Flood Hazard

Model description

INPUT → **HAZARD MODEL** → **OUTPUT**

DETAILED

- ✓ Basin contour
- ✓ River bed and start point over the river bed
- ✓ Runoff factors
- ✓ Detailed topography
- ✓ Rainfall hazard (from non-hurricane or hurricane rainfall hazard analysis)

- ✓ Computation of hydrograph at the start point in the river bed
- ✓ Hydraulic computation of water speed and direction (finite differences model)
- ✓ Hazard calculation lasts as long as the hydrograph duration

- ✓ Maximum flood depth reached at any time in every calculation site, for each scenario

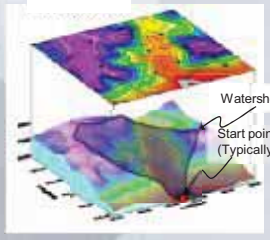
SOFTWARE MODULE: ERN-FLOOD

Flood Hazard

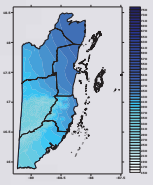
Model description (Detailed)

Digital Elevation Model

Basin countour



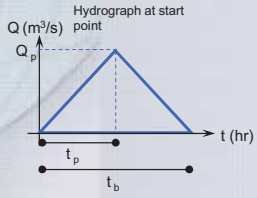
Rainfall hazard



Runoff analysis

-Duration factors
-Land use factors
- Area reduction factors
- Runoff factors

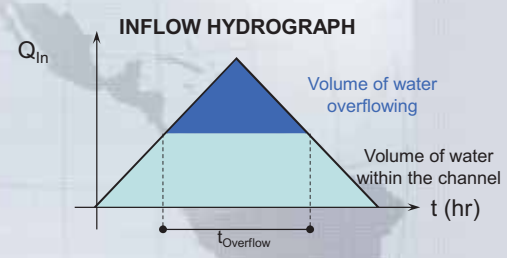
Hydrograph calculation



Repeated for different scenarios

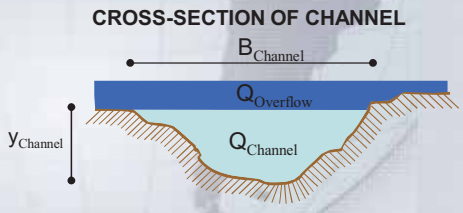
Flood Hazard

Model description (Detailed)



There is overflow of the river when

$$Q_{In} > Q_{Channel}$$



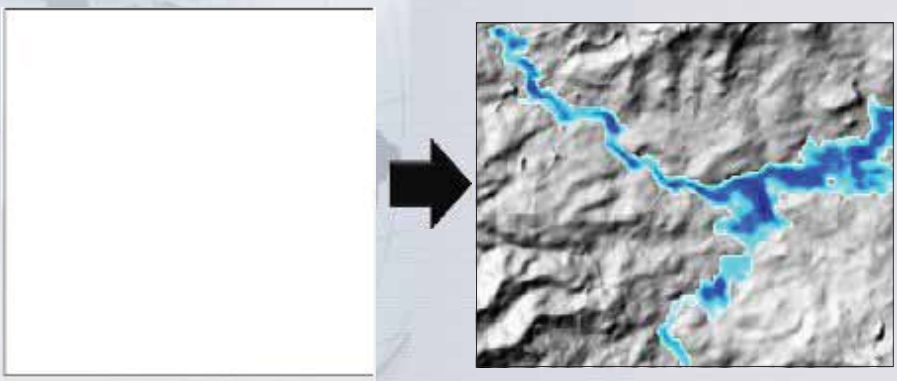
Overflow is computed as:

$$Q_{Overflow} = Q_{In} - Q_{Channel}$$

$$Q_{Channel} = \frac{1}{n} \cdot S^{1/2} \cdot R_{Channel}^{2/3} \cdot A_{Channel}$$

Flood Hazard

Detailed model run



Computing hazard

Final result

SEISMIC HAZARD

Seismic Hazard

Damaging effects


Managua Earthquake- 1972


Popayan Earthquake- 1983


Mexico City Earthquake - 1985


Loma Prieta Earthquake- 1989

Seismic Hazard

Damaging effects

Kobe Earthquake -1995

Armenia (COL) Earthquake- 1999

Pisco Earthquake - 2007

Seismic Hazard

Model descripction

INPUT

- ✓ Seismic sources geometry
- ✓ Sources seismicity parameters
- ✓ Intensity attenuation laws

HAZARD MODEL

- ✓ Seismic sources partitioning
- ✓ Calculation of seismicity curves for each sub-zone
- ✓ Detonation of several earthquakes of different magnitudes within each sub-zone,
- ✓ Calculation of intensity values for each simulated earthquake

OUTPUT

- ✓ Ground shaking measures (acceleration, velocity, displacement)
- ✓ Spectral shaking measures, for different structural fundamental periods

SOFTWARE MODULE: CRISIS 2007

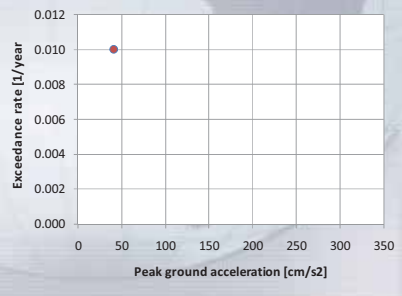
Seismic Hazard

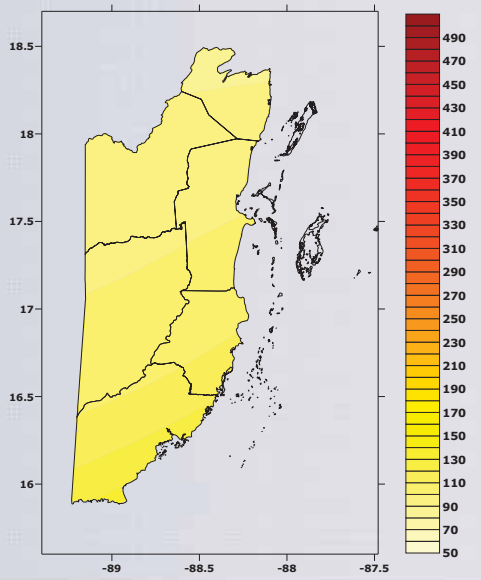
Hazard results

Peak ground acceleration[cm/s2]

100 years return period

Seismic hazard curve at Belmopan





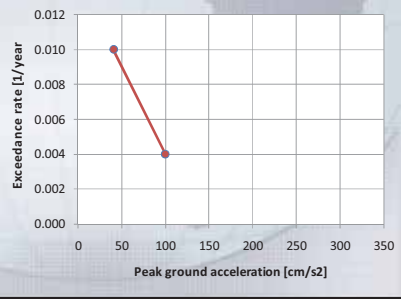
Seismic Hazard

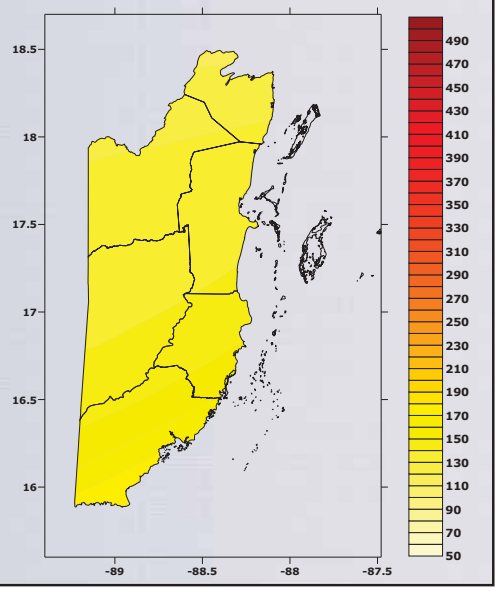
Hazard results

Peak ground acceleration[cm/s2]

250 years return period

Seismic hazard curve at Belmopan





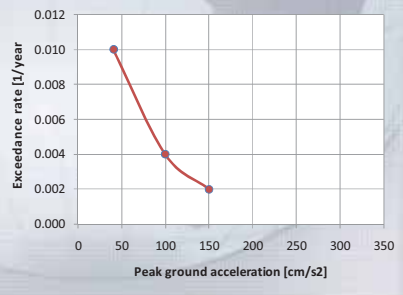
Seismic Hazard

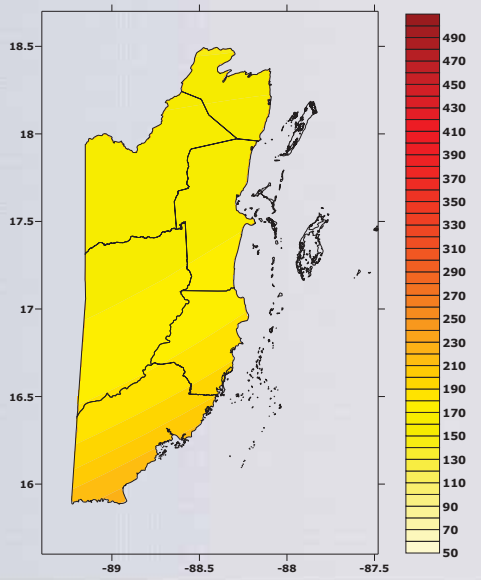
Hazard results

Peak ground acceleration[cm/s2]

500 years return period

Seismic hazard curve at Belmopan





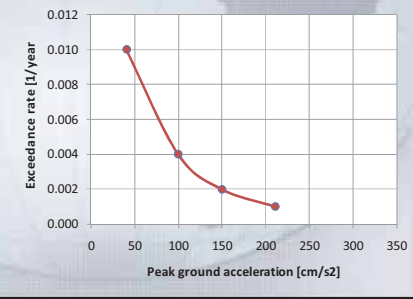
Seismic Hazard

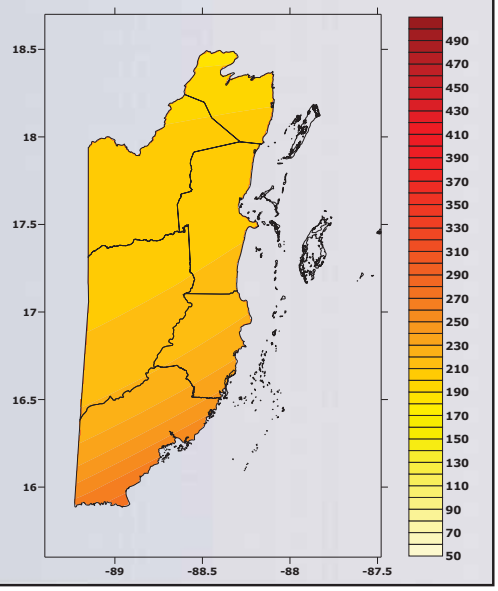
Hazard results

Peak ground acceleration[cm/s2]

1000 years return period

Seismic hazard curve at Belmopan





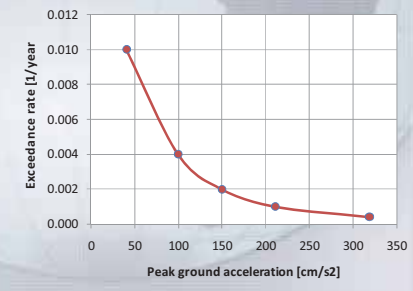
Seismic Hazard

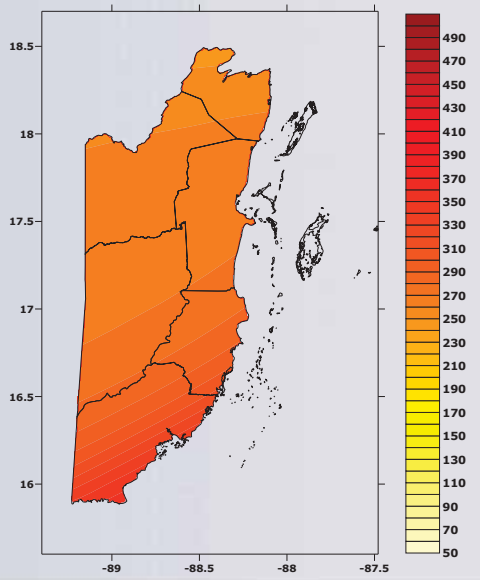
Hazard results

Peak ground acceleration[cm/s2]

2500 years return period

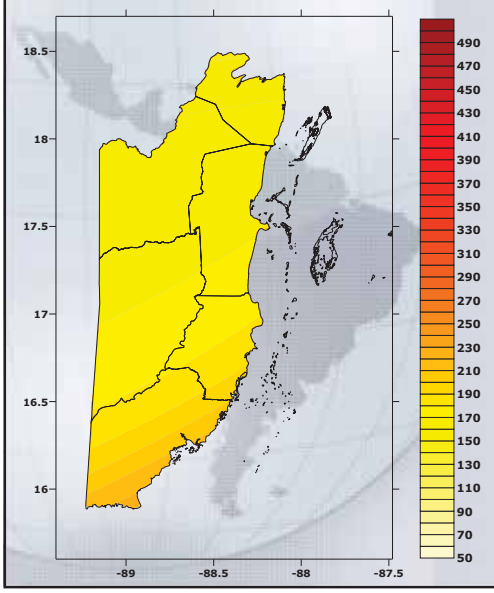
Seismic hazard curve at Belmopan





Seismic Hazard

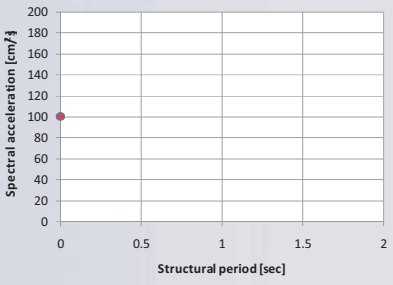
Hazard results



Spectral acceleration [cm/s2]
500 years return period

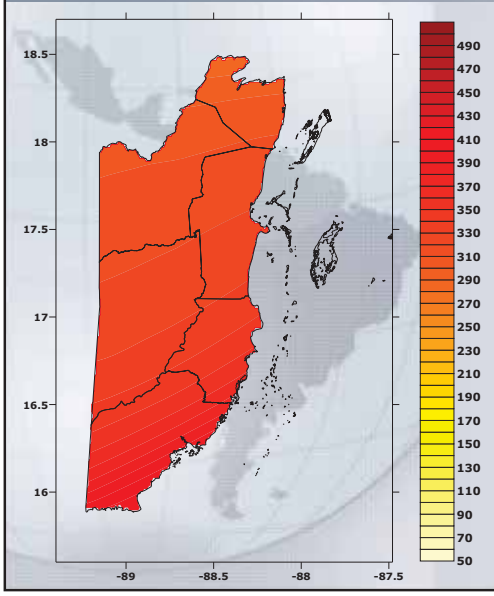
Structural period 0.0 sec

Uniform hazard spectrum at Belmopan



Seismic Hazard

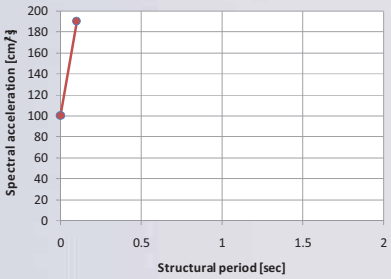
Hazard results



Spectral acceleration [cm/s2]
500 years return period

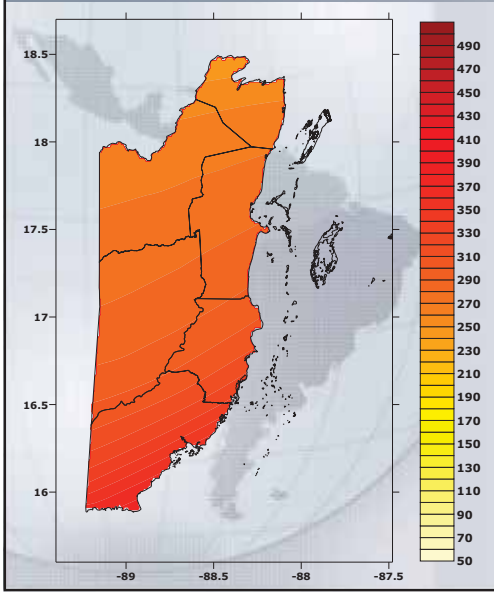
Structural period 0.1 sec

Uniform hazard spectrum at Belmopan



Seismic Hazard

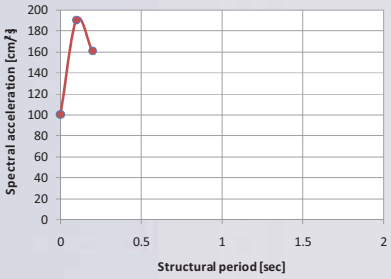
Hazard results



Spectral acceleration [cm/s2]
500 years return period

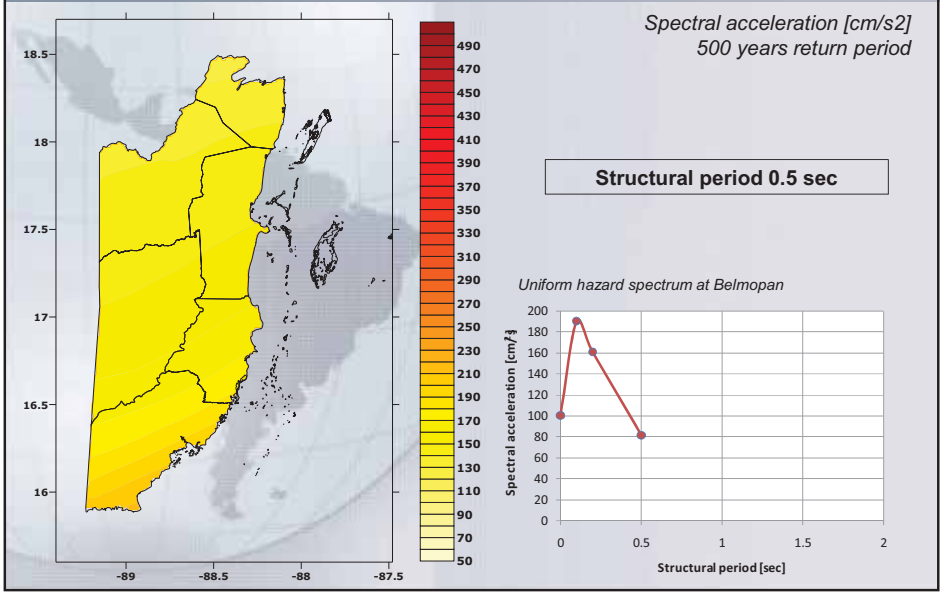
Structural period 0.2 sec

Uniform hazard spectrum at Belmopan



Seismic Hazard

Hazard results



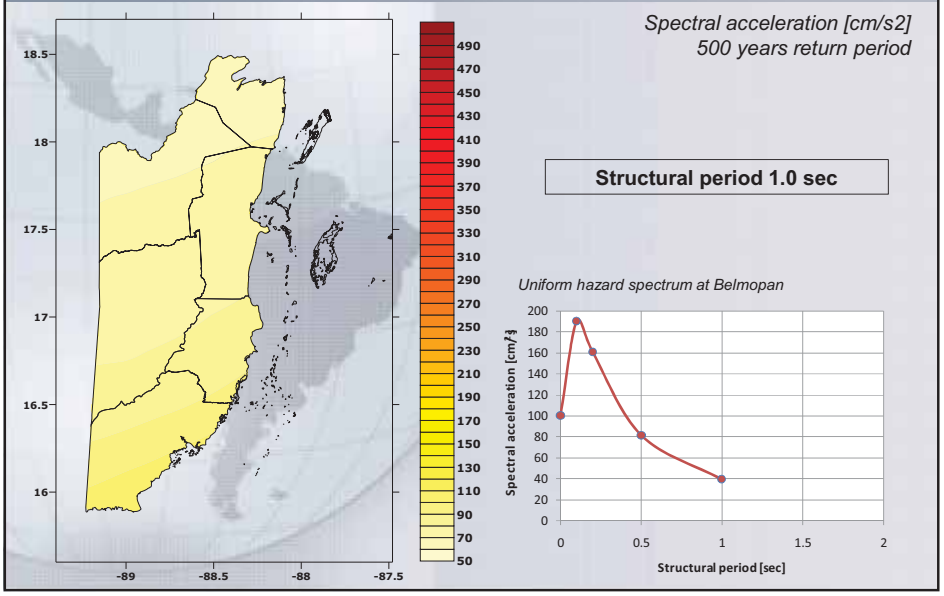
Spectral acceleration [cm/s2]
500 years return period

Structural period 0.5 sec

Uniform hazard spectrum at Belmopan

Seismic Hazard

Hazard results



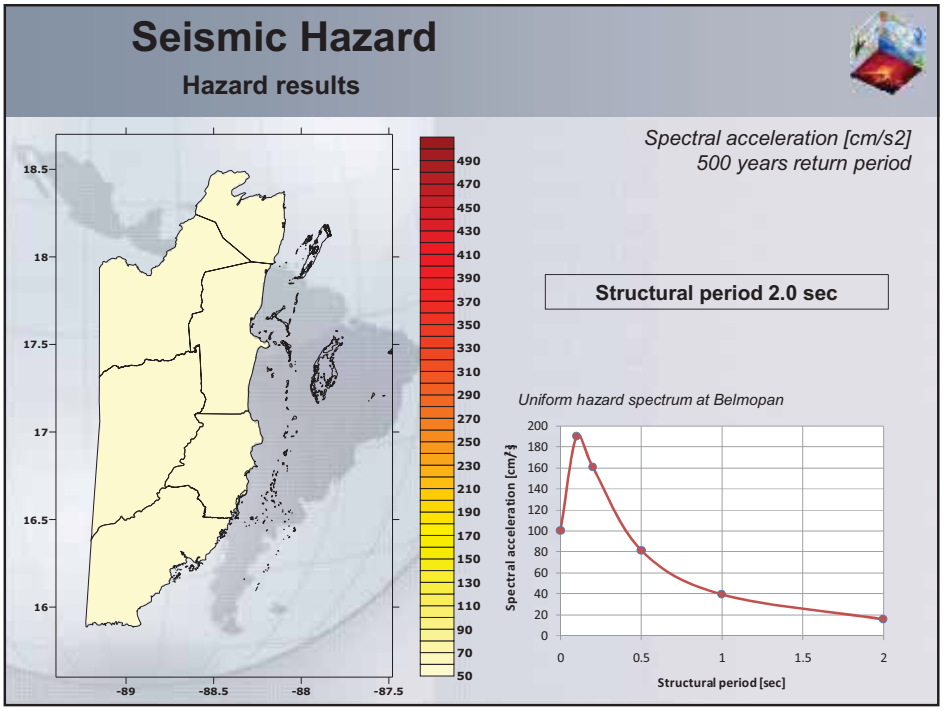
Spectral acceleration [cm/s2]
500 years return period

Structural period 1.0 sec

Uniform hazard spectrum at Belmopan

Seismic Hazard

Hazard results



Spectral acceleration [cm/s2]
500 years return period

Structural period 2.0 sec

Uniform hazard spectrum at Belmopan

TSUNAMI HAZARD

Tsunami Hazard

Damaging effects

Banda Aceh. 2004 Indonesian tsunami

Tsunami Hazard

Model descripction

INPUT

- ✓ Complete seismic hazard model
- ✓ Linear grid of computation sites
- ✓ Bathymety at regional level
- ✓ Topography at local level (grid bounding box)

HAZARD MODEL

- ✓ Stochastic earthquake scenarios generation (same as seismic hazard)
- ✓ Calculation of model parameters (hypocentral depth, epicentral distance, seismic moment, ocean floor depth, mean bathymetry slope)

OUTPUT

- ✓ Tsunami run-up height at computation sites, for each scenario

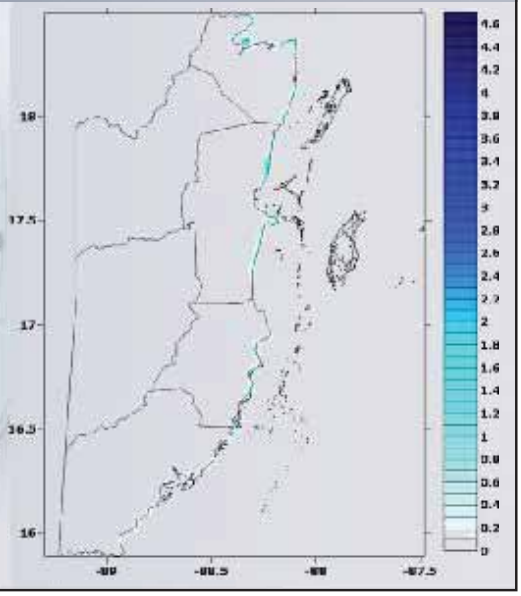
SOFTWARE MODULE: CRISIS 2007

Tsunami Hazard

Hazard results

Run-up height [m]

50 years return period

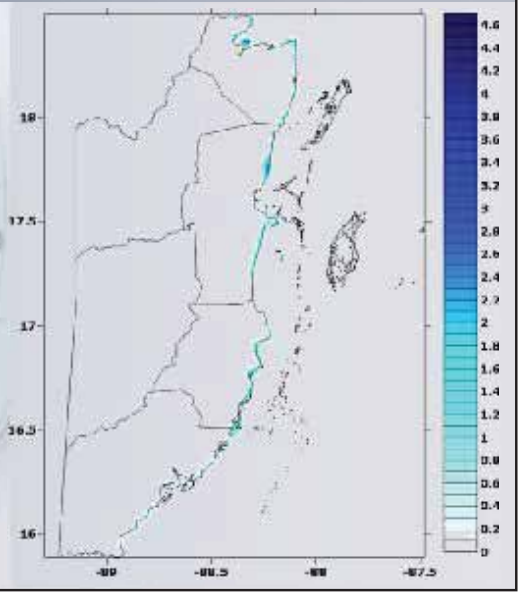


Tsunami Hazard

Hazard results

Run-up height [m]

100 years return period

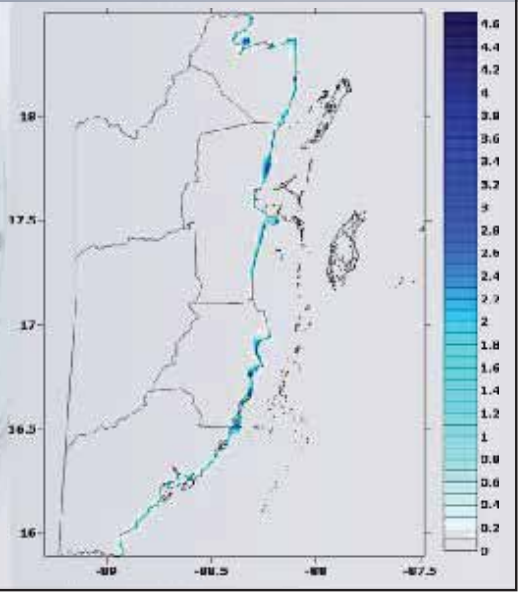


Tsunami Hazard

Hazard results

Run-up height [m]

500 years return period

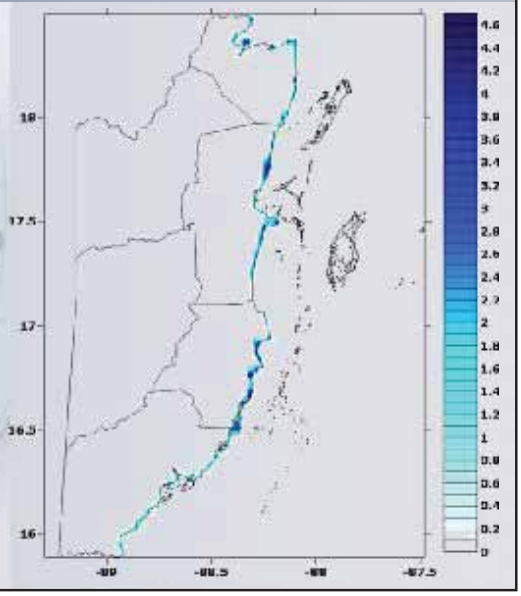


Tsunami Hazard

Hazard results

Run-up height [m]

1000 years return period



LANDSLIDE HAZARD

Landslide Hazard

Model description

INPUT

- ✓ Detailed topography
- ✓ Bedrock mechanical properties
- ✓ Surface soil mechanical properties
- ✓ Fault surface geometry (model dependent)
- ✓ Water table depth
- ✓ Earthquake hazard

HAZARD MODEL

- ✓ Stability safety factor calculation
- ✓ 4 different models available:
  - Mora-Varhson (Heuristic)
  - Newmark (Peak allowable acceleration)
  - Infinite slope (Forces equilibrium)
  - Spherical fault (Moment equilibrium)

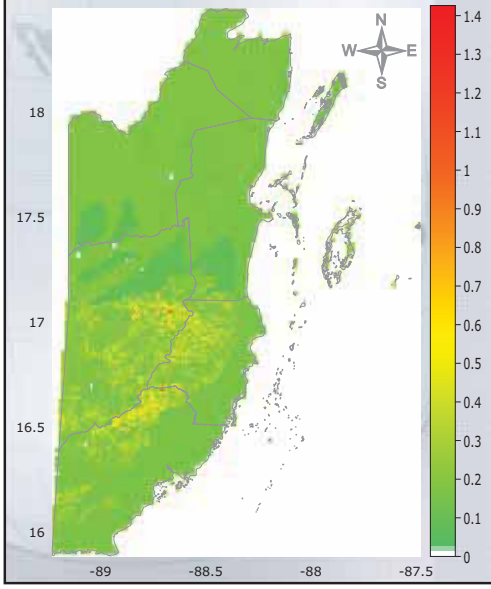
OUTPUT

- ✓ Stability safety factor for each calculation site
- ✓ Stability analysis is performed for all the water table – seismic hazard combinations

SOFTWARE MODULE: ERN-LANDSLIDE

Landslide Hazard

Hazard results



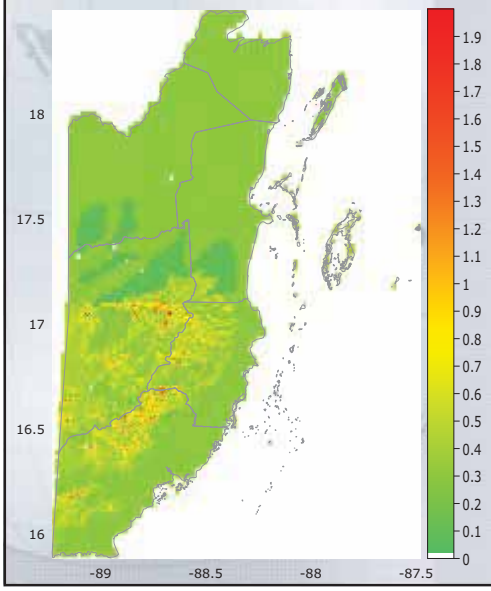
Infinite slope safety factor inverse (forces equilibrium)

Dry soil condition

No earthquake

Landslide Hazard

Hazard results



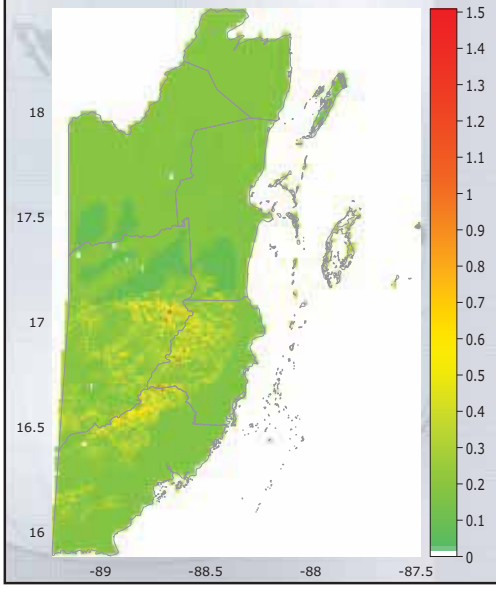
Infinite slope safety factor inverse (forces equilibrium)

Wet soil condition

No earthquake

Landslide Hazard

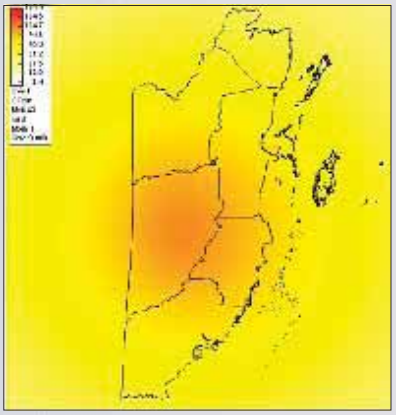
Hazard results



Infinite slope safety factor inverse (forces equilibrium)

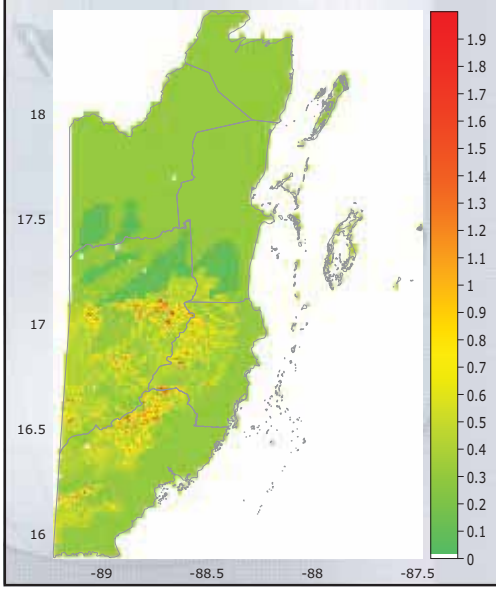
Dry soil condition

6.8 Mw earthquake



Landslide Hazard

Hazard results



Infinite slope safety factor inverse (forces equilibrium)

Wet soil condition

6.8 Mw earthquake