Spatial distribution analysis of buildings with middle-level damage following Kumamoto earthquakes in 2016

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A series of M6-7 class earthquakes were initiated on April 14, 2016 around Kumamoto. Following these events, many buildings were covered with plastic sheets to facilitate repair, making their spatial distribution heterogeneous. By assumes this spatial heterogeneity of building damage, this study clarifies the spatial distribution of buildings. In addition, relationships with geomorphological factors are considered, and a preliminary method for early recognition of damage distribution using a remote sensing technique is determined.
Google Earth is a well-known digital earth software used globally. In this study, three-dimensional post-quake building models located around Kumamoto city taken by aerial photography a few weeks after the quakes were identified from Google Earth. The images enabled viewing from all angles; roofs with plastic sheets were visually identified, mostly as blue, green, and white, and their locations were recorded and defined as “middle-damaged building (MDB)”. Such buildings were the ordinal residences of individual families and also commercial multiple-floor buildings. Multiple sheets on a single building were regarded as one MDB. Green houses on farms, exterior objects, vehicles, and buildings under construction were excluded from analysis. In addition, digitized information of the original and whole building distribution was obtained from the Geospatial Information Authority of Japan (GSI) (i.e. two-dimensional polygons of building outlines).
Geospatial statistics show 15675 MBDs out of a total of 165177 buildings (9.5%). Spatial distribution on a GSI geomorphologic map shows that all buildings are mainly distributed as follows: 40.2% on terrace, 14.8% on alluvial fan, 15.0% on flood plain, and 8.0% on natural levee; whereas the distribution of MDBs is as follows: 13.0% on terrace, 5.5% on alluvial fan, 5.3% on flood plain, and 6.7% on natural levee. These results suggest that buildings on a terrace have are relatively more likely to suffer damage compared to those on an alluvial fan, flood plain, or natural levee. Although catastrophic devastation is significantly identified near the moved active fault (e.g. Mashiki town in Kumamoto), the occurrence of moderate damage (where buildings could possibly be reused after repair) has a remarkable correlation with geomorphologic condition type. Further discussion is expected in relation to characteristics of the earthquake mechanism.
Significant surface change causes a decrease in coherence in the interferometric processing of synthetic aperture radar, and there is thus less similarity between the reflected phases. This method is used to determine the distribution of damaged buildings. Normalized coherence decrease (NCD) is calculated using PALSAR-2 data observed on November 30, 2015, March 7, 2016 (both for pre-quake), and on April 18, 2016 (post-quake). The frequency of NCD values on MDBs and those for whole buildings show statistically different distributions within histograms. This result shows that moderate damage occurring to the roofs of buildings causes a higher NCD. Further improvement is thus required to detect individual damaged buildings in a case of hazard response.

Keywords: Remote sensing, ALOS-2, Geomorphology, Coherence

