Electronic Supplementary Material (ESI) for Environmental Science: Processes & Impacts.

Electronic Supplementary Information

A review of simulation experiment techniques used to analyze wildfire effects on water quality and supply

The studies included in this review have a complex set of study design factors and wide range of foci on different burn responses. However, for the purpose of cross-study analyses, we created simplified tables reporting five key hydrologic and water quality responses. These topically focused tables allow for useful cross-comparisons between simulation studies, in terms of the variability in measurements, the magnitude of responses for increasing burn intensity, and the level of statistical significance in results. Key responses synthesized include runoff, infiltration, sediment production, water repellency, and solutes/soil chemical properties—i.e., metals, nutrients, and organic matter in leachates and runoff, as well as in burned material. Results are divided into approximate burn intensities (unburned, mild, moderate, and severe), with peak temperature approximations selected by compiling temperature-based burn intensity scales in previous studies[1–6]. A summary column provides an approximate synthesis of each study's results, with estimated or reported error and variability displayed in the adjacent column. These summaries are reported with respect to unburned conditions unless otherwise stated, e.g. a *percent decrease* indicates the percent decrease of a response after burning from the control or unburned case in the study. Results were limited to those showing response exclusively to burning or fire exposure in various environments, while results from other joint treatments such as logging were excluded.

Table 1 Runoff data reported from simulation studies. Time elapsed since the burn event (simulated or natural wildfire) and precipitation information are shown for each study. ± indicates the upper and lower bounds of the 95% confidence interval and parentheses indicate standard deviations. An *N/A* entry denotes an unreported study characteristic.

Time elapsed post-burn	Precipitation intensity and duration	Runoff				Summary	Error and Variability	Source
		Unburned	Mild Burn (~100-200 ºC)	Moderate Burn (~200-350 ºC)	Severe Burn (~<350 ºC)			
0 years	66-94 mm/hr (mean: 79 mm/hr) for 60 mins	Runoff ratio: 55%		Runoff ratio: 58%	Runoff ratio: 66%	Runoff ratios increased 5% for moderate burns and 20% for severe burns	N/A	Benavides-Solorio and MacDonald, 2001
1 year		Runoff ratio: 61%		Runoff ratio: 48%	Runoff ratio: 61%	Runoff ratios decreased 20% for moderate burns and 0% for severe burns		
6 years		Runoff ratio: 59%		N/A	Runoff ratio: 36%	Runoff ratios decreased 39% for severe burns		
Same day	55 mm/hr for 45 mins	Runoff ratio: 5 (8)%	Runoff ratios: 6 (10)%	N/A	N/A	Runoff ratio increased 19% for mild burns	Standard deviations ranged from 114% to 179% of the means	Emmerich and Cox, 1992
	110 mm/hr for 15 mins (subsequent)	Runoff ratio: 14 (16)%	Runoff ratio: 17 (22)%			Runoff ratio increased 23% for mild burns		
	Total: average 151.5 mm/hr for 60 mins	Runoff ratio: 8 (11)%	Runoff ratio: 10 (14)%			Runoff ratio increased 21% for mild burns		
N/A	Microplots: 50.5 mm/hr for 45-60 mins Plots and catchments: variable natural precipitation	Runoff ratios: 5.5% and <1% for microplots, 0.09% and 0.05% for plots (two replicates)	Runoff ratios: 14.4% for microplots, 0.08% for plots (prescribed fire)	Runoff ratios: 23.2% for microplots (experimental fire)	Runoff ratios: 65.1% and 54.9% for microplots (two replicates), 11.6% for plots (natural wildfire)	Runoff ratios increased 343% and 14% for mild burns (microplots and plots, respectively), 614% for moderate burns (microplots), and 1746% and 16,471% for severe burns (microplots and plots, respectively)	N/A	Ferreira et al., 2005
80 days	60 mm/hr for 60 mins	Runoff ratios: 19% and 21% (two replicates)	N/A	N/A	Runoff ratios: 25% and 58% (two replicates)	Runoff ratios on average increased 104% for severe burns	Standard deviations ranged from 0% to 56% of the means	Johansen, et al., 2001
	60 mm/hr for 30 mins (subsequent)	Runoff ratios: 20% and 18% (two replicates)			Runoff ratios: 35% and 58% (two replicates)	Runoff ratios on average increased 149% for severe burns		
	60 mm/hr for 30 mins (subsequent)	Runoff ratios: 31% and 31% (two replicates)			Runoff ratios: 32% and 64% (two replicates)	Runoff ratios on average increased 55% for severe burns		
Same day	33 mm/hr for 4 hrs	Runoff rates: 25-28 and 0.2-0.8 mm/hr peak (bare and litter-covered soils,	N/A	Runoff rates: 20-23 and 12-14 mm/hr peak (soils without and with ash, respectively)	N/A	Peak runoff rates decreased 2% and increased 2500% for moderate burns (samples without and with litter/ash, respectively)	N/A	Keesstra, et al., 2014

		respectively)						
	33 mm/hr for 2 hrs (subsequent)	Runoff rates: 23 and 0.2-0.6 mm/hr peak (bare and litter-covered soils, respectively)		Runoff rates: 20-25 mm/hr steady state for all samples		Peak runoff rates decreased 19% and increased 5525% for moderate burns (samples without and with litter/ash, respectively)		
0 months	180 mm/hr for 5 mins	Runoff ratios: 9.1% total, and 8.7%, 14.7%, 1.4%, 18.2%, and 10.5%*	N/A	N/A	Runoff ratios: 34.0% total, and 8.7%, 17.9%, 1.7%, 15.2%, and 9.4%*	Runoff ratios increased 275% for the entire plot and on average increased 3% (range: -16% to 22%) for individual subplots for severe burns	N/A	Marcos et al., 2000
18 months		N/A			Runoff ratios: 1.6%, 12.8%, 31.2%, 24.5%, and 1.1%*	Runoff ratios on average increased 396% (range: -89% to 2129%) for individual subplots for severe burns		
0 years	100 mm/hr for 60 mins	Runoff ratio: 58 (3.5)%	N/A	N/A	Runoff ratio: 70 (1.1)%	Runoff ratio increased 21% for severe burns	Standard deviations ranged from 2% to 11% of the means	Robichaud et al., 2016
1 year		Runoff ratio: 56 (3.9)%			Runoff ratio: 61 (1.4)%	Runoff ratio increased 9% for severe burns		
2 years		Runoff ratio: 53 (3.6)%			Runoff ratio: 62 (1.3)%	Runoff ratio increased 17% for severe burns		
5 years		Runoff ratio: 53 (3.4)%			Runoff ratio: 14 (1.5)%	Runoff ratio decreased 74% for severe burns		
6 weeks	Unburned: 58 mm/hr for 42 mins Burned: 74 mm/hr for 60 mins	Runoff ratio: 0% Peak runoff: 0 mm/hr	N/A	N/A	Runoff ratio: 21% Peak runoff: 33.5 mm/hr	Runoff ratio and peak runoff increased from no response, to 21% and 33.5 mm/hr, respectively, for severe burns	N/A	Rosso et al., 2007
	Unburned: 74 mm/hr for 61 mins Burned: 68 mm/hr for 55 mins (several days later)	Runoff ratio: 0.4% Peak runoff: 0.7 mm/hr			Runoff ratio: 24% Peak runoff: 25.3 mm/hr	Runoff ratio and peak runoff increased 5900% and 3514%, respectively, for severe burns		
	Unburned: 74 mm/hr for 71 mins Burned: 76 mm/hr for 60 mins (2 hrs later)	Runoff ratio: 2% Peak runoff: 2.2 mm/hr			Runoff ratio: 41% Peak runoff: 41.3 mm/hr	Runoff ratio and peak runoff increased 1950% and 1777%, respectively, for severe burns		
0 years	Unburned: 56.1, 57.3, 43.7, 44.6 mm/hr for 60 mins Severe burn: 33.5, 33.9 mm/hr for 60 mins	Runoff ratios: 0.0%, 0.3%, 0.0%, and 0.4% (four replicates)	N/A	N/A	Runoff ratios: 0.3% and 2.9% (two replicates)	Runoff ratio increased 715% for severe burns	Standard deviations ranged from 1.6% to 117% of the means	Simanton et al., 1986
	Unburned: 48.0, 46.8, 46.4, 49.2 mm/hr for 30 mins Severe burn: 56.0, 51.4 mm/hr for 30 mins (24 hrs later)	Runoff ratios: 1.7%, 0.9%, 0.4%, and 3.3% (four replicates)			Runoff ratios: 3.6% and 7.8% (two replicates)	Runoff ratio increased 266% for severe burns		
	Unburned: 69.6, 52.2, 91.4, 54.8 mm/hr for 30 mins Severe burn: 66.4, 71.6 mm/hr for 30 mins	Runoff ratios: 5.3%, 2.7%, 0.2%, and 4.7% (four replicates)			Runoff ratios: 11.7% and 14.8% (two replicates)	Runoff ratio increased 314% for severe burns		

	(subsequent)							
1/2 year	41.4, 45.8 mm/hr for 60 mins	N/A	N/A	N/A	Runoff ratios: 0.2% and 1.3% (two replicates)	Runoff ratio increased 289% for severe burns		
	53.8, 55.0 mm/hr for 30 mins (24 hrs later)				Runoff ratios: 7.4% and 7.3% (two replicates)	Runoff ratio increased 374% for severe burns		
	59.2, 59.4 mm/hr for 30 mins (subsequent)				Runoff ratios: 21.3% and 17.8% (two replicates)	Runoff ratio increased 511% for severe burns		
1 year	42.9, 44.2 mm/hr for 60 mins	N/A	Runoff ratios: 1.2% and 0.2% (two replicates)	N/A	N/A	Runoff ratio increased 249% for mild burns		
	48.4, 51.4 mm/hr for 30 mins (24 hrs later)		Runoff ratios: 1.7% and 0.8% (two replicates)			Runoff ratio decreased 22% for mild burns		
	51.8, 51,4 mm/hr for 30 mins (subsequent)		Runoff ratios: 6.6% and 2.3% (two replicates)			Runoff ratio increased 39% for mild burns		
6 months	Unburned: 47 mm/hr for 44 mins Burned: 35, 70 mm/hr for 35, 21 mins, respectively	Peak runoff: 2 mm/hr	N/A	N/A	Peak runoff: 1 and 4 mm/hr (two replicates)	Peak runoff rates increased 25% for severe burns	Standard deviations ranged from 13% to 85% of the means	Wilson, 1999
	Unburned: 75 mm/hr for 21 mins Burned: 38, 68 mm/hr for 49, 21 mins, respectively	Peak runoff: 8 mm/hr			Peak runoff: 1 and 4 mm/hr (two replicates)	Peak runoff rates decreased 69% for severe burns		
	Unburned: 162 mm/hr for 10 mins Burned: 143, 110 mm/hr for 10, 14 mins, respectively	Peak runoff: 45 mm/hr			Peak runoff: 43 and 36 mm/hr (two replicates)	Peak runoff rates decreased 12% for severe burns		
1 month	75 ± 0.4 mm/hr for 1 hr	N/A	N/A	N/A	Final runoff: 23 and 42 mm/hr Runoff ratio: 15.8% and 44.2% (ash and no-ash plots, respectively)	Final runoff rates and runoff ratios increased 83% and 180%, respectively, when ash was removed for severe burns	N/A	Woods and Balfour, 2008
9 months	76 ± 0.4 mm/hr for 1 hr				Final runoff: 25 and 23 mm/hr Runoff ratio: 27.5% and 21.4% (ash and no-ash plots, respectively)	Final runoff rates and runoff ratios decreased 8% and 22%, respectively, when ash was removed for severe burns		
12 months	75 ± 0.4 mm/hr for 1 hr				Final runoff: 46 and 45 mm/hr Runoff ratio: 36.5% and 36.5% (ash and no-ash plots, respectively)	Final runoff rates and runoff ratios decreased 2% and 0%, respectively, when ash was removed for severe burns		

*for plots sown with herb species; herb and shrub species; herb and oak species; herb, shrub, and oak species; and unsown, respectively

Table 2 Infiltration data reported from simulation studies. Time elapsed since the burn event (simulated or natural wildfire) and precipitation information are shown for each study. *±* indicates the upper and lower bounds of the 95% confidence interval and parentheses indicate standard deviations. An *N/A* entry denotes an unreported study characteristic.

Time elapsed post-burn	Precipitation intensity and duration	Infiltration				Summary	Error and Variability	Source
		Unburned	Mild Burn (~100-200 ºC)	Moderate Burn (~200-350 ºC)	Severe Burn (~<350 ºC)			
3 months	20 for 15 mins 40 mm/hr for 15 mins 60 mm/hr for 15 mins	Saturated hydraulic conductivity: 505 ± 24, 812 ± 29, and 1114 ± 97 mm/hr (three replicates)	N/A	Saturated hydraulic conductivity: 321 ± 104, 510 ± 96, and 263 ± 70 mm/hr (three replicates)	Saturated hydraulic conductivity: 62 ± 30, 69 ± 11, and 289 ± 35 mm/hr (three replicates)	Saturated hydraulic conductivity decreased on average 50% for moderate burn and 84% for severe burn areas	95% confidence intervals ranged 4%-48% of the means	Blake et al., 2001
5 months	203 mm/hr for 50 mins	Infiltration rates*: 202, 183, 146, and 105 mm/hr	Infiltration rates*: 129, 162, 110, and 76 mm/hr	N/A	N/A	Infiltration rates on average decreased 25% (range: 11%-36%) for mild burn areas	Standard deviations ranged 27% to 30% of the means	Hester et al., 1997
Same day	33 mm/hr for 4 hrs	Infiltration rates: 1.5 and 33 mm/hr (bare and litter-covered soils, respectively)	N/A	Infiltration rates: ~33 mm/hr peak, then decrease for all samples (ash was slightly higher than without ash)	N/A	Peak infiltration rates increased 2100% and decreased 0% for moderate burns (samples without and with litter/ash, respectively)	N/A	Keesstra, et al., 2014
	33 mm/hr for 2 hrs (subsequent)	Infiltration rates: 1.6 and 33 mm/hr (bare and litter-covered soils, respectively)		Infiltration rates: 2-7 mm/hr steady state for all samples		Peak infiltration rates increased 181% and decreased 86% for moderate burns (samples without and with litter/ash, respectively)		
10 months	203 mm/hr for 30 mins	Infiltration rates: 124 and 128 mm/hr (two replicates)	Infiltration rate: 128 mm/hr	N/A	N/A	Infiltration rates increased 1.6% for mild burns	Standard deviation was 2% of the mean	Knight et al., 1983
0 years	100 mm/hr for 60 mins	Infiltration rate: 44 (3.5) mm/hr	N/A	N/A	Infiltration rate: 31 (1.0) mm/hr	Infiltration rate decreased 30% for severe burns	Standard deviations ranged from 2% to 9% of the means	Robichaud et al., 2016
1 year		Infiltration rate: 45 (4.0) mm/hr			Infiltration rate: 38 (1.4) mm/hr	Infiltration rate decreased 16% for severe burns		
2 years		Infiltration rate: 48 (3.6) mm/hr			Infiltration rate: 37 (1.3) mm/hr	Infiltration rate decreased 23% for severe burns		
5 years		Infiltration rate: 47 (3.4) mm/hr			Infiltration rate: 84 (1.5) mm/hr	Infiltration rate increased 79% for severe burns		
1-2 months	83.8 mm/hr for 60 mins	Infiltration rates**: 83.2 and 82.8, 78.2 and 80.2, 80.7 and 81.5, and 57.6 and 41.2 mm/hr for dry conditions; 82.6 and 82.2, 72.5 and 74,2, 77.6 and 78.2, and 37.5 and 19.5 mm/hr for field capacity conditions (two replicates)	Infiltration rates**: 83.2 and 82.8, 78.2 and 80.2, 80.7 and 81.5, and 57.6 and 41.2 mm/hr for dry conditions; 82.6 and 82.2, 72.5 and 74,2, 77.6 and 78.2, and 37.5 and 19.5 for field capacity conditions (two replicates)	N/A	N/A	Infiltration rates on average decreased 2.3% (range: 0.6% to 3.8%) and 10.6% (range: -1.4% to 14.9%) (dry and field capacity moisture conditions, respectively) for mild burns	Standard deviations ranged from 0% to 30% of the means	Roundy et al., 1978
1 year		N/A	Infiltration rates**: 82.0 and 81.3, 72.3 and 75.5, 77.1 and 78.4, and 45.3 and 59.7 mm/hr for dry conditions; 78 and 75.8, 57.2 and 58.3, 67.6 and 67.1, and 22.5 and 38.5			Infiltration rates on average decreased 1.6% (range: -6.3% to 6.7%) and 8.2% (range: -7.0% to 21.3%) (dry and field capacity antecedent moisture contents, respectively) for mild burn areas		

			mm/hr for field capacity conditions (two replicates)					
Same day	23 mm/hr for 80 mins	Field saturated hydraulic conductivity: 3.7×10^{-4} mm/s	N/A	Field saturated hydraulic conductivity: 2.0×10^{-4} mm/s	Field saturated hydraulic conductivity: 14×10^{-4} mm/s	Field saturated hydraulic conductivity decreased 46% for moderate burns and increased 278% for severe burns	N/A	Wieting et al., 2017
6 months	Unburned: 47 mm/hr for 44 mins Burned: 35, 70 mm/hr for 35, 21 mins, respectively	Infiltration rate: 45 mm/hr	N/A	N/A	Infiltration rates: 37 and 66 mm/hr (two replicates)	Infiltration rate increased 14% for severe burns	Standard deviations ranged from 30% to 40% of the means	Wilson, 1999
	Unburned: 75 mm/hr for 21 mins Burned: 38, 68 mm/hr for 49, 21 mins, respectively	Infiltration rate: 67 mm/hr			Infiltration rates: 37 and 64 mm/hr (two replicates)	Infiltration rate decreased 25% for severe burns		
	Unburned: 162 mm/hr for 10 mins Burned: 143, 110 mm/hr for 10, 14 mins, respectively	Infiltration rate: 117 mm/hr			Infiltration rates: 114 and 74 mm/hr (two replicates)	Infiltration rate decreased 20% for severe burns		
1 month	75 ± 0.4 mm/hr for 1 hr	N/A	N/A	N/A	Infiltration rates: 62 and 42 mm/hr (ash and no-ash plots, respectively)	Infiltration rates decreased 32% when ash was removed for severe burns	N/A	Woods and Balfour, 2008
9 months	76 ± 0.4 mm/hr for 1 hr				Infiltration rates: 56 and 58 mm/hr (ash and no-ash plots, respectively)	Infiltration rates increased 4% when ash was removed for severe burns		
12 months	75 ± 0.4 mm/hr for 1 hr				Infiltration rates: 48 and 48 mm/hr (ash and no-ash plots, respectively)	Infiltration rates did not change when ash was removed for severe burns		

*oak, juniper, bunchgrass, and shortgrass sites, respectively

**for tree coppice, shrub coppice, all coppice, and interspace, respectively

Table 3 Sedimentation and erosion data reported from simulation studies. Time elapsed since the burn event (simulated or natural wildfire) and precipitation information are shown for each study. ± indicates the upper and lower bounds of the 95% confidence interval and parentheses indicate standard deviations. An *N/A* entry denotes an unreported study characteristic.

Time elapsed post-burn	Precipitation intensity and duration	Sedimentation and Erosion				Summary	Error and Variability	Source
		Unburned	Mild Burn (~100-200 ºC)	Moderate Burn (~200-350 ºC)	Severe Burn (~<350 ºC)			
0 years	66-94 mm/hr (mean: 79 mm/hr) for 60 mins	Total sediment: 43 g Sediment concentration: 1.9 g/L		Total sediment: 89 g Sediment concentration: 4.0 g/L	Total sediment: 428 g Sediment concentration: 23.5 g/L	Total and suspended sediment increased 107% and decreased 79%, respectively, for moderate burns and increased 895% and 1137%, respectively, for severe burns	N/A	Benavides-Solorio and MacDonald, 2001
1 year		Total sediment: 13 g Sediment concentration: 0.6 g/L		Total sediment: 76 g Sediment concentration: 3.5 g/L	Total sediment: 342 g Sediment concentration: 17.1 g/L	Total and suspended sediment increased 485% and 483%, respectively, for moderate burns and increased 2392% and 2750%, respectively, for severe burns		
6 years		Total sediment: 13 g Sediment concentration: 0.5 g/L		N/A	Total sediment: 27 g Sediment concentration: 1.7 g/L	Total and suspended sediment increased 108% and 240%, respectively, for severe burns		
3 months	20 for 15 mins	Sediment concentration: ~2.5 g/L	N/A	Sediment concentration: ~3 g/L	Sediment concentration: ~5 g/L	Suspended sediment concentration increased 20% for moderate burns and 100% for severe burns	N/A	Blake et al., 2001
	40 mm/hr for 15 mins	Sediment concentration: ~1 g/L		Sediment concentration: ~1.5 g/L	Sediment concentrations: ~2.5 g/L	Suspended sediment concentration increased 50% for moderate burns and 150% for severe burns		
	60 mm/hr for 15 mins	Sediment concentration: < 0.1 g/L		Sediment concentration: ~1 g/L	Sediment concentrations: ~2 g/L	Suspended sediment concentration increased 900% for moderate burns and 1900% for severe burns		
Same day	55 mm/hr for 45 mins	Sediment yield: 2.5 (4.7) g/m^2	Sediment yield: 3.4 (6.7) g/m^2	N/A	N/A	Sediment yield increased 36% for mild burns	Standard deviations ranged from 112% to 197% of the means	Emmerich and Cox, 1992
	110 mm/hr for 15 mins (subsequent)	Sediment yield: 5.0 (5.6) g/m^2	Sediment yield: 7.2 (8.7) g/m^2			Sediment yield increased 44% for mild burns		
	Total: average 151.5 mm/hr for 60 mins	Sediment yield: 7.6 (9.8) g/m^2	Sediment yield: 10.6 (14.5) g/m^2			Sediment yield increased 39% for mild burns		
5 months	203 mm/hr for 50 mins	Sediment yield: 0.2, 3.4, 30, and 130 g/m^2*	Sediment yield: 450, 193, 446, and 577 g/m^2*	N/A	N/A	Sediment yield on average increased 58,049% (range: 344%-224,900%) for mild burn areas	Standard deviations ranged from 39% to 149% of the means	Hester et al., 1997
80 days	60 mm/hr for 60 mins	Sediment yield per mm precip: 0.3 and 0.4 $g/m^2 \cdot mm$ (two replicates)	N/A	N/A	Sediment yield per mm precip: 2.8 and 11 $g/m^2 \cdot mm$ (two replicates)	Sediment yield per mm precip increased 1742% for severe burns	Standard deviations ranged from 0% to 84% of the means	Johansen, et al., 2001
	60 mm/hr for 30 mins (subsequent)	Sediment yield per mm precip: 0.2 and 0.3 $g/m^2 \cdot mm$ (two replicates)			Sediment yield per mm precip: 4.8 and 11.3 $g/m^2 \cdot mm$ (two replicates)	Sediment yield per mm precip increased 2983% for severe burns		
	60 mm/hr for 30 mins (subsequent)	Sediment yield per mm precip: 0.3 and 0.4 $g/m^2 \cdot mm$ (two replicates)			Sediment yield per mm precip: 4.1 and 11.3 $g/m^2 \cdot mm$ (two replicates)	Sediment yield per mm precip increased 1996% for severe burns		

Same day	33 mm/hr for 4 hrs	Sedimentation rates: 168 and 0 g/m^2·hr (bare and litter-covered soils, respectively)	N/A	Sedimentation rates: ~60-90 and ~30 g/m^2·hr (soils without and with ash, respectively)	N/A	Peak sedimentation rates decreased 55% for samples without litter/ash and samples with littler/ash increased from no response to 40% of the bare samples for moderates	N/A	Keesstra, et al., 2014
	33 mm/hr for 2 hrs (subsequent)	Sedimentation rates: 222-252 and 0 g/m^2·hr (bare and litter-covered soils, respectively)		Sedimentation rates: ~105-120 and ~105 g/m^2·hr (soils without and with ash, respectively)		Peak sedimentation rates decreased 53% for samples without litter/ash and samples with littler/ash increased from no response to 93% of the bare samples for moderate burns		
10 months	203 mm/hr for 30 mins	Sediment yield: 73 and 196 g/m^2 (two replicates)	Sediment yield: 130 g/m^2	N/A	N/A	Sediment yield decreased 3% for mild burns	Standard deviation was 65% of the mean	Knight et al., 1983
0 months	180 mm/hr for 5 mins	Sediment yield: 1.18 g/m^2 total, and 1.66, 20.11, 5.16, 8.80, and 4.94 g/m^2	N/A	N/A	Sediment yield: 10.32 g/m^2 total, and 17.06, 10.38, 5.11, (lost data), and 11.23 g/m^2	Sediment yields increased 775% for the entire plot and on average increased 241% (range: -48% to 928%) for individual subplots for severe burns	N/A	Marcos et al., 2000
18 months		N/A			Sediment yield: 0.32, 17.99, 12.07, 14.23, and 4.49 g/m^2	Sediment yields on average increased 19% (range: -81% to 134%) for individual subplots for severe burns		
0 years	100 mm/hr for 60 mins	Sediment yield: 50 (7.1) g/m^2	N/A	N/A	Sediment yield: 1757 (114) g/m^2	Sediment yield increased 3414% for severe burns	Standard deviations ranged from 5% to 41% of the means	Robichaud et al., 2016
1 year		Sediment yield: 15 (3.0) g/m^2			Sediment yield: 1099 (60) g/m^2	Sediment yield increased 7227% for severe burns		
2 years		Sediment yield: 7 (1.4) g/m^2			Sediment yield: 391 (47) g/m^2	Sediment yield increased 5486% for severe burns		
5 years		Sediment yield: 54 (22) g/m^2			Sediment yield: 15 (3.6) g/m^2	Sediment yield decreased 72% for severe burns		
6 weeks	Unburned: 58 mm/hr for 42 mins Burned: 74 mm/hr for 60 mins	Sedimentation rate: 0 g/m^2·hr	N/A	N/A	Sedimentation rate: 16.8 g/m^2·hr	Sedimentation rate increased from no response to 16.8 g/m^2h for severe burns	N/A	Rosso et al., 2007
	Unburned: 74 mm/hr for 61 mins Burned: 68 mm/hr for 55 mins (several days later)	Sedimentation rate: 0.1 g/m^2·hr			Sedimentation rate: 17.8 g/m^2·hr	Sedimentation rate increased 17700% for severe burns		
	Unburned: 74 mm/hr for 71 mins Burned: 76 mm/hr for 60 mins (2 hrs later)	Sedimentation rate: 0.2 g/m^2·hr			Sedimentation rate: 32.9 g/m^2·hr	Sedimentation rate increased 16350% for severe burns		

1-2 months	83.8 mm/hr for 60 mins	Sediment yields**: 49 and 105, 397 and 537, 140 and 240, and 932 and 1445 kg/ha for dry conditions; 50 and 98, 572 and 813, 157 and 282, and 850 and 1820 kg/ha for field capacity conditions (two replicates)	Sediment yields**: 181 and 389, 630 and 794, 338 and 550, and 666 and 1047 kg/ha for dry conditions; 194 and 603, 1046 and 1096, 456 and 813, and 870 and 2188 kg/ha for field capacity conditions (two replicates)	N/A	N/A	Sediment yields on average increased 107% (range: -28% to 270%) and 174% (range: 15% to 439%) (dry and field capacity antecedent moisture contents, respectively) for mild burns	N/A	Roundy et al., 1978
1 year		N/A	Sediment yields**: 55 and 457, 1229 and 1148, 262 and 724, and 1697 and 997 kg/ha for dry conditions; 190 and 741, 1861 and 1585, 602 and 1072, and 2753 and 1145 kg/ha for field capacity conditions (two replicates)			Sediment yields on average increased 140% (range: 13% to 232%) and 251% (range: 46% to 529%) (dry and field capacity antecedent moisture contents, respectively) for mild burns		
0 years	Unburned: 56.1, 57.3, 43.7, 44.6 mm/hr for 60 mins Severe burn: 33.5, 33.9 mm/hr for 60 mins	Sediment yield: 0.0, 1.2, 0.0, and 0.5 g/m^2 (four replicates)	N/A	N/A	Sediment yield: 0.0 and 7.3 g/m^2 (two replicates)	Sediment yield increased 798% for severe burns	Standard deviations ranged from 15% to 141%	Simanton et al., 1986
	Unburned: 48.0, 46.8, 46.4, 49.2 mm/hr for 30 mins Severe burn: 56.0, 51.4 mm/hr for 30 mins (24 hrs later)	Sediment yield: 1.1, 1.7, 0.1, and 2.0 g/m^2 (four replicates)			Sediment yield: 11 and 17.1 g/m^2 (two replicates)	Sediment yield increased 1044% for severe burns		
	Unburned: 69.6, 52.2, 91.4, 54.8 mm/hr for 30 mins Severe burn: 66.4, 71.6 mm/hr for 30 mins (subsequent)	Sediment yield: 7.9, 9.8, 0.5, and 4.8 g/m^2 (four replicates)			Sediment yield: 40.8 and 50.3 g/m^2 (two replicates)	Sediment yield increased 692% for severe burns		
1/2 year	41.4, 45.8 mm/hr for 60 mins	N/A	N/A		Sediment yield: 0.06 and 1.9 g/m^2 (two replicates)	Sediment yield increased 144% for severe burns		
	53.8, 55.0 mm/hr for 30 mins (24 hrs later)				Sediment yield: 18.8 and 13.6 g/m^2 (two replicates)	Sediment yield increased 1216% for severe burns		
	59.2, 59.4 mm/hr for 30 mins (subsequent)				Sediment yield: 65.1 and 28.1 g/m^2 (two replicates)	Sediment yield increased 711% for severe burns		
1 year	42.9, 44.2 mm/hr for 60 mins	N/A	Sediment yield: 0.5 and 0.05 g/m^2 (two replicates)		N/A	Sediment yield increased 534% for mild burns		
	48.4, 51.4 mm/hr for 30 mins (24 hrs later)		Sediment yield: 3.2 and 1.3 g/m^2 (two replicates)			Sediment yield increased 84% for mild burns		
	51.8, 51,4 mm/hr		Sediment yield: 18.9 and			Sediment yield increased 136% for		

	for 30 mins (subsequent)		8.3 g/m^2 (two replicates)			mild burns		
6 months	Unburned: 47 mm/hr for 44 mins Burned: 35, 70 mm/hr for 35, 21 mins, respectively	Sediment yield: 0.09 g/m^2	N/A	N/A	Sediment yield: 0.03 and 1.5 g/m^2 (two replicates)	Sediment yield increased 730% for severe burns	Standard deviations ranged from 15% to 136% of the means	Wilson, 1999
	Unburned: 75 mm/hr for 21 mins Burned: 38, 68 mm/hr for 49, 21 mins, respectively	Sediment yield: 1.3 g/m^2			Sediment yield: 0.03 and 1.2 g/m^2 (two replicates)	Sediment yield decreased 53% for severe burns		
	Unburned: 162 mm/hr for 10 mins Burned: 143, 110 mm/hr for 10, 14 mins, respectively	Sediment yield: 20 g/m^2			Sediment yield: 81 and 100 g/m^2 (two replicates)	Sediment yield increased 353% for severe burns		
1 month	75 ± 0.4 mm/hr for 1 hr	N/A	N/A	N/A	Sediment yield: 137 ± 98 and 520 ± 225 g Sediment concentration: 22 ± 9 g/L and 35 ± 23 g/L (ash and no-ash plots, respectively)	Sediment yield and sediment concentration increased 280% and 59%, respectively, when ash was removed for severe burns	Standard deviations ranged from 41%-140% and 43%-100% of the means for sediment yield and sediment concentration, respectively	Woods and Balfour , 2008
9 months	76 ± 0.4 mm/hr for 1 hr				Sediment yield: 207 ± 247 and 58 ± 40 g Sediment concentration: 17 ± 12 g/L and 8.0 ± 6.0 g/L (ash and no-ash plots, respectively)	Sediment yield and sediment concentration decreased 72% and 53%, respectively, when ash was removed for severe burns		
12 months	75 ± 0.4 mm/hr for 1 hr				Sediment yield: 33 ± 33 and 16 ± 16 g Sediment concentration: 3.0 ± 4.2 g/L and 1.4 ± 1.2 g/L (ash and no-ash plots, respectively)	Sediment yield and sediment concentration decreased 52% and 53%, respectively, when ash was removed for severe burns		

*oak, juniper, bunchgrass, and shortgrass sites, respectively

**for tree coppice, shrub coppice, all coppice, and interspace, respectively

Table 4 Water repellency data reported from simulation studies. ± indicates the upper and lower bounds of the 95% confidence interval and parentheses indicate standard deviations. An *N/A* entry denotes an unreported study characteristic, *O horizon* is *organic soil horizon*, *Ah horizon* is *soil mineral horizon*, and *WDPT* is *water drop penetration time*.

Water repellency				Summary	Error and Variability	Source
Unburned	**Mild Burn (~100-200 ºC)**	**Moderate Burn (~200-350 ºC)**	**Severe Burn (~<350 ºC)**			
Ethanol %: O horizon: 36.0 ± 0; Ah horizon: 24.0 ± 0, 22.0 ± 3.5, and 20.0 ± 3.5*	N/A	Ethanol %: O horizon: 0 ± 0 and 1.7 ± 2.9 (ashes and O charred, respectively); Ah horizon: 6.2 ± 2.0, 18.3 ± 5.5, and 18.3 ± 5.5*	N/A	Ethanol % decreased 98% for the O horizon and 74%, 17%, and 9% for 3 depths in the Ah horizon*, respectively, for moderate burns	N/A	Badía-Villas et al., 2014
Max WDPT tests: ~110, 120, and 90 s (three replicates)		Max WDPT tests: ~100 and 100 s (three replicates)	Max WDPT tests: ~100, 120, and 0 s (three replicates)	Max WDPT tests decreased ~6% for moderate burns and ~31% for severe burns	Standard deviations ranged from 0% to 88% of the means	Benavides-Solorio and MacDonald, 2001
N/A	149 ºC (300 ºF) for 5, 10, 15, and 20 mins: no increase in non-wettability	204 ºC (400 ºF) for 5 and 10 mins: no increase in non-wettability, increase after 10 and 20 minutes; 260 ºC (500 ºF): impenetrability reached after 10 mins; > 316 ºC (600 ºF): impenetrability reached after 5 minutes	427 ºC (800 ºF) and 482 ºC (900 ºF): non-wettability started decreasing after 10 mins	Non-wettability: no increase for low burns, increase after 10-20 mins for mild-moderate burns; impenetrability reached in 5-10 mins for moderate burns; started decreasing after 10 mins for severe burns	N/A	Debano and Krammes, 1966
Ethanol %: ~0-6	Ethanol %: 4.3 (prescribed fire)	Ethanol %: 9.46 (experimental fire)	N/A	Ethanol % increased 43% for mild burns and 215% for moderate burns	N/A	Ferreira et al., 2005
N/A	N/A	WR test** before precip: 1.07 and 1.48 (4- and 15-mm aggregate, respectively), ash removed; 1.49 (15-mm aggregate) with ash After precip: 1.28 and 1.23 (4- and 15-mm aggregate, respectively), ash removed; 1.13 and 1.02 (4- and 15-mm aggregate, respectively), with ash	N/A	WDPT tests decreased by 1% for samples with removed ash before the precip and on average increased 17% (range: 13%-21%) for samples with removed ash after the precip	N/A	Keesstra, et al., 2014
WDPT test ranges***: 5 to 60, 5 to 60, > 60, and 5 to 60 s (dry conditions); 5 to 60, > 60, < 5, and <5 s (wet conditions)	WDPT test ranges***: (missing data), > 60, 5 to 60, and 5 to 60 s (dry conditions); 5 to 60, 5 to 60, 5 to 60, and 5 to 60 s (wet conditions)	WDPT test ranges***: < 5, 5 to 60, 5 to 60, and 5 to 60 s (dry conditions); < 5, (missing data), (missing data), and 5 to 60 s (wet conditions)	WDPT test ranges***: < 5, < 5, < 5, and 5 to 60 s (dry conditions); 5 to 60, < 5, 5 to 60, and 5 to 60 s (wet conditions)	WDPT tests increased ~70% and ~600% for mild burn, decreased ~40% and increased ~1000% for moderate burns, and decreased ~70% and increased ~600% for severe burns (dry and wet conditions, respectively)	N/A	Robichaud and Hungerford, 2000
0 yrs post-burn: Water repellency occurrence: 93 (3.9) %	N/A	N/A	0 yrs post-burn: Water repellency occurrence: 88 (2.3) %	0 yrs post-burn: Water repellency occurrence decreased 5% for severe burns	Standard deviations ranged from 3% to 22% of the means	Robichaud et al., 2016
1 yr post-burn: Water repellency occurrence: 39 (8.6) %			1 yr post-burn: Water repellency occurrence: 79 (3.5) %	1 yr post-burn: Water repellency occurrence increased 103% for severe burns		
2 yrs post-burn: Water repellency occurrence: 51 (8.8) %			2 yrs post-burn: Water repellency occurrence: 48 (4.4) %	2 yrs post-burn: Water repellency occurrence decreased 6% for severe burns		
5 yrs post-burn: Water repellency occurrence: 94 (4.1) %			5 yrs post-burn: Water repellency occurrence: 45 (5.2) %	5 yrs post-burn: Water repellency occurrence decreased 52% for severe burns		
WDPT test**** ranges: < 5 to 225, < 5 to 164, and < 5 to 64 s (three replicates)	N/A	WDPT test**** ranges: 440 to > 3600, 570 to > 3600, and 680 to > 1990 s (three replicates)	WDPT test**** ranges: < 5 to 75, < 5, and < 5 to 20 s (three replicates)	WDPT tests increased ~2500% for moderate burn and decreased ~75% for severe burns	N/A	Wieting et al., 2017

*0-1 cm, 1-2 cm, and 2-3 cm depths, respectively
**1 = hydrophilic (< 5 s), 2 = slight (6-10 s), 3-4 = moderate (11-60 s), 5-6 = strong (61-300 s), and 7-8 = severe (> 300 s)
***for ash-cap, mixed ash-cap, no ash-cap, and granitic soils, respectively
****Repellency rating: ≤ 5 s = wettable, 5-80 = slight, 80-600 = strong, 600-3600 = severe, > 3600 = extreme

Table 5 Water quality and soil chemical composition data reported from simulation studies. ± indicates the upper and lower bounds of the 95% confidence interval and parentheses indicate standard deviations. An *N/A* entry denotes an unreported study characteristic, *O horizon* is *organic soil horizon*, *Ah horizon* is *soil mineral horizon*, *TOC* is *total organic carbon*, *PyC* is *pyrolyzed carbon*, *DOC* is *dissolved organic carbon*, and *DON* is *dissolved organic nitrogen*.

Runoff Solutes and Soil Chemical Composition				Summary	Error and Variability	Source
Unburned	**Mild Burn (~100-200 ºC)**	**Moderate Burn (~200-350 ºC)**	**Severe Burn (~<350 ºC)**			
TOC: O horizon: 20.4 ± 2.5%; Ah horizon: 16.1 ± 3.2%, 13.2 ± 2.1%, and 10.3 ± 1.6%* PyC: O horizon: 45.3 ± 6.9%; Ah horizon: 29.8 ± 6.6%, 28.5 ± 3.0%, and 26.7 ± 5.1%*	N/A	TOC: O horizon: 11.2 ± 3.7% and 10.4 ± 0.6% (ashes and O charred, respectively), Ah horizon: 11.4 ± 1.0%, 12.2 ± 3.1%, and 11.5 ± 1.1%* PyC: O horizon: 10.4 ± 3.4% and 13.6 ± 1.8% (ashes and O charred, respectively), Ah horizon: 18.5 ± 1.2%, 23.5 ± 0.9%, and 27.4 ± 6.2%*	N/A	TOC and PyC decreased 47% and 74%, respectively, for the O horizon and decreased 29% and 38%, decreased 8% and 18%, and increased 12% and 3% for 3 depths in the Ah horizon*, respectively, for moderate burns	N/A	Badía-Villas et al., 2014
Total P: 1112 ± 410, 709 ± 472, and 1111 ± 366 mg/kg (three different plots)	N/A	Total P: 1023 ± 322, 944 ± 468, and 1488 ± 411 mg/kg (three replicates)	Total P: 1676 ± 181, 1243 ± 462, and 1357 ± 447 mg/kg (three replicates)	Total P on average increased 20% for moderate burn and 49% for severe burn areas	Standard deviations ranged from 11% to 67% of the means	Blake et al., 2001
Leached cations: 2.2, 1.8, 21.7, and 14.2 kg/ha for Ca, Mg, K, and Na, respectively	N/A	Leached cations: 3.6 and 61.6, 6.7 and 12.1, 27.4 and 18.5, and 14.2 and 26.45 kg/ha for Ca, Mg, K, and Na, respectively (two replicates)	Leached cations: 36.5 and 61.4, 8.3 and 12.7, 28.4 and 39.9, and 13.4 and 25.4 kg/ha for Ca, Mg, K, and Na, respectively (two replicates)	Leached Ca, Mg, K, and Na on average increased 1382%, 422%, 6%, and 43%, respectively, for moderate burns and 2125%, 483%, 57%, and 37%, respectively, for severe burns	Standard deviations ranged from 24% to 126% of the means	Cancelo-Gonzalez et al., 2013
Leached metals: 2.52 and 3.84 mg (Al and Fe, respectively)		Leached metals: 3.01 and 3.55 mg (Al and Fe, respectively)	Leached metals: 3.62 and 6.37 mg (Al and Fe, respectively)	Leached Al and Fe increased 19% and decreased 8%, respectively, for moderate burns and increased 44% and 66%, respectively, for severe burns	N/A	Cancelo-Gonzalez et al., 2015
DOC: 9.35 and 18.4 mg_c/L Fe: 0.050 and 0.026 ppm (two replicates)	N/A	DOC: 24.4 and 26.7 (burned at 225 ºC), 15.5 and 8.54 mg_c/L (burned at 350 ºC) Fe: 0.058 and 0.100 (burned at 225 ºC), 0.034 and 0.009 ppm (burned at 350 ºC) (two replicates)	DOC: < 0.2 and < 0.2 mg_c/L Fe: 0.007 and 0.012 ppm (two replicates)	DOC and Fe increased 84% and 108%, respectively, for mild-moderate burns, decreased 13% and 43%, respectively, for moderate burns, and decreased 99% and 75%, respectively, for severe burns	N/A	Cawley et al., 2017
Total C: 410 ± 18 and 444 ± 8 g/kg Total P: 165 ± 10 and 95 ± 8 mg/kg Total N: 8.1 ± 2.1 and 5.3 ± 0.2 g/kg (low nutrient and high nutrient plant biomass, respectively)	Total C: 595 and 554 g/kg Total P: 88 and 107 mg/kg Total N: ~6 and 11 g/kg (low nutrient and high nutrient plant biomass, respectively) (muffled at 200 ºC)	Total N: ~35 and 30 g/kg (muffled at 350 ºC) (low nutrient and high nutrient plant biomass, respectively)	Total C: 29 and 66 (muffled at 550 ºC), 199 and 181 g/kg (10 g lab burn at 460 ºC) Total P: 3244 and 4454 (muffled at 550 ºC), 1761 and 2090 mg/kg (10 g lab burn at 460 ºC) Total N: 5.1 and 4.0 g/kg (10 g lab burn at 460 ºC) (low nutrient and high nutrient plant biomass, respectively)	Total C, P, and N on average increased 35%, decreased 25%, and increased 27%, respectively, for mild burns; decreased 89%, increased 2851%, and decreased to no response, respectively, for (muffle furnace) severe burn; and decreased 56%, increased 1381%, and decreased 32%, respectively, for (litter burn) severe burns (total N peaked at moderate burn, increasing 385%)	N/A	Hogue and Inglett, 2012
DOC: 3.3 (0.7) mg_c/g; DOC:DON: 32.7 (10.5) mg_c/mg_N	N/A	DOC: 1.6 (0.7) mg_c/g; DOC:DON: 23.9 (7.6) mg_c/mg_N	N/A	DOC and DOC:DON decreased 52% and 27%, respectively, for moderate burn areas	Standard deviations ranged from 21% to 44% of the means	Hohner et al., 2019
N/A	N/A	N/A	PyC median mass loss: 6.6 (0-70.4)% and 15.1 (0-100)% (experimental fire); 15.1 (13.3-16.0)% and 1.0 (0.7-	PyC median mass decreased 6.6% and 15.1% for granular PyC and PyC pieces, respectively, for experimental fire and on average 22.8% and 34%,	Wide range of variability (up to 533% of the	Santin et al., 2013

			25.4)% (lab heating at 370 ºC); 27.6 (25.4-34.2)% and 63.3 (20.9-76.7)% (lab heating at 470 ºC); 25.7 (21.8-29.0)% and 36.7 (16.7-81.4)% (lab heating at 570 ºC) (granular PyC and PyC pieces, respectively)	respectively, for lab muffle burns	medians)	
TOC: 7.5%, 13%, and 9.6% (three replicates)	N/A	TOC: 17%, 23%, and 7.9% (three replicates)	TOC: 9.7%, 9.2%, and 7.8% (three replicates)	TOC increased 60% for moderate burns and decreased 11% for severe burns	N/A	Wieting et al., 2017

*0-1 cm, 1-2 cm, and 2-3 cm depths, respectively

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