浅海域における航空LiDAR測深の精度評価
Accuracy assessment of airborne LiDAR bathymetry in shallow coastal regions

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Japan is susceptible to natural disasters, such as typhoons, earthquakes, tsunamis and volcanic eruptions from geographical conditions. These natural disasters not only disturb water quality, bottom sediments and aquatic organisms, but also change the seabed topography itself. Therefore, it is necessary to quickly update the land deformation after the natural disaster for ensuring the security of the national land and marine transportation. For the reasons, the demand for measurement of seabed topography is increasing. Echo sounders have been widely used to measure water depth. By using multi-beam echo sounders, a map of seabed topography can be created with a resolution of a few centimeters in the shallow water area. However, it is impossible to measure in a shallow reef area where the survey ship can not pass. Also, it takes a lot of time and labor to measure large areas by small vessels. In recent years, an airborne laser bathymetry has attracted attentions as a method of quickly observing large areas.

The airborne laser bathymetry utilizes the LiDAR (Light Detection And Ranging) system to estimate water depth from the differential time-of-flight of an optical pulse transmitted from the aircraft to the water bottom through the air-water interface. The LiDAR system in terrestrial environments is recognized as a surveying tool with high quality. However, there are few studies on the bathymetric LiDAR system. Only the Japan Coast Guard (JCG) has innovated since 2003 in Japan. It is necessary to investigate under what circumstances the bathymetric LiDAR system can be used in water environments. In this study, the bathymetric LiDAR data are evaluated through a comparison to the existing data derived from acoustic and other bathymetric LiDAR (owned by JGC) instruments.

As a result, the vertical accuracy of bathymetric LiDAR data satisfied the International Hydrographic Organization’s Order 1 standards (±0.50 m) as compared to the reference data of water depth. Moreover, the bathymetric LiDAR data were strongly correlated with data derived from acoustic (R2=0.923, RMSE=0.243 m) and JGC bathymetric LiDAR (R2=0.983, RMSE=0.139 m) instruments. The wider swath width and faster acquisition speed were advantages of airborne LiDAR bathymetry. The combination of topographic-bathymetric LiDAR data also creates a seamless elevation map across the land/water boundary. These results indicate there is potential for applying airborne LiDAR bathymetry in water environments. However, the airborne LiDAR bathymetry was sensitive to turbidity and bottom material. Measurable water depth varied somewhat depending on the location. In this study areas, measurable water depth was shallower than approximately 30 m. It would be necessary to choose the bathymetric methods in consideration of the purpose of seabed mapping, required time, target area, economic cost, etc.

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