## Geotechnical aspect of damage found along seismic fault that appeared in the 2016 Kumamoto Earthquake

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Starting with a magnitude-6.5 foreshock on April 14, 2016, a series of major earthquakes including the magnitude-7.3 main shock on April 16 have hit the central Kumamoto area of Kyushu, Japan, causing deaths, injuries and widespread damage to various facilities. The activity of the fault, whose right-lateral offset appeared in the main shock along the previously known section of the Futagawa fault zone, caused extensive damage to roads, bridges, a tunnel and a dam. The observed features of the damage again showed that not only intense shakes but also ground deformations such as landslides, lateral spread of embankments and levees, soil liquefactions etc., which can be found within a swath along the fault trace, can be equally or often more responsible for devastations. Moreover close to 500 millimeters of rain fell on some parts along the quake-hit areas on June 20 and 21, causing further extensive landslides and flooding, highlighting the difficulty to cope with earthquake-flood multi hazards.

LiDAR, Laser based altimetry, can penetrate through tree canopy, revealing detailed feature of bare earth left behind by past natural hazards, and the LiDAR image of the mountain slope along the outer rim of the Aso crater shows evidence of past landslides as well as the most recent one that has hit an important location for traffic. Moreover cracks are seen along the exposed scar indicating future risk. As long as clear evidence for past large soil deformation was there in LiDAR images, landslides/active fault maps etc., we could bring potential hazard to light and take necessary actions. However these pieces of evidence can be often buried beneath surface soil deposits particularly when they are near an active volcano. Because large ground deformations can be repeated in any extreme natural events as can be seen in the past major earthquakes, they are to be recorded in a quantitative manner.

Keywords: Kumamoto Earthquake of 2016, Geotechnical hazard, earthquake-flood multi hazards

