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In-Situ Measurement of Selected Water Quality Parameters in Ringlet's Lake, Cameron Highlands

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Abstract: Cameron Highland in Malaysia is famous as a high hill agro-tourism destination, as well as chief produces of vegetables and tea. The intensive agricultural activities and plantation in the area have attracted concerned and studies by many parties on the possible pollution effect as the consequence of such activities. Runoff from agriculture and residential sites find its way into the river and disturbed the water quality dramatically especially in the lake or catchment area. In the present study in-situ measurements of selected water quality parameters was carried out in Ringlet's lake/dam, Cameron Highland. The measurements were carried out by using multi-probes instrument HYDROLAB *series 4a* from HACH Company Brand at 12 locations throughout the lake. The parameters measured were pH, DO, NH_4^-, temperature, turbidity, chlorine and specific conductivity. The sampling point was determined by using Global Positioning System (GPS). All the results were plotted in histogram graph by making profile for water quality parameter across the lake. The study found that pH ranged from 7.12 – 7.69, DO from 2.5 – 5.48 mg/L, NH_4^- ranged from 0.255 – 0.825 mg/L, temperature from 19.01 – 22.11 ^oC, turbidity from 72.8 – 1978 NTU, chlorine ranged 29.1 – 203.4 mg/L and Specific Conductivity ranged from 0.024 – 0.054 mS/cm respectively.

Keywords**:** water quality, parameters, Cameron Highland.

Introduction

Agriculture related anthropogenic activities such as vegetables farming and plantation on highlands has raised concerned among environmentalists and local authorities on the possible effect to environment, especially to rivers and water catchments. Study showed that the water pollutants were mainly attributed to domestic and agricultural activities from the local people [1]. Water quality of the lake, sea, river and water reservoirs depends on the sources of the water, as well as the presence of organisms such as green algae [2]. In Cameron Highlands, water runoff in the main river (Sungai Bertam) and its tributaries that flows from the higher latitude to the lower latitude and pass through every farming, plantation and residential area before entering the water reservoir which is Ringlet Lake. The runoff and soil erosion would carry along the excess fertilizers, pesticides and domestic discards into the river and find their ways into and accumulated in the lake. This in turn would alter the lake water quality. The agricultural activities and development may not only affect the quality of the water but also aquatic live in the water [3]. As widely known, the change in water quality is an indicator that pollution has taken place in the water.

Ringlet Lake was formed when the Sultan Abu Bakar Dam for hydroelectric was build, and essentially it is a part of Bertam River, the main river in Cameron Highlands. The lake known as Ringlet Lake today and is known to have high sedimentation rate and accumulation of matter occur in the lake. The water in the lake may contain high impurities that led to heavy water pollution in that area. In the present study, in-situ measurements were carried out on selected water quality parameters of the lake, to assess the extent of pollution caused by the various activities in Cameron Highlands area on the lake.

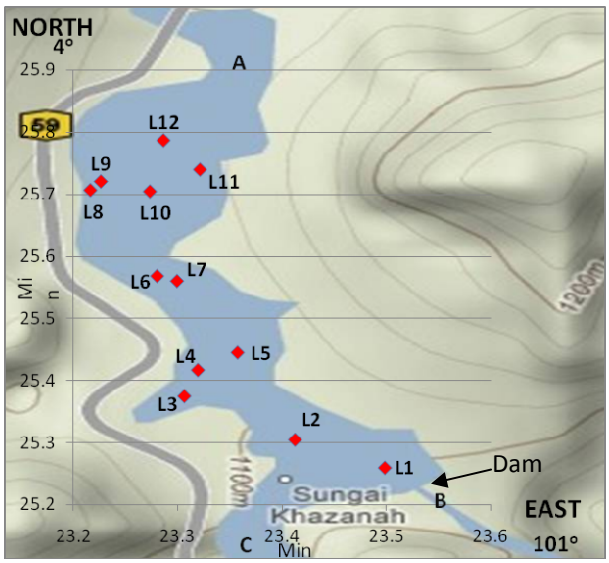

Figure 1: Sampling locations at Ringlet Lake (Source: googleMap.com)

Methods

The study was conducted in February 2009 at Ringlet Lake, Cameron Highland, Pahang, a man-made lake formed by a hydro-electric power dam (Sultan Abu Bakar Dam) (Figure 1). The main river of the area, the Sungai Bertam originating from Brinchang town at the top of the hill, and its tributaries flows into the lake. The elevation of the study area is 1100 m above sea level. The lake is about 1300 m in length with maximum and minimum widths of 200 m and 100 m respectively. In the study twelve locations within the lake were selected, and the positions were determined by using a Global Positioning System (GPS). The depth of the locations ranged between 4 to 9 meters. These study locations and their respective positions are shown in Figure 1. The water flows from A to C, and B is the location of the dam. In each location nine water quality parameter, pH, total dissolved solids (TDS), dissolved oxygen (DO), ammonium (NH_4^-), temperature, turbidity, chlorine (Cl^-) and specific conductivity were determined in-situ by using multi-probes instrument from Hydrolab Instrument. The instruments were calibrated by using standards supplied by Hydrolab less than six months from the study date. On each location, measurements were carried out at one meter interval from the surface of the lake. For each depth two measurements of each parameter were done, and the average is reported in this paper.

Results and Discussion

Figure 2 to Figure 10 show the results of the study on the nine parameters presented against depths (different colors of the bars) and locations (L1 to L12). From each figure we would be able to observe the each parameter variation or trend vertically (according to depth) and spatially (according to locations).

Figure 2 shows that DO for all locations and depths ranged between 2.50 – 5.48 mg/L with a mean value is 3.19 mg/L. In locations L3 to L11 a decreasing pattern of DO with depth was observed, however an opposite pattern was observed for L1, L2 and L12. The different trend at L12, L1 and L2 might be attributed to the water layers circulation, as L12 is the entrance of the lake while L1 and L2 near the dam. When water enters the lake (L12), the water will go from lower to deeper depth, which disturbed the layered flow of water and causes the original upper layer to flow into the lower depth of L12. At L1 and L2 water circulation takes place when its flow is retarded by the barrier of the dam. At other locations the flow are more of streamlined-like, hence identical trend is observed.

The range for the specific conductivity is 0.024-0.054 mS/cm with a mean value calculates is 0.049 mS/cm (Figure 3). The range of specific conductivity for all location is not far for each depth profile. Only for L12 is different where the specific conductivity is constant for all depth. This may cause from the water from the river enters the lake that has same specific conductivity.

In Figure 4, the TDS measured ranged between 0.028 mg/L and 0.035 mg/L with the mean of 0.030 mg/L. In all locations, except for L1, L2 and L12, the observed pattern showed a decreasing trend with depth. The different trends of L1, L2 and L12 could be explained as due to water circulation in the same manner as in DO above. For L12 the TDS is almost in the same level for all depth and this because when the water from the river enters the lake its go to all direction and its cause same distribution.

The pH range in the water is 7.12 to 7.69 and the mean for the pH is 7.30. From Figure 5, the pH of the water is decreasing with each of the depth. The surface water has the higher value compare to the other depth. This means that surface water is more bases compared to bottom. The trend from the graph is the pH get lower when the water closes to the bottom. There are strong correlation between pH and turbidity for location L3, L6, L7, L8, L9, L10 and L11.

From the data in Figure 6, the temperature is decreasing as we go deeper. This natural observation is due to the fact that the surface layer is in contact with the surrounding air, which generally at higher temperature. The range of the temperature is 19.01-22.11 ^oC and the mean is 20.04 ^oC. As the lake is located at 1100 m above sea level, this temperature is lower than the normal average temperature of 30 ^oC of Malaysia.

The range concentration of NH_4^- in the lake is 0.255 - 0.825 mg/L and the mean concentration is 0.370 mg/L. In Figure 7, the NH_4^- the concentrations are almost following the same trend in all locations except at L12 where it is higher and showing an increasing trend with depth. When observing from location to location, it shows that the average is higher at the lake's entry point (L12), reduced to almost constant concentration as we go downstream, and increases again near the dam (L2 and L1). This is because the water from the river carried higher concentration of NH_4^- and when the water enters the lake then the NH_4^- is dissolve in high volume of water in the lake. Near the dam NH_4^- tends to accumulate.

The range concentration of the chlorine in the lake is 29.10- 203.4 mg/L and the mean concentration is 61.47 mg/L. From Figure 8, the concentration of chlorine in the lake is higher at L2. The concentration of chlorine at L2 has about twice or more concentration from other location. This indicates the accumulation of chlorine at L2.

From Figure 10, the turbidity of the water is increase with depth goes lower for all location. The turbidity of water gets higher at the bottom of the lake because the presence of suspended matter

for example is mud, clay and silica. The range turbidity in the lake is from 72.8 NTU to 1978 NTU and the mean of the turbidity is 603 NTU.

From the data of the Parameters, the mean value was used to classify the class of each parameter with the National Quality Standard for Malaysia (table 1). Then the data of the current are compared to others study that conducted at Temenggor Dam, Telopok River, Tasik Chini and Semenyih Dam (table 2).

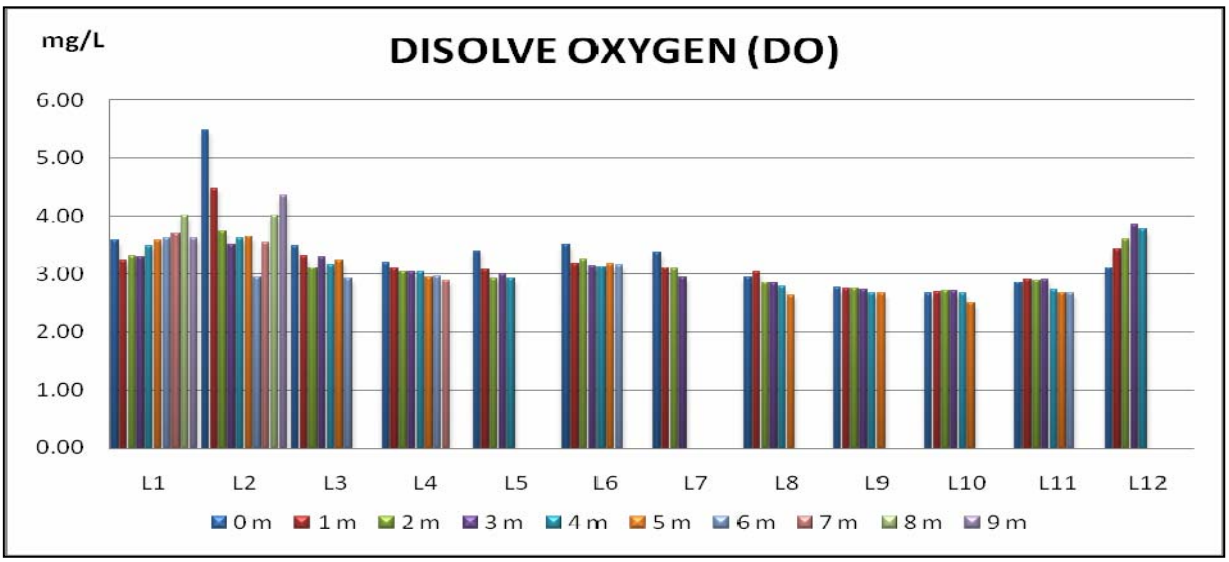

Figure 2: Dissolve Oxygen in water

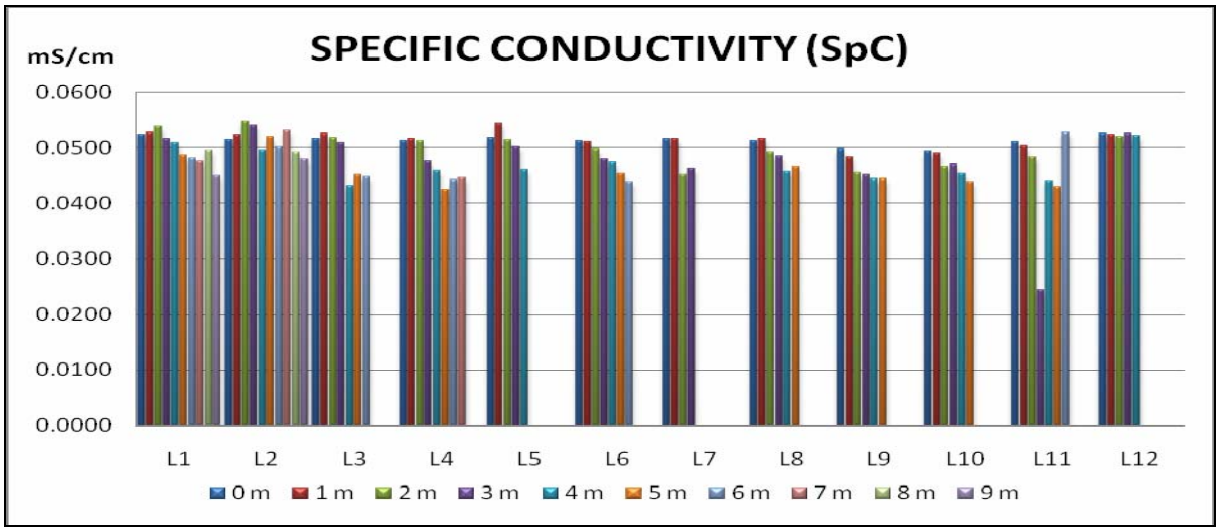

Figure 3: Specific conductivity in water

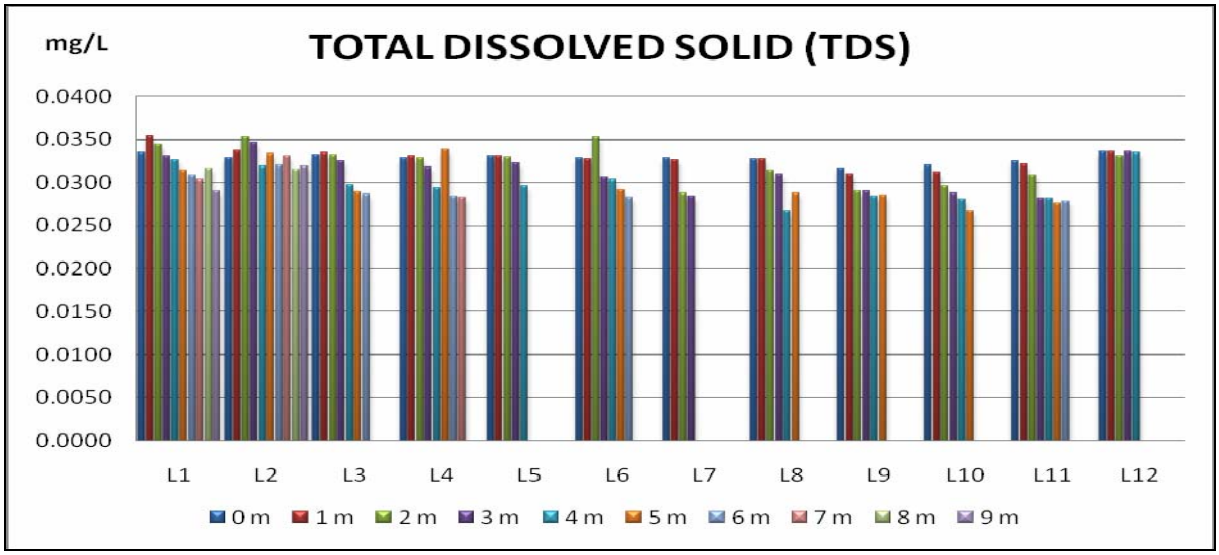

Figure 4: Total Dissolve Solid in water

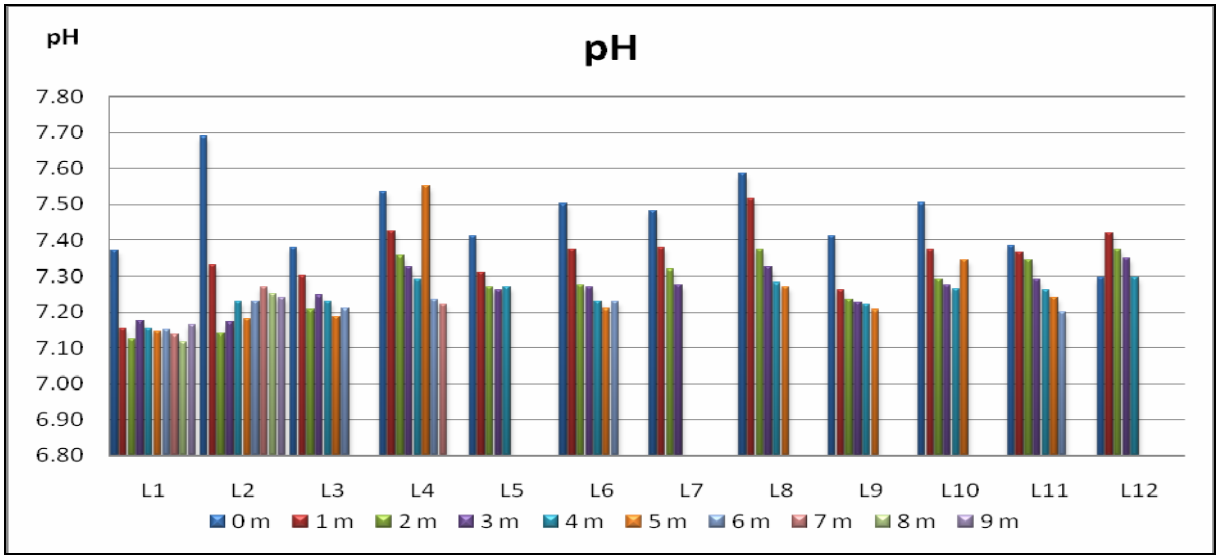

Figure 5: pH in water

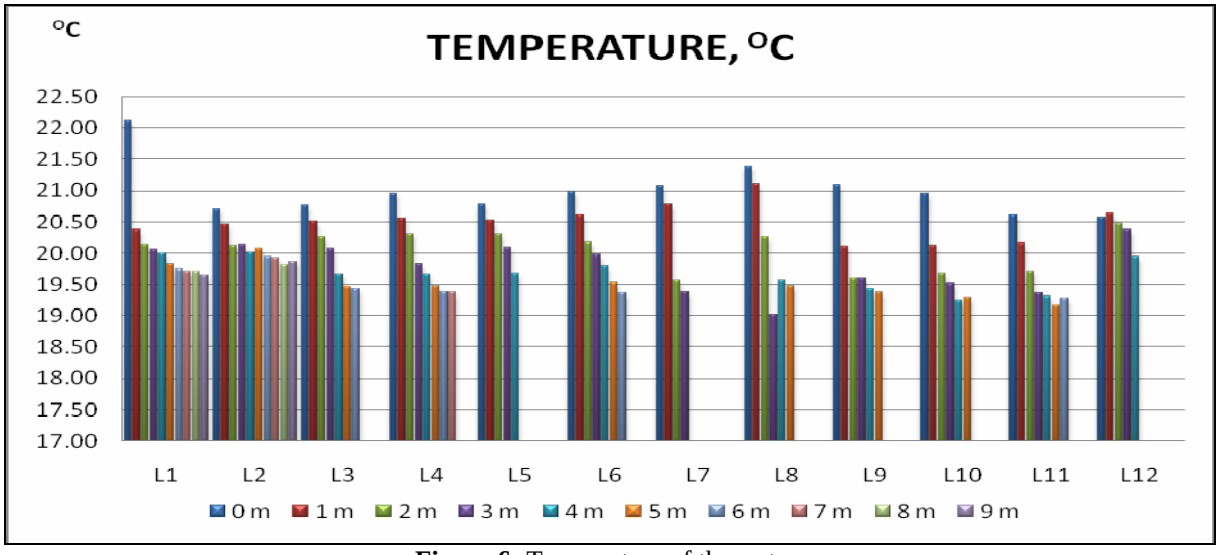

Figure 6: Temperature of the water

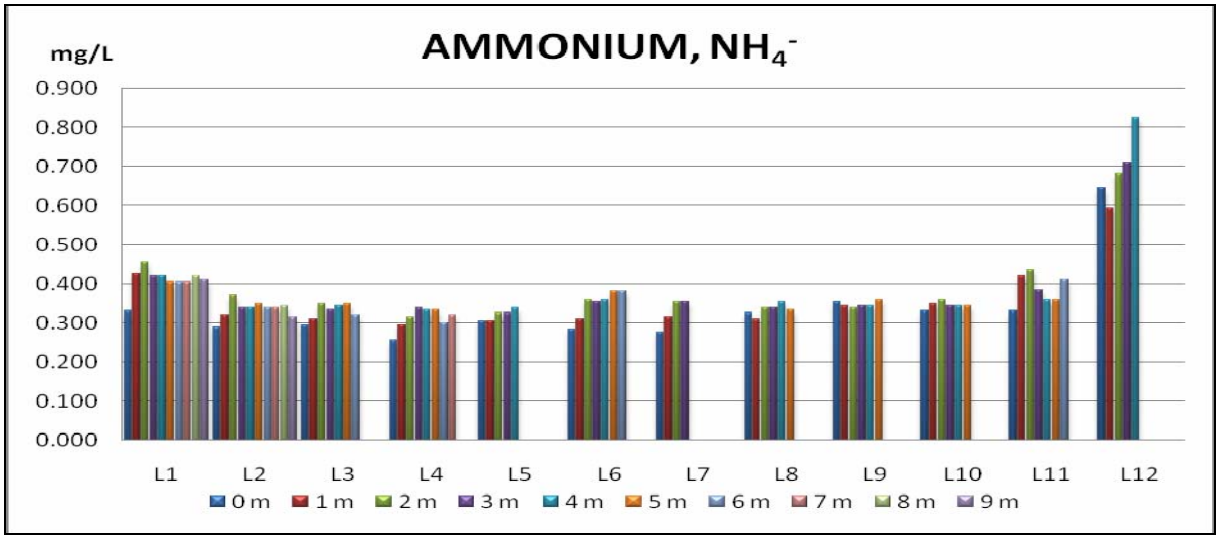

Figure 7: Ammonium in water

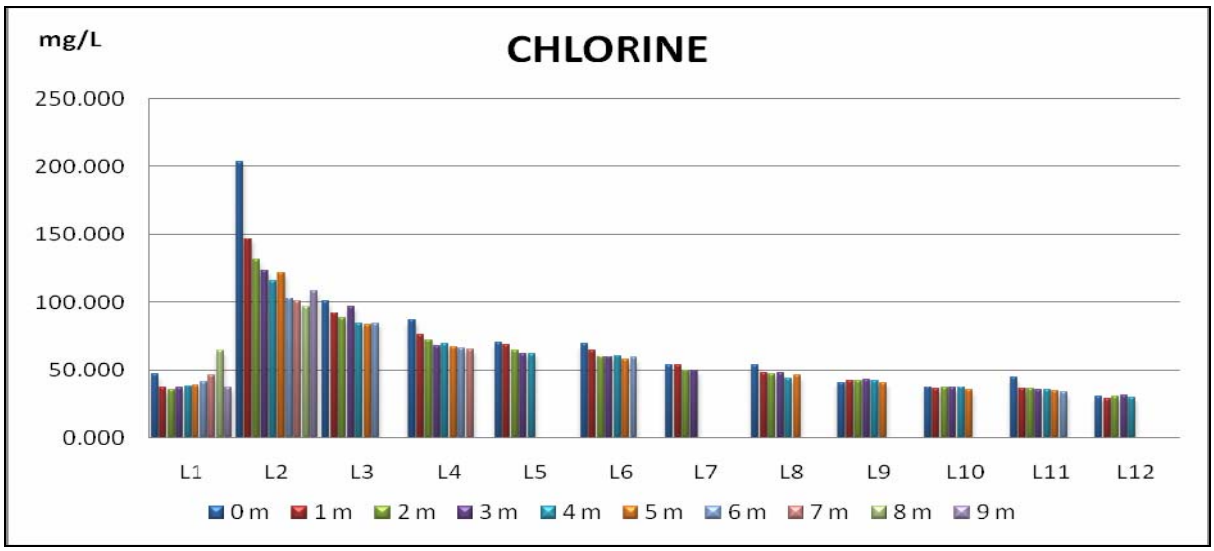

Figure 8: Chlorine in Water

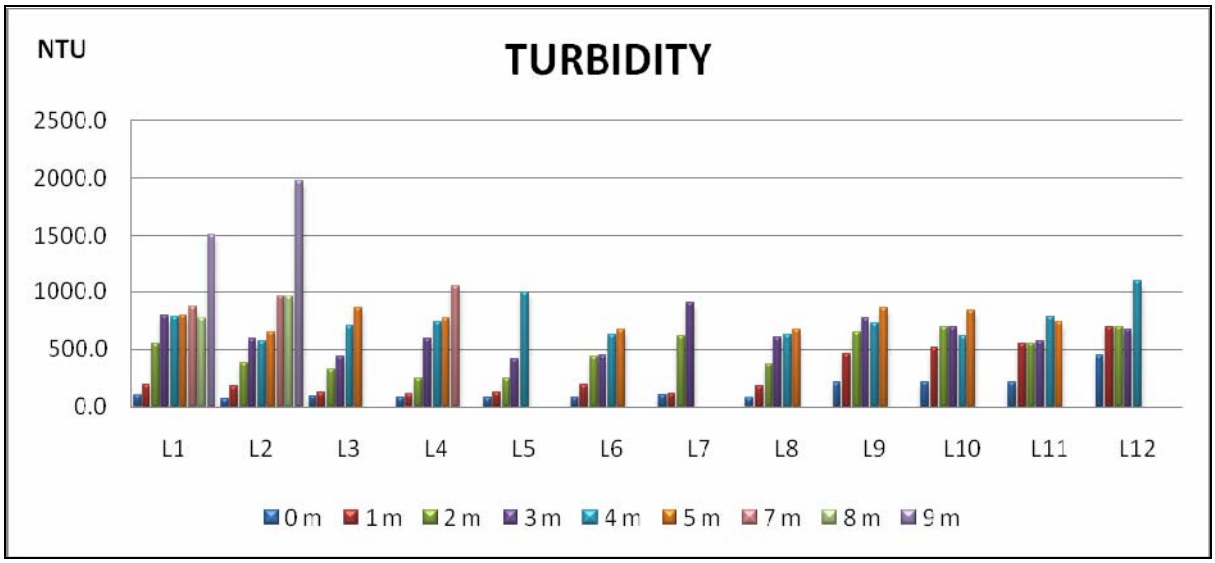

Figure 9: Turbidity in water

Table 1: Class of the study compared to Interim National Quality Standard for Malaysia (INWQS)

Parameters	Mean Value	Classes
DO, mg/L	3.19	III
SpC, mS/cm	0.049	I
TDS, mg/L	0.03	I
pH	7.30	I
Temperature, ^{o}C	20.04	I
NH_4^-, mg/L N	0.37	IIA
Cl^-, mg/L	61.47	II
Turbidity, NTU	603	v

According to INWQS classes, the water quality parameters of Ringlet Lake show that the lake needs a treatment to make sure the condition of the water can be control. From the table 1, the class of DO is III which need extensive treatment and for ammonium and chlorine is class IIA which also need a treatment. The quality of the water will affect the aquatic life in the lake. It will give a stress to the fish because the DO is less than 7 mg/L. The turbidity of the lake is out of range, these mean that the water is too turbid. Others parameters SpC, TDS, pH and Temperature, is considered as normal. Although some of the parameter is normal, the normal water quality is not only considered to one parameter. There are many parameters to be considered before the water can be categorized as normal.

From table 2, when compare the water quality parameters to other study at other location, the size of the Ringlet Lake is not as big compared to others lake since its originally is a river. So the comparison with the river is to see the difference between river and the lake and also as a reference of others studies. From the table it seen that Ringlet lake has higher in ammonia concentration and turbidity than other location. High turbidity in water was cause by high rate soil erosion and cause high sedimentation rate in Ringlet Lake. For the ammonia, it been suspected it cause from fertilizer used by farmer at Cameron highland land. The temperature also low compare to others. This is because the lake is at 1100 m above sea level compared to others study location. The pH range for Ringlet Lake is at normal because it in neutral range. The DO for Ringlet is better compared to Telopok River and Tasik Chini. This comparison is to see the different between Ringlet and others lake which show the current condition of the Ringlet Lake that need further action to control.

Conclusion

Ringlet Lake at Cameron Highland faced major water quality pollution with the accumulation of matter that carried from the river to the Ringlet Lake. The load is increasing if there is no action take to control this pollution. The main cause of this pollution is the erosion of the soil at Cameron Highland. The water quality parameter of this study for pH range from 7.12 – 7.69, DO range from 2.5 - 5.48 mg/L, NH_4^- range from 0.255 - 0.825 mg/L, temperature range from 19.01 – 22.11 ^{o}C, turbidity range from 72.8 – 1978 NTU, chlorine range 29.1 –

T**able 2:** Comparison current study with previous study of others location.

Parameters	Present Study (Ringlet Lake)	Malaysia (Temenggor Dam) [4]	Malaysia (Telopok River) [5]	Malaysia (Tasik Chini) [6]	Malaysia (Semenyih Dam) [7]
DO (mg/L)	2.50 – 5.48	-	4.64-6.48	0.27 – 6.4	-
SpC (mS/cm)	0.024 – 0.054	-	0.058-0.267	0.014-0.086	-
TDS mg/L	0.028-0.035	0.020-0.035	-	22.67-184	-
pH	7.12 – 7.69	6.37-7.75	6.72-7.59	3.2 - 6.32	6.42 - 8.12
TEMPERATURE (^{o}C)	19.01 – 22.11	24.8-28.6	-	24.07-32.1	24.04 - 31.19
NH_4^- (mg/L)	0.255 - 0.825	-	-	0.007-0.57	undetected to 0.173
CHLORINE (mg/L)	29.10 –203.4	-	-	-	0.663- 0.941
TURBIDITY (NTU)	72.8-1978	-	12.6-474.1	4.67-28.67	-

203.4 mg/L and Specific Conductivity range from 0.024 – 0.054 mS/cm respectively.

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