Probabilistic Flood Mapping Using Volunteered Geographical Information

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Motivation

- Traditional flood inundation maps
  - 1-D, 2-D or 3-D hydrologic model and/or remote sensing
  - Limited by spatiotemporal resolution of input data

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- Wealth of real time flood information
  - Social media, news, emergency calls, etc.

Image sources: http://www.youtube.com
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Research question:

How can volunteered geographical information (VGI) be used to provide reliable probabilistic flood maps, especially in areas where no model and/or gauge data is available?

Conceptual Overview

Collect, Filter and Geo-tag Data

Photo or Video?

Yes

Estimate Water Depth

Probabilistic Flood Extent Model

No

Assume Water Depth

Probabilistic Flood Extent
Methodology: Floodwater Depth Estimation

1. Social media videos/photos
   - Parts of Downtown Austin are underwater
   - Social media geo-location

2. Extraction of Google Street View data (images and depth map)
   - Find camera direction and corresponding Google Street View images

3. 3D Reconstruction of Google Street View
   - Estimate water horizon

4. Associate to Google Street View
   - Find and match reference points

5. Projection of water horizon to 3D model
   - Estimation of water depth
Methodology: Probabilistic Flood Mapping

Inputs
- DEM
- VGI data points & flood water depth
- Stream centerlines

Monte Carlo Simulation

Multiple seed points → Hydro Region Growing Algorithm → Flood extent → Estimate probability of regions outside the distance threshold → Smoothing algorithm

Output
- Probabilistic flood extent
Case Study

• Shoal Creek catchment
  – Austin, TX

• Memorial Day flood
  – *May, 25 2015 – 2-6 PM*
  – 17 water rescues
  – 20.5 ft max. flood depths

• Sub-locations:
  – **a**: Downtown Austin
  – **b**: Dry Creek

• Validation
  – HEC-RAS hydraulic modeling results
  – FEMA 25 & 100 yrs maps
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Preliminary Results: Floodwater Depth Estimations

Parts of Downtown Austin are underwater
@foxaustin #txflood2015 #atxflood
#ShoalCreek #AustinFloods

Tweeted video

Panorama image created from video

3D reconstruction of Google Street View

<table>
<thead>
<tr>
<th>Flood depth</th>
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<th>Modeled (ft)</th>
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<tr>
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<td>4.5 - 5.2</td>
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<td>6.5 - 7.2</td>
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# Preliminary Results: Floodwater Depth Estimations

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Preliminary Results: Flood Extent Estimation

A: Downtown Austin

85% of overlap with HEC-RAS modeled flood extent

B: Dry Creek

*un-modeled / un-gauged creek

75 - 82% of overlap with FEMA flood extents
Conclusions & On-going Work

- Preliminary study was intended as an initial exploration of the feasibility of using VGI for real time probabilistic flood mapping
- Preliminary results demonstrated promising results which encourage the further development
  - Further validation of the proposed approaches
    - Estimation of water depths from social media photos/videos
    - Additional case study: Onion Creek, Austin, Texas
  - Assess the effects of current challenges and limitations
    - Spatial distribution/coverage of VGI data
    - Limitations associated with considering the different levels of confidence in the social media data
- Propose a methodology for the identification of critical areas from where VGI data is most needed
Acknowledgments

• National Flood Interoperability Experiment Summer Institute (NFIE)
  – Prof. David R. Maidment & Prof. Jim Nelson
• NFIE student collaborators
  – Fernando Salas, Cassandra Fagan, Caleb Buahnin, Nikhil Sangwan
• National Science Foundation Graduate Research Fellowship Program (GRFP)
• Consortium of Universities for the Advancement of Hydrologic Science, Inc. (CUAHSI)
  – National Science Foundation
• The National Water Center
• The National Oceanic and Atmospheric Administration
• The National Weather Service
• The University of Alabama
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