TSUNAMI RISK ASSESSMENT OF NIIGATA CITY ACCOUNTING FOR SOIL LIQUEFACTION AND SNOW MELT

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AIMS AND OBJECTIVES

Tsunami risk assessment was conducted for Niigata City, one of the largest cities facing Japan Sea. Niigata City is known as historical port town developed on a low land formed as the delta by the Shinano River and the Agano River (Figure 1). The city is therefore vulnerable for soil liquefaction. In 1964, the city was devastated by a large earthquake in which soil liquefaction and tsunami worsened the damage. In addition, because of the heavy snowfall in winter, like many coastal cities on the Japan Sea side, the water level rise in the Shinano River in the snow-melt season appears to increase the flooding risk of the harbor area. The harbor is protected by a 4 km long breakwater. This study aims to investigate the tsunami risk of the Niigata City considering the collapse of the infrastructures, the soil liquefaction and the tsunami invasion to rivers in the snow-melt period.

TSUNAMI SIMULATION

Numerical tsunami simulation was conducted for three sources, F34, F35 and F38, assigned by the government. The computation was conducted on the basis of the nonlinear long wave equations. The computation domain was nested into three domains, with mesh size 1.67 km, 50 m and 10 m. The sea water level was assumed to be T.P. + 0.5m, which is the high tide at the full moon. The simulated results showed that the tsunami height at the river mouth was 2.2 m for F34 and 1.3 m for F35 and F38 (Figure 2). The arrival time of the first tsunami was earliest for F38. Flooding to the urbanized area was limited to the area < 1 km from the river mouth where the river bank is low. No flooding was simulated in the coastal area and along the Shinano River since the coastal area is protected by sand dunes with high elevation and the river bank is high enough in the area > 1 km upstream from the river mouth.

COLLAPSE OF STRUCTURES AND SNOW MELT

The collapse of the harbor breakwater was found to be most essential in increasing the tsunami damage. The collapse of infrastructures increased the flooding area by 30 % with a 60 % increase in the number of affected people. The effect of snow-melt flood was minor in the Shinano River with only a few percent increase in the flooding area. However, it was significant in the Agano River owing to the steeper slope of the river bed. It is recommended to strengthen the infrastructures around the river mouth.

EVACUATION DELAY DUE TO SOIL LIQUEFACTION

The effect of soil liquefaction was investigated in terms of the delay of evacuation. The evacuation time was calculated on the assumption that people start to evacuate 3 minutes after the shaking. Initial distribution of people was from the population data in 50 m mesh. The evacuation was assumed to be by walking with a speed of 2.3 km/h. The speed was decreased by 15 % and 35 % depending on the liquefaction map as shown in Fig. 3. The evacuation time was significantly delayed by the soil liquefaction especially in the area close to the river mouth. Appropriate assignment of tsunami evacuation buildings was found to be effective in increasing successful evacuations.

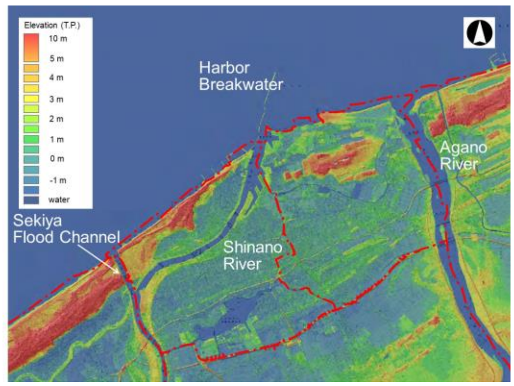

Figure 1 Topography of Niigata City

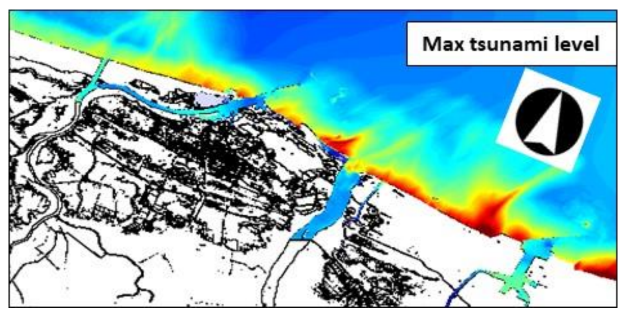

Figure 2 Maximum tsunami water level

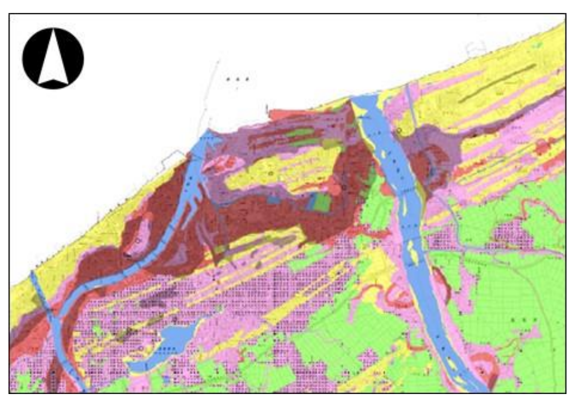

Figure 3 Distribution of liquefaction-prone area