
Post- 2010 forest fire hydrological and sedimentological changes in the Upper Nahal Oren Basin, Mt. Carmel Israel – a comparison to pre-fire natural rates

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Wildfires, in general, increase overland flow and therefore, are expected to cause an increase in soil erosion. At the catchment scale, the number of studies is significantly smaller than at the plot sizes, because of difficulties in monitoring, costs, heterogeneity of fire severity, absence of monitoring of pre-fire conditions and short studies that do not include the full recovery of the area.

The Upper Nahal Oren catchment –18 km² is a typical mountainous, ephemeral stream system of Mt. Carmel draining westward into the Mediterranean Sea with a general channel gradient of 3%. The carbonate rocks of Mt. Carmel enables the existence of a rich groundwater aquifer. Land-use includes: natural and planted forests of oaks and pines - 61%; agriculture - 17%, and 22% - rural area.

The climate is Mediterranean-type characterized by dry and hot summers and rainy winters with mean annual rainfall of about 695 mm/yr.

Flows along the ephemeral channel of Nahal Oren basin, are characterized by steep rising limb and a swift, long recession, caused by the drainage of the large water storage of the basin and by the increased discharge of 2 springs during winter, which feed a temporal base flow that can last up to 2-3 weeks after large floods. Annual rainfall-runoff ratio is 3-4% and runoff volumes are typically tens to a few hundred thousand m³. The typical lag time is generally a few hours.

Rainfall, flows and suspended sediments were monitored using 4 rain-gauges, hydrometric station and water sampling, respectively, since 2001. Sediment yield (SY) was analyzed from the nearby Pond Reservoir, which accumulates most of the sediments transported during flows.

The 2010 fire burnt 2500 hectar, – about 35% of the basin area, all of which are forests or open areas.

The results indicate that: (a) The first floods during the 3 years after the fire (2010-2013) generated after rainfall amounts of 52-65 mm and after 23-55 mm, for the following winter floods in comparison to 120-150 mm and 50-60 mm, respectively, prior to the fire. Since 2014, these values increased again to >100 mm for the first flood and to 40-62 mm for the following floods. (b) The number of flow events (>0.2 m³ s⁻¹) increased from 2-6 flows per year (\bar{x} = 3.8 flows/yr) pre-fire (2001-2010) to 5.7 flows/yr (2011-2013) after the fire (an increase of about 50%). During the years -2014-2016, the average number of flows returned to 3.7 flows/yr. (c) Post-flood base flows shortened from an average of 7.2 days pre-fire to about 2.7 days post-fire. The flows during 2010-12 had no base-flows at all.



These results show that the Upper Nahal Oren Basin became more responsive to rainfall after the fire i.e., generates runoff after smaller rainfall amounts for the first seasonal flood as well as to the following winter floods. These are explained by the absence of the vegetation cover, the disturbance/disappearance of the organic A horizon of the soil, the exposure of the finer B or C horizons and the soil water repellency/hydrophobicity development, all of which result in decrease of infiltration. These contribute to shortening of the lag time between rainfall and flows and an increase in rainfall/runoff ratio. The decrease in post-flood base-flow duration is caused by the decrease in deep infiltration into the shallow and alluvial aquifers, which in turn, result in decrease in discharge of the springs and seepages along the channel.

Maximum pre-fire SSC's exceeded 3-4 g/lit and mean annual sediment yield (ASY) about 16.7 ton/km²/yr. These low rates were related to the intensive vegetation cover of the Mediterranean Maqui. The post-fire SSC rates exceeded 28 g/l (7 times the pre-fire rates), and the ASY's 22.5 ton/km²/yr (1.3 times the pre-fire rates). This is explained by the increase in runoff, which in turn, increase soil erosion.

The resilience of the various hydrological and sedimentological characteristics of the basin after the fire took 3-5 years until they returned to the natural, pre-fire values along with the recovery of the vegetation cover.