How the major Swedish forest fire of 2014 affected the ecosystem

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Credit: Uppsala University

Swedish researchers from institutions including Uppsala University have spent four years gathering data from the areas affected by the major forest fire of 2014. In their study of how the ecosystem as a whole has

been altered, they could see that water quality in watercourses quickly returned to normal, while forested areas continued to lose carbon for many years after the fire.

The consequences of major forest fires remain poorly studied in Northern Europe. To improve this situation, researchers from Uppsala University, the Swedish University of Agricultural Sciences (SLU) and the Swedish Meteorological and Hydrological Institute (SMHI) decided to investigate just how much carbon and nutrients are released into the atmosphere and watercourses during fires and how quickly the ecosystem returns to its previous state. The results of this research are now being presented in the scientific journal *Biogeosciences*.

The 2014 fire in the Swedish province Västmanland was particularly ferocious, burning both woodland and wetland. Only in a few areas did the trees survive.

"It is not however the trees that release carbon during fires in coniferous forests. Only some of the needles and small branches up in the trees burn, while around 90% of losses come from organic soil, the so-called humus layer. Ditched peatlands that dry a great deal of organic material in the soil are therefore large point sources for emissions from the landscape. This makes it important to measure how deep the burning goes in the ground in order to estimate carbon emissions after a forest fire. We had the opportunity to do just that over a wide area in Västmanland," says Uppsala University researcher Gustaf Granath, lead author of the study.

The loss of the humus layer releases large amounts of carbon and nitrogen from woodland and risks other nutrients leaching out after the fire. It is therefore important that vegetation can quickly re-establish itself in the interests of retaining nutrients and restoring soil carbon.

The results from Västmanland demonstrate that during the fire between 145 and 160 tonnes of carbon dioxide was lost to the atmosphere per hectare. For the whole burned area this is equivalent to 10% of the carbon dioxide emitted annually by Sweden's domestic transport sector. Due to the lack of vegetation after the fire, the soil continued to lose carbon over the next few years, with a net uptake of carbon first noted during a summer month three years after the fire. Researchers were concerned that a great deal of carbon would be lost to watercourses after the fire but were unable to observe any such additional export of carbon into streams when comparing conditions before and after the fire.

Quantities of nutrients such as nitrogen and phosphorus did however increase in streams and lakes after the fire, reaching a peak within one to two months of the fire before declining over time. For many of these substances, in the region of five times as much was transported away during the first year after the fire compared to before; however, most values had returned to normal one to two years after the fire.

"This rapid leaching of nutrients after the fire is due to the lack of vegetation that could absorb the substances, as well as the large release of the substances during the fire as organic soil burned. Without living vegetation and organic soil, water flows in streams increased by 50%" explains Stephan Köhler, professor of environmental geochemistry at SLU, who initiated the measurement of water quality immediately after the fire.

Other studies have shown how vegetation in the area of forest fires has re-established itself and how carbon and nutrient stocks have been rebuilt. How quickly this happens and what parameters affect the process will influence whether or not Sweden's forests could become long-term sources of CO_2 to the atmosphere, is something that the researchers intend to continue studying in the area.

"While we now know more about how much and where carbon and nutrients disappear in fires, what happens next is equally interesting. There is a great deal of carbon bound in dead trees that will soon begin to decompose, while at the same time the soil and vegetation will store new carbon and build up stocks of nitrogen. It's important to follow this if we are to understand how our forests are affected when they burn," says Gustaf Granath.

More information: Gustaf Granath et al, The impact of wildfire on biogeochemical fluxes and water quality in boreal catchments, *Biogeosciences* (2021). DOI: 10.5194/bg-18-3243-2021

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