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The Role of Wildfire in the Export of Particulate and Pyrogenic Organic Carbon from a Small Mountainous River

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The delivery of particulate organic carbon (POC) from rivers to marine sediments is the major long-term sink of CO_2 on Earth and a net source of oxygen over millennial time scales. Small mountainous river systems (SMRS) may be responsible for half of the POC delivery to global oceans. The flux of POC in SMRS has been thought to be regulated by hydro-geomorphic factors, such as runoff, tectonic uplift rates, and bedrock geology. To date, the role of landscape disturbances such as fire has not been investigated. Two large wildfires (1977 and 2008) in the chaparral-dominated Arroyo Seco watershed of California provided a unique opportunity to examine the effects of fire on sediment and POC flux at the watershed-scale. Suspended sediments were measured before and after both fires while POC was measured after the 2008 wildfire. Relationships between sediment and sediment carbon concentration of the 2008 fire were used to determine POC flux as a result of the earlier 1977 fire. For two years after the 2008 Basin Complex POC fluxes were 25 and 50 times more than would be expected during a non-fire affected year (5.9 and 59.7 Mg/sq. km/yr during 2009 and 2010, respectively, versus 1.1 M/sq. km/yr-1 during non-fire year). This was driven fire caused increases in suspended sediment flux and an increase in suspended sediment carbon concentration. Flux weighted average organic carbon concentrations of suspended sediment collected from the Arroyo Seco River after the 2008 Basin Complex wildfire were over 3.2 times higher than pre-fire levels. Using a Monte Carlo analysis of fire and flooding we determine that over the long-term fire caused erosion and hydrological change is responsible for over 90% of the POC flux. Elemental, stable isotope, and biomarker analyses show that both burned and unburned organic matter has contributed to the elevated carbon concentrations as a result of enhanced surface erosion processes. Our preliminary results suggest that 25% of the POC discharged from the Arroyo Seco watershed for two years after fire is pyrogenic organic carbon. While these fire-flood events may be rare, sediment associated constituent yield will be greatly underestimated if these events are not considered. Fire-flood events may be especially important to consider in light of shifting fire regimes and more frequent extreme precipitation events predicted as a result of climate change.