DSS-WISE to Support RISK-MAP

Tricks and Tools for Rapid Inundation Risk Modeling

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Objective

To provide an overview of DSS-WISE Lite, it’s uses, and how it can be integrated in FEMA’s RiskMAP

Topics of Discussion

• Disaster Response/Preparedness
• Overview of DSS-WISE Lite/ Tips for Use
• Potential Applications in RiskMAP
DSS-WISE Lite Intro

✓ Web-based 2D-Modeling software
✓ Easy to learn with minimal user input
✓ Robust numerical model
✓ Produces digital GIS output and report
- ~20 failures per year (2005-2013)
- 587 “incidents”
- Aging dams
- Population

Taken from [https://damsafety.org/dam-failures](https://damsafety.org/dam-failures)
The Disaster Cycle

“By failing to prepare, you are preparing to fail”

Disaster Cycle-steps emergency managers take in planning for and responding to disasters
The Disaster Cycle

“By failing to prepare, you are preparing to fail”

Disaster Cycle steps emergency managers take in planning for and responding to disasters

Prevention
Mitigation
Emergency Management
Recovery
Preparedness
Response
Enact Emergency Action Plans (EAPs)
Why Perform Breach Analysis

- Estimate Possible Inundation Areas
- Estimate Warning Times
- Plan Evacuation Routes
- Identify Ways to Mitigate Risk
Dam Breach Consequences Datasets

Foundational datasets from dam breach modeling

• Flood depth
• Velocity
• Flood timing

Datasets to assess consequences

• Population characteristics
• Structures / critical infrastructure
• Transportation network
DSS-WISE Lite Intro

✓ Web-based 2D-Modeling software
✓ Easy to learn with minimal user input
✓ Robust numerical model
✓ Produces digital GIS output and report
✓ Inundation Mapping Can be Available Within Hours
DSS-WISE Lite In Disaster Response

Hurricane Florence 2018

Hurricane Harvey 2017

Hurricane Maria 2017
Overview of DSS-WISE Lite for Dam Breach Modeling

Each user's must have approved access.
Overview of DSS-WISE Lite for Dam Breach Modeling
Overview of DSS-WISE Lite for Dam Breach Modeling
Overview of DSS-WISE Lite for Dam Breach Modeling
Overview of DSS-WISE Lite for Dam Breach Modeling

Requires limited data entry
- Dam Height/Crest Elev
- Draw Line Across Crest
- WSEL/Storage Info
- Breach Location
- Type of Failure
- Breach dimensions (uses calculator)
- Distance downstream
- Downstream bridge locations
Topo/Storage Evacuation issue

Embarkment Assumed to Fail

Some Reservoir Volume not Included in Outflow

Principal Spillway Pipe

Valley Invert in topo is too high

Actual Valley Invert
DSS-WISE Lite Tips

Choose Hydrograph Simulation Type to Enter Hydrograph

<table>
<thead>
<tr>
<th>Time (hrs)</th>
<th>Discharge (cfs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.21666667</td>
<td>3.262362583</td>
</tr>
<tr>
<td>2.23333333</td>
<td>3.006258596</td>
</tr>
<tr>
<td>2.25</td>
<td>2.770255556</td>
</tr>
<tr>
<td>2.26666667</td>
<td>2.527811742</td>
</tr>
<tr>
<td>2.28333333</td>
<td>2.352380141</td>
</tr>
<tr>
<td>2.3</td>
<td>2.167710711</td>
</tr>
</tbody>
</table>
DSS-WISE Lite Tips

Hydrograph Estimation – TR 60 Spreadsheet Inputs

<table>
<thead>
<tr>
<th>Source</th>
<th>Input data required:</th>
</tr>
</thead>
<tbody>
<tr>
<td>December 2006 Inspection Report</td>
<td>246</td>
</tr>
<tr>
<td>Top of Dam Elev</td>
<td>246</td>
</tr>
<tr>
<td>Estimated from drawing in inspection report</td>
<td>7.75</td>
</tr>
<tr>
<td>December 2006 Inspection Report</td>
<td>0.1</td>
</tr>
<tr>
<td>December 2006 Inspection Report</td>
<td>0.7</td>
</tr>
<tr>
<td>Top of Dam minus NID Height</td>
<td>172</td>
</tr>
<tr>
<td>December 2006 Inspection Report, Top of Dam</td>
<td>2800</td>
</tr>
<tr>
<td>Measured in ArchMap</td>
<td>650</td>
</tr>
<tr>
<td>ELwave</td>
<td>0</td>
</tr>
<tr>
<td>Wwave</td>
<td>0</td>
</tr>
<tr>
<td>SSwave</td>
<td>0</td>
</tr>
<tr>
<td>ELstab</td>
<td>0</td>
</tr>
<tr>
<td>Wstab</td>
<td>0</td>
</tr>
<tr>
<td>SSstab</td>
<td>1</td>
</tr>
</tbody>
</table>
Overview of DSS-WISE Lite for Dam Breach Modeling
Development of Dam Breach Hazard Mapping

• The report provides the inputs and some images of the mapping generated
• The digital files inputs can be used to generate data needed for EAPs
## DSS-WISE Lite Data Output

<table>
<thead>
<tr>
<th>Description</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final report in PDF format</td>
<td></td>
</tr>
<tr>
<td>Raster files</td>
<td></td>
</tr>
<tr>
<td>Max. flood depth polygons</td>
<td></td>
</tr>
<tr>
<td>Flood arrival time polygons</td>
<td></td>
</tr>
<tr>
<td>Max. DV polygons</td>
<td></td>
</tr>
<tr>
<td>Max. DV arrival time polygons</td>
<td></td>
</tr>
<tr>
<td>Max. velocity polygons</td>
<td></td>
</tr>
<tr>
<td>Flood extent when flood front is at 3 mi</td>
<td></td>
</tr>
<tr>
<td>Flood extent when flood front is at 7 mi</td>
<td></td>
</tr>
<tr>
<td>Flood extent at the end of simulation</td>
<td></td>
</tr>
<tr>
<td>Hydrographs extracted as “cvs” files</td>
<td></td>
</tr>
<tr>
<td>KMZ file to view on Google Earth</td>
<td></td>
</tr>
<tr>
<td>Shapefiles of simulation setup</td>
<td></td>
</tr>
</tbody>
</table>

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### Simulation Results Package: 10.38 MB

- **Final Report**: 3.52 MB
  - PDF document describing simulation
- **Raster Files**: 7.88 MB
  - Gridded raster files for DEM, maximum depth, and arrival time
- **Maximum Depth Polygons**: 267.79 MB
  - Shapefile containing polygons of maximum depth intervals
- **Arrival Time Polygons**: 453.64 MB
  - Shapefile containing polygons of arrival time intervals
- **Maximum Specific Discharge Polygons**: 267.51 MB
  - Shapefile containing polygons of maximum specific discharge intervals
- **Maximum Specific Discharge Arrival Time Polygons**: 14.59 MB
  - Shapefile containing polygons of maximum specific discharge arrival time intervals
- **Maximum Velocity Polygons**: 129.96 MB
  - Shapefile containing polygons of maximum velocity intervals
- **Inundation Extent at 3 miles**: 138.03 MB
  - Shapefile containing inundation extent at 3 miles
- **Inundation Extent at 7 miles**: 28.84 MB
  - Shapefile containing inundation extent at 7 miles
- **Final Inundation Extent**: 38.67 MB
  - Shapefile containing inundation extent at the end of the simulation at 10.164 miles
- **Observation Lines**: 3.27 MB
  - Tabulated CSV files of time vs. discharge and cumulative volume
- **Inundation Extent KMZ File**: 63.52 MB
  - Google Earth KMZ file showing final inundation extent
- **Input Features**: 5.02 MB
  - Shapefiles containing drawn input features
Human Consequences Module

- Human Consequences Results Package: 17.33 MB
  Zipped results package containing final report, shapefiles, gridded raster files, and other outputs
- HCOM Final Report: 17.46 MB
  PDF Document describing the results of this HCOM calculation
- HCOM PAR Analysis Results: 43.33 MB
  MS Excel spreadsheet containing tabulated results of population at risk analysis
- HCOM Potentially Lethal Flood Zones: 77.42 MB
  Shapefile containing polygons of flood zones potentially lethal to adults and children
- HCOM Hazard Level to People Indoors: 23.21 MB
  Shapefile containing polygons of hazard levels to people caught indoors in the flooded extent
- HCOM Hazard Level to People Outdoors: 235.65 MB
  Shapefile containing polygons of hazard levels to people caught outdoors in the flooded extent
- HCOM PAR by Census Blocks: 129.92 MB
  Shapefile containing polygons of census blocks in the inundation extent
- HCOM Nighttime Population Density: 7.9 MB
  Shapefile containing polygons of nighttime population density derived from LANDSCAN data
  Shapefile containing polygons of daytime population density derived from LANDSCAN data
Why Integrate Dam Breach Modeling in RiskMap?

• 20,000 communities in NFIP
• FEMA is authorized under the Biggert-Waters Flood Insurance Reform Act of 2012 (BW12) to produce maps of residual risk for areas protected by dams or could be inundated by failure
• The Technical Mapping Advisory Council (TMAC) has recommended:

“...mapping prototype products aimed at more effectively communicating residual flood risk related to levees, dams, and event-driven coastal erosion. Products developed should incorporate end user and stakeholder testing, and FEMA should develop standards for routine production...”
FEMA RiskMAP Products

FEMA non-regulatory products currently provide a platform for use by communities for dam safety
Non-Regulatory Products

- Flood Risk Map
- Flood Risk Database
- Flood Risk Assessment Data
- Flood Depth & Analysis Grids
- Changes Since Last FIRM Data
- Areas of Mitigation Interest
- Ad-Hoc Flood Risk Analyses
- Flood Risk Report
Non Regulatory Products for Dams

• Leverages existing analysis from dam safety officials
• Flexible depending on varying state regulations & methods
• Datasets proposed:
  • Basic dam characteristics
  • Upstream inundation areas delineated
  • Downstream inundation areas delineated
  • Assorted depth and analysis grids (depth, velocity, arrival time)
  • Easements & critical facilities
  • Flood risk assessments
  • Additional Areas of Mitigation Interest
• Data would be used to communicate risks & promote mitigation
Sunny Day Downstream Inundation Area
Sunny Day Depth times Velocity (DV) Grid
Severity Grid Showing Danger Levels

- Can be categorized into Zones of Potential Danger
- Subdivides the inundation area into zones of differing potential danger.
# Danger Zones

<table>
<thead>
<tr>
<th>Category</th>
<th>Color Code</th>
<th>$D_{\text{max}}$ (ft.)</th>
<th>$DV_{\text{max}}$ $(ft^2/s)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Children caught outdoors (tent camping, fishing, hiking, etc.)</td>
<td>Red</td>
<td>$\geq 2$</td>
<td>or</td>
</tr>
<tr>
<td>Adults caught outdoors (tent camping, fishing, hiking, etc.)</td>
<td>Red</td>
<td>$\geq 4$</td>
<td>$\geq 6.5$</td>
</tr>
<tr>
<td>Motor vehicle (compact car) floating</td>
<td>None</td>
<td>$\geq 1$</td>
<td>or</td>
</tr>
<tr>
<td>Motor vehicle (compact car) sliding/toppling</td>
<td>None</td>
<td></td>
<td>$\geq 5.4$</td>
</tr>
<tr>
<td>Mobile homes</td>
<td>None</td>
<td>$\geq 2$</td>
<td>or</td>
</tr>
<tr>
<td>Typical residential structures</td>
<td>None</td>
<td>$\geq 4$</td>
<td>or</td>
</tr>
</tbody>
</table>

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Changes Since Last FIRM Data
Areas of Mitigation Interest

Flood Risk Database

Depth and Velocity Grids Associated with Dam Breach Scenarios

Flood Risk Assessment Data
Flood Depth & Analysis Grids

Changes Since Last FIRM Data
Areas of Mitigation Interest

Severity Grids and Danger Zones*

Arrival Time Grids for the Dam Breach Wave

Dam Breach Scenarios

Critical Facilities

Dam Breach US and DS Inundation Areas

Dam Easements

Depth and Velocity Grids Associated with Dam Breach Scenarios
DSS-WISE Lite FEMA Uses

Risk Communication

- DSS-WISE Lite model runs for community engagement at new study scoping to inform the community about flood risk
- DSS-WISE Lite modeling for FEMA to generate the enhanced non-regulatory products for dams
- Development of fact sheets for the Risk Review Meetings to show dam risk in the study watershed

Potential New Non-Regulatory Products

- Development of a combined dam breach and SFHA map
- Development of a new “Danger Zone” enhanced raster
- New section in the Flood Risk Report describing how dams shown on FIRM’s were mapped or not and the specific dam risk
Residual Flood Risk
Short Summary of Modeling with Reference to Report for More Information

Dam Breach Inundation Fact Sheet

<table>
<thead>
<tr>
<th>DAM NAME: LOCO DAM</th>
<th>TYPE: CONCRETE GRAVITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASSUMED WATER SURFACE: TOP OF DAM</td>
<td>BREACH TYPE: COMPLETE / INSTANTANEOUS</td>
</tr>
</tbody>
</table>

Description: Breach analysis was performed using DSS-WISE software in May 2019. A sunny-day breach was assumed with the water surface at the maximum storage elevation. For further information see "DSS-WISE Lite Flood Simulation Report, Loco Dam Rerun 1," dated May 9, 2019.
DSS-WISE Lite As A Tool for Risk-MAP

• Simple to Use / Get Results Quickly
• Output Provides Much of the Information Needed
• Human Consequences Module provides an analysis of the population within the estimated inundated area.
• Has Some Limitations
Questions???