BIOGEOCHEMICAL CYCLING OF NUTRIENTS AND SELECTED METAL IONS IN THE PADAVIYA RESERVOIR

By

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PhD

2019

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Thesis submitted to the University of Sri Jayewardenepura
for the award of the Degree of Doctor of Philosophy

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The work described in this thesis was carried out by me under the supervision of Senior Prof. Sudantha Liyanage and Dr. Asitha Cooray and a report on this has not been submitted in whole or in part to any university or any other institution for another Degree/Diploma

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LIST OF ABBREVIATIONS

TP	Total Phosphorus
TOM	Total Organic Matter
UV	Ultra Violet
AAS	Atomic Absorption Spectroscopy
FAAS	Flame Atomic Absorption Spectroscopy
GFAAS	Graphite Furnace Atomic Absorption Spectroscopy
FTIR	Fourier Transform Infrared Spectroscopy
ATR-FTIR	Attenuated Total Reflectance Fourier Transform Infrared Spectroscopy
WQI	Water Quality Index
SQG	Numerical Sediment Quality Guidelines
TEC	Threshold Effect Concentration
PEC	Probable Effect Concentration

ACKNOWLEDGMENT

I would first like to thank my supervisors Prof. Sudantha Liyanage and Dr. Asitha Cooray of the Department of Chemistry, Faculty of Applied Sciences, University of Sri Jayewardenepura with great respect and honor for the guidance and encouragement throughout my research project. The door to Prof. Sudantha Liyanage and Dr. Asitha Cooray were always open whenever I ran into a trouble spot or had a question about my research or writing.

I would also like to extend my special thanks to the University Research Grants (ASP/06/RE/SCI/2015/26 and ASP/01/RE/SCI/2017/15 for financial support, Instrument Centre the Department of Chemistry, University of Sri Jayewardenepura for providing required facilities to carry out my research successfully.

Finally, I must express my very profound gratitude to my parents to my loving friends (especially our research assistant family) for providing me with unfailing support and continuous encouragement throughout my years of study and through the process of researching and writing this thesis. This accomplishment would not have been possible without them.

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Chamika Siriwardhana

ABSTRACT

Lakes, reservoirs, rivers, and aquifers are important freshwater sources. The anthropogenic influences on the natural environment, especially on freshwater resources, have increased dramatically during the last few decades. There are thousands of reservoirs in Sri Lanka, but only a handful of them have been extensively studied and monitored. Padaviya reservoir is a medium-sized reservoir in the Anuradhapura District. The reservoir is permanent, but subject to wide seasonal fluctuations in water level due to dry and wet climate conditions. Other than that, a minimal amount of information is known about the input and biogeochemical cycling of nutrients and trace elements. This study investigates the spatial and seasonal variations in water quality of Padaviya Reservoir by studying the inputs to the reservoir, vertical distribution and cycling of physical parameters and inorganic nitrogen species: ammonia, nitrite and nitrate, phosphate, dissolved oxygen, metal distribution, and stable isotopes. In addition, sediment total phosphorus content (TP), total organic matter content (TOM), sediment pH, acid-soluble metal content, and mineralogical composition of sediments were analyzed using standard methods during 2016 January to 2019 December. Sharp chemical gradients for ammonia, nitrite, nitrate, reactive phosphate and dissolved oxygen were observed between the surface and bottom waters of the reservoir, suggesting that it does not overturn completely. The maximum temperature difference between the surface and bottom waters of about 2 °C, which is not large enough to cause thermal stratification. The most probable reason for the stratification is extensive

photosynthesis at surface waters with the subsequent decomposition of organic material at the bottom, which enable bottom loading and affecting biogeochemical cycling. The anoxic, oxygen-depleted conditions in bottom layers support the loading of Fe, Mn, Zn, Cd from lake sediments except for Arsenic. Besides that, water quality index revealed that the Padaviya Reservoir surface water index value for drinking, aquatic, and recreation were recorded as poor, irrigation and livestock were good and excellent respectively. The stable isotope fluctuations were extremely stable, and data indicates intensive evaporation during sampling periods. Padaviya shows lack of vertical isotopic stratification despite the vertical distribution of temperature and a few chemical parameters. Sediment analysis results obtained from this study show that the average TP in the surface sediment was higher than the other eutrophic lakes and reservoirs in the world. There is no significant change of TP with the depth of the sediment; however, bottom sediments were slightly enriched with phosphate compared to surface sediments. Therefore, phosphate rich sediments can release phosphate back into the water column by dissolution and desorption and increasing the bioavailable pool of phosphate, may suggest the development of eutrophication processes during the wet season. The abundance of metals in sediment is Fe> Mg> Mn> Ca> Cr> Zn> As> Cd> Pb. The acid-soluble Fe concentration in the sediment was significantly higher than that of other metals. This richness can derive from weathering of surrounding rocks carried by upstream rivers. These results indicate that Padaviya sediments have a moderate level of organic matter content and slightly acidic medium. The ATR-FTIR spectra indicated wave numbers closely match with montmorillonite, kaolinite, muscovite, and quartz minerals.

Keywords - Padaviya Reservoir, Clinograde, Chemical gradients, Nutrients, Anoxic