Soil Development in Heterogeneous High Mountain Environments of the Central European Alps

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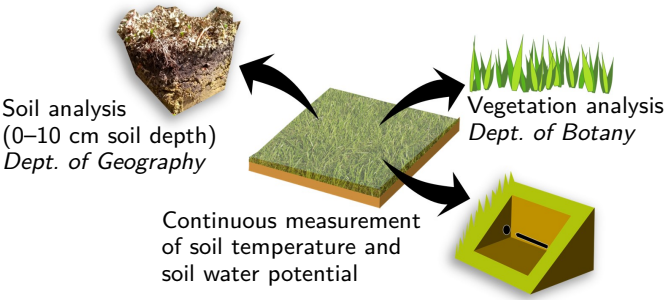
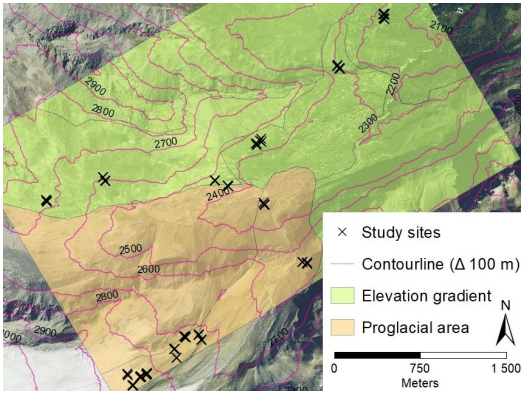
High mountain environments (HMEs) are characterized by heterogeneous environmental conditions. We determined the impact of diverse site factors on soil development (i) in a glacier foreland with initial soils younger than 200 years, (ii) along an elevation gradient outside of the glacier foreland with more developed soils, and (iii) at sites with geomorphodynamic impact, directly bordering to the elevational gradient sites.



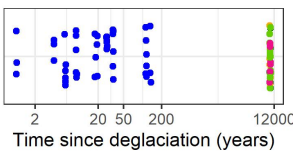


Location of the study sites (n=26) in Upper Martelltal, South Tyrol. Orthophoto (2008) and DTM (2006): http://geoservices.buergernetz.bz.it

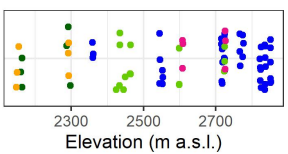
Heterogeneity of the soil samples

Soil samples were taken along several gradients (age, elevation, aspect, slope) in order to display the heterogeneity of HMEs. Some study sites were impacted by geomorphic processes (constant scree input, nivation around snow accumulation).

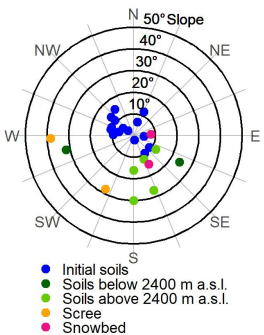
Age gradient



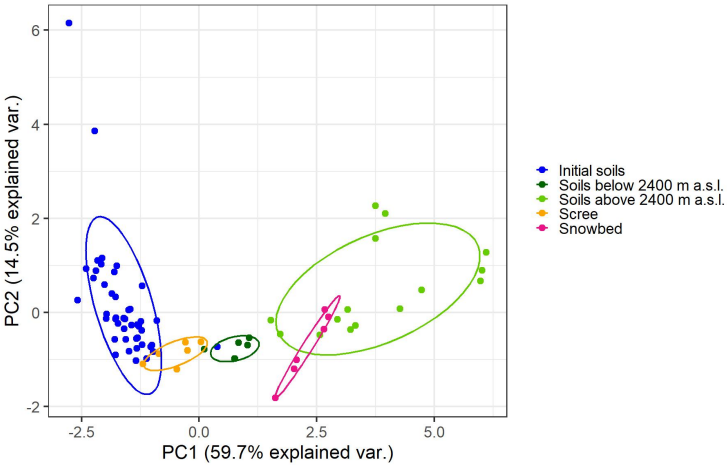
Elevation gradient



Aspect and slope



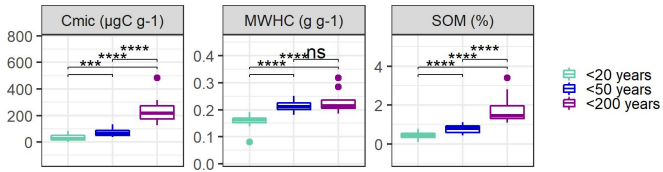
A PCA indicates that the sampled soils can be associated with five groups (as shown by 95 % concentration ellipses).



PC1 and PC2 explain ≈75 % of the data variance, even though only soil parameters were taken into account (SOM content, soil moisture, skeleton content, soil pH ($CaCl_2$), water holding capacity, plant-available NH_4^+, microbial biomass, microbial basal respiration, qCO_2).

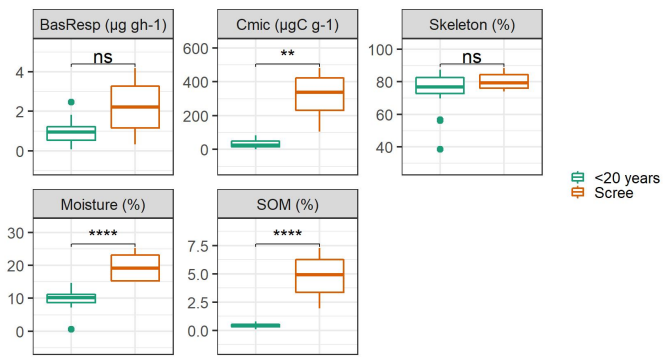
Initial soil development during the first 200 years

Important soil parameters (e. g. SOM content, microbial biomass) increase strongly after only a few decades.



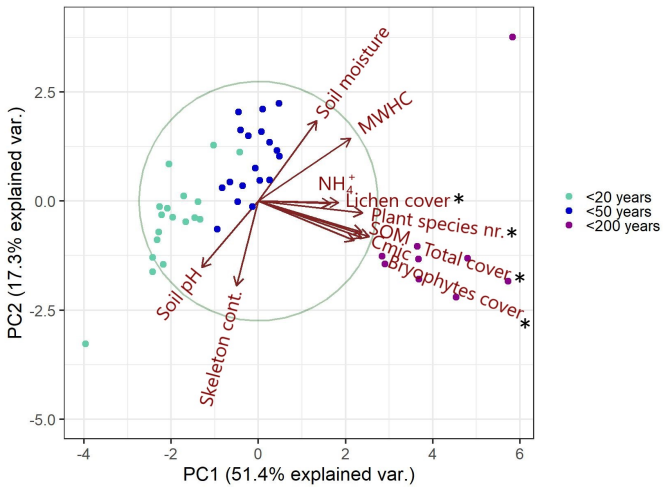
Are soils on scree comparable to proglacial soils?

Scree-impacted soils outside of the glacier foreland differ from initial proglacial soils.



Vegetation during initial soil development

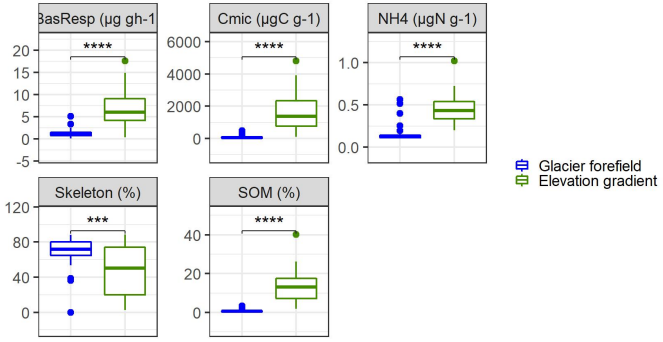
Vegetation cover and species number are closely related to SOM content and related parameters (e. g. microbial biomass). In contrast to soil, vegetation seems not to be correlated to skeleton content.



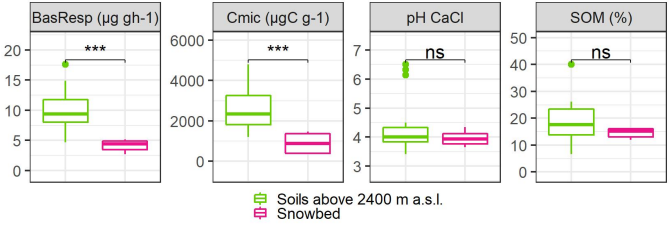
More developed soils along an elevation gradient

Initial soils vs. more developed soils

More developed soils differ strongly from initial soils in all tested soil parameters, and show a higher variability.

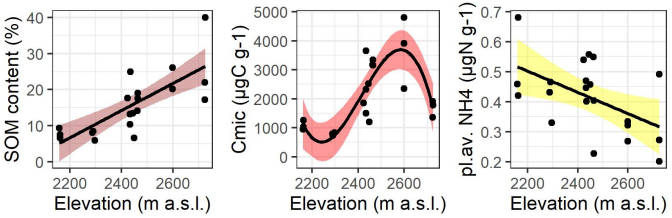


Soils at sites with nivation had lower microbial biomass and activity than their reference soils.

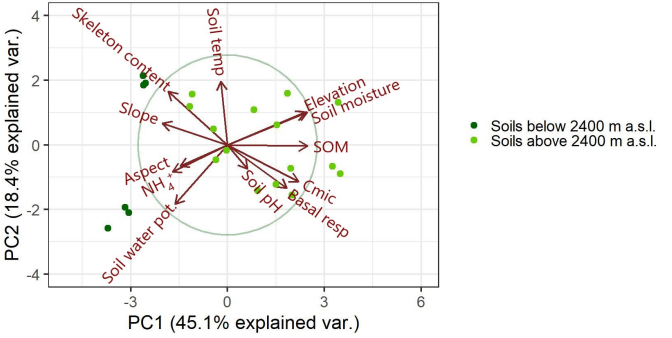


The influence of elevation on more developed soils

Elevational differences explain most of the variability of the soil parameters.



Apart from elevation, the high variability can also be explained by aspect, slope, and skeleton content.



- Initial soil development in glacier forelands is especially pronounced during the first decades.
- During the first decades of soil development, aspect and slope play a minor role.
- More developed soils are more variable and mainly influenced by the key drivers elevation and vegetation.
- Geomorphic processes (here: constant scree input, snowbeds) play a minor role for soil formation compared to elevation.
- Sites with scree input differ from young proglacial sites.

Internal collaborations

- Erschbamer B and Ramskogler K (Dept. of Botany): *Plant-soil-interactions in high mountain areas
- Illmer P (Dept. of Microbiology): Use of laboratory technologies
- Stötter J and Knoflach B (Dept. of Geography): Spatio-temporal reconstruction of glacier areas since the LIA
- Keller L and Deisenrieder V (Dept. of Geography): Research-education-cooperation

External collaborations

- SEHAG project (Cath. U of Eichstätt-Ingolstadt; TU Vienna; U of Bremen; TU Munich; U of Innsbruck): Sensitivity of high-alpine geosystems to climate change since the year 1850