IMPROVING TIME-VARYING SEISMIC HAZARD ASSESSMENT: ICELAND AS A CSEP TESTING REGION

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Abstract

Improving our ability to accurately forecast where and when the next damaging earthquake will likely occur is one of the key steps towards improving the earthquake resilience of modern societies. Model testing & validation is a critical next step in implementing time-varying probabilistic seismic hazard assessment (TV-PSHA). Progress in TV-PSHA has been impeded by the lack of an adequate experimental infrastructure, making it difficult to conduct scientific prediction experiments and model development under rigorous, controlled conditions, and even more difficult to evaluate forecasts using accepted criteria specified in advance. To remedy this deficiency, the Collaboratory for the Study of Earthquake Predictability (CSEP, www.cseptesting.org) is currently developing a community-supported, geographically-distributed laboratory with a computational infrastructure that is adequate to support a global program of research on earthquake predictability.

The CSEP EU Testing Center at ETH Zurich (eu.cseptesting.org) represents the European node of CSEP. It is funded in part through the EU project NERIES (www.neries-eu.org), and it will serve multiple testing regions within Europe. The first such region is in Italy, and experiments there are being sponsored by the Istituto Nazionale di Geofisica e Vulcanologia (INGV). For the Italian testing region, fully prospective testing of long-term (five- and ten-year) models started August 1 2009; 18 long-term models are participating. Models span the full range from purely statistical to mostly physics-based, and forecasts have been contributed by researchers from more than eight institutions across Europe. Model forecasts will be evaluated against earthquakes of magnitude at least 4 and 5 and above, as reported by INGV.

We propose that, because of the high seismicity and deformation rates, the excellent monitoring network, and the existence of several geophysical models, Iceland is ideally suited as a future testing region within the CSEP EU Testing Centre. Applying the wide range of existing models in Iceland should help improve our understanding of the physical processes underlying earthquakes in Iceland, and it may also lead us to generalisations regarding seismicity elsewhere. We have obtained seed funding from the Swiss National Science Foundation for the first phase of such a project. In collaboration with IMO scientists, we want to develop Iceland as a CSEP testing region within the next three years. This work will include (1) studies of earthquake network homogeneity and catalogue magnitude completeness; (2) calibration of a range of existing forecasting models to the seismic regions of Iceland; (3) evaluation of model forecasting ability based on retrospective testing and finally (4) implementation of fully prospective testing of models against a define authoritative data stream provided by IMO.

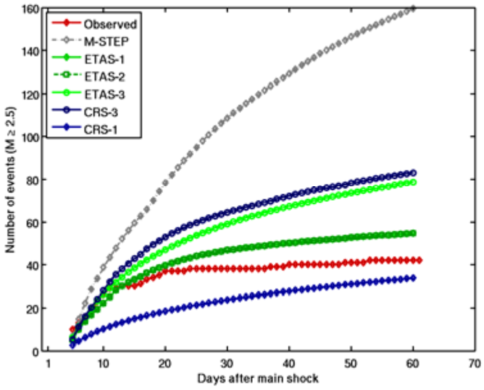

Figure 1: Cumulative observed number of events since the 2008 Selfoss earthquake (red), compared here with forecasts from six models.

As part of the EU FP6 Project SAFER (www.saferproject.net) we conducted an initial comparison of the forecasting skills of a range of physics-based and statistical models. We retrospectively analysed seismicity following the M_W=6.3 2008 Selfoss earthquake. The abundant seismicity in such sequences offers ideal conditions for studying earthquake interaction. We analyzed the performance of eight models from different classes: (1) two modified Short-Term Earthquake Probability models (M-STEP), (2) four Epidemic Type Aftershock Sequence (ETAS) models with and without time- and space-varying parameters and using various spatial triggering kernels, and (3) two models based on a combination of Coulomb stress change and rate and state theory (CRS).

The results of this case study (Figure 1) show that ETAS-type models perform quite well, followed by the CRS-3 model, which incorporates much more statistical variability than CRS-1. The fit of the M-STEP model is poor as it likely suffers from insufficient regionalization.