JP2.8 DEVELOPMENT OF A DETAILED DATABASE OF FLASH FLOOD OBSERVATIONS

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ABSTRACT

The primary tool used in the National Weather Service (NWS) to provide guidance toward the likelihood of imminent flash flooding is the Flash Flood Monitoring and Prediction system (FFMP). FFMP “triggers” when rainfall amounts exceed a 1-, 3-, or 6-hour accumulation threshold, or flash flood guidance (FFG), over basins less than 260 km^2 in catchment area. It has been noted that legacy or county-wide FFG values are derived from soil states produced by the Sacramento model which operates on basins up to 4000 km^2 at a 6-hourly time step. New, gridded approaches toward deriving FFG (GFFG) have emerged in order to address this scale mismatch. A high-resolution, accurate flash flood observation database was needed in order to evaluate the new GFFG methods relative to the legacy FFG approach.

The Severe Hazards Analysis and Verification Experiment (SHAVE; Ortega et al. 2009) has been in operation at the National Severe Storms Laboratory since 2006. Undergraduate students use radar-based products and digital telephone databases, all accessible within Google Earth™, in order to call and poll the public about the occurrence and severity of hail, wind, tornadoes, and now flash floods. This paper discusses the criteria used to prompt phone calls and the information requested from the public. We show statistics and make some initial inferences based on the flood calls that were made during the summer of 2008. It is envisioned that this database combined with streamflow observations and NWS Storm Data reports will lead to better tools to predict the likelihood of flash floods.

1. INTRODUCTION

Research leading to better tools to identify regions being impacted by impending flash floods requires a detailed flash flood observation dataset. This study is an effort to augment the existing databases of flash floods from USGS streamflow measurements and observer reports collected by the NWS. The latter databases contain a single observation within a large area or characterize a basin-wide flash flood threat. It is desirable to collect flash flood observations, including null reports, at much finer spatial resolution for detailed research studies. It is also preferable that these reports are collected independently from the NWS warning process.

The SHAVE experiment has been underway since 2006 at NSSL, and was initially focused on hail and wind reports. Flash flood observations have been added in the summer of 2008. The collection of severe weather observations occurs in the Development Laboratory in the National Weather Center in Norman. This paper describes the collection methodology and a preliminary analysis of the flash flood reports.

2. DATA COLLECTION

The remote data collection effort was led and run by undergraduate meteorology majors enrolled at the University of Oklahoma. Prior to the experiment, digitial phone databases using information available through Google Earth™ and Delorme database, NWS watches and warnings, rainfall estimates from NSSL’s National Mosaic and QPE System (NMQ), flash flood guidance thresholds from the NWS’s National Precipitation and Verification Unit (NPVU), and QPE/FFG ratios at 1-, 3-, and 6-hour periods were computed and displayed in real-time in Google Earth™. All relevant sources of information were used to guide the callers to poll the public in regions of interest.

FIG. 1 – Participants in the SHAVE experiment during the summer of 2008.

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Student participants called residences and businesses anywhere in the US if any of the following three criteria were met:

- The NWS issued a flash flood warning or urban/small stream advisory
- QPE*100/FFG > ~100%
- A call for another targeted hazard, e.g. hail, suggested flooding was a problem

The data collection effort began as soon as finals were over in early May 2008 and ended in late Aug 2008. Information was desired for flash flood events which followed causative rainfall by less than six hours. Larger-scale river floods were avoided by examining aerial maps of river locations in Google Earth[TM] and referencing a static map of DEM-derived flow accumulation.

Once a respondent was on the line, the student caller asked questions regarding the impacts of flooding, start and end time, estimated depth, horizontal extent, and motion of the flood waters, occurrence of evacuations or rescues, and estimated frequency of event experienced at residence. Above questions were initially based on the NWS Storm Data Directive and then refined based on comments from personnel at the Arkansas-Red Basin River Forecast Center and Office of Hydrologic Development. All information, including caller comments, was entered into a digital database for later retrieval and analysis. Caution was exercised to ensure no one from the public put themselves at risk when estimating flood depths or lateral extents.

3. RESULTS

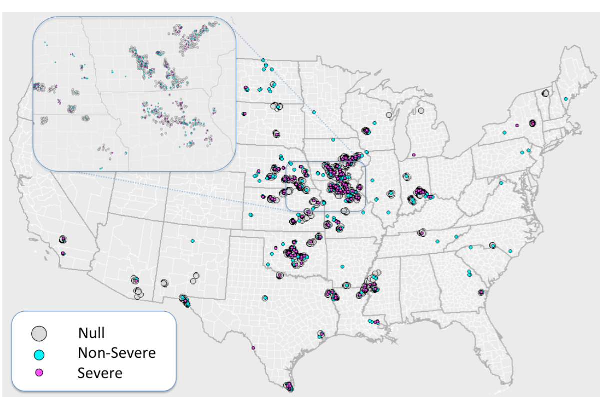

FIG. 2 – Spatial coverage of SHAVE flash flood database developed during the summer of 2008.

The geographic extent of flash flood reports collected during SHAVE 2008 is shown in Fig. 2. The calls tended to focus on populated regions in the Midwest due to the occurrence of flooding there. Coarse population densities in the Intermountain West limited the spatial coverage of the developed database, which is also the case for Storm Data reports and USGS measurements. The callout in Fig. 2 shows the high density of reports that essentially "contoured" events with null, non-severe, and severe flooding reports. The segregation of the flooding reports was made based on the Storm Data Directive. Reports were classified as severe if there was > 0.15 m (0.5 ft) of moving water or > 0.91 m (3 ft) of standing water that posed a threat to life or property. Severe reports also included rivers or streams out of their banks, evacuations or rescues, road closures, and floodwaters in an above-ground residence. Non-severe classifications were assigned to reports that didn't meet the depth thresholds and were typically associated with pastures, crops, farmlands, and yards being flooded.

Overall, there were 1935 null reports, 525 non-severe reports, and 417 severe reports of flash flooding collected throughout the summer of 2008. Figure 3 shows the various impacts of flooding for all non-severe and severe reports combined. A majority of the reports were associated with creeks, streams, or ponds overflowing while a minority was due to 44 reported rescues and evacuations.

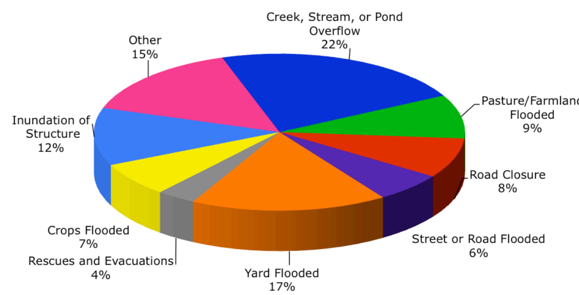

FIG. 3 – Impacts from severe and non-severe flooding.

The distributions of estimated depth of flooding for moving and standing water are shown in Fig. 4. There was a relatively higher frequency of standing water from 0.25-0.5 m, and a higher frequency of moving water at greater depths (generally > 0.5 m). This finding may be useful for refining the thresholds used to define severe flooding events by the NWS, as it indicates deeper water was more often associated with moving rather than standing water in the SHAVE database.

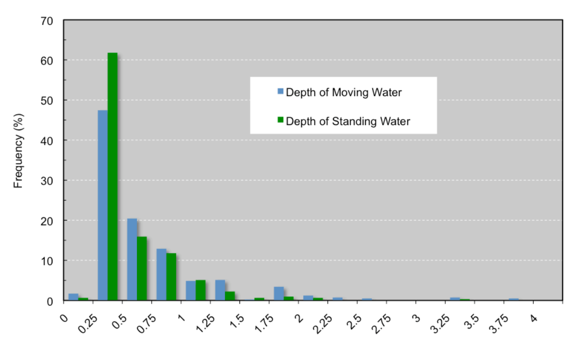

FIG. 4 – Relative frequency histograms of reported flood depth for standing and moving water.

The distribution of the lateral extent of water out of its stream or creek banks is shown in Fig. 5. By definition, all events in this analysis were classified as severe. The shape of the distribution is similar to those in Fig. 4, except the largest bin of lateral extent > 320 m included a relative maximum of 28 events. Inspection of the comments section associated with these reports showed values of "999.999" were entered to indicate water from nearby creeks inundated crops and farmland extending as far as the call respondent could see.

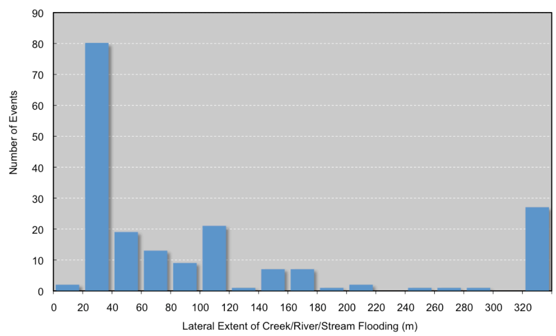

FIG. 5 – Histogram of lateral extent of flooding from creeks and streams. All events comprising this analysis were classified as severe.

The final piece of information collected during SHAVE was the estimated return period of the event according to the respondents' experience. The determination of severe vs. non-severe floods was made independently from the flood frequency information. Figure 6 indicates there were a relatively greater proportion of severe reports associated with rare events (e.g. "Never seen it like this before") and more non-severe reports associated with common events (e.g. "It floods like this every time there is heavy rain"). This result indicates the classification of non-severe and severe events is qualitatively correct, and further enhancements to the water depth thresholds associated with flood severity can be expected with information regarding flood return periods collected during SHAVE.

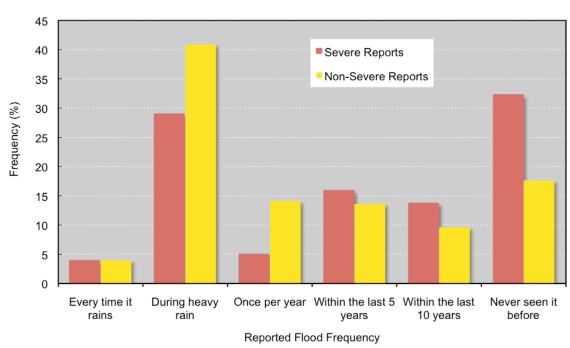

FIG. 6 - Relative frequency histograms of flood frequency for non-severe and severe reports.

4. CONCLUSION

The data collected during SHAVE provides a unique dataset which allows for current research to more accurately and confidently (due to the high resolution) relate radar-based algorithms to ground truth. The dataset is unique not only for its spatial accuracy and resolution, but also the types of information contained within the dataset.

The project is unique in the fact that, except for the building of the project's infrastructure and initial training, the project is largely student-led and student-run. For a sponsoring organization, this provides for an inexpensive project which yields a large amount of data. Opportunities to learn about severe storm forecasting, radar interrogation of storms and severe storm hazards provide the students with an extraordinary learning experience and potential research topics for course work. Further, the students must apply critical thinking and teamwork during the verification process; combined with invaluable face time with project scientists, the project also provides students a great professional development experience. More details about SHAVE can be found in an article recently submitted by Ortega et al. (2009).

An effort is currently underway to evaluate and benchmark legacy FFG thresholds and newly developed, gridded approaches (GFFG) using NWS Storm Data reports, USGS streamflow, and now SHAVE reports. An envisioned outcome from this study will be a simple table reporting the ratios of QPE/FFG and QPE/GFFG for 1-, 3-, and 6-hour duration that result in the greatest skill in predicting flash floods. These thresholds can be used immediately in a forecasting environment to help minimize false alarms and maximum the detection of flash floods.

5. REFERENCES

Ortega, K. L., T. M. Smith, K. L. Manross, K. A. Scharfenberg, A. Witt, A. G. Kolodziej, and J. J. Gourley, 2009: Severe hazards analysis and verification experiment. Submitted to *Bull. Amer. Meteor. Soc.*