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Impact of the 2011 M=9.0 Tohoku-oki earthquake on increased seismic hazard for greater Tokyo

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The Kanto seismic corridor surrounding Tokyo has hosted 4-5 damaging M>=7 earthquakes in the past 400 years, and 55 M>=3 shocks per year were recorded in the decade before the Tohoku-oki earthquake. Both observations would indicate a 1.0-1.4% annual M>=7 probability, or 5-7% for 5 yr. Immediately after the Tohoku-oki earthquake, the seismicity rate in the corridor jumped ten-fold, while normal and strike-slip focal mechanisms all but ceased. The seismicity rate then decayed for less than a year, after which the rate steadied at three times the pre-Tohoku rate. The seismicity rate jump and decay to a new rate, as well as the shutdown of non-thrust mechanisms, can be explained by static Coulomb stress imparted to faults 40-80 km beneath the Kanto plain by the Tohoku rupture and postseismic megathrust creep. We fit the observations with a rate/state model, which we use to estimate the time-dependent probability of future large earthquakes in the corridor. Although it is possible that the increased Kanto seismicity accompanies accelerated creep that is shedding -rather than accumulating- the stress imparted by Tohoku-oki, the ratio of small to large shocks was not changed by the Tohoku-oki mainshock, and so the simplest assumption is that the probability of large shocks has climbed with the increased rate of small ones. Thus, for a b-value of 0.9, we estimate a 17% probability of a M>=7.0 shock over the 5-year prospective period, 11 March 2013 to 10 March 2018, two-and-a-half times the probability before the Tohuku-oki earthquake.

Keywords: Tohoku-oki earthquake, seismicity, Coulomb stress change, seismic hazard, earthquake probability