

Seasonal and interannual variability of seagrass distribution detected by Landsat TM, ETM+ and OLI images in western Nanao Bay

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Western Nanao Bay is known for being a home to massive seagrass beds. A massive die-off of seagrass was reported in 2012 in this area, possibly due to high water temperature in summer. Archive images of Landsat Thematic Mapper (TM), Enhanced Thematic Mapper Plus (ETM+) and Operational Land Imager (OLI) were obtained from USGS to detect seasonal and interannual variability of seagrass distribution. Ground truthing survey with an underwater video camera were carried out from a small boat to study sea floor substrates on June 1, 2 and 16 in 2016. Still photos were also taken from a Stand Up Paddleboard on June 1, 2016 to study seagrass species in a very shallow (< 1m) water area. Information of sea floor substrates obtained from the field survey was then used to classify sea floor types. Six classes of training data were then prepared for classifying the Landsat OLI image observed on June 1, 2016 namely: (1) dense seagrass, (2) dense seagrass with *Sargassum*, (3) *Sargassum*, (4) sandy bottom, (5) mud and (6) exposed sand. Supervised classification of the bottom substrates was carried out by the maximum likelihood method using bands of Red, Green and Blue or ratios of Green/Blue, Green/Red, Blue/Red and Green/Coastal bands corrected with the Depth Invariant Index (DII) method. Accuracy assessment showed better results in the DII corrected band ratios: overall accuracy of 0.73 and tau coefficient of 0.66.

To study seasonal and interannual variability for seagrass, past Landsat archive images were analyzed to detect seagrass distribution. Since past field data of seagrass distribution were not sufficient, the K means unsupervised classification technique with the six classes was applied for mapping the seagrass distribution from past Landsat archive images. The classification result of the Landsat OLI image on June 1, 2015 was used as a reference to determine seagrass distributions as it had a good compliance with the ground truth data. Since two out of the six classes obtained from the unsupervised classification corresponded to a distribution pattern of (1) the dense seagrass and (2) the dense seagrass with *Sargassum* classes from the June 1, 2015, these two classes were merged into one class to represent seagrass distribution in Western Nanao Bay. A comparison of seasonal patterns of seagrass distribution estimated by the unsupervised classification of the Landsat archive data from November 22, 1991 to June 1, 1992 and from November 21, 2014 to June 1, 2015 showed consistent similar seasonal pattern; indicating seagrass recovery between late fall to early summer, which corresponds to seagrass seed germination periods. The Landsat archive data during the seagrass seed germination periods were also obtained to study interannual variability of seagrass distribution. The obtained results showed that there are fewer seagrass years (1994, 1996 and 1999) and more seagrass years (2000, 2004, 2007 and 2008) during the seagrass seed germination periods, indicating the survival rate of seagrass varied depending on the year.

Keywords: seagrass, landsat, remote sensing, mapping, Nanao Bay