Soil Moisture Studies

ESTIMATING THE MOISTURE CONTENT OF THE 0- TO 6-INCH SOIL HORIZON FROM CLIMATIC DATA

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The moisture content of the soil at the time excessive storms occur is generally conceded to influence infiltration and runoff. Since measurements of soil moisture prior to the development of moisture meters entailed too large an amount of labor, complete records of soil moisture are not available for use in analysis of runoff records at this, and possibly other locations. Soil moisture at the time of storm-runoff periods occurring over the last decade must, therefore, in many instances, be estimated by indirect methods.

Previous approach to the problem has been made by Baver, who suggested the precipitation-evaporation ratio as a measure of soil moisture and evaluated it on a monthly basis in terms of total inches of precipitation and average temperature. A quantity termed "antecedent rainfall" has also been used to evaluate the effect of previous rainfall upon the particular storm under investigation in Flood Control work. It is calculated for a 20-day period by summing the quotients determined from dividing the rainfall, in inches, by the number of days it preceded the storm under study.

The purpose of this research was to test the applicability of estimating methods developed by other investigators by comparing them with actual measurements obtained on the Shelby soils, and, if possible, to develop a more accurate estimating procedure for this particular location. The specific use of such an estimate is to obtain the most probable value of soil moisture under the crops of corn, small grain, meadow, and bluegrass. Such values may subsequently be correlated with water losses from the several crops in an attempt to explain contrasts in runoff accompanying their culture.

Measurements of soil moisture were secured under various crops during the 3-year period 1934-36 on the Shelby loam soil at the Soil Conservation Research Station at Bethany, Mo. During this period soil moisture determinations were made under crops of corn, small grain, meadow, and bluegrass on 62 occasions. Samples were taken of the 0- to 6-, 6- to 12-, 12- to 24-, and 24- to 36-inch soil horizons at weekly or biweekly intervals. They were secured in triplicate by the use of a soil auger and steel tube and the per cent moisture content by weight was determined by oven drying. Only the averaged results of the triplicate determinations of the 0- to 6-inch horizon for various crops are used in this analysis. The moisture content of the surface horizon possesses the greatest bearing on storm-runoff, and would tend to be responsive to changing weather conditions.

METHOD OF STUDY

Statistical methods have been used in relating climatic data to soil moisture data. As an initial approach to this problem, triplicate field moisture determinations on a given date for each of the crops of corn, small grain and meadow were averaged. These crops represent a 3-year crop rotation commonly grown in the soils region and the average moisture figure on a given date would, therefore, represent average moisture. The selection of rotation average moisture as the vehicle with which various combinations of data were correlated in an attempt to determine the most probable value of soil moisture is entirely arbitrary. Relationships resulting therefrom will be of direct use unless it is desired to compare one method of use with another, as, for instance, the mass effect of a rotation of corn, small grain, and meadow with that of grass pasture.

Rotation moisture was correlated with various combinations of temperature and rainfall, and time of occurrence thereof. Lapse of time required for rainfall to penetrate to a total of ½ inch, and finally, a factor for estimating moisture content at a prior date were also added in an effort to further refine such relationships. Data for the winter months were excluded to avoid snow and freezing temperatures.

Correlations were made only for exponential relationships of the data. All relationships have been expressed in logarithmic form to save space in presenting results. Confusion as to the meaning of such logarithmic expressions may be avoided if it is recognized that an exponential relationship of the type

\[ Y = C \cdot Z^a \]

may be written

\[ \log Y = \log C + a \log Z \]

It is recognized that many variable factors in addition to those correlated contribute to the moisture content of the 0- to 6-inch soil horizon at a given time and that an attempt to evaluate soil moisture on an empirical basis will lead to considerable error. Correlation methods do, however, enable one to know the probable error of such an expression and its adaptability for a specific use can be evaluated.

The use of derived relationships will be applicable to moisture in the Shelby soils. Similar methodology can be used to develop expressions of the same type for various soils, vegetal cover, and contrasted climatic influences. Other variables may well be included where they have been measured. As an example, wind velocity is used as a variable which should be included in similar equations.

After determining the relationship of factors most likely to be useful, the most practical equation for estimating moisture under the crop rotation, equations containing these identical variables were derived. M.