GEM FOUNDATION

FOR A WORLD
THAT IS RESILIENT TO
EARTHQUAKES

Global Earthquake Model GEM

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VISION & MISSION

Initiated by the OECD's Global Science Forum, GEM was formed in 2009 as a non-profit foundation in Pavia, Italy, funded through a public-private sponsorship with the vision to create **a world that is resilient to earthquakes**. GEM's mission is to become one of the world's most complete sources of risk resources and a globally accepted standard for seismic risk assessment, whose products are applied in risk management worldwide.

Photo credit: Rebecca Blackwell—AP/REX/Shutterstock
Source: http://time.com/earthquake-mexico-city-photos/

Leadership

John Schneider
Secretary General

Mauro Dolce - DPC Italy
Governing Board Chairperson

WHO WE ARE

GEM Team and Partners

GEM is comprised of collaborators from public, private, academic and non-government organizations worldwide. These partners work together to advance the state-of-the-art for disaster risk reduction by developing data, tools and information for improving our understanding of earthquake hazard and risk globally. (https://www.globalquakemodel.org/who-we-are).

GEM Secretariat staff with the Governing Board members, December 2017

2009-2019 Sponsors

Private sponsors

Munich RE, ZURICH, AIR, EUCENTRE, hannover re, FM Global, PartnerRe, sura SEGUROS, TENDENCIAS Y RIESGOS, ARUP, OYO, Nephila, General Insurance Rating Organization of Japan, Renaissance Re RISK SCIENCES FOUNDATION, INC., Willis Towers Watson

Public sponsors

Australian Government Geoscience Australia — Australia

Natural Resources Canada / Ressources naturelles Canada — Canada

CIGIDEN — Chile

Servicio Geológico Colombiano — Colombia

CAMICON — Ecuador

GFZ Helmholtz Centre Potsdam — Germany

Protezione Civile — Italy

NIED 防災科研 — Japan

NSET — Nepal

GNS Science Te Pū Ao — New Zealand

The Research Council of Norway — Norway

Nanyang Technological University Singapore — Singapore

Schweizerische Eidgenossenschaft / Confédération suisse / Confederazione Svizzera / Confederaziun svizra — Switzerland

Taiwan Earthquake Model — Taiwan

AFAD Doğal Afet Sigortaları Kurumu — Turkey

NERC Science of the Environment — United Kingdom

USAID From the American People — United States of America

funvisis — Venezuela

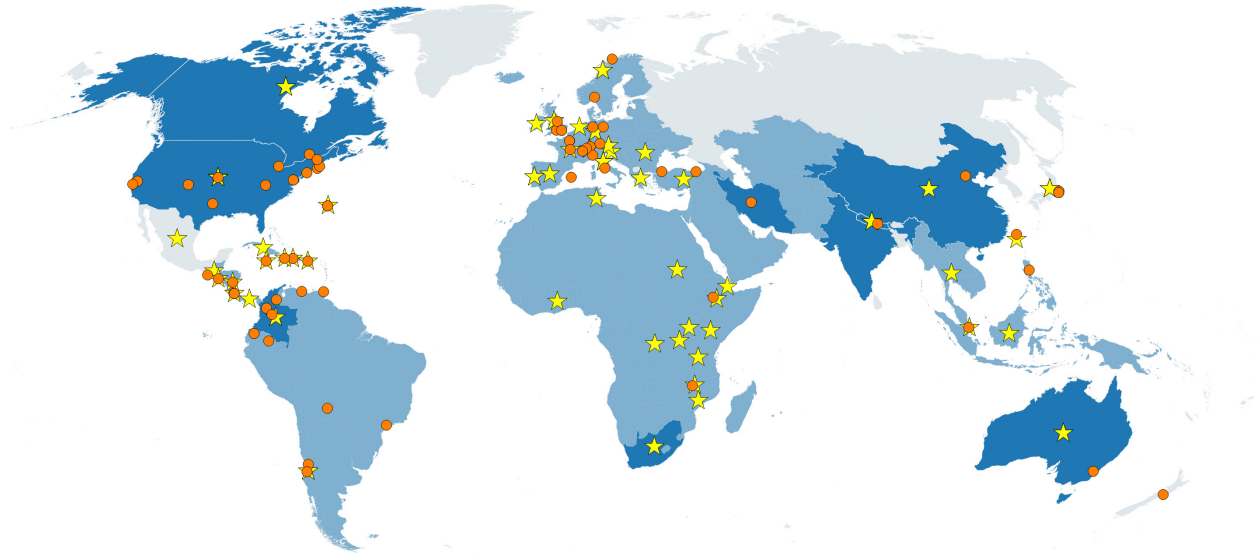
Associates

CSSC, EERI, IAEE, IASPEI, IRDR/ICSU, The Institution of Structural Engineers (ISE), OECD, UNESCO, UNISDR, GFDRR (WB-GFDRR), 100 Resilient Cities (100RC)

WHO WE ARE

GEM At A Glance

GEM works with an international network of experts and regional collaborators to ensure that GEM tools, models and datasets support the creation of earthquake risk reduction strategies that are promoted and utilized by local and international communities. GEM is a unique organization due to its open, collaborative approach, global coverage, and commitment to scientific credibility. GEM is UNISDR's Damir Čemerin 2018 Awardee for its contribution to earthquake hazard and risk reduction efforts globally.



70+

Public, Private partners and collaborators

30+

National and Regional Projects

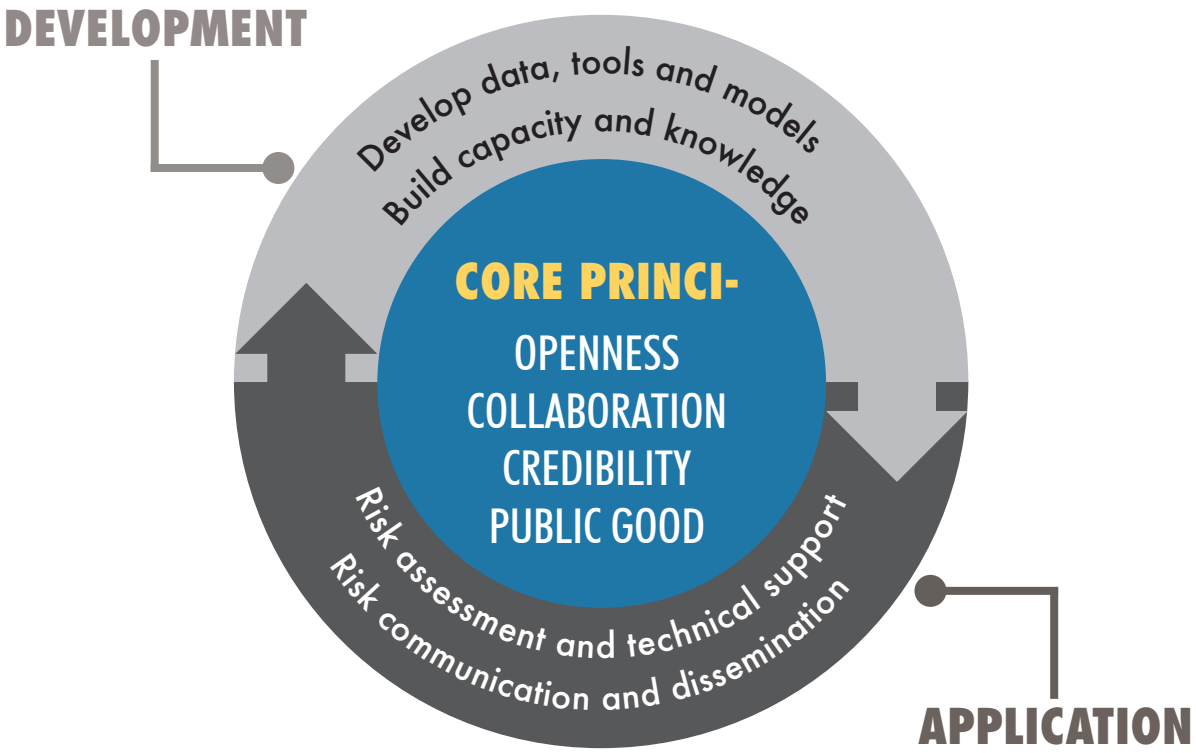
750+

Individuals trained from 90+ countries

FRAMEWORK

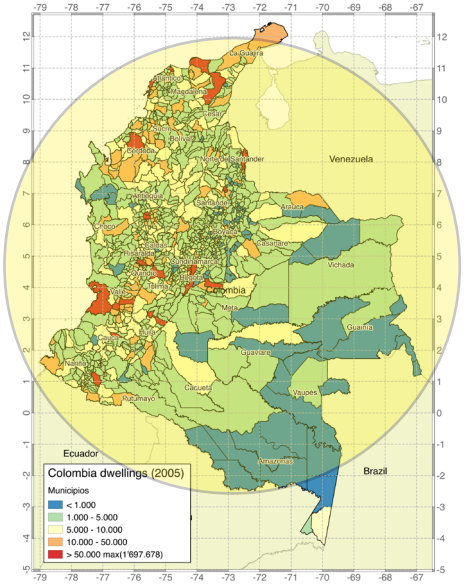
Core Activities and Principles

GEM builds capacity to assess and manage risk through open, transparent and collaborative seismic risk assessment at local, national, regional and global scales. Using state-of-the-art tools, GEM is committed to share and advocate open, reliable earthquake risk information to support sound disaster risk-reduction planning at various levels.



GEM builds risk assessment capacity across academic, public and private sectors using GEM's open data, tools and models.

An exposure model for Colombia, which can support risk reduction managers in the development of risk reduction strategies.

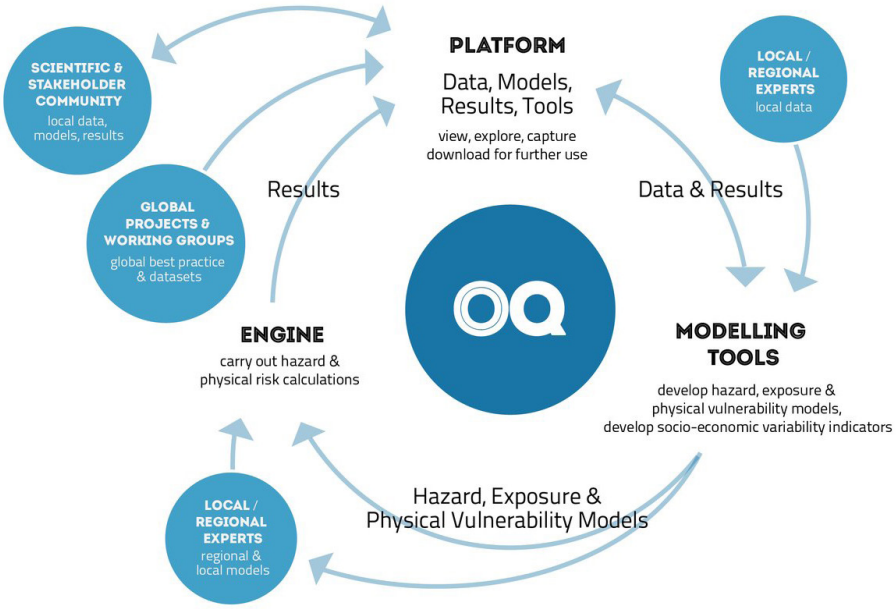


GEM collaborators in Lima, Peru creating a building inventory with GEM's Android and Windows apps. The activity was part of the South America Risk Assessment project in 2015.

OUR WORK

OpenQuake

OpenQuake (OQ) - comprised of the engine, platform, data and tools - caters to a variety of users, from modellers and researchers to emergency planners - OpenQuake is used for a wide range of purposes for disaster risk reduction and management. The OQ engine (https://github.com/gem/oq-engine/#openquake-engine) is a free, open-source software collaboratively developed for the assessment of earthquake hazard and risk.



OpenQuake engine

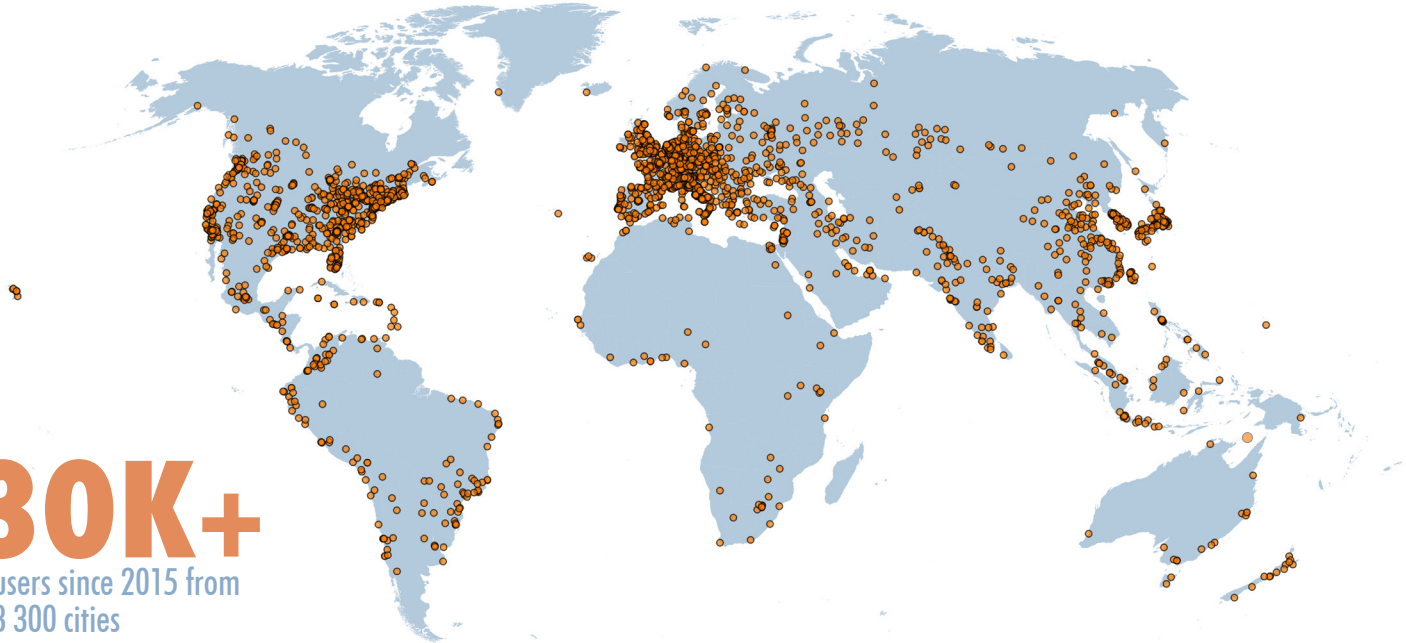
The functionality to analyze hazard and risk at a specific location, city, country or region makes the OpenQuake engine a powerful and dynamic tool for assessing the potential impacts of earthquakes worldwide.

“OpenQuake is a huge effort from GEM. It is recognized as one of the most advanced tools in the world. Because of its transparent nature, you can trace the outputs of your work giving modellers access to how it works – it’s not a ‘black box’.

Jack Baker
Stanford University, USA

OpenQuake platform

The OpenQuake engine is complemented by a wide range of data, information and tools that are accessible on the OpenQuake Platform (https://platform.openquake.org). The OQ Platform enables the community to freely explore, access, manipulate and visualize GEM datasets, models and tools. The platform also allows users to contribute, share and discuss new findings and results with the GEM community.

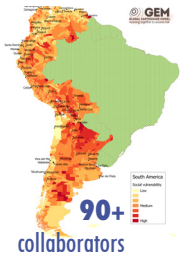


30K+
users since 2015 from 3 300 cities

OUR WORK

Collaborative Projects

GEM successfully implemented risk assessment projects with regional, national and local collaborators covering more than **150 countries** in the following areas: Europe, Middle East, South America, Central America, North America, Sub-Saharan Africa, Asia and the Pacific. (https://www.globalquakemodel.org/projects)



650+ participants

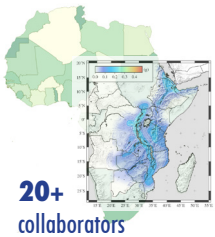
country risk profiles

90+ collaborators

South America Risk Assessment (SARA)

■ Period: 2013-2015 ■ Countries: Argentina, Bolivia, Chile, Colombia, Ecuador, Peru and Venezuela

Description: The objective of the project was to develop an open and uniform seismic hazard model covering the entire continent, and seismic risk profiles for the Andean countries.
Funding partner: Swiss Re Foundation
Collaborators: Geological groups & associations, universities, scientists, engineers, international agencies, municipalities and government agencies



500+ participants

country risk profiles

20+ collaborators

Sub-Saharan Africa Hazard and Risk Assessment (SSAHARA)

■ Period: 2014-2016 ■ Countries: Burundi, Ethiopia, Kenya, Malawi, Mozambique, Rwanda, Tanzania, Uganda

Description: GEM led a program in East Sub-Saharan Africa to develop a uniform and open earthquake hazard and risk model for this region.
Funding partner: United States Agency for International Development (USAID)
Collaborators: African Union, AfricaArray FEPRA – Ethiopia, University of Pennsylvania, Addis Ababa City Government, UNDP Regional Office, international agencies, municipalities and government agencies

320+ participants

country risk profiles

20+ collaborators

Assessing and Mitigating Earthquake Risk in the Caribbean and Central America (CCARA)

■ Period: 2016-2018 ■ Central America and the Caribbean (excluding Cuba)

Description: GEM developed the capacity in the region for earthquake risk assessment using open tools and resources to bridge the gap between risk assessment and disaster risk reduction.
Funding partner: United States Agency for International Development (USAID)
Collaborators: Municipality of San José (Costa Rica), National Commission of Emergencies (CNE), University of Costa Rica (UCR) - Laboratorio Nacional de Materiales y Estructuras (LANAMME), INETER, ONESVIE, ODPEM, BRGM, Bureau des Mines, VT, Geologica UPR Mayaquez, UNI, SRC and UMG

Assessing and Mitigating Earthquake Risk in the Caribbean and Central America final workshop in Santo Domingo, Dominican Republic (2018)

South America Risk Assessment training in Lima, Peru (2015)

Sub-Saharan Africa Hazard and Risk Assessment conference in Addis Ababa, Ethiopia (2014)

OUR WORK

Key Projects - 2015 and Beyond

GEM collaborates with its partners and stakeholders to build the foundation for well-informed disaster risk management through projects that provide technical support and training on the use and application of GEM's tools and methodologies.

Below is a list of GEM's most recent projects implemented in various parts of the world.

Country	End year	Title	Funder	Partners
Global	2021	Modelling Exposure Through Earth Observation Routines (METEOR)	UK Space Agency	BGS, HOT, ImageCat, NSET, DMD Tanzania
Europe	2020	Seismology and Earthquake Engineering Research Infrastructure Alliance for Europe (SERA)	EUCENTRE	EUCENTRE
USA	2019	Monitoring of earthquake risk of buildings using Safehub low cost sensors	GEM, Safehub	Safehub
Global	2019	Collaborative Risk Assessment for Volcanoes and Earthquakes (CRAVE)	USAID	BGS, EOS, Univ. of Edinburgh, VDAP-USGS, SGC, PhiVolcs, Badan Geologi
Canada	2019	A new earthquake risk model for Canada	Aon-Benfield	Canadian Geological Survey, Impact Forecasting
Central Asia, Global	2018	Earthquake Model for Central Asia (EMCA); Testing & Evaluation Facility	GFZ Potsdam/GEM	GFZ Potsdam
Middle East and Asia	2018	Assistance with regional models for Middle East and Asia	SER Switzerland/GEM	ETH Switzerland
New Zealand	2018	New Zealand earthquake risk model and review for Oceania	GNS New Zealand/ GEM	GNS New Zealand
Australia	2018	Modelling critical infrastructure earthquake risk in Perth, Australia	Geoscience Australia/ GEM	Geoscience Australia, Western Power, Main Roads, Water Corporation (Australia)
Philippines	2018	Developing slip rates on faults in the Philippines	Taiwan Earthquake Model (TEM)/GEM	TEM, Phivolcs (Philippines)
Global	2018	GFDRR-DFID – Challenge Funds	GFDRR-DFID	HOT, ImageCat, BGS, UCL, CIMA, Norwegian Geotechnical Institute
Colombia	2018	National seismic hazard model for Colombia	Colombian Geological Survey	
Armenia	2018	Improving Post-Disaster Damage Data Collection to inform Decision Making	World Bank	JBA Consulting, CIMA, Geocom Ltd.
Latin America	2018	Hazard, Exposure and Vulnerability Model for Latin America	Suramericana	
Armenia	2017	Probabilistic Seismic Hazard Assessment for the Republic of Armenia	World Bank	AIR Worldwide, GeoRisk
USA	2017	"Beyond Button Pushing": Probabilistic loss assessment in California	California Seismic Safety Commission	UCLA
USA	2017	"Back to Normal": Earthquake Recovery Modelling	California Seismic Safety Commission	
Global	2017	Open Risk Data Dashboard	GFDRR	CIMA, Deltares
Kyrgyzstan Republic	2017	Measuring seismic risk in the Kyrgyz Republic	World Bank-GFDRR	Arup, GFZ Potsdam, CAIAG

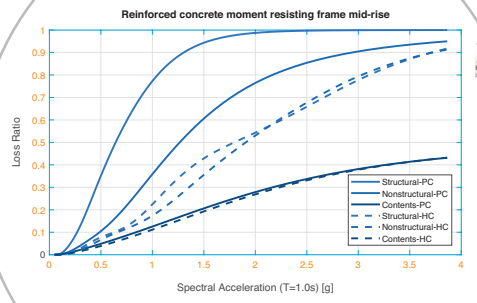
OUR WORK

Global Earthquake Model 2018

The development of the Global Earthquake Hazard and Risk Model was a key priority for GEM under its 2014-2018 Work Program. The objective is to collaboratively develop a complete set of earthquake data and models, and to deliver a comprehensive global assessment of earthquake risk. The current version of the global maps is available at https://www.globalquakemodel.org/gem.

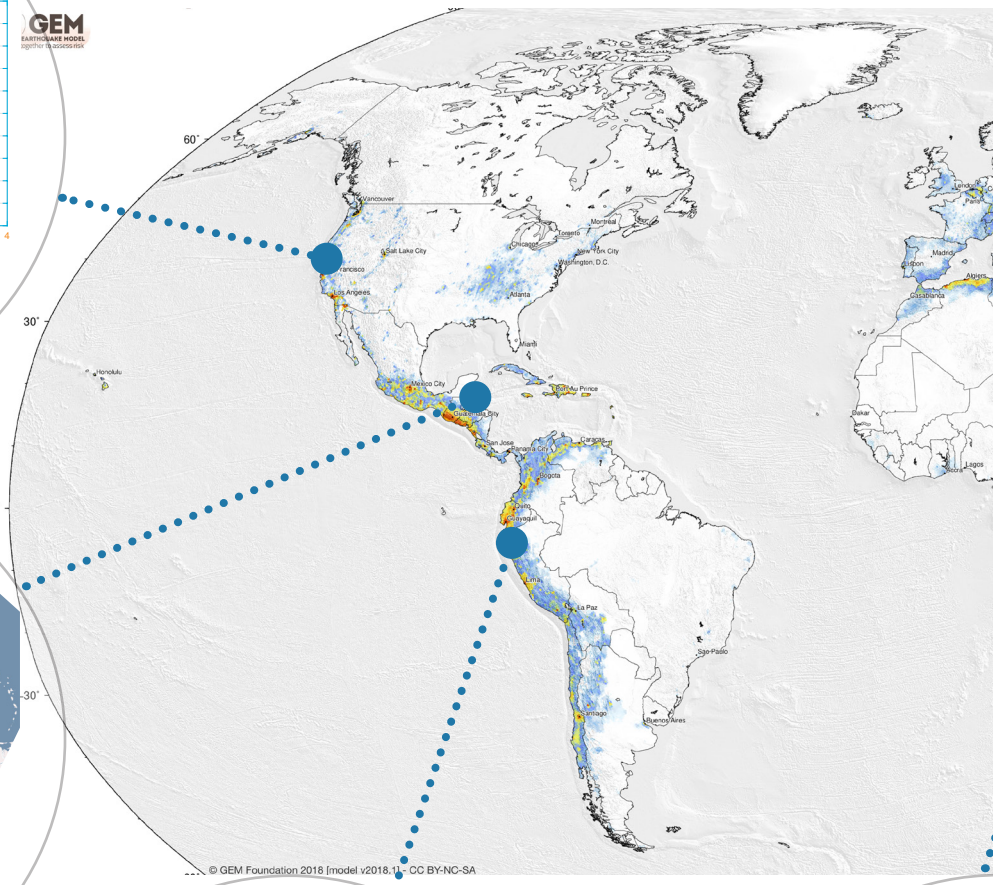
Snapshot of the Glob

Vulnerability



Example of California Vulnerability curve (pre-code vs high-code) for Structural, Nonstructural and Contents

AREAS COVERED BY GLOB



Hazard

Central America & the Caribbean model developed through the CCARA project

Risk

Andean Region Risk model developed through the SARA project

Social Vulnerabilit

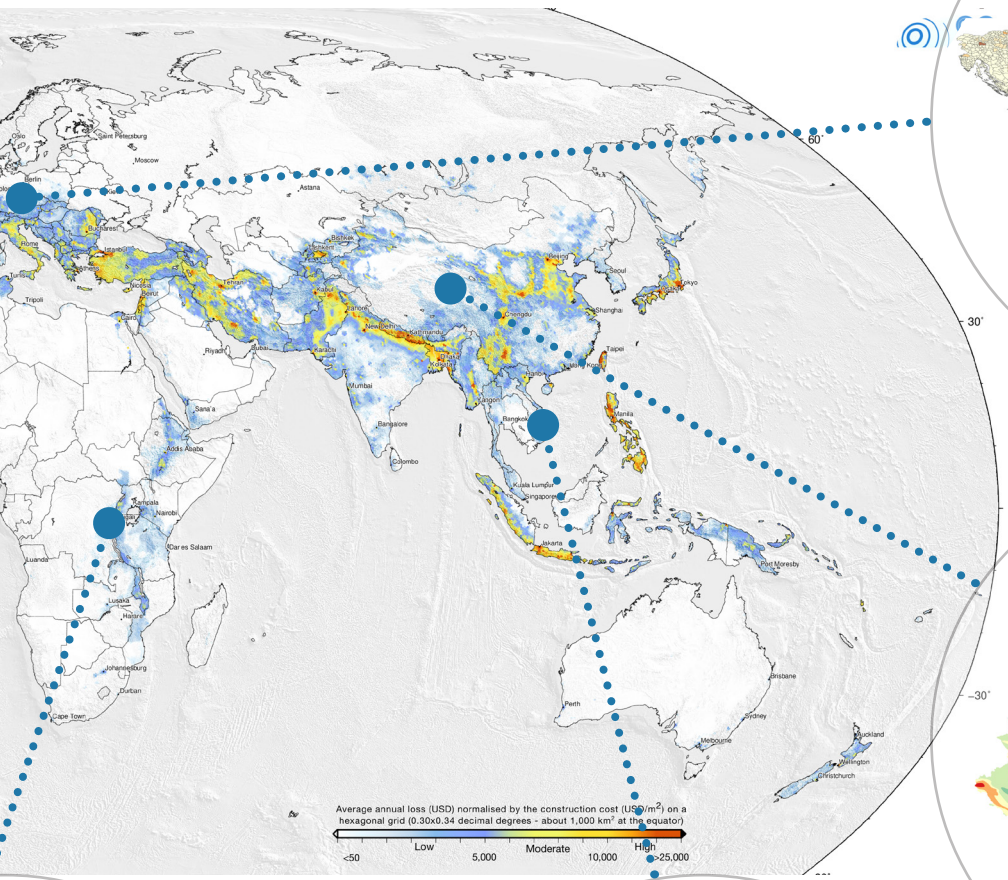
East Africa model develo through the SSAHARA pr

The resulting maps support a wide range of disaster risk management purposes, including (re)insurance pricing and risk transfer, emergency response, recovery, and planning in support of the Sendai Framework for DRR at subnational, national and regional scales.

This initiative was funded by GEM public and private sponsors, and benefitted as well from in-kind contributions and project funding from local, national and government agencies, universities, research institutions, non-government organizations, and international institutions and aid agencies. In 2019, GEM is releasing publicly the underlying hazard and risk models under an open license.

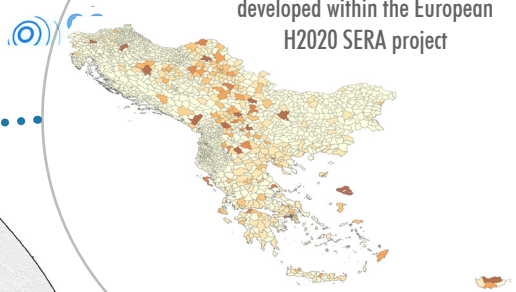
al Earthquake Model layers

BAL EARTHQUAKE MODEL



Exposure

Exposure data for the Balkans developed within the European H2020 SERA project

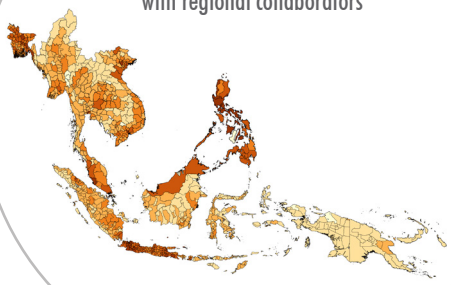


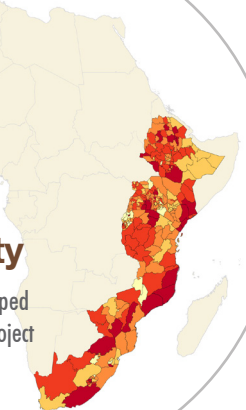
Hazard

China national hazard model ported into the OpenQuake engine through a collaboration with the China Earthquake Administration

Exposure

Southeast Asia Risk model developed with regional collaborators





GEM IMPACT

From Knowledge to Application

GEM strives to deliver lasting effects on the ground in the form of reduced earthquake risk and improved earthquake risk management at local and national levels. Scientifically robust, open, transparent and accessible earthquake hazard and risk analysis tools and models combined with collaborative capacity development are key to achieving a world that is resilient to earthquakes.
(https://www.globalquakemodel.org/gem-impact)

25K+ OpenQuake platform users from **156** countries since 2015

"

OpenQuake and the ISC-GEM catalog were used in countless presentations at the 2017 Fall AGU meeting in New Orleans. Really fantastic impact on the research community, raising the bar on seismic risk assessment; it was great.

Ross Stein
CEO & Cofounder, Temblor, Inc. USA

- OpenQuake engine, supporting tools and web platform
- Databases for earthquakes, exposure, faultlines
- Seismic risk models at various scales
- Global earthquake risk model

Global Earthquake Model

covering **240+** countries

10+ global seismic risk databases

1000+ fragility curves

150+ publications

Outputs & Products

Technical Activities

- Seismic risk assessment tools development
- Seismic risk data collection and standardization
- Seismic risk model development at local, national, regional and global scales

20+ open computational tools and global databases for earthquake hazard, vulnerability and exposure highlighted by the **OpenQuake (OQ)** analysis engine.

"

In ARUP, we really value sharing and collaboration, so for us, GEM is a natural fit. ARUP supports GEM's mission - to share information and promote the use of open tools more widely through collaboration.

Katherine Coates
ARUP, UK

"

GEM has been highly successful in mobilising support and cooperation for achieving its goal of producing a global map of seismic hazard and risk. At the time of writing, no other special interest group has been anything like as successful in producing global hazard and risk maps.

Edmund Booth
The Institution of Structural Engineers

Delivery Mechanisms

- Capacity development through OpenQuake tools training, technical support and assistance

550+ trained in seismic risk assessment using OpenQuake in **90+** countries since 2014

- Local, national, regional and global seismic risk projects implementation

30+ local, national, regional and global seismic risk assessment projects covering **150+** countries

- Data and information sharing through the OpenQuake web platform and GEM website

70K+ website and platform users from **180+** countries since 2015

We are particularly impressed by GEM's collaborative, interactive approach in working with its stakeholders, and are proud to support GEM in their goal of worldwide earthquake resilience.

Paul Della Marta
PartnerRe, Head of Catastrophe Research

Global earthquake resilience.

Safer communities.

IMPACT

- National government agencies
- Municipalities and cities
- Insurance & reinsurance companies
- CAT modellers
- Engineering companies
- Universities
- International agencies
- Energy companies

20+
Government agencies using OQ and GEM resources to develop or revise national hazard maps

20+
Insurance and reinsurance companies using OQ, GEM resources and technical services to enhance in-house capabilities in seismic risk assessment

Immediate Beneficiaries

GEM has successfully developed a 21st century seismic risk assessment software – OpenQuake, and addressed the challenges of global database standards for risk assessment.

Kelvin Berryman
GNS Science, New Zealand

GEM's earthquake resilience performance scorecard methodology has been used in Lalitpur as inputs for the building code process. We are keen to move forward and to further use the scorecard method in the future.

Surya Shrestha
National Society for Earthquake Technology, Nepal

Outcomes


Enhanced global understanding of earthquake risk


Improved, standardized and more accessible information for disaster management


Improved information for insurance pricing


Improved skills in scientific seismic risk assessment

GEM is a groundbreaking initiative. From the scientific perspective, I am impressed with the extent and level of development of the tools such as OpenQuake.

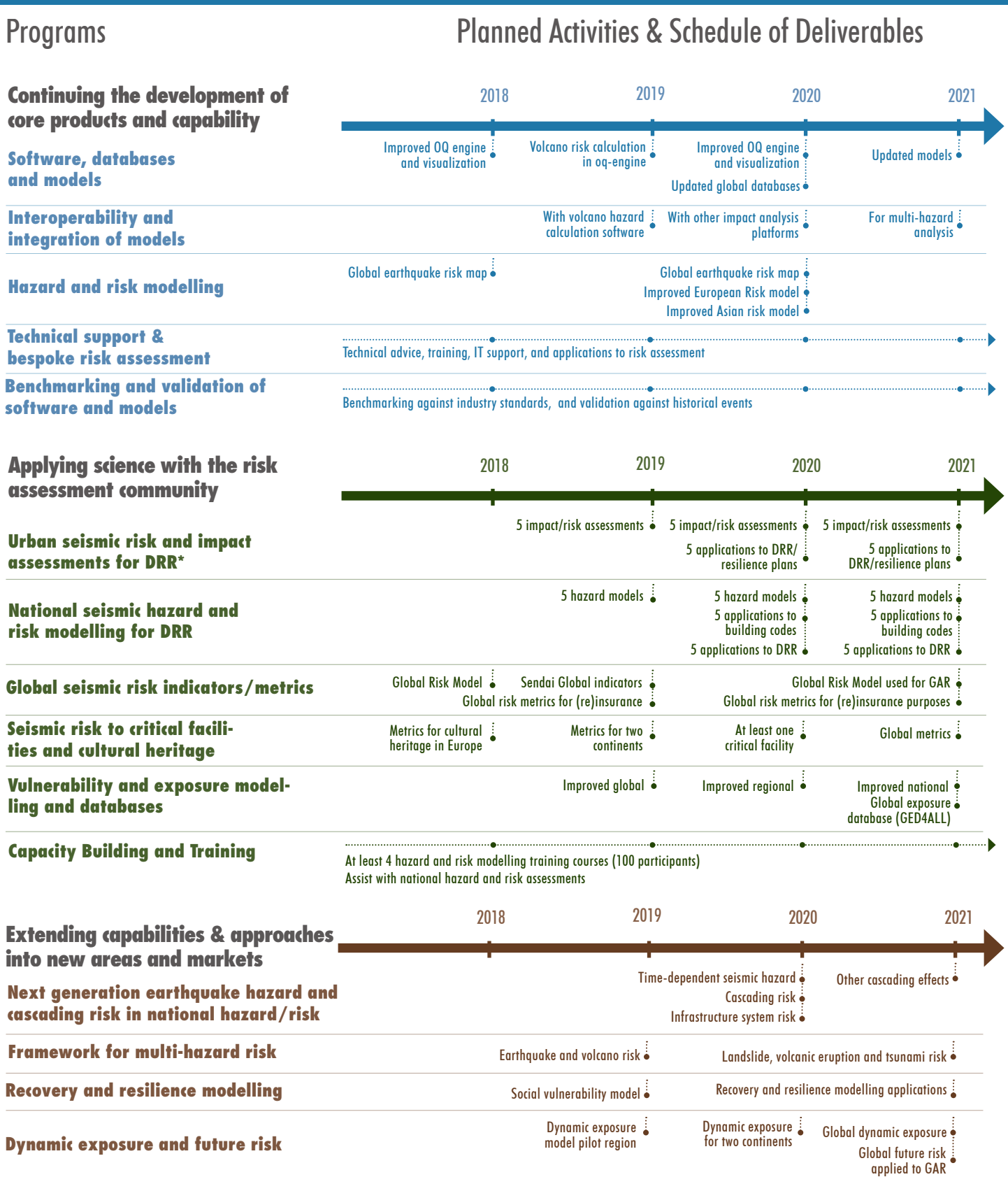
Rosa Sobradelo
Willis Towers Watson, UK

Our partnership with GEM expanded in-house expertise on earthquake risk and strengthened our overall internal and external risk management processes. We hope to continue this productive collaboration in the years to come.

Jörg Steffensen
Hannover Re - Group Risk Management Modelling

FUTURE WORK

GEM will continue to focus on the development of models and tools for earthquake risk assessment, and on their application at global, regional, national and local levels. Key activities will include improving the OpenQuake engine and its supporting tools and databases, and strengthening our capacity building and user support program. GEM will also extend its activities to address more complex risk issues, and will collaborate more extensively with other communities to make OpenQuake tools and models useful for multi-hazard risk assessment. (https://www.globalquakemodel.org/future-work)



*disaster risk reduction

HOW TO JOIN

GEM offers flexible mechanisms to enable potential partners to contribute to its ongoing and future work programs. Partners and collaborators may enter into sponsorships, project partnerships and service agreements, and may select the level of engagement based on their needs and requirements.
(https://www.globalquakemodel.org/get-involved)

GEM's new sponsorship structure and fees have been designed to incentivize greater participation of public and private organizations. Private organizations may become Governor sponsors for less than half the previous annual fees and returning Governor sponsors may qualify for further reductions. New and returning Public Governors may propose to contribute directly to the work program via an in-kind project to offset the *GERD-based sponsorship contribution.

Sponsor Types and Contributions

2013-2018 program		2018 - onwards			
Sponsor Type	Minimum contribution (k EUR)	Sponsor Type	Minimum Contribution (k EUR)	Voting Rights	Attends GB Meetings & Events
Public Participant	Based on GERD	Public Governor	As 2013-2018 program	Yes	Yes
Governor (returning)	100	Returning Governor	60-80**	Yes	Yes
Governor (new)	250	New Governor	100	Yes	Yes
Advisor	60	Advisor	75	No	Yes
Patron	50	Patron	30	No	No

**80K EUR for those returning from either 2009-2013 program or 2013-2018 program; 60K if returning from both WP1 and WP2.

Contribution Levels based on GERD

*Gross Domestic Expenditure on Research and Development (GERD) (current PPP $)	Annual GEM contribution
GERD > $50,000 million	□275,000
$50,000 m > GERD > $25,000 m	□170,000
$25,000 m > GERD > $10,000 m	□100,000
$10,000 m > GERD > $2,000 m	□70,000
$2,000 m > GERD > $1,000 m	□30,000
GERD < $1,000 m	□15,000

*Public Governor minimum contribution levels based on GERD

For more information on how to join GEM, please contact us at join@globalquakemodel.org.

JOIN US

GEM has implemented a framework for developing and sharing information and tools for analyzing earthquake hazard and risk, and a collective ownership of the process, which has resulted in a common understanding of the risk and a will to act on it.

Though GEM products are important and play an important role in risk reduction, they do not possess the power to further advance GEM's vision. That power lies in GEM's motivation and commitment to serve the public good in a collaborative, inclusive, credible and transparent way.

Join us now in promoting open data and tools and support risk information sharing on publicly accessible platforms.

GEM OpenQuake training in Medellin, Colombia (June 2017)