Integration of elevation and bathymetry measurements from SONAR, LIDAR, GPS and CASI: Towards a seamless coastal DEM, Prince Edward Island

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In the study area on the North Shore of Prince Edward Island, the coastal zone can be considered to extend from a landward limit of sand dune sedimentation to a seaward limit of storm-induced sand mobilisation. Construction of a seamless digital elevation model (DEM) across this zone is important for the interpretation of coastal geology and geomorphology, detection and measurement of coastal change, storm-surge flood-hazard mapping and as a base for dynamic coastal modelling. Due, however, to the wide range of environments present within the coastal zone, seamless DEM construction has been challenging and a strip with no data coverage is usually present between the land-water interface and some depth offshore.

We used airborne terrestrial LIDAR at low tide to map the landward portion of the coastal zone and various SONAR systems to chart bathymetry of the seaward portion out to depths of 30 m or more. The acoutic methods included swath multibeam (EM1000 and EM3000) systems in deeper water and 12-channel sweep multibeam or dual-frequency single-beam systems in shallow water. In selected dynamic intertidal areas, elevation data were collected using dual-phase differential GPS in real-time kinematic mode. Even with the use of all these systems, bathymetric coverage typically does not extend far enough landward to seamlessly meet the terrestrial LIDAR. Where shallow water sweep SONAR bathymetric mapping was not conducted, this gap extends from the intertidal zone to 10 m water depth.

In this study, we tested the application of hyperspectral CASI data and the Self-Calibrated Spectral Supervised Shallow-water Modeller (4SM) method to filling this nearshore gap. The 4SM method utilises the variable attenuation by water of differing wavelengths of visible light along with a band-ratioing technique to estimate attenuation coefficients and derive bottom depths from geometrically and radiometrically corrected CASI imagery. Single-beam echosounding data collected and used to fine-tune and validate the derived bathymetry demonstrate excellent accuracy of the CASI bathymetry in some areas and problems with the technique in others.

The integration of the CASI bathymetry with SONAR, LIDAR and GPS bathymetry and elevations shows considerable promise for filling the nearshore gap and represents a relatively fast and low-cost method for the development of a seamless coastal DEM.