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PROOF RESEARCH PAPER

Monitoring Eutrophication Trends in Bolgoda North Lake, Sri Lanka by Satellite Remote Sensing

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Abstract

This study was aimed to determine the present level and past trends of eutrophication of the Bolgoda North lake, Sri Lanka using *in situ* Chlorophyll-a (Chl-a) measurements and remote sensing data obtained from Advanced Space-borne Thermal Emission and Reflectance Radiometer (ASTER) satellite data. From March to October 2013, Chl-a, nitrate and phosphate contents of the lake were measured once a month on the days of ASTER overpass and using standard laboratory methods. Cloud-free ASTER images of the lake for the 2000-2013 period were atmospherically corrected using Fast Line-of-sight Atmospheric Analysis of Hypercubes (FLAASH) and *in-situ* Chl-a data were regressed with atmospherically corrected three ASTER Visible and Near Infrared band ratios of the same date. The green/red band ratio, which had the highest coefficient of determination, was used to develop algorithm for generation of 15-m resolution Chl-a distribution maps. Results indicated that eutrophication of this lake has increased from 2008 to 2011. Heavy eutrophic conditions were noted in several regions of the lake in 2013, especially in water stagnant areas and adjacent to freshwater inlets. Unplanned urbanization and inadequate facilities for waste management have resulted in heavy eutrophication of the water body. If the present trends of waste disposal and unplanned urbanization continue, enormous environmental problems would be resulted in future.

Keywords: ASTER, Bolgoda North Lake, chlorophyll-a, eutrophication, Sri Lanka.

Introduction

Although chlorophyll-a (Chl-a) is widely used as a measure of the trophic condition of water bodies (Jayasiri and Dahanayaka, 2009; Huang *et al*., 2010), it is not easy to monitor the Chl-a content over a large area continuously by conventional methods of *in-situ* sampling because of high cost, manpower and time consumed. Therefore, *in-situ* measurements do not provide sufficient information on the spatial and temporal variations of environmental parameters of aquatic systems, which are essential for their proper management (Ritchie *et al*., 2003). Chl-a determination through satellite sensors offers several advantages over traditional monitoring techniques. Because of the high altitude of the satellite large area can be monitored including the areas where accessibility is difficult or impossible (Pattiaratchi *et al*., 1994). Satellite imageries are useful also in studying past trends even when *in-situ* data are not available (Dahdouh-Guebas, 2002). Most Chl-a retrieval algorithms developed using remote sensing data are for waters where color is mainly due to Chl-a with little amount of suspended particles and dissolved color substances. However, in most coastal and inland waters suspended particles and dissolved substances also contribute to the color and interfere with the spectral signal of Chl-a (Pattiaratchi *et al*. 1994, Dall'Olmo *et al*.2005, Tzortziou *et al*. 2007). Hence satellite imageries have to be correlated with *in-situ* data (Dahanayaka *et al*., 2011,2012, 2013)

Natural eutrophication is a slow and gradual process, occurring over many centuries as nutrient-rich soil washes into lakes. However, human-induced eutrophication occurs within a short period of time (Addy and Green, 1996).Nutrients responsible for eutrophication are mainly nitrates and phosphorus as they contribute to heavy growth of algae (Bachmann, 2011).

Trophic state of water bodies has been categorized according to phosphorus concentration. Lakes with phosphorus concentrations of <10 µg/L are classified as oligotrophic lakes and those with 10-30 µg/L of phosphorous are categorized as mesotrophic lakes, while those with >30-100 µg/L of phosphorous are classified as eutrophic lakes (Bronmark and Hansson, 2005). When the dissolved oxygen concentration is low, most of the nitrates in