Periglacial puzzles: Unravelling environmental controls on solifluction lobe morphometry

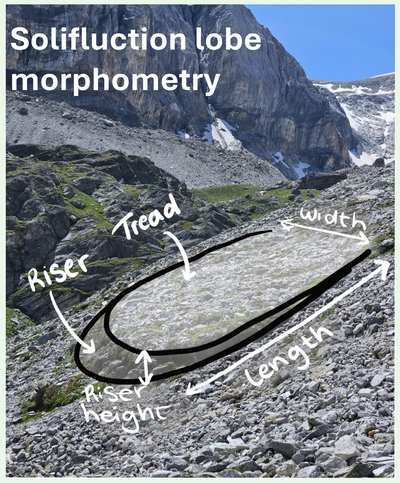
J.S. van Etten, J. Eichel, D. Draebing
Department of Physical Geography, Utrecht University

Utrecht University

Jil van Etten
Master student
j.s.vanetten@uu.nl
www.linkedin.com/in/jil-van-etten-83b1a2195
@jilvanetten.bsky.social

1. Introduction

Find the abstract here!



Motivation:

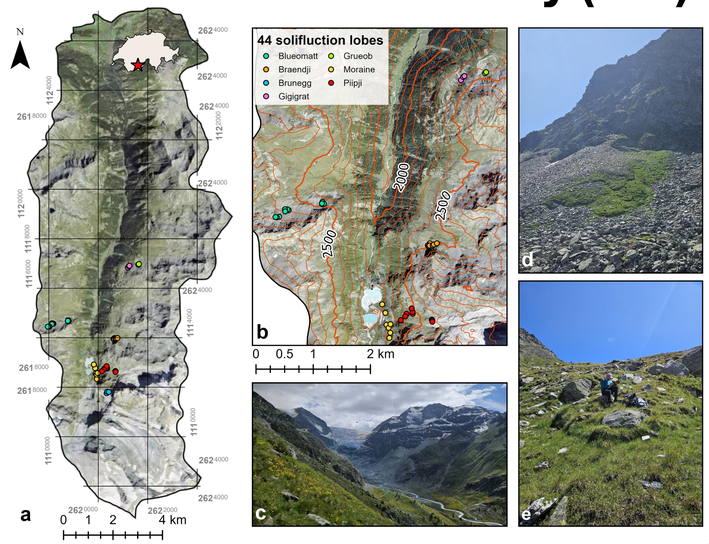
Research into solifluction lobe morphometry is crucial for understanding their role in landscape evolution, hydrology, sediment budgets, and providing microhabitats.

Aim:

I. ***Quantify the morphometry*** *of the solifluction lobes in the Turtmann Valley and compare the lobe morphometry of the study area to other regions.*

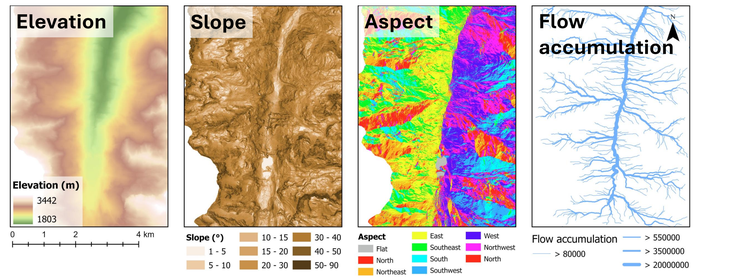
II. ***Determine the environmental controls*** *on solifluction lobe dimensions in the Turtmann Valley and assess if and how these controls differ from other regions.*

2. The Turtmann Valley (CH)

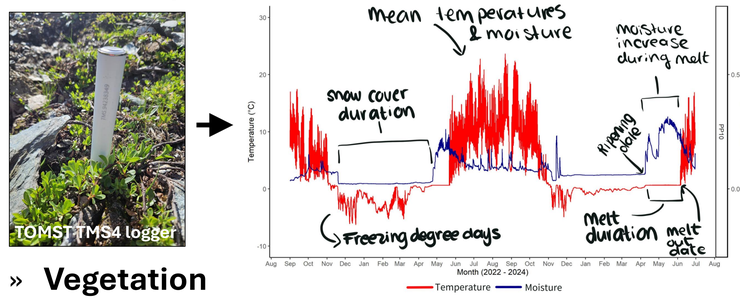


3. Data & Methods

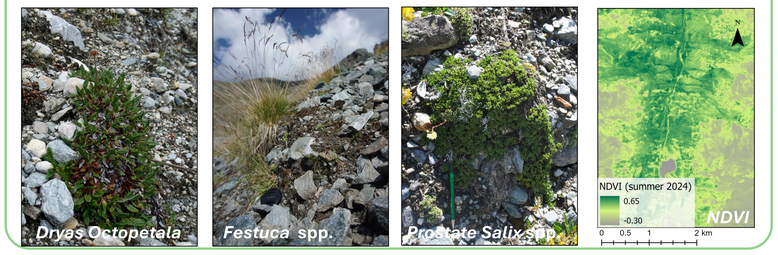
» DEM derivatives



» Soil temperature and moisture derivatives



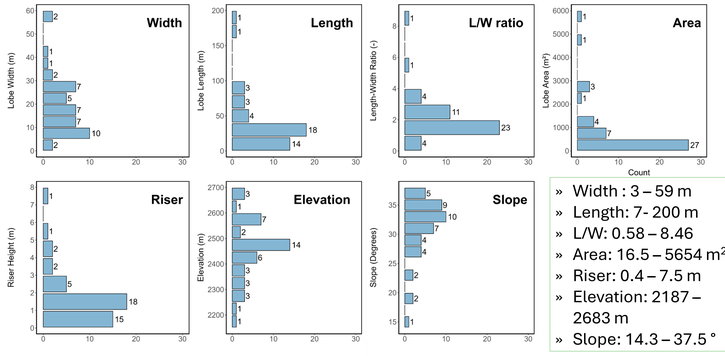
» Vegetation



4. Results and discussion

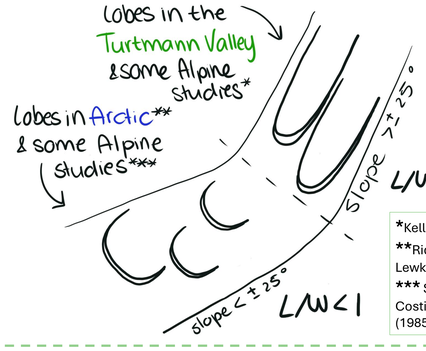
I. Lobe dimensions

» **Lobes in the Turtmann Valley are long and steep, with high risers**



- Width : 3 – 59 m
- Length: 7- 200 m
- L/W: 0.58 – 8.46
- Area: 16.5 – 5654 m²
- Riser: 0.4 – 7.5 m
- Elevation: 2187 – 2683 m
- Slope: 14.3 – 37.5 °

» **Lobes in the Turtmann valley are much more elongated than in the Arctic**



*Kellerer-Pirklbauer (2017).
**Ridefelt & Boelhouwers (2006), Hugenholtz & Lewkowics (2002), Harrison (1996).
*** Smith (1987), Matthews & Ballantyne (1986), Costin et al. (1967), Hansen-Bristow & Price (1985), Gengnian et al. (1995).

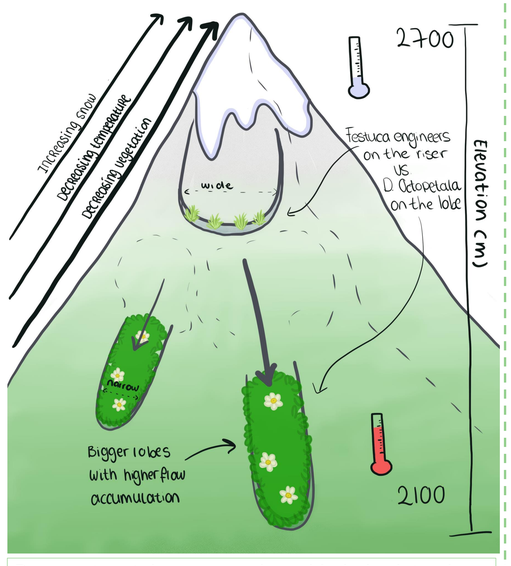
II. Environmental controls

» **Elevation controls width through temperature, snow and vegetation.** → More freezing, longer snow cover and less vegetation likely decrease slope stability and increase soil movement leading to wider lobes.

» **Fine material content controls riser height.** → High fine material content creates the cohesion needed for high risers.

» **Flow accumulation affects all lobe dimensions.** → High influx of water and sediment (more active slope) creates larger lobes.

Bold values **p < 0.05**



Dryas octopetala grows upslope, hindering lateral growth, while *Festuca spp*. grows along the slope, not hindering lateral growth.

5. Conclusions

I. The studied lobes are **longer and steeper, with higher risers and higher L/W ratios** than those studied in the Arctic.

II. Several environmental factors control lobe geometry:
- **Wider lobes occur at higher elevations**, influenced by changing temperatures, vegetation and snow over the elevation gradient.
- Lobes with **high risers** are correlated to **high fine material and clay content**, as the fine material provides the cohesion necessary for high risers to form.
- **Large lobes with high risers** are present in areas with **high flow accumulation**.

The relevant environmental factors differ between the Turtmann Valley and the Arctic regions studied before.

6. References

Costin, A. B., Thom, B. G., Wimbush, D. J., & Stuiver, M. (1967). Nonsorted steps in the Mt. Kosciusko area, Australia. *Geological Society of America Bulletin*, *78*(8), 979. https://doi.org/10.1130/0016-7606(1967)78

Gengnian, L., Heigang, X., & Zhijiu, C. (1995). Gelifluction in the alpine periglacial environment of the Tianshan Mountains, China. *Permafrost and Periglacial Processes*, *6*(3), 265–271. https://doi.org/10.1002/ppp.3430060308

Hansen-Bristow, K. J., & Price, L. W. (1985). Turf-Banked terraces in the Olympic Mountains, Washington, U.S.A. *Arctic and Alpine Research*, *17*(3), 261–270. https://doi.org/10.1080/00040851.1985.12004034

Harrison, T. D. D. a. S. (1996). Turf-Banked terraces in Drasfi, southeast Iceland: morphometry, rates of movement, and environmental controls. *Arctic and Alpine Research*, *28*(2), 228–236. https://doi.org/10.2307/1551764https://www.jstor.org/stable/1551764

Hugenholtz, C. H., & Lewkowicz, A. G. (2002). Morphometry and environmental characteristics of turf-banked solifluction lobes, Kluane Range, Yukon Territory, Canada. *Permafrost and Periglacial Processes*, *13*(4), 301–313. https://doi.org/10.1002/ppp.433

Kellerer-Pirklbauer, A. (2017). Solifluction rates and environmental controls at local and regional scales in central Austria. *Norsk Geografisk Tidsskrift - Norwegian Journal of Geography*, *72*(1), 37–56. https://doi.org/10.1080/00291951.2017.1399164

Matthews, J. A., & Ballantyne, C. H. a. C. K. (1986). Studies on a gelifluction Lobe, Jotunheimen, Norway: 14C Chronology, Stratigraphy, Sedimentology and Pal\u00e6oenvironment. *Geografiska Annaler. Series a, Physical Geography*, *68*(4), 345–360. https://doi.org/10.2307/521526https://www.jstor.org/stable/521526

Oliva, M., Schulte, L., & Gómez Ortiz, A. (2008, June). Solifluction lobes in Sierra Nevada (Southern Spain): morphometry and palaeoenvironmental changes. In *Proceedings of the 9 International Conference on Permafrost* (Vol. 2, pp. 1321-1326).

Ridefelt, H., & Boelhouwers, J. (2006). Observations on regional variation in solifluction landform morphology and environment in the Abisko region, northern Sweden. *Permafrost and Periglacial Processes*, *17*(3), 253–266. https://doi.org/10.1002/ppp.560

Smith, D. J. (1987). Observations of turf-banked solifluction lobe geomorphometry. *Albertan Geographer*, *23*, 45–55. https://www.researchgate.net/publication/270395511_Observations_of_turf-banked_solifluction_lobe_geomorphometry