CAPRA

CENTRAL AMERICA PROBABILISTIC RISK ASSESSMENT

Concepts and Hazards

Stryszawa, September 23 - 2011

ERN

Evaluación de Riesgos Naturales

– América Latina –

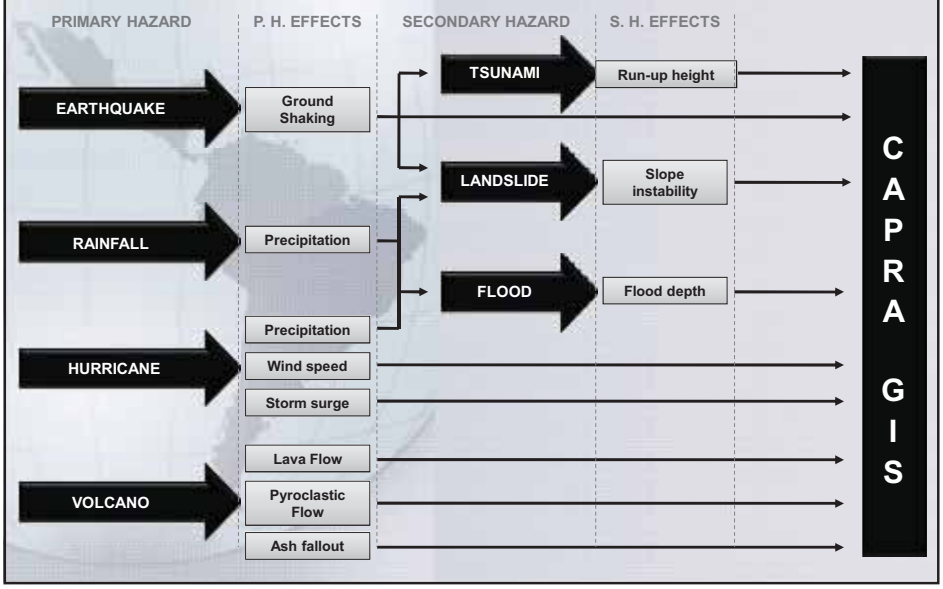
CAPRA is an initiative to **understand**, **communicate** and **support** decisions related to **disaster risk** at the local, subnational, national and regional levels.

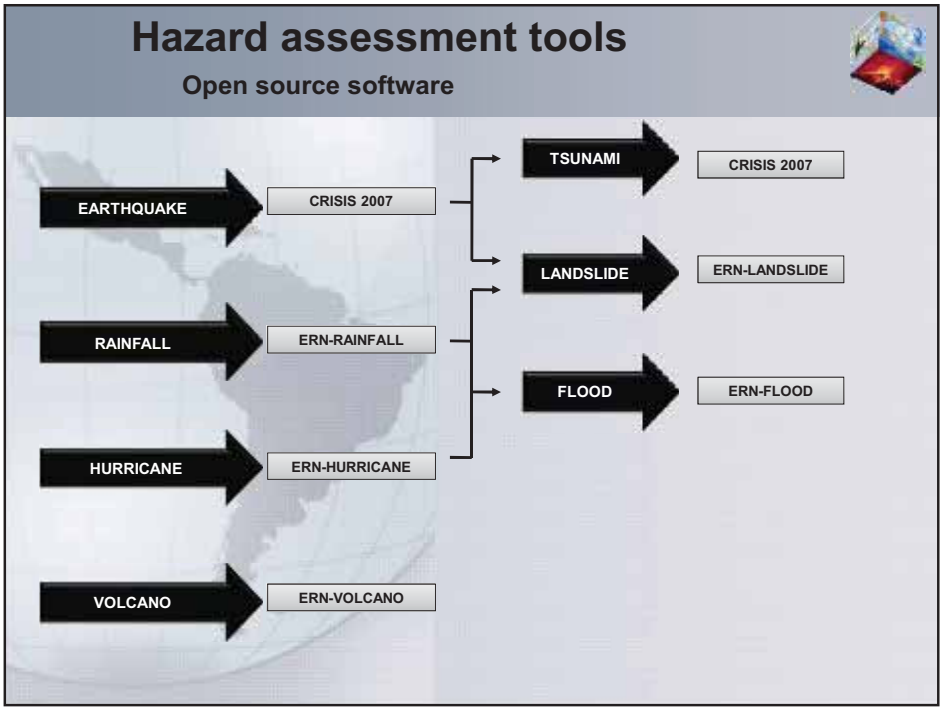
Probabilistic hazard modeling

Warnings

- ✓ *Most catastrophic events haven't occurred yet*
- ✓ *Scarce historical data*
- ✓ *Short memory for previous disasters*
- ✓ *Short time data gathering window for modeling hazard events of long recurrence periods*
- ✓ *Simplified hazard modeling of complex physical phenomena*
- ✓ *The modeling process requires experience and common sense*

Multi-hazard approach




Hazard assessment tools
Open source software
EARTHQUAKE
CRISIS 2007
RAINFALL
ERN-RAINFALL
HURRICANE
ERN-HURRICANE
VOLCANO
ERN-VOLCANO
TSUNAMI
CRISIS 2007
LANDSLIDE
ERN-LANDSLIDE
FLOOD
ERN-FLOOD


HURRICANE HAZARD

Hurricane Hazard

Damaging effects

Extreme wind





Hurricane Hazard

Damaging effects

Storm surge

Hurricane Hazard

Damaging effects

Hurricane rainfall and flood

Hurricane Hazard

Model descripction

INPUT

- ✓ Catalog of historical hurricane paths (wind speed, central pressure and forward speed at each location)
- ✓ Rectangular and linear grid of computation sites
- ✓ Bathymetry
- ✓ Topography
- ✓ Urban areas and land use polygons

HAZARD MODEL

- ✓ Generation of stochastic hurricane paths based on each one of the historical paths (random walk)
- ✓ Wind exposed areas calculation
- ✓ Land roughness calculation
- ✓ Wind speed, storm surge and rainfall modeling using field equations

OUTPUT

- ✓ Top wind speed at computation sites, for each scenario
- ✓ Storm surge run-up at computation sites, for each scenario
- ✓ Rainfall at computation sites, for each scenario

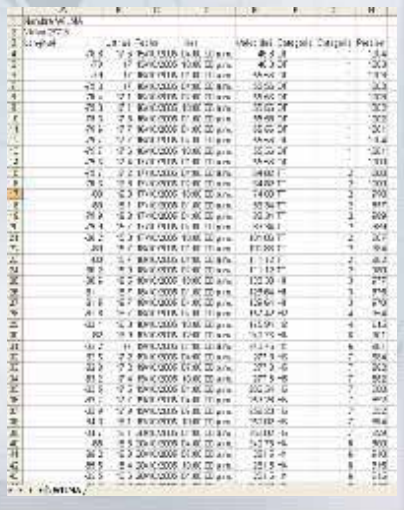
SOFTWARE MODULE: ERN-HURRICANE

Hurricane Hazard

Model descripction

Wind field model

Hurricane advisories

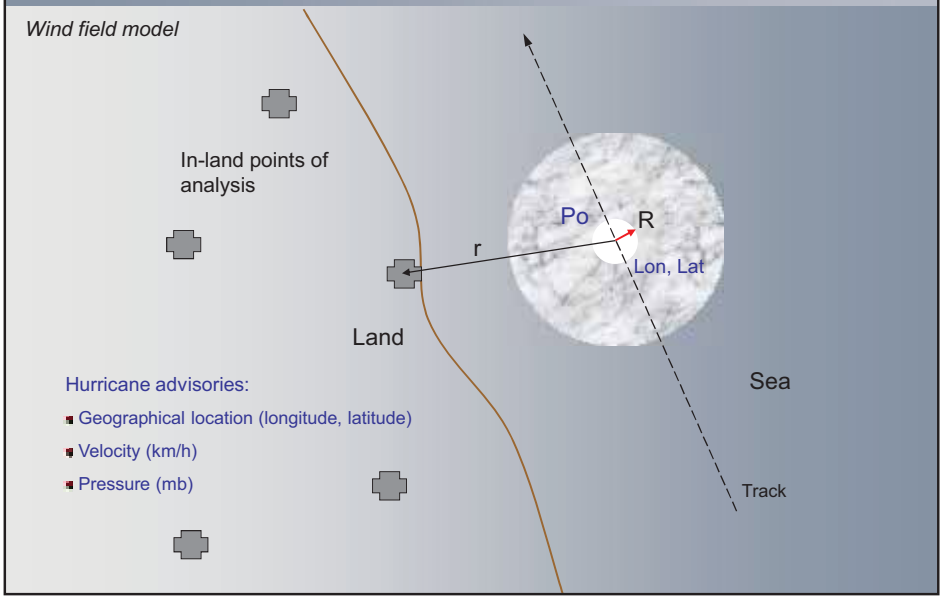


- **Eye location (latitude, longitude)**
- **Velocity (km/h)**
- **Central pressure (mb)**

Hurricane Hazard

Model descripction

Wind field model



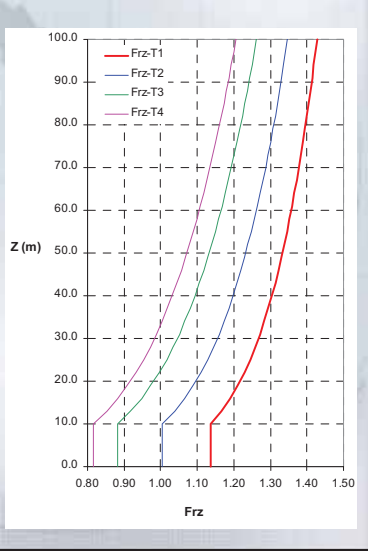
Hurricane advisories:

- Geographical location (longitude, latitude)
- Velocity (km/h)
- Pressure (mb)

Hurricane Hazard

Model descripction

Soil roughness and Height variation



4 roughness type:

- No obstructions.
- Disperse obstructions.
- Sub-urban area.
- Large urban area.

$$Frz = 1.56 \left(\frac{10}{\delta}\right)^{\alpha} \quad si \quad Z \le 10 \quad m$$

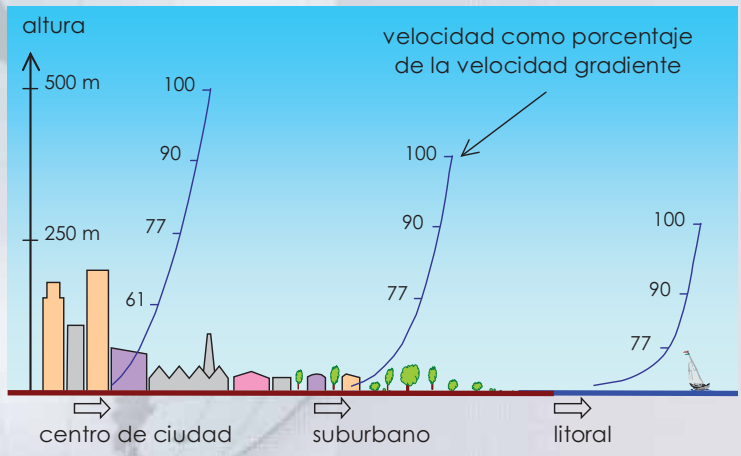
$$Frz = 1.56 \left(\frac{Z}{\delta}\right)^{\alpha} \quad si \quad 10 < Z < \delta$$

$$Frz = 1.56 \quad si \quad Z \ge \delta$$

Hurricane Hazard

Model descripction

Soil roughness and Height variation



Hurricane Hazard

Model descripction

Roughness type

1. No obstructions

2. Disperse obstructions.

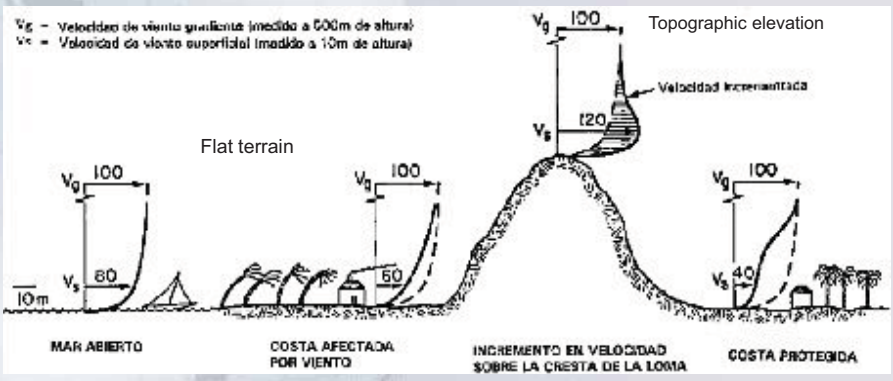
3. Sub-urban area.

4. Large urban area.

Hurricane Hazard

Model descripction

Topography

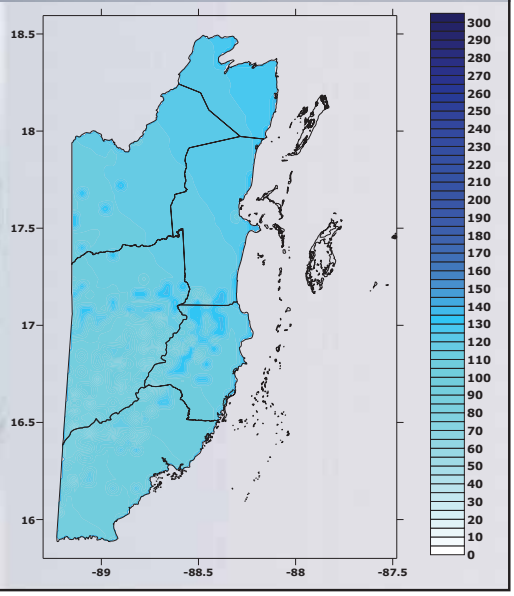


Hurricane Hazard

Hazard results

Top wind speed [km/h]

50 years return period

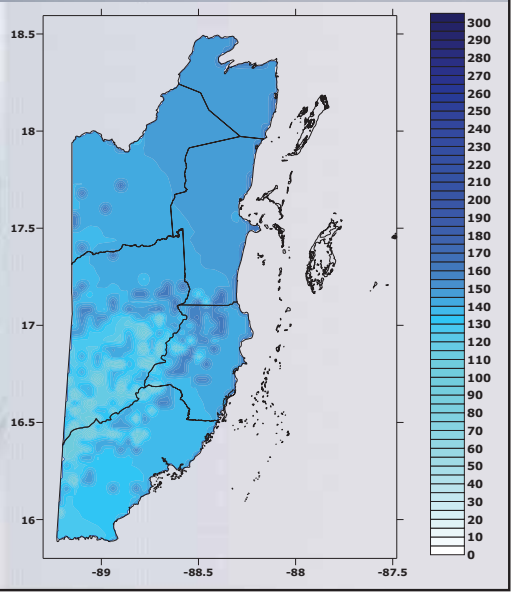


Hurricane Hazard

Hazard results

Top wind speed [km/h]

100 years return period

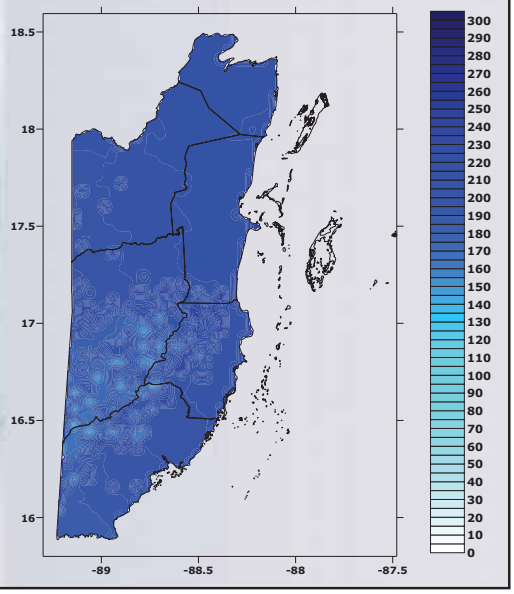


Hurricane Hazard

Hazard results

Top wind speed [km/h]

500 years return period

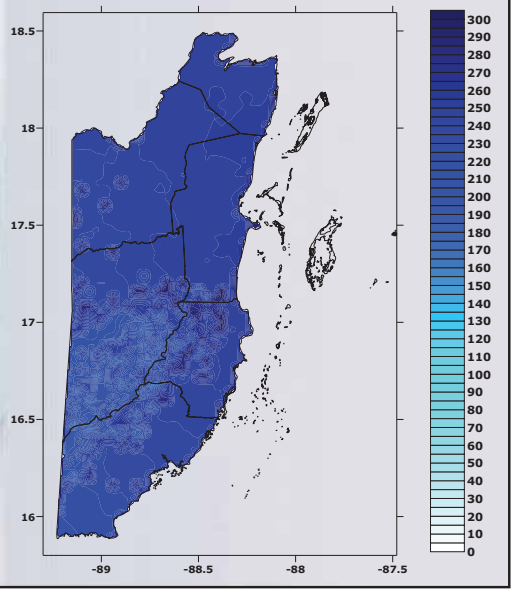


Hurricane Hazard

Hazard results

Top wind speed [km/h]

1000 years return period

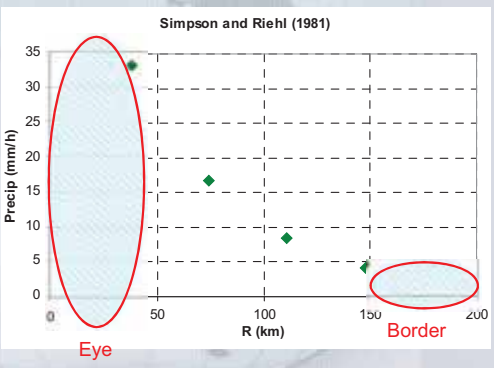


Hurricane Hazard

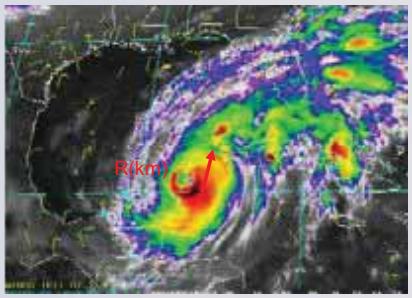
Model descripction

Rainfall field

Average rainfall observed in TC



Real rainfall field (asymmetric)



Hurricane Hazard

Model descripction

Rainfall field

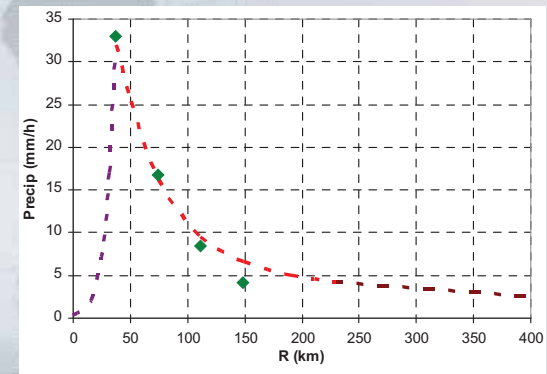
Proposal

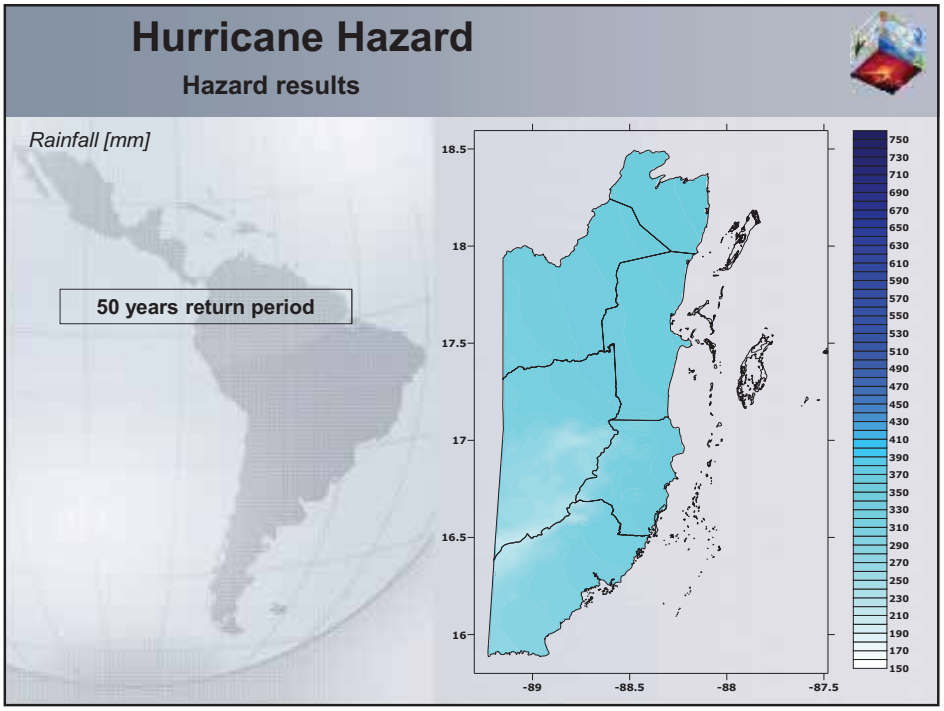
$$\text{Precip} = \left[\frac{a_1}{1 + b_1 \cdot e^{-c_1 \cdot R}}\right] \qquad si\ R \le 37$$

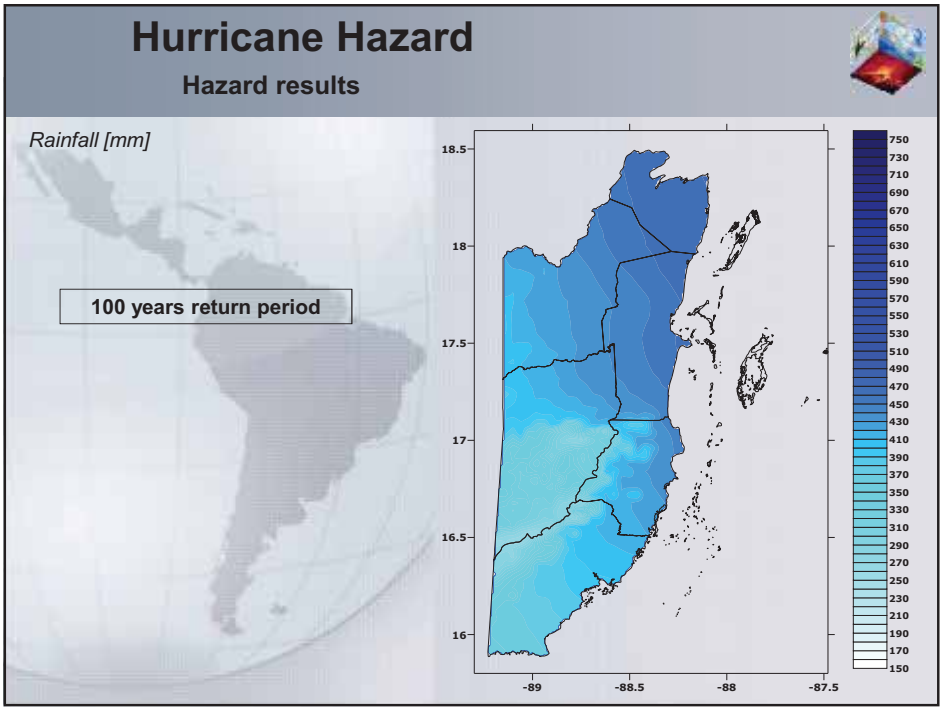
$$\text{Precip} = (a_2 - b_2 \cdot e^{-c_2 R^{d_2}}) \qquad si\ 37 < R \le 230$$

$$\text{Precip} = (a_3 + b_3 \cdot R) \qquad si\ R > 230$$

Field




Hurricane Hazard
Hazard results
Rainfall [mm]
50 years return period
18.5
18
17.5
17
16.5
16
-89
-88.5
-88
-87.5
750
730
710
690
670
650
630
610
590
570
550
530
510
490
470
450
430
410
390
370
350
330
310
290
270
250
230
210
190
170
150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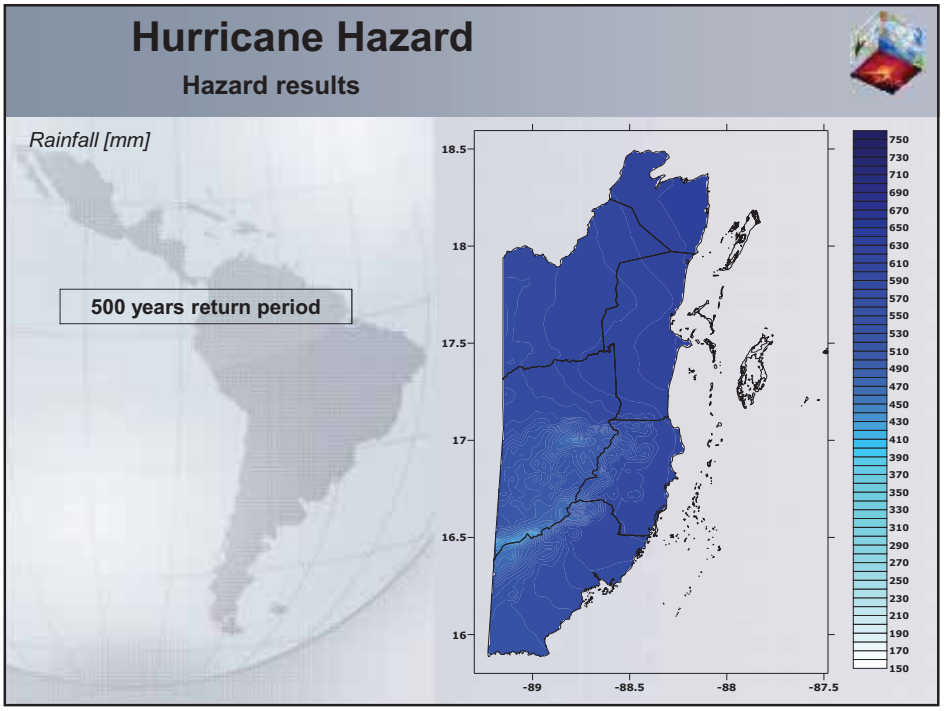
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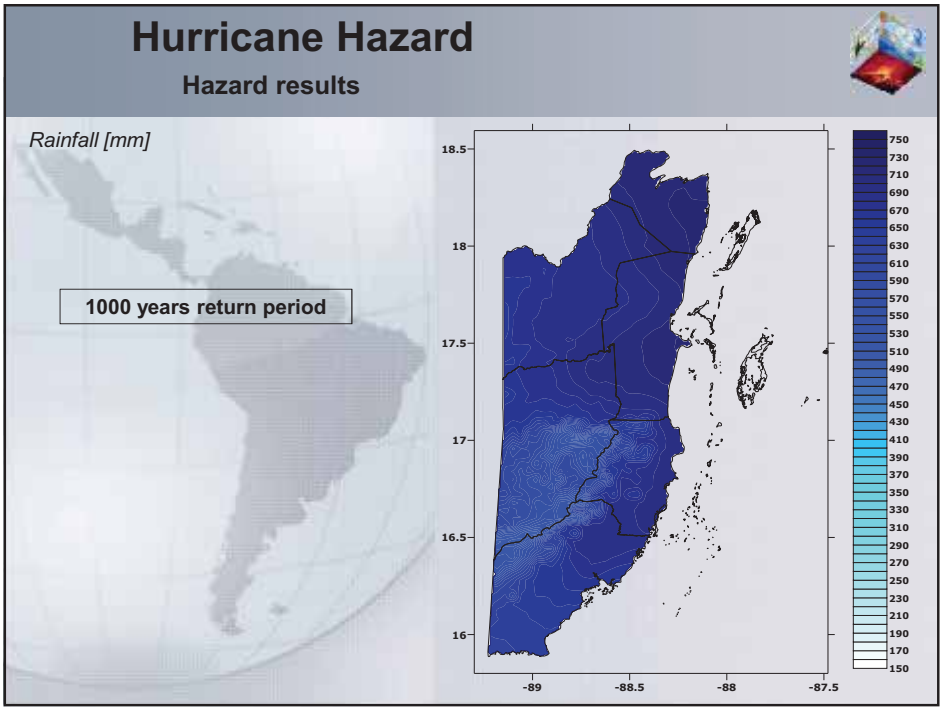
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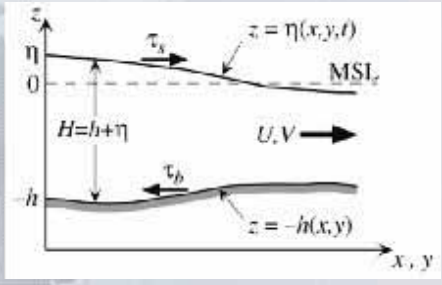
Hurricane Hazard

Model descripction

Storm surge

Storm surge is a function of the pressure gradient and tangential stresses exerted by the wind and bottom



$\eta_v =$ Elevation due to wind

$\tau_s =$ Tangential tension due to wind

$\tau_b =$ Tangential tension due to bottom friction

$H = h + \eta$ = Total depth

$\eta =$ Elevation due to storm surge

$h =$ Water depth at hurricane center

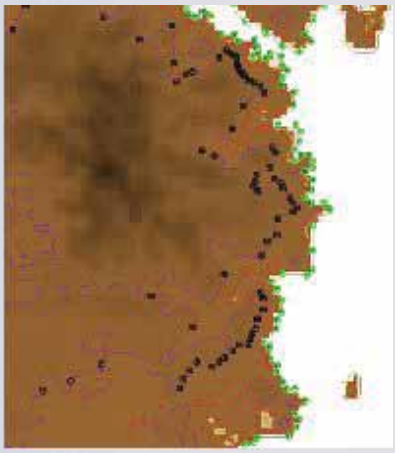
$g =$ Gravity acceleration

Hurricane Hazard

Model descripction

Storm surge

Linear grid along shore line

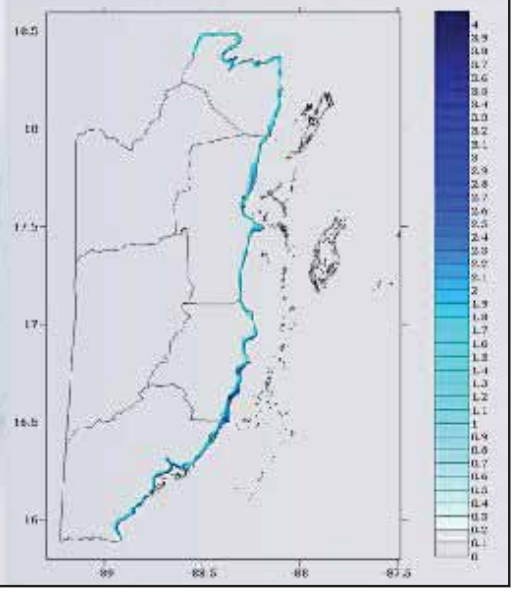


Hurricane Hazard

Hazard results

Storm surge [m]

500 years return period



FLOOD HAZARD

Flood Hazard

Damaging effects

Flooding in rural areas

Flood Hazard

Damaging effects

Flooding in urban areas