TEMPORALLY AND AREALLY DISTRIBUTED RAINFALL[a]

Discussion by Walter T. Sittner[3], F.ASCE

The authors have explored the problem of estimating point precipitation, from that measured at other points, by distance weighting. Specifically, they have attempted to gain an insight into the appropriate value of the exponent and have concluded that the commonly used value of 2 is quite acceptable if not optimal. Their statement:

> "There seems to have been no search for a mathematically optimum value for the exponent."

is not really correct since some fairly extensive studies were made over a decade ago. The authors can be easily excused for not being aware of this work since it was never published. The presentation of some background information as a supplement to the authors' work may be of interest at this time.

The technique of analyzing precipitation patterns by computer, making point estimates by a reciprocal-distance-squared technique was originally developed and first used in 1963. The work was done in the Washington, D.C. River Forecast Unit of the National Weather Service (then U.S. Weather Bureau) of which the writer was in charge. The problem was the automatic determination of basin mean precipitation from point amounts for river forecasting purposes. The areal means were computed by Thiessen weights, but before these predetermined

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[a]June, 1977, by John David Dean and Willard M. Snyder (Proc. Paper 13002)

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weights could be applied, it was necessary to estimate the precipitation at those network stations which had not reported. Working in real time, there was always a great number of these. It was for this purpose, estimating missing reports, that the method was devised.

An exponent of 2 was used for the following reasons. First, logic and an understanding of the precipitation process indicated a value greater than unity. Second, and very important in that era, it was "cheap". That is, in searching for the closest reports to the subject station, the squared distances were computed as with the authors' eq. (1), but without raising to the 1/2 power. All distance comparisons were made using the squared distance and when the weights were computed, d^2 was already available. Thus, 2 was the only exponent which could be used without making an actual exponential computation.

The adequacy of the method, and of the exponent, was established at that time in a manner similar to the work reported by the authors. All verification however was based on areal means computed from the combination of point estimates and point observations, no attempt being made to verify the point estimates directly.

The method was quickly adopted by most of the River Forecast Centers in the country since it was the only alternative to manual analysis of precipitation data. In the process, the River Forecast Center at Ft. Worth, Texas did some further evaluation in which they saved point estimates made in real time and compared them with the actual observations when these observations were received, on a delayed basis, a few days later. They found the results to be excellent although, once again,

no attempt was made to determine if some exponent value other than 2 might give even better results.

Somewhat later, the writer became aware of some independent work done by Brooks and McWhorter (11). While this work was presented at the Mississippi Water Resources Conference in April of 1968, the writer has no knowledge of its ever having been published. The investigators made statistical analyses of observations from a dense network to optimize both the exponent and the number of estimator stations. Their conclusion was six estimator stations (the closest six without regard to direction) and an exponent of 1.6. The writer feels that if one considers the size of the sample and the vagaries of the data, there is no real disagreement between a recommendation of 1.6 and the actual use of 2.0.

In 1972, the National Weather Service published Ref. 12, which includes a considerable amount of material on the technique as developed, and further expanded, in house. This publication is slanted toward implementation and contains little or nothing in regard to background rationale and research. This reference describes a modification to the method which permits estimates to be adjusted for orographic and storm type effects. It also presents a system of "grid point" weighting. These weights are similar to Thiessen weights and are used in the same manner. The areal mean determined from them is identical to that which would be obtained by estimating the precipitation at each grid point or element and then averaging these, but it is obtained with only a tiny fraction of the volume of computation which would be required to estimate all of the grid elements in the area.

References.

11. Brooks, B. P., Jr. and McWhorter, J. C., "Depth of Area Rainfall from Point Rainfall" Presented at Mississippi Water Resources Conference, April, 1968.

12. NOAA Technical Memorandum NWS HYDRO-14 "National Weather Service River Forecast System Forecast Procedures," December, 1972.