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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)

Jerry Anak Umpi[1], Mohd Hairul Khamidun[1*], Mohd Daud Abdullah[2]

[1]Faculty of Civil Engineering and Built Environment,
Universiti Tun Hussein Onn Malaysia, Batu Pahat, 86400, MALAYSIA

[2]Galas Engineering Consultant, 43000, Kajang, Selangor MALAYSIA

*Corresponding Author

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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 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, roads, parking lots, and other transportation-related structures. It is also caused by pollutants, including vehicle emissions and maintenance of side swale such as grass cutting. The concentration ammonium presence in the swale around the Faculty of Civil Engineering and Built Environment and G3 Lake was verified. Surfer Software was used to develop spatial distribution mapping. The color pattern shows that the ammonium concentration each week by the number of all sampling point areas. 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 mg/L. The outcome of this research could be to give insights about the adequacy of water for daily usage activities, reducing the environmental impact and exhibit the trend of ammonium in the swale for future reference.

Keywords: Ammonium, swale, spatial distribution, surfer software

1. Introduction

Water quality varies depending on the location, time travel, source of pollutants and weather. The main sources of water is categorized as high salinity and not suitable for human consumption. Furthermore, excessive pollution from anthropogenic causes has damaged the quality of freshwater and reducing its utility [1]. In Malaysia, concentration of ammonium released to water bodies was limited no exceed of 0.5 mg/L. The limit of ammonium can be avoided negative water quality consequences when 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 flow control of water than the incoming water [3].

*Corresponding author: hairulk@uthm.edu.my

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, and it has been discovered that large amounts of organics, nutrients, and heavy metals are present in storm water runoff [5]. Furthermore, non-point 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 identified as influencing pollution build-up and wash-off processes [6]. 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-urbanizing watershed, land use is often diverse, which can lead to considerable geographic differences in storm runoff pollution [7]. Ammonium, nitrous oxide (N2O), 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 [8].

Swales are open vegetated (usually grass-covered) drains that filter storm water 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 [9]. With increased urbanisation, impervious area rises. As a consequence, water penetration rates in the soil are decreasing, resulting in increased runoff [10]. Drainage renewal, such as resurfacing the drainage surface with pervious patches, may help increase water penetration. The present drainage system is inefficient since the surface is constructed of concrete and serves merely to drain water without providing any filtering for the runoff. Swale drainage, in general, works by decreasing and filtering runoff. Hydraulically, the swales perform three functions: 40% of water volume completely infiltrate, 40% of volume flowing in the swale and remaining 20% of volume was loses in miscellaneous hydraulics factors [11]. The volume reduction generated by filtration and the improved water quality is important because it adds to the overall mass reduction of swale discharge pollution.

According to [12], 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. Additionally, excessive ammonium in the environment leads to ecosystem acidification and eutrophication, as well as to climate change. Natural emissions are outnumbered by anthropogenic emissions, which are mostly the result of agricultural, residential, and industrial activities. However, at several regional scales, the total ammonium budget, and the attribution of emissions to individual sources remain very ambiguous. Significant effort is spent on developing geographically and temporally resolved ammonium bottom-up emission inventories, since they are key inputs to models used to estimate ammonium distributions and environmental implications [13].

The dissolution of nitrogen on road surface and topsoil might be lead to the presence of excessive ammonium concentration in swale at 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 side swale. Another key concern is that civilization has changed natural catchments significantly by increasing the quantity of impervious surfaces like as buildings, roofs, highways, parking lots, and other transportation-related amenities [14]. The aim of the study is to conduct on 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. In order, to determine the presence of the ammonium in the swale, there are various parameters that are required for the analysis and assessment of the ammonium in the swale. This study refers to the National Water Quality Standard for Malaysia (NWQS) in classification of the parameters as a benchmark for the analysis and assessment of the presence of the ammonium. The outcome of the study is the development of mapping for ammonium content in swale along the Faculty of Civil Engineering and Built Environment and G3 Lake. It is critical to be able to determine the higher concentration of ammonium accumulated in the swale at specific locations.

2. Methodology

2.1 Study Area

This study is focused on the presence of ammonium concentration in swale at Faculty of Civil Engineering and Build Environment and G3 Lake, University Tun Hussien Onn Malaysia, Johor. Based on Fig. 1, 12 sampling points was identified along the swale started from the Faculty of Civil Engineering and Built Environment to G3 Lake to acquire an accurate result in mapping.

2.2 Sample Collection

The samples collection from the swale at the Faculty of Civil Engineering and Built Environment and G3 Lake are conducted within 6 week. Samples were collected using grab method directly in swale using 500 mL pre-washed polyethylene bottles.

Fig. 1 - Study location of swale at Universiti Tun Hussien Onn Malaysia. (earth.google.com)

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 and lake.

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 an ultraviolet-visible spectrophotometer (HACH DR6000) according Nesslar method (Method 8038). Temperature, pH, DO and TDS were measured using a multi-parameter meter; HANNA Instruments (Model H19828). All water quality sample analyses were in accordance with the American Public Health Association standard methods for the examination of water and wastewater.

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.

Fig. 2 depicted the overall data analysis from three consecutive weeks (one time per week) with an average value of ammonium concentration along swale at 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 with 0.8 mg/L. According to NWQS, this value is categorized as 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. 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 meet Class I the standard according to NWQS compared to the other sample point on three consecutive weeks.

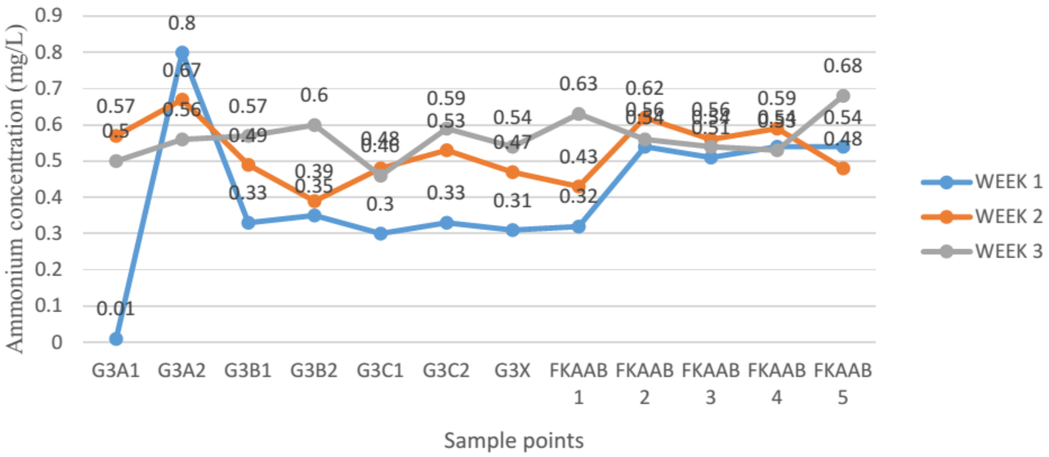

Fig. 2 - Ammonium concentration in weeks specified with sample points.

3.2 Spatial Mapping of Ammonium

Fig.3 show color visualization along the swale from FKAAB to G3 Lake to display spatial distribution of ammonium concentration in week 1. The orange color on the map indicates high ammonium concentration while the blue color indicates low ammonium concentration. The swale area at FKAAB 1 - 5 shows high concentration of ammonium and the ammonium concentration decreased when reach to 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 might be affected the ammonium concentration along the swale. Higher concentration of ammonium in swale area might be due to the value of runoff concentrations, infiltration effectiveness in swale and detention time of swale [14].

Fig. 3 - Ammonium concentration map along the Faculty of Civil Engineering and Built Environment and G3 Lake in week 1

The spatial distribution maps of ammonium concentration in week 2 show that the highest values characterize the swale area at FKAAB 1-4 as shown in Fig.4.The decreasing trend of ammonium concentration with the flow direction is registered (see point FKAAB 1 to G3C2). The trend ammonium distribution in Week 1 and Week 2. The highest concentration of ammonium at point FKAAB 1 – 4 might be contributed from to natural sources such as soil and vegetation from surrounding swale area [15].

Fig. 4 - Ammonium concentration map along the Faculty of Civil Engineering and Built Environment and G3 Lake in week 2

Fig. 5 shows same trend of ammonium distribution as in week 1 and 2. However the concentration of ammonium in week 3 is slightly higher compared to week 1 and 2 the ammonium concentration collected in three times (one time per week) in week 3. In lake area, the concentration of ammonium remained lower compared to swale area due to higher aeration process occurred in lake. The lake have aeration system that aid to reduce ammonium concentration. Accessibility of adequate dissolve oxygen concentration in lake water could reduce the ammonium concentration [16].

Fig. 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 results shows that ammonium concentration is higher in week 3 compared to in week 1 and week 2. As a result, the swale beside the Faculty of Civil Engineering and Built Environment and G3 Lake had an inadequate water quality in term of ammonium parameter. The spatial distribution of ammonium was successfully identified 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 of ammonium map was advantageous in this investigation since it determined which at area of the swale had the higher concentration (polluted). The study will be used as effective tool in runoff water quality problem such as identify the pollution control for non-point source.

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