

Achievements, Lessons, Opportunities and Challenges

GEM Foundation 2009-2014

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Based on a paper that is forthcoming in a special edition of Planet@RISK written by Nicole Keller and John Schneider: "Working together to assess risk from global to local: lessons from the Global Earthquake Model"

Executive Summary

Reliable, high-quality risk assessment is the basis for an objective understanding of risk; priority 1 of the proposed post-2015 framework for disaster risk reduction. It is the foundation of decisions and actions that effectively build resilience. Earthquake risk continues to rise, yet reliable data, risk information, and assessment tools are out of reach or under-utilised in many areas of the world. The Global Earthquake Model (GEM Foundation) was created to bridge these critical gaps. Through authentic collaboration across public and private stakeholders, the GEM community supports risk management and awareness by developing and implementing open risk assessment tools, compiling and generating risk information. GEM influences risk reduction by promoting technology transfer and developing risk assessment capacity. All GEM risk assessment resources are made freely available through its web-based OpenQuake platform.

This document provides an overview of GEM's achievements to date, lessons learnt - emphasizing effective modes of collaboration and capacity development -, and presents opportunities and challenges in going forward.

1. Achievements

Almost ten years ago GEM founders started the process of creating an initiative that would assemble and develop global knowledge on earthquake risk¹. In 2009, the GEM Foundation was incorporated as a public-private partnership to facilitate a global collaborative effort named GEM (Global Earthquake Model) to develop open tools and resources for advanced earthquake risk assessment worldwide. Mainly due to population growth and ill-planned construction, earthquake risk continues to increase, especially in developing countries. Although the science of modeling earthquake hazard and risk had evolved, little of that knowledge was accessible to organisations and individuals around the globe to effectively inform disaster risk reduction decisions.

1.1. Shaping GEM

Under the auspices of the OECD Global Science Forum, the GEM Foundation was founded in Pavia, Italy, where a Secretary General heads a technical-administrative Secretariat. The foundation is governed by its public and private participants; currently 35 participants or sponsors take seat in the Governing Board. 11 private sponsors from mainly the insurance and engineering sector; 16 public sponsors representing mainly national governments or agencies responsible for earthquake hazard/risk assessment; and 8 associate sponsors from international organisations which include professional societies, the UN, World Bank, and others with global interests in understanding and/or reducing earthquake and other natural hazard risk. The public and private sponsors provide financial support and make strategic decisions, while associate sponsors do not provide funds, but provide guidance and assist the foundation through their network and knowledge. A Science Board of renowned experts in GEM-related disciplines oversees the effort from a scientific/technical point of

¹ See also <http://www.globalquakemodel.org/gem/organisation/history/>

view.

GEM is setting a precedent in the field of DRR by bringing together key sectors in a collaborative governance framework for inclusive disaster risk assessment²: scientific and technical experts, the private sector, public agencies, international organisations and non-governmental organisations.

Four guiding principles were defined to guide the effort going forward:

- **Collaborative:** Bringing people across sectors, geographies and disciplines together to work on development, testing, application and information sharing.
- **Open:** Providing open access to data, methods and results, develop all (modeling) software open-source, but also having transparent processes and facilitate debate, knowledge and information sharing.
- **Credible:** Ensuring a high quality of products, in collaboration with the international science community, testing products and providing quality control mechanisms.
- **Public Good:** Developing a platform for exploring risk, accessing products and sharing information, facilitating application for risk reduction.

1.2. Achievements

GEM has created credible and transparent risk information:

- More than 300 experts in earthquake hazard and risk assessment and related disciplines have been involved in the development of datasets, methodologies and tools through collaborative, international projects.
- The collaborative OpenQuake platform which launches in January 2015 allows organisations and individuals worldwide to access, explore and enhance a wide variety of resources, enabling them to carry out cutting-edge risk assessment, and to share their information with a broad community.
- After a six-year development phase, GEM resources comprise:
 - Eight global uniform datasets: a historical catalogue and archive, an instrumental catalogue, a database of active faults, a database and model of geodetic strain rate and tectonic regionalisation, a global exposure database, a database on earthquake consequences and a socio-economic database.
 - There are best practice guidelines, for example on estimating ground motion/shaking from earthquakes, building classification and exposure data capture
 - A full spectrum of risk assessment tools ranging from crowdsourcing apps for building inventory assessment to tools for community-based resilience measurement.
 - Hazard and risk assessments and other risk information for many parts of the world.

Most importantly, all of this information is enabled through the OpenQuake Engine, a state-of-the-art software for hazard and risk modeling and the OpenQuake Platform, which is freely accessible.

² Taken from Ortwin Renn; see: <http://www.slideshare.net/GRFDavos/resilience-davos-2012-renn>

GEM PRODUCTS FOR DISASTER RISK REDUCTION

To improve earthquake resilience, GEM is developing collaborative products and resources that can be used by organisations and individuals worldwide. They allow for transparent, accessible, credible and actionable risk assessment in **CALM TIMES**, but can also be used for applications that focus on response and recovery

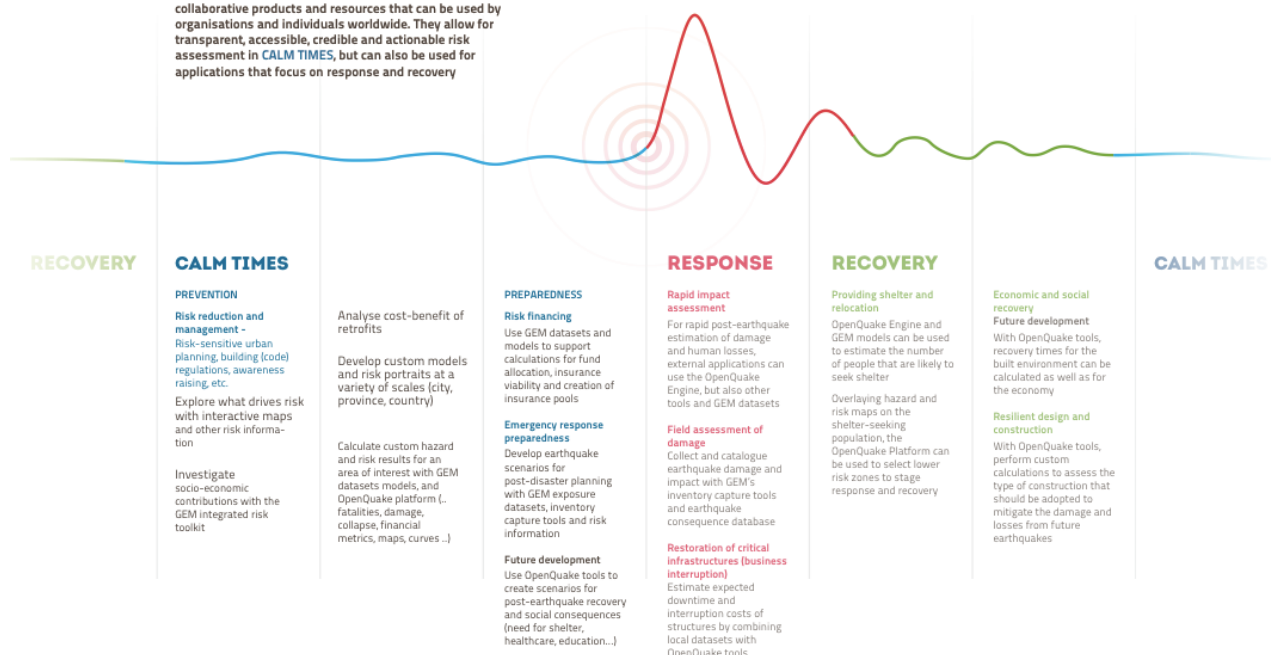


Figure 1: An overview of how different GEM products can be used for disaster risk reduction

The GEM Foundation is transforming collaborative risk assessment from an idea into a tangible effort to strengthen earthquake resilience across the globe:

- The collaborative GEM effort comprises a growing number of organisations and individuals from the scientific community, private sector (in particular insurance and engineering), data providers, public agencies working on urban planning, finance and disaster risk management, international / development agencies, regulators and standards organisations as well as NGOs and compatible programmes. Its core is the GEM Foundation.
- The GEM Foundation is fostering relations and collaborations with programmes and projects on hazard and risk assessment in over 10 regions of the world. Collaborations with programmes in Europe, the Middle East and Central Asia have resulted in state-of-the-art models and information that can be shared with the community. A GEM-led programme in South America and soon to be in sub-Saharan Africa are major collaborative opportunities in these regions. Workshops, meetings and exchange of knowledge, data and information throughout the world have led to enrichment of GEM resources as well as the building of a global community. Many activities in regions have in turn led to transfer of knowledge and technology on the tools and resources, methods and approaches.
- More than 550 experts have participated in workshops and trainings globally, with the goal to put tools and knowledge in the hands of local experts.
- The tools and resources that have already been released are being used in many different ways. Two examples: 1) In Ecuador, scientists have used the OpenQuake Engine to develop a national hazard model, which is now being considered as a basis for the country's new building code³ 2) In Lalitpur, Nepal, GEM brought together local policymakers for the first time in 12 years, to assess the resilience of their city with GEM's risk and resilience scorecard tool, which has contributed to the creation of disaster risk management committees both at the ward and the municipal level.⁴

³ <http://www.globalquakemodel.org/gem/mission/stories/tools/building-safer-ecuador/>

⁴ LSMC (2014, forthcoming) Participatory Evaluation of Earthquake Risk and Resilience in Lalitpur Sub Metropolitan City

2. Lessons

2.1 *The public and private sector have similar goals and are stronger when working together*

GEM's most notable success in operating as a public-private partnership has been to unify diverse perspectives under a common interest; *credible, accessible risk information that is widely used and understood*. During Governing Board meetings, public and private sector representatives share perspectives drawn from diverse interests and experience to find common ground and integrated solutions that are necessary to forge the way forward for GEM.

2.2 *A collaborative approach is worth the investment*

Many programmes and organisations that are goal-oriented adopt a top-down approach. Fundamental to the GEM Foundation is the partnership between public and the private sectors, and the development of synergies between local professionals and international experts. Taking such a collaborative approach is time and resource intensive, but has great value. It engenders ownership, it creates knowledge, and most importantly gives rise to a community of champions and users around the globe. Examples of the value collaborative approaches bring include: an improved understanding of earthquake safety level of typical structures in Medellin, Colombia by bringing scientists, engineers and local government representatives together; a more accurate understanding of global earthquake history, by investing in an effort of international and local scientists, sharing knowledge and data on hundreds of events.

2.3 *Flexibility and compromise are needed*

Over the course of the past six years it has become clear that partners need to compromise. For example, "Open data" and "open software" have been viewed in different ways, with division between public and private sponsors over distribution of products under free or commercial licenses. Lacking clear precedence or guidance elsewhere, a special task force of the Governing Board was formed to develop a path forward that would be acceptable to the majority of public and private participants. In general, because GEM is a multi-stakeholder effort, working with many types of organisations from all parts of the world, it is important to be flexible and adjust to changing circumstances, whilst assuring progress is made.

2.4 *Leadership and internal communication are key*

Exactly because GEM is a multi-stakeholder effort, it is important that there is strong leadership. Many individuals with different roles from the GEM community have opinions on priorities and future directions for activities and policies. Experienced individuals in the Secretariat, the Science Board and the Governing Board are critical to guide the initiative. In particular, a key to success has been the ability to build at the Secretariat an international team of energetic individuals that are committed to the cause, where scientists work together with engineers and programmers on the technical side, and, in turn, with administration, communication and business development professionals.

2.5 *Together you can really make a difference*

When GEM was conceived, the goal was to fill critical gaps in earthquake risk assessment capability and access to risk information. However it was perceived by some as primarily a research programme for earthquake scientists and engineers; and although there was also interest to go "beyond physical risk"; it took quite some time and perseverance of many collaborators to make that happen. The GEM Foundation is now a tangible reality that is

making a real impact; not only at the global level, but also at the local level, in particular because of the work on tools, methods and data for socio-economic vulnerability and resilience assessment. The collaborative work of hundreds of individuals and organisations is slowly starting to be used by a global community, and other organisations have started to build applications on top of these tools and resources. GEM takes pride in being able to serve as an example and to contribute to other global efforts in the fields of natural hazards resilience, and because of its recognition as major player in the field of earthquake risk understanding, GEM is honored to be invited to major events such as the OECD High Level Risk Forum.



Figure 2: Governing Board members from private and public organisations and Science Board members discussing GEM's road ahead with Secretariat employees, representatives of international organisations and renowned members of the scientific community: working together to advance the effort.

3. Opportunities and Challenges

3.1 Global collaboration and knowledge from the crowd

Tapping into the knowledge and information from millions of people provides a huge opportunity. The more detailed and reliable the data that is available, the better the risk information derived from it, both pre- and post-earthquake. GEM has developed its databases and taken an approach to product licensing that encourages and supports contributions from the broader community. In addition, by providing mechanisms to capture such data, people can contribute and advance knowledge together. The global exposure database for example was designed to incorporate data at 4 levels of geography, from national to building-by-building, and therefore provides a basis for local data to be accessed globally and for global or national data to be used locally in the absence of detailed information. A major investment was also made into the development of data capture tools that enable investigators to gather and contribute information about buildings and other infrastructure. Similarly, geologists are enabled to incorporate information about active

faults into a global dataset with common formats, and to use tools to put this information into a form needed for earthquake hazard analysis. And as stated before, there are many more datasets that will soon be available, together with guidelines and applications on how to develop and apply the information they contain. Together, these products and the collaborative framework within in which they are managed, provide a global system for building and sharing earthquake hazard and risk information.

3.2 Empowerment

Risk reduction and resilience building takes place locally, yet many governmental agencies, companies and other organisations do not have access to reliable, transparent tools and resources that their professionals can use to assess earthquake risk and to produce actionable information. Through GEM's focus on high-quality, open tools and resources in combination with technology transfer and training, professionals are empowered to carry out risk assessment themselves, and governments and organisations will need to rely less on external expertise and advice.

3.3 Investing in risk upfront

Quantitative estimates of the potential for future losses is essential to building a strong case for investing in retrofitting, urban planning, insurance pooling and many more measures which will help to reduce loss of life, as well as economic, cultural and environmental loss. Having tools and resources for anyone to access provides a huge opportunity to understand investment decisions as well as cost-effective options to mitigate or transfer risk and/or to build resilience.

3.4 Social and Economic Vulnerability, and Resilience

By including socioeconomic metrics of vulnerability and resilience in risk assessments, we can understand, manage, and eventually reduce risk more effectively. At present the ability to measure socioeconomic vulnerabilities to disasters is very limited. GEM has invested in the development of tools and resources, which provides an important step forward as well as an opportunity for others to build upon. GEM has developed a flexible, user-driven method for estimating socio-economic vulnerability and resilience. The user can elect to adopt a pre-defined set of parameters and values, or can use (modeling) tools to define a unique set for use in a particular context. The approach emphasizes the need for tools and methodologies that users themselves can shape and develop into specific models, recognising that there are many ways to express social vulnerability and resilience, depending on the social and geographic context. For measuring and understanding resilience in areas where data are lacking, or where it is possible or desirable to have local decision makers and managers directly participating, a “bottom-up” and participatory approach has been developed which is centered around a scorecard. Building upon the six elements of the HFA¹ and the UNISDR's *10 Essentials for Making Cities Resilient*⁵, the risk and resilience scorecard is a multilevel and multi-scale self-evaluation tool that empowers stakeholders to quantitatively assess risk and resilience parameters based on qualitatively derived information.

3.5 Openness and transparency

The GEM Foundation has established a collaborative framework that encourages and supports openness and transparency at all stages of development. Data used to form

⁵ See UNISDR, *Hyogo Framework for Action 2005–2015: Building the Resilience of Nations and Communities to Disasters* (Geneva: UNISDR, 2007), <http://www.unisdr.org/hfa>; and UNISDR, “The 10 Essentials for Making Cities Resilient,” <http://www.unisdr.org/campaign/resilientcities/toolkit/essentials>.

models are obtained from free and open sources; databases are developed through collaboration and consensus of a broad range of experts to assure maximum credibility; software is developed through an open and accessible platform; results are licensed using Creative Commons, assuring that data and models that are released openly remain open in derivative products.

3.6 Where science meets risk modeling and application for DRR

Catastrophe risk modeling has been developing for several decades. Initially developed for the insurance market, nowadays also governmental agencies and scientists use hazard and risk models. In response to the increasing availability of higher-resolution data and powerful computers, models are becoming more complex, which is making it more and more difficult for users to understand and apply them. Today, commercial risk models are largely 'black boxes', where the inner-workings and assumptions are known in detail only by the developers. The GEM Foundation is committed to opening up the black boxes and to facilitate their use outside the insurance sector. Transparent and open models that are grounded in state-of-the-art science are needed to make credible information available and accessible to all that have a stake in risk reduction.

3.7 Enhancing technical capacity

Advanced risk assessment is complex and multi-faceted. Even when the tools and resources are available, a big challenge lies in the need to enhance or develop technical capacity. Growing and fostering technical capacity requires long-term investment in teaching and training hazard and risk experts, with a special focus on capacity development in emerging and developing regions of the world. Examples include:

- Funding and facilitation of PhD and post-docs on advanced hazard and risk assessment
- Funding of training programmes
- Incorporation of risk assessment and managements elements in Master and PhD programmes related to architecture, engineering, urban planning and others.

3.8 Connecting expertise with policy and business needs

Even when technical capacity exists, an important challenge is to find ways for experts to work together with policymakers as well as companies and non-profit organisations to reduce risk. Only by working together will cultural issues be overcome, and will the trust be generated that is required to develop solutions for a city, vulnerable group or nation.

4. Conclusion

Thanks to its community of hundreds of individuals and organisations worldwide, the GEM public-private partnership is now a tangible reality upon which people, governments, companies and other organisations can build.

Major achievements include the creation of open and transparent resource such as OpenQuake, a global earthquake risk computational platform, and 8 global uniform databases. Achievements also include turning collaborative risk assessment into a reality, resulting in the following value that GEM Foundation can offer the community worldwide:

- Access to transparent, high-quality risk assessment tools and necessary technical support
- Access to high-quality earthquake risk data and information in standardised formats
- Access to capacity development tools and mechanisms
- Access to an international network of key players in the field of earthquake risk assessment and management
- The opportunity to contribute effectively to the understanding of earthquake risk as a first step towards its reduction and proper management

Over the past years, the GEM Foundation has learnt valuable lessons that could be helpful for others in the disaster risk management community. These comprise lessons about the importance of collaborative approaches, of organisational leadership and flexibility to progress a complex multi-faceted effort like GEM. There are many opportunities going forward; in leveraging the knowledge of the crowd, in fostering open data and open source approaches and in integrated risk assessment, whereby measures of social and economic vulnerability and resilience are combined with physical risk estimates to obtain a holistic understanding of earthquake risk to society. Major challenges lie in growing and enhancing the technical capacity for earthquake risk assessment, in particular in at risk societies situated in low-income regions and in connecting decision-makers and scientists to jointly find solutions to the complex challenge of earthquake risk and safeguarding populations from earthquakes.

With the release of the OpenQuake Platform and suite of tools and resources in January 2015, the GEM public-private partnership is now a tangible reality upon which individuals and organisations can build to organically grow the understanding of earthquake risk, the first pillar of the post-2015 framework for DRR.