PANEL DISCUSSION 2 *(Smr2142, May 12, 2010, 17:00 to 18:00)*

Toward validation of SHA

Recordings using the automated ICTP EyA system are available on the web at:
http://www.ictp.tv/ under the item "Conferences".

Panel Discussion – Group B

Panel Discussion Group B focused on the verification and validation of SHA models, considering the lessons from recent earthquakes. V. Kossobokov (Russia), Art Lerner-Lam (USA), Zhenming Wang (USA), and Zhongliang Wu (China, rapporteur) acted as the panelists. Comments and suggestions are also from the audience.

In the Discussion, the following issues were addressed. The records are just listed by the order of the issues addressed in the discussion, with necessary combination of similar or correlated issues discussed by different speakers. Since this is a Panel Discussion, it is not necessary to require that all the statements are consistent with each other. And it is not necessary to require that each statement reflects the opinions of the Panel or the whole audience.

- SHA models have to be verifiable. But how to verify a SHA model is one of the questions which have to be considered seriously. Comparing the model results against real data is one of the critical steps in the verification. But one needs a clear definition of what is a ‘failure’ and what is a ‘success’.
- Different audience may have different definitions what is a ‘success’ and what is a ‘failure’. Therefore, in both the theoretical perspective and the practical perspective, there is a need of common understanding about these basic concepts.
- In the verification of SHA models, attention has to be paid to the data used for the analysis, and the region-dependence of the result, considering the spatial heterogeneities of earthquake phenomena as well as earthquake studies.
- In the SHA models, input from the physics of earthquakes plays an important role. Such physical aspects consists the properties of earthquake fault, the excitation and propagation of seismic waves, and the amplification by site effects. Physical verification is important in judging how good a model is.
- For most of the counties, it has been over half a century since their first zonation maps (often for the time scale of 50 years) were published. It is time to systematically collect all these results and evaluate the performance of these zonation maps.
- Probabilistic SHA maps, over the past decades, have provided so many ‘surprises’ comparing to real earthquake situation that one has to suspect that something is wrong

with these maps – some problems might be fatal. This calls for a change of 'paradigm' – that is, the basic thinking and the whole procedure – of the making of these hazard maps. Some of the assumptions, such as earthquake recurrence and periodicity, and the capability to deduce the future based on history, seem problematic.

- Better ways to estimate the earthquake rate along a fault is needed. Pattern recognition, as proposed by V. I. Keilis-Borok since the 1970s, can contribute to the change of the traditional approaches to SHA.
- How to understand probabilities, such as in the language of 'seismic lottery tickets', is a critical problem both to researchers and to end-users.
- Considering both PSHA and DSHA, the problem of earthquake forecast/prediction cannot be avoided. Since seismic hazard is intrinsically time-dependent. And hazard assessment has to consider such time dependence.
- In dealing with probabilities, one has to be alerted that there are two concepts used in parallel: the ('classical') probability as defined by Cornell and McGuire in the 1960s and used in USGS; and the probability used in other places such as in Japan.
- How to verify probability is another issue we have to pay attention to, especially in the case that earthquakes to be considered are rare extreme events.
- Many past and recent earthquakes are not on The Map. And we have to explain. It is necessary for us to explain to the clients what is the meaning of these products and how to use them properly. In the mean time, it is necessary for us to find out what is the problem with these maps.
- When we say probabilistic hazard maps, we generally refer to conditional probabilities.
- After each earthquake, and especially after each failure, more investigations will be conducted to a specific earthquake fault, leading to 'new' conclusions about the seismic hazard. This conditional probability also depends on the 'targets' to be considered in the hazard analysis. For example, if a nuclear power plant is to be considered, then automatically more thorough investigation will be conducted. On the other hand, other hazard maps such as GSHAP are only for general purposes, therefore, not very much information is contained for many regions. Results of SHA depend to much extent on what data we have and what knowledge we have.
- SHA, by definition, is different for different purposes – such as emergency management, insurance, and engineering design. The difference also exists for the understanding of 'probabilities'.
- Hazard maps cannot solve the problems of all the audience. And none of the hazard maps is perfect. Therefore, we need different kinds of hazard maps for different purposes. Producers of the hazard maps need to keep an open mind to alternatives. Now the discussion about PSHA, DSHA, and Neo-DSHA is moving in the right direction, and should be going on.
- SHA maps with wrong conclusions may mislead the clients and generate unexpected results. Example is the earthquake in 1995 in Italy. In the same region both PSHA and DSHA have been made, with DSHA providing correct estimation. But the neglecting of the DSHA results (partly due to the PSHA result) led to disastrous results during the earthquake.
- There is a need of a formal procedure for the official collection and scientific evaluation

of seismic hazard assessment results as well as earthquake forecast/prediction results, so that society may be benefited from the scientific studies (such as the geological studies in Haiti which led to the correct estimate of seismic hazard) and may not be misled by the incorrect hazard assessment results (such as the Russian forecast of a magnitude 6-7 earthquake around Beijing in August 2008) and even non-scientific results (such as the Iben Browning prediction of the New Madrid earthquake). This issue becomes complicated especially after the occurrence of earthquakes, such as the case of L'Aquila in the last year. This issue is of special importance when dealing with forecasts or predictions abroad, considering .the American forecast of earthquake in Peru in the 1970s. In some countries such as USA, Russia and China, there are such national evaluation committees. Some of the international organizations such as IASPEI also have some actions in this issue. Another mechanism is the CSEP project.

- In the physics-based SHA, one of the important issues is the properties of seismic source. This includes both the identification of asperities along a known fault and the identification of unknown (blind) faults which may produce earthquakes.
- In the process of SHA, it is also the case that the final SHA results are sometimes affected by many factors from economic to political. However, our job is to try our best to state what is the right way and what is the wrong way, and to guarantee the quality of our scientific products.
- To promote the advancement of SHA study and application, internationally open data and open source endeavor is important.
- SHA is not just numbers or time series. SHA deals with many people and billion billion dollars of money. To this end, dialogue between different professional approaches, dialogue with the clients to make sure what is the best way, and understandings of both the products and their use are all important to find the best solution to the problem of seismic safety.
- A real scientific model has to be verifiable. Since recent years, learning from the lessons of different earthquakes, modern science and technology have provided new opportunities to revise and improve the SHA, which will in turn provide the society with even better service.

The discussion was conducted from 5:00 to 6:00 pm, May 12, 2010.