

GEM Review Panel – Final Report

20 June 2018

Executive Summary

Upon request of the GEM Governing Board, an independent Review Panel was convened to provide advice on the effectiveness of GEM's development of the global earthquake hazard/risk model, and the future direction and character of the model.

The Panel, consisting of 7 international experts and chaired by Dr Tom De Groeve of the European Commission Joint Research Centre, met on 18-19 April 2018 at the offices of the GEM Foundation in Pavia, Italy.

The Panel found that GEM is on target to launch the first version of its Global Model by the end of this year (2018) as planned. The Panel considers this to be an excellent achievement.

The Panel commends GEM's work to develop the most comprehensive assessment of earthquake hazard and risk on a global scale that has been achieved to date. The hazard and physical risk components of the Model are at a mature level of development. The social vulnerability modelling, whilst evolving rapidly, requires further development before products should be released as part of the global hazard and risk model.

The Panel expects that the planned hazard and physical risk products of the Model to be released at the same time. They will serve a very useful need and have the potential to significantly raise the profile of GEM globally.

The Panel believes that the Model itself should have direct application to the private sector, such as to the insurance and construction industries, and to the public sector, for a wide range of disaster reduction and mitigation activities.

The Panel judges that the Model represents a major step forward for applications in global and national disaster policy, including for the Sendai Framework for Disaster Risk Reduction. To achieve its potential as a tool for local policy-making and emergency management planning development, the work should continue to be extended to include infrastructure risk and how the impact on the built environment will impact on community and individual resilience.

The Panel recommends that GEM's work continues to be driven by the principles of collaboration, credibility, openness and public good, and that GEM continues to address the needs of the private sector as well as the global policy agenda of disaster risk reduction and sustainable development. The Panel sees opportunities to leverage GEM's work through new collaboration with external partners, in particular for developing the less mature elements and for raising the awareness about GEM in all target user groups.

Introduction

Terms of Reference

Objective: To provide advice to the GEM Governing Board on the effectiveness of GEM's development of the global earthquake hazard/risk model, and the future direction and character of the model.

The suitability of the Global Hazard/risk model will be reviewed with respect to:

1. **GEM's principles for collaboration, credibility, openness and public good.**
 - a) **Collaboration.** Was the model developed through collaboration with local, national and regional experts where possible? Where collaboration was not possible, were reasonable efforts to engage partners made?
 - b) **Credibility.** Are the results credible from a scientific perspective, using the best available information, and following best-practice methodologies?
 - c) **Openness.** Were the data, information and tools used available openly or in the public domain?
 - d) **Public Good.** Were the models developed for use in the public good? Who are the beneficiaries? Do they meet the expectations of sponsors and partners?
2. **The intended application of the model (or component elements/models) to agreed use cases (defined in the GM Task Force Report) based on model development over two timescales:**
 - i) **The current Work Programme 2 (WP2), to its completion in December 2018)**
 - ii) **Work in the next GEM Work Programme (January 2019 onwards)**

The review panel shall make recommendations on the direction and nature of GEM work over these timescales, bearing in mind the available resources are limited to make improvements within the current work programme on:

1. **Technical improvements** to the model from the perspective of the key disciplines and expertise involved in developing the model;
2. **Publication of the results** as products for various stakeholders, beneficiaries and users. Products may include technical publications in peer-reviewed journals, reports for sponsors and users.
3. **Communication /dissemination** of results through various media, to professionals, stakeholders, the public, private industry, etc...

Process

The composition of the Panel was based on initial recommendations from the Board. The full panel composition aimed at balancing scientific expertise, expertise of various use cases, gender, and geographic representation.

Initial teleconference meetings between the Chair and Panellists were held to provide context and to prepare for the face-to-face meeting. Requests for additional documentation were forwarded to the GEM Secretariat, who made all documentation available to the Panel before the meeting.

The Panel met on 18-19 April 2018 at the offices of the GEM Foundation in Pavia, Italy. During the first day, the GEM Secretariat presented progress and plans of the Global Earthquake Model in all its aspects, and the Panel asked questions. During the second day,

the Panel met behind closed doors, without the presence of the GEM Secretariat, to deliberate on its recommendations. The draft recommendations were communicated to the GEM Secretariat at the end of the day.

Panel composition

Global Model Review Panel Members:

- **Tom De Groot** (Chair), European Commission, Joint Research Centre
- **David Wald**, US Geological Survey
- **George Walker**, Aon-Benfield, retired
- **Masyhur Irsyam**, Institute of Technology, Bandung, Indonesia
- **Ricardo Mena**, UN ISDR
- **Malcolm Haylock**, Catastrophe risk modelling consultant
- **Samuel Rufat**, Université de Cergy Pontoise
- *Ex officio GEM Representative:* **John Rees**, GEM Governing Board, British Geological Survey and UK Natural Environment Research Council

GEM Secretariat contributors (Day 1, or as requested by Review Panel on Day 2):

- **John Schneider**, Secretary General
- **Paul Henshaw**, Director of Technology
- **Vitor Silva**, Risk Team Leader
- **Marco Pagani**, Hazard Team Leader
- **Jeph Oro**, Communications Manager
- **Miguel Toquica**, Social Vulnerability and Resilience Scientist
- **Chris Burton**, former Social Vulnerability Team leader (Advisor) (available remotely)

It was observed that there is a gender imbalance in the panel; it was identified that this is by accident rather than design.

Interpretation of Terms of Reference

After discussions with the Secretariat and bearing in mind a need to focus the Panel efforts on the most important aspects of the review the Panel evaluated the GEM Global Earthquake Model according to the following interpretation of the Terms of Reference.

- Evaluate the GEM Global Model, rather than the whole of the GEM Programme.
- Judge GEM's performance against its principles: collaboration, credibility, openness, public good.
- Evaluate against use-cases.
- Make recommendations for the future programme.
- Assess both technical and communication aspects.
- Bear in mind that the review is effectively about the progress and direction of GEM modelling, considering both process and products.

Recommendations on the direction and nature of GEM are required in relation to work to be undertaken: a) by end of 2018; and b) from 2019 onwards – in relation to technical improvements, publication and communication.

Overall Impression

The Panel found that GEM is on target to launch the first version of its Global Model by the end of this year (2018) as planned. The Panel considers this to be an excellent achievement.

The Panel commends GEM's work to develop the most comprehensive assessment of earthquake hazard and physical risk on a global scale that has been achieved to date. The hazard and physical risk components of the Model are at a mature level of development. The social vulnerability modelling, whilst evolving rapidly, requires further development before products should be released as part of the global hazard and risk model.

The Panel expects that the planned products of this Model to be released at the same time. These will serve a very useful need and have the potential to significantly raise the profile of GEM globally.

The Panel believes that the model itself should have direct application to the private sector, such as to the insurance and construction industries, and to the public sector, for a wide range of disaster reduction and mitigation activities.

The Panel judges that to the Model represents a major step forward for applications in global and national disaster policy, including for the Sendai Framework for Disaster Risk Reduction. To achieve its potential as a tool for local policy-making and emergency management planning development, the work should continue to be extended to include the infrastructure risk and how the impact on the built environment will impact on community and individual resilience.

Recommendations

Strategy and vision

The Panel in general found that the strategy and vision lacked clarity and consistency in places, and in respect of the multi-disciplinary strategy rather confusing.

The Panel recommends that:

- The clarity and consistency of the vision, mission and strategy statements be improved;
- They be made publicly available.
- They allow flexibility for periodic updating in response to changing needs.
- In respect of the multi-disciplinary vision and strategy - see later recommendations under Multi-Risk.

GEM Principles

Collaboration

The Panel found that:

- The level of collaboration with scientific counterparts and authorities in many countries and regions has been a huge achievement.

- That GEM gives good visibility to their partners.

The Panel recommends that

- GEM continues to collaborate with relevant scientific and risk management agencies where possible for the continuing development of GEM and the marketing of the model.
- GEM regularly revisits bilateral relationships with countries, including through third parties that may provide access to new partners for collaboration.
- GEM regularly revisits opportunities for collaboration with research groups in various disciplines, e.g. in fast developing areas such as exposure and social vulnerability.

Credible

The Panel found that:

- GEM's work is highly credible on the hazard side and is approaching comparable levels of credibility on the risk side. This credibility is demonstrated by its good peer reviewed publication record.
- The private sector recognizes the model credibility on hazard side and is undergoing testing of the risk modelling.

The Panel recommends that:

- GEM recognizes and transparently communicates the limitations of the Global Model including:
 - On the hazard side: being clear about the assumptions and approximations (e.g. as in local site effects).
 - On the risk side: having appropriate disclaimers (e.g. indicating that infrastructure and secondary hazards are not included).
 - Being careful in communicating on validation to not imply that successful case studies represent validation.
- GEM avoids implying new work on social vulnerability is at the same level of maturity as the work on hazard and risk, and instead consider branding it as an important line of research in the next work programme, including it as a key objective in the post-2018 strategy. GEM needs to identify key partners and existing work outside of GEM for collaboration in this area.
- GEM should work with “early adopters” from different user groups to document case studies how the various products of the Global Earthquake Model that will be released can be used in concrete applications. If possible, GEM should have “early adopters” describe their experience as part of the launch at the end of 2018.

Openness

The Panel found that GEM has succeeded very well in this area.

Public good

The Panel found that:

- The benefit to the public good will be one of GEM's major benefits. Although the public will generally not be a direct beneficiary of the Global Model, it will benefit indirectly.

- There is currently little information available for the general public, and it will be to the benefit of GEM to develop such information.

The Panel recommends that:

- GEM assesses and communicates the potential impact of GEM products on the public (e.g. a safer built environment from new building codes, improvements in emergency services based on GEM products and the use of GEM products in education).
- GEM takes the opportunity to develop such material with the purpose of capacity and/or awareness building in respect of earthquake risk, particularly for developing countries.

Technical aspects

Hazard

The Panel found that:

- The mosaic approach is appropriate for the objectives of GEM. It is consistent with how several countries (e.g. United States) use a mosaic approach at subnational level.
- The GEM products planned for release are appropriate for the scientific and professional communities for whom they are designed.
- There was no work presented on using GEM products as a source input to global tsunami risk assessment and warning systems, which was a listed objective of the current Work Programme.

The Panel recommends that in the short term:

- GEM continues to use the mosaic approach, but ensures that the quality of the mosaic pieces is always clearly communicated (e.g. by reference to the tiers identified by the Secretariat) and that a clear explanation is provided on all products on how to interpret discrepancies at national borders.
- GEM versions the global earthquake products to acknowledge limitations and recognize further progress.
- GEM clearly defines one “signature” hazard product dedicated to the general public e.g. a global map showing estimated peak ground accelerations having a 10% risk of occurrence in 50 years, with a corresponding macroseismic intensity legend. For the purpose of the map this should include smoothing across borders with the following disclaimer “These values are for display purposes only. For actual values go to URL”. This should be part of a coherent set of products for the public covering all 4 ingredients: hazard, exposure, vulnerability and risk.
- In producing media messages accompanying the launch GEM should, on the hazard side, highlight areas of significant changes of seismic hazard compared to previous assessments.

The Panel recommends that in the long term:

- GEM continues to improve the global earthquake hazard models using the mosaic approach.

- GEM needs to address, through partnership, secondary and cascading hazards such as tsunamis, landslides, fire, liquefaction, natechs (natural hazard induced technological hazards).
- GEM undertakes more work on the transparent representation of quality (e.g. disclose where uncertainty can't be quantified) and better quantification of uncertainty.

Risk

The Panel found that:

- GEM demonstrated sufficient progress to reach the objectives of releasing a global risk model by the end of 2018.
- GEM has made innovative and useful progress on the visualisation of risk and its uncertainty e.g. the use of hexagonal cells and country risk profiles.
- The Quality matrix is an interesting approach to communicate realistically achievable levels of quality for a Global Model and what can be improved.

The Panel recommends that in the short term:

- GEM clearly indicates the limitations in its specification of products (e.g. indicate that specified AAL is only for direct structural loss).
- GEM produces some specific products for the release, including global AAL, draft Sendai Framework Indicators, and other analysis products of the Global Model for key messages to be included in the release communication for different user communities → see communication section.
- GEM's initial work on country risk profiles (i.e. "Fact Sheets") is commendable. The draft profile for Haiti presents well, and that format should be replicated for all nations with significant seismic risks. This would constitute a library of country risk profiles.

The Panel recommends that in the long term:

- GEM formulates strategy to develop and/or foster the development of more detailed local models for urban areas most at risk (e.g. fast growing urban centres, areas with significant basin effects).
- GEM spends appropriate efforts on the maintenance of the Risk Model, including updating the exposure, vulnerability and fragility data, in conjunction with periodic (e.g. annual) release of key products (e.g. updated AALs).
- GEM produces risk-based estimates of the Sendai Framework indicators (targets A-D) for demonstration to the 2019 Global Platform for Disaster Risk Reduction.
- GEM sets research priorities:
 - To enable the Global Model to cover all damage, structural and non-structural, to the built environment including infrastructure.
 - In collaboration with key partners, extend the Global Model to enable modelling of future risk (including future exposure and vulnerability).

Social vulnerability

The Panel found that:

- This is a very important aspect of global earthquake risk which is required to address the issue of community and individual resilience, and which linked with the rate of

recovery from the impact of an earthquake. The current state of development of this area in GEM is at a preliminary stage.

- The concept of integrated risk in GEM is not clear. How to fold social vulnerability into integrated risk and/or resilience needs further consideration.

The Panel recommends that in the short term:

- Consideration should be given to whether the results to date of this aspect should be presented in the first release, as it could generate negative publicity from the ‘resilience community’. If the results are presented, they should be described as preliminary results only.
- GEM needs to better identify the audience, likely use, and appropriate format of anticipated products of this aspect, e.g. use by government policy makers for cost benefit studies in relation to allocation of resources to disaster risk management.
- GEM needs to clarify the concept of integrated risk; for example does it include insurance, coping capacity, financial/reconstruction resources, etc.? Can a meaningful unit or metric of integrated risk be defined (qualitative or quantitative)? What is understood by an “aggravating factor”? What is the bottom line in terms of human and economic impact? If it is related to indirect impacts, this must be made clear.

The Panel recommends that in the long term:

- GEM extends the Model to include cost benefit analysis in relation to the socio-economic impact on the community for use by government policy makers concerned with the allocation of resources to disaster risk management.
- GEM develops closer collaboration with other initiatives in this field, such as existing partnerships (e.g. INFORM) or key organisations (e.g. United Nations University).
- GEM develops a product, which may include country profiles, indicating the main drivers of social vulnerability.

Multi-risk

In the context of the future plans of the Global Earthquake Model, the Panel made some considerations on the multi-risk approach of GEM. This should not be seen as a review of the strategic directions of GEM, but rather as input for future development of the Global Earthquake Model.

The Panel understands that GEM has an interest in exploiting the results of the global earthquake model and its components in a multi-risk context. Although its ambitions are currently not fully defined, the Panel sees opportunities for GEM to exploit GEM’s IT and modelling platform, including its Open Quake engine and building taxonomy system by working in partnership with initiatives developing models for other hazards. In particular, the approach of focusing on the interface with other hazard communities is useful, such as the use of GEM exposure models by the flood and volcano communities. The Panel encourages GEM to participate in multi-hazard initiatives, such as the UN Global Risk Assessment Framework, which are seeking a more systemic and integrated way of assessing disaster risk.

Communications

The Panel found that:

- The communication strategy, and work plan to implement it, are considered sound, but expectations are high and may need to be managed.
- In the Mission Statement the use of the term ‘official’ may be misunderstood.
- It is important to get the information about GEM outside the current ‘in-group’

The Panel recommends in the short term that:

- GEM takes measures to manage the expectations of all user groups. → see below.
- The Board consider replacing term “official” with “the leader” in the mission statement.
- GEM collaborates with key actors to develop key messages (e.g. International Federation of Red Cross and Red Crescent Societies (IFRC) to develop messages for local communities and the United Nations International Strategy for Disaster Reduction (UNISDR) for the global risk community.)

The Panel recommends in the long term that:

- GEM provides documentation of the Open Quake system and its products in multiple languages.
- GEM considers the development of simple versions of the tools intended for general use (e.g. calculation of Average Annual Losses (AALs) and the graphical user interface).

Insurance and construction industry professionals

The Panel recommends that in relation to the launch of the Global Model:

- GEM seeks to publish articles in relevant industry and professional publications.
- In relation to the insurance industry, emphasise that the model can be customised for internal use to provide a non-black box model for use in conjunction with the black-box commercial models.

The Panel recommends that in the longer term:

- For uptake in insurance sector, it will be important to have a model which is interoperable with other operational cat modelling platforms.

Global risk

The Panel recommends that:

- GEM work with UNISDR on the following messages:
 - “The Global Model is a first step in provision of a global tool that can help identifying strategies for reducing seismic risk”.
 - “The AAL results from the global model improve understanding of global seismic risk compared to GAR15.”
- GEM consider contributing to global multi-risk publications, such as the UN Global Assessment Report.
- GEM consider producing an articles outlining what we have learned about global earthquake risk, where it has been underestimated, and trends in global earthquake risk.

- GEM promote the Global Model and its products at the 2019 Global Platform for Disaster Risk Reduction (GP2019).

National level risk assessment and DRR

The Panel recommends that in relation to the launch of the Global Model:

- GEM targets communications to national risk management agencies.
- For political reasons GEM carefully manages the release of the GEM Model in countries that are least involved (i.e. Tier 3).
- In launching in Tier 1 countries (generally developed countries) GEM strongly acknowledges the collaboration with their agencies.
- In the release to developing countries GEM promotes their provision of tools and training for capacity building, and emphasise the potential use as an educational tool.

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