FEMA

Hazus-MH Modernization

NTHMP Summer MES Subcommittee Meeting
July 26, 2016

RiskMAP
Increasing Resilience Together

Hazus-MH 3.2 – October 2016

Release Contents

- Enhance Reports
  - Upgrade the existing reports - New graphics capabilities, selected reports to include thematic maps, pie graphs, and charts.
- ArcGIS 10.4 Upgrade
- CDMS Desktop Enhancements
  - Implement functionality for importing data – Polyline, UDF, HSIP, AEBM
- EQ module integration of USGS ShakeMap
  - To integrate EQ module with USGS JSON API for accessing ShakeMap data
  - Enhance setup to add a new Hazard input folder
- Minimize impact of ArcGIS version change
  - Enhance code to replace dependency on ArcGIS versions
  - Enhance setup to remove dependency on ArcGIS versions
  - Replace ArcObjects calls with Stored Procedures

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Hazus-MH 4.0 Tsunami Model Integration

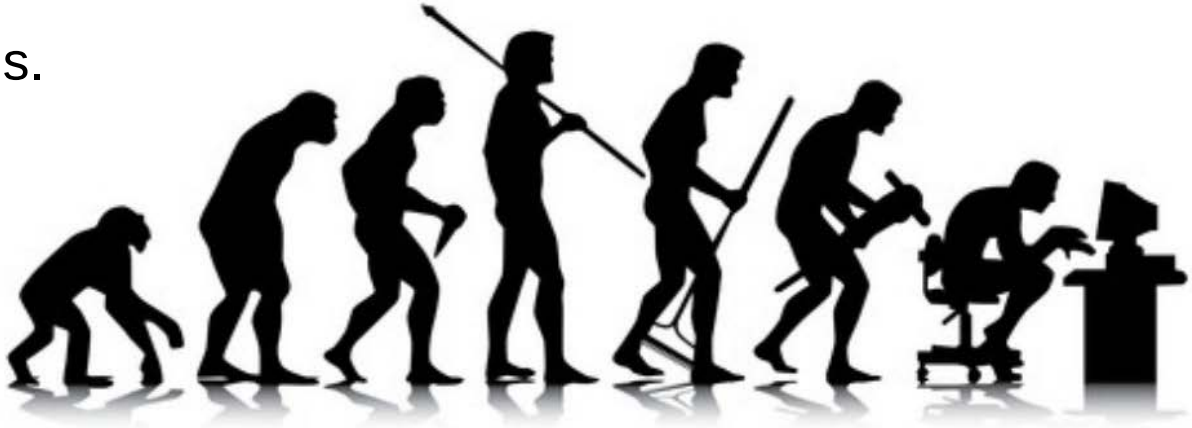
High Level Design Overview

RiskMAP

Increasing Resilience Together

Hazus-MH Evolution

- Second decade of existence
  - Reaching original paradigm maturity and facing new challenges
- Users and use cases continue to grow
  - Including internationally - Puerto Rico, Egypt, Israel, Canada
- Needs to evolve and answer to the increasing demands of its users
  - Incorporate new perils.



Development of new Tsunami Model

- *An easy to use graphical interface within Hazus to access and use tsunami hazard data from external providers, including NOAA, providing access to and integration of the authoritative hazard data layers necessary for analysis.*
  - Incorporating the Hazus Tsunami Methodology (FEMA, 2013)



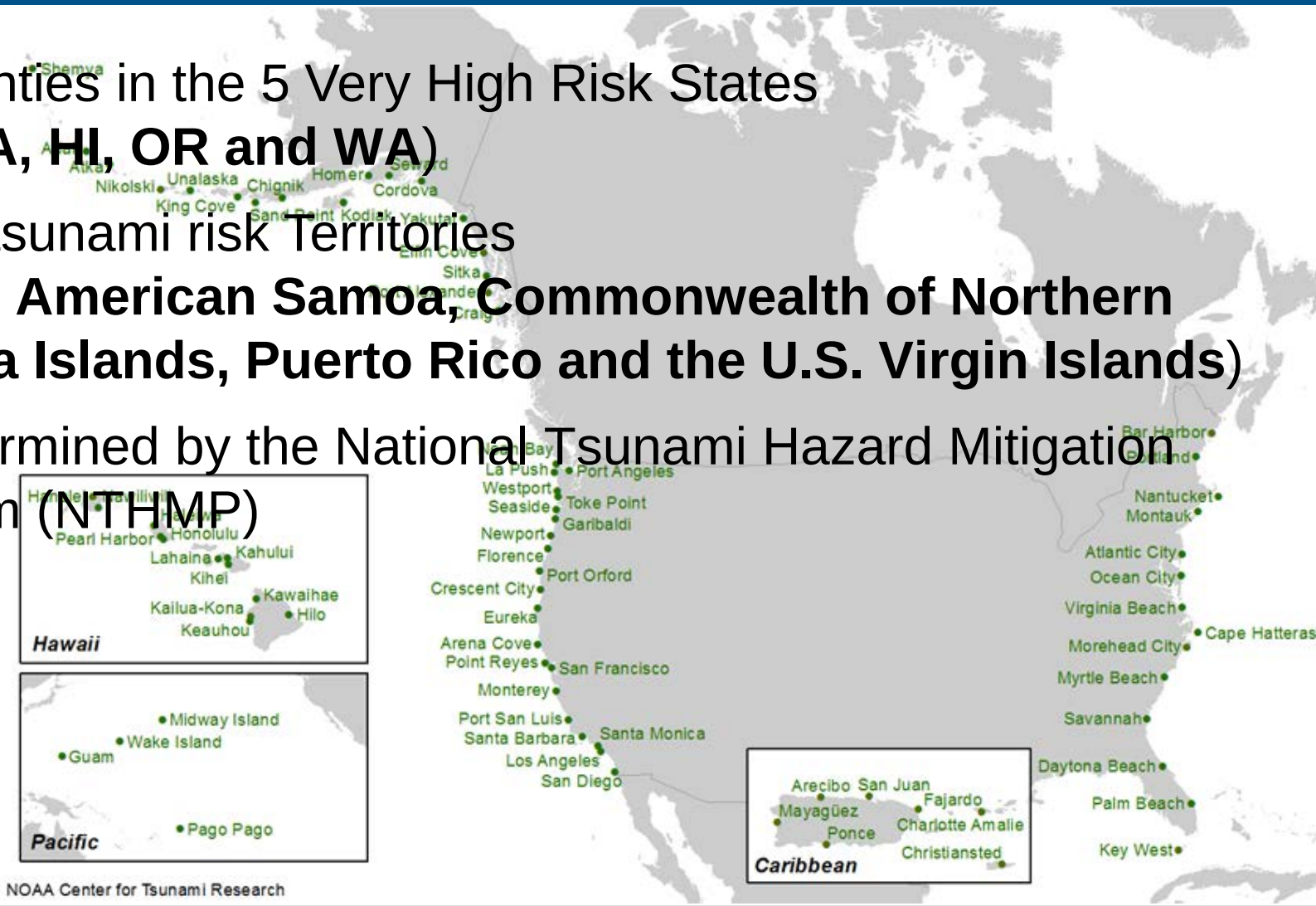

Hazus-HM 4.0 – March 2017

Release Contents

- Operate on Arc GIS 10.4/10.5
- Hazus will continue to be 32-bit Windows desktop application.
- Require 64 Bit System, Windows 8.0 Operating System
- Testing : **December 2016 / January 2017**
  - Please contact Cynthia McCoy if interested.
  - Cynthia.mccoy@fema.dhs.gov

Primary areas of Risk

- 72 Counties in the 5 Very High Risk States (**AK, CA, HI, OR and WA**)
- 5 High tsunami risk Territories (**Guam, American Samoa, Commonwealth of Northern Mariana Islands, Puerto Rico and the U.S. Virgin Islands**)
- As determined by the National Tsunami Hazard Mitigation Program (NTHMP)



NOAA Center for Tsunami Research

Hazard Data

- System will Leverage hazard inundation data from authoritative sources
  - NOAA
  - *Alaska Division of Geological & Geophysical Surveys*
  - *Washington Department of Natural Resources*
  - *Oregon Department of Geology and Mineral Industries*
  - *California Geological Survey, California Emergency Management Agency*
  - *Alaska Division of Geological & Geophysical Surveys*
    - ***Inundation data testing - Case Studies***
      - Homer, AK
      - Westport, WA
      - Garibaldi, OR
      - Crescent City, CA
      - Kahului, HI

Tsunami Hazard input data

- Hazard Type
  - Near Source Tsunami - Combined tsunami & earthquake impacts
  - Distant Tsunami - Tsunami impacts only

Input Layers

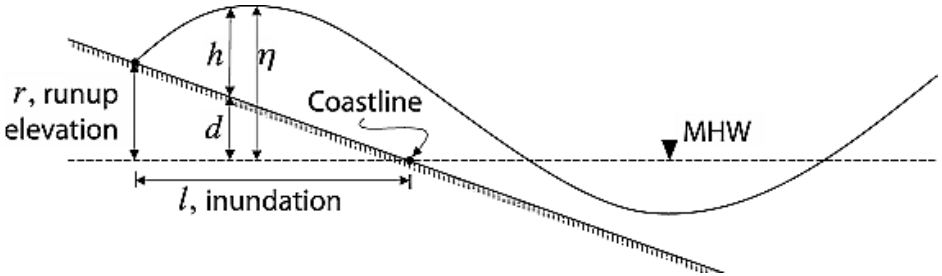
- Runup elevation limit
- Max Inundation depth throughout zone
- Max Inundation elevation throughout zone
- Max Velocity throughout zone
- Max Momentum Flux throughout zone
- Topography
- Deformed Topography
- Land Use

Required for Analysis

- Maximum Inundation Depth (ft)
- Maximum Momentum Flux (ft^3/sec^2)

3 Levels of Analytical precision & Complexity

- **Level 1**: *Runup Only (velocity based on equation)*
  - Data consist of a runup grid file with ***heights*** relative to **Mean Sea-Level (MSL)**
- ***Level 2:*** *Runup (AGL) and Velocity*
  - Data consist of a runup grid file with ***depths*** relative to **Above Ground Level (AGL)** and are based on deformed topography in the case of near source earthquakes.
- ***Level 3:*** *Numerical Modeling (H an HV2)*
  - ***Depth (H)*** and ***Momentum Flux (HV2)*** are already formatted in ArcGIS Grid. Depth (***feet Above Ground Level (AGL***) are based on deformed topography in the case of near source earthquakes and Momentum Flux *(ft^3/sec^2)* are calculated and in correct units.



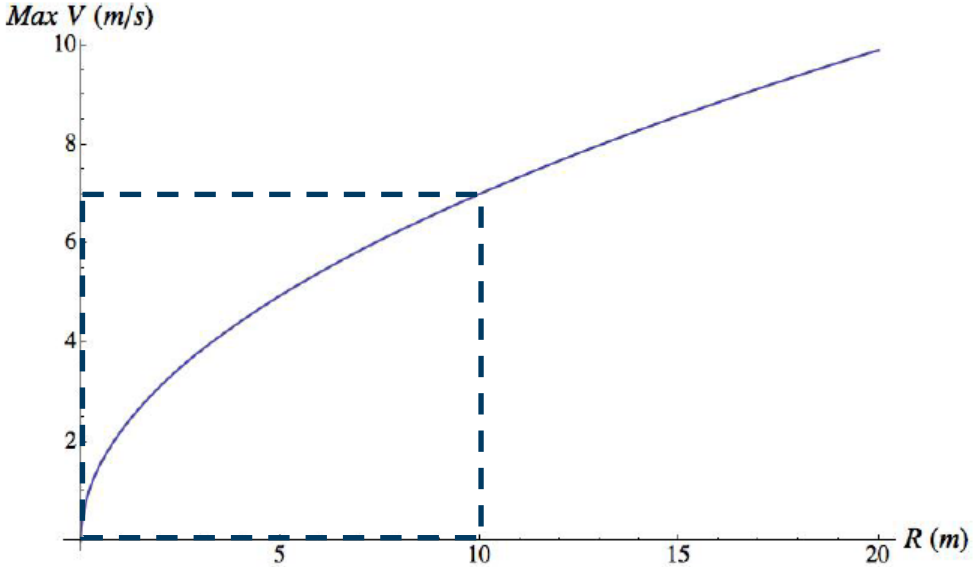
Tsunami (Level 1) Hazard Data Limitations

- An equation (eq 4.4, FEMA P-646) is *used to estimate flow velocity using runup when only runup is available* (Level 1)
  - Provides an efficient way to relate velocity to runup for hazard products that only provide runup.

The maximum flow velocity at a given location can be estimated by:

$$\underset{t}{Max}[u(x,y,t)] = f_v \sqrt{2gR\left(1-\frac{z}{R}\right)}$$

Damage to Structural Systems



Damage to Non-Structural Systems and Contents

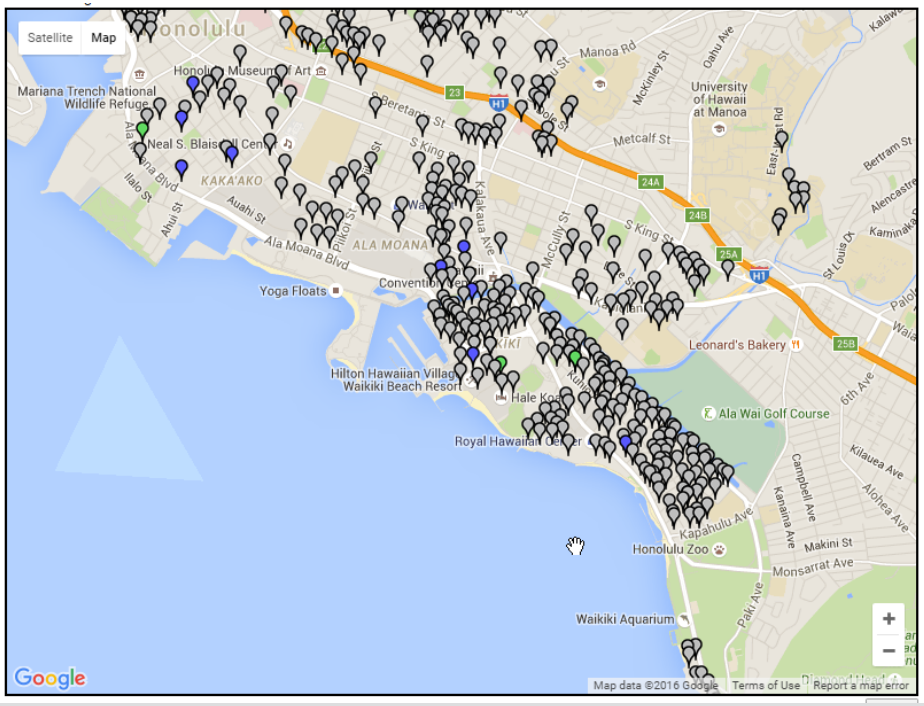
Inventory – Aggregated

- **Leverage USACE National Structure Inventory (NSI)**
  - (US States) Randomly distributed point level data based on dasymetric Census Blocks
  - (US Territories) Randomly distributed based on 1KM Grid
  - Includes day and night occupancy + household dynamics
- **Including the following attributes**:
  - School locations, numbers of teachers and students
  - Day/night population by occupancy type
  - Over 65 population
  - Median year built
  - First floor elevations (FFE) based on flood foundation type
  - Area (Square footage)
  - EQ building types (Construction Type)
  - Seismic Building Code Design Levels – Determined by year built
  - Estimated High Rises

Inventory – Point Specific (UDF)

- Will require the following attributes to calculate building loss
  - User Defined Facility ID
  - Occupancy – Land Use
  - Cost to rebuild structure
  - Cost of contents
  - EQ building types (Construction Type)
  - Seismic Building Code Design Levels
  - First Floor height
  - Coordinate location

STATE	Pre-Code*	Low Code	Moderate Code	High Code	Special High-Code
Alaska	</= 1964	1965-1994	1994-2000	>/=2001	NA
California	</= 1940	1941-1975	1975-1994	1995-2000	>/=2001
Hawaii	</= 1974	1975-1994	1994-2000	>/=2001	NA
Oregon	</= 1974	1975-1994	1994-2000	>/=2001	NA
Washington	</= 1955	1956-1974	1974-2003	>/= 2004	NA



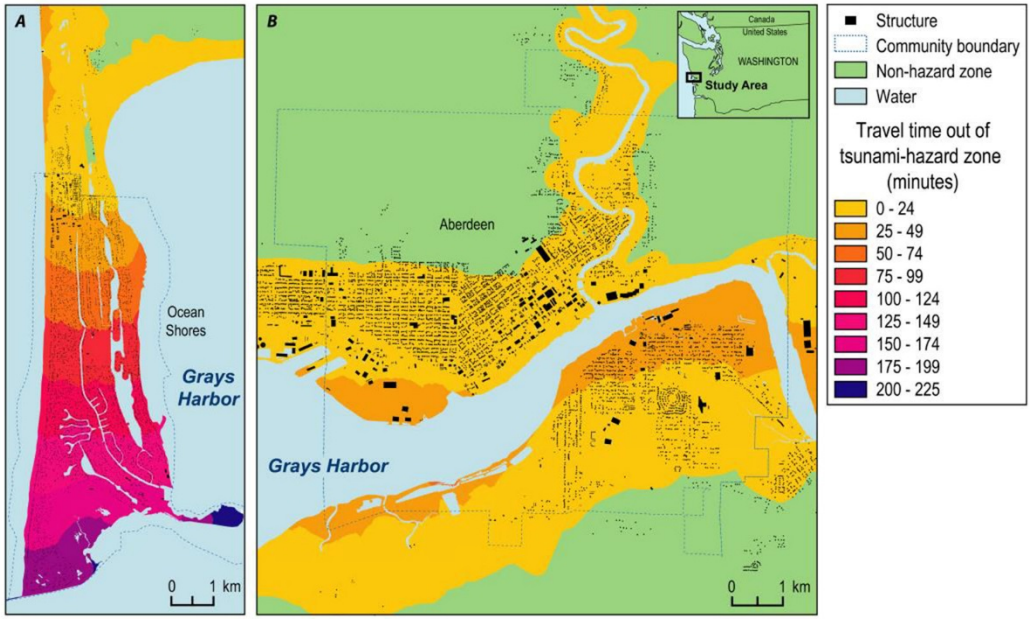
Tsunami Building Damage Parameters

- **Structural Damage Parameters** (flow): Median values in ft3/s2
- **Non-Structural Damage Parameters** (depth): Median values in feet
- **Content Damage Parameters** (depth): Median values in feet.

  - *Unlike Flood Model - Damage state parameters incorporate uncertainty.*
  - *Not accounting for hydrostatic or buoyance – Only velocity*
  - Evaluate 7 design levels (High, Moderate, Low, Pre-Code, Special-High, Special-Moderate and Special-Low
  - *Model will apply Replacement Cost ratio for Moderate, Extensive and Complete loss.*
    - *No slight damage will occur in Tsunami Model if structure within inundation area*

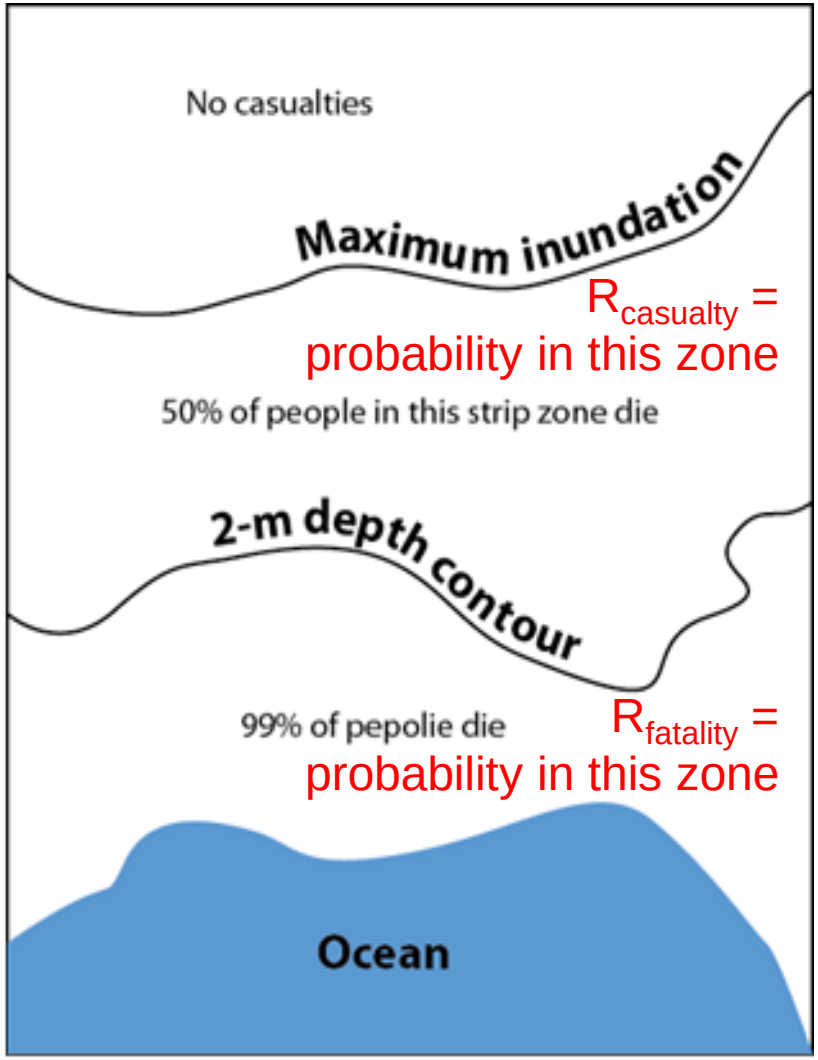
Casualty Model

- 2 Step Process
  1. leverage the USGS Pedestrian Evacuation Analyst tool
     - Estimating travel time in minutes along road network
  2. Probability of Casualties and Fatalities - R
- Input data
  - Time of day and year
  - Average walking speed
    - Function of evacuation route grade (DEM) and demographics (age and gender)
  - EQ damage assessment
  - Evaluation of Community Preparedness
    - Determine evacuation initiation time
    - User Supplied Values – Good, Fair & Poor



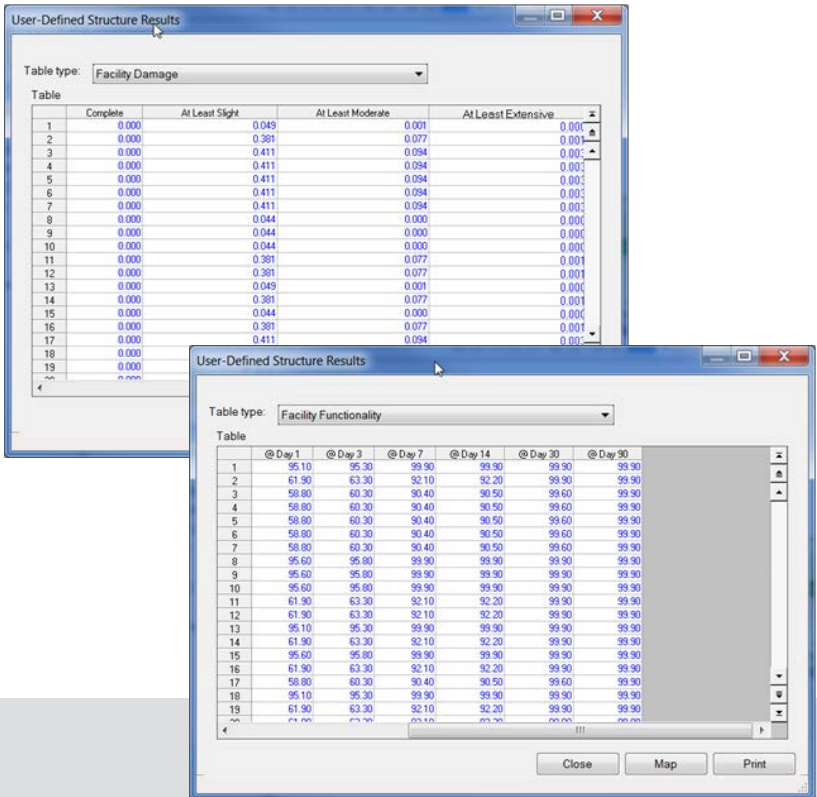
Casualty Model

- Computation Function of distance, obstacles and evacuation route
  - Evacuation time to the maximum tsunami inundation extent
  - Evacuation time to the partial safety
    - Needed to distinguish between fatality and injury



Results Reporting

- GBS and UDF
  - Building Damage summarized by occupancy and EQ general building type by damage state (at block level).
  - Economic Loss Results summarized by occupancy and EQ general building type
    - Structural
    - Non-Structural
    - Content
  - Combined reports with earthquake loss results.
- Casualty and Fatalities
  - By EQ general building types
  - Injury Severity reported by Day and Night time and age
  - Separate reports EQ



Next Steps – Hazus Tsunami Model

- **Methodology & Inventory (Combined EQ & Tsunami)**
  - Essential Facilities
  - Displaced Households and Shelter
  - Debris Analysis (inventory and methodology gaps)
  - Lifelines/Infrastructure (inventory and methodology gaps)

- Development of training courses, technical and user manuals

- User defined reports

Questions?

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