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Modelling Forest Fire and Post-Fire Mitigation Measures: Impacts on sediment yield

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Abstract

A forest fire may change soil properties, alter the hydrological processes, and increase soil erosion. To mitigate the effect of fire on erosion, post-fire rehabilitation measures are used. The aim of this work was to predict the effect of forest fire and post-fire mitigation measures on runoff and specific sediment yield (SSY) in a mountainous river basin (Celone, S-E Italy). The Soil and Water Assessment Tool model, calibrated with field observations, was used to evaluate runoff and SSY for the current land use (baseline) and for six post-fire scenarios. From 1990 to 2011, at the basin scale, the average annual SSY was 5.60 t ha^{-1} y^{-1} (SD = 3.47 t ha^{-1} y^{-1}). The 20% of the total drainage area showed a critical value of SSY (>10 t ha^{-1} y^{-1}). Different fire-severity levels were analysed acting on a limited burnt area (2.3% of the basin). At the basin scale, the post-fire effect on surface runoff was negligible for all the scenarios except for the high-severity fire and post-fire logging (Fr1), and the impact on SSY was an increase up to 12.05 t ha^{-1} y^{-1}. At the subbasin scale, Fr1 scenario showed the highest increase in soil loss (57.4 t ha^{-1} y^{-1}), meanwhile, the post-fire mitigation treatments such as straw mulching and erosion barriers were effective to reduce soil erosion in high- and moderate-severity fires (19.1 t ha^{-1} y^{-1} and 21 t ha^{-1} y^{-1}, respectively). At the hydrologic response unit level, SSY estimated for the forest in the baseline ranged from 1.18 t ha^{-1} y^{-1} to 2.04 t ha^{-1} y^{-1}. It increased more than one order of magnitude for the high-severity fire scenarios and ranged from 4.33 to 6.74 t ha^{-1} y^{-1} in the very low-severity fire scenarios. This work provides a contribution to post-fire risk management.

Keywords: forest fire, sediment yield, runoff, SWAT model, post-fire mitigation measures