A Tool to Predict the Effects of Land Management on Water and Sediment Yield

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Key Findings

- WEPP-simulated daily streamflow was in close agreement with observed values from the undisturbed, untreated reference watershed, as well as those from the disturbed (clear-cut and partial-cut) watersheds.
- WEPP captured water yields and sediment yields and changes in these yields due to harvesting practices (Figures 1 and 2), successfully characterizing the temporal changes in annual sediment yield with treatments.
- Good agreement between predicted and observed suspended sediment yield was achieved through the calibration of a single channel critical shear stress parameter.

There is demand for greater understanding concerning the impacts of forest management practices on water and sediment yield in the mountainous watersheds of the Pacific Northwest. Common forest operations such as **harvesting** and **road construction** can significantly affect hydrology and sediment transport at the hillslope and watershed scales, influencing the soil's ability to retain water, its permeability, the pressure of the water within soil pores, and root decay, which can increase soil instability. Indeed, much of the upland erosion related to forest management can be due to **road construction and skid-trails**. The resultant compacted soils can decrease soil hydraulic conductivity and increase overland flow as precipitation exceeds infiltration capacity and/or where road cut slopes intercept subsurface flow. Increased peak streamflow after logging can also lead to increased stream sediment transport from the stream bed and banks.

A team led by researchers from the University of Idaho applied the Water Erosion Prediction Project (**WEPP**) model to the Mica Creek Experimental Watershed in Idaho to demonstrate the viability of using the WEPP model to simulate the direct and cumulative effects of clear-cutting and partial-cutting (50% canopy removal) on water and sediment yield. Simulated results were compared to real-world observed results over the period 1991–2007. This study allowed the researchers to evaluate the WEPP model's performance under undisturbed reference watershed conditions, and to simulate water and sediment yield for pre- and post-harvest treatment conditions. In nested, paired watersheds they used a sampling design that compares measurements before and after treatments to estimate impacts (before-after-control-impact/treatment (**BACI**) approach). Streamflow and sediment were measured at seven watershed outlets before the road construction and timber harvesting, after road construction, and again after harvesting.

Management Implications

Results suggest that WEPP simulations of streamflow in undisturbed, reference watersheds can have strong agreement with observed data. Promisingly, WEPP's ability to simulate streamflow for the disturbed watersheds was similar to that for undisturbed watersheds, and the specific effects of timber harvest on water yield were also represented well in the WEPP outputs. The ability of the WEPP model to generally reproduce the effects of forest harvesting

Clear-cut (foreground) and partial-cut (background) harvest treatments at Mica Creek Experimental Watershed, Idaho. Photo: Timothy Link.

Keywords. Forest harvesting, hydrology, sediment transport, WEPP

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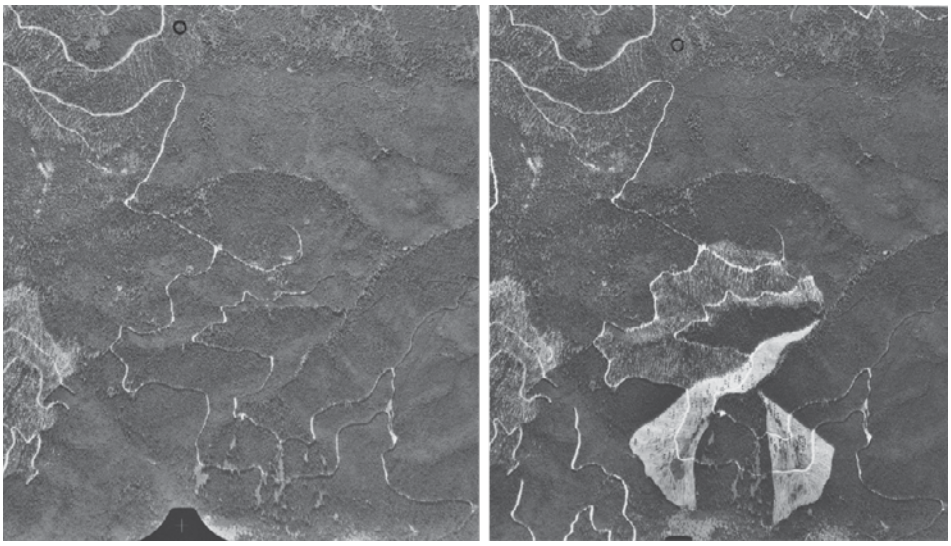

Aerial images of the Mica Creek Experimental Watershed before (left) and after (right) implementing the harvest treatments. Images reproduced with permission from Timothy Link.

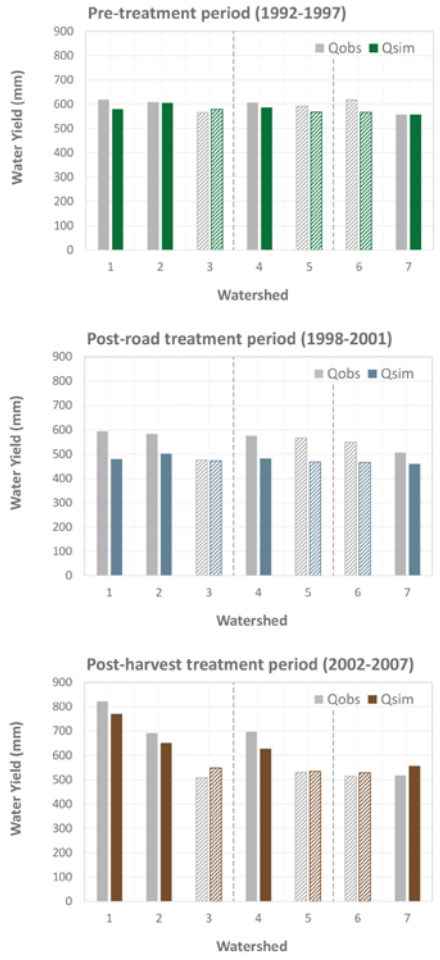

Figure 1. *Observed (gray) and simulated (colored) water yield at the Mica Creek Experimental Watershed. The top panel shows water yield during the pre-treatment period, the center panel shows water yield after the road treatment, and the bottom panel shows water yields after the harvest treatment. The dashed vertical lines show how the watersheds, numbered 1 through 7, were paired in this experiment. The reference watershed in each pair is shown with striped bars (note that watershed 3 is the reference for both watersheds 1 and 2).*

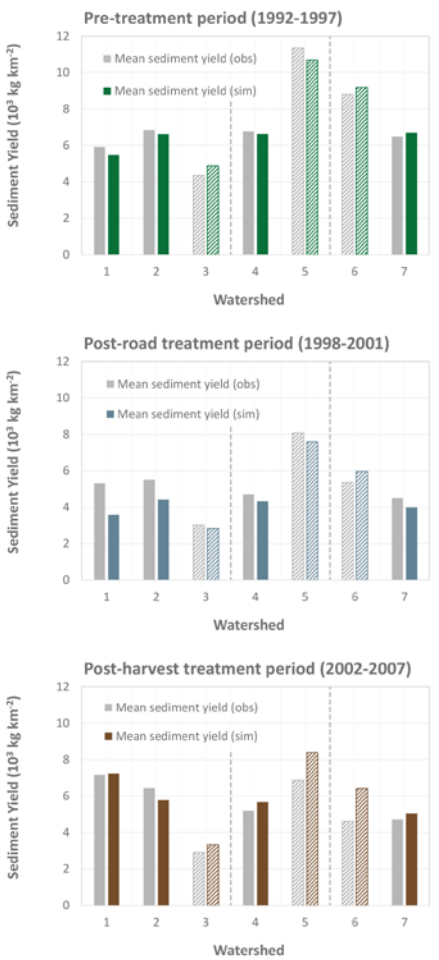

Figure 2. *Observed (gray) and simulated (colored) sediment yield at the Mica Creek Experimental Watershed. The top panel shows sediment yield during the pre-treatment period, the center panel shows sediment yield after the road treatment, and the bottom panel shows sediment yields after the harvest treatment. The dashed vertical lines show how the watersheds, numbered 1 through 7, were paired in this experiment. The reference watershed in each pair is shown with striped bars (note that watershed 3 is the reference for both watersheds 1 and 2).*

practices on hydrologic regime (water yield, peak flow) and upland erosion and stream sediment transport with minimal calibration demonstrates WEPP's potential as a decision-aid tool for forest management in the Pacific Northwest. Additionally, the **online version of WEPP** and the model's ability to draw on publicly accessible climatic, soil, and land-use databases enhances the ease of use and broad applicability of the model. WEPP can potentially be employed by land managers to better understand the effects of forest management changes to both streamflow and sediment yield. Furthermore, WEPP's potential might be far reaching. With rising global temperatures and increasingly frequent and destructive forest fires expected in the Pacific Northwest over the coming years, researchers are now employing this model in post-fire assessments, and in exploring the risk of erosion in not yet burned areas.

Foundational Publication

Srivastava, A., Brooks, E. S., Dobre, M., Elliot, W. J., Wu, J. Q., Flanagan, D. C., Gravelle, J. A. & Link, T. E. (2020). *Modeling forest management effects on water and sediment yield from nested, paired watersheds in the interior Pacific Northwest, USA using WEPP.* Science of The Total Environment, 701, 134877. **https://doi.org/10.1016/j.scitotenv.2019.134877**