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Litter quality and its response to water level drawdown in boreal peatlands at plant species and community level

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There is increasing evidence that changes in the species composition and structure of plant communities induced by global change will have much more impact on plant-mediated carbon cycling than any phenotypic responses. These impacts are largely mediated by shifts in litter quality. There are few documentations of these changes so far, due to the relatively long time scale required for their direct observation. Here, we examine the changes in litter inputs induced by persistent water-level drawdown in boreal peatland sites. Peatlands contain a major proportion of the terrestrial carbon pool, and it is thus important to be able to predict their behaviour and role in the global C cycle under different global change factors.

We studied the effects of short-term (ca. 4 years) and long-term (ca. 40 years) persistent water level (WL) drawdown on the quantity and chemical quality of above-ground plant litter inputs at three sites: bog, oligotrophic fen and mesotrophic fen. The parameters used to characterize litter quality included various extractable substances, cellulose, holocellulose, composition of hemicellulose (neutral sugars, uronic acids), lignin, CuO oxidation phenolic products, and concentrations of C, nitrogen (N), phosphorus (P), potassium, magnesium, manganese and calcium.

Four different groups of litter were clearly distinct based on their chemical quality: foliar litters, graminoids, mosses and woody litters. The pristine conditions were characterized by Sphagnum moss and graminoid litter. Following short-term WL drawdown, changes in the quality and quantity of litter inputs were small. Following long-term WL drawdown, total litter inputs dramatically increased, due to increased tree litter inputs, and the litter type composition greatly changed. These changes resulted in annual inputs of 1901-2010 kg•ha-1 C, 22-24 kg•ha-1 N, 1.5-2.2 kg•ha-1 P, 967-1235 kg•ha-1 lignin and lignin-like compounds and 254-300 kg•ha-1 water solubles after long-term WL drawdown, compared to respective values of 394-658, 5.6-9.3, 0.22-24.4, 161-293 and 44-81 for the pristine conditions.

The direct effects of WL drawdown on litter quality were overruled by the indirect effects via changes in vegetation composition. The short-term (reflecting transient conditions) and long-term (reflecting longer-lasting situation of already adapted ecosystem) effects were very different. Our results imply that the long-term effects will strongly affect the soil properties and C cycle of peatlands.