

Conclusions of the Merci workshop on: Management of Earthquake Risks

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Management of risks due to earthquake hazards involves a broad range of disciplines from the field of civil engineering, earth sciences and social and human sciences. Understanding the physics of the mechanisms triggering earthquakes at different locations, and being able to model the characteristics of these constitutes one of the first prerequisites in the assessment of risk. The modeling of the wave propagation through the earth structure from source to site and the nonlinear soil behavior of the topmost layers play a key role in the assessment of the excitation of structures and lifelines. Having modeled the structural excitation the assessment of structural damages necessitates a detailed understanding and modeling of the structural response which also involves the collection of various types of data such as facilitated by modern techniques of photogrammetry and remote sensing. This then forms the basis for assessing the direct consequences of earthquakes in terms of loss of lives, material damages, rescue and cleanup costs and rehabilitation. However, in the consequence assessment it is important also to consider indirect costs such as long term socio-economical effects, mortality and possible damages to the environment.

The problem complex is rather daunting and an additional complicating factor is the fact that all the models involved in the assessments are subject to significant uncertainties. Furthermore, the data which are normally required to substantiate and calibrate the models are scarce or in some cases not available. For this reason most earthquake risk assessments are based on a probabilistic modeling of all relevant uncertainties and consequences are assessed as expected values.

The various research projects initiated and planned in the area of management of risks due to earthquake hazards typically set out within the framework outlined in the above. Often for the purpose of achieving a reasonable balance between quality and relevance, however, only limited parts or specific aspects are considered.

The potential for synergy between the present research initiatives by exchange of research ideas, results, data and tools is tremendous and could significantly improve future developments in the area. However, a prerequisite for this is that a certain common basis for the underlying modeling is established and that the communication between the involved research groups is strengthened.

With this out-set the interdisciplinary research project Merci ([Management of earthquake risks using condition indicators](http://www.merci.ethz.ch/)¹) decided to organize a workshop on Management of Earthquake Risks. The aim of the workshop being to:

- Establish a long term platform for achieving and maintaining a common basis in regard to the modeling aspects of earthquake risk management.
- Facilitate that the communication between different research groups as well as academia and industry is strengthened at an international level.
- Enhance coordinated and targeted research in the area in the future.
- Focus directions of future research.

¹ <http://www.merci.ethz.ch/>

The workshop was held at the ETH, Zürich on August 28-29, 2006. Around 40 professionals in the area of earthquake risk management participated in the workshop representing re-insurance companies, consulting engineers, researchers and members of (pre-) normative committees. At the workshop 27 presentations were given on various subjects of earthquake risk management. Presentations were given on insurance perspectives to earthquake risk management, implementation and modeling of earthquake hazard representations, soil response and liquefaction due to earthquake excitation, application of remote sensing and photogrammetry in earthquake risk management and finally structural vulnerability modeling and societal consequence assessment.

The discussions at the workshop were lively and constructive and clearly reflected the substantial interest of the participants to make benefit of the workshop in achieving consensus on basic modeling aspects and directions for further research and developments. Many viewpoints were brought forward in regard to which issues need intensified treatment, research and collaboration for the field to progress further.

At the end of the workshop the results of the workshop were summarized and one full closing session was devoted to a discussion on to what extent the aims of the workshop could be reached.

The outcome of the closing discussion was very positive as it turned out that agreement could be reached on a number of important issues:

Which are the big issues in earthquake risk management?

There is a general consensus that the uncertainties in earthquake risk management should be reduced. Substantial research in this direction is being performed at universities and industry research groups; however, there seems to be some difficulties in communication between researchers and stakeholders. University researchers often fail to appreciate the context and needs of the industry and thus focus on very specific areas which for the large picture might be of less significance. The situation is hampered also by the fact, that funding agencies predominantly support fundamental research and private industries focus on projects with immediate applicability. Thus interdisciplinary research activities considering both aspects face substantial funding problems. Presently most applied risk management is performed by “black box” tools mainly developed by the industry with some specific inputs from academia. Whereas it is clear that there are many possibilities to improve earthquake risk management the “black box” environment makes it difficult to identify in which of the different components of earthquake risk management the benefit of intensified research and development would be the largest. As a result of this there is presently no clear knowledge on how uncertainty reduction is most efficiently achieved. Finally the issue of good data for the support of decision making was raised continuously during the discussions. Information concerning buildings, roads, bridges and other relevant objects (geometry, function and other attributes) before and immediately after an earthquake are in particular missing.

What was agreed?

First of all it would be desirable to establish a consensus on a common and standardized basis for earthquake risk assessment as well as the representation and treatment of uncertainties and lack of knowledge. Standardization facilitates comparability and also enhances to possibilities for exchange of tools developed for

individual purposes within earthquake risk management. Standardization would provide an improved basis for synergy in international research and developments in the area of earthquake risk management.

In aiming for such standardized approaches it is essential that models are formulated such that they facilitate adaptation to site specific data as well as updating based on new information which may be collected or otherwise achieved over time.

Furthermore, it was noted that future developments should get earthquake risk management out of the “black box”, preferably in terms of an integral scenario based methodology with clearly defined components covering the different aspects of earthquake risk management with clearly defined interfaces. Increased efforts are needed in collecting relevant data from experienced earthquakes in regard to consequences but more general data of relevance for the estimation of potential future earthquakes are also needed. This concerns not least information on structures, lifelines and their criticality. In this context information collected from aerial photographs may play a major role in the future. It was finally highlighted that several stakeholders in earthquake risk management e.g. at supranational, national and industry levels have significantly overlapping interests and that future developments in the area should acknowledge this. Substantial recourses are presently being allocated to research in this field but the possibilities for increasing efficiency, for the benefit of all, by joining efforts in defining, financing and conducting future developments is tremendous. It is a responsibility of all stake holders to improve the situation in this regard.

Where are we going?

As a consequence of the identified big questions and problems as well as the issues on which agreement could be established a number of directions for future research and developments were identified.

First of all future developments of methods and tools for earthquake risk management should be performed in an open source environment. Some tools are already available in open source environment such as OpenSees developed and maintained at University of California Berkeley (<http://opensees.berkeley.edu/index.php>) or OpenSHA developed by the Southern California Earthquake Center and the U.S. Geological Survey (<http://www.opensha.org/>). However, the many other building blocks involved in earthquake risk management could equally well be developed in similar environments and thereby facilitates synergetic effects in the future.

Secondly, research and development agendas need to be formulated in collaboration between the various stakeholders. Such agendas will greatly improve efficiency in future research and developments and also facilitate funding of larger and more complete research activities as well as implementation of earthquake risk management at various levels in society. Sharing data and information between stakeholders also appears to be the only possible way of gathering sufficient relevant hard data which are needed for modeling purposes.

Thirdly it was found that establishing an integral platform for earthquake risk management where not only focus is directed on the various individual constituents of the framework (process related research) but rather on the consistent integration of the different constituents will greatly enhance the identification of where additional research and developments will lead to reductions in the uncertainty associated with loss estimation.

Finally it was found that that the issue of acceptable risks in earthquake risk management is an issue of significant importance in societal decision making on how

to allocate limited available resources efficiently for life saving activities. Additional research in this direction appears to be in need at the present time.