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The role of extreme winter storms in the overall retreat pattern of an actively eroding eolianite coastal cliff-line in the eastern Mediterranean

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Eolianite cliffs along the Mediterranean coast of Israel form an actively eroding 55-km-long linear feature with local average retreat rates of up to 0.3 m/year over the past 60 years. Here, we investigate the effect of extreme winter storms with decadal-scale recurrence intervals, on the overall retreat pattern of this 'weak rock' coastal cliff-line. Repeat high-resolution (1-2 cm) ground based LiDAR surveys before and after an extreme '20-year' winter storm that occurred in the eastern Mediterranean during December 2010 allowed us to characterize syn- and post-storm erosional effects at cm-km scales.

The LiDAR surveys documented cliff instability initiated by syn-storm erosion of basal cliff notches that propagated up-cliff during the months that followed and lead to post-storm activity, which constituted $>75\%$ of the total storm-related cliff erosion. The latter occurred primarily as discrete catastrophic gravity driven slope-failure events that range in volume between 10^0-10^3 m^3. The cliff-line returned to its long-term activity level $\sim$5 months after the storm. Locally, storm induced landward cliff retreat reached 7 m, which is comparable to the total retreat previously documented along this coastal stretch during the past 60 years. Yet, in a broader spatial context, cliff-retreat associated with the December 2010 storm accounts for $<5\%$ of the total retreat documented for this cliff-line during the past 60 years, thus implying only a secondary role for extreme winter storms in the overall volumetric retreat of this coastal cliff line. Nonetheless, the preferred occurrence of peak storm-associated erosion at local capes suggests that extreme winter storms may have a central role in maintaining the large-scale linearity of Israel's coastal cliff-line.