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Executive Summary

Post-Fire Debris Flows: Leveraging Science for Environmental Management and Community Resiliency

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Addressing Management and Hazard of Post-Fire Debris Flow

Debris flows in Santa Barbara County are a public management concern, particularly due to threats they pose to people and property. This study focuses on characteristics and impacts of post-fire debris flow in three Montecito-area watersheds. The steep hillslopes of the Montecito Creek, San Ysidro Creek, and Romero Creek watersheds (Figure 1) are prone to varying amounts of sediment transport. In the 1960s and 1970s, the Army Corps of Engineers (ACOE) constructed debris retention basins to mitigate hazard from debris flow to the downstream communities. This infrastructure reduces hazard by capturing large debris moving from higher elevations but presents additional management challenges with socioeconomic and environmental consequences. These challenges require examination and consideration, especially in a changing climate.

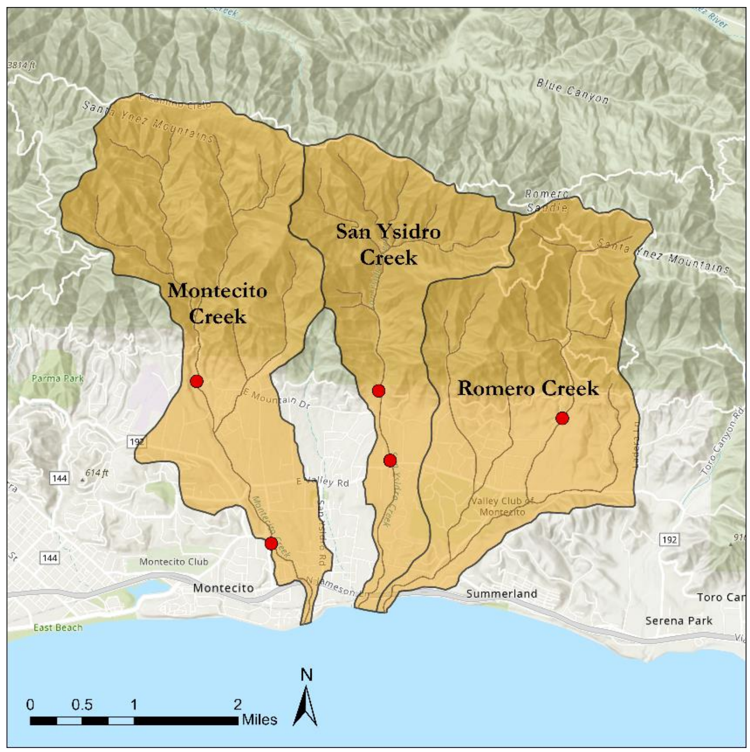

Figure 1 - Map of the study watersheds with red dots indicating debris basin locations.

This project addresses the inquiry of South Coast Habitat Restoration (SCHR) to analyze management strategies by (1) modeling debris flow probabilities and volumes with geospatial tools and datasets; (2) evaluating environmental and socioeconomic impacts of debris flow and sediment management via cost-benefit analysis; and (3) examining the broader implications of climate change on debris flow recurrence and volumes.

Using Modeling to Examine Likelihood and Potential Magnitude of Debris Flow

The study examined the present likelihood of debris flow and major debris flow, and also tested potential climate change effects using a simulated increase in fire severity and an 18 percent increase in regional precipitation intensity. Mean debris flow probability in all watersheds was unchanged with an increase in either fire severity or precipitation intensity, while major debris flow likelihood increased under both climate change scenarios. For an increase in both fire severity and precipitation intensity, the watersheds experienced an increase in major debris flow probability from 0.4 percent to 0.7 percent.

Using an empirical model, this project estimated the potential volumes of debris generated during post-fire debris flow events in the study watersheds. The results of this modeling indicate that single precipitation events with rainfall intensities ranging from 0.87 in/hr to 1.57 in/hr could produce post-fire debris flow volumes from 75,000 yd^3 to 141,000 yd^3 in Montecito basin, 64,000 yd^3 to 120,000 yd^3 in San Ysidro, and 48,000 yd^3 to 92,000 yd^3 in Romero Canyon. These values can be used as a tool to inform future management decisions and evaluate potential socioeconomic and environmental impacts.

Cost-Benefit Analysis of Sediment

Three separate cost-benefit analyses were performed: (1) the implementation of a redesigned debris basin with slotted outfalls, (2) sediment delivered to Goleta Beach to maintain shoreline, and (3) the direct market sale of sediment. The cost-benefit analysis accounts for selected costs associated with sediment transportation from the basin. Out of the three management options examined, replacement of boxed outfalls with slotted outfalls maximizes benefits for the county. The slotted outfall design improves fish passage while avoiding the cost of transporting sediment. The management strategies are not mutually exclusive and can be implemented in combination with one another to maximize public wellbeing.

This study dealt with multidisciplinary facets that are the subjects of active research and was further limited due to the complex nature of the topic. As a result, more local research is necessary to improve accuracy. For instance, this study's probability modeling is based on a larger regional data set, which does not capture unique local characteristics of the study watersheds. A possible next step to improve modeling accuracy is to collect and employ more localized data to predict debris flow volumes and likelihood under various climate conditions. Patterns of climate change will influence the variability of rainfall, fire regime, and vegetation cover. Uncertainty can be addressed as local climate change models continue to advance.

The cost-benefit analysis was limited due to the availability of data capturing true economic values of non-market goods and services. Secondary data used in the cost-benefit analysis comes from varied geographical and temporal settings, which results in assumptions that influence the accuracy of the findings. A next step to address these limitations is to assess the valuation of endangered species habitat in the watersheds. Improvement of this data will give a better idea of the public benefit to be gained from the slotted outfall option. For a comprehensive understanding of beach nourishment value, further research should obtain more applicable estimates of beach erosion rates and the present value of beach area. Additional study can more accurately capture the value of non-market goods, informing future decision-making.

Debris Flow in a Changing Climate

Climate change will be an influential factor for sediment management in the future because of the likelihood of shifts in fire regimes and rainfall intensity. While the exact local impacts of climate change remain inconclusive, precipitation extremes are anticipated to increase. Furthermore, climate change is amplifying autumn wildfire probability in California and lengthening the fire season. Increased intensity of rain events in this region, which remains prone to high wildfire recurrence, underlines an increased need to adapt current strategies of managing sediment and mitigating impacts from debris flows.

Debris flow hazard and sediment generation remain constant management concerns in the region, which will continue into the future. While modification of existing infrastructure can help alleviate the accumulation of fine sediments, management that considers the public good of sediment resources (i.e., beneficial reuse) can further accrue societal benefits. Field measurements and modeling will be needed to accurately estimate debris flow recurrence and volume, particularly as climate change influences fire regimes and precipitation intensity. Continued refinement of analytical tools is an important step to understand the potential hazard and sediment management challenges underlying future debris flow events. Using science to reduce uncertainty can give managers a meaningful edge in the challenge of post-fire debris flow in a changing climate.