UNIVERSITI TEKNOLOGI MARA

WATER QUALITY MONITORING USING LOW-COST DIGITAL CAMERA

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ABSTRACT

Water quality describes the physical, chemical and biological characteristic of water that relates to human and nature life. Water quality parameters consist of Total Suspended Solids (TSS), turbidity, Secchi Disk Depth (SDD), temperature and colour. Example of factors affecting the quality of water bodies (i.e. lakes and reservoirs) are urban runoff, solid waste and soil erosion. Several methods i.e. conventional method, satellite remote sensing method, and digital camera method can be used to determine water quality parameters. Conventional method involves collecting water sample and laboratory analysis. This method is time consuming and not efficient to represent water quality of large area. Satellite remote sensing techniques using various sensors i.e. Landsat, Moderate Resolution Imaging Spectroradiometer (MODIS), IKONOS and Tiungsat-1 can be used to assess several water quality parameters (i.e. TSS, turbidity, chlorophyll and SDD) on large area coverage. Although this method can be used to monitor water quality of large area, image acquisition and data processing are costly and time consuming. A number of studies have utilized digital cameras to determine the water quality parameters; the results are still not conclusive. The aim of this study is to access the potential use of low-cost digital cameras in water quality assessment. Based on this aim, the objectives are i) to determine the relationship between digital number (DN) and TSS concentrations using different digital cameras; ii) to determine turbidity concentrations based on the calculated TSS values and iii) to compare TSS and turbidity concentration based on different models, different digital cameras and different dates of study area. The study areas for this research are two lakes located at Section 7 and Section 14 (Taman Tasik Shah Alam). This study only concentrates on two water quality parameters (i.e. TSS and turbidity). Two digital cameras (i.e. Olympus FE-100 and I-iC2070) each costing less than RM1000 were used to capture image of the water surface. The methodology adopted for this research involve i) collecting water samples, ii) capturing digital images of water surface, iii) data analysis (including regression analysis and generating water quality maps of the study area). Water samples collected in these two lakes were processed in the laboratory to determine the TSS and turbidity concentrations. Digital images captured on three different dates i.e. 1st and 15th September 2006 and 23rd November 2006 were used to determine the regression models (or relationship between DN and water quality concentration). Images acquired on the 8th and 15th February 2007 were used to generate TSS and turbidity maps of Tasik Shah Alam. Kriging interpolation module in the ArcGIS 9.0 software is used to generate the water quality maps of the study area. Linear regression algorithm is used to determine the relationship between DN and TSS concentrations and relationship among water quality parameters (i.e. TSS and turbidity). The relationship between TSS and turbidity concentration is $R^2=0.73$. Six multiple regression models have been developed by the author to relate the DN of the two digital cameras and TSS concentrations. The highest correlation ($R^2=0.96$, RMSE=±7.94 Model 3) using multiple regression model is obtained using Olympus FE-100 digital camera. Results obtained from the Olympus FE-100 digital camera differ slightly with obtained from I-iC2070 digital camera. The correlation between different models ranged from 0.94 to 0.96 for Olympus FE-100 digital camera and 0.93 to 0.95 for I-iC2070 digital camera. Findings from this research have shown that images acquired from low-cost digital cameras can be used to assess water quality.

ACKNOWLEDGEMENTS

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CHAPTER 1

INTRODUCTION

1.1   Background

Rapid urbanization and the hope of improving better living has increased the demand of water supply for irrigation, recreational, industrial, mining, fisheries and domestic purposes. High demand for water supply had caused several problems such as water pollution, shortage of water supply and flood. Currently, Malaysia has often encountered environmental issues and one of the problems is water pollution. The main source of water pollution is due to agricultural activities, logging activities, illegal factories, manufacturing activities, urban runoff and land development activities. The water pollution could threaten water quality and harm human health. In addition, water pollution can destroy the ecosystem and smother the habitat. According to Li and Li (2004), pollution can break the ecological balance and contribute to a permanent loss of the once transparent lake.

Department of Environment (DOE), Department of Irrigation and Drainage (DID) and Alam Sekitar Malaysia Sdn. Bhd. (ASMA) are among the organizations responsible to monitor the water quality in Malaysia. Environmental Quality Act (EQR) (1974) is one of the principal legislations in Malaysia regulating to prevent and control pollution of inland water as well as Malaysian waters. Based on the report by DOE (1997), the number of polluted rivers has increased from 13 in 1996 to 25 in 1997 while the number of clean rivers decreased from 42 in 1996 to 24 in 1997 in terms of water quality index (e.g. Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Ammoniacal Nitrogen (AN), Suspended Solids (SS), acidity (pH) and Dissolved Oxygen (DO)).