Distribution morphology of deformed reclaimed valley associated with the 2018 Hokkaido Eastern Iburi Earthquake

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1. Introduction

In the 2018 Hokkaido Eastern Iburi Earthquake (M6.7) that occurred on September 6, 2018 (Japan Society of Erosion Control Engineering, 2018 etc.), the fluidization phenomenon of filled land caused by liquefaction etc. in reclaimed valley on Kiyota Ward, Sapporo City seriously damaged residential land and social infrastructures (Japanese Geotechnical Society and Japan Society of Civil Engineers, 2018 etc.). In order to discuss this fluidization phenomenon of reclaimed valley, it is necessary to know the reclaimed valley distribution morphology. Therefore, we disclosed the distribution morphology of the reclaimed valley created by the difference between the pseudo DEM generated from aerial photos using the SfM-MVS technique and the post-construction DEM. Also, we extracted the surface deformation in this area from SAR interferogram and compared it with reclaimed valley distribution.

2. Target area and study method

Reclaimed valley distribution maps were created in Kiyota Ward, Sapporo City (Kiyota site) and Atsuma Town (Atsuma site). Pre-construction DSMs were generated from 44 aerial photos of the 1960s and 1970s taken by the GSI of Japan, respectively. The DSMs were generated by using the SfM-MVS technique and the DSMs were converted to a pseudo DEM by filtering (Nakano, 2017). On the SfM analysis, we established 35 and 20 ground control points (GCPs) respectively. A 5-m grid DEM of the fundamental geospatial data was used for the post-construction DEM. The used SAR interferogram is an image by a pair of August 23, 2018 and September 6, 2018 analyzed by the GSI of Japan using the ALOS-2 data of JAXA.

3. Result & Discussion

We acquired the reclaimed valley distribution map more detail than the past distribution map in the Kiyota site. The reclaimed thickness at the Satozuka district where ground damage was serious in the Kiyota site was ca. 15 m at the maximum. Since the RMSE of vertical residual of GCPs on the SfM analysis was ca. 1.2 m, the value of reclaimed thickness has an error equivalent to that. Comparing this reclaimed valley distribution map with the SAR interferogram, we could identify surface deformations moving away from the satellite or non-interference areas in the reclaimed valley area. This non-interference areas correspond the serious damage areas and the surface deformations area has the potential to show the subsidence or sliding-like deformation of reclaimed valley.

In the Atsuma site, we confirmed small reclaimed valley which the thickness is less than 10 m. The RMSE of vertical residual of GCPs on the SfM analysis was ca. 0.8 m. Surface fissures in this site were discovered on site (Iiba and Nagai, 2018 etc.), and it is estimated that the sliding-like deformation of reclaimed valley occurred.

4. Challenges

We identified the reclaimed valley distribution morphology easily and quickly by using SfM-MVS and filtering analysis with aerial photo. Also, InSAR indicated the possibility of quickly detecting the surface deformation immediately after the disaster. However, we should be careful since the pseudo DEM created from DSM generated by the SfM analysis will have large errors when the area was forest land before construction. It is necessary to examine a more effective and prompt filtering method. Finally, I would like

to offer my sincere sympathy to the people living in the damaged regions by the earthquake.

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References:

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