Learning Tropical Meteorology in PR
Back to DC to Save the World From Hydrologic Forecast Uncertainty
Communicating Risk is EASY

Please see the document:
http://apps.weather.gov/tempdocuments_ext/NWS_FIM_QAQC_Plan_FY09Q4_FINAL_NWS.pdf
NWS Hydrologic Forecast Uncertainty

Background

• The NWS issues river forecasts, watches and warnings for over 4000 locations nationwide.

• Uncertainty Information is provided at approximately half of these locations.

http://www.weather.gov/water
NWS Hydrologic Forecast Uncertainty
Biennial Customer Satisfaction Survey

Hydrology Receives High Marks Again
Similar to other NWS scores; above ACSI too

<table>
<thead>
<tr>
<th>Service Area</th>
<th>ACSI Score</th>
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<tbody>
<tr>
<td>ACSI (Overall) 2008</td>
<td>75.1</td>
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<td>Federal Government 2007</td>
<td>67.8</td>
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<td>Event Driven - Hurricane Rita 2006</td>
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<td>General Public 2006</td>
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<td>Hydrology 2008</td>
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<td>Emergency Managers 2006</td>
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<td>Aviation 2007</td>
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<td>Marine &amp; Tropical 2006</td>
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<td>Fire Weather 2006</td>
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<td>Climate 2006</td>
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Biennial Customer Satisfaction Survey

Overall Scores for Graphics
Based on average of 3 questions

- Visual Appeal
- Ease of Understanding
- Tells me what I need to know about...

<table>
<thead>
<tr>
<th></th>
<th>Score</th>
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<tbody>
<tr>
<td>Area of Interest</td>
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<td>National Precipitation Analysis</td>
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<td>Graphical Flood Severity</td>
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<tr>
<td>River Conditions - 5</td>
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<td>Water in Snow Pack</td>
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<tr>
<td>River Conditions - 3</td>
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<td>Hydrograph w/o Average Level</td>
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<td>Hydrograph w/ Average Level</td>
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<tr>
<td>River Stages - Given Week</td>
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<tr>
<td>River Stage - Daily</td>
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<tr>
<td>River Stages - 90 day</td>
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</table>

Significantly Lower Scores
Probability Focus Group Study

Participants and Objective

- **Who Participated**
  - Water Resources Managers – AWRA 2005 Annual Conference in Seattle, WA on November 9, 2005
  - Emergency Managers IAEM 53rd Annual Conference in Phoenix, AZ on November 13, 2005
  - Broadcast media - AMS meeting January 31, 2006
  - Private-sector value-added partners - AMS meeting - February 1, 2006

- **Objective:** Understand the underlying need for probabilistic forecast information among various user groups

  - How do respondents deal with uncertainty in their forecasts?
  - Where do they get information about uncertainty now?
  - What are shortfalls of current uncertainty data?
  - What type of uncertainty information would be most useful?
  - Gather feedback about probabilistic forecasts graphics that are currently available.
Social Science Approach

Why Aptima, Inc?

Aptima’s Approach

1. Knowledge Acquisition

2. Uncertainty Modeling

3. Visual Display Design
Advanced Hydrologic Prediction Service

Probabilistic information to support risk-based decisions

Implementation Status

✓ Demonstrating components of short-term capability at 6 RFCs
✓ Will deploy additional prototypes during the next 2 years
✓ Initial version of full capability in 2013
NWS Hydrologic Forecast Uncertainty
River Extent Visualization

- Visualization of river extent for given point selected in the river prediction of flow/height
- Stage, Likelihood and Confidence of a selected point
- Impact of given scenario shown (items affected)
NWS Hydrologic Forecast Uncertainty (Interplay of Visualization)

- Organization of information for enhanced decision making
  - Clear understanding of relationship
  - Easy access to needed information for decision making
Average: 84
85: Visual Appeal
82: Ease of Understanding
86: Tells me what I need to know
Advanced Hydrologic Prediction Service (Contingency Event Planning)

- Geographic representation of current and possible future flooding scenarios.

Conceptualization

- Flood inundation referenced to potential loss estimates.
Doesn’t Work So Well During Rapid Developing Flash Flood Events Arkansas - June 11th 2010

The Little Missouri River mowed down trees as it went from roughly 3 feet to 23 feet in just a few hours.
Arkansas Flash Flooding June 11th 2010

Time Line: Observations and Reports

1:50 AM: National Weather Service Radar indicates heavy precipitation developing over the area.

2:00 AM – 5:30 AM: USGS Stream flow gage records 20 ft rise on the Little Missouri near Langley, Arkansas -- 9 miles downstream from Albert Pike Recreation Area.

~3:15 AM Campers at Albert Pike Recreation Area are reported to begin evacuating to high ground. Loss of life likely to have occurred.

Arkansas Flash Flooding June 11th 2010
Arkansas Flash Flooding
June 11th 2010

• Flash flooding devastated the Albert Pike Recreation Area (Montgomery County, Arkansas) early on 06/11/2010.

  • As many as 200 to 300 people camping were awakened to a rapidly unfolding high water situation, with water rescues necessary.

• 20 lives were lost
Findings from Official NWS Service Assessment Following Atlanta Floods Sept 2009

✓ The NWS WFOs issued timely flash flood/flood watches, warnings, and statements in the assessment area before and during the period of heaviest rain and flooding. Each of the fatalities occurred in an area encompassed by an NWS Warning: two during areal flood warnings and nine during flash flood warnings.

✓ A major flood forecast was made for Austell, GA on Sweetwater Creek with 36 hour lead time, and a major flood forecast crest for Whitesburg, GA on the Chattahoochee River was forecast within a foot of observed with 36 hour lead time. RFC forecast hydrographs and crest forecasts for the two rivers where the greatest property damage occurred were considerably under forecast, with subsequent forecasts each nudging closer to the conditions eventually observed.
However...

- Even though there were significant flood impacts, including water rescues, no city, county or other EMs or first responders called WFO Peachtree City on Sunday night, September 20-21, to report the severity of impacts.

- NOAA Weather Radio (NWR) broadcast cycles at WFO Peachtree City became excessively long (more than 20 minutes in length) due to the number and length of warnings in effect. Many residents said they owned an NWR receiver but did not have it turned on during the flood event. When asked why, the majority stated, “It goes off too often.”

- WFO flash flood warnings and statements generally contained standard Warning Generation Software (WarnGen) call-to-action statements and generic impact information. These generic statements failed to convey the severity of the flash flood/flood events. Emergency management and media representatives wanted more specific impact information in statements, despite having difficulty with the long length and large number of warnings issued. These users would like more strongly worded impact information at the top of the statement where it would be readily noticed.
Warning Response

- Residents responded better to warnings communicated down to a personal level (e.g., evacuation notice, reverse-911call) than from mass communication methods. Few residents took action solely on warnings received via mass communications systems (media, NWR). Warnings heightened residents’ awareness, which led to subsequent personal validation of the warning threat before precautionary measures were taken.

- Residents have a low tolerance for missed warnings or false alarms when communications get down to a personal level. People quickly become disenchanted with telephone warnings and evacuation messages when no threat materializes.
Like many other tragic events that are hard to react to even if perfectly warned...

Many of the fatalities occurred at night, in heavy rain, when visibility was minimal. It was not evident that the victims intentionally attempted to drive through water on the roadway; rather, they were blinded by the heavy rain. Drivers did not seem aware of the danger of driving at night, even though flash flood warnings had been issued.

WFO staffing levels during the weekend and nights of many of these heavy rain events were augmented and adequate for issuing basic forecast and warning services, but not for aggressively soliciting feedback reports and providing coordination and other decision-support activities. EMs in Georgia believe WFO Peachtree City provides a reduced level of service during weekend events, which they attribute to reduced weekend staffing.

The loss of river gage data played a significant role in underestimating the river forecast for Sweetwater Creek near Austell, GA (AUSG1). The Southeast River Forecast Center and WFO Peachtree City did not exhaust alternative means to infer reference river stage at Austell along Sweetwater Creek once gages became inoperable.
The Service Assessment Team Recommendations

✓ The Duties Priority statement (Appendix C) should incorporate decision support as a top priority along with warning responsibility. NWS should conduct a comprehensive communication effort and training program to help employees make the culture change from a product-oriented organization to a high impact and decision-support agency.
Discussion