# Mapping of Shallow Water Bathymetry in Okinawa by ICESat-2 and Sentinel-2

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NASA launched ICESat-2 laser altimeter in 2018 and provides a roster of standard products regarding multiple surface heights. It has also been demonstrated that the six green laser beams onboard ICESat-2 could penetrate clear and shallow waters up to several tens of meters. Meanwhile, ESA's Sentinel-2A/B twin satellite takes multispectral images every 5 days in their ascending/descending passes. The log ratio of green and blue bands could be utilized to estimate water depth based on the Beer-Lambert Law. Hence, this study aims to integrate both datasets and map the shallow water bathymetry in Okinawa, Japan. We use ICESat-2 elevation profiles as training data to solve parameters in a semi-empirical model for optical images. The model is then applied to multiple cloud-free Sentinel-2 images to calculate the water depth of the entire scene. Our preliminary results show that the accuracy of ICESat-2 elevation points, in terms of root-mean-square error (RMSE), is about 0.6 m as compared with an airborne LiDAR campaign in another test site. Moreover, the bathymetry derived herein is better than 1-meter RMSE as compared with independent ICESat-2 elevation points up to 20 m deep. This study could help with the production of an Electronic Navigation Chart (ENC) for many shallow water areas with restricted on-site surveys.

**Keywords:** Satellite Derived Bathymetry, Electronic Navigation Chart, Spaceborne LiDAR