Risk Analysis for Greene County and Wright Patterson Air Force Base, Ohio: Simulation of Riverine Flooding Using HAZUS-MH

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Scope of Paper & Overall

• Summary report on risk determination and economic impact data for Greene County and WPAFB (within Greene County), for riverine flooding, using FEMA’s HAZUS-MH tool.

• WPAFB’s estimated 2009 economic impact within its Metropolitan Statistical Area (MSA) is $5.17 million.

• No published comprehensive risk analysis for WPAFB, or even Greene County, across the entire spectrum of hazards from natural to technological to man-made (including terrorism).

• Future work aims to expand regional risk determination to other natural disasters and terrorism scenarios.

• Ultimate goal of risk determination is to provide vital input for risk management, which helps to identify and prioritize appropriate mitigation actions to reduce losses from the identified hazards.
Methodology & Risk Assessment Tool

• Secondary research - broad literature review of government & industry websites and reports, academic journal & conference publications and books to obtain information (to the extent possible) on the probabilities, vulnerabilities and impact associated with a specific natural hazard striking the particular locality (Greene County).

• Primary research - generating loss estimates for a selected scenario, floods, by running FEMA’s HAZUS multi-hazard (MH) model, at the basic level, probabilistically, for different return periods.
Historical Record* and Ranking of Select Disasters: Greene County, Ohio.

<table>
<thead>
<tr>
<th>Event</th>
<th># of Events</th>
<th>Average Annual Frequency of Occurrence</th>
<th>Total Property Damage ($000)</th>
<th>Average Damage Per Event ($)</th>
<th>Average Annual Damage from Events ($): Economic Impact A x B</th>
<th>Top Five Ranking Based on Frequency of Occurrence</th>
<th>Top Five Ranking Based on Average Damage Per Event</th>
<th>Top Five Ranking Based on Average Damage Per Year (Economic Impact)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thunderstorm Wind</td>
<td>152</td>
<td>2.49</td>
<td>801</td>
<td>5,269.74</td>
<td>13,121.64</td>
<td>2</td>
<td>1</td>
<td>1</td>
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<tr>
<td>Hail</td>
<td>91</td>
<td>1.62</td>
<td>101</td>
<td>1,109.89</td>
<td>1,687.03</td>
<td>3</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Snow and Ice</td>
<td>41</td>
<td>1.46</td>
<td>17,082</td>
<td>416,634.15</td>
<td>608,285.85</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Floods</td>
<td>28</td>
<td>0.469</td>
<td>1,184</td>
<td>42,285.71</td>
<td>19,409.11</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Tornadoes</td>
<td>14</td>
<td>0.23</td>
<td>268,361</td>
<td>19,204,357.14</td>
<td>4,417,002.14</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>High Winds</td>
<td>9</td>
<td>0.148</td>
<td>19,046</td>
<td>2,116,222.22</td>
<td>313,200.89</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Temperature Extremes</td>
<td>5</td>
<td>0.062</td>
<td>1,362</td>
<td>22,327.87</td>
<td>1,830.89</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Strong Wind</td>
<td>1</td>
<td>0.016</td>
<td>60</td>
<td>60,000.00</td>
<td>960.00</td>
<td>4</td>
<td>4</td>
<td>4</td>
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<tr>
<td>Fires</td>
<td>5412</td>
<td>541.2</td>
<td>2,519</td>
<td>465.45</td>
<td>251,900</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

* Occurrences for all events except fires are from 1950 - 2010 (61 yrs). For fires occurrences are from 2000-2009 (10 yrs)

Source for Data on Frequencies and Total Damage: NOAA; [http://www4.ncdc.noaa.gov/cgi-win/wvwcgi.dll?wwevent~storms](http://www4.ncdc.noaa.gov/cgi-win/wvwcgi.dll?wwevent~storms). Individual Event Data for severe weather events was isolated by County.

Source for Fire Data: Pitzer, C., Records Management Supervisor. Ohio Fire Marshal, Fire Prevention Bureau, Reynoldsburg, OH.

Note: Damages are in actual dollars at the time incurred (not converted to constant dollars). Furthermore, the damages are direct damages and do not include indirect losses.
HAZUS-MH SOFTWARE

• GIS-based modeling tool
• Allows for probabilistic & deterministic risk estimation – user can modify default parameters, and has capabilities to run specified deterministic scenarios
• Enhances a unified approach to the assessment and evaluation of risks from different natural hazards
• Open source software tested over the years by a variety of government, commercial and academic users, who compared the simulated results with actual disasters and their known damages
• Default probabilistic scenarios are used here, to obtain quick estimates over a range of disasters, for ranking purposes.
SCHEMATIC FOR NATURAL DISASTER IMPACT ESTIMATION

* Hurricane, Tornado, Earthquake, Flood

# Hurricane: Saffir-Simpson Scale
  Tornado: Fujita Scale
  Earthquake: Richter Scale

OUTPUTS

Area Categorization

Inputs

Population
Number of Commercial Enterprises
Number of Non-commercial Institutions
Additional Risk Factors/Modules
Databases in HAZUS-MH

• Default inventory databases include demographics; general building stock; essential, high potential loss, and hazmat facilities; and transportation and utility lifelines.

• The building stock information is collected from the US Census of population & housing, Dun & Bradstreet, and the Dept. of Energy (Meyer, 2004).

• HAZUS riverine flood model performs two inter-related analyses: flood hazard analysis & flood loss estimation.

• Stochastic scenarios for riverine flooding were run using associated inventory data sets from January 2005.

• Two study regions – Greene County and Census Tract 2002 (WPAFB within Greene County).

• Losses were obtained and compiled for each of the two study regions.
Asset Base/Inventory of Greene County

Greene County: 415 square miles and 121 census blocks/33 census tracts.

• Over 55,000 households and a total population of 147,886 (2000 Census)
• Estimated 45,138 buildings in the county, with a total building replacement value of 8,958 million dollars (2002 constant dollars)
• 98.77% of the buildings, and 85.92% of the building value associated with residential (HAZUS output based on Census Bureau and valuation information).
Asset Base/Inventory of Greene County (contd.)

• Essential facilities include hospitals (1, 150 beds), schools (54), fire stations (14), police stations (11),

• High potential loss facilities (HPL) include 13 dams, of which 7 are classified as high hazard, and 25 hazmat sites (HAZUS-MH Probabilistic Earthquake Scenario run for Greene County, December 30, 2010)

• Transportation systems in Greene Co. include highways, railways and airports, with a total replacement value estimated at $1,762 million

• Utility systems including potable water, waste water, natural gas and communications are valued at around $1,184 million.
Asset Base/Inventory of Greene County (contd.)

• Other inventory inputs in HAZUS-MH: agricultural crops (corn & soybean in Greene) and businesses.

• The business listing inventory is too large to detail individually - the commercial building exposure totals $852.4 million. This is dwarfed however by the total residential building value of Greene, estimated at roughly $7.7 billion (in 2002 constant dollars).
Asset Base/Inventory of WPAFB Within Greene County

- The Buildings Capital Asset Base of WPAFB includes

<table>
<thead>
<tr>
<th>Category</th>
<th>Sq. Footage</th>
</tr>
</thead>
<tbody>
<tr>
<td>R &amp;D</td>
<td>5 million</td>
</tr>
<tr>
<td>Utilities &amp; Grounds Imp.</td>
<td>243,000</td>
</tr>
<tr>
<td>Housing</td>
<td>860,000</td>
</tr>
<tr>
<td>Hospital</td>
<td>826,000</td>
</tr>
<tr>
<td>Other Bldgs. &amp; Str.</td>
<td>7.4 million</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>16.8 million</strong></td>
</tr>
</tbody>
</table>

- The annual economic impact in it’s 5 county Metropolitan Statistical Area (MSA) of Greene, Clark, Miami, Montgomery and Preble, is estimated at $5.17 million (Economic Impact Analysis, 2009).
PARAMETERS FOR HAZUS-MH FLOOD SIMULATIONS

- Riverine flooding in Greene County from Great Miami River, Mad River, Little Miami River on large basins as well as smaller tributaries.

- Probabilistic simulations – 4 square mile drainage area assumed (Ohio EMA), for a variety of return periods – 10, 50, 100 and 500 years.

- The 100 yr. flood/base flood has a 1 percent or greater chance of being exceeded in any given year. Used as a regulatory standard by Federal agencies, most states and the NFIP. It actually has a 26% chance of occurring during a 30 year period – length of popular fixed mortgage.
RESULTS – Greene County, 100 year

- Agricultural Crop Damage ~ $23 million
- Vehicular Damages ~ ~6.5 million
- Debris ~ 8,889 tons estimated @$2.49 million to dispose
- Utilities: ~ $197 million including potable and waste water (~ 16.6% of replacement value of region’s utilities)
- Buildings: ~$199.5 million, about 13.2% of regions total replacement value of buildings (2002 constant dollars).
- Estimated Business Interruption Losses ~$145 million.
- Total Losses: ~ $284 million in Direct plus $145 million in Indirect losses.
RESULTS: WPAFB (Census Tract 2002)

• Total Losses: ~$65.5 million, largely Indirect.
• Losses from Census Tract 2002 ~ 15.3% of Greene County (~33 Census Tracts).
• WPAFB presence likely skews Greene’s high Business Interruption Losses
LIMITATIONS, DISCUSSION & CONCLUSIONS

• Probabilistic estimates, assumed parameters, based on inventory databases from 2005, valued in constant dollars from 2002.

• Goal of risk determination is to provide some underlying factual data to identify & prioritize appropriate mitigation actions to reduce potential losses. County & local data is sparse.

• In the pre-disaster stage reduce vulnerability – strengthen barriers to storm surges, improve building codes, develop ‘contra-flow routes’ and invest heavily in disaster warning systems, disaster plans & education.

• Lastly, the importance of a coordinated communication effort cannot be overstressed.
REFERENCES


5. HAZUS–MH User Manual, Chapter 3


REFERENCES (contd.)


Thank You!

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Any Questions?