

# International collaboration within the hazard component of the Global Earthquake Model

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working together to assess risk

**GLOBAL EARTHQUAKE MODEL**

# Presentation outline



- ▶ Possible ways for establishing international scientific collaboration in seismic hazard
- ▶ Some examples from the GEM experience



*“Although scientific practice still invokes images of the ‘lone, long-haired genius, mouldering in an attic or basement workshop...motivated by the flame burning within him’ (Price, 1963, p. 3), scientific knowledge creation is increasingly dependent on collaborative efforts”*

Hoekman et al. (2009)

# GEM a global collaborative effort

GEM

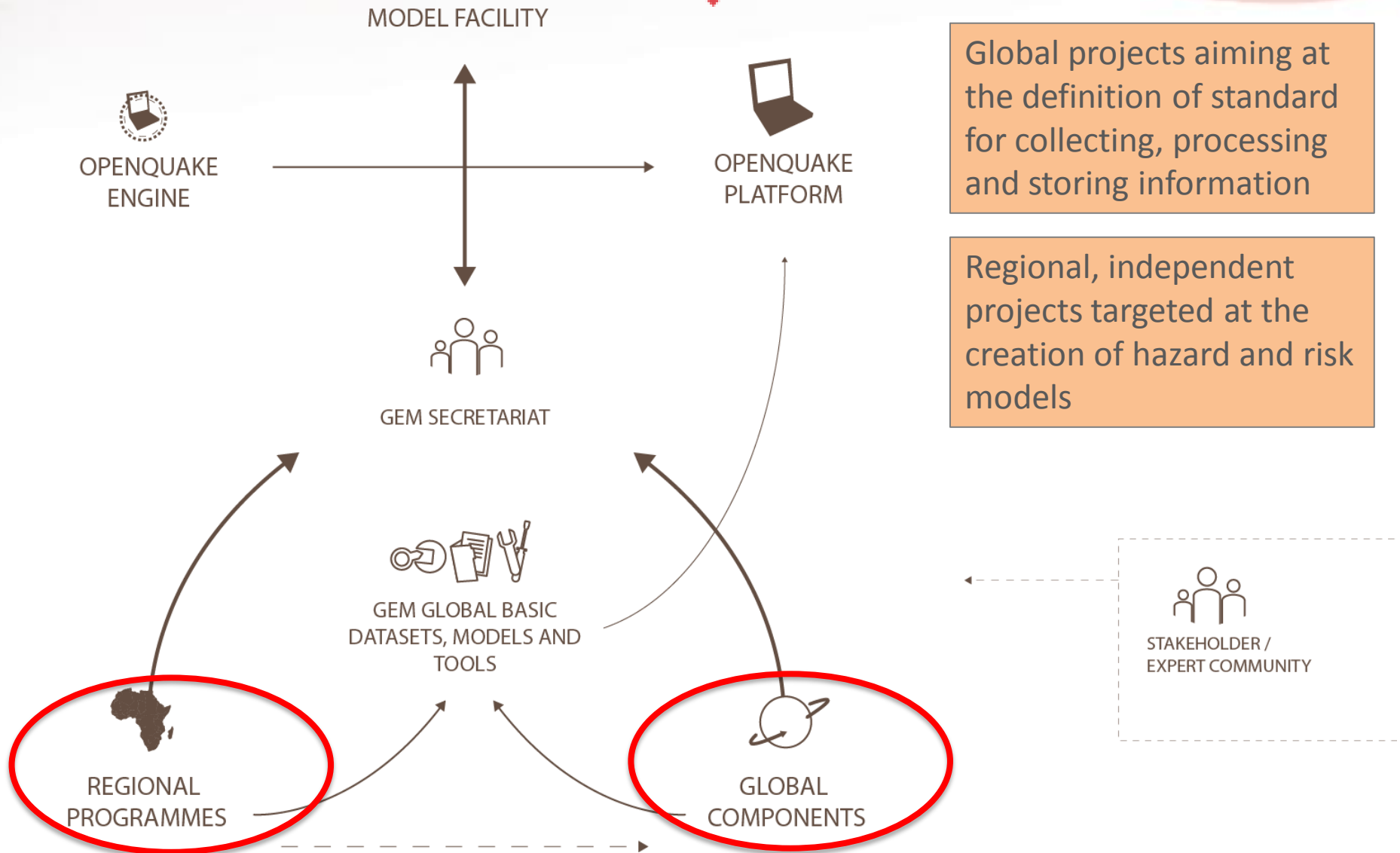


“A collaborative effort devised and launched by OECD’s Global Science Forum, aimed at **engaging the global community** in the transparent design, development and deployment of uniform open standards and tools for earthquake risk assessment worldwide”



- ▶ Combining the strengths, knowledge and needs of public and private sectors
- ▶ Currently 10 corporates, 15 nations or national organizations, 8 international organizations

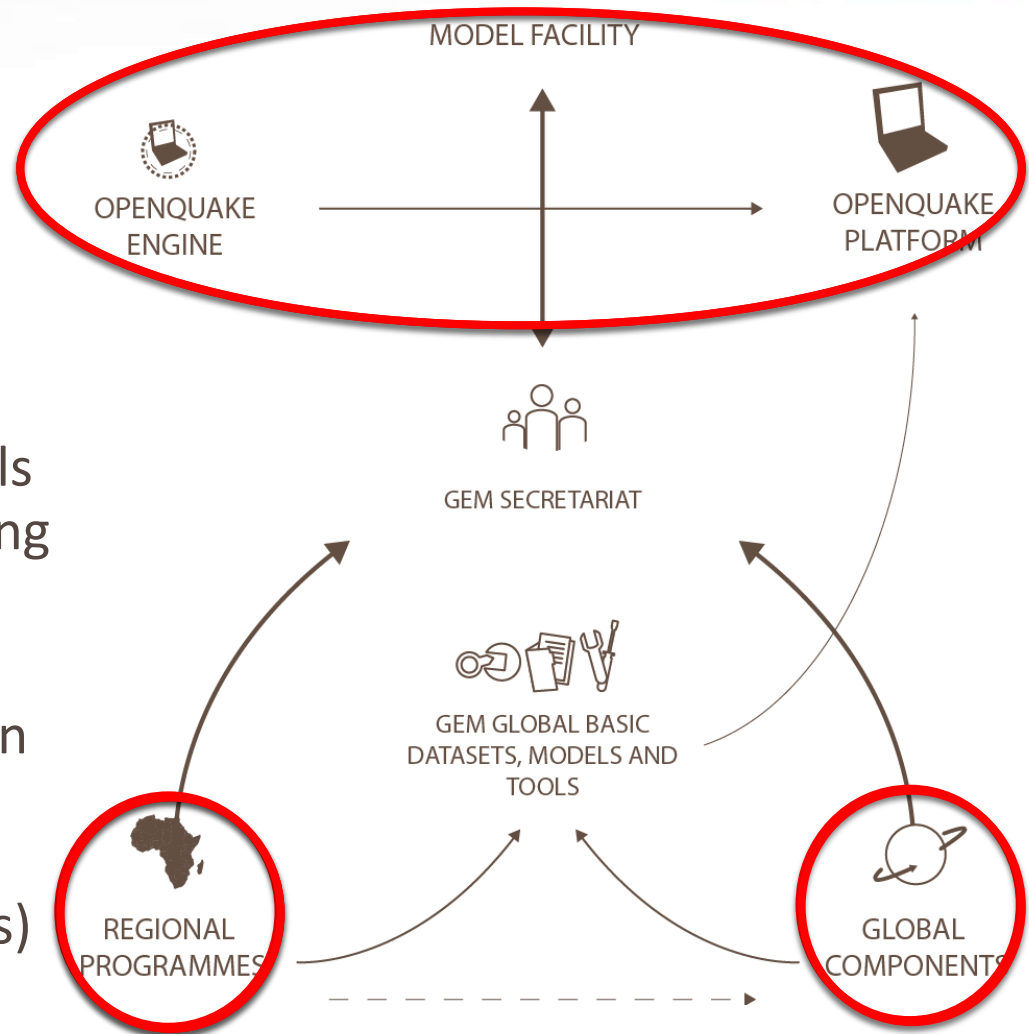
# GEM a global collaborative effort



# Collaboration schemes

Possible alternatives:

- ▶ Creation of harmonised databases (e.g. federated seismic networks, fault databases)
- ▶ Development of new methodologies and/or tools (e.g. methods for integrating crustal deformation into PSHA)
- ▶ Design and implementation of PSHA models (e.g. development of a harmonised hazard models)



# Collaboration needs

## Main preconditions:

- ▶ Talk the same language. From a scientific point of view this means:
  - Contribute to standards for representing the basic information
  - Share methods and tools for model building and hazard calculation
- ▶ Discuss openly!



# Global Components



# Global Instrumental Earthquake Catalogue



What is it?

- ▶ A global catalogue of earthquakes containing about 25.000 events occurred in the period between AD 1900 and 2009.
  - In the interval 1900-1917 the catalogue comprises events with magnitude greater or equal to 7.5;
  - from 1918 until 1959 it has events with magnitude greater of equal to 6.25 and,
  - from 1960 on the catalogue includes earthquakes with magnitude equal or greater than 5.5.

# Global Instrumental Earthquake Catalogue



What are the special features:

- ▶ This catalogue is composed of earthquakes with homogeneous locations and magnitude estimates, determined using the same tools and techniques to the extent possible.
- ▶ The magnitude determination and location procedures applied represent a synthesis of state-of-the-art methods.
- ▶ Each event has a  $M_W$  value (with related uncertainty) based on seismic moment where possible (mainly for events that occurred between 1976-2009) and where not, empirical relations between  $M_W$  and  $M_S/m_b$  are used to obtain proxy values of moment magnitude.

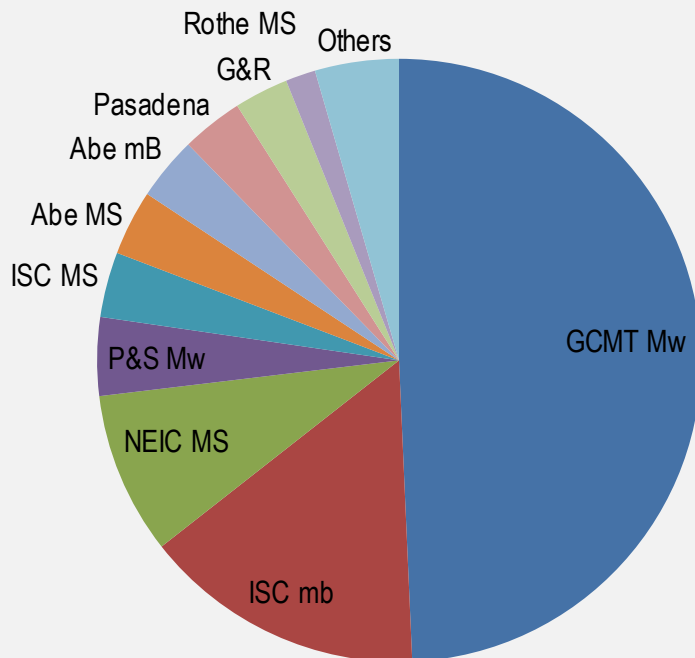
# Global Instrumental Earthquake Catalogue



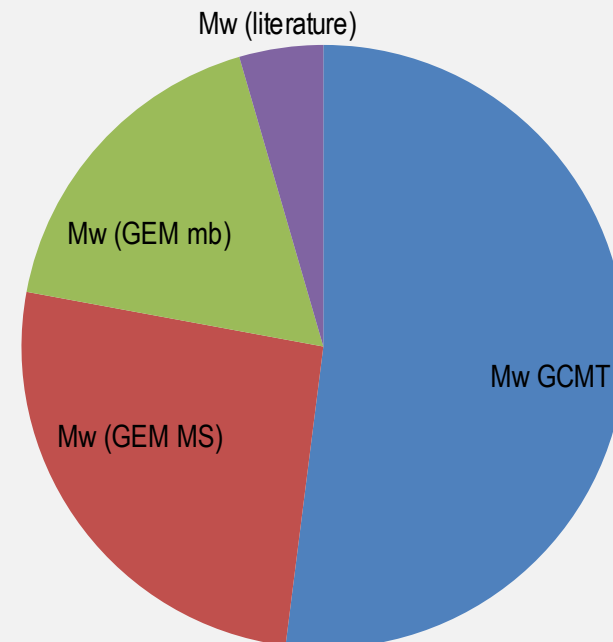
What are the special features:

- ▶ The majority of events in the pre-1971 period have their  $M_S$  magnitudes computed systematically from the surface wave amplitude measurements recovered from the historical paper-based seismic station bulletins.
- ▶ These  $M_S$  magnitudes were never available before and are the result of a massive data entry effort carried out within the scope of this project.

In **Centennial** Catalogue, magnitudes have been compiled from different authors and scales



In **GEM** Catalogue, magnitudes have been recomputed from original amplitudes and periods and then, where necessary, converted to Mw.



Uncertainties and quality of magnitude determinations is given in **GEM** Catalogue

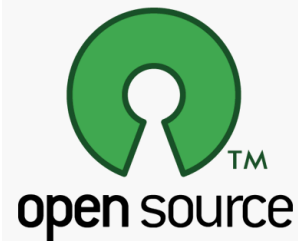
Development of new  
methodologies and/or tools

# OpenQuake Hazard Tools

GEM



- ▶ *Openquake-hazard*: a module in the OpenQuake-engine dedicated to Seismic Hazard Analysis (Openquake-engine is an open source project of the Global Earthquake Model)
- ▶ *Openquake-modeller*: a suite of tools for PSHA input model preparation e.g. catalogue processing, seismicity recurrence calculation



Open Source code. Available at the following address:

<http://github.com/gem>

# OpenQuake Hazard Tools

# GEM



nhlib/nhlib/calc/gmf.py at master · gem/nhlib · GitHub

github.com/gem/nhlib/blob/master/nhlib/calc/gmf.py

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PUBLIC **gem / nhlib** Pull Request Unwatch Unstar 12 Fork 10

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**nhlib / nhlib / calc / gmf.py** 887 commits

**angri** August 29, 2012 correlation: factored applying correlation to model class from gmf calc

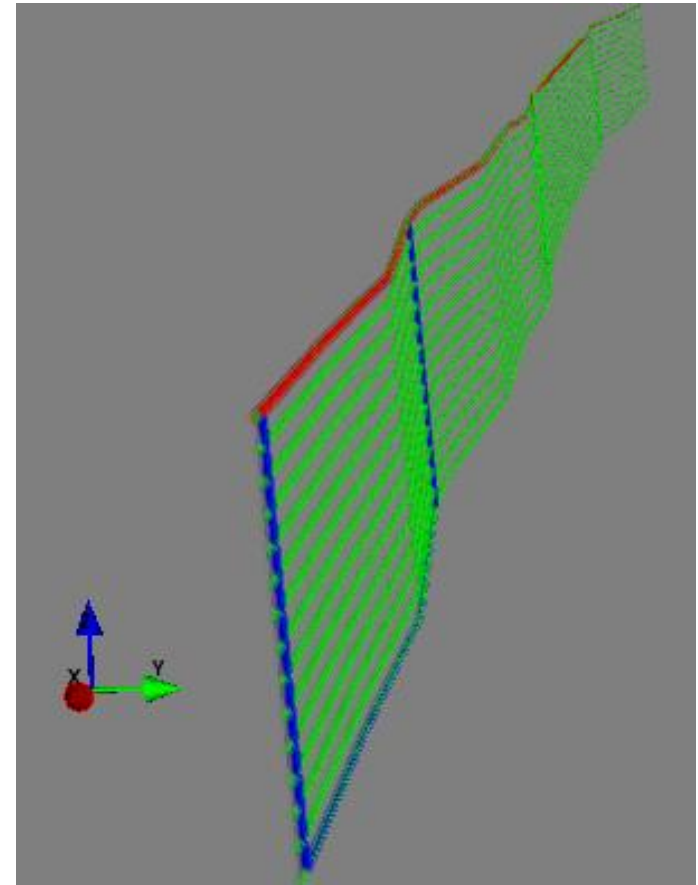
1 contributor

file | 118 lines (103 sloc) | 5.061 kb Edit Raw Blame History

```
1 # nhlib: A New Hazard Library
2 # Copyright (C) 2012 GEM Foundation
3 #
4 # This program is free software: you can redistribute it and/or modify
5 # it under the terms of the GNU Affero General Public License as
6 # published by the Free Software Foundation, either version 3 of the
7 # License, or (at your option) any later version.
8 #
9 # This program is distributed in the hope that it will be useful,
10 # but WITHOUT ANY WARRANTY; without even the implied warranty of
11 # MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the
12 # GNU Affero General Public License for more details.
13 #
14 # You should have received a copy of the GNU Affero General Public License
15 # along with this program. If not, see <http://www.gnu.org/licenses/>.
16 """
17 Module :mod:`~nhlib.calc.gmf` exports :func:`ground_motion_fields`.
18 """
```



- ▶ The main functionalities of OpenQuake-engine are:
  - Earthquake Rupture Forecast creation for different tectonic regimes (e.g. active shallow crust, stable continental regions, subduction)
  - Calculate hazard considering spatially variable site conditions
  - Stochastic Event Set generation
  - Ground Motion fields calculation (eventually accounting for spatial correlation)
  - Supports logic trees
  - Seismic hazard disaggregation





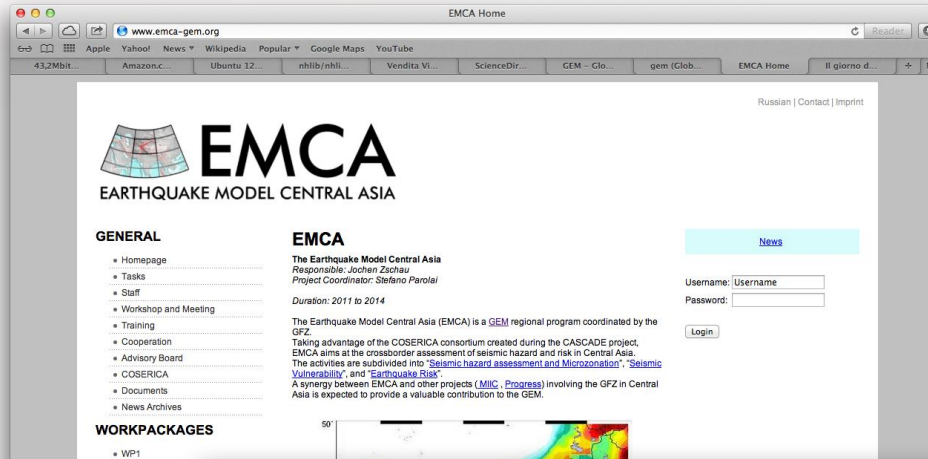
# OpenQuake Hazard Tools



- ▶ OpenQuake-engine used for calculation in most of the currently active regional programmes: SHARE, EMME and EMCA
- ▶ Training workshops (completed and planned) in Sub-Saharan Africa, Central Asia, Balkan Region, South East Asia (Brisbane and Philippines), South Asia
- ▶ OpenQuake-modeller and OpenQuake-engine are currently in a phase of extensive refactoring that will hopefully generate more powerful and flexible tools

# Regional Programmes

# Hazard Regional Programmes



**EMCA**  
EARTHQUAKE MODEL CENTRAL ASIA

**GENERAL**

- Homepage
- Tasks
- Staff
- Workshop and Meeting
- Training
- Cooperation
- Advisory Board
- COSERICA
- Documents
- News Archives

**EMCA**

The Earthquake Model Central Asia  
Responsible: Jochen Zschau  
Project Coordinator: Stefano Parolai

Duration: 2011 to 2014

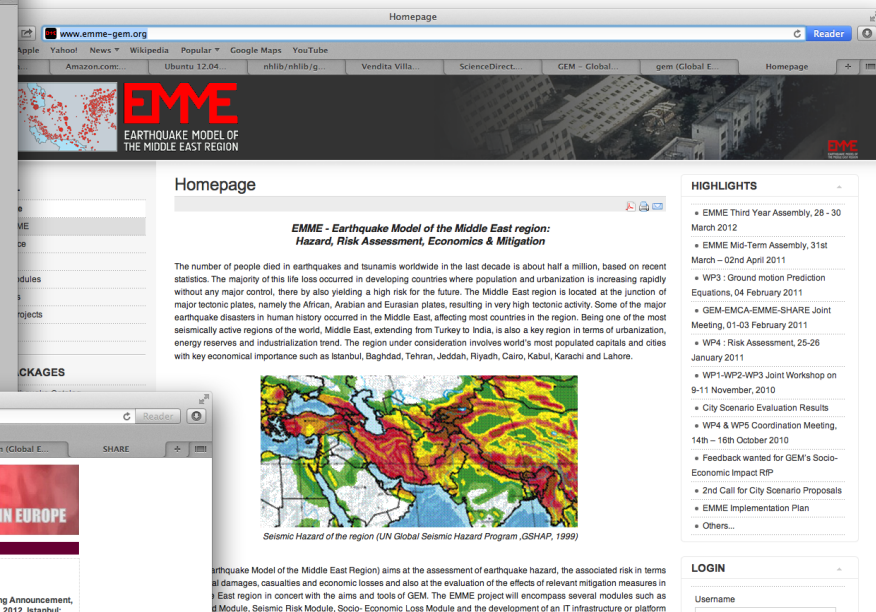
The Earthquake Model Central Asia (EMCA) is a GEM regional program coordinated by the GFZ. Taking advantage of the COSERICA consortium created during the CASCADE project, EMCA aims at the crossborder assessment of seismic hazard and risk in Central Asia. The activities are subdivided into "Seismic hazard assessment and Microzonation", "Seismic Vulnerability", and "Earthquake Risk". A synergy between EMCA and other projects (MHC, Progress) involving the GFZ in Central Asia is expected to provide a valuable contribution to the GEM.

News

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**EMME**  
EARTHQUAKE MODEL OF THE MIDDLE EAST REGION

Homepage

**EMME - Earthquake Model of the Middle East region: Hazard, Risk Assessment, Economics & Mitigation**

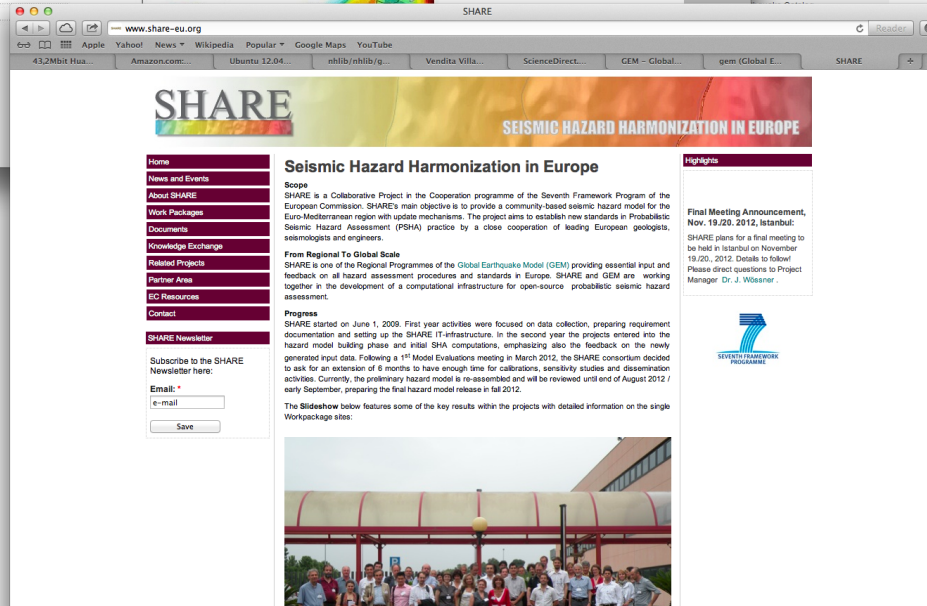
The number of people died in earthquakes and tsunamis worldwide in the last decade is about half a million, based on recent statistics. The majority of this life loss occurred in developing countries where population and urbanization is increasing rapidly without any major control, there by also yielding a high risk for the future. The Middle East region is located at the junction of major tectonic plates, namely the African, Arabian and Eurasian plates, resulting in very high tectonic activity. Some of the major earthquake disasters in human history occurred in the Middle East, affecting most countries in the region. Being one of the most seismically active regions of the world, Middle East, extending from Turkey to India, is also a key region in terms of urbanization, energy reserves and industrialization trend. The region under consideration involves world's most populated capitals and cities with key economical importance such as Istanbul, Baghdad, Tehran, Jeddah, Riyadh, Cairo, Kabul, Karachi and Lahore.

**HIGHLIGHTS**

- EMME Third Year Assembly, 28 - 30 March 2012
- EMME Mid-Term Assembly, 31st March - 02nd April 2011
- WP3: Ground motion Prediction Equations, 04 February 2011
- GEM-EMCA-EMME-SHARE Joint Meeting, 01-03 February 2011
- WP4: Risk Assessment, 25-26 January 2011
- WP1-WP2-WP3 Joint Workshop on 9-11 November, 2010
- City Scenario Evaluation Results
- WP4 & WP5 Coordination Meeting, 14th - 16th October 2010
- Feedback wanted for GEM's Socio-Economic Impact RIP
- 2nd Call for City Scenario Proposals
- EMME Implementation Plan
- Others...

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**SHARE**  
SEISMIC HAZARD HARMONIZATION IN EUROPE

**Seismic Hazard Harmonization in Europe**

**Scope**

SHARE is a Collaborative Project in the Cooperation programme of the Seventh Framework Program of the European Commission. SHARE's main objective is to provide a community-based seismic hazard model for the Euro-Mediterranean region with update mechanisms. The project aims to establish new standards in Probabilistic Seismic Hazard Assessment (PSHA) practice by a close cooperation of leading European geologists, seismologists and engineers.

**From Regional To Global Scale**

SHARE is one of the Regional Programmes of the Global Earthquake Model (GEM) providing essential input and feedback on all hazard assessment procedures and standards in Europe. SHARE and GEM are working together in the development of a computational infrastructure for open-source probabilistic seismic hazard assessment.

**Progress**

SHARE started on June 1, 2009. First year activities were focused on data collection, preparing requirement documentation and setting up the SHARE IT-infrastructure. In the second year the projects entered into the hazard model building phase and initial SHA computations, emphasizing also the feedback on the newly generated input data. Following a 1<sup>st</sup> Model Evaluations meeting in March 2012, the SHARE consortium decided to ask for an extension of 8 months to have enough time for calibrations, sensitivity studies and dissemination activities. Currently, the preliminary hazard model is re-assembled and will be reviewed until end of August 2012 / early September, preparing the final hazard model release in fall 2012.

The Slideshow below features some of the key results within the projects with detailed information on the single Workpackage sites.

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... several new initiatives currently starting and/or developing

# The role of Hazard Regional Programmes



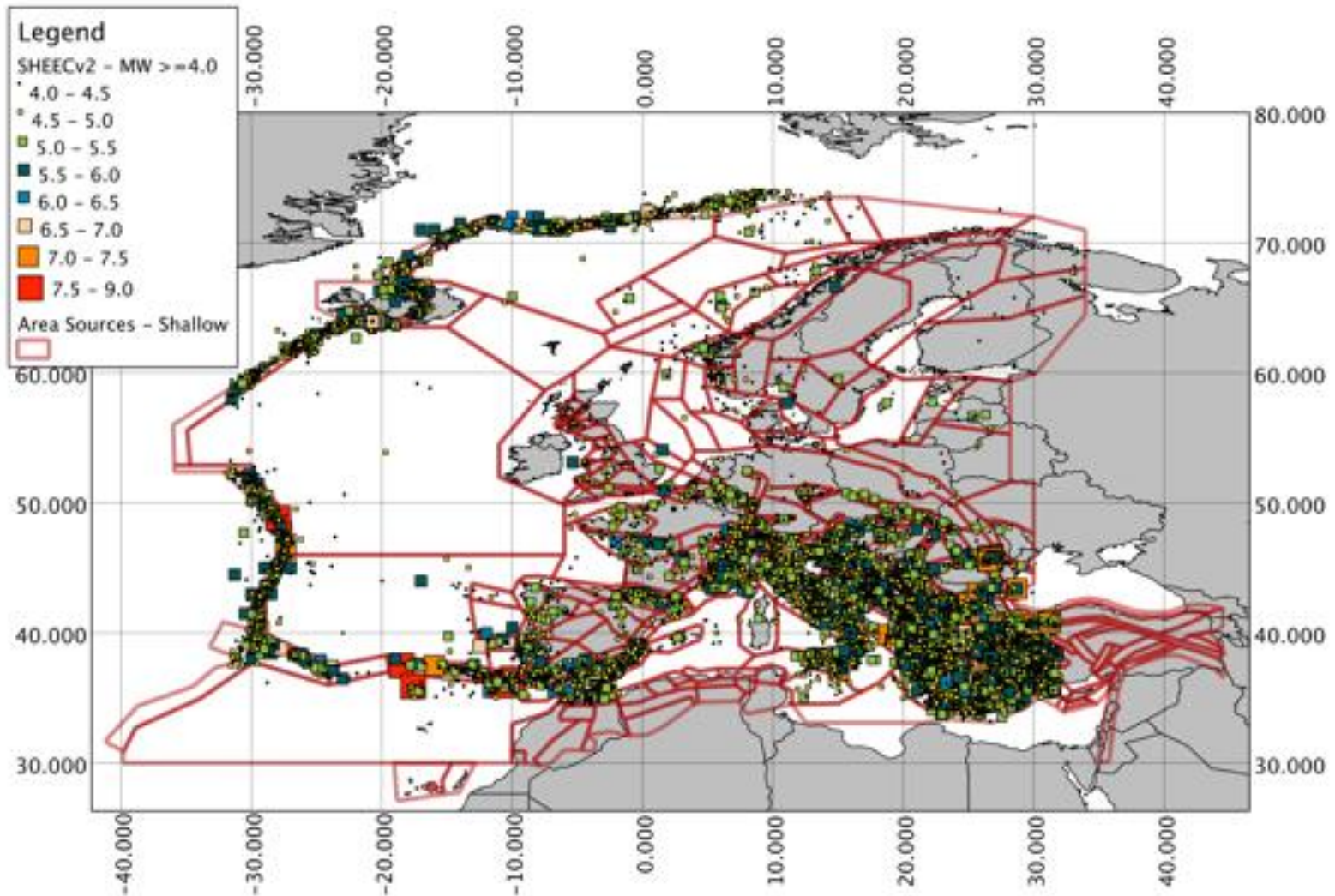
- ▶ Create regional datasets e.g. EQ catalogues (historic and instrumental) – active faults – seismic sources – GMPEs – site effects
- ▶ Collaborate with GEM on producing and validating consensual methodologies + computational infrastructure for seismic hazard and risk calculations
- ▶ Evaluate the results of GEM's global components
- ▶ Ensure GEM standards and procedures are compatible with regional conditions
- ▶ Create harmonized seismic hazard and risk models across borders

# The SHARE example



- ▶ 18 international partners involved
- ▶ Numerous new databases developed at regional scale: historical and instrumental seismicity DBs, active faults DB
- ▶ Harmonised PSHA input models:
  - Area source based model
  - Fault + background seismicity model
  - 2 Smoothed seismicity models

# The SHARE example





# The SHARE example



- ▶ Calculations performed with OpenQuake: feedback of great significance provided to the GEM model facility for further improving the capabilities of the engine

# Conclusions



- ▶ International collaboration is A CORE activity within the Global Earthquake Model
- ▶ Different ways are available to pursue GEM's goals while international collaboration remains central
- ▶ Several GEM's regional initiatives now active or in the process of starting soon ... it's time to join, we need your contribution