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HYDROLOGICAL MONITORING AT PEAT SWAMP FOREST, AYER HITAM FOREST RESERVE, JOHOR, MALAYSIA FOR FOREST CONSERVATION

Siti Aisah Shamsuddin*, Ibharim Hasim, Mohd Muflif Mohd Rodzi and Hafizi Mohd Jaafar

Forest Research Institute Malaysia, Malaysia

**Corresponding author: sitiaisah@frim.gov.my*

SUMMARY

The quick hydrological assessment was carried at peat swamp area of Ayer Hitam Forest Reserve (N), Johor. This preliminary study at the site is part of the component that will be included in the management and conservation of the forest area as this is the only peat swamp forest left in this state. The observation was carried out in June 2015 for water quality and water level at 2 m below the surface. Basically the longer term monitoring is necessary to determine the fluctuation in water level in accordance to the monsoon seasons. The conservation of this peat area is important as its functions in flood control in case if there is an extreme rainfall event occurred. This area also conducive to the forest fire and appropriate action should be taken as an alternative to face the problem. This project will be continuing in the second phase for details study in hydrology and method selected to help forestry department in the management of the forest.

Keywords*: water quality, ground water, water level, water pumping test*

INTRODUCTION

The Ayer Hitam Forest Reserve (AHFR) is located in Muar district, state of Johor with the total area of 3,797 hectares (ha.). This is the largest and the last remaining peat swamp forest in the state of Johor (Figure 1). This forest reserve is surrounded by oil palm estates, cash crops and also settlement areas, thus there are canals established at the edge of the forest area in the management of agriculture and plantation. Hence, there is a possibility that water resource in this peat swamp forest is affected by the canals system. The dark yellowish water from the forest will be drained into the canals and these canals also protected the oil palm trees from submersion during wetted season. Besides that, this forest reserve is threatened by fire.

Basically there are no river systems that flow in this forest area but a small stream was found at point Wq 14, which is located at the forest border between AHFR and oil palm plantation. This is not a stream originated from peat swamp area as identified from the colour of the water and the soil properties. Hence, there are no inflow to and outflow from the areas so that water flows slowly or it seems not moving at most of the locations. Naturally, water bodies in the area of peat swamp are depending on rainfall for replenishment.

There was an ex-mining water body located inside the AHFR that is at the southeastern part of the area and canals were constructed along the access road to the site. A canal at one side of the road is bigger than the other side. Water in the big canal will remain and the water level slightly dropped only during drought period.

The objectives of the study are to determine the status of water quality and water availability below the surface by measuring the water levels which can be represented the values for peat swamp area of AHFR.

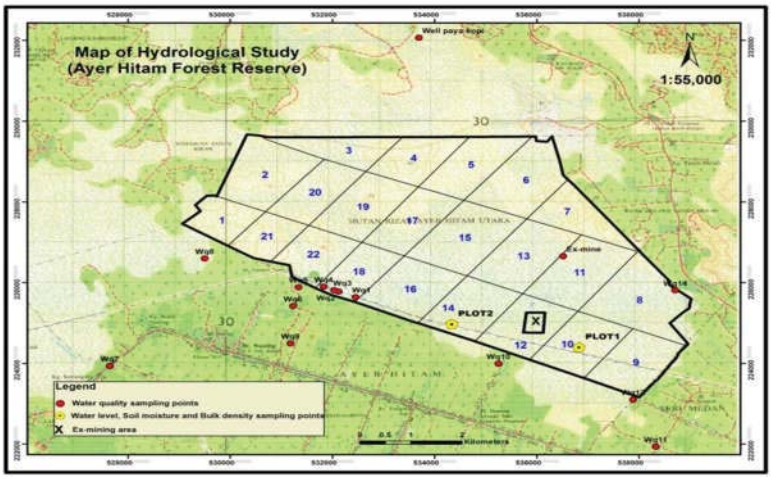

Figure 1: Map of hydrological study at AHFR

METHODS

Water quality monitoring was carried out inside AHFR where water bodies can be found and most of the points of observations were outside the AHFR which many of the canals were established.

The water quality were measured at 15 locations (Figure 1) which 6 points inside the forest (Wq 1, Wq 2, Wq 3, Wq 4, Wq 14 and at ex-mining area), 9 points outside the AHFR area (Wq 5, Wq 6, Wq 7, Wq 8, Wq 9, Wq 10, Wq 11, Wq 12, Wq 13) which are located in oil palm plantation areas. Points Wq 1-4 are surface water body retention in the canal that has been covered with sediment. YSI Profesional Series Pro Plus (S.N: 14B101084) Multiparameter was used in the measurement.

Water quality sample from pumping test was also measured and another reading was taken from the canal located at Paya Kopi, AHFR Tambahan. The water quality parameters measured were pH, dissolved oxygen (DO), Conductivity (Cond), total dissolved solids (TDS) and turbidity. The observations were carried out from 9 to 11 June and 23 to 25 June 2015.

Figure 2: Observation on water body inside the forest reserve.

Figure 2: Observation on the canal outside the forest reserve.

The water levels were measured at two locations (plots 1 and 2) as shown in figure 1. Cera Diver was used to measure the water level while mini diver is a barometer to measure the pressure (Figure 2). The pvc with 5.0 cm in diameter and 2.5 m length was inserted into the borehole at 2.0 m depth below the surface (Figure 3). The divers were carefully installed into the borehole casing and all the measurements needed were determined as shown in Figure 4. The monitoring was started on 27 May 2015 on hourly basis at plots 1 and 2. Figures 5 and 6 show the process of water pumping and it was carried out continuously after one event to the next event in order to get the consistent rates of recovery period.

Figure 2: Mini diver (above) and Cera Diver (below) used in the water quantity study.

Figure 3: Cera diver was placed in the pvc tube.

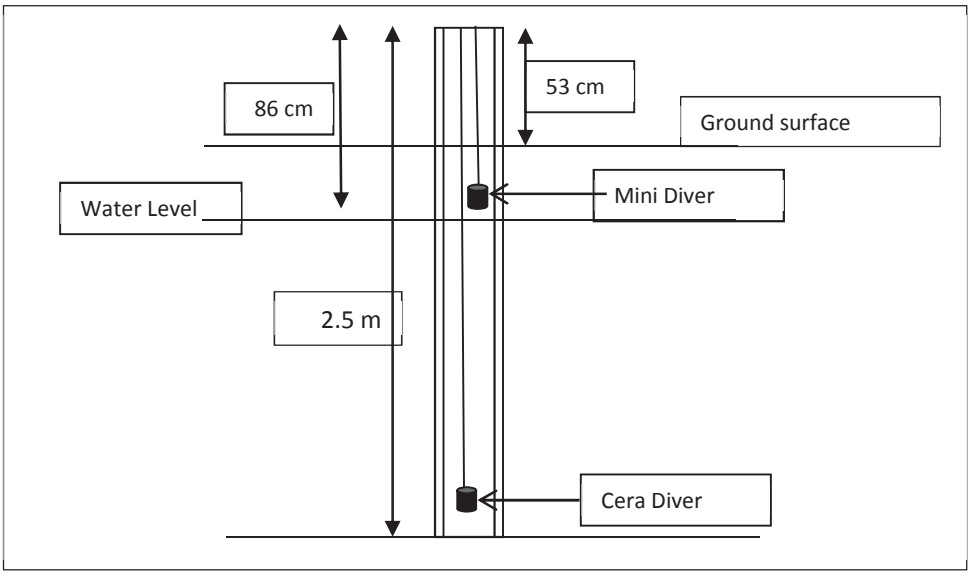

Figure 4: Schematic diagram of instrumental set-up for water level measurement.

Figure 5: Inserting the water pump instrument into borehole casing.

Figure 6 Water yield from the pumped well.

RESULTS

Tables 3 to 6 show the results for water quality observation at the study site and also surrounding areas.

Table 3: Water quality observation near the border and inside the AHFR

Date (June)	Location	Time	Temp. °C	DO %	DO mg/l	Cond. uS/cm	TDS mg/l	pH	Turb. NTU
9	Wq 1	11:10	30.9	71.0	5.22	58.5	34.45	4.2	72.50
	Wq 2	11:22	31.8	59.8	4.44	77.2	44.20	3.9	46.10
	Wq 3	11:31	28.5	29.7	2.32	67.5	40.95	3.8	2.59
	Wq 4	11:40	32.1	80.6	6.03	24.8	14.30	5.0	25.80
11	Wq 14	9:50	26.3	51.1	4.16	112.0	70.85	6.3	82.10
25	Ex-mining	10:10	27.0	14.0	1.1	99.4	62.4	3.2	2.2

(Note: Wq 14 is not water body from the peat swamp forest)

Table 4: Water quality observation at oil palm plantations

Date (June)	Location	Time	Temp.	DO		Cond.	TDS	pH	Turb.
			°C	%	mg/l	uS/cm	mg/l		NTU
9	Wq 5	11:50	29.9	26.8	2.13	61.2	36.40	5.5	43.50
	Wq 6 (1)	12:00	28.0	32.1	2.58	102.6	63.05	3.6	42.00
	Wq 6 (2)	12:00	28.0	32.4	2.58	102.9	63.05	3.4	20.10
	Wq 6 (3)	12:00	28.1	30.0	2.37	103.0	63.05	3.5	44.20
10	Wq 7	9:00	27.7	46.2	3.68	102.3	63.05	4.9	5.89
	Wq 8	9:36	26.9	33.0	2.72	58.0	36.40	5.4	13.70
	Wq 9	10:16	28.1	35.6	2.90	56.0	34.46	4.6	8.69
	Wq 10	10:38	27.8	43.1	3.44	95.7	59.15	3.6	1.62
	Wq 11	10:56	27.7	44.7	3.58	140.2	86.45	3.4	2.29
	Wq 12	11:08	27.3	49.0	3.97	131.4	81.90	3.4	1.20
	Wq 13	11:36	28.8	32.0	2.47	645.0	390.00	3.3	55.20

(*Note: Canal maintenance work had just carried at point Wq 13 when observation was carried out)*

Table 5: Water quality of water sample from pumping tests and at Paya Kopi.

Date (June)	Location	Time	Temp.	DO		Cond.	TDS	pH	Turb.
			°C	%	mg/l	uS/cm	mg/l		NTU
23	Plot 1	11:19	26.9	15.2	1.21	74.8	46.8	5.9	18.8
24		10:40	27.0	21.5	1.80	73.5	45.8	5.0	14.4
25	Paya Kopi	11:04	27.7	18.4	1.5	83.8	51.8	3.9	5.3

The acidity of surface water at peat swamp forest is high which the value can be as low as pH 3.2 (ex-mining area) and it was found that water pH from pumping test (2 m below surface) was less acidic than surface water. The pH values obtained from pumping test were 5.0 and 5.9. Basically, most of the pH values ranging from 3.2 to 3.9. These values are consistent with the pH values obtained at Sungai Bebar peat swamp forest at Pekan Forest Reserve, Pahang which ranged from 3.3 to 4.2 (Suhaimi & Lim, 2005).

The water turbidity was low when there is no influence of sedimentation such as at points Wq 10-12 which ranged from 1.2 to 1.62 NTU. Conductivity was quite high ranges from 56 to 103 uS/cm while, DO was low ranges from 1.1 to 3.9 mg/l. The TDS is also high which ranged from 34.5 to 86.4 mg/l.

Table 7: The water volume obtained from the pumping test was 3.09 L The parameters involved and volume of water determined from the pumping test about 2 m below the surface.

1.	Length of pump inserted in the pvc tube.	2.23 m
2.	Distance between pvc tube pump and soil moisture sensor point.	4.67 m
3.	Water level from the surface before water pumping.	33 cm
4.	Drawdown period of time.	23 s
5.	Saturated level at the soil moisture sensor measured after water was pumped.	38 cm
6.	Volume of water.	0.00309 m^3 /23s (3.09 L)

DISCUSSION

The hydrological study conducted at the peat swamp forest has given basic information on the availability of water through pumping below the surface and also the status of water quality found at the study site and also from the surrounding area.

The canals were also established in the preparation of the construction of high voltage power along the border line of the southern part of the forest. The canals were at both sides of the road but through time already covered by sedimentation. The existence of the roads had effected the water level under the surface and resulted in subsidence occurred slowly through time and this can be evidenced by the exposure of the power line's pole.

The most important thing when conducting the water pumping test is the interval of water level recorded by the water level sensor. The small interval will give more accurate time of recovery phase. In this study the

interval will be changed from one hour to 1 second for the next water pumping test. This result will provide us with the frequency of water that could be pumped from the tube well. Another aspect that is also need to be determined is the zone around the point of pvc tube well that will be affected by the drawdown of water.

The water level measured at AHFR was about 33 cm below the surface. The study reported at Pekan Forest Reserve that water level seldom fall below 40 cm (Danida, 2004) and the same condition was also reported at north Selangor peat swamp forest (DANCED, 2000). The water resource from the peat swamp forest is not obtained from the 2 m level below the surface but should be at the depth of the aquifer level. The mineral level at the study site was found between 7–9 m below the surface.

This area is very sensitive to forest fire every year as it is near to the agricultural site which is involved in forest burning prior to planting during the dry season especially from January to Mac. The forest reserve was affected by the worst forest fire event in year 2013. The government has taken action under the Ministry of Natural Resources to construct a check dam and ground water tube well as an effort to mitigate the problem. Both infrastructures were established at peat swamp of Paya Kopi, Pagoh which ground water tube well was provided by the Mineral and Geoscience Department (JMG), Johor while, the check dam was provided by Drainage and Irrigation Department (DID), Johor. The ground water tube well is planned to establish at another two sites.

CONCLUSION

The AHFR area is not similar with other peat area in Peninsular Malaysia as there is no streamflow into and out of the area. The quick assessment on water quality indicated the acidic condition of water at the surface (as low as pH 3.2) but the water quality pumped from 2 m below the surface is less acidic (up to pH 5.6). The water volume obtained was little (~ 3 L) with long recovery period of 12 hours.

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