

IMPORTANT ROLE OF HARD STRUCTURE TO PREVENT THE OVERWASHING WAVES IN THE GAMO LAGOON

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1. INTRODUCTION

Every year, there have been many severe storms occurred around the world in general and in Japan in particular. The occurrence of storms is expected to increase because of the global warming effects. The study on a barrier island responses caused by the storm is therefore become very importance in terms of beach morphology change, sediment transport as well as near-shore structures destroyed due to overtopping wave and inundation overwash.

Due to the fact that the Nanakita Beach is low and frequently impacted by typhoons from the Pacific Ocean, these both aspects made a high wave can overtop the dune crest and bring a lot of sediments on the top of dune and even can reach to the Gamo Lagoon in some places. During the last typhoon no.18 on October 9th, 2009, there was a lot of sediment deposited inland on the overwash area and less in construction area as seen in **Fig.1**. It seems that the barrier island is migrating into the lagoon side and make the lagoon area becomes smaller, this is not good for the environment of lagoon. This study presents a discussion of the hard structure to prevent wave overwashing in the Nanakita Beach.

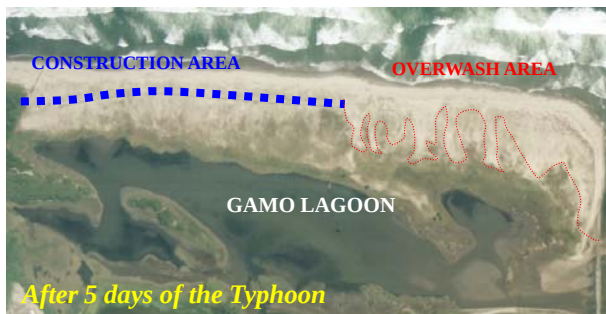


Fig.1 Aerial photo of study area on 14th Oct. 2009

2. DATA COMPILATION AND ANALYSIS

2.1 Study area

Study area is located in the southern part of Sendai Port as shown in the **Fig.2**. This sandy beach is limited by Nanakita River mouth in the south and Sendai port in the north. However, this study will be focused on the sandy beach at the Gamo Lagoon as denoted by a dot-line in the **Fig.2**.

2.2 Field observation

In order to estimate the impacts of Typhoon to the beach and calculate how much was the deposited sediment inland, the pre- and post-storm beach profiles as well as the hydrodynamics condition are appreciated. However, there were no historical data of the previous cross-shore profiles that available to use in this study area. Based on the evidence that the before surface

beach layer was covered by vegetation and grass, the cross-shore profile holes were dug until reaching this grass layer and then measure the sediment thickness so that the previous beach surface was roughly known. In total, there seven different cross-shore profiles were measured and the average thickness of deposited sediment is about 10cm of height.

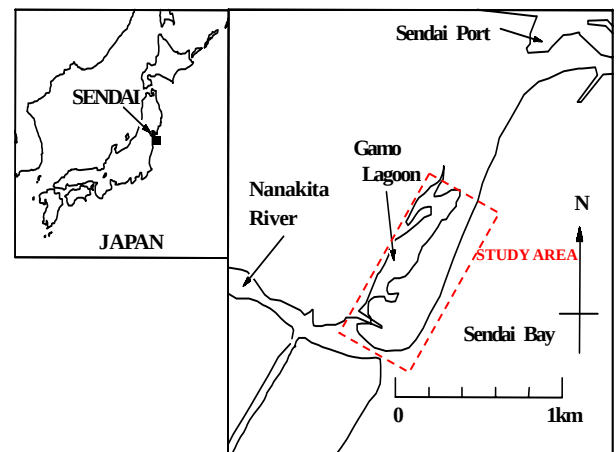


Fig.2: Location of the study area on Japan map

A field survey is also conducted to measure the topography of study area in order to get the shape of dunes and overwash fans morphology. The result is plotted and shown in **Fig.3**. It is clearly seen that overwash only occurred through the lower notch in between two dunes. In the southern part near Nanakita River mouth, the elevation of topography is quite low and morphological changes suggested that this part was inundated during the typhoon.

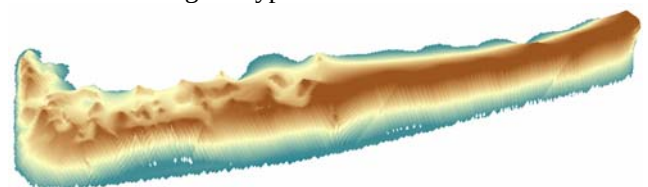


Fig.3 Topography of the study area

2.3 Hydrodynamic conditions of the Typhoon

The time series of hydrodynamic conditions of typhoon such as the wave height, wave period, and water level including storm surge height are of interest when estimating beach profiles response due to overwash and for developing and applying the empirical formula discussed in this study. The wave information is taken from the Sendai Port station which located in about 20m of water depth. The tidal level is obtained from the Ayukawa station. The time-series of Typhoon 18th hydrodynamic conditions are illustrated in **Fig.4**.

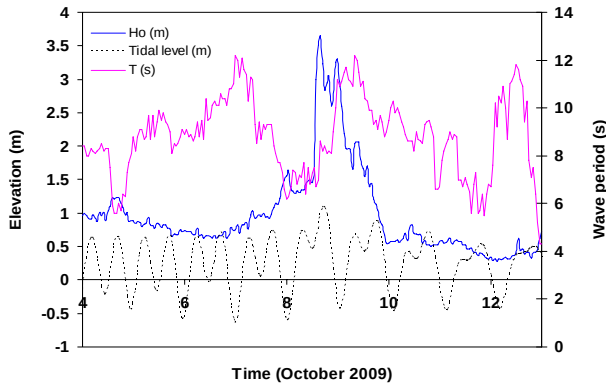


Fig.4 Hydrodynamic conditions of the Typhoon

3. RESULTS AND DISCUSSIONS

3.1. Overwashed sediment volume

Nguyen (2008) has developed an empirical formula for overwashed sediment volume by assuming this volume is proportional to the sediment transport rate multiplied by the excess runup duration (t_D).

$$Q = 0.0011 \frac{H_c}{R} \frac{t_D}{T} (R - H_c)^2 \quad (1)$$

where Q is the cross-shore sediment transport volume (m^3/m), R is the wave runup height (m), and H_c the beach crest height (m) referenced to the still-water level, t_D is the overwash duration (s), T is the wave period (s), and an empirical coefficient, $\alpha = 0.0011$, was calibrated using the field data sets from United States.

By applying this new equation to the study area at any locations, the beach crest height and locations were obtained from the results of field topography measurement as shown in **Fig.5**. The results of sediment volume deposited inland direction after the typhoon at different crest levels are illustrated in **Fig.5**.

3.2. Important role of the hard-construction

As seen in **Fig.5**, there is a lot of sediment deposited in the lower part, which is closed to the Nanakita River

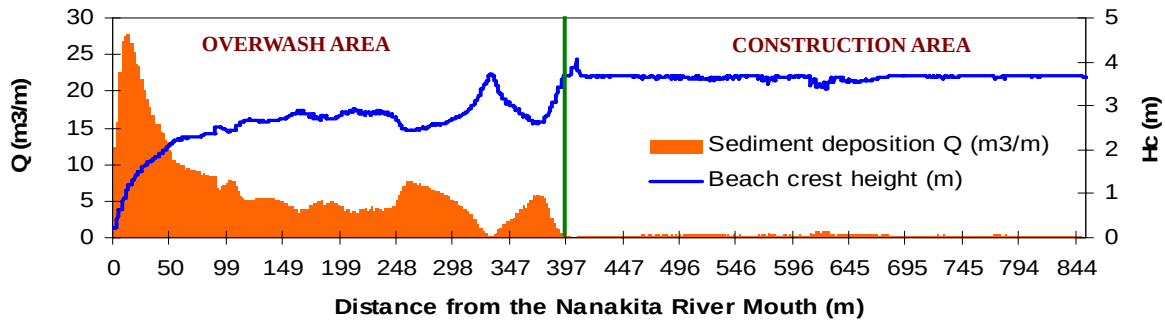


Fig.5 Overwashed sediment volume at different beach crest height

month as called as overwash area, compared to the construction part. This is because of at the site of construction; the elevation was designed as a constant level and no v-notching places, which make the overwash can occur and sediment intrude to the inland direction so that there were almost no sediment deposited on the back side of construction, even though the structure elevation was not so high compared to the overwash area part (see **Fig. 5**). Therefore, the hard-construction is played in important roles to prevent wave overwash.

Based on this, the study recommends to further construct the hard-rock structure to the northern part and in the overwash area we might have to conduct the beach nourishment such as bring the transported and deposited sediment in the lagoon to the nearshore zone. Since the fresh sediment in overwash area is somehow important for the immigrating birds that living in the lagoon.

4. CONCLUSION

As the sediment reaches to the Gamo Lagoon side, the area of the lagoon will probably smaller and it is not good for the environment of lagoon. Therefore, a recommendation is to further build up a hard rock construction up to the northern part of Gamo Lagoon. In the southern part, which is closed to the Nanakita River

mouth, we allowed overwash occurrence for some environmental reasons but the deposited sediment by overwash needs to move to the nearshore zone if it is necessary.

ACKNOWLEDGEMENTS

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Nguyen, X.T., Donnelly C., Tanaka H., and Larson M., 2008: A new empirical formula for coastal washover sediment volume, *Proceedings of 31st International Conference on Coastal Engineering*, ASCE, pp.975-985.