Supplementary figures:

Table S1: Model paramètres

Parameters	***value***	***unit***	***Short description***	***source/ status***
α_{mean}	-2,3	-	Exponent of reference for the power scaling law on the landslides size distribution	literature
field erosion rate	0.7 - 1.1	mm/yr	Erosion rate range for the Ecrins massif (Delunel et al, 2010)	observation
φ	0,7	m/m	Internal angle of friction (0,7m/m = 35°)	calibrated
C	60	kPa	Cohesion	calibrated
t_{LS}	150 000	yr	Return time of landslides	calibrated
Ff	1	-	Fine fraction parameter	initial setting
grid resolution	25	m	cell size (regular grid)	intial setting
dt	10	yr	Simulation timestep	initial setting
total time	100 000	yr	Total simulation time	initial setting
calibration time	1500	yr	Total simulation time for the calibration phase	literature

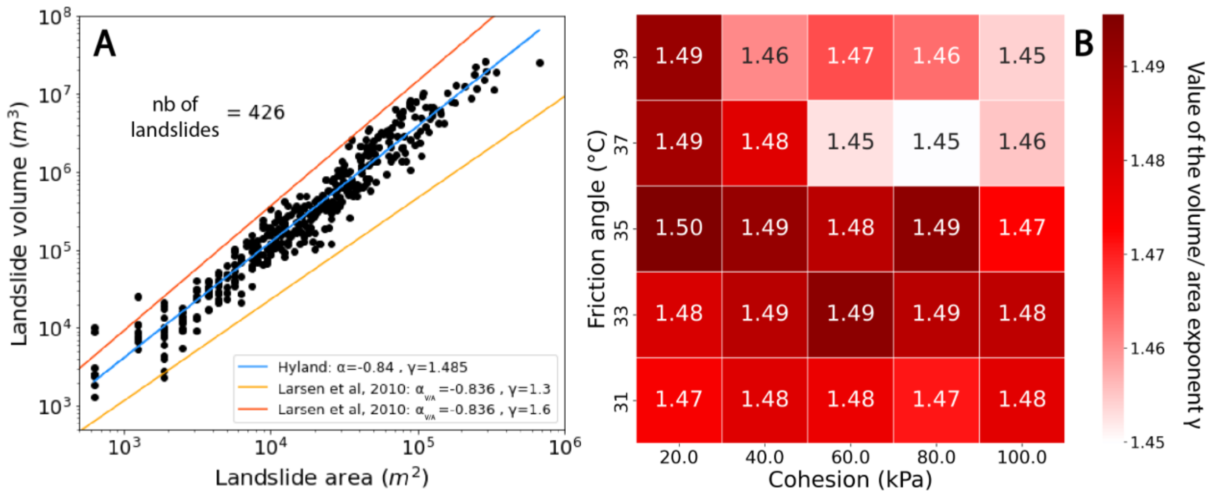

Figure S1: A) Relationship between landslide volume and area of each predicted landslide for 20 individual simulations (total number of landslides: 426) with an internal friction angle of 35°, cohesion of 60 kPa and a landslide return time of 1.5 10^5 yr. The blue line is the power-law fit of the simulated dataset (HyLands) with ɣ = 1.485 and α = -0.84. The gamma values have a reference interval for bedrock landslides ranging between 1.3 (light orange line) and 1.6 (dark orange line) (Larsen et al., 2010). B) Calibration matrix between the internal angle of friction and the cohesion parameters based on the power-law exponent of the landslide volume / area relationship exponent. Only small variations of the power-law exponent ɣ are observed between all the different parameter combinations.

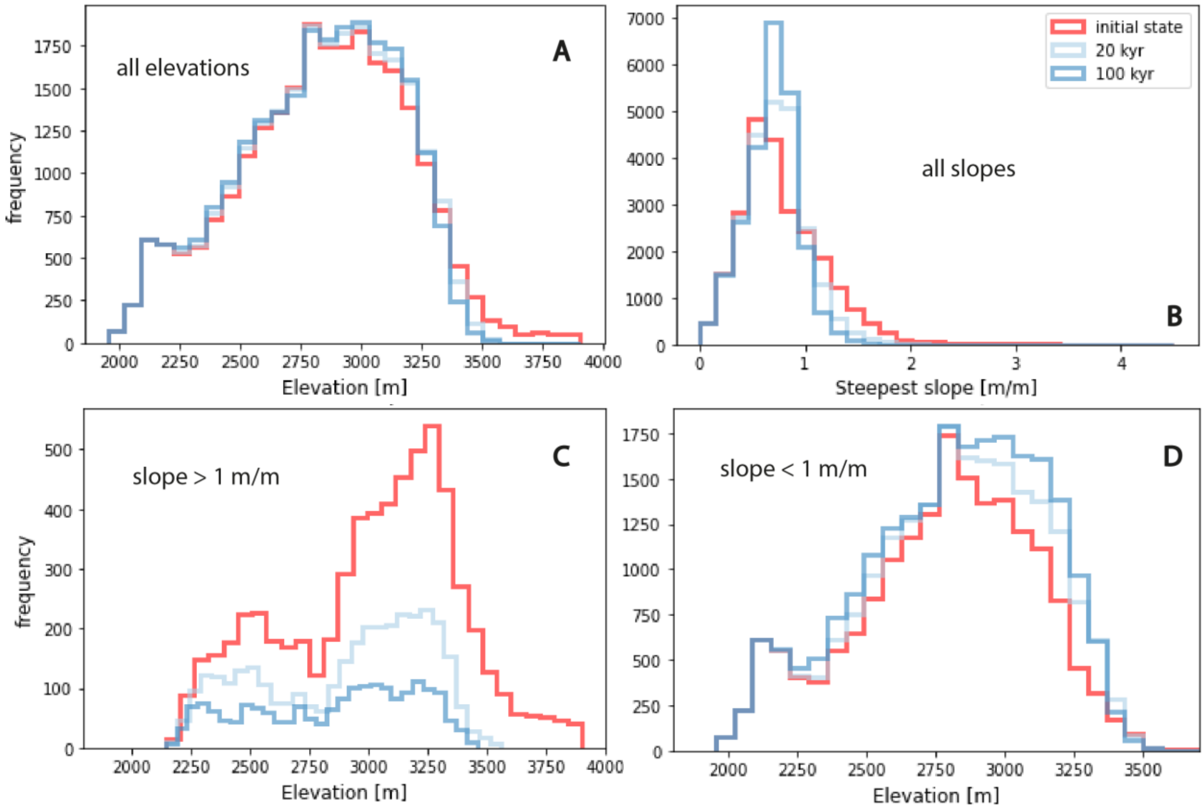

Figure S2: For the Pilatte catchment (glacial), temporal evolution of (A) elevation distribution, (B) slope distribution, C-D) Elevation distribution with slope threshold values (above or below 1m/m). The colors illustrate the initial topography (red), an intermediate stage (20 kyr – light blue line) and the final topography (100 kyr – dark blue).

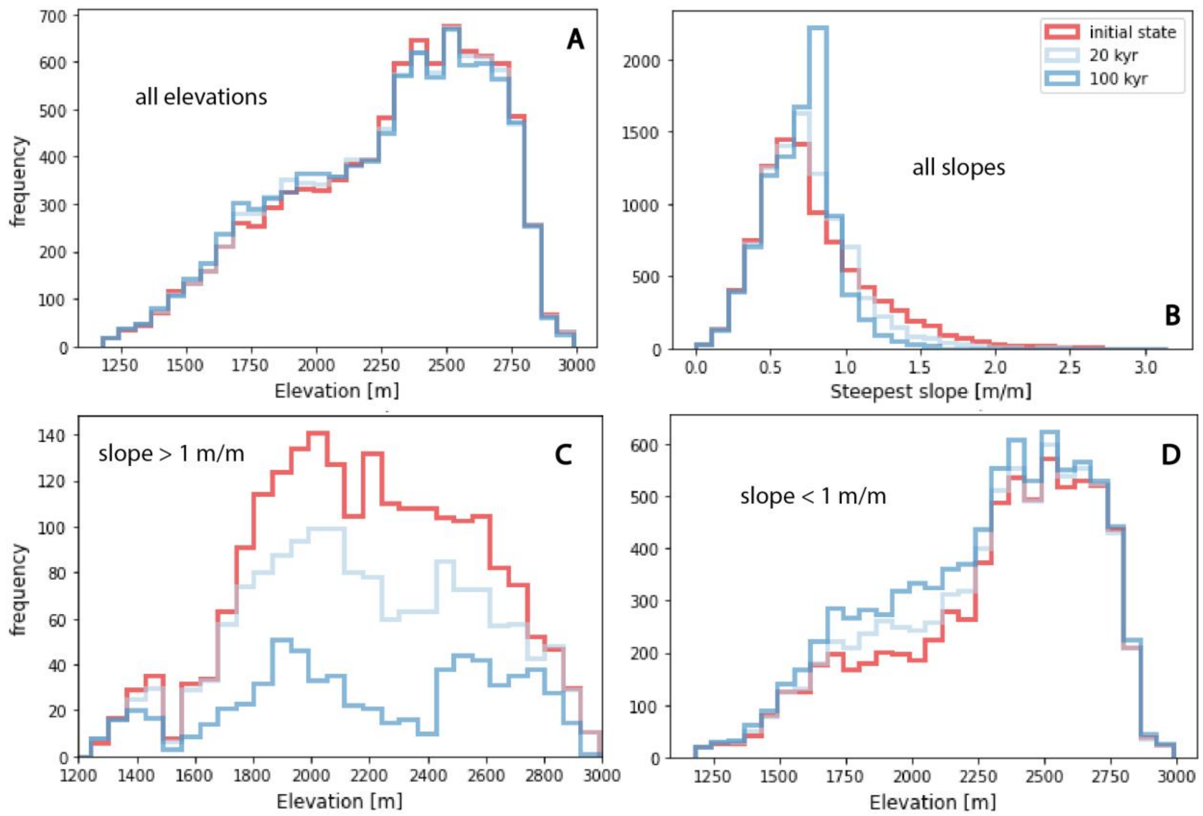

Figure S3: For the Pisse catchment (fluvial), temporal evolution of (A) elevation distribution, (B) slope distribution, C-D) slope distribution with threshold values (above or below 1m/m). The colors illustrate the initial topography (red), an intermediate stage (20 kyr – light blue line) and the final topography (100 kyr – dark blue).

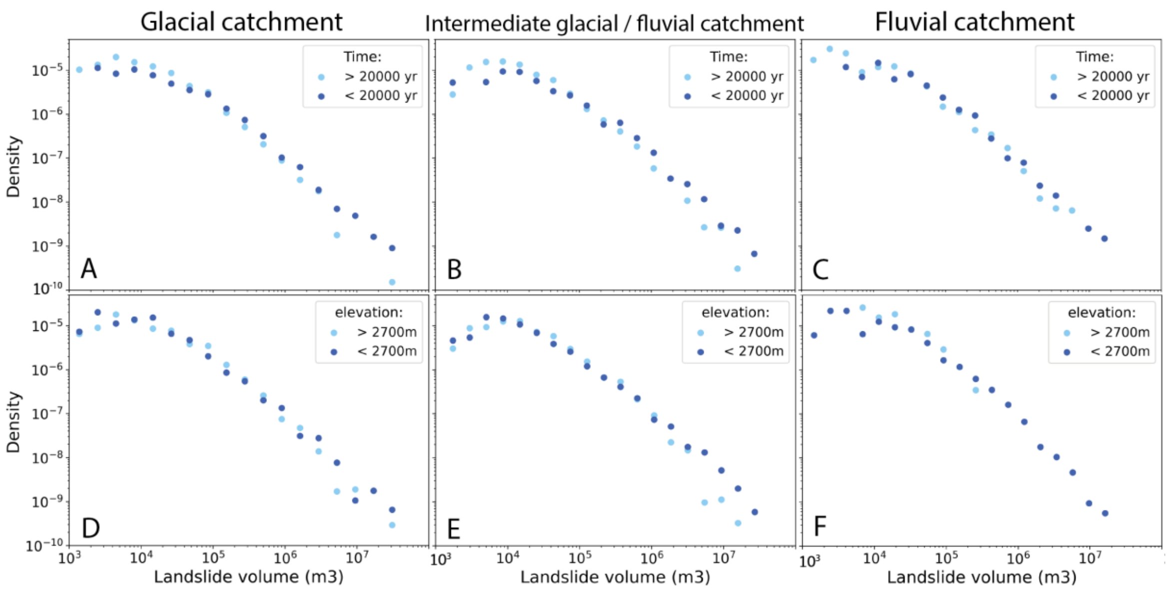

Figure S4: Probability density functions (pdfs) of the predicted landslide volumes for 100kyr simulation (Fig. 9 in main text) for the three studied catchments. A-B-C) Pdfs of landslide volumes classified by simulation time (before or after 20 kyr). D-E-F) Pdfs of landslide volumes classified by the triggered point elevation of the each landslide (above or below 2700 m). See text for discussion.

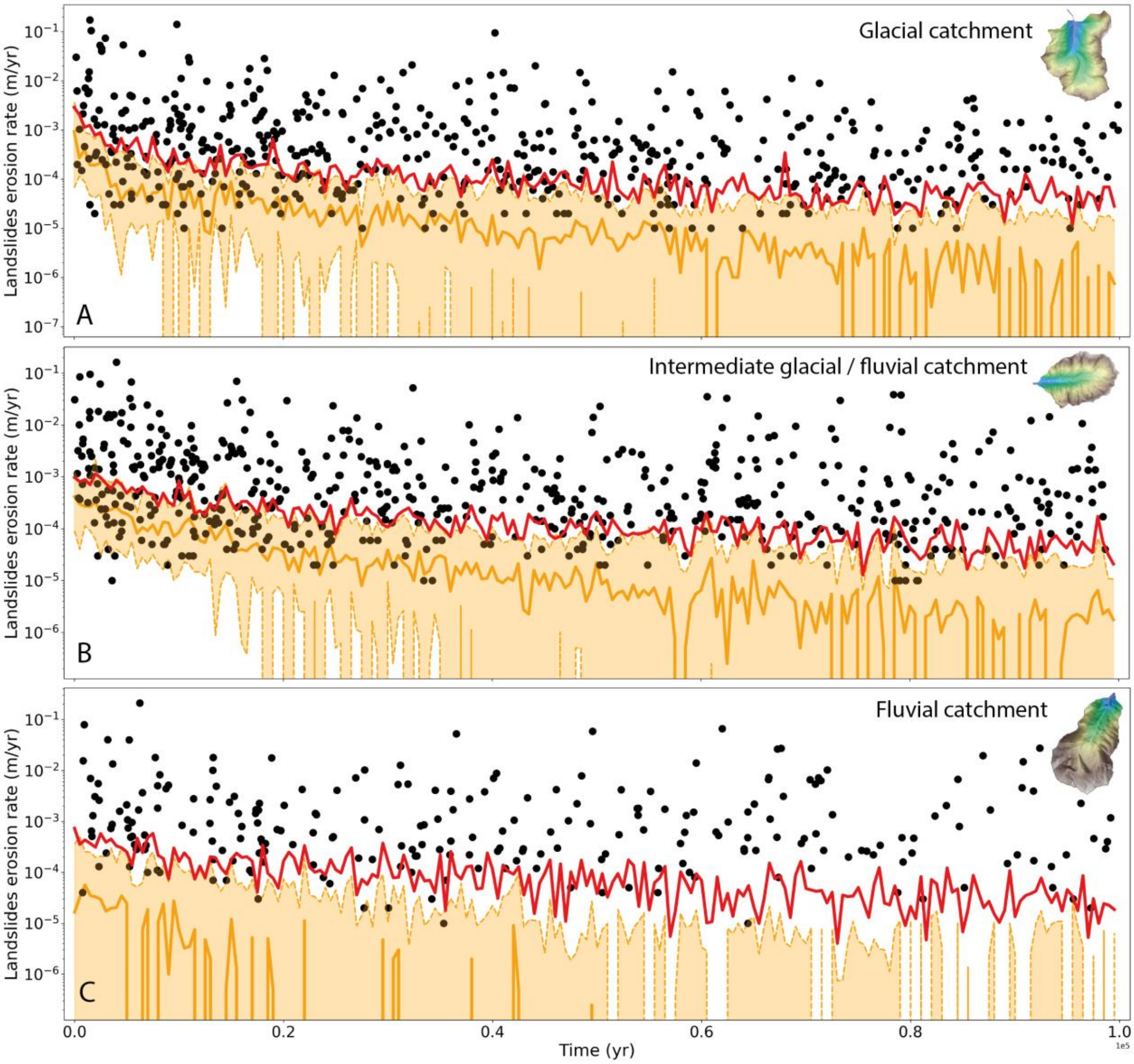

Figure S5: Temporal evolution of the landslide (catchment-averaged) erosion rate for the three studied catchments: A) Pilatte (glacial), B) Etages (intermediate glacial-fluvial). And C) Pisse (fluvial). Black dots illustrate the non-zero landslide erosion rates for each time step of one individual simulation, while red and orange lines depict respectively the mean and median (with 25^{th} and 75^{th} percentiles as dashed orange lines) erosion rates compiled from 20 individual simulations (with a smoothing temporal window of 0.5 kyr). For all catchments, the simulated landslide erosion rates decrease over time, especially during the first 20 kyr of simulation time, with different temporal trends depending on the catchment. The high-frequency erosion rates reflect the stochastic nature of landsliding.

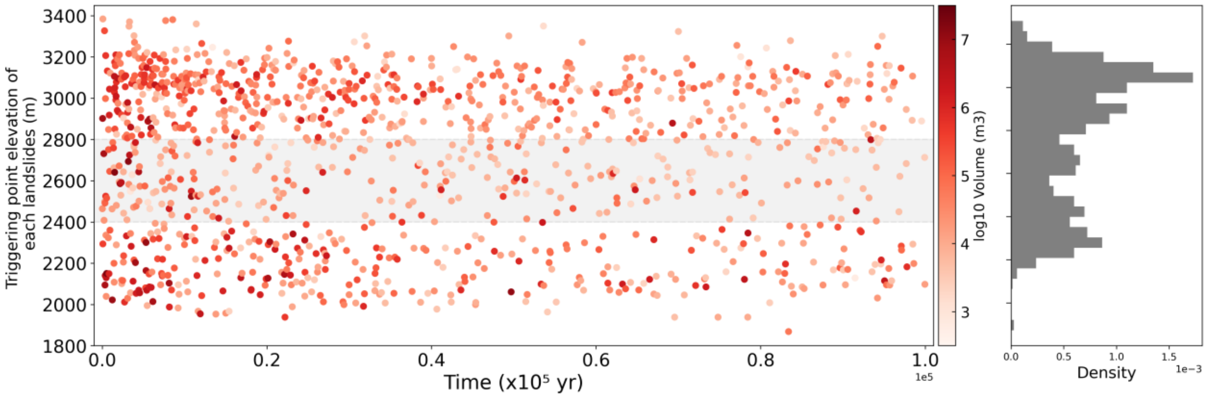

Figure S6 : Triggering point elevation of each landslide over the total simulation time (100 kyr) and its associated volume (red gradient colors) for the Etages (intermediate glacial-fluvial) catchment. Here the simulation is run with a smaller cohesion then in the reference case study (Fig 8). Note that the number of landslide appears higher here but the landslide distribution is still bimodal with elevation.

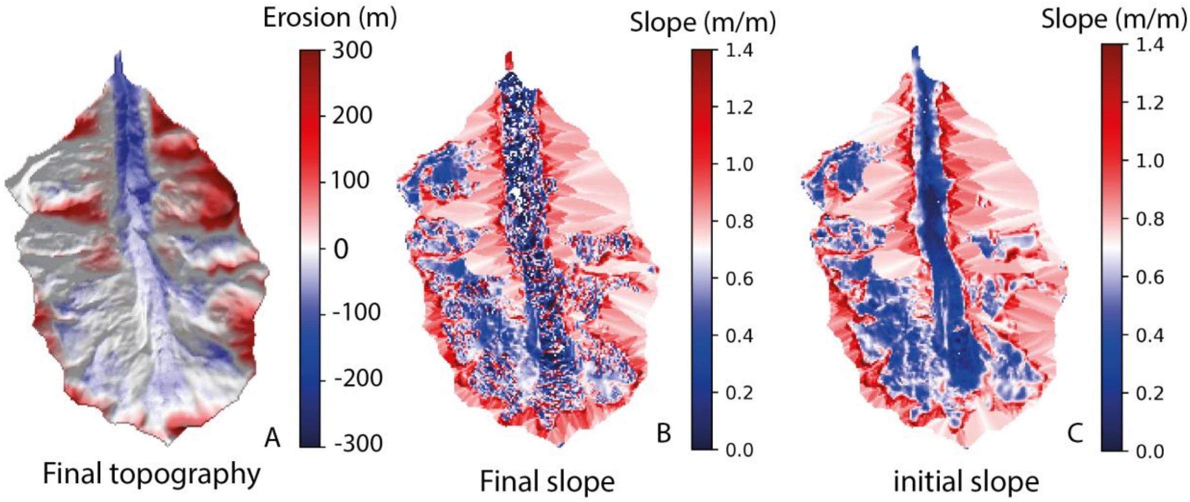

Figure S7: Simulation results (100 kyr) for the Etages catchment with a null connectivity (fine fraction = 1). A) Cumulative landslide erosion (red) and deposition (blue) over the hillshade DEM. B) Final slope distribution. The accumulation of sediments in the valley bottom and on gentle hillslopes generates some roughness and steep unrealistic piles of sediments, promoting landsliding. C) Final slope distribution with a full connectivity (fine fraction = 0) as shown in the main text.

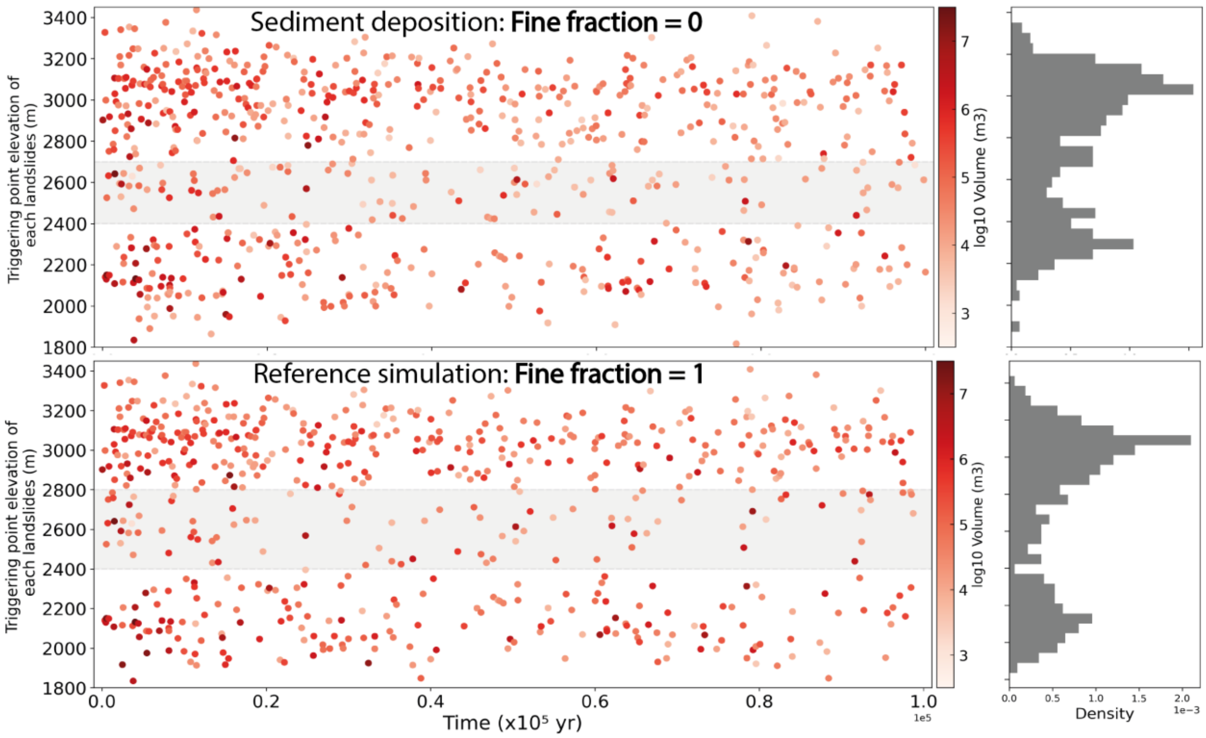

Figure S8: Triggering point elevation of each landslide over the total simulation time (100 kyr) and its associated volume (red gradient colors) for the Etages (intermediate glacial-fluvial) catchment. Comparison between two case studies: a full connectivity (fine fraction = 1) and a null connectivity (fine fraction = 0). Overall, the simulations give similar landslide activity patterns but more scattered distribution for the "Sediment deposition" simulation.

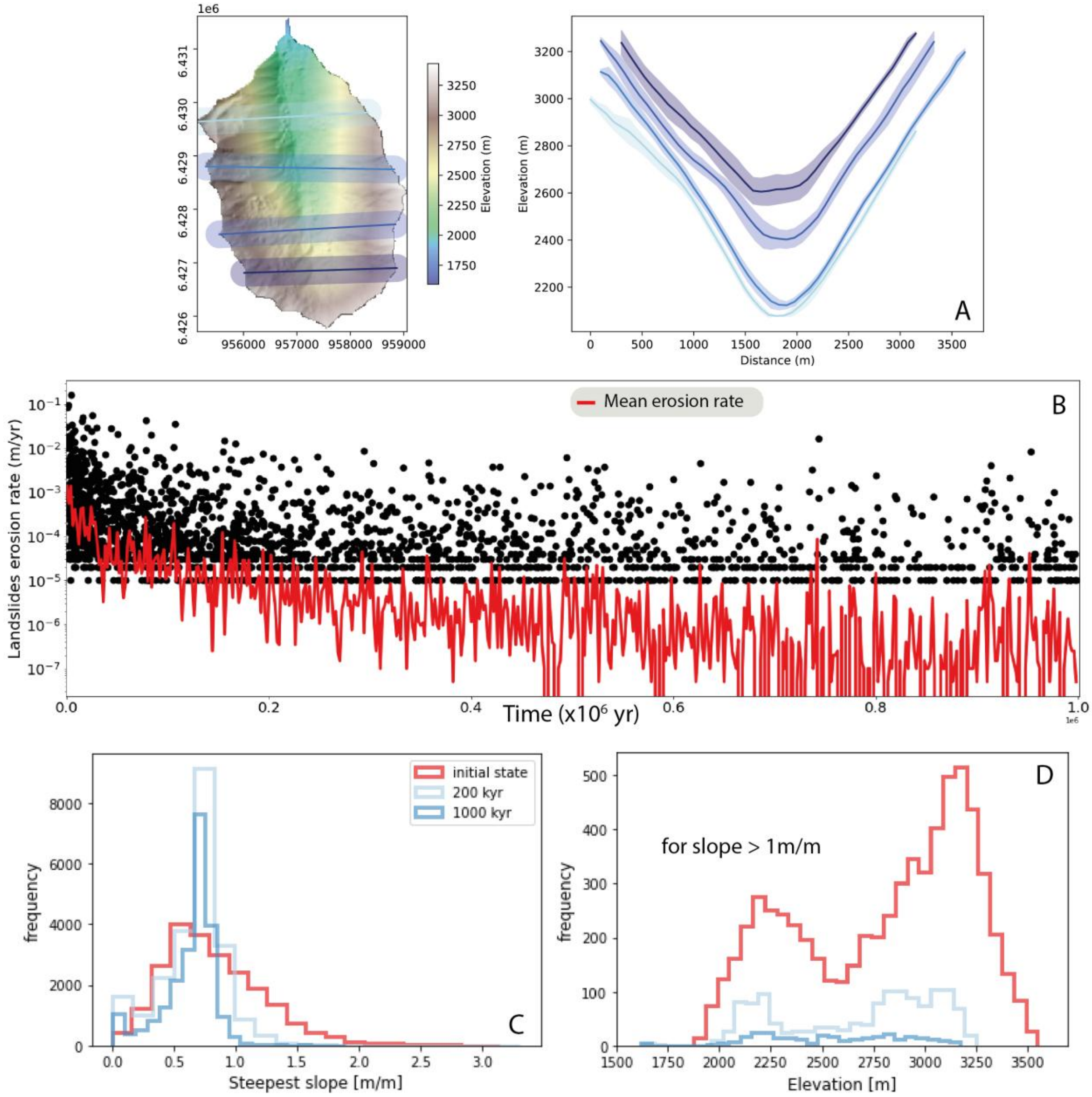

Figure S9: Topographic and quantitative results of the 1e6 yr simulation on the intermediate catchment (Etage). A) Cross sections showing homogeneous hillslopes, like a V-shaped valley, in contrast to the initial catchment profile (Fig. 3). B) Erosion rate evolution for one simulation (black dots). The mean is smooth every 2000 yr. The erosion rate decrease is fast in the first 200 kyr and get stable after 400 kyr. C) Hypsometry histogram for several time step. D) Elevation histogram for slope > 1m/m. Different time steps are shown.