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.

A world that is resilient to earthquakes

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 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 Team and Partners

GEM Secretariat staff with the Governing Board members, December 2017

2009-2019 Sponsors

Private sponsors

Public sponsors

Associates
WHO WE ARE

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 Cemerin 2018 Awardee for its contribution to earthquake hazard and risk reduction efforts globally.

GEM At A Glance

70+ Public, Private partners and collaborators
30+ National and Regional Projects
750+ Individuals trained from 90+ countries
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.

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

GEM collaborates with academic, public and private sectors using GEM’s open data, tools and models.

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.
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

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](https://www.globalquakemodel.org/projects))

**Collaborative Projects**

**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

**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 FEPR — Ethiopia, University of Pennsylvania, Addis Ababa City Government, UNDP Regional Office, international agencies, municipalities and government agencies

**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 Mayaguez, 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)
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.

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

**Vulnerability**

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

**Hazard**

Central America & the Caribbean model developed through the CCARA project

**Risk**

Andean Region Risk model developed through the SARA project

**Social Vulnerability**

East Africa model developed through the SSAHARA project

**AREAS COVERED BY GLOBAL EARTHQUAKE MODEL**

- **Hazard**
  - Central America & the Caribbean model developed through the CCARA project

- **Risk**
  - Andean Region Risk model developed through the SARA project

- **Social Vulnerability**
  - East Africa model developed through the SSAHARA project
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.
GEM IMPACT

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)

From Knowledge to Application

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

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

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.

Outputs & Products

25K+ OpenQuake platform users from 156 countries since 2015

Global Earthquake Model

covering 240+ countries

10+ global seismic risk databases

1000+ fragility curves

150+ publications

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
Immediate Beneficiaries

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

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

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

Global earthquake resilience.
Safer communities.

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

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

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

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
**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](https://www.globalquakemodel.org/future-work))

*Planned Activities & Schedule of Deliverables*

**Continuing the development of core products and capability**

**Software, databases and models**

- **2018**: Improved OQ engine and visualization
- **2019**: Volcano risk calculation in OQ-engine
- **2020**: Improved OQ engine and visualization
- **2021**: Updated global databases

**Interoperability and integration of models**

- **2018**: With volcano hazard calculation software
- **2019**: With other impact analysis platforms
- **2020**: For multi-hazard analysis

**Hazard and risk modelling**

- **2018**: Global earthquake risk map
- **2019**: Global earthquake risk map
- **2020**: Improved European Risk model
- **2021**: Improved Asian risk model

**Technical support & bespoke risk assessment**

- **2018**: Technical advice, training, IT support, and applications to risk assessment
- **2019**: Technical advice, training, IT support, and applications to risk assessment
- **2020**: Technical advice, training, IT support, and applications to risk assessment
- **2021**: Technical advice, training, IT support, and applications to risk assessment

**Benchmarking and validation of software and models**

- **2018**: Benchmarking against industry standards, and validation against historical events
- **2019**: Benchmarking against industry standards, and validation against historical events
- **2020**: Benchmarking against industry standards, and validation against historical events
- **2021**: Benchmarking against industry standards, and validation against historical events

**Applying science with the risk assessment community**

**Urban seismic risk and impact assessments for DRR**

- **2018**: 5 impact/risk assessments
- **2019**: 5 impact/risk assessments
- **2020**: 5 impact/risk assessments
- **2021**: 5 impact/risk assessments

**National seismic hazard and risk modelling for DRR**

- **2018**: 5 hazard models
- **2019**: 5 hazard models
- **2020**: 5 hazard models
- **2021**: 5 hazard models

**Global seismic risk indicators/metrics**

- **2018**: Global Risk Model
- **2019**: Sendai Global indicators
- **2020**: Global Risk Model for (re)insurance purposes
- **2021**: Global Risk Model for (re)insurance purposes

**Seismic risk to critical facilities and cultural heritage**

- **2018**: Metrics for cultural heritage in Europe
- **2019**: Metrics for two continents
- **2020**: At least one critical facility
- **2021**: Global metrics

**Vulnerability and exposure modelling and databases**

- **2018**: Improved global
- **2019**: Improved regional
- **2020**: Improved national
- **2021**: Global exposure database (GED4ALL)

**Capacity Building and Training**

- **2018**: At least 4 hazard and risk modelling training courses (100 participants)
- **2019**: Assist with national hazard and risk assessments
- **2020**: Assist with national hazard and risk assessments
- **2021**: Assist with national hazard and risk assessments

**Extending capabilities & approaches into new areas and markets**

**Next generation earthquake hazard and cascading risk in national hazard/risk**

- **2018**: Time-dependent seismic hazard
- **2019**: Cascading risk
- **2020**: Infrastructure system risk
- **2021**: Other cascading effects

**Framework for multi-hazard risk**

- **2018**: Earthquake and volcano risk
- **2019**: Landslide, volcanic eruption and tsunami risk
- **2020**: Recovery and resilience modelling applications

**Recovery and resilience modelling**

- **2018**: Social vulnerability model
- **2019**: Recovery and resilience modelling applications

**Dynamic exposure and future risk**

- **2018**: Dynamic exposure model pilot region
- **2019**: Dynamic exposure for two continents
- **2020**: Global dynamic exposure
- **2021**: Global future risk applied to GAR

*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 sponsorship structure and fees have been designed to incentivize participation of public and private organizations. 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 (2020 onwards)

<table>
<thead>
<tr>
<th>Sponsor Type</th>
<th>Minimum Contribution (k EUR)</th>
<th>Voting Rights</th>
<th>Attends GB Meetings &amp; Events</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public Governor</td>
<td>See GERD</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Governor</td>
<td>100</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Advisor</td>
<td>75</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Patron</td>
<td>30</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

### Contribution Levels based on GERD

<table>
<thead>
<tr>
<th>*Gross Domestic Expenditure on Research and Development (GERD) (current PPP $)</th>
<th>Annual GEM contribution (euro)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GERD &gt; $50,000 million</td>
<td>275,000</td>
</tr>
<tr>
<td>$50,000 m &gt; GERD &gt; $25,000 m</td>
<td>170,000</td>
</tr>
<tr>
<td>$25,000 m &gt; GERD &gt; $10,000 m</td>
<td>100,000</td>
</tr>
<tr>
<td>$10,000 m &gt; GERD &gt; $2,000 m</td>
<td>70,000</td>
</tr>
<tr>
<td>$2,000 m &gt; GERD &gt; $1,000 m</td>
<td>30,000</td>
</tr>
<tr>
<td>GERD &lt; $1,000 m</td>
<td>15,000</td>
</tr>
</tbody>
</table>

*Public Governor minimum contribution levels based on GERD

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