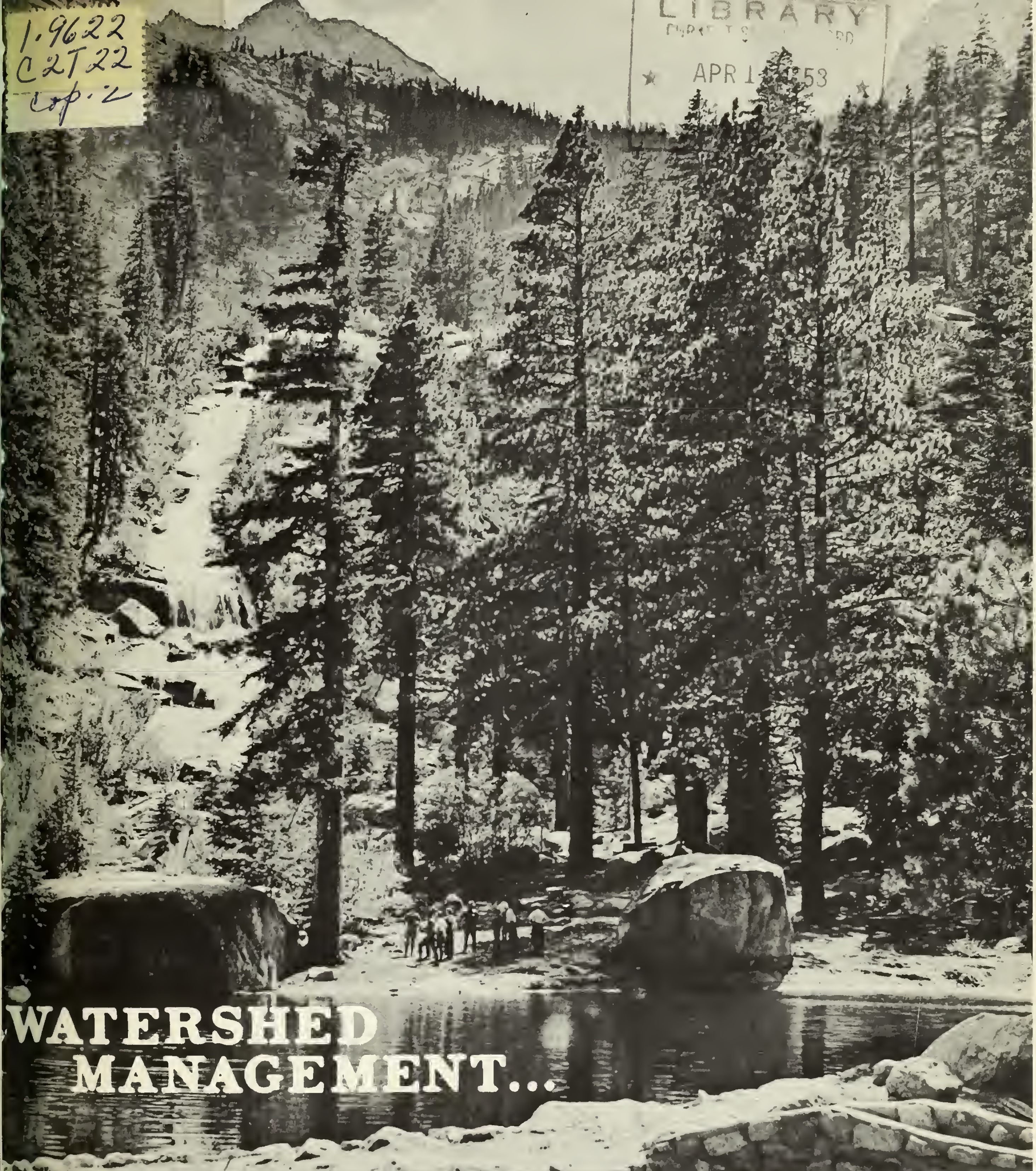
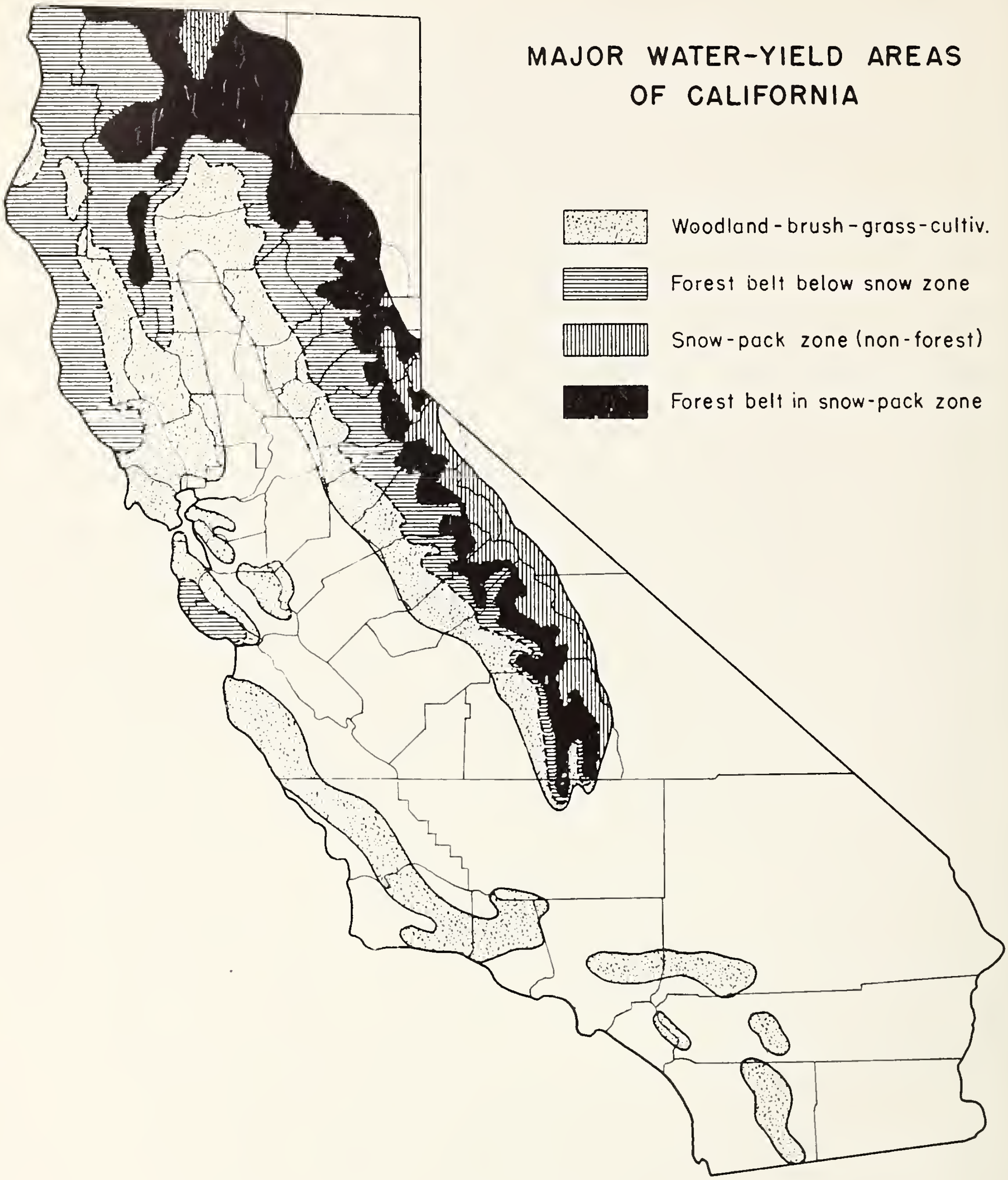


# WATERSHED MANAGEMENT...

. . . an annotated bibliography of erosion, streamflow, and water yield publications by the California Forest and Range Experiment Station

TECHNICAL PAPER NO. 23 JANUARY, 1958
CALIFORNIA FOREST AND RANGE EXPERIMENT STATION
KEITH ARNOLD, DIRECTOR
U.S. DEPARTMENT OF AGRICULTURE - FOREST SERVICE




| | Area (Acres) | Av. ann. water yield (Acre feet) |
|---|---|---|
| Woodland-brush-grass-cultivated | 17,850,000 | 8,930,000 |
| Forest belt below snow zone | 12,530,000 | 22,550,000 |
| Forest belt in snow-pack zone | 9,070,000 | 27,200,000 |
| Alpine snow zone | 3,000,000 | 9,000,000 |
| Total | 42,450,000 | 67,680,000 |
| Entire state | 101,300,000 | 71,000,000 |

# WATERSHED MANAGEMENT--AN ANNOTATED BIBLIOGRAPHY OF EROSION, STREAMFLOW, AND WATER YIELD PUBLICATIONS BY THE CALIFORNIA FOREST & RANGE EXPERIMENT STATION

By Clark H. Gleason

Technical Paper No. 23 January 1958

CALIFORNIA FOREST AND RANGE EXPERIMENT STATION
FOREST SERVICE, U.S. DEPARTMENT OF AGRICULTURE

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The Experiment Station is maintained at Berkeley, California, in cooperation with the University of California.

Agriculture--Forest Service, Berkeley, California

## FOREWORD

This bibliography has two purposes: (1) to list and describe publications of the California Forest and Range Experiment Station that have contributed to watershed management knowledge from establishment of the Station in 1926 to the end of May 1957, and (2) to cite a few important early articles by other workers that helped set the stage for the Station's work. The list covers original contributions in the watershed management field, including publications by staff members on foreign and special assignments. However, reviews of articles not bearing directly on watershed management in California have been excluded.

The titles are arranged alphabetically by authors and chronologically under each author's name. In cases of joint authorship the arrangement is based on the senior author, then alphabetically and chronologically by the junior authors. Author and subject indexes are given.

Before the Station was established many studies had been made of the effects of forest cover upon runoff, erosion, streamflow, and climate. Publications by E. N. Munns in 1919, 1920, and 1923 are cited in the bibliography because they relate specifically to problems in California that were investigated later by the Station. Three authors, not members of this Station, produced important papers of national interest relating to forest influences:

Zon, Raphael. 1912. Forests and water in the light of scientific investigation. Final Report of the National Waterways Commission, pp. 205-302. Reprinted with revised bibliography, 1927, as Senate Document No. 469, 62d Congress, 2d Session. 106 pp., illus.

__________ 1920. Review of The effect of forests upon streamflow, by Arnold Engler (untersuchungen über den Einfluss des Waldes auf den Stand der Gewässer. Mitteilungen der Schweizerischen Zentralanstalt fur das forstliche Versuchswesen, Zurich, 1919). Jour. Forestry 18 (6): 625-633.

Bates, C. G., and Henry, A. J. 1928. Forest and streamflow experiment at Wagon Wheel Gap, Colorado. Monthly Weather Review Supplement 30. 79 pp., illus.

Three translations by staff members describing watershed management work in foreign countries also helped guide our research. These articles pointed up the inadequacy of standard rain gages for hydrologic studies in mountainous areas and reported forest influences work in the Carpathian Mountains of Czechoslovakia and in the Alps of Austria and France:

Hamilton, E. L. 1933. Translation of The measurement of precipitation in mountainous regions, by Robert Pers (La mesure des precipitations en haute montagne. Rev. des Eaux et Forèts 71 (2): 117-118, Feb. 1933). U. S. Forest Service, Div. of Silvics, Washington, D. C. 3 pp. (Processed)

Perenin, R. F. 1935. Translation of Flood control of torrential streams, by Vojtech Kaisler (Correction des torrents. Sylviculture dans la republique Tchecoslovaque, Trans. 66: 245-260). U. S. Forest Service, Div. of Silvics, Trans. 157. 13 pp. (Processed)

Wilm, H. G. 1939. Translation of Investigations and results of research into the influence of vegetation on streamflow from the mountain drainage basins of Kychova and Zdechovka 1928 to 1934, by Z. Valek (Resumé of the French and German summaries of Výzkum s výsledky pozorovani vlivu porostu na odtok srázkových vod v bystrinnych povodích kychove a zdechovky za leta 1928-1934. From Vyzkumnictvi v oboru zemedelske techniky 2: 109-128). U. S. Forest Service, Div. of Forest Mangt. Res. Trans. 365. 12 pp. (Processed)

Acknowledgment is made for the use of lists and abstract material by others, often verbatim, from the following sources:

Staff Publications Lists for the California Forest and Range Experiment Station, by D. H. Vinther, P. E. Rader, and others.

A Guide to the San Dimas Experimental Forest, by J. D. Sinclair, E. L. Hamilton, and M. N. Waite.

Authors' abstracts published with the articles.

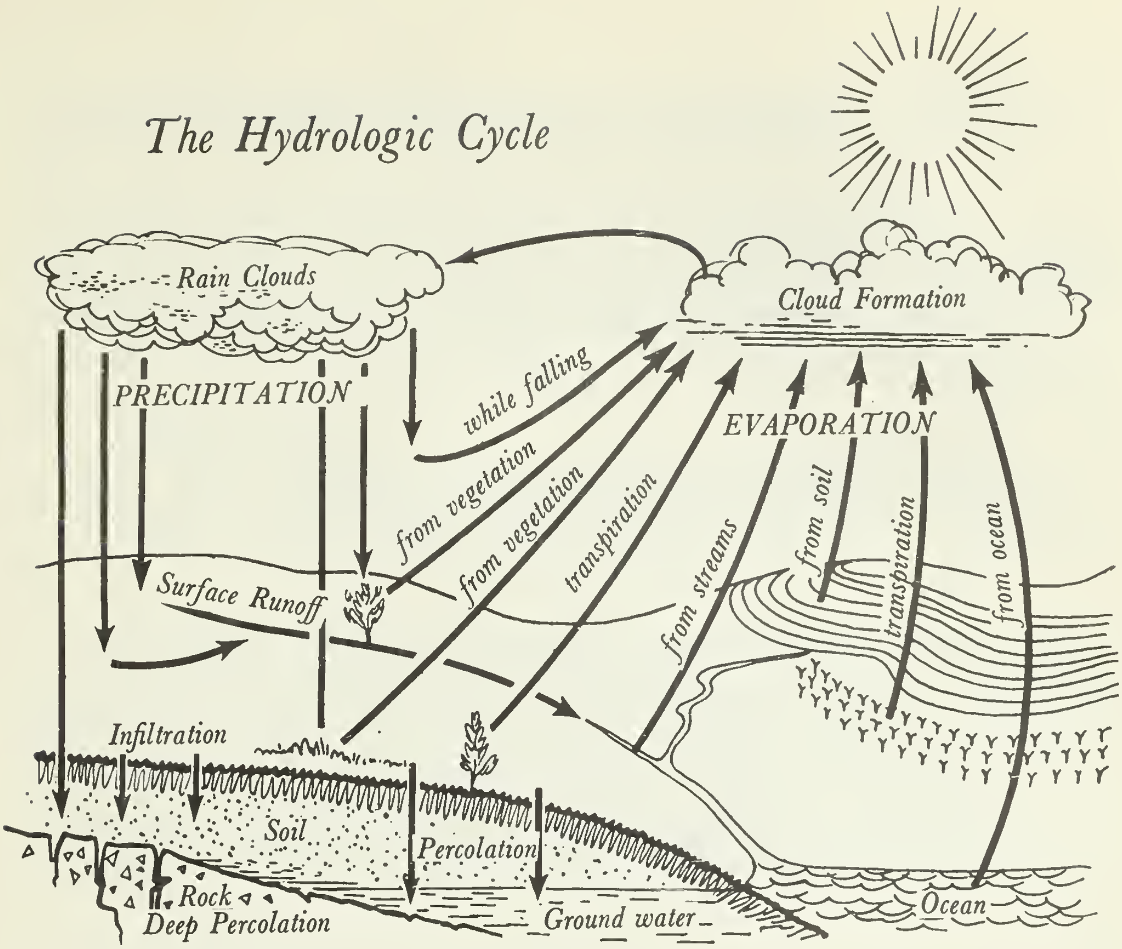
Annual reports of the California Forest and Range Experiment Station.

Annotated Bibliography on Hydrology, 1941-50. Bureau of Reclamation, U. S. Department of the Interior, Bulletin 5, June 1952.

The symbol * preceding the title of a publication indicates that copies are obtainable on request to the Station.

INDEX TO STATION AUTHORS

## SUBJECT INDEX




From: U. S. Dept. Agr. Yearbook 1955

(1) ACKERMANN, W. C., COLMAN, E. A., and OGROSKY, H. O.
* 1955. Where we get our water; from ocean to sky to land to ocean. Water. U. S. Dept. Agr. Yearbook 1955: 41-48, illus.

The world's moisture and water are constant in quantity, but in endless circulation between ocean, sky, and land. This circulation, called the hydrologic cycle, is described in simple terms. The authors tell about the storms that bring rain and snow; and they explain processes such as interception, infiltration, runoff, erosion, and groundwater behavior that are important to man's use of water and the land.

(2) AMIDON, R. E.
1941. Determining the value of public works expenditures. Civ. Engin. 11 (3): 175.

Acknowledging that flood control and water conservation projects should be economically justified, that is, their benefits should exceed their costs, Amidon pointed out that current economic procedures are inadequate to appraise many real benefits of such projects, owing to the intangible nature of the benefits or to uncertainty as to the time when they will accrue.

(3) ______
1942. Discussion of Evaluation of flood losses and benefits, by Edgar E. Foster (Amer. Soc. Civ. Engin. Trans. 107: 871-894). Amer. Soc. Civ. Engin. Trans. 107: 901-903.

Foster had termed the analysis of flood damages the outstanding problem of the economics of flood control, in which benefits must be weighed against costs, and described several methods of analysis. Amidon comments that relationships commonly used to estimate flood damage under future conditions in large watersheds are not applicable in small tributary drainages. Moreover, he says, the "social benefits" defined by Foster do not include intangible benefits peculiar to the heavily used canyon bottoms in southern California.

(4) ______
1947. Discussion of Model study of Brown Canyon debris barrier by Karl J. Bermel and Robert L. Sanks (Amer. Soc. Civ. Engin. Trans. 112: 999-1014). Amer. Soc. Civ. Engin. Trans. 112: 1015-1016.

Amidon discusses factors governing the surface gradient of debris deposits upstream from channel barriers and points out the necessity of estimating this gradient beforehand in order to make the slope-storage calculations needed to determine the economic feasibility of building barriers.

(5) ______
1949. Discussion of Multiple-purpose reservoirs: a symposium (Amer. Soc. Civ. Engin. Proc. 75 (3): 287-390). Amer. Soc. Civ. Engin. Proc. 75 (6): 881-883.

The symposium defined multiple-purpose reservoirs, outlined the conflicting requirements of various reservoir uses, and discussed economic considerations involved in the different operations.

Amidon comments that sedimentation was not adequately treated in the symposium. He notes that the "life of the project" was not considered, and discusses the sedimentation rate, the possibility of sediment removal, and the reduction of sediment rate by watershed treatments. Watershed condition and land treatments, he says, have a direct bearing on reservoir life. Evaluation of the longtime sedimentation characteristics of a watershed is essential, Amidon concludes, to determine the economic justification of a reservoir project.

(6) ANDERSON, H. W.
1944. Discussion of Soil-moisture records from burned and unburned plots in certain grazing areas of California, by F. J. Veihmeyer and C. N. Johnston (Amer. Geophys. Union Trans. 1944 (1): 72-84). Amer. Geophys. Union Trans. 1944 (1): 86.

Discussing the Veihmeyer-Johnston statement that neither the field capacities of soils nor the amount of usable water that can be stored in soils can be changed markedly by adding organic matter, Anderson calls attention to the authors' data as published showing increases in moisture-equivalent ranging from 5.3 to 86 percent upon the addition of organic matter to different soils. He states that experimental techniques may explain differences between the Veihmeyer-Johnston results and those of other investigators.

(7) ______
* 1946. The effect of freezing on soil moisture and on evaporation from a bare soil. Amer. Geophys. Union Trans. 1946: 863-870.

Reports the effect of soil freezing on moisture distribution in the profile of a soil kept bare of vegetation. From successive soil moisture samplings and by means of regression analysis of freezing and concomitant climatic data, the effect of soil freezing on surface soil moisture and on evaporation from the bare soil were obtained. Evaporation rates from the bare soil during freezing periods are compared with those from brush-covered soil during the same periods, with those from bare soil during similar non-freezing periods, with those from a free water surface during the same periods, and with the calculated values for the same periods. Freezing of the bare soil caused the surface to become and remain wet, and greatly increased evaporation.

(8) ANDERSON, H. W.
1947. Soil freezing and thawing as related to some vegetation, climatic and soil variables. Jour. Forestry 45 (2): 94-101.

Analysis of data taken under brush cover, a light grass cover, and in bare soil showed that the light grass cover decreased freezing depth, delayed the first occurrence of freezing, and advanced the date of the last freeze of the year, as compared with bare soil. There was no freezing in the brush-covered soil during the 5 years of the study. Multiple regression analyses showed that freezing was quantitatively related to air and soil temperatures, cloud cover, soil moisture, and snow depth. The rate of thawing of frozen soil was related to solar radiation, air temperature, soil temperature, and cloud cover. Soil freezing was found to keep the surface soil wet by drawing moisture from deeper depths of the soil, resulting in high evaporation rates during rainless periods and rapid soil erosion during rainstorms.

(9) ______
* 1949. Does burning increase surface runoff? Jour. Forestry 47 (1): 54-57.

Anderson comments on the Adams-Ewing-Huberty publication "Hydrologic Aspects of Burning Brush and Woodland-Grass Ranges in California", pointing out that some of the specific findings and methods which led to those findings needed further critical inspection. He noted that the longtime effects of repeated burning on site productivity should be considered, and that southern California data not reported by the authors would have clarified the findings quoted as well as the needs for future research. Anderson points out that one study which led to the conclusion that runoff was not accelerated by burning can be interpreted differently. This conclusion was drawn, he shows, from an unclassified and unweighted sample. By rearranging the data according to the kinds of plant cover, Anderson found that burning did increase surface runoff in 3 of the 4 brush types studied.

(10) ______
1949. Flood frequencies and sedimentation from forest watersheds. Amer. Geophys. Union Trans. 30 (4): 567-584, illus.

For the economic justification of flood prevention and control measures, information is required on the size and number of floods to be expected with and without a flood control program.

Past floods furnish the chief clue to future floods. But streamflow records are short and have been obtained under changing watershed conditions. Accordingly, a method was needed for extending streamflow records and adjusting them to watershed conditions as a basis for estimating future flood frequencies.

Anderson shows by multiple regression analysis that flood peak discharge was related to 6 variables: watershed area, maximum 24-hour precipitation, maximum 1-hour precipitation, precipitation occurrence as snow or rain, watershed wetness (amount of precipitation in 21 days immediately preceding the storm studied), and the density of plant cover in the watershed. Results of the study are applied to give frequencies of discharges and sedimentation for 41 watersheds in southern California; the effects of individual forest fires and of fire-control programs on discharges and sedimentation are calculated.

(11) ANDERSON, H. W.
1949. Discussion of Trends in runoff in the Pacific Northwest, by C. C. McDonald and W. B. Langbein (Amer. Geophys. Union Trans. 29 (3): 387-397). Amer. Geophys. Union Trans. 30 (4): 603-604.

McDonald and Langbein analyzed precipitation-runoff relations in the Columbia River basin and concluded that the decreased streamflow was associated primarily with a trend in climate but also with works of man such as increased irrigation and storage. As the available records of precipitation and streamflow were too short for precise determinations, the authors used multiple regression analysis for expanding and comparing records. Final appraisal of their findings, they pointed out, would have to await a wet climatic period similar to the one experienced before records were generally kept.

In discussing the study, Anderson suggests a more suitable way of expressing short-time effects of precipitation on runoff, and compliments the authors on their start toward solving the problem by using multiple regression analysis.

(12) ______
1950. Discussion of A reference plane of flood volumes in the Sacramento-San Joaquin basin, California, by John W. Kuhnel (Amer. Geophys. Union Trans. 30 (1): 98-115). Amer. Geophys. Union Trans. 31 (1): 126-129.

Kuhnel presented a method of establishing by correlation analysis a flood runoff reference plane for comparing the degree of protection afforded by flood control projects. The method was based on a statistical study of floods recorded in the Sacramento-San Joaquin basin of California. It correlated flood runoff with 4 stream basin characteristics: mean elevation, area, and orientation of the basin and mean annual runoff.

Anderson cites correlation analysis as "... probably the most promising tool for obtaining approximate answers to many problems in applied hydrology." Examining the method in the light of 6 criteria he had suggested earlier (10), Anderson notes certain deficiencies and suggests ways of improving the method.

(13) ANDERSON, H. W.
1950. (Author's closure) Amer. Geophys. Union Trans. 31: 621-623.

Responds to Leonard Schiff's discussion (Amer. Geophys. Union Trans. 30: 584-586) of "Flood Frequencies and Sedimentation from Forest Watersheds" (Amer. Geophys. Union Trans. 30: 567-584). Anderson amplifies Schiff's comments on the use of multiple regression analysis, and reports further tests of the method.

(14) ______
* 1951. Physical characteristics of soils related to erosion. Jour. Soil and Water Conserv. 6 (3): 129-133.

Land management decisions involving the location of erosion sources and control of erosion can be made more soundly when they are based on the principal causes of erosion. Characteristics of the soil itself are often an important cause. Anderson shows how soil effects on erosion can be separated from other effects by making physical analyses of relatively few soil samples and applying suitable analytical techniques.

(15) ______
1952. How will you have your water? Jour. Forestry 50 (2): 135.

Refuting claims that logging has had no influence on floods of the Willamette River, Oregon, Anderson shows that flood peaks actually increased 30 percent after logging. This was shown by comparing discharges of the logged Willamette and the unlogged MacKenzie Rivers. Even with flood control dams in place, flood peaks on the Willamette remained 13 percent above those of the pre-logging period.

(16) ANDERSON, H. W.
* 1954. Suspended sediment discharge as related to streamflow, topography, soil, and land use. Amer. Geophys. Union Trans. 35 (2): 268-281.

By regression analysis of data from 29 watersheds in western Oregon, Anderson calculated the present sediment yield of forest land, agricultural land, and the channel banks of main streams; he determined the sediment producing potential of lands with average use; and he estimated the changes in sediment production with deviation of land use from average. A map is presented showing erosion potential of the lands studied.

(17) ______
1955. Detecting hydrologic effects of changes in watershed conditions by double-mass analysis. Amer. Geophys. Union Trans. 36 (1): 119-125, illus.

Measuring the effects of wildfires on reservoir sedimentation and on flood peaks is difficult because of the many variables involved, and the short-term records of sedimentation and floods. Anderson shows a way of evaluating the effects of wildfire and estimating the long-term effects from the short records usually available. By this method the sedimentation of Gibraltar Reservoir, which supplies water for the City of Santa Barbara, was found to have increased markedly after wildfires, then decreased as the watershed vegetation recovered. Peak inflow to the reservoir was affected similarly, but the total annual inflow showed no change.

(18) ______
1956. Forest-cover effects on snowpack accumulation and melt, Central Sierra Snow Laboratory. Amer. Geophys. Union Trans. 37 (3): 307-312.

Snowpack accumulation and melt within snow courses were related to the amount of shade to the south of snow measuring points, and to the amount of shielding from trees to the north of the points. Water equivalent of the snowpack beginning April 1 was studied. By covariance analysis a high degree of association was found between the snowpack and forest cover variables. The study is interpreted in terms of timber cutting patterns that would result in maximum snow accumulation, minimum melt rate, and delayed release of snow water.

(19) ANDERSON, H. W.
1956. Relating sediment yield to watershed variables. Amer. Geophys. Union Trans. 37 (3): 335. (Abstract of paper presented at the 37th annual meeting, Washington, D. C., April 26 - May 4, 1956.)

Noting that sediment yield varies with watershed characteristics, watershed conditions, and the nature of storms and streamflow, Anderson discusses the uses of multiple regression analysis as a means of relating sediment yield to the several watershed variables.

(20) ______
1957. (Author's closure) Amer. Geophys. Union Trans. 38 (1): 116.

Responds to J. E. Church's discussion (Amer. Geophys. Union Trans. 38 (1): 116) of "Forest-Cover Effects on Snowpack Accumulation and Melt, Central Sierra Snow Laboratory" by H. W. Anderson (Amer. Geophys. Union Trans. 37 (3): 307-312). Anderson acknowledges Church's pioneer work in snow research. He reports that a cooperative program in snow management research begun in 1956 will test both the "wall-and-step forest" and Church's "honey-comb" hypotheses. Through the cooperation of the Federal government and the State of California, Anderson says, we are "... making a concerted effort to test the observations and proposals advanced by Church some 40 years ago."

(21) ANDERSON, H. W.
1957. Watershed management in the snow zone. Paper presented at Intersociety Conference on Irrigation and Drainage sponsored by Amer. Soc. Civ. Engin., Amer. Soc. Agr. Engin., and Soil Sci. Soc. Amer. San Francisco, Calif., April 29-30. 9 pp. (Processed.)

Describes the snow management research program of the California Forest and Range Experiment Station in cooperation with the California Department of Water Resources. Reports studies under way to determine if, by how much, where, and how lands in the snow zone can be managed to improve California's water supply.

(22) ______ and TROBITZ, H. K.
* 1949. Influence of some watershed variables on a major flood. Jour. Forestry 47 (5): 347-356.

Whether increased flood peaks and sedimentation result from forest fires has been a question of long standing, owing to the lack of quantitative methods for relating burning to runoff and soil erosion. Using multiple regression analysis, Anderson and Trobitz found a way to isolate the effects of watershed variables, particularly the density of plant cover, on peak discharge and sediment production so that the effects of burning can be measured. Behavior of 40 gaged watersheds in southern California during the major storm of March 1938 was appraised. The study included such variables as peak flow, deposition of sediment, maximum 24-hour precipitation, size and physiography of watershed, the extent and age of old burns, length of stream channels, and reservoir capacity at beginning of storm. Reservoir sedimentation was found related quantitatively to the maximum 24-hour precipitation, density of forest cover, extent of barren area, area of old burns, and area of the individual watershed. Peak discharges were found related to forest cover density, maximum 24-hour precipitation, watershed physiography, and watershed area. Under 1938 conditions, if 20 percent of a watershed were burned over, a peak discharge increase of 55 percent would be expected the first year after the fire.

(23) ASHBY, WILLIAM C., and HELLMERS, HENRY
1955. Temperature requirements for germination in relation to wild-land seeding. Jour. Range Mangt. 8 (2): 80-83.

Reports a study designed to determine the relationship of temperature to germination of various grasses and forbs considered promising for range improvement and erosion-control seeding of burned-over wild lands in southern California. The seeds were sown under controls simulating summer, spring-fall, and winter temperatures. Of the 20 species tested only 11 germinated equally well over the entire range of seasonal temperature conditions. It was concluded that successful field sowings require species that will germinate under temperatures that occur when soil moisture is adequate.

(24) BARNES, F. F., KRAEBEL, C. J., and LaMOTTE, R. S.
1939. Effect of accelerated erosion on silting in Morena Reservoir, San Diego County, California. U. S. Dept. Agr. Tech. Bul. 639. 22 pp., illus.

The kinds and locations of sediment in Morena Reservoir are described, and it is shown that the reservoir had lost 10.5 percent of its useful storage capacity through sedimentation in the 25.7 years since its construction. Physical and vegetation features of the watershed are described. The severe slope erosion and valley trenching that characterize the watershed area are reported to be the result of overgrazing and burning.

(25) BERMEL, KARL J.
1940. Discussion of Transient flood peaks, by Henry B. Lynch (Amer. Soc. Civ. Engin. Proc. 65 (9): 1605-1624). Amer. Soc. Civ. Engin. Proc. 66 (5): 995-1002. (Original article also in Amer. Soc. Civ. Engin. Trans. 106: 199-218 followed by Bermel discussion pp. 251-254.)

The Lynch article described the La Crescenta flood of January 1, 1934, Los Angeles County, California, as of the "cloudburst" type that commonly yields momentary runoff peaks greatly in excess of the flows that could be sustained by the rate of rainfall. Such floods are caused, Lynch concluded, by an abrupt increase in rainfall intensity and surface runoff that result in streamflow surges or transient flood peaks.

Pointing out that variation in the estimates of either rainfall or runoff would influence the rainfall-runoff relation, Bermel shows how the bulking of runoff by eroded debris in the

La Crescenta flood may have led to erroneous estimates of the water runoff that actually occurred. He then shows that the burned-over watersheds above La Crescenta, because they faced into the wind, may have intercepted considerably more rain than was measured by the standard rain gages that were used.

(26) BODMAN, G. B., and COLMAN, E. A.
* 1944. Moisture and energy conditions during downward entry of water into soils. Soil Sci. Soc. Amer. Proc. 8: 116-122, illus.

Reports a laboratory study of the infiltration of water into columns of air-dry soil in which the impact of drops falling on the soil, the in-washing of colloids, and compression of air ahead of the wet front were excluded. Although clay migration was probably negligible, the infiltration rate was found to diminish, approaching a final constant value determined by gravity and pressure potentials.

(27) CALIFORNIA FOREST AND RANGE EXPERIMENT STATION
1951. The work of the California Forest and Range Experiment Station. Division of Forest Influences Research. p. 8 (Revised 1952.)

Concise statement of the main watershed management problems in California, and of the Station's 1952 attack on them.

(28) ______
1951. The work of the California Forest and Range Experiment Station. Division of Flood Control Surveys. p. 9. (Revised 1952.)

Concise statement of the purposes of U. S. Department of Agriculture flood control surveys, how they are made, surveys undertaken up to 1952, and the kinds of remedial measures proposed.

(29) COLMAN, E. A.
1943. Contribution to the report of the American Geophysical Union Committee on transpiration and evaporation, 1942-43. Amer. Geophys. Union Trans. 1943: 401-402.

Measurements of transpiration and evaporation are important to watershed management research, but such measurements are difficult to make, and measurement techniques were still under study by the committee.

Colman notes that the committee's reports of 1940 and 1941 raised some fundamental questions and revealed differences of

opinion showing the need for more research on the problem. To aid future research on lysimeter design and use, Colman describes the several types of lysimeters in operation on the San Dimas Experimental Forest, and suggests that analysis of data from them should help answer some of the technical questions about how to use lysimeters.

(30) COLMAN, E. A.
* 1944. The dependence of field capacity upon the depth of wetting of field soils. Soil Sci. 58 (1): 43-50, illus.

Irrigation of field plots and subsequent soil moisture sampling is sometimes used to determine the field capacity, which is the maximum amount of moisture the soil can retain against drainage. This paper points out the errors which may arise from such determinations when based upon too shallow depths of penetration of the irrigation water.

(31) ______
1945. Contribution to Report of the Committee on Transpiration and Evaporation, 1943-44. Amer. Geophys. Union Trans. 1944 (5): 683-684.

Acknowledging the difficulties of duplicating within lysimeters the environmental conditions of natural soils, Colman reports a method of draining lysimeters that may increase their usefulness. Ordinarily, water drains from lysimeters by gravity, but when seepage stops, the lowest soil layer still holds moisture well above field capacity. This is caused by influence of the soil-air interface at the bottom of the soil column. To overcome this influence Colman applied moisture tensions of 50 and 150 centimeters of water. He concludes that the proper tension to lower soil moisture to field capacity lies between these values.

(32) ______
* 1946. A laboratory study of lysimeter drainage under controlled soil moisture tension. Soil Sci. 62 (5): 365-382, illus.

A cylindrical column of soil 6 inches in diameter and 6 feet long was irrigated and drained four times, each time with a different moisture tension maintained at or beneath its base. The study showed it is possible to control seepage rate and the drained moisture content of a deep soil column, as in a gravity-drained lysimeter, by controlling the moisture tension maintained at the base of the soil.

(33) COLMAN, E. A.
* 1946. The place of electrical soil-moisture meters in hydrologic research. Amer. Geophys. Union Trans. 27 (6): 847-853, illus.

Direct-reading electrical soil-moisture meters are useful in many kinds of hydrologic research, as gains and losses of soil moisture and the direction and rate of soil-water movement can be measured. Such meters can provide a means of controlling the time and amount of irrigation on crop land, and discern freezing and melting conditions in soil and snow. Colman describes such a meter developed by the California Forest and Range Experiment Station. It consists of a portable battery-powered ohmmeter and small sensing elements that can be buried and left permanently at any desired depth in the soil.

(34) ______
* 1947. A laboratory procedure for determining the field capacity of soils. Soil Sci. 63 (4): 277-283, illus.

It was found that if small soil blocks were drained on a porous ceramic cell under a moisture tension of one-third atmosphere, the moisture retained in the blocks could be related empirically to the field capacity of the same soils determined under natural field conditions. A satisfactory degree of consistency was observed in the relationship between one-third atmosphere moisture percentage and field capacity. It is suggested that the procedure described may provide a convenient and rapid way of making an indirect determination of field capacity. Details of the design of the ceramic cell and moisture tension control equipment are given.

(35) ______
1947. Manual of instructions for use of the fiberglas soil-moisture instrument. U. S. Forest Serv. Calif. Forest and Range Expt. Sta. 17 pp., illus. (Processed.) (Revised 1948, 1950, 1952.)

This manual gives a detailed description of the fiberglas sensing unit and the ohmmeter unit of the electrical soil-moisture instrument. The method of installing the soil units, the method of using the ohmmeters, and the necessary steps in standardizing and calibrating the soil units are discussed.

(36) COLMAN, E. A.
* 1948. Soil surveying on wildlands: the problem and one solution. Jour. Forestry 46 (10): 755-762, illus.

Owing to the great variation in characteristics of soils in the mountains of southern California, soil survey procedures well suited to agricultural lands were not found applicable in mapping soils of the San Dimas Experimental Forest. The author suggests ways of simplifying field and laboratory work so as to make wild-land soil surveying yield the type of information most useful to the wild-land manager. A soil survey of the Angeles National Forest is presented as an example of how these suggestions can be applied.

(37) ______
1950. Hydrologic problems of brushland management. Proc. Short Course on Range Improvement, Univ. California, Davis. pp. 59-65. (Processed.)

The "short course" of which this paper is a part covered several aspects of range improvement in California. Colman's paper summarized Forest Service studies of the hydrologic consequences of burning brushland. The most intensive study, at North Fork in Madera County, showed that burning markedly increased runoff and erosion, and reduced infiltration. Burning of the brush cover on Mt. Lukens, Los Angeles County, was cited as being responsible for the La Crescenta flood of New Year's 1934. "Forest Service research," said Colman, "is now seeking vegetation treatments ... that will increase water yield without increasing surface runoff, erosion, or flood hazard. ... In some ... areas grazing needs will have to be subordinated to the needs of watershed protection and safe water yield."

(38) ______
1953. Fire and water in southern California's mountains. U. S. Forest Serv., Calif. Forest and Range Expt. Sta. Misc. Paper 3. 7 pp. (Processed.)

Colman discusses forest fire as the cause of accelerated erosion and floods under certain conditions in southern California, and cites the fire-flood sequence of 1933-34 at La Crescenta and Montrose, the sequence of 1945-46 east of San Bernardino, and the sequence of July 1950 in the Yucaipa Valley. Cases in which floods did not follow fires are cited and explained. Colman then discusses the effects of burning upon water yield, citing and interpreting the Hoyt-Troxell study of Santa Anita and Fish canyons, and concludes that protection from fire is necessary for flood protection and maximum yield of usable water.

(39) COLMAN, E. A.
1953. Vegetation and watershed management. New York, N. Y. 412 pp., illus.

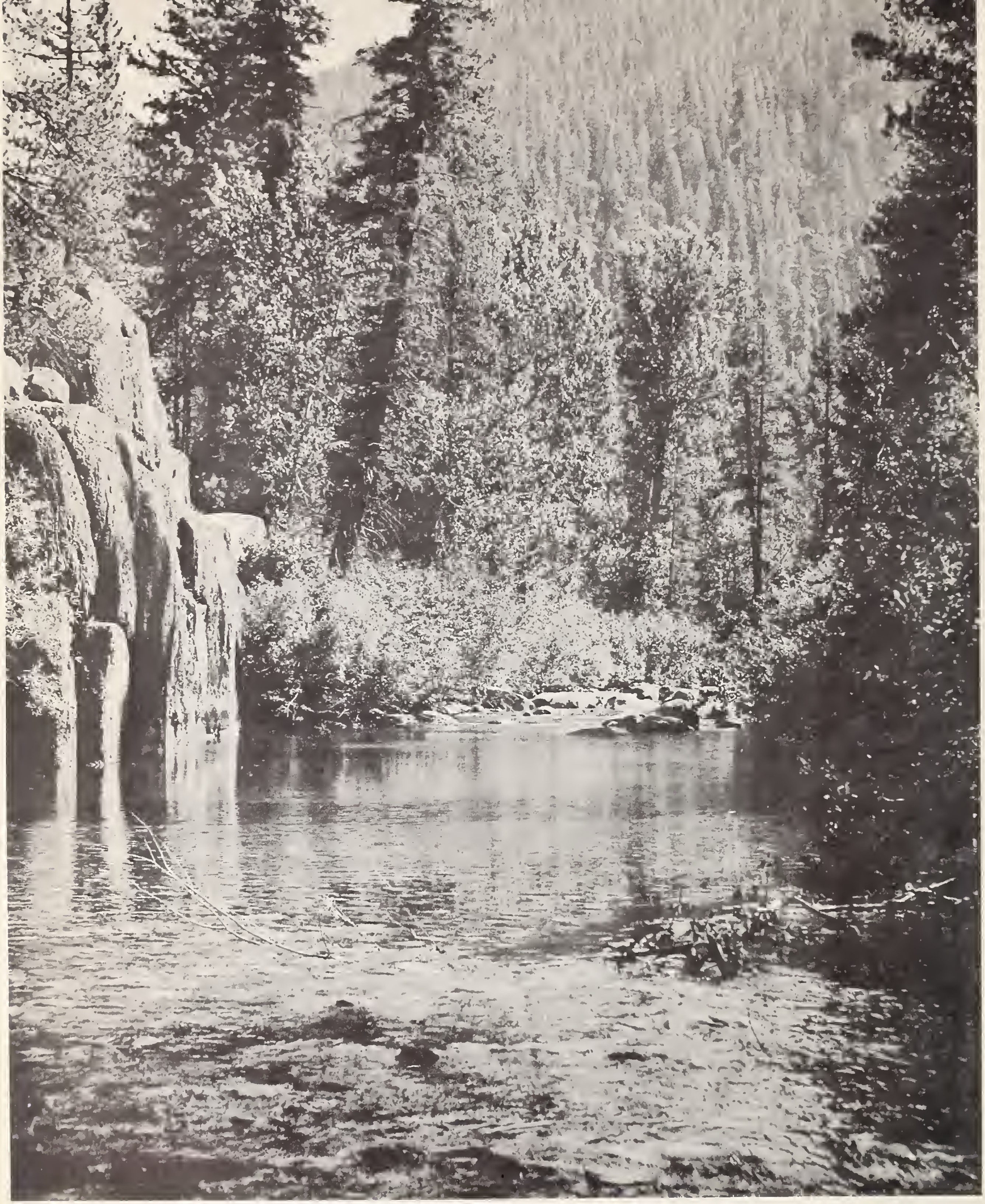
Examining the close relationship of vegetation to water supply and control, Colman's book provides the first systematic estimate of the opportunities and methods of managing vegetation on watershed lands.

The volume points out how the management of vegetation is related to the control of water in streams and ground-water basins. It describes the influence of vegetation on the hydrologic processes of interception, infiltration, soil-water drainage and storage, evapo-transpiration, surface runoff, and erosion. It indicates how proper management can augment ground-water supplies, check soil erosion and the siltation of rivers and reservoirs, and reduce flood peaks.

Colman analyzes the significant experimental work done in the United States and abroad that bears on vegetation management as it affects the control of water on the land. He places this research against the background of the current water situation, stressing those aspects which the treatment of vegetation can favorably affect--flooding, extreme seasonal fluctuations of streamflow, erosion, etc. Research sections conclude with summaries showing what has been achieved and the further research needed before vegetation management can be widely applied.

(40) ______
1953. Watershed management in California. Statement for joint meeting of California State Board of Forestry and the State Water Resources Board. January 8, 1954. 25 pp. (Processed.)

Colman appraises the overall watershed management problem in California and methods of solving it. He explains the functions of watershed management, what can happen without it, and what can be done to maintain, repair, and improve watershed conditions. He discusses the water problems, opportunities for water yield control, and the research needs of the 4 water-producing regions of the state: the chaparral, brush and woodland-grass, timber below the snowpack level, and the snowpack lands. After summarizing the past and present watershed research in California, Colman recommends that (1) research be put on a more sound, longtime basis; (2) a statewide watershed survey be made to pinpoint watershed management problems; (3) a handbook be prepared to summarize our present knowledge of watershed management for use by the people on the land; and (4) research be strengthened.



(41) COLMAN, E. A.
1954. Water control and timber management. 45th Annual Western Forestry Conf. Western Forestry and Conserv. Assn. Proc. 1954: 24-26.

Discusses ways in which timber production can be integrated with land management for controlling water flow in the western United States.

(42) ______
1955. Operation wet blanket: proposed research in snowpack management in California. Paper presented at Pacific Southwest Regional Meeting. Amer. Geophys. Union, Berkeley, California, February 5, 1955. 10 pp., illus. (Processed.)

Discusses possibilities of improving water yield on snowpack lands, and the need for snow research in California. Proposes a research project on the physics of snow and the water-yield consequences of snow management with particular reference to logging patterns. A letter-size map shows the extent of major water-yield areas in California, together with their acreages and estimated average annual water yield (this map is reproduced on the inside front cover of this report).

(43) ______
1955. Where will your water come from? Talk presented at state-wide meeting of County Agricultural Commissioners, Quincy, Calif., June 8, 1955. 6 pp. (Processed.)

Noting that forestry has progressed from the stage of "cut out and get out" to the stage of orderly management of all wildland resources, Colman discusses the struggle to provide adequate water for California, and the part that forest management can play in improving water yield. He tells the importance of forest cover in regulating water yield in southern California, in the forest belt below 5,000 feet, and in the snow zone above 5,000 feet, and describes research that is underway and planned to increase water yield in these areas.

(44) ______ and BODMAN, G. B.
1944. Moisture and energy conditions during downward entry of water into moist and layered soils. Soil Sci. Soc. Amer. Proc. 9: 3-11, illus.

Reports a continuation of the study of water movement into and through laboratory-packed columns of uniform-textured soils that were initially air-dry, described previously by Bodman and Colman. The current study was made of (1) soil with uniform texture that had been moistened, and (2) soil of different textures, arranged in layers and initially air-dry. The moist soil tests showed infiltration and percolation rates greater than the rates for dry soil. In the layered columns the less permeable layer was found to limit infiltration regardless of whether it lay above or below the more permeable layer.

(45) COLMAN, E. A., BROWN, CARL B., and SHANNON, W. G.
1955. Measures needed to manage watersheds. Jour. Soil and Water Conserv. 10 (5): 237-240. illus. Reprinted as Chapter 4 in Our Watershed Resource, Soil. Conserv. Soc. of Amer. 1956: 15-18.

This article, the fourth in a series of six on protecting and developing the nation's watersheds, describes the place of upstream and downstream operations in watershed management.

(46) ______ and HAMILTON, E. L.
1944. The San Dimas water-stage transmitter. Civ. Engin. 14 (6): 257-258, illus.

A simple float-actuated electrical transmitter permits remote recording of water level by a counter-type mechanism recording increments of stage. The device is particularly adapted for stations having a small range in stage.

(47) ______ and HAMILTON, E. L.
1947. The San Dimas lysimeters: Part 1 - The lysimeter installation and research programs. Part 2 - The relative performance of four types of lysimeters. U. S. Forest Serv. Calif. Forest and Range Expt. Sta. Res. Note 47, 33 pp., illus. (Processed.)

Part 1 of the research note discusses problems of lysimeter design and describes the 5 types of lysimeters used on the San Dimas Experimental Forest. Part 2 presents data on the water content of lysimeter soils during the calibration period, analyzes the relation between water content of different sized lysimeters with and without annual grass cover, and suggests improvements in lysimeter design.

(48) COLMAN, E. A., HANAWALT, W. B., and BURCK, C. R.
* 1946. Some improvements in tensiometer design. Amer. Soc. Agron. Jour. 38 (5): 455-458, illus.

A description of the tensiometer designed for use in the San Dimas lysimeters. The design follows that of L. A. Richards, but has certain advantages. For example, installation and removal of the porous cup is simplified; the use of copper tubing reduces water volume changes induced by temperature; and provision is made for eliminating air entrapment.

(49) ______ and HENDRIX, T. M.
1949. The fiberglas electrical soil-moisture instrument. Soil Sci. 67 (6): 425-438, illus.

Describes an instrument devised to measure soil moisture in place. The instrument consists of fiberglas soil-moisture units and a portable alternating current ohhmeter powered by a self-contained dry battery. Each soil-moisture unit contains a sandwich of monel screen and fiberglas cloth that is sensitive to moisture, and a thermistor for measuring temperature.

(50) DAVIS, WENDELL E.
1939. Measurement of precipitation above forest canopies. Jour. Forestry 37 (4): 324-329.

Citing the need for measuring precipitation above the trees to determine the amount intercepted by the tree canopies, Davis describes a hoist to raise standard rain gages, hold them at the desired height, and lower them for measurement. The method is convenient and economical, and it is reported to meet the statistical requirements for rainfall sampling.

(51) DAVIS, WENDELL E., and SAMPSON, ARTHUR W.
1936. Experiment in correlation of tree-growth rings and precipitation-cycles. Amer. Geophys. Union Trans. 1936: 493-496.

Tree-ring evidence back to the year 1400 was studied in relation to weather records dating back to 1865, in an effort to answer questions about fluctuations in the level of Goose Lake, Modoc County. The study showed that tree growth was related to climatic trends rather than to annual precipitation, and that fluctuations in lake level could not be forecast with accuracy.

(52) GLEASON, CLARK H.
1935. Erosion control - Las Flores burn. Conservation Activities 3 (11): 9. (Processed.)

Reports the sowing of mustard cover-crop for erosion control in Las Flores burn, southern California. Six tons of seed were broadcast on 2,400 acres by CCC crews within 2 weeks after the fire--a record in sowing burns by hand. Experience indicates the seed will sprout within a week after the first rain, and winter growth will develop cover for soil protection against wind and rain. The mustard is expected to volunteer for 2 or 3 years until the native shrub cover returns.

(53) ______
1937. Rain alarm. Construction Hints 3 (13): 4-5, illus.

Describes a device that rings a bell when a predetermined amount of rain has fallen. A foil-covered float contacts electrodes suspended in a glass rain-measuring cylinder, closing the circuit.

(54) ______
1938. Pickens' burn a lesson. West. Trees, Parks & Forests 1 (2): 6, illus.

Four years after the cities of La Crescenta, Montrose, and Glendale were ravaged by floods from the Pickens burn the areas had been protected by engineering and forestry practices. The author calls for 2 other safeguards against future flood damage along the San Gabriel Mountain front. They are (1) zoning to prevent the occupation of areas with flood hazard, and (2) giving special danger warnings when forest fires set the stage for floods.

(55) GLEASON, CLARK H.
1944. Directions for sowing mustard for erosion control in burned areas of southern California. U. S. Forest Serv. Calif. Forest and Range Expt. Sta. Res. Note 37. 29 pp. (Processed.) Revised 1948 and 1953 under title How to sow mustard in burned watersheds of southern California.

A manual to aid land managers in sowing mustard as a first-aid measure for erosion control in burned-over watersheds of southern California. It sums up Forest Service experience in planning the job, sowing the seed by hand or aircraft, and appraising its success. Specifications are given for such details as buying seed, hiring aircraft for use over mountainous terrain, and checking seed distribution. Much of the information is applicable to grass seeding projects.

(56) ______
1948. Water for today and tomorrow. California - Magazine of the Pacific 38 (3): 30, 59-62, illus.

Noting that 90 percent of the water used in California is produced in California, the author points out that both the quantity and quality of water produced are influenced by the condition of the water-yielding lands. Problems of water supply, requirements, redistribution, and importation are discussed. Describes how water is wasted and floods are increased by abuse of land. Burning, grazing, logging, road building, mining, and cultivation are discussed, together with ways of reducing watershed damage from these causes.

(57) ______
1949. Forest Service use of aircraft for sowing burned-over watershed land in southern California. Minutes, State-Wide Conference (Forum) on Agricultural Usage of Aircraft. Davis, California, Feb. 8-9, 1949. pp. 27-33.

Summarizes the reasons for sowing mustard in burns and names the pilots and planes used for this work from 1932 to 1947. First use of the helicoper for this purpose in 1947 is described, followed by the combination airplane-helicopter jobs of 1948. Acreages and costs are summarized. Discusses air and ground equipment and procedures that have been developed, together with ways for improving seed distribution.

(58) GLEASON, CLARK H.
* 1953. Indicators of erosion on watershed land in California. Amer. Geophys. Union Trans. 34 (3): 419-426, illus.

Describes some indicators of erosion which can be observed on watershed land and suggests the use of these indicators in comparable disturbed and undisturbed areas to determine whether or not erosion has been accelerated by the disturbance.

(59) ______
1955. Symposium on water conservation and use in California. Upstream water conservation. Calif. Conserv. Council, Berkeley, Nov. 15. 3 pp., illus. (Processed.)

After discussing the water supply and requirements of California the author shows that despite importation of water the State will have to rely on its own watershed lands for 90 percent of the water it needs in the forseeable future. Problems of watershed protection, repair, and improvement are discussed with relation to the several uses of land. Research needs and research already begun are outlined.

(60) GLEASON, CLARK H.
1957. Reconnaissance methods of measuring erosion. Jour. Soil and Water Conserv. 12 (3): 105-107, illus.

Describes the use of gully transects, spikes with washers, bottlecaps, and paint collars as reference points for measuring erosion at the place where it occurs.

(61) ______ and HERBERT, FRED W.
1954. Teaching the blind about soil. Soil Conserv. 20 (1): 12-15, 23, illus.

Describes techniques by which a group of 11 Boy Scouts, partially to totally blind, were led in study to successful completion of the requirements for the merit badge in Soil and Water Conservation.

(62) ______ and MacBEAN, DONALD G.
* 1949. Use of the helicopter for sowing mustard seed in burned areas of southern California. Jour. Forestry 47 (3): 192-195.

Describes the first use of a helicopter for seeding rugged mountain areas in California. On two seeding jobs in burned areas ranging from 1,450 to more than 5,000 feet above sea level the helicopter broadcast the seed evenly, with speed and precision. Testing techniques, operational data, seeding patterns, payload limits, and costs of sowing are given. From this experience it is concluded that the helicopter is a highly useful tool for seeding work because it can fly close to the ground in canyons too deep and narrow for safe operation of an airplane.

(63) ______ PACKER, PAUL E., and HOCKENSMITH, R. D.
* 1955. Watershed damage--its signs and causes. Amer. Forests 61 (6): 34-37, illus.

Suggesting that if people learn to recognize signs of watershed abuse they can act to prevent serious damage to the land and water resources, the authors give examples of damaged watersheds in the United States and relate these conditions to the land uses that were responsible.

(64) HAMILTON, E. L.
1940. San Dimas Experimental Forest. Southern Calif. Social Studies Rev. 16 (5): 10, 12-14, illus.

Describes the water problem in southern California, the experimental installations on the San Dimas Experimental Forest, and objectives of the research program being carried out on the Forest.

(65) ______
1943. A system for the synchronization of hydrologic records. Amer. Geophys. Union Trans. 1943 (2): 624-631, illus.

Describes how recording instrument charts on the San Dimas Experimental Forest are kept in step with each other by electrical time impulses sent hourly by a master clock at the field headquarters. Several widely distributed tipping-bucket rain gages send impulses over similar circuits to the headquarters. There, the impulses are amplified, through relays, and rainfall measurements of 0.02 inch are recorded on a strip chart having a separate space for each gage.

(66) ______
1944. Rainfall-measurement as influenced by storm-characteristics in southern California mountains. Amer. Geophys. Union Trans. 1944: 502-518, illus.

Studies to determine the total rainfall catch by mountainous watersheds indicated the need for supplementary research on rainfall characteristics and storm behavior. From observations of 173 storms which produced 251 inches of rain over a 7-year period, a representative sample of 60 storms was subjected to detailed study. Directional storm patterns were developed, and the angle of inclination of rainfall computed. The study indicated that southern California storms follow patterns which can readily be classified into groups having definite characteristics.

(67) ______
* 1947. The San Dimas tipping-bucket rain-gage mechanism. Amer. Met. Society Bul. 28 (2): 93-95, illus.

Describes an inexpensive tipping-bucket mechanism for the measurement of rainfall intensities. The unit can be installed in a standard 8-inch rain gage and the rainfall rates transmitted electrically to a suitable recorder. Featured are frictionless and non-corrodible electrical contacts.

(68) HAMILTON, E. L.
1949. Stem surface area determination [by] nomograph. Jour. Forestry 47 (1): 57, illus.

Use of the alignment chart described here avoids many computations formerly needed to determine the surface area of stems on a plant.

(69) ______
1949. The problem of sampling rainfall in mountainous areas. Berkeley Symposium on Mathematical Statistics and Probability. Proc.: 469-475, illus.

Deviations among the records from 200 rain gages on the San Dimas Experimental Forest suggested that the rainfall measuring techniques were faulty. Accordingly, studies were made of the accuracy of conventional rain gages, storm behavior, and the placement of gages for adequate rainfall sampling. It was found that the catch of conventional vertical gages was consistently low; gages tilted according to slope and aspect of the watershed were acceptably accurate. Direction of storm and velocity of wind were important causes of the deviations. Greater accuracy of rainfall measurement was obtained by using only 19 tilted gages, each one representing a facet of the watershed studied.

(70) ______
1950. The San Dimas Experimental Forest. U.S. Forest Serv. Calif. Forest and Range Expt. Sta. 16 pp., illus. (Processed.) Revised 1951 and 1952.

Describes water supply problems of southern California, the San Dimas Experimental Forest research programs, and the watersheds and equipment used for measuring precipitation, runoff, water yield, and soil erosion. Contains an annotated bibliography of publications by the Experimental Forest staff and colleagues.

(71) ______
1954. Rainfall sampling on rugged terrain. U. S. Dept. Agr. Tech. Bul. No. 1096. 41 pp., illus.

When the San Dimas Experimental Forest was established an extensive network of rain gages was set up according to the best known procedures. The accuracy of watershed rainfall measurements obtained from the conventional vertically placed gages was questioned. A series of experiments showed that a vertical gage did not accurately sample the rainfall actually reaching the ground, whereas a gage tilted and oriented to the slope gave a very good sample. Inadequacy of the vertical gage was related to the velocity of wind, which causes rain to be inclined as it falls.

(72) HAMILTON, E. L., and ANDREWS, L. A.
* 1951. San Dimas rainfall and wind velocity recorder. Amer. Met. Soc. Bul. 32 (1): 32-33, illus.

Describes a recorder for long-time records of wind velocity and rainfall. The device consists of a rotating vertical drum on which a magnetically operated pen traces a spiral line. The recorder will run for 8 days, and 75 feet of lineal record can be made on a 12 x 18 inch standard chart at a speed of $4\frac{1}{2}$ inches per hour. The pen is operated through a relay such that both wind velocity and rainfall are recorded simultaneously.

(73) ______ and ANDREWS, L. A.
* 1953. Control of evaporation from rain gages by oil. Amer. Met. Soc. Bul. 34 (5): 202-204, illus.

It is often impossible to service out-lying rain gages promptly after a storm, and appreciable water loss is likely to occur through evaporation. Evaporation can be prevented by putting transformer oil in the gage to form a layer 0.15 inch thick on the water surface.

(74) ______, REIMANN, L. F., and ANDREWS, L. A.
1952. Shock resistant lucite graduate. U. S. Forest Serv. Calif. Forest and Range Expt. Sta. Misc. Paper 9 3 pp., illus. (Processed.)

Describes the construction of a durable plastic graduate designed to measure rain-gage catch.

(75) ______ and ROWE, P. B.
1949. Rainfall interception by chaparral in California. Calif. Dept. Nat. Resources, Div. Forestry. 43 pp., illus.

Rainfall intercepted by shrubs was measured at 3 locations in California. In the central Sierra Nevada foothills, 81 percent of an average annual rainfall of 42 inches reached the soil as throughfall and drip from the brush cover, and 14 percent as flow down the stems; 5 percent was lost by evaporation from the vegetation. On another area in the same vicinity with a different type of brush cover, 8 percent was interception loss. In the San Gabriel Mountains of southern California, 81 percent of an average annual rainfall of 22 inches reached the soil as throughfall and 8 percent as stemflow; 11 percent was interception loss. Amounts of throughfall, stemflow, and interception loss varied directly with storm size.

(76) HELLMERS, HENRY, BONNER, JAMES F., and KELLEHER, JOHN M.
1955. Soil fertility: a watershed management problem in the San Gabriel Mountains of southern California. Soil Sci. 80: 189-197, illus.

Application of nitrogen to the shallow, undeveloped soils of the San Gabriel Mountains stimulated plant growth. The resulting increase in density of vegetation may aid in reducing the normally high soil erosion rate in these mountains.

(77) ______ HORTON, J. S., JUHREN, G., and O'KEEFE, J.
* 1955. Root systems of some chaparral plants in southern California. Ecology 36 (4): 667-678, illus.

The root systems of 68 plants, representing 18 species of shrubs and sub-shrubs, were studied. The relative importance of the different types of root systems is discussed in relation to the erosion and water-yield problems of watershed management.

(78) HENDRIX, T. M., and COLMAN, E. A.
* 1951. Calibration of fiberglas soil-moisture units. Soil Sci. 71 (6): 419-427, illus.

Units calibrated in field soil over a period of 15 months showed no indication of drift in relation between soil moisture content and soil-unit resistance. Field and laboratory calibration were in good agreement when laboratory calibration was made in a natural soil core, whereas laboratory calibration made in granulated soil repacked to field apparent density did not agree with field calibration.

(79) HOPKINS, WALT
1957. Watershed management considerations for sanitation-salvage logging in southern California. U. S. Forest Serv. Calif. Forest and Range Expt. Sta. Res. Note 121. 4 pp. (Processed.)

Saying "The watershed manager considers sanitation-salvage logging a help when it is done properly," Hopkins gives several practical suggestions for doing the work so as to minimize surface runoff and soil erosion.

(80) HORTON, J. S.
1941. The sample plot as a method of quantitative analysis of chaparral vegetation in southern California. Ecology 22 (4): 457-468.

To analyze the density of vegetation on a series of small chaparral-covered watersheds, 225 random milacre quadrats were measured. The data were segregated to show vegetative composition. Frequency distributions of vegetative densities were shown to be statistical curves other than normal. Size of plots had no significant influence on the results.

(81) ______
1949. Trees and shrubs for erosion control in southern California mountains. Calif. Dept. Nat. Resources, Div. Forestry. 72 pp., illus.

Discusses problems of erosion-control planting in the mountains of southern California. Fifty-eight species of trees and shrubs are described and their place in erosion control outlined. A section is also included on methods of planting.

(82) ______
1950. Effect of weed competition upon survival of planted pine and chaparral seedlings. U. S. Forest Serv. Calif. Forest and Range Expt. Sta. Res. Note 72, 6 pp. (Processed.)

The effect of competition between annual plants and planted trees and shrubs was studied in 1944 on the San Dimas Experimental Forest. These plantings were made in an area adjacent to lysimeters to develop the proper method of establishing the desired vegetation. The study has shown that under conditions of summer drought, good survival of planted stock is dependent upon removal (at least during the first season) of competing annual grasses and herbs.

(83) HORTON, J. S., and KRAEBEL, C. J.
1955. Development of vegetation after fire in the chamise chaparral of southern California. Ecology 36 (2): 244-262, illus.

Describes periodic observations of plant succession after fire, on permanently marked plots. The study was continued for 25 years, through the period of rise and decline of temporary vegetation, until the permanent shrubs again dominated the burned area.

(84) ______ and WRIGHT, J. T.
1944. The wood rat as an ecological factor in southern California watersheds. Ecology 25 (3): 341-351, illus.

The wood rat is one of the most abundant rodents of the chaparral. Feeding habits of this animal exert no appreciable influence on chaparral cover because leaf and stem material, rather than seeds of the common chaparral shrubs, forms the bulk of its diet. However it does make heavy use of acorns at elevations above 4,500 feet.

(85) ILCH, D. M.
1952. Some limitation on the use of succulents for erosion control. Jour. Soil and Water Conserv. 7 (4): 174-176, 196, illus.

"Why not plant succulents?" is a question often asked by persons concerned about erosion in the mountains of southern California. Noting that deer, rodents, and low temperatures threaten the success of plantings, Ilch lists 15 criteria that limit the choice of plants for erosion-control work. Of 35 species of succulents appraised according to these criteria, 8 species were found suitable for field testing. Test plantings fenced against deer and rabbits showed that 4 species of Mesembyranthemum have some value for erosion control when restricted to elevations below 3,500 feet.

(86) JOHNSON, PAUL B.
1943. A nomograph for the integration of streamflow records. Civ. Engin. 13 (10): 494-495, illus.

The conversion of streamflow rates to total volume of water for given periods of time was facilitated by a nomograph which also contained a means for ready determination of the decimal point.

(87) ______
1944. Instrument for measuring stream flow. Civ. Engin. 14 (12): 523-524.

Discussing the paper "Velocity-Head Rod Calibrated for Measuring Stream Flow" by Wilm and Storey (199), Johnson points out possible sources of error in computing the data, and comments on the measures of accuracy and terminology employed by the authors.

(88) ______ and STOREY, HERBERT C.
1948. Instrument facilitates setting of weir zero values. Civ. Engin. 18 (11): 41-42, illus.

The instrument described in this paper was designed for rapid and easy determination of the zero value on 90-degree V-notch weirs. A similar instrument could be used for weirs of different angles. It is simple to make, rugged, highly accurate, and requires little skill to use.

(89) KOTOK, E. I.
1930. Influence of forest cover on water supply; investigations relating to south coastal basin, conducted or proposed by the California Forest Experiment Station. Calif. Dept. Pub. Works. Div. Water Resources Bul. 32. pp. 26-33.

Stating that studies of the relation between water supply, plant cover, and land treatment are essential to the development of a water resource management plan for southern California, Kotok describes the work of the California Forest Experiment Station in the South Coastal basin at that time.

(90) ______
1931. Erosion: a problem in forestry. Jour. Forestry 29 (2): 193-198.

The necessity of maintaining a soil cover to check erosion, aside from its effect on water conservation, is emphasized as a problem requiring careful study. On badly eroded land the forester will have the dual job of devising means to check erosion and start a new forest.

(91) KOTOK, E. I.
1931. Relation of forest management to water resources. Jour. Forestry 29 (3): 432-442.

A report to the Hoover-Young Commission on Water Resources, describing forest and wild lands as the principal source of water in California. Summarizes the area, character of cover, and ownership of these lands. Discusses the relationship of land management to the water crop, and the obligations of federal, state, and local agencies for watershed management. Cites preliminary results of studies showing that the destruction of plant cover by burning, overgrazing, and lumbering may greatly accelerate surface runoff and erosion. It states the need for expanded studies on the problems of water and forests, and for men technically trained to carry on this work.

(92) ______
1931. Vegetative cover, the water cycle and erosion. Agr. Engin. 12 (4): 112-113.

Reviewing the controversy between foresters and engineers over the effects of forest cover in regulating a streamflow and preventing floods, Kotok cites George Marsh's work "Man and Nature" (1863) as the first to recognize accelerated erosion as a prime destructive force in watershed management. Kotok discusses the Wagon Wheel Gap experiment and reviews Lowdermilk's experiment that showed the value of plant litter in aiding infiltration and preventing accelerated runoff and erosion. In California, Kotok concludes, plans for the state-wide water system require quantitative knowledge of plant cover as a safeguard against accelerated erosion.

(93) ______
1932. Solving the forest and water riddle. Amer. Forests 38 (9): 488-491, illus. Also published as Solving the water riddle. Illus. Canad. Forest and Outdoors 28 (11): 415-418.

After explaining the basic reasons for different opinions about the effects of forest cover on flood flows, Kotok surveys the scope and seriousness of land abuse in the United States. Examples of erosion accelerated by the white man's use of the land are cited. Against this background Kotok points out that plant cover, which he terms the keystone of conservation, must be maintained on forest and range lands in order to keep rivers and harbors navigable and to protect our water resources. He calls for a coordinated land policy to make effective conservation possible.

(94) KOTOK, E. I.

1934. The work of the California forest experiment station in southern California. Conserv. Assoc. Los Angeles County. Flood Control Conf. Proc. 1934: 27-31. (Processed.)

Kotok describes the Station's forest research program underway in 1934 in southern California. Included were studies of the relations between plant cover, erosion, and water yield; the forest vegetation survey; and studies of forest fire detection, communication, and control.

(95) ______

1935. Forest influences studies at the San Dimas Experimental Forest. Conf. on water conserv. Amer. Soc. Civ. Engin. Irrigation Div. Los Angeles, Prog. Report 1935: 80-82.

Referring to a watershed as a dynamic, living entity of complicated character, Kotok suggests that the job of the forester is to protect and develop the productive forces in a watershed, while that of the engineer is to capture and put to use the water that is surplus. Some experimental approaches to watershed management problems are outlined. The San Dimas Experimental Forest will be a proving ground for the use of both foresters and engineers.

(96) ______

1938. Watershed-management from the viewpoint of the forester. Amer. Geophys. Union Trans. 1938 (2): 629-634.

Describes the role of vegetation in the water cycle, and the changes induced by man's occupancy of the land. In view of the sometimes unfavorable results of grazing, burning, logging, mining, and cultivating, scientists are called on to discover the facts that foresters need to provide good watershed management.

(97) ______

1938. Regulating the uses of private land - an essential function of modern government. First Pacific Southwest Planning Conf. Proc. 1938: 36-41. (Processed.)

Kotok pointed out the inter-relationships between land use, stabilized water flow, and soil fertility, and advocated democratic formulation and enforcement of rules that will prevent land abuse.

(98) KOTOK, E. I.

1939. Some economic problems in Pacific Coast forestry. 17th Ann. Conf. Pacific Coast Econ. Assoc. Proc. 1938: 90-94.

Reviews the recreation, grazing, and watershed protection values of forest land, and the problems created by cut-out-and-get-out lumbering. Kotok stated that the public must ensure the protection of all watershed values regardless of land ownership, and suggested ways by which management can be improved: (1) by giving public cooperation and aid to private land owners, (2) by public acquisition of important watershed lands, and (3) by public regulation of forestry operations.

(99) ______

1939. Watershed management for water production. South. Calif. Water and Soil Conserv. Conf., Los Angeles, Calif. Nov. 9, 1939: 1-4. (Processed.)

Kotok discusses the history, status, and needs of watershed-management work and reviews the significant federal legislation, from creation of the Forest Reserves in 1891 to the Flood Control Act of 1936. He defines a watershed and lists watershed-management objectives. In the early stages of watershed management, he says, much work will go toward curbing destructive land uses and healing the sore spots created by past abuses, as shown by Swiss, Austrian, and French experience. At the same time we must carry on research to gather the factual data needed before we can write a watershed management prescription for any given parcel of land.

(100) ______

* 1940. The forester's dependence on the science of meteorology. Amer. Met. Soc. Bul. 21 (9): 383-384. 21 (10): 397-406.

The author reviews the early history of forest meteorology in Europe as background for presenting American problems. He discusses the need for meteorological information to help solve problems of timber production and management; studies of weather with respect to forest fire behavior and control; and the relation of forest cover to streamflow. A bibliography of 59 titles on forest meteorology is included.

(101) KOTOK, E. I., KELLEY, EVAN W., EVANS, C. F., and KIRKLAND, BURT P.
1933. A national plan for American forestry. Ownership responsibilities, costs, and returns. Senate Document 12, 73rd Congress. 2 vols. Vol. 2: 1303-1328.

Known popularly as The Copeland Report, this publication described the status of forest, range, and watershed management at the time, and presented a national plan for the development and utilization of wild lands. In the section on land ownership the authors point out that inherent in ownership is the responsibility of stewardship for the land. They estimate future costs and returns from federal, state, and private forest lands, and conclude that after the 50 to 80 years required to bring depleted forest areas back to full production, the nation's forests could continue indefinitely to support their quota of business activity, employment, and the many services which no other resource can replace in full.

(102) ______ and KRAEBEL, C. J.
1936. Discussion of Flood and erosion control problems and their solution, by E. Courtlandt Eaton (Amer. Soc. Civ. Engin. Proc. 61 (7): 1021-1049; also in Trans. 101: 1302-1330). Amer. Soc. Civ. Engin. Proc. 62 (3): 423-428; also in Trans. 101: 1350-1355, illus.

Commenting on Eaton's statement that the natural cover of vegetation affords the best protection against erosion debris, Kotok and Kraebel point out that adequate plans for watershed management require quantitative data on the influence of different types and conditions of forest cover upon soil and water movement. The authors present runoff and erosion measurements from unburned watersheds in the San Dimas Experimental Forest and its vicinity for comparison with data from burned areas reported by Eaton. Forest Service use of a mustard cover-crop to reduce erosion in burned-over watersheds is described.

(103) KRAEBEL, C. J.
1930. The Barranca watershed study. Conference on research problems in consumptive use of water and conservation of rainfall. Amer. Soc. Civ. Engin., Irrigation Div., Committee on Conserv. of Water. Proc. 1930: J 1-7 (Processed.)

Describes the first California installation for measuring rainfall on a watershed and relating it to runoff and sedimentation measured at the canyon mouth. The 44-acre Barranca watershed on the south face of the San Bernardino Mountains, burned-over in 1925, was equipped with 7 rain gages, a Parshall flume, and a catchment basin with a Friez water stage recorder. This study was helpful in devising installations for the new San Dimas Experimental Forest in 1933. (Plant succession in the Barranca burn was studied for several years as reported by Horton and Kraebel in 1955.)

(104) KRAEBEL, C. J.
1931. Forestry well represented at western scientist meeting. Jour. Forestry 29 (4): 626-627.

Reports the Ecology session of the American Association for the Advancement of Science meeting at Stanford University in December 1930. The program consisted of 8 papers by forestry workers of the University of California and the California Forest Experiment Station. Forest influences were discussed by 3 Station authors: W. C. Lowdermilk on the effectiveness of rainfall for human use as governed by land condition; H. L. Sundling on runoff and erosion as influenced by steepness of slope; and C. J. Kraebel on plant succession, runoff, and erosion following fire in the chaparral of California.

(105) ______
1933. Willow cuttings for erosion control. U. S. Forest Serv. Calif. Forest and Range Expt. Sta. Tech. Note 1. 3 pp. (Processed.)

Willows growing in the right places can help control erosion in range meadows, reinforce small dams, protect bridge abutments, and stabilize road slopes. The author tells how to make cuttings as a simple means of establishing willows at selected spots and using them as stakes for mechanical anchorage. Species to use and time to plant are discussed broadly.

(106) ______
1933. Erosion control on mountain roads, a preliminary manual of procedure. U. S. Forest Serv. Calif. Forest and Range Expt. Sta. 6 pp., illus. (Processed.)

Recognizing the severity of erosion accelerated by road construction in the mountains, the author describes a few simple methods of preventing such erosion on overcast road slopes. Guidelines are given for determining what kinds of slopes need treatment, together with suggestions of what to sow and plant. Methods of road slope treatment are illustrated by sketches and photographs.

(107) KRAEBEL, C. J.
1933. Use of willows to control erosion. Ala. Forest News 7 (10): 2-3.

After describing the usefulness of willow cuttings as a quick and effective means of establishing plant cover to stabilize soil, Kraebel gives specific suggestions on where and when to plant cuttings, and how to prepare and set them in place.

(108) ______
1934. Study of the New Year's storm by the California Forest Experiment Station. Flood Control Conf. Conserv. Assoc. Los Angeles County. Proc. 1934: 3-11. (Processed.)

Discusses technical aspects of the rainstorm that caused the La Crescenta-Montrose flood of New Year's 1934. Describes characteristics of the storm and refutes the theory that a cloudburst was responsible for the flood. Compares runoff and erosion rates from burned and unburned watersheds in this storm, and from plots used for runoff and erosion studies. Concludes that such floods are caused by a sequence of severe fire followed by intense and heavy rainfall.

(109) ______
1934. The La Crescenta flood. Real origin of California's New Year catastrophe traced to mountain slopes recently swept by fire. Amer. Forests 40 (6): 251-254, illus.

Tells the story of the 1934 flood at La Crescenta and Montrose, caused by 12.6 inches of rain falling in 38 hours on chaparral slopes recently denuded by forest fire. Maximum rain intensity of 0.94 inches in 1 hour was recorded, far below the 4-inch intensity of a cloudburst as defined in the U. S. Weather Bureau glossary. Tabulations compare the high runoff and erosion rates in the burn with the low rates from adjacent unburned watersheds, demonstrating the regulatory influence of the brush cover.

(110) KRAEBEL, C. J.
1934. The erosion problem in land use. Paper for Land use series, station KPO San Francisco. August 14, 1934. 6 pp. (Processed.)

After distinguishing geologic and accelerated erosion, the author discusses causes of acceleration, such as cultivation, grazing, mining, and burning, and shows how careless land use leads to destructive erosion, deposition, and floods. Kraebel concludes that intelligent use of both public and private land is required to prevent damage from deposition and floods, and to conserve the soil.

(111) ______
1934. Erosion control on mountain roads. Outline of procedure in the control of erosion on road slopes. U. S. Forest Serv. Calif. Forest and Range Expt. Sta. 3 pp. (Processed.)

To meet an urgent need for guidance of road construction and maintenance workers, this revision of the 1933 manual with the same title contains a 3-page outline of job procedure, revised sketches showing methods, a chart of slope gradients in degrees and percent, and suggestions for improvements in berm construction.

(112) KRAEBEL, C. J.
1935. Forest cover proved a controlling factor in flood prevention. U. S. Dept. Agr. Yearbook 1935: 202-206, illus.

Reports Forest Service watershed studies in California showing that the destruction of natural forest or brush cover may lead to destructive erosion and floods. The La Crescenta-Montrose flood, which originated on a fresh burn, is described, and its rainfall, runoff, and erosion data are given. From comparative measurements in burned and unburned areas it is concluded that this flood was primarily the result of burning, and that maintaining good watershed plant cover is the best means of preventing such floods and excessive reservoir sedimentation.

(113) ______
1935. Runoff and erosion experiments in mountain areas. Conf. on water conserv., Los Angeles Sect., Amer. Soc. Civ. Engin., March 13-14, 1935. 17 pp. (Processed.)

Reports rainfall, runoff, and erosion measurements in 1933 and 1934 from burned and unburned watersheds in and near the San Dimas Experimental Forest; from small burned plots in Los Angeles and San Bernardino Counties; and from plots and lysimeters at North Fork and Berkeley, Madera and Alameda counties. The author points out that despite variations in data from the several sources, vegetation and litter were shown to have a powerful effect in reducing surface runoff, controlling erosion, and inducing infiltration. He concludes that large-scale experiments over a considerable period of time are needed for quantitative determination of the influence of forest cover upon the water cycle.

(114) ______
1935. Plant lists and planting districts for the California region. Excerpt from "Erosion Control on Mountain Roads". 16 pp., illus. (Processed.)

Lists native trees, shrubs, and other plants suitable for use in erosion control and scenic restoration along mountain roads in California. Describes for each species its natural habitat, the section of the state to which it is adapted, the best position for it on a road slope, and how to propagate it.

(115) KRAEBEL, C. J.
1936. Report and recommendations for fire and flood control in Hollywood Hills and Santa Monica Mountains. San Antonio Canyon burn of September 16, 1935. Santa Monica Mountains Fire Prevention Assoc. pp. 23-25. (Processed.)

Forecasts flood danger in San Antonio Heights and Upland, California, resulting from watershed denudation by the recent San Antonio fire. The homes, properties, and general areas subject to damage by flood flows and debris from the burned area are identified. Notable as the first public warning of flood hazard in specific areas, resulting from watershed denudation by fire in southern California.

(116) ______
* 1936. Erosion control on mountain roads. U. S. Dept. Agr. Cir. 380. 45 pp., illus.

The author sums up and expands material published earlier on the same subject, making it a reference manual for use wherever erosion problems are met on road overcast and fill slopes. Discussed are criteria for road location, improved alignment, use of retaining walls and cribbing, placement of excess material, use of tunnels and bridges, and improved drainage practices. The section on control measures for existing roads takes up problems of drainage and

describes the techniques of staking, wattling, sowing, and planting slopes. Needs for maintenance of structures and plant cover are discussed. Appendixes give examples of road erosion in California; specifications for labor, equipment, and materials for control work; an outline of procedure in wattling slopes; specimens of standard forms for keeping reconnaissance and cost records; lists of plants for use in different parts of California; and notes on handling and sowing seed.

(117) KRAEBEL, C. J.
1940. Reduction in debris load through soil conservation and watershed management. South. Calif. Coastal Drainage Basin Com., National Resources Planning Board, Region 8, Proc. Report 18: 20-23.

Discussing the possible effect of U. S. Department of Agriculture flood control programs in cutting off the supply of sand needed to perpetuate California's ocean beaches, Kraebel suggests that if the rate of sand delivery is found to be reduced materially it should be feasible to increase the yield by dedicating selected small watersheds to sand production and denuding them of their chaparral cover to accelerate erosion.

(118) ______
1950. Forestry and flood control in Japan. Gen. Hdqrs. Supreme Commander Allied Powers, Natural Resources Sect. Prelim. Study 39, Tokyo, Japan. 31 pp., illus. (Processed.)

The role of forests in reducing flood damage is reviewed, and the needs for watershed plans and improvements in Japan are summarized.

(119) ______
* 1955. Conquering Kennett's gullies. Amer. Forests 61 (12): 36-39, 42, 44, illus.

Describes the killing of forest cover by smelter fumes 50 years ago in northern California, subsequent erosion of the bared slopes, studies that developed successful methods of reforestation and erosion control, and recent application of the methods on the area.


36318

(120) KRAEBEL, C. J., and KELLOGG, L. F.
1938. The forest guardians of our watersheds. Jour. Forestry 36 (9): 858-60.

Commemorating the 10th anniversary of the McSweeney-McNary Forest Research Act under which forest and range experiment stations were established in the United States, the Journal of Forestry for September 1938 was devoted to articles describing forest research progress made possible by the Act. Kraebel and Kellogg reported water-yield studies showing that runoff and erosion are accelerated by watershed denudation through careless land use and burning. They point out the need for expanded research to answer important watershed management questions.

(121) ______ and PILLSBURY, ARTHUR F.
1933. Use of vegetation for erosion control in mountain meadows. U. S. Forest Serv. Calif. Forest and Range Expt. Sta. Tech. Note 2. 13 pp., illus. (Processed.)

Noting that structures commonly built for erosion control in mountain meadows are temporary, the authors recommend establishing vegetation to take over permanent control. The vegetation may be established by planting cuttings, sodding, or wattling an area. Wattles can be made of hay or pine needles, or of cut brush reinforced with willow stakes. Practical suggestions are given for selecting the materials to be used, and for doing the planting, seeding, and staking.

(122) ______ and PILLSBURY, ARTHUR F.
1934. Handbook of erosion control in mountain meadows. U. S. Forest Serv. Calif. Forest and Range Expt. Sta. 69 pp., illus. (Processed.)

The use of structures and vegetation for control of gullies in mountain meadows is described, and the process and causes of accelerated erosion are discussed. Separate chapters take up specifications for materials to be used, the design and construction of gully-head controls, location and construction of check dams, control of channels, and the selection and establishing of vegetation by cuttings, sod, wattles, and seeding. Sample forms for keeping cost records are included.

(123) KRAEBEL, C. J., and SCHUMACHER, F. H.
1937. Notes on collecting and handling seeds of native California plants. U. S. Forest Serv. Calif. Forest and Range Expt. Sta. 2 pp. (Processed.)

Describes equipment and techniques helpful in collecting, cleaning, and storing the seeds of native wild plants for erosion control and landscaping use.

(124) ______ and SINCLAIR, J. D.
1940. The San Dimas Experimental Forest. Amer. Geophys. Union Trans. 1940 (1): 84-92, illus.

An article describing the experimental forest, its installations, and the kinds of studies under way. Data collected during 6 years of operation are summarized.

(125) LOWDERMILK, W. C.
1927. A method for rapid surveys of vegetation. Jour. Forestry 25 (2): 181-185.

Describes the milacre plot as a means of sampling the restocking of forest stands, their species composition, and conditions on the forest floor. The discussion covers reasons for choice of the milacre unit, procedures for the 2-man crew needed in cross-country work, the form for recording field data, and the low probable error of the method.

(126) ______
1927. The third Pan-Pacific Science Congress under the auspices of the National Research Council of Japan. Jour. Forestry 25 (7): 873-884.

The author describes attendance, program, and facilities at the Congress, which he attended as a delegate of the Society of American Foresters. Lowdermilk's paper on "Factors Influencing the Surface Run-off of Rainfall" was followed by the passage of a resotion by the Congress" ... recommending the restriction of cultivation to lands with gradients safe from erosion; a systematic studies to determine the safe gradients for cultivation of sloping land; the terracing of lands to maintain safe gradients; and the maintenance of all other lands in a cover of vegetation." The report closes with appraisals of the progress of science in Japan, the significance of the Congress, and the contribution that such meetings can make toward world peace.

(127) LOWDERMILK, W. C.

1928. Forest litter aids in conserving water for California farms. U. S. Dept. Agr. Yearbook, 1928: 326-327.

Noting that water is the limiting factor in the development and growth of California, Lowdermilk recognizes the need for more storage facilities, but points out that the principal source of water for agriculture will continue to be wells tapping the great underground basins of California's valleys. Controlled experiments show, he reports, that muddy water will not percolate effectively to recharge underground basins, and that maximum recharge is achieved by keeping streamflow clear.

(128) ______

1928. The water cycle; a discussion of theoretical considerations and the point at which practical application may be made. Jour. Forestry 26 (3): 352-354.

In this paper Lowdermilk analyzes the sources of rainfall, the water cycle in nature, and the best point at which man can act to regulate the cycle for his own benefit. Theoretically, he says, man cannot control the moisture brought by cyclonic winds from the ocean to the land. Practically, however, man can control the moisture at the point where rain strikes the land surface--where it becomes either surface flow or seepage. Calling vegetation "... our most dependable ally in the control of the absorption of precipitation waters", Lowdermilk points out that the destruction of vegetation and conditions for its regrowth may cause great acceleration of erosion. Measuring the extent of erosion acceleration, he says, gives us an index to the extent of our control over precipitation.

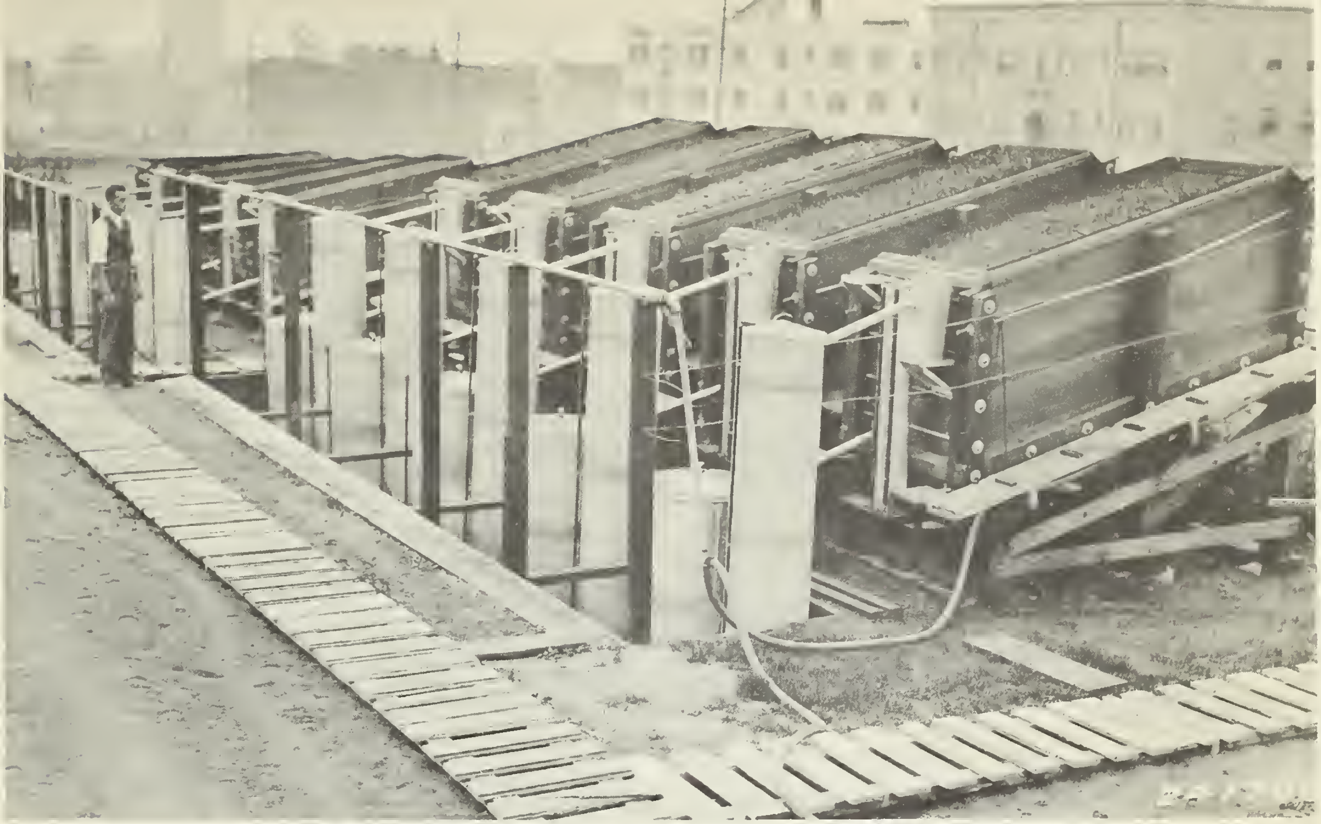
(129) ______

1929. Erosion in the Orient as related to soil conservation in America. Amer. Soc. Agron. Jour. 21 (4): 404-414.

Lowdermilk describes soil erosion and floods in China, Japan, and Korea, and points out that the severely damaged watersheds of China lacked controlled land management through the centuries.

(130) ______

1929. Further studies of factors affecting surficial runoff and erosion. Internatl. Cong. Forestry Expt. Sta. Proc. 1929: 606-628, illus.



After referring to previous attempts, dating from 1841, to measure the effects of plant cover upon surface runoff, erosion, and infiltration, the author reports findings of plot studies at Devil Canyon, in southern California, then describes the Berkeley experiment which was designed to measure the influence of forest litter on rainfall disposition. At Berkeley soil-filled tanks were used and artificial rain was provided. Runoff from tanks with burned-over, bare soil was 3 to 30 times that from tanks with litter-covered soil. Erosion from the bare soil was 50 to 6,000 times as great as from the covered soil. The "sponge" effect of forest litter in absorbing rainfall was found unimportant in comparison with the ability of the litter to maintain the maximum infiltration capacity of a soil profile. How the litter accomplished this was shown by a separate experiment in which muddy and clear waters were led to pass through columns of soil. The muddy water percolated at a small fraction of the rate for clear water, owing to the deposition of suspended particles that tended to seal the soil surface. This proved the previously unrecognized function of forest litter in stabilizing the soil surface, thus keeping rainwater clear, and maintaining the soil's infiltration capacity.

(131) LOWDERMILK, W. C.
1930. Forestry in denuded China. Amer. Acad. of Polit. and Social Sci. Ann. 152: 127-141.

Writing after extended studies in North, Central, and South China as Research Professor of Forestry at the University of Nanking, Lowdermilk explains the shortage of wood material in once-forested areas, the critical erosion problems resulting from land abuse, and the elements of a conservation program needed to restore the forests and soil stability.

(132) ______
1930. Studies of factors affecting the yield of water from watersheds in southern California. Amer. Soc. Civ. Engin. Irrigation Div. Com. on Conserv. of Water. Conf. on research problems in consumptive use of water and conservation of rainfall. Proc. 1930: H 1-22. (Processed.)

Lowdermilk analyzes and discusses the sources and disposition of meteoric waters. He describes the use of plots and soil-filled tanks for measuring runoff and erosion, and reports studies showing how plant litter aids the entry of rainwater into the ground. Turning to the consumptive use of water, the author describes its processes and explains the marked difference in water use between chaparral growing on the mountain slopes and broad-leaved trees growing along the stream channels. He suggests the installation of pipelines in mountain canyons to carry the flow and prevent evaporation and transpiration. Throughout the discussion he notes points requiring further study. The literature cited lists 30 titles that date back to 1853.

(133) ______
1930. Influence of forest litter on run-off, percolation, and erosion. Jour. Forestry 28 (4): 474-491, illus.

Runoff and erosion findings from burned and unburned plots at Devil Canyon, in southern California, confirmed the author's earlier plot studies in China. Surface runoff and erosion were found to be considerably less on plots with chaparral cover than on burned plots, and infiltration was greater. The author also describes techniques and findings of the Berkeley experiment reported in 1929 at Stockholm (130).

(134) LOWDERMILK, W. C.
1930. An analysis of factors affecting the yield of water from watersheds in southern California. U. S. Forest Serv. Calif. Forest and Range Expt. Sta. 12 pp. (Processed.)

Processes that affect the supply and disposition of meteoric waters (rain, snow, cloud drip, fog drip, and intrasolum condensation) are discussed. The author concludes that rain and snow are the most important water sources requiring study. He emphasizes the need for more experimental information on the disposition of rainfall with respect to streamflow, and suggests specific studies of water use by plants, particularly the chaparral and riparian vegetation of southern California. This analysis was basic to planning and establishing the San Dimas Experimental Forest, and starting the research now under way there.

(135) ______
1931. Managing brush and forest lands primarily for yield of irrigation water. 2d National Water Users Conf. San Francisco, February 9-11, 1931. 14 pp., illus. (Processed.)

Stating that "Water is becoming more and more the chief natural product from the mountains of western United States", Lowdermilk presents a comprehensive review of watershed management--its importance; establishment of the National Forests to protect both water and timber supplies; questions about the relations of plant cover to water yield; and the studies under way and planned to answer these questions. He continues with a discussion of the complexity of problems to be solved; analysis of the supply and disposition of meteoric waters; findings about runoff, erosion, retention, and evapo-transpiration; and the importance of making a full accounting of evaporation and transpiration losses. Water balance sheets for several experimental areas are included.

(136) ______
1931. Studies of the role of forest vegetation in surficial run-off and soil erosion. Agr. Engin. 12 (4): 107-112.

Lowdermilk explains the interdependence of vegetation and soil, the geologic norm of erosion, accelerated erosion, the formation of erosion pavement, and the reasons for using runoff plots instead of entire watersheds to measure specific factors affecting surface runoff and soil erosion. The instrumentation of plots and soil tanks (now called lysimeters) used at Berkeley and North Fork is described, and the results of experiments showing the relation of runoff to slope of the ground and intensity of rainfall are presented. Lowdermilk concludes that the highest community interest, in the long run, will be served by discovering and specifying the conditions under which land may be cultivated or used otherwise without inducing accelerated erosion.

(137) LOWDERMILK, W. C.
1933. Comments on The water conservation problem in forestry, by C. L. Forsling, (Jour. Forestry 31 (2): 177-184). Jour. Forestry 31 (2): 185-188.

Forsling's paper, on which Lowdermilk comments, sums up the effects of plant cover depletion on runoff, erosion, and floods, and suggests the restoration of plant cover as the only economical means of restoring depleted soils over large areas.

Lowdermilk expresses agreement with Forsling's conclusions and then discusses aspects of the subject that require special consideration. He calls for watershed research not only on forest lands but on all wild lands and submarginal farm lands. He discusses the relation of forest vegetation to water yield and refutes certain conclusions in the Hoyt-Troxell report on forest burning and streamflow.

(138) ______
1933. Studies in the role of forest vegetation in erosion control and water conservation. 5th Pacific Sci. Cong. Proc. 5: 3963-3990.

After reviewing the status of knowledge on the relation of forest vegetation to climate and streamflow, Lowdermilk notes that contrary conclusions as to several aspects of the relation have been reached by serious students. These divergent conclusions result, he says, from a misunderstanding of the basic factors affecting streamflow. To resolve the differences, Lowdermilk proposes studies of the hydrologic processes in undisturbed and disturbed areas suitable for comparison. He defines geologic and accelerated erosion, analyzes the supply and disposition of precipitation, and describes runoff and erosion studies made in China and in California. From these studies he concludes that the destruction of plant cover by fire, grazing, cultivation, or other land uses, reduces infiltration, increases surface runoff, and accelerates soil erosion. In regions of critical water supply, he says, the management of watersheds for maximum beneficial yield of water must become paramount.

(139) LOWDERMILK, W. C.

1933. Forests and streamflow, a discussion of the Hoyt-Troxell report. Jour. Forestry 31 (3): 296-307. (Also in Amer. Soc. Civ. Engin. Proc. 59 (3): 484-490.)

Hoyt and Troxell concluded that after denudation of mountain watersheds in Colorado and southern California (1) total runoff was increased, (2) more than half of the increase occurred in non-flood periods, (3) maximum daily discharge was increased, (4) summer runoff was increased, (5) summer minimum flows were increased and prolonged, (6) winter minimum flows in Colorado were not affected, and (7) erosion was increased by surface runoff. From these results they deduced that (a) forest maintenance for "conservation of the water supply" may have an effect opposite to the one desired, and (b) where water supply is a controlling economic factor, careful study is needed as to whether the acknowledged benefits of maintaining forest cover may not be outweighed by the water consumed by forest growth.

Lowdermilk reviews the Colorado and southern California studies reported, and analyzes the authors' interpretation of geologic, soil, and vegetation factors and watershed treatment. He points out that the "denuded" watershed in Colorado was never really denuded. He notes inadequacies in the measurement of rainfall in the southern California study and the authors' failure to distinguish chaparral vegetation growing on the drained soils of mountain slopes from the riparian vegetation that grows within reach of abundant water in the stream bottoms. Lowdermilk states that destruction of the riparian vegetation stops transpiration and causes an immediate increase in streamflow; but this is not true of slope soils because they drain quickly to field capacity and no water is available for release to streamflow when the vegetation is removed by summer fires. In view of the importance of the questions raised, particularly in southern California, Lowdermilk calls for a thoroughly executed study to answer the questions raised by the findings of Hoyt and Troxell.

(140) ______

1933. Considerations in measurement of yield of snow packs in percolation water. Western Interstate Snow Survey Conf. Proc. 1933: 35-37.

As a basis for research on water yield, Lowdermilk analyzes problems of measuring the influence of plant cover upon water yield, and notes the special difficulties encountered when precipitation occurs as snow. He lists the sources and disposition of precipitation, noting that the most important losses result from evaporation and transpiration. To measure these losses he proposes using a "rain retention pan". The pan is described as a rectangular tank exposed to catch snow and equipped for collecting and measuring snow melt, evaporation to be calculated as precipitation minus runoff and percolation.

(141) LOWDERMILK, W. C., and ROWE, P. B.
1934. Still further studies on absorption of rainfall in its relations to surficial runoff and erosion. Amer. Geophys. Union Trans. 15th Ann. Mtg. 1934: 509-515.

Reports runoff and erosion data for 6 major storms in the period 1929-30 to 1933-34 as measured by 1/40-acre plots at North Fork, California. The data show that (1) undisturbed plant cover maintains the soil in condition to absorb rainfall of heavy intensity, (2) baring the soil by fire causes increased surface runoff, and (3) owing to increased surface runoff, soil erosion is greatly accelerated.

(142) ______ and SUNDLING, H. L.
1950. Erosion pavement, its formation and significance. Amer. Geophys. Union Trans. 31 (1): 96-100, illus.

Describes the experimental production of erosion pavement on lysimeters at Berkeley under conditions of artificial rainfall. Shows by size analysis of eroded soil particles that pavement results from the progressive removal of finer particles, leaving pebbles and stones on the soil surface.

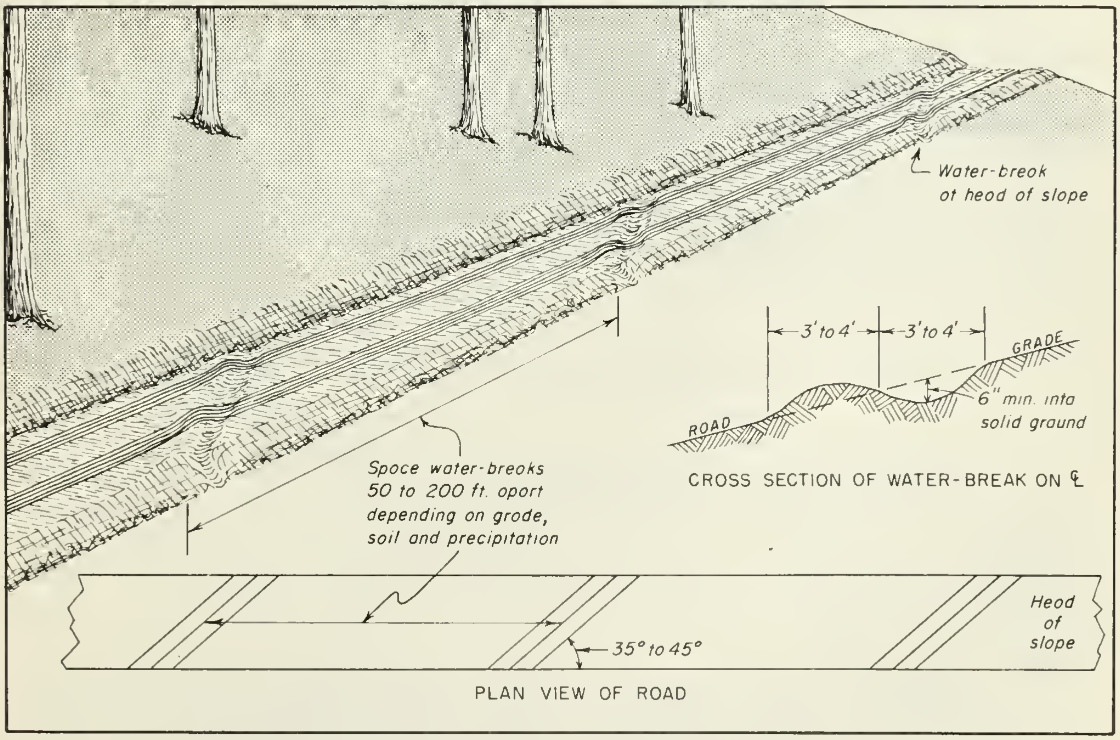
(143) MAEVERS, M.
1951. Discussion of Economic effects of reservoir sedimentation by William E. Corfitzen (Amer. Soc. Civ. Engin. Trans. 116: 1109-1114). Amer. Soc. Civ. Engin. Trans. 116: 1116-1118.

The Corfitzen paper sets forth three methods of computing sedimentation damage: The annual cost method, the present worth method, and the capitalized cost method. For large reservoirs Corfitzen favors the capitalized cost method for calculating the economy of reservoir replacement.

Maevers discusses the concept of public loss resulting from sedimentation of large reservoirs and analyzes the considerations that affect the cost of furnishing permanent water service. He concludes that either (1) "...a plan for perpetuating the services of a reservoir will justify its execution" or (2) the cost of a remedial plan is less than the cost to liquidate the economy created by the original dam. In the first case, he says, the plan provides a true benefit to society; in the second, it only minimizes the loss to society.

(144) McROREY, R. P., MEADOWCROFT, N. F., and KRAEBEL, C. J.
1954. A guide to erosion reduction on national forest timber sale areas. U. S. Forest Serv., Calif. Region. Revised 1955. 78 pp., illus. (Processed.)

Outlines factors influencing watershed conditions in logging areas. Discusses watershed damage caused by incorrect logging practices. Describes road building and logging practices designed to preserve the stability of soil and stream channels.



(145) MIROV, N. T.
1936. Germination behavior of some California plants. Ecology 17 (4): 667-672.

In connection with the Station's work on how to use native California plants for soil stabilization on road-banks, Mirov made an extensive study of seed dormancy. Studies were made of the germination of 300 species in relation to their taxonomic position, altitudinal distribution, and growth form. No relation was found between germination and taxonomic position, although certain tendencies were indicated within families. A relation was found between germination and altitudinal distribution. Delayed germination was governed by seed coat conditions, need for afterripening, or a combination of both.

(146) ______
1936. A note on germination methods for coniferous species. Jour. Forestry 34 (7): 719-723.

To explain the erratic germination of certain conifer seeds, Mirov studied procedures and compared the results of germination tests, cutting tests, and staining tests. He found that stratification of seed from 9 species of conifers raised the average germination from 20 to 57 percent. The greatest response was obtained with Digger pine (Pinus sabiniana), in which stratification raised the germination from 2 to 86 percent. The use of cutting and staining tests as checks on the germination tests is described. Mirov concludes that the conventional germination test methods used by agronomists for cereal and vegetable seeds are unsuited to conifers. He recommends, instead, stratification of conifer seeds before the germination test.

(147) ______
1937. Application of growth hormones in forest nurseries. Planting Quart. 6 (3): 18. (Processed.)

Mirov counsels plant propagators on the use of hormones to stimulate root growth. He names the acids proved effective, so that they may be purchased in bulk at minimum cost. He also gives instructions for the preparation and use of the hormone solutions in plant nursery work.

(148) ______
1937. Certain phases of enzyme activity in seeds. U. S. Forest Serv. Calif. Forest and Range Expt. Sta. Tech. Note 7. 11 pp. (Processed.)

In studying ways to germinate refractory seeds of California plants for use in watershed erosion-control work, Mirov was led to investigate the processes of seed ripening. This paper reviews and interprets work done previously by other workers on the role of enzymes in seed ripening.

(149) MIROV, N. T.
1940. Additional data on collecting and propagating the seeds of California wild plants. U. S. Forest Serv. Calif. Forest and Range Expt. Sta. Res. Note 21. 17 pp. (Processed.) Revised 1945.

Gives suggestions for collecting, handling, and germinating the seeds of an additional 178 species of California native plants for soil stabilization and ornamental use. With the 1937 and 1939 publications by Mirov and Kraebel, this paper brings to 432 the total number of plants whose propagation has been investigated and reported.

(150) ______ and KRAEBEL, C. J.
1937. Collecting and propagating the seeds of California wild plants. U. S. Forest Serv. Calif. Forest and Range Expt. Sta. Res. Note 18. 27 pp. (Processed.)

Native wild plants are sought for erosion control and landscaping use, but few nurseries or seed houses stock the seed. Moreover, the seeds of some desirable plants are hard to germinate without special treatment. The authors give suggestions for collecting, extracting, cleaning, storing, and germinating the seed of more than 250 wild plants. Species are tabulated with data on the time of seed ripening, number of seeds per pound, length of germination period, percentage of germination, and the kind of treatment needed to make the seeds germinate.

(151) ______ and KRAEBEL, C. J.
1939. Collecting and handling seeds of wild plants. Civilian Conserv. Corps Forestry Pub. 5. 42 pp., illus.

A printed and illustrated revision of the 1937 Research Note by the same authors describing methods of collecting, extracting, storing, and germinating the seeds of wild plants for erosion control and ornamental use. Data are given for 254 species. A training manual, this publication gives lists of publications on identifying and propagating western plants, together with practical suggestions for doing the work.

(152) MUNNS, E. N.
1919. The control of flood water in southern California. Jour. Forestry 17 (4): 423-429, illus.

After describing how debris eroded from the mountains damages valley improvements in Los Angeles County, Munns explains the construction and function of small check dams built in headwaters areas to slow runoff, entrap debris, and reduce flood damage by "tackling the trouble at its source". More than 500 such dams built in Haines Canyon after the fire of 1913 were successful he reports, in preventing subsequent flood and erosion damage in the Sunland district. Comparison of stream discharges showed low, sustained runoff from Haines Canyon (with check dams) in the storms of February to April 1917, although the runoff from Little Santa Anita Canyon (without check dams) was peaked and irregular during the same storms.

(153) ______
1920. Chaparral cover, run-off, and erosion. Jour. Forestry 18 (8): 806-814.

Describes effects of the great fires of 1919 in Los Angeles County, California, upon streamflow, erosion, and volunteer plant cover in Pacoima, Little Tujunga, Dalton, and San Dimas canyons. Streamflow peaks came sooner from burned than from unburned watersheds; in burned-over canyons the high water passed more quickly and normal flow conditions were established sooner. Storm runoff from the burns was very muddy while streams in unburned areas remained practically clear. After the first rains, pools in Little Dalton Canyon, which had been burned over, held water so bitter as to be unfit for domestic use. Slope erosion was active in the burns, beginning with the first rains. By the end of the first winter the basins above small check dams built in tributaries of Little Dalton Canyon were filled with eroded debris. Plot studies showed 100 percent survival for most species of sprouting shrubs; these sprouts and the growth of shrub seedlings promised ultimate restoration of the burned chaparral cover. Forty-two species of annual plants found in the burns are listed and rated as to abundance. A study of erosion deposits showed substantial losses of seed washed from the burns along with the soil.

(154) ______
1923. Erosion and flood problems in California. Report to the Legislature on Senate Concurrent Resolution No. 27 (Legislature of 1921) by the California State Board of Forestry. 165 pp., illus.

The report is based on an extended erosion survey made by car and on foot in the forest, brush, and grasslands of California. Munns explains California watershed policy, then discusses land uses that affect erosion and streamflow, and ways of correcting unsatisfactory conditions revealed by the survey.

In the first section Munns tells how erosion occurs and why it is important. He gives examples of erosion acceleration by burning, grazing, mining, and lumbering; discusses the relation of forests to streamflow; and describes methods of controlling erosion. He estimates erosion resulting from denudation by smelter fumes in the Kennett, Bully Hill, and Calaveras districts. And he gives a resume of hydraulic mining in the Sacramento Valley and its effects on navigation downstream to San Francisco Bay. In the second section he takes up the problem of restoring devastated forest land, and discusses ways of preventing such damage in the future. The section closes with a short discussion of other unproductive lands. Appendixes give forest statistics for California in 1921; legal opinions on regulation of land use; and an extensive bibliography on the influence of plant cover upon erosion, streamflow, and climate.

(155) MUNSON, S. M.
1938. Kings River branch watershed study units. U. S. Forest Serv. Calif. Forest and Range Expt. Sta. Tech. Note 11. 12 pp., illus. (Processed.)

After describing the need for additional irrigation water in the upper San Joaquin Valley of California, water which is obtainable under favorable conditions from the adjacent Sierra Nevada Mountains, the author describes research undertaken at the Kings River Branch Station, east of Fresno, to develop principles for managing the mountain watersheds for the maximum yield of clear, usable water. Munson reports the objectives, status, and procedures of the project, and describes the Big Creek and Teakettle Creek groups of watersheds.

(156) RETZER, J. L., and COLMAN, E. A.
* 1955. Soil surveys on forest and range lands. U. S. Dept. Agr. Yearbook 1955: 242-246.

Stating that "The farmer, the grazier, and the forester need more information about the productivity of their land if they are to manage it effectively," the authors explain the several kinds of land surveys that can help the land manager put each piece of land to its best use. They describe the kinds of practical information available from soil surveys, then discuss the need for and

steps being taken to gain uniformity in making soil surveys. The difference between soil surveys for cultivated land and wild land is pointed out, and two methods of surveying wild lands are described. The authors close with a number of examples showing the practical uses for soil surveys of forest and range lands.

(157) ROGERS, D. H.
1942. Measuring the efficiency of fire control in California chaparral. Jour. Forestry 40 (9): 697-703.

For use in the economic analyses of flood control measures, Rogers developed a relation between age of plant cover and size of fire in the chaparral watersheds of southern California. The paper describes this relationship and develops a formula, based on present age of cover, by which to measure the efficiency of a fire-control organization. The formula takes into account the effects of old burns in reducing the required amount of current fire protection effort.

(158) ROOF, J. B.
1941. Growing California's two wax myrtles. Calif. Hort. Soc. Jour. 2 (3): 167-172.

Describes Myrica californica and M. hartwegii, the only wax myrtles native to California, and gives instructions for propagating them.

(159) ROWE, P. B.
1933. Erosion control studies of the Juncal Reservoir. Conserv. Activities 1 (3): 9-11. (Processed.)

Describes the Juncal watershed, source of water for the city of Montecito in southern California, and reports flood and erosion control studies in the watershed after the Matilija fire of 1932. Check dams built in the river channel above the reservoir to catch eroded debris were made of loose rock bound by poles and cables. Transit surveys were made of the dam basins, the stream channels, and the reservoir floor (by sounding) as a basis for deposition measurements in later years. The watershed land was seeded to help control erosion.

(160) ______
1940. The construction, operation, and use of the North Fork infiltrometer. U. S. Dept. Agr. Flood Control Coordinating Com. Misc. Pub. 1. 64 pp., illus.

The North Fork infiltrometer is an instrument developed for determining the infiltration capacities of soils on large areas by sampling methods. Intensive tests show the infiltrometer to be a practical and reliable tool for measuring soil infiltration capacity under field conditions. It proved useful in determining the infiltration effects of plant cover, land-use practices, and cultural treatments.

(161) ROWE, P. B.
1940. The North Fork infiltrometer, an instrument for measuring the infiltration capacities of soils. Jour. Forestry 38 (7): 588-589, illus.

A short account of the North Fork infiltrometer, which is easily made and portable.

(162) ______
1941. Some factors of the hydrology of the Sierra Nevada foothills. Amer. Geophys. Union Trans. 1941 (1): 90-100, illus.

Reports on hydrologic studies by the Forest Service at North Fork, California, to determine the influence of woodland-chaparral on water yield, surface runoff, and erosion. The methods and instrumentation used are described and the results of studies are presented. It was concluded that: (1) Size of area, character of precipitation, and soil moisture content are important factors in the hydrology of the Sierra Nevada foothills; (2) undisturbed woodland-chaparral cover is effective in the control of surface runoff, erosion, and floods; and (3) woodland-chaparral cover is highly beneficial in the production of usable water.

In the following discussion section (pp. 100-101) F. J. Veihmeyer states that 2 plots are not enough on which to base conclusions, as shown by his own experience; the extension of plot data to large areas is hazardous because flow retardation of the kind reported will not prevent floods; and he has found direct evaporation from bare soil to be very small in comparison to evapotranspiration losses. He interprets the data as showing that the few small plants that grew on the burned plots depleted the soil moisture to the same extent as the many large plants on the undisturbed plots. To these contentions Rowe replies, in the author's closure, that 5 pairs of plots were used at North Fork, and that their data were in qualitative agreement with the results from over 400 plot-years of data from 75 plots in 12 different chaparral areas throughout the state. The total water yield from annually burned and unburned plots was approximately the same, but the quality and distribution of water yield were definitely better from the undisturbed than from the annually burned areas.

(163) ROWE, P. B.
1943. Discussion of Role of the land during flood periods, by W. W. Horner (Amer. Soc. Civ. Engin. Proc. 69 (5): 665-690). Amer. Soc. Civ. Engin. Proc. 69 (10): 1616-1618.

Rowe compares Horner's method of hydrologic analysis with that used by the California Forest and Range Experiment Station. In the Horner method an average infiltration capacity curve for each infiltration complex was derived from the rainfall and runoff records of small watersheds. In the Station approach, infiltration capacity curves for the complexes were obtained from small plot (infiltrometer) measurements that permitted calculating the full range of infiltration capacities within complexes. In Horner's analysis, stream channel inflow was visualized as occurring predominantly as surface runoff. In the watersheds studied in California, more than 10 percent of the channel flows at flood crest during major storms, and much higher proportions during minor storms, were composed of quick subsurface flow. The percentage of quick subsurface flow was greater under the conditions assumed with improved land use. In both methods the infiltration capacity curves were correlated with soil moisture and other antecedent watershed conditions to determine the correct position of curves with respect to storm rainfall patterns used in the surface runoff calculations.

(164) ______
1943. A method of hydrologic analysis in watershed-management. Amer. Geophys. Union Trans. 1943 (2): 632-643, illus.

An approach to hydrologic analysis for the purpose of determining the physical effects of watershed conditions, particularly those subject to change through land management, on floods and streamflow. A detailed accounting of the course of precipitation is made, from its occurrence to its final disposition in the watershed. The determination of the character and extent of the effects of watershed conditions on floods and streamflow is dependent upon the evaluation of the physical elements and processes controlling them. The techniques used and sequence of procedures followed can be adapted to different watershed conditions and to the objectives of individual analyses.

Essential steps of the procedure include: (1) Delimitation of watershed complexes of similar hydrologic characteristics based upon such factors as precipitation, vegetation, soil types, geologic types, and land use under present and expected future conditions; (2) construction of infiltration-capacity curves of individual hydrologic complexes; (3) determination of storm-precipitation patterns and streamflow hydrographs, interception and evaporation losses, depression storage, available water-storage capacities of the soil and rock, and surface and subsurface runoff relations; (4) adjustment of infiltration-capacity curves of the hydrologic complexes to measured storms and stream discharges; (5) application of established precipitation, infiltration, runoff, and soil-water relations to streamflow predictions for present and expected watershed conditions.

(165) ROWE, P. B.
1944. Discussion of Soil-moisture records from burned and unburned plots in certain grazing areas of California, by F. J. Veihmeyer and C. N. Johnston (Amer. Geophys. Union Trans. 1944 (1): 72-84). Amer. Geophys. Union Trans. 1944 (1): 84-86.

Rowe compliments the authors' contribution of original data on soil moisture, and states that their findings on moisture stored in the soil at the end of the rainy season in burned and unburned plots agree in general with the findings of other workers. However, he suggests that the authors' data may have been influenced more by differences in winter evapo-transpiration than by infiltration. Also, the authors calculated rainfall interception from measurements by trough rain gages. Studies by the California Forest and Range Experiment Station, however, show that 75 percent of the rainfall intercepted by a brush canopy reaches the ground as stemflow which Veihmeyer and Johnston were not equipped to measure. The small differences between runoff and erosion on burned and unburned plots are not in accord with Station experience; these differences suggest that the plots may not have recovered from previous burning and grazing when the experiments were begun. Rowe points out the need to calibrate small plots for several years before experimental treatment in order to discover inherent differences in their behavior.

(166) ______
1944. Review of Effect of chaparral burning on soil erosion and on soil-moisture relations, by Arthur W. Sampson (Ecology 25 (2): 171-191). Jour. Forestry 42 (10): 770-771.

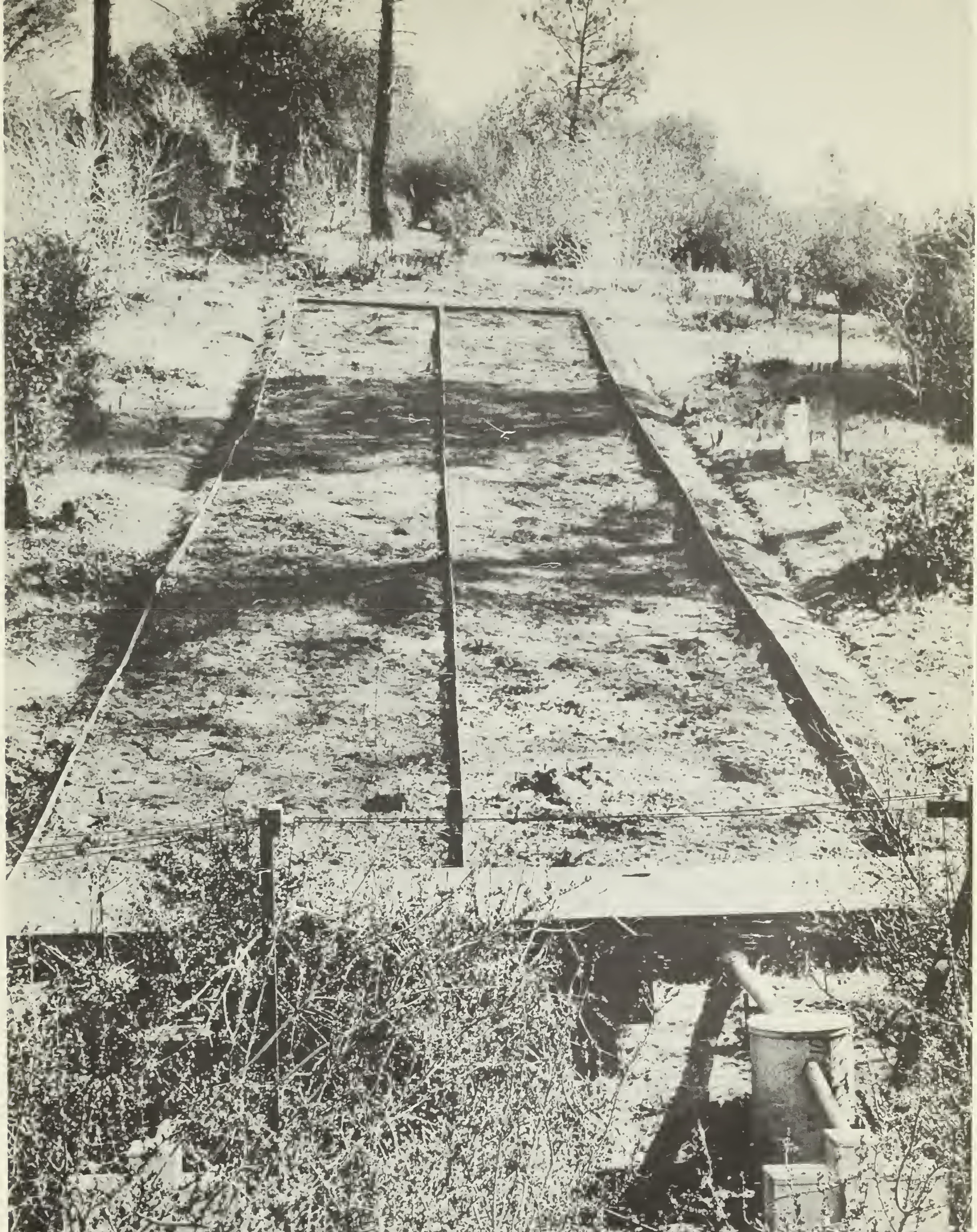
After reviewing Sampson's findings that burning California chaparral tends to decrease soil infiltration capacity, increase sheet and gully erosion, increase evaporation losses in the upper 3 to 12 inches of soil, and increase moisture carryover in soils deeper than 48 inches, Rowe cites confirming data from studies in the chaparral of central and southern California. Infiltration capacities of soils in fully stocked old-growth chaparral stands are generally greater than the highest local rainfall rates. Burning decreased infiltration and increased surface runoff and erosion in all areas studied except where the soil was especially sandy and porous.

(167) ROWE, P. B.
1945. Contribution to Report of the Committee on Transpiration and Evaporation, 1943-44. Amer. Geophys. Union Trans. 1944 (5): 685-686.

Rowe reports the progress of studies by the California Forest and Range Experiment Station to determine the influence of forest vegetation and land use on evaporation losses in the woodland-grass, grassland, second-growth ponderosa pine, and chaparral types in California. The studies showed that rainfall interception losses are lower than previously supposed, averaging only 4 to 8 percent of total precipitation in chaparral and less than 15 percent in pine. Soil moisture sampling showed that evapo-transpiration losses of moisture stored in the soil at the end of the rainy season were not appreciably reduced by annual burning or other manipulation of the vegetation. Any gain in soil moisture from reduced evapotranspiration on burned plots were usually far outbalanced by reductions in infiltration. In flood control surveys it was found that evapo-transpiration losses in areas of good vegetative cover were more than compensated by reduced flood flows and more even distribution of streamflow.

(168) ______
1948. Influence of woodland chaparral on water and soil in central California. Calif. Dept. Nat. Resources, Div. Forestry. 70 pp., illus.

Reports a 9-year study of water yield and erosion as affected by chaparral burning in the Sierra Nevada foothills. Runoff and erosion were heavy in the burned plots, and infiltration was reduced. Little surface runoff and no appreciable soil loss occurred on the unburned plots. Although 20 percent of the annual precipitation was intercepted by brush cover, 15 percent reached the soil as stemflow; consequently, only 5 percent was lost by evaporation. Percolation to 4-foot depth was 39 percent of annual precipitation on the burned plots and 58 percent on the unburned plots. Thus the brush-covered areas yielded more water than the burned areas, and at the same time protect the soil.



(169) ROWE, P. B.
1955. Effects of the forest floor on disposition of rainfall in pine stands. Jour. Forestry 53: 342-348, illus.

Presents results of a series of litter-pan, lysimeter, and moisture-sampling experiments designed to measure evaporation from forest floors of pine stands in California and determine the influences of these floors on surface runoff, percolation, and evaporation from the floor.

(170) ______
1956. Possible ways of increasing stream flow yield of the Salt River drainage by watershed modification. Arizona Watershed Program. Recovering Rainfall, Part II: 197-207.

Rowe discusses means of increasing streamflow without regard to the effects that possible land treatments may have upon the land, floods, or soil erosion. For the several cover types in the Salt River watershed he estimates the deposition of rainfall before and after cover conversion from brush and timber to grass, and the control of riparian vegetation. He urges that complete hydrologic studies be made before an action program to increase water yield is begun.

(171) ______ and COLMAN, E. A.
1951. Disposition of rainfall in two mountain areas of California. U. S. Dept. Agr. Tech. Bul.1048. 84 pp., illus.

An evaluation of some of the hydrologic processes involved in the disposition of rainfall in two mountain areas. One area is near North Fork in the Sierra Nevada of central California, and one is in the San Dimas Experimental Forest in the San Gabriel Mountains of southern California.

The first part of the study was made on hillside plots in forest (ponderosa pine) and brush types of the two areas. These studies showed that annual burning of the vegetation, although reducing interception loss, did not appreciably affect total evapotranspiration loss. It did reduce the infiltration capacity of the soil, thereby increasing surface runoff. The reduced interception loss resulted in increased water yield (surface runoff plus seepage), but this increase was achieved by greatly increased surface runoff and erosion, and correspondingly reduced underground water yields. Removing the vegetation, trenching to prevent root intrusions, and maintaining a bare soil surface on the brush plots eliminated all interception and transpiration loss. Total evaporation loss was reduced but as in the case of annual burning, surface runoff and erosion was greatly increased. During the long dry period of each summer, the bare soils lost appreciable quantities of water from all depths, but drying was slower and less complete in deep than in shallow soils. Total water yield was greatest from the plots with bare soil. However, underground yield was greatest from plots with natural vegetation.

The second part of the study was carried on in Monroe Canyon, a typical 875-acre brush-covered watershed of the San Dimas Experimental Forest. Average annual rainfall during the 2-year period of the study (1943-44 and 1944-45) was about 31.0 inches. Interception loss averaged about 2.4 inches per year and evapotranspiration, including riparian water loss, averaged 10.8 inches per year. Nearly 18.0 inches of rainfall was unaccounted for by the evaporative loss, but of this amount only about 4 inches appeared as streamflow. Thus more than three times as much water appears to have been yielded from the watershed as underground flow than as streamflow.

(172) ROWE, P. B., and COLMAN, E. A.
1957. Uses of soil-vegetation survey information in watershed management. Soil Sci. Soc. Amer. Proc. 21 (1): 112-114.

Managing land for purposes of flood and erosion control and for maximum yield of usable water requires knowledge of the hydrologic properties of soil in particular areas. Such knowledge can be obtained in the course of soil-vegetation surveys if the surveys are planned to provide the needed kinds of information. This paper discusses the kinds of information required, and points out the need for improved methods of measuring the hydrologic characteristics of soils. In addition it describes the hydrologic properties of three wild land soils in Mendocino County, California, and interprets these properties in terms of some of their watershed management implications.

(173) ______ COUNTRYMAN, C. M. and STOREY, H. C.
1954. Hydrologic analysis used to determine effects of fire on peak discharge and erosion rates in southern California watersheds. Calif. Forest and Range Expt. Sta. 49 pp., illus. (Processed.)

Describes the hydrologic analysis used in one phase of a study to appraise the flood and erosion damage resulting from watershed fires in southern California.

(174) ROWE, P. B., and HENDRIX, T. M.
1951. Interception of rain and snow by second-growth ponderosa pine. Amer. Geophys. Union Trans. 32 (6): 903-908, illus.

How much water is lost through interception by forest cover and subsequent evaporation was determined by a 6-year study in a fully stocked 65- to 75-year-old stand of second-growth ponderosa pine near Bass Lake, Madera County, California. Of an average annual precipitation of 47 inches, 84 percent reached the forest floor as throughfall and 4 percent as stemflow. Interception loss amounted to 12 percent. This loss consisted principally of the water retained by the vegetation during its initial wetting period, plus that evaporated in rainless periods during the storms. The interception loss process is illustrated by rate graphs showing when and how loss occurred during a typical storm.

(175) ______ ILCH, D. M., and BOLLAERT, RENE
1937. An infiltration study of a denuded and a forest covered soil. U. S. Forest Serv. Calif. Forest and Range Expt. Sta. Res. Note 14. 4 pp., illus. (Processed.)

The extent of the influence of forest cover in developing and maintaining soil permeability and in increasing the infiltration capacity of soil is demonstrated by a series of infiltration tests

made at Kennett, California, on smelter-fume-denuded and adjacent forested soils. It was concluded that (1) the vast differences in the present infiltration capacities of the two soils are due largely to the influence of forest cover; and (2) the destruction of the forest has impaired the ability of the denuded soil to absorb precipitation, resulting in accelerated surface runoff and erosion and finally complete devastation of the area.

(176) SAMPSON, A. W., and GLEASON, CLARK H.
1957. Suggestions for revision of terminology dealing with fire. Jour. Forestry 55 (3): 219.

The authors suggest changes to make the terminology of burning more specific. "Management burning", the general term they propose to cover the deliberate use of fire for removing unwanted plant material, is divided into "convenience burning", "control-burning", and "prescribed burning", according to the degree of care used in planning and conducting the burn.

(177) SINCLAIR, J. D.
* 1936. Watershed management research; the San Dimas Experimental Forest. Trails Magazine 3 (2): 17, 20-21, illus.

An early description of the San Dimas Experimental Forest, the reasons for its establishment, its instrumentation, and the types of studies planned there.

(178) ______
* 1954. Erosion in the San Gabriel Mountains of California. Amer. Geophys. Union Trans. 35 (2): 264-268, illus.

Topography, geology, soil, and climate in the San Gabriel Mountains are all conducive to high rates of erosion. When the vegetation on steep slopes is removed, as by fire, or when the land surface is disturbed, erosion may be greatly accelerated through increased surface runoff. Erosion reduces the amount of soil available for water storage and limits the development of soil-protecting vegetation. Flood flows bulked with eroded debris have caused loss of life, rapid sedimentation of reservoirs, and extensive property damage downstream. Eroded material carried by flood runoff from the mountains complicates problems of flood regulation and water conservation on valley land below. Solution of these problems has been sought mainly through the protection of mountain vegetation from fire, and by construction of engineering works. Studies are being made by the U. S. Forest Service of the sources, processes, and

rates of erosion on the mountain slopes, and of means to increase the stability of soils by improving the vegetation on areas where erosion is most severe.

(179) SINCLAIR, J. D., and HAMILTON, E. L.
1953. A guide to the San Dimas Experimental Forest, Glendora, California. U. S. Forest Serv. Calif. Forest and Range Expt. Sta. Misc. Paper 11. 19 pp., illus. (Processed.) Revised 1956 by J. D. Sinclair, E. L. Hamilton, and M. N. Waite.

Describes objectives and operation of the experimental forest; includes an annotated bibliography of publications resulting from work of the experimental forest staff and colleagues.

(180) ______ and HAMILTON, E. L.
* 1955. Streamflow reactions of a fire-damaged watershed. Amer. Soc. Civ. Engin. Proc. 81, Separate 629. 17 pp., illus.

After reviewing other studies of the relation of watershed burning to streamflow and erosion, the authors report streamflow reactions of two watersheds in the San Gabriel Mountains of southern California before and after their partial denudation by fire in 1953. Precipitation and streamflow in these watersheds, on the San Dimas Experimental Forest, had been measured continuously for nearly 20 years before the fire, giving an excellent base for comparison of post-fire flows. The authors report and analyze the rainfall amounts and intensities, streamflow reactions, and erosion measurements for the storms of January 1954. They conclude that (1) abnormally large peak flows bulked by debris from fire-damaged watersheds complicate the problem of flood control in southern California; (2) the increased volume of storm discharge from fire-damaged watersheds is not an accurate measure of increased water yield because the flows were bulked with unmeasured quantities of debris; and (3) adequate wild-land fire protection in the mountains of southern California will aid in regulating flood flows and debris movement.

(181) STAFF, DIVISION OF FOREST INFLUENCES RESEARCH
1951. Some aspects of watershed management in southern California. U. S. Forest Serv. Calif. Forest and Range Expt. Sta. Misc. Paper 1. 29 pp., illus. (Processed.)

Watershed management problems in southern California and the research program carried on by the California Forest and Range Experiment Station to aid in solving these problems are discussed

briefly. Second, the climate, geology, soils, and vegetation of the southern California mountains are described. Third, some of the results of the Station's hydrologic research are given.

(182) STAFF, SAN DIMAS EXPERIMENTAL FOREST
1935. The San Dimas Experimental Forest. U. S. Forest Serv. Calif. Forest and Range Expt. Sta. 19 pp., illus. (Processed.) Revised 1936, 1946.

Booklet outlining objectives and describing experimental installations.

(183) ______
* 1954. Fire-flood sequences on the San Dimas Experimental Forest. U. S. Forest Serv. Calif. Forest and Range Expt. Sta. Tech. Paper 6. 29 pp., illus. (Processed.)

Describes how a brush fire burned into experimental watersheds of the experimental forest; gives eyewitness account of the floods that followed, peak flow and erosion measurements before and after burning, and a photo story of the 1954 fire-flood sequence.

(184) STONE, E. C.
1951. The stimulative effect of fire on the flowering of the golden brodiaea (Brodiaea ixiodes Wats. var. lugens Jeps.). Ecology 32 (3): 534-537, illus.

Stone noted that within a few months after chaparral fires, golden brodiaea flowers often covered extensive areas although several years are required to develop flowering plants from seed. To learn how burning stimulated such growth, he studied plots in burned and unburned areas, and grew the plants under controlled light in a greenhouse. He found that the numbers of brodiaea plants were about the same in burned and unburned areas, and that flowering was induced by the removal of shade rather than by the heat of the fire.

(185) ______ and HOLT, J.
* 1950. A rapid method of separating seed of chamise (Adenostoma fasciculatum) from the duff. Ecology 31 (1): 149, illus.

In attempting to obtain large quantities of seed from the duff, various methods of separation by screening and floating were unsuccessful. A satisfactory procedure, making use of a small hand-operated seed separator, was worked out.

(186) STONE, E. C., and JUHREN, G.
1951. The effect of fire on the germination of the seed of Rhus ovata Wats. Amer. Jour. Bot. 38 (5): 368-372, illus.

High temperature was found to be the factor responsible for fire-induced germination of seed of Rhus ovata. These temperatures rupture the second seed coat, which then allows water to reach the embryo, causing the seed to germinate.

(187) ______ WENT, F. W., and YOUNG, C. L.
* 1950. Water absorption from the atmosphere by plants growing in dry soil. Sci. 111 (2890): 546-548, illus.

The ability of Coulter pine to survive long periods of drought on soils at or below the wilting point was investigated to determine the possibility of the plants taking up water from the atmosphere. A 2-year old Coulter pine seedling, growing in a sealed container to which no water had been added for 10 months, was sealed in a chamber which enclosed the vegetative portion of the plant and in which the initial humidity could be adjusted. Measurements with a temperature-humidity sensing unit indicated a lowering of the humidity in the chamber from 98 to around 90 percent in 3 to 9 hours.

(188) STOREY, H. C.
1941. Topographic influences on precipitation. 6th Pacific Sci. Cong. Proc. 4: 985-993, illus.

Isohyetal maps show distribution of annual precipitation in California, then over Los Angeles County and finally in detail over the San Dimas Experimental Forest. Variations in precipitation are explained by reference to topographic influences.

(189) ______
1948. Geology of the San Gabriel Mountains, California, and its relation to water distribution. Calif. Dept. Nat. Resources, Div. Forestry. 19 pp., illus.

Description of areal geology, structure, and history of the San Gabriel Mountains. Discussion of the manner in which geology influences the hydrology of a watershed from two viewpoints, (1) effect of land forms on the rainfall pattern, (2) the effect of structural fractures permitting water storage in rock formations, and the faults and dikes that determine the location of streams, springs, and underground basins.

(190) STOREY, H. C., and HAMILTON, E. L.
1943. A comparative study of rain-gages. Amer. Geophys. Union Trans. 1943 (3): 133-141, illus.

An experiment was designed to test several types of rain gages and the effect of their placement on the accuracy of sampling rainfall in mountain areas. Three concrete surfaces 10 feet in diameter exposed parallel to and at ground level on south, east, and northwest slopes served as controls. The study showed that rainfall measurements made with the standard 8-inch gage placed vertically with funnel 40 inches from the ground were consistently low. Accuracy was improved by tilting the gage normal to the slope, and further slight improvement in accuracy was effected by lowering the gage so that its funnel was at ground level.

(191) ______ and WILM, H. G.
1944. A comparison of vertical and tilted rain-gages in estimated precipitation on mountain watersheds. Amer. Geophys. Union Trans. 1944 (3): 518-523, illus.

Precipitation on a 100-acre watershed within the San Dimas Experimental Forest was measured with a network of rain gages at 22 sites. Two gages were placed at each location, one installed vertically and the other tilted normal to the slope. Analysis of 4 years records showed that a better measure of the total rainfall on this steep mountainous watershed was obtained by the use of tilted gages.

(192) TALBOT, M. W., BISWELL, H. H., ROWE, P. B., and SAMPSON, A. W.
1942. The San Joaquin Experimental Range. Other studies and experiments in the program of the San Joaquin Experimental Range. Calif. Agr. Expt. Sta. Bul. 663: 136-142.

Describes studies on artificial reseeding of rangeland, runoff, and erosion as affected by cattle grazing, and the chemical composition of important range plants. Nine 1/40-acre plots were established on gentle slopes with grass cover for the runoff and erosion studies. The plots were left ungrazed during 4 rainy seasons for purposes of calibration. During the next two seasons grazing of light and moderate intensity by cattle showed no significant increase in surface runoff and erosion. The study did not investigate total water yield nor the effects of heavy grazing.

(193) TALBOT, M. W., and KRAEBEL, C. J.
1944. Relation of forest lands to agriculture, industry, and people in southern California. U. S. Forest Serv. Calif. Forest and Range Expt. Sta. Res. Note 39. 5 pp. (Processed.)

After reviewing the water, flood and erosion problems of southern California, the authors describe the chaparral forest that dominates the area and explain its function in regulating streamflow and controlling erosion. They then discuss the watershed protection and improvement work needed in the area.

(194) U. S. FOREST SERVICE and CALIFORNIA STATE CHAMBER OF COMMERCE
1930. Forest handbook for California. Amer. Tree Assoc. 48 pp.

This handbook, compiled and approved for use in the public schools of California, contains 11 lessons on forests, their importance to the state, and the need for protecting them. Lesson 5 (pages 20-25) describes the need for and sources of water in California and the role of forest cover in producing the maximum yield of usable water by regulating runoff and controlling soil erosion.

(195) VLAMIS, J., STONE, E. C., and YOUNG, C. L.
1954. Nutrient status of brushland soils in southern California. Soil Sci. 78 (1): 51-55, illus.

To learn how the fertility of soils in the chaparral zone limited plant growth, and how to improve it, the authors sampled soils with good, poor, and scattered brush cover. Greenhouse tests of the samples, using lettuce plants as indicators, showed a general deficiency of nitrogen and phosphorus, particularly in the lower soil horizons, and occasional deficiency of potash. It was concluded that some of the soils tested could produce good yields of agricultural plants if properly fertilized.

(196) WIESLANDER, A. E., and GLEASON, CLARK H.
1954. Major brushland areas of the Coast Ranges and Sierra-Cascade foothills in California. U. S. Forest Serv. Calif. Forest and Range Expt. Sta. Misc. Paper 15. 9 pp., illus. (Processed.)

Defines woodland, chaparral, and associated cover types which pose problems in land use below California's commercial timber zone; gives the area of each type. The accompanying map shows location of the problem cover types; it is available separately on a scale of 1:1,000,000 (1 inch = 18 miles).

(197) WILM, H. G., COTTON, JOHN S., and STOREY, H. C.
1937. Measurement of debris-laden stream flow with critical-depth flumes. Amer. Soc. Civ. Engin. Proc. 63 (7): 1259-1275, illus. Also in Amer. Soc. Civ. Engin. Trans. 103 (9): 1237-1278.

Experiments using a testing channel built below the outlet gates of the San Dimas Flood Control dam were conducted for the purpose of adapting existing gaging stations to measurements of loaded flows. Several types of flumes were tested, including a modification of the Parshall flume, trapezoidal flumes, and rectangular flumes with sloping floors. Following these experiments, a control flume of the third type was developed. It functions as a broad-crested weir in which water depths are measured at a point downstream of the "critical" section. Super-critical water velocities kept the flume scoured clean, and it could be rated to give greater accuracy of loaded streamflow than any existing devices.

(198) WILM, H. G., NELSON, A. Z., and STOREY, H. C.
1939. An analysis of precipitation measurements on mountain watersheds. Monthly Weather Rev. 67 (6): 163-172, illus.

Analysis was made of precipitation measurements from gage systems upon mountainous watersheds to determine reliability of computed rainfall averages and to decide if the original gage distribution provided accurate sampling of the watershed rain catch. The requirements for accuracy of averages should be modified in inverse relation to size and importance of storms. A simple average of well distributed gage readings agreed within close limits with the rain catch computed from isohyetal maps.

(199) ______ and STOREY, HERBERT C.
1944. Velocity-head rod calibrated for measuring stream flow. Civ. Engin. 14 (11): 475-476, illus.

The measuring stick described was developed to facilitate the gaging of small volumes of streamflow containing varying amounts of bed load and silt where standard measuring gages are not provided. It can be used even when the water carries considerable amounts of debris.

(200) WRIGHT, JOHN T., and HORTON, JEROME S.
* 1946. Check-list of the vertebrate fauna of the San Dimas Experimental Forest. U. S. Forest Serv. Calif. Forest and Range Expt. Sta. 15 pp. (Processed.)

During the initial phase of watershed management research on the San Dimas Experimental Forest inventory surveys were made of the physical features that influence streamflow, including vegetation, soils, and geologic structure, and the animal life. This report describes the habitats found on the Forest, then lists 162 species of animals found there. Brief notes, usually covering abundance and habitat, are given for each species.

(201) ______ and HORTON, JEROME S.
1951. Checklist of the vertebrate fauna of the San Dimas Experimental Forest. U. S. Forest Serv. Calif. Forest and Range Expt. Sta. Misc. Paper 7. 15 pp. (Processed.)

Revises the text of checklist first published in 1946 and adds 9 species for a total of 171; gives brief notes on abundance and habitat of each.

(202) WRIGHT, JOHN T., and HORTON, JEROME S.
1953. Supplement to checklist of vertebrate fauna of San Dimas Experimental Forest. U. S. Forest Serv. Calif. Forest and Range Expt. Sta. Misc. Paper 13. 4 pp. (Processed.)

Adds to the checklists of 1946 and 1951 one rodent and 30 birds found on the Forest during recent studies by H. L. Cogswell, of the University of California Department of Zoology. Gives brief notes on the habitat and occurrence of each species.

(203) WYCKOFF, STEPHEN N.
1948. California's watersheds. Jour. Forestry 46 (2): 99-103.

After defining California's water-producing and water-using areas, Wyckoff notes that the total water supply is ample for forseeable needs except that it is often not available at the times and places of need. He tabulates the area, population, water yield, and water requirements of the 7 drainage basins in the state. As means of meeting shortages, he discusses redistribution of water within the state, importation of water from outside the state, and the conservation of local water supplies, concluding that the last is the most economic method. The most effective and cheapest way to store water, Wyckoff says, is by inducing it to percolate underground in the mountain watersheds. Noting that forest and range management practices govern to a great extent how much water percolates and how much is wasted in flood flows, Wyckoff calls for land-management practices that will stabilize and perpetuate the lumber and range livestock industries, and at the same time keep the best plant cover on our mountain watersheds to insure the maximum yield of usable water.

(204) ______
1949. The work of the California Forest and Range Experiment Station. Berkeley Symposium on Mathematical Statistics and Probability, Proc. 1945, 1946: 459-463.

Describes the forest, range, and forest influences research of the Station, stressing the complexity of this work and the resulting need for mathematical help in designing experiments and evaluating data.

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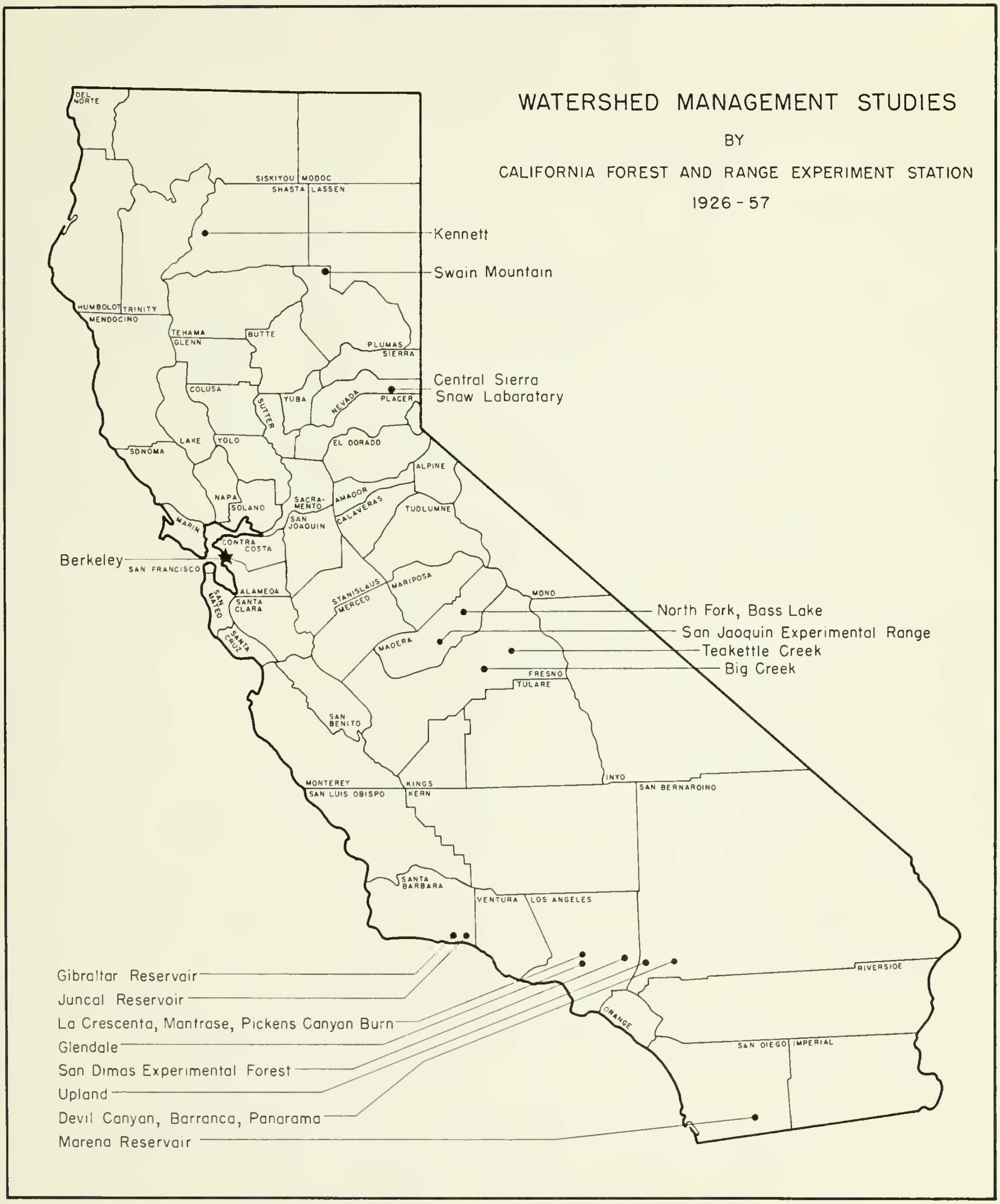
WATERSHED MANAGEMENT STUDIES
BY
CALIFORNIA FOREST AND RANGE EXPERIMENT STATION
1926 - 57
Kennett
Swain Mountain
Central Sierra
Snow Laboratory
Berkeley
North Fork, Bass Lake
San Joaquin Experimental Range
Teakettle Creek
Big Creek
Gibraltar Reservoir
Juncal Reservoir
La Crescenta, Montrose, Pickens Canyon Burn
Glendale
San Dimas Experimental Forest
Upland
Devil Canyon, Barranca, Panorama
Morena Reservoir
DEL NORTE
SISKIYOU
MODOC
SHASTA
LASSEN
HUMBOLDT
TRINITY
MENDOCINO
TEHAMA
GLENN
BUTTE
PLUMAS
SIERRA
COLUSA
SUTTER
YUBA
NEVADA
PLACER
LAKE
YOLO
SONOMA
EL DORADO
ALPINE
NAPA
SOLANO
SACRAMENTO
AMADOR
CALAVERAS
TUOLUMNE
MARIN
SAN JOAQUIN
CONTRA COSTA
SAN FRANCISCO
ALAMEDA
SAN MATEO
SANTA CLARA
SANTA CRUZ
STANISLAUS
MERCED
MARIPOSA
MONO
MADERA
FRESNO
TULARE
SAN BENITO
MONTEREY
SAN LUIS OBISPO
KINGS
KERN
INYO
SAN BERNARDINO
SANTA BARBARA
VENTURA
LOS ANGELES
RIVERSIDE
ORANGE
SAN DIEGO
IMPERIAL