Damage Islands in Mashiki Town from the 2016 Kumamoto Earthquakes

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The 2016 Kumamoto earthquakes caused serious building damage in the near-source regions. The first earthquake (foreshock, Mj6.5) occurred at 21:26, April 14 and the second event (mainshock, Mj7.3) occurred at 1:25, April 16. Since there was only a 28 hour interval between the two events, it is difficult to separate the damage of the two earthquakes from field surveys.

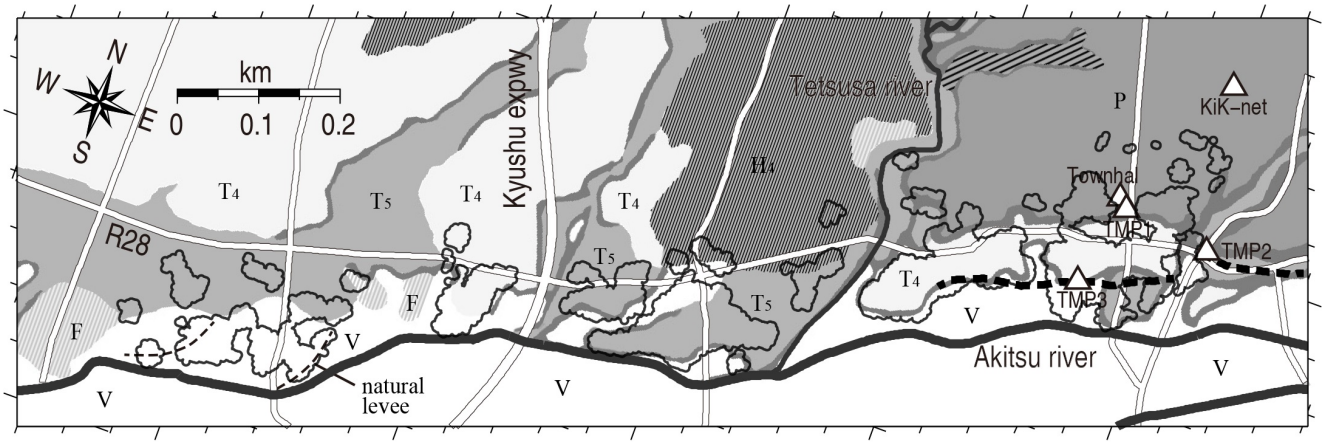
We analyzed aerial photos taken by the Geospatial Information Authority of Japan on the 15th and 16th of April and investigated the distribution of collapsed buildings along the Akitsu river. The photos cover the most severely damaged areas in Mashiki town. The two sets of photos taken between the foreshock and mainshock and after the mainshock, enable identification of the separate damage due to the foreshock and mainshock. The damage distribution is very heterogeneous, and the concentrations of severe damage occur in isolated areas resembling islands. The spatial pattern of the collapsed buildings due to the foreshock and mainshock were similar, but the number of collapsed buildings from the mainshock was 4 to 5 times the number for the foreshock.

The distribution of the collapsed buildings was compared with other information, such as the location of fault surface rupture, geomorphological map, and the location of the older built areas. The surface rupture was observed in the center of Mashiki town. The largest offset was about 40 cm along the southern edge of the concentrated damage area. Since this surface rupture was observed only after the mainshock, it is unlikely that the presence of the surface rupture generated the similar pattern of damage for the foreshock and mainshock in Mashiki.

Local geology in the survey area consists of the floodplain of the Akitsu river, multiple layers of river terraces, and an upper plateau of volcanic material. The heavily damaged area was in consistently in the lowest river terrace. The floodplain has the softest soil conditions in the area, but damage on the floodplain was much less than on the river terrace. The soft soil conditions are confirmed by microtremor array observations which showed thick sedimentary deposits with S-wave velocity less than 100 m/s on the floodplain. The observation that the most severe damage did not occur on the softest soil sites, is contradictory to many past studies. This unusual result needs further study to clarify the mechanisms of this damage distribution.

The damage islands correspond well to the distribution of the older built areas, which were constructed in the Meiji era (~1900s). Our photo analysis showed that the older buildings have a higher collapse ratio throughout the area. Therefore, building age and deterioration of the structures contribute to the damage distribution. The cause of the damage islands is likely due to a combination of the subsurface soil structure and age of buildings.

Keywords: kumamoto earthquake, building damage, strong motion



V: valley plain
F: fan and talus
T4: terrace surface 4
T5: terrace surface 5
H4: low relief hill composed of pyroclastic flow deposits
P: surface of pyroclastic flow plateau