No Cell Left Behind: North Dakota Statewide 2D Modeling and Mapping
Acknowledgements

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Largely Unmapped
Statewide LiDAR
Alignment with Risk MAP Goals

- **Delivering high-quality risk data**
  - Coordinated Needs Management Strategy (CNMS)
  - New, Validated, or Updated Engineering (NVUE)

- **Increasing awareness of flood risk**
  - Percent of local officials aware of flood risk affecting their communities

- **Promoting community mitigation action**
  - Percent of population acting on community planned mitigation strategies

- **Building towards TMAC recommendations**
  - Structure-based risk and flood frequency determination
  - Database driven, digital display environment

- **Reduce risk to lives and property**
## Awareness for Mitigation Action

**National Benefit-Cost Ratio Per Peril**

*BCR numbers in this study have been rounded

<table>
<thead>
<tr>
<th>Overall Hazard Benefit-Cost Ratio</th>
<th>Federally Funded</th>
<th>Beyond Code Requirements</th>
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<td><strong>6:1</strong></td>
<td><strong>7:1</strong></td>
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<td><strong>7:1</strong></td>
<td><strong>Too few grants</strong></td>
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- **Riverine Flood**
- **Hurricane Surge**
- **Wind**
- **Earthquake**
- **Wildland-Urban Interface Fire**

*Image from FEMA RiskMAP: Increasing Resilience Together*
LSAE vs BLE

<< Less detailed and less accurate

*FOA is no longer used and has been replaced with LSAE

More detailed and more accurate >>

First Order Approximation (FOA)*

Large-Scale Automated Engineering (LSAE)

Base Level Engineering (BLE) Zone A

Base Level Engineering (BLE) Zone AE

Enhanced Level Zone AE

Regulatory
FEMA Process

Kickoff Meeting with Communities (FEMA/SWC/CERC)

Base Level Engineering (Compass PTS)

Discovery (FEMA/SWC/CERC)

Create Flood Insurance Products and Follow the Quality Review Process

Provide the Products to Communities
1D or 2D?
Identify Study Area
Identify Study Area

*Inflow Pt*

*Outflow Pt*
Model Inputs (Hydrology)

INFLOW HYDROGRAPHS

- Option 1: Use outflow hydrographs from upstream 2D model as inflow
- Option 2: Generate hydrographs from simple HEC-HMS models
Model Inputs (Hydrology)

PRECIPITATION (RAIN-on-GRID)

- NOAA Precipitation Frequency Data Server or Atlas 14

- Simple HEC-HMS model developed to determine excess rainfall to apply within the 2D model (HEC-RAS 5.0)
Model Inputs (H&H)

LAND USE & SOILS

- **Land Use:** National Land Cover Database (2011)
- **Soils:** NRCS Web Soil Survey
- Used as an input in all HEC-HMS models to support the calculation of Curve Numbers and Lag Times
- Also used within the 2D model to estimate roughness values
Model Inputs (Hydraulics)

TERRAIN

- LiDAR-derived DEM
- DEM assured to meet FEMA SID 43 vertical accuracy standards
- Critical component to carry LSBLE products through regulatory process
2D Mesh Enhancements with Breaklines
REASONABILITY CHECKS

- Multiple comparison check locations added to the 2D model (at gages and other representative locations within the study area)

- 1% annual chance peak discharges, WSELs, and/or flood boundaries from 2D model compared with other available data at these locations (gage analysis, regression equations, effective study*, etc.)

*age and level of detail of effective study are taken into consideration when weighing comparisons
Model Outputs

WSEL Grids
- 10%, 4%, 2%, 1%, 0.2%, 1%+, 1%-  

Depth Grids
- 10%, 4%, 2%, 1%, 0.2%, 1%+, 1%-  

Velocity Grids
- 1% (others as needed)
CNMS Zone A Validation

- A1 – Significant Topography Update Check
- A2 – Significant hydrology changes
- A3 – Check for significant development
- A4 – Studies backed by technical data

- A5 – Comparison of LSAE and Effective Zone A
  - Modified FBS check using 1-percent minus and 1-percent plus error band
  - Stream must have 90% points passing to be Valid in CNMS for next 5 years
A5 Check
BLE Mapping (1 and 0.2%)
Mapping SFHA
Mapping SFHA

Legend
- BLE SFHA
- BLE 1% WSEL (ft)
  - High: 1554.71
  - Low: 1474.85
Mapping SFHA
Mapping SFHA
BLE Products

- **Terrain**
- **Engineering**
  - HMS Models
  - RAS Models
- **Geospatial**
  - WSEL Grids (10, 4, 2, 1-, 1, 1+, 0.2%)
  - Depth Grids (10, 4, 2, 1-, 1, 1+, 0.2%)
  - Velocity Grid (1% [others as necessary])
  - S_Fld_Haz_Ar (1% Zone A and 0.2% Shaded X)
  - S_CSLF_Ar
  - CNMS Validation Points
Cost-Effective Flood Risk Database Buildup Opportunity
Multi-Frequency Spatial Assessment
Data Dissemination
Data Dissemination

MapServices

The State Water Commission MapServices are a variety of internet map servers with various themes. Our general map service uses the Water Commission's vast data resources such as water data locations, drillers' logs, aquifers, and precipitation info to integrate with our spatial data holdings including aerial photography, geo-political boundaries, transportation, and hydrographic features. Our specialized map services are designed for specific data sets. We also have specialized map services related to the data they are designed to deliver such as the LiDAR map service, survey map service, and an aerial imagery map service.
Other uses of 2d LSBLE Best Available Information

- LOMC Processing
- State/Local Mitigation Plans
- Emergency Response
- Evacuation Planning
- Critical Facilities in or near flood hazard area
- Residential/Commercial Development Planning
- Hazard Mitigation Grant Program
ND Statewide 2D BLE Key Takeaways

▸ Large Scale BLE completed in two years
  • Massive coordination effort with Region, NDSWC, PTS, CERC

▸ Outreach Process Successful
  • Kickoff to inform communities of modeling approach and schedule
  • Discovery to roll out results of BLE

▸ Best Available Data for unmapped and non-deployed areas

▸ Awareness of flood risk for non-participating communities

▸ Watershed Approach provides flood risk awareness outside of SFHA

▸ BLE basis for follow on work
  • Flood Risk Products
  • Freeboard grids, scenario-based, near real time modeling
  • Zone AE enhancements
Scalable to AE
NO CELL LEFT BEHIND!
Questions