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LiDAR monitoring of coastal cliff geomorphic response to an extreme winter storm with comparison to the long term retreat rate of the cliff (Eastern Mediterranean Sea, Israel)

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The Israeli coastal cliff extends about 60 kilometers along the Eastern-Mediterranean shores. Cliff height rises up to 50 meters with outcrops of eolianites and paleosols. In past 60 years cliff-top inland local retreat-rates of up to a few decimeters per year were recorded with a consequent hazard to infrastructure and shore-communities. Cliff retreat is in general a result of wave induced slope-failure. On mid December, 2010 an extreme winter storm with up to 10 meters high waves hit the Israeli coastal cliff, resulted in extensive slope failure. In the presented study we characterize the geomorphic response of the coastal cliff to this extreme winter storm using pre and post-storm high resolution ground-based LiDAR scans. Then, we compare the storm related retreat to the long term decadal retreat of the Israeli coastal cliff.

Pre and post-storm ground based LiDAR scans acquired at 4 separate, ca 200 meters long, cliff stretches. The geomorphic response of the coastal cliff to the storm included: (a) erosion and seaward washing of pre-existing landslides deposits with volumes in the order of tens cubic meters; (b) extensive slope failure (slumps, toppling and rock falls), generally from the lower half of the cliff with a consequent steepening of the cliff face; landslide cliff-parallel width is up to 10 meters and density is a few landslides per 100 meters; (c) erosion and seaward washing of the sand deposited on the shore below the cliff; (d) development of a terrace at the cliff base; terrace is up to 1.5 meters high and consist of eolianite pebbles with diameter of up to 0.3 meters. Post storm cliff deformation included continuous slope failure in general from the upper part of the coastal cliff.

Measured retreat of the cliff face and cliff top as a result of the storm was up to a few meters. Considering the storm recurrence time of more than 20 years, the measured retreat is locally comparable to the decadal retreat rate. Our results suggest that the long-term erosion rates can be explained solely by severe storms like this one.