IMPACT OF ANTHROPOGENIC ACTIVITY ON WATER QUALITY OF TASIK BIRU AT BUKIT IBAM, MUADZAM SHAH

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ABSTRACT

The anthropogenic activity is the impact of deterioration of current water quality status of Tasik Biru at Bukit Ibam, Muadzam Shah. Entirely, five sampling stations were selected within the study area in order to determine the current water quality characteristics. Both in-situ and ex-situ testing were conducted within the study area to test the selected parameters. From the experiment conducted, the average value of temperature and pH was 28.97°C and 8.19 respectively. Meanwhile, dissolved oxygen, chemical oxygen demand and biochemical oxygen demand recorded the average amount of 7.03 mg/L, 12.41 mg/L and 6.0 mg/L respectively. The study water was in class I for parameters such as nitrate and iron based on National Water Quality Standard (NWQS),. Additionally, turbidity and chemical oxygen demand was classified in class IIA whereas pH, phosphate and dissolved oxygen was categorized in class IIB in accordance with NWQS. The temperature was within normal ranges under class III, electrical conductivity, total dissolved solids and biochemical oxygen demand parameters came under class IV according to NWQS. According to DOE-WQI of Malaysia, the water sample collected from January to March was classified as class III, which ranging from 64.20 to 73.63. The water in this class indicated that intensive water treatment is necessary for tolerant aquatic life. For seasonal basis, the study water also classified in class III with the range of 64.20 up to 69.94. This result showed that the wet season was polluted than dry season. Both the anthropogenic activities have affected the water quality status of the lake. Based on study, the mining activity that was carried out in the past has increased the total dissolved solids and heavy metals constituents. As the overall, this study water is moderately polluted. Thus, the water can be used for public water supply after treatment besides, was suitable for navigation uses and treated water transportation as well.

ABSTRAK

Aktiviti antropogenik adalah kesan kemerosotan status kualiti air semasa Tasik Biru di Bukit Ibam, Muadzam Shah. Secara keseluruhannya, lima stesen persampelan telah dipilih dalam kawasan kajian untuk menentukan ciri-ciri kualiti air semasa. Kedua-dua kajian in-situ dan ex-situ telah dijalankan di kawasan kajian untuk menguji parameter yang telah dipilih. Daripada ujikaji yang dijalankan, nilai purata suhu dan pH masing-masing adalah sebanyak 28.97 ° C dan 8.19. Sementara itu, oksigen terlarut, permintaan oksigen kimia dan permintaan oksigen biokimia masing-masing mencatatkan jumlah purata 7.03 mg / L, 12.41 mg / L dan 6.0 mg / L. Air kajian adalah di dalam kelas I untuk parameter seperti nitrat dan besi berdasarkan Standard Kualiti Air Negara (NWQS). Selain itu, kekeruhan dan kimia permintaan oksigen telah dikelaskan dalam kelas IIA manakala pH, fosfat dan oksigen terlarut dikategorikan dalam kelas IIB mengikut NWQS. Suhu adalah dalam julat normal iaitu dalam kelas III, kekonduksian elektrik, jumlah pepejal terlarut dan biokimia parameter permintaan oksigen berada di bawah kelas IV mengikut NWQS. Menurut JAS-WQI Malaysia, sampel air yang dikumpul dari Januari hingga Mac telah diklasifikasikan sebagai kelas III, yang terdiri 64.20-73.63. Air di dalam kelas ini menunjukkan bahawa rawatan air intensif adalah perlu untuk kehidupan akuatik toleran. Bagi kategori musim, air kajian juga dikelaskan di dalam kelas III dengan julat sebanyak 64.20 sehingga 69.94. Keputusan ini menunjukkan bahawa musim hujan adalah lebih tercemar daripada musim kering. Kedua-dua aktiviti antropogenik telah memberi kesan kepada status kualiti air tasik tersebut. Berdasarkan kajian, aktiviti perlombongan yang telah dijalankan pada masa lalu telah meningkatkan jumlah pepejal terlarut dan logam berat. Secara keseluruhannya, air kajian ini berada di paras sederhana tercemar. Oleh itu, air ini yang boleh digunakan untuk bekalan air awam selepas rawatan dijalankan selain itu, air ini sesuai untuk kegunaan navigasi dan pengangkutan air dirawat.

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BOD	Biochemical Oxygen Demand
Cd	Cadmium
Co	Cobalt
COD	Chemical Oxygen Demand
Cr	Chromium
Cu	Copper
DO	Dissolved Oxygen
EC	Electrical Conductivity
Fe	Iron
GPS	Global Positioning System
Ni	Nickel
NO_3^-	Nitrate
Pb	Lead
PO_4^{3-}	Phosphate
SO_4^{2-}	Sulphate
TDS	Total Dissolved Solids
TSS	Total Suspended Solids
Zn	Zinc

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF STUDY

Our world depends on surface water such as rivers, lakes and canals for about one third as the sources of drinking water (Gasim, 2006). As the example, a study conducted by Ochieng et al. (2010) showed that up to 70% of people in South Africa rely on surface water sources from both urban and rural areas. This cause water source to be insufficient to support the people needs.

This phenomenon is also rising in our own country, where water source is getting scarce. According to National Water Quality Standard of Malaysia, the range of Titiwangsa lake is in class 2, which is beyond the natural concentration resulting from rapid population growth, enlarged urbanization and increasing industrial based activities (Said et al., 2012). The local people activities produce both organic and inorganic surplus that were discharged into Chini lake and resulting in deterioration of its water quality status (Gasim, 2006).

Tasik Biru is a natural lake from the former iron ore mining. Lake is known as "tasik" among the local people, and "biru" refers to blue. According to the draft of the Environmental Impact Statement (EIS) for the PotyMet mining project, the former iron ore mining pit was filled with water and overspill into the Partridge River after the closure of about 45 years age. After some time, the chemical and biological reaction took place and thus changed the water quality (Gammons et al., 2009). A similar incident had occurred in a Tasik Biru where the lake is still likely to contain heavy metals that deteriorate its water quality, even after the mine's closure.

1.2 PROBLEM STATEMENT

Nowadays, the water quality is deteriorating due to the anthropogenic activity that was carried out. There was mining activity being actively carried held within the lake in the past. Moreover, rock quarrying activity is currently taking place near the study area that leads to the degradation of its water quality status. This lake has the potential to be developed as a recreational area, but the current quality of the water has not been studied. There is a possibility that the water of this lake can harm the aquatic lives if fish farming activities performed here, since it is a former iron ore mining site. This can be proven through (Muiruri, 2013) where the fish has detrimental effects over heavy metal contained in the contaminated water because it has very close contact with the water that carries the heavy metals through its gills during breathing mechanism. But, if the content of the water quality status is identified, we could utilize hundreds of gallons of water for various purposes. Mostly, the deserted mine lakes could function for various purposes including fishing, irrigation, and further domestic and industrial purposes such as bathing, laundry and for block making if proper research was done as being stated by Gyang and Ashano (2010).

1.3 SIGNIFICANCE OF STUDY

The study in this lake allows us to identify the impact of anthropogenic activity on the present water quality of Tasik Biru at Bukit Ibam. This study also enables us know the heavy metal constituents and related parameters of the water. Through this research, the current water quality of the lake was identified in order to develop the lake as one of the recreational areas in Pahang in upcoming time. This research can be ultimately helpful for policy makers to make decisions in order to save the lake in the future. By determining the water quality status, the area can be make use for a variety of functions if it is managed appropriately.

1.4 OBJECTIVES

The objectives of the research are as follows:

- To determine the current water quality status of Tasik Biru at Bukit Ibam.

- To investigate the impact of anthropogenic activity on the water quality of Tasik Biru at Bukit Ibam.

1.5 SCOPE OF RESEARCH

In order to accomplish the objectives of this research, the scope of study was focused on determining the current water quality status of Tasik Biru and the impact of anthropogenic activity on its water quality. The anthropogenic activity here referred to the iron ore mining activity that has been carried out during the year of 1960s.

The three bottles of sample water was taken from each sampling station within the study area, which is Tasik Biru at Bukit Ibam located in Muadzam Shah. Overall, five specified sampling points which can be accessed from land were ascertained to collect the samples for laboratory test and in-situ parameters measuring process. Both laboratory testing and in-situ parameter measurements were involved in determining the water quality status. The sample water collections were carried out three times, which is once in every three weeks starting from 23th January 2014 till 12th March 2014.

Specific methods and instruments were used to measure the parameters such as total suspended solids, turbidity, temperature, pH, dissolved oxygen, electrical conductivity, total dissolved solids, chemical oxygen demand, biological oxygen demand, total hardness and nutrients in order to determine the current water quality status of Tasik Biru. Conversely, atomic absorption spectrometer and spectrophotometer were used to indicate heavy metal constituents in the lake water. Finally, the data that directly affect the quality of the lake water were recorded.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter focuses on researches that have been done related to this study. This chapter also comparatively important since it acts as the basis for the study on water quality of the study area. Here, the importance of water and the effects of land use practices on water quality were discussed. In addition, the water quality parameters were physical, chemical, biological nutrients and related heavy metals that were examined as well.

2.2 IMPORTANCE OF WATER

Water consumption has increased globally to more than twice the rate of population increase. This shows that the water usage is getting doubled within every 20 years, but less than 1% of it is potable. However, over the past 50 years, water supplies become limited due to the deterioration of water quality in many of the areas that lead to health hazards (Prodi, 2003).

Water is very essential for all life, including humans who often depend on supply of water in food production, economy, health and environment (Ryerson, 2010). About 70% of current demand for water supply was from agriculture, whereas the leftover from household, urban and industrial utilization and consumption (Prodi, 2003).

By the year 2050, the world population is expected to grow to 9 billion people. Therefore, the water supply needs rise eventually. Figure 2.1 shows the global water

consumption from year 1900 to 2025 for every region. Figure 2.1 indicated that the water needs is escalating for every region, with Asia at the leading stage followed by other regions (Ryerson, 2010).

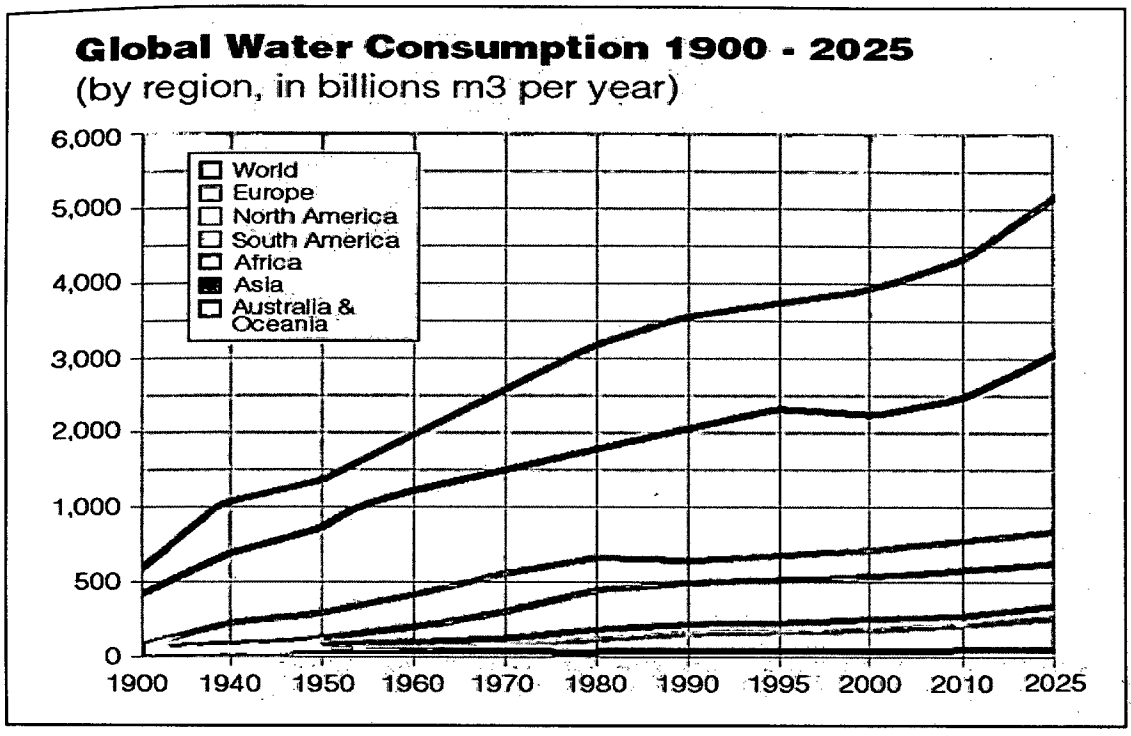

Figure 2.1: Global water consumption for year 1900 – 2025

Adapted from: Ryerson, 2010.

2.3 EFFECT OF LAND USE ON WATER QUALITY

The Earth's crust was disturbed during mineral extraction for industrial usage. When mining activity took place, the life patterns of living things on the crust was troubled consequence in loss of biodiversity. Both active and inactive mining excavation generated direct relationship between ground water and land surface, in term of water source contamination. Here, heavy metals leakage caused hazards in addition to the oxidation of exposed minerals that lead towards acid mine drainage. Materials drainage from dumping mines proceeded as surface water and ground water contamination scenario for years, even after mining operations have been closed. The

plentiful mine lake, overload and mine tailings have adverse effect to the environment since it was considered as death traps as stated by Gyang and Ashano (2010).

The pollutants produced from mining were almost same with the one produced from other industries. But, various mining activities generated a variety of heavy metals, minerals and solids into watercourses which created trouble to all direct or indirect water dependent life. Polluted water from mining was out of use as a potable water source. It has unattractive colour, taste, odour, turbidity, unsafe chemical contents,

Pollution occurred when leakage of mineral containing water entered into surface water or aquifer system. The mine water consists of high concentration of salt and large constituents of iron, sulphates and heavy metals derived from natural resources or mining equipments used. Metal mining water contained a mixture of heavy metals that were either toxic or non-toxic. Here, the salts were freed into working area when the mining operation occurred. Commonly, the presence of salts leads to rise in salinity which increases the depth of water below its surface as stated by Rout and Das (2012).

In addition to that, rebounding of mine water caused pollution to the surface water in mining. This scenario referred to the return of the mine water into mining area or its surface in case pumping action was completely stopped. This was due to the reason that, pumping procedure allowed for drainage and prevention of mine water from entering back into the mining area. Mining subsidence was expected to stimulate breakage in overlying strata, improving its hydraulic conductivity, and generating new path for mine water to travel upward. This upward moving water likely brings pollution to potable water supply abstraction. But, the mine water was not dangerous and the discarded mine pits function as aquifers most of the times as stated by Rout and Das (2012).

2.4.2 Current Rock Quarrying Activity

Engineering activities that related with quarrying works have directly changed the condition of the surface water. The water surface flow can be interrupted by the sinkholes that formed due to quarrying. In addition, the surface water flow was modified by the blasting activity that took place in rock quarry site (Langer, 2010).

During rock quarrying activity, the polluted materials were carried into the surface water, without experienced any filtration process. This occurrence naturally degraded the water quality status of the lake. The polluted surface water has quickly polluted the groundwater as well. Quarrying works generated fine debris that can be carried into the surface water which finally caused degradation of its quality, especially during the storm events (Langer, 2010).

2.5 WATER QUALITY PARAMETERS

Some of the parameters that affected the water quality status of the water bodies were physical, chemical and biological parameters. Physical parameters consisted of color, total suspended solids, turbidity and temperature. Chemical parameters included pH, dissolved oxygen, electrical conductivity, total dissolved solids, chemical oxygen demand, biological oxygen demand and total hardness. Nutrients such as nitrate, phosphate and sulphate were tested as well. Here, the heavy metals were also been taken into account such as lead, chromium, cadmium, copper, nickel, zinc, cobalt and iron.

2.6 PHYSICAL PARAMETERS

Physical parameters refer to characteristics of water that respond towards sight, taste, smell and touch. Some of the physical parameters tested were total suspended solids, turbidity and temperature.

2.6.1 Total Suspended Solids (TSS)

Total suspended solids refer to all suspended particles or matters that are unable to pass through a filter. Quantities of suspended solids were caused by the number of colloidal and coarse particles dispersed in water. These suspended solids leading towards unwanted troubles such as avoid photosynthesis process by preventing light penetration, amplify heat absorption, worsen aesthetic value of water and blocking fish gills (Chiang, 2010).

For rivers in Malaysia, the permissible range of total suspended solid is in the range of 25 to 50 mg/L, as been approved in National Water Quality Standards. On the other hand, the threshold level of NQWS for total suspended solid is approximately 150 mg/L, which is the suitable condition for the survival of aquatic life in fresh water ecosystems (Gasim, 2006). Total suspended solid has a positive relationship with turbidity and has a negative relationship with temperature, pH, clarity and biochemical oxygen demand. According to National Water Quality Standards, utmost totals

suspended solids level for Malaysian surface water is in between 25 to 50 mg/L while for sustaining aquatic life in an ecosystem is around 150 mg/L. Thus, containing a higher total suspended solids concentration was unpleasant and potentially harmful (Islam, 2012).

2.6.2 Turbidity

Turbidity showed an indication for the presence of suspended substance such as silt, clay, organic material which finely divided plankton, and other organic and inorganic materials as stated by Gyang and Ashano (2010).

All natural water will surely have some dissolved solids in it in consequence of weathering and dissolution of soil and rock. When an identified volume of water sample was filtered off, and the residue left was weighted, it is known as suspended solids. Some part of the suspended solids performed as conductors and contributed towards turbidity state. The quantity of species and organisms lessen when a stream received more suspended solid load, as they was backed off from the turbid water. Turbidity have positive correlation with total suspended solids, whereas negative link with pH and temperature (Islam, 2012).

The adequate limit of water for domestic purpose is in between 5 to 25 NTU, as been set by International standards. There was none threshold level of turbidity in the water that will support the marine life. Consequently, Malaysian Ministry of Health has fixed a threshold level for the minor turbidity of water at 1000.00 NTU (Gasim, 2006). Surface water such as mine lakes showed high levels of turbidity due to pumping of water for irrigation purposes as proven by Gyang and Ashano (2010).

2.6.3 Temperature

The ability to retain heat in the stagnant lake water was higher, where the temperature went beyond 31°C especially during the precipitation months. The rise in temperature leaded to decline in dissolved oxygen level because the metabolic rate of the organism in the lake is escalating (Islam, 2012).

Typically water organisms adapted to survive in a permitted temperature range because temperature changes have changed their living environment. Water bodies faced thermal pollution when water cooling takes place. This happened as a result of returning warmer water from cooling process into the water system or discharging heated effluents into water bodies. In the end, temperature rises have lethally affect the water creatures (Chiang, 2010).

2.7 CHEMICAL PARAMETERS

Chemical parameters refer to the characteristics of water that capable to solvent it. Some of the chemical parameters tested were pH, dissolved oxygen, electrical conductivity, total dissolved solids, chemical oxygen demand, biological oxygen demand and total hardness.

2.7.1 pH

pH point for acidity and alkalinity measurement of water. Chemical processes that occurred in a water system were greatly influenced by pH reading and this caused indirect pollution via conversion of harmful substances that already present in the water (Chiang, 2010).

Normally, the reading indicated slightly acidic pH values where the water was under Class III according to National Water Quality Standards. This was due to the reason that, this pH condition occurred when carbon dioxide turn into carbonic acid in the water. Basically, the pH threshold range in National Water Quality Standards for the Malaysian rivers was in between 5.00 to 9.00 (Gasim, 2006). In a natural lake ecosystem, the acidity level was from 4.5 to 6.5 and essentially, low pH founded in organic matter rich water that was finally undergo decomposition (Islam, 2012).

2.7.2 Dissolved Oxygen (DO)

In the main, dissolved oxygen referred to the quantity of oxygen enclosed in the water depending on the aspect such as temperature, pressure and salinity. The solubility

of oxygen increased due to certain condition where the temperature was low, decreasing salinity and increasing atmospheric pressure. It was one of the most significant parameters that manipulate the condition of aquatic ecosystems, mortality of fishes, odour and aesthetical feature of surface water. The surface area of water influenced the rate of air-water interface in transmitting the oxygen. Thus, stagnant water consisted of low oxygen concentration in contrast to flowing water, such as in a river, due to the reason that accessible surface for oxygen absorption increased with water movement (Chiang, 2010).

Dissolved oxygen referred to a vital constituent since every aquatic life required it for their survival and when its amount falls than the normal limit, these creatures tend to die (Chiang, 2010). According to Department of Environment (DOE), the dissolved oxygen for Malaysian main rivers falls in the range of 3.00 to 5.00 mg/L (Gasim, 2006). Declining water plant's photosynthesis rate, diminished oxygen solubility in water column, disturbance in oxygen transfer within an air-water interface and uplifting aerobic bacterial component's oxygen demands trimmed down the oxygen level of a system (Chiang, 2010).

2.7.3 Electrical Conductivity (EC)

Conductivity reading positively interconnected with total dissolved solid and sulphate content. Higher conductivity reading was gained due to activation of the iron mining activities (Islam, 2012).

Electrical conductivity related with amount of inorganic ions that contained in the water. The conductivity reading was increased with ions that present in the water such as chloride, sodium, calcium and magnesium. Conductivity referred to act as an indicator for water quality measurement. Rises in conductivity reading indicates the existence of dissolved ions in the vicinity. Due to weathering of rock and dissolution, all natural water has some dissolved solids in it. Few dissolved solids performed as conductor that allowed for conductance. Water with higher level of dissolved solids was potentially unhealthy and unpleasant. This kind of water have an adverse effect on human, crops and animals (Paul, 2011).

2.7.4 Total Dissolved Solid (TDS)

Fundamentally, the total dissolved solid for water samples that have been collected in different seasons varied from 22.67 to 112.67 mg/L , which was the permitted limit range of the World Health Organization (WHO). In addition, National Water Quality Standards stated that the water sample was in Class I when the total dissolved solid value was lesser than 500 mg/L (Gasim, 2006). The concentration of total dissolved solid of water sample near the mining area was higher. Total dissolved solid has a significant positive relationship with electrical conductivity values (Islam, 2012).

Total dissolved solids involved the measurement of total salt in the form of inorganic ions that was enclosed in the water. The release of wastewater containing high total dissolved solids intensity caused negative impact on marine life, provide unhealthy receiving water for consumption and household purposes, shrink crop yield for irrigation, besides worsen deterioration of water networks (Paul, 2011).

2.7.5 Chemical Oxygen Demand (COD)

The chemical oxygen demand value has a positive connection with temperature. This parameter has a threshold level of 50.00 mg/L for Malaysian surface water as being declared in National Water Quality Standards. Both biological oxygen demand and chemical oxygen demand value ascended with the raised in pollution load (Islam, 2012).

Chemical oxygen demand showed the quantity of oxygen needed to entirely oxidize the organic substances contain in waste water by converting them into carbon dioxide and water using a strong oxidant. In this test, potassium dichromate ($K_2Cr_2O_7$) was used since it has the superior oxidizing capability. The potassium chromate with the existence of sulphuric acid (H_2SO_4) oxidized the organic matter and the sum of oxygen used for the oxidizing process able to be determined (Paul, 2011).