Introduction to Earthquake Hazard, Risk, and Disasters: Why a Book on Earthquake Problems Now?

Two megaearthquakes that generated great tsunamis, killing hundreds of thousands during the last decade, also shocked millions of people, who watched on television the horrific devastation filmed by owners of smart phones, who miraculously survived. These extraordinary events changed the thinking of experts as well as that of the public. The inadequate protection of the Dai Ichi nuclear power plant prompted the Swiss population to outlaw nuclear generation of energy by a nationwide vote.

Seismologists had to revise their thinking. When C. F. Richter, in his classic book "Elementary Seismology" defined the term "great earthquake" as one with magnitude M8+, there were no M9+ earthquakes known. Now that two of them have ruptured 1,000 and 650 km long plate boundary segments, respectively, we need to coin the new expression "megaearthquake" for referring to them, an expression that fits the current age of superlatives.

More important is the new understanding of ruptures along faults that these two events have taught us. The maximum credible earthquake (MCE), which a fault is capable of, forms a key input for estimating the seismic hazard near a fault. Because faults are segmented and plate boundaries, like the Pacific coast of Japan, mostly rupture in limited segments, generating M8 class earthquakes, seismologists have not been bold enough to consider the possibility that M(MCE) may be larger than 9. Previously, it was thought that the greatest earthquakes, like the ones in Chile (1960) and Alaska (1964), were only possible along straight segments of subduction zones. Now, one has to consider the possibility that plate boundaries like the Himalayas and the Pacific coast of Mexico may surprise us with megaearthquakes rupturing through the segments usually generating "only" great earthquakes.

Chapters in this book describe the state of the art in new and important tools and methods to understand the earthquake hazard and to reduce the risk. Paleoseismology (*Meghraoui and Atakan*) is the primary tool for hunting for evidence concerning megaearthquakes of the past approximately 10,000 years. Space techniques allow the mapping of deformations of the Earth's surface with centimeters, even millimeters, accuracy (*Taubenboeck et al.*), which allows the construction of detailed models for past earthquakes and provides maps of strain accumulation for future earthquakes. In addition, satellite images greatly facilitate mapping the damage in the wakes of disasters, enabling an effective response on an informed basis (*Hyuck et al.*). In addition to these technological advances, simple well-designed approaches to reconstruction in devastated areas are much needed (*Schacher*).

Advances in early warning (*Hoshiba*) make it possible to shut down dangerous processes, while the high amplitude seismic waves are approaching. Once these waves have hit population centers, real-time earthquake loss assessments can now estimate reasonably reliably the numbers of casualties that probably resulted within about an hour of the earthquake (*Wyss*). This enables first responders to mount rescue efforts commensurate with the extent of the disaster.

The dream of predicting earthquakes reliably has not been realized yet, but attempts to make progress in this field are described in three chapters (*Wu; Sobolev and Chebrov; Kossobokov*). The shift away from predicting to forecasting is presented by *Schorlemmer and Gerstenberger and by Zechar et al.*

The current controversy concerning the method and results of estimating seismic hazard and risk is addressed in detail. *Stirling* argues the case of the standard method of estimating seismic hazard, whereas *Panza et al.* present the objections to what they consider an inadequate, even incorrect method. Although deterministic estimates of the hazard have some advantages, *Michel* explains the need of insurers to calculate the hazard and risk probabilistically. *Anderson et al.* summarize the ingenious method of using the presence of precariously balanced rocks to estimate the upper limit of ground accelerations that could have occurred locally during the last approximately 10,000 years.

Earthquake engineering is most useful in reducing the risk the population is exposed to by designing new structures so they will resist strong ground shaking (*Tolis*). However, special techniques have to be developed and taught in regions where the construction materials and skills are limited (*Dixit et al.*). Unfortunately, the best efforts of earthquake engineers are nixed, if greedy developers and companies find ways of ignoring building codes (*Bilham*). A related problem influencing damage patterns is that of often unknown soil conditions beneath the built environment (*Parvez and Rosset*).

The impact of earthquake disasters on the population and the socioeconomic consequences is examined by *Daniell* and the responses of the Japanese coastal population in the face of the approaching megatsunami are analyzed by *Ishida and Ando*. With these topics, this book covers the most significant advances in the struggle to slow the increasing earthquake casualties we experience because of population growth.

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