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Are Late Holocene coastal-cliff retreat rates accelerating in the eastern Mediterranean?

Oded Katz and Amit Mushkin
Geological Survey of Israel, Jerusalem, Israel

Inland retreat of coastal cliffs in response to sea-level rise presents one of the most dynamic natural processes affecting coastal environments worldwide. Measured rates for annual - decadal ('modern') cliff retreat are variable and range up to 10 m/yr whereas estimates for centennial - millennial retreat rates, where available, are typically 1 - 2 orders of magnitude lower. And yet, the paucity in quantitative estimates for such longer-term retreat rates hinders our ability to distinguish whether the higher modern rates reflect a sampling bias of an episodic process or alternatively a true acceleration in erosion rates.

In this context, we present a suite of new geological and archeological time-scale constraints on sea-cliff retreat rates and failure processes along the Mediterranean coast of central Israel. We focus on a 30 km sea-cliff escarpment comprised of late Quaternary eolianites that reaches heights of up to 50 meters above sea-level and retreats via discrete cliff failure events. Our results reveal millennial - centennial cliff retreat rates of 0.01 - 0.10 m/yr that compare with significantly higher modern rates of 0.5 - 10.0 m/yr previously inferred for this cliff. In addition we find that cliff retreat along this escarpment has been occurring through episodic cliff-falure activity with a characteristic-time and retreat-scales of 1000 years and 15+-5 m, respectively. We demonstrate that all cliff retreat rates previously inferred for this sea-cliff escarpment plot along reciprocal function of observation time-scale as they asymptotically decrease towards measured millennial rates of several cm/yr. This observation indicates that the apparent acceleration in modern rates in the eastern Mediterranean results from a sampling bias of a natural geomorphic process characterized by episodic activity with a characteristic time-scale that is longer than the sampling time interval.

While ruling out an acceleration in coastal cliff retreat along the eastern Mediterranean, our results also highlight the due caution in interpreting measurements of modern sea-cliff retreat rates without consideration of long-term process. We propose that in cases where the characteristic-time and retreat-scales of long term erosion process can be determined, 'true' acceleration in retreat rates will plot above the reciprocal function of retreat rates vs. time-scales.