STUDY ON WATER QUALITY INDEX OF THE SUNGAI SOI, KUANTAN, PAHANG

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

Faculty of Civil Engineering and Earth Resources
UNIVERSITI MALAYSIA PAHANG

JANUARY 2014

ABSTRACT

The Sungai Soi, Kuantan, Pahang has been selected to study of the water quality for its importance and function to the communities. The local peoples are using this river as a source of water. Due to the rapid development and urbanization process around the study area, the water quality of the Sungai Soi is significantly disturbed and the possibility of pollution. A total of twelve water quality parameters were analyzed including in situ test and laboratory analysis. Water samples were assessed by analyzing the various physic-chemical parameter such as pH value, turbidity, electrical conductivity (EC), dissolved oxygen (DO), biological oxygen demand (BOD), chemical oxygen demand (COD), ammonia nitrogen (NH_3-N), nitrate (NO_3), phosphate (PO_4), sulphate (SO_4),total suspended solids (TSS) and total dissolve solid (TDS). A total of 6 parameters were considered to calculate the Water Quality Index (WQI). According to the result, it was found that the Sungai Soi is in class 4 which is suitable for irrigation purpose only and not suitable for drinking or recreational purpose. It also can be conclude that water quality index can play a big role in ascertain quality of river during various season and location. The result revealed that the study areas were slightly polluted to polluted due to anthropogenic activities such as agriculture activities. It was also found that most of the parameter reading for all station was higher during the wet day due to the surface runoff and urban storm-water runoff.

ABSTRAK

Sungai Soi, Kuantan, Pahang telah dipilih untuk dikaji kualiti air kerana kepentingan dan fungsinya kepada masyarakat. Penduduk tempatan menggunakan sungai ini sebagai sumber air. Oleh kerana pembangunan dan proses pembandaran yang pesat di sekitar kawasan kajian, kualiti air Sungai Soi adalah lebih terganggu dan berkemungkinan terdedah kepada pencemaran. Sebanyak dua belas parameter kualiti air telah dianalisis termasuk ujian in-situ dan analisis makmal. Sampel air telah dinilai dengan menganalisis parameter fizik-kimia yang pelbagai seperti nilai pH, kekeruhan, kekonduksian elektrik (EC), oksigen terlarut (DO), permintaan oksigen biokimia (BOD), permintaan oksigen kimia (COD), ammonia nitrogen (NH_3 - N), nitrat (NO_3), fosfat (PO_4), sulfat (SO_4), jumlah pepejal terampai (TSS) dan jumlah pepejal larut (TDS). Sebanyak 6 parameter akan diguna pakai untuk mengira Indeks Kualiti Air (WQI). Menurut keputusan, didapati bahawa Sungai Soi di dalam kelas 4 yang sesuai untuk tujuan pengairan sahaja dan tidak sesuai untuk minum atau tujuan rekreasi. Ia juga boleh dibuat kesimpulan bahawa indeks kualiti air boleh memainkan peranan yang besar dalam kualiti untuk mengenalpastikan sungai dalam pelbagai musim dan lokasi. Hasilnya menunjukkan bahawa kawasan kajian telah sedikit tercemar disebabkan oleh aktiviti antropogenik seperti aktiviti pertanian. Ia juga didapati bahawa kebanyakan parameter untuk semua stesen memberi membaca lebih tinggi pada hari basah kerana disebabkan oleh air larian permukaan dan air larian bandar serta air ribut .

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AN	Ammonia Nitrogen
APHA	American Public Health Association
BOD	Biochemical Oxygen Demand
COD	Chemical Oxygen Demand
DO	Dissolved Oxygen
DOE	Department of Environment
EC	Electrical Conductivity
GPS	Global Positioning System
H_2SO_4	Sulphuric Acid
LR	Low Range
Mg/L	Milligram per Litre
NaOH	Sodium Hydroxide
NH_3-N	Ammonia Nitrogen
NTU	Nephelometric Turbidity Units
NWQS	National Water Quality Index
pH	pH Value
SIAN	Subindex Ammonical Nitrogen
SIBOD	Subindex Biochemical Oxygen Demand
SICOD	Subindex Chemical Oxygen Demand
SIDO	Subindex Dissolved Oxygen
SIpH	Subindex pH Value
SISS	Subindex Suspended Solid
TDS	Total Dissolved Solid

TSS	Total Suspended Solid
WHO	World Health Organization
WQI	Water Quality Index
WWF-Malaysia	World Wide Fund for Nature (Malaysia)
µS/cm	Micro-Siemens per Centimetre
°C	Degree Celsius

CHAPTER 1

INTRODUCTION

1.1 Background Study

Water is the most valuable thing in the earth. Water is needed for all life either as a drinking and also requirement in the process of plant photosynthesis and as well as daily necessities such as washing and cooking. So if there is any change in the water that can causes it not be able to maintain freshness, then it will cause things that depend on it will stand in trouble and even worse may be dead. So as to avoid any bad things happen such as water pollution, the water quality status for selected area should be identified.

In an attempt to simplify the wide amount of data collected clear to the parameters listed in the Interim National Water Quality Standards (INWQS), an indexing system was introduced. A Water Quality Index (WQI) describes quality value to an aggregate set of measured parameters. The WQI primarily used in Malaysia (also referred to as the DOE-WQI) is formula where a panel of experts is referring to on the choice of parameters and on the weight age to each parameter.

1.2 Problem statement

Water quality in Malaysia is things to be taken care by all parties before it get worse. Many living creatures that depend on water resources including human being in everyday use will be in trouble if water resource is polluted. The Sungai Soi, Kuantan, Pahang has been chosen for the study of water quality because of its importance and function to the communities. They used this river as water sources. Due to the rapid development and urbanization process around the area, the water

quality of the Sungai Soi is significantly disturbed and the possibility of polluted. The impact of water quality can be getting from land exploration for development. Land exploration can cause soil erosion and land slide can occur during rain which directly flow into the nearby water resources and become sediment. Other problem is rubbish and garbage dumping inside the river by the irresponsible parties.

1.3 Objectives

I. To determine the water quality status of the Sungai Soi.

II. To classify the water quality of the Sungai Soi based on Water Quality Index (DOE – WQI).

1.4 Scope of Study

The scope of this study is to evaluate and analysis the current status of water quality for the Sungai Soi, Kuantan Pahang based on the Water Quality Index (WQI) and Interim National Water Quality Standard for Malaysia (INWQS). The parameters will be used and they are biochemical oxygen demand, chemical oxygen demand, dissolved oxygen, total suspended solids, pH, ammonia nitrogen, phosphate, nitrate, sulphate, turbidity, electrical conductivity and total dissolved solids. River classification was based on DOE-WQI. Sample will be collected from field and testing each at field and laboratory.

1.5 Significant of Study

I. To know the quality level of water might fulfill or not the water quality standards of drinking water for domestic uses as well as quality water for commercial use like bathing (recreational), fishing and washing.

II. To decide the advance improvement and protection that should be taken if the river is polluted.

CHAPTER 2

LITERATURE REVIEW

The river is one of the most valuable assets for human to protect and preserve it because the river provides the most important source such as water for living things. We all also known that the river also a starting point for the development of civilization and culture. Therefore if the uncontrolled development and planning happen it may indirectly give negatively impact to the river.

2.1 Pollution in Malaysia

As Malaysia is becoming an industrial country it also inseparable from his river pollution problems which some of his rivers have become polluted due to the many wastes that have been poured out into his rivers without proper control. According (Water Environment Partnership in Malaysia, n.d.) in 2006, a total of 1,064 water quality monitoring stations located within 146 river basins were monitored. Out of these 1,064 monitoring stations, 619 (58%) were found to be clean, 359 (34%) slightly polluted and 86 (8%) polluted. Stations located upstream were generally clean, while those downstream were either slightly polluted or polluted. In terms of river basin water quality, 80 river basins (55%) were clean, 59 (40%) slightly polluted and 7 (5%) were polluted.

Such as the paper and pulp industry, clay and glass industry, metal industry and also polymer and plastic industry it requires chemicals and in same time often

poisonous in its production. The rivers are used as an outlet for the chemicals to drain away, in turn the chemical harming the waters and the lives that revolve around the river. Based on this problem Water Quality Index (WQI) will be used to evaluate the status of the river water quality.

2.2 Water Quality Index

The WQI serves as the basis for environment assessment of a watercourse in relation to pollution load categorization and designation of classes of beneficial uses as provided for under the National Water Quality Standards for Malaysia (NWQS).

Water quality is an important factor to know or determine the water changes. As mention by Papita (2010) water quality can be define those chemical, physical, biological, or radiological characteristic by which we evaluate the acceptability of water. Information of water quality will be more convenient to integrate physical and chemical properties data to describe the water quality by single parameter. For these reason Water Quality Index (WQI) was create and design by National Sanitation Foundation (NSF).

"Water Quality Index is a form of average derived by relating a group of variable to a common scale and combining them into a single number. A WQI summarizes information by combining several sub-indices of constituents (quality variables) into a univariate expression. The group should contain the most significant parameters of the dataset, so that the index can describe the overall position and reflect change in a representative manner." (Srikanth et al, 2011, p. 174).

2.3 Water Quality Parameter

2.3.1 Biochemical Oxygen Demand

Biochemical Oxygen Demand is one of the most important and useful parameters (measured characteristics) indicating the organic strength of a wastewater. BOD measurement permits an estimate of the waste strength in terms of the amount of dissolved oxygen required to break down the wastewater. The specifics of the analysis are discussed in detail in Standard Methods for the Examination of Water and Wastewater. The BOD test is one of the most basic tests used in the wastewater field. It is essentially a measure of the biological and the chemical component of the waste in terms of the dissolved oxygen

needed by the natural aerobic biological systems in the wastewater to break down the waste under defined conditions. Generally the BOD test is carried out by determining the dissolved oxygen on the wastewater or a diluted mixture at the beginning of the test period, incubating the wastewater mixture at 20°C, and determining the dissolved oxygen at the end of 5 days. The difference in dissolved oxygen between the initial measurement and the fifth day measurement represents the biochemical oxygen demand. (Mountain Empire Community College, n.d.)

2.3.2 Chemical Oxygen Demand

The Chemical Oxygen Demand test measures the oxygen equivalent consumed by organic matter in a sample during strong chemical oxidation. The strong chemical oxidation conditions are provided by the reagents used in the analysis. Potassium dichromate is used as the oxygen source with concentrated sulfuric acid added to yield a strong acid medium. Several reagents are added during the set-up of the analysis to drive the oxidation reaction to completion and also to remove any possible interference. Specifically, these reagents are mercuric sulfate, silver sulfate and sulfamic acid. Mercuric sulfate is added to remove complex chloride ions present in the sample. Without the mercuric sulfate the chloride ions would form chlorine compounds in the strong acid media used in the procedure. These chlorine compounds would oxidize the organic matter in the sample, resulting in a COD value lower than the actual value. Silver sulfate is added as a catalyst for the oxidation of short, straight chain organics and alcohols. Again, without the silver sulfate the COD of the sample would be lower than the actual value. Sulfamic acid is added to remove interferences caused by nitrite ions. Without sulfamic acid the COD of the sample would measure higher than the actual value. (Mountain Empire Community College, n.d.)

2.3.3 Total Suspended Solids

Total Suspended Solids is solids in water that can be trapped by a filter. TSS can include a wide variety of material, such as silt, decaying plant and animal matter, industrial wastes, and sewage. High concentrations of suspended solids can cause many problems for stream health and aquatic life. High TSS can block light from reaching submerged vegetation. As the amount of light passing through the water is reduced, photosynthesis slows down. Reduced rates of photosynthesis causes less dissolved oxygen to be released into the water by plants. If light is completely blocked from bottom dwelling plants, the plants will stop producing oxygen and will die. As the plants are decomposed, bacteria will use up even more oxygen from the water. Low dissolved oxygen can lead to fish kills. High TSS can also cause an increase in surface water temperature, because the suspended particles absorb heat from sunlight. This can cause dissolved oxygen levels to fall even further (because warmer waters can hold less DO), and can harm aquatic life in many other ways, as discussed in the temperature section. (Murphy as cited in Mitchell and Stapp, 1992)

2.3.4 Total Dissolved Solids

Total Dissolved Solids are solids in water that can pass through a filter (usually with a pore size of 0.45 micrometers). TDS is a measure of the amount of material dissolved in water. This material can include carbonate, bicarbonate, chloride, sulfate, phosphate, nitrate, calcium, magnesium, sodium, organic ions, and other ions. A certain level of these ions in water is necessary for aquatic life. Changes in TDS concentrations can be harmful because the density of the water determines the flow of water into and out of an organism's cells. However, if TDS concentrations are too high or too low, the growth of many aquatic lives can be limited, and death may occur. Similar to TSS, high concentrations of TDS may also reduce water clarity, contribute to a decrease in photosynthesis, combine with toxic compounds and heavy metals, and lead to an increase in water temperature. TDS is used to estimate the quality of drinking water, because it represents the amount of ions in the water. Water with high TDS often has a bad taste and/or high water hardness, and could result in a laxative effect. (Murphy as cited in Mitchell and Stapp, 1992)

2.3.5 Sulphate

Sulphate is a naturally occurring substance that contains sulphur and oxygen. It is present in various mineral salts that are found in soil. Sulphate forms salts with a variety of elements including barium, calcium, magnesium, potassium and sodium. Sulphate may be leached from the soil and is commonly found in most water supplies. Magnesium, potassium and sodium sulphate salts are all soluble in water. Calcium and barium sulphates are not very easily dissolved in water. There are several other sources of sulphate in water. Decaying plant and animal matter may release sulphate into water. Numerous chemical products including ammonium sulphate fertilizers contain sulphate in a variety of forms. The treatment of water with aluminum sulphate (alum) or copper sulphate also introduces sulphate into a water supply. Human activities such as the combustion of fossil fuels and sour gas processing release sulphur oxides to the atmosphere, some of which is converted to sulphate. Sulphate is generally considered to be non-toxic. The consumption of drinking water containing high amounts of magnesium or sodium sulphate may result in intestinal discomfort, diarrhea and consequently dehydration. This laxative effect is often observed when someone drinks water that contains greater than 500 milligrams per liter (mg/L) of sulphate. Over time, individuals appear to develop a tolerance to higher concentrations of sulphate. Diarrhea and dehydration are often observed when individuals accustomed to drinking water with low concentrations of sulphate consume water with high amounts of sulphate. It is not advisable to use water that contains high concentrations of sulphate for infant feeding.(Government of Saskatchewan, 2003)

2.3.6 Nitrate

Nitrate (NO_3) is a naturally occurring form of nitrogen found in soil. Nitrogen is essential to all life. Most crop plants require large quantities to sustain high yields. The formation of nitrates is an integral part of the nitrogen cycle in our environment. In moderate amounts, nitrate is a harmless constituent of food and water. Plants use nitrates from the soil to satisfy nutrient requirements and may accumulate nitrate in their leaves and stems. Due to its high mobility, nitrate also can leach into groundwater. If people or animals drink water high in nitrate, it may cause methemoglobinemia, an illness found especially in infants. Nitrates form when microorganisms break down fertilizers, decaying plants, manures or other organic residues. Usually plants take up these nitrates, but sometimes rain or irrigation water can leach them into groundwater. Although nitrate occurs naturally in some groundwater, in most cases higher levels are thought to result from human activities. (Self & Waskom, 2013)

2.3.7 Phosphates

Phosphates are chemical compounds containing phosphorus. Phosphorus is a non-metallic element which is necessary for life and is found in rock as inorganic phosphates. As water runs over and through rocks it carries off small amounts of minerals such as calcium, magnesium, and phosphates. Inorganic phosphates are a plant nutrient and are taken in by plants with water and incorporated into organic phosphate compounds. Animals obtain their essential phosphorus from phosphates in water and plant material. Natural waters have a phosphorus concentration of approximately 0.02 parts per million (ppm) which is a limiting factor for plant growth. On the other hand, large concentrations of this nutrient can accelerate plant growth. Phosphates enter waterways through manmade sources also. The addition of large quantities of phosphates to waterways accelerates algae and plant growth in natural waters; enhancing eutrophication and depleting the water body of oxygen. This can lead to fish kills and the degradation of habitat with loss of species. Large mats of algae can form and in severe cases can completely cover small lakes. As a result, water can become putrid from decaying organic matter. When the concentration of phosphates rises above 100 mg/liter the coagulation processes in drinking water

treatment plants may be adversely affected. Manmade sources of phosphate include human sewage, agricultural run-off from crops, sewage from animal feedlots, pulp and paper industry, vegetable and fruit processing, chemical and fertilizer manufacturing, and detergents.(Pedersen, 1997)

2.3.8 Ammonia-nitrogen

Ammonia-nitrogen is an inorganic, dissolved form of nitrogen that can be found in water and is the preferred form for algae and plant growth. Ammonia is the most reduced form of nitrogen and is found in water where dissolved oxygen is lacking. When dissolved oxygen is readily available, bacteria quickly oxidize ammonia to nitrate through a process known as nitrification. Other types of bacteria produce ammonia as they decompose dead plant and animal matter. Depending on temperature and pH (a measurement of acidity), high levels of ammonia can be toxic to aquatic life. High pH and warmer temperatures increase the toxicity of a given ammonia concentration. High ammonia concentrations can stimulate excessive aquatic production and indicate pollution. Important sources of ammonia to lakes and streams can include: fertilizers, human and animal wastes, and byproducts from industrial manufacturing processes. Techniques to prevent high ammonia concentrations involve filtration of runoff water especially from barnyards and other areas where animals may be kept in larger numbers, proper septic system maintenance, and not over-fertilizing yards or fields. (Shifflett,n.d)

2.3.9 Dissolved Oxygen

The dissolved oxygen concentrations in a wastewater before and after treatment are very important. While dissolved oxygen concentrations are necessary to carry out the BOD determination, as described above, dissolved oxygen levels are also quite important in determining how satisfactory a biological wastewater treatment plant is operating. For example, for satisfactory biological wastewater decomposition (i.e. treatment) some dissolved oxygen must be present. If it is not, the system will be inefficient and is said to be anaerobic. Septic conditions follow, accompanied by a variety of nuisance conditions such as odor and color changes. Normally, oxygen is not a very

soluble gas and dissolved oxygen concentrations in wastewaters are very low. For example, dissolved oxygen concentrations of a few milligrams per liter (or parts per million) are commonplace in water. The solubility of oxygen is such that dissolved oxygen levels in clean water are affected by temperature and salt concentrations expressed as chlorides. When microorganisms and an available food supply are present, dissolved oxygen will be consumed. Since many of the components present in a raw wastewater can serve as a nutrient for microorganisms, most domestic wastewaters will undergo some decomposition and usually any available dissolved oxygen supplies are consumed during travel through the sewer system. Generally, raw wastewater will have little if any dissolved oxygen present while wastewater in the aeration tanks, final settling tanks, or in the final effluent will probably have at least measurable dissolved oxygen concentrations. (Mountain Empire Community College, n.d.)

2.3.10 pH

pH is defined as the negative logarithm of the hydrogen ion concentration. pH is a convenient way of expressing a very small number. The pH scale ranges from 0 to 14 with 7 being neutral. pH values of less than 7 are considered acid, or acidic, while values greater than 7 are considered basic or alkaline. pH greatly affects biological activity. Extremes of pH may injure or kill many bacteria and even cause a halt to all biological activity. Most bacteria perform best at pHs between 6.5 to 8.0. pH also affects digester performance, sludge dewatering, chemical treatment, and disinfection processes. (Mountain Empire Community College, n.d.)

2.3.11 Turbidity

Turbidity is a measure of water clarity how much the material suspended in water decreases the passage of light through the water. Suspended materials include soil particles (clay, silt, and sand), algae, plankton, microbes, and other substances. These materials are typically in the size range of 0.004 mm (clay) to 1.0 mm (sand). Turbidity can affect the color of the water. Higher turbidity increases water temperatures because suspended particles absorb more heat. This, in turn, reduces the concentration of dissolved oxygen because warm water

holds less DO than cold. Higher turbidity also reduces the amount of light penetrating the water, which reduces photosynthesis and the production of DO. Suspended materials can clog fish gills, reducing resistance to disease in fish, lowering growth rates, and affecting egg and larval development. As the particles settle, they can blanket the stream bottom, especially in slower waters, and smother fish eggs and benthic macroinvertebrates. Sources of turbidity include soil erosion, waste discharge, urban runoff, eroding stream banks, Large numbers of bottom feeders (such as carp), which stir up bottom sediments and excessive algal growth. (United State Environmental Protection Agency, 2012)

2.3.12 Electrical Conductivity

Electrical Conductivity is a measure of the ability of water to pass an electrical current. Conductivity in water is affected by the presence of inorganic dissolved solids such as chloride, nitrate, sulfate, and phosphate anions (ions that carry a negative charge) or sodium, magnesium, calcium, iron, and aluminum cations (ions that carry a positive charge). Organic compounds like oil, phenol, alcohol, and sugar do not conduct electrical current very well and therefore have a low conductivity when in water. Conductivity is also affected by temperature: the warmer the water, the higher the conductivity. For this reason, conductivity is reported as conductivity at 25 degrees Celsius (25 C). (United State Environmental Protection Agency, 2012)

CHAPTER 3

METHODOLOGY

Methodology is a planning or rules from which specific methods or procedures may be derived that start from beginning until the end of research to understand or solve different problems within the scope of study. Knowing how the data was collected will help the study in evaluation the validity and reliability of the result.

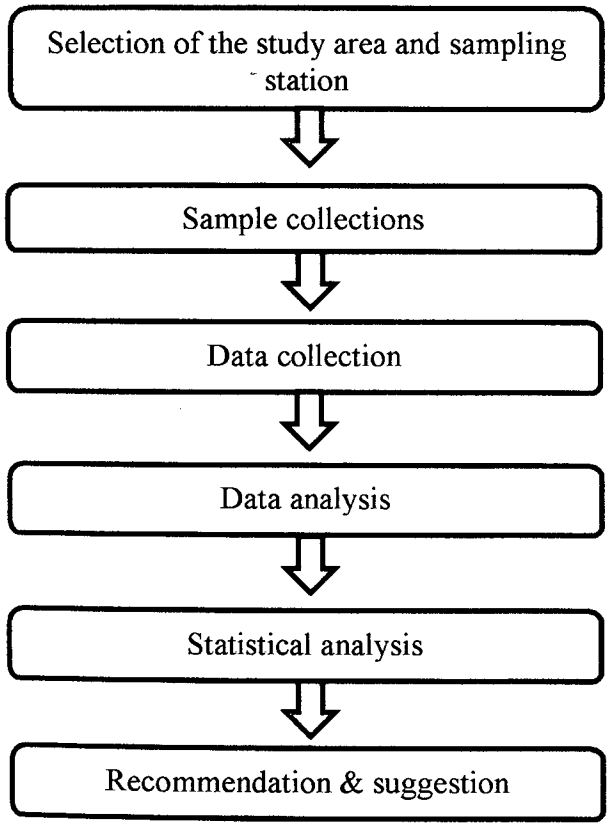

Fig 3.1: Methodology Flow Chart