RIVER FLOOD AND STAGE FORECASTING IN MISSISSIPPI

by

Donald B. Munro
Meteorologist in Charge
ESSA, Weather Bureau Office, Jackson, Mississippi

River Flood and Stage Forecasts are prepared by the Weather Bureau division of the United States Environmental Science Services Administration. The intent of this paper is to give a brief, non-technical resume of River Forecasting in the State of Mississippi.

A flood is one of the most dramatic disasters that plagues mankind. Mr. M. Bernard, one of the Weather Bureau's recent river experts, defines it thus:

> A flood is a temporary unbalance in nature that results when more water is supplied to the land in the form of precipitation than can be absorbed by the land itself and its vegetation, or retained in natural reservoirs and man-made works for providing storage. The localized effect is the rapid rise of the water to and above the in-bank capacity of the channel reach; often the accompanying inundation of fertile and highly developed valley areas.
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> The cost of a flood to a community includes these principal items:
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> 1. Loss of human life.
> 2. Danger to public health.
> 3. Damage to movable property.
> 4. Damage to immovable property.
> 5. Intangible losses, such as disruption of business and transportation.
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> An accurate and timely forecast of an impending flood should eliminate the first; materially reduce the second and third; to some extent reduce the fourth by providing an opportunity to protect the less vulnerable areas; and help to decrease the fifth class of damage.

There are two general types of floods. Flash floods affect local areas. Very heavy rains, in a short period of time over small local areas cause these local flash floods. The other general type brings water from distant places that has accumulated to a great excess over a long period of time. Most floods affecting Mississippi are a combination of these two.

River forecasting is basically an engineering procedure that involves a vast accounting system. Moisture that falls on Mississippi in the form of precipitation follows many courses. Some evaporates into the air and moves out of the area. Some runs off the land to the rivers and into the Gulf of Mexico. Much of the moisture that eventually follows this latter course has many delays en route. Part is held in surface storage, temporary or semi-permanent. Part infiltrates deep into the ground and some of this returns as ground water and eventually enters the surface run-off system.

Seasons affect surface storage, ground infiltration and evaporation. Even within a season, there is much variation. If the weather has been wet for some time, immediate run-off will be increased. Heavy vegetation and loose dry soil decrease and retard the run-off.

For practical forecast purposes, Mississippi is divided into three river districts or systems. In the west and delta section of the State the Mississippi River with its tributaries, of which the principal ones are the Big Black River, Yazoo River, Sunflower River, and Tallahatchie River make up one district. A second district covering most of the south and central Mississippi is made up of the Pearl River, the Pascagoula River with its principal tributaries, the Leaf River, and the Chickasawhay River. The third district in northeast Mississippi is the upper reaches of the Tombigbee River.

Annual rainfall over the State averages near 50 inches ranging from 35 to 40 inches in very dry years to near 70 inches in wet years. Brief heavy rains may occur in any month of the year and heavy rains of 2 to 3 days duration are relatively common during the winter and early spring. These periods of rain may give 10 to 12 inches of rain over small portions of the State and occasionally 6 to 8 inches over most of the State. The flood season extends from November to June with most major floods developing between December 1 and June 1. During late summer and fall rainfall from tropical storms occasionally produces floods but these are usually more of the local flash flood type on smaller streams and rarely produce large floods on the lower reaches of major rivers.

Information for river forecasting comes from three main sources. River gaging stations are established at various points on all major rivers. These stations measure the height of the river stage daily, or more often if needed. A listing of the more important of these river gage stations in Mississippi is included at the end of this paper. Rainfall reporting stations are spotted over the State. These stations report the amount of daily precipitation each day and in case of heavier rains sometimes several times each day. In addition to these, radar is also used to track areas of heavy precipitation and to determine if the reports from the network of rainfall reporting stations is actually representative of the average rainfall over a river basin.

In Mississippi, River Forecasts and Warnings may be divided into 3 classifications, as follows:

1. Headwater - In headwater areas there are few if any river gaging stations and the river rises almost as soon as the rain falls. Urgent or short-term warnings are issued generally for flash flooding. These warn-

ings are based on rainfall reports received, radar information, and in some cases on forecasts of expected heavy rainfall in the area. They cannot be specific as to stage, but immediate action is required by all interests affected by flash floods. At the present time radar is the best tool for tracking heavy rainfall. Radar provides a basis for the provision of alerts of imminent heavy rain, and advice concerning distribution, and duration of precipitation over the basin.
2. Tributary - Stage forecasts and warnings in tributary areas are based on known conditions in the basin. River and rainfall data are processed through routing and rainfall-run-off procedures each day. Forecasts are issued for periods ranging from a few hours to several days in advance, and are revised as later data is received.
3. Main Stem - Forecasts are issued several days to weeks in advance in major downstream area, where the time-lag is sufficient to allow normal routing of upstream stages through the area. The crest stage and time of occurrence are forecast for numerous points along the river, and the accuracy of the forecast should increase as the day of the crest approaches. The Mississippi River, and to some extent the Pascagoula, and lower reaches of the Pearl River are the only rivers in the State where this type forecast is applicable.

River Stage Forecasting is possible because of two principal factors:
1. Stage Height - Stages are the result of the natural behavior of streams. The history of the stream is studied; a relationship is established between storms, snowmelt, soil and river conditions, etc., with the end product being a forecast procedure.
2. Timing - There is a time lag between rainfall and snowmelt and the surface run-off. The delay ranges from a few hours in the headwaters, up to a few days in the tributaries and varies from a few days to perhaps weeks later in the main stream, in the case of the Mississippi River.

As previously mentioned, flash flood warnings are issued on the basis of early reports from rainfall observers, radar observations of areas of heavy precipitation and forecasts of additional heavy rainfall over the area.

In preparing stage and crest forecasts for tributaries in areas where the crest will not be reached for several hours or days after the occurrence of heavy precipitation the following procedure is used: Reports of amounts of rainfall at the various stations over the basin are collected and plotted on a river basin chart. From these the average amount of rainfall over the basin is computed. Antecedent precipitation, time weighted, for the past several days is computed. From river stages before the storm the actual discharge of the river at various gaging stations is determined. Using these three parameters and a series of graphs involving the season of the year, duration of precipitation and a relation between total amount of precipitation and percentage run-off, the actual amount of run-off is determined. This actual run-off is then distributed time-wise by multiplying the proper daily increment from the unit graph. This in turn gives the volume in CFS (cubic feet per second) of the storm run-

off for the particular river station. This is added to the base flow before the storm and converted from CFS to the daily stages expected at the river station.

For stations farther down stream, the routed volume of water from the up stream stations, corrected for enroute storage, is added to the local run-off before converting to stage heights. At stations in the lower reaches of a river two crests frequently occur. The first from the local run-off, and the second several days later with the routed crest from the headwater area.

Flood Warnings are issued when crests at down stream stations are expected to exceed bankfull or flood stage heights.

It is readily apparent that the relatively simple river forecast is the end product resulting from the utilization of all possible reports of rainfall from up stream stations, coupled with the river stage and discharge relationships between river stations along with travel time between stations. River forecasts are issued based on all data available at forecast time. In flood periods, we should not listen to rumor started by those who do not have all the facts in the case. If you have property or other interests affected by the river, your best bet is to select the nearest river station, watch closely the forecasts for that station, and make preparation for the expected stage, knowing the effect that stage will have at your particular location. Naturally stage and crest forecasts and flood warnings will be updated as often as possible when additional information or additional precipitation indicate that a revision is in order.

Levees provide protection for low areas near the river but usually result in higher stages in a river because the water is held in a restricted channel. Cutoffs and other channel improvements result in lower stages for a given discharge because they shorten the distance water must travel to reach the Gulf of Mexico, thus increasing the slope of the river and its rate of flow.

Flood control reservoirs can materially reduce the stages down stream by storing vast quantities of water and releasing it over a longer period of time. Conversely non-flood control reservoirs may contribute to a more rapid rise of the river below them by shortening the normal period required for run-off to reach a particular river station.

Many people are interested in the behavior of the river, but shippers, farmers, ranchers, sportsmen, and the construction industry are the principal users of river services. In some cases small additional levees can save crops and businesses in a potential flood area. In other cases, livestock, equipment, and personnel can be moved to safe areas.

Forecasts and Warnings are primarily disseminated by mass news media such as newspapers, radio, and television. Local interests are

also usually warned by the cooperative observer at river stations.

Numerous flash floods have occurred on creeks in the vicinity of Jackson and in other similar areas of the State. Two of the larger more recent flash floods were the Tallahalla Creek flood in Laurel on April 7-8, 1964 and the July 8-9, 1968 flood in Columbus. On April 6, 1964 over 10 inches of rain fell over the headwaters of Tallahalla Creek. Additional heavy rain fell on April 7 and 8 in the Laurel area as the main crest on Tallahalla Creek moved into that area. In Columbus on July 8 and 9, 1968 nearly 16 inches of rain fell in less than a 24-hour period.

The following table lists some of the major river forecast stations in Mississippi with data on some of the major floods:

Station	River	Flood Stage Feet	Highest Stage On Record	Date
Greenville	Mississippi	48.0	53.8	April 6, 1945
Vicksburg	Mississippi	43.0	58.4	May 4, 1927
Natchez	Mississippi	48.0	58.0	Feb. 21, 1937
Yazoo City	Yazoo	29.0	43.4	May 5, 1927
Greenwood	Yazoo	35.0	40.1	June 19, 1932
Swan Lake	Tallahatchie	26.0	37.0	Jan. 15, 1932
Anquilla	Sunflower	45.0	48.16	May 1958
Bovina	Big Black	28.0	40.53	Dec. 1961
Aberdeen	Tombigbee	34.0	45.30	March 23, 1955
Columbus	Tombigbee	29.0	39.4	Jan. 7, 1949
Hattiesburg	Leaf	22.0	31.0	Dec. 11, 1919
Enterprise	Chickasawhay	20.0	36.02	Dec. 10, 1919
Shubuta	Chickasawhay	30.0	47.2	Dec. 11, 1919
Waynesboro	Chickasawhay	35.0	47.1	April 11, 1938
Merrill	Pascagoula	22.0	31.0	July 9, 1919
Edinburg	Pearl	20.0	26.3	Feb. 16, 1950
Jackson	Pearl	18.0	37.2	Dec. 21, 1961

Station	River	Flood Stage Feet	Highest Stage On Record	Date
Monticello	Pearl	19.0	30.15	April 8, 1938
Columbia	Pearl	17.0	26.40	April 9, 1938