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Use of a mobile terrestrial laser system to quantify the impact of rigid coastal protective structures on sandy beaches, Quebec, Canada

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Coastal erosion is an important issue within the St-Lawrence estuary and gulf, especially in zones of unconsolidated material. Wide beaches are important coastal environments; they act as a buffer against breaking waves by absorbing and dissipating their energy, thus reducing the rate of coastal erosion. They also offer protection to humans and nearby ecosystems, providing habitat for plants, animals and lifeforms such as algae and microfauna. Conventional methods, such as aerial photograph analysis, fail to adequately quantify the morphosedimentary behavior of beaches at the scale of a hydrosedimentary cells. The lack of reliable and quantitative data leads to considerable errors of overestimation and underestimation of sediment budgets. To address these gaps and to minimize acquisition costs posed by airborne LiDAR survey, a mobile terrestrial LiDAR has been set up to acquire topographic data of the coastal zone. The acquisition system includes a LiDAR sensor, a high precision navigation system (GPS-INS) and a video camera. Comparison of LiDAR data with 1050 DGPS control points shows a vertical mean absolute error of 0.1 m in beach areas. The extracted data is used to calculate sediment volumes, widths, slopes, and a sediment budget index. A high accuracy coastal characterization is achieved through the integration of laser data and video. The main objective of this first project using this system is to quantify the impact of rigid coastal protective structures on sediment budget and beach morphology. Results show that the average sediment volume of beaches located before a rock armour barrier (12 m3/m) were three times narrower than for natural beaches (35,5 m3/m). Natural beaches were also found to have twice the width (25.4 m) of the beaches bordering inhabited areas (12.7 m). The development of sediment budget index for beach areas is an excellent proxy to quickly identify deficit areas and therefore the coastal segments most at risk of erosion. The obtained LiDAR coverage also revealed that beach profiles made at an interval of more than 200 m on diversified coasts lead to results significantly different from reality. However, profile intervals have little impact on long uniform beaches.