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PRELIMINARY ANALYSES OF METEOROLOGICAL PARAMETERS
IN THE UPPER COLORADO RIVER BASIN

DEC 14 1959

Status Report of Work Done
by
Colorado State University
in cooperation with
The University of Colorado Bureau of Economic Research
The High Altitude Observatory
and
Mr. Loren Crow
in a study of
THE VARIABILITY OF STREAM FLOW IN THE UPPER COLORADO RIVER

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ENGINEERING RESEARCH

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INTRODUCTION

The work done at Colorado State University in connection with the study of the variability of the Upper Colorado River has consisted of two phases:

1. To process climatological data for machine analyses, using IBM punch cards.
2. To compile basic data for use in preliminary (manual) analyses which will be used as a guide for determining the types of machine computations to be used.

WORK ACCOMPLISHED

Transfer of weather data to punched cards - Weather data have been transferred to IBM punched cards for the following stations for the years indicated:

<u>Station</u>	<u>Period</u>	<u>Station - years</u>
Crested Butte, Colo.	1909-1948	39
Collbran, Colo.	1893-1948	55
Telluride, Colo.	1900-04, 1911-48	41
Silverton, Colo.	1906-50	44
		<u>179</u>

These stations comprise about 16 per cent of the total of 1100 station years.

Data transferred to the IBM cards includes station identification, date, daily maximum and minimum temperatures, precipitation, snowfall, and snowdepth. These data are coded in columns 1-19 and 23-32 of the attached IBM card.

The data are processed for accuracy by comparing machine-computed totals with totals from the original records. When a discrepancy is noted, the error is corrected and a new card prepared. The procedure followed is the same as used for previous work at Colorado State University. (1)*

* Numbers refer to appended references



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Compilation of data for preliminary analyses - Daily precipitation data have been compiled for 13 selected stations in the Upper Colorado River Basin for the time period from about 1900 through 1958.

Consistency of the precipitation records has been checked, using double-mass plotting techniques. (2).

Accumulated degree-days above various base temperatures during the snow-melt period are being compiled for use in comparisons with snow-melt runoff.

The accumulated precipitation greater than 0.10, 0.20, and 0.40 inch per day is being compared with resulting runoff at downstream stations.

The significant results of these analyses will be presented in a later report by Mr. Crow.

USE OF MACHINE ANALYSIS TECHNIQUES IN ANALYSIS OF METEOROLOGICAL DATA

The incomplete Gamma distribution - It has been shown by Barger and Thom (3) that n -week precipitation amounts can be fitted to the general form of the incomplete Gamma function

$$y = \frac{N (\gamma)^g x^{g-1}}{e^{\gamma x} \Gamma(g)} \quad (1)$$

where

y = the frequency of given rainfall amounts

x = precipitation amount

N = number of years of record

γ and g = parameters to be estimated from the various (x, y) values.

The estimate of g is obtained from a solution of the quadratic equation

$$12 \left[\ln \bar{x} - \frac{\sum \ln x}{N} \right] g^2 - 6g - 1 = 0 \quad (2)$$

and

$$\gamma = \frac{g}{\bar{x}} \quad (3)$$

Values for the quantity in brackets in equation 2 are obtained directly from the rainfall data. Equation 1 defines the curves fitted to the frequency distributions of rainfall amounts.

For a given set of parameters (δ, q) the probabilities of occurrence of receiving various amounts of precipitation can be determined. This has recently been accomplished for one, two, and three-week rainfalls for 125 stations in north-central United States (4). Procedures for performing this type of analysis have been worked out in detail and have been made available to the author (5, 6, 7).

Example of use - The following example illustrates how information derived from this type of analysis can be used to characterize precipitation. Fig 1 shows the probabilities of occurrence of various three-week amounts of rainfall as a function of time for two selected stations (4).

Distinct differences in the characteristics of precipitation at the two stations can be noted in Fig 1. The small variation in rainfall amount at Ann Arbor, Michigan for both the 50 and 90 per cent probability is in contrast to the marked peak at week 12 (about June 1) for Colby, Kansas.

These differences illustrate the variations in rainfall characteristics between humid and semi-arid climates.

The same techniques used to derive the data of Fig 1 can be used for other probabilities and for other time periods.

WORK PLANNED

It is planned to continue the work of placing climatological data for the Upper Colorado River Basin on IBM cards for machine processing. After completion of this phase, it is planned to perform machine analyses of the data, using the technique illustrated above, and other techniques that develop from the results of the preliminary analyses.

3-Week Rainfall,
Inches

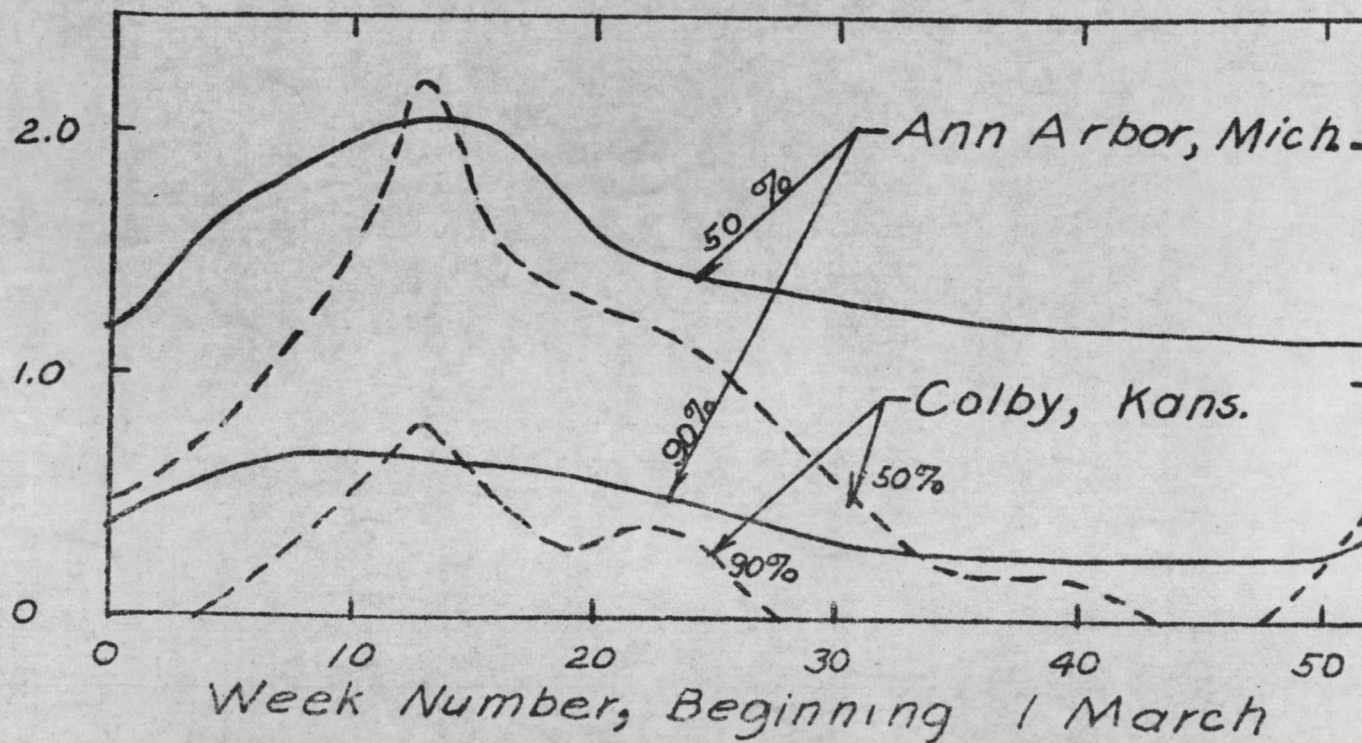


Fig 1. Probabilities of occurrence of various 3-week amounts of rainfall as a function of time at Ann Arbor Michigan (Humid climate) and Colby Kansas (Semi-arid climate)
Source: Reference (4).

Analyses will be planned to coordinate with the studies at the High Altitude Observatory on changes in the general circulation of the atmosphere, and in cooperation with the studies on stream flow being made at the Colorado University Bureau of Economic Research.

REFERENCES

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6. Hartley, H.O., and W. T. Lewis. Fitting of data to the two parameter Gamma Distribution with Special Reference to Rainfall Data. Unpublished report, Statistical Laboratory, Iowa State University, Ames, Iowa, June 29, 1959.
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STATION		DATE		TEMPERATURE °F			PRECIP (INCHES)		SNOW		DAY WITH												MAX DEP.		MAX CHG.		MIN DEP.		MIN CHG.		TEMPERATURE		WIND		HOURS	
STATE	ALPHA	YR	MO	DAY	MAX	MIN	AT TIME OF OBS	24 HR FALL	DEPTH ON GROUND	RAIN	SNOW	WAVE	DRIZZLE	SLEET	GLAZE	THUNDER	HAIL	POST SANDSTN	BLNR SNOW	HIGH WIND	FOUR WIND	MAX	MAX	MIN	MIN	TEMPERATURE	WIND	HOURS	WIND	HOURS						
00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00					
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32					
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1					
2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2					
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3					
4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4					
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5					
6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6					
7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7					
8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8					
9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9					
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32					

WB FORMS 1009, 1006 AND 1024
CLIMATOLOGICAL RAINFALL & EVAPORATION DAILY OBS

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Example of the type of IBM cards used for transfer of climatological data to punched cards.