Assessing the Error Budget for Permanent Laser Scanning on Coastal Beaches

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SUMMARY

Coastal beaches are dynamic areas that undergo continuous change. These areas are increasingly vulnerable to extreme weather events due to climate change and additional knowledge and monitoring is needed for coastal management to protect these areas in the future. Permanent laser scanning (PLS) is a promising technique to monitor and provide knowledge of the beach. It delivers a 4D spatio-temporal representation of a part of the coast at hourly temporal and centimetre spatial resolution. A laser scanner is mounted on top of a high building close to the beach in the Netherlands to acquire point clouds of a section of the coast of about 1 km length over a period of several months. Deformation behaviour of the observed area such as erosion due to waves or aeolian sand transport to the dunes will be derived from this data set with high accuracy. However, to assess the accuracy of the observed deformation processes it is essential to understand the error sources and error budget of the PLS data set.

Although mounted in a stable and fixed location, the data set from permanent laser scanning contains differences in range between consecutive point clouds in the order of decimetres. Possible error sources include measurement errors due to inaccuracy of the scanner, small deformations in the frame or building on which the scanner is mounted, atmospheric effects or objects blocking the line of sight of the scanner. In a first step to analyse these effects, we assess the accuracy in range for each point cloud. The second step consists of the alignment between consecutive point clouds to one reference point cloud based on stable surfaces in the observation area. We account for a large part of the error per point cloud and between consecutive point clouds and quantify the remaining errors (and possible causes) to derive the overall error budget of the data set. When extracting for example elevation changes to quantify the deformation due to a specific process (i.e. aeolian sand transport), this error budget provides an accuracy value for each time step and an estimated error for the deformation over the entire observed period.