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Reference File No. 116.65

Pacific Southwest Forest and Range
Experiment Station - Berkeley, California
Forest Service - U. S. Department of Agriculture

U. S. FOREST SERVICE RESEARCH NOTE PSW-29 1963

"FIRST AID" FOR BURNED WATERSHEDS

By

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ABSTRACT: Most of the vegetative cover on the San Dimas Experimental Forest was destroyed by a wildfire in 1960. Following the fire an emergency research program was initiated to test several "first-aid" treatments aimed at reducing flood and erosion damage from burned watersheds. This paper summarizes first- and second-year results of the research program.

Wildfires destroyed more than 70,000 acres of brush-covered watersheds in the San Gabriel Mountains in July 1960, and about 15,000 acres of the San Dimas Experimental Forest[1] were burned in one fire. Burned southern California watersheds have long had a reputation for extreme erosion rates (fig. 1) and high flood discharge records. Consequently, after that disastrous month, an emergency research program was started on the experimental forest to test several "first-aid" treatments. These treatments are aimed at reducing the flood and erosion damage that usually follows fires in these steep mountains. This note presents quantitative data[2] on peak discharges and debris production to augment the qualitative results previously published,[3] and presents second-year results of the research program.

1/ Maintained by the Forest Service, U. S. Department of Agriculture, in cooperation with the State of California, Department of Conservation, Division of Forestry.

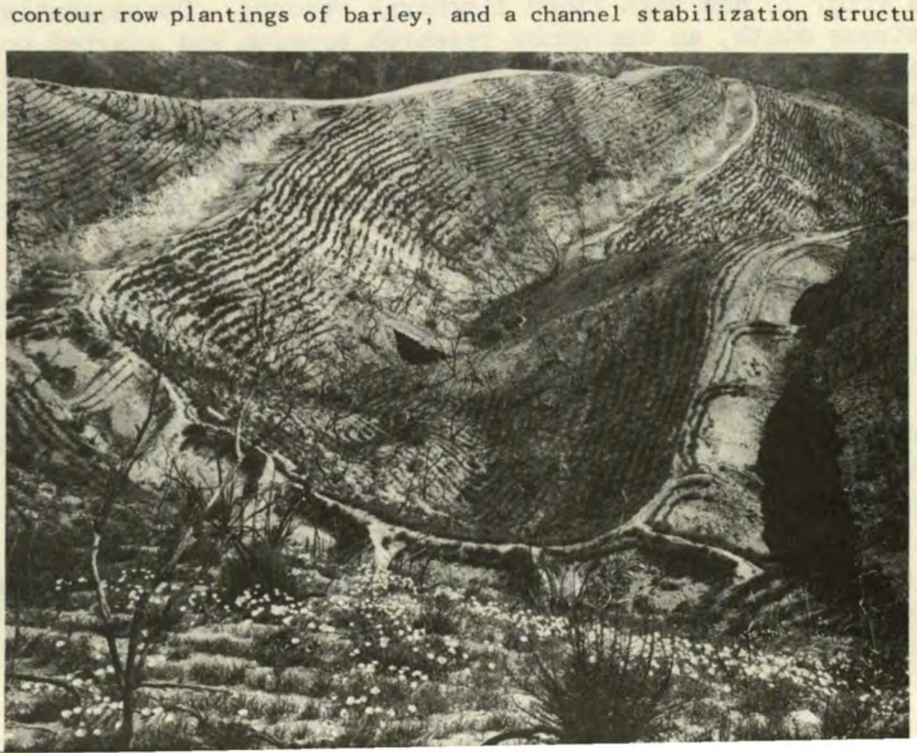
2/ Summarized from: Rice, R. M., Crouse, R. P., and Corbett, E. S. Effectiveness of emergency erosion control measures following fire on the San Dimas Experimental Forest. (Paper presented at the Federal Inter-Agency Conference on Sedimentation, Jackson, Mississippi, Jan. 28-Feb. 1, 1963.)

3/ Crouse, R. P., and Hill, L. W. What's happening at San Dimas? U.S. Forest Serv. Pacific SW. Forest & Range Expt. Sta. Misc. Paper 68. 6 pp., illus. 1962.

Figure 1.--Material deposited in a debris basin during the rainy season of 1961-62 is removed to maintain storage capacity.

Figure 2.--Crew loads seed hoppers for broadcast sowing of grass on experimental watersheds.

Figure 3.--An experimental watershed that contains contour trenches, contour row plantings of barley, and a channel stabilization structure.



TREATMENTS

The methods under study include broadcast seeding of annual and perennial grasses (fig. 2), large contour trenches, small channel stabilization dams, and contour row plantings of barley (fig. 3). Twenty small (2- to 8-acre) gaged watersheds make up the study areas.

A mixture of annual grass seed, the most widely used "first-aid" treatment in southern California, was broadcast on the watersheds at two rates: 20 pounds per acre and 2.25 pounds per acre. Ryegrass (Wimmera 62 ryegrass, *Lolium rigidum*) and Blando brome (*Bromus mollis*)were the annual grasses sown.

Deep-rooted perennial grasses, often suggested for erosion control purposes, were sown at rates of 4 pounds per acre and 18 pounds per acre. Hardinggrass (*Phalaris tuberosa* var. *stenoptera*) and pubescent wheatgrass (*Agropyron trichophorum*) were the dominant deep-rooted perennials in the mixture.

TREATMENT EFFECTS ON PEAK STORMFLOW

Four storms (table 1) produced sizable peak stormflows during the 1961-62 rainy season (table 2).

Seeding effects.--Owing to scanty and poorly distributed rainfall in 1961, the first seeding after the fire failed to produce appreciable ground cover. The study watersheds were seeded again in 1961, before the next rainy season. By the time of the last big storm in February 1962, perennial grass seeding had produced only about 1 percent ground cover; low rate of ryegrass seeding, about 4 percent; and high rate of grass seeding, about 8 percent.

The perennial grass watersheds had been sprayed with herbicidal chemicals to reduce brush competition as an aid to grass establishment. The spraying reduced native vegetation; this effect combined with the lack of perennial grass cover led to high flood peaks from these watersheds.

Broadcast seeding, on the whole, failed to reduce flood peaks from the 1961-62 storms. An effective grass cover had not established itself by the time of the last storm.

Contour trenches.--Large contour trenches were designed to provide storage for about 3 inches of rainfall. During the November 30 storm, rainfall exceeded storage capacities of the trenches for the first time, and failures occurred. Sometimes individual trench basins failed when the berms softened and settled below the level of the drainage system. When a basin overtopped, water moved downslope to the trench below; a chain reaction of failures usually followed, producing high peak flows.

Table 1.--Rainfall intensities and amounts for major storms

Storm date	Maximum intensity with duration (minutes) of-- 5	10	15	20	30	60	Total storm precipitation
	Inches per hour						Inches
November 20, 1961	2.16	1.70	1.38	1.21	1.16	0.99	2.47
November 30, 1961	1.80	1.32	1.09	.96	.91	.73	4.58
January 20, 1962	1.38	1.10	.92	.82	.79	.70	4.75
February 7, 1962	1.59	1.24	.96	.81	.63	.39	9.27
February 9, 1963	1.32	.96	.88	.72	.72	.72	6.05

Table 2.--Maximum peak stormflow observed in hydrologic year, October 1, 1961 through September 1962

Seeding treatments	No physical treatments	Contour trenches	Channel stabilization	Contour plantings	Mean response
	Cubic feet/second/acre				
No broadcast seeding	2.1	1.7	1.2	3.8	2.2
Low rate of annual grass	6.0	1.6	2.8	1.1	2.9
High rate of annual grass	2.5	1.4	3.3	1.8	2.2
Low rate of perennial grass	3.6	7.4	7.7	2.5	5.3
High rate of perennial grass	3.9	.7	3.0	1.8	2.4
Mean response	3.6	2.6	3.6	2.2	3.0

Channel stabilizing dams.--Most of the channel stabilizing structures reached their design capacity as they filled with debris during the first two storms. Experimental watersheds with these dams produced higher peak flows than those with the other physical treatments. The increase in peak stormflow is possibly due to the reduced channel roughness and shortened channel length caused by deposition between structures.

Contour plantings.--This treatment planted barley (Hordeum vulgare var. Atlas) with fertilizer in rows at 2-foot contour intervals along the slope. The rates used were 150 pounds per acre of barley and 140 pounds per acre of diammonium phosphate. Growth of the barley was excellent, and the multiple barriers created by this treatment were effective in preventing appreciable surface runoff. The barley watersheds had the lowest stormflow peaks.

TREATMENT EFFECTS ON DEBRIS PRODUCTION

Of these rehabilitation measures, the physical treatments produced the most striking contrasts in total annual debris production (table 3). Debris yields were:

Treatment	Cubic yards per acre
None	30
Channel stabilization	19
Contour-trench	13
Contour-planting (barley)	10

These figures include a correction, not applied in table 3, for physical differences between watersheds in each treatment.

Table 3.--Total debris produced during the hydrologic year, October 1, 1961 through September 1962

Seeding treatments	No physical treatments	Contour trenches	Channel stabilization	Contour plantings	Mean response
			Cubic yards/acre		
No broadcast seeding	29.0	16.7	13.8	9.9	17.4
Low rate of annual grass	39.7	1.8	25.4	5.8	18.2
High rate of annual grass	31.4	6.7	8.4	9.1	13.9
Low rate of perennial grass	35.6	26.6	26.4	8.6	24.3
High rate of perennial grass	26.0	6.9	23.3	8.7	16.2
Mean response	32.3	11.7	19.5	8.4	18.0

The distribution and amount of rain and the lack of abundant deep soils appear to limit the use of perennial grasses as an emergency erosion control measure. This treatment was associated with a debris reduction of only 4 percent. High-rate ryegrass, which averaged 8 percent cover, was associated with about a 16 percent reduction in debris yield.

When a fire denudes large areas, a land manager usually tries to establish a temporary vegetative cover. The fact that broadcast seeding is an inexpensive treatment probably justifies its use even though low rainfall years may limit seeding success.

SECOND-YEAR RESULTS

The first-year results indicated that contour trenching may not be a satisfactory flood control measure for our steep slopes; that is, the trenches could not be spaced closely enough to provide adequate storage for runoff from large storms. But to continue the evaluation, repairs and maintenance work were undertaken during the summer of 1962. Three of the trenched watersheds were rebuilt and two were left in their existing condition. We will continue to study the effects of this treatment as an erosion control measure.

The 1962-63 rainy season in southern California started out to be one of the driest on record. By the second week in February the seasonal total at our Tanbark Flats headquarters was a scant 1.26 inches. Since the 1890's, only a few other years had so little rainfall. Through the end of May the study area received about 14 inches of rainfall (50 percent of normal). Only one storm produced any significant amount of runoff (table 4). The treatments appear to be following the same trends as established during the previous year.

SUMMARY

The results of post-fire rehabilitation on the San Dimas Experimental Forest so far look like this:

1. Perennial grasses did not appear to be suited as an emergency remedial treatment. They were the least effective in reducing peak flows and debris yields.
2. Annual grasses had little effect on moderating peaks but may have resulted in a 16 percent reduction in debris.
3. Channel stabilization structures had a lesser effect in reducing peak flows than the other physical treatments but accounted for about a 35 percent reduction in debris yields.
4. Because of steep topography, contour trenches could not be spaced closely enough to provide sufficient storage for runoff from large storms. Despite their weakness in reducing peak flows, contour trenches accounted for a 60 percent reduction in debris.

5. Contour row plantings of barley have been the most successful treatment for reducing both peak flows and debris yields. This treatment showed a 65 percent reduction in debris yields.

Table 4.--Maximum peak stormflow observed during the hydrologic year, October 1, 1962 through September 1963

Seeding treatments	No physical treatments	Contour trenches	Channel stabilization	Contour plantings	Mean response
	Cubic feet/second/acre				
No broadcast seeding	0.06	1/ 0.24	0.07	0.28	0.16
Low rate of annual grass	.92	.13	.06	.13	.31
High rate of annual grass	.12	1/ .10	.27	0	.12
Low rate of perennial grass	1.30	.86	.37	.27	.70
High rate of perennial grass	1.41	1/ .04	.51	.33	.57
Mean response	.76	.27	.27	.20	.37

1/ Contour trenches repaired.