# Application of SRH-2D to Predict Post-Fire Water and Sediment Delivery from a Watershed

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## Introduction

Recent enhancements to the SRH-2D model make it a good model for predicting sediment delivery from watersheds to reservoirs and evaluating the effects of phenomena such as wildfires on reservoir sedimentation. This works demonstrates a hydrologic and hydraulic application of SRH-2D to predict post-fire water and sediment fluxes from a 282 km² area of the Upper Cache Creek Watershed, CA, USA. The Rocky and Jerusalem Fires occurred in July and August of 2015 and burned approximately 163 km² of the sub-watershed considered herein. Observed flow and sediment records are available both pre- and post- fire, making it a good watershed for examining the effects of fire.

## Watershed Description and Methods

The simulated watershed is shown in Figure 1. There are three inlet locations shown with the yellow dots and four United States Geological Survey (USGS) gauging stations around the site. Flow is downwards in the southeast direction. The area that was burned is shown in Figure 2 (Wang et al., 2019), which also highlights the burn severities.

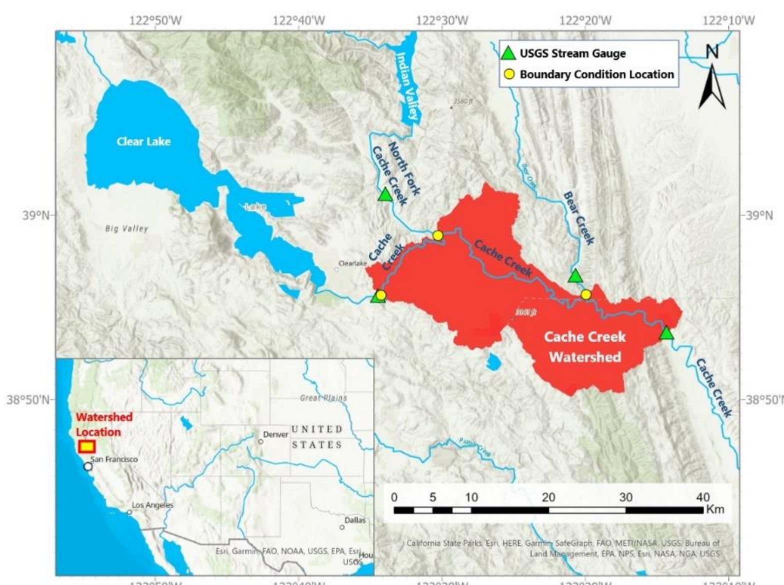


**Figure 1.** Simulated Cache Creek Watershed (Lai et al, 2022)

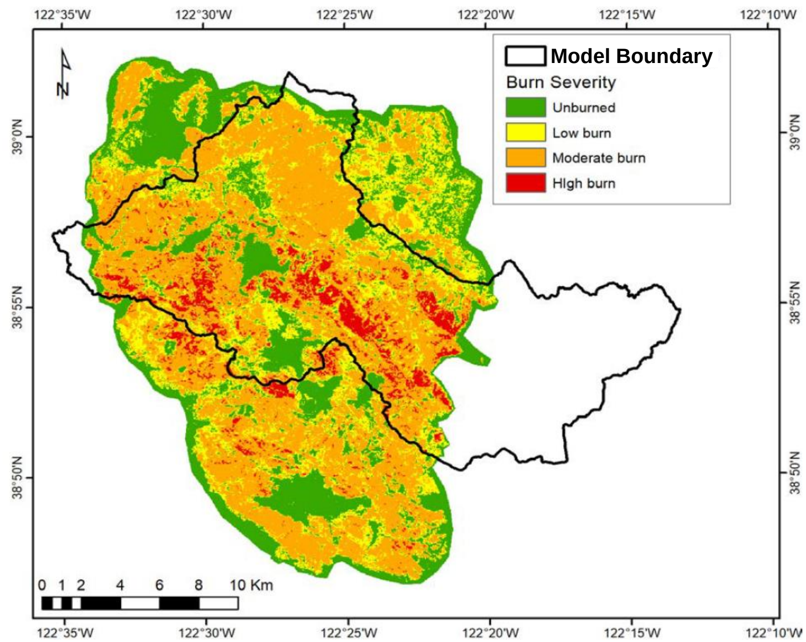


**Figure 2.** Burned area and burn severities (Wang et al, 2019)

We performed continuous simulations for water years 2015 and 2016 representing pre- and post-fire conditions respectively. Land cover classifications were derived from Landsat imagery , and soil hydraulic properties were obtained from the USGS SURGO database. Land cover is a mix between shrubs, trees, short vegetation, and bare land. Hydraulic conductivities ranged between 0.8 mm/hr and 330 mm/hr. Hourly precipitation data for the watershed were derived from eleven local climate stations. Readers are referred to Wang et al. (2019) for a more detailed presentation of the watershed properties and how they were processed.

The effects of soil water repellency and cover modification were accounted for in the model by adjusting pre- and post- fire soil hydraulic conductivities and land covers to reflect the effects of burn severities on the properties. Following Wang et al. (2019), hydraulic conductivities were reduced up to 10%. Similarly, changes to the surface coverage were based on the burn intensity. The results from our simulations are presented in the following section.

# Results

Predicted and observed flow rates pre- and post-fire are shown in Figure 3. The Nash-Sutcliffe Efficiency coefficients were 0.81 and 0.79 respectively for the two years, indicating good model performance. The predicted and observed daily sediment fluxes are also shown in Figure 4. The NSE coefficients in this case is 0.9 and 0.67 respectively, also indicating good model performance. An interesting trend is observed in which the sediment fluxes in the year immediately after the fires were of much lower magnitude than the previous pre-fire year simply because there was less runoff. This highlights the importance of being able to forecast and predict fire impact without always assuming that net flux will increase.

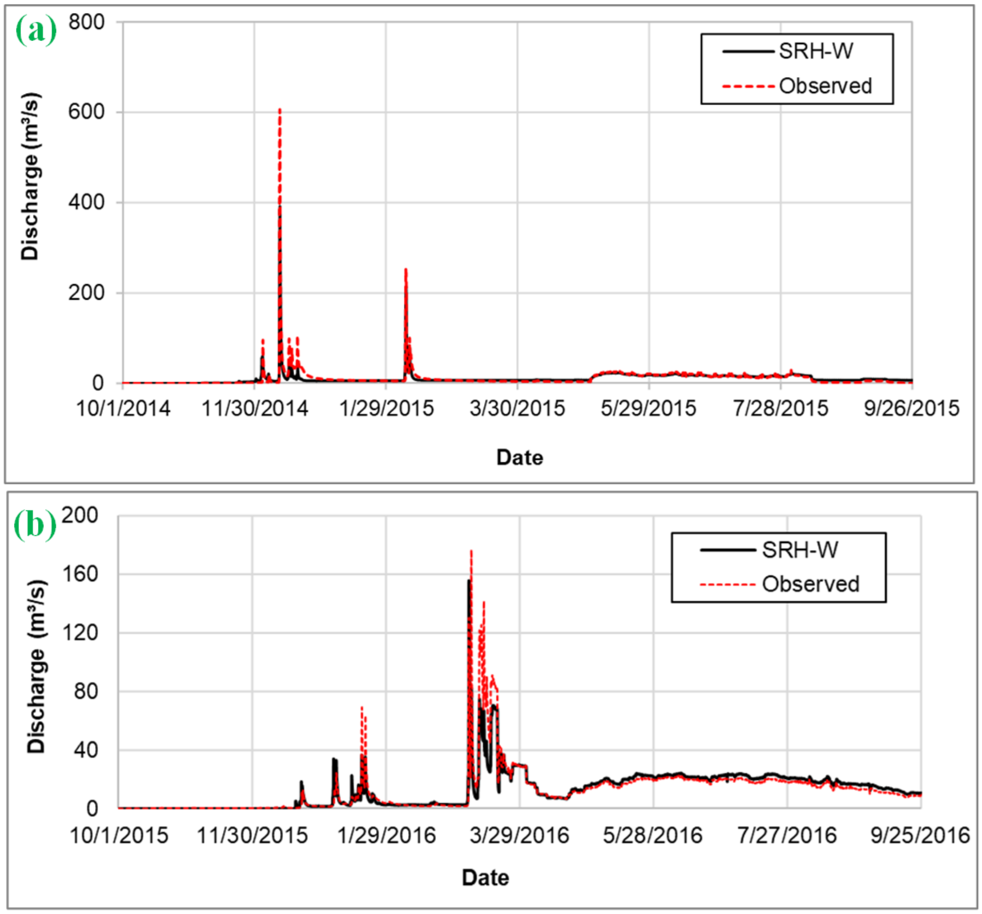


**Figure 3.** Comparison between SRH-predicted and observed flow discharge: (a) pre-fire WY2015 (top), and (b) post-fire WY2016 (bottom).

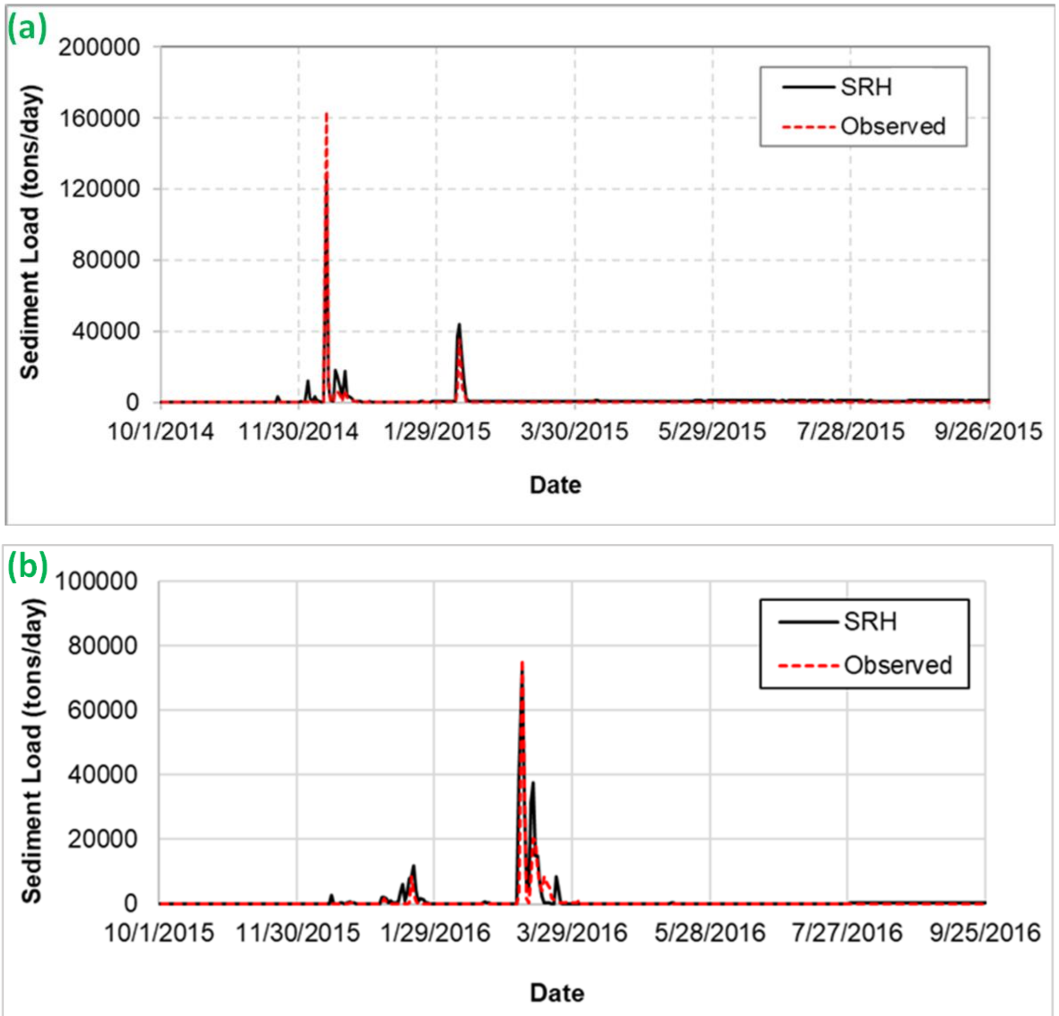


**Figure 4.** Comparison between SRH-predicted and observed sediment loads: (a) pre-fire WY2015 (top), and (b) post-fire WY2016 (bottom).

# Conclusion and Future Work

The enhancement of SRH-2D for performing hydrologic and hydraulic analyses is ongoing, and this work has demonstrated its capability to perform watershed analyses. Part of this ongoing effort will include physics-based representation of wildfire impacts to landscape properties, quantitatively accounting for effects of different burn severities on the overall impact to water and sediment fluxes. The ultimate goal is the development of a predictive tool for evaluating the effects of climate change, wildfire, and different management actions, among others, on sediment delivery to reservoirs and similar facilities.

# References

Lai, Y.G., Abban, B., and Politano, M. 2022. A process-based mesh-distributed watershed model for water runoff and soil erosion simulation, International Journal of River Basin Management, DOI: 10.1080/15715124.2022.2101465

Wang, J., Stern, M., Alpers, C.N., King, V.M., Webster, J., Quinn, N.W.T, and Lai, Y. 2019. Research and Development of a Watershed-Scale Model/Tool for Simulating Effects of Wildfires on Mercury Contamination of Land and Water, Report No. ST-2019-7112-01, Research and Development Office, Bureau of Reclamation, USA.