SURFACE WATER QUALITY ASSESSMENT USING A REMOTE SENSING, GIS, AND MATHEMATICAL MODELLING FRAMEWORK

Abstract

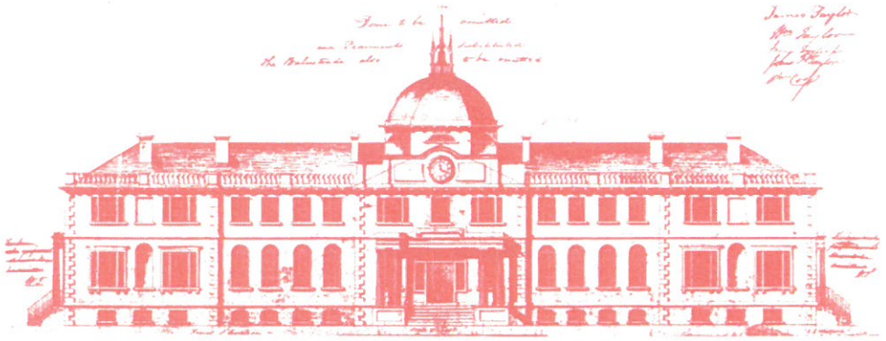
The presence of various pollutants in water bodies can lead to the deterioration of both surface water quality and aquatic life. Surface water quality researchers are confronted with significant challenges to properly assess surface water quality in order to provide an appropriate treatment to water bodies in a cost-effective manner. Conventional surface water quality assessment methods are widely performed using laboratory analysis, which are labour intensive, costly, and time consuming. Moreover, these methods can only provide individual concentrations of surface water quality parameters (SWQPs), measured at monitoring stations and shown in a discrete point format, which are difficult for decision-makers to understand without providing the overall patterns of surface water quality.

In contrast, remote sensing has shown significant benefits over conventional methods because of its low cost, spatial continuity, and temporal consistency. Thus, exploring the potential of using remotely sensed data for surface water quality assessment is important for improving the efficiency of surface water quality evaluation and water body treatment.

In order to properly assess surface water quality from satellite imagery, the relationship between satellite multi-spectral data and concentrations of SWQPs should be modelled. Moreover, to make the process accessible to decision-makers, it is important to extract the accurate surface water quality levels from surface water quality raw data. Additionally, to improve the cost effectiveness of surface water body treatment, identifying the major pollution sources that negatively influence water bodies is essential.

Therefore, this PhD dissertation focuses on the development of new techniques for (1) estimating the concentrations of both optical and non-optical SWQPs from a recently launched earth observation satellite (i.e., Landsat-8), which is freely available and has the potential to support coastal studies, (2) mapping the complex relationship between satellite multi-spectral signatures and concentrations of SWQPs, (3) simplifying the expression of surface water quality and delineating the accurate levels of surface water quality in water bodies, and (4) classifying the most significant SWQPs that contribute to both spatial and temporal variations of surface water quality.

The outcome of this PhD dissertation proved the feasibility of developing models to retrieve the concentrations of both optical and non-optical SWQPs from satellite imagery with highly accurate estimations. It exhibited the potential of using remote sensing to achieve routine water quality monitoring. Moreover, this research demonstrated the possibility of improving the accuracy of surface water quality level extraction with inexpensive implementation cost. Finally, this research showed the capability of using satellite data to provide continuously updated information about surface water quality, which can support the process of water body treatment and lead to effective savings and proper utilization of surface water resources.



Home of the School of Graduate Studies, Sir Howard Douglas Hall was designed by J.E. Woolford in 1825 and is the oldest university building in Canada still in use.

UNIVERSITY OF NEW BRUNSWICK

SCHOOL OF GRADUATE STUDIES

ORAL EXAMINATION

Essam Sharaf El Din

IN PARTIAL FULFILMENT
OF THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

Ph.D. Candidate

Essam Helmy Mahfouz Sharaf El Din

Graduate Academic Unit

Geodesy & Geomatics Engineering

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July 19, 2018

2:00 p.m.

Head Hall
Room E-11

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Examining Board:
Dr. Yun Zhang (Geodesy & Geomatics Eng.) Supervisor
Dr. David Coleman (Geodesy & Geomatics Eng.)
Dr. Ian Church (Geodesy & Geomatics Eng.)
Dr. Katy Haralampides (Civil Eng.)

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Dr. Quazi K. Hassan
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The Oral Examination will be chaired by:
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2015-present	PhD candidate, University of New Brunswick
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Publications:

Peer Reviewed Journal Papers:

Sharaf El Din, E., Zhang, Y., & Suliman, A. (2017). Mapping concentrations of surface water quality parameters using a novel remote sensing and artificial intelligence framework. *International Journal of Remote Sensing, 38 (4)*, pp. 1023- 1042. http://dx.doi.org/10.1080/01431161.2016.1275056

Sharaf El Din, E., & Zhang, Y. (2017). Improving the accuracy of extracting surface water quality levels (SWQLs) using remote sensing and artificial neural network: a case study in the Saint John River, Canada. *International Archives of the Photogrammetry, Remote Sensing, and Spatial Information Sciences,* XLII-4/W4, pp. 245-249, https://doi.org/10.5194/isprs-archives-XLII-4-W4-245-2017.

Sharaf El Din, E., & Zhang, Y. (2017). Estimation of both optical and non-optical surface water quality parameters using Landsat-8 OLI imagery and statistical techniques. *Journal of Applied Remote Sensing, 11 (4)*, 046008 (2017), doi: 10.1117/1.JRS.11.046008.

Sharaf El Din, E., & Zhang, Y. (2018). Assessment of spatio-temporal surface water quality variations using multivariate statistical techniques: a case study of the Saint John River, Canada. *Journal of the American Water Resources Association,* submitted.

Sharaf El Din, E., & Zhang, Y. (2018). Delineating the accurate patterns of surface water quality by integrating Landsat-8 OLI imagery, artificial intelligence, and the water quality index. *Remote Sensing of Environment,* submitted.

Peer Reviewed Conference Papers:

Sharaf El Din, E., & Zhang, Y. (2017). Statistical estimation of the Saint John River surface water quality using Landsat-8 multi-spectral data. *ASPRS Annual Conference 2017. Proceedings of Imaging & Geospatial Technology Forum (IGTF). March 12- 17, Baltimore, US.*

Sharaf El Din, E., & Zhang, Y. (2017). Neural network modelling of the Saint John River sediments and dissolved oxygen content from Landsat OLI imagery. *ASPRS Annual Conference 2017. Proceedings of Imaging & Geospatial Technology Forum (IGTF). March 12-17, Baltimore, US.*

Sharaf El Din, E., & Zhang, Y. (2017). Using remote sensing and artificial intelligence to improve the accuracy of surface water quality level extraction: a case study in the Saint John River, Canada. *ISPRS International Joint Conference 2017. Commission IV, ISPRS WG IV/3. October (07-10), Tehran, Iran.*

Conference Abstracts:

Sharaf El Din, E., & Zhang, Y. (2018). Application of multivariate statistical techniques in the assessment of surface water quality in the Saint John River, Canada. *UNB Annual Graduate Research Conference (GRC). March 23, Fredericton, Canada.*