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Mediterranean catchments post-fire hydrogeological behavior and water quality: insights from the Pisano Mount area (Tuscany, Italy)

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Wildfires are recognized as one of the most affecting ecological agents, altering geomorphological processes, hydrologic cycles, and water quality. On average from 50,000 to 65,000 fires occur in Europe every year, burning approximately 500,000 ha of forested areas. Between September 2018 and February 2019 two large wildfires burnt nearly 1,400 ha of forests and farmlands in the Pisano Mount area (northwestern Tuscany). The mountainous morphology of the area linked to the proximity to the sea causes high precipitation variability and intensity. This, joined with low permeability bedrock (mainly quartzites, schists, and phyllites) and with the extensive vegetation coverage, make the study site a hot spot for surface waters analysis. Moreover, burnt catchments are of primary importance in the recharge processes of the groundwater resources of the costal plain, which are exploited by a large number of inhabitants and agricultural facility. Consequently, the present study is aimed at understanding and quantifying the wildfire impacts on the hydrogeological dynamics and water quality in the studied catchments. Such impacts are being evaluated by comparing burnt and unburnt catchments, which were selected to be as similar as possible from geological, morphological, and vegetational perspectives. The multi-parameter selection method involved Principal Component Analysis and Distance analysis on many potentially feasible catchments. A network of automatic monitoring instruments was deployed on site. Five hydraulic sections of the main streams draining the area were monitored for hydraulic level and physico-chemical parameters. Hydrographs analysis was performed to infer differences in hydrogeological dynamics between burnt and unburnt basins. Monthly samples were collected for stream water and groundwater chemical analysis. In addition, four plate lysimeters were installed to sample soil water for its chemical characterization. The chemical analysis involved major anions and cations, trace elements, water isotopes, and organic compounds, to search for chemical perturbation potentially arising from the wildfire. The investigation highlighted various differences between the burnt and unburnt basin, mainly for the surface waters. The streams draining the burnt areas present different hydraulic behaviour and changes in physiochemical parameters in response to rainfall events. Moreover, the yearly variation of physiochemical parameters and chemical characteristics present an higher variance for those streams draining wildfire affected catchments.