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A Collaborative Global Effort

The Global Earthquake Model, GEM, envisions and has embarked on the bringing together of state-of-the-art science and national, regional, international organisations as well as individuals, in a global collaborative effort that will have a lasting impact on seismic risk assessment.

By functioning as a true **community effort, involving hundreds of organisations and individuals**, GEM aims to produce a state-of-the-art, dynamic and openly accessible model for the assessment of seismic risk worldwide, featuring not only the computation of the probability of earthquakes occurring and inducing damage to buildings and houses, but also methods and tools for analysing impacts of earthquakes on economy and society.

The model and its tools are aimed at a wide group of prospective users and beneficiaries and are to s include features that support the work of all those working and deciding on risk resilience and mitigation.

By 2013, GEM stakeholders from around the globe will be able to access the OpenGEM web platform to analyse seismic risk, including the consequences of earthquakes on society and economy.

Recent events have taught us that we need to learn more about the earth and its behaviour, and how that impacts us. Knowledge sharing and collaboration on a global scale is therefore of critical **importance**: open discussion and debate is needed, so that collectively we improve our knowledge on earthquake hazard and risk and come up with tools that are able to capture that growing body of knowledge and support mitigation activities and can extend datasets in areas currently less covered. We can then test the tools and models together, compare them with national and regional models, with existing tools, and make improvements where possible.

More than **250 organisations and thousands of individuals** are already involved in GEM. As the effort continues, ever-more individuals, organisations and governments will be included, so that we can continiously improve the model and its applications for stakeholders around the globe.

Global models, databases and methods

Around 200 collaborators from more than 50 renowned institutions are working in 1 different projects on the development and definitions of the models, databasases and methods that will form the core of the 'GEM model'. There are 5 projects related to Hazard, 5 related to Risk and 1 to Socio-Economic Impact and they are listed below. New RfPs are incidentally released, filling essential research gaps.

Through interaction with Regional Programmes, the findings and proposals of the 'Global' Component' projects will be adjusted to regional variances and completed with more detailed regional data. A collaboration platform is currently being developed, allowinga wider community of experts and non-experts to follow and comment on these activities.

Building up a global earthquake history [1000-1903]; a database of parametric entries. Development of a global, uniform instrumental catalogue [1900-2009].

Creation of global database of active faults and seismic sources, and development of tools assisting scientists in uploading of fault data into the database.

Development of a harmonized suite of ground-motion prediction equations.

Creation of a comprehensive and uniform model for geodetic strain rates.

Development of a GEM Ontology and Taxonomy.

Creation of an open homogenized database of global building stock and population distribution. Creation of a structure to assemble and store earthquake consequence data (damage to buildings, lifelines, infrastructure, casualties, social disruption, financial and economic loss, etc.) in a web-accessible way. Development & deployment of tools to capture and transfer of high-resolution inventory or damage data Development of global vulnerability estimation methods.

Methods (tools, indicators, models) for assessing, estimating and communicating the social and economic impacts of earthquakes, whereby also supporting decisions and choices on mitigation actions.



Technical Capacity Building, Knowledge Transfer, and Skills Development in Earthquake Hazard and Risk Assessment Nicole Keller (1), Florian Haslinger (2) and Marco Pagani (1) - (1) GEM Foundation, Eucentre, Pavia, Italy (2) Swiss Seismological Service, ETH Zurich, Switzerland



Capitalising on regional knowledge and strengthening regional capacity



Developing a global model can only be done with full involvement of all regions of this globe. Collaboration preferably takes place through Regional Programmes (RPs): independently-run programmes closely linked to GEM, focused on hazard, risk or socio-economic impact, or a combination of these. RPs involve local experts using GEM software and tools that generate local data and validate the methods and standards that are being created on a global level. They hereby ensure that regional needs and characteristics are adequately accounted for. Five GEM Regional Programmes are currently operative:

- In Europe there are 3 RPs linking to GEM: SHARE, SYNER-G and NERA, covering the entire continent and in some cases also the Maghreb countries. EMME is a large RP in the Middle East region (plus Pakistan and Azerbedijan) on seismic hazard and risk. EMME furthermore has a specific module on megacities.
- In **Central Asia** the hazard/risk programme EMCA recently took off, covering 5 Central-Asian countries.

- In Africa, the framework for a RP is in place, combining the 2 sub-regions of North and sub-Saharan Africa. A workshop is being held in North-Africa in May 2011.
- In the **Caribbean**, a GEM Operations Manager is organising a workshop in May 2011 for definition of a RP in the region.
- In South-East Asia/Pacific, workshops have been held and are planned, bringing together organisations from many countries to discuss hazard and risk.
- An Operations Manager has been active in **South America** since 2010, enlarging the GEM network and researching available datasets and models.
- There are close ties with the CAPRA programme in **Central America**.
- In South Asia links have been established with the majority of institutions in the field of hazard and risk assessment, especially in India.
- With the many contacts GEM has in the region, first explorations have been made for definition of one or more RPs in North-East Asia.

For many of the tools and software, regional experts will be the primary users, technology transfer and capacity building activities are important to improve their take-up and application within the regions. Regional workshops will be organised over the next years, and training modules will become available. GEM tools and software are to benefit individuals around the globe, also those with no specific expertise or knowledge of seismic risk. In collaboration with partners, such as UN/ISDR, OECD and The World Bank, appropriate mechnanisms are to be put in place. Case studies will furthermore be carried out for the application of OpenGEM, with a view to explore how tools can be used (best) to support risk mitigation.





OpenGEM: open access to a state-of-the-art seismic risk assessment platform

After only18 months, GEM demonstrated that calculations could be performed on a global scale, following the proof-of-concept calculations carried out within the GEM1 pilot project, hereby laying the foundation for the development of the **OpenGEM seismic risk-assessment platform**.

- Ready in 2013, OpenGEM will allow users with different needs and with varying levels of expertise to assess seismic risk information on local, national and regional scale.
- By accessing OpenGEM, users can browse maps, indicators and other outputs in order to analyse earthquake risk and to get information about possible implications of decisions, experts users can carry out calculations using GEM data or using own data. All users will be connected in a network, so they can discuss their assessments, learn from each other, and improve the GEM model and tools.
- There are different scenarios of use of OpenGEM, as has been displayed in the image.
- OpenGEM will be powered by the **open source OpenQuake software**, which is currently developed in the open, so that a wider community of experts and developers can contribute and stakeholders can start testing it. The software is incrementally being improved and expanded with features.
- The current OpenQuake version 0.3 is a 'development' release without user interface, but already contains a Classical PSHA-based risk calculator and a Probabilistic event-based calculator. It can can produce hazard curves and maps, as well as loss curves and maps. Visit www.openquake.org.
- From June 2011, a first **user interface** will be ready, allowing demonstration of the OpenQuake capabilities. From then on, step-by-step features will be added to the interface. First features will be aimed at GEM collaborators, allowing them to use OpenQuake when developing the GEM model. Final interface(s) will be ready in 2013.

GEM's mission is to engage a global community in the design, development of state-of-the-art models and tools for earthquake risk assessment worldwide.

In the other regions, RPs are being prepared, links are being established and research is carried out as to what existing data is present in the region. GEM Operations Managers are coordinating these activities in a number of regions. In total more than a 100 insitutions in the regions are involved in GEM.

Serving stakeholders, creating synergy

Buildina capacity in the context of GEM has many dimensions. Synergy is created when they are combined, leading to a more sustainable impact on earthquake risk assessment, in order to serve stakeholders best:

Ensuring openess and transparancy

As methods and standards are being developed they will be shared through an open web-based collaboration platform, allowing the wider community to comment and rate. Such collaboration platform will hence become a body of knowledge on earthquake risk assessment from which experts worldwide can benefit. It will also be used to host training material, videos and tutorials.

Databases and the raw datasets upon which they are based will be open access to the extent possible; tools and software are being developed as open source.

Thinking 'multi-hazard'; ensuring that the work carried out can be used by others GEM's collaborative open-source development IT infrastructure, described above, has been developed in such manner that it is multi-hazard by nature, and because it is developed in the open, other initiatives can use (pieces of) it. The core engine can hence easily be expanded to include also other hazards. Furthermore GEM's components on socio-economic impact and exposure are appliccable to all hazards.

Creating an active GEM user network As is visualised above, GEM envisages a vivid user-community of the OpenGEM platform. They are connected through a user network and can share output, discuss outcomes and jointly build up a body of knowledge that will help to improve both the model and the tools and of course individual and common understanding of earthquake risk (assessment).





GEM MAIN FEATURES

Global coverage

The model will feature global and regional coverage, and include where possible currently less covered/monitored areas. Technology transfer will be an integral part of GEM, to support use of the model around the globe.

State-of-the-art

Leading experts in all relevant disciplines are working on development of an innovative model, incorporating the latest developments in science and technology, and develop standards that are applicable and accepted around the world.

Community-based

The model will be consensual, accepted and actually used, because a wide community involved in designing and developing GEM's software and tools, and in collecting the main data of this model which is therefore owned by the public and trusted.

Open access

Risk information must be broadly available in order to cater for the adoption of risk-mitigation behaviour. GEM will deliver open-source software, transparent tools and global datasets that are accessible to different users around the world.

Public/private partnership

GEM combines the strengths and objectives of both the public and the private sectors and ensures hereby that its output will serve a variety of stakeholder groups.

Serving users

To ensure that the model will serve the needs of all possible users, from the general public to decision makers, risk will be communicated in an effective manner through intuitive interfaces. User needs assessment exercises and case studies are carried out to ensure that GEM can be effectively used to support risk

A comprehensive tool

The global earthquake risk model will not only cover earthquake hazard and earthquake risk (exposure and vulnerability), but also allow for assessment of impacts of seismic events on society and economy, on different timescales: short term (relief), medium term (reconstruction and recovery) and long term (risk reduction and mitigation).

Dynamic

GEM is producing an updatable, modular and flexible model that users can plug their own data into, that is able to communicate risk through various types of outputs (customisable maps, graphs, tables) and allows for sharing of data, output and

Application beyond GEM

GEM's software is built in such a way that it is expandable to other perils. Moreover, through modular construction, GEM will collaborate with other initiatives, organisations and individuals on software modules that have an application that goes beyond GEM or even risk assessment alone.