Development of Framework in Estimating Chlorophyll-a Concentration by Excluding the Impact of Aquatic Plants in Lake Biwa Using Landsat-5 TM Data, as a part of Satellite, Computational, and Field Integrated Monitoring Systems.

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Abstract. The South Basin of Lake Biwa is known as a eutrophic lake basin, with massive algal bloom since the 1970's. Recently, from the early 1990's to 2010's, a regime shift occurred from harmful cyanobacterial bloom into massive bloom of aquatic plants such as *Egeria densa*. This provides serious difficulties in monitoring Chlorophyll-a concentration by remote sensing techniques; as massive aquatic weeds cause significant overestimation when converted into final Chlorophyll-a concentration, due to the similarity of these substances.

In this study, we attempted to propose techniques to exclude the impact of aquatic plants when performing Chlorophyll-a concentration measurements, using remote-sensing techniques, together with an effective algorithm to convert into Chlorophyll-a concentration.

Through comparison with field observation datasets of aquatic plants, we observed an increase of Digital Numbers by 1.3(B1), 0.75(B2), 0.2(B4), 0.2(B5) and 0.55(B7) respectively, when the coverage of aquatic plants decreased by 25%. Using these findings, prediction of Chlorophyll-a concentration in the eutrophic south basin improved significantly. The proposed technique is being implemented as integrated manner, combining Satellite, Computational, and Field Integrated Monitoring Systems for Lake Biwa in order to observe the status of the lake in effective manner.

Keywords: Chlorophyll-a, satellite, remote sensing, lake, acatic plant.

1. INTRODUCTION

Lake Biwa is located in Shiga Prefecture in the middle of Japan. As the biggest lake in Japan, it is an important water resource in the Kansai district, providing drinking water for over 14 million people. The South Basin of Lake Biwa is known as a eutrophic lake basin, with massive algal bloom since the 1970's, due to heavy population density and shallow depth. Recently, from the early 1990's to 2010's, a regime shift occurred from harmful cyanobacterial bloom into massive aquatic plants such as *Egeria densa*. This provides serious difficulty in monitoring Chlorophyll-a concentration by remote sensing techniques, as massive aquatic weeds cause overestimation when converted into final Chlorophyll-a concentration, due to the optical similarity of these substances. To circumvent this, differentiation (separation, distinction) of these substances using remote sensing information comparing field observation is required. In this survey, we introduce a conceptual framework to reduce the effect of aquatic plants when applying remote sensing output into the eutrophic basin.

2. STRUCTURE OF THE SURVEY

The goal of the survey is to establish an effective framework to obtain field observation data of aquatic plant distribution, together with corresponding Chlorophyll-a concentration, and including species of phytoplankton in the field. We started by taking an initial survey using long-term observed Chlorophyll-a concentration and satellite data to follow decadal trends of the water quality. The Landsat-5 TM Level 1 product is has satellite data that is used for five scenes from 1984, 1989, 1994, 1997 and 2002. The value of water observation point of Band 1 was (0.45 - 0.52 μm), Band2

(0.52 - 0.60 μm), Band3 (0.63 - 0.69 μm), Band4 (0.76 - 0.90 μm), Band5 (1.55 - 1.75 μm), and Band7 (2.08 - 2.35 μm) respectively. The Chlorophyll-a data was obtained from the Water Information System of Ministry of Land, Infrastructure and Transport, together with routine observation results from the Lake Biwa Environmental Research Institute (LBERI). Water plant distribution data was also obtained from LBERI observation for 1997.

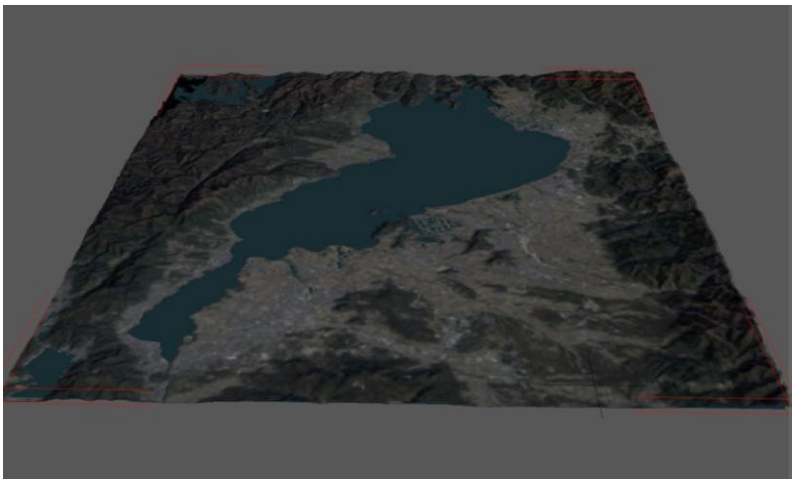

Figure 1 Three dimensional texture for Lake Biwa created from Satellite Image and ASTER GDEM

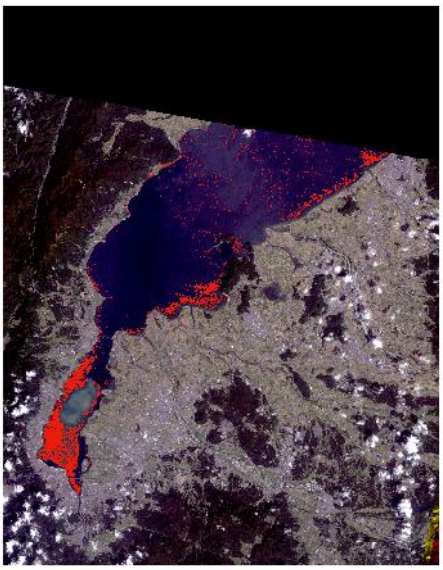

Figure 2 Reproduced distribution of aquatic plants using Lyzeng BI model (Teramoto 2015).

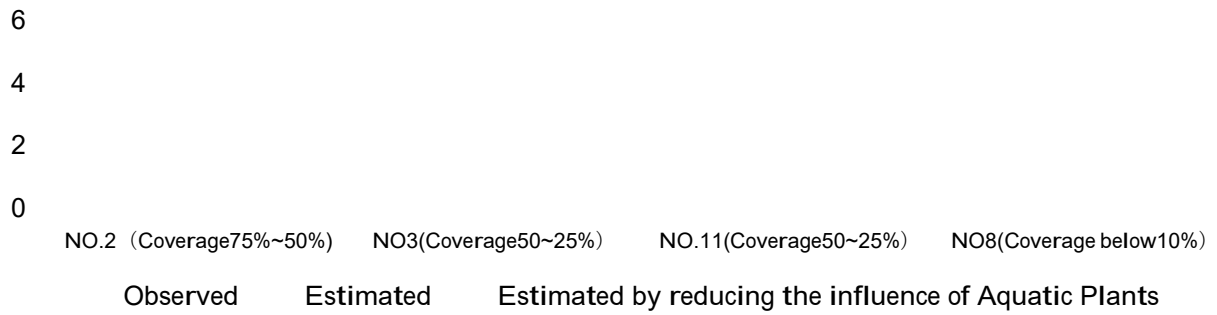

Figure 3 Improvement of the results of Chlorophyll-a concentration by remote sensing by eliminating effect of Aquatic Plants

3. RESULTS AND DISCUSSIONS

This satellite based monitoring is being implemented as integrated manner, combining Satellite, Computational, and Field Integrated Monitoring Systems for Lake Biwa in order to observe the status of the lake in effective manner. Satellite-based information provides preliminary assumptions in the eutrophic status of the lake. The missing information through the satellite-based monitoring results is interpolated by both numerical model and field observation results by portable sensor, creating three-dimensional distribution of the lake water quality.

Satellite image combined with ASTER GDEM data is compiled to create three-dimensional texture in visualizing whole structure of the lake condition, as shown in Figure 1. Figure 2 shows recreated distribution of water plants in the bottom of the lake for the year 1997 using Lyzeng BI model. Figure 3 illustrates improvement of Chlorophyll-a concentration estimation excluding effect of aquatic plants. We observed that the value of Digital Number is increasing by 1.3(B1), 0.75(B2), 0.2(B4), 0.2(B5) and 0.55(B7) respectively when the coverage of aquatic plant is decreasing 25%. The results are compiled using this relationship.

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Figure 1 Created

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