STUDY ON TOPOGRAPHIC MONITORING AND ANALYSIS OF TOPOGRAPHIC CHANGES ON MAESHIMA TOMBOLO TIDAL FLAT IN 5 YEARS

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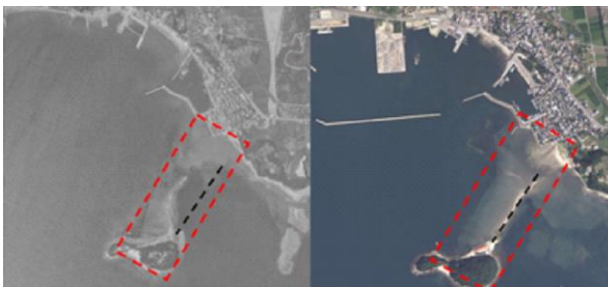
1. INTRODUCTION

A tidal flat has several important functions, such as the formation of fine biological environment, water quality purification, and economic value creation [1]. In this study, the target area is the tidal flat formed between Maeshima Island and the coast. The Maeshima Tombolo tidal flat has long been confirmed to have seasonal topographical changes and movement of the shallowest part of the tidal flat to the eastern part. By comparing the photographs (**Figure 1**), it can be confirmed that the white and dry position has moved from the west to the east. Topographical changes in tidal flats can cause problems such as deterioration of water purification function and changes in ecosystems, which can have a great impact on aquatic organisms [1]. In this study, we continue conducting UAV survey on Maeshima Tombolo Tidal Flat to collect the elevation data. The monitoring objective is to understand the topographic change and sediment transport in the tidal flat. This monitoring was started in 2017. Then, our accumulated data from 2017 to 2021 were used to analyze and compare the changes occurring in the topography. From the results, the topographic changes in 5 years were understood, and the way to manage and conserve the Maeshima Tombolo Tidal Flat was discussed. In our study survey, as the flight conditions, the forward overlap rate for each photo was set to 90% and 65% for the side overlap with an altitude of 50 m from the ground. Furthermore, VRS-GNSS (TOPCON comp.) survey was conducted to obtain the positional information of the 8 Ground Control Points (GCP).



(a)1973 (b)2010

Figure 1. Maeshima Tombolo tidal flat condition

2. ANALYSIS METHOD

(1) Color Map Comparison

The topographical changes of the tidal flat are extracted using the DEM data obtained by the SfM process. The DEM data was constructed with the resolution of 50 cm. The analysis area was set from 137.144° to 137.150° in the longitude and from 34.779°to 34.785° in the latitude.

(2) Cross-section Comparison

Cross-section diagrams were made at 6 lines (**Table 1**), 4 East-West (EW) lines (Line 1-4) and 2 North-South (NS) lines (Line 5-6) (**Figure 2**). All the lines cross the shallow area to investigate the yearly cross-sectional shape changes of this tidal flat and the top (shallowest) position on the sandbar (tombolo). Sedimentation and erosion are observed from the cross-section diagram.

(3) Volume Comparison

Volume comparison is done for the analysis quantitatively. Sand volume was calculated in the elevation range of -0.5 m from the standard height, T.P.±0.0 m (T.P.: Tokyo Peil, mean sea level of Tokyo Bay) and above in the target area. The way to calculate volume as below:

1. 10 cross-section lines are set (yellow line in **Figure 3**).
2. The area above -0.5 m of each cross-section are calculated.
3. The areas are multiplied to the gap distance, ds, between cross-section line to get the volume for each part.
4. All the volume of 10 parts are sum up to get total volume.

Table 1. Cross-section's target lines

Line No.	Line's Position
1	Latitude 34.7805°
2	Latitude 34.7815°
3	Latitude 34.7825°
4	Latitude 34.7830°
5	Longitude 137.146°
6	Longitude 137.148°

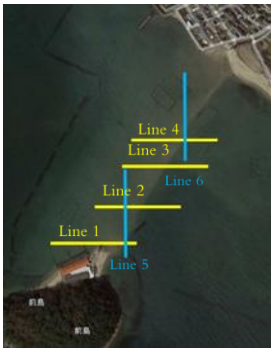


Figure 2. Lines' location

Figure 3. Cross-section lines' location

3. RESULT AND DISCUSSION

From the color map data comparison (**Figure 4**), throughout the 5 years, sedimentation can clearly be seen occurring at the north area near the land. Meanwhile, at the center area, erosion affected the upper part (yellow box) and sedimentation affected the down part (red box). While the area near the island, erosion has crucially occurred. A formation of pool (a little deeper area) can be seen at the area (dotted-line circle), which cannot be seen in 2017.

From the yearly cross-section comparison (**Figure 5**: Line 2 as sample), sedimentation significantly occurred on the west side. On the other hand, erosion occurred particularly on the east side. Moreover, from the movement of the tops (the highest locations), we can understand the tendency of movement of the sand, which moves to the west in 2018 and 2019, but returns to the east in 2020 and 2021.

Based on the volume analysis (**Figure 6**), an increase and a decrease are repeating in the 5 years. The increase slightly higher compared to the decrease makes the overall increasing trend. According to the yearly fluctuations, the decrease is expected to occur from 2021 to 2022. However, the volume in 2022 will not be less than 2020 (6062 m³). For the confirmation of the yearly fluctuations and the long-term trends, it is necessary to continue the topography monitoring and the volume analysis of Maeshima Tombolo tidal flat in 2022 and in the future. One good point from volume analysis result is the tombolo keeps its sand volume even though the topographic changes significantly occurred in the 5 years.

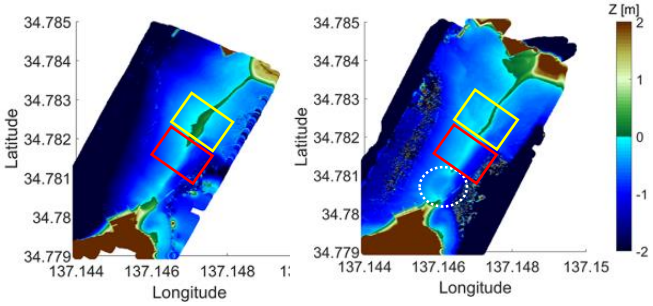


Figure 4. Colormap in 2017 and 2021

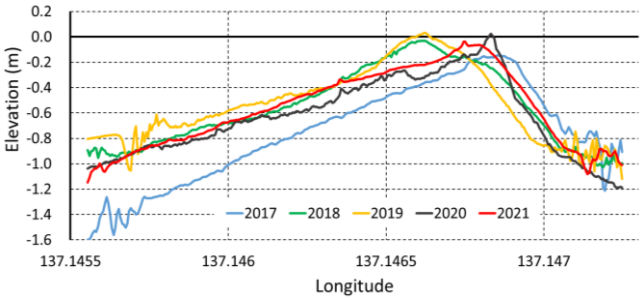


Figure 5. Cross-section of line 2

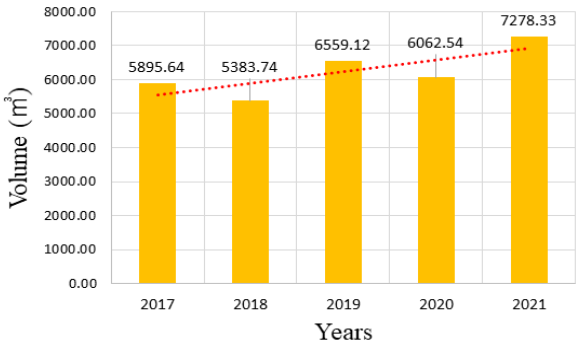


Figure 6. Total volume of sand above -0.5m over 5 years

4. CONCLUSIONS

From all the analysis results, sedimentation significantly occurred at the most northern part. Both erosion and sedimentation occurred at the center part but erosion slightly more affected. Meanwhile, erosion significantly occurred at the most southern part (near the island). In addition, sedimentation significantly occurred on the west side and erosion on the east side. However, the total sand volume above T.P.-0.5m slightly increases in these 5 years.

Reference:

(1) S. Kato, I. Kuritani, T. Tabata, R. Nakamura, and T. Okabe, Topographic change and sediment transport on Maeshima Tombolo tidal flat, IOP Conference Series: Materials Science and Engineering, https://iopscience.iop.org/article/10.1088/1757-899X/933/1/012015/pdf, p.1-2