Earthquake Hazard Assessment: An Independent Review

Vladimir G. Kossobokov (1, 2, 3)
E-mails: volodya@mitp.ru; volodya@ipgp.fr

(1) Institute of Earthquake Prediction Theory and Mathematical Geophysics, RAS, Moscow, Russian Federation | (2) Institut de Physique du Globe de Paris, Paris, France | (3) International Seismic Safety Organization, ISSO, Arzila, Italy

Seismic hazard assessment (SHA), from term-less (probabilistic PHSA or deterministic DSIA) to time-dependent (t-DASH), including short-term earthquake forecast/prediction (SIEF), is not an easy task that implies a delicate application of statistics to data of limited size and different accuracy. Regrettably, in many cases of PHSA, LOAS, and SIEF, the claims of a high potential and efficiency of the methodology are based on a flawed application of statistics and hardly suitable for communication to decision makers. The necessity and possibility of applying the modified tools of Earthquake Prediction Strategies, in particular, the Error Diagram, introduced by G.M. Molchan in early 1990’s for evaluation of SHA, and the Seismic Roulette null-hypothesis as a measure of the alert level, is evident, and such a testing must be done in advance claiming hazardous areas and/or times. The set of errors, i.e., the rates of failure and of the alert space-time volume, compared to those obtained in the same number of random guess trials permits evaluating the SHA method effectiveness and determining the optimal choice of the parameters in regard to specified cost-benefit functions. These and other information obtained in such a testing may supply us with a realistic estimate of confidence in SHA results and related recommendations on the level of risks for decision making in regard to engineering design, insurance, and emergency management.

These basics of SHA evaluation are exemplified with examples of misleading “seismic hazard maps,” “predictors,” and “forecast/prediction methods.”

How earthquake prediction methods work?

“Predicting earthquakes is as easy as one-two-three.

Step 1: Deploy your precursor detection instruments at the site of the coming earthquake.

Step 2: Detect and recognize the precursors.

Step 3: Get all your colleagues to agree and then publicly predict the earthquake through approved channels.”

(Scholz, 1997)

Earthquake prediction definition

The United States National Research Council, Panel on Earthquake Prediction, of the Earthquake Hazard Assessment: an Independent Review, published in 1988, defines earthquake prediction as “prediction is the assessment of the time, location, magnitude, and other attributes of an earthquake, based on a priori knowledge of physical processes that generate seismic energy.”

Natural seismic volume

Earthquakes can be classified according to their size, location, and magnitude. Earthquakes can be divided into four categories based on the magnitude of the earthquake. These categories include microearthquakes, small earthquakes, medium earthquakes, and large earthquakes.

Earthquake magnitude scales

Earthquake magnitude scales include the Richter scale, the moment magnitude scale, and the magnitude-moment scale. Each scale has its own advantages and disadvantages.

The Richter scale is a logarithmic scale that measures the energy released by an earthquake. The scale ranges from 1 to 10, with each increase of 1 on the Richter scale representing a tenfold increase in energy.

The moment magnitude scale is a scale that measures the total seismic moment of an earthquake. The scale ranges from 0 to 10, with each increase of 1 on the moment magnitude scale representing a tenfold increase in seismic moment.

The magnitude-moment scale is a scale that combines the magnitude and moment of an earthquake. The scale ranges from 0 to 10, with each increase of 1 on the magnitude-moment scale representing a tenfold increase in magnitude and moment.

The magnitude and moment of an earthquake can be used to determine the size and power of an earthquake.

Earthquake hazard assessment

Earthquake hazard assessment (SHA) is the process of evaluating the risk of future earthquakes. SHA is important for understanding the potential impact of earthquakes on human populations, infrastructure, and the environment.

Pros of SHA

- SHA helps in the development of emergency plans and evacuation routes.
- SHA helps in the development of building codes and regulations.
- SHA helps in the development of land-use plans.
- SHA helps in the development of insurance policies.
- SHA helps in the development of evacuation plans.
- SHA helps in the development of disaster preparedness plans.

Cons of SHA

- SHA is based on statistical models and is subject to uncertainty.
- SHA can lead to overestimation of earthquake risk.
- SHA can lead to underestimation of earthquake risk.
- SHA can be expensive to perform.
- SHA can be time-consuming to perform.
- SHA can be controversial among different countries.

How to do SHA

1. Collect data on past earthquakes.
2. Analyze the data to identify patterns.
3. Use the patterns to predict future earthquakes.
4. Use the predictions to develop emergency plans and evacuation routes.
5. Use the predictions to develop building codes and regulations.
6. Use the predictions to develop land-use plans.
7. Use the predictions to develop insurance policies.
8. Use the predictions to develop evacuation plans.
9. Use the predictions to develop disaster preparedness plans.

Risks of SHA

- SHA can lead to overestimation of earthquake risk.
- SHA can lead to underestimation of earthquake risk.
- SHA can be expensive to perform.
- SHA can be time-consuming to perform.
- SHA can be controversial among different countries.

Earthquake hazard assessment can be performed using various methodologies, including probabilistic seismic hazard analysis (PSHA), deterministic seismic hazard analysis (DSHA), and probabilistic forecast/prediction (SIEF).

Probabilistic Seismic Hazard Analysis, PSJA

Probabilistic seismic hazard analysis (PSHA) is a method for estimating the probability of earthquake occurrence in a given location over a specified time period.

Deterministic Seismic Hazard Analysis, DSHA

Deterministic seismic hazard analysis (DSHA) is a method for estimating the maximum seismic hazard in a given location over a specified time period.

Probabilistic Seismic Forecasting, PSF

Probabilistic seismic forecasting (PSF) is a method for estimating the probability of an earthquake occurring in a given location over a specified time period.

The future is uncertain and earthquakes are a natural part of our planet. As we continue to study and learn about earthquakes, we will continue to improve our understanding of these phenomena.

For more information on earthquake hazard assessment, please contact the United States Geological Survey (USGS) at 1-888-ASK-USGS or visit their website at http://earthquake.usgs.gov.

This document is protected by copyright laws. unauthorized reproduction of all or part of this document is strictly forbidden.