NWS River Forecasting, GIS, and the 2016 Amite/Comite River Flood

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Overview

1. LMRFC river forecast process
2. GIS at the LMRFC
3. The 2016 Amite/Comite River Flood
LMRFC river forecast process
River Forecast Process

What do we do at the LMRFC?

• Forecast river stages for ~220,000 mi$^2$ area
  – River Gauge Data
  – Rainfall Data
    • Amount/Location and Fallen/Forecasted
  – Soil Moisture Data

• Assist with Flash Flooding
The Water Cycle

Hydrologists focus mostly on water at the Earth’s surface.

Hydro forecasters for the National Weather Service focus primarily on “Surface Runoff”
River Forecast Process
River Forecast Process

Sacramento Soil Moisture Accounting (SACSMA) Model
- Conceptual model
- Total runoff based on interaction of 2 soil zones
- Variable parameters used to simulate movement of water into and out of zones

Routing
- Movement of water from one river location to next
- Parameters simulate time delay and also attenuation
River Forecast Process

- River Forecast Centers issue precipitation, river, and flash flood guidance based on hydrologic/hydraulic models
- Provide river forecast guidance to Weather Forecast Offices (WFOs)
- Develop and calibrate models
Flood Outlook and Warning Products (2016 08 Example)

- **Outlooks** – Issued for long lead time, days in advance.  
  *(mentioned on Sat Aug 6 and issued special product on Mon Aug 8)*

- **Flood/Flash Flood Watch** – Issued 36 to 48 hours in advance.  
  *(Initial Watch issued Tue 9 – continued thru event)*

- **River Flood Warnings** – Lead time up several days in advance, if possible, depending on rainfall forecasts and river watershed size
  - Utilize RFC guidance to generate River Forecasts and Warnings.  
    *(Wed, Aug 10 – initial river flood warning based strictly on forecasted rainfall)*

- **Flash Flood Warnings** – issued for flooding small streams/bayous/local drainages.
  - Tools – real time precip estimates from radar/gages/satellite, radar trends, reports, and flash flood guidance. Software tools.  
    *(Initial Warnings Thu – Aug 11)*
  - Can elevate Warnings to “Emergency” level when there is a particular threat to life.  
    *(Fri early morning – Aug 12)*
River Forecast Process

• **Provide Advice to State and Local Emergency Management**
  • Blast e-mails, webinars, conference calls, direct briefings. *(started Mon Aug 8 and continued thru event)*

• **Direct to Media and Public**
  • Media - Conference calls *(Wed Aug 10)*
  • Public - thru media as partner/conduit
  • Public – direct thru Web Page, Social Media, NOAA Weather Radio, phone calls *(utilized throughout the event)*
GIS at LMRFC
GIS at LMRFC

• Most data used by LMRFC (or any NWS office) inherently geospatial

• Tools/Techniques for Situational Awareness

• Research
GIS at LMRFC

Spatial Averaging

At RFCs, virtually all modeling is done on the watershed/basin-scale.

Gridded data is averaged by forecast basin before being used by models.
GIS at LMRFC

Other “Map Algebra”

Comparison of values (rainfall, soil moisture) to climatology

Calculation of potential evapotranspiration

Comparison of rainfall to flash flood guidance
GIS at LMRFC

Other Analyses

Estimating gauge crest elevation for Hurricane Isaac flooding
GIS at LMRFC

Other Analyses

Monitoring development patterns for possible model parameter changes
Situational Awareness

Joins of watersheds to numeric data

Comparison of parameters between neighboring watersheds
GIS at LMRFC

Situational Awareness

Simple joins of watersheds to text file of “yes” or “no”

Tells forecasters if updates available
GIS at LMRFC

From simple to complex...

- Master River Location Metadata File
- LMRFC
- Old Metadata File
- Report of Changes
- Locations to Update
- Auto Create Metadata Pages
- Flag Outdated Locations in Database
GIS at LMRFC

Consistent Metadata

Built from an ArcMap layout

Python edits text boxes based upon metadata, python moves map window
Past Event Archive

Over 60 years of daily point precipitation data converted to shapefiles, then interpolated (kriging) to grids

Tool created to access database and auto create maps
GIS at LMRFC

Analyzing Major Events

Acquisition of rainfall data from numerous networks to verify extreme rainfall totals.

Using pumping records to confirm rainfall amounts
### Rainfall Rates and Pumping Rates

<table>
<thead>
<tr>
<th>Subbasin</th>
<th>Rainfall (in)</th>
<th>Loss (%)</th>
<th>Loss (in)</th>
<th>Modeled Runoff (in)</th>
<th>Equivalent Depth Pumped (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>16.97</td>
<td>13.5%</td>
<td>2.29</td>
<td>14.77</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>11.29</td>
<td>1.5%</td>
<td>0.17</td>
<td>11.02</td>
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<tr>
<td>3</td>
<td>10.42</td>
<td>2.2%</td>
<td>0.22</td>
<td>10.11</td>
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<tr>
<td>4</td>
<td>12.02</td>
<td>4.3%</td>
<td>0.51</td>
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<tr>
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<td>3.54</td>
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<td>7</td>
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<tr>
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<td>2.7%</td>
<td>0.24</td>
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<td>PolderAVG</td>
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<td>10.2%</td>
<td>1.39</td>
<td>12.13</td>
<td>11.94</td>
</tr>
</tbody>
</table>
GIS at LMRFC

Analyzing Past Events – “Geo-intelligence”

Neda Burtman, posted to social media

Power lines

Boathouse

Google Maps
GIS at LMRFC

Analyzing Past Events – “Geo-intelligence”

Gap in traffic data coincident with waterway

Gap in traffic data with standstill traffic

Google Maps - Data recreation
GIS at LMRFC

Analyzing Major Events

Comparing rainfall to climatology to determine annual exceedance probability (AEP) / average recurrence interval (ARI)

Comparison to flood reports
2016 Amite/Comite River Flood
2016 Amite/Comite River Flood
Five-Day Graphical Tropical Weather Outlook
National Hurricane Center Miami, Florida

Tropical Cyclone Formation Potential for the Five-Day Period Ending at 2:00 pm EDT Mon Aug 15 2016
Chance of Cyclone Formation in Five Days:  ▪ Low < 40%  ▪ Medium 40-60%  ▪ High > 60%
X indicates current disturbance location; shading indicates potential formation area.
2016 Amite/Comite River Flood

Near record atmospheric moisture

Climatology of moisture content 1948-2014

3rd highest value on record, above daily maximum
2016 Amite/Comite River Flood

Excessive Rainfall Outlook

Issued 1200 UTC (7am CDT) Friday Aug 12

Language included
“life threatening flash flooding”
“Model rainfall truly prolific”

“High Risk” used in Day 2 – very unusual
2016 Amite/Comite River Flood

Tuesday
Aug 9

Wednesday
Aug 10

Thursday
Aug 11

Friday
Aug 12
Already forecasting a record flood event with much less rainfall than what actually occurred.
1983 04 Rainfall
2016 08 Rainfall
1983 04 River Crests
2016 08 River Crests

[Map showing river crests and rainfall intensity areas]
2016 08 Rain Event in Context

• Can we really expect only a 0.1% chance of this event occurring again in any year?

Yes and no.

• What does this mean for 2017?... Beyond?

Also hard to say, but we have some educated guesses.
2016 08 Rain Event in Context

• ARI/AEP analyses are based upon statistics of observed data, and valid only for *point locations*

• **Creation of** ARI/AEP rainfall frequency data assumes *stationary climate* over reference period

• **Usage of** ARI/AEP analyses assumes *no future changes to climate*
2016 08 Rain Event in Context

Something to keep in mind as regional/urban planners...

[Graphs and charts from climate.gov and NOAA NCEI]

2/8/2017
2016 08 Rain Event in Context

2016 08 Rain Event was...

• 1/1000 event for specific point locations, but
• Estimated as only a 1/30 event for the central Gulf Coast (roughly Houston to Tallahassee) as a whole
• At least 40% more likely to occur because of increased sea surface temperatures and atmospheric moisture, compared to early 1900s, according to recent study

What do these probabilities really mean?

Probability of at least one event within...

- Typical Mortgage
- Human Lifespan

AEP
- 0.1%
- 0.2%
- 1.0%
- 10.0%
2016 08 Rain Event Summary

- Caused by extreme, low-probability rainfall event
- Rarity of causative rainfall does not necessarily correlate to magnitude of river levels!
  - NO: “This was a 1000-yr flood event”
  - YES: “For isolated areas NE of Baton Rouge the rainfall event was estimated to have only 0.1% chance of occurring in a given year”
What does this mean for 2017?... Beyond?

- NO: “We just had our 1000-yr flood last year, so we won’t flood this year.”
- YES: “There was a 0.1% chance of that extreme rainfall last year and there is also a 0.1% chance of it occurring this year.”*

*Although these statistics are likely changing, in hard to quantify ways, due to climate change and development.
Numerous independent, scientific studies have shown that heavier rainfall events are already observed as increasing in frequency, and this trend is expected to continue.

Low probability, high impact events are often difficult to forecast.
Questions/Comments?

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Credits & Citations

Graphics and references:

• NOAA Sea Grant
• NOAA NCEI
• NOAA Climate.gov
• NOAA SPC
• NOAA WPC
• NASA
• USDA
• New Orleans Sewerage and Water Board
• maps.google.com
• gisgeography.com