United States Department of Agriculture
Natural Resources Conservation Service

CEAP Science Note
Conservation Effects Assessment Project

December 2012

Simulating the Effects of Brush Management on Runoff and Erosion on the ARS Walnut Gulch Experimental Watershed

Summary of Findings

- Brush removal followed by grass seeding on brush-contaminated rangeland can potentially reduce runoff and sedimentation, according to computer simulations conducted in the Walnut Gulch Experimental Watershed by the Agricultural Research Service Southwest Watershed Research Center in Tucson, AZ.
- If the entire watershed were converted to grasslands, peak runoff during the first half-hour after a 5-year rainfall event would be negligible, compared to more than 2.5 inches per hour before the conversion.
- Peak and annual sediment losses from uplands would decline by 90 percent or more in most places where the conversion had been made.

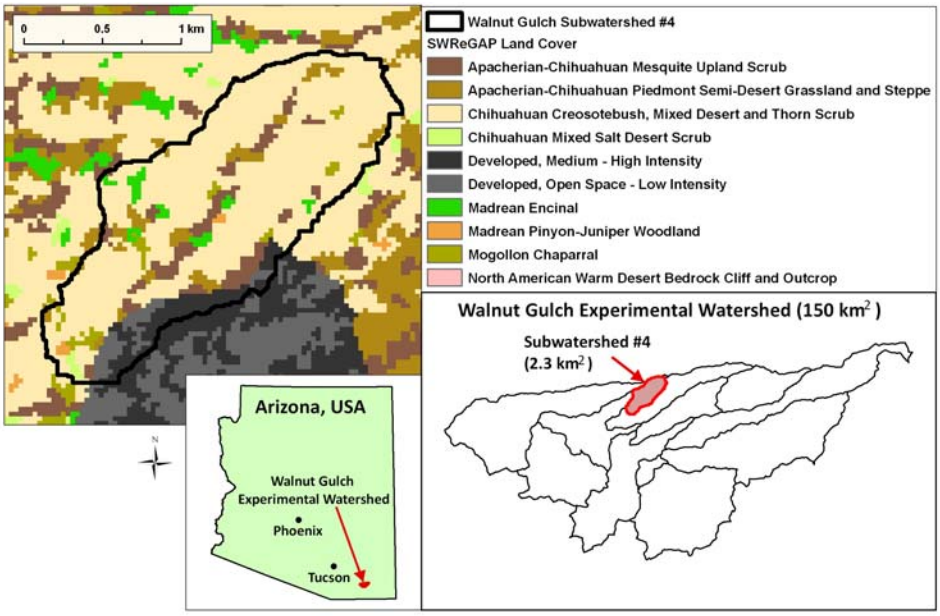
The Conservation Effects Assessment Project (CEAP)-Grazing Lands national assessment is designed to quantify the environmental effects of conservation practices on U.S. non-Federal grazing lands. The assessment includes science-based estimates of expected environmental effects of installed conservation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

As part of this effort, scientists with the Agricultural Research Service Southwest Watershed Research Center in Tucson, AZ, simulated results of brush removal and grass seeding on brush-infested rangeland in southeastern Arizona. They used AGWA/KINEROS2 [1] simulations on Walnut Gulch Experimental Subwatershed #4 before and after brush removal and reseeding to grassland. Walnut Gulch is approximately 150 km^2 (37,070 acres), and Subwatershed #4 is approximately 2.3 km^2 (572 acres). Subwatershed #4 was selected because it is primarily Chihuahuan creosotebush, mixed desert and thorn scrub (fig. 1).

The Southwest Regional Gap Analysis Project (SWReGAP) land cover dataset (circa 1999–2001: http://earth.gis.usu.edu/swgap/) was used as a basis for defining land cover for the watershed. A "new" grassland class was created for this simulation, based on existing grassland classifications and the KINEROS2 manual, which specifies a decrease in interception of rainfall and increases in cover and roughness

[1] KINEROS2 is a watershed rainfall-runoff-erosion model. The AGWA (Automated Geospatial Watershed Assessment) tool uses commonly available, national GIS data layers to develop geographic data layers for the SWAT (Soil and Water Assessment Tool) and KINEROS2 models. By employing these two models, AGWA can conduct hydrologic modeling and watershed assessments at multiple temporal and spatial scales.

Figure 1. Subwatershed #4 with original SWReGAP land cover classes



(Manning's N) (table 1). It was assumed that the entire watershed area was successfully converted to grassland with the characteristics displayed in table 1.

Simulations were performed using a 5-year, 30-minute rainfall event. Results indicated that large decreases in peak flow (mm/hr) (fig. 2), peak sediment yield (kg/s), and average annual runoff (m^3/s) would be expected to occur after the watershed was converted to grassland. Percent change in peak flow is illustrated in figure 3 for streams and adjacent uplands. Simulations suggest that reductions in peak streamflow would range from 72 to 98 percent, and reductions in peak overland flow, from 21 to 81 percent.

Percent change in average annual runoff (m^3/s), sediment yield (kg/ha), and peak sediment yield (kg/s) are illustrated in Figures 4, 5, and 6 respectively. Establishment of grasses would reduce average annual runoff from uplands by 35 to more than 90 percent, average annual instream sediment yield by 85 to 99 percent, average annual sediment loss from the landscape by 44 to 97 percent, peak sediment discharge to streams by 79 to 99 percent, and peak sediment discharge from the landscape by 34 to 96 percent.

The Land Cover Modification Tool in AGWA was used to change the land cover from Chihuahuan creosotebush to Grassland in Subwatershed #4. This tool allows the user to change an entire polygon or a specific land cover from one type to another. A percentage of success in converting one land cover type to another can also be specified. Using the tool and the hydrologic models in AGWA (KINEROS2 or SWAT), impacts to runoff, infiltration, sediment yield and peak flows can be simulated before and after land cover change.

This type of analysis provides land managers with the ability to determine which areas are better suited for land cover modification for management purposes such as brush management for fire control or grazing land improvement as well as the spatial location and magnitude of the consequences of the conservation practices.

Table 1. SWReGAP land cover characteristics for brush and grassland

Cover type	Cover	Interception of rainfall	Roughness
	percent	*mm*	*Manning's N*
Chihuahuan creosotebush, mixed desert, and thorn scrub	25	3.00	0.055
Grassland	50	2.80	0.150

Figure 2. Subwatershed #4 Peak flow (mm/hr) for Chihuahuan creosotebush vs. grassland

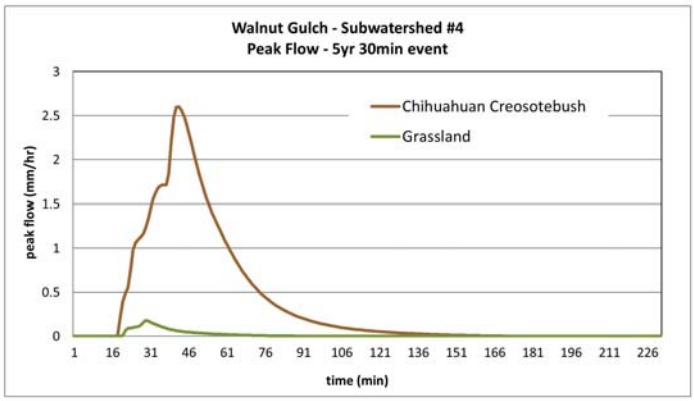


Figure 3. Subwatershed #4 percent change in peak flow (mm/hr) from Chihuahuan creosotebush to grassland

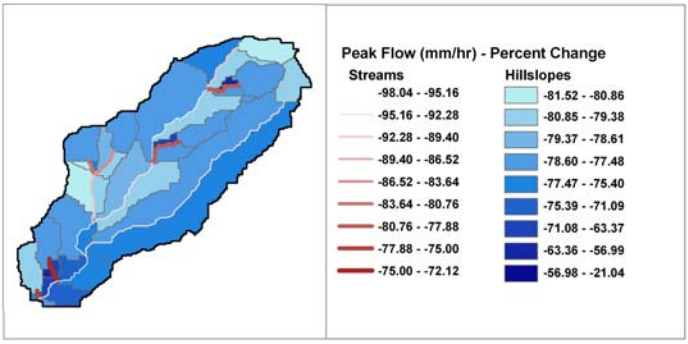


Figure 4. Subwatershed #4 percent change in average annual runoff (m^3) from Chihuahuan creosotebush to grassland

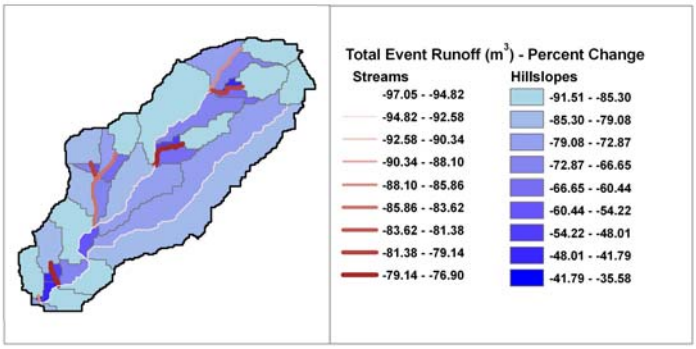


Figure 5. Subwatershed #4 percent change in sediment yield (kg/ha) from Chihuahuan creosotebush to grassland

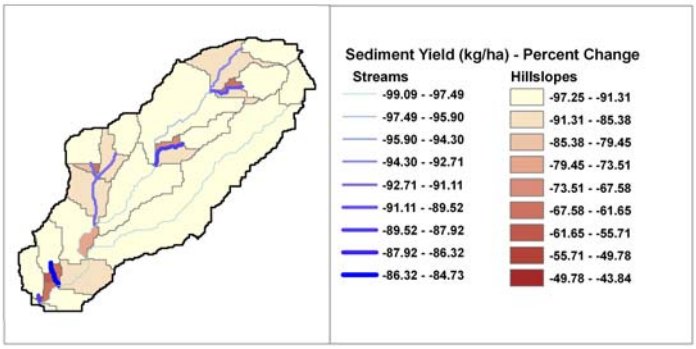
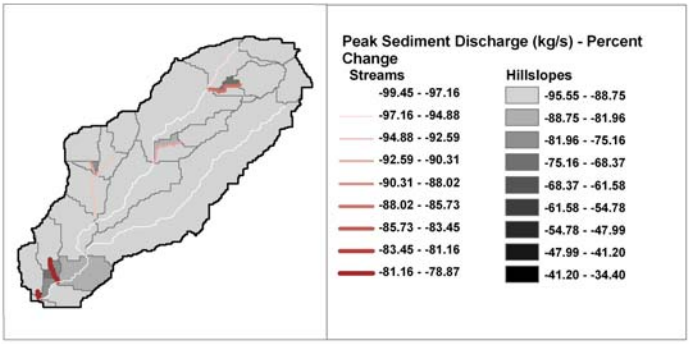


Figure 6. Subwatershed #4 percent change in peak sediment yield (kg/s) from Chihuahuan creosotebush to grassland



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.

The CEAP-Grazing Lands national assessment is designed to quantify the environmental effects of conservation practices on U.S. non-Federal grazing lands. The 584 million acres of non-Federal grazing lands in the contiguous 48 states are composed of 409 million acres of rangeland, 119 million acres of pastureland, and 56 million acres of grazed forest land.

Development of CEAP Grazing Lands must address a number of unique challenges that are typically not present on croplands at management scales. Grazing lands typically have more diversity in climate (especially precipitation), soils, and topography than does cropland. Management practices and their effects are less precise and less well defined, making the results of specific studies more difficult to extrapolate. There are three scales of investigation for CEAP-Grazing Lands. Ecological sites will be used to stratify assessments at all three levels for the rangeland portion.

Study findings were provided by Dr. David Goodrich and Dr. Mark Nearing, ARS Southwest Watershed Research Center, Tucson, AZ.; 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/

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