Flood modeling and return period determination in Schoharie Creek

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2/21/2012

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Aug 28, 2011 Hurricane Irene brought floods in Schoharie Watershed...
Study Area

- Schoharie Creek, New York
- Between North Blenheim and Breakabeen
- USGS gauging stations on both ends
Objectives

Event & post-event:
• Pair flood gauge readings and FEMA flood scenarios;
• Model flood extent & determine return period;
• Assist in the damage assessment and analysis.

Pre-event:
• Augment the flood stage category system for the current area
• Set up a warning system for un-gauged areas
Latest observed value: 7.78 ft at 5:30 PM EDT 29-Aug-2011. Flood Stage is 11 ft

Record Stage: 20.5'

Major Stage: 18.0'
Moderate Stage: 16.0'
Flood Stage: 11.0'
Action Stage: 8.0'

Graph Created (6:15PM Aug 29, 2011)  Observed  Forecast (issued 10:46AM Aug 29)

BKB666(plotting HGIRG) "Gage 0" Datum: 686.79'  Observations courtesy of US Geological Survey
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action stage, …record flood stage

Gauging station data

- Breakabean
- North Blenheim

HEC-RAS

- NED 10m
- LiDAR
- Landcover dataset

Model validation

- Ortho imagery, social media
- FEMA scenarios, social media

Model result pairing
# Gauging station data

<table>
<thead>
<tr>
<th></th>
<th>North Blenheim</th>
<th>Breakabeen</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Gage height/ft</td>
<td>Discharge/cms</td>
</tr>
<tr>
<td><strong>Monthly mean of Jul+Aug+Sep, 1990-2010</strong></td>
<td>1.9&lt;sup&gt;r&lt;/sup&gt;</td>
<td>3.5</td>
</tr>
<tr>
<td><strong>Action stage</strong></td>
<td>5.9&lt;sup&gt;t&lt;/sup&gt;</td>
<td>96.0&lt;sup&gt;t&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>08-30-2011 (imagery collecting day)</strong></td>
<td>6.1</td>
<td>100.2</td>
</tr>
<tr>
<td><strong>Minor stage</strong></td>
<td>8.3&lt;sup&gt;t&lt;/sup&gt;</td>
<td>195.4&lt;sup&gt;t&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>Moderate stage</strong></td>
<td>12.3&lt;sup&gt;t&lt;/sup&gt;</td>
<td>606.0&lt;sup&gt;t&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>Major stage</strong></td>
<td>13.2&lt;sup&gt;t&lt;/sup&gt;</td>
<td>795.7&lt;sup&gt;t&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>Record stage</strong></td>
<td>17.2</td>
<td>2075.6&lt;sup&gt;t&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>08-28-2011 (event day)</strong></td>
<td>22.0</td>
<td>3567.9&lt;sup&gt;e&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

**Note:**

- <sup>e</sup> refers to estimated.
- <sup>t</sup> refers to time stamp based.
- <sup>r</sup> refers to calculated with the discharge-stage rating equation.
Validation of HEC-RAS model

Model result ↔ Observation
Monthly mean discharge

- Constrained to the channel

1: Mean data of Jul, Aug, Sep, 1900-2010
Aug 30, 2011 (imagery collecting day)

- Ortho imagery (water line)

NED 10m

LiDAR 10m
Maximum flood extent indicated on the imagery by:
- physical evidence
- sudden color change
Aug 28, 2011 (event day)

- Ortho imagery (max flood extent)

Red border stands for maximum flood extent.
Pairing model results

Gauge reading (water stage) ↔ FEMA flood scenarios
Action stage

One cross section

River profile
Minor stage

One cross section

River profile
Moderate stage

One cross section

River profile
Major stage

One cross section

River profile
Record stage

One cross section

River profile
Aug 28, 2011 Event

One cross section

River profile
Use two indexes as the pairing standards:

**Root-mean-square error (RMSE):**

\[
RMSE = \sqrt{\frac{\sum_{i=1}^{N} (P_i - O_i)^2}{N}}
\]

(most agree) \(0 \sim +\infty\) (most disagree)

**Index of agreement (IOA):**

\[
d = 1 - \frac{\sum_{i=1}^{N} |P_i - O_i|^2}{\sum_{i=1}^{N} (|P_i - \hat{O}| + |O_i - \hat{O}|)^2}
\]

(most agree) \(1 \sim 0\) (most disagree)

Pairing principle: find the pair with the **smallest RMSE & largest IOA**.
FEMA flood scenarios
## Pairing results

<table>
<thead>
<tr>
<th>Gauging station data</th>
<th>FEMA flood scenarios</th>
</tr>
</thead>
<tbody>
<tr>
<td>Action stage</td>
<td>2yr-5yr flood</td>
</tr>
<tr>
<td>Minor stage</td>
<td>10yr-25yr flood</td>
</tr>
<tr>
<td>Moderate stage</td>
<td>200yr flood</td>
</tr>
<tr>
<td>Major stage</td>
<td>200yr-500yr flood</td>
</tr>
<tr>
<td>Record stage</td>
<td>500yr flood</td>
</tr>
</tbody>
</table>
Aug 28, 2011 event

**NED 10m**
- High: 15.089249
- Low: 0.000595

**LiDAR 10m**
- High: 13.1826
- Low: 0.000396729
Aug 28, 2011 event------ >500yr flood (most parts)
Conclusion

• Aug 28, 2011 event at Schoharie Watershed was (at least) a 500yr flood.
• Flood scenarios of a single event could be locally different.
• Ground feature & topography transformations during the events could cause flow rate/flood inundation change.
Future work

• Integrate social media information
• Set up a warning system for un-gauged areas
Acknowledgement

Sincere thanks to:

- Chris Renschler
- Graham Hayes
- Martin Minkowski
- Ryan Mendiate
- and all other coworkers in LESAM lab.

Also thank Dr. Mark R. Read and Dr. Kathleen Dietrich!

This research study is part of the (Information Products Lab for Emergency Response) IPLER project.

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