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EVOLUTION OF NOBIRU COAST AT DECADAL TO CENTENNIAL SCALES INCLUDING THE 2011 TSUNAMI IMPACT

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Background

- The earthquake – tsunami happened on March 11th, 2011 in northeast of Japan
  - One of most 5 powerful recorded earthquake on earth
  - Tsunami wave is about 10m offshore and about 40m maximum run-up height on the coast of Japan (about 19.5m in Sendai area)

Tsunami in Sendai area

- Causing extensive and severe damage to infrastructure, and significant changes of coastal and estuarine morphology.

Objective

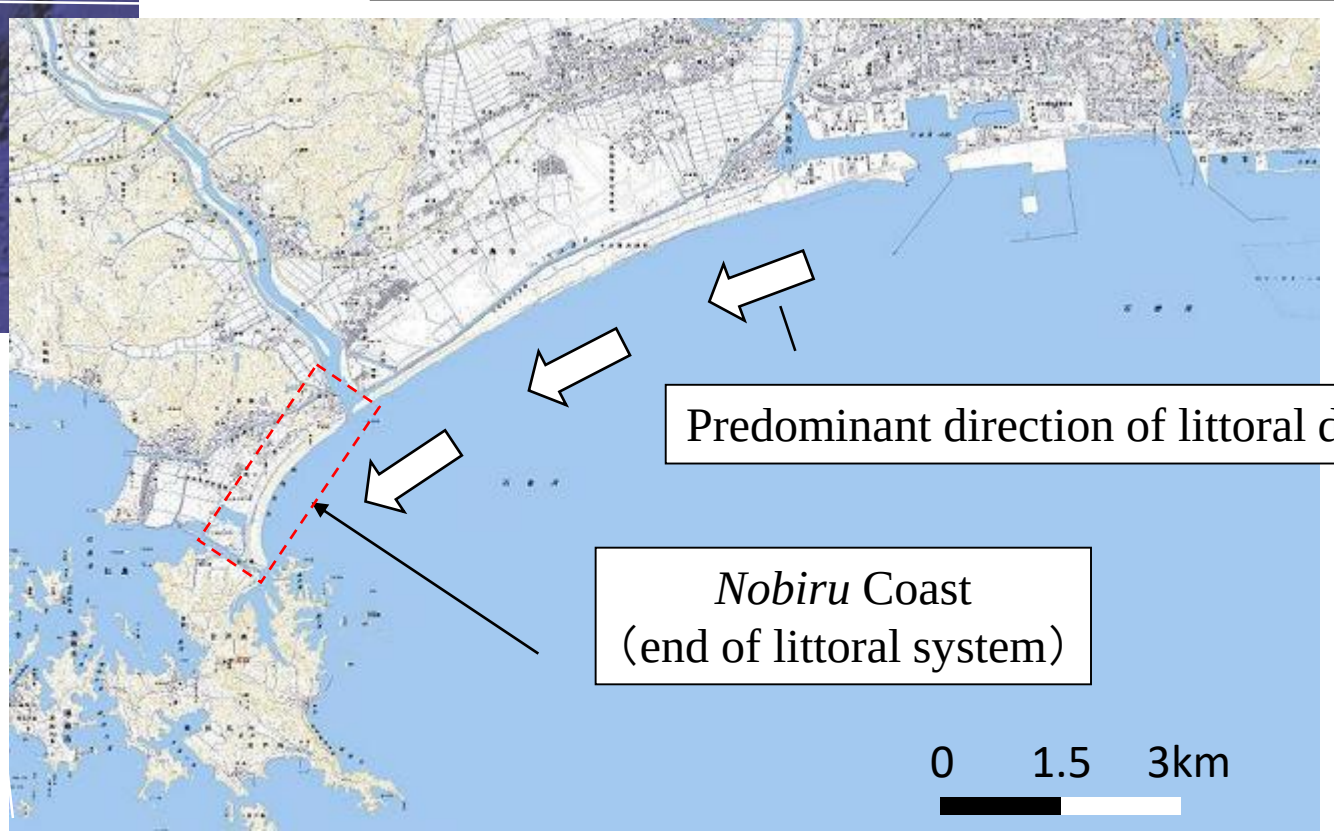
Studying the change of coastal morphology on Nobiru Coast, Miyagi Prefecture, Japan at decadal to centennial scales including the 2011 tsunami impact using old maps, aerial and satellite images.

Study Area

Japan

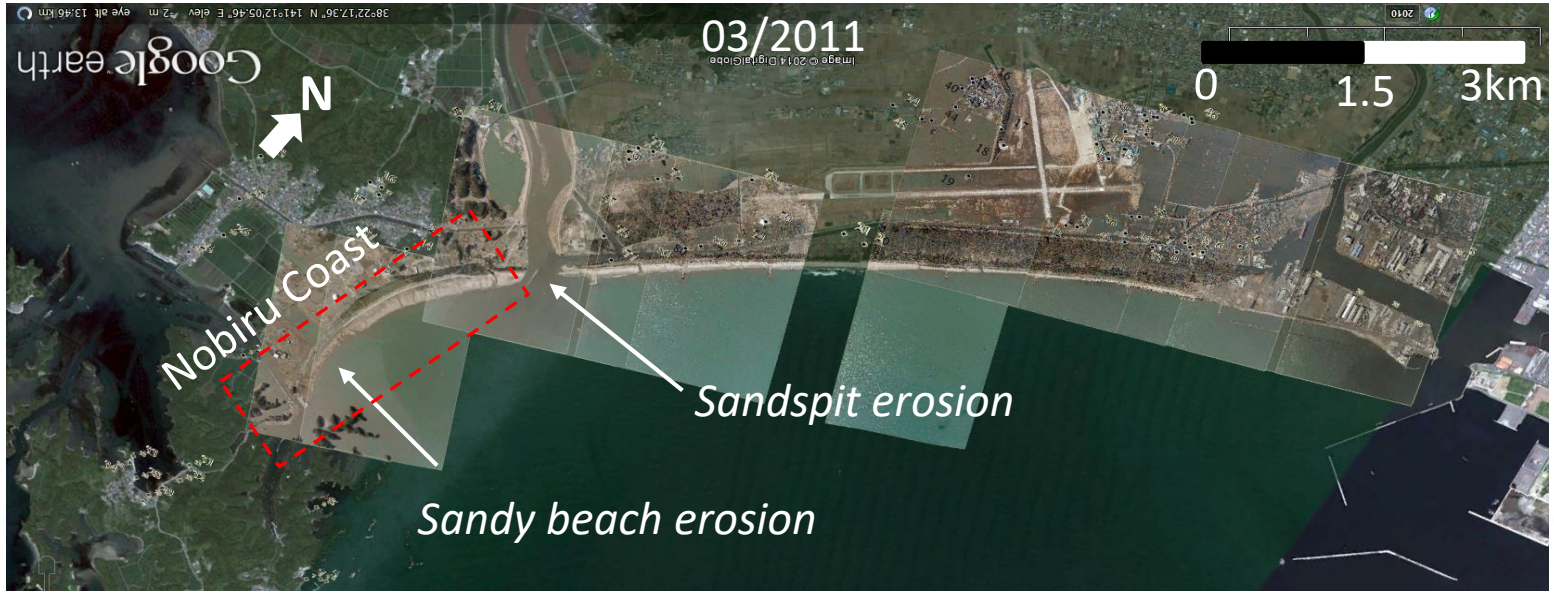
Nobiru Coast

- Located in Miyagi Pref.
- 2.8 km long
- The end of Ishinomaki Coast
- Serious beach erosion by the 2011 Tsunami



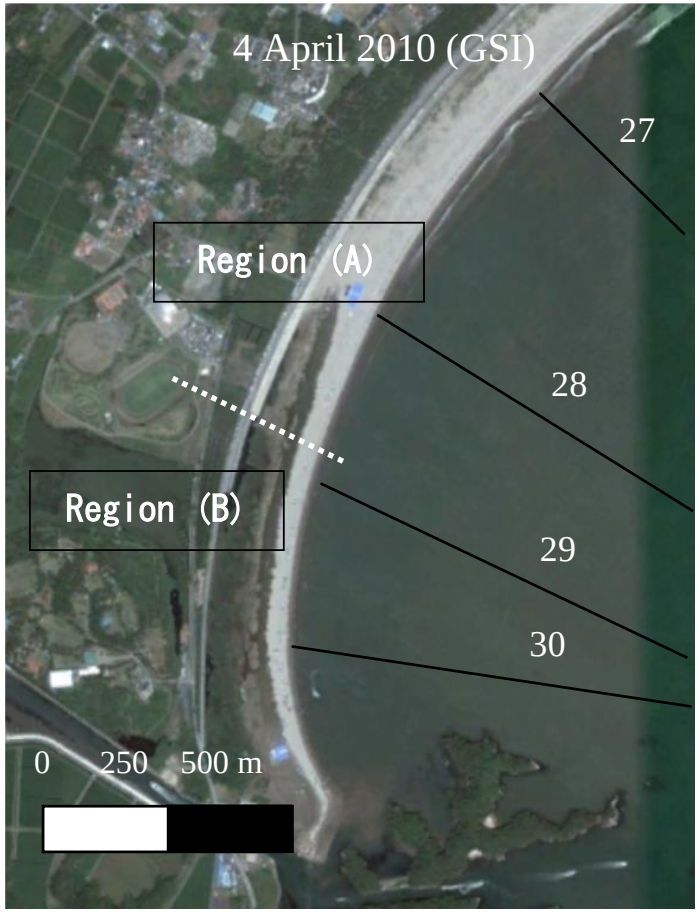
Coastal and estuarine erosion by the 2011 Tsunami

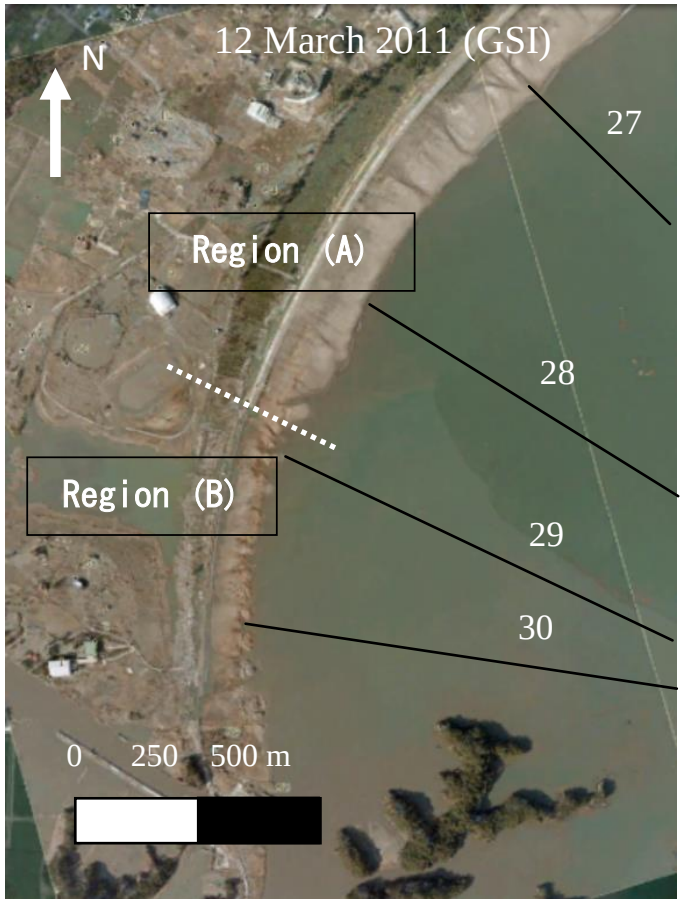
Before tsunami



After tsunami

Beach erosion on Nobiru Coast

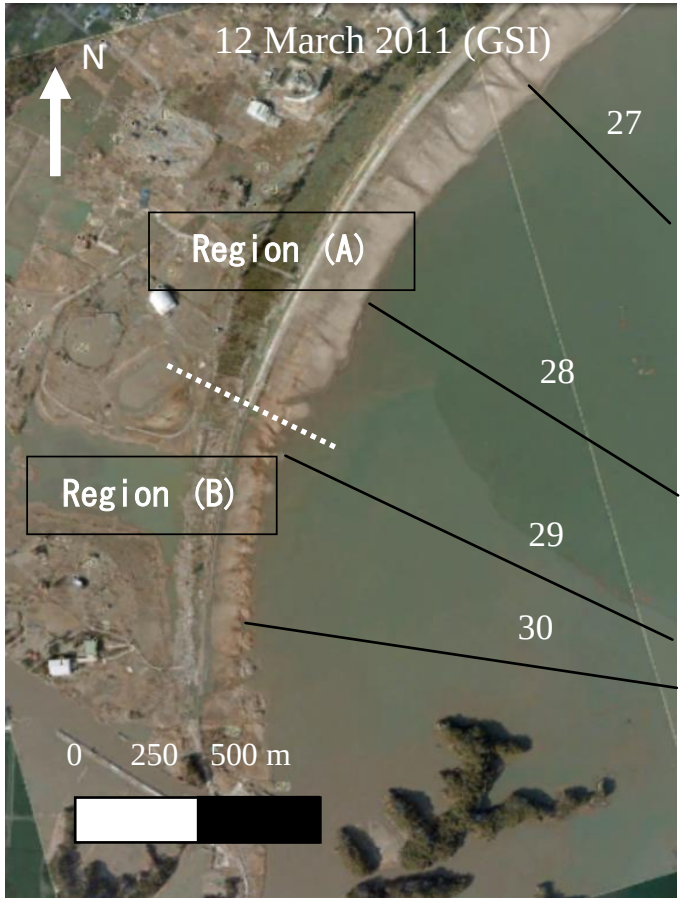


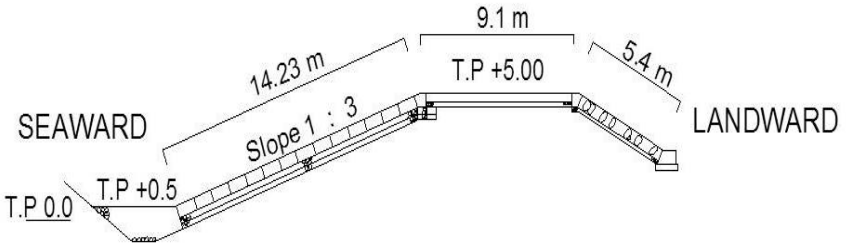


Aerial photo at Nbiru Coast before and after tsunami

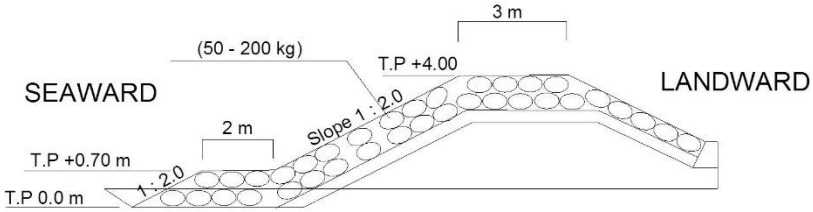
There is large differences in the damages in Region (A) and Region (B)

Beach erosion and structural type





The concrete embankment in Region A is still intact by tsunami.



Whereas riprap embankment in Region B was completely flushed.

Maps covering centennial scale (1)

Inoh Map (1801) and latest map (2001) at Nobiru Coast

Immovable rocks and rocky hills.

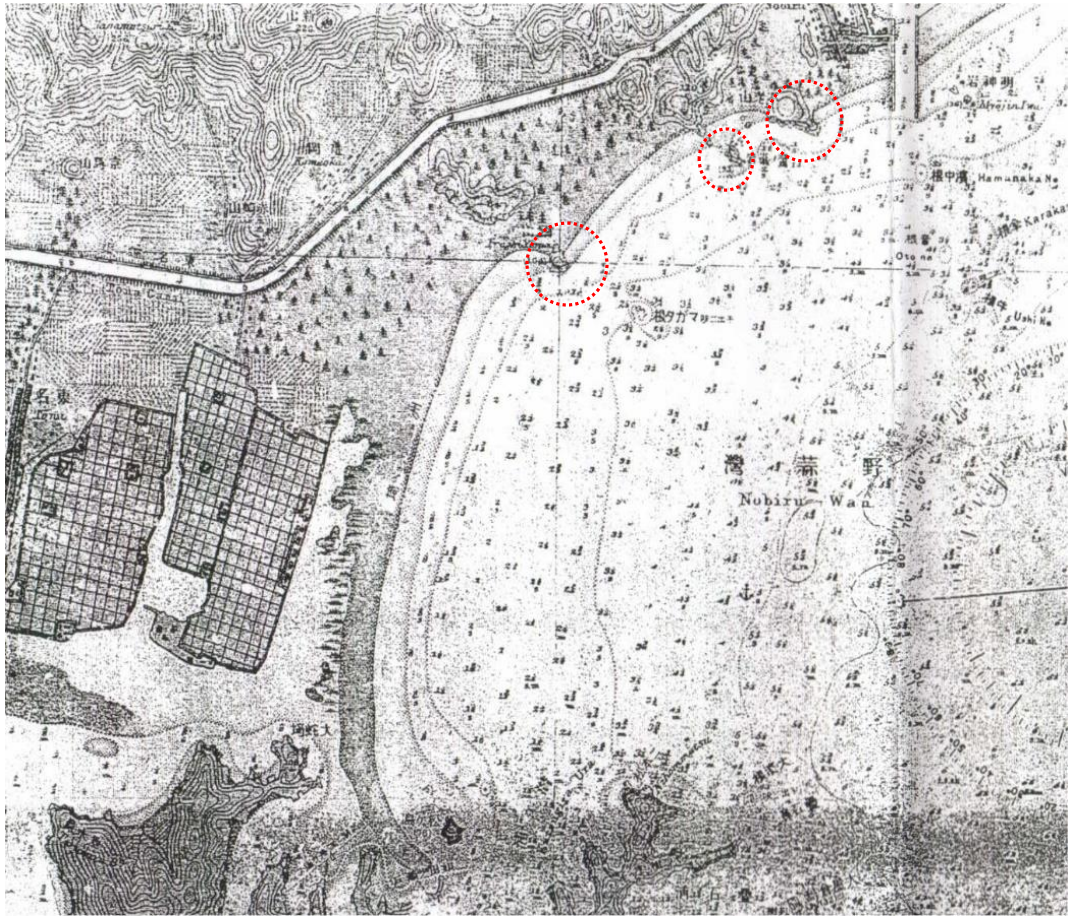
Inoh Map（1801）

Latest map（2001）

Geometric correction by Affine transformation on the basis of these reference points.

Maps covering centennial scale (2)

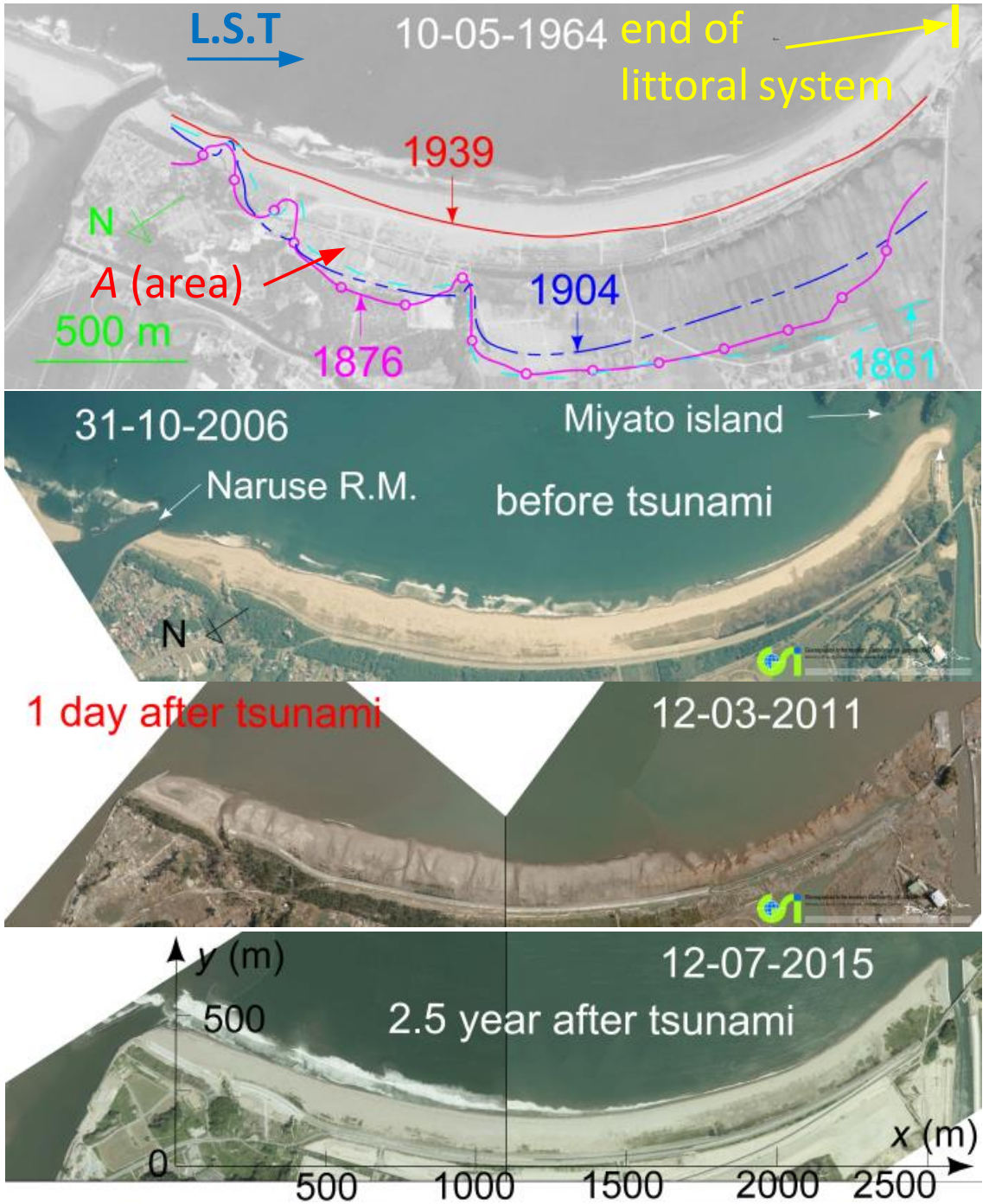
Immovable rocks and rocky hills.



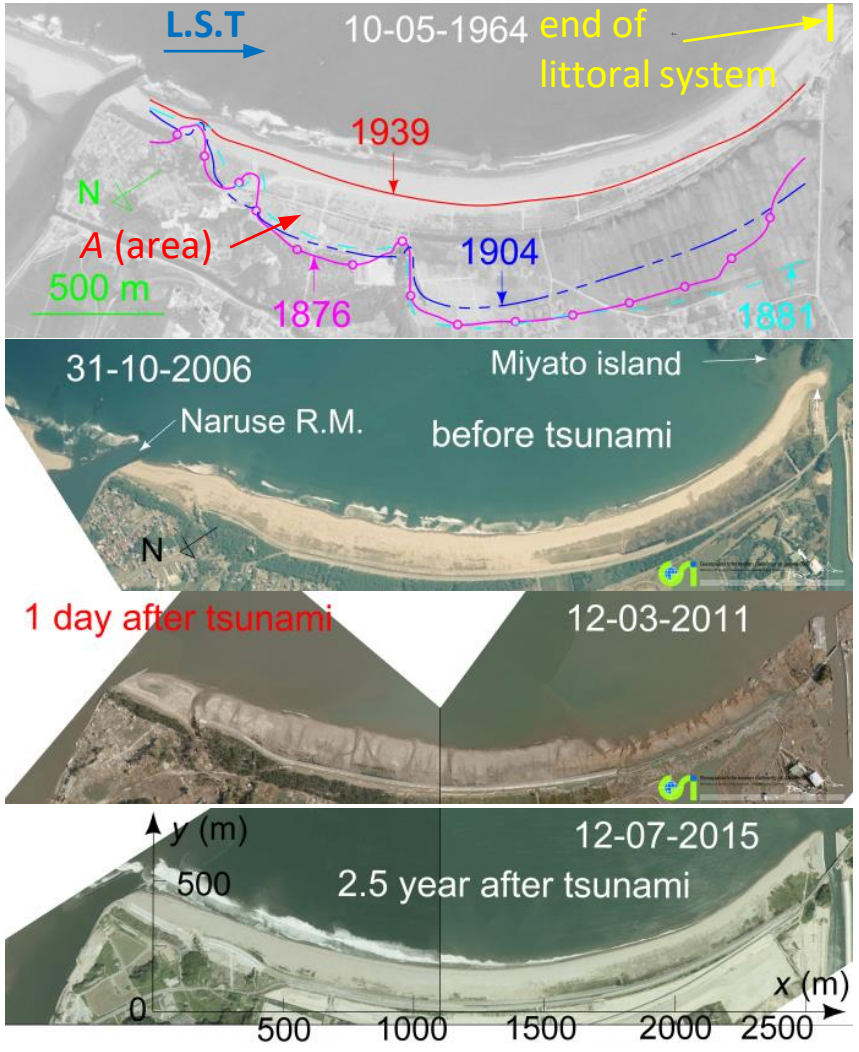
Old chart (1904)

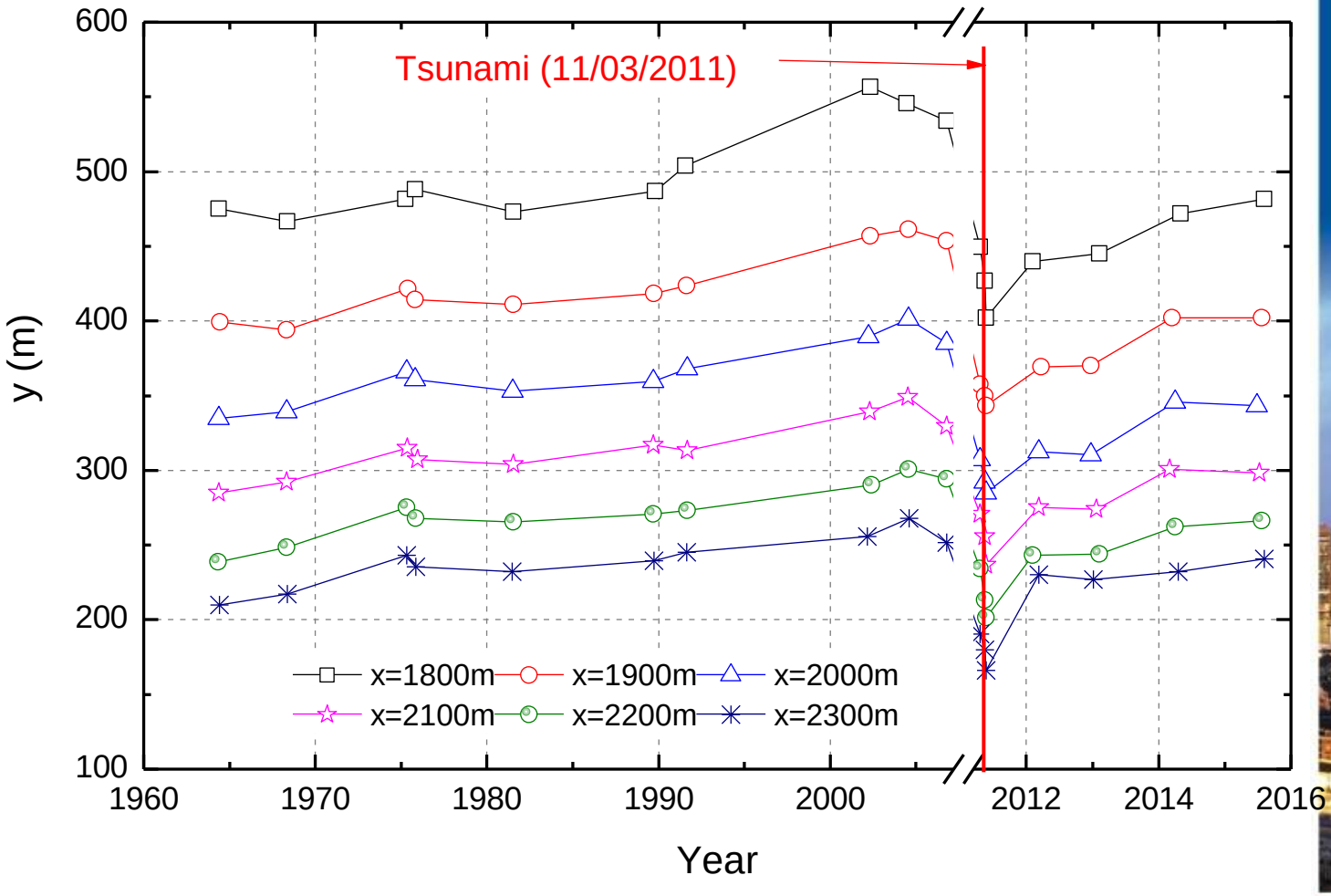
Google Earth (2004)

Recent aerial photographs

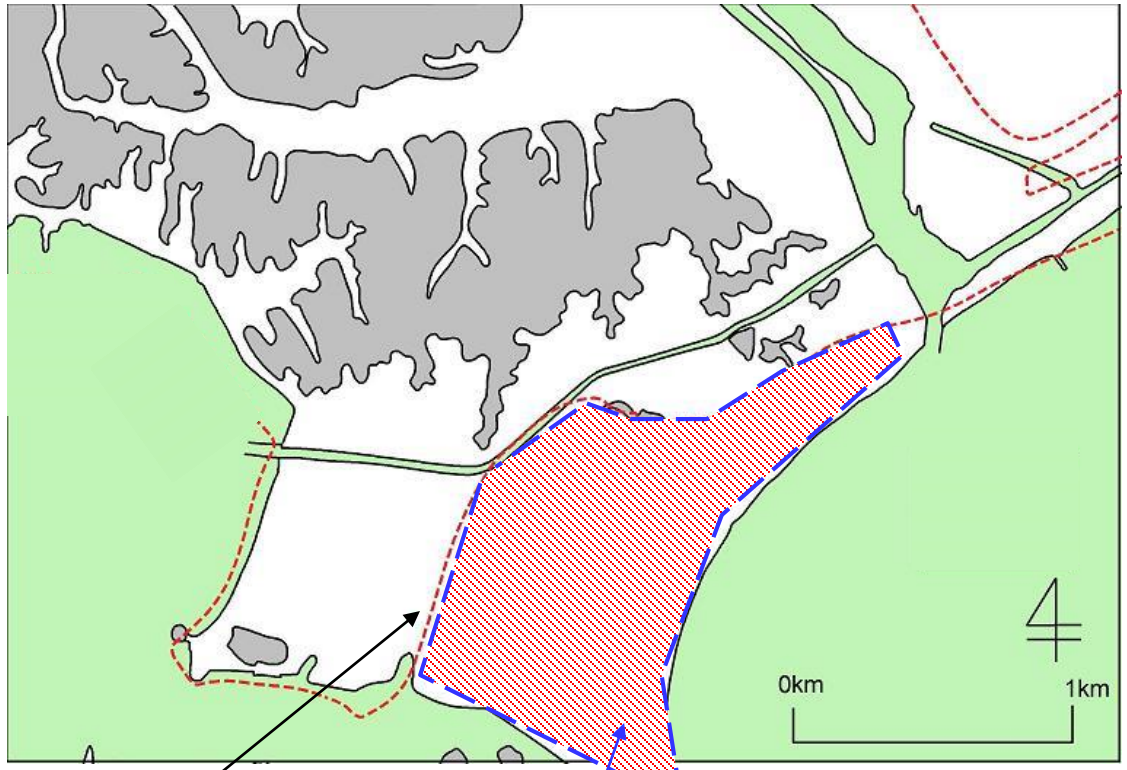


Shoreline change from recent aerial photographs





Evaluation of sand volume change on Nobiru Coast



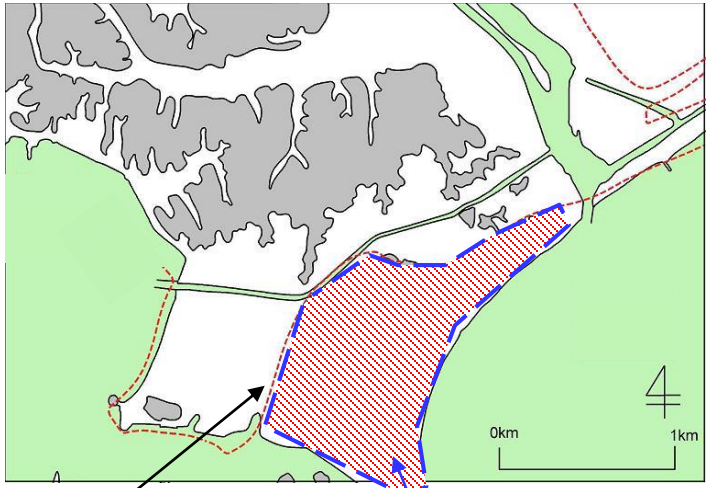
Initial shoreline (1801)

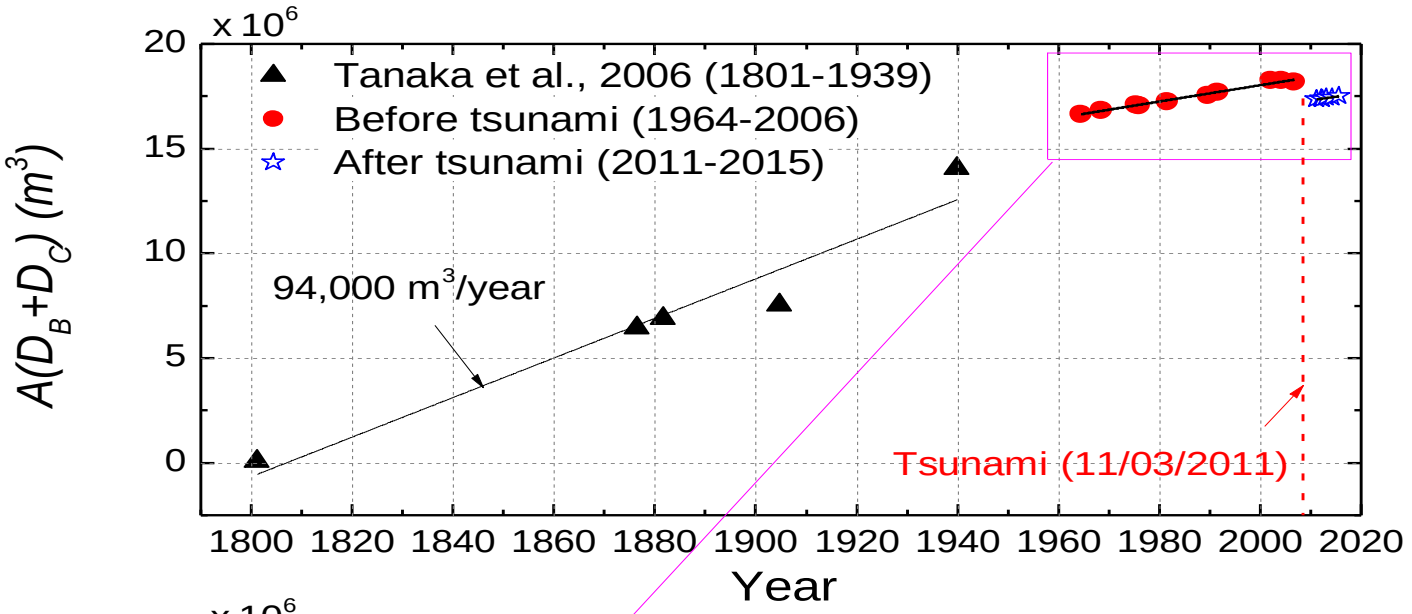
A

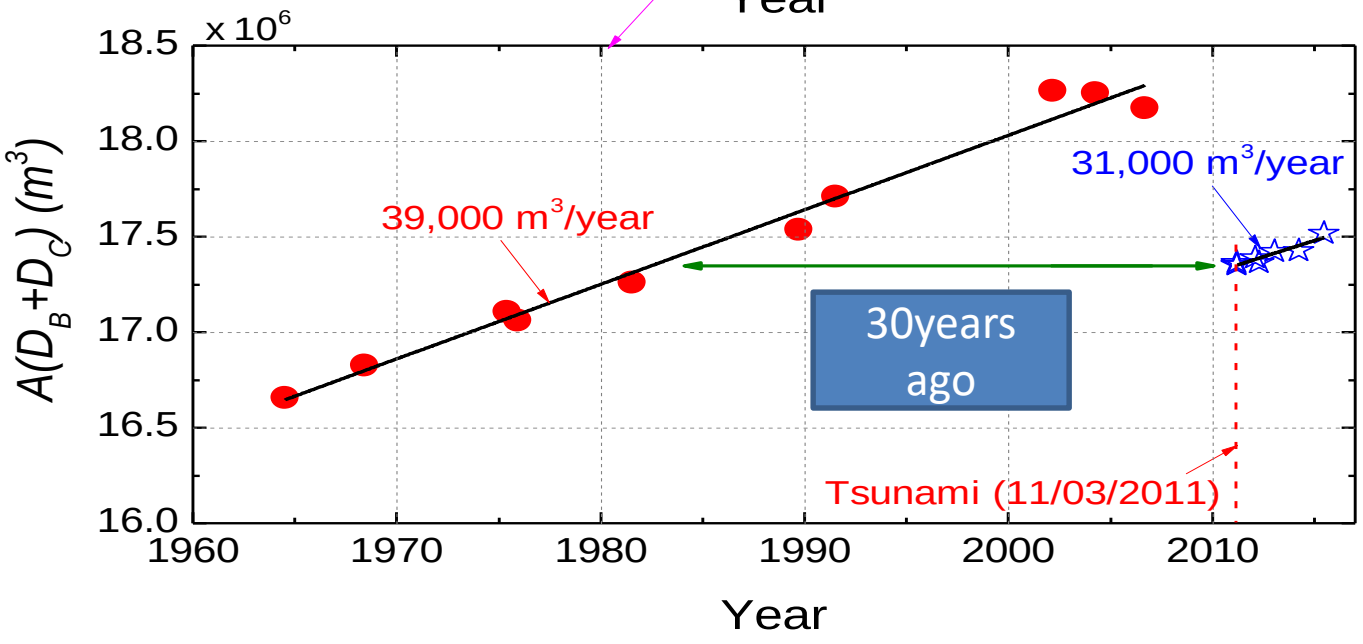
$$V = A \times (D_B + D_C)$$

V : sediment volume (m^3)
A : area (m^2)
D_B : Berm height = 2m
D_C : Depth of closure = 8m

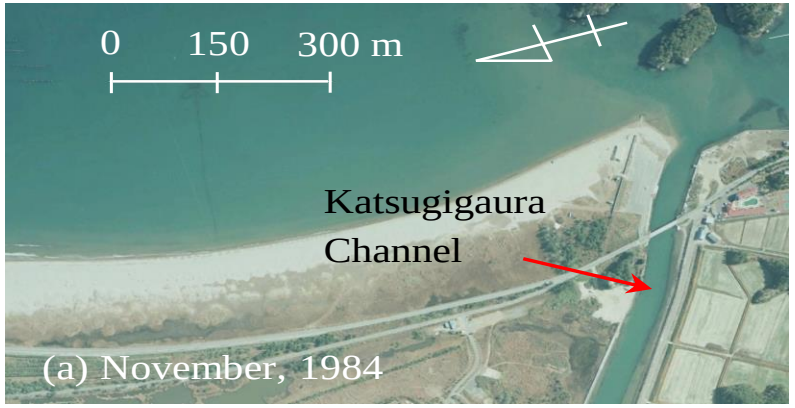
Evaluation of sand volume change on Nobiru Coast



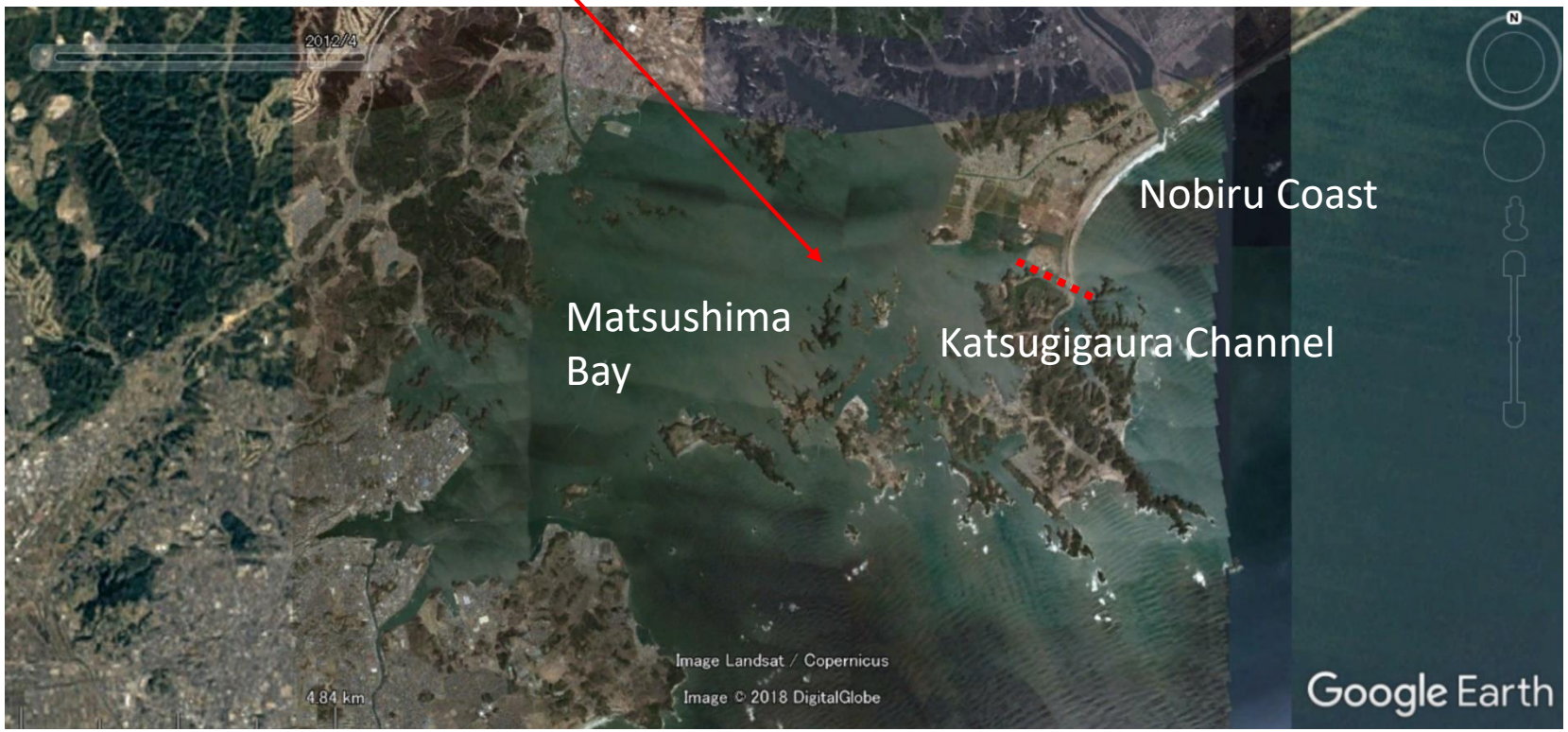




Relationship between sediment deposit and water quality in Matsushima Bay



- Katsugigaura Channel: Artificially excavated in early 1960s for promoting bay water exchange.
- In 2006: the channel has been blockaded.
- In 2011: removal of sediment by the tsunami
- The blockade problem has been postponed by 30 years due to tsunami-induced erosion.



Conclusions

This study has been made to evaluate the change of shoreline on Nobiru Coast at decadal to centennial scales including the 2011 tsunami impact using aerial and satellites images.

1. **The longshore sediment transport rate on Nobiru Coast from 1964 to 2006 reduced about 60% compared to the one in the previous period.**
2. **However, that rate does not change much in the period after the tsunami although severe damages could be observed.**
3. **This result indicates that the effect on the aquaculture in Matsushima Bay due to sediment deposition on the west end of the coast will take place again.**