Influence of permafrost degradation and shift in vegetation on litter and soil properties: case study in Central Alaska

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Global warming affects the Arctic and sub-Arctic regions by exposing previously frozen permafrost to thaw, unlocking mineral nutrients, stimulating microbial activity, and boosting plant growth. Initially composed of graminoids, forbs, deciduous and evergreen shrubs, mosses and lichens, Arctic tundra is subject to a shrub, forb and moss expansion, at the expense of graminoid species. For now, little is known about the intrinsic foliar properties of these plant species and how they may influence properties of the underlying litter. Therefore, we investigated vegetation foliar properties and litter properties (organic carbon, C/N ratio, cation exchange capacity (CEC), pH, and concentrations of major and trace elements), from a typical Arctic tundra across a natural gradient of permafrost degradation.

Results show that vegetation foliar properties are intrinsic to plant species and do not depend on the permafrost degradation stage. Furthermore, the natural gradient of permafrost degradation showed contrasts in litter mineral element concentrations, related to the occurring shift in vegetation. For example, we found a decrease in silicon concentrations in the litter between the least and the most degraded permafrost site, which is concurrent with the decrease in graminoids (Si-rich plant species) and the increase in shrubs biomass (Si-poor plant species), upon permafrost degradation. Therefore, changes in vegetation composition may influence litter properties, such as C/N ratio, CEC and mineral element concentrations (Figure 1), which could in turn influence C dynamics with the change of nutrient availability for plant cover.

References

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Figure: Changing litter elemental composition and properties upon shift in subarctic tundra vegetation from sedges (left) to forbs and mosses (right) upon permafrost degradation.