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The effect of wood ash fertilization on soil respiration and tree stand growth in boreal peatland forests

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Out of Finland's original 10 million hectares of peatlands over half has been drained for forestry. Natural peatlands act as a sink for carbon but when peatland is drained, increased oxygen concentration in the peat accelerates the aerobic decomposition of the old organic matter of the peat leading to carbon dioxide (CO_2) emissions to atmosphere.

Increasing use of bioenergy increases also the amount of ash produced as a byproduct in power plants. Wood ash contains all essential nutrients for trees to grow except nitrogen. Therefore, wood ash is ideal fertilizer for nitrogen rich peatland forests where lack of phosphorus or potassium may restrict tree growth. At the moment, wood ash is the only available PK-fertilizer for peatland forests in Finland and areas of peatland forests fertilized with ash are increasing annually.

The effects of wood ash on vegetation, soil properties and tree growth are rather well known although most of the studies have been made using fine ash whereas nowadays mostly stabilized ash (e.g. granulated) is used. Transporting and spreading of stabilized ash is easier than that of dusty fine ash. Also, slower leaching rate of nutrients is environmentally beneficial and prolongs the fertilizer effect. The knowledge on the impact of granulated wood ash on greenhouse gas emissions is still very limited. The aim of this study was to examine the effects of granulated wood ash on CO_2 emissions from peat and tree stand growth.

Field measurements were done in two boreal peatland forests in 2011 and 2012. One of the sites is more nutrient rich with soil carbon to nitrogen ratio (C/N) of 18 whereas the other site is nutrient poor with C/N ratio of 82. Both sites were fertilized with granulated wood ash in 2003 (5000 kg ha^{-1}). The effect of fertilization was followed with tree stand measurements conducted 0, 5 and 10 years after the fertilization. The CO_2 emissions of the decomposing peat (heterotrophic respiration) were measured from study plots where vegetation and litter were removed to eliminate respiration by vegetation (autotrophic respiration). Roots were cut by installing aluminum tubes into the depth of 30 cm. Emissions were measured with chamber method using portable CO_2 analyzer. Soil temperature was measured simultaneously with gas measurements manually from the depth of 5 cm as well as continuously with data loggers embedded into the peat. Annual soil respiration was modelled assuming that emissions change as a function of temperature.

According to preliminary results, fertilization with granulated wood ash increased CO_2 emissions of the peat significantly, especially in nutrient poor site. Ash fertilization increased also strongly the accumulation of carbon into the trees. Nonetheless, in both sites CO_2emissions from decomposing peat where higher than carbon that was stored in biomass. This was the case especially in the nutrient poor site where trees are growing poorly and due to low peat nitrogen content the area is not considered suitable for ash fertilization. However, at the more fertile site both stand C sequestration and soil C efflux increased similarly.