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Re-examination of the damage distribution and the source area of the 1751 Takada Earthquake

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The Takada earthquake (M7.0-7.4) that occurred in the western Niigata Prefecture at 1-3 a.m., 26th day of 4th month, Kan'en 4th (Gregorian calendar: 26 May, 1751) caused serious damage especially along the western edge of the Takada plain, in the western mountain regions, and along the coastal area of the Sea of Japan. The epicenter is estimated in the northwestern part of Takada plain (Usami, 2003).

In this study, we investigate damage distribution and focal region of the Takada earthquake. At first, we select reliable and contemporary historical documents, because historical documents written in later ages sometimes include a wrong or exaggerate description. Next, we calculate the collapse ratio of houses (hereafter referred as CR) using only historical records that describe both the number of houses before the mainshock and that of collapsed houses. Finally, we convert CR at each village or town to seismic intensity scale (SI) based on Usami (1986)'s table as described below, and examine the focal region of the Takada earthquake.

SI 7: 81 - 100 % CR.

SI 6: 71 - 80 % CR.

SI 5+: 1 - 70 % CR.

SI 5-: 0 % CR.

The CR and SI in the western Niigata Prefecture are summarized as below.

(a) The CR in Takenao village situated on terraces with hard ground condition is 2 % [SI 5+]. However, the CR in other villages situated on the alluvial plain with soft ground condition is 13-58 % [SI 5+]. The Iwadegumi area (present Joetsu City Kakizaki-ku area) is not the focal region because the CR is low in village with hard ground condition.

(b) The CR in Ima-machi town situated on sand dune of hard ground condition is 5 % [SI 5+]. The CR in Yoko-machi situated on inclined sand dune is 45% [SI 5+]. The CR in Naka-machi situated on flood plain with soft ground condition is 83% [SI 7]. The Ima-machi area is not the focal region because the CR is low in village with hard ground condition.

(c) The Nagahama village is situated on coastal lowland with hard ground condition and damage due to landslides accompanied with the Takada earthquake was not severe. The CR is 43% [SI 5+]. Coastal area along the Sea of Japan is not the focal region because the CR is not high in villages with hard ground condition although most villages in beachfront such as Nadachikodomari village are severely damaged by landslides.

(d) The CR in the downstream of the Kuwadori River, which flows in the western part of Joetsu City from south to north, is low (0 % [SI 5-] for the Hanatate, Nakakuwadori, and Shimo-Tsunago villages; 5 % [SI 5+] for Yamadera village). This region is not the focal region because of low CR.

(e) The villages in midstream of the Kuwadori River locate on landslide deposits with soft ground condition, and the CR is significantly high (100 % for Koike and Higashi-Yoshio villages, 91 % for the Nishi-Yoshio village, and 58 % for the Yokoyama village). However, these CRs include numerous houses due to landslides and hence, this area is not the focal region.

(f) The upper stream of the Kuwadori River is situated on hard ground condition. However, the CR is relatively high (26% [SI 5+] for the Doguchi village; 40 % [SI 5+] for the Minakuchi and Yokobatake villages). The CRs of villages in the upper stream of the Kuwadori River are significantly higher than those of downstream. In addition, the CR is high (20 % [SI 5+] for the Nakanomata village; 53 % [SI 5+] for the Kami-Tsunago village) in the mountains between the Kuwadori River and Takada plain in spite of hard ground condition. Therefore, this area is close to the focal region because of high CR with hard ground condition.

(g) Machiya area, the western part of the Takada plain, locates on river terraces with hard ground condition. However, the CR is as high as 71 % [SI 6].

The focal region of the 1751 Takada earthquake probably locates near (f) and (g).

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