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DEVELOPMENT OF AN AUTOMATIC MONITORING SYSTEM FOR THE ASSESSMENT OF WATER QUALITY IN GALING RIVER, KUANTAN

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Abstract
The common approach in monitoring river water quality consists of manual sampling and transport the sample to the laboratory for chemical analysis. This approach although it is non-technical and easily reproducible, however it is increasingly difficult if the location of sampling located in remote locations and far away from the urban area. An effective water quality monitoring must be implemented for water resources management in order to overcome this severe condition towards the watershed. Without accurate and intensive data acquisition, the condition of water resources cannot be adequately assessed, effective preservation and remediation programs cannot be run and the evaluation to the monitoring program cannot be successfully evaluated. In this study. Generally, this instrument is used to measure about 10 of water quality parameters which are pH, dissolved oxygen, electric conductivity, turbidity, ammoniacal nitrogen, nitrite, nitrate, phosphate and biochemical oxygen demand. These parameters will be compared according to the standard method APHA 1948.

Keywords: Galing River, LOC, automatic monitoring, standard method APHA 1948

1.0 Introduction

Rivers and streams plays an important roles in order to support human's life including water supply for industry and domestic uses; recreational usage such as swimming and fishing; transportation mode and a mean of waste disposal. Good quality of waters is essential for all living beings not only as for daily usage, but it also can contribute to the economic strength through eco-tourism (Faridah, 2012). For the previous 20 years ago, rapid development and urbanization have led to the water pollution and have polluted many urban rivers by overland run off from point and non-point sources (Yang, 2007). The water quality status of rivers in Malaysia has always been a cause for concern to various local authorities, government agencies as well as public. The quality of river water is directly affected by the amount of waste discharged into the river and its assimilative capacity. Several studies investigating that the pollution problem is dominated by industrial activities, household, markets and various activities that contribute to the water quality problem. Previous study conducted by (Woo, 2010) state that the rapid process in urbanization and industrialization since 1960s had accelerated the degradation of natural ecosystems including aquatic zone. A number of studies have found that rivers in Malaysia are generally considered to be polluted with coherent examples such as Galing River, Klang River and Melaka River basin which is one of the most densely populated area is significantly degraded due to human activities as well as urbanization (Datusahlan, 2013; Faridah, 2012). The increasing needs and limitations on resources for water quality monitoring, emerging tools complement the traditional procedures based on sampling and laboratory analysis. The need for effective water quality monitoring and control system has become more apparent as demand on water supplies increases (Duffy, 2010). Based on the research done by (Karamouz, 2008) state that due to the important role of rivers for supplying water demands and the considerable capital and operational costs of sampling and monitoring systems, the design of an optimal monitoring network as well as economic constraints should be considered The design of a water quality monitoring network is considered as the main component of water quality management including selection of the water quality variables, location of sampling stations and determination of sampling frequencies. A well planned and managed water quantity and quality measuring network can serve as a valuable tool for predicting shifts or trends.

A system, which can provide accurate, real-time, remote monitoring and control capabilities would prove to be a useful tool in water quality monitoring and ensuring the quality standards

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are met. The emerging tools such as automatic monitoring will make it easier. The tools also intended to provide relevant information with additional economic and social benefits (Gagnon, 2007). From the study conducted by (Glasgow, 2004), field measurements for water quality evaluation have depended upon costly, time and labor intensive on-site sampling and data collection. In addition, generally these way have been too limited on temporal and spatial scales to adequately address factors influencing development of events such as harmful algal blooms, oxygen depletion and fish kills. As been stated above, the traditional method in manual sampling is increasingly difficult if the location is located in remote area. Furthermore, as has been carried out by (Teillet, 2001) and (Glasgow, 2004), data utility may be compromised due to the inadequate quality control and quality assurance protocols such as extended holding times before analysis and use of non-standardized methodologies. Same goes with the study conducted by (Yang, 2007) state that accidental pollution often occurred and sometimes identification of water pollutants and polluters was not possible because of the water samples could not be obtain in a timely manner.

This study aimed at assessing the water quality of Galing River using selected physico-chemical properties of river water. The results will form the baseline for monitoring and tracking changes in the water quality as a result of the reservoir's natural dynamic over time or impact of men's activities on the reservoir and its watershed.

2.0 Methodology

2.1 Study Site

Galing River is one of the major contributors to the Kuantan River, which is the main river that flows in the middle of Kuantan, Malaysia. Recent years, rapid growth and development of Kuantan City has led into the worst and serious problem of river in Kuantan especially Galing River. The mouth of the Galing River is directly affected by tides, which travel several kilometres to the upstream of the Galing River. The length of Galing River is about 5 km and it is started from Semambu Industrial Area and its mouth opens to the Kuantan River. Along 5 kilometres, there are many sources and types of pollution along the Galing River such as food courts, residential area, industrial area and also wet markets which developed water quality issues in Galing River. The increasing human activities resulted in poor water quality and the quality is deteriorating day by day in Galing River. The river water quality also been affected by direct discharge of wastewater from point sources and non-point sources around Kuantan City. The extent of the condition is severe enough to downgrade socio-economic activities and degrade the quality of life of the city inhabitants. At this location, there are lot of domestic waste flowing through the Galing River and contribute more than 80% of pollution and the bad quality of the river. Figure 1 summarize the process on how the pollutants from point sources such as residential area, industrial area and also including non-point sources which are from agricultural activities and improperly managed sediment from construction site.

2.2 Process Description

The automatic monitoring system is equipped with water quality sensors such as pH, turbidity, dissolved oxygen, electric conductivity and temperature. It is also equipped with automatic water samplers. It is designed that water sample is pumped flowing through stainless steel pipe into a holding tank inside monitoring stations where water quality sensors are installed and the water sample are taken. In this way, it is possible to protect water quality sensors from damage. Parameters like pH, turbidity, dissolved oxygen, electric conductivity and temperature can be measured in situ and data can be sent immediately by using data logger. Table 1 summarizes the specification of equipment used for automatic monitoring system.

Lab on Chip (LOC) also known as S^3 River Watcher is divided into three parts. The upper part is specialized for Biochemical Oxygen Demand (BOD), Dissolved Organic Carbon (DOC) and Total Organic Carbon (TOC). In the middle part of the instrument, it is mainly for nutritive salt reagent analyzer such as Nitrogen Ammonia (NH^3-N), Nitrate (NO^3), Nitrite (NO^2) and Phosphorus (PO^4). The last part is for pH, turbidity, dissolved oxygen, electric conductivity and temperature. The steps in experimental work are as follows:

i. Biochemical Oxygen Demand (BOD)

LOC can measure BOD concentration by using mathematical model from regression analysis. It is done by the oxidation of filtered sample and

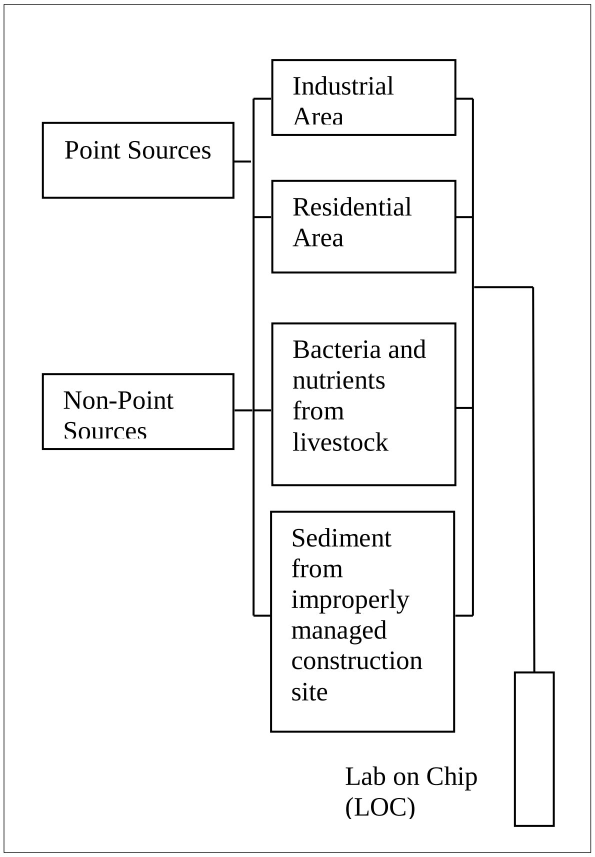

Figure 1: General Layout of Testing Site

the concentration of total carbon (TC) and inorganic carbon (IC) was measured. Both of these value is from the built-in conductivity sensor and from that, dissolved organic carbon (DOC) was measured. At the same time, the instrument measures the filtered sample at UV 254 nm. Both of these will be inserted into the regression analysis and measure the BOD concentration.

ii. Nitrogen Ammonia
In this test, river water sample will be pumped and flow to the nutritive salt analyzer. The ammonia compounds in the sample will combine with chlorine to form monochloramine. 5-aminosalicylate will be formed when monochloramine reacts with salicylate. In the presence of nitroprusside catalyst, 5-aminosalicylate will be oxidized and blue-colored compound will be formed. The ammonia concentration will be read at 655 nm.

Table 1: Specification of equipment used for automatic monitoring system

Item	Range	Unit
Dissolved Oxygen	0 - 20	mg/L
pH	1 - 12	-
Electric Conductivity (EC)	0 - 2000	Micro Siemens (µS)
Turbidity	40 - 40 000	NTU
BOD	0 - 100	mg/L
Nitrogen Ammonia	0 - 2	mg/L
Nitrogen Nitrate	0 - 0.4	mg/L
Nitrogen Nitrite	0 - 0.2	mg/L
Phosphorus	0 - 0.7	mg/L
Sample flow required	100-150	L/min
Cycle time	0-20	minutes

iii. Nitrogen Nitrate
In nitrogen-nitrate test which is also known as cadmium reduction test, cadmium metal reduces nitrates in the sample to nitrite. The nitrite ion reacts in an acidic medium with sulfanilic acid to form an intermediate diazonium salt. The salt couples with gentisic acid to form an amber colored solution that shows the nitrate is present in the sample. This method is technique-sensitive which is shaking time and technique will influence the color development. The results will be tested and measured at 430 nm.

iv.Nitrogen Nitrite
Nitrite is determined through the formation of reddish purple azo dye by coupling diazotized sulfanilamide with NED dihydrochloride. The applicable range of the method for spectrophotometric measurements 10 to 1000 µg NO_2/L.

v. Phosphorus
Phosphorus analyses embody two general procedural steps which are conversion of the phosphorus form of interest to dissolved orthophosphate, and colorimetric determination of dissolved orthophosphate**.** In phosphorus analysis by using ascorbic acid method, the principle is ammonium molybdate ad antimony potassium tartrate react in an acid medium with dilute solutions of phosphorus to form an

antimony-phosphomolybdate complex. This complex is reduced to an intensely blue colored complex by ascorbic acid. The color is proportional to the phosphorus concentration. The sample will be tested and measured at 880 nm.

3.0 Result and Discussion

3.1 Precision and Accuracy testing

The precision and accuracy of S^3 River-Watcher were evaluated by replication test of 6 samples for different water quality parameters with standard reagents. The values of relative standard deviation (RSD) and relative percent difference (RPD) for different water quality parameters were determined for evaluating the precision and accuracy of S^3 River-Watcher, respectively.

Based on the precision evaluation, all water quality parameter except for NH3-N (blank test) met the QA/QC criteria, as proposed in Materials and Methods. The RSD value of pH less than 0.3%, while the RSD values of turbidity, NO2- were less than 5%, which indicating the measurement obtained from S3 River-Watcher is precise. On the other hand, for the accuracy evaluation, the RPD values of pH and NO2- were less than 5%, indicating an accurate technique using S3 River-Watcher. The RPD value of NO_3- (i.e., 16%) was found to be less than 20%, which meets the QA/QC criteria as proposed in the research project. However, for the water quality parameters including NO_2- and NH_3-, the RPD values were greater than 20%. It suggests that calibration and validation for the software sensor should be implemented based on the water quality parameter of Galing River.

4.0 Conclusion

Efforts to improve public awareness to the good quality of the river water have been focused on obtaining real-time estimates of water quality. Recently, researchers have shown an increased interest in remote sensing system and real-time monitoring system of water quality. The tremendous developments of communication and sensor technology have catalysed progress in remote capabilities of monitoring water qualities. These advances have led to improved statistical and mechanistic modeling in monitoring of water quality trends at local, watershed and regional scales for freshwater, estuarine and marine ecosystem. Accurate information of pollutant concentrations from basin area and watershed is the essential factor for the development of effective water quality management system. Using the developed system in this study, it is possible to accurately estimate water pollutant concentration in time and to develop pollutograph for a river basin. Automatic water quality monitoring system will initiate entire real time environment control in basin scale. This system can be used to protect environment in basin and in surface water more effectively.

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