Risk Assessment of Mount Rainier Lahars on Urban Populations

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Lahar Definition

- Definition- Indonesian word mudflow composed of water and volcanic ash (80% solid material by weight).¹
- Triggered by the flash melting of the snow cap of a volcanic mountain or from heavy rain.²
- Travels at great speeds.

Mount St. Helens, 1980

Lahar History

- Scott and Valance, 1995

Peak was 600 m (2000 ft) higher?
Residential Growth 1990-2000

- Pierce County 114,615 residents
- Thurston County 46,117 residents
- King County 229,741 residents

Questions for Database
1. Calculate population affected by lahar
2. Calculate population volumes on identified evacuation routes
3. Calculate potential lahar depth and compare to existing data

Data
- Lahar Hazard Zones
- 30m DEM of Washington State
- Mount Rainier National Park
  - Glaciers shapefile
  - 10 m DEM and DOQ
  - Park Roads
  - Park Trails
- Hydrology
  - Watersheds
  - Rivers
  - Gage stations
  - FEMA flood maps

Data
- Compilation of Data
  - U.S. Census Block Data
    - King
    - Pierce
    - Thurston
  - Washington State Roads
    - Interstates
    - Highways
    - Arterials
    - Secondary roads
Reduction of Data Redundancy (Normalization)

- Shapefile tables are full of redundant data

Redundant fields in the Shapefiles can be removed and put into attribute tables to give more tables with less data

Lahar Feature Dataset
- Consists of
  - Lahar Hazard Zone
  - Gage Stations
  - County Boundaries
  - Lahar Definitions
  - Merged County Census Data
  - Census Tables

Lahar Topology Rules
- Based on counties, census blocks
- Created to ensure census block were correct with the counties

Population
- Consists of
  - Census data for King, Pierce, and Thurston counties
  - Thiessen Polygons

Population
- Created Thiessen Polygons from block centroids
- Found Centroids of the Thiessen Polygons
Data Query

2. Roads

• Data Consists of:
  – Washington roads
  – Roads definition table
  – Tables based on analysis
    • Population near feature id

3. Lahar Depth Calculations

<table>
<thead>
<tr>
<th>Feature Name</th>
<th>Water Volume km$^3$</th>
<th>Solids volume km$^3$</th>
<th>Total volume km$^3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emmons &amp; Winthrop</td>
<td>1.28</td>
<td>3.41</td>
<td>4.69</td>
</tr>
<tr>
<td>All Mount Rainier Glaciers</td>
<td>4.21</td>
<td>11.22</td>
<td>15.43</td>
</tr>
<tr>
<td>Crater Lake (for comparison)</td>
<td>17.46</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Approximately 80% of a lahar volume is estimated to be solids.
Data

Mt. Rainier Summit 14,410ft

Puget Sound Elevation = 0ft

Modeling

Lahar Ending at Puget Sound

Lahar on Mt. Rainier

Modeling

Modeling

Lahar extent

Ridgeline

Modeling
• Data Storage is accomplished through the use of “flat” files (ASCII and binary), as well as the HEC-DSS. User input data are stored in flow files under separate categories of project, plan, geometry, steady flow, unsteady flow, and sediment data. Output data is predominantly stored in separate binary files. Data can be transferred between HEC-RAS and other programs by utilizing the HEC-DSS.

1283m ~ 4,209ft.
921m ~ 3,021ft.
1149m ~ 3,976ft.

Width = 4,866 ft ~ .921 miles

4,209ft. + 3,976ft./2 – 3,021ft. =
Depth of Lahar at cross section
1071ft.
Answers

1. Population effect > 215,000
2. Road evacuation densities up to 18,000 on secondary roads

Conclusions

• Database diagramming
  – necessary for construction and modification
• PGDB - useful for projection consistency (limited user access)
  – Relationship classes – special attention to tables
• SQL queries
  – Topology - data integrity

Limitations and Future Work

• Limitations
  – Census
  – Lack of evacuation routes
• Future work
  – Future population growth
  – Dasymetric mapping with land use
  – File geodatabase and new database software
  – Flood software and lahar raster DEM

References

• Geography Network Services. Hosted by ESRI
Questions

Data

Modeling

Analysis

1st Cross-Section near summit of West Fork of the White River

Analysis
3rd Cross-Section in Eastern Tacoma Analysis