Analyzing Flood Damages in North Dakota

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FEMA Region VIII

Minot, North Dakota – June 28th, 2011

Photo courtesy of Pictometry
Designated Counties and Tribal Nations

- IA and PA
- PA
- Designated Tribal Nations

Location of ISB: Ellsworth AFB Rapid City, SD

All counties and Indian Tribes in the State of North Dakota are eligible to apply for assistance under the Hazard Mitigation Grant Program.

Name: smcabb
Date Created: 06/25/2011
Source: HSIP Gold & FEMA Region VIII data
Extensive Flooding in Minot, North Dakota – Rapid Turnaround Damage Assessment Needed

Accomplished using the following:

• USGS High Water Mark Collections
• Pictometry Oblique Aerial Imagery
• New Light/ImageCAT Damage Assessment

Results:
Number of Structures Impacted
HAZUS Site Specific Derived Financial Impacts
USGS High Water Mark Collection

- Helped to calibrate H&H modeled outputs used to determine depth at structure
- USGS/FEMA field crews visually verified areas “protected”
Pictometry Oblique Imagery

- Includes 5 angle oblique aerial imagery, and Orthophoto
- Assisted in obtaining structure attributes required for HAZUS financial losses
Satellite Imagery Copyright GeoEye 2011

Data Layer/Map Description(s):
Flood extents and depths were obtained from USACE/Montana Eng.

Maps generated/day were verified on the ground by FEMA/USGS field survey. Depths at extensive coverages are actual depths from USACE/Montana Eng., 20K data. High Water Marks Obtained by USGS.Satellite imagery acquired Saturday, June 25, 2011.

Map Legend:
- Hospitals
- Colleges and Universities
- Sports Complex
- Law Enforcement Locations
- Schools
- High Water Marks (NAVD 88)
- US National Grid

Structures Affected - 4,165

Water Depth at Structure:
- 0 - 1 ft
- 1 - 4 ft
- 4 - 6 ft
- 6 - 7 ft
- 7 - 10 ft
- > 10 ft

Satellite Imagery Copyright GeoEye 2011 NextView License
AOI- National grids in red (Minot, ND)
Distribution of modeled flooding
Exposure Development

- Rapid online product development to support widespread interpretation
- Detailed protocol developed
- Heavy use of Google Earth, Pictometry, and Bing to make determinations
Exposure Development: Occupancy

- Analysts used Google earth, parcel data, imagery interpretation
- Largely residential
Exposure Development: Basements

- Engineering-based protocol with design considerations
- Manufactured Housing: Defined as at grade
- Options: Basement, At Grade, Crawl Space, Unable to determine
- Google Earth used when imagery not clear.
Exposure Development: Number of Stories

- 2-story or 1-story with basement determinations made with guidance from assessor data, livability considerations
- Depth of flooding measured in conjunction with assessment
Flood Depth protocol

- Analysts measured from a visual cue to first floor elevation in before imagery, and from visual cue to flood elevation in after imagery
- Results had to be assessed with building design considerations
- Results at short distances, with roof overhangs, or in difficult terrain not deemed reliable
Example from Pictometry interface
Prioritization

- Prioritization in assessment given to Oak Park area of town
- 12 key structures identified for in depth analysis
# Priority Structures

<table>
<thead>
<tr>
<th>Facility</th>
<th>Address</th>
<th>Parcel ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Ramstad Middle School</td>
<td>501 Lincoln Ave Minot, ND 58703</td>
<td>MI142590800040</td>
</tr>
<tr>
<td>2 Lincoln Elementary School</td>
<td>17th St SW Minot, ND 58701</td>
<td>MI233720300000</td>
</tr>
<tr>
<td>3 Longfellow Elementary School</td>
<td>600 16th St Minot, ND 58703</td>
<td>MI142760002760</td>
</tr>
<tr>
<td>4 Holiday Inn</td>
<td>2200 Burdick Exp Minot, ND 58701</td>
<td>MI19B280000010</td>
</tr>
<tr>
<td>5 Trinity Mental Health building</td>
<td>1900 8th Ave SE Minot, ND 58701</td>
<td>MI192882520280</td>
</tr>
<tr>
<td>6 Arrowhead Shopping Center</td>
<td>1600 2nd Ave SW Minot, ND 58701</td>
<td>MI222920200021</td>
</tr>
<tr>
<td>7 Ferrell Gas LP</td>
<td>1200 3RD Ave NE Minot, ND 58703</td>
<td>MI247960000020</td>
</tr>
<tr>
<td>8 Coca Cola Bottling Co West</td>
<td>405 9th St SE Minot, ND</td>
<td>MI243970100110</td>
</tr>
<tr>
<td>9 Water treatment plant</td>
<td>905 16th St SW Minot, ND</td>
<td>MI239530300330</td>
</tr>
<tr>
<td>10 IRET Minot Apartments</td>
<td>1805 2nd Ave SW Minot, ND</td>
<td>MI222910860000</td>
</tr>
</tbody>
</table>
Example: Holiday Inn

Building ID: 4  
Facility: Holiday Inn  
Address: 2200 Burdick Expy E, Minot, ND 58701  
Parcel: MI19B2800000010  
HAZUS occupancy: COM 8, COM 8, RES 4  
Description: 7 story hotel with a connection ballroom, indoor pool and entertainment casino area. The hotel appears to be constructed of reinforced concrete with steel framing in the larger open areas.  
Square Footage: 1)hotel 109,203  2)warehouse 12,460  3)casino 22,425. Total 144,088  
Water depth at first floor: 2-5 feet
### Residential

<table>
<thead>
<tr>
<th>Depth (feet)</th>
<th>Number of Parcels</th>
<th>Total Square Footage</th>
<th>RS Means Building Replacement Costs (using $183/sqft)</th>
<th>Building Damage Percent (Hazus)</th>
<th>Estimated Building Damages ($)</th>
<th>Content Replacement Costs (using 50% building)</th>
<th>Content Damage Percent (Hazus)</th>
<th>Estimated Content Damages ($)</th>
<th>Total Estimated Damages ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1-2.0</td>
<td>58</td>
<td>64,084</td>
<td>$5,949,559</td>
<td>18%</td>
<td>$1,070,921</td>
<td>$2,974,779</td>
<td>35%</td>
<td>$1,041,173</td>
<td>$2,112,093</td>
</tr>
<tr>
<td>2.0-4.0</td>
<td>106</td>
<td>134,814</td>
<td>$12,516,132</td>
<td>25%</td>
<td>$3,129,033</td>
<td>$6,258,066</td>
<td>38%</td>
<td>$2,378,065</td>
<td>$5,507,098</td>
</tr>
<tr>
<td>4.0-6.0</td>
<td>445</td>
<td>788,491</td>
<td>$73,203,504</td>
<td>30%</td>
<td>$21,961,051</td>
<td>$36,601,752</td>
<td>45%</td>
<td>$16,470,788</td>
<td>$38,431,840</td>
</tr>
<tr>
<td>6.0-8.0</td>
<td>817</td>
<td>1,018,895</td>
<td>$94,594,212</td>
<td>40%</td>
<td>$37,837,685</td>
<td>$47,297,106</td>
<td>55%</td>
<td>$26,013,408</td>
<td>$63,851,093</td>
</tr>
<tr>
<td>8.0-10.0</td>
<td>595</td>
<td>839,950</td>
<td>$77,980,958</td>
<td>43%</td>
<td>$33,531,812</td>
<td>$38,990,479</td>
<td>60%</td>
<td>$23,394,287</td>
<td>$56,926,099</td>
</tr>
<tr>
<td>10.0-12.0</td>
<td>349</td>
<td>505,210</td>
<td>$46,903,696</td>
<td>46%</td>
<td>$21,575,700</td>
<td>$23,451,848</td>
<td>60%</td>
<td>$14,071,109</td>
<td>$35,646,809</td>
</tr>
<tr>
<td>&gt;12.0</td>
<td>93</td>
<td>120,930</td>
<td>$11,227,141</td>
<td>51%</td>
<td>$5,725,842</td>
<td>$5,613,571</td>
<td>60%</td>
<td>$3,368,142</td>
<td>$9,093,984</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2,463</strong></td>
<td><strong>3,472,374</strong></td>
<td><strong>$322,375,202</strong></td>
<td></td>
<td><strong>$124,832,044</strong></td>
<td><strong>$161,187,601</strong></td>
<td></td>
<td><strong>$86,736,973</strong></td>
<td><strong>$211,569,017</strong></td>
</tr>
</tbody>
</table>

*Note*: Depths are estimated relative to the ground surface at each structure, damage percents are averages and will vary by building and foundation type, as well as flood duration and velocity.

### Commercial/Industrial

<table>
<thead>
<tr>
<th>Depth (feet)</th>
<th>Number of Parcels</th>
<th>Total Square Footage</th>
<th>RS Means Replacement Costs (using $183/sqft)</th>
<th>Damage Percent (Hazus)</th>
<th>Estimated Building Damages ($)</th>
<th>Content Replacement Costs (using 50% building)</th>
<th>Damage Percent (Hazus)</th>
<th>Estimated Content Damages ($)</th>
<th>Total Estimated Damages ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1-2.0</td>
<td>2</td>
<td>16,367</td>
<td>$1,358,461</td>
<td>14%</td>
<td>$190,185</td>
<td>$679,231</td>
<td>26%</td>
<td>$176,600</td>
<td>$366,784</td>
</tr>
<tr>
<td>2.0-4.0</td>
<td>17</td>
<td>609,730</td>
<td>$50,607,590</td>
<td>18%</td>
<td>$9,109,366</td>
<td>$25,303,795</td>
<td>56%</td>
<td>$14,170,125</td>
<td>$23,279,491</td>
</tr>
<tr>
<td>4.0-6.0</td>
<td>60</td>
<td>444,151</td>
<td>$36,864,533</td>
<td>23%</td>
<td>$8,478,843</td>
<td>$18,432,267</td>
<td>78%</td>
<td>$14,377,168</td>
<td>$22,856,010</td>
</tr>
<tr>
<td>6.0-8.0</td>
<td>61</td>
<td>392,936</td>
<td>$32,613,688</td>
<td>30%</td>
<td>$9,784,106</td>
<td>$16,306,844</td>
<td>85%</td>
<td>$13,860,817</td>
<td>$23,644,924</td>
</tr>
<tr>
<td>8.0-10.0</td>
<td>20</td>
<td>91,491</td>
<td>$7,593,753</td>
<td>38%</td>
<td>$2,885,626</td>
<td>$3,796,877</td>
<td>88%</td>
<td>$3,341,251</td>
<td>$6,226,877</td>
</tr>
<tr>
<td>&gt;10.0</td>
<td>4</td>
<td>11,178</td>
<td>$927,774</td>
<td>51%</td>
<td>$473,165</td>
<td>$463,887</td>
<td>90%</td>
<td>$417,498</td>
<td>$890,663</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>164</strong></td>
<td><strong>1,565,853</strong></td>
<td><strong>$129,965,799</strong></td>
<td></td>
<td><strong>$30,921,291</strong></td>
<td><strong>$64,982,900</strong></td>
<td></td>
<td><strong>$46,343,460</strong></td>
<td><strong>$77,264,751</strong></td>
</tr>
</tbody>
</table>
A Comparison: Site Specific vs. Aggregated Flood Loss Modeling Approach

Case Study – Fargo, ND
<table>
<thead>
<tr>
<th>Scenario</th>
<th>Flood Related Building Damage (buildings only) - Census Block Analysis</th>
<th>Flood Related Building Damage (buildings only) - Site Specific Analysis</th>
<th>Level I Area Weighting Approach Overestimation</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010 37 foot crest, closest to actual event</td>
<td>$69,016,000</td>
<td>$968,919</td>
<td>$68,047,081</td>
</tr>
<tr>
<td>2010 37 foot crest, if flood protection measures had failed</td>
<td>$81,561,000</td>
<td>$2,835,323</td>
<td>$78,725,677</td>
</tr>
<tr>
<td>2009 41 foot crest, closest to actual event</td>
<td>$87,024,000</td>
<td>$1,894,676</td>
<td>$85,129,324</td>
</tr>
<tr>
<td>2009 41 foot crest, if flood protection measures had failed</td>
<td>$374,937,000</td>
<td>$232,863,548</td>
<td>$142,073,452</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>User Defined Assessors Inventory - Dollar Exposure Total (bldg. values only, does not account for contents)</th>
<th>$5,923,485,360</th>
<th>$5.9B</th>
</tr>
</thead>
<tbody>
<tr>
<td>HAZUS Census Block Inventory - Dollar Exposure Total (bldg. values only, does not account for contents)</td>
<td>$7,476,342,000</td>
<td>$7.47B</td>
</tr>
</tbody>
</table>
Site Specific Loss Approach (8 structures affected)

Area Weighting Estimation – Assumes Uniform distribution of Structures

Many homes are at higher elevations than the street or surrounding areas

Aggregated Flood Losses Approach – Possible Reasons for Overestimation of Losses
Dasymetric Mapping

- General Definition: Redistributes data from one spatial unit to a new spatial geography using an ancillary data source
- Components:

```plaintext
<table>
<thead>
<tr>
<th>Census Block</th>
<th>Land Use Land Cover</th>
<th>Population Grid</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000 People</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>High Density</td>
<td>72, 72, 72, 72, 57</td>
</tr>
<tr>
<td></td>
<td>Low Density</td>
<td>72, 72, 72, 72, 0.02</td>
</tr>
<tr>
<td></td>
<td>Non-Urban</td>
<td>72, 72, 72, 72, 0.02</td>
</tr>
<tr>
<td></td>
<td></td>
<td>72, 72, 72, 72, 0.02</td>
</tr>
</tbody>
</table>
```
Dasymetric Mapping

- Census Block Population
- Aerial Imagery
- Land Use Land Cover
- Population Grid (30M)
Dasymetric Mapping

Maui Total Population Distribution (Census Block)

Oahu Total Population Distribution (Census Block)
Dasymetric Mapping

- Population Distribution (Dasymetric)
Dasymetric Mapping

Oahu Total Population Distribution (Census Block)

Oahu Total Population Distribution (Dasymetric)
Dasymetric Mapping

Oahu Total Population Distribution (Census Block)

Population
- < 500
- 501 - 1,000
- 1,001 - 2,000
- 2,001 - 3,000
- > 3,001

Honolulu

Oahu Total Population Distribution (Dasymetric)

Population (per cell)
- < 1
- 1 - 5
- 5 - 10
- 10 - 20
- > 20

Honolulu
Dasymetric Mapping allows for more accurate population mapping in HAZUS and RiskMap, resulting in more accurate estimations of impacts and losses related to population and the general building stock.

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Questions?