# EVALUATING THE IMPACT OF LAND DEVELOPMENT ON WATER QUALITY OF THE LARGEST LAKES IN MALAYSIA

MAIZATUL AIDA BINTI MOHD REDZUAN

B. ENG(HONS.) CIVIL ENGINEERING

UNIVERSITI MALAYSIA PAHANG

**UNIVERSITI MALAYSIA PAHANG**

**DECLARATION OF THESIS AND COPYRIGHT**

| | |
|---|---|
| Author's Full Name | : MAIZATUL AIDA BINTI MOHD REDZUAN |
| Date of Birth | : 25 JANUARY 1994 |
| Title | : EVALUATING THE IMPACT OF LAND DEVELOPMENT ON WATER QUALITY OF THE LARGEST LAKES IN MALAYSIA |
| Academic Session | : 2017/2018 |

I declare that this thesis is classified as:

| | | |
|---|---|---|
| ☐ | CONFIDENTIAL | (Contains confidential information under the Official Secret Act 1997)* |
| ☐ | RESTRICTED | (Contains restricted information as specified by the organization where research was done)* |
| ☑ | OPEN ACCESS | I agree that my thesis to be published as online open access (Full Text) |

I acknowledge that Universiti Malaysia Pahang reserves the following rights:

1. The Thesis is the Property of Universiti Malaysia Pahang
2. The Library of Universiti Malaysia Pahang has the right to make copies of the thesis for the purpose of research only.
3. The Library has the right to make copies of the thesis for academic exchange.

Certified by:

| | |
|---|---|
| _______________________ | _______________________ |
| (Student's Signature) | (Supervisor's Signature) |
| _______________________ | _______________________ |
| 940125-03-5718 | DR. MIR SUJAUL ISLAM |
| Date: | Date: |

NOTE : * If the thesis is CONFIDENTIAL or RESTRICTED, please attach a thesis declaration letter.

Universiti Malaysia PAHANG
Engineering • Technology • Creativity

**SUPERVISOR'S DECLARATION**

I/We* hereby declare that I/We* have checked this thesis/project* and in my/our* opinion, this thesis/project* is adequate in terms of scope and quality for the award of the Bachelor Degree of Civil Engineering

_______________________________

(Supervisor's Signature)

Full Name : DR.MIR SUJAUL ISLAM

Position : Senior Lecturer

Date :

**STUDENT'S DECLARATION**

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

_______________________________

(Student's Signature)

Full Name : MAIZATUL AIDA BINTI MOHD REDZUAN

ID Number : AA14149

Date : 12 June 2018

# EVALUATING THE IMPACT OF LAND DEVELOPMENT ON WATER QUALITY OF THE LARGEST LAKES IN MALAYSIA

MAIZATUL AIDA BINTI MOHD REDZUAN

Thesis submitted in fulfillment of the requirements
for the award of the
Bachelor Degree in Civil Engineering

Faculty of Civil Engineering and Earth Resources

UNIVERSITI MALAYSIA PAHANG

JUNE 2018

## ACKNOWLEDGEMENTS

Alhamdulillah, all praise to Allah, the most merciful for the successful completion of this thesis entitled “EVALUATING THE IMPACT OF LAND DEVELOPMENT ON WATER QUALITY OF THE LARGEST LAKES IN MALAYSIA’. I am very grateful and sincerely would like to give my special thanks to my supervisor, Dr. Mir Sujaul Islam for giving infinite guidance, support, knowledge, motivation and cooperation in the completion of this thesis.

I am very thankful to both of my parents, Mohd Redzuan Bin Abdullah and also Ruslina Binti Razali for every supports in every aspects such as love, financial and emotion. Not forgetting my little sister, Maizatul Ainun for her companion in completing the study.

My friends, especially Nur Musfirah Binti Muhamad Din and Nor Suhada Binti Abdul Zaman. Thank you for all of your helps, guidance, cooperation, and knowledge sharing to help me finish my thesis. With the aids from all of them, I am able to finish this thesis.

Lastly, I would like to express my high gratitude to University Malaysia Pahang for giving me the opportunity to learn in the Faculty of Civil Engineering and Earth Resources. This is the best faculty in my heart.

# ABSTRAK

Kajian terhadap kesan - kesan dari aktiviti - aktiviti pembalakan dan juga pertanian ke atas kualiti air di Tasik Bera telah dijalankan pada bulan Februari dan April 2018. Sebanyak tiga stesen pengsampelan telah dipilih untuk kajian ini: kawasan pembalakan, kawasan pertanian dan jeti telah dipilih.Sebanyak tiga belas parameter kualiti air telah diambil kira dalam kajian ini semasa tempoh kajian. Parameter - parameter ini kemudiannya dianalisis dan diukur berdasarkan kaedah standard. Parameter kualiti air dikelaskan mengikut Indeks Kualiti Air Jabatan Alam Sekitar (DOE-WQI) dan Standard Kualiti Air Negara (NWQS) untuk Malaysia. Permintaan Oksigen Biokimia (BOD) tinggi di kawasan pembalakan (3.73) dan rendah di stesen jeti (2.7). Oksigen terlarut (DO) adalah tinggi di kawasan pertanian (5.54) dan rendah di kawasan pembalakan (4.11). Jumlah Pepejal Terampai (TSS) tinggi di kawasan pertanian (10.5) dan rendah di stesen jeti (6).Kualiti air Tasik Bera dikelaskan dalam kelas II berdasarkan Indeks Kualiti Air Jabatan Alam Sekitar (DOE- WQI). Oleh Itu, ia boleh digunakan bagi tujuan rekreasi. Akan tetapi, ia memerlukan rawatan konvensional untuk dijadikan sumber bekalan air. Aktiviti pertanian seperti ladang kelapa sawit di Felda Triang, serta aktiviti pembalakan di Pos Iskandar berhampiran tasik telah memberi kesan terhadap kualiti air di Tasik Bera. Jika keadaan ini berterusan, ia akan menyebabkan Tasik Bera menghadapi masalah alam sekitar dan seterusnya memberi kesan langsung terhadap hidupan di dalam Tasik Bera untuk jangka masa yang panjang.

# ABSTRACT

A study on the impact of logging and agricultural activity towards water quality in Bera Lake was carried out in February until May 2018. Three sampling stations were selected for this study: logging area, agricultural area, and jetty station. Thirteen water quality parameters were considered in this study during study periods. The parameters were then analyzed and measured based on standard method. The water quality parameter were classified according to Department of Environment Water Quality Index (DOE-WQI) and National Water Quality Standard (NWQS) for Malaysia. The Biochemical Oxygen Demand (BOD) was high at logging area (3.73) and low at jetty station (2.7). The dissolved oxygen (DO) was high at agricultural area (5.54) and low at logging area (4.11). The Total Suspended Solid (TSS) was high at agricutural area (10.5) and low at jetty station (6). The water quality of Bera Lake falls into class II according to DOE-WQI. Therefore, it is suitable for recreational uses but need conventional treatment for water supply. Agricultural activity, such as palm oil plantation at Felda Triang, and logging activities at Pos Iskandar near the lake did affected water quality in Bera Lake. If these situations continued, may have caused Bera Lake environmental degradation and may affect the aquatic life and hydrological characteristics of water system in long term deterioration.

# TABLE OF CONTENT

## LIST OF TABLES

## LIST OF FIGURES

# LIST OF ABBREVIATIONS

| | |
|---|---|
| AN | Ammoniacal Nitrogen |
| APHA | American Public Health Association |
| BOD | Biochemical Oxygen Demand |
| COD | Chemical Oxygen Demand |
| DO | Dissolved Oxygen |
| DOE | Department of Environment |
| EC | Electrical Conductivity |
| Mg/L | Milligram per litre |
| MPN | Most Probable Number |
| NTU | Nephelometric Turbidity Units |
| NWQS | National Water Quality Standard |
| $NH_3$-N | Ammoniacal Nitrogen |
| $NO_3^-$ | Nitrate |
| $PO_4^{3-}$ | Phosphate |
| TDS | Total Dissolved Solids |
| TSS | Total Suspended Solids |
| USEPA | Unites States Environmental Protection Agency |
| WQI | Water Quality Index |
| µs/cm | Microsiemens per centimetre |

# CHAPTER 1

# INTRODUCTION

## 1.1 Background of Study

The earth surface is covered by water is approximately 70%. The water on the water surface on the earth consists of ocean, lakes, river, and streams. There are a lot of lakes in Malaysia, Bera Lake is Malaysia's largest natural freshwater lake system located in southwest Pahang extending 30km long and 25km wide. It encompasses 61% of the total area (10,000 ha) represented by only 2 sites. Bera Lake was designated as Malaysia's first Ramsar site in recognition of its social, economic and ecological importance. Bera Lake is very important and it gives many benefits to the community around the area of this lake. Semelai branch of the Orang Asli are the example of the community around the lake and they normally inhibited the lakeshores. Its catchment has been occupied for over 600 years by the Semelai Orang Asli (aboriginal people), who traditionally practice shifting cultivation of hill rice combined with collection of forest and wetland products, although their livelihoods are changing (Crawford, 2016). Some benefits of this lake to them are the lake acts as a medium of transportation and also the source of the fish.

Basically, there are so many activities in the surrounding area of this lake that can contribute to the water pollution. Some of them are the agricultural activities, resort activities, and logging. These are the main activities that believed to act as the factors affecting the water quality in the Bera Lake. The once serene waters in Bera Lake are said to be less clear now, especially in areas located nearby to oil palm estates. The fertilizers and insecticides running off from nearby plantations believed to contribute to the pollution by disturbing natural ecology of the lake system. They are known to affect plant growth, ground cover and to have a negative impact on soil microflora (Sonia Pinho, 2012).

## 1.2 Problem Statement

The Orang Asli who lives in the bank of Bera Lake complained that the lake is more polluted day by day. These are to believe that the pollution comes from certain activities at the Bera Lake such as agricultural activities, logging activities and many other activities that can contribute to the pollution of water there. According to the previous research, the result of the research shows that water quality parameters in Lake Bera are influenced by seasonal change and sampling stations position (Miefthawati, 2014). In addition, Federal Land Development Activity (FELDA) also sponsored oil plantation at Felda Triang and Bera Selatan.

An upward increment in eutrophication amid and following area utilize changes. The outcomes additionally propose increasing acidic conditions in Lake Bera, prompting a decrease in replaceable cation substance (Ca, Mg, and K), and an incremental option of $SO_4$ (sulphate) and $NO_3$ (nitrate) particles. This circumstance will bring Lake Bera being to hazard, as represented by low dissolved oxygen substance, large amounts of nitrate, and a decrease in the fish population (Mohammadreza Gharibrezaa, 2013). Agricultural runoff consists of fertilizers, pesticides and domestic discards which will affect the quality of water and aquatic life (Hariprasad, 2013). Excessive of nitrogen and phosphorus in the lake will accelerate the eutrophication of the lake (Smol, 2008). The lake and forest environments were once full of swamps and largely occupied by lowlands forests but now greatly disturbed bt shifting cultivation activities, illegal logging and excessive exploitation by humans (Hairazi Rahim, 2013). Therefore, it is important that a study is conducted to assess the water quality in Bera Lake based on agricultural activity. This study will identify the impacts of agricultural activities and seasonal change to the water quality of Bera Lake.

## 1.3 Research Objectives

The objectives of this study are:

i. To determine the current water quality of the Bera Lake systems spatially.

ii. To compare the water characteristics based on National Water Quality Standard (NQWS) and Water Quality Index (WQI) Malaysia.

## 1.4 Scope of Study

The scope of study on this research is basically based on the environmental studies and to be specific, the study of water quality in Bera Lake from the impact of seasonal change and agricultural activities inside and near the area of the lake. This research will be conducted on February 2018 until early of May 2018. However, the time frame of the research fall on normally wet season in Malaysia. Therefore, the wet season were considered after rain occurs in Bera Lake. There are two type of test will be conducted which are in situ test and laboratory test. The parameters considered during in situ testing are temperature, pH, dissolved oxygen (DO), turbidity and electrical conductivity while parameter for laboratory test is mainly Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solids, Total Dissolved Solids, Phosphate, Ammoniacal Nitrogen and heavy metals for instance lead, zinc, copper and cadmium.

## 1.5 Significant of Study

This study of water quality can improve more understanding of the students on the water physically and chemically. The Bera Lake has many surrounding activities on going which can affect the water there. Logging and agricultural activities were studied to identify whether they can the water quality of Bera Lake. This research is conducted to know the condition of water quality, pH, temperature, scale of water pollution, nutrient present and heavy metals. The results produced through classification according WQI and NWQS are considered valuable. This will become more significant if the result of this study can be the reference for future research by local authorities in forming a strategic development and improvement of the water systems in Malaysia.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Introduction

The most important compound found on earth is water ($H_2O$) and it covers the surface of the earth for almost *75%* in overall (Smol, 2008). As we all know, the main of the water sources in the earth comes from rivers, lakes and also the ocean. If the rivers were to be compared with the lakes, the lakes have the additional components in having greater depth and area of the water. The water molecules are made of an oxygen atom which bounds two hydrogen atoms together. Actually, a body of water on earth did not only consist of water only but also other particles inside them as water holds the title "the universal solvent". This chapter of literature review is mostly on the lakes, the water pollution, the water quality parameters and also the water quality classification. In addition, few records of water quality by RAMSAR site, available in some cross sections along the Bera Lake have been reported but not published. Evaluation of water quality of Malaysian lakes has been the target of several research contribution. Previous studies mainly have applied the Interim National Water Quality Standard, Malaysia (INWQS) to qualify and classify water quality of lakes.

## 2.2 Bera Lake

In this world, the lakes can be classified into two types that are natural lakes and also man - made lakes. Lake Bera is the biggest natural lake in Peninsular Malaysia and was assigned as its first RAMSAR site in 1994 (Masrom, 2014). The lake has an catchment zone of 593.1 km2, albeit roughly 340 $km^2$ of the first tropical rain timberland cover has been changed over to oil palm and rubber plantation since 1972. Research was directed to decide the water quality in the ranges of created arrive and to connect verifiable varieties in supplement focuses and eutrophication at the lake with anthropogenic exercises. In freshwater lakes, the limiting nutrient is usually phosphorus. Fertilisers and human sewage are rich in both phosphorus and nitrogen, so pollution of freshwater by either of these causes eutrophication (Michael L. McKinney, 2013). In this manner, water tests in zones of various land use in the catchment range were gathered. The water samples of this study were taken from Bera Lake. It is the largest naturally occurring lake in Malaysia. Bera lake has 10 swamp area division that were recognized Kelantong swamp, Kemiyan swamp, Chenderong swamp, Tebok swamp, Kura swamp, Lengut swamp, Kura swamp, Kuwang swamp, Burong Bangkong swamp, Belino swamp and Dampar Lake. Another place taken note in this study is the area which is situated very near to the palm oil plantation. The lake is surrounded by natural environment that includes rivers, swamp, lowland and hill forest as well as the indigenous people of Semelai community for eco-tourism purposes.

## 2.3 Water Pollution

The verb "pollute" is defined as "to make foul" in the Webster dictionary. The human activities have now impacted almost all water bodies on the planet to some extent. Some of the impacts can be minor and barely noticeable but others have degraded lakes and rivers to enormous stage. Normally, the pollution impacted the water physically, chemically and also biologically (Smol, 2008). The pollutants that causes pollution on-the water can he categorized into "point source" and also "non – point source".

Water contamination is the defilement of water bodies (e.g. lakes, streams, seas, aquifers and groundwater). This type of natural corruption happens when toxins are specifically or by implication released into water bodies without satisfactory treatment to evacuate unsafe mixes. Water contamination influences the whole biosphere – plants and living beings living in these waterways. In all cases the impact is harming to singular species and populace, as well as to the characteristic organic groups.

### 2.3.1 Point Sources Pollution

Point sources pollution comes from the pollutant that can be easily measured and discharged directly to water body at a specific place only such as the pollutants that comes from discharge pipes of a certain factory. The various nutrients of the sewage from urbanization and rural building development that was discharged into a certain body of water is the common cause of the death of aquatic ecosystem (Sulekh Chandra, 2012).

### 2.3.2 Non - Point Sources Pollution

Non - point Sources pollution or its other name "diffuse source pollution" normally comes from the pollutants that have no specific point of entry to the water. For example, during the rain, the soils erosion and debris from the human activities around the lake will enter to the water during surface runoff which will cause siltation process to occur in the lake.

### 2.3.3 Agricultural Runoff

The non - point sources pollution known as agricultural run-off are pollutants which are transported through soil by rainwater and snow during wet season. It normally consists of nitrogen and phosphorus. The nutrients mn-off specifically phosphorus will lead to eutrophication and will change the taste and the odour of the water. Besides that, the pesticides can also leads to the contamination of the lake. It will cause ecological system dysfunctional by inhibiting the growth and reproduction of the top predators. Turbidity and sedimentation are caused by tillage. These sediments contain phosphorus and pesticides absorbed to the sediment particles. Fertilizers activities will cause contamination of water by pathogens, metals, phosphorus and nitrogen which will lead to eutrophication (Nitasha Khatri, 2014).

### 2.3.4 Logging Activities

Forest is a complex living system that has a limitation on utilization of what the forest can sustain. Forest ecosystem can adapt and is able to recover to naturally occurring phenomenon such as windstorms, fires and landslips but if there is a change in intensity, frequency or extend of the disturbance to which the ecosystem is adapted, the recovery is far more difficult (Lamb, 2011). Logging activities can accelerate erosion primarily through felling, yarding, skidding, building and using road and landings, and burning.

## 2.4 Physical Water Quality Parameters

The characteristics of water that responds to the sense of touch, taste, smell and sight can be defined as physical parameter. The physical water quality parameters that are taken into consideration in this study are temperature, turbidity and also total suspended solid.

### 2.4.1 Temperature

Temperature is measureable. Normally, it is measure in the unit Kelvin, degree celcius and also degree farenheit. Temperature has the effect on the most chemical reactions which occur in our surrounding nature. The temperature measured in Bera Lake did not show big difference in two different seasons and it was considered in its normal range of its climate (Gharibreza, 2014).

### 2.4.2 Turbidity

In definition, turbidity is a measure of the transparency of-water-due to the presence of suspended material, dissolved solid and colloidal material in the water. Because of these materials, the water with high turbidity did not transmit light as well as clear water. The water with high turbidity normally looks cloudier compared with the water of low turbidity (Ahmad, 2009). Turbidity is measured in the unit of NTU which stands for Nephelometric Turbidity Unit.

### 2.4.3 Total Suspended Solids

Total suspended solid is a measure of the suspended particles which exist in the water such as sand, clay, and also organic material that moves along with the water flow. Too high of suspended solid in the water can affect the aquatic life such as fish (Branigan, 2013). For example, the fish vision and respiratory organ; gills can be affected by the suspended solid in the water. The total suspended solid in the water are normally measured in terms of the concentration that is milligrams per litre, mg/L .

Solids refer to matter suspended or dissolved in water or wastewater. Solids may affect water or effluent quality adversely in a number of ways. Waters with high dissolved solids generally are of inferior palatability and may induce an unfavourable physiological reaction in the transient consumer. Highly mineralized waters also are unsuitable for many industrial applications. Waters high in suspended solids may be aesthetically unsatisfactory for such purposes as bathing.

### 2.4.4 Total Dissolved Solids

Total Dissolved Solid (TDS) is an estimation of inorganic salts, natural issue and other disintegrated materials in water. Estimations of TDS do not differentiate among particles. The measure of TDS in a water test is measured by separating the sample through a 2.0 μm pore estimate channel, vanishing the remaining filtrate and after that drying what is left to a consistent weight at 180ºC. The fixation and piece of TDS in natural waters is controlled by the geography of the waste, barometrical precipitation and the water balance (vanishing precipitation). The mean salinity of the world's waterways is around 120 mg L¯1 and the real anion found in normal waters is bicarbonate. The second familiar natural anion is sulfate, with a mean convergence of 20 mg L¯1. The most regularly happening cation in fresh water is calcium, the following most regularly happening cations are sodium and silica, each with a average concentration of 9 mg L¯1. Water with total dissloved solids concentration more prominent than 1000 mg L¯1 is thought to be "brackish". Changes in TDS focuses in regular waters frequently result from mechanical gushing, changes to the water adjust (by constraining inflow, by expanded water utilize or expanded precipitation), or by salt-water interruption. It is prescribed that distinctive breaking points for singular particles, as opposed to TDS, be utilized for salmonid species. TDS concentrations can be harmful can be harmful because the density of the water determines the flow of water into and out of an organism’s cells (Arvind Kumar, 2008).

## 2.5 Chemical Water Quality Parameters

The chemical water quality parameter can be relate to the chemical compounds or combinations of them at which can be considered harmful to living organism if in abundant. Electrical conductivity, pH, COD, BOD, DO, Ammoniacal Nitrogen, and Phosphate are the chemical parameters that were taken into consideration during the study.

### 2.5.1 pH

A pH reading shows the measurements of the water state in terms of acidity,neutrality, and alkalinity7 is the reading that can show the water was in neutral state. A reading below 7 can be considered in acidic state and the reading higher than 7 can be considered in alkaline state. The pH readings can be affected by the agricultural runoff and also the overflows of sewerage. The survival of aquatic life depends on the ability to resist changes in water pH.

### 2.5.2 Electrical Conductivity

Electrical conductivity is a parameter that shows the ability of a solution to conduct the electrical current. The ions exist in water transport electrical current and the increase concentration of ions results in the increase in the conductivity (Bruckner, 2018). The unit of electrical conductivity that is normally used is µS/cm.

### 2.5.3 Chemical Oxygen Demand (COD)

Chemical Oxygen demand is a measure of the total quantity of oxygen required to oxidize the organic material by a strong chemical oxidant to carbon dioxide and water. The COD will increase as the concentration of organic matter in water increase (Sulekh Chandra, 2012).

### 2.5.4 Biochemical Oxygen Demand (BOD)

Biochemical Oxygen demand can be related to the total quantity of oxygen required to biochemically oxidize by the organic matter exists in the water. The rate of oxygen consumption in the water is affected by many variables such as temperature, pH, microorganisms, organic and inorganic substances found in the water.

### 2.5.5 Dissolved Oxygen

The amount of molecular oxygen dissolved in the water is the right definition of dissolved oxygen (DO) and it is the most affecting parameter, in water studies. The DO values actually low during rainy season which is from September to December and the factors contributing to this phenomenon are the rate of photosynthesis, seasonal variables and the organic matter decomposition. DO decreases as atmospheric temperature increses and pressure decreases (less DO at higher altitudes). DO is used up by aerobic bacteria using decomposition of organic matter (Bhattacharyya, 2015).

### 2.5.6 Ammoniacal Nitrogen

Ammoniacal nitrogen is a dissolved inorganic form of nitrogen found in the water. The sources of ammonia in a lake normally come from fertilizers, human and animal wastes and products from industrial activities. The presence of this compound in the water can be considered harmful to human because of its toxic nature.

### 2.5.8 Phosphate

Phosphorus is also a nutrient exist in water just like nitrogen. Phosphate and organophosphate are the types of compound that phosphorus normally exists in nature. Fertilizers, untreated sewage, domestic waste and also animal waste are some of the common sources of nutrients in the water (Nitasha Khatri, 2014).

### 2.5.9 Nitrate

Nitrate is common inorganic pollutants of water. Nitrate in surface and groundwater come primarily from animal waste and artificial fertilisers. Besides stimulating algal and plant growth, nitrates are also converted to toxic nitrates in the intestines of humans (Chiras, 2013). Nitrate are essential plant nutrients, but excess amounts can cause significant water quality problems. Together with phosphorus, nitrates in excess amounts can accelerate eutrophication, causing dramatic increases in aquatic plant growth and changes in the types of plants and animals that live in the lake. This, in turn, affects dissolved oxygen, temperature, and other indicators. Excess nitrates can cause hypoxia (low levels of dissolved oxygen) (Spellman, 2015).

## 2.7 Heavy Metals

Many metals, such as mercury, lead, cadmium, tin and nickel are highly toxic in minute concentrations. Because metals are highly persistent, they can accumulate in food webs and have a cumulative effect in top predators – including humans (William, 2010). Substantial metals are singular metals and metal compund that can affect human wellbeing. Four familiar substantial metals are talked about in this concise are lead, zinc, copper and cadmium. These are generally normally happening substances which are frequently present in the earth at low levels. In bigger sums, they can be perilous. For the most part, people are presented to these metals by ingestion (drinking or eating) or inward breath (relaxing). Working in or living close to a modern site which uses these metals and their compounds increases ones risk of exposure, as does living almost a site where these metals have been improperly disposed (Sabine Martin, 2009).

### 2.7.1 Lead (Pb)

Lead (Pb) is a glossy white significantly adaptable metal. Among his physical properties, at run of the mill regular conditions this metal is presented in the solid state; it is thick, ductiles, and sensitive with poor electrical conductivity when stood out from most extraordinary metals. The blend picture for lead, Pb, is a consolidating of the Latin word plumbum, which means fragile metal. Pb is from time to time found fit as a fiddle in nature anyway it unites with various parts to outline an arrangement of entrancing what's increasingly, magnificent minerals. Galena, which is the prevalent Pb metal mineral, is blue-white in shading when at first uncovered however stains to dull diminish when exhibited to air.

Lead moves into and all through biological systems. Environmental lead is kept in vegetation, ground and water surfaces. The compound and physical properties of lead and the biogeochemical forms inside biological systems will impact the movement of lead through ecosystems. The metal can influence all parts of the earth and can move through the ecosystems until the point when it achieves an equilibrium. Lead collects in nature, yet in certain substance environ-ments it will be changed so as to increase its solubility (e.g., the arrangements of lead sulfate in soils), its bioavailability or its harmfulness. The impacts of lead at the biological system level are typically observed as a type of stress.

### 2.7.2 Zinc

Zinc is a standout amongst the most regularly occuring substantial metals in common waters, and is a basic component for most plants and creatures. Zinc is utilized pricipally for alloys and galvanizing. In spite of the fact that outcomes of zinc lack have been perceived for a long time, it is just as of late that consideration has been coordinated to the potential results of extreme zinc consumption. This is an audit of the writing on indications of danger at a few levels of zinc consumption. Zinc is thought to be moderately nontoxic, especially if taken orally.

### 2.7.3 Copper

In its basic frame, copper is soft, shiny and very pliable. Because of its delicate nature, it is frequently utilized as a composite. An alloy is a material involved a metal and a non-metal or two metals. Combinations are commonly more grounded than single metal materials. Two regular copper alloys are bronze and metal.

It was reasoned that neither the total concentration of copper nor that of "soluble" copper in a water could be utilized to decide the poisonous quality to aquatic life which was inferable from copper. It was likewise presumed that information from toxicity tests with copper in which characteristic surface waters are utilized for weakening purposes can't characterize the genuine danger of copper or have application to other common waters aside from when the concentration of the toxic chemical species are known.

### 2.7.4 Cadmium

Cadmium is an extremely poisonous metal. All dirts and rocks, counting coal and mineral composts, contain a few cadmium. Cadmium has many utilizations, including batteries, shades, metal coatings, and plastics. It is utilized widely in electroplating. Wellbeing impacts Cadmium and cadmium mixes are known human cancer-causing agents. Extreme harm to the lungs may happen through breathing elevated amounts of cadmium (Sabine Martin, 2009).

As follow component is conceivably at some bioavailability (Samuel N. Luoma, 2008), their quality in amphibian conditions can bring about injurious consequences for sea-going life form. Thus, Cd can exist in both abiotic (water and silt) and biotic (creatures) parts of sea-going situations at various focuses. In any case, danger happens in oceanic creatures when the rate of take-up of a follow component surpasses the consolidated rates of efflux and detoxification of metal into metabolically idle structures.

## 2.8 Water Quality Index (WQI)

One of the techniques to evaluate the health of any river is to monitor the Water Quality Index (WQI). Information on water quality are utilized to decide the status by looking at to see whether it is clean, slightly polluted or contaminated. Water quality record considers have been led by a few specialists for different water systems like streams,rivers, tidal ponds, lakes and coastal system. As revealed by DOE (2006) the six chemical,biological and physical parameters used to compute the Water Quality Index are dissolved oxygen (DO) as percentage saturation, biological oxygen demand (BOD) in mg/L, chemical oxygen demand (COD) in mg/L, ammonical nitrogen ($NH_3$-N) in mg/L, total suspended solids (SS) in mg/L and pH. The result of WQI can be obtained by a series of process. The process starts from the data tabulation in Microsoft Excel 2007 to calculation of the sub-indices until the classification.

# CHAPTER 3

# METHODOLOGY

## 3.1 Introduction

In the methodology chapter, the whole process in having the result data and also how the research was conducted will be explained for the reader’s deep understanding. This chapter did not only cover the summaries of the process, but also the details of the research. From methodology flowchart to the procedures done will be explained in this chapter. Besides that, this chapter also includes the explanations on how the sample is taken, preserved, tested and analyzed. In addition to that, the equipments used in this study will be also explained in this chapter. In general, all important parts in doing this study will be explained in this chapter from beginning to finish. This chapter is very crucial so that future researchers did not wrongly refer and also reader will understand how the study is conducted properly. This can help in reducing errors in study that will be taken place in near future. Besides that, this chapter will also tell the sample preservation taken into consideration during this study. The research flowchart is given in the Figure 3.1.

### 3.2 Research Methodology Flowchart

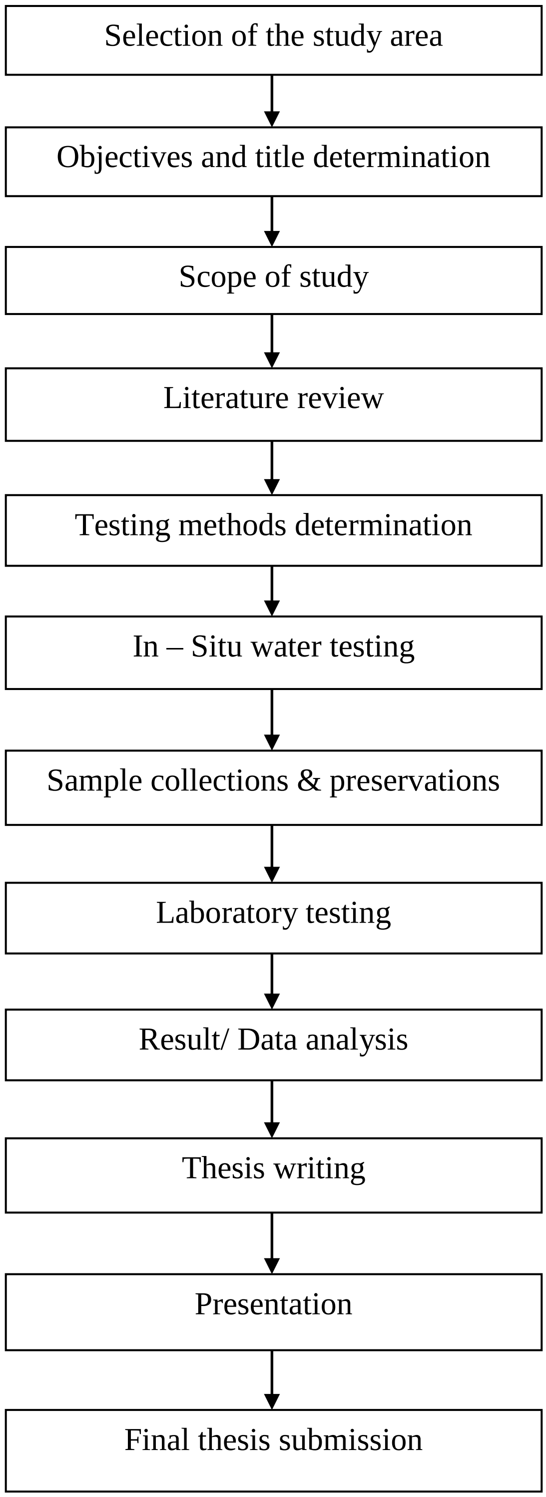


**Figure 3.1**: Research Methodology Flowchart

## 3.3 Methodology Descriptions

Bera lake in Pahang Darul Makmur, Malaysia was the study area in this research. There are 3 places inside Bera Lake that was considered as sampling stations in doing this research. The water samples were collected in both during dry and rainy season. Each season, there was 1 time of water collection to be tested. Each time, there were 3 samples collected in each sampling stations. The samples were considered as the surface water samples. This means that, the water samples were taken approximately 10 cm below the actual water surface in Bera Lake. There were 2 types of test that were conducted during this study was done which were In – Situ testing and also Laboratory testing. The readings of the parameter taken immediately during In – Situ testing were temperature, pH, electrical conductivity (EC), dissolved oxygen (DO), and also turbidity. Meanwhile, the readings of the parameter such as total suspended solids (TSS), total dissolved solids (TDS), biochemical oxygen demand ($BOD_5$), chemical oxygen demand (COD), Ammoniacal nitrogen ($NH_3$-N), phosphate and nitrate were tested in the UMP Environmental laboratory.

## 3.4 Sampling Station

In this study, there were 3 stations that were chosen as sampling stations. The stations were chosen as this place nearby to roadside so that it was easy to take the water sample. This place also very near to the palm oil plantation and near with the resort and village which many human activities happened. Place nearby the RAMSAR site was chosen as there was a forest and maybe the water is not polluted as other places. Felda Triang was chosen as this place is very near to the palm oil plantation while Pos Iskandar was chosen as these place was assumed to be affected by logging activities where at this village inhabited by Semelai people or Orang Asli. They make agricultural as their main income there which makes it a very good place as a sampling station in this study. The next station was Sudin Jetty where the place being as the point for tourist to ride motorboat. This is because the determination of water quality in the lake need to be whole. This study cannot be considered right if only the affected points were taken into the consideration. The sampling station(s) are shown in Figure 3.2.


**Figure 3.2:** Map of Bera Lake showing the sampling stations

**Table 3.1:** sampling stations and their coordinate

| Station No. | Location of the Sampling Stations |
|---|---|
| 1 | Pos Iskandar |
| 2 | Felda Triang |
| 3 | Sudin Jetty |

## 3.5 In – Situ Testing

The water quality parameters involved in this testing were pH, temperatures, dissolved oxygen, electrical conductivity and also turbidity.

**Table 3.2**: In – situ equipments and the considered parameters

| Parameter | Equipments |
|---|---|
| pH | YSI 6600 V2-4 Multi-parameter Water Quality Sonde & YSI 650 MDS Display |
| Temperatures | |
| Electrical Conductivity | |
| Dissolved Oxygen | |
| Turbidity | Turbidity meter |

The calibrated YSI 6600 sensors were first cleaned with the distilled water in the laboratory before going to Bera Lake. During the testing was conducted, half of the YSI 6600 body was placed in the water. This is required so that the readings were taken approximately 10 cm from water surface.

## 3.6 Laboratory Testing

There are certain parameters that cannot be obtain just only doing the in- situ testing. The parameters mentioned were total suspended solids (TSS), total dissolved solids (TDS), biochemical oxygen demand (BOD), chemical oxygen demand (COD), ammoniacal nitrogen, phosphate, nitrate heavy metals such as lead, zinc, copper and cadmium. These parameters need to be determined using methods of laboratory testing. Therefore, the water samples were taken to the UMP Environmental laboratory for further testing.

### 3.6.1 Laboratory Testing Equipment

**Table 3.3:** List of laboratory test and the main equipment

| Test | Main Equipment |
|---|---|
| $BOD_5$ | Dissolved oxygen |
| COD | COD Reactor<br>DR2500 / DR5000 Spectrophometer |
| Total Suspended Solids | Non-vacuum dessicators<br>Glass fiber (47mm) & filter disc<br>Drying oven, pump |
| Total Dissolved Solids | Filter paper, scale |
| Ammoniacal Nitrogen & Phosphate | DR2500 / DR5000 Spectrophometer |

### 3.6.2 Sampling Preservation

The water samples were taken approximately 10cm below the water surface. The one liter HDPE bottles were used to take the water samples at each station. Before, in the laboratory, the bottles were cleaned using distilled water and each of them were labeled. After the process of water collection, the bottles filled with the water samples were put into an ice box to be transported to the laboratory for laboratory testing. Each type of experiments that have been done in the laboratory has their own specific preservation. The table below shows their preservations.

**Table 3.4**: Water samples preservation technique

| Parameter | Container | Preservation | Maximum Preservetime |
|---|---|---|---|
| Ammoniacal Nitrogen | Plastic / Glass | Cool (4ºC) $H_2SO_4$ (pH < 2) | 7 days |
| Orthophosphate | Plastic / Glass | Filter Immediately Cool (4ºC) | 48 hours |
| $BOD_5$ | BOD bottle | Cool (4ºC) | 48 hours |
| COD | Plastic / Glass | Cool (4ºC) $H_2SO_4$ (pH < 2) | 48 hours |
| TSS | Plastic / Glass | Cool (4ºC) | 7 days |
| TDS | Plastic / Glass | Cool (4ºC) | 7 days |
| Heavy metals | Plastic / Glass | Cool (4ºC) $H_2SO_4$ (pH < 2) | 7 days |

**Source**: Environment Protection Agency guidelines for handling and preserving

### 3.6.3 The Method Used In Laboratory Testing

**Table 3.5**: Type of test done in the laboratory and their method

| Test | Method |
|---|---|
| COD | APHA 5220B: Vial method |
| $BOD_5$ | APHA 5210B |
| Ammoniacal Nitrogen ($NH_3$-N) | Salicylate Method |
| Phosphate | Ascorbic acid method |
| Total Suspended Solids (TSS) | USEPA Gravimetric Method 8158 |
| Total Dissolved Solids (TDS) | Using filter paper & scale |

## 3.7 Laboratory Testing Procedures

In this subchapter, all the procedures done in the laboratory testing will be listed from the beginning until the end of a specific testing.

### 3.7.1 Chemical Oxygen Demand (COD)

Chemical Oxygen Demand is calculated using formula:

$$COD = \frac{8000\ (b - s)\ n}{\text{Sample volume}}$$

Where :

b = the titrant used for sample expressed in mL

s = the titrant used for your blank sample in mL

n = the normality of the ferrous ammonium sulfate

### 3.7.2 Biochemical Oxygen Demand ($BOD_5$)

The BOD can be calculated using equation:

$$BOD_5 = \frac{DO_i - DO_5}{P}$$

Where ;

$BOD_5$ = Biochemical Oxygen demand for 5 days

$DO_i$ = Initial reading of dissolved oxygen in mg/L

$DO_5$ = Final reading of dissolved oxygen in mg/L

P = Dilution factor

### 3.7.3 Ammoniacal Nitrogen Test Procedures

Ammoniacal Nitrogen is conduct using salicylate method.

### 3.7.4 Phosphate Test Procedures

Phosphate is conduct using ascorbic acid method.

### 3.7.5 Total Suspended Solids Test (TSS) Procedures

The total suspended solid can be determine using:

$$TSS = \frac{(A-B)\times 100}{C}$$

Where;

A = weight of filter + glass + residue (in mg)

B = weight of filter + glass (in mg)

C = volume of sample filtered (in mL)

### 3.7.6 Total Dissolved Solids Test (TDS)

$$TDS = \frac{[(A\text{-}B) \times 1000]}{\text{mL sample}}$$

where:

A = weight of evaporating dish + filtrate

B = weight of evaporating dish

## 3.8 Water Quality Index (WQI)

The result of WQI can be obtained by a series of process. The process starts from the data tabulation in Microsoft Excel 2007 to calculation of the sub-indices until the classification. The WQI can be calculated using formulae shown below:

**WQI** = $\mathbf{0.22\ SI_{DO} + 0.19SI_{BOD} + 0.16SI_{COD} + 0.16SI_{TSS} + 0.15SI_{AN} + 0.12SI_{pH}}$

**Sub- index for DO (in % saturation):**

| | |
|---|---|
| $SI_{DO} = 0$ | for DO<8 |
| $= 100$ | for DO>92 |
| $= -0.\ 395+O.030DO^2 - O.00020DO^3$ | for 8<DO<92 |

**Sub —index for BOD:**

| | |
|---|---|
| $SI_{BOD}$ =100.4-4.23B0D | for BOD<5 |
| = 108e-0.055B0D -0.1BOD | for BOD>5 |

**Sub-index for COD:**

| | |
|---|---|
| $SI_{COD}$ = -1.33C0D+99.1 | for COD<20 |
| $= 103e^{-0\text{-}01\ 57COD}$ - 0.04COD | for COD>20 |

**Sub-index for AN:**

$SI_{AN}$ = 100.5-I05AN for AN<0.3

= $94e^{-0.573AN}$ -5 |AN - 2| for 0.3<AN<4

= 0 for >4

**Sub-index for TSS:**

$SI_{TSS}$ = $97.5e^{-0.00676TSS}$ + 0.05TSS for TSS<100

= $71e^{-0.0016TSS}$ – 0.015TSS for 100<TSS<1000

= 0 for TSS>1000

**Sub-index for pH:**

$SI_{pH}$ = 17.2- 17.2pH+5.02$pH^2$ for pH<5.5

= -242+95 .5pH-6.67$pH^2$ for *5* .5<pH<7

= -181+82.4pH-6.05 $pH^2$ for 7<pH<8.75

= 536-77.0pH+2.76 $pH^2$ for pH>8.75

**Where,**

WQI = Water Quality Index

$SI_{DO}$ = Sub-index of DO

$SI_{BOD}$ = Sub-index of BOD

$SI_{COD}$ = Sub-index of COD

$SI_{AN}$ = Sub-index of AN

$SI_{TSS}$ = Sub-index of TSS

$SI_{pH}$ = Sub-index of pH

The tables below show the classification of water using DOE Water Quality Index.

**Table 3.6**: DOE Water Quality Index Classification

| Parameter | Unit | Class | | | | |
|---|---|---|---|---|---|---|
| | | I | II | III | IV | V |
| Ammoniacal Nitrogen | mg/l | < 0.1 | 0.1 - 0.3 | 0.3 - 0.9 | 0.9 - 2.7 | > 2.7 |
| Biological Oxygen Demand | mg/l | < 1 | 1 - 3 | 3 - 6 | 6 - 12 | > 12 |
| Chemical Oxygen Demand | mg/l | < 10 | 10 - 25 | 25 - 50 | 50 - 100 | > 100 |
| Dissolved Oxygen | mg/l | > 7 | 5 - 7 | 3 - 5 | 1 - 3 | < 1 |
| pH | - | > 7 | 6 - 7 | 5 - 6 | < 5 | > 5 |
| Total Suspended Solid | mg/l | < 25 | 25 – 50 | 50 - 150 | 150 - 300 | > 300 |
| Water Quality Index (WQI) | - | < 92.7 | 76.5–92.7 | 51.9–76.5 | 31.0–51.9 | > 31.0 |

**Source**: Malaysia Environmental Quality Report 2010

**Table 3.7**: DOE Water Quality Index Classification Based on Water Quality Index

| SUB INDEX | INDEX RANGE | | |
|---|---|---|---|
| WATER QUALITY INDEX | CLEAN | SLIGHTLY POLLUTED | POLLUTED |
| Biochemical Oxygen Demand (BOD) | 91 – 100 | 80 – 90 | 0 – 79 |
| Ammoniacal Nitrogen ($NH_3$ –N) | 92 – 100 | 71 – 91 | 0 – 70 |
| Suspended Solid (SS) | 76 – 100 | 70 – 75 | 0 – 69 |
| Water Quality Index (WQI) | 81 – 100 | 60 – 80 | 0 – 59 |

**Source** : Malaysia Environmental Quality Report 2010

## 3.9 Expected Outcome

(i) This data will be helpful for policy maker and planner.

(ii) The research data / result will provide the scenario of the water quality of the Bera Lake.

(iii) The data and result will be useful for future water quality project as it baseline information.

## 3.10 Gantt Chart

| No. | Activity | Sept 2017 | October | November | December | January 2018 | February | March | April | May | Jun |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Final Year Project 1 | | | | Final Year Project 2 | | | | | |
| 1 | Title/ topic and objective selection | | | | | | | | | | |
| 2 | Discussion of problem statement, significant of study | | | | | | | | | | |
| 3 | Introduction writing | | | | | | | | | | |
| 4 | Literature Review writing | | | | | | | | | | |
| 5 | Methodology writing | | | | | | | | | | |
| 6 | Proposal define | | | | | | | | | | |
| 7 | Proposal submission | | | | | | | | | | |
| 8 | 1st sample collection and analysis | | | | | | | | | | |
| 9 | 2nd sample collection and analysis | | | | | | | | | | |
| 10 | Data presentation in front the panel | | | | | | | | | | |
| 11 | Draft thesis submission | | | | | | | | | | |
| 12 | Final Thesis submission | | | | | | | | | | |

# CHAPTER 4

# RESULTS AND DISCUSSION

## 4.1 Introduction

Basically, in this chapter, all the results from the experiments done will be analyzed and discussed. The Bera Lake water quality will be determined using both DOE Water Quality Index (WQI) and also National Water Quality Standard (NWQS). These were done by conducting the experiments on physical, chemical parameter and heavy metal test. Temperature, turbidity and total suspended solid (TSS) are the physical parameter considered. For chemical parameters, pH, dissolved oxygen demand (DO), electrical conductivity, Ammoniacal Nitrogen ($NH_3$-N), nitrates and phosphate test were conducted. The heavy metals that involved were lead, zinc, copper and cadmium.

All data during this study were conducted using both in situ reading and also laboratory testing result. These results are from both dry season and rainy season reading from the samples. The data collected were analyzed, and they were plotted into line graph using Microsoft Excel 2007 software. These line graph show the comparisons of data between the sampling stations during first and second sample. Also from the data collected, the WQI score and the NWQS classification will be determined.

## 4.2 Physical Parameter Result

### 4.2.1 Temperature

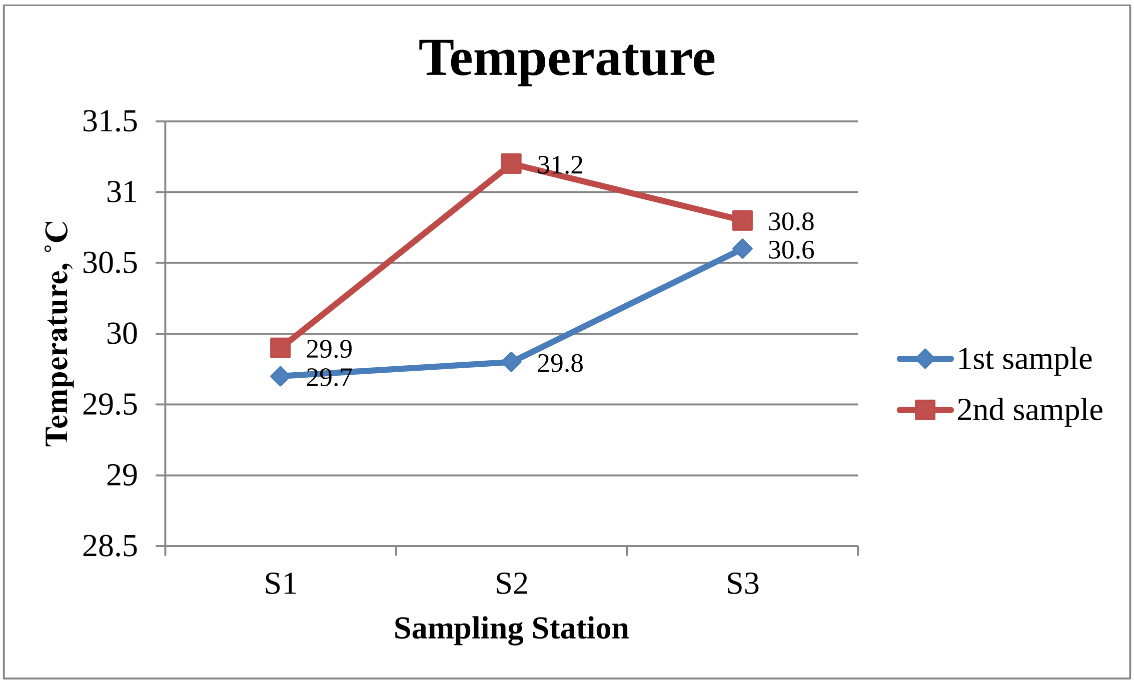


**Figure 4.1**: Graph on all the temperatures (˚C) of all sampling stations during first and second sample.

The figure above shows a line graph of the temperatures at all sampling stations where the data was collected. The temperatures range from 29.7 ˚C to 31.2 ˚C. The highest value recorded is at the station 2 which was 31.2˚C during second sampling. Although the temperature was affected by the rainfall and the time data collected, it did not leave great effect on the temperature of the stations in Bera Lake. These temperatures can be considered normal for the climate of Bera Lake.

#### 4.2.2 Turbidity

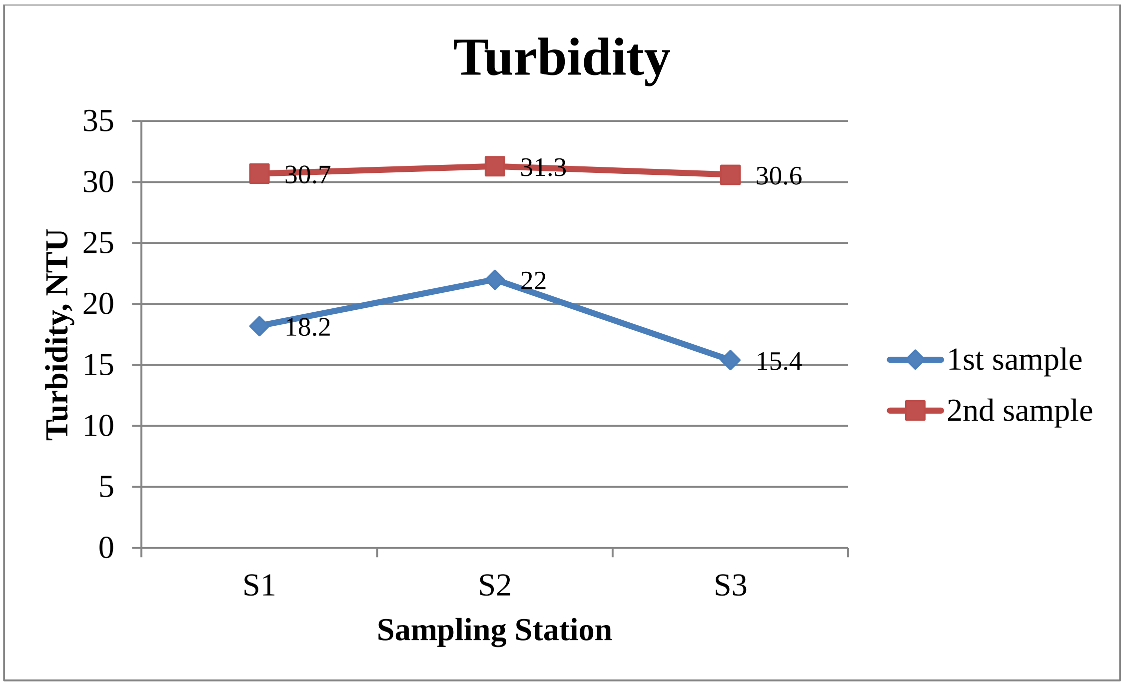


**Figure 4.2**: Graph on turbidity of all sampling stations during first and second sample.

The figure 4.2 above shows the graph of line graph on the comparison of turbidity at the sampling stations in Bera Lake. According to the figure, the range of turbidity of the Bera Lake was 15.4 NTU to 31.3 NTU. The highest reading (31.3 NTU) were recorded during second sample at station 2 while the lowest value recorded (15.4 NTU) was at jetty area in first sample. During the first sample, station 2 area state the highest value which is 22.0 NTU compared to the other stations. Generally, the turbidity in second sample state the higher reading compared to the first sample at all sampling stations.

### 4.2.3 Total Dissolved Solids

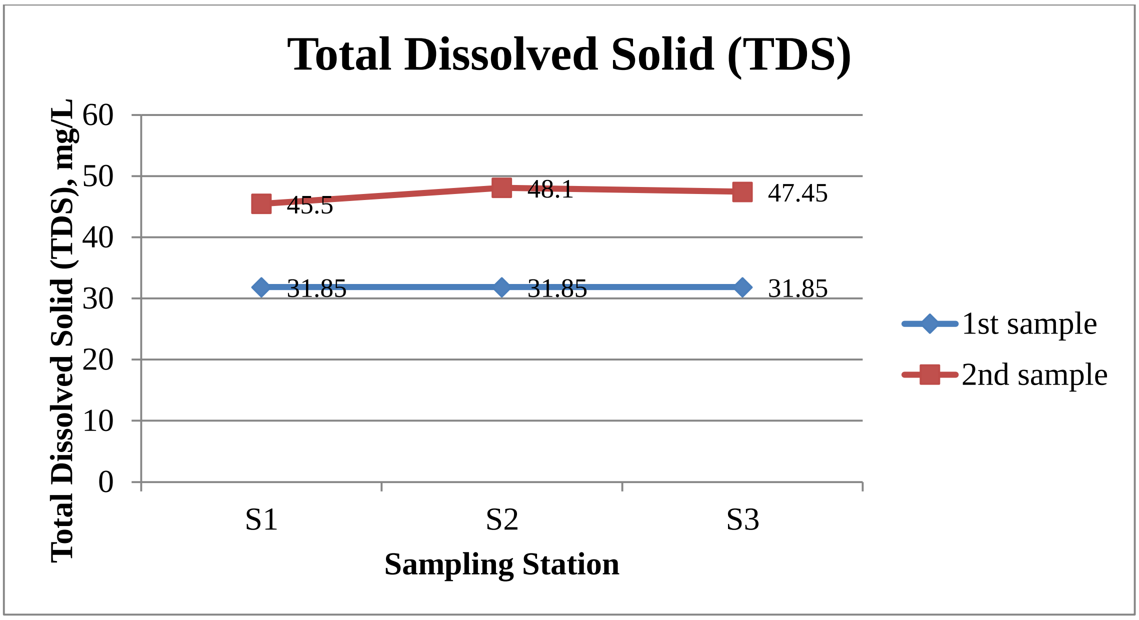


**Figure 4.3**: Graph on total dissolved solid of all sampling stations first and second sample.

The figure 4.3 shows the data of total dissolved solids recorded at all sampling stations in this study. The total dissolved solids recorded ranges from 31.85 mg/L to 48.1 mg/L. The first sampling stated same reading at all stations which were 31.85 mg/L. The highest value recorded was at station 2 during second sample taken which was 48.1 mg/L. In overall, all the total dissolved solids during second sample were higher than first sample. When dissolved oxygen becomes too low, fish and other aquatic organisms cannot survive. Oxygen levels may be reduced because the water becomes too warm or because there are too many bacteria or algae in the water.

### 4.2.4 Total Suspended Solid

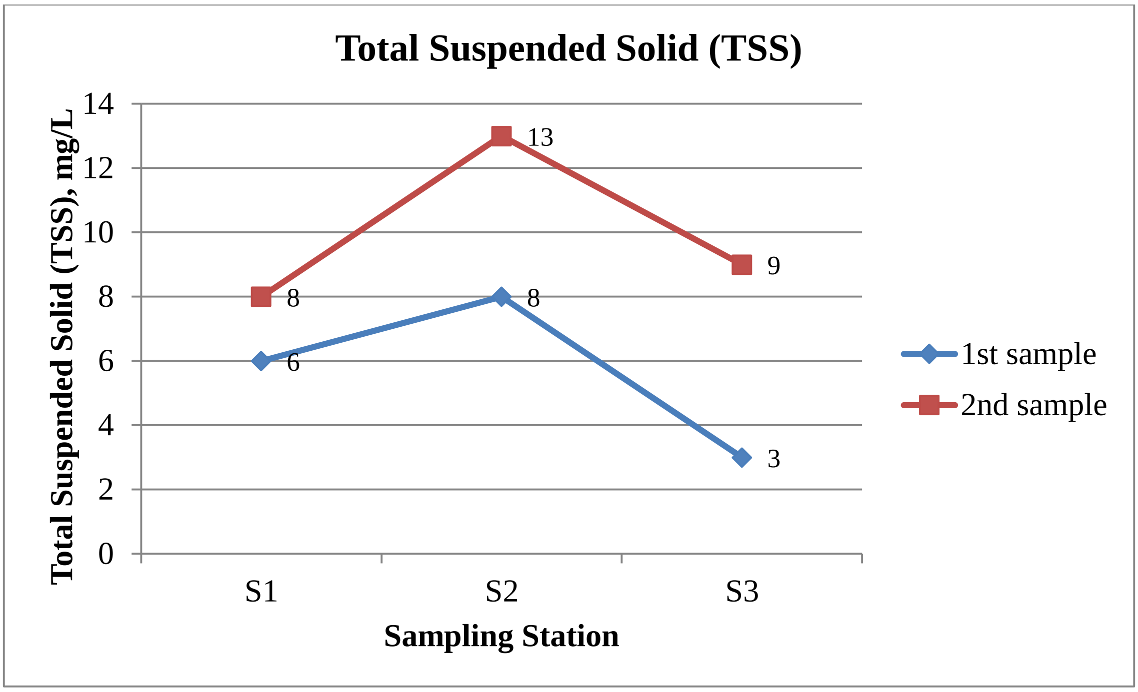


**Figure 4.4**: Graph on total suspended solid of all sampling stations first and second sample.

According to line graph above, the reading of total suspended solid increase during the second sample .The total suspended solid data in the above figure ranges from 3 mg/L to 13 mg/L. The highest value (13 mg/L) was recorded at the station 2 area during second sample. The lowest value (3 mg/L) was recorded at station 3 which was nearby the jetty during first sampling. The total suspended solid may be come from the plantation nearby the Bera Lake.

## 4.3 Chemical Parameter Result

### 4.3.1 pH

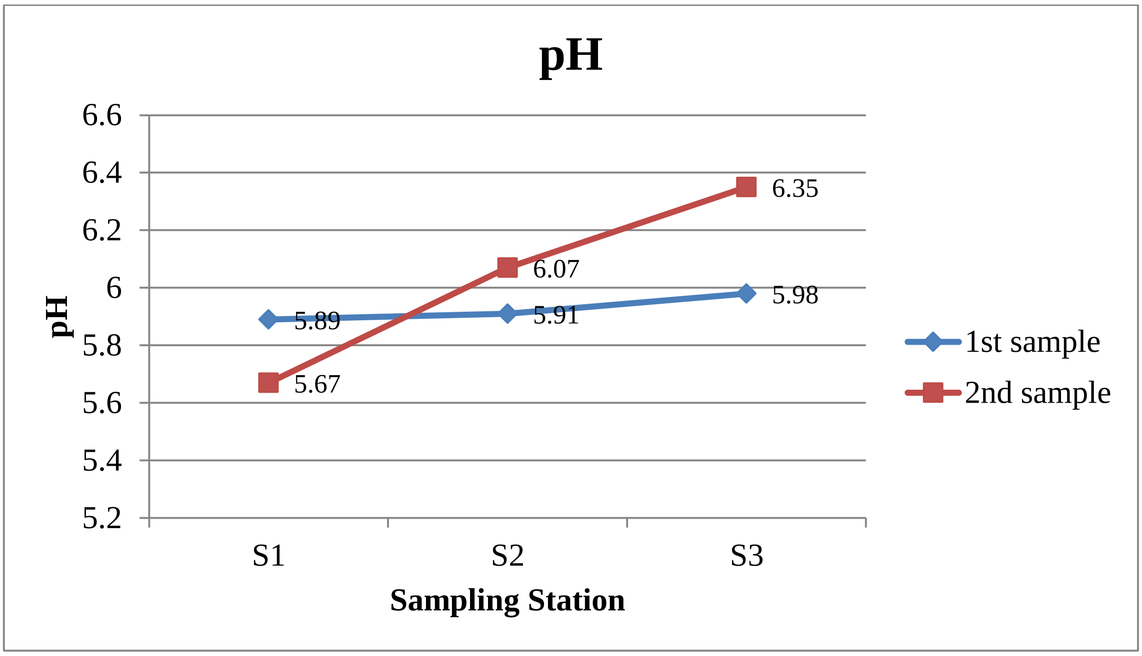


**Figure 4.5**: Graph on pH of Bera Lake during first and second sample at all sampling stations.

The figure 4.5 shows the data of pH recorded at all sampling stations in this study. The pH recorded ranges from 5.67 to 6.35. The lowest value recorded was at station 1 during first sampling which was 5.67. The highest value recorded was at station 3 during second sample taken which was 6.35. The change of the pH is not to distinguished based on the figure. Only small changes in value happen to water at each station. In overall, all the pH readings were in acidic state. The pH values are actually affected by the dissolved carbon dioxide in the water. Therefore, it can be conclude that dissolved carbon dioxide changes as season changes.

### 4.3.2 Electrical conductivity

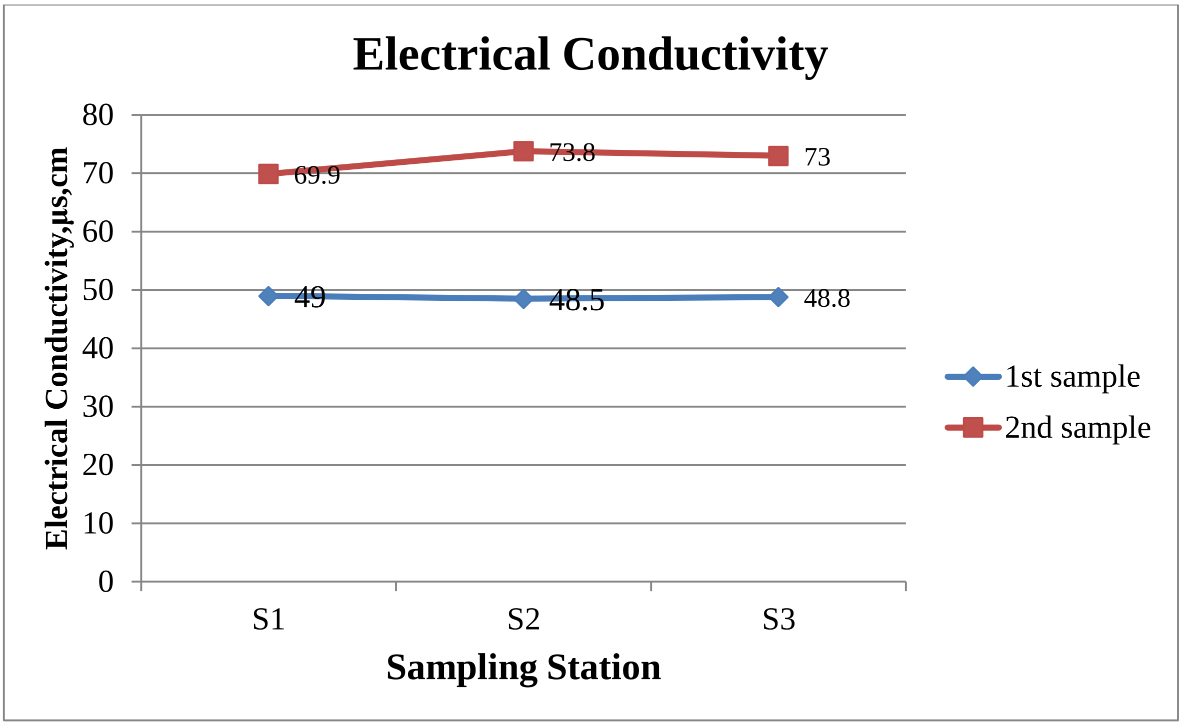


**Figure 4.6:** Graph on electrical conductivity of Bera Lake during first and second sample.

The figure 4.6 shows the data of electrical conductivity recorded at all sampling stations in this study. The electrical conductivity recorded ranges from 48.8µs/cm to 73.8µs/cm. The lowest value recorded was at station 3 during first sampling which was 48.8µs/cm. The highest value recorded was at station 2 during second sample taken which was 73.8µs/cm. In overall, all the electrical readings during second sample were higher than first sample.

### 4.3.3 Chemical Oxygen Demand

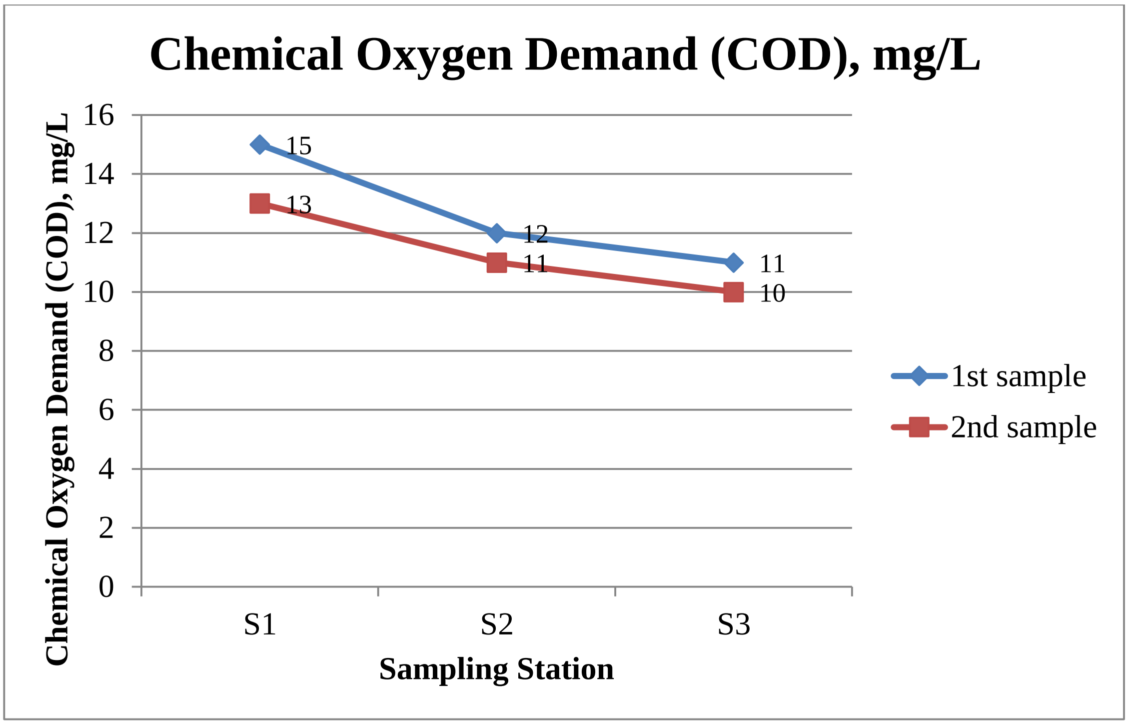


**Figure 4.7:** Graph on Chemical Oxygen Demand (COD) of Bera Lake during first and second sample.

The graph above shows the reading of COD in Bera Lake at all sampling stations. The ranges were from 10 mg/L to 15 mg/L. Station 1 state the highest reading with 15 mg/L for the first sample. Generally, the first sample state higher reading compared to second sample. There was a little change of value COD for all sampling stations. COD was standard test for measurement of the amount of material that can be oxidized (combined with oxygen) in the presence of strong chemical oxidizing agent.

#### 4.3.4 Biochemical Oxygen Demand

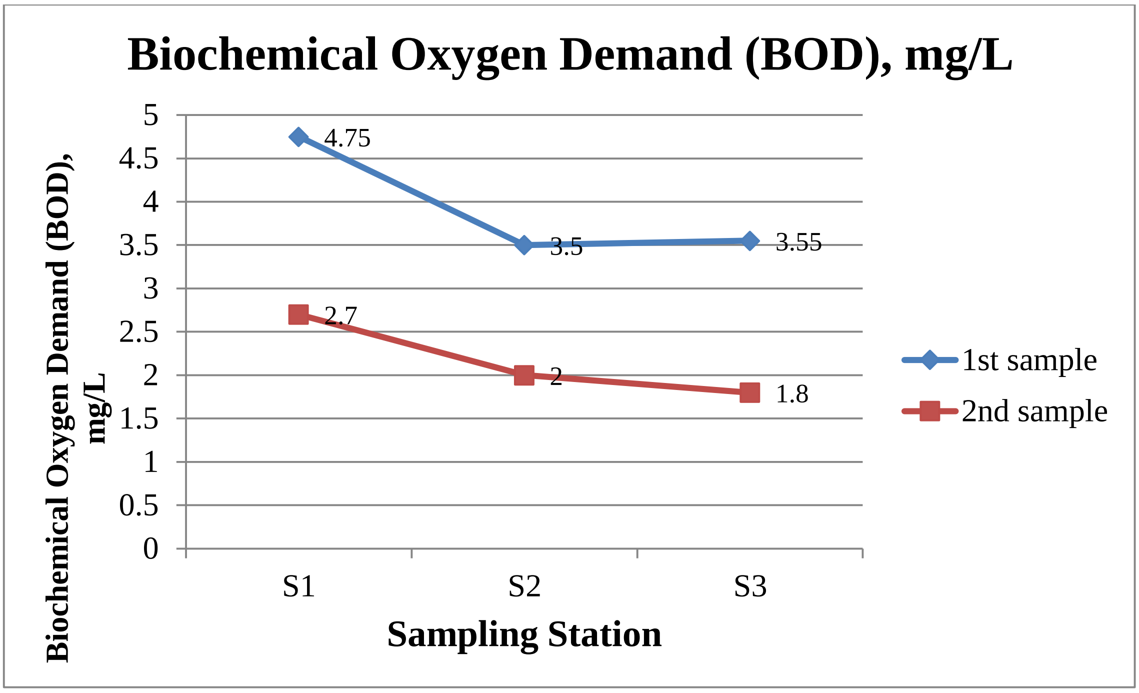


**Figure 4.8:** Graph on biochemical oxygen demand of all sampling stations during first and second sample.

The data on the results of $BOD_5$ experiments on the water samples of Bera Lake during both rainy and dry season were plotted and shown in the above figure. Based on the figure above, the BOD readings have the range from 1.8 mg/L to 4.75 mg/L. The highest BOD reading was at station 1 during the first sample. From the graph, we can see that the second sample have lower level of BOD compared to the first sample. BOD was for measuring the amount of dissolved oxygen (DO) utilized by the aquatic microorganisms. Higher BOD level corresponds with lower DO level.

### 4.3.5 Dissolved Oxygen

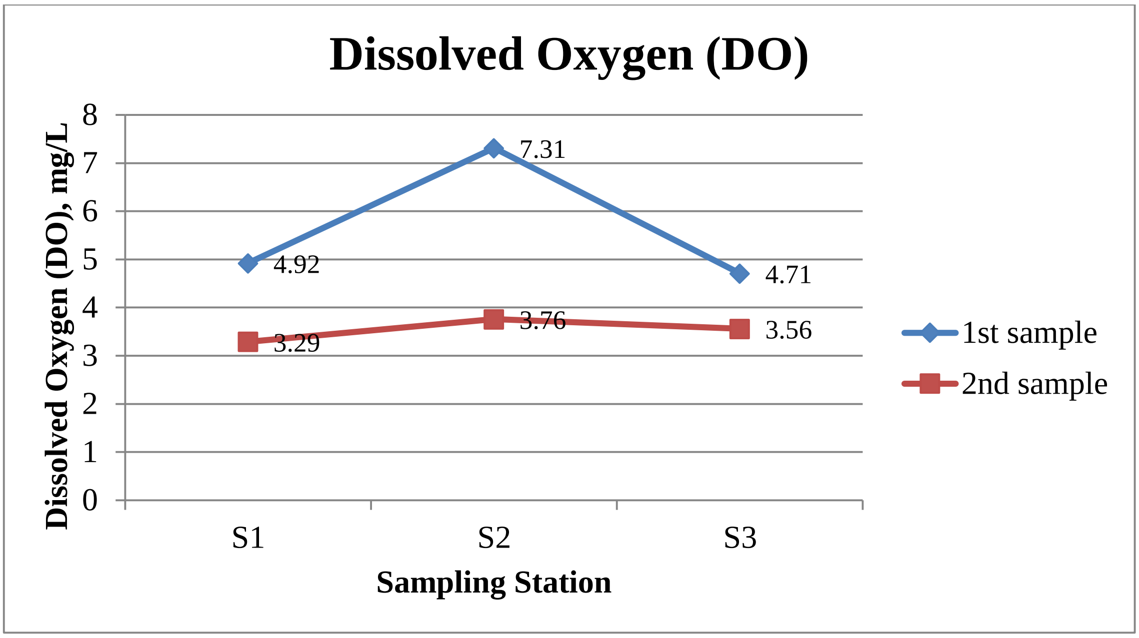


**Figure 4.9**: Graph on dissolved oxygen of all sampling stations during first and second sample.

The figure 4.9 shows the data of dissolved oxygen taken using in situ testing. The value of dissolved oxygen recorded ranging from 3.29 mg/L to 7.31 mg/L. The highest value recorded was at the station 2 sampling station during the first sample and the lowest value recorded was from the station 1 sampling station during second sample. Basically, the figure shows that the readings of all sampling stations were higher during first sample compared to the readings taken during second sample. This happens because during the first sample, most of the temperatures were slightly lower than in second sample. This make an increment of DO concentration in water at all sampling stations.

### 4.3.6 Ammoniacal Nitrogen

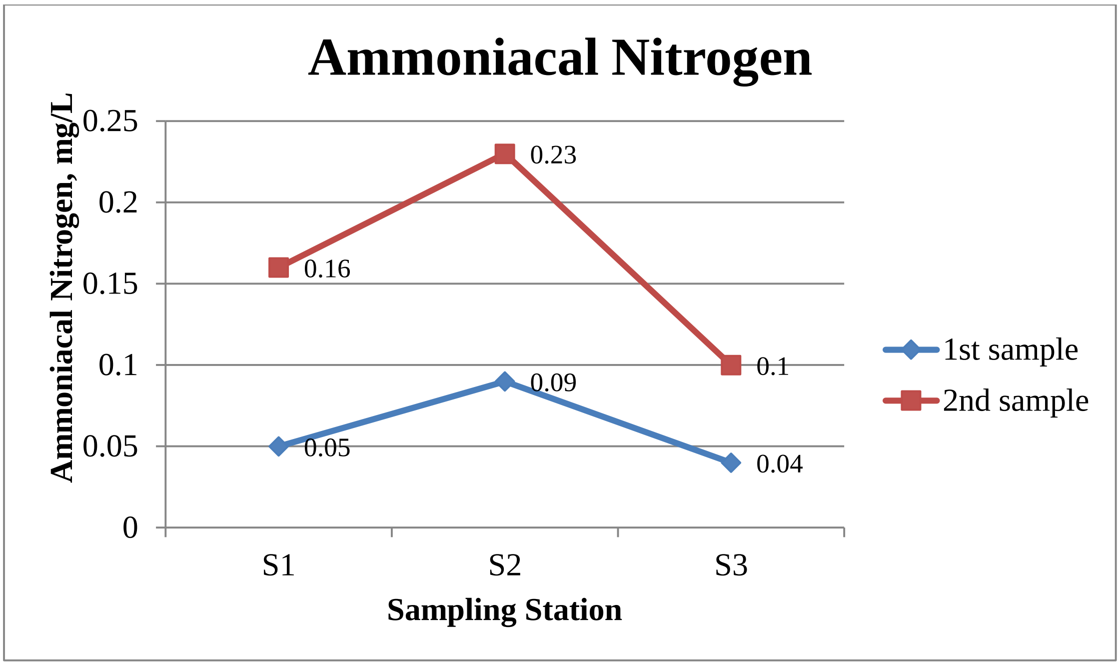


**Figure 4.10**: Graph on ammoniacal nitrogen of all sampling stations during first and second sample

The figure above shows a line graph of the ammoniacal nitrogen at all sampling stations where the data was collected. The ammoniacal nitrogen ranges from 0.04 mg/L to 0.23 mg/L. The highest value recorded is at the station 2 which is 0.23 mg/L during first sample. There was a village nearby the station 2 and waste from residential area and organic waste product can contribute to the present of ammoniacal nitrogen in the lake. Generally, the reading of the second sample was higher than first sample. When ammoniacal nitrogen is present in the water, it can be harmful to aquatic life because of its toxic nature.

### 4.3.7 Nitrate

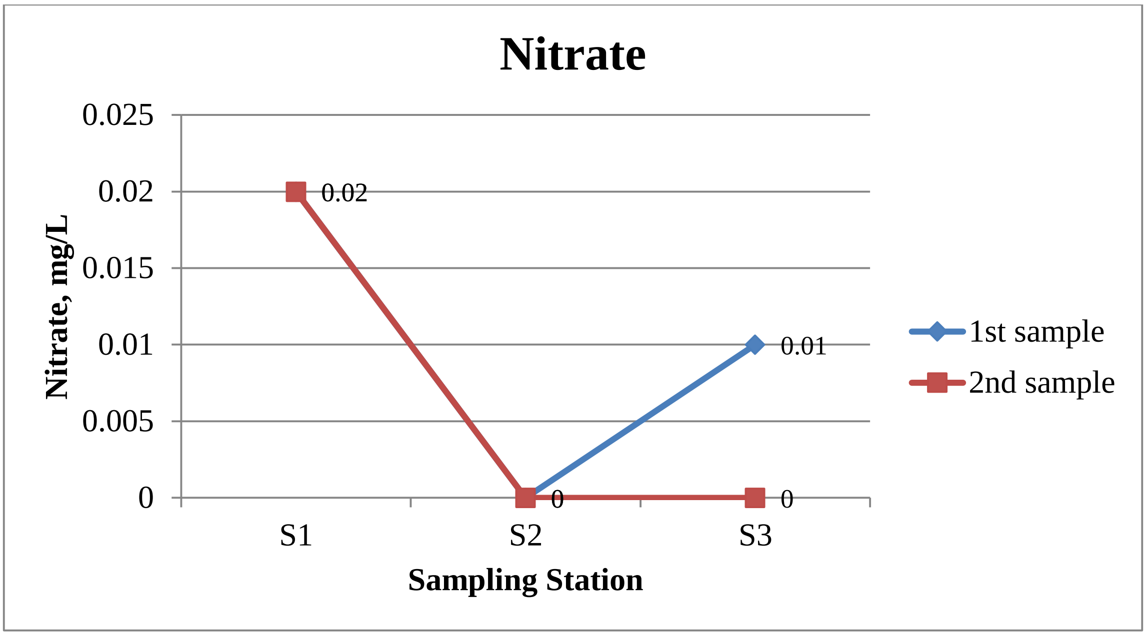


**Figure 4.11** : Graph on nitrate in Bera Lake during first and second sample.

The figure 4.11 shows the reading of nitrate that was present in the water during first and second sample. The ranges of nitrate were from 0.00 mg/L to 0.02 mg/L. The highest reading record at station 1 with 0.02 mg/L while station 2 states the same reading with 0.00 mg/L for both samples. Fundamentally, any abundance nitrate in the water is a source of fertilizer for aquatic plants and algae. In many cases, the measure of nitrate in the water is the thing that points of confinement how much plant and algae can develop. On the off chance that there is an abundance level of nitrates, plants and green growth will develop too much.

#### 4.3.8 Phosphate

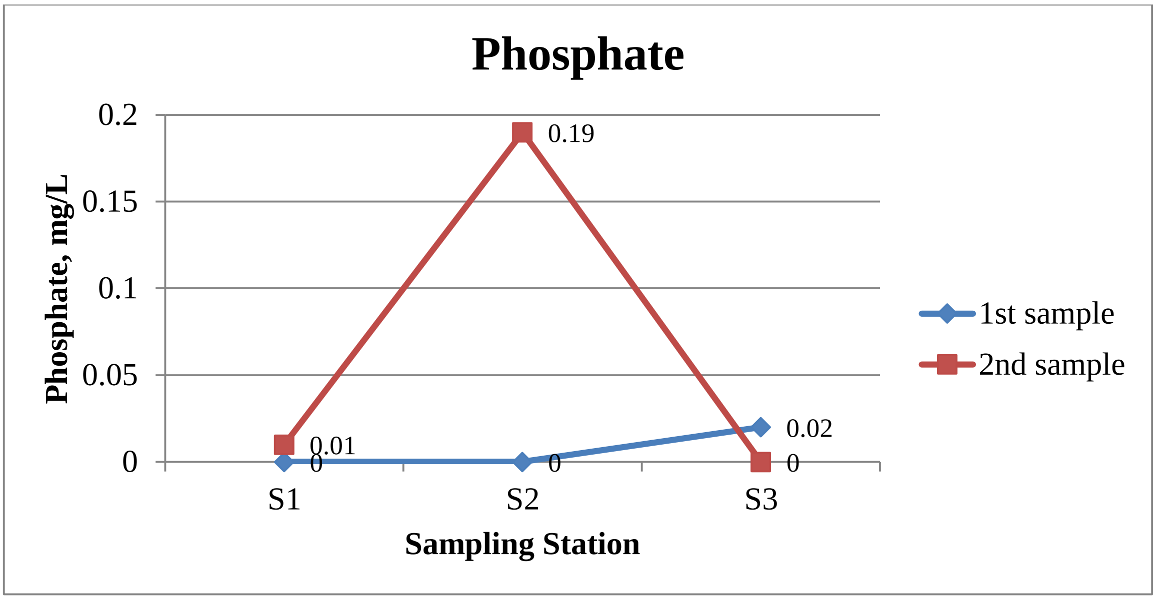


**Figure 4.12**: Graph on phosphate that was present in the water samples during first and second sample.

The phosphate data were described in the above figure. The data ranges from 0.00 mg/L to 0.19 mg/L. Based on the figure, the water samples from station 2 sampling station were so far higher compared to the other water samples. Station 2 is a place near the palm oil and plantation and a village. The agricultural runoff from the agricultural activities which use heavy pesticides and fertilizers was some of the sources orthophosphate at station 2. Besides that, the human daily activities such as using detergent can also contribute to the orthophosphate. The aquatic life in the lake will be affected if the concentration of phosphate keep rising.

## 4.4 Heavy Metal

### 4.4.1 Lead (Pb)

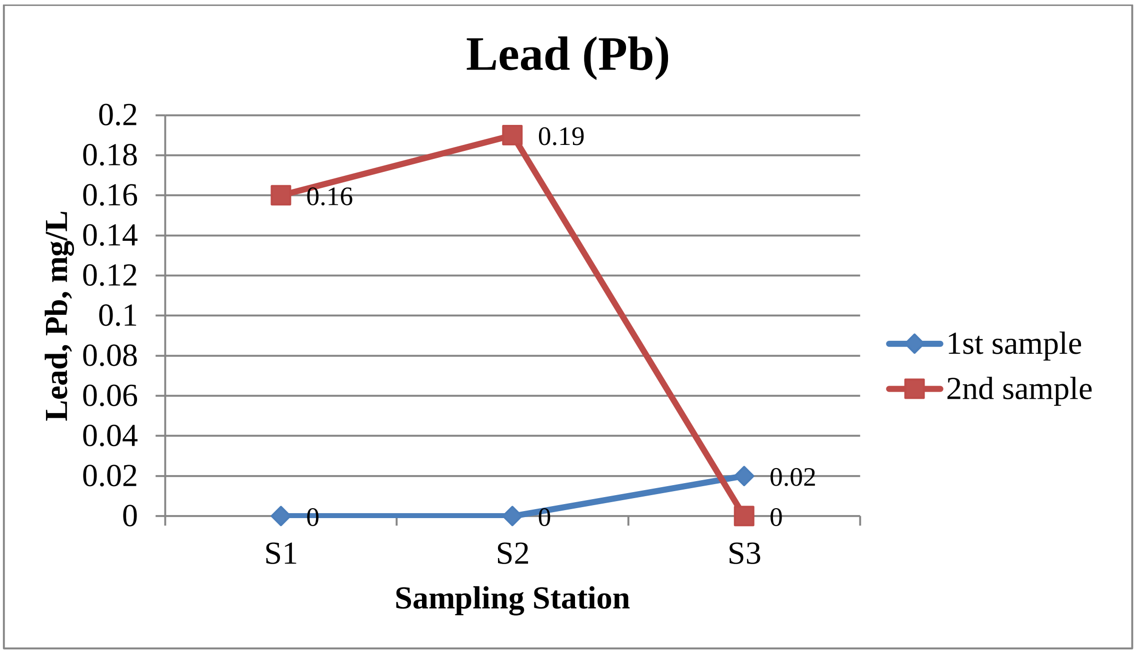


**Figure 4.13:** Graph on lead in the water during of first and second sampling.

The figure above shows the amount of lead that was present in the Bera Lake. According to the reading, the ranges of lead were from 0.00 mg/L to 0.19 mg/L. The highest value was at station 2 during the second sampling with 0.19 mg/L while both of station 1 and station 2 state 0.00 mg/L during the first sampling. Lead accumulations can become sources of future water pollution.

### 4.4.2 Zinc (Zn)

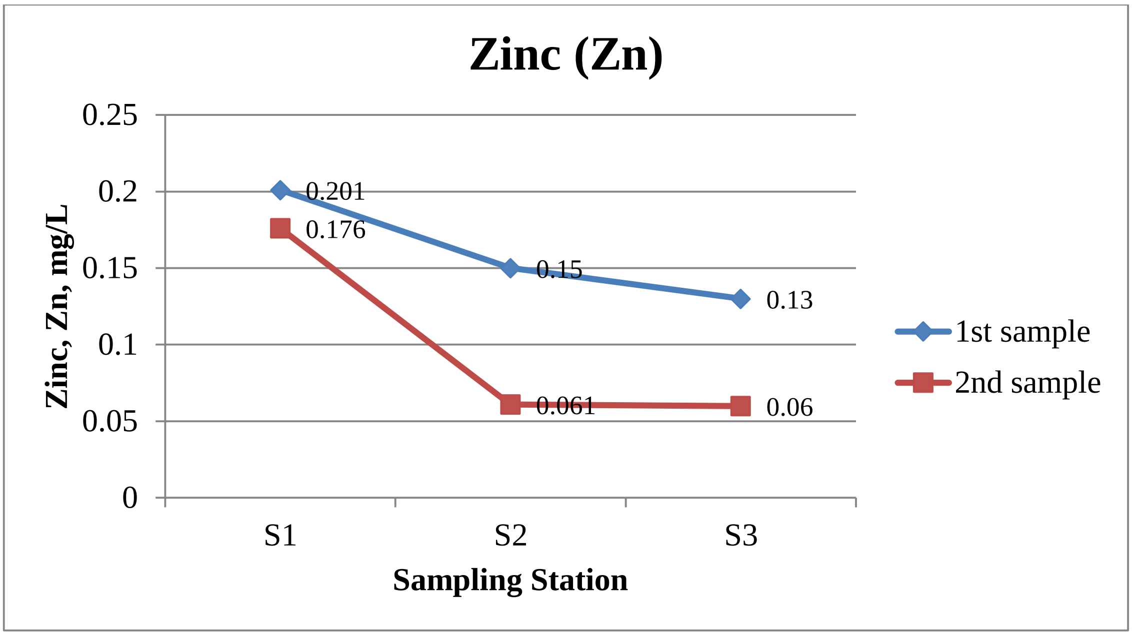


**Figure 4.14:** Graph on zinc that was present in water during of first and second sampling.

The figure 4.14 shows the graph on zinc that was present in Bera Lake during the first and second sampling. The ranges of zinc were from 0.06 mg/L to 0.201 mg/L. The highest reading was stated at station 1 during the first sampling with 0.201 mg/L while the lowest was at station 3 with 0.06 mg/L during the second sample. Generally, the graph during first sample is higher compared to the second sample at all sampling stations. Heavy metal pollution was one of the main causes of environmental hazards due to their high level of toxicity. This situation happen because of the rapid growth of population, increased urbanization, other modern agricultural practices as well as the lack of environmental regulations

### 4.4.3 Copper (Cu)

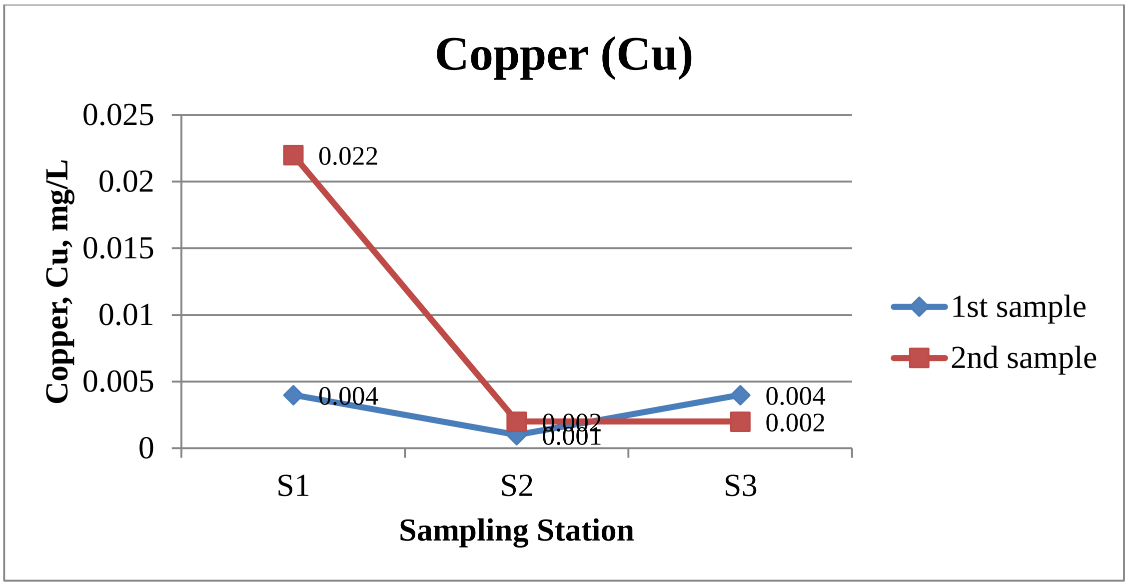


**Figure 4.15:** The graph on copper that was present in water during first and second sample at all sampling stations.

The graph above shows the reading of copper in Bera Lake at all sampling stations. The ranges of copper reading were from 0.001 mg/L to 0.022 mg/L. Station 1 state the highest reading with 0.022 mg/L for the second sample which was increase drastically compared to the first sampling. Generally, the second sample state higher reading compared to first sample except for the station 3 show a bit decrease. Copper is usually found in aquatic systems because of both natural and anthropogenic sources. Natural sources of copper in lake incorporate weathering and disintegration of rocks and soils. Anthropogenic sources of copper incorporate agricultural, and pesticide utilize. Copper is a fundamental nutrient at low concentration, yet was dangerous to oceanic living beings at higher concentrations.

#### 4.4.4 Cadmium (Cd)

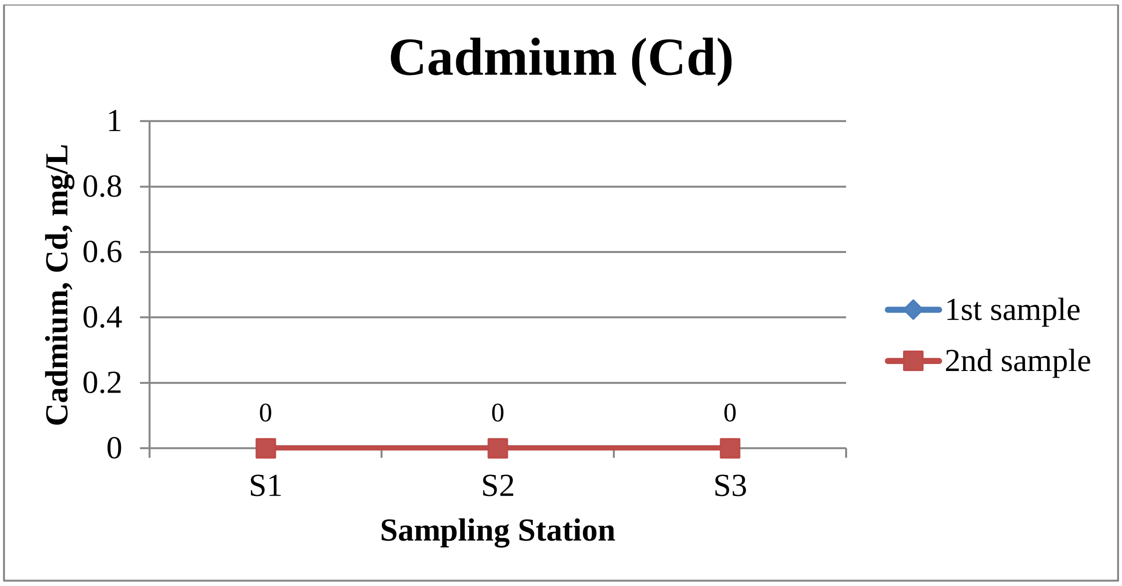


**Figure 4.16**: Graph on cadmium in water during first and second sampling at all sampling stations.

The figure shows there were no presence of cadmium in Bera Lake during first and second sample at all sampling stations.

## 4.5 WQI of Each Station

**Table 4.1:** WQI score at each sampling stations during first and second sample

| Station | Score | | | Class |
|---|---|---|---|---|
| | 1st sample | 2nd sample | Average | |
| Station 1 | 82.82 | 75.34 | 79.08 | II |
| Station 2 | 89.79 | 77.10 | 83.45 | II |
| Station 3 | 85.04 | 78.79 | 81.91 | II |

## 4.6 NWQS for All Parameters

**Table 4.2:** The classification of all parameters (average)

| **Parameter** | **Value** | **Class** |
|---|---|---|
| Temperature | 30.30 | I |
| pH | 5.98 | IIA |
| Electrical Conductivity | 60.50 | IIB |
| Dissolved Oxygen | 4.60 | III |
| Turbidity | 24.72 | IIA |
| $BOD_5$ | 3.05 | IIA |
| COD | 12.00 | IIA |
| Total Suspended Solids | 7.84 | I |
| Total Dissolved Solids | 39.44 | IIA |
| Ammoniacal Nitrogen | 0.11 | I |
| Nitrate | 0.009 | I |
| Phosphate | 0.07 | I |
| Lead | 0.103 | I |
| Zinc | 0.13 | I |
| Copper | 0.006 | I |
| Cadmium | 0 | I |

## 4.7 Discussion

Based on the result obtained on all 13 parameters tested, the least impacted parameters are pH and temperature. These stations are the places that have relation or nearest to logging and agricultural activities. Therefore, it can clearly affect the water quality physically and chemically.

The classifications of result according to DOE-WQI have made the water quality in Bera Lake falls onto class II. This means that, the water is still suitable for recreational activities but the water will need conventional water treatment to be the source of water supply. On the other hand, the classification using NWQS make the Bera Lake falls into many classes that varies according to seasonal change, parameter and the location.

# CHAPTER 5

# CONCLUSION

## 5.1 Introduction

From data analyzed, conclusion can be made and this sub chapter will focus on the conclusion that can be derived from the results of this study. Some of the conclusions that can be made are shown below:

1) The logging activities that occur impact the nearby water quality of Bera Lake.

2) The agricultural activities such as palm oil plantation did impact the nearby water quality of Bera Lake.

3) Based on DOE – WQI, the water in Bera Lake can be classified under Class II because most of them fall in that class during the both first and second sample.

4) The classification of the water in Bera Lake according to the NWQS varies in term of place, time and also parameter. The variation has been shown in Chapter 4 which mainly the explaination and the presentation of results.

## 5.2 Recommendation

After carrying out the study on the impact of logging and agricultural activities on water quality of Bera Lake, there are some ideas to be proposed to improve and maintain the water quality in the future.

1) Pollution should control by indigeneous people and time to time monitor the water quality because the pollution majority comes from their activities.

2) The farmers should use of eco-friendly fertilizers and herbicides so that the impact of pollution to water quality can be reduced.

3) Pollution-control rules enforced by government should be followed strictly.

4) Helpful for policy maker of new development.

5) This result is helpful for the policy maker of new development.

# REFERENCES


Ahmad Fairuz Bin Omar, M. Z. (2009). Turbidimeter Design and Analysis: A Review on Optical Fiber Sensors for the Measurement of Water Turbidity. *Sensors (Basel)* .

Arvind Kumar, P. K. (2008). *Environmental Issues and Solutions.* Delhi: Daya Publishing House.

Branigan, J. (2013). Development of a Field Test for Total Suspended. *Civil Engineering Theses, Dissertations, and Student Research* .

Chiras, D. D. (2013). *Environmental Science (Ninth Editon).* United States of America: Jones & Bartlett Learning .

Gharibreza, M. A. (2014). *Applied Limnology: Comprehensive View from Watershed to Lake.* Japan: Springer.

Hairazi Rahim, T. S. (2013). Tasek Bera Forest Reserve in Pahang: Deplete or conserve . *Economic and Technology Management Review* , 61-70.

Hariprasad N. V., D. H. (2013). Environmental Impact due to Agricultural runoff Environmental Impact due to Agricultural runoff. *International Journal of Scientific and Research Publications* .

Bhattacharyya, K.G, A. S. (2015). *Comprehensive Environmental Studies.* U.K: Alpha Science.

Lamb:, D. (2011). Regreening the Bare Hills: Tropical Forest Restoration in the Asia-Pacific Region. *Netherland: Springer* , 41-91.

Masrom, H. O. (2014). Flora Diversity of Tasek Bera RAMSAR Site , Pahang, Malaysia. *Journal of Wildlife and Parks* .

Michael L. McKinney, R. M. (2013). *Environmental Science: System and Solutions (Fifth Edition).* Burlington: Jones & Bartlett Learning.

Miefthawati, N. P. (2014). Analisa Penentuan Kualitas Air Tasik Bera Di Pahang Malaysia Berdasarkan Pengukuran Parameter Fisika-Kimia. *SiTekIn Jurnal Sains, Teknologi & Industri* .

Mohammadreza Gharibrezaa, J. K. (2013). Effects of agricultural projects on nutrient levels in Lake Bera (Tasek Bera),. *Agriculture, Ecosystems and Environment* .

Nitasha Khatri, S. T. (2014). Influences of natural and anthropogenic factors on surface and groundwater quality in rural and urban areas. *Frontiers in Life science* , 23-39.

Crawford. R (2016). Wetlands of Tasek Bera (Peninsular Malaysia). *ResearchGate* .

Spellman, F.R (2015). *The Science of Water: Concepts and Applications.* U.K: CRC Press.

Sabine Martin, W. G. (2009). Human Health Effects of Heavy Metals. *Environmental Science and Technology Briefs for Citizens* .

Samuel N. Luoma, P. S. (2008). *Metal Contamination in Aquatic Environments: Science and Lateral Management.* Cambridge University Press.

Smol, J. P. (2008). *Pollution of Lakes and Rivers: A Paleoenvironmental Perspective.* Blackwell.

Sonia Pinho, B. L. (2012). Phytotoxicity by Lead as Heavy Metal Focus on Oxidative Stress. *Journal of Botany* .

Sulekh Chandra, A. S. (2012). Assessment of Water Quality Values in Porur Lake Chennai, Hussain Sagar Hyderabad and Vihar Lake Mumbai, India. *Chemical Science Transactions* , 508-515.

William P. Cunningham, M. A. (2010). *Environmental Science: A Global Concern, Eleventh Edition.* New York: McGraw-Hill.

Bruckner, M.Z (2018). *Water and Soil Characterization - pH and Electrical Conductivity*. Retrieved from Microbial Life Educational Resources: https://serc.carleton.edu/microbelife/research_methods/environ_sampling/pH_EC.html

## APPENDIX A1

**Photo During Research Conducted**

Figure A1: In – Situ Testing

Figure A2: Laboratory Testing

**APPENDIX A2**

Photos at Bera Lake


Figure A3: At Bera Lake

Figure A4: During first sample

**APPENDIX A3**

Figure A5: During second sample (Low water level)

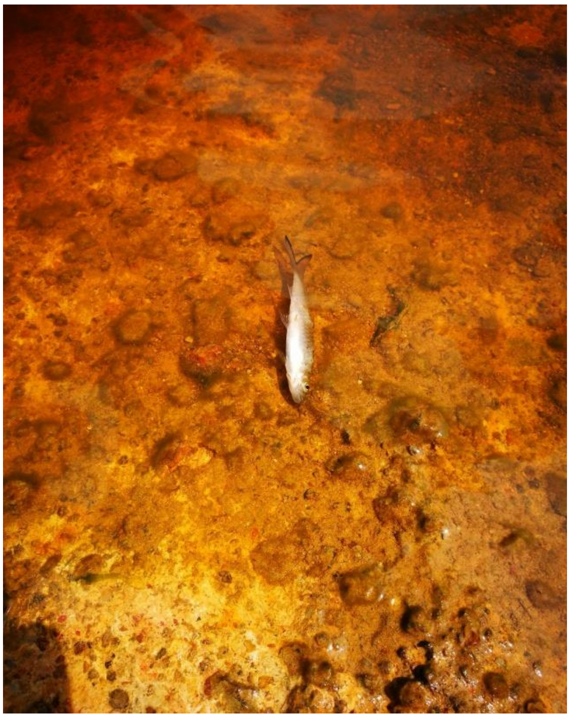

Figure A6: The fish died because of pollution

**APPENDIX B1**

**WQI Result (First Sample)**

**Table B1:** WQI result during first sample

| | Parameter | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Station | DO | DO % | SI DO | BOD | SI BOD | COD | SI COD | TSS | SI TSS | NH3-N | SI NH3-N | pH | SI pH | WQI | Class |
| Station 1 | 4.92 | 64.8 | 71.16 | 4.75 | 80.31 | 15 | 79.15 | 6 | 89.11 | 0.05 | 95.25 | 5.89 | 89.1 | 82.82 | II |
| Station 2 | 7.31 | 98.8 | 100 | 3.5 | 85.6 | 12 | 83.14 | 8 | 86.48 | 0.09 | 91.05 | 5.91 | 89.44 | 89.79 | II |
| Station 3 | 4.71 | 62.9 | 68.53 | 3.55 | 85.38 | 11 | 84.47 | 3 | 93.2 | 0.04 | 96.3 | 5.98 | 90.57 | 85.04 | II |

**APPENDIX B2**

**WQI Result (Second Sample)**

**Table B2:** WQI result during second sample

| | Parameter | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Station | DO | DO % | SI DO | BOD | SI BOD | COD | SI COD | TSS | SI TSS | NH3-N | SI NH3-N | pH | SI pH | WQI | Class |
| Station 1 | 3.29 | 43.3 | 39.91 | 2.7 | 88.78 | 13 | 81.81 | 8 | 86.48 | 0.16 | 83.7 | 5.67 | 85.05 | 75.34 | III |
| Station 2 | 3.76 | 49.6 | 49.01 | 2 | 91.94 | 11 | 84.47 | 13 | 80.29 | 0.23 | 76.35 | 6.07 | 91.93 | 77.1 | II |
| Station 3 | 3.56 | 43.7 | 40.21 | 1.8 | 92.79 | 10 | 85.8 | 9 | 85.2 | 0.1 | 90 | 6.35 | 95.47 | 78.79 | II |

# APPENDIX C1

## Equation for WQI

**WQI = 0.22 $SI_{DO}$ + 0.19$SI_{BOD}$ + 0.16$SI_{COD}$ + 0.16$SI_{TSS}$ + 0.15$SI_{AN}$ + 0.12$SI_{pH}$**

**Sub- index for DO (in % saturation):**

$SI_{DO}$ = 0 for DO<8

= 100 for DO>92

= -0. 395+O.030$DO^2$ - O.00020$DO^3$ for 8<DO<92

**Sub —index for BOD:**

$SI_{BOD}$ =100.4-4.23B0D for BOD<5

= 108e-0.055B0D -0.1BOD for BOD>5

**Sub-index for COD:**

$SI_{COD}$ = -1.33C0D+99.1 for COD<20

= $103e^{-0-01\ 57COD}$ - 0.04COD for COD>20

**Sub-index for AN:**

$SI_{AN}$ = 100.5-I05AN for AN<0.3

= $94e^{-0.573AN}$ -5 |AN - 2| for 0.3<AN<4

= 0 for >4

**Sub-index for TSS:**

$SI_{TSS}$ = $97.5e^{-0.00676TSS}$ + 0.05TSS for TSS<100

= $71e^{-0.0016TSS}$ – 0.015TSS for 100<TSS<1000

= 0 for TSS>1000

## APPENDIX C2

**Sub-index for pH:**

| | |
|---|---|
| $SI_{pH} = 17.2- 17.2pH+5.02pH^2$ | for pH<5.5 |
| $= -242+95 .5pH-6.67pH^2$ | for 5 .5<pH<7 |
| $= -181+82.4pH-6.05\ pH^2$ | for 7<pH<8.75 |
| $= 536-77.0pH+2.76\ pH^2$ | for pH>8.75 |

**Where,**

WQI = Water Quality Index

$SI_{DO}$ = Sub-index of DO

$SI_{BOD}$ = Sub-index of BOD

$SI_{COD}$ = Sub-index of COD

$SI_{AN}$ = Sub-index of AN

$SI_{TSS}$ = Sub-index of TSS

$SI_{pH}$ = Sub-index of pH

## APPENDIX D

**Table D1**: DOE Water Qualification Index

| Parameter | Unit | Class | | | | |
|---|---|---|---|---|---|---|
| | | I | II | III | IV | V |
| Ammoniacal Nitrogen | mg/l | < 0.1 | 0.1 - 0.3 | 0.3 - 0.9 | 0.9 - 2.7 | > 2.7 |
| Biological Oxygen Demand | mg/l | < 1 | 1 - 3 | 3 - 6 | 6 - 12 | > 12 |
| Chemical Oxygen Demand | mg/l | < 10 | 10 - 25 | 25 - 50 | 50 - 100 | > 100 |
| Dissolved Oxygen | mg/l | > 7 | 5 - 7 | 3 - 5 | 1 - 3 | < 1 |
| pH | - | > 7 | 6 - 7 | 5 - 6 | < 5 | > 5 |
| Total Suspended Solid | mg/l | < 25 | 25 – 50 | 50 - 150 | 150 - 300 | > 300 |
| Water Quality Index (WQI) | - | < 92.7 | 76.5–92.7 | 51.9–76.5 | 31.0–51.9 | > 31.0 |

**Table D2**: Descriptive category of WQI values

| Water Quality Index Level | Water Quality Status |
|---|---|
| 0-25 | Excellent Water Quality |
| 26-50 | Good Water Quality |
| 51-75 | Moderate Water Quality |
| 76-100 | Poor Water Quality |
| >100 | Unsuitable for Drinking |

**APPENDIX E**

**Table D3**: National Water Quality Standard for Malaysia (NWQS)

## National Water Quality Standards For Malaysia

| PARAMETER | UNIT | CLASS | | | | | |
|---|---|---|---|---|---|---|---|
| | | I | IIA | IIB | III | IV | V |
| Ammoniacal Nitrogen | mg/l | 0.1 | 0.3 | 0.3 | 0.9 | 2.7 | > 2.7 |
| Biochemical Oxygen Demand | mg/l | 1 | 3 | 3 | 6 | 12 | > 12 |
| Chemical Oxygen Demand | mg/l | 10 | 25 | 25 | 50 | 100 | > 100 |
| Dissolved Oxygen | mg/l | 7 | 5 - 7 | 5 - 7 | 3 - 5 | < 3 | < 1 |
| pH | - | 6.5 - 8.5 | 6 - 9 | 6 - 9 | 5 - 9 | 5 - 9 | - |
| Colour | TCU | 15 | 150 | 150 | - | - | - |
| Electrical Conductivity* | μS/cm | 1000 | 1000 | - | - | 6000 | - |
| Floatables | - | N | N | N | - | - | - |
| Odour | - | N | N | N | - | - | - |
| Salinity | % | 0.5 | 1 | - | - | 2 | - |
| Taste | - | N | N | N | - | - | - |
| Total Dissolved Solid | mg/l | 500 | 1000 | - | - | 4000 | - |
| Total Suspended Solid | mg/l | 25 | 50 | 50 | 150 | 300 | 300 |
| Temperature | °C | - | Normal + 2 °C | - | Normal + 2 °C | - | - |
| Turbidity | NTU | 5 | 50 | 50 | - | - | - |
| Faecal Coliform** | count/100 ml | 10 | 100 | 400 | 5000 (20000)a | 5000 (20000)a | - |
| Total Coliform | count/100 ml | 100 | 5000 | 5000 | 50000 | 50000 | > 50000 |

**Notes**

* = At hardness 50 mg/l CaCO3

# = Maximum (unbracketed) and 24-hour average (bracketed) concentrations

N = Free from visible film sheen, discolouration and deposits

Sourse : EQR2006