

FIELD STUDY OF CONTRASTING BEACH RECOVERY PROCESSES OBSERVED IN NAMI-ITA and KIRIKIRI COASTS AFTER THE 2011 TOHOKU EARTHQUAKE

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INTRODUCTION

The 2011 Tohoku Earthquake caused significant shoreline retreat along the northern Pacific coast of Japan and most of the affected beaches have not yet fully recovered even six years after the event. This study investigates overall characteristics of the shoreline change after the event and also investigates contrasting beach recovery processes observed in Nami-ita and Kirikiri coasts.

ANALYSIS OF SHORELINE CHANGE

Temporal and spatial variations of the shoreline were extracted from the optical satellite images along different coasts shown in Fig.1. These coasts cover various factors which may affect the shoreline change during and after the event. At each coast, shoreline changes from the one before the event were extracted with alongshore intervals of 100m and extracted shoreline changes were averaged in each coast. The left panel of Fig.2 shows the correlation of the obtained shoreline change just after the event and the following three factors: H , the maximum tsunami height at each coast; S , land subsidence; and A_i/L_s with A_i , inundated area and L_s , alongshore stretch of the shoreline. Except the coasts, E and I_N , the observed shoreline retreat (negative shoreline change) showed positive correlation with H and S and negative correlation with A_i/L_s . It should also be noted that both C and D, Nami-ita and Kirikiri coasts, exhibit the similar characteristics.

The right panel of Fig.2 compares the time-series of the shoreline changes after the event. The amount of negative shoreline change decreases with time in all the other coasts except C and G. Clear contrast is observed between C and

D, i.e., Nami-ita and Kirikiri, in their recovery process while their initial shoreline changes were nearly the same.

FIELD SURVEY AND PRIMARY FINDINGS

Field survey was conducted to investigate the sediment transport characteristics at Nami-ita coast. The top-view movie of the nearshore waves captured by UAV clearly showed significant reflected waves from the shoreline. Four wave gauges were installed as shown in Fig.3 to evaluate the wave reflection rate of the coast. To track the sediment movement, the blue sand grains ($D_{50}=0.56\text{mm}$) and white gravels ($D_{50}=3$ to 5mm) were placed around the shoreline at the high tide on June 23rd, 2017. Horizontal movement of these tracer grains were then monitored by counting the number of each grain around the coast.

As shown in Fig.4, white gravels were transported southward along the shore and no gravels were found outside of the surf zone. While blue sand grains were also transported southward along the shore, a small fraction of blue sand grains were also found outside of the surf zone. Analysis of the time-series of the wave gauge data yielded the wave reflection rate of around 0.2 to 0.5 depending on the tide and wave conditions and the higher reflection rate was observed on the south side of the coast where has the narrow and steep gravel bed in front of the seawall. These primary results indicate that reduction of wave reflection from the shore and the nourishment by gravels with diameter of greater than several mm may be effective measures to enhance beach recovery. Details of the obtained and analyzed data will be presented at the conference and in the full paper.

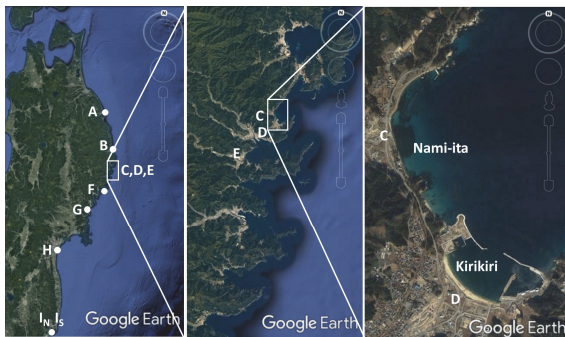


Figure 1 Target sites (base map: Google Earth)

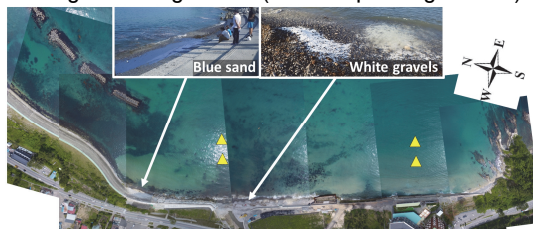


Figure 3 Top view of Nami-ita coast (UAV) with locations where tracers and wave gauges(triangle) were placed.

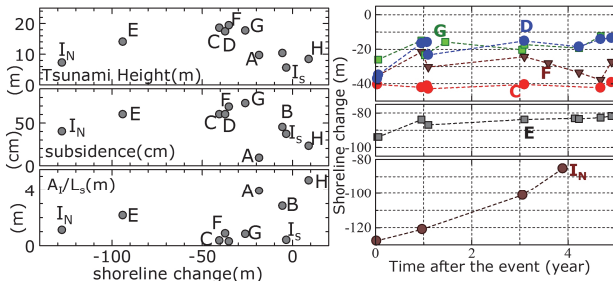


Figure 2 Correlation between the initial shoreline change and three factors, H , S and A_i/L_s (left) and the time-variations of the shoreline change after the event (right). Capital letters indicate the different coasts shown in Fig.1 and the shoreline change is negative if retreated.

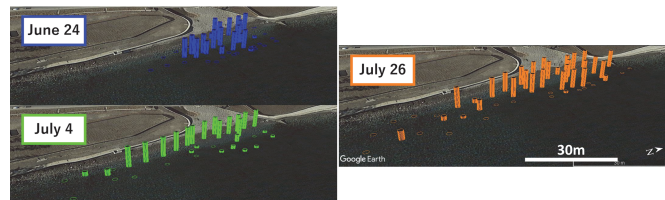


Figure 4 Spatial variations of the counted number of gravels per unit area on three different days (base map: GoogleEarth).