ECO-SYSTEM BASED BEACH EROSION CONTROL BY BERM NOURISHMENT COMBINED WITH BURIED SAND TUBE

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Aims and Objectives

Miyazaki Coast is a 10 km stretch sandy beach between the Miyazaki Port and the Hitotsuse River, located south of Japan facing the Pacific Ocean (**Fig. 1**). Significant beach erosion has been observed owing to the entrapment of sand in the harbor area and the blockage of longshore sand transport by the river mouth jetties. Sato et al. (ICCE 2010) estimated that the direction of the long-term longshore sand transport is to the southward on the basis of thermo-luminescence measurement of beach sediments. Continuous bathymetry surveys indicated the southward longshore sand transport rate at 200 thousand m3/year. However, a large variability of the incident wave direction suggested the variability in the direction of the longshore transport. Occasional attacks of typhoon storms appeared to accelerate the erosion.

As a countermeasure to mitigate the erosion, sand nourishment has been introduced since 2008 with the amount of 50 to 80 thousand m3/year. Three groins were constructed to decrease the longshore transport. However, further erosion has been observed by typhoon storms even on the nourished area.

This paper describes the results of on-site monitoring of waves, currents and topography change to understand the role of typhoon storms in beach erosion and to investigate the performance of eco-system based erosion control works.

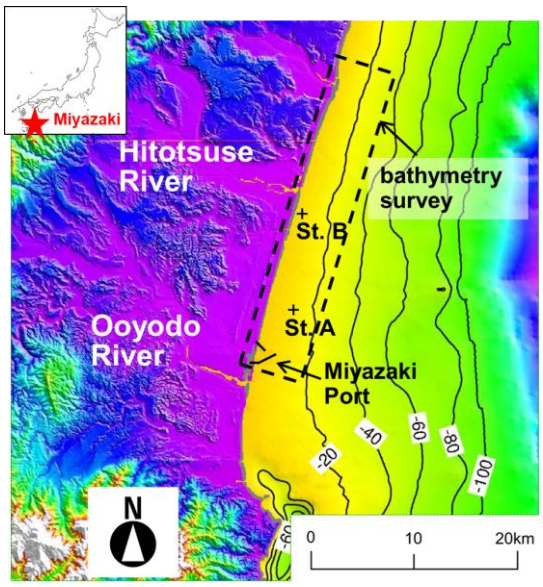

Fig. 1 Miyazaki Coast, located in south Japan

Observation of Waves, Currents and Sand Transport due to typhoon storms

In order to understand the role of typhoon storms in beach erosion, intensive measurements were conducted for waves, currents and beach topography in the period from June to December 2014. Impacts of five typhoons were observed (**Fig. 2**). The largest wave height observed at **St. A** (h=21m, see **Fig. 1**) was H1/3=8.2m with T1/3=12.1s (**Fig. 2**). Strong northward longshore currents were observed at **St. B** (h=4m). The velocity of the longshore current exceeded 1.5 m/s. Based on the velocity measurements, the longshore sand transport rate was calculated. The total longshore sand transport in the period from June to December 2014 was estimated at 580 thousand m3 to the northward direction, which was consistent with high-resolution bathymetry surveys in June and December 2014 (**Fig. 3**). The northward sand transport was primarily developed by typhoon storms and was larger than the southward transport calculated from the long-term bathymetry surveys. The total northward sand transport by five typhoon storms were estimated at 760 thousand m3, indicating the essential role of typhoon storms in beach erosion. The significant impact due to typhoons confirmed the necessity of additional erosion control works as groins were designed only to decrease the 'average' longshore transport.

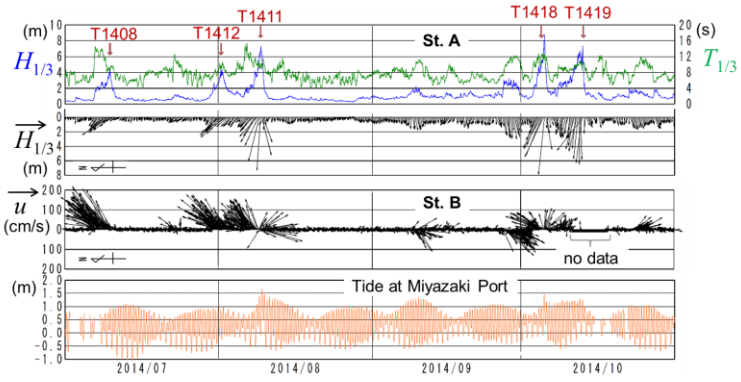

Fig. 2 Waves and currents observed in the period from July to October 2014, impacted by five typhoons

Mitigation for Dune Erosion

Eco-system based approach is introduced for the dune erosion control since the Miyazaki Coast is known as one of the coasts where loggerhead turtles land and lay eggs on the backshore. Explicit reluctance of beach users to concrete structures is to be considered as well. On the basis of a number of consensus building workshops involving various stakeholders, such as fishermen,

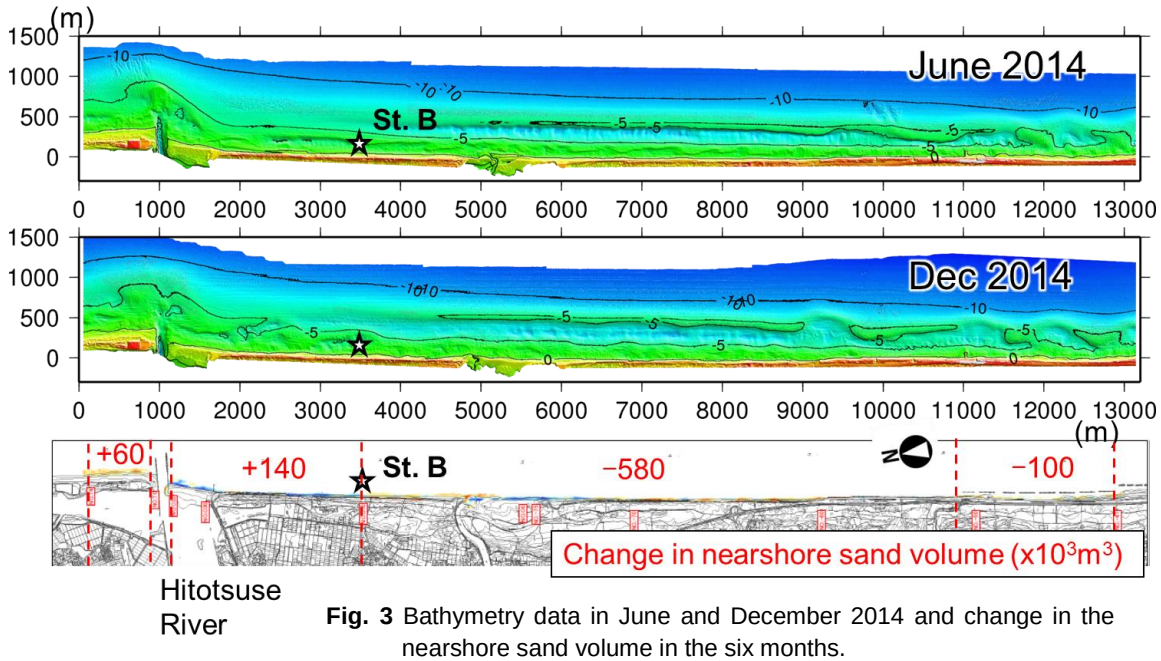

Fig. 3 Bathymetry data in June and December 2014 and change in the nearshore sand volume in the six months.

surfers and local residents, the government decided to introduce geotextile sand tubes buried in berm nourishment at the foot of dune face in order to prevent rapid erosion due to typhoon storms. Each sand tube is 20 m long with diameter of 1.5 m. Sand tubes are buried alongshore for 1.6 km stretch of the coast with their top elevation +4m above MSL as shown in **Fig. 4**. The slope of the berm nourishment was 1/6 for considering loggerhead turtle landings and run-up of storm waves.

Berm nourishment with buried sand tubes successfully prevented further dune erosion although five typhoons impacted the coast in 2014 which partially eroded the nourished berm and exposed some sand tubes (**Photo 1**). Emerged sand tubes were buried again by re-nourishment. More than hundreds of turtle egg-laying spots observed on the nourished berm appeared to demonstrate the advantage of the eco-system friendly infrastructures.

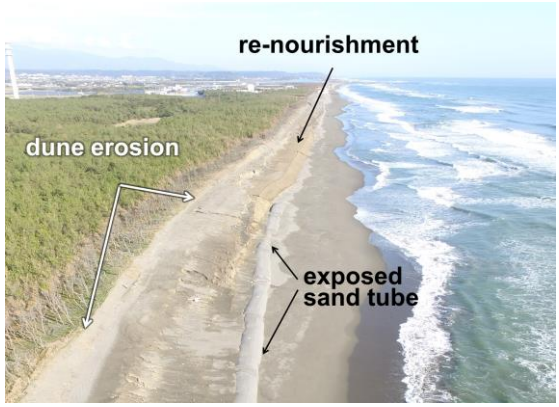

Photo 1 Exposed and re-nourished sand tubes after a storm (Dec 9, 2015)

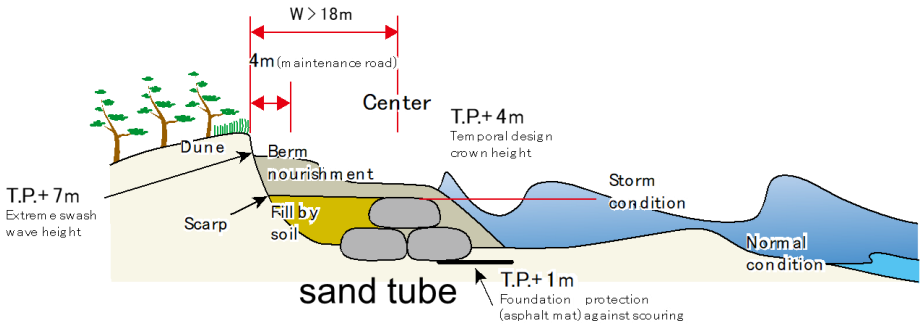

Fig. 4 Berm nourishment with buried sand tubes

Conclusions

Observation of waves, currents and sand transport demonstrated that typhoon storms developed significant sand transport due to strong northward longshore currents. The northward longshore sand transport due to a single typhoon storm is found to be as large as the annual southward longshore sand transport, thus causing rapid dune erosion. Eco-system based control works, berm nourishment with buried sand tubes, appeared effective to mitigate dune erosion.

References

Sato, S., Kishimoto S. and Hiramatsu H.: Long-term evolution of sand and gravel beaches on the Miyazaki Coast, ICCE 2010.