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Effect of granulated wood ash fertilization on N2O emissions in boreal peat forests

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Peatlands cover one third of the land surface area in Finland and over half of that are drained for forestry. Natural peatlands are either small sources of nitrous oxide (N2O) or they can also act as a sinks of N2O. When peatlands are drained, oxygen concentration in the peat increases, organic matter decomposition accelerates and N2O emissions may increase significantly, especially in nutrient rich peat soils. Hence drainage and land-use changes can have a big impact on N2O fluxes in peatlands. The annual consumption of wood chips is to be increased to 13.5 M m3 from the present 8.7 M m3 in Finland. This will also increase the amount of wood ash in the power plants. Wood ash contains considerable amounts of mineral nutrients but lacks nitrogen. Therefore, it has been used as a fertilizer in nitrogen rich peatland forests lacking other nutrients. Recycling of ash would also return the nutrients lost during biomass harvesting back to the forests.

We studied the effects of granulated wood ash as a fertilizer in peat soils drained for forestry. Ash is nowadays granulated mainly to facilitate its handling and spreading. Granulation also stabilizes the ash decreasing the solubility of most of the nutrients and minimizing harmful effects of ash spread over the vegetation. Granulated wood ash increases soil pH less than loose ash. Drainage of peatland forests increases microbial activity in the soil which is furthermore intensified with the addition of ash promoting organic matter decomposition and possibly affecting N2O emissions. We studied the effect of granulated wood ash on N2O fluxes in three different peat forests in Finland in both field and laboratory experiments.

In the field, N2O emissions were not affected by granulated wood ash fertilization but the soil respiration rate increased. However, in the laboratory studies we observed a clear decrease in N2O production due to wood ash addition, although changes in pH values were only minor. We studied what could explain this decrease in N2O production. Despite of the granulation process some nutrients (e.g. K, Na, B, S) still leach quickly from the ash in form of ions, which was observed as an increased electrical conductivity. Granulated ash contains a high concentration of sulfates and we created in the laboratory experiments with the addition of K2SO4 or (NH4)2SO4 similar decrease in N2O production as observed with the addition of granulated wood ash. Our results indicate that quickly leaching ions inhibit nitrification in peat. In the field experiments the same phenomena was not observed, probably due to leaching of the nutrients (ions) deeper into the soil and due to the competition of vegetation which outcompetes microbes for available nutrients. In conclusion, the use of granulated wood ash does not increase N2O emissions in boreal peat forests.