Water and soil

A water-measuring weir and a basin to collect the stream soil load were installed in the canyon where all surface water leaving the area could be measured.

The water measurements have been inconclusive, due principally to the underlying fractured rock formation, which causes much of the flow to run subsurface where it cannot be measured by the channel weir. This is most pronounced during low discharge where the channel flow does not reach the measuring structure. Well drillings indicate, however, that subsurface flow is close to the surface during much of the year.

The change of vegetation from trees and brush to herbaceous ground cover has resulted in very little erosion disturbance. Because this watershed's subsurface structure is porous, the surplus moisture is not retained in the soil mantle; thus, soils do not become saturated with water, and soil movement is minimized. Likewise, the increase in available water is not expressed as visible stream flow. A good stand of forage species has been maintained in the area by applying phosphorus and sulfur when nutrient needs were indicated. This has resulted in a high rate of productivity for livestock use, maximizing the production efficiency of this grazing land while minimizing soil disturbance.

WATERSHED II

Watershed II is a 210-acre drainage basin that has a west-facing orientation and drains directly into the Russian River. Elevations range from 600 to 1,300 feet. The pre-treatment vegetation consisted of approximately 13 acres of grass; 49 acres of mixed grass and deciduous oak trees; 125 acres of black oak, live oak, blue oak, and madrone; and 23 acres of brush, principally chamise and chaparral. The soils consisted of eight series: 28 percent Sutherland-Laughlin complex, 1 percent Sutherland, 4 percent Laughlin, 46 percent Josephine, 8 percent Yorkville, 3 percent Los Gatos, 9 percent Maymen, 1 percent Montara. The soils, several feet thick, are over sandstone and shale rock of the Franciscan formation. The formations are typical of coastal mountain ranges--extremely shattered and jointed, with intrusions of basic rock and interlaced with faults.

In the lower part of the watershed, near the gauging station, sediments of varying depths are present adjacent to the channel, which appears to be oriented along a fault line. The sediments are well consolidated and have low permeability.

The study on this area began in 1952 when the watershed was fenced as a unit, and a weir and settling basin were installed for measuring runoff and erosion. Other instruments to measure precipitation, soil moisture, and ground water levels also were installed.

Objectives

The vegetative change in this watershed was gradual compared with the rapid change in Watershed I. The management program involved three phases: pre-treatment monitoring, or calibration (September 1952 to December 1959); chemical treatment of trees, seeding, burning, and reseeding (December 1959 to September 1965); post-treatment monitoring (September 1965 to present).

Vegetative treatment

The trees were killed by placing 2,4-D amine in surface cuts around the base of the trees. Deciduous trees treated in December and January, for the most part, did not come into leaf in the spring; however, those treated later did leaf out but lost most of their leaves before September. The evergreen trees--live oak and madrone--gradually lost their leaves and were bare within a year following the treatment. Many of the smaller limbs fell during the first winter after treatment. Three years later many of the live oak trunks were well rotted and were falling. Five years following treatment, over 50 percent of the trees had fallen, and a heavy litter of tree material lay on the ground, making access through the area difficult for man and livestock.

Tree density in the area varied from approximately 150 to 700 stems per acre. The cut surface treatment cost from $2.54 per acre for 3-inch-diameter black oaks to $11.50 per acre for 11-inch-diameter live oaks.

With the opening of the overhead tree canopy, herbaceous cover developed rapidly. To increase the ground cover and improve forage quality under killed trees, the watershed was seeded by aircraft in November 1959, just before the start of the tree treatment. The seed mixture consisted of Mt. Barker subclover and lana vetch at 4 pounds each per acre, crimson clover at 1 pound per acre, and hardinggrass at 1/2 pound per acre. At the same time, to control rodent use of these seeds, cracked grain and yellow sweet clover seeds were treated with 1080 and applied at a rate of 1 pound per acre as a rodenticide.

The rainfall pattern during this growing season was not favorable for the legume growth, resulting in only a fair stand of sub and crimson clover. Lana vetch, however, became established and persisted throughout the area until the burn in 1965 when vetch was again seeded. Some hardinggrass persisted from this application but mostly as widely scattered plants.

Changes resulting from tree treatment

During the 5 years from the start of the tree treatment until the burning, sheep use increased from approximately 56 animal unit months to approximately 208 animal unit months. In the same period, forage production increased from 930 pounds per acre to 2,850 pounds per acre.

Stream flow was another positive change. During the calibration phase, the stream flow ceased as early as April 30 and as late as July 7, depending on the seasonal rainfall.

The stream has flowed continuously since the trees were treated. It is estimated that the removal of woody plant cover has increased the runoff an average of 50 percent because of reduced interception and transpiration by the trees. Research on oak tree rooting depth indicates that they extend their roots to 70 feet, thus having a wide area from which to extract moisture. The replacement vegetation, mostly grasses and other herbaceous plants, are relatively shallow rooted and extract moisture from a much reduced area.

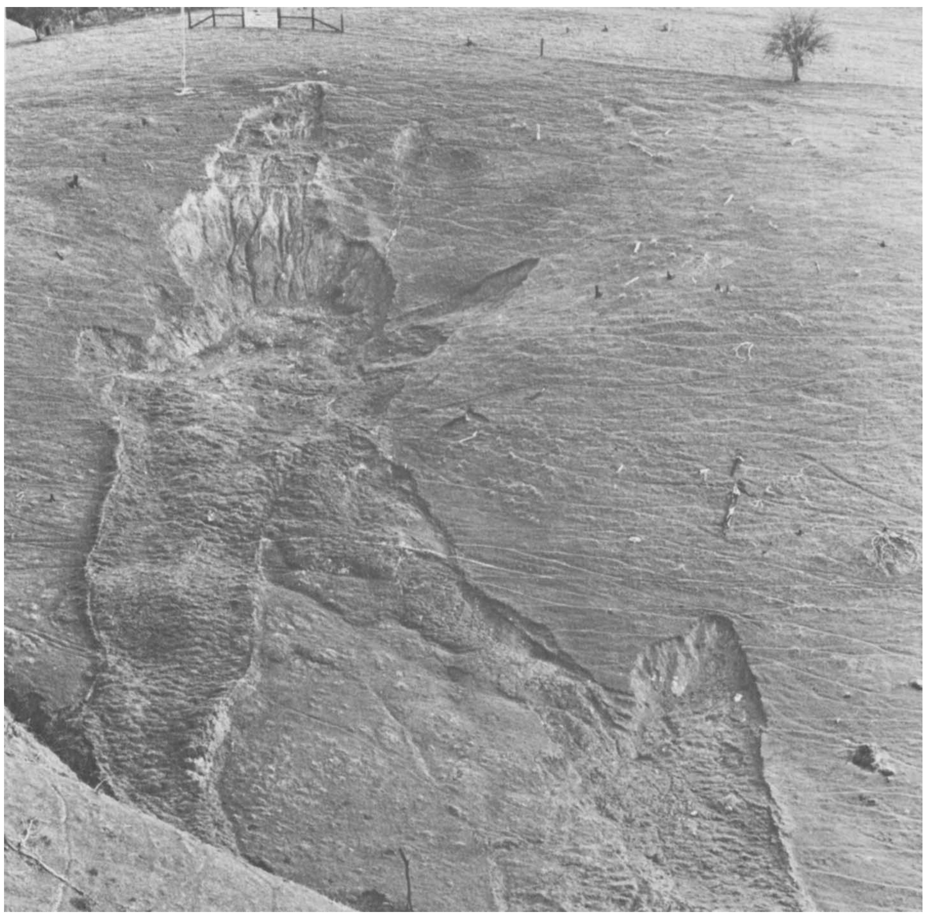
Burning

By 1964 enough trees had died and fallen to suggest that the area was ready for burning and reseeding. Sheep were withheld from the area during the 1964-65 grazing season, because experience had indicated that better burning could be achieved if a good cover of grass was available to carry a fire. The burning, done in late July, distributed ash over much of the area, providing good conditions for seeding of forage species.

Seeding

During the last week of September, the area was seeded by aircraft to 2 pounds of hardinggrass, 2 1/2 pounds of blando brome, 1 pound of Palestine orchard, 1/2 pound of smilo, 2 pounds of Mt. Barker subclover, 1 pound of rose clover, and 1 pound of lana vetch per acre for a total of 10 pounds of seed per acre. The legumes were lime pellet inoculated before seeding. Two weeks in advance of seeding, 300 pounds of 1080-treated oat groats were applied to the area by aircraft to control seed-eating rodents.

The first rains to initiate germination did not occur until November, and low temperatures caused slow development of the seeded materials. By the first spring following the seeding, a good vegetative cover was achieved to ensure soil stabilization. Sheep grazing was started in



Landslides are common in one watershed study area but not the other, indicating that characteristics of certain soils make them more prone to slippage.

the area by May 22 and continued throughout the summer until the fall rains commenced. Grazing was delayed until May to allow the seeded species to become well established and to set seed. The summer and early fall grazing resulted in good use of the sprouting brush species, thus holding their growth down to where it could be grazed.

The increase of herbaceous vegetation as a result of seeding and removal of trees retards runoff during storms and has nearly doubled the base time of the water flow.

Removing woody plant cover and adding grasses removes the soil reinforcement provided by the tree root systems; increases seasonal runoff, streamflow peaks, suspended sediment, bank scouring and cutting, and bedload; causes piping and subterranean erosion from decaying tree roots; raises soil moisture (saturated zone may reach soil surface); and increases seepage. The removal of the mechanical reinforcement provided by the root system of the woody plants alone may cause landslides if the safety factor is at or near the critical state under this cover.

Before the application of vegetative treatments, Watershed II soils were essentially stable. No massive soil movements were observed, even with periods of heavy precipitation. Throughout the region there is evidence of older massive soil movements generally associated with less densely vegetated areas.

During the treatment and post-treatment period (1959-70), 61 soil slips have occurred. All landslides were near stream channels. In most cases, bank cutting preceded the landslides. Minimum slope gradients on which landslides occurred were approximately 45 percent, and the number of slips was directly proportional to the amount of rainfall. No firm conclusions can yet be made regarding critical slopes and soil moisture contents. There is evidence that creep deformation is under way in a number of sites and the critical slope under saturated soil conditions can be expected to be below 45 percent. Mud flows observed at certain sites may be associated with the many land tremors that occur daily in this area. If the soil is saturated, shocks produced by tremors are transmitted directly to pore water and liquefaction may occur.

Sedimentation from Watershed II averaged approximately 400 tons per year during the calibration period, but increased to 4,000 tons per year following conversion. Runoff also increased. Sedimentation and soil slippage in the vicinity of streams increased, particularly after the root systems of woody vegetation on the slopes of these streams decayed.

Runoff was highly correlated with total precipitation. Once annual vegetation became established, herbaceous crop cover and botanical composition of the vegetation exerted only negligible influences on total runoff.

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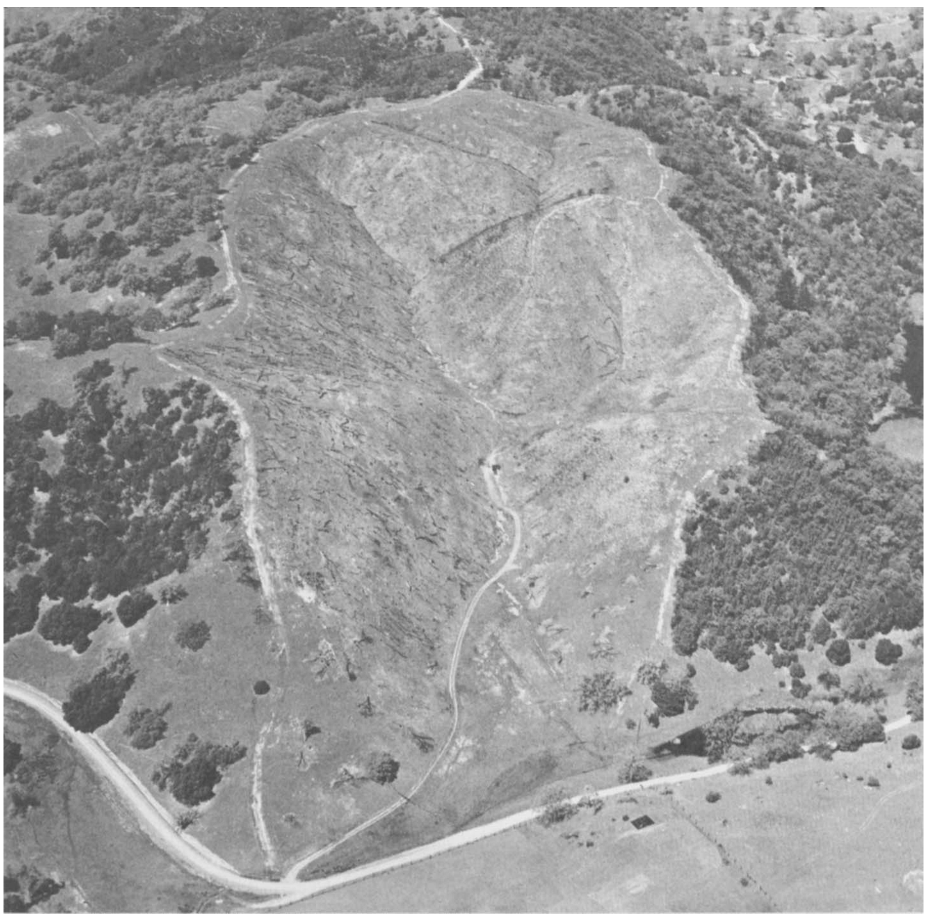

Tree and brush removal from watershed areas allows researchers to study the advantages and disadvantages of such practices.