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Predicting impact of fires on water quality

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Abstract: Wildfires and prescribed burns are becoming more common in a warming world potentially affecting drinking water resources. User-friendly tools are needed to evaluate potential post-fire responses and mitigation strategies. Although simple models to predict soil erosion following fires are available, they (1) often require a specialised software; and (2) may be too generic for certain regions. One of these regions is the northern jarrah forest near Perth, in which soil erosion occurs in very limited circumstances due to an advanced stage of landscape evolution and highly permeable lateritic cover limiting the occurrence of overland flow.

To address the needs, we developed a cloud-based tool to be used in decision making. The tool informs short-term erosion effects and long-term hydrological risks. The tool utilises cloud-based satellite imagery and weather predictions to generate maps of both erosion rates and hydrological risks.

The erosion calculation is similar to RUSLE used for post-wildfire environs by incorporating the rainfall, soil properties, topography, and the land use from satellites. The major differences from the classic RUSLE are governed by greater data availability and how rainfall erosivity and post-wildfire debris mass are calculated. The rainfall erosivity rate takes into account weather predictions as opposed to the historical rainfall, although its spatial distribution may be calculated from historical datasets. The post-wildfire debris mass, which in jarrah forest is chiefly derived from vegetation, is a proxy for a land use change and is derived from ten-metre-resolution Sentinel-2 images. The hydrological risks are based on numerical modelling which assume that preferential flow paths, low regolith depth and high-conductivity soils predominantly affect contaminant transport rates from the burnt areas to creeks and, consequently, to drinking water reservoirs.

The tool allows for a quick and easy evaluation of post-fire conditions by managers and rangers without the need for an expert knowledge or specialised software. The short-term predictions of erosion rates immediately following a fire facilitate on-site evaluation and potential responses as next step actions. The long-term predictions of hydrological hotspots are helpful to manage the use of land and to develop post-fire mitigation strategies. Although the short-term erosion rates are consistent with field observations, there is a need to develop new monitoring strategies and a water quality database of long-term observations following wildfires and prescribed burns.

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