SPATIAL ASPECTS OF WEEKLY PRECIPITATION PROBABILITIES

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INTRODUCTION

The source of both surface water and ground water is precipitation. Although precipitation is generally included within the realm of meteorology, it has direct bearing on the only part of the hydrologic cycle with which man can interact. It should, therefore, be considered strongly in water resource management strategies.

Mississippi is particularly well-supplied with water from the atmosphere and this climatological characteristic establishes the nature of the state's water resource. With the exception of Louisiana, no other state in the union receives as much precipitation per square mile on an annual basis as Mississippi (2). During the past 30 years, the state has received an annual average of about 54 inches in the northern part of the state and 62 inches in the southern part of the state. The statewide annual average of 56 inches, if spread evenly over the state, would amount to approximately 142 million acre-feet of water delivered by the atmosphere to the state each year (3). However, this resource is not equally distributed in either time or space, so the real water situation in the various areas in the state is quite different; at times it is drastically different.

Many aspects of water resource management could be enhanced by a better understanding of the temporal and spatial characteristics of precipitation in Mississippi. The temporal occurrence, timing, and amount of precipitation in Mississippi have been recently quantified and stated in probabilities for seven-day periods through the year (4). The probabilities were developed from the precipitation record from 1951-80 at 56 locations in the state using the incomplete gamma distribution. A description of the gamma distribution and its use in precipitation analyses is not included in this paper but is available in the referenced document (4). The probability information is used in this paper to produce maps to evaluate the spatial characteristics of weekly precipitation statewide for selected periods during the year.

METHOD OF ANALYSIS

Maps were chosen to display the probability data for selected weeks in order to compare conditions between places in the state during those weeks and thereby emphasize the highly variable character of a week's precipitation regime across Mississippi. The maps were produced using a synagraphic computer mapping program called SYMAP, which has been used extensively to depict spatially disposed quantitative information (1), (3).

The following four analyses were selected to illustrate aspects of both the variability and homogeneity that characterize precipitation events across the state during a given seven-day period:

1) statewide probability of receiving no precipitation during the week of June 7-13; 2) statewide probability of receiving at least 1 inch of precipitation during the week of October 25-31; 3) statewide probability of receiving at least 6 inches of precipitation during the week of April 12-18; and 4) amount of precipitation expected statewide at the 80% probability level during the week of August 2-8.

Results of each of the four analyses listed above are shown on maps (Figures 1-4). Frequency distributions of data point values, showing how many of the 56 locations analyzed to produce each of the four maps are included within the stated value intervals on each map, are summarized in Table 1. A final spatial analysis was conducted to determine the week during the year that exhibited the highest variability in weekly precipitation at each of the 56 locations.

Table 1. Frequency Distributions of Data Point Values in Each Value Interval in Figures 1-4

Figure	Week of						
#1 - No Precipitation	June 7-13	Probability range	<20%	20-30%	30-40%	40-50%	> 50%
		No. of Station Included	4	20	23	6	3
#2-At least One inch	Oct. 25-31	Probability range	< 15%	15-20%	20-25%	25-30%	> 30%
		No. of Stations included	1	4	26	21	4
#3-At least Six Inches	April 12-18	Probability range	< 3%	3-6%	> 6%		
		No. of Stations Included	18	20	18		
#4-Precipitation Amounts at 80% Probability Level	August 2-8	Amount (inches)	< 1	1-1.5	1.5-2	> 2	
		No. of Stations Included	14	27	10	5	

RESULTS AND DISCUSSION

Figure 1

Figure 1 shows the pattern characterizing the chances for no precipitation during the second week in June when most planting should be about completed in the state and when crops are in need of rain to germinate and sprout. The map's legend shows that probabilities for no precipitation range from <20% to >50% with the central and delta regions having the highest chance for no rain at that time. By summing cumulatively, it can be seen in Table 1 that 47 of the 56 stations (about 85% of the state) have less than a 40% chance for no precipitation while 3 of the 56 stations (about 5% of the state) have a little over 50% chance for no precipitation that week.

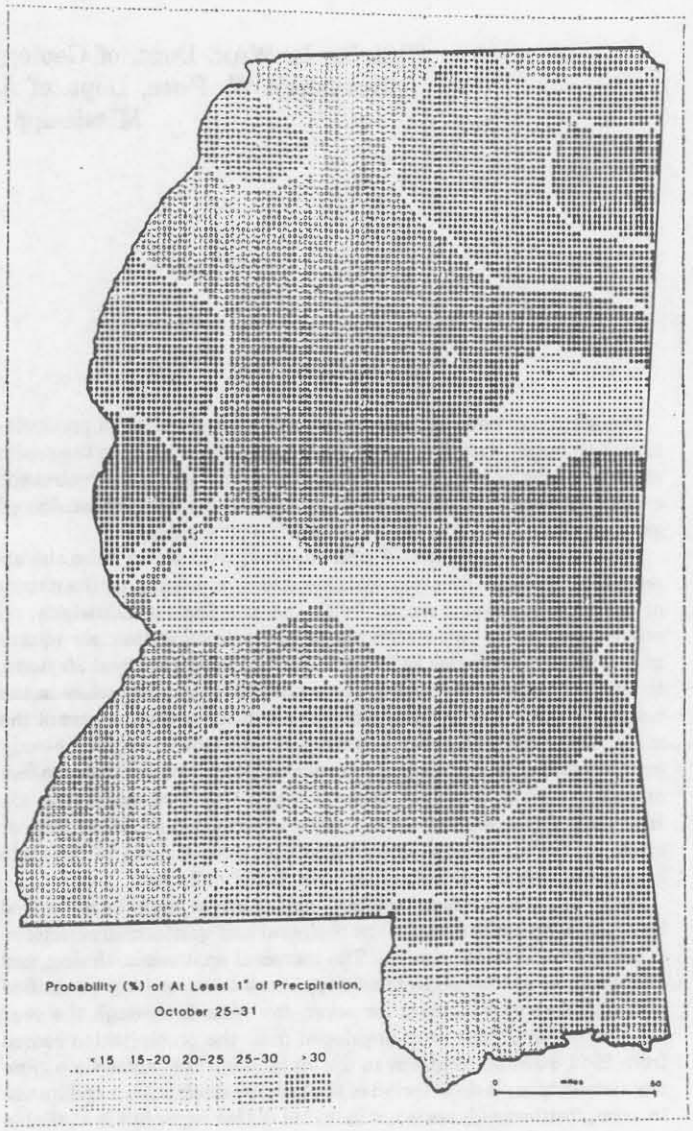

Figure 2

Figure 2 illustrates the probability of 1 inch or more of precipitation over the state during the last week of October when harvest operations are dependent on dry conditions statewide. Chances for a rain of 1 inch or more range from <15% to >30%, with the coastal region, the northeast region, and lower delta region having the highest likelihood for precipitation of that magnitude that week. Table 1 shows that 52 stations (about 93% of the state) have less than 30% probability for at least 1 inch of rain that week, with 4 stations (7% of the state) having a little greater than a 30% chance.

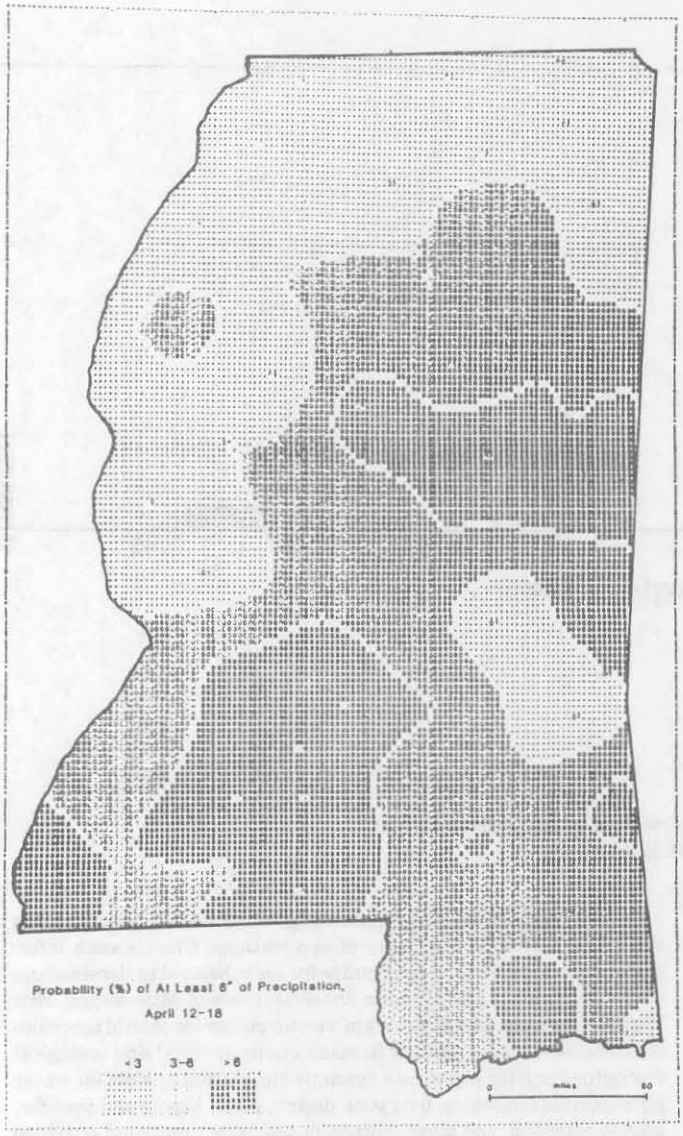

Figure 3

Figure 3 shows the probability of at least 6 inches of precipitation occurring in the state during the third week of April, a time when fields are likely to be freshly-plowed and thus highly susceptible to erosion from a heavy rain. A distinct pattern can be seen in the figure, reflecting the physical process that causes such large precipitation events around that time of the year in Mississippi. Probabilities for such an event are small statewide, ranging from 0% to 9%. However, the figure shows that highest probabilities occur in a southwest-northeast linear pattern, dividing the northwest and southeast regions of the state into areas of lower and higher probability for such a large event, respectively. This pattern is clearly a response to late spring cold fronts moving across the state and stalling near the coast, providing a meteorological mechanism capable of producing major precipitation events in the state. The recurrence of this process year after year has made the pattern depicted in Figure 3 an integral part of the climate of Mississippi. Table 1 shows that 18 stations (about ⅓ of the state) have greater than a 6% probability of receiving 6 inches or more rainfall the third week of April each year.

Figure 4

Figure 4 illustrates the pattern of weekly precipitation from a different perspective. This figure models the amounts of precipitation expected statewide at the 80% level of probability, or the maximum expected in 4 out of 5 years, during the first week of August, a time when water is needed by maturing crops in the state. Amounts range from 0.85 inches to 2.99 inches with a steep gradient from south to north. The coastal region has the likelihood of the highest amounts while the delta and central regions experience chances for the smallest amounts that week. Table 1 shows that nearly 75% of the state (41 out of the 56 stations) can expect less than 1.5 inches, whereas only about 9% of the state (5 stations) can expect more than 2 inches that week in 4 out of 5 years.

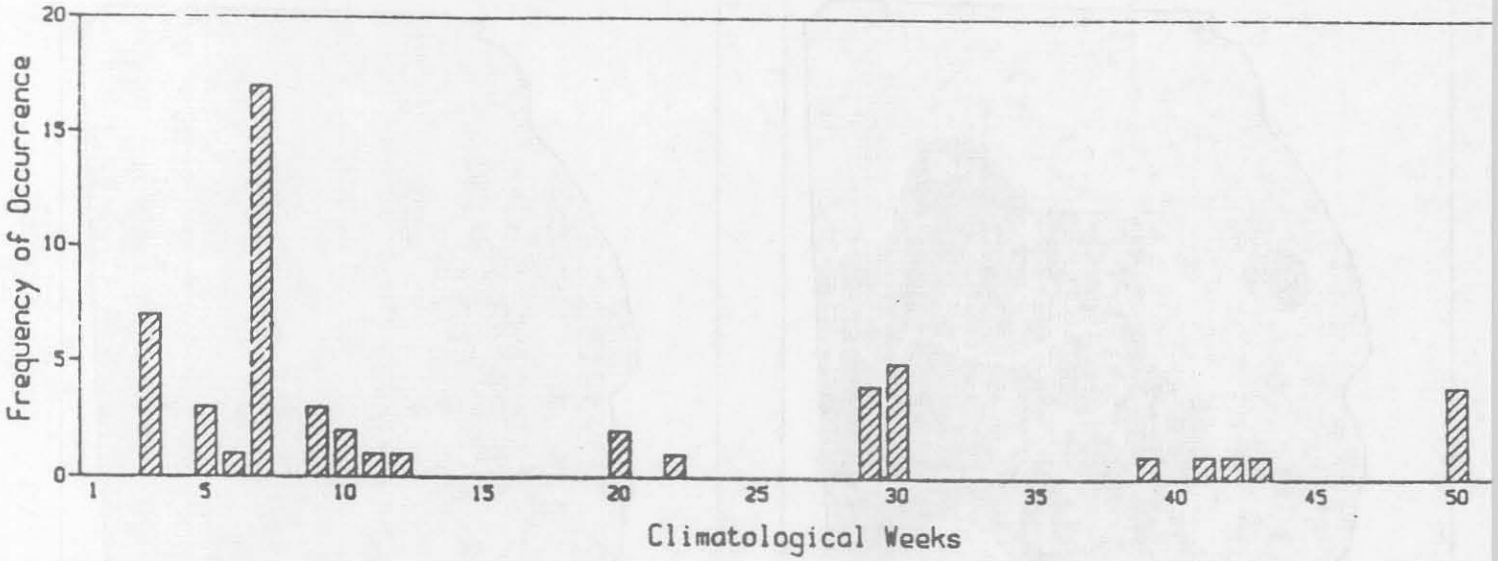

Figure 5 Distribution of Weeks with Highest Variability of Precipitation at the 56 Locations

The final spatial analysis undertaken identified the week at each of the 56 locations which exhibited the greatest variability in precipitation amounts from year to year in order to determine if variability of weekly precipitation was grouped in either time or space. Figure 5 shows that the most variable weeks at all places do tend to be grouped through the year. The period covering weeks #3-12 (March 15-May 23) included 35 (63%) of the 56 most highly variable weeks. Four other periods of minor grouping and the percent of most variable weeks they include are: 1) weeks #20-22 (July 12-August 1), 5%; 2) weeks #29-30 (September 13-26), 16%; 3) weeks #39-43 (November 22-December 25), 7%; and 4) week #50 (February 7-13), 7%. Week #7, April 12-18, was the most variable week at the largest number of places (17 of 56, or 30%). That week was strongly biased by a single meteorological event during that week in 1979 when between 16-20″ of rain fell over the east-central part of the state. Even with this bias, the figure shows that variability does tend to be greater at a few times during the year, and that those times are the same for many places in the state.

SUMMARY AND CONCLUSIONS

These selected analyses illustrate only a few of the spatial characteristics of weekly precipitation in the state. They are presented to show the highly variable nature of short-term precipitation amounts across the state at a given time, and to illustrate that some aspects of weekly precipitation regimes at all 56 places in the state also have some common characteristics. The information available on weekly precipitation regimes in Mississippi (4) can be used in a spatial framework to prepare similar analyses for numerous other specific purposes.

An understanding of the spatial aspects of weekly precipitation should be useful for a number of applications. Clearly such information can provide the opportunity for an enhanced understanding of the geographic and climatic characteristics of Mississippi. This kind of perspective on Mississippi's water resources should therefore be useful in decision making in many environmental and ecological disciplines and for input into dynamic simulation models for water management strategies. Irrigation design, water supply and transfer, erosion potential, and other short-term precipitation-related activities are further examples of areas in which this type of information should prove useful.

REFERENCES

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