Changing soil chemistry in Rocky Mountain forests impacted by the mountain pine beetle

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The visual impact of record mountain pine beetle infestation in the Rocky Mountains is stunning. The potential impact on soil and water chemistry in these forested watersheds, while less obvious, may be a longer lasting legacy of this climate change induced widespread epidemic. Once a blue stain fungus carried by the pine beetle invades a pine tree, transpiration ceases and the tree begins to die. Over an approximately three-year period, healthy green trees turn red and then grey and drop all their needles onto the forest floor. Increased influx of organic carbon and base cations from the degrading needles into the soil pore waters has the potential to alter soil chemistry, including mobilization of metals from the soil into the pore waters. Soil columns flushed with pine needle tea take up dissolved organic carbon and zinc, acting as a potential sink and buffer for carbon and some metals. In contrast, these same soils release copper and aluminum. Preliminary geochemical models suggest that the formation of mobile organo-metallic complexes mobilizes the metals. The composition of leachate from pine needles changes as trees turn from green to red to grey. Leachate pH decreased with increased contact time between water and the pine needles. Degraded (red and grey) needles released higher concentrations of dissolved organic carbon, organic acids, and base cations (Na, K and Mn). Metal concentrations varied in leaches of needles from different watersheds suggesting that metal concentration in pine needles is related to the metal concentration of the underlying rocks. Succinic acid was the organic acid with the highest concentration (~ 30 ppm) followed by nearly equivalent concentrations of citric and oxalic acid (5-10 ppm). Epicuticular waxes from the pine needle surfaces were solubilized in the first leach, but only minimally in subsequent leach periods. Leach experiments with variable contact time indicate that the controlling factor in change in leachate chemistry is not needle-water contact time but number of flushes through the pine needles. Results from this study will allow for evaluation of the potential long-term impacts of widespread tree death on soil and water chemistry.