A CLIMATOLOGICAL ASSESSMENT OF FLOOD EVENTS IN GEORGIA

Jeffrey C. Dobur [1/] and James Noel [2/]

AUTHORS: [1/]Hydrometeorologist [2/]Senior Service Hydrologist. National Oceanic and Atmospheric Administration, National Weather Service Forecast Office. 4 Falcon Drive. Peachtree City, GA 30269
REFERENCE: Proceedings of the 2005 Georgia Water Resources Conference, held April 25-27, 2005, at the University of Georgia. Kathryn J. Hatcher, editor, Institute of Ecology, The University of Georgia, Athens, Georgia.

Abstract. Almost every year, flooding impacts Georgia. In April of 2000, the Georgia Emergency Management Agency reported that nearly 75 percent of Georgia's disaster losses since 1990 had been linked to flooding with an estimated 2 billion dollars in total damage. Flooding in Georgia is wide-ranging and impacts areas from the coastal regions to the mountains at various times of the year. In addition, most flooding events can be characterized by the temporal and spatial distribution of precipitation events.

The climatology of flooding in Georgia was studied in an attempt to gain a better understanding of the spatial and temporal distribution of flooding events. Utilizing the National Climatic Data Center (NCDC) monthly publication entitled Storm Data, flooding events across Georgia from 1987 to 2003 were organized into three categories. These categories were "Small-scale Flooding", which included isolated short duration flood events generally associated with mesoscale weather, "Large-scale Flooding", which included long duration widespread flood events generally associated with synoptic rainfall events, and "Tropical Flooding", which were associated with inland tropical systems. In addition, analysis of Georgia's flood fatalities from 1987 to 2003 was completed. The National Weather Service Forecast Office and the Southeast River Forecast Center in Peachtree City, Georgia hopes that this increase in knowledge will lead to a better understanding of flooding in Georgia resulting in improved flood forecasts for the future.

BACKGROUND

Flooding in Georgia is mainly a function of location with respect to mesoscale, extra-tropical and tropical storm systems, interaction with the local topography, and seasonal vegetative characteristics. Hydrologic forecasting and flood warning responsibility in Georgia is divided among six different National Weather Service Forecast Offices (NWSFO). The NWSFO in Peachtree City, Georgia has a hydrologic service area that encompasses 96 counties of north and central Georgia and their related river basins. Offices in Greer, SC, Columbia, SC, Charleston, SC, Jacksonville, FL, and Tallahassee, FL cover the remaining 63 counties in Georgia. It is the hope with a better climatological understanding of flood types in Georgia, these National Weather Service Forecast Offices will better serve their associated hydrological service areas.

METHODOLOGY

Data for the study was taken from the National Climatic Data Center (NCDC) publication entitled *Storm Data*. This publication includes a chronological listing by state of occurrences of storms including flood, flash flood and river flood events. This is the only known national database for flooding reports. Event data from 1987 to 2003 were examined as this period was found to be most complete. An event was defined based on overall scale. The scale of a flooding event was determined by evaluating the number of counties affected by flooding over a certain time period. Small-scale events were defined by those flood events that were geographically isolated, generally affecting two counties or less and of short duration, mainly less than three hours. Large-scale events were defined by those events that included multiple counties affected over a time period 3 hours or greater and often included river flooding. Small-scale and large-scale events did not include those flood events associated with a tropical storm. Events associated with tropical storms were grouped into a third category called "tropical events". Events were grouped into 12 geographic areas subjectively based on climatological divisions and topography (fig. 1). Flood fatality data was also examined for gender, age, causation, storm-scale type and geographic area.

Zone	Area
1	Northwest Highlands
2	Northeast Mountains
3	West-central Highlands
4	Atlanta Urban Zone
5	East-central Hills
6	Midland Hills
7	West-central Hills
8	Macon Uplands
9	Eastern Uplands
10	Southeast Gulf Plain
11	South-central Plain
12	Eastern Coastal Plain

Figure 1. Geographic Flood Climatology Areas

RESULTS

Small-scale Flood Events

Data showed that nearly two-thirds of the small-scale flood events occurred in the summer months of June through August with nearly 78 percent of the events occurring between noon and midnight local time (fig. 2 and fig. 3). The relatively high proportion of small-scale flood events occurring within the warm season during the afternoon and evening time period illustrates that convective rainfall processes are the most dominant in producing rainfall that results in small-scale flooding. Brooks et al. found this to be true in a study examining one-hour heavy rainfall observations across the United States. It was discovered that 81% of the one-hour heavy rainfall observations in the study occurred from April through September, peaking in July. These results correlate well with the finding from

Maddox et al. (1979), who found that nationally 25% of flash floods occur in July and 86% of flash floods occur from April through September.

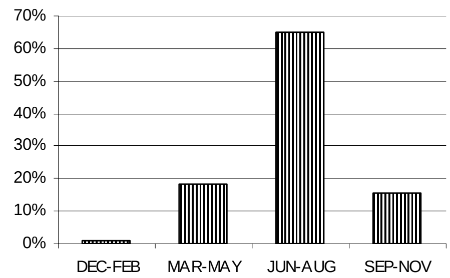

Figure 2. Seasonal Distribution of
Small-scale Flood Events

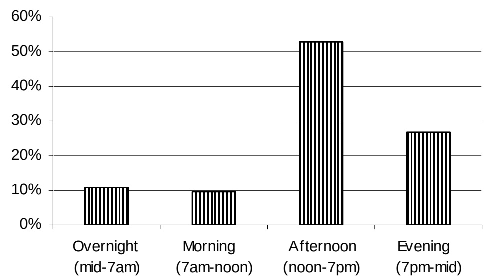

Figure 3. Daily Distribution of
Small-scale Flood Events

Figure 4. Spatial Distribution of
Small-scale Flood Events

Over one-fifth of the small-scale events were observed in the Atlanta Urban Zone (fig. 4). The large number of small-scale events in the Atlanta Urban Zone relative to other areas is likely due to urbanization. The effects of urbanization on the flood hydrograph include increased total runoff volumes and peak flow rates. The major differences in urban watersheds come from generally two causes. First, the volume of water available for runoff increases due to the increased impervious surface cover provided by parking lots, streets, and roofs, which reduce the amount of infiltration. Second, changes in hydraulic efficiency associated with artificial channels, curbing, gutters, and storm drainage collection systems increase the velocity of flow and magnitude of flood peaks. (Chow, 1988) A secondary maximum was observed across the Eastern Coastal Plain. Of the 21 small-scale flood events recorded in Zone 12, eleven of the 21 events occurred in Chatham County, which encompasses the city of Savannah, the third largest city in terms of population in Georgia. With a high proportion of Southeastern Coastal Plain small-scale events occurring in Chatham County, urbanized flooding must also be considered a contributive factor in this zone.

Large-scale Flood Events

Data showed that nearly two-thirds of the large-scale events occurred during the winter and spring seasons with the other third almost evenly occurring between the summer and fall seasons (fig. 5). The winter season was the most active overall. As identified across the Tennessee Valley by Gaffin and Hotz, large-scale flooding events are generally a result of the typical storm track being farther south during the winter and spring. Synoptic systems can often produce southerly upslope flow, while advecting moisture northward from the Gulf of Mexico. In addition, evapotranspiration rates are limited with the decrease in temperature and increase in cloud cover for this time of year along with the increase in dormant vegetation. The Atlanta Urban Zone was observed to have the greatest number of large-scale events (fig. 6), once again highlighting the affect of urbanization. The Northeast Mountains received the second highest number of large-scale events possibly reflecting the aforementioned upslope moisture as a contributing factor typical for large-scale flood events this time of year.

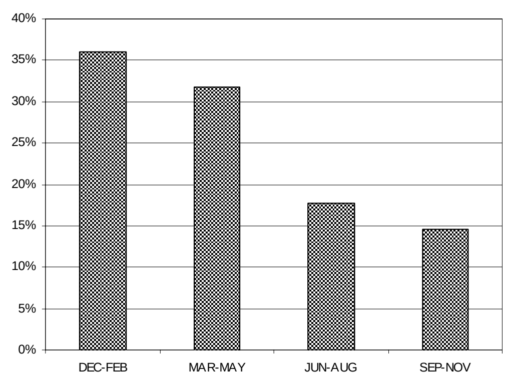

Figure 5. Seasonal Distribution of
Large-scale Flood Events

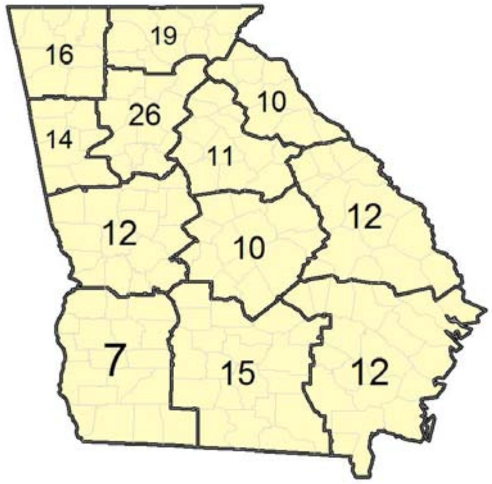

Figure 6. Spatial Distribution of
Large-scale Flood Events

Tropical Flood Event

Data showed that tropical events were evenly distributed between the summer and fall seasons (fig. 7). Tropical-scale events were also more likely in the Eastern Uplands and Eastern Coastal Plain, which together encompassed 39 percent of the events (fig. 8).

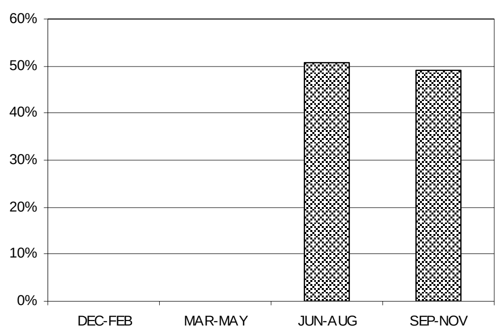

Figure 7. Seasonal Distribution of
Tropical Flood Events

Figure 8. Spatial Distribution of
Tropical Flood Events

Georgia Flood Fatalities

From 1987 to 2003, *Storm Data* reported 53 flood fatalities in Georgia. Of the 53, thirty-nine lost their lives while in a vehicle either from driving into flooded waters or by structural failure of the driving surface caused by flood waters (i.e. bridge, sinkhole, road eroded or scoured away) (fig. 9). The second largest contributing activity was by direct contact with flooded waters either by swimming or falling into flooded waters including culverts and drainage ditches. These two factors made up 90 percent of the flood fatalities in Georgia from 1987 through 2003. The number of male fatalities was nearly twice the number of female fatalities (fig.10) with most fatalities falling into the age range of 30 to 50 (fig.11).

Tropical systems accounted for much of the flood fatalities (fig. 12), in particular, Tropical Storm Alberto when 27 people lost their lives from July 4, 1994 through July 7, 1994 mainly across middle and south Georgia (fig. 13).

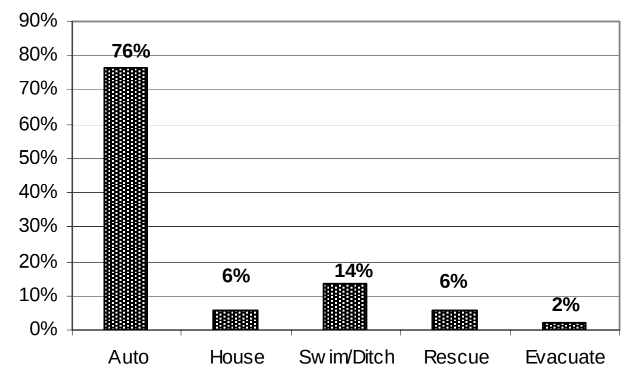

Figure 9. Georgia Flood Fatalities

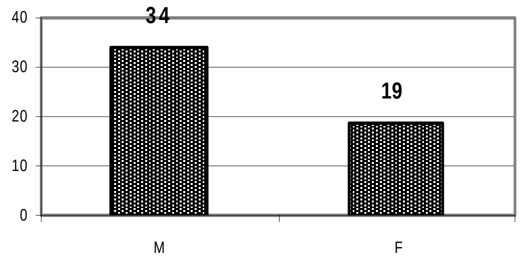

Figure 10. Georgia Flood Fatalities by Gender

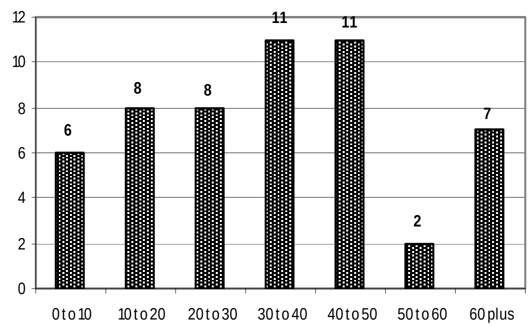

Figure 11. Georgia Flood Fatalities by Age

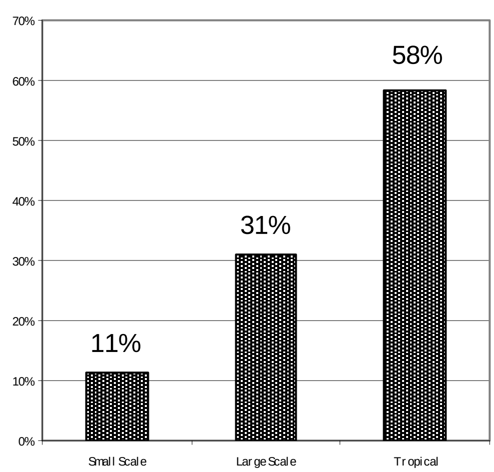

Figure 12. Georgia Flood Fatalities by Storm-scale

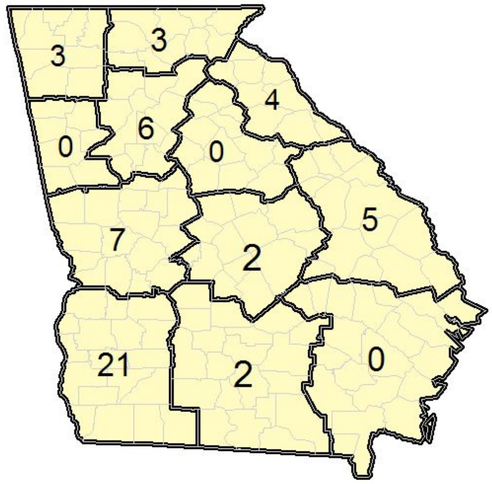

Figure 13. Georgia Flood Fatalities by Area

SUMMARY

Flooding in Georgia is wide-ranging both in scale, geographic area and by season. Small-scale flooding is typical in the summer and more prone in urbanized areas. Large-scale flooding is typical during the winter and spring when synoptic-scale weather is more prominent and evapotranspiration is less. Flooding induced by tropical systems is generally confined to the summer and fall months and are more prone to affect the south and east portion of Georgia. Overall, the Atlanta Urban Zone was shown to be one of the most flood prone areas in Georgia highlighting the effects of urbanization on flood threat.

Georgia flood fatality causation data remain similar to national statistics in that driving a vehicle through a flooded roadway can cost lives. The National Weather Service will continue to emphasize this causation in the hope to reduce flood deaths for Georgia. The National Weather Service remains dedicated to its "Turn Around, Don't Drown" philosophy when it comes to vehicles and flooded roadways.

REFERENCES

Brooks. H. E., Stensrud. D. J., 2000: Climatology of Heavy Rain Events in the United States from Hourly Precipitation Observations: Monthly Weather Review, 128, 1194-1201.

Chow. V.T., Maidment. D.R., and Mays, L.W., 1988. Applied Hydrology. 152 p.

Gaffin.D.M., Hotz. G.H., 2000. Precipitation and Flash Flood Climatology of the WFO Morristown Hydrologic Service Area: NOAA Technical Memorandum (NWS SR-204), February 2000.

Maddox, R. A., Chappell. C. F., and Hoxit. L. R., 1979: Synoptic and Mesoalpha Aspects of Flash Flood Events. Bulletin of The American Meteorological Society, 60, 115-123.