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Re-examination of the damage distribution and the source area of the 1828 Sanjo Earthquake

Toshifumi Yata[1], Atsushi Urabe[2], Akihito Nishiyama[3*], Kenji Satake[3]

[1]Faculty of Humanities, Niigata Univ., [2]NHDR, Niigata Univ., [3]ERI, Univ. of Tokyo

The earthquake that occurred in the mid-Niigata Prefecture at 6:20 a.m. -7:00 a.m., 12th day of 11 th month, Bunsei 11th (Gregorian calendar: 18 December, 1828) caused serious damages especially in the flood plain of the Shinano River. This earthquake exerted serious damages in Sanjo town, and therefore it has been called as the Sanjo Earthquake. The epicenter and source fault were investigated by Usami (2003) and Uetake et al. (2005). Moreover, Usami (2003) estimated the magnitude as 6.9.

According to historical records, the number of completely collapsed houses is 2418 in Sanjo town and 305 in Yoita town, respectively. It indicates that the damages were serious in large population towns in those days such as Sanjo town and Yoita town. However, it is erroneous to conclude that the source of this earthquake is around Sanjo town or Yoita town from the number of collapsed houses, because large population towns yield more collapsed houses. Therefore, it is also necessary to investigate damages in the other area, and also to estimate damage ratio in order to specify the focal region of the Sanjo Earthquake.

In this study, we selected reliable historical records which describe the original population and number of house, as well as casualties or damages caused by this earthquake. Using such reliable documents, the collapse ratio of houses can be estimated with a high accuracy at each village. Moreover, we converted the collapse ratio of houses at each village into seismic intensity scale, and iestimated the focal region of the 1828 Sanjo Earthquake.

Historical documents describing both the number of houses and the number of damaged houses are essential to estimate the collapse ratio of houses at each village. Supposing two different historical documents: one describing the number of houses at each village and the other describing the number of damaged houses are used, it is difficult to reliably estimate the collapse ratio, due to that fact that the actual areas of each village may be different even for the same village name because the documents were written in different time by different authors.

In this study, we estimate the collapse ratio of houses using three reliable historical records from which both the number of houses and the number of damaged houses can be specified. The first historical document records the number of houses and damaged houses at 54 villages. Therefore, it provides accurate distribution of collapse ratios of houses. The second historical document seems to be based on a report compiling damages and casualties to a public office of the Nagaoka feudal clan, and records both the number of houses and of non-collapsed houses. Therefore, it is also possible to estimate the accurate collapse ratio of houses. The third document describes the number of houses and damages at each house (burned, collapsed and partially collapsed) in each region of Yoita-machi. The collapse ratio of houses at each village estimated by using above three historical documents is then converted into seismic intensity scale based on Usami (1986)'s table, i. e.

Seismic intensity 7: 80 - 100 % collapse ratio of houses.
Seismic intensity 6: 70 - 80 % collapse ratio of houses.
Seismic intensity 5+: 1 - 70 % collapse ratio of houses.
Seismic intensity 5-: 0 % collapse ratio of houses.

The estimated focal region of the Sanjo Earthquake is neither in Sanjo town , the worst-damaged area, nor Yoita town locating in the western edge of plain. The collapse ratio of houses and seismic intensity distribution revealed in this study indicate that the focal region of the 1828 Sanjo Earthquake is an area including the Higashiyama hill located in the south part of Mitsuke City.