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Assessment and Mapping of Ammonium Concentration in Swale around Faculty of Civil Engineering and Built Environment and G3 Lake, Universiti Tun Hussien Onn Malaysia, (UTHM)

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Abstract: Water contamination can occur in a variety distinct way, point source and non-point source, leading to the catchment by surface runoff. This study has shown that the presence of untreated ammonium in the swales at the Faculty of Civil Engineering and Built Environment and G3 Lake, Universiti Tun Hussien Onn Malaysia. Undoubtedly, this ammonium concentration presence in the swale is generated by urbanization and the rise in the quantity of impermeable surfaces like buildings, roofs, highways, parking lots, and other transportation-related structures. It is also caused by pollutants, including vehicle emissions and maintenance such as grass cutting. The ammonium was successfully found as a result obtained from the laboratory experiment, in the swale around the Faculty of Civil Engineering and Built Environment and G3 Lake, illustrating the trend of concentration mapping to figure out which part of the swale sample site had the highest concentration. Surfer Software (V16) developed spatial distribution mapping on the color pattern that shows the ammonium concentration each week by the number of all sampling point areas collected. The result of each parameter for ammonium ranged 0.01- 0.8 mg/L, DO ranged 5.83- 8.47 mg/L, turbidity ranged 0.97- 63.27 NTU, pH ranged 3.62- 6.94, temperature ranged 23.3-28.1°C and TDS ranged 100- 900. The outcome of this research could give insights into the adequacy of water for daily usage activities, reducing the environmental impact and exhibiting the trend of ammonium in the swale for future reference.

Keywords: Ammonium, Concentration, Swale, Trend, Mapping, Surfer Software (V16)

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1. Introduction

Water is necessary for life in all forms, and thankfully, the world does not run out of it. Despite the optimistic outlook, water is frequently in limited supply, a problem that will only worsen as the global population grows. This is because not all areas of the earth's land mass are evenly watered, some have little water, and even well-watered sites may have water shortages during droughts. Water quality varies from location to place and from time to time. The majority of the world's water is too salty for human consumption, and pollution from anthropogenic causes has damaged the quality of much freshwater, reducing its utility [1]. Ammonium, which has a standard of 5 mg/L, is a concentration-based water quality criterion for an effluent. This standard can avoid negative water quality consequences in the mixing zone, where the effluent mixes with the incoming water [2]. Swales are sometimes known as grassed waterways or biological filters. They are water-management vegetated open channels that have been constructed to treat storm water for a given volume of run-off. Polluted storm water flows through grass that grows on porous soil in a shallow overland flow; the water, along with dissolved pollutants, infiltrates into the ground, while suspended particles settle in the grass; the outflow from the grass is of much better quality and quantity than the incoming water [3].

Urban storm water runoff, which alters the volume, pattern, and quality of flow in streams, is a dilemma that calls into question traditional approaches to storm and water resource management, as well as environmental flow assessment [4]. The quality, hydrology, retention, and other aspects of storm water runoff have all been studied in the literature. It has been discovered that large amounts of organics, nutrients, and heavy metals are present in storm water runoff. Furthermore, nonpoint source (NPS) contamination from urban storm water runoff is one of the leading sources of water-related ill health effects among city dwellers. Rainfall and watershed features have long been recognized as influencing pollution build-up and wash-off processes [5]. Many local studies have focused on identifying correlations between different land uses and storm runoff pollutant features, such as residential, industrial, commercial, highways, bridges, lawns, roads, rooftops, and parking lots. In a fast urbanising watershed, land use is often diverse, leading to considerable geographic differences in storm runoff pollution [6]. Ammonium, Nitrous oxide (N_2O), Nitric oxide (NO), Nitrogen dioxide (NO_2), and Nitrate are all nitrogen chemicals found in the environment in combination (NO_3). Ammonia is produced in enormous amounts as a byproduct of plant waste volatilization [7].

Swales are open vegetated (usually grass-covered) drains that filter stormwater before it is released into downstream drainage systems or receives rainfall. Swale drainage, in general, works by decreasing and filtering runoff. The primary method for pollution reduction in swale drainage is filtering via vegetation, particle settling, and penetration into the sub-surface zone. Swale drainage has been shown to be an effective method of reducing runoff pollution. The removal of pollutants from runoff may help enhance the river's water quality [8].

Additionally, excessive ammonium in the environment leads to ecosystem acidification, eutrophication, and climate change. Natural emissions are outnumbered by anthropogenic emissions, primarily agricultural, residential, and industrial activities. However, the total ammonium budget and the attribution of emissions to individual sources remain very ambiguous at several regional scales. Therefore, significant effort is spent developing geographically and temporally resolved ammonium bottom-up emission inventories, since they are critical inputs to models used to estimate ammonium distributions and environmental implications [9].

Several sources lead to untreated ammonium in swale at the Faculty of Civil Engineering and Built Environment, Universiti Tun Hussien Onn Malaysia. Those prime issues are as follows; Ammonium volatilization contributes to contaminants in crops and by-products., especially the grass cutting along the swale. Another critical concern is that civilization has changed natural catchments significantly by increasing the number of impervious surfaces like buildings, roofs, highways, parking lots, and other transportation-related amenities. The study aims to conduct an assessment and to produce a mapping of ammonium concentrations in swale, thus this inquiry's purpose are to evaluate characteristics of water quality in the swale and to develop the map of ammonium concentrations for swale around the Faculty of Civil Engineering and Built Environment and G3 Lake.

This study focusses on evaluating ammonium concentration in swale along Faculty of Civil Engineering and Built Environment and G3 Lake, Universiti Tun Hussien Onn Malaysia, Johor. Various parameters are required for the analysis and assessment of the ammonium in swale, to determine the presence of the ammonium in the swale. This study refers to the National Water Quality Standard for Malaysia (NWQS) in classifying the parameters as a benchmark for the analyzing and assessing the presence of ammonium. The importance of the study was that it allowed for the development of mapping for ammonium content in swale around the Faculty of Civil Engineering and Built Environment and G3 Lake. It is critical to be able to determine the largest quantity of ammonium collected in the swale at specific locations and to map the trend of ammonium present around the swale along the Faculty of Civil Engineering and Built Environment and G3 Lake.

2. Methodology

2.1 Study Area

This study is focused on the ammonium located in swale at Faculty of Civil Engineering and Build Environment and G3 Lake, University Tun Hussien Onn Malaysia, Johor. Based on Figure 1, to acquire an accurate result, a few samples from the swale at the Faculty of Civil Engineering and Built Environment and G3 Lake are required, as are several samples from points along the swale, which total of twelve samples.

Figure 1: Location of swale at Universiti Tun Hussien Onn Malaysia. (earth.google.com)

2.2 Data Collection

A few samples from the swale at the Faculty of Civil Engineering and Built Environment and G3 Lake are required to acquire an accurate result, there are several samples from points along the swale. Water samples are often collected by filling a container held under the water's surface, a procedure referred to as a grab sample. The sample procedure is evaluated using a well-established technique. This technique may be used to quantify the nitrogen and ammonium concentrations within (0.02–2.50 mg/L NH_3–N).

2.3 Spatial distribution mapping

Spatial distribution is the organization of phenomena throughout the earth's surface, and displaying this arrangement graphically is a critical tool in geographical and environmental statistics. A graphical representation of a geographical distribution may be used to summarize raw data or represent the result of a more advanced data study. Numerous facets of phenomena may be shown graphically in a single presentation using a proper palette of various colors to express distinctions. Surfer Software (V16), a mapping software tool was used to determine the ammonium concentration along the swale.

2.4 Water analysis method

Several parameters were measured, such as ammonium, turbidity, temperature, pH, DO, and TDS, determine the water quality around the swale at the Faculty of Civil Engineering and Built Environment and G3 Lake. The ammonium concentration was measured using the Nesslar method (Method 8038). The ammonium test is performed by selecting a blank (deionized water) and sampling on a separate mixing cylinder filled to the brim with 25 mL. Three drops Mineral Stabilizer in each mixing cylinder, secure with a stopper, and invert both mixing cylinders several times to combine. Following that, add three drops of Polyvinyl Alcohol Dispersing Agent to each mixing cylinder and flip the mixing cylinders several times to mix. Following that, add 1.0 mL of Nesslar Reagent to each mixing cylinder using a pipet and mix several times with the stopper on the mixing cylinder. Start a one-minute timer for the reaction to begin. Fill a sample cell with the blank and sample, and when the timer sounds, clean the blank (deionize water) and enter it into the cell holder. Set the 0.00 mg/L value on the DR6000 Spectrophotometer and insert the sample into the cell holder. Repeat the testing procedure to get the sample's average results. The measurement of the others parameter was carried out with the standard experimental procedure to obtain a result.

3. Results and Discussion

The data was tabulated to conduct analysis and mapping on ammonium concentration at the swale, with a total of twelve sample points collected over three weeks (one time per week). The sample size is decided by the area covered by the swale at the Faculty of Civil Engineering and Built Environment and G3 Lake, and the study's scope. The ammonium concentration data are then shown along the swale at the Faculty of Civil Engineering, Built Environment, and G3 Lake using the Surfer Software (V16).

3.1 Relationship of National Water Quality Standard (NWQS) to Ammonium Concentration.

Based on Figure 2, overall data analysis most of the point in three consecutive weeks (one time per week) has an average value of ammonium concentration around the Faculty of Civil Engineering and Built Environment and G3 Lake. The highest amount of ammonium concentration was spotted in the first on point G3A2, which has the highest value that has 0.8 mg/L, which is in range of Ammoniacal Nitrogen concentration according to NWQS (Class III which was the Water Supply III that needed for extensive treatment required and Fishery III for common, of economic value and tolerant species; livestock, drinking) that was considered for treatment for the ammonium concentration of the untreated storm water in swale around the Faculty of Civil Engineering and Built Environment and G3 Lake, compared to the others sample point on three consecutive weeks. On the other hand, the lowest amount of ammonium concentration was spotted on week 1 on point G3A1, which has the lowest value of 0.01 mg/L, which did not meet the standard according to NWQS compared to the other sample point on three consecutive weeks.

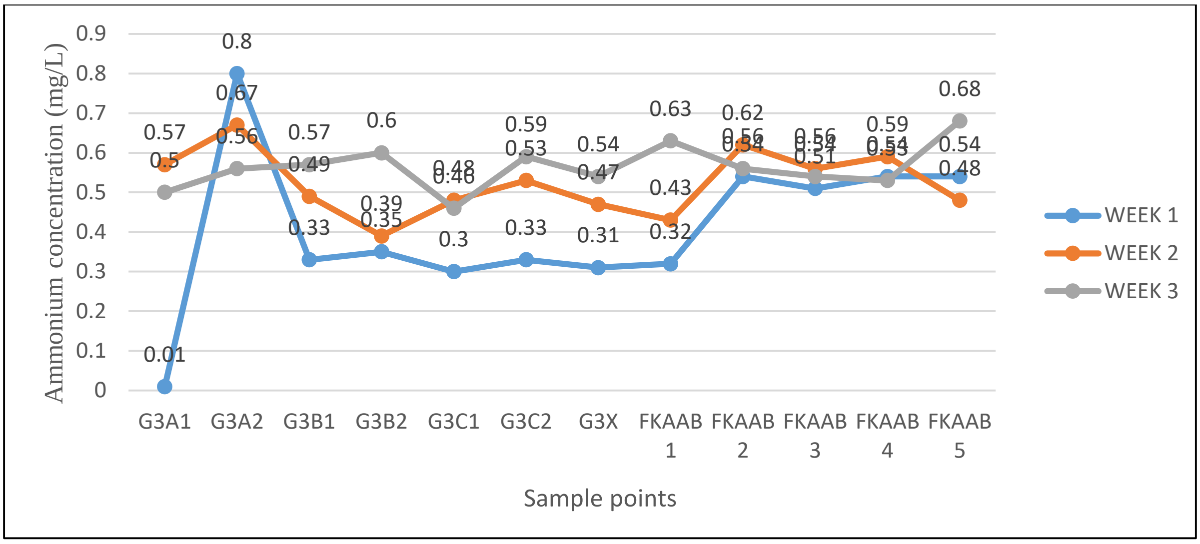

Figure 2: Ammonium concentration in weeks specified with sample points

3.2 Spatial Mapping of Ammonium.

Based on Figure 3, the visualization shows the ammonium concentration of each sampling point on swale along the Faculty of Civil Engineering and Built Environment and G3 Lake on the mapping in the Figure 3 show the ammonium concentration collected in three times (one time per week) in week 1. As the study area categorized as nonpoint source pollutant area, the trend of ammonium concentration along the swale was based on the color in the map flow through the inlet. The outlet of the swale is not specific on a particular sampling point. It distributes the ammonium concentration along the swale was connected. Possible factors changed the ammonium concentration level around the Faculty of Civil Engineering, Built Environment and G3 Lake. The activity carried out on the site of sampling point such as grass cutting, surface runoff, vehicular traffic and excavation of the swale affecting the ammonium concentration and the dry precipitation event during the first week.

Figure 3: Ammonium concentration map along the Faculty of Civil Engineering and Built Environment and G3 Lake in week 1

Based on Figure 4, the visualization shows the ammonium concentration of each sampling point on swale along the Faculty of Civil Engineering and Built Environment, and G3 Lake on the mapping in the Figure 4 shows the ammonium concentration collected three times (one time per week) in week 2. However, many precipitation events occur during the week, which relatively changes the ammonium concentration on week 2. As the study area categorized as a non-point source pollutant area, the trend of ammonium concentration along the swale was based on the color in the map flow through the inlet. The outlet of the swale is not specific on a particular sampling point. Instead, it distributes the ammonium concentration along the swale was connected.

Figure 4: Ammonium concentration map along the Faculty of Civil Engineering and Built Environment and G3 Lake in week 2

Based on the Figure 5, the visualization shown the ammonium concentration of each sampling point on swale along the Faculty of Civil Engineering and Built Environment, and G3 Lake on the mapping in the Figure 5 shows the ammonium concentration collected in three times (one time per week) in week 3. However, during the week dry precipitation events occurs, which relatively change the amount of ammonium concentration on week 3. In the week of the sampling point being collected dry precipitation frequently occurred, settling the pollutant on land, roof surfaces, and impervious surfaces (roadway). Therefore, the activity carried out on site of sampling point such as grass cutting, surface runoff, vehicular traffic and excavation of the swale affecting the ammonium concentration on week 3. As the study area is categorized as non-point source pollutant area, the trend of ammonium concentration along the swale was based on the colour in the map flow through the inlet. The outlet of the swale is not specific on particular sampling point. It distributes the ammonium concentration along the swale was connected.

Figure 5: Ammonium concentration map along the Faculty of Civil Engineering and Built Environment and G3 Lake in week 3

4. Conclusion

The swale that runs beside the Faculty of Civil Engineering and Built Environment and G3 Lake is assigned to the swale's concentration changes. The activities did affect the data distribution in the swale around the Faculty of Civil Engineering and Built Environment and G3 Lake, such as the data obtained from the experiment resulting in week 3 performed the highest ammonium concentration compared to the data obtained in week 1 and week 2. The ammonium was successfully found as a result obtained from the laboratory experiment, in the swale around the Faculty of Civil Engineering and Built Environment and G3 Lake. Based on the study's purpose, it is reasonable to assume that is swale's parameter did not meet Malaysia's National Water Quality Standard (NWQS). Concentration mapping was advantageous in this investigation since it determined which portion of the swale sample point had the greatest concentration. As a result, the swale beside the Faculty of Civil Engineering and Built Environment and G3 Lake had an inadequate water quality.

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