Quantification of post-wildfire hydrologic response, hillslope erosion, and channel morphology: baseline data following the High Park Fire

Daniel J. Brogan[1], Sarah Schmeer[2], Stephanie K. Kampf[2], Lee H. MacDonald[2], and Peter A. Nelson[1]
Department of Civil and Environmental Engineering, Colorado State University

Abstract. Previous wildfire research has shown that fires can lead to dramatic increases in runoff and erosion rates at the hillslope scale; however, relating post-fire hillslope-scale processes to watershed-scale response remains a challenge. To better understand the hydrologic and geomorphic effects of wildfire at different scales, we are using field measurements and remote sensing data to quantify post-fire hydrologic response, erosion rates, and channel change at the hillslope, channel reach, and watershed scale. Our study areas, Hill Gulch and Skin Gulch, are two watersheds with intermittent stream flow (14 km^2 and 15 km^2, respectively) that were extensively burned at moderate to high severity in the High Park Fire, which burned 34,330 hectares during the summer of 2012, making it the second largest forest fire in Colorado's recorded history. Data collected since July 2012 include: 22 locations of hillslope-scale erosion rates and site characteristics, surveys of 20 channel cross-sections and eight longitudinal profiles, 22 high-resolution GPS locations of channel heads, and terrestrial LiDAR topographic scans of seven channel heads and two in-channel environments. Eight recording rain gages have been installed in the watersheds to capture spatial variability of summer thunderstorms which are the primary driver of post-fire runoff, erosion, and channel change. Airborne LiDAR data and hyperspectral imagery were collected by the National Ecological Observatory Network Airborne Observation Platform in October 2012, and similar imagery is expected to be collected annually over the next several years. This imagery will be used to characterize watershed-scale regrowth and channel change. Preliminary results show moderate and severely burned hillslopes typically had 50-75% bare soil; surface cover was primarily due to rock and litter, as live vegetation cover averaged only 3% and never exceeded 8%. Most of the large storms occurred prior to the installation of rain gages and our sediment fences, but one storm of 19 mm generated over 450kg of sediment which was collected in one fence with a drainage area of approximately 1200m^2. Another storm in the Skin Gulch watershed caused extensive rilling and gullying in headwaters, transport of large boulders and woody debris in the middle portion, and at least half a meter of deposition in the lower gradient reaches. No comparable event was observed in Hill Gulch, indicating high spatial variability in rainfall and the associated geomorphic effects. Ultimately, the field collected data and airborne LiDAR will be used to quantify hydrologic response, erosion and deposition from the hillslope to watershed scale, and then develop a modeling framework to predict post-fire hydrologic and geomorphic responses at varying scales.

[1] Department of Civil and Environmental Engineering, Colorado State University, Fort Collins, CO, 80523-1372 Tel: 608.547.2226; e-mail: djbrogan@uwalumni.com
[2] Department of Ecosystem Science and Sustainability, Colorado State University, Fort Collins, CO, 80523