

**USING HEC-RAS AND QUAL2E TO ASSESS JOHOR RIVER WATER
QUALITY**

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USING HEC-RAS AND QUAL2E TO ASSESS JOHOR RIVER WATER
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Lastly, to all my fellow friends,

Thanks for everything...

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ABSTRACT

Johor River is a major raw water supplier for a highly populated region, Johor state as well as Singapore. Because of the development over the entire catchment, water quality has become a sensitive matter. For this reason, several studies have been carried out in order to investigate its affects on the environment. Computer simulation and Numerical model are considered as essential and powerful tools in water resources monitoring plan in decision-making process. HEC-RAS is integrated system software designed to perform one dimensional hydraulic calculation. It was used to estimate the hydraulic changes due to the hydrological alteration of Johor River in response to the change of river discharges and to calculate the sediment transport capacity. Also in this study, QUAL2E was used as the water quality modeling analysis tool. It is suitable for one-dimensional analysis with constant flow and it is applied to predict the water quality model for the Johor River. The model was used to simulate both dissolved oxygen (DO) and biological oxygen demand (BOD₅)

along the certain reach of the river. Data was collected from several stations along Johor River, ranging from Rantau Panjang till water treatment plant. Flow rates, depths, loads, dissolved oxygen, and length of the river were measured in the field. Moreover, biochemical oxygen demands concentrations and total suspended solid were measured in the laboratory. Those entire databases were used to supply inputs to the two models. As first time the HEC-RAS has been used to model; and followed by QUAL2E for simulating water quality at Johor River. Also In order to assess the vegetation buffer strips' performance, and because of the reducing of the light penetration, harmful algal blooms, decrease in dissolved oxygen, total suspended solid (TSS) was estimated. All parameters are compared to the Interim National Water Quality Standard (INWQS) provided by Department of Environment (DOE). From the finding, the average concentration of suspended solid was 17.97 mg/l. The trap efficiency for pollution load reduction by vegetation buffer strip was estimated 9.17 % and this value would be bigger during high discharges.

ABSTRAK

Sungai Johor merupakan pembekal air mentah utama untuk daerah yang sangat padat di negeri Johor serta Singapura. Kerana pembangunan pesat, ketinggian air telah menjadi masalah sensitif. Untuk alasan ini, kajian telah dilakukan untuk menyiasat kesan ruyak terhadap persekitaran. Simulasi komputer dan model berangka dianggap sebagai alat penting dan berkuasa dalam pemantauan sumber daya air di dalam proses membuat keputusan. HEC-RAS terintegrasi perisian sistem yang direka untuk melakukan perhitungan hidraulik satu dimensi. Ini digunakan untuk menganggarkan perubahan hidraulik kerana perubahan hidrologi Sungai Johor dalam menanggapi perubahan rejim sungai dan untuk mengira kapasiti pengangkutan sedimen. Juga dalam kajian ini, QUAL2E digunakan sebagai alat analisis pemodelan ketinggian air. Sangat cocok untuk analisis satu-dimensi dengan arus konstan dan itu tersirat untuk memprediksi model ketinggian air bagi Sungai Johor. Model ini digunakan untuk simulasi kedua oksigen terlarut (DO) dan keperluan oksigen biologi

(BOD5) sepanjang liputan tertentu sungai. Data dikumpul daripada beberapa stesen di sepanjang Sungai Johor, pemprosesan air bermula dari Rantau panjang. Nilai Arus, kedalaman, beban, oksigen terlarut, dan panjang sungai diukur di lapangan. Selain itu, permintaan oksigen biokimia dan konsentrasi total pepejal tersuspensi diukur dalam makmal. Kesemua database digunakan sebagai input kepada dua model. Pertama, HEC-RAS telah digunakan untuk model, dan diikuti oleh QUAL2E untuk simulasi high air di Sungai Johor. Juga Untuk menilai prestasi jalur penyangga vegetasi, pengurangan penetrasi cahaya, mekar alga berbahaya, penurunan oksigen terlarut, total suspended solid (TSS) dianggarkan. Semua parameter yang dibandingkan dengan Kualiti Air Kebangsaan Interim Standard (INWQS) disediakan oleh Jabatan Alam Sekitar (DOE). Dari laporan tersebut, maka konsentrasi paurate bahan teranpai adalah 17,97 mg / l. Kecekapan perangkap untuk pengurangan beban pencemaran oleh vegetasi buffer dianggarkan 9.17% dan nilai ini akan lebih besar mengilcut kadar aliram sungai.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Water plays an important role in our daily life and without it no life on the earth. Most activities in our life depend on water such as agriculture, drinking, a medium of transportation and many more. In fact, many great civilizations have started at near to the source of water whether river or stream, such as Mesopotamia, Egypt, and many more.

According to the study of Hydrology, river is defined as a natural stream flow in a channel. River water quality is affected by a wide range of natural and human pollution. The most important of the natural pollution are geological, hydrological and climatic. Water pollution occurs when a body of water is unfavorably affected by the addition amount of bad materials to the water body. It can come from a number of different sources. If the pollution comes from a single source, like oil leak,

we called it, point-source pollution. While, the pollution that comes from many unknown sources called, non-point source pollution. Approximately, all the pollution types affect the immediate area surround for that source. Sometimes the pollution may affect the environment for miles away from the source. The effects of water pollution are not just hurtful for people, but it has effects on habitat such as animals, fish, and birds. It can destroy the aquatic life and reduces its productive ability. It is also hazardous to human health, and overall water supply system.

In Malaysia, there are 1800 rivers comprising 150 systems that run up to 38000 km. As in many part of the world, water from rivers in Malaysia is used extensively for domestic needs, agriculture, drinking, cooking, washing, and many other purposes. One of those rivers is Johor River. It is very important fresh water supply to the treatment plant located at Kota Tinggi which distributed treated water to eater local need. The water quality of Johor River has been deteriorated with increasing level of various pollutants. This contaminant eventually flow into Johor River from the area neighbor it.

Computer simulation and numerical model is one of the best ways for hydrodynamic study and controlling the water quality. It is powerful and essential tool to monitoring plan in making decision related to the parameters of the water quality. We can compile and analyze the hydrodynamic data and the water quality parameters data for a particular length of river to evaluate river water quality.

HEC-RAS is an integrated system composed of separate hydraulic analysis components, data storage and management capabilities, graphics, and reporting facilities. The system ultimately contains three one-dimensional hydraulic analysis

components for (1) steady flow water surface profile computations, (2) unsteady flow simulation, and (3) moveable boundary sediment transport computations. All three components use a common geometric data representation and common geometric and hydraulic computation routines. In addition, the system contains several hydraulic design features that can compute the basic water surface profiles.

Qual2e is a one-dimensional mathematical model. It is available as free software to simulate river water quality. It is a multi-purpose model for determining the quality of stream flow by allowing the simulation of fifteen parameters associated to water quality in any reach of river chosen by researcher. The model is applicable to well mixed streams and considers the transport mechanisms – dispersion and advection – significant only along the main direction of flow (longitudinal direction).

When the discharge decrease as well as the depth of water will reduce, the vegetation buffer strip area will increase within the river. So, this area can play as filter to intercept the sediment transport capacity. Riparian buffer is the area of permanent vegetation (trees, shrubs and grass) neighbor surface water bodies, and are to improve water quality by trapping or removing various non-point source pollutants from over land and shallow subsurface flowing in the same time [14]. It is important to use vegetation buffers in reducing the contaminant to the river especially before or during the high discharges.

1.2 Statement of the Problem

The development over the entire world leads to more concentration on water quality which is considered as a sensitive matter and has affects on humans and environment. The contamination loadings in Johor River come from many sources as a non-point source contamination, when the rain falls on catchment area surround Johor River. The contaminant substances are carried by runoff, and before the contaminants enter the water body, they pass through the buffer zones to pour in watershed or directly to the river. This would create many problems for the water quality status such as decrease in dissolved oxygen, harmful algal blooms, and reduced light penetration. Moreover, the sediment transport capacity also consider as a serious problem which is affect on the flow depth and bed river condition. The study on hydrological characteristics of river is so important for future development especially in water resources engineering in term of water resource management.

The aim of this study is to determine and analyze the concentration of some parameters which are considered as important parameters to cover river water quality. These parameters are Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Total Suspended Solid (TSS), and PH, and also sediment transport capacity for several cross sections. Because the raw water of the Johor River is used to supply the domestic requirement, therefore, all these parameters are compared to the Interim National Water Quality Standard (INWQS) provided by Department of Environment (DOE).

1.3 Objective of Study

1. To estimate a hydrological model for 5000 m of Johor River using HEC-RAS.
2. To predict the fluctuation water level for and sediment transport capacity for different discharge using HEC-RAS.
3. To analyze and simulate water quality for Johor River using QUAL2E program.
4. To estimate the typical concentration of suspended solid and trap efficiency of the vegetation buffer strip along the Johor River.

1.4 Scope of Study

The scope of this study is as follows:

1. Buffer zones identification.
2. Water quality sampling and the analysis in the lab after we bring the samples from the site.
3. IN-SITU testing.
4. Sediment transport capacity calculation.
5. Getting Samples from the river for grain size test.