

# Towards a Uniform Approach for Risk Assessment due to Volcanoes and Earthquakes

*A case study for the Nevado del Ruiz Volcano*

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CITIES ON VOLCANOES (CoV11)  
JUNE 16, 2022



working together  
to assess risk

# CRAVE PROJECT (2018-2019)

## COLLABORATIVE RISK ASSESSMENT FOR VOLCANOES & EARTHQUAKES

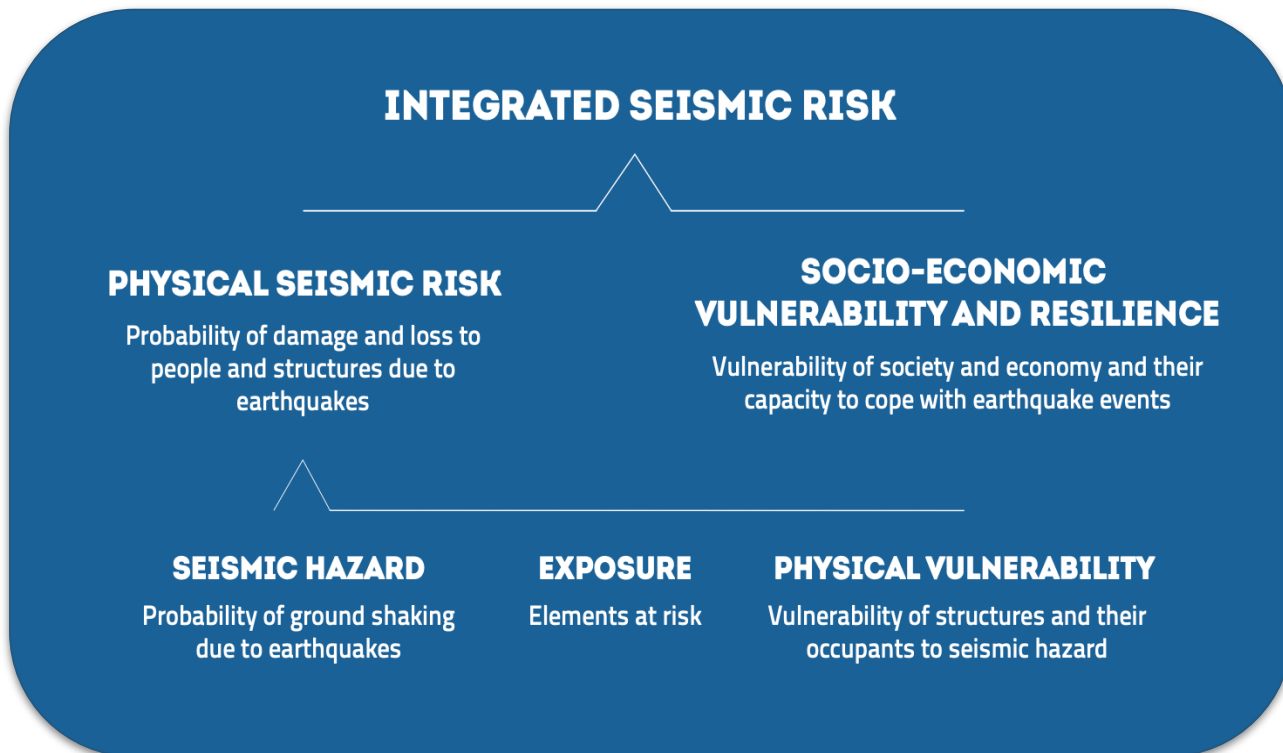
- Unified framework for the assessment of losses
- Multi-hazard exposure modelling
- Application to Colombia, Philippines, and Indonesia



# The Global Earthquake Model Foundation (GEM)



# Earthquake Risk Assessment Framework



# OpenQuake applications

## Regional hazard and risk analysis:

- SARA
- CCARA
- SHARE
- SERA
- EMME
- EMCA
- SSAHARA
- Southeast Asia

## National hazard and risk analysis:

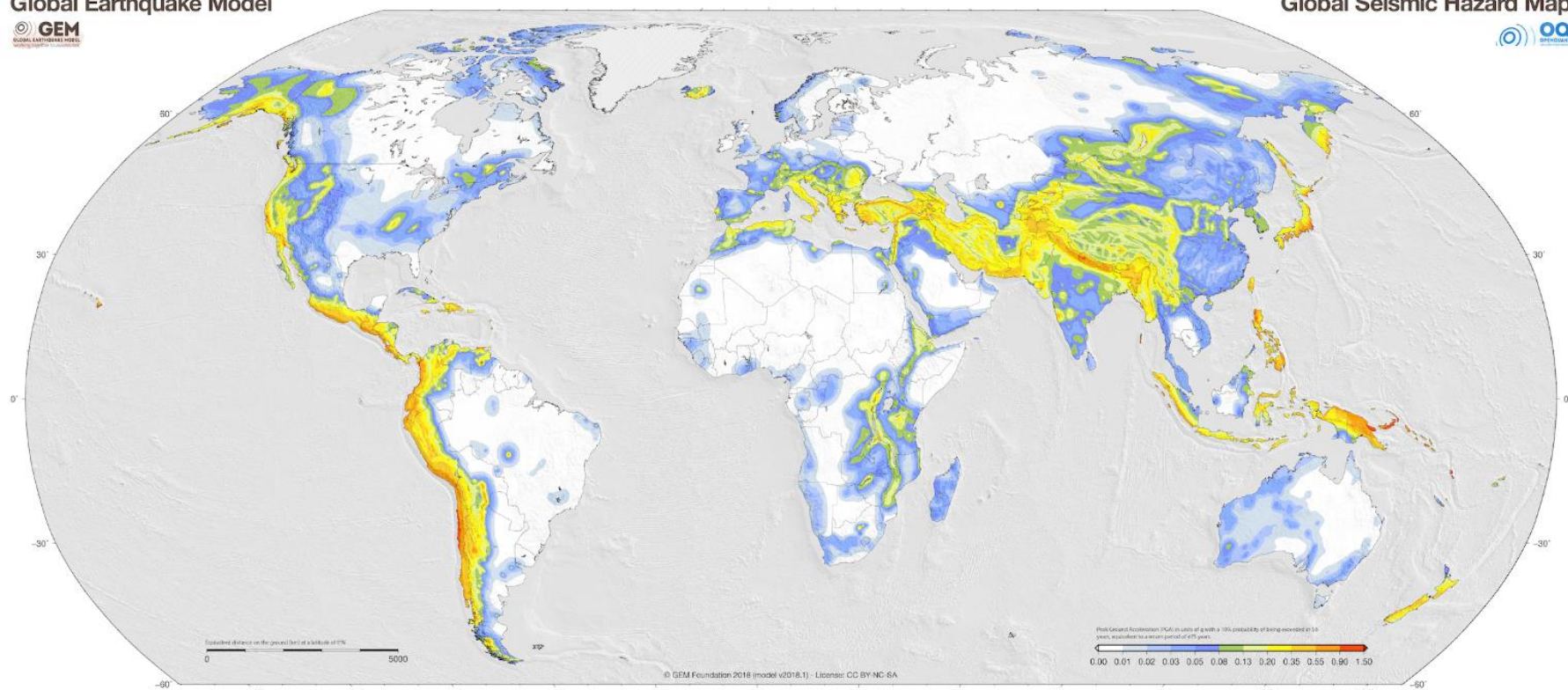
- Italy
- Switzerland
- Turkey
- Colombia
- Ecuador
- Taiwan
- New Zealand
- Australia
- Canada
- South Africa

## Near real time ground shaking assessment:

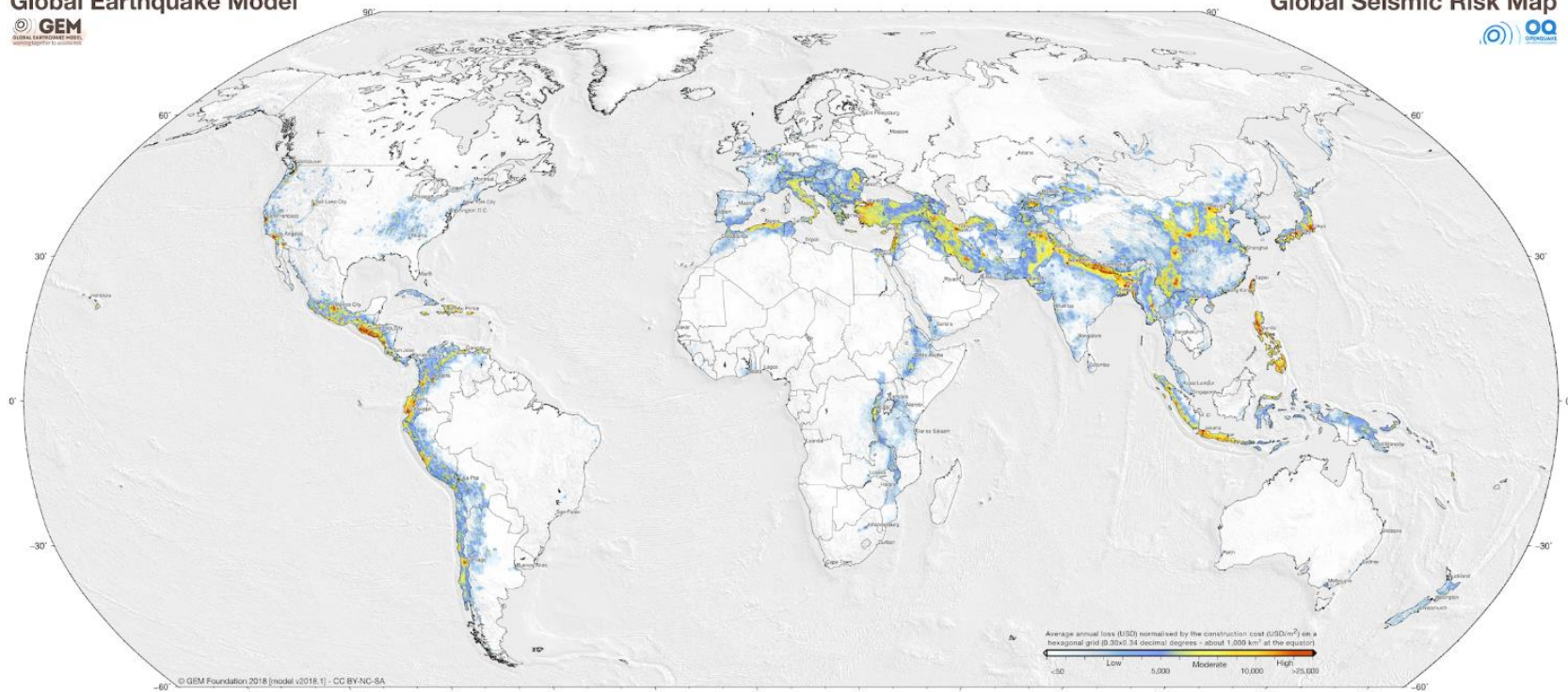
- OQ libraries used in the USGS ShakeMaps system
- OQ components used in national projects (Italy, Canada, and Colombia)

## Site-specific studies:

- SSHAC Level 3 PSHA in nuclear power plants (Europe and South Africa)
- Induced seismicity (hazard and risk) (United States, Europe and South Africa)



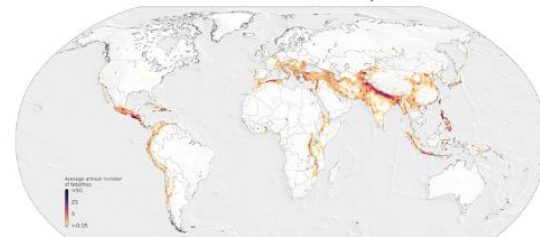
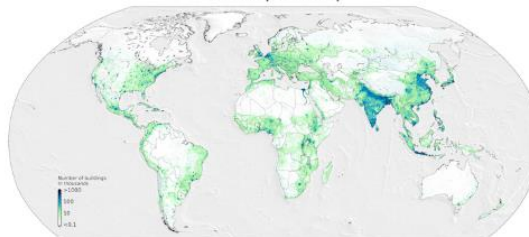
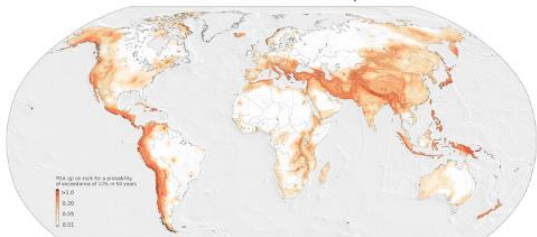




Global Seismic Hazard Map

Global Exposure Map

Global Seismic Fatalities Map





# Volcanic Scenarios using OpenQuake

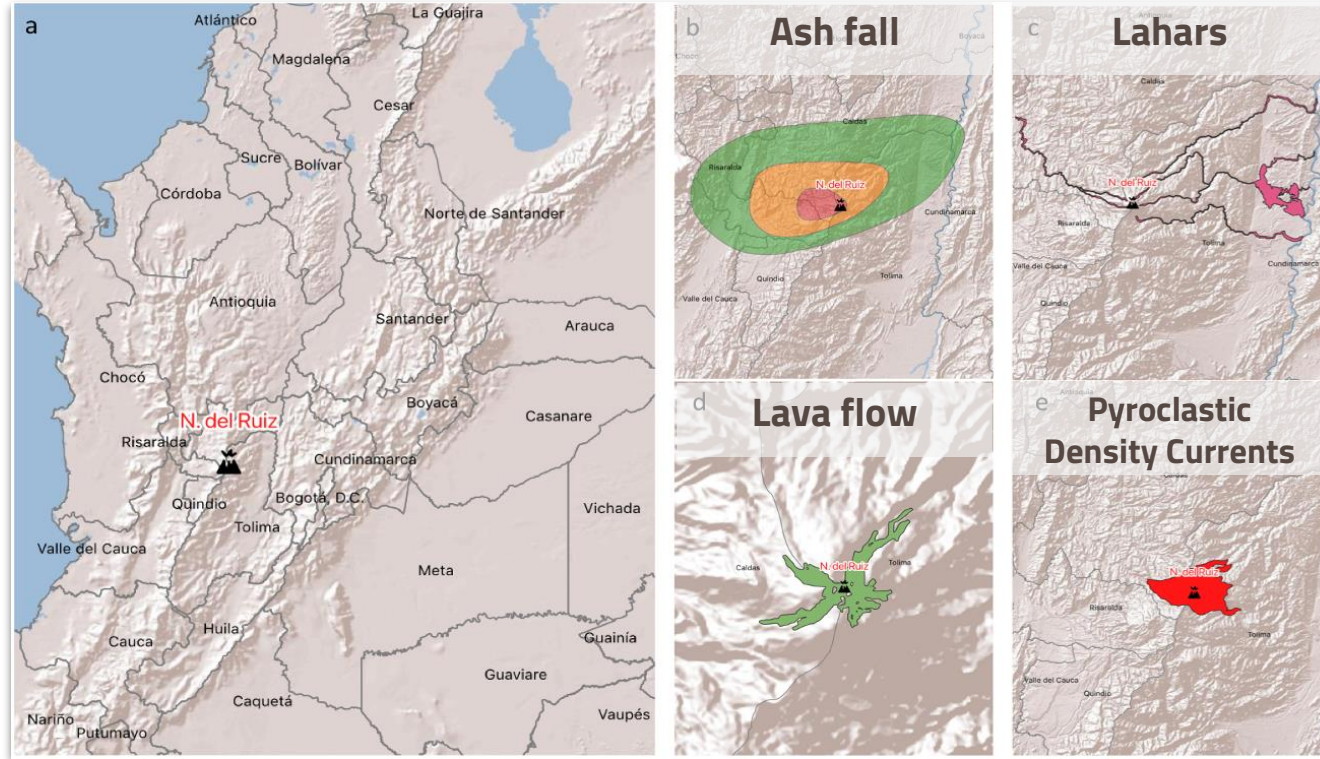
Implementation of a new calculator in the OpenQuake Engine called **'multi\_risk'**

Hazard Peril	Software	Organization	Intensity
Ashfall	Ash3d	USGS	Ash thickness and load
Lava Flow	Q-LavHa	Vrije Universiteit Brussel	Binary (1- affected, 0- not affected)
Pyroclastic Density Currents	Titan2d	Vhub and Buffalo University	Binary (1- affected, 0- not affected)
Lahar	LaharZ	USGS	Binary (1- affected, 0- not affected)

The screenshot shows the 'INPUT PREPARATION TOOLKIT' interface for 'Volcano Scenarios'. It includes a navigation bar with 'Calculate', 'Share', and 'Explore' buttons. The main content area is titled 'INPUT PREPARATION TOOLKIT' and contains a description of the calculator's purpose and supported hazard types (Ash fall, Lahar, Lava flow, Pyroclastic flow). Below this, there are configuration sections for each hazard type, including input format, hazard footprint, and other parameters. The 'Ash fall' section is currently active, showing a 'Default CSV format' dropdown and a 'Hazard footprint' field with an 'Upload' button. The 'Lava flow' and 'Lahar' sections also have similar configuration options.



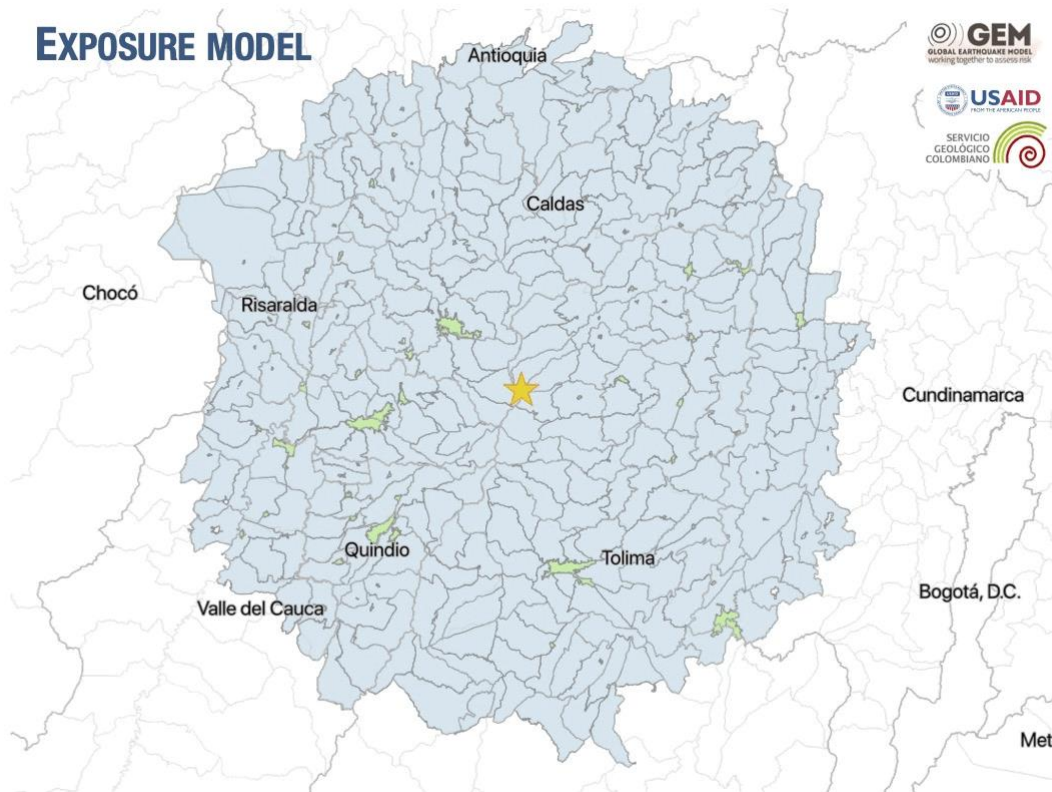
# Pilot case: El Ruiz Volcano in Colombia



## Volcanic hazard footprints for El Ruiz Volcano

(Monica Arcila, Julián Andrés Ceballos, Luis Jerónimo Valencia, Carlos Andrés Laverde, SGC)

# Pilot case: El Ruiz Volcano in Colombia



## Exposure model:

Number of buildings with structural characteristics:

- Construction material
- Number of stories
- Roof type
- Number of occupants
- Location (lon, lat)

Development of multi-hazard models (SGC and GEM)

# Scenario risk estimates

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## OpenQuake input files:

- Volcanic hazard footprints
- Exposure model
- Vulnerability model (for ash fall)

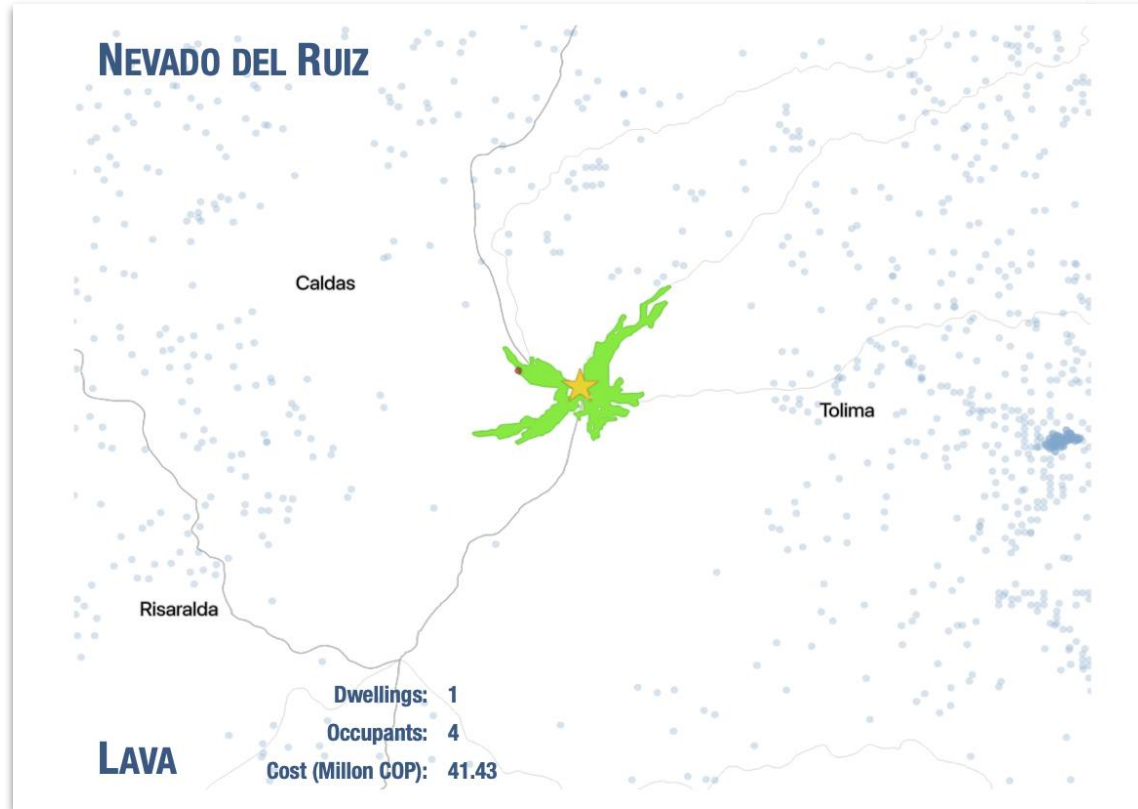


## OpenQuake output files:

- Affected population
- Damage to the building stock
- Economic losses to the built environment
- ...
- Which other outputs will be useful?



# Pilot case: El Ruiz Volcano in Colombia



Results of a Volcanic Scenario Risk Assessment



# Online workshop for volcanic risk scenarios in OpenQuake

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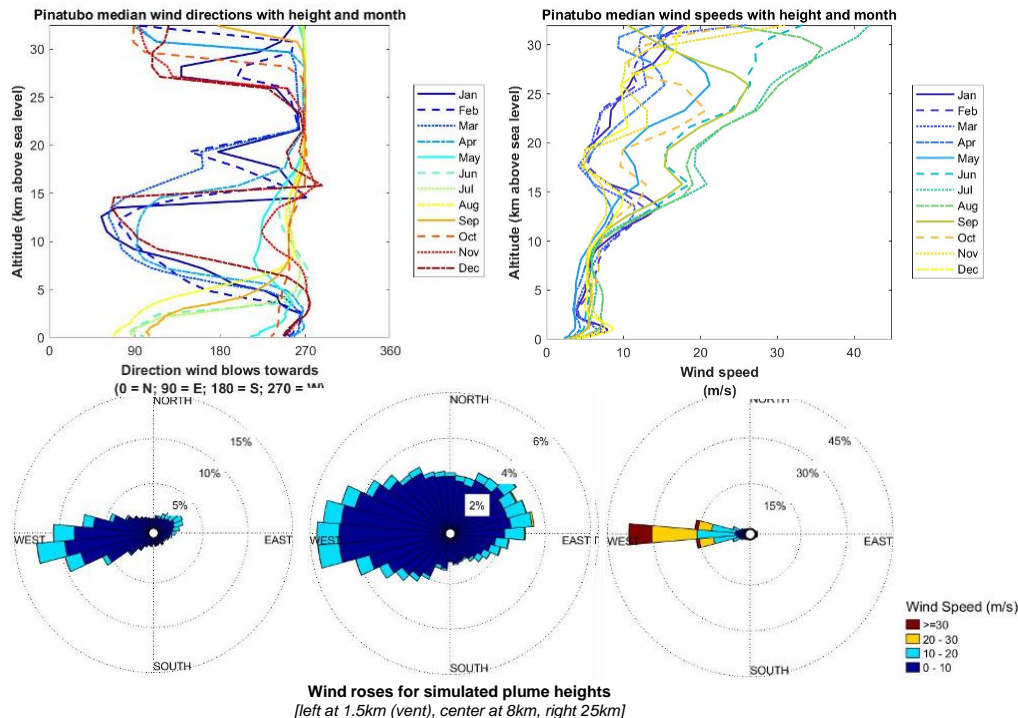
**Friday, July 8th 2022**

Online session (3 hours) with hands-on examples.

Registration available at:

[www.training.openquake.org](http://www.training.openquake.org)

# Towards probabilistic scenario risk assessment: Pinatubo Volcano, Philippines



## Tephra hazard footprints:

5,000 footprints from simulations for:

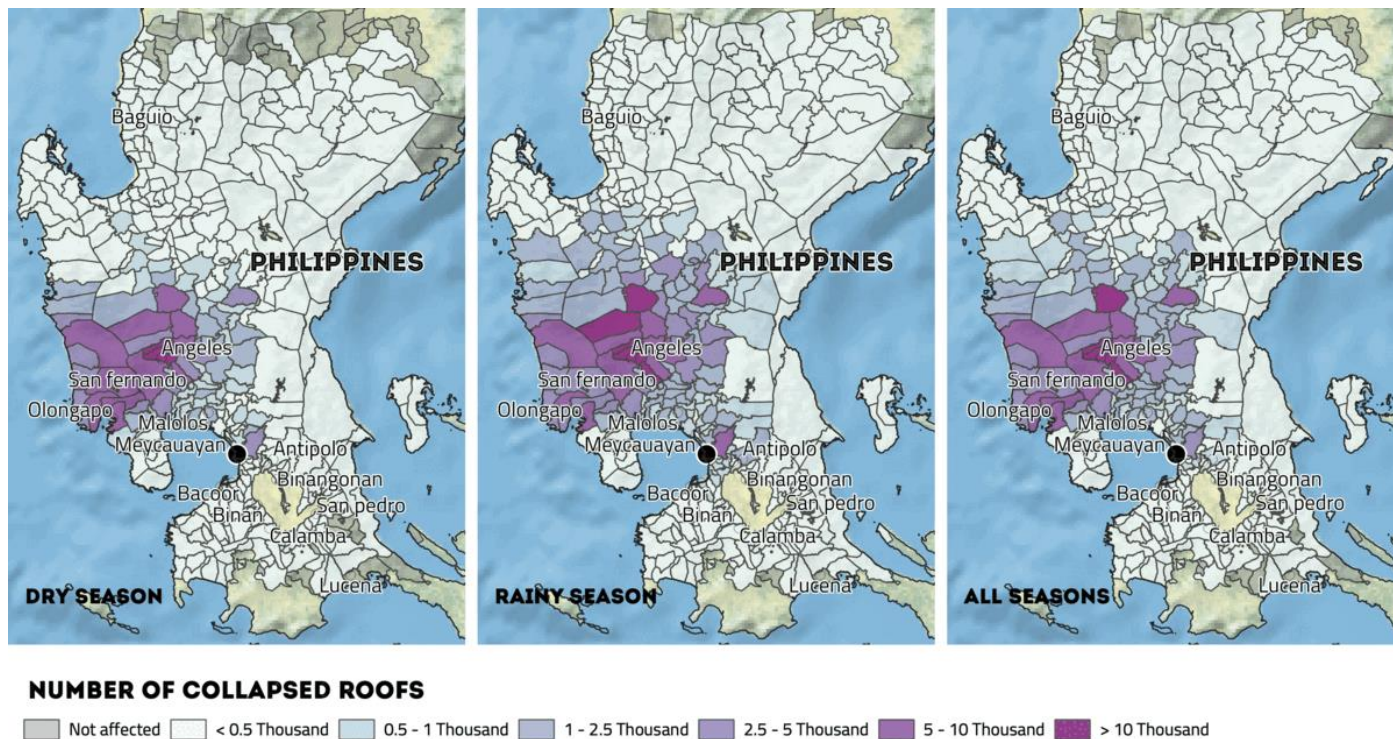
- Each of the whole year
- Rainy seasons
- Dry seasons

Total of 15.000 simulations

Probabilistic scenario tephra dispersal modelling for a VEI 6 eruption scenario  
(Susanna Jenkins, Sébastien Biass and Chow Jun Rui, EOS)

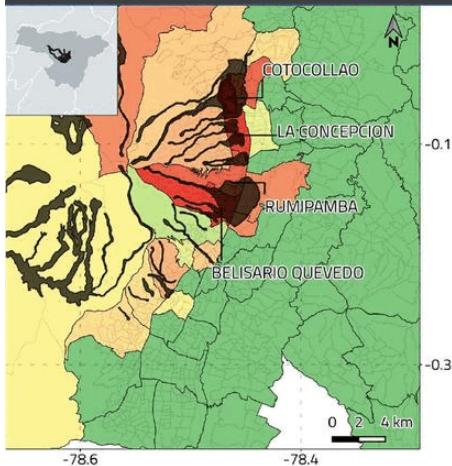


# Towards probabilistic scenario risk assessment: Pinatubo Volcano, Philippines

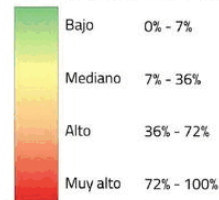


Probabilistic scenario tephra dispersal modelling for a VEI 6 eruption scenario

# Volcanic Scenario Profiles, Quito - Ecuador



Mapa de parroquias más vulnerables:  
Índice de afectación por parroquias



**PARROQUIAS EN MAYOR RIESGO**

Parroquias	Índice de afectación	Personas desplazadas (miles)	Estructuras destruidas (miles)	Pérdidas económicas (mill. USD)
COTOCOLLO	100%	31	3.8	716
BELISARIO QUEVEDO	72%	29	3.9	1059
LA CONCEPCION	68%	22	3.1	638
RUMIPAMBA	51%	15	1.8	733
PONCEANO	43%	22	2.6	517
NONO	36%	0	0.0	3
IÑAQUITO	33%	15	1.7	1567
MARISCAL SUCRE	32%	3	0.9	491
COCHAPAMBA	24%	14	1.2	270
CHILIBULO	20%	9	1.0	162
EL CONDADO	7%	7	1.0	252
CENTRO HISTORICO	4%	2	0.1	42
LA MENA	2%	1	0.2	14
CARCELEN	1%	1	0.1	31
CHILLOGALLO	1%	1	0.1	9

## IMPACTO TOTAL EN LA CIUDAD

Índice de afectación de la ciudad  
**7.6%**

Estructuras destruidas  
**21,700**

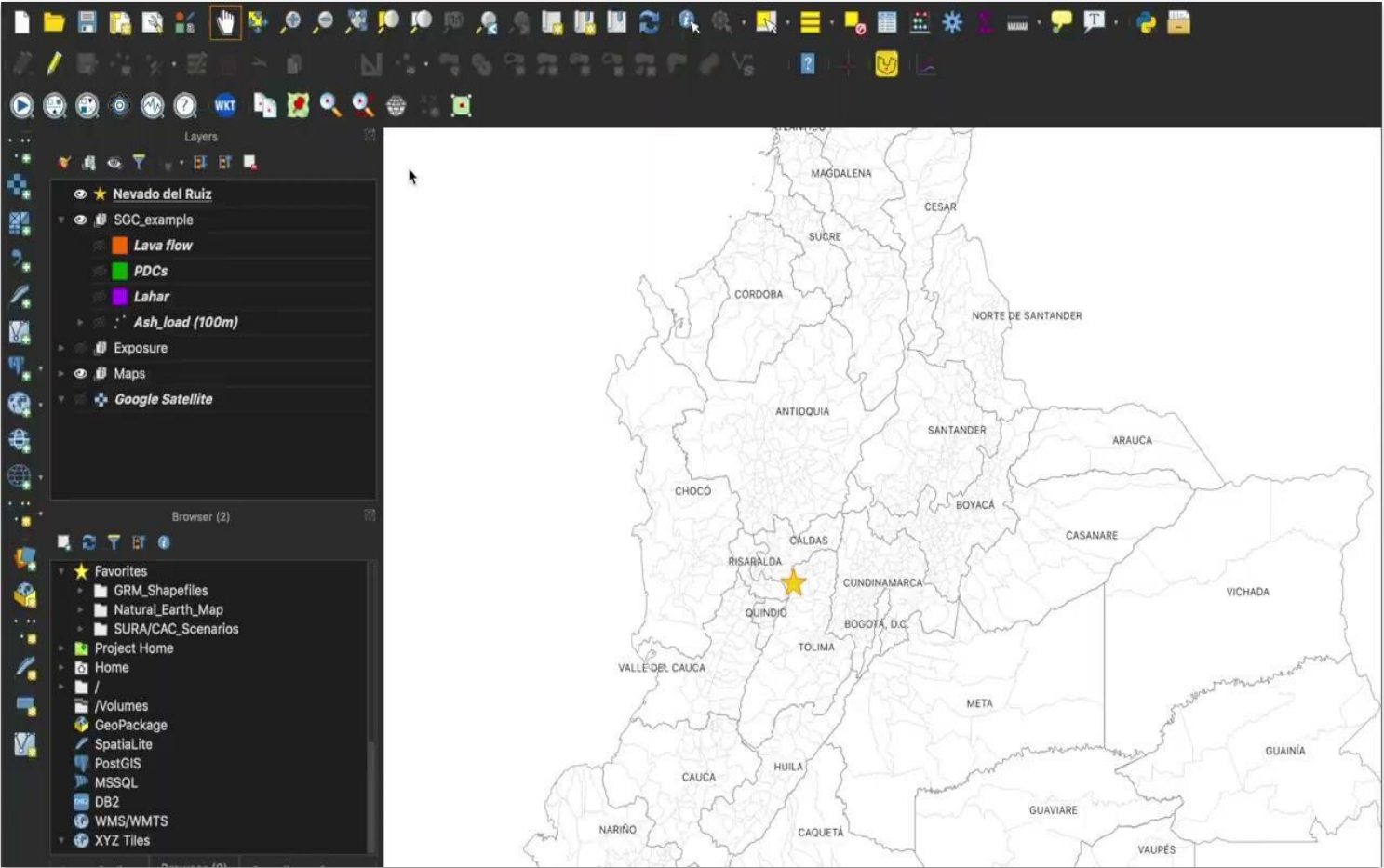
Personas desplazadas  
**173,000**

Pérdidas Económicas (mill. USD)  
**\$6,500**

## Volcanic Scenarios:

- Atacazo
- Guagua Pichincha
- Cotopaxi

El índice de afectación es el porcentaje de estructuras expuestas por región que son destruidas debido a los fenómenos volcánicos que resulta de la erupción. El número de fatalidades asume la ocurrencia del evento en horario nocturno y el 100% de la población ubicada en las residencias. Puede encontrar más información sobre las suposiciones del análisis del escenario sísmico en el documento 'Atlas de riesgo para la ciudad de Quito'.



# Thank you!

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