MAP OF SOIL SUBSIDENCE IN URAYASU, CHIBA, CAUSED BY THE MARCH 11TH 2011 EAST JAPAN EARTHQUAKE

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ABSTRACT: On March 11th, 2011, the East Japan earthquake caused extensive damage to the eastern Japan including Tokyo bay area. Urayasu city, whose three quarters are reclaimed lands, has suffered extensive damage to lifelines due to liquefaction. In order to keep exact record of liquefaction-induced ground subsidence for rational rehabilitation strategies, an airborne LIDAR survey was carried out on April 20th 2011, and the obtained Digital Surface Model (DSM) was compared with the DSM before the earthquake. This report shows the obtained subsidence map of Urayasu.

Key Words: East Japan earthquake, Liquefaction, Reclaimed land, Airbone LIDAR, DSM, Ground subsidence map

INTRODUCTION

Tokyo Bay area is home to millions of people as well as port/factory zone to support urban lives. The March 11th 2011 East-Japan Earthquake has caused sand-liquefaction over a long stretch of landfills along the coast of Tokyo Bay, leaving many houses tilting and lifelines cut off on and in loosened sediments of sands. After almost all sands were cleared up for rehabilitation, subsidence of the liquefied area was observed as clear differences in level between ground floors of pile-supported RC buildings and exposed sidewalks. Both Konagai Laboratory, IIS, University of Tokyo and Aero Asahi Corporation jointly surveyed Urayasu City. Three quarters of Urayasu city are reclaimed lands, which suffered serious liquefactions. An airborne LIDAR imagery was obtained on April 20th, 2011, and compared with the digital surface model (DSM hereafter) for the period of December 2006 to January 2007, and pixel-wise-defined change in elevation was obtained over the entire reclaimed lands in Urayasu[1)].

METHOD

Using semi-automated techniques, the “raw” LIDAR data is normally processed to obtain an accurate “bare-earth” terrain model in which trees, vegetation, and manmade structures have been edited out. However it was most likely that single manmade structures like houses and factories have followed the soil deformations, DSM was used instead. Point density, which refers to the number of points in a given area, was about 4/m^2. And the lowest point among the four was assumed to represent the elevation of the 1m^2 square pixel. In case no point was available within a 1m^2 square pixel, inverse distance weighted (IDW) interpolation was made for this pixel using all points available within 10m

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by 10m area surrounding it. GPS point “Ichikawa” for Geo-net Japan, which is the work being done in Japan with GPS sensors that can detect minute movements in the Earth’s crust, was used as a reference to obtain the DSM. Verification was done by conducting a vehicle-borne LIDAR survey through some streets in Urayasu. Also a dual-frequency DGPS survey was conducted along some streets. The observed elevations along the streets were in good agreements with those from air-borne LIDAR survey.

DSM before the earthquake was obtained from the airborne-LIDAR survey for the period of December 2006 to January 2007. The same procedure mentioned above was taken for it. However its spatial resolution was lower than the DSM after the quake, given the point density of about 0.25/m^2.

When these DSMs before and after the quake are compared, a problem lies in that the earthquake have caused serious nation-wide misalignments of triangulation points. Therefore, only for detecting liquefaction-induced change in elevation, a pile-supported building at N35.647994, E139.913147 was assumed to have not suffered any change in elevation.

RESULT AND SUMMARY

Figure 1 is the soil-subsidence map obtained from the above-mentioned procedure. Subsidence can be seen as a green brush roughly extending in EW direction across the reclaimed lands, which brush is found to be similar in pattern to the distribution of temporary water supply valves (Figure 2) and toilets (Figure 3). On the other hand, on the long-existing natural land of Urayasu before the time of land-fills (Northwest part of Figure 1), no clear change of elevation is seen excluding yellow lateral stripes. These stripes that appear at about 500m regular interval are due to errors in the air-borne LIDAR survey in 2006 to 2007, the error is more pronounced where the laser-beam takes a turn in scanning. The obtained DSMs and the subsidence map are expected to provide necessary information for mapping practical tactics for better rehabilitations.

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SPECIAL NOTICE

The soil-subsidence image prepared here is one of the results of cooperative survey between Konagai Laboratory, Institute of Industrial Science, University of Tokyo and Aero Asahi Corporation. Aero Asahi Corporation retains copyright control over Digital Surface Models as their works.

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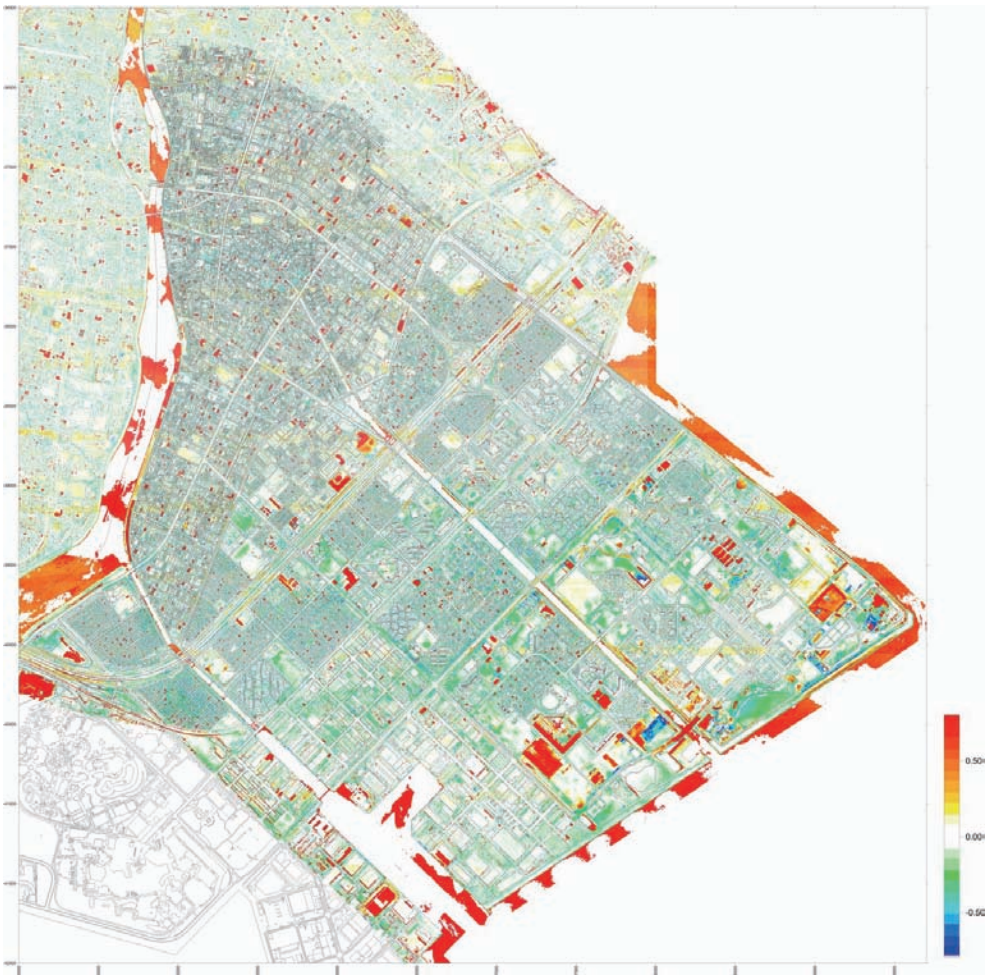

Figure 1 Soil subsidence map of Urayasu: TheJapaneseGeological Survey uses the Japanese National Grid System. It divides Japan into a set of 19 zones assigned with Greek numerals from I to XIX. The surveyed area is included in Zone IX with its origin located at 139.833333’E, 36.000000N.