UNIVERSITI TEKNOLOGI MARA

SPATIAL DISTRIBUTION OF WATER QUALITY IN RELATION TO PHYTOPLANKTON ABUNDANCE OF SELAT TUBA, LANGKAWI

HASMIDA BINTI MUHAMAD

Thesis submitted in fulfilment
of the requirements for the degree of
Master of Science
(Built Environment)

College of Built Environment

February 2024

ABSTRACT

Phytoplankton is a microscopic marine alga that is mostly buoyant and floats in the upper part of the water body. Despite its size, it plays a vital role in sustaining the biological clock of marine life by serving as one of the primary providers of food and oxygen. However, their abundance greatly depends on the water quality of their habitat. The structure of the phytoplankton population changes in response to changes in water quality and other regulatory factors, which may or may not have an impact on the animal community and may result in a general loss of biodiversity, including a decline in fish production. Thus, this study aims to assess the water quality parameters (WQP) at Selat Tuba River by i) evaluating the spatial interpolation (IDW and Kriging models) for WQP estimation, ii) establishing a correlation between WQP and phytoplankton abundance, and iii) establishing regression equations for phytoplankton abundance. The WQPs involved are salinity, dissolved oxygen, Secchi disc depth, temperature (temp), and pH. The WQP and phytoplankton abundance were collected by in-situ sampling and assessed by laboratory experiments. The in-situ water samplings consist of 113 points and about 36 points for phytoplankton that were collected in December 2020 and December 2021. For the laboratory experiment, each individual phytoplankton was calculated in every 1 ml of water, and the total phytoplankton abundance was calculated in ind/mg^3 units. To reduce uncertainty errors in the WQP, a Monte Carlo uncertainty analysis has been conducted. Spatial interpolation (IDW and Kriging models) was applied and tested; 70% and 30% of the water sampling data were used for model development and verification, respectively. The root means square error (RMSE) and mean absolute error (MAE) are applied to measure the goodness of fit of the regression equation for WQP estimation. The study found that pH and DO have the strongest correlation (0.948), while salinity and temperature have the lowest correlation (0.368). The IDW provides more robust models to estimate DO, pH, and temperature, with RMSE values of 0.517, 0.084, and 0.450, respectively. The optimal regression model for phytoplankton abundance estimation has an RMSE of 11.451 and an R^2 of 0.3740. This study contributes to establishing the final regressions that can be employed to estimate water quality and phytoplankton abundance at the mangrove area as well as support the fishing industry's economy. Overall, the relationship between each WQP and phytoplankton had been established, the IDW interpolation model is proven to serve a more stable model compared to Kriging, and lastly the regressions for WQP and phytoplankton estimation has been established.

ACKNOWLEDGEMENT

First and foremost, Alhamdulillah and immense gratitude to Allah s.w.t for giving me chances in pursuing another improvement in my life. I would like to express my deepest gratitude to my thesis advisor, Dr Ernieza Suhana Mokhtar, and co-adviser En. Muhammad Akmal Roslni. Their valuable guidance, unwavering support, and insightful feedback have been instrumental throughout the entire process. Their expertise in the field has pushed me to think critically, expand my research skills, and further develop my writing skills. I would also like to extend my sincere thanks to the members of the the group committee during data collection for their valuable contributions and input, their expertise and constructive criticism have immensely helped in shaping the quality and depth of my research. I am truly grateful for the opportunity to have had them as part of my committee. Furthermore, I would like to acknowledge the staff of the university library and laboratory who provided me with access to numerous research and materials that were pivotal to the success of my thesis. I am also indebted to research Universiti Teknologi MARA for funding my research through Lestari SDG grant 2019, I am grateful for the support provided, which has greatly contributed to the successful completion of my research project. Finally, I would like to express my heartfelt gratitude to both of my parents En. Muhamad and
for their endless love, understanding, and continuous encouragement throughout the entire thesis process. Without them, I would not be here today completing this research.

TABLE OF CONTENTS

CHAPTER 1
INTRODUCTION

1.1 Background of Study

Phytoplankton is a component of nature's maritime food cycle and an indigenous source of oxygen for both animals and humans (Shams et al., 2012). The community structure of phytoplankton may alter in response to nutrient status and other regulatory factors, which may be influenced by water quality conditions that affect phytoplankton abundance (Veronica, 2014). Water is essential to phytoplankton's ability to absorb and utilise nutrients for growth. It also enhance water quality by removing harmful substances and absorbing nutrients while removing ammonia and nitrogen (Boyd, 2017). Several variables, such as salinity, temperature, pH, dissolved oxygen (DO), and chlorophyll-a, may affect the composition of phytoplankton as well as the water quality (Abdu & Lake, 2018). Additionally, phytoplankton-produced oxygen may increase the quantity of DO in the water (Shaharuddin et al., 2019). Several studies on the relationship between water quality parameters and phytoplankton abundance have been conducted, emphasizing the importance of water quality for phytoplankton abundance (Medupin, 2011; Shaharuddin et al., 2019). Although monitoring the water quality at phytoplankton abundance is critical, the sampling and laboratory measurement method have several drawbacks, including labour intensiveness and cost (Gholizadeh et al., 2016).

Many studies have established mathematical models such as linear regressions to estimate the parameters for water quality parameters (Chen & Liu, 2015; Pereira et al., 2020; Ravichandran & Ramakrishnan, 2007). Commonly, linear regression was created and evaluated to determine how strongly the water quality factors may influence one another (Pereira et al., 2020; Ravichandran & Ramakrishnan, 2007). However, during the development to estimate the water quality conditions, it is difficult to minimise measurement uncertainty resulting from random and/or systematic errors made during the data collection procedure and reflected in the observed data (Farrance & Frenkel, 2016). In an effort to reduce inaccuracy and evaluate the dependability of the observed data, past research has utilised uncertainty analysis (Mokhtar et al., 2018; Roberto & Couto, 2013; Sonnemann et al., 2003). Generalized likelihood uncertainty