IN SITU ANALYSIS OF WATER QUALITY MONITORING IN EX-MINING LAKE TASIK PUTERI (TERENGGANU, MALAYSIA)

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ABSTRACT
Tasik Puteri, a man-made lake with an area of 131 hectares is located in Dungun District, Terengganu. The lake was once used for iron ore washing process and has now turned into a recreation centre for people living nearby. Nearly, a decade of industrial scale iron mining operations in Bukit Besi has passed and has caused an impact on the region’s surface water quality. However, no information with respect to the water quality status of this lake has been provided to the public. The aim of this work is to evaluate the physicochemical quality of the lake water. Parameters measured were temperature, pH and dissolved oxygen. Water samples from 14 sampling point with different depth were taken. All the parameters were measured in situ by using Hach Water Quality Analysis Kit and was done according to the guidelines of Department of Environment (DOE) Malaysian water quality assessment with respect to Interim National Water Quality standards (INWQS). Results showed that the pH for almost all sampling point is around 3-4, temperature around 30 °C and dissolved oxygen less than 10 mg/L. Based on DOE Water Quality Index Classification the lake was classified as polluted against class IV. This shows the lake is not suitable for recreational activities such as fishing and canoeing but more to irrigation.

Keywords: acidic, contamination, iron ore, man-made lake.

INTRODUCTION
Bukit Besi is a small mining town in Terengganu, Malaysia famous for its high quality iron ore. The iron ore mining activities in Bukit Besi began from 1916. The production peak for iron ore mining is between the year 1960-1964, where the amount withdrawn exceeds 2,000,000 tons a year. However, on October 1, 1970, the Board of Directors EMMCO have made decision to close Bukit Besi mine [1].

Among the types of rock mined at Bukit Besi by that time are iron ore with massive sulphide which consist of pirite (FeS2), pyrrhotitite (Fe1-xS), calcopirite (CuFeS2), bernetite (Cu8FeS8), hornfels (SiO2) and dolerite. Other than that is hematite (Fe2O3), limonite (2Fe2O3.3H2O) and magnetite (Fe3O4) [2].

Tasik Puteri is man-made lake resulted from Bukit Besi mines. The lake is created around 1960s by constructing dams through Sungai Dalam stream [2]. It was once used in iron ore washing process and now has turned into a major recreation center for people living nearby. The area of the lake is 131 hectares. The lake which involves neighbourhood of about 5 sq. km is bordered on the north Dikinson Village, located approximately 3 km from Bandar Bukit Besi. On the west bank of the lake is stranded a beautiful green golf course area of Tasik Puteri Golf Club.

Nearly a decade of industrial scale iron mining operations in Bukit Besi has passed and has caused an impact on the region’s surface water quality. However, no information with respect to the water quality status of this lake has been provided to the public. Number of people claimed skin irritation and eyes irritant when they swim in the lake. Some also reported a ‘rotten egg’ or swampy odor come from the water. Nonexistence of aquatic lives also brought attention to initiate this research. The odour of the lake and all the unreported problems might be due to the iron mining which consists of numerous types of sulphide.

The aim of this paper is to present the measured of pH, temperature and dissolved oxygen at 14 sampling point in Tasik Puteri. In situ analysis for temperature, pH and dissolved oxygen is taken by using Hach Water Analysis Kit. The result obtained showed a great concern need to be taken on this lake water quality that might bring hazard to people who use this lake directly or indirectly.

METHODOLOGY

Sampling location
Tasik Puteri is located at 4°44'00.2"N 103°11'31.0"E in Dungun district in between of Universiti Teknologi MARA, Bukit Besi Campus and Kampung Besol, Bukit Besi. The width of the lake from inlet to outlet is equal to 1.4 km.

Method of sampling preservation
Water samples collected using laboratory glass containers 250ml. Water is collected for each 2-meter depth of the lake including water surface and ground water. In situ analysis for temperature, pH and dissolved oxygen is taken by using Hach Water Analysis Kit.
Method of sampling location and depth selection

Using an equal width increment method, 14 sampling points have been chosen from inlet to outlet water stream since the width of the lake equal to 1.4 km. Due to the large study area, Global Positioning System was used to determine the actual coordinates of every single point from the water inlet to the water exit. The depth of each location is measured using Amron International Divers Scan Personal Portable. Table-1 shows the coordinate and depth of the sampling location.

RESULTS AND DISCUSSIONS

Health of a water body can be determined from water quality parameters. These parameters are used to find out if the quality of water is good enough for drinking water, recreation, irrigation and aquatic life. These parameters include a variety of physical, chemical and biological. Among the types of physical parameters are temperature, pH and dissolved oxygen.

Survival of aquatic life depends mostly on temperature. Water temperature changes naturally both daily as well as seasonally. Aquatic environment, including bacteria, algae, invertebrates and fish are seriously affected by the moderate change in temperature [3]. Biological activity is proportional to water temperature, the higher the water temperature, the greater the biological activity [4].

The pH is the measurement of the hydrogen ion concentration in the water. The pH balance is important because it helps to maintain aquatic ecological conditions of the water. Low pH levels can disturb the fish physiological system and therefore can increase the mortality rate of the fish population [5]. While acid mine drainage or mine water pollution is usually identified with low pH, elevated levels of a range of heavy metal contaminants. The main source of acid contamination in acid mine drainage is when mining activities are involved with the exposure of pyrite (FeS₂) and other sulphide containing minerals. This compound will undergo oxidation, chemically and microbially mediated [6]. Dissolved oxygen is defined as molecules oxygen in water. Sufficient level of dissolved oxygen in water determines survival for aquatic life like the air human being breath. Many factors involved in solubility of oxygen molecules in water. One of the factors is water temperature [7]. Increase in water temperature will decrease the solubility of dissolved oxygen [8].

Figures-2-4 show the results obtained from in situ monitoring for surface, in the middle depth and ground or bottom sampling. All the results show quite the same pattern. All the values measured are discussed compared to Interim National Water Quality Standard (INWQS).
Based on Figures-2-4, pH value are observed in the range of 3-4, which is not an acceptable range compared to INWQS and being at the status IV water quality. Status 4 means than the lake is suitable only for irrigation, but not for recreational activities. This acidification status might closely related with previously mining operation that have being operated in the area nearby, since most of the iron ore produced in the form of sulphide which obviously agreed with the previous research findings [9]. The non-existence of aquatic life from aesthetic point of view in the lake is closely related to the low pH value if it is based on Table-2.

### Table-2. pH tolerance levels and its effect on aquaculture [10].

<table>
<thead>
<tr>
<th>pH levels</th>
<th>Effects on warm water pond fish</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 4.0</td>
<td>Acid death point</td>
</tr>
<tr>
<td>4.0-5.0</td>
<td>No production</td>
</tr>
<tr>
<td>6.5-9.0</td>
<td>Desirable range for fish production</td>
</tr>
<tr>
<td>9.0-11.0</td>
<td>Slow growth</td>
</tr>
<tr>
<td>&gt; 11.0</td>
<td>Alkaline death point</td>
</tr>
</tbody>
</table>

Meanwhile, for the dissolved oxygen value, it fall in status I when compared to INWQS which define as conservation of natural environment, water supply I-practically no treatment necessary and fishery I-very sensitive aquatic species. In the other word, the water is quite in good condition.

For the temperature value, it is in the range of 30-34 °C and these temperature values are normal according to the climatic conditions of the area.

**CONCLUSIONS**

The result of water quality based on in situ measurement on Tasik Puteri, Terengganu, Malaysia obviously shows that the water quality is contaminated. Further investigation need to be carried out on this lake in order to bring the ecological system back to balance.

**ACKNOWLEDGEMENT**

The authors would like to express our gratitude Universiti Teknologi MARA for providing the laboratory facilities and technical support. The authors also would like to express our sincere appreciation and heartfelt gratitude to divers from Akademi Bomba Wakaf Tapai Terengganu for helping us undergo rinse sampling for each location.

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