

# Geomorphological Change on Misawa Coasts between Artificial Headlands

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**Abstract**—Severe beach erosion occurred rapidly on the Misawa coast after the construction of the Misawa fishery port. It is because the coastal sand drift to the north along the coast is obstructed by the breakwater. A total of 13 artificial headlands have been under construction on the Misawa coast by Aomori Prefecture to prevent the beach erosion. The shorelines of the coasts between the artificial headlands have been regularly observed in this research. The present study investigates the feature of changing shorelines and geomorphological change on Misawa coasts. The present study clarifies the following. The shorelines between the artificial headlands advanced. Almost all of the shoreline of the coast between the artificial headlands has an arc shape. The arc coastline indicates that the coast is stable. Compared with the 2003 shoreline, the shoreline retreats remarkably in the coasts between the north of B6HL and the south of B8HL, and in the north coast of B13HL. However, the shoreline is moving around the same position. That means that the coast is becoming stable. The shorelines from 2017 tended to advance in the summer and retreat in the fall. The present study shows that the artificial headland method for the beach erosion is effective in the coast.

**Index Terms**— Artificial headland, Beach erosion, Geomorphological Change, Sandy beach.

## I. INTRODUCTION

Severe beach erosion occurred rapidly on the Misawa coast after the construction of the Misawa fishery port. It is because the coastal sand drift to the north along the coast is obstructed by the breakwater. A total of 13 artificial headlands have been under construction on the Misawa coast by Aomori Prefecture to prevent the beach erosion. The artificial headland method might be useful for other coasts in the world in which beach erosion occurs. The artificial headlands are named B1HL, B2HL, B3HL, so on, B12HL and B13HL in order from the south to the north. Sasaki and Takeuchi (2010) showed that the geographical features change slightly on each coast between the headlands. Shoreline changes along the Misawa coast have been the subject of several previous studies, Sasaki & Takeuchi (2010)[1], Sasaki (2012)[2], and Sasaki (2014)[3]. The present study updates the shoreline changes for the period 2003 to 2017. Aomori Prefecture wants to know the effects of the artificial headlands. Therefore, the shorelines of the coasts between the artificial headlands have been regularly observed in this research.

The present study investigates the feature of changing shorelines and geomorphological change on Misawa coasts.

## II. METHODS

The field observation for the shoreline was made by walking about 14 km along the coast between B1HL and B13HL once a month. GPS and a small personal computer were used for the measurement. The small personal computer and GPS are shown in Fig. 1. Fig. 2 shows that the shoreline position was just measured. The measurement of the shoreline position was made at a temporary shoreline that moves to the landward side from the true shoreline only when the wave height is smaller than 1.5 m. Table 1 shows the observations of 2017, namely the wave conditions, and the temporary shoreline position. The shoreline was safely observed when the waves were calm, and it did not rain. Table 1 shows the shoreline observation in 2017. The table shows the month in which the observation was scheduled, execution day, height of wave breaking, wave direction, and setback distance. In the table, setback distance means the distance between the temporary shoreline and the real shoreline.



Fig 1. The small personal computer and GPS



Fig. 2: Shoreline observation

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Table I: Shoreline observation in 2017

Times	Target month	Execution day	Wave breaking height	Wave direction	Setback distance
1	April	April 24	1.5 m	E	15 m
2	May	May 30	0.7 m	ENE	10 m
3	June	July 6	0.7 m	E	20 m
4	July	July 26	1.5 m	E	20 m
5	August	August 23	0.9 m	E	20 m
6	September	September 13	1.5 m	E	20 m
7	October	October 4	0.4 m	E	15 m
8	November	November 1	0.6 m	E	15 m
9	December	November 28	0.4 m	E	10 m
10	January	December 24	0.4 m	E	10 m

### III. GEOMORPHOLOGICAL CHANGE

Fig. 3 shows the coast between B1HL and B2HL on September 5, 2017. The coast is sands. The south coast of B1HL is also sands, but it is 100 m in length. Fig. 4 shows the shoreline position of each month on the coast between B1HL and B2HL. In the figure, the shoreline position from April 24, 2017 to December 24, 2017 is shown. As shown in the figure, a thin solid line shows the shoreline on April 24th, the thin round dotted line shows May 30th, and the dotted-thick line is on July 6th, the broken line is showing July 26th, the one point dot-dashed line shows August 23rd, the long broken line is showing the shoreline on September 13th, the long one point dot-dashed line shows the 4th of October, two point dot-dashed line shows the 1st of November, the thick line is on the 28th of November, and the thick dotted line shows the shoreline on the 24th of December. The right side is the sea, and the left side is the land in the figure. The shoreline of July 6th is advanced most to the sea on the coast between B1HL and B2HL. The shoreline on October 4th is retreated most towards to the land. The shoreline of July 6th is also advanced most towards to the sea in the south coast of B1HL. Other month's shorelines were located between these two shorelines. Moreover, the shoreline of September 5th shown in Fig. 3 is presumed to be located between the shorelines of August 23rd and September 13th. Fig. 5 shows the shoreline of July 6th that is the most advanced and the shoreline of October 4th that is the most retreated on the coast between B1HL and B2HL and the shoreline of 2000. A thick dotted line shows the shoreline of October 4 which is similar to the shoreline on April 28, 2000 in the half on the north side; the thin dotted line shows the shoreline of July 6th that is the most advanced. On the coast between B1HL and B2HL, the most advanced shoreline of July 6th is more advanced than the 2000 shoreline. The shoreline of October 4th is located near the shoreline of April 2000. However, the shoreline of October 6th retreated a little between 600 m and 800 m in the vertical axis in the coast of B1HL. The retreat distance is about 15 m or less. However, advancement is seen in most of

the part of the coast. As well as the north coast of B1HL, the shorelines advanced more than the shoreline of 2000. Fig. 6 shows the shorelines of each month on the coast between B4HL and B6HL. The shorelines in the figure are shown for a year from April 24th to December 24th, 2017. The shoreline on July 6th advanced the most towards the sea on the coast between 4HL and B5HL. The shoreline on November 1st moved back towards the land. The shoreline on July 6th also advanced the most towards the sea on the coast between B5HL and B6HL. The shoreline on November 28th moved the most back towards the land. Though showing was omitted, the shoreline has been greatly advancing towards to the sea near the artificial headlands year by year. The shoreline shape is becoming a circular arc. Fig. 7 shows the shorelines on April 24th and November 1st that retreated the most and the shoreline on July 6th that advanced the most on the coasts between B4HL and B6HL. The shoreline of 2000 is also shown in the figure. Comparing with shorelines on April 28th of 2000 and July 6th of 2017, the retreat distance is about 20 or less at the coast between 800 m and 1400 m in the vertical axis in the north coast of B4HL.



Fig. 3. Coast between B1HL and B2HL on September 5, 2017

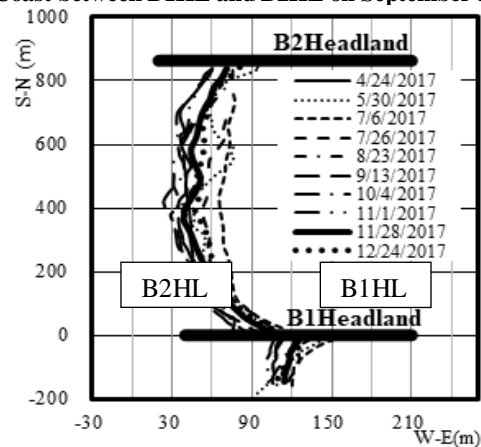


Fig. 4. The shoreline position of each month on the coast between B1HL and B2HL

However, the shoreline of July 6th advanced about 30 m at the coast between 1400 m and 1700 m in the vertical axis. The most retreated shoreline on November 1st is more retreated than in 2000. Therefore, recovery of the shoreline is

not obtained in this coast since 2000. In the coast between B5HL and B6HL, the most advanced shoreline of July 6th advanced more than the shoreline of 2000, and the most retreated shoreline of November 1st was located near the shoreline of 2000. The distance of the advancement between the shorelines on July 6th, 2017 and April 28th, 2000 was 60 m or less. Fig. 8 shows the shorelines of each month on the coasts between B8HL and B10HL. The shoreline positions are shown from April 24th, 2017 to December 24th, 2017. The shoreline on July 6th is the most advanced to the sea on the coast between B8HL and B9HL. The shoreline on November 28th retreats the most towards the land. The shoreline on July 26th recovers the most towards the sea on the coast between B9HL and B10HL. The shoreline on April 24th retreats the most towards the land. Fig. 9 shows the shoreline of July 26th that is the most advanced on the coast between B9HL and B10HL and the shoreline on July 6th that is the most advanced on the coast between B8HL and B9HL, the shoreline on November 28th that retreats the most on the coast between B8HL and B9HL and the shoreline on April 24th that retreats the most on the coast between B9HL and B10HL. The shoreline of 2000 is also shown in the figure. The following can be said in the coast between B8HL and B9HL. By comparing with the 2000 shoreline and the 2017 shoreline of July 6th, the retreat distance can understand about 10 m or less on the coast between -1000 m and -600 m in the vertical axis. The advancement distance is about 20 m or less on the B8HL north coast between -600 m and B9HL in the vertical axis. The 2017 shoreline on July 6th retreats about 20 m or less on the B9HL north coast between 150 m and 350 m vertical axis. However, the 2017 shoreline on July 6th advances on the B9HL north coast between 350 m and B10HL. The advancement distance is about 50 m or less. Fig. 10 shows the shoreline of each month on the coast between B12HL and B13HL. The figure shows the shoreline position from April 24th, 2017 to December 24th, 2017. The shoreline on July 6th recovers the most between B12HL and B13HL. The shoreline on October 4th retreats the most. The shoreline on July 6th is also advanced the most on the B13HL north coast. Moreover, the shoreline on November 28th retreats the most on the B13HL north coast. The shorelines of other month are located between these two shorelines. Fig. 11 shows the shorelines on November 28th and on October 4th that retreat the most on the B13HL south coast and on the B13HL north coast, and the shoreline on July 6th that is the most advanced on the B13HL north coast, and the shoreline of 2000. The following can be said on the coast between B12HL and B13HL. By comparing with the 2017 shoreline on 6 July and the 2000 shoreline, the retreat distance can understand about 10 m or less between B12HL and -500 m in the vertical axis. Moreover, the 2017 shoreline on July 6th recovers towards to the 2000 shoreline on the coast between -500 m and B13HL. From the 2000 shoreline and the 2017 shoreline on 4 October, the retreat distance is about 35 m or less on the coast between B12 HL and B13HL. By comparing with 2000 shoreline and the 2017 shoreline on July 6th that advances the most on the B13HL north coast, the shoreline of

2017 retreats. The retreated distance is about 60 m. However, the shoreline is approaching an arc shaped coast. It means that the coast is getting steady. The beach erosion never occurs even on the B13HL north coast. Fig. 12 shows the distance of the shoreline advancement on each month in 2017 based on the shoreline on April 2003. A positive value shows the advancement distance from the 2003 shoreline, and a negative value shows the retreat distance to the shore from the 2003 shoreline. The figure is showing that the 2017 shorelines advance on the coast between B1HL and B6HL, and between B8HL and B13HL. The shoreline moves repeating the retreat and advancement. The 2017 shorelines retreat on the coast between B6HL south and B8HL, and on north coast of B13HL. In the coast between B1HL and B2HL, the shoreline on July 26th advances the most, and the advancement is about 65 m or less. Moreover, the shoreline on October 4th retreats the most. The shoreline change shows the advancement in the summer, and the retreat in the autumn. On the B13HL north coast, the 2017 shorelines retreat. The retreat distance is about 35 m or less. As shown in the figure, the 2017 shorelines all around the headlands are advancing. The shape of the shorelines is getting an arc shape due to the advancing.

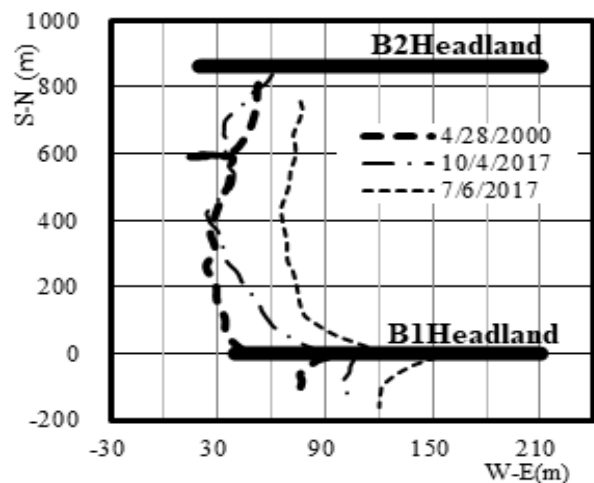


Fig. 5. The shoreline position of July & October on the coast between B1HL and B2HL

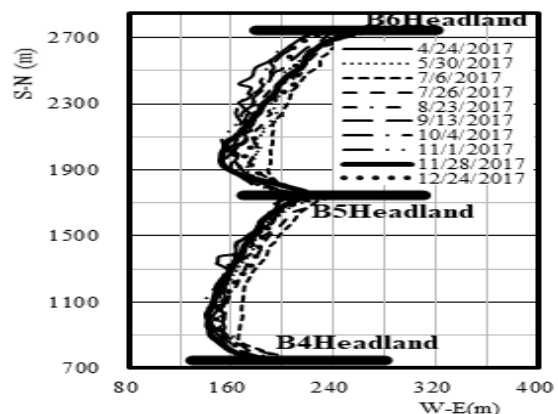


Fig. 6 The shorelines of each month on the coast between B4HL and B6HL.

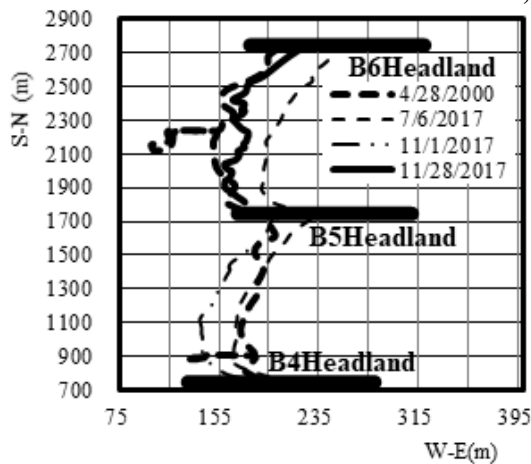


Fig. 7. The shorelines of April & November on the coast between B4HL and B6HL

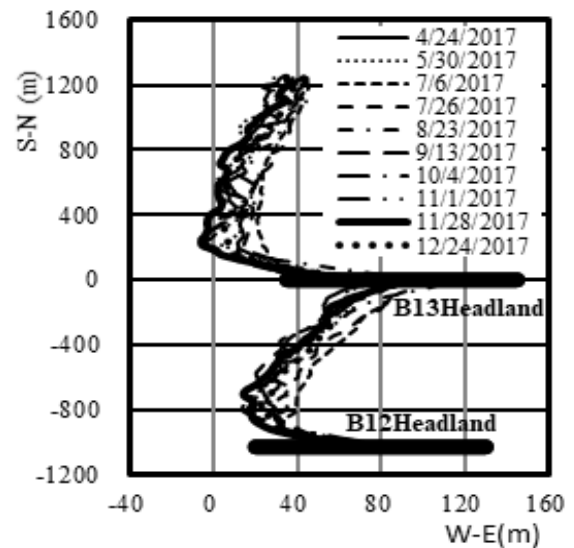


Fig. 10. The shoreline of each month on the coast between B12HL and B13HL

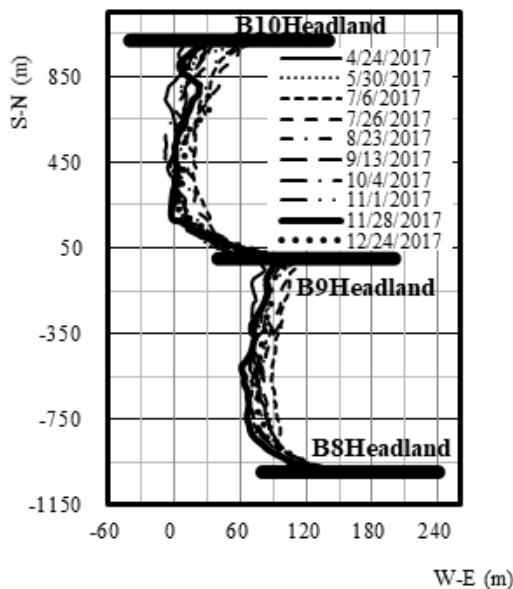


Fig. 8. The shorelines of each month on the coasts between B8HL and B10HL.

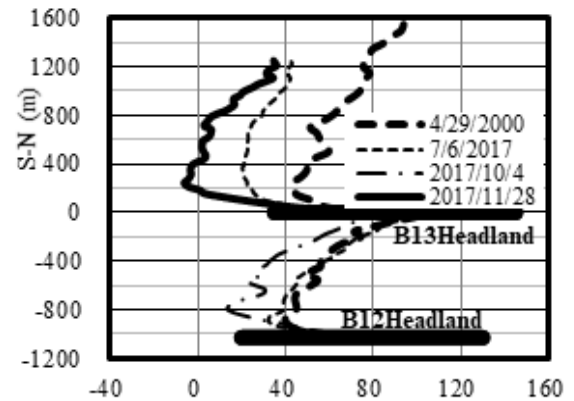


Fig. 11. The shoreline of October & November on the coast between B12HL and B13HL

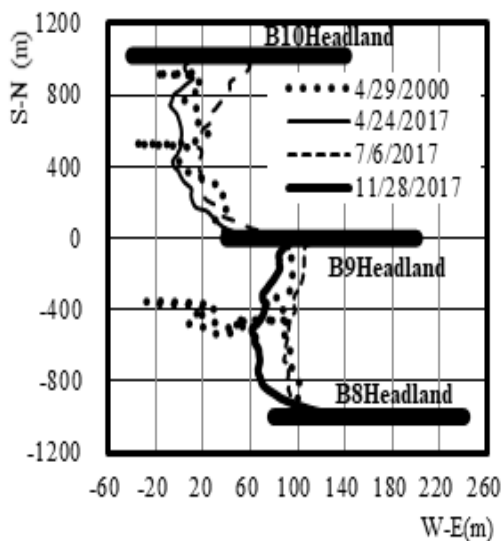


Fig. 9 The shoreline of April, July & November on the coast between B9HL and B10HL

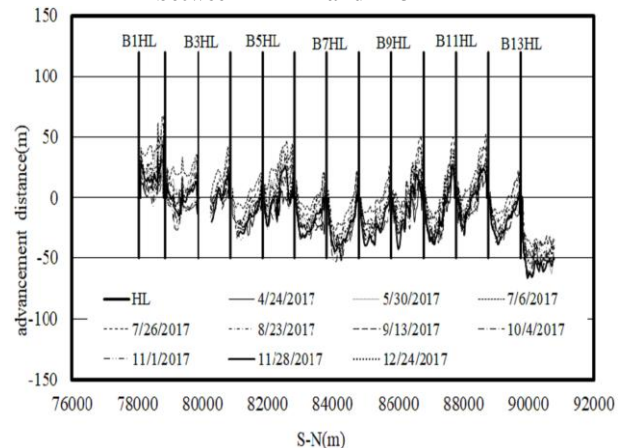


Fig. 12: Advancement distance on Misawa coast

#### IV. DISCUSSION

The characteristics of the geographic feature change in 2017 are shown in the present study. The shape of the shoreline becomes the circular arc. On the coasts between B6HL and B9HL, the shoreline is moving around the same position compared with a past shoreline. However, on the

coast between B1HL and B2HL the shoreline is advancing. This means that the coast is steady due to the artificial headland. It seems that the industrial method of the artificial headlands is useful also in the other coast where the beach erosion occurs.

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