United States Department of Agriculture
Natural Resources Conservation Service

CEAP Science Note
Conservation Effects Assessment Project
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Simulating the Effects of Fire on the ARS Reynolds Creek Experimental Watershed

Summary of Findings

- Fire on rangeland significantly increases runoff and erosion, according to computer simulations conducted in the Reynolds Experimental Watershed in Idaho by the Agricultural Research Service Southwest Watershed Research Center in Tucson, AZ.
- Where the simulated burn covered 35.4 percent of the watershed, total runoff, peak flow, and sediment yield would increase by nearly 600 percent, about 1,060 percent, and 170 percent, respectively.
- Where the simulated burn covered 100 percent of the watershed, total runoff, peak flow, and sediment yield would increase by more than 2,400 percent, 2,860 percent, and about 360 percent, respectively.
- The simulations could be used to evaluate various burn severity scenarios to guide pre-fire efforts to reduce fire hazards and to help set priorities for post-fire conservation and mitigation efforts.

The Conservation Effects Assessment Project (CEAP)-Grazing Lands national assessment is designed to quantify the environmental effects of conservation practices on U.S. non-Federal grazing lands. The assessment includes science-based estimates of expected environmental effects of installed conservation practices using environmental models.

Agricultural Research Service (ARS) scientists at the Southwest Watershed Research Center, Tucson, AZ, used computer modeling to simulate the effects of fire on the 238 km^2 Reynolds Creek Experimental Watershed in southwestern Idaho (fig. 1). The researchers used the Automated Geospatial Watershed Assessment (AGWA) tool to set up, parameterize, and execute the Kinematic Erosion and Runoff Model (KINEROS2) using pre- and post-fire land cover and a 5-year, 30 minute design storm. Two hypothetical fires burned 35.4 percent and 100 percent of the watershed. The simulated effect of the fire on the burned areas reduced vegetative cover that would normally intercept rainfall, reduced Manning's N (a measure of streamflow) from a watershed average of 0.05 to 0.011, and reduced saturated hydraulic conductivity from a watershed average of 10.07 mm/hr to 2.0 mm/hr.

The pre- and post-fire simulations are retained for each watershed model element (hillslope and channels). Percent or absolute differences in watershed response for each of these elements, for a variety of model outputs (e.g., total run-

Figure 1. Reynolds Creek Experimental Watershed with 35.4% burn area depicted.

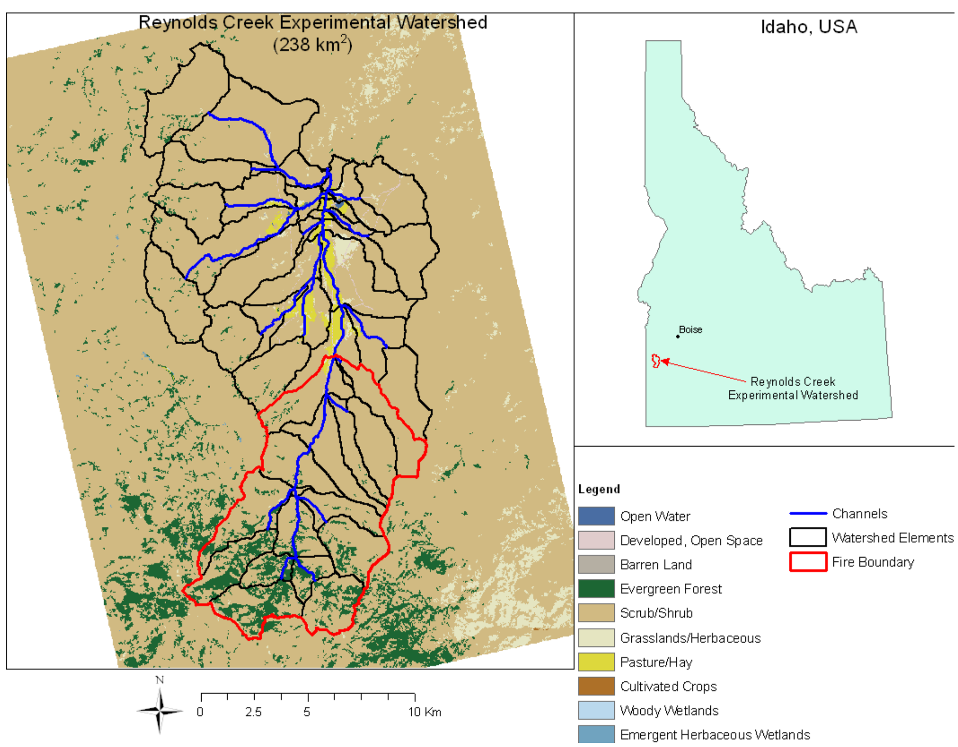


Figure 2. Absolute change between pre- and post-fire runoff volume for simulated burn of 35.4% of Reynolds Creek Experimental Watershed.

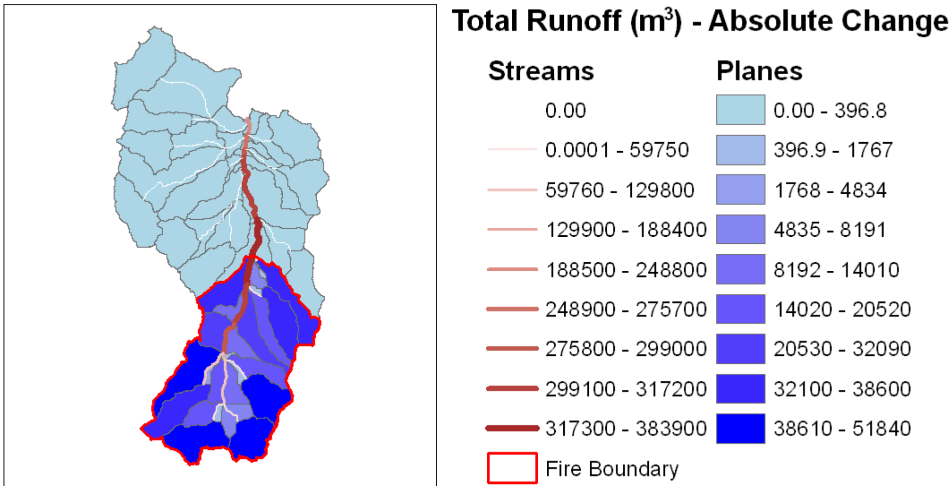


Figure 3. Absolute change between pre- and post-fire peak flow for simulated burn of 35.4% of Reynolds Creek Experimental Watershed.

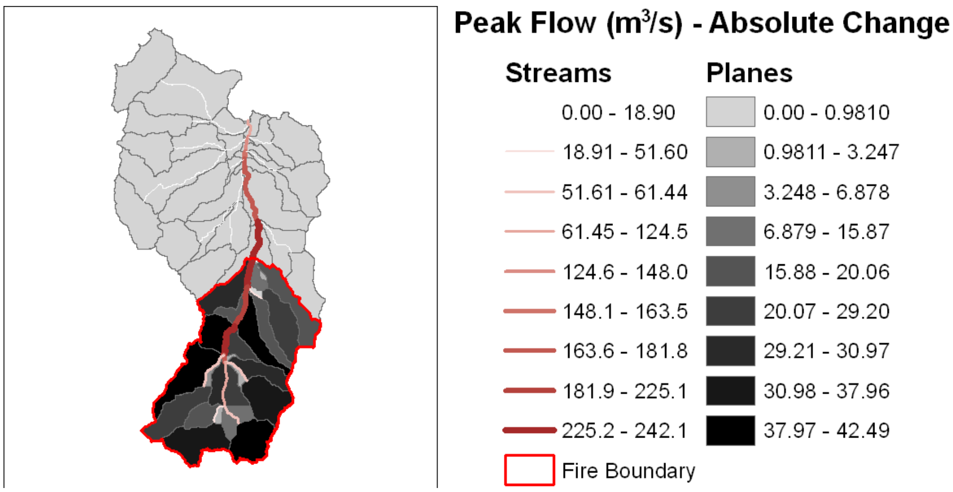
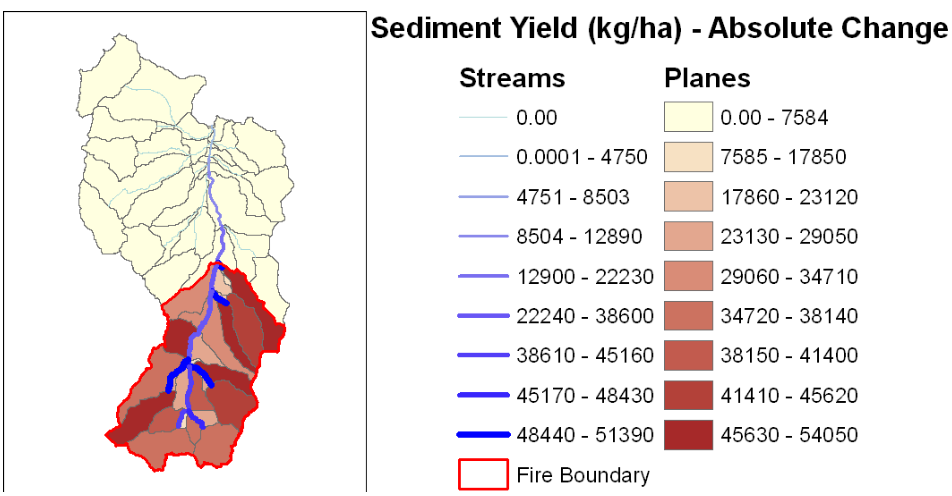


Figure 4. Absolute change between pre- and post-fire runoff sediment yield for simulated burn of 35.4% of Reynolds Creek Experimental Watershed.



off—fig. 2; peak flow—fig. 3; and sediment yield—fig. 4) can then be mapped back into the GIS-based spatial watershed representation. This enables ready identification of highly impacted upland areas and their downstream impacts and allows the focused implementation of post-fire mitigation practices.

Table 1 shows the percent difference in selected outputs between the pre-fire and the 35.4-percent burn and between the pre-fire and the 100-percent burn. Under these scenarios, total runoff, peak flow, and sediment yield would increase by nearly 600 percent, about 1,060 percent, and 170 percent for the 35.4-percent burn, and by more than 2,400 percent, 2,860 percent, and about 360 percent for the 100-percent burn.

The pre- and post-fire difference maps (figs. 2, 3, and 4) can be use to target post-fire conservation and management practices in either uplands or channels. Ideally, to enable rapid post-fire assessments to directly aid Burned Area Emergency Rehabilitation (BAER) teams in deploying mitigation conservation practices, AGWA and the Soil and Water Assessment Tool (SWAT) or KINEROS2 model could be set up and run for pre-fire (current land cover) conditions for watersheds of interest. That way the necessary topographic data, soils, climate/weather, and current land use/land cover data have been collected and geo-referenced, and the model discretization, parameterization, and initial execution has been completed. Outputs from this initial watershed simulation could be spatially examined to identify areas that may be prone to flooding or high-erosion under current conditions to target preventative conservation measures.

If a fire were to occur, the burn severity map produced immediately after the fire by the BAER team could be imported directly into AGWA once geo-referenced. Research has been conducted (Canfield et al. 2005; Goodrich et al.

Table 1. Percent difference between pre-fire and 35.4-percent and 100-percent watershed burns

	Percent change from pre-fire condition	
Factor	35.4% burn	100% burn
Total runoff	593.19	2,432.13
Peak flow	1,059.43	2,860.00
Sediment yield	172.22	359.41

2005) to estimate post-burn infiltration and hydraulic roughness parameters as a function of burn severity. These values are already contained within AGWA look-up tables. This allows immediate post-fire watershed simulation to be driven by the same climatic inputs as the pre-fire simulation, differencing of the simulations, and spatial display of the differences. BAER teams would then be able to target and deploy post-fire conservation and mitigation efforts.

Fire models could also be employed to derive a series of hypothetical burn severity maps. With the aid of AGWA these burn scenarios could also be used to identify where pre-fire thinning or controlled burns should be conducted to reduce fire hazards as well as minimize erosion and downstream sediment and flooding.

References

Canfield, H.E., D.C. Goodrich, and I.S. Burns. 2005. Application of Models to Predict Post-Fire Runoff and Sediment Transport at the Watershed Scale in Southwestern Forests. *In* Proceedings of the ASCE Watershed Management Conference, Williamsburg, VA, July 19–22, 2005. 12 pp. CD-ROM.

Goodrich, D.C., H.E. Canfield, I.S. Burns, D.J. Semmens, M. Hernandez, L.R. Levick, L. R., D.P. Guertin,, and W.G. Kepner. 2005. Rapid post-fire hydrologic watershed assessment using the AGWA GIS-based hydrologic modeling tool. *In* Proceedings of the ASCE Watershed Management Conference, Williamsburg, VA, July 19–22, 2005. 12 pp. CD-ROM.

The Conservation Effects Assessment Project: Translating Science into Practice

The Conservation Effects Assessment Project (CEAP) is a multi-agency effort to build the science base for conservation. Project findings will help to guide USDA conservation policy and program development and help farmers and ranchers make informed conservation choices.

Study findings were provided by the USDA Grazing Land team members Dr. Dave Goodrich, ARS Southwest Watershed Research Center, Tucson, AZ; Dr. Fred Pierson and C. Jason Williams, ARS Northwest Watershed Research Center, Boise, ID; Dr. Phil Guertin, Dr. Mariano Hernandez, Lainie Levick, and Shea Burns, University of Arizona, Tucson, AZ; Dr. Leonard Jolley, NRCS, Beltsville, MD (retired); and Dr. Mark Weltz, ARS Great Basin Rangelands Research, Reno, NV.

For more information:
www.nrcs.usda.gov/technical/NRI/ceap/