

Hydrology-Snow Survey Section of the Northwest Scientific Association

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This section was added at the meeting of the Association December 29, 1938. It is composed of the Hydrology Section of the American Geophysical Union, North Continental Divide Area, and the Western Interstate Snow Survey Conference, who had previously met conjointly with the Engineering Section of the Northwest Scientific Association.

Dr. Joseph E. Church, Chairman of the Hydrology Section of the American Geophysical Union, and Professor H. P. Boardman, Chairman of the Western Interstate Snow Survey Conference, both from the University of Nevada, were present. Mr. O. W. Monson, Irrigation Engineer, Montana Agricultural Experiment Station, is chairman of the new Section of the Northwest Scientific Association.

Dr. Church explained briefly the purpose of the Hydrology Section and the Western Interstate Snow Survey Conference, traced the development of the new science of snow surveying, and outlined some of its possibilities.

A symposium on the topic, "The Limit of Practicable Usefulness of Snow Surveys Made in the Headwater Regions When Used for Predicting Runoff at Localities Quite Removed From the Courses," was discussed by D. B. Freeman of the U. S. Army Engineers, H. T. Gisborne of the U. S. Forest Service, and J. P. Bonner of the Soil Conservation Service.

Mr. Freeman discussed the question from the standpoint of practicable usefulness, being concerned with the prediction and control of runoff at Fort Peck Reservoir in Montana. For the operation of this reservoir it is necessary to forecast the amount of water

which will need to be controlled at the reservoir each year during the flood period. As a result of the studies made to date, it appears that predictions of runoff for years in which the summer rainfall is comparatively small can be made quite accurately. In the Upper Missouri Basin the rainfall during the years 1934-37 inclusive was consistently below normal. The prediction of runoff for these years was remarkably close to the actual runoff—the greatest divergence being in 1937, when the actual runoff was 37% of normal, while the predicted runoff was 45%, a divergence of only 8%. During 1938 the actual snow depth and water content were not much different from those obtained in 1937, but the actual runoff at Fort Peck was much greater than it was in 1937 or for a considerable number of years prior to that time, and the inaccuracy of the prediction during this year was much greater than it had been during any of the dry years. The explanation is that a relatively larger amount of runoff during 1938 was a direct result of rainfall and was not a direct function of the water content of the snow blanket. For this reason, the limitation of practicable usefulness of snow surveys for localities quite removed from the course depends largely upon the extent to which correct evaluation can be made of the proportion of runoff which should be attributed to snow melt and the proportion of runoff which should be attributed to rainfall."

Mr. Gisborne approached the problem from the standpoint of watershed management. He said: "The headwaters of many streams in the North Rocky Mountains are within national forests

and the obligation and expense of protecting these headwaters from devastation by fire fall upon Region One of the U. S. Forest Service. Region One has to compete with nine other regions for its share of total fire control funds which are appropriated annually to the Forest Service for the country as a whole. No region as yet receives as much money for fire control as it believes is needed. Therefore, that forest or region whose snow courses serve as a basis for prediction of runoff or stream flow over the largest area should receive a larger proportion of fire control funds than other regions of otherwise similar fire protection problems. The principle seems already recognized that those snow courses useful in predicting stream flow of the most used or the most dangerous streams are most worth installation and operation."

Mr. Bonner discussed the problem from the standpoint of the soil conservationist. Here the problem is to have information, not only as to the amount, but also as to the rate of runoff caused by rains or melting snows. He said: "Because of the urgent need for information not only as to amount, but also as to rate of runoff caused by melting snows or by rains of varying intensities, it appears desirable to modify the existing snow survey program to include areas of lower elevation which bear no relation to the information obtained in the headwater regions. Snow courses have been located at various points in the states of Idaho, Washington and Oregon to secure information which would not be available from the courses in remote areas. The procedure to be employed follows the same general pattern of the work in higher elevations, with the exception that these courses will have to be run at more frequent intervals, so that for each period of runoff the quantity of moisture in the form of snow is available."

The afternoon session consisted of a symposium on the subject, "The Effect of Soil Priming by Fall Precipitation on Spring Runoff." This topic was discussed by James C. Warr of the U. S. Bureau of Agricultural Engineering, O. W. Monson of the Montana Agricultural Experiment Station, and a paper by Henry C. Eagle of the U. S. Geological Survey was read by Mr. L. T. Jessup.

Mr. Marr introduced the subject by explaining that "various procedures are required for different watersheds in order to successfully correlate snow survey data with runoff, and various factors, in addition to the principal one, namely the amount of water held in storage by snow cover on the watershed, must be considered. Among these is the soil priming influence of fall precipitation."

Mr. Marr's analysis to determine the influence of watershed priming was made by four tests applied to the Jackson Lake watershed in Wyoming. The first test showed the relationship which exists between snow cover and runoff without any correction for watershed priming. In the second test the fall precipitation which occurred before the snow begins to accumulate was added to the water content of the accumulated snowfall. In test number three, spring instead of fall precipitation is added. In test number four, both fall and spring rainfall were added to the water content of the snow. A comparison between test number one and test number two showed that for some years the correlation was much closer when the precipitation at Moran during October was added to the maximum water content. The best example of this was the year 1925, but when this same correction was applied for the year 1936, however, the correlation was not improved.

The net result of the four tests was that the maximum error without any

correction for watershed priming of 205,000 acre feet was reduced to 135,000 acre feet when the October precipitation was added to the water content in the snow cover, and still further reduced to 105,000 acre feet when both the fall and the spring precipitation were added to the water content of snow cover. Thus, it is seen that the factor of watershed priming must be given consideration in forecasting the runoff from a watershed and that fall and spring rainfall on the watershed may serve as fairly reliable correction factors.

Mr. Monson stated that "the water content of the snow cover, while perhaps the most important, is only one of several factors which affect the amount of runoff from a given watershed. Other factors are: (1) Precipitation on the watershed during the runoff period; (2) evaporation losses from the watershed; (3) ground storage; (4) deep percolation losses. The engineer is faced with the problem of making corrections for these factors, although but very little basic information is available.

"The factor of ground storage or watershed priming was considered in two ways: (1) Fall precipitation as a measure of watershed priming; (2) low water flow as an index to general ground water conditions. These two tests were applied to the Snake River Basin above Moran, based on the Jackson Lake snow surveys, and to Swift Current Creek at Many Glaciers, based upon the Swift Current snow surveys. The correlation coefficient was used as the measure of influence for each of the correcting factors. It was found that the correlation between water content of snow cover and the runoff from Snake River at Moran was increased from .81 to .84 when the previous October precipitation was added to the water content. When ten times the October runoff expressed in inches was added to the wa-

ter content, the correlation was increased to .88. On the Swift Current Creek watershed, the correlation between water content and runoff was .85. This was not improved by correcting for fall precipitation nor for the October runoff. Thus, it appears that in the case of runoff of the Snake River at Moran, correction by adding the previous October precipitation to the water content of snow cover on Jackson Lake watershed gave a higher coefficient of correlation than when no correction was made, but on the Swift Current watershed the factor of precipitation during the runoff season disturbed the relationship between water content of snow cover and runoff to a greater degree than could be accounted for by watershed priming." Curves and tables were submitted to support the discussion.

Mr. Eagle used the precipitation and stream flow records in the Upper Yellowstone Basin as the basis for a study.

Quoting from his paper: "The spring runoff for the Yellowstone River at Corwin Springs was compared with the precipitation at Yellowstone Park, Wyoming. The period of spring runoff chosen was from May 1 to July 31. Precipitation for the period November 1 to April 30 was considered winter precipitation. Various methods were tried to correct for ground storage. First the minimum flows for October and April were selected, but the results were unsatisfactory. The minimum flow seemed to be subject to influences such as abnormal cold spells, making it a poor index of the ground water level, and the mean flow for October was finally used in the computations. After it was converted into inches of runoff this was multiplied by three, since the period of spring runoff is three months. It was found that the correlation was slightly improved, by this method, over those for which no correlation for ground storage was made. An inspec-

tion of the amount of correction obtained showed that for most years a larger correction was needed. Therefore, instead of multiplying the October runoff in inches by three, it was multiplied by six. This method seemed to improve the correlation over those of either of the previous methods.

"In conclusion, the results indicate that there is a relationship between October runoff and that of the following spring. More representative precipitation records including snow surveys would probably give more satisfactory predictions of spring runoff."

Mr. R. A. Work gave an interesting discussion, illustrated by slides, on the construction of shelter cabins. He emphasized the importance of sturdy construction to withstand snow load in areas where deep snows occur. A novel

feature to shelter cabin design is a Santa Claus chimney extending 10 to 12 feet above the ridge of the cabin through which the snow survey party may enter the cabin. Wood, food, and bedding are cached in the cabin during the fall. Salient points to be considered in locating and constructing shelter cabins for winter use by snow surveyors in isolated mountainous regions were outlined. Detailed plans of three types of cabins were shown, and some actual cost figures were submitted.

Mr. Marr described the preparation of a snow surveyor's manual now ready for publication. It contains specific information pertaining to snow surveys, including the laying out of snow courses, the taking of measurements, and a short section on first aid.