Comparative study of water quality of rivers used for raw water supply & ex-mining lakes in Perak, Malaysia

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Abstract. Ex-mining lakes are seldom used as sources of raw water for the treatment of public water supply due to the general view that they are highly polluted. This study examined the water quality of these lakes, compared and contrasted them to the water quality of the rivers used for Perak drinking water supply. Ten water samples were analyzed from different ex-mining lakes. Two water samples were from Kinta and Perak rivers. They were analyzed for physico-chemical properties such as temperature, pH, EC, TDS, SO\textsubscript{4}\textsuperscript{2-}, COD, Cl\textsuperscript{-}, Na\textsuperscript{+}, Fe, As, and Pb. The results showed that temperature varied from 28.1°C to 34.1°C, pH 6.2 to 9.0, EC 55 to 400 µs/cm, turbidity 5.6 to 74.2 NTU, TDS 36.8 to 268mg/l, Cl\textsuperscript{-} 0.483 to 3.339mg/l, SO\textsubscript{4}\textsuperscript{2-} 0.051 to 15.307mg/l, Na 0.669 to 3.668mg/l, Fe 0 to 0.14mg/l, As 0 to 0.004mg/l, and Pb 0.019 to 0.075mg/l. All the samples were highly turbid, had slightly high concentration of Pb, and had common water quality problem. The ex-mining lakes can also be used to supply water after treatment since these rivers are already being used by the Metropolitan Utilities Corporation for water treatment. The ex-mining pools can be used as alternative sources of drinking water supply to the people of Perak.

1. Introduction
Malaysia is facing an ever growing need for the management of her water resources due to rapid socio-economic development [1]. For the future water needs to be met, the government must make every effort to develop, conserve, utilize and manage all the available potential water sources.

River is the major source of raw water supply. Due to the increase in river pollution, it becomes pertinent that the other water sources be developed and tapped in order to either augment or serve as alternative sources of water supply. Shah Alam and Sandakan have introduced rainwater harvesting in new housing developments [2]. Kelatan, Perlis, Pahang, Selangor, and Terengganu States have also been combining surface water with groundwater for their integrated water resources management [3].

Ex-mining pools have basically been used for irrigation, recreational activities, and retention ponds except for drinking due to the view that they are highly polluted. Study has shown that ex-tin mining lakes located in Bestari Jaya area, Selangor, are highly polluted with heavy metals [4]. More lakes have to be analyzed in other parts of Malaysia in order to assess their suitability for public water supply. The objectives of this study were to examine the water quality of ex-mining lakes in Perak; and to compare and contrast them to the water quality of the rivers used for Perak drinking water supply.
2. Materials and Methods

2.1. Sample locations

Twelve water samples, ten from ex-mining lakes and two from rivers, were collected for analyses on water quality. Details of the sampling sites are shown in Table 1. The sample collection was done on the 29th of July and 2nd of August, 2012. River Perak and River Kinta are currently used by the Metropolitan Utilities Corporation Sdn Bhd (MUC) as intake points for water supply in the State of Perak.

Table 1. Sampling information with sampling sites descriptions

| No | Date / Time   | Site/Source                  | Site Description                                                                 | Coordinates                     | Elevation (m) |
|----|---------------|------------------------------|----------------------------------------------------------------------------------|---------------------------------|---------------|
| S1 | 29/7/12 11:30am | Lalua Tronoh Mines/Ex – Mining Pool | Inactive mining site that is partly surrounded by residential buildings and forests. The vicinity of the other part is used for cattle grazing. | 4°25’47.4”N 100°58’53”E | 30.79         |
| S2 | 29/7/12 12:01pm | Coop. Sec. of State, Tronoh/Ex – Mining Pool | It has the same future as in S1.                                                   | 4°25’05.9”N 101°00’59”E | 27.13         |
| S3 | 29/7/12 6:31pm  | Bumban 1, Batu Gajah/Ex – Mining Pool | A lake with muddy shore & surrounded by forests. It is located near the roadside and a construction site. | 4°28’05.9”N 101°00’59”E | 42.07         |
| S4 | 30/7/12 4:16pm  | Bumban 2, Batu Gajah/Ex – Mining Pool | A mangrove area. Sewage is discharge into it through a drainage busy road. Some restaurants and stores in the vicinity. | 4°28’08.4”N 101°01’31”E | 40.85         |
| S5 | 31/7/12 4:31pm  | Train Station, Batu Gajah/Ex – Mining Pool | It is located adjacent to a busy road and train station. It is almost fully surrounded by forests and used for fishing by the villagers. | 4°27’44.7”N 101°03’04”E | 20.12         |
| S6 | 30/7/12 6:17pm  | Taman Bumban, Batu Gajah/Ex – Mining Pool | It lies by the side of road, agricultural area and residential buildings. Wreckages of building materials deposited close to shoreline of it. | 4°27’57.0”N 101°00’56”E | 42.38         |
| S7 | 31/7/12 7:05pm  | Kampung Bumban G.G.1, Batu Gajah/Ex – Mining Pool | It lies by the side of forests, agricultural area and residential buildings. It is basically used as irrigation water. | 4°27’52.0”N 101°00’54”E | 42.99         |
| S8 | 31/7/12 6:10pm  | Kampung Bumban G.G.2, Batu Gajah/Ex – Mining Pool | It has the same future as in S7.                                                   | 4°27’48.2”N 101°00’53”E | 41.46         |
| S9 | 02/8/12 7:05pm  | Taman Taufik Putra, Opp. ESSO Mobil/Ex – Mining Pool | It is located opposite a filling station and surrounded by forests.                 | 4°23’56.9”N 100°59’09”E | 18.90         |
| R10 | 31/7/12 5:34pm | Kepayan Bay, Bota/Sungai Perak | A river with fishing site. Turtle breeding center, market, restaurants and abattoir are located within the vicinity. | 4°21’18.1”N 100°52’25”E | 18.29         |
| R11 | 02/8/12 6:00pm | Batu Gajah/ Sungai Kinta | The river cuts across residential area. The bank faces erosion. Mills, restaurants, and busy rods are within its vicinity. | 4°28’25.9”N 101°03’08”E | 25.00         |
| S12 | 02/8/12 6:30pm | Universiti Teknologi Petronas, Tronoh/Ex – Mining Pool | This is an open mining lake that is surrounded by few trees, and close to a filling station and hostels. | 4°23’04.0”N 100°58’43”E | 18.60         |

2.2. Methods

Temperature, pH, turbidity, and Electrical Conductivity (EC) were measured in the field at each sampling point. The Total Dissolved Solids (TDS) was obtained by multiplying the EC values by a conversion factor of 0.67. Temperature and pH were measured with pH meter (HACH – Sension 4, USA), Turbidity with turbidimeter 2100P (HACH, USA), and EC with EP meter (MYRON, USA). The samples were measured in triplicates and the average value calculated. All analyses were of analytical grades and complied with the standard methods [5]. $\text{SO}_4^{2-}$ and $\text{Cl}^-$ in the samples were measured using Ion Chromatography (Metrohm) and other cations by Atomic Absorption Spectrophotometer (AAS, AA-6800, SHIMADZU, Japan). Chemical Oxygen Demand (COD) was determined by digestion using DRB 200 and colorimetric method using Spectrophotometer DR 2800 (HACH, USA).
3. Results and Discussion

Physico-chemical parameters from the 12 sampling locations are summarized in Table 2.

| No | Temp. p. °C | pH | Turbidity NTU | EC µs/cm | TDS mg/l | COD mg/l | SO₄²⁻ mg/l | Cl⁻ mg/l | Na⁺ mg/l | As mg/l | Fe mg/l | Pb mg/l |
|----|-------------|----|---------------|----------|----------|----------|-------------|----------|----------|---------|---------|---------|
| S1 | 30.5        | 9.0| 85            | 140      | 93.8     | 14       | 0.205       | 1.014    | 1.215    | ND      | ND      | 0.047   |
| S2 | 29.8        | 8.8| 39.3          | 200      | 134      | 22       | 0.051       | 1.103    | 1.471    | ND      | 0.14    | 0.047   |
| S3 | 34.1        | 8.8| 34            | 275      | 184      | 31       | 15.31       | 1.747    | 0.947    | ND      | ND      | 0.047   |
| S4 | 33.7        | 7.4| 41.3          | 160      | 107      | 10       | 3.030       | 3.339    | 3.071    | ND      | 0.075   |
| S5 | 29.1        | 7.5| 28.5          | 120      | 80       | 9        | 0.336       | 1.360    | 0.947    | ND      | ND      | 0.070   |
| S6 | 29.8        | 7.7| 19            | 344      | 230      | 51       | 0.273       | 1.550    | 1.710    | 0.004   | ND      | 0.056   |
| S7 | 28.1        | 7.8| 51.4          | 355      | 238      | 20       | 0.692       | 2.517    | 2.738    | 0.002   | ND      | 0.042   |
| S8 | 30.6        | 8.8| 69.4          | 400      | 268      | 38       | 0.176       | 3.148    | 2.869    | 0.005   | ND      | ND      |
| S9 | 31.7        | 7.5| 5.6           | 115      | 77       | 11       | 1.029       | 2.895    | 0.669    | 0.002   | ND      | ND      |
| R10| 29.9        | 6.2| 74.2          | 55       | 36.8     | 40       | 0.977       | 0.545    | 2.230    | 0.003   | ND      | 0.019   |
| R11| 30.8        | 7.1| 11.8          | 340      | 228      | 35       | 0.956       | 2.253    | 3.668    | 0.004   | ND      | 0.037   |
| S12| 30.6        | 7.4| 32.9          | 100      | 67       | 4        | 2.408       | 0.483    | 1.123    | 0.004   | ND      | 0.019   |
| WHO| -           | 6.5-8| 5           | 1000     | 500      | 10       | 250         | 250      | 200      | 0.001   | 0.3     | 0.01    |

ND = Not Detected

3.1. Physical Parameters

3.1.1. Temperature

Temperatures of the samples fell within the range (27.8 – 35.3°C). Similar range was reported by Yap et al, 2009 [6].

3.1.2. pH

The pH ranged from 4.96 to 9.81, similar to the one reported by Yap et al, 2009 [6]. R10 was most acidic water. This is in line with the findings by Chau and Jiang, 2002 [7], which argued that natural rivers are always slightly acidic because they normally originate from rain water and incorporate with acid released from the leaves of the forests within the area. S1 had the highest alkaline in its water. This could be due to high algal concentrations in the pool.

3.1.3. Electrical Conductivity (EC)

The results showed that the EC of all the water samples were low and met up with the WHO standard [8].

3.1.4. Total Dissolved Solutes (TDS)

The highest range of TDS was found in S8. This could be due to the runoff of agricultural activities in the area and leaching of soil contaminant. However, TDS in all the samples were still within the WHO limit.

3.1.5. Turbidity

All the water samples fell above the WHO standard. Highest turbidity was recorded in S1 and could be caused by the high presence of fine clay, silt particles, and plankton observed in the lake.

3.2. Chemical Parameters

Sulfate, Chloride, Sodium, Arsenic, and Iron in the water samples were found to be within the prescribed limit. The concentrations of Pb ranged from 0.00 to 0.075mg/l. This result was close to the ones obtained by Yap et al, 2009 [6] and Yap et al, 2011 [9], wider than that reported by Shuhaimi et al, 2012, [10], and far wider than the report obtained by Muhammad et al, 2010 [11]. The concentrations of Pb in all the samples except S8 and S9 are slightly above the prescribed limit.
3.3. Organic Pollutant

S6 had the highest COD value. This could be as a result of the indiscriminate discharge of agricultural wastes into the water. Reports have shown that agricultural, industrial, and domestic wastewaters are considerable sources of high COD [12].

4. Conclusions

Analyses showed that the rivers and the mining lakes are highly turbid, have high concentrations of Pb, and have common water quality problem. This implies that water from the ex-mining lakes can also be used for water supply after treatment since the rivers are already used by the MUC for treatment. However, future work should carry out more tests on other water quality parameters and at different seasons.

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