Geophysical Research Abstracts
Vol. 19, EGU2017-6983, 2017
EGU General Assembly 2017

Ground-based LiDAR application to characterize sea cliff instability processes along a densely populated coastline in Southern Italy

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Sea cliff retreatment along the coastline of the Campi Flegrei volcanic area (Southern Italy) is becoming a threat for public and private structures due to the massive urbanization occurred in the last few decades. In this area, geological features of the outcropping rocks represent one of the most important factors conditioning the sea cliff retreatment. In fact, pyroclastic deposits formed by pumices, scoria, ashes and lapilli are arranged in weakly to moderately welded layers of variable thicknesses, resulting very erodible and prone to landslide processes. Available methods to evaluate topographic changes and retreat rates of sea cliffs include a variety of geomatic techniques, like terrestrial and aerial photogrammetry and LiDAR (Light Detection And Ranging). By means of such techniques, it is in fact possible to obtain high resolution topography of sea cliffs and perform multi-temporal change detection analysis. In this contribution, we present an application of Terrestrial Laser Scanning (TLS or ground-based LiDAR) aimed to identify and quantify instability processes acting along the Torrefumo coastal cliff, in the Campi Flegrei area. Specifically, we acquired a series of 3D point clouds on the years 2013 and 2016, and compared them through a cloud-to-cloud distance computation. Furthermore, a statistical analysis was applied to the change detection results. In this way, an inventory of the cliff failures occurred along the Torrefumo cliff in the 2013-2016 time span was created, as well as the spatial and volumetric distribution of these failures was evaluated. The volumetric analysis shows that large collapses occurred rarely, whereas the spatial analysis shows that the majority of failures occurred in the middle and upper parts of the cliff face. Results also show that both rock fall and surficial erosion processes contribute to the cliff retreatment, acting in turn according to the geological properties of the involved pyroclastic deposits. The presented TLS approach proves to be a cost and time efficient method for characterizing the geomorphic changes involving the sea cliff surfaces over a short-time period (i.e. monthly or yearly). The accuracy of the acquired data allows the characterization of a full range of failures to be located and quantified with a level of detail not reachable using traditional techniques. Results obtained in this research will be used in future applications to assess hazard conditions affecting the anthropic structures built close to the cliff top.