EARTHQUAKE LOSS ESTIMATES, REAL-TIME AND SCENARIO MODE, WORLDWIDE

by

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The time is right to make an effort to bring the reliability of estimates of casualties and damage to the built environment to a higher level, worldwide. Immediately after major and large earthquakes, rescue agencies and civil defense managers need quantitative information about the extent of the potential disaster, early when data from the affected area may not yet have reached the outside world. Before future devastating earthquakes, it is important to estimate losses likely to be sustained in earthquake prone areas, by constructing loss scenarios.

With the current advances in accuracy and speed of determining teleseismic hypocenters and magnitudes, the availability of satellite images of the built environment and the accumulation of engineering information on buildings in the EERI encyclopedia, a quantum step in improvement in loss estimates is possible. Whereas the time to calculate earthquake parameters and losses has shrunk to seconds and minutes in the most advanced seismograph networks, it often takes many hours, even days, in developing countries. Also, loss estimates in the most developed countries are based on detailed information on properties of building stock and sophisticated computer programs. Therefore, the advanced loss estimating expertise in developed countries should be harnessed to bring to a high level the capability of real-time and scenario loss estimates.

A number of groups are developing methods and data bases to estimate losses worldwide. The most extensive, publishes record of real-time loss estimates is that of the computer tool QUAKELOSS. This record (Figure 1), and the corresponding evaluations of QUAKELOSS performance in past events show that even now excellent results can be obtained with approximate methods. However, there are several shortcomings in methods and data bases currently used that should be improved. Some of the needed improvements can easily be achieved, others require a sustained effort.

IASPEI has formed a working group under the commission for hazard and risk with the aim to foster the development of worldwide earthquake loss estimates. The title of the working group is ‘Earthquake Loss Estimates, Real-Time and Scenario Mode Worldwide’, and M. Wyss is its chairman. The specific fields of activity proposed by this working group include the following.

(1) **Elimination of the last mile failure of communication**. The most serious impediment for rapid rescue deployment is the lack of local experience with and trust in international real-time loss estimates. Local civil protection officials routinely turn down early offers by international rescue teams because they underestimate the extent of the disaster, basing their decision on reports of limited damage coming from the edges of the devastated area, where communication still functions. At the same time, communication from the strongly affected area is interrupted, making it temporarily impossible to get loss observations from there, yet international experts correctly estimate the losses as high. Forming an international consortium, which includes loss estimators, civil defense officials, local seismologists, and rescuers will solve this fatal problem.

(2) **Encyclopedia of accurate hypocentral depths world-wide**. The weakest parameter in teleseismic earthquake parameters is the hypocentral depth. In the case of a shallow earthquake, it makes no sense to use the default depths of 33 or 10 km. Instead of replacing these default values by an ad-hoc expert estimate, we recommend the use of the local average value derived from local permanent or temporary networks for seismicity of the past. To make this vital information available to all loss estimators, an encyclopedia of accurate hypocentral depths world-wide is necessary.

(3) **Application of satellite images to loss quantification**. Clearly, direct inspection of satellite photographs of the damage to the built environment immediately after earthquakes can significantly contribute to real-time loss estimates (Figure 2). Conditions are that a satellite happens to pass over the affected area, that the earthquake occurred during day-time, and that clouds are not obstructing the view from space. Methods to quantify loss estimates, especially those of the number of injured, should be advanced.

(4) **Speeding up the delay of estimates**. Real-time loss estimates must become available as quickly as possible, if lives are to be saved. The current standard delay of 2 hours is chiefly due to the need for a reliable moment magnitude, *Mw*. Methods to estimate *Mw* from P-waves and other means to speed up the determination of source parameters shall be fostered.

(5) **Application of satellite images to classify building stock**. Details concerning the building stock in developing countries are poorly known, and the numbers of buildings are far too large to make individual inspection of buildings feasible. Thus there is a need to use a combination of information from satellite images, the engineering reports encyclopedia, and limited inspection on the ground to increase information on properties of the building stock, world-wide. Based on satellite images, 3D models of cities can be developed, where the height of every building is calculated from its shadow. Based on height, assignment of buildings to groups of a given fragility class is possible.

(6) **Encyclopedia of soil conditions**. It is important to know the local soil conditions for estimating losses because they can lead to amplifications of the ground accelerations by factors of two to or more. However, reports on local conditions, including microzonation studies, are scattered in the literature (sometimes restricted to grey literature) and not generally known. A collection of relevant information is therefore needed.

(7) **Encyclopedia of attenuation functions**. More detailed information on local attenuation function could be helpful for refining the calculations of the degree of shaking. Because this information is scattered in the literature, a collection on a web page would be helpful.

In summary, a number of elements that are needed for all approaches to teleseismic loss estimation, real-time, as well as scenario mode can be improved in significant ways. Because the lacking data and undeveloped methods are generally needed, this working group has been formed to advance the implementation of these improvements. Also, the tasks of this working group are in line with the number two priority on IASPEI's list of important future developments in seismology, namely 'simulating disaster scenarios'. Some of the advances we seek can be achieved easily, others need contracted efforts. All of them are hands on measures, not research proposals with uncertain outcome, and are guaranteed to lead to improvements in the reliability of real-time loss estimates.

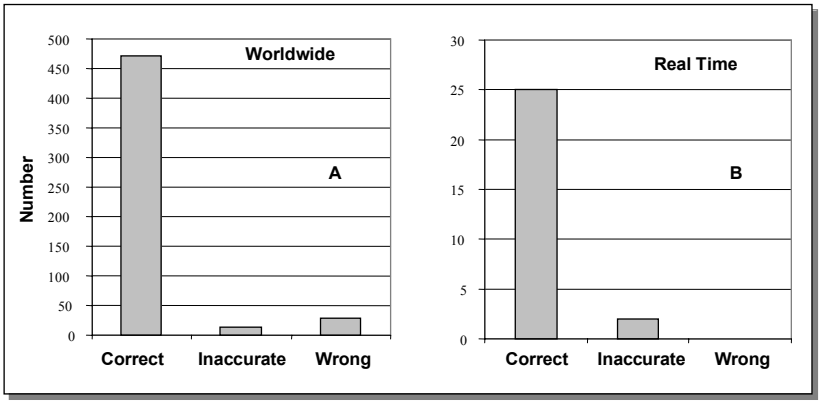

Figure 1: Performance of QUAKELOSS in earthquake loss estimates (A) a-posteriory and (B) in real time (also worldwide). These data sets were selected by the users and thus dominated by small events with no human losses. The over-all reliability of the estimates is 92%. For disasters with more then 1000 fatalities the reliability is 70%.

Figure 2: Three dimensional model for part of Dubai. The height of each building is constructed from its shadow.