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Supplemental Material

Figure S1. (A) The distribution of steepness indices (Ksn) along Tzuk Tamrur channel network over shaded relief image derived from LiDAR (0.5 m resolution) data. (B) Channels incision depth as a function of the normalized distance from the channel outlet to the cliff.

Figure S2. (A) Slope versus distance (in log-log space) across Tzuk Tamrur active talus slopes. (B) Dimensionless topographic longitudinal profiles of active talus slopes.

Figure S3. Talus profiles location map.

Figure S4. Talus flatiron projection profiles in the south-facing watershed.

Figure S5. Talus flatiron projection profiles in the east-facing watershed.

Figure S6. Talus flatiron projection profiles in the north-facing watershed.

Figure S7. Slope-Area diagrams for north- and south-facing stream networks in Tzuk Tamrur.

Figure S8. Cross-section through the cliff-slope system of Tzuk Tamrur (see Fig. 4b in the main text for location) illustrating active and relic slope (talus flatirons) geometry and an example of two different approaches to determine retreat distance.

Table S1. Cliff retreat and polynomial fit of measured talus flatiron profiles in Tzuk Tamrur (profiles location in Figure S1).

Text S1. Evaluating cliff retreat and comparison with previous studies

Supplemental File S1 for

Aspect-dependent bedrock weathering, cliff retreat, and cliff morphology in a hyperarid environment

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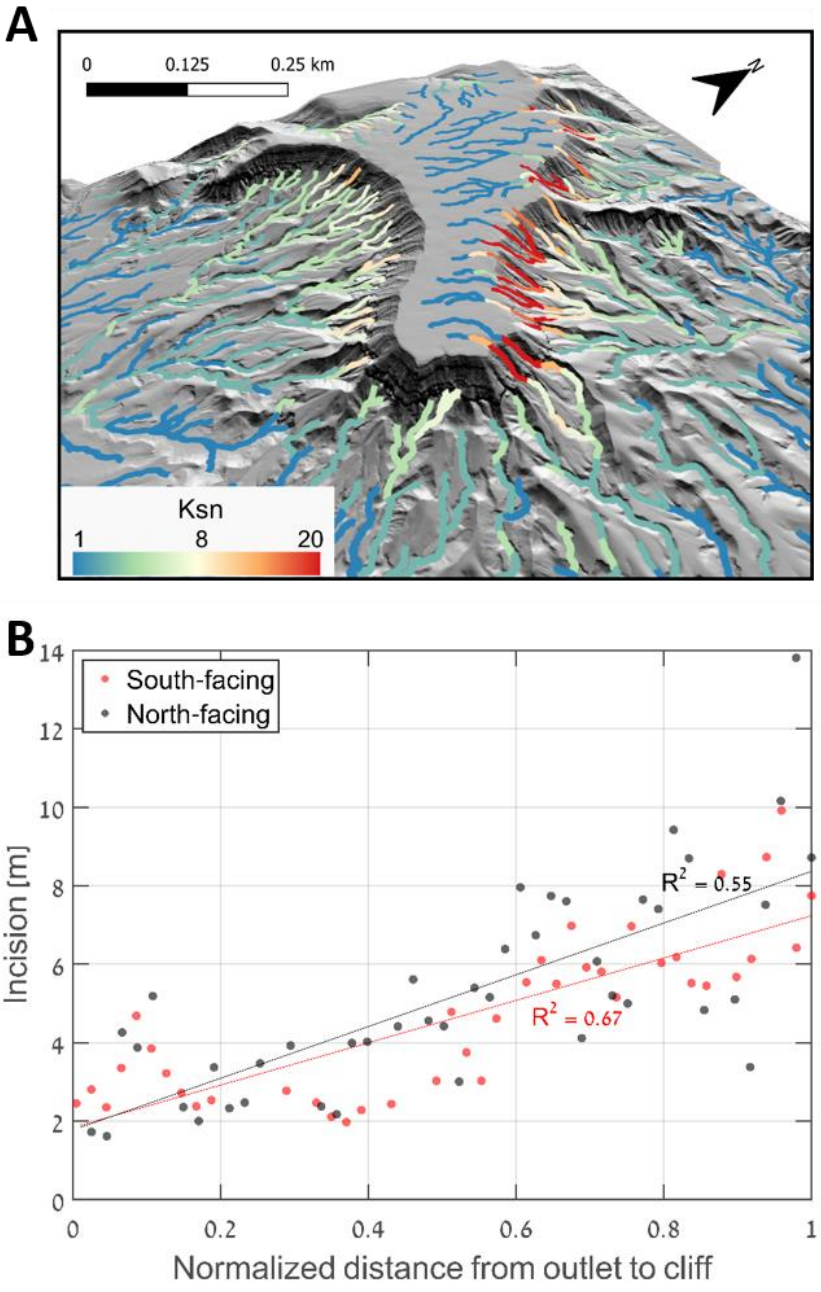
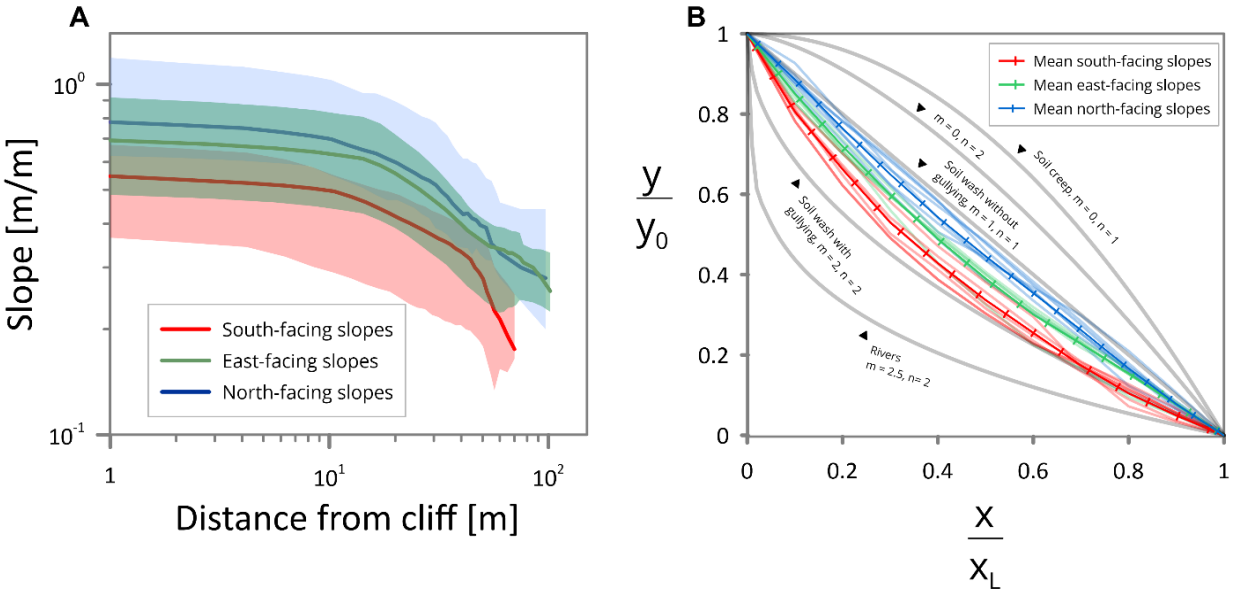
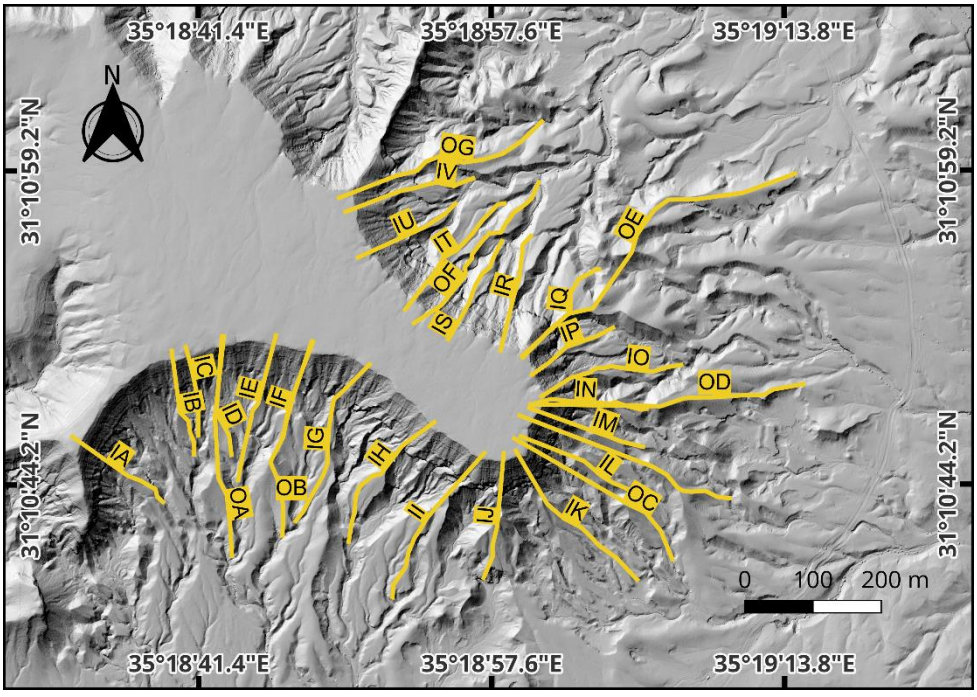
Supplementary Figure 1: (A) The distribution of steepness indices (Ksn) along Tzuk Tamrur channel network over shaded relief image derived from LiDAR (0.5 m resolution) data. The mean steepness indices for the north- and south-facing stream networks are 7.3 and 4.5 respectively. (B) Channel incision depth as a function of the normalized distance from the channel outlet to cliff.



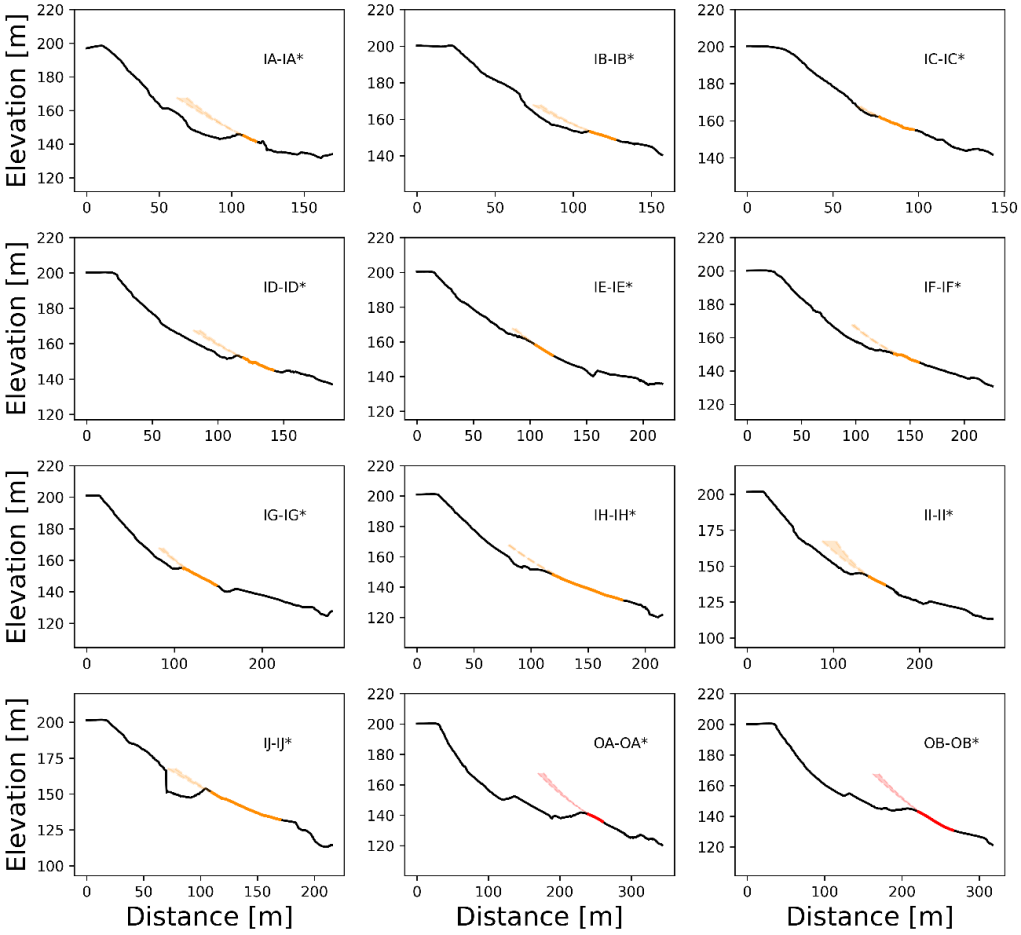
Supplementary Figure 2: (A) Slope versus distance (in log-log space) across Tzuk Tamrur active talus slopes. (B) Dimensionless topographic longitudinal profiles of active talus slopes. The y axis is elevation normalized to the maximum elevation and the x axis is the distance from ridge normalized to the maximum distance downhill. Reddish, greenish and blueish lines are the profiles of south-, east- and north-facing talus slopes, respectively. The mean profile for each aspect group is also shown. Gray curves are characteristic-form hillslope profiles of Kirkby (1971).



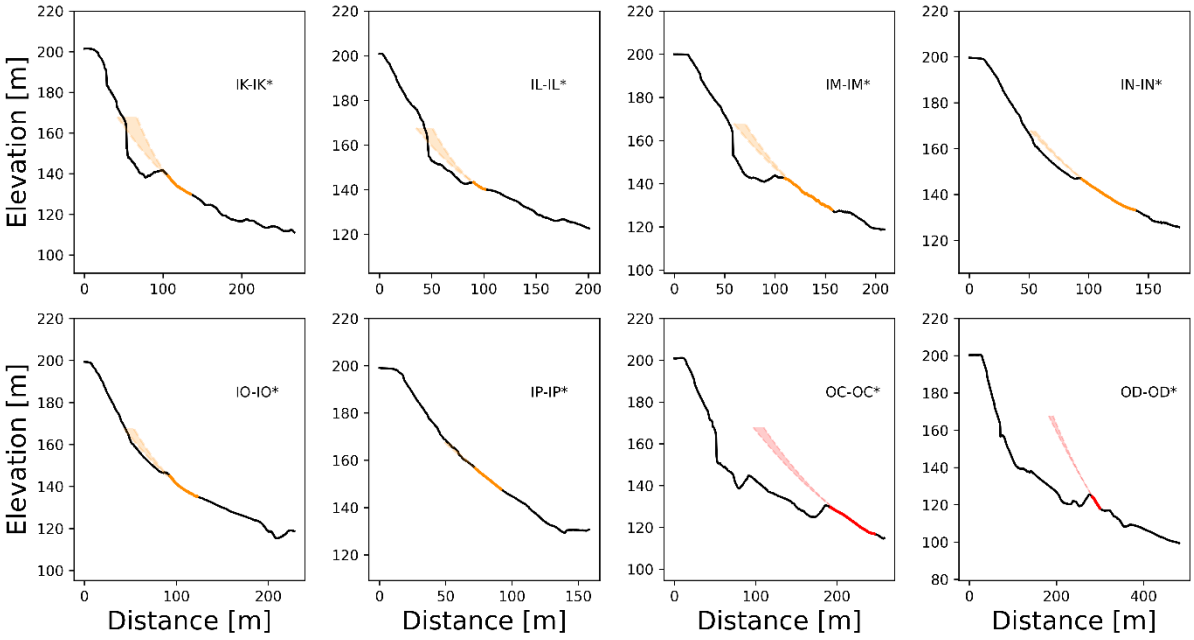
Supplementary Figure 3: Talus profiles location map



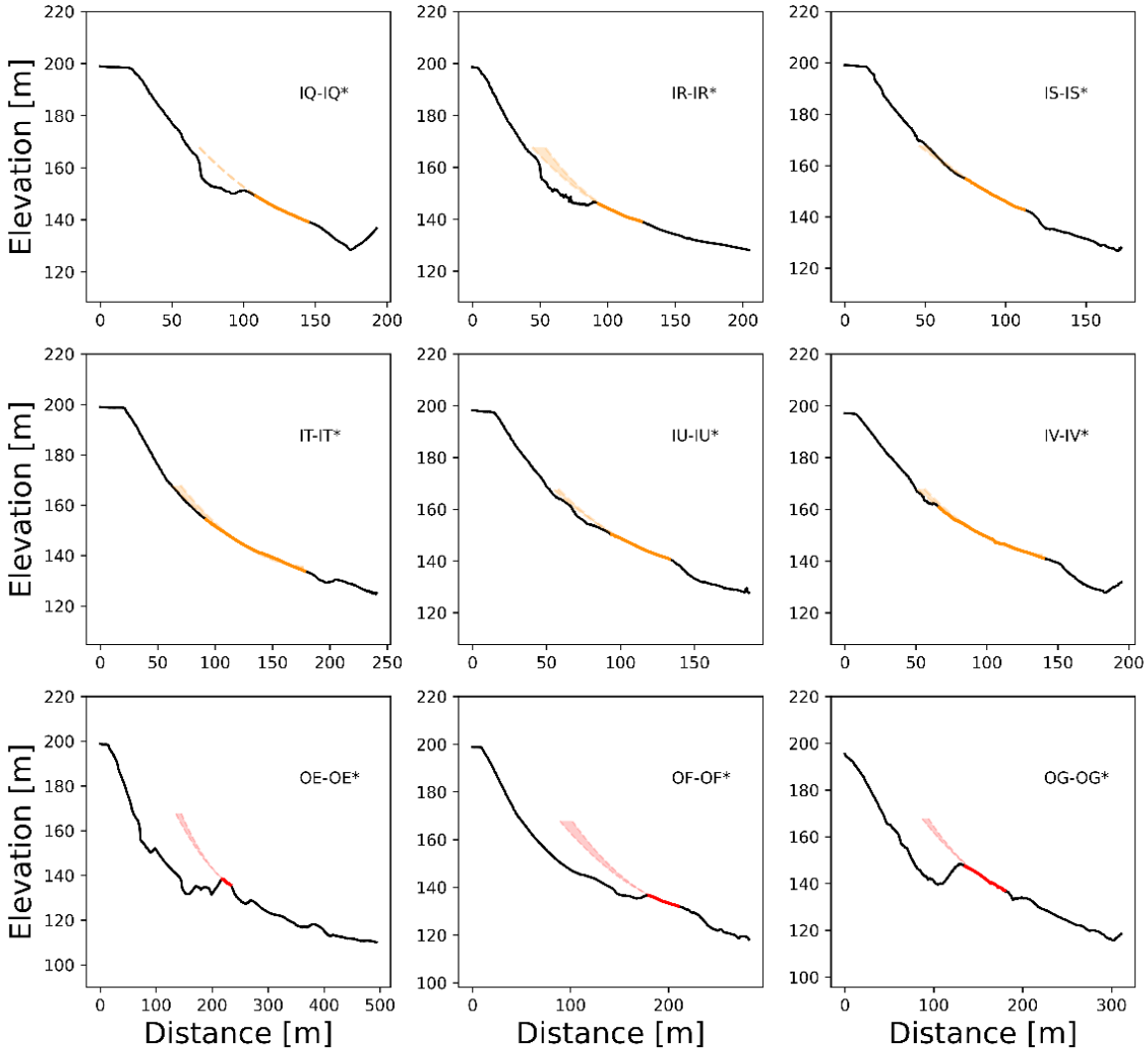
Supplementary Figure 4: Talus flatiron projection profiles in the south-facing watershed



Supplementary Figure 5: Talus flatiron projection profiles in the east-facing watershed



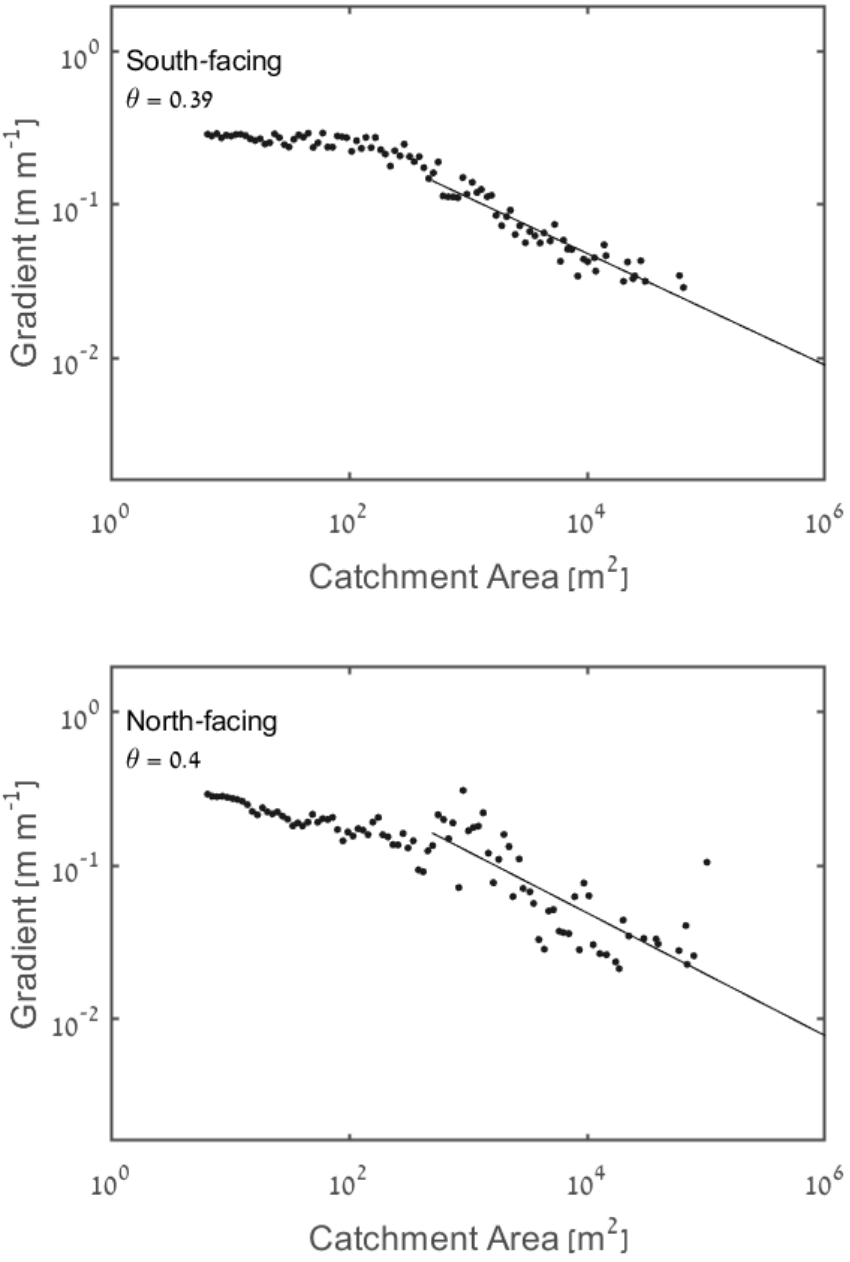
Supplementary Figure 6: Talus flatiron projection profiles in the north-facing watershed



Supplementary Table 1: Cliff retreat and polynomial fit of measured talus flatiron profiles in Tzuk Tamrur (profiles location in Figure S1).

ID	Generation	Aspect	Cliff retreat Max [m]	Cliff retreat Min [m]	Cliff retreat Average [m]	a	b	c	r^2
IA	Intermediate	S	18.0	11.0	14.5	0.00001	-0.5	204.5	0.99
IB	Intermediate	S	10.8	6.8	8.8	0.0036	-1.1	233.2	1.00
IC	Intermediate	S	4.9	0.0	2.4	0.0055	-1.3	230.6	0.99
ID	Intermediate	S	28.4	17.4	22.9	0.0030	-1.2	253.4	0.99
IE	Intermediate	S	23.4	15.4	19.4	0.0032	-1.1	244.4	0.99
IF	Intermediate	S	26.0	19.3	22.7	0.0037	-1.3	263.8	0.98
IG	Intermediate	S	17.0	14.0	15.5	0.0031	-1.2	250.7	0.99
IH	Intermediate	S	16.6	13.2	14.9	0.0020	-0.9	230.4	1.00
II	Intermediate	S	23.3	16.2	19.8	0.0022	-1.0	237.0	1.00
IJ	Intermediate	S	6.6	3.2	4.9	0.0020	-0.9	224.1	1.00
IK	Intermediate	E	20.0	0.0	10.0	0.0017	-0.7	199.2	0.99
IL	Intermediate	E	9.4	0.0	4.7	0.0024	-0.7	188.6	0.97
IM	Intermediate	E	13.8	5.8	9.8	0.0016	-0.8	208.1	0.99
IN	Intermediate	E	6.4	3.4	4.9	0.0011	-0.7	215.6	1.00
IO	Intermediate	E	16.0	0.0	8.0	0.0020	-0.8	208.3	0.99
IP	Intermediate	E	0.0	0.0	0.0	0.0021	-0.8	197.0	1.00
IQ	Intermediate	N	4.5	4.5	4.5	0.0026	-0.9	219.9	1.00
IR	Intermediate	N	9.0	1.0	5.0	0.0027	-0.9	215.3	1.00
IS	Intermediate	N	0.0	0.0	0.0	0.0029	-0.9	202.9	1.00
IT	Intermediate	N	8.2	1.2	4.7	0.0025	-0.9	220.4	0.98
IU	Intermediate	N	6.3	2.1	4.2	0.0029	-0.9	210.7	1.00
IV	Intermediate	N	6.2	2.2	4.2	0.0032	-0.9	209.9	0.99
OA	Old	S	99.5	70.0	84.1	0.0023	-1.4	340.2	0.98
OB	Old	S	119.0	92.8	105.9	0.0019	-1.2	321.2	1.00
OC	Old	E	88.0	68.0	78.0	0.0015	-0.9	248.6	0.99
OD	Old	E	111.0	85.0	98.0	0.0011	-1.0	317.2	1.00
OE	Old	N	92.0	77.2	84.6	0.0024	-1.3	300.5	0.99
OF	Old	N	68.6	42.8	55.7	0.0024	-1.0	240.3	0.99
OG	Old	N	58.5	42.4	42.4	0.0025	-1.0	244.0	0.98

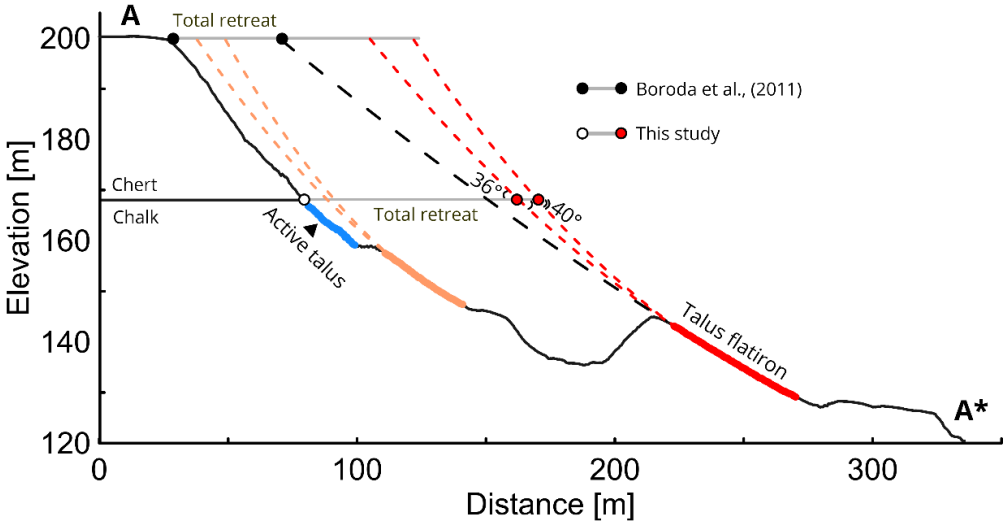
Supplementary Figure 7: Slope-Area diagrams for north- and south-facing stream networks in Tzuk Tamrur.



Supplementary Text S1: Evaluating cliff retreat and comparison with previous studies

Our current estimate of cliff retreat using projected talus flatirons profiles is higher than our previous estimates (Boroda et al., 2011). The difference reflects the higher resolution of the LiDAR topographic data as well as a few methodological modifications. Rather than measuring the total retreat as the horizontal distance from the cliff top to the projected profile at the same height (Figure S8, black circle to black circle) we define the total retreat as the horizontal distance between the base of the chert cliff and the projected flatiron profile at the height of this stratigraphic marker (Figure S8, white circle to red circle). In addition, we use a conditional polynomial curve in which the first derivative of the curve is forced to specific gradient in order to match the observed active cliff-talus morphology (red dashed lines). Fitting a polynomial curve in this way is less dependent on preservation of the upper part of flatirons and can be accomplished accurately even in cases where the apex has retreated. The projected profile is thus more realistic and the accuracy of cliff retreat estimation is improved.

Supplementary Figure S8: Cross-section through the cliff-slope system of Tzuk Tamrur (see Fig. 4b in the main text for location) illustrating active and relic slope (talus flatirons) geometry and an example of two different approaches to determine retreat distance. The lines with black circle as end points represent the approach used by Boroda et al. (2011) where the top of the modern cliff is used in order to quantify the retreat distance. The line with red circles as end points represents the approach used in this study in which extrapolation was conducted using a 2^{nd} order polynomial curve and the first derivative of the curve was forced to provide the observed range of gradients at the level of the cliff-bedrock and talus contact.



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