The relationship between liquefaction distribution and microtopography classification during the 1948 Fukui earthquake - Toward improvement of liquefaction hazard map -

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Introduction
In most of the cases of recent large-scale natural disasters, it seems that the present hazard maps cannot have forecasted its damages precisely (Wakamatsu et al., 2017; Une et al., 2015). This is because the specific method for establishing a hazard map is not defined nationally and it is entrusted to each local government. For further disaster prevention and reduction, it is important to establish a more reliable hazard map with a low cost and simple method. Forecast of liquefaction occurrence from a geomorphological point of view can respond to such demand. Nakao et al. (2015) proposed a method for creating a liquefaction hazard map based on the liquefaction hazard evaluation criteria and corresponding geomorphic classification from past liquefaction cases in the Kanto region. However, even in regions other than the Kanto region with different geomorphic development histories, it is not certain whether these criteria are effective. This study treats the case of the liquefaction caused by the 1948 Fukui earthquake (M 7.1) in the central part of Fukui City and examines the issues of present hazard map. Then we would like to propose the direction for creating more precise liquefaction hazard map.

Method
To clarify the liquefaction distribution of the Fukui earthquake, I obtained old air-photographs of the survey area taken by GHQ immediately after the earthquake published by the Geospatial Information Authority Japan (GSI). This study independently defined the criteria of air-photo interpretation to identify the traces of liquefaction. The results of air-photo interpretation were drawn on the map by vector data using QGIS and compared to present hazard map and various geomorphic classification maps published by GSI.

Results and Discussion
Comparison results of the liquefaction distribution of the 1948 Fukui earthquake revealed from air-photo interpretation in this study with various maps suggest that the geomorphic classification defined by Nakao et al. (2015) can apply to this study area. And also our results can newly propose some geomorphic features relating to liquefaction. For example, liquefaction occurred intensively near the old artificial bank overlapped with the former river channel, and also old bank at the adjacent point with the natural levee located on the outer shore of the former meandering river. Because beneath such areas are composed of thick loose sand, liquefaction can easily occur and geomorphic condition triggered lateral flow.
From the above results, it can be regarded that the risk of liquefaction occurrence varies depending on the combination with surrounding microtopography. Therefore, consideration of microtopography is indispensable for establishing liquefaction hazard map.
The liquefaction hazard map of Fukui City is hardly consistent with the liquefaction distribution due to the 1948 Fukui earthquake and does not reflect the actual liquefaction risk, because the present hazard map does not only refer to liquefaction history but also does not consider microtopography.For more precise forecast the liquefaction damages, we propose that the liquefaction hazard map should be established by

considering liquefaction history and microtopography.

Remained Issues
Because this study uses old black and white air-photographs, there is some difficulty part to detect details of liquefaction. To reveal the relationship between the liquefaction distribution and microtopography, it is necessary to conduct a field survey and interview to victims. The relationship between the distance from the seismic source of the 1948 event and the reaction of each microtopography is not yet resolved because this study focused on only in the central part of Fukui City. Therefore, it is also necessary to conduct air-photo interpretation in whole areas of the liquefaction damage caused by the 1948 event.

Keywords: 1948 Fukui Earthquake, liquefaction , microtopography classification, liquefaction hazard map

