

Felt earthquakes in Tokyo (Edo) based on historical daily records and seismic intensity data

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There have been three generations of collection and publication of historical materials on earthquakes. They are “Dai-Nihon Jishin Shiryo (Collection of Historical Documents on Earthquakes in Great Japan)” in 1904, “Zotei Dai-Nihon Jishin Shiryo” and “Nihon Jishin Shiryo” in 1941-1951, and “Shinshu Nihon Jishin Shiryo” in 1981-1991. On the basis of these collected materials, annual number of felt earthquakes in Tokyo (formerly Edo) was examined by Usami (1979, CCERP report) and Usami and Watanabe (2005, 2006, Historical Earthquakes). Number of felt earthquakes strongly depends on the available materials. The above collections contains some daily records of clans which documented daily weather and earthquakes, and the recorded earthquakes include small shocks or aftershocks of large damaging earthquakes. In order to discuss temporal changes of seismicity, such homogeneous records should be used. In this study, number of yearly earthquakes in several daily records are counted, and compared with seismic intensity data of Japan Meteorological Agency since 1885.

Among the daily records during the Edo period (1603-1867), “Tsugaru-han On-nikki” recorded the largest number of felt earthquakes; approximately 1550 events during 200 year period between 1668 and 1866. However, there are several years during which no earthquake was documented. The next one is “Sakaki-bara Nikki” , which documented approximately 700 events during 200 year period between 1651 and 1859. This record also contains years without any earthquake, but such years are different from those of the previous record. By merging these two daily records, there are only few years without felt earthquakes. For the earlier Edo period, “Edo-bakufu Nikki” (two different sources) cover more or less continuously from 1631 to 1707 with 680 earthquakes. In addition, several other records such as “Tsushima-han Mainichiki” , “Inaba-shi Eidai Nikki” or “Sakai-ke Shiryo” each documented more than 100 earthquakes. Yearly number of earthquakes were counted for each record, and the largest number for each year was selected. The dataset thus made contain nearly 2500 earthquakes for 241 year period (1628-1868) with annual average of about 10 events. The yearly record has several peaks in 1704 (about 60 events), in 1855 (about 50 events) and in 1649 (about 50 events). These represent aftershocks of the 1703 (31 December) Kanto earthquake, 1855 Edo earthquake and two M7 earthquakes in 1649.

Seismic intensity data since 1885 has been compiled by JMA (Ishigaki and Takagi, 2000, Quarterly J. Seismology; Ishigaki, 2007, *ibid*), which shows that the annual number of earthquakes with intensity 1 or larger, 2 or larger, 3 or larger are 52, 16 and 5, respectively. If we assume that the seismic intensity rate is constant in the last 400 years, then the above merged historical daily data recorded felt earthquakes with intensity 2 or larger. The JMA data show that the largest number of felt earthquakes was recorded in 2011, with 148 events with intensity 2 or larger, representing aftershocks and triggered seismicity by the Tohoku earthquake. Numbers of earthquakes with intensity 2 or larger were 36 and 35 in 1923 and 1924, following the Taisho Kanto earthquake. Combining the historical data from daily records, it is concluded that the number of felt earthquakes was largest in 2011 in the last 400 years.

Keywords: Historical earthquakes, Daily records, Tokyo