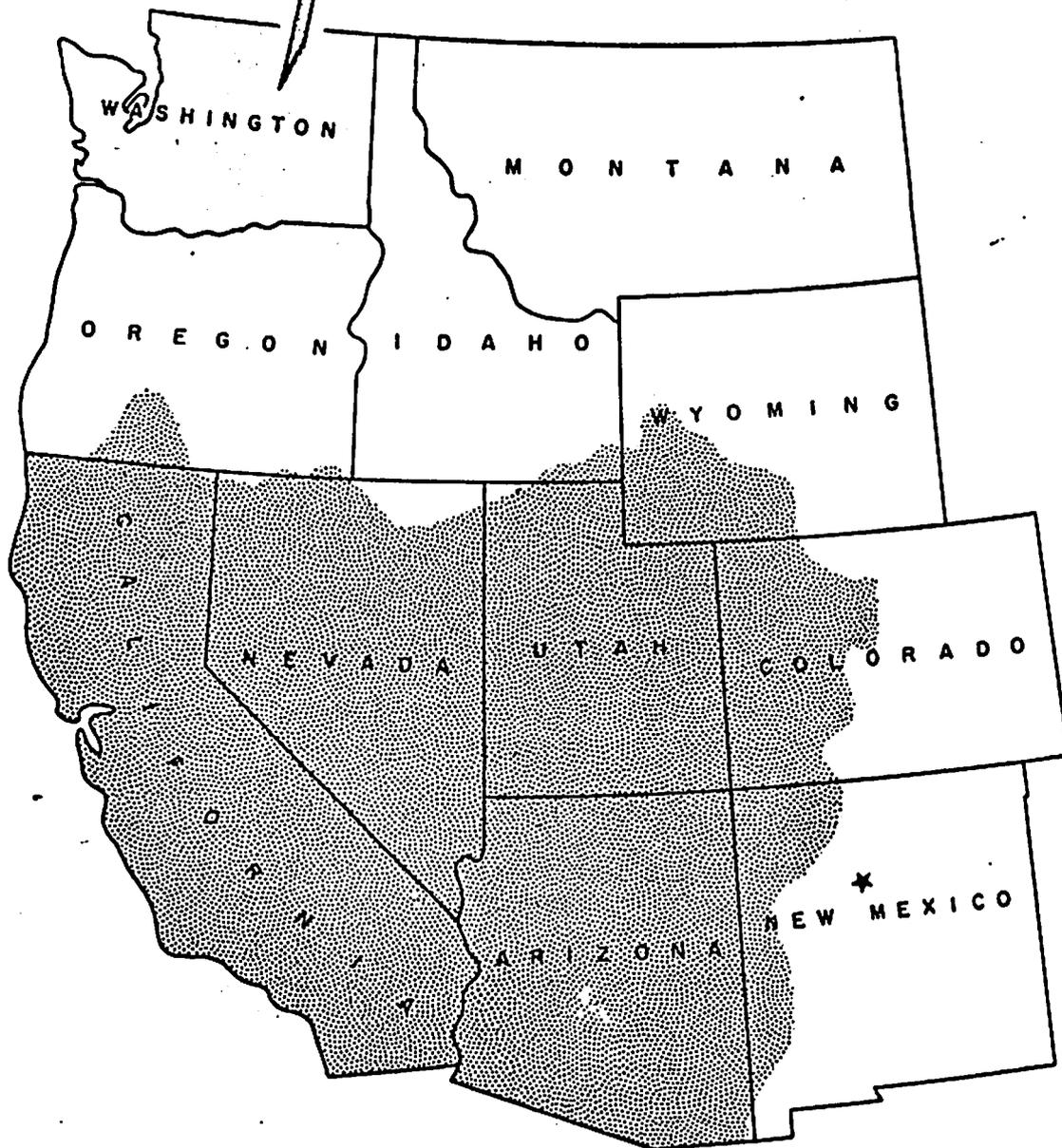


Pacific Southwest INTER-AGENCY COMMITTEE

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SEDIMENT STUDIES UNDERWAY IN THE PACIFIC-SOUTHWEST, BY THE
AGRICULTURAL RESEARCH SERVICE, USDA

by

K. G. Renard and R. B. Hickok.

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Semiarid Rangeland Watersheds, Arizona and New Mexico

Sediment studies are being carried on in three concurrent phases, all of which are integral parts of a comprehensive semiarid rangeland, watershed hydrology research program. One phase deals with sediment production on experimental plots and small unit-source area watersheds. A second phase deals with sediment yields of complex watersheds. The third phase deals with geomorphology and geologic sedimentation as related to present sediment problems. While other aspects of the watershed hydrology studies have been underway for some time, the sedimentation phases have been started in the past three years.

The Southwest Rangeland Watershed studies are being conducted mainly on the Walnut Gulch Experimental Watershed, which is a 57 square mile ephemeral tributary to the San Pedro River in Southeastern Arizona. Approximately 2/3 of the 14 inch annual rainfall occurs as high intensity convective thunderstorms during July, August, and September. It is during this period that essentially all of the runoff and erosion occurs. Elevations in the watershed, which supports a mixed grass and brush cover, range from 4,000 feet at the outlet to about 6,000 feet at the highest point.

The studies also include four small watersheds (up to 700 acres) near Safford, Arizona and three small watersheds (up to 183 acres) west of Albuquerque, as well as the 67 square mile Alamogordo Creek Watershed east of Santa Rosa, New Mexico.

Experimental Plots and Unit-Source Area Watersheds:

Note: Unit-source watersheds are natural watersheds with hydrologically uniform soils, vegetation, and geology, and small enough to receive generally similar precipitation over their entire area.

Objectives:

1. To evaluate effects of various soil-vegetation complexes and, for each, the effects of climatic factors and topographic features and sediment production.

2. To investigate effects of grazing practices, brush clearing, reseeding rangeland, etc., on sediment production.
3. To develop criteria for judging potential production of sediment source areas on the basis of soil erodibility and infiltration capacity, cover of vegetation, and topographic features, and climatic factors.
4. To determine the volume of sediment retained by stock ponds, as related to sediment yields from complex watersheds.

Sediment measurements from plots and unit-source watersheds are obtained either by using manual and automatic sediment samplers in conjunction with volumetric measurement of the runoff and/or measurements of deposited sediments in stock tanks which are instrumented for runoff inflow-outflow measurements.

Progress:

Although insufficient runoff data are presently available for comparisons of water yields from unit-source watersheds on Walnut Gulch with instrumented stock tanks, with respect to cover of vegetation, measurements of longer period deposits of sediments in the beds of the ponds show a strong relation of annual sediment yields to the basal area of grasses on the watersheds. Depth-integrated samples of suspended sediment in the runoff from one of these watersheds having comparatively good grass cover were found to be slightly over one percent, by weight, of the total runoff. This correlates well with the accumulated deposits and estimated total inflows.

Analysis of sediment production from 48 experimentally treated plots are, to date, inconclusive because of the short period of their record (now in second year).

Plans:

Schumm and Lusby (1) found on arid-semiarid hillslopes in Colorado, that seasonal changes in infiltration capacity control the rate of erosion, and also significantly affect the hydrologic characteristics of small drainage basins. On Walnut Gulch similarly variability is observed in runoff from unit-source areas because of changes in the amount of water retained by the soil mantle. Changes in the soil surface are being followed to evaluate

(1) : Schumm, S. A. and Lusby, G. C. 1963. Seasonal variation of infiltration capacity and runoff on hillslopes in western Colorado. *Journal Geophysical Research* 68 (12) 3655-3666.

some of the characteristics of the soil surface which may bear a relation to infiltration capacity, and therefore runoff and erosion. Three-eighths-inch reinforcing steel rods have been placed at 100 foot intervals up each drainage and two ridges in the Lucky Hills on the Walnut Gulch Watershed. Each stake was inserted so that one foot remained above the soil surface. The markers are being measured monthly and after each storm to estimate the erosion and deposition.

Sediment Transport and Channel Stability on Complex Semiarid Watersheds:

Objectives:

1. To determine the relation of upstream sediment production to the stability of downstream channels and the net sediment yield of complex watersheds.
2. To relate channel stability to pertinent hydraulic and geometric parameters, and mechanical properties of the stream bed and bank materials.
3. To develop improved methods of predicting net sediment yields based on evaluation of watershed and climatic factors.

The channels of the Walnut Gulch Watershed contain unconsolidated sand and gravel deposits of various depths overlying conglomerate bedrock. The geometric mean grain size of the bed material (an average of many samples) is 2.3 mm. and the geometric standard deviation is 3.65, indicating a large mean grain size with a wide range of particle sizes. Channel gradients throughout the mainstream and major tributaries of the watershed are approximately one percent.

Because of the "flashy" nature of ephemeral streams (rapidly changing stage and high velocities), good samples of suspended sediment are difficult to obtain. During the past three years fluvial sediment samples have been collected on the Walnut Gulch Experimental Watershed from fixed (single stage) samplers and by using depth-integrating samplers when possible. On larger flows, depth-integrated samples have been collected only at one section on the mainstream (at Flume No. 6), using a D-49 sampler from a cableway. This season a "bottle wheel" automatic pump-type sampler, developed by the inter-agency project at St. Anthony Falls, Minnesota, is being test operated at Flume No. 6.

Progress:

Sufficient samples have not as yet been collected or analyzed to develop sediment rating curves nor to determine the suspended sediment load associated with the individual hydrographs. Suspended sediment samples collected in the mainstream of Walnut Gulch have been found to vary between 2 and 8 percent by weight. Unfortunately,

these results have been confined so far to relatively small discharges. The following are indications from the samples analyzed to date:

1. The sediment peak precedes the hydrograph peak.
2. The sand load is relatively low on the samples collected before the hydrograph peak, and from the peak on is higher and seems to be more closely related to the actual discharge than are the small fractions.
3. Silt load is heavy at the sediment peak and drops off thereafter, i. e., clay to silt ratio rises after the sediment peak.
4. Correlation of consecutive depth-integrated samples is very good when the stage is not fluctuating rapidly.
5. The majority of the fixed samples on the main channel appear to agree well with the depth-integrated samples taken during the same period.
6. There is a considerable increase in the percentage of clay for samples taken in the mainstream as compared to samples taken upstream (stock pond No. 20) in the good grasslands. Greater gullying on other areas and bank erosion along the main channels are probably responsible for this increase.

Plans:

Future sampling will be directed toward the development of sediment rating curves at Flumes 6 and 1 on Walnut Gulch Experimental Watershed (drainage areas of 37- and 58-square miles, respectively), and toward evaluating differences in the sediment makeup from various portions of the watershed. Single stage samples augmented by wading samples taken using a D-48 hand sampler will be collected from the smaller tributaries.

Studies are underway to determine the feasibility of using the interagency automatic pumping sampler in western ephemeral, sand-gravel bed streams. A pumping sampler was installed above Flume 6 in April 1964 with an intake located at the channel's edge, one foot above the bed. Results from samples obtained from this sampler have not been analyzed to date.

A heavy mineral analysis is planned to determine the source of the sediments in the watershed. This program will require sampling the channels for their entire length and a subsequent correlation with the heavy mineral analysis of the fluvial sediment samples.

Channel aggradation and degradation is being checked at permanent cross sections for both gaged and ungaged tributaries, as well as one channel reach on the main stream between gaging stations 2 and 6. Results to date are inconclusive, but they show considerable bank erosion on larger flows where the bank is formed from unconsolidated materials.

The sediment sampling program on the Alamogordo Creek Watershed is being accelerated since the vacancy in the resident engineer's position was filled this past July. Also, channel stability studies are underway on this watershed, in cohesive valley-fill materials.

Relation of Geologic Sediments and Stratigraphy to the Sediment Yields of Semi-arid Watersheds:

Objectives:

1. To determine the sources of sediment, both past and present, and their relative contributions to existing valley deposits.
2. To determine paleoclimatic and geomorphic influences on the structure and present stability of the various rock and soil types as related to sediment production and stream channel stability.

The sources of sediments, both past and present, have been multiple. Their relative contributions are being determined by a petrographic heavy mineral study and other systematic laboratory studies. Heavy mineral studies on the various soil exposures will aid in explaining the extensive variation of soil types, and will aid in determining their rates of weathering and erosion.

Progress:

From limited work to date, the following general statement can be made: The San Pedro Valley is of Middle Pleistocene geologic age. Deposition occurred on flat, low-energy floodplains that contained local swamps and lakes. The paleoclimate was cool and humid. These conditions affected the degree of chemical weathering and resulted in fine breakdown of the complex lithology. Thus, fine-grained sediments make up the bulk of the valley fill. A period of erosion stripped an unknown amount of sediment prior to deposition of younger gravels. Following this cycle, alluvial fans deposited extensive coarse-grained sands and gravels. These cycles of geologic erosion and deposition have a strong influence on present sediment sources and channel stability. Their understanding enters into any scientific understanding of existing sediment control problems.

Southern Pacific Coast Studies

Sediment studies were undertaken on the Calleguas Watershed in Ventura County, California during the past year. Extensive private and public efforts have been made on this watershed over the past 30 years to reduce severe erosion and sediment deposition damage, and current plans for dredging and protection of downstream channel reaches are estimated to cost approximately \$10 million.

A wide range of the sediment problems are represented in this watershed, from severely eroding headwaters areas (coastal range foothills) and degradation of the stream channels in their intermediate reaches, to aggradation downstream to the extent that their beds are now 7 to 8 feet above the surrounding coastal plain (a highly developed agricultural and urban area). In between lie valuable hillside orchards and new expensive residential developments that are jeopardized by active gully head cutting.

There are numerous existing grade control structures in several channels on the watershed. For many there is substantial record of original conditions. Effort will be made by resurveys to determine the relation of stabilized channel grades to their original grades, as affected by varying stream flow and sediment transport regimes. At a number of existing grade control structures there is opportunity, and work has been started, to secure both bed and suspended load measurements. Also, measurements of gully advance rates and total sediment production of hill areas under various cover conditions are planned. Study of numerous other aspects of sediment production, transport, and channel stabilization are possible.

This watershed was selected for study because of its array of sediment control problems, the existence of considerable documentation of past conditions, and related hydrologic data, and the fact that numerous existing control structures provide unusual opportunity for flow and sediment measurements at a minimum of cost.