Abstract

In this thesis, we investigated stoichiometric imbalance due to changes in carbon (C), nitrogen (N), and phosphorus (P) availability in different terrestrial scenarios. In the first study, we investigated the effect on biomass of a two-way N and P fertilisation gradient, ranging from deficient to sufficient supply of nutrients, in barley (*hordeum vulgare*). In particular, shoot-root biomass allocation and synergistic effects were investigated when availability of both N and P was varied. In the second study, we moved our attention to soil as we investigated the accrual of nutrients into soil microbial biomass along a soil organic matter (SOM) gradient formed from a post-mining chronosequence. In a third study, we investigated stoichiometric imbalance in soil due to changes in soil and microbial stoichiometry after a freeze-thaw (FT) event. In the first two studies, we found, as expected, that accrual of nutrients into biomass (plant and soil microbial) increased with increasing nutrient availability. Unexpectedly however, these responses were not linear but instead exhibited critical values that determined the response of the variables in question. In the first study, we could show that there was a synergistic response of barley biomass to N and P fertilisation. This effect, however, was only observed above a critical P level, when P was not limiting growth. Furthermore, we could show that balanced supply of nutrients had a greater effect when P was limiting. From this we further hypothesise that the plants were not able to cope with increases in stoichiometric imbalance due to widening N:P ratio when P was limiting, yet they were more able to do so when not limited by P.

Similarly, in the second study of the recultivated soils of the post-mining chronosequence, we could show that the accrual of carbon and nitrogen into microbial biomass and relative respiratory carbon losses shifted around a 1% soil organic carbon (SOC) threshold. We interpreted this result to mean that when the soils contained less than 1% SOC, soil microbes were extremely carbon limited and in a stoichiometric inefficient state due to stoichiometric imbalance. Whereas when SOC increased above this critical value, stoichiometric imbalance was alleviated and the microbes shifted to a more efficient stoichiometric state. Lastly, in the third study, we could show that, in the few hours after a freeze-thaw event, there was an enrichment of nitrogen into soil microbial biomass. This was due to a coupled effect of increased N uptake by the surviving microbial biomass and disproportionate C losses via respiration. We hereby could present evidence that stoichiometric imbalance due to enriched microbial N, in the first freeze-thaw cycle, may be the first step that leads to significant N losses in subsequent freeze-thaw cycles in agricultural soils. In summary, we present two main findings in this thesis: Firstly, we provide evidence, for the first time, that critical thresholds between stoichiometric states may exist that are dependent on the absolute nutrient status of the system, rather than relative stoichiometric ratios. Secondly, we present a mechanism for microbial derived N_2O emissions after freeze-thaw events due to short-term stoichiometric imbalance in soil microbial biomass. These results contribute to a better understanding of stoichiometric transformations in ecology and may lead to a more complete understanding of nutrient cycling and nutrient limitations in terrestrial ecosystems.