QUAL2E SIMULATION OF SELECTED POLLUTANT CONSTITUENTS FOR SEMBERONG RIVER, BATU PAHAT, JOHOR

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ABSTRACT

A comparison between actual data collected on site and laboratory analyzed against simulated results using mathematical model represented by Enhanced Stream Water Quality Model (QUAL2E) computer programme for selected pollutant constituents for part of Sungai Semberong is proposed. Four types of stream pollutant constituents will be analyzed to represent the consistency of the compared results, Conventional pollutant, conservative constituent, reactive consituent and general water characteristic. Various reaction coefficients constant and global parameter associated with the selected constituents will be analyzed to determine the most suitable value for adoption to local condition. Successful verification of the consitency and and realiability of the simulated results will permit adoption of the mathematical model and the computer programme for subsequent analysis of the stream water quality parameters for Semberong River.

ABSTRAK

Adalah dicadangkan agar dibuat satu perbandingan di antara data sebenar yang dicerap di tapak kajian dan dianalisis di dalam makmal dengan data yang di simulasi menggunakan model matematikal yang di wakili oleh perisian komputer "Enhanced Stream Water Quality Model" (QUAL2E) untuk beberapa jenis bahan pencemar di Sungai Semberong Empat jenis pencemaran air sungai akan dianalisis untuk memberikan perwakilan yang adil dan seimbang dalam perbandingan iaitu pencemar konvensional, pencemar konservatif, pencemar bertindakbalas dan parameter am air. Beberapa kombinasi pekali tindak balas dan parameter global yang berkaitan dengan pencemar yang dipilih akan dianalisis untuk menentukan nilai nilai yang paling bersesuaian dengan keadaan setempat.. Keputusan perbandingan untuk beberapa cerapan akan di kaji dari segi konsisten dan boleh ulang bagi menentukan keupayaan model mewakili keadaan sebenar. Keputusan yang positif akan membolehkan model diterima sebagai perisian yang boleh digunakan sebagai alat untuk kajian kajian yang akan datang.

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H	-	Depth of stream
mg/l	-	milligram per litre
mg/m^2-d	-	milligram per meter square per day
n	-	Manning number
N	-	Nitrogen
NH_3	-	Ammonia
NO_2	-	Nitrite
NO_3	-	Nitrate
O	-	Oxygen
P	-	Phosphorus
Q	-	Volume of flows
V	-	Velocity of flows

LIST OF ABBREVIATION

Al	-	Aluminium
Cms	-	Cubic meter per second
EPA	-	Environmental Protection Agency
Fe	-	Ferum
Kg.	-	Kampung
Mn	-	Mangenese
DO	-	Dissolved Oxygen
GPS	-	Global Positioning System
Km	-	Kilometer
KUiTTHO	-	Kolej Universiti Technologi Tun Hussein Onn
Mps	-	Meter per second
QUAL2E	-	Enhanced Stream Water Quality Model
RSQ	-	R square
St.	-	Station
Temp	-	Temperature
USA	-	United State Of America

CHAPTER I

INTRODUCTION

1.1 Introduction

Quality of life in Malaysia in general is steadily improving from period of 1985 to 2003 (Economic Planning Unit, 2003). Only two of the quality indexes show declining trend, which is public safety and environmental quality index. While people might leave the former for respective authority to deal with, the letter is somewhat different. The figure is a cause to be concerned to all people because it shows the lack of attention devoted toward the well being of the environment and to certain extend shows that while the human strive forward to achieve the status of a developed nation, the quality of the environment were being be sacrificed. Everybody is responsible in addressing this issue, as the reciprocal effect of human ignorance is grievous not only in present, but also to future generation.

1.2 Water in Life

The most prominent environment element affected by this decline is a surface water quality and thus deserved special attention for obvious reason. First of all, the surface water is the major source of portable drinking water. Human being can live without food for a week but without water, survival limit is reducing to a mere three days. Agricultural industries which supply food sources are also heavily dependable on steady supply of surface water for irrigation. Marine dwellers residing in lake, river and ocean is also an important source of food for human. Contamination in the surface water digested by these living creatures and plants will eventually be consumed back by the polluter, not to mention the direct consumption from drinking polluted water.

Surface water is also notoriously known as a convenient and cheap location for all kind of waste dumping, intentional or otherwise which might include hazardous material. While agricultural activities demand a steady supply of consumable water, they themselves are the major water polluter by mean of discharging excess fertilizers, pesticides and herbicides into surface water system. Waste discharges from industries are seldom treated in a proper manner before being released into surface water system. With increasing volume and concentration of above mentioned discharge, surface water can no longer cope in diluting the contamination to an acceptable level.

Constant monitoring of surface water is vital to determine the quality of the water by identifying the constituents of pollution and the severity of the contamination. This process is necessary for control purpose not only to gauge the present state of the water but also a mean to trace and identify the sources and magnitude of the pollution. Direct sampling is the most desirable method of locating and quantifying the location and magnitude of contamination but economic factor might be limiting. Time constrain could also restrict the frequencies of sample collection beside the fact that some sample need to be analyzed in a laboratory for some extended length of time before results are obtain.

An alternative solution to this process is to build a mathematical model to simulate the surface water system constituents. Base on the actual result obtained from direct sampling and theoretical analysis of given constituent, that is physical and chemical reaction, a mathematical model can be derived to emulate the said actual physical and chemical process. The mathematical model must be flexible enough to accommodate varying parameter to be analyzed, yet will still yield acceptable level of accurate results. One can build this mathematical model from scratch if enough resources are available such as excellent computer literacy, full understanding of the whole process in surface water system and permitting time for testing. Another option is to adopt any one of the available mathematical model already produced by other party. For the purpose of this study, the second choice is more appropriate and a mathematical model called Enhanced Stream Water Quality Model or QUAL2E is adopted for reason that will be presented below.

1.3 Objective of Study

The goal to which this study will contribute are the verification of the consistency of simulated results of pollutant constituent measurement using mathematical model presented in Enhanced Stream Water Quality Model (QUAL2E) compared with actual data collected on site and analyzed in laboratory. To have a balance comparison, three types of constituents are analyzed, which is conservative constituents, reactive constituents and general water characteristic. The conservative constituent are represented by Iron (Fe), Aluminium (Al) and Manganese (Mn), while the reactive constituent are represented by Phosphorus (P) and Nitrate (N) and general water characteristic is by Dissolved Oxygen (DO), pH and temperature.

The process involved collecting the actual physical data on site for the selected constituents. The location of study site is along Sungai Semberong which stretches for about ten kilometers. These data together with hydraulic data and other geographical properties of the study site is used as input data for the mathematical model (QUAL2E) execution.

Although QUAL2E are known to be a comprehensive water quality simulation model and adopted by Environmental Protection Agency (EPA) of United States of America (US), attention have to be focused to the history and development of it predecessor. QUAL2E families of programme are custom made for EPA (US) and various modifications have been made to suit different job purpose and different environmental condition since its inception. In this study, no attempt is made to modify the programme code if the simulated results show negative compatibility with field data although it is possible to do so. Analysis is only being done on changing combination of the reaction constants and variables to find the most proximate value for local condition. Upon successful verification of the consistency of simulated results, and adoption of reaction constant, subsequent analysis can be made by inputting user forcing function.

1.4 Scope of Study

The scope of this study will focus on the suitability of using QUAL2E to simulate the reactions of common stream water constituents in local geographical conditions base only on data collected from the selected study site. The selected study site is restricted to a ten kilometer stretch of Sungai Semberong from Ayer Hitam to Parit Bingan which is almost uniform in term of characteristic, hydraulic wise, thus results of this study might not be suitable other stream analysis.

Due to the comprehensiveness and the complexity of the model, some of the required user input value cannot be supplied according to the exact local condition. For study purpose, either default value range suggested by user manual or value from previous study is adopted.

CHAPTER II

LITERATURE REVIEW

2.1 Introduction

This chapter will briefly present the background of each topic that is related to the project. The topics are location of study, elements of pollutant and river system modeling selected to carry out the study.

2.2 Semberong River

The selected river system have been studied is part of Semberong River that stretch about ten kilometers, starting from Ayer Hitam and ending just before Parit Raja. The short travel distance from the location of study to Kolej Universiti Teknologi Tun Hussein Onn (KUiTTHO) campus is the main reason for the selection. Prior, a similar study was done on the same location and its function as the source of drinking water are other factors considered.

The whole of Semberong River system can actually be divided into two separate river system with two different catchments areas with the tail end of Banjaran Titiwangsa as the divider. The system on the east side of the mountain range flows eastward, joining with Endau River before discharging into South China Sea. The one on the west side of the range begin at Kluang, flowing westward before joining with Simpang Kanan River before discharging into Strait of Malacca. The west bound river flow almost parallel with federal road 50 and part of this river which stretch about ten kilometer from Air Hitam to Parit Raja is chosen as the study area. The exact location of the study area is shown in Figure 2.1.

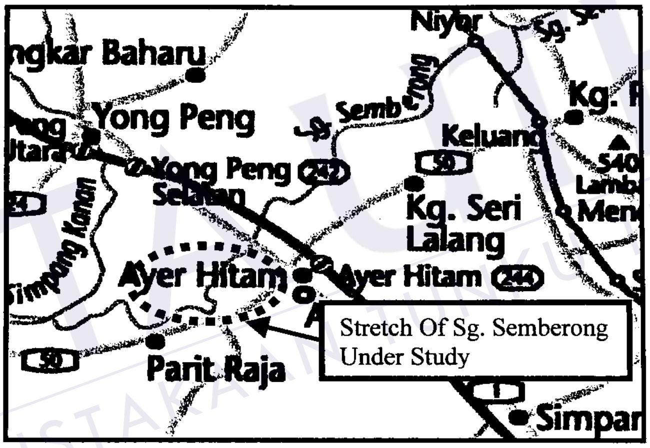

Figure 2.1 : Geographical location of part of Semberong River under study.

The location of the catchments area of the study is primarily utilized as an agricultural and livestock rearing activities. The population density in this area is considered high and they are emergence of industrial activities in the vicinity. The water from the river are drawn and processed for portable consumption downstream of the study location. Further still downstream, the water from the river is drawn once again for consumption at Sri Gading, after it merge with Simpang Kanan River.

2.3 Pollutant

Four types of polluting elements are studied to represent a balanced analysis of the models capability to simulate the river condition.

2.3.1 General Parameter

Although temperature in itself is not considered as contaminant, it is an important parameter that greatly influenced the reaction of other contaminant. In addition to having its own toxic effect, temperature affects the solubility and, in turn, the toxicity of many other parameters. Generally the solubility of solids increases with increasing temperature, while gases tend to be more soluble in cold water. Temperature is a factor in determining allowable limits for other parameters such as ammonia. An important physical relationship exists between the amount of dissolved oxygen in a body of water and its temperature.

Primary sources of heat to a water body are radiation from sunlight. The net incoming solar radiation magnitude that the surface of earth received from the sun depend on altitude of the sun, damping effect of scattering , absorption by clouds cover and reflection by water surface. Other factor that might influence the heat level in a body of water is present of vegetation and flows rate of the stream.

2.3.2 Conventional Pollutant

Dissolved oxygen analysis measures the amount of gaseous oxygen (O_2) dissolved in an aqueous solution. Dissolved oxygen is one of the most important parameters in aquatic systems. This gas is an absolute requirement for the metabolism of aerobic organisms and also influences inorganic chemical reactions. Therefore, knowledge of the solubility and dynamics of oxygen distribution is essential to interpret both biological and chemical processes within water bodies.

Oxygen gets into water by diffusion from the surrounding air, by aeration (rapid movement) and as a waste product of photosynthesis. Oxygen is removed from the water by respiration and decomposition of organic matter. The amount of dissolved oxygen gas is highly dependent on temperature. Atmospheric pressure also has an effect on dissolved oxygen. The amount of oxygen (or any gas) that can dissolve in pure water (saturation point) is inversely proportional to the temperature of water as shown in Figure 2.2.

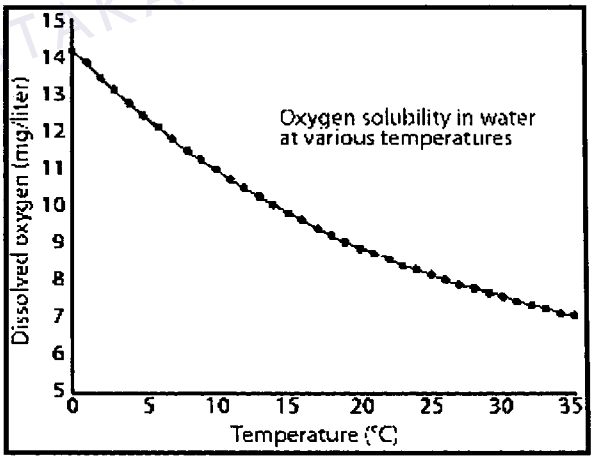

Figure 2.2 : Relation between Dissolved Oxygen with temperature

The amount of oxygen dissolved in water is expressed as a concentration, in milligrams per liter (mg/l) of water. Dissolved Oxygen (DO) levels are also often reported in percent saturation. Temperature affects DO concentrations, and calculating the percent saturation will factor out the effect of temperature. The "saturation level" is the maximum concentration of dissolved oxygen that would be present in water at a specific temperature, in the absence of other factors. Concentration of Dissolved Oxygen in water can be attributed to seven factors which are described in the following sections.

2.3.2.1 Volume and Velocity of Water Flowing in the Water Body

In fast-moving streams, rushing water is aerated by bubbles as it churns over rocks and falls down hundreds of tiny waterfalls. These streams, if unpolluted, are usually saturated with oxygen. In slow, stagnant waters, oxygen only enters the top layer of water, and deeper water is often low in DO concentration due to decomposition of organic matter by bacteria that live on or near the bottom of the reservoir.

2.3.2.2 Climate/Season

The colder the water, the more oxygen can be dissolved in the water. Therefore, DO concentrations at one location are usually higher in the winter than in the summer.

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