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Mobile Laser Scanning along Dieppe coastal cliffs: reliability of the acquired point clouds applied to rockfall assessments

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Dieppe coastal cliffs, in Normandy, France, are mainly formed by sub-horizontal deposits of chalk and flintstone. Largely destabilized by an intense weathering and the Channel sea erosion, small and large rockfalls are regularly observed and contribute to retrogressive cliff processes. During autumn 2012, cliff and intertidal topographies have been acquired with a Terrestrial Laser Scanner (TLS) and a Mobile Laser Scanner (MLS), coupled with seafloor bathymetries realized with a multibeam echosounder (MBES).

MLS is a recent development of laser scanning based on the same theoretical principles of aerial LiDAR, but using smaller, cheaper and portable devices. The MLS system, which is composed by an accurate dynamic positioning and orientation (INS) devices and a long range LiDAR, is mounted on a marine vessel; it is then possible to quickly acquire in motion georeferenced LiDAR point clouds with a resolution of about 15 cm. For example, it takes about 1 h to scan of shoreline of 2 km long. MLS is becoming a promising technique supporting erosion and rockfall assessments along the shores of lakes, fjords or seas.

In this study, the MLS system used to acquire cliffs and intertidal areas of the Cap d'Ailly was composed by the INS Applanix POS-MV 320 V4 and the LiDAR Optech Ilirs LR. On the same day, three MLS scans with large overlaps (J1, J21 and J3) have been performed at ranges from 600 m at 4 knots (low tide) up to 200 m at 2.2 knots (up tide) with a calm sea at 2.5 Beaufort (small wavelets). Mean scan resolutions go from 26 cm for far scan (J1) to about 8.1 cm for close scan (J3). Moreover, one TLS point cloud on this test site has been acquired with a mean resolution of about 2.3 cm, using a Riegl LMS Z390i. In order to quantify the reliability of the methodology, comparisons between scans have been realized with the software Polyworks™, calculating shortest distances between points of one cloud and the interpolated surface of the reference point cloud. A MatLab™ routine was also written to extract interesting statistics.

First, mean distances between points of the reference point clouds (J21) and its interpolated surface are about 0.35 cm with a standard deviation of 15 cm; errors introduced during the surface interpolation step, especially in vegetated areas, may explain those differences. Then, mean distances between J1's points (resp. J3) and the J21's reference surface are about 4 cm (resp. -17 cm) with a standard deviation of 53 cm (resp. 55 cm). After a best fit alignment of J1 and J3 on J21, mean distances between J1 (resp. J3) and the J21's reference surface decrease to about 0.15 cm (resp. 1.6 cm) with a standard deviation of 41 cm (resp. 21 cm). Finally, mean distances between the TLS point clouds and the J21's reference surface are about 3.2 cm with a standard deviation of 26 cm.

In conclusion, MLS devices are able to quickly scan long shoreline with a resolution up to about 10 cm. The precision of the acquired data is relatively small enough to investigate on geomorphological features of coastal cliffs. The ability of the MLS technique to detect and monitor small and large rockfalls will be investigated thanks to new acquisitions of the Dieppe cliffs in a close future and enhanced adapted post-processing steps.