able and bring out the seasonal and annual variation in a very striking manner.

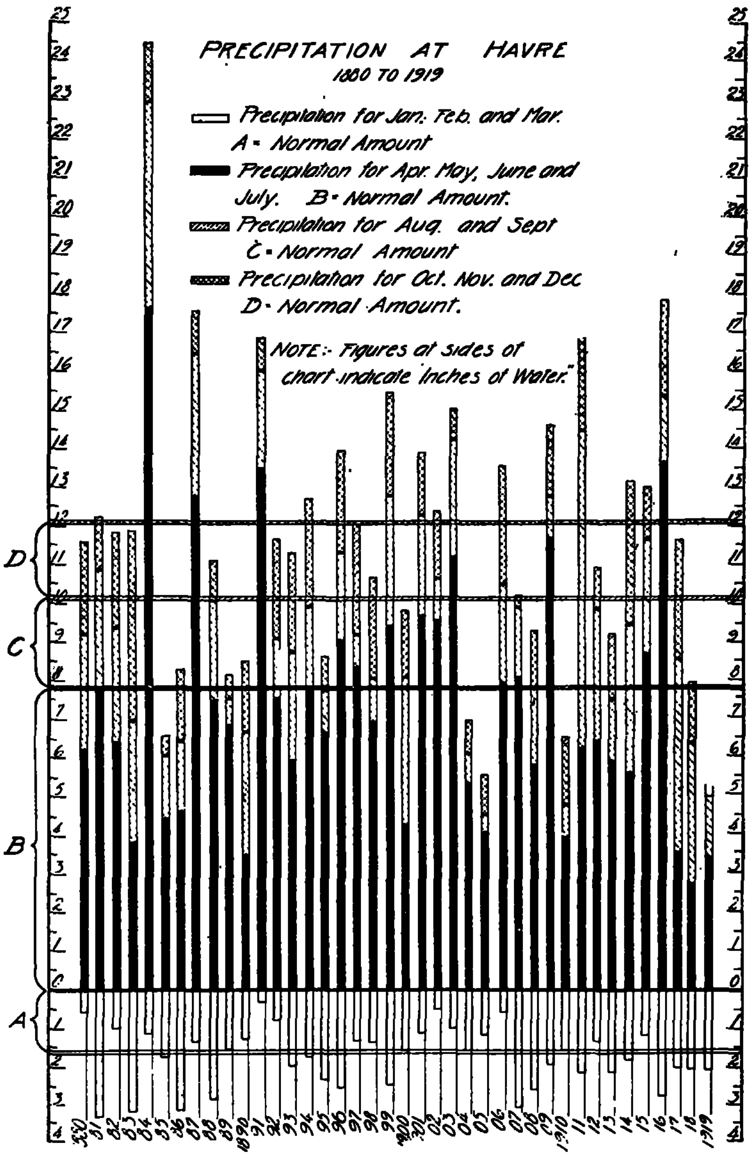
"In studying these charts it should be remembered that the rain which falls just when the crop needs it is subjected for only a limited time to the forces that tend to remove it, so this seasonal rainfall has a much greater value, so far as producing crops is concerned, than that which falls before the crop is ready to use it. * * *

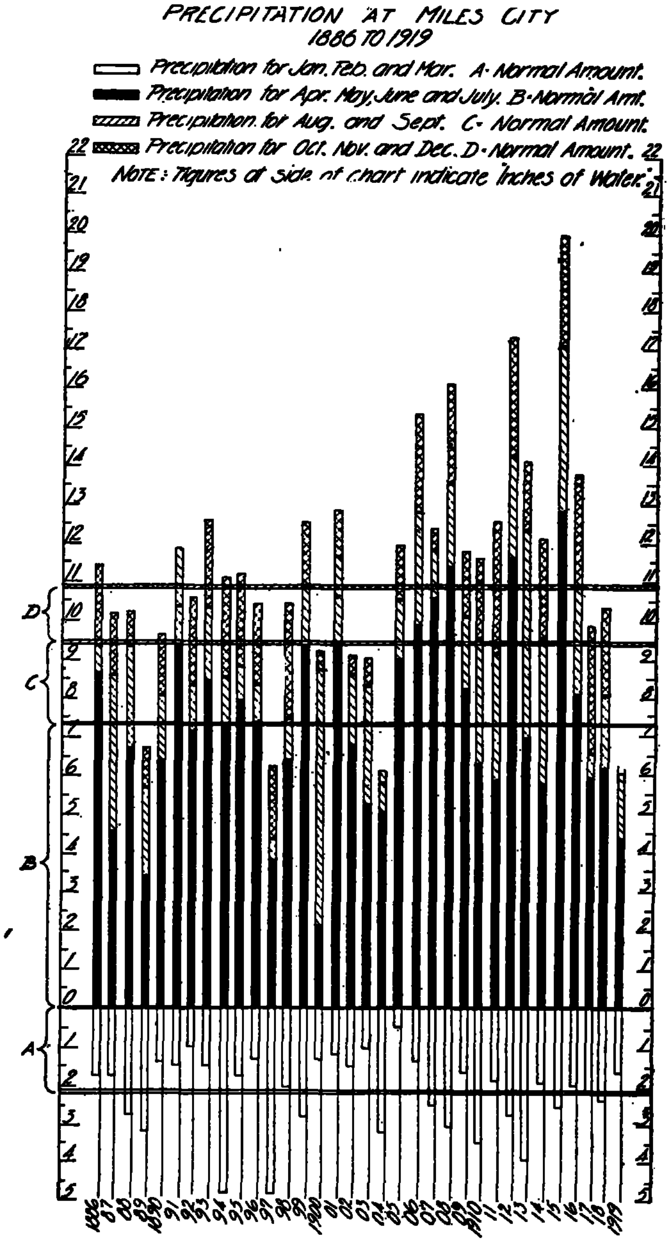
"* * * The average rainfall for all points which have long records proves to be very constant" [i. e., shows no secular change].

"But not all the water that falls on the land is used by the crop planted. The various sources of loss of moisture are (1) water that runs off; (2) water that sinks too deep for crops to reach it; (3) water that evaporates from the soil; (4) water used by growing weeds."

The four months for 1919 had higher mean temperatures than any of the similar dry years—1904 (driest), 1917, 1918—thus reducing the value of what moisture the soil had, so far as influenced by temperature, and reducing the available supply below that of the other years.

In preparing this bulletin the writers had the able cooperation of Mr. William T. Lathrop, meteorologist, Montana section, United States Weather Bureau, in assembling the data from official sources.—*H. L.*





RAINFALL AND LAND DRAINAGE.[1]

Dr. Brysson Cunningham reviews in Nature of March 11, 1920, the three papers listed in the footnote below. These papers, as indicated by their respective titles, treat of the disposal of rainfall from several points of view.

In the first paper the proportion of runoff to rainfall is discussed a problem that has also been studied extensively in this country. Col. Craster finds that 0.065 inch of water is required to wet a crop of rough grass about 5 inches in height, the aftermath of a hay field,

[1] Estimating river flow from rain all records, by Lieut. Col. J. E. E. Craster. *Engineering*, Jan. 2, 1920. Land drainage from the engineering point of view, by C. H. J. Clayton. Land drainage from the administrative point of view, by E. M. Konstam. (The last two are papers read before the Surveyors' Institution on Jan. 12, 1920.)

up to the point at which it commences to drip onto the soil. It is therefore assumed that not less than 0.04 inch, or 1 mm., of water is required to wet vegetation and the surface of plowed land. This amount is, of course, lost by direct evaporation after the fall of every rain. It is this part of the summary by Dr. Cunningham that is of particular interest to American students of the problem. The amount required to wet vegetation given as 0.04 inch corresponds very closely with the amount tentatively used by Weather Bureau officials in approximating the amount of rainfall intercepted by the vegetal covering of the soil. In a forest cover the amount naturally varies with the dominant species of trees within the forest. Precise observations as to the amount of rainfall intercepted by different species of trees by Horton [2] show the difficulty of generalizing upon a problem in which the individual variations depart so widely from the means.

The values for transpiration appear to have been taken from German sources and afford no new material.

In the opinion of the writer of this note the relation of rainfall to runoff is so complicated that it is unsafe to assume that any definite proportion of the rainfall will later appear as runoff. The safer procedure, as recommended by eminent hydraulic engineers, is to make a careful analysis of the physical conditions of the drainage area as influencing the runoff so that the mean results already available may be adapted to suit the watershed under consideration. This, however, is merely another way of stating that more precise data bearing upon the physical and cultural conditions are needed in hydrologic studies.—*A. J. H.*

THE INTERNATIONAL COUNCIL FOR THE EXPLORATION OF THE SEA.

[Reprinted from the *Scientific American*, New York, June 19, 1920, p. 669.]

The International Council for the Exploration of the Sea, which has gathered so much valuable information in behalf of the fisheries of the North Atlantic, held its first meeting since 1913 in London March 2–6, 1920. Great Britain, France, Belgium, Holland, Denmark, Sweden, Norway, and Finland were represented by two delegates each, in addition to scientific experts from the fishery authorities of each country. Germany and Russia, formerly prominent in this work, were not represented. Extensive programs of study and exploration were adopted. The next meeting is to be held at Copenhagen in 1921.

OCEANOGRAPHIC RESEARCH IN THE MEDITERRANEAN.

[Reprinted from *Scientific American*, New York, June 26, 1920, p. 697.]

An international conference which met recently in London took steps to organize cooperative researches in the Mediterranean, in which the various countries bordering that sea will take part. A permanent central office of fisheries is to be opened at Monaco, and regular campaigns of fishery investigations will be made every spring and autumn. Four ships will be at the disposal of the office. Cooperative hydrographic surveys will also be carried out. Results of these activities will be published in a bulletin in French, Italian, Spanish, and English.

[2] Horton, Robert E.: Rainfall interception. MONTHLY WEATHER REVIEW, September, 1919, 47: 603–623.

THE BALLISTIC WIND.

By Lieut. I. R. TANNEHILL.

[Author's abstract.]

[From *Journal of the United States Artillery*, June, 1920, p. 553–576.]

The true wind movement aloft is determined from the observation of the drift of a pilot balloon as it ascends. Mean wind values are obtained for successive vertical intervals of 500 meters. These wind values are weighted so as to take into account the relative amount of time during which each zone wind acts upon the projectile. The methods of measuring the true wind are therefore varied to facilitate the computation of the ballistic wind.

The observations may be made with a single theodolite. The readings may be taken at the end of each minute after release of the balloon or at intervals of time required for the balloon to rise 500 meters. Two or more theodolites are sometimes used, in which case the plot is made by intersection and the actual heights computed.

During periods of unfavorable weather and when heights reached are insufficient the wind aloft must be estimated. A careful study of cloud movement, previous observations, and weather maps are essential to success in estimating. Mr. W. R. Gregg has formulated a number of rules for forecasting winds aloft when the pressure distribution is known. It is often necessary to make estimates as modern artillery fire reaches heights of 10 kilometers or more.

The mean winds in 500-meter zones are then weighted to obtain a fictitious wind which, acting constantly throughout the trajectory, would produce the same effect as the total of all true winds. The time weighting factors used generally during the recent war are based upon the flight of a projectile in vacuo. The vertical speed of the projectile decreases with altitude in accordance with the acceleration produced by gravitation, neglecting the effect of air resistance.

It has been maintained by some ballisticians that the time weighting factors are inaccurate. Weighting factors may be computed for each particular piece, taking into account the muzzle velocity and the angle of elevation. In time of war a meteorological message must be broadcasted, and it must contain data appropriate to any class of artillery fire. Therefore it is urged that computations involving the nature of the battery and the range of the objective are too complex to be practicable. It has been proposed that three types of weighting factors be used and that all artillery fire be classified into three corresponding divisions, thus necessitating the preparation of three separate ballistic winds from each sounding. This proposition is under investigation.

The battery commander receives the meteorological message and determines the effect of the wind upon the range and direction of his firing. Prior to the introduction of pilot balloon methods surface wind values were used, and the charts employed in finding corrections were prepared with the assumption that the wind at 1,000 feet is approximately twice the ground wind. Because of the extreme ranges and the great heights to which modern artillery fire reaches, the use of the ballistic wind is essential to the attainment of effective fire. Range tables are being prepared in which are tabulated the variations in range and direction due to the wind aloft as actually measured by means of pilot balloons. Until such tables are available caution is advised in avoiding the natural error which arises from applying a ballistic wind value to a range chart intended for surface wind use only.