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Estimation for water surface temperature distribution in Lake Shinji and Lake Nakaumi using Landsat-8 TIRS data

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Lake Shinji and Lake Nakaumi are brackish water lakes with the rich biological resources represented by Corbicula japonica. However, the abrupt increase of blue-green algae or the spontaneous expand of aquatic macrophytes are anxious about the influence on such a biological resources of the lake in recent years. Therefore, various monitoring methodology for the elucidation of those generating mechanisms is examined. The satellite remote sensing is expected as a leading monitoring tool. Especially water temperature is important as most fundamental physical parameter. On the other hand, the Landsat-8 in the field of satellite remote sensing on February 11, 2013 was launched by NASA/USGS. This satellite has been continuing observation with 16 diurnal periodicity. The thermal infrared sensor (spatial resolution of 100 m) called TIRS (Thermal Infrared Sensor) with the multiple-spectrum sensor at visible and near- infrared bands with a spatial resolution of 30 m called OLI is carried in this satellite. Since high quantization (12 bits) and 2 band of TIR are realized as compared with conventional Landsat-7, more highly precise WT distribution estimation is expected. So, in this paper, to develop the surface water temperature (SWT) estimation by MCSST (Multi Channel Sea Surface Temperature) algorithm in these lakes using TIRS sensor and the accuracy was checked. Moreover, the SWT distribution characteristic in these lakes was considered using the proposed algorithm. The satellite data used is ten scenes from April to December, 2013. The Landsat-8 TIRS Leve l 1 product data was downloaded through the Internet site ”Earth Exploler.” The average value of 3x3 pixels of Band10 (10.6 - 11.2 μm) and Band11 (11.5 - 12.5 μm) in these lakes was extracted from the obtained satellite data. The data was changed into brightness temperature (BT). On the other hand, the SWT data at 1.0 meters under water was obtained from the Water Information System of Ministry of Land, Infrastructure and Transport. Moreover, MCSST (Multi Channel Sea Surface Temperature) which can reduce the air effect using two bands at thermal infrared for WST estimation from TIRS data was adopted. 19 datasets in the center of these lakes were used for development of MCSST. Three datasets acquired to the Yonago Bay were used for validation. WST estimation accuracy is expressed by average (bias) and standard deviation (error) of the residual substance of in-situ WST and satellite estimation WST. The WST accuracy using the single band algorithm of TIRS Band 10 and Band 11 was [bias: 1.3 oC, error: 1.7 oC] and [bias: 0.9 oC and error: 2.4 oC], respectively. On the other hand, the WST accuracy by the MC method was calculated with [bias: 1.3 oC, error: 0.6 oC]. The WST difference of the 3 data validated in Yonago Bay was an average of 1oC. Noise Equivalent Differential Temperature (NEdeltaT) of TIRS sensor, The estimation accuracy of NOAA AVHRR in Mutsu Bay using the MCSST method is considered that this result is an appropriate numerical value from their being 0.4K (= 0.4 oC) (Irons et al, 2012) and about 0.5±0.2oC, respectively. The WST map in these lakes was created using the proposed MCSST type. As for the WST in Lake Shinji lake in this period, it was checked through every year from these figures that a surface water temperature difference is about 3-5oC in the range of 5-30oC. Moreover, in the mouth of a river of Hii River and Shintate River which are located in the Shinji Kosai shore especially in a summer, the low-wash temperature pattern resulting from inflow of river water was observed.

Keywords: satellite, remote sensing, water temperature, lake