water-intake pipes. Decaying mats of dead algae can cause unpleasant tastes and aromas in the water; microorganisms absorb dissolved oxygen from the water, causing fish deaths in some cases [10]. By increasing the pace at which nutrients enter the water, humans might hasten eutrophication. Eutrophication is a natural phenomenon caused by nutrient buildup in lakes or other bodies of water [8]. Eutrophication has resulted in a slew of water-quality issues for both freshwater and marine environments [11].

IAP has become a major danger to biodiversity and the stability of global water ecosystems. Increasing nutrient availability may be a significant component in the plant invasion process, since some species have the potential to boost their growth rates in response to increased nutrition availability, inhibiting native species that cannot respond in the same manner [12]. As a result, these IAP with greater growth rates may have far-reaching consequences for native community structure [12]. In most water ecosystems, nitrogen and phosphorus cycles are the limiting forces [13]. Previous research has shown that phosphorus and ammonia concentrations have a larger role in influencing the fast development of IAP in lakes [12]. Excessive ammonia concentrations (due to human activities) might hasten the development of eutrophication (the progressive rise in phosphorus, nitrogen, and other plant nutrients concentrations) [12]. Pollution in water bodies can kill fish and pose health risks to humans [5].

The invasive aquatic plant was classified into four types: 1) rooted emergent plant, 2) free-floating emergent plant, 3) rooted submerged plant, and 4) rooted floating leaved plant [7]. Some species colonize and naturalize successfully in their new surroundings, while others become invasive [14]. Eichhornia crassipes (water hyacinth) (Mart.) Solms is one of the most widely spread invasive aquatic macrophytes on the planet. The Amazon basin and the vast marshes of western Brazil's Pantanal are where the species originated [15]. Water hyacinth, Lemna, and hydrilla are aquatic plant species classified noxious weeds in Malaysia [14].

It is critical to assess the water characteristics before using for household, agricultural, or industrial purposes [1]. Several physicochemical criteria must be used to assess water. Water contains a variety of pollutants, including floating, dissolved, suspended, microbiological, and bacteriological impurities [1]. Temperature, pH, turbidity, TDS, and other physical tests should be done, whereas chemical testing for ammonia, BOD, COD, dissolved oxygen, alkalinity, phosphorus, and other parameters should be performed [1].

Interim National Water Quality Standard (INWQS) is a standard that focuses on water quality based on beneficial applications. Water can be declared acceptable for a given use if it falls within the range provided for the designated classes [16]. INWQS can be used for classification of use for freshwater. The fresh water beneficial use was categorized to five classes, Class 1 implies that no treatment is required and that the water supply and sensitive fisheries activity can proceed. The worst is Class V, where the water is no use at all [2].

The corresponding to the high growth rate of IAP and water nutrients, the Water Quality Index (WQI) are measured to identify the result of ammonia and phosphorous level. Both nutrients (N and P) are very related to the rapid growth of IAP and it also leads to eutrophication. Phosphorus is a vital mineral for the aquatic food web's plants and animals. Because phosphorus is a nutrient that is scarce in most freshwaters, even a tiny increase in phosphorus in a stream can start a chain reaction of unfavorable occurrences, including increased plant growth, algae blooms, low dissolved oxygen, and the mortality of some fish, invertebrates, and other aquatic creatures [1].

Water Quality Index (WQI) practiced in Malaysia enforced by Department of Environment (DOE) primarily based on six essential characteristics including total suspended solid and ammoniacal nitrogen [2]. WQI is a basic and succinct way of describing the quality of surface water using single digits [4]. Because there are no national guidelines for lake water in Malaysia, lake water parameters are still determined using WQI techniques [2]. The water quality of the freshwater can be determined using the sub index of total suspended solid and ammoniacal nitrogen. Arif, [17] also used the subindex ammoniacal nitrogen to determine the water quality of the pond.

2. Materials and Methods

2.1 Water Sampling

The water sampling was conducted following the Standard Method 1060 in which the suitable plastic bottles to avoid direct contact with the sunlight was used [18]. All sampling equipment were cleaned from any impurities to avoid contamination happened to water samples.

The detail of sampling information including the location, and time of taking water samples need to be recorded. Also gloves need to be worn before opening the bottles for water sampling. The plastic bottle needed to be rinsed at least 3 times with distilled water before taking real water samples and were filled by immersing it inside the water [18]. Samplings were done for three sampling point, each for pond within UTHM as shown in Fig. 1 and Fig. 2.

The water samples were stored inside the bag immediately after closing the lid and were brought to the lab for further analysis [19]. For this study, the laboratory work for water characterization was done immediately after the sample arrived at the laboratory. The water samples were analyzed for 3 days in a row, collected between 8:30 to 10.00 am and during sunny day (dry season) [15].

Fig. 1 - (a) Pond A near Pusat Kesihatan Universiti; (b) pond B near Fakulti Kejuruteraan Awam dan Alam Sekitar; (c) pond C near library

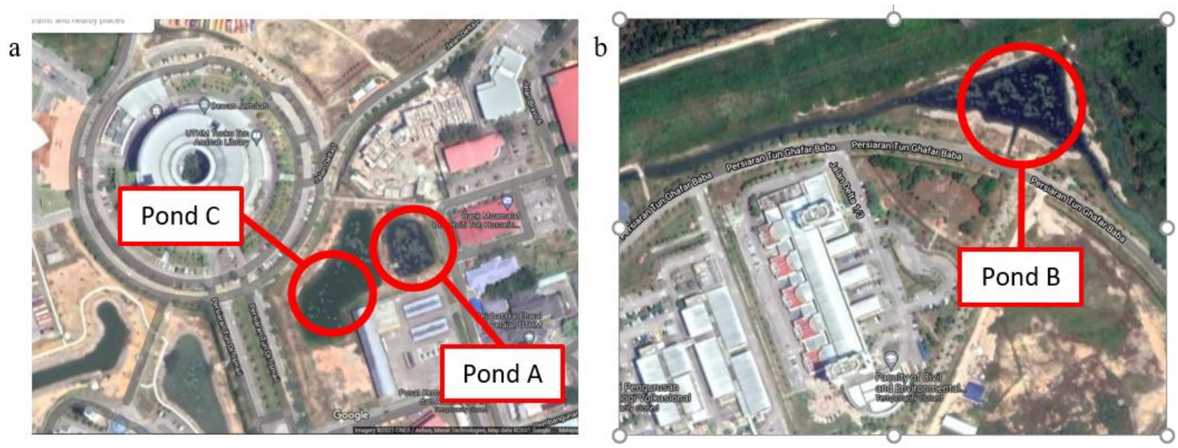

Fig. 2 - (a) Pond A and pond C; (b) pond B

2.2 Analytical Method

The water sample was measured for ammoniacal nitrogen by following Method 8038 Nessler's in which the spectrophotometer was used to determine the value in mg/L [19]. Standard Method 2540, APHA, 2017 was followed to determine the total suspended solid in which the drying oven at 105ºC was used for drying purpose [14].

2.3 Analytical Method

Aquatic plants on all 3 different ponds were observed and photographed by using a high-resolution camera. Then, the images of the aquatic plants were cross-referenced in the websites such as www.worldfloraonline.org (formerly known as www.plantlist.org) and www.cabi.org.

3. Results and Discussion

3.1 Aquatic Plants Availability in UTHM Ponds

The aquatic plants in the ponds were observed visually during the water sampling. For pond A (near the PKU), no aquatic plant was observed with the naked eyes during sampling. (Fig. 3) shows the condition of pond A during sampling. Fanwort and Nymphaea *lotus* (water lily) are aquatic plant that were found in pond B as shown in (Fig. 4). The only plant that was observed in pond C was water lily (Fig. 5). Shaker [20] reported the presence of Fanwort from few lakes in Adirondack Park Region of New York, USA. Water lily is one of the invasive aquatic plants in Malaysia [21]. The plant is native to the Nile and is cultivated in different regions of East Africa and Southeast Asia [22]. Water Lily is commonly found in coastal environments where it is distributed and visible floating over water bodies [7]. Besides, water lily typically requires shallow water, full sunlight and neutral to slightly alkaline pH [23]. These requirements are in accordance to the natural situation in the UTHM ponds. Thus, it is highly expected that these water lilies are present abundantly in UTHM ponds. Additionally, water lilies obtain its nutrient requirements from the organic detritus into which it is rooted [24].

Fig. 3 - None of aquatic plant is observed in pond A

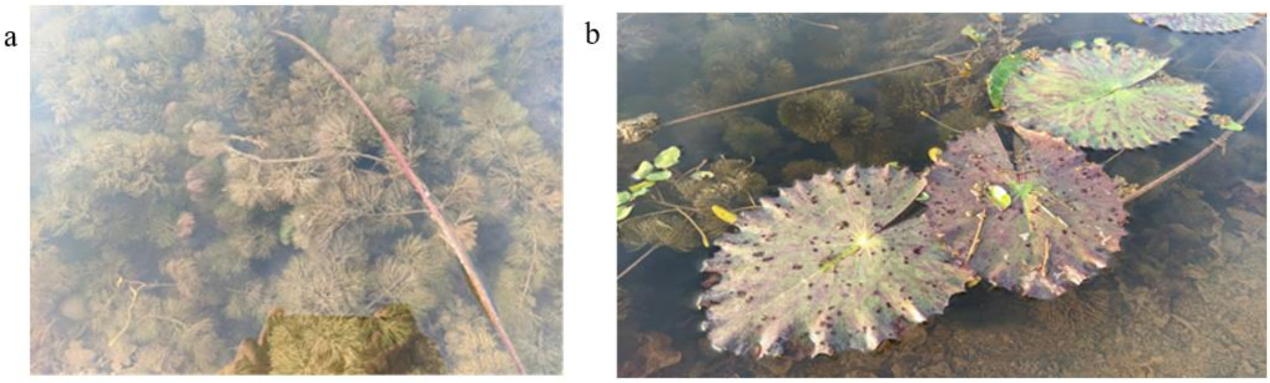

Fig. 4 - Found in pond B (a) fanwort; (b) water lily

Fig. 5 - Water lily in pond C

3.2 Water Quality

The water quality for the ponds for ammoniacal nitrogen was tabulated in Table 1. The higher ammonia concentration was found consistently from pond A. Pond B shows the lowest concentration ranged from 0.05 to 0.24 mg/L. However, for each pond, the concentration of ammonia nitrogen increased gradually. According to Ariff, [17], ammoniacal nitrogen concentration of ponds in UTHM ranged between 0.61 mg/l to 1.66 mg/l. Aliyu [3] found ammoniacal nitrogen concentration for an artificial lake in the range of $0.17 \pm 0.014 + 0.4 \pm 0.021$ mg/l.

The water quality for the ponds for total suspended solid was tabulated in Table 2. The concentrations were fluctuated for each sampling day. Ismail, [14] also reported the lower TSS concentration of Chenderoh lake which is between 0.0097 mg/L to 0.0036 mg/L. Safwan, [2] recorded the average TSS of 19.7 ± 0.58 mg/l in UTHM lake. The quantity of contaminants discharged into water bodies has risen as a result of growth and population, degrading the quality of water and ecological system. Changes in anthropology or natural causes have also had an impact on lakes, ponds, and water streams [10].

Table 1 - Ammoniacal nitrogen concentration for 3 sampling days (in average)

Pond ID	3 May 2021	4 May 2021	5 May 2021
Pond A (near PKU)	0.56 mg/L	1.09 mg/L	1.32 mg/L
Pond B (near FKAAB faculty)	0.05 mg/L	0.18 mg/L	0.24 mg/L
Pond C (near UTHM library)	0.09 mg/L	0.21 mg/L	0.6 mg/L

Table 2 - Total suspended solid concentration for 3 sampling days (in average)

Pond ID	3 May 2021	4 May 2021	5 May 2021
Pond A (near PKU)	0.0010 mg/L	0.0002 mg/L	0.0004 mg/L
Pond B (near FKAAB faculty)	0.0006 mg/L	0.0002 mg/L	0.0003 mg/L
Pond C (near UTHM library)	0.0009 mg/L	0.0003 mg/L	0.0003 mg/L

Table 3 and Table 4 showed the range of ammoniacal nitrogen and total suspended solid for each pond for three days monitoring. By using the range of concentration of ammoniacal nitrogen and Interim National Water Quality Standard (INWQS) classification as the reference, the water for each pond was classified for different beneficial use. However, when referring to TSS concentration, each pond is classified as Class 1 (Table 4).

Table 3 - INWQS beneficial use classification as based on ammonia nitrogen concentration

Pond ID	Ammoniacal nitrogen (mg/L)	INWQS beneficial use class [25].
Pond A (near PKU)	0.56- 1.32 mg/L	IV
Pond B (near FKAAB faculty)	0.05- 0.24 mg/L	II
Pond C (near UTHM library)	0.09 -0.6 mg/L	III

Water quality status can be determined by using the subindex of BOD, subindex ammoniacal nitrogen and subindex total suspended solid [10]. Using the best fix equation for ammonia nitrogen and total suspended solid, the subindex for both parameters were tabulated in Table 5 and Table 6. According to [17], the subindex ammoniacal nitrogen at many locations inside the UTHM pond varied between 30 and 45. This stated that the water quality rating might change at any time based on natural conditions and others. According to Akinbile, [26], the TSS sub index was measured on the Bukit Merah's lake, Malaysia and was found in the range is 95.1–96.89 subsequently indicated the water was clean and any water treatment does not necessary.

Table 4 - Total suspended solid concentration for 3 sampling days (in average)

Pond ID	TSS (mg/L)	INWQS beneficial use class [25]
Pond A (near PKU)	0.0002 – 0.0010 mg/L	I
Pond B (near FKAAB faculty)	0.0002 – 0.0006 mg/L	I
Pond C (near UTHM library)	0.0003 – 0.0009 mg/L	I

Table 5 - Subindex ammoniacal nitrogen

Pond ID	3 May 2021	4 May 2021	5 May 2021	Subindex range	INWQS beneficial use class [25]
Pond A (near PKU)	74.96	54.55	47.22	47 - 75	75 (Slightly polluted)
Pond B (near FKAAB faculty)	95.25	80.56	74.25	74 – 95	95 (clean)
Pond C (near UTHM library)	90	78.45	73.65	73 - 90	90 (Slightly polluted)

Table 6 - Subindex total suspended solid

Pond ID	3 May 2021	4 May 2021	5 May 2021	Subindex range	INWQS beneficial use class [25]
Pond A (near PKU)	97.5	97.5	97.5	97.5	97.5 (Clean)
Pond B (near FKAAB faculty)	97.5	97.5	97.5	97.5	97.5 (Clean)
Pond C (near UTHM library)	97.5	97.5	97.5	97.5	97.5 (Clean)

4. Conclusion

The finding of this study showed that the water characteristic of ponds in UTHM are varies. However, each pond constantly showing the low TSS concentration. Subsequently, water from each pond is considered clean. As for the ammoniacal nitrogen, Pond A showing the highest concentration range of 0.56- 1.32 mg/L indicated that Pond A is classified as Class 4 and slightly polluted in term of water quality. Between three ponds, Pond B showed the clean status as based to ammoniacal nitrogen and total suspended solid.

For the future study, all of water quality parameter and the aquatic plant need to be observed. The three water quality parameters (pH, DO and temperature) were measured in-situ to gain best appropriate result for the study [2]. For the best result, the sampling must be done during the sunny day. The sampling point need to be accurate and on point at the location of the presence of aquatic plant weather on boat or diving. The aquatic plant must be extracted from the root and sampled in order to perform numerous measures such as plant stem length, plant density, and dry weight [27].

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