PRACTICAL LESSONS FROM USING EARTHQUAKE SCENARIOS IN EMERGING COUNTRIES

J. Rodgers¹, B. Tucker², L. Tobin³, H. Kumar⁴, M. Ortiz-Millan⁵, and A. Chakos⁶

ABSTRACT

Earthquake scenarios have been used extensively in Japan, the United States and other industrialized countries to understand and communicate earthquake impacts. Since 1992, GeoHazards International (GHI) has used earthquake scenarios in emerging countries as tools to communicate risk, raise awareness and motivate action in vulnerable communities. This paper draws lessons from GHI’s experience and examines how scenarios can contribute to resilience-building. GHI pioneered using scenarios to reduce risk in emerging countries with projects in Ecuador and Nepal, and held a first-of-its-kind workshop in 1993 to agree on good practices for such scenarios. In projects in Bhutan, India, China, Mexico, Chile, and Indonesia, GHI used scenarios with varying depth and technical detail. Lessons from GHI’s practice of using scenarios as risk communication tools include: (1) scenarios intended to communicate and motivate need not be costly loss estimation exercise, and funds may be better spent mitigating risk; (2) involve both experienced practitioners and local professionals; (3) select the scenario earthquake for the intended use, based on sound science; (4) combine scenario development with mitigation planning to create a pathway to action; and (5) communicate clearly with attention to local audience needs.

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Practical Lessons from Using Earthquake Scenarios in Emerging Countries

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Earthquake scenarios have been used extensively in Japan, the United States and other industrialized countries to understand and communicate earthquake impacts. Since 1992, GeoHazards International (GHI) has used earthquake scenarios in emerging countries as tools to communicate risk, raise awareness and motivate action in vulnerable communities. This paper draws lessons from GHI’s experience and examines how scenarios can contribute to resilience-building. GHI pioneered using scenarios to reduce risk in emerging countries with projects in Ecuador and Nepal, and held a first-of-its-kind workshop in 1992 to agree on good practices for such scenarios. In projects in Bhutan, India, China, Mexico, Chile, and Indonesia, GHI used scenarios with varying depth and technical detail. Lessons from GHI’s practice of using scenarios as risk communication tools include: (1) scenarios intended to communicate and motive need not be costly loss estimation exercise, and funds may be better spent mitigating risk; (2) involve both experienced practitioners and local professionals; (3) select the scenario earthquake for the intended use, based on sound science; (4) combine scenario development with mitigation planning to create a pathway to action; and (5) communicate clearly with attention to local audience needs.

Background on Earthquake Scenario Development and Usage

Beginning in the late 1960s and early 1970s, professionals in Japan and California began preparing earthquake scenarios describing the effects of a single damaging earthquake, based on formal loss estimates. Among the earliest publicly prepared scenarios published, though not necessarily identified as such, were loss estimates by the US National Oceanic and Atmospheric Administration (NOAA) and the US Geological Survey (USGS) for specific earthquakes. These included studies of San Francisco in 1972 [1] and Los Angeles in 1973 [2]; Puget Sound, Washington in 1975 [3] and Salt Lake City, Utah in 1976 [4]. In Tokyo, a very detailed 15-year study of the effects of a repeat of the 1923 M7.9 Kanto earthquake on the modern city was released in 1978 (described in [5]), which was probably the first comprehensive earthquake scenario. A similarly detailed 10-year study on suburban Tokyo was released in 1985, and both studies were revised and updated in 1991 [5].

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Beginning in 1980, the California Division of Mines and Geology (now the California Geological Survey) began preparing earthquake scenarios for planning purposes. After the 1980 Mt. St. Helens volcanic eruption, the President requested that the National Security Council consider the impact of a large damaging earthquake in California and present findings to decisionmakers, emergency planners and the public [6]. CDMG prepared scenarios for several events of particular concern, beginning with M8.3 events on the San Andreas Fault near Los Angeles [6] and San Francisco [7]. The southern San Andreas Fault scenario focused on damage to lifelines including highway, airport, railway, marine, communication, water, waste disposal, electrical power, natural gas, and petroleum servicing the Los Angeles Basin and nearby areas.

In the 1990s, GeoHazards International pioneered the use of earthquake scenarios for risk reduction in emerging and developing countries, working with local professionals to create scenarios in Quito, Ecuador [8] and Kathmandu, Nepal [9], as well as in additional cities under the RADIUS project [10]. These scenarios are early examples of transdisciplinary, participatory approaches to scenario creation in emerging countries. In 1992, GHI and OYO Corporation hosted a state-of-the-practice workshop in Istanbul, which explored scenario development techniques and uses at the time and resulted in a Sourcebook for practitioners [11] preparing earthquake scenarios in developing countries. More recently, GHI developed an earthquake scenario for Aizawl, India, in which landslide hazard figures prominently [12]. Other scenarios prepared outside the US and Japan include those for Bogota, Colombia [13]; Kangra, India; Banepa, Dharan and Vyas [14] and at regional level in Nepal (Robinson, personal comm. 2017).

Also following the early CDMG scenarios, the Earthquake Engineering Research Institute (EERI), US Geological Survey (USGS) and agencies in several US states developed earthquake scenarios with a variety of emphases and levels of technical detail. These scenarios and those to follow made use of developments in earthquake loss estimation, including the ATC-13 project [15], advancements by commercial firms in risk modeling for insurance purposes, and the development of loss estimation software such as HAZUS. Notable EERI scenarios included repeats of the 1868 Hayward Fault [16] and 1906 San Francisco earthquakes [17] in the San Francisco Bay Area; a hypothetical M6.7 Seattle Fault earthquake [18]; and a M7 earthquake on the Salt Lake City segment of the Wasatch Fault Zone in Utah in 2015, and development of a guidebook on scenario development for local professional organizations.

In 2008, the USGS and numerous partners released the ShakeOut Earthquake Scenario [19], the most elaborate earthquake scenario in the US to date, which describes the effects of M7.8 earthquake on the southern San Andreas Fault near Los Angeles. The ShakeOut scenario was used as the basis for large public drills and the Golden Guardian response simulation exercise; developers prepared the scenario specifically for these uses. USGS has also developed scenarios for other major hazards including severe storms and an Aleutian tsunami. Scenario-based planning and awareness methods are similarly applicable to a range of other hazards.

In 2010, the Applied Technology Council and City and County of San Francisco published a notable, locally focused set of scenarios, under the Community Action Plan for Seismic Safety (CAPSS) program, which supported significant mitigation actions on some of the most important of San Francisco’s remaining seismically vulnerable buildings. In the Pacific Northwest region, the Oregon Department of Geology and Mineral Industries (DOGAMI), the Cascadia Region Earthquake Working Group and others have prepared scenarios describing the effects of a large
Cascadia subduction zone event. Professionals in the insurance and risk modeling industries have also created numerous earthquake scenarios that typically explore insured losses caused by specific scenario earthquakes (e.g., [20]). Several additional notable scenarios were in process as of this writing, including the “Haywired” Scenario, a USGS effort focused on effects of a M7 Hayward Fault earthquake on lifelines and technology in the San Francisco Bay Area, and a China-UK-US collaborative scenario project in Weinan, China in which GeoHazards International is providing scenario development expertise.

Practical Lessons from GHI’s Experience

GHI’s experience provides lessons for those using scenarios to motivate risk reduction in emerging countries. First, technical rigor should not be the enemy of the effective. Scenarios intended to communicate or motivate need not be data-intensive, costly loss estimation exercises—they must describe consequences of disruptive shaking on things the community values. Scarce mitigation funds are typically better used to develop and implement solutions, rather than on more exhaustive analyses.

Keeping the scenario’s intended use in mind is essential. Second, involve experienced practitioners and local professionals from multiple disciplines who can ensure findings agree with community realities, recommend solutions to problems uncovered, and bring credibility to the process. The process of diagnosing consequences and developing solutions with locals who will implement recommendations is essential. Third, select the scenario earthquake based on intended use as well as sound earth science. A worst case scenario earthquake does not necessarily motivate people or help uncover the main risk problems, but is useful for emergency planning and critical facilities. Fourth, combine scenario development with mitigation planning to create a pathway to action. Finally, communicate clearly what people need to do to make themselves safer, with a local voice, good graphics and plain language.

Scenario development provides opportunities for key local actors to begin working together, and for stakeholders to agree on resilience-building priorities. Cities and local institutions can use the scenario, priorities and mitigation plans to advocate for resources from local sources, the national government, and in some cases, international agencies. Scenarios bring together community leaders, local professionals, and often, national and international technical specialists, leading to partnerships and collaborations that enhance earthquake safety. GHI’s experience demonstrates that scenarios—and most importantly, the process used to develop them—can be catalysts for resilience.

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References

2. Algermissen ST, Hopper M, Campbell K, Rinehart WA, Perkins D, Steinbrugge KV, Lagorio HJ, Moran DF,


8. Escuela Politecnica Nacional; GeoHazards International (GHI); Ilustre Municipio de Quito; ORSTOM, Quito; OYO Corp., *The Quito, Ecuador, earthquake risk management project: an overview,* GHI, California, 1994.


16. EERI. *Scenario for a Magnitude 7.0 Earthquake on the Hayward Fault,* Earthquake Engineering Research Institute, Oakland, California, 1996.


18. EERI. *Scenario for a Magnitude 6.7 Earthquake on the Seattle Fault,* Earthquake Engineering Research Institute, Oakland, California, 2005.
