

Supplementary Material: Strengthening the Rigidity of Landslide Materials Measured by Seismic Interferometry

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Table S1. Description of Drill Cores.

| unit | lithology |
|----------|--|
| coluvium | shallow landslide deposit and weathered material |
| SS/SH | mainly composed of interlays of sandstone and shale |
| SS2 | massive sandstone |
| SH | shale lined with thin sandstone |
| SS-SH | sandstone lined with shale, a transition unit form unit SH to unit SS1, displays a gradual and progressive change from top to base |
| SS1 | gray sandstone |
| DRM2 | sandstone lined with shale(SS-SH), mainly shale, upper part of unit SS-SH |
| DRM1 | sandstone lined with shale(SS-SH), mainly sandstone, lower part of unit SS-SH |

Table S2. Hydrogeological conceptual model of the Chashan site.

| Parameters | Hydrogeologic Unit | | | | | | | Data Sources |
|---------------------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|--|
| | Coluvium | DRM | SS/SH | SS2 | SH | SS-SH | SS1 | |
| Unit weigh (kN/m ³) | 19.6 | 19.6 | 24.5 | 24.5 | 24.5 | 24.5 | 24.5 | Soil classification test |
| Cohesion (kPa) | 25 | 25 | 1700 | 4171 | 903 | 835 | 4171 | Direct shear test, Unconfined compression test |
| Friction angle (deg.) | 34.0 | 34.0 | 30.0 | 38.1 | 23.5 | 41.0 | 38.1 | Direct shear test, Unconfined compression test |
| Hydraulic conductivity (m/s) | 5.8×10^{-5} | 5.8×10^{-5} | 2.5×10^{-7} | 5.0×10^{-7} | 2.5×10^{-7} | 2.5×10^{-7} | 5.0×10^{-7} | Back analysis (compare with monitoring data) |

Table S3. Parameters used in RAMMS model for the Chashan site.

| Parameters | Laboratory Test | Numerical Simulation |
|---|-----------------|-------------------------------|
| Unit weight (ρ , kN/m ³) | 19.6 | 19.6 |
| Friction angle (φ , deg.) | 34.0 | 34.0 |
| Friction coefficient (μ) | 0.675 | 0.675 |
| Turbulent friction coefficient (ξ , m/s ²) | - | 300 ¹ |
| Simulation stop criteria | | $M_{\max} < 5\%$ ² |

Note: ¹ Suggestion value by RAMMS manual (SLF/WSL, 2013) (Volume > 60,000 m³; elevation < 1000 m).

² M_{\max} : Maximum momentum.

Table S4. Safety factor of each analysis scenario.

| Scenario | Potential Sliding Mass | | | |
|----------------------------|------------------------|------|------|--------------|
| | B1 | B2 | B3 | Auto located |
| Normal condition | 2.67 | 2.31 | 1.57 | 2.21 |
| 0602 torrential rain event | 2.19 | 1.66 | 1.04 | 1.79 |
| 0823 torrential rain event | 2.33 | 1.77 | 1.13 | 1.94 |
| Earthquake condition | 1.81 | 1.60 | 1.20 | 1.53 |

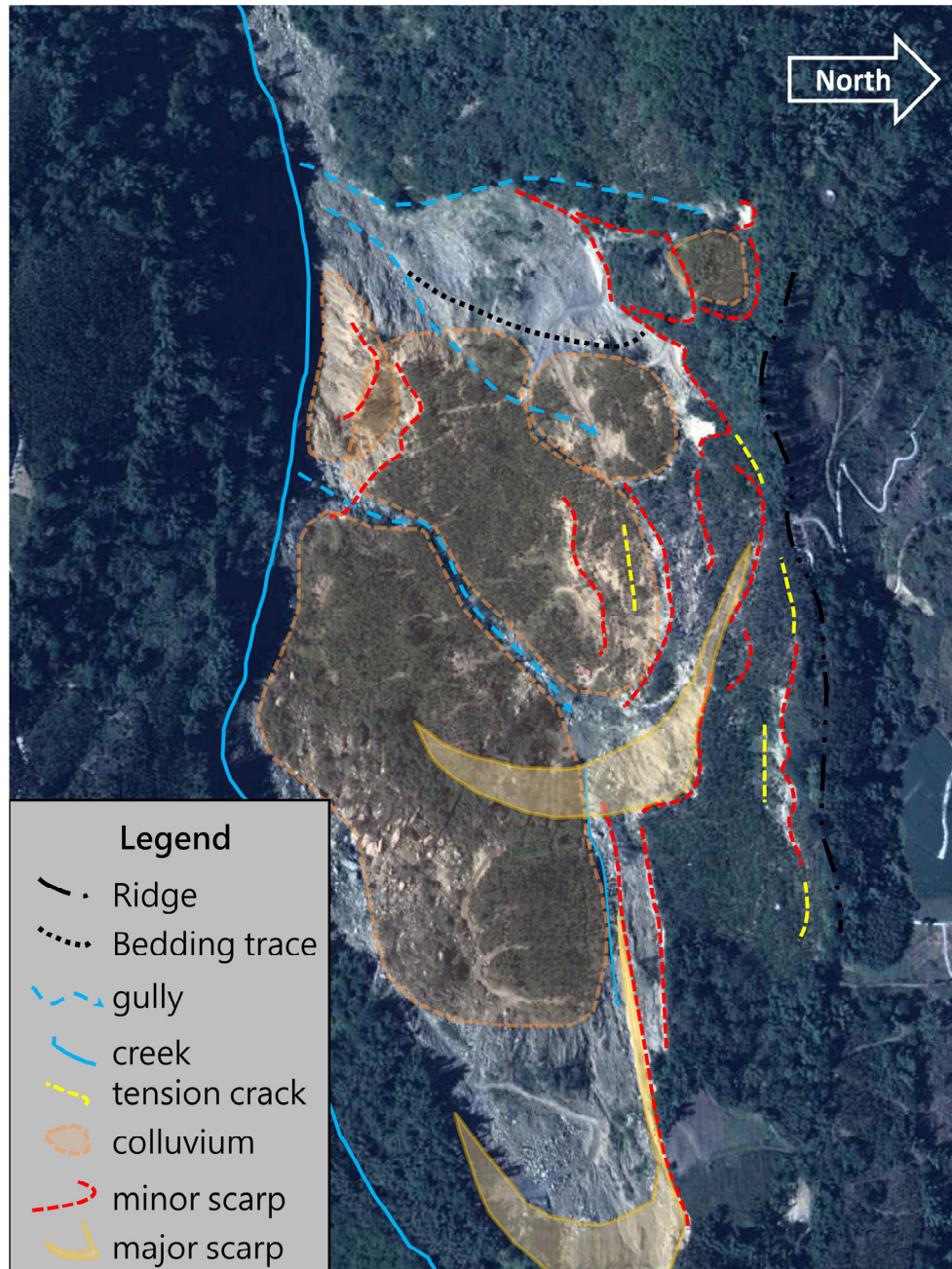


Figure S1. Aerial photography.

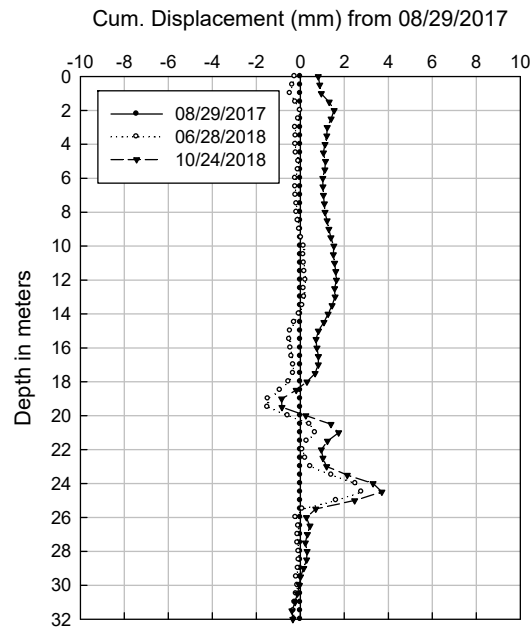


Figure S2. Measurement data (A-Axis) of BH1 inclinometer.

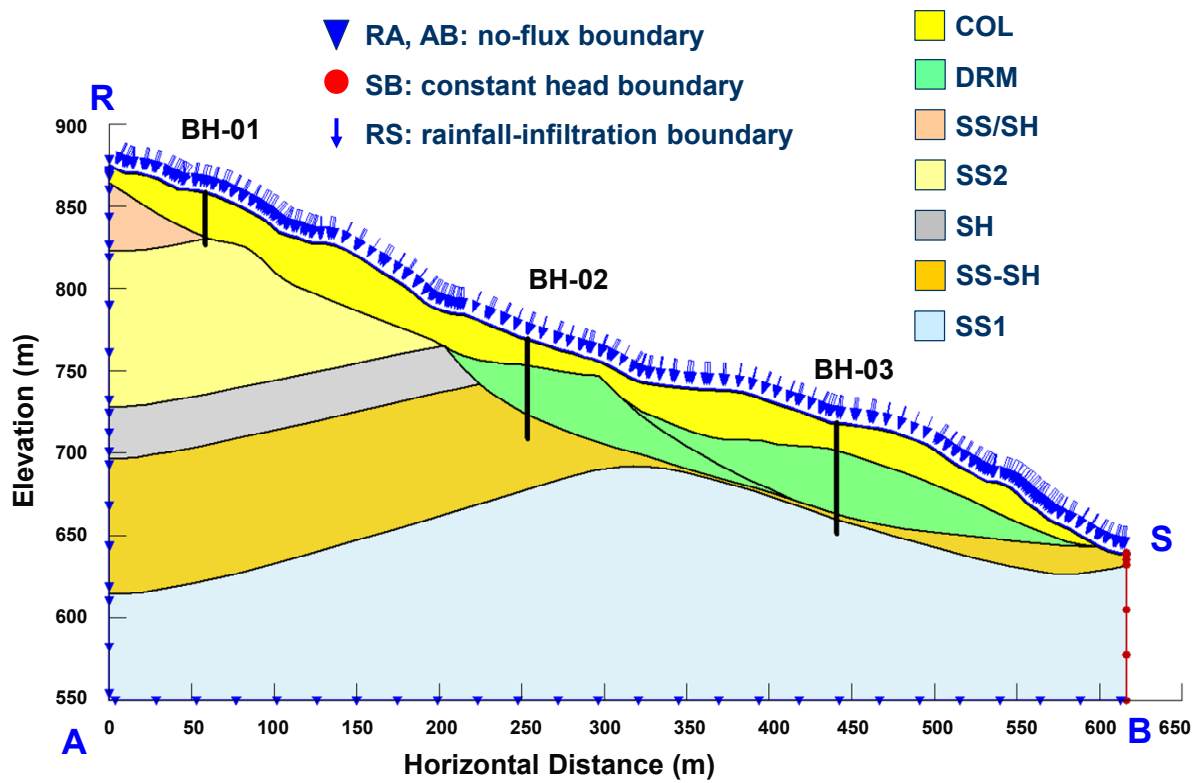


Figure S3. Hydrogeological conceptual model of the Chashan site.

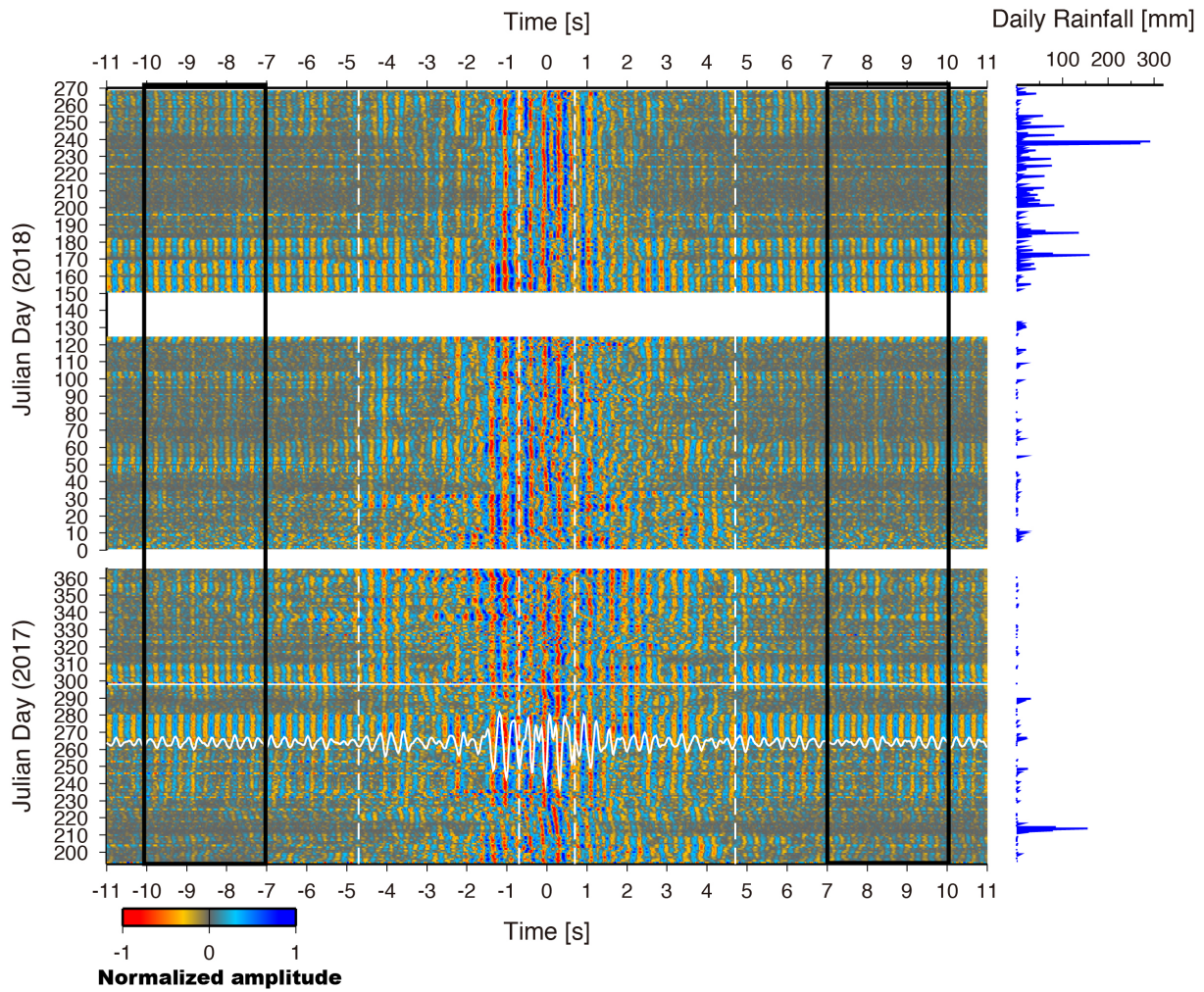


Figure S4. Filtered (2–10 Hz) daily vertical-component noise cross-correlation functions (NCFs). Amplitude of NCF is normalized each day. The reference NCF (RNCF) linearly stacked from all daily NCF. Black rectangle in NCF and RNCF waveforms indicates the portions of the coda wave used in dv/v measurement. Time series of daily precipitation is shown in the right panel.

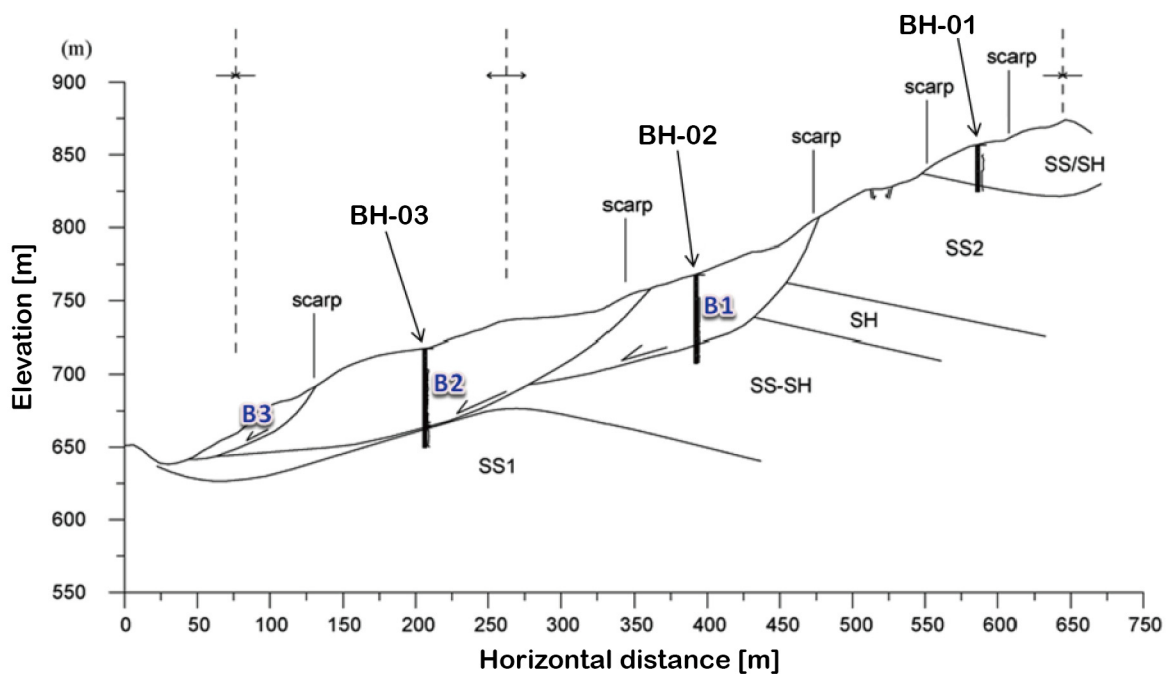


Figure S5. Inferred potential sliding mass.

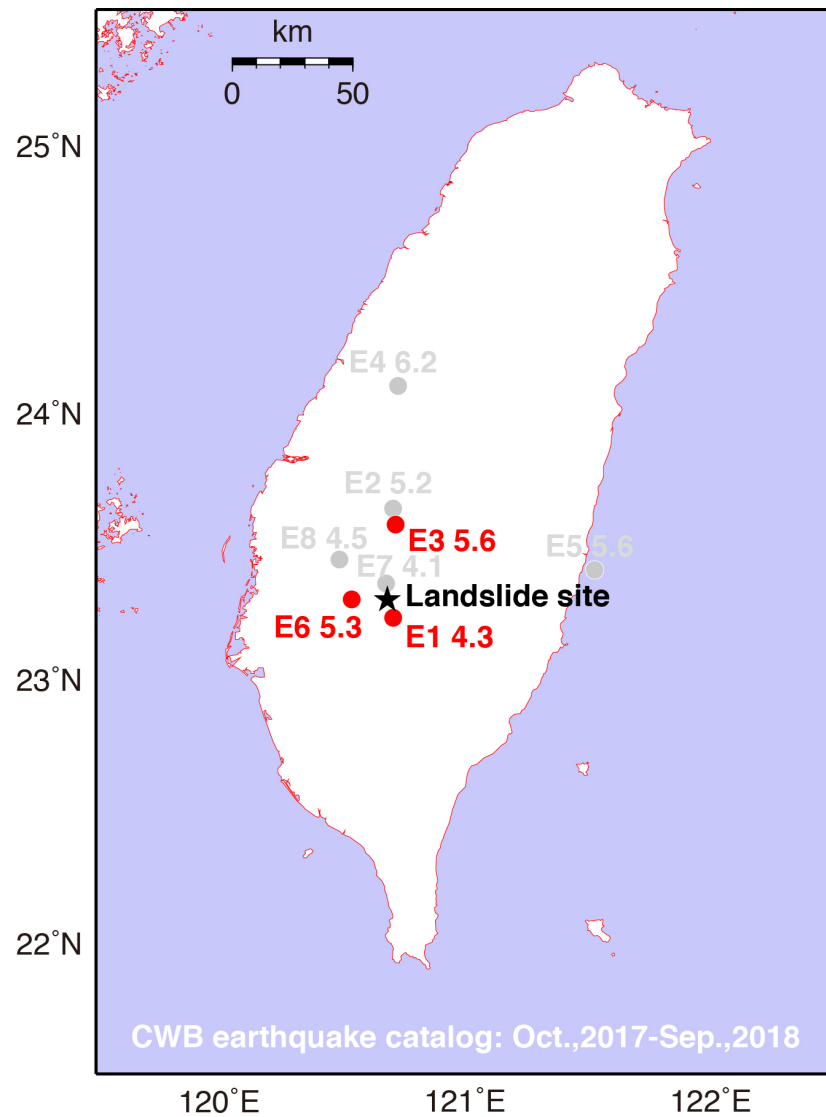


Figure S6. Distribution of earthquakes from the CWB catalog. The gray and red dots indicate the earthquake events excited the ground shaking intensities of III and IV at landslide area, respectively. Star is study area. The numbers shown beside the dots are event number and local magnitude (M_L).

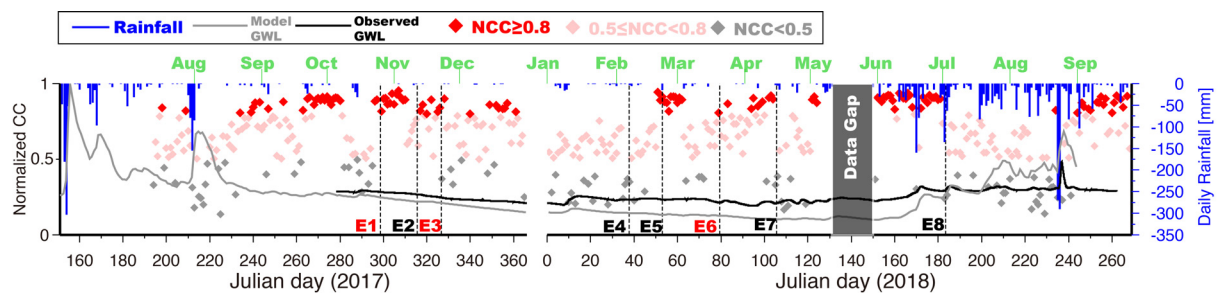


Figure S7. Time series of the normalized cross-correlation coefficient (NCC) and precipitations. Diamonds with different colors indicate different ranges of NCC values (red: $NCC \geq 0.8$; light red: $0.5 \leq NCC < 0.8$; gray: $NCC < 0.5$). The black and red labels indicate the earthquake events excited the ground shaking intensities of III and IV at landslide area, respectively. The gray shaded area indicates the seismic data gap.

Supplementary References:

SLF/WSL (2013), *RAMMS: User Manual v1.5. Avalanche, a Numerical Model for Snow Avalanches in Research and Practice*; SLF/WSL: Davos, Switzerland, 97p.