Impact of Surrounding Soils on Surface Water Quality in Sembrong River

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Abstract. Peatlands enclosed around 2.7 million ha in Peninsular Malaysia, 1.66 million ha in Sarawak, 0.8 million ha in Sabah, and are commonly found in Johor. Previous studies showed that waters in the peat soils area are acidic (pH 5.7 and pH 6.6). Anthropogenic activities such as mining and agriculture, will in turn impact water quality. Agriculture activities, through the usage of fertilizers, produces cadmium and zinc. Furthermore, soils in acidic conditions could liberate aluminum into the river. This study aims to characterize acidified peat soils based on geochemical properties (pH and heavy metals concentrations), identify the impact of the geochemical variability on surface water quality, and determine the effects of hydrologic cycle on the geochemical variability. Sembrong River was chosen as the study site; soils and water samples were collected nearby and from the river. Testing methods for soils and water covered both in-situ measurements and laboratory analyses. All parameters were taken thrice in each of the sampling point (labelled as S1, S2 and S3). The data of precipitation a week before sampling was recorded for early prediction of the water level. Real water level (depth of the river) was measured on the day of sampling. Based on the relation between month and geochemical properties according to water depth, results showed that the properties were affected by the rainfall intensities. Results also revealed the increased water depth, the decreased the pH value for soil and water. The most acidic for pH value is peat soils with pH 2.52. Besides, the concentration of heavy metals in the surface water for Sembrong River followed the sequence: aluminum > iron > zinc. Overall results of this study have indicated that properties of peat soils, anthropogenic activities and hydrologic cycles have a major impacts on surface water quality of Sembrong River.

1. Introduction

Surface water is the vital source in the world and could be known as the clear liquid which had the appearance colorless or pale. The function of waters cannot be denied for the consumers and high demand for clean water is very critical nowadays. Besides, 2.5% of Earth’s water contains freshwater and very peril by the days because of climate change and human actions (economic) [1]. Nowadays, the issue of the water pollution is very highlighted because of due the contamination factor.

The main source of water contamination comes from anthropogenic activities; agricultural, industrial and municipal. According to United States Environmental Protection Agency, the human activities comprise of municipal, industrial, agricultural, residential and commercial, and these
activities would attack the quality of both surface and ground water [2]. Besides, the industrial consumption of water can produce an effluent which can lead to poor water quality which carries chemicals and non-chemicals and also suspended materials [3]. In addition, when all of these substances are going through into the aquatic surrounding, it will form intricate mixtures that might contribute to the illnesses to human being and also the organisms that consume the polluted waters [4]. Previous study also has shown, acidity of upland freshwater can be influenced by the decay of blanket peat process [5]. The impact from decay of blanket peat process will influence the water quality, hence, will contribute acidity to water body as compared to the previous natural conditions. For instance, acid sulfate soils can produce harmful effects by liberating the toxic mixture (between acidity and heavy metals) to the river and release amount of Al, Cd, Co, Ni, and Zn [6]. Acidic soils could liberate Al to the soil and outward water [7]. High concentration of Al will lead to the diseases and a study by Muthuraman, has shown that aluminum sulfate will create the illness such as Alzheimer’s disease in human [8].

Fertilizer and pesticides are the main factor blooming of crop yields. The micronutrients and macronutrients can get from the fertilizers or pesticides. The macronutrients comprise of calcium and magnesium while micronutrients comprise of iron, copper, cobalt, zinc and also manganese [9]. All of these nutrients will exist the toxicity in the soil that will lead to destroying the environment and also will produce retard crops. All of these factors that occur is important to check the water quality because the elements that contain in the soil could influence the surface water.

Water quality monitoring is needed in understanding the palatable conditions of a water body. Study by Mhlongo, has mentioned that highest quantity of chemicals is used in human routine life which could influence the quality of surface water, and raised challenges in maintaining the surface water quality [10]. Hence, the monitoring and management are crucial in ensuring the sustainability of water quality is preserved [11]. Thus, the measurement of geochemical properties of surface water will provide a better understanding of a surface water conditions. This will lead to sustainable environmental friendly to both human beings and other aquatic life.

This present study was proposed to identify the surface water conditions through the monitoring of geochemical properties and hydrological impacts on the conditions of the acidic peat soils surrounding the river as well as the geochemical properties. The objectives of this study comprise of three: 1) characterize acidified peat soils based on geochemical properties (heavy metals and pH), 2) identify the impact of the geochemical variability on surface water quality and 3) determine the effects of hydrologic cycle on the geochemical variability (determined by rainfall intensities). This will lead to the understanding on the surface water quality and soil management based on the elements and factors that contribute to the soil and surface water acidity.

2. Material and Methods

2.1 Study area

The study was conducted at Sembrong River, Batu Pahat, Johor. Sembrong River has been taken as natural water supply for the residence in Parit Raja and Sri Gading. Besides, Sembrong River also collects natural water for Sembrong Dam. According to Boteru, the length of Sembrong River is 22 km while the river container wrapping about 200 km² [12]. The surrounding of study zone (partially of Sembrong River) was covered with anthropogenic activities which comprise agricultural such as palm oil plantations and paddy cultivation, and also covers residential areas.

In this study, three stations were selected along the study river, namely S1, S2 and S3 as shown in figure 1 for studying the geochemical properties condition of water quality and acidified peat soils. The latitude and longitude of the station: S1 (N 1° 55’ 17.47”, E 103° 8’ 48.50”), S2 (N 1° 53’ 12.41”, E 103° 7’ 29.04”) and S3 (N 1° 52’ 57.99”, E 103° 5’ 13.44”). The station points of this sampling were chosen because appropriate for sample to be taken.
2.2 Methods

2.2.1 Sample collection and preservation
Soil and water samples were collected from three sampling stations (S1, S2 and S3) within three different sampling events, while the soil samples were collected at the river, nearby the water sampling points. Water levels (depth) were also measured in every sampling. Water samples were collected at approximately one third of the water depth using cylindrical water bailer [13], and soil samples were taken at approximately 0.5 to 1.0 m depth using hand auger [14]. Water samples were kept in a 1-L polypropylene or polyethylene bottles [15]. The sampling bottles were acid washed and rinsed with deionized water prior to sampling session to elude contaminations [16]. Soil samples were kept in a 500 g radiation-sterilized polyethylene zipper bag to ensure the moisture content of the soils is well preserved [17]. All soil and water samples were then kept in ice during transportation and kept in dark cold room at 4°C in the laboratory [18], prior to analyses.

2.2.2 Testing methods
In this study, a multi-parameter meter; HANNA Instruments (Model H19828) was used for in-situ measurement. The in-situ parameters include pH, temperature, total dissolved solids (TDS), electrical conductivity (EC), and oxidation reduction potential (ORP) and dissolved oxygen (DO) [19, 20]. Echo sounder was utilized to measure the water depth [21]. Table 1 shows the summary of methods for in-situ measurement and laboratory analyses.

Maintenance is defined as “the combination of all technical and administrative actions, including supervision actions, intended to retain an item, or restore it to, a state in which it can perform a required action [4]. Another definition of maintenance also being offered by the Chartered Institute of Building, which is “work undertaken in order to keep, restore or improve every facility, every part of the building, its services and surrounds, to an agreed standard, determined by the balance between need and available resources”. Meanwhile The Committee of Building Maintenance recommended the adoption of the maintenance definition as follows, “Work undertaken in order to keep, restore or improve every facility, every part of the building, its services and surrounds to a currently acceptable standard and to sustain the utility and value of the facility” [5].
Table 1. Parameters for in-situ measurements and laboratory analysis on this study.

| Type         | Data                                      |
|--------------|-------------------------------------------|
| Water Parameter | In-situ measurements:                     |
|              | Temperature, pH, DO, ORP, EC, Depth       |
|              | Laboratory analysis:                     |
|              | Al, Fe and Zn                             |
| Soils        | Laboratory analysis:                     |
| Parameter    | pH, Al, Fe and Zn,                        |
| Methods and  | EPA Method 9045D (7.2.1):                 |
| References   | Determination for soil pH                 |
|              | EPA Method 300.0.:                        |
|              | Extraction for soil and water sample      |

All laboratory analyses were conducted in FKAAS Laboratories. The laboratory analyses comprise of determination of Fe, Al and Zn concentrations (for both water and soil samples) and pH (for soils only). The determination of pH for soils, the slurry method need to be done with ratio water and soils (1:1) with followed the EPA Method 9045D (7.2.1). For the determination for heavy metals comprise of Fe, Zn and Al, an Inductively Couple Plasma-Mass Spectrometer, (ICP-MS ELAN 9000) were utilized [12].

The method of extraction for water and soil sample were based on EPA Method 300.0. The solid materials such as soils, extraction need to be done with ratio soils and distilled water (1:10). After that, the mixture of water and soils were stirred using magnetic stirring equipment for 10 minutes and filter the occur slurry. Then, after the filter was done, used the syringe and attached the 0.45 µ membrane type filter at the nozzle of the syringe [22].

After all of the extraction were completed, the dilution method need to be done before using ICP-MS. The dilution factor calculation is shown below:

\[ Df = \frac{V_t}{V_s} \]  \hspace{1cm} (1)

where, \( V_t \) is volume total; \( V_s \) is volume sample; and \( Df \) is dilution factor.

All data were recorded and examined with using the software which is Microsoft Excel 2016. This application will produce the accurate and fast results for all of the information and data that occur in the all of the experiments that will be conducted in future research. The appropriate results will ease the future study to accomplish the aim of the future research and all of the results will be as the guideline to maintain and manage the acidified peat soils that impact to natural water quality in Batu Pahat.

3. Results and Discussion

3.1 Water and soils characteristics analysis

The geochemical parameters of this study comprises of pH and heavy metals (Al, Zn, Fe). All of the parameters were taken in each of the sampling site and labelled as 3 station point (S1, S2 and S3). All of the results were taken thrice for each station point for more precise data. All data that acquired from
all the three stations to recognize the features of water and soils that concerning the geochemical properties.

The data of precipitation a week before sampling was recorded in Table 2 to estimate the accuracy of water depth (measured using depth sounder) which could produce the grow of surface water that would touch the near soil surroundings. Based on the Table 2 the precipitation data for the first sampling shows the sample of each site was taken a day before with the overall average were rainfall for 30 minutes while for the second sampling, the sample was taken 3 days before which occurred two heavy rainfall events with the overall average of rainfall session was 4 hours. Lastly for the third sampling, the sample was taken 3 days before with the overall average were rainfall for 1 hour.

| Date     | Type of rain | Periods      |
|----------|--------------|--------------|
| 5/3/2018 | Heavy rain   | 6:00-7:00p.m |
| 6/3/2018 | Light rain   | 9:00-9:30p.m |
| 7/3/2018 | Rain         | 12:00-4:00p.m|
| 8/3/2018 | -            | -            |
| 9/3/2018 | -            | -            |
| 10/3/2018| Rain         | 10:00-10:30a.m|
| 29/3/2018| -            | -            |
| 30/3/2018| -            | -            |
| 31/3/2018| -            | -            |
| 1/4/2018 | Heavy rain   | 4:00-7:00p.m |
| 2/4/2018 | -            | -            |
| 3/4/2018 | Heavy rain   | 2:00-3:00p.m |
| 26/7/2018| -            | -            |
| 27/7/2018| -            | -            |
| 28/7/2018| -            | -            |
| 29/7/2018| Rain         | 8.00–9.00a.m.|
| 30/7/2018| -            | -            |
| 31/7/2018| -            | -            |

3.2 Analysis the effects of soils surrounding features on surface water

The analysis effects of soils surrounding features on surface water comprise of effects month on geochemical properties according to water depth. All of the results could be guide as monitoring for the future presents. The data collection from Sembrong River which contains three dissimilar sampling point were evaluated.

3.2.1 Effects of month on geochemical parameters

Effects of month on geochemical parameters comprise of pH, Fe, Al and Zn, Figure 2 and Figure 3 shows the connection between month and pH for sampling station 1 (S1), sampling station 2 (S2) and sampling station 3 (S3). pH is one of the crucial parameters in water quality while the different water depth is occurred depending on the precipitation prior to the sampling duration.

Based on the Figure 2 and Figure 3, S1, S2 and S3 showed the higher the water depth, the decreased pH value for water and soil. Results can be proven in april month by Figure 2 with highest water depth is 2.2 m at S2 with pH water 2.55 meanwhile for Figure 3 highest water depth is 2.7 m at S3 with pH soils of 2.52. Besides, compared to precipitation data in april month, 2 heavy rains was occurred before the water and soils sampling were started. Overall, rain is influenced the pH of water and soils based on the increased of water depth. The factors that impact the pH water and soil more
decreased because of the elements in the soil and also the precipitation. A study by Wei, stated that, the outcome of acid rain influenced the ecological comprise of ground and water to be acidic [23].

Figure 4 and Figure 5 showed the connection between month and heavy metals for Fe. Figure 4 and Figure 5 showed the more lower the water depth value, the more reduced the Fe concentration. In august month for water and soils results, all of the results tend to increased compared to other both month in march and april meanwhile for the Fe soils concentration, the results for S3 is the highest compared to other sampling site. Overall results, not spotted rain influenced the Fe concentrations to be more increased. The elements in the soil (such as: pyrite (FeS\textsubscript{2})) tend Fe concentrations were rise. Based on the previous study, study had reported that, pyrite was spotted in the compound of stone (metamorphic) and sedimentary [24]. In conclusion, the Fe concentrations could rise even no precipitation because of due the elements in the soil.

Figure 6 and Figure 7 show the connection between month and Al. The outcomes revealed that, the more lower the water depth value, the more reduced the Al concentration for water and soil and can be proven by Al concentration value decreased in water and soil (0.08 mg/l and 0.05 mg/l) at lowest water depth (1.5 m) for S1.

Furthermore, Figure 7 showed in april month, all of the sampling site results tends to increased compared to al water concentration. Moreover, two heavy rains in april month can affect the increased of the al soils concentration. A study by Wei, revealed that, the accretion of acid rain may increase the poisonous of aluminum [23]. Furthermore, the lessen of pH values could contains the rise leaching waste of Al\textsuperscript{3+} [25].

Figure 8 and Figure 9 shows the connection between month and heavy metals for Zn. Based on the graph and results in Figure 8 and Figure 9, what had been observed that the decreased the water depth value, the more decreased the Zn concentration and be proven by S1 (1.5 m), Zn concentration value reduced for water (0.02 mg/l) meanwhile for S2 with water depth (2 m), the results low in Zn concentration value for soil (0.13 mg/l). In august month, all of the sampling points (S1, S2 and S3) results were higher than other months for water and soils. Generally, zinc concentrations were grow with not spotted rain in august month. Besides, the comparison results between pH (water and soils) and Zn concentrations in march month, the more higher the pH, the lessen the zinc concentrations. According to Martinez, claim that, the zinc poisonous reduced when pH ascend [26].

Figure 2. The relation between month and pH for water. Figure 3. The relation between month and pH for soil.
Figure 4. The relation between month and Fe for water.

Figure 5. The relation between month and Fe for soil.

Figure 6. The relation between month and Al for water.

Figure 7. The relation between month and Al for soil.

Figure 8. The relation between month and Zn for water.

Figure 9. The relation between month and Zn for soil.

4. Summary
To sum up, the characteristics of acidified peat soils based on the geochemical properties (pH, Al, Fe and Zn concentrations), identify the impact of the geochemical variability on surface water and determine the effect of hydrolysis cycle on the geochemical variability (determine the rainfall intensities). Overall of the study based on the results that had achieved for the relation between month
and geochemical properties according to water depth, the raining was influenced the results by the increased the number of water depth, the more decreased the pH value for soil and water that tends to pH 2. Besides, the most acidic for pH value is peat soils with pH 2.52 compared the other results for peat soils. Besides, the concentration of heavy metals in the surface water for Sembrong River followed the sequence: Al > Fe > Zn. The results showed that, aluminium is the most contaminated compare Fe and Zn and this tends the Sembrong River to be polluted. Moreover, results had shown the acidified peat soils have a major impact on surface water quality for Sembrong River.

5. References

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