Topographic and ground-ice controls on shallow landsliding in thawing Arctic permafrost – model setup and output data.

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The repository has one zip file:

active_layer_detachment_analysis.zip

inside which are two folders:

1. slope_stability_model_data
2. topographic_model_data

1. slope_stability_model_data

To understand how different ground ice conditions can promote ALD failures, we developed three tests to assess slope stability: (1) by controlling the volume of ice lenses along the permafrost-active layer boundary, (2) a test with three ice-lens distribution scenarios in the active-layer, and (3) testing the impact of three excess pore-water dissipation rates, simulating advancing thaw fronts. To design our hillslope and implement our slope-stability tests we used the geotechnical software GeoStudio (Krahn, 2004).

Folder content

hillslope_geoslope.gsz - a file of the modelled hillslope to be opened in geoslope.

slope_stability_test1.xlsx - geoslope pore-pressure data for test (1). – Sheets starting with 'GeoSlope' are geoslope pore pressure data for tests 1. Output is in sheet labelled 'FactorOfSafety'. Used in figure 3a.

slope_stability_test2&3_scenario1.xlsx – Sheets starting with 'GeoSlope' are geoslope pore pressure data for tests (2 and 3). In scenario 1 we varied the total volume of ice within the soil column, first considering scenarios with the same total volume of ice within the soil column (2230 ice-lens cells). Other sheets relate to the distribution of ice lenses and therefore excess pore-water pressures in the soil column. Output is in sheet labelled 'FactorOfSafety'. Used in figure 2, 3b, S1(a-c), and S2(a-c).

slope_stability_test2&3_scenario2.xlsx - Sheets starting with 'GeoSlope' are geoslope pore pressure data for tests (2 and 3). In scenario 2 we varied the total volume of ice lenses in the soil column to maintain a 60% ice volume at a depth of 1.5 m. Other sheets relate to the distribution of ice lenses and therefore excess pore-water pressures in the soil column. Output is in sheet labelled ‘FactorOfSafety’. Used in figure S1(d-f) and S2(d-f).

2. topographic_model_data

We developed an ALD inventory for a 100 km2 region in the central Brooks Range (68.01⍰ N, 155.85⍰ W). We compared our mapped ALD polygons to topographic derivatives of a 5-meter interferometric synthetic-aperture radar (IFSAR)-derived digital elevation model (available at USGS, 2015). To establish the importance of convergent topography to ALD failures we created a series of hypothetical stream networks with drainage area thresholds ranging from 12,500 m2 to 125,500 m2 at intervals of 2,500 m2. Mapped ALD rasters were compared to these hypothetical drainage networks, which we buffered to account for the width of each ALD. Buffer widths varied from 10 m to 100 m in increments of 10 m, for each stream network. For a given buffer width and threshold drainage area, we calculated the area of ALD failures and non-failed terrain. By comparing the two datasets, we were able to establish which drainage areas were most susceptible to ALD failures, and the proximity of landsliding to topographically defined drainage areas. We compared the distribution of ALD failures with a topographically derived landslide susceptibility model called SHALSTAB (Dietrich & Montgomery, 1998; Montgomery & Dietrich, 1994).

Folder content

ald_shapefiles – a folder containing a list of shapefiles of mapped ALDs including projection files. Used in figure 1a.

buffer_flow_accumulation – a folder containing a list of raster files of varying drainage densities and widths. Used in figure 1b.

Landscape_Factor_of_safety.tiff – The output from our SHALSTAB analysis. Used in figure 1a.

Please cite this data and accompanying paper if you use the data for publication.

References

Dietrich, W. E., & Montgomery, D. R. (1998). *SHALSTAB: a digital terrain model for mapping shallow landslide potential*. University of California.

Krahn, J. (2004). Stability modeling with SLOPE/W: An engineering methodology. *GEOSLOPE/W International Ltd. Calgary, Alberta, Canada*.

Montgomery, D. R., & Dietrich, W. E. (1994). A physically-based model for the topographic control on shallow landsliding. *Water Resources Research*, *30*(4), 1153–1171. https://doi.org/10.1029/93wr02979

USGS. (2015). U.S. Geological Survey, 20150804, USGS NED Original Product Resolution AK IFSAR-D6-L2-C60 2013 ArcGrid 2015. Retrieved from https://www.sciencebase.gov/catalog/item/581d2302e4b08da350d55d18