Flash Flood Warning Performance Improvement

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Outline

- Motivation / Statistics
- Specific Topics
  - A Sampling of Past and Present WFO BGM Research on Flooding
    - “Three Strikes and You’re Out”
    - Flash Flood Potential Index (FFPI)
    - Maximum Potential PWAT
Flash Flood Warning Performance Improvement

Motivation
ER FFW Statistics

ER - 7 YEAR MOVING AVERAGE FFW VERIFICATION TRENDS

ENDPOINT YEAR OF SERIES

LOAD TIME (MINUTES)

POD, PER and CH

ER FFW Lead Time Issues

% Zero LT


% Zero LT
Things to Consider

- Although overall trends in LT have been good through the last 10 years:
  - Zero LT Warnings are still running 15–25%
    - About 1 out of every 5 FFW’s
    - Simply in “reactive mode”
  - POD has remained about steady, however:
    - FAR’s have steadily increased
      - As a result, CSI’s have lowered over time

- What to do?
An established “tool of the trade” for warning operations is comparing Gridded FFG to accumulated / radar estimated rainfall

- Other tools / strategies to help us better differentiate?
Previous research by Davis (2000) and Kelsch (2001)

- Frequency of short-duration bursts vs. FFG / cumulative rainfall ratios
  - Main suggestion: Monitoring instantaneous rate trends may be at least as important as using FFG (especially in fast responding watersheds)
Selected 10 major flash flood events from NY / PA since 2002

- Combined costs:
  - 11 fatalities
  - At least hundreds of millions of dollars in damages

- Other numbers:
  - Warm season cases (8):
    - Averaged 6–7” rainfall / 3 hours
    - Maximum: 10+” on 6/19/07 (Colchester, NY)
  - Cool season cases (2):
    - Averaged 2–3” rainfall / 2 hours
Testing the Hypothesis / Methodology

- For our selected list of events, we evaluated the following data:
  - KBGM WSR 88–D
    - 0.5 Degree Base / Composite reflectivity
    - 1–hour, 3–hour, and storm total rainfall
    - Calculated 1–hour instantaneous rates
  - 1–hour and 3–hour FFG (MARFC)
    - Unavailable for one of the cases

- Graphically compared the following
  - Instantaneous rates over time
  - Ratios of accumulated rainfall to FFG
Rainfall Rates and FFMP

Rainfall rates tracked every volume scan, basin by basin.

Instantaneous hourly rates, accumulated rainfall, and FFG can all be displayed graphically.

Threat Basin Table

Basin Trend Graphs
Heavy Rain Bursts

- In the majority of cases (8 / 10), initial reports of major flooding coincided with the *third burst* of high intensity rainfall
  - Specific rainfall rates were relative (air mass / season dependent)
Rates vs. Times Examples

Colchester: Rate vs. Time

January 2010 (Broome/Susq FF): Rate vs. Time

June 19, 2007

January 25, 2010
FFW vs. Actual Flooding (LT Issues)

Colchester: Rate vs. Time

January 2010 (Broome/Susq FF): Rate vs. Time

Opportunity for more LT?
Rainfall to FFG Ratios

- At times when major flooding was reported/observed, mean accumulated rainfall to FFG ratios were:
  - **Warm season**
    - 1-hour: 1.45; 3-hour: 1.95
    - Significant flooding normally occurred *well after FFG values were exceeded*
  - **Cool season**
    - 1-hour: 0.75; 3-hour: 0.9
    - Significant flooding occurred *prior to FFG values being reached*
      - Impervious / frozen surface?
Warm Season Case

Broome FF: Rate vs. Time

Rainfall first reaches FFG values

Major Flooding

22z, 13 June – 03z, 14 June 2003 (Rate vs. Time)

22z, 13 June – 03z, 14 June 2003 (Rainfall / FFG Ratio vs. Time)
January 2010 (Broome/Susq FF): Rate vs. Time

11z – 17z, 25 January 2010 (Rate vs. Time)

1100z 1132z 1204z 1236z 1308z 1340z 1412z 1444z 1516z 1548z 1620z 1652z

1 Hr FFG
3 Hr FFG

3 Major Flooding

Rainfall not yet at FFG values

Major Flooding

11z – 17z, 25 January 2010 (Rainfall / FFG Ratio vs. Time)
Potential Uses / Caveats

- Timing bursts of high intensity rainfall show promise as a flash flood predictor
  - At least for higher-end events
    - Opportunities to combine this kind of diagnosis with analyses of FFG
    - Sooner recognition of major flooding / better LT?
- Rainfall amounts tend to “rocket” past FFG values for significant warm season flash floods
  - Possible assistance in warning decision making
  - Lower FAR’s / better CSI’s?
- However, the BGM CWA features fairly homogenous soil types / similar land uses most areas
- No accounting was made for antecedent conditions
Flash Flood Warning Performance Improvement

FFPI
FFPI Refresher

- Index is a mathematical average of geophysical characteristics of a basin
  - Slope
  - Land Use/Land Cover
  - Soil Type
  - Forest Density
- Index gradient is from 1 (Low) to 10 (High)
  - Basin’s potential to respond to heavy rain events leading to flash flooding.
- Antecedent conditions not accounted for
The Data

- Four geographic data sets were utilized.
  - Slope derived from the USGS DEM
  - MLRC Land Use/Land Cover Grid
  - AVHRR Forest Density Grid
  - STATSGO Soil Type Classification
Note the good fit to empirical understanding developed over the years

Also some new realizations, especially the low potential areas

Differentiates the “best of the worst” basins in an area generally known for high flash flood potential
Current/Future Enhancements

- Resolution increased from 90 m to 30 m
- Readily displayable in AWIPS
- Further tweaks / mathematical re-indexing is ongoing
  - Based on FF reports / case studies
- For further information: James.Brewster@noaa.gov (WFO BGM SSH)
Flash Flood Warning Performance Improvement

Maximum Potential PWAT
Assessing flash flood potential can be especially difficult in rapidly changing situations
  ◦ Severe threat evolving to a flash flood threat
Precipitable water (PWAT) can be a fickle parameter
  ◦ Values can change substantially / quickly as NWP convective schemes trigger
    • Another way to view this field?
As storms develop/CPS trigger, then they depart, model moisture profiles tend to modify quickly. PWAT could change significantly, hour to hour.

Max Potential PWAT values should be less subject to wild fluctuations in time / space.
Maximum potential PWAT (Arnott, 2008, http://www.erh.noaa.gov/bgm/research/2008/MaxPwat_Abstract.pdf) may provide a useful way to assess flash flood potential ahead of time, especially given the expectation of training / repeat cells

- May have the advantage of being a more stable value

Needs an automated application to run (not yet developed)

Local testing planned at WFO BGM


The End !!

Questions ??