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# The impact of wildfire on contaminated moorland catchment water quality

Nicholas Kettridge (1), Emma Shuttleworth (2), Jonay Neris (3), Stefan Doerr (3), Christina Satin (3), Claire Belcher (4), Gareth Clay (2), Danny Croghan Croghan (1), Stefan Krause (1), Alex Hurley (1), Kieran Khamis (1), Angeliki Kourmouli (1), Samantha Leader (1), and Sami Ullah (1)

(1) School of Geography Earth and Environmental Science, University of Birmingham, Birmingham, United Kingdom , (2) Geography, University of Manchester, Manchester, UK, (3) Geography, Swansea University, Swansea UK, (4) Geography, University of Exeter, Exeter, UK

The large-scale, high-severity Saddleworth wildfire burned over 1000 hectares of UK moorland surrounding key water supply reservoirs in June and July 2018 and instigated a 'major national incident'. The burned region of moorland is situated in the heart of a formerly industrialised region of the UK that has been exposed to high atmospheric deposition of contaminants such as heavy metals. Such wildfires and the concurrent drought experienced in the region during the summer of 2018 are projected to increase in frequency under future climate change, posing unknown risks to UK industry and public health due to the importance of these upland areas as a source of drinking water. Utilizing the Saddleworth wildfire, we characterise down-stream moorland water quality through recurrent post-fire rainfall events in response to the compound impacts of extensive, severe wildfire and extreme drought conditions.

Water quality (EC, DO, DOC, pH, turbidity, DOM characterisation) was measured semi-continuously in-situ within a small upland headwater catchment entirely burned by the Saddleworth wildfire. Measurements were performed for a period of five months from the time of active fire and prior to any post-fire rainfall event. In addition, storm sample measurements were captured at 1-hr intervals during the first and second post-fire storm events, and the first high turbidity autumn post-fire storm event. Storm samples were measured for nitrate, phosphate, ammonium, DOC, and a suite of metals through ICP-MS (notably lead). Catchment scale measurements were complemented with i) distributed in-situ measures of heavy metal concentrations through the catchment with pXRF, ii) laboratory based measures of ash leaching on samples collected prior to rainfall, and iii) semi-continuous measures of catchment water table positions and gully stage.

Concentrations of lead within the ash were up to 4500 ppm, respectively, higher than any concentrations observed previously within nearby unburned moorlands. This suggests that the combustion of peat and organic soils acts to concentrate atmospherically derived contaminants that have accumulated within upland organic soils. However, high metal concentrations in ash did not lead to acute stream water contamination. The first post-fire storm event, an intense 30 mm precipitation event, induced severe pH reductions from 6.4 to 3.9, and the highest increases in stream EC and DOC, reaching a maximum of 840 $\mu$S cm-1 and 47 mg/L respectively. These were accompanied by in-stream lead concentration peaking at 0.76 ppb. During the first high turbidity autumn storm event, peak lead concentrations increased to 4.6 ppb. These peak concentrations are within previously observed limits of unburned moorland catchments. This is likely due to any contaminants being strongly bound within the ash deposits, with levels of dissolution of metal contaminants being equivalent to a diverse range of comparatively uncontaminated heathland and forestland ecosystems. However, despite the low severity of the immediate water quality response to fire through dissolution of contaminants, concentrated heavy metals within the catchment may provide a potential chronic impact on catchment water quality if subsequently transported through leaching or sediment erosional processes.