REASON FOR FIXATION OF MOUTH OF SMALL RIVER BEHIND NATURAL REEF

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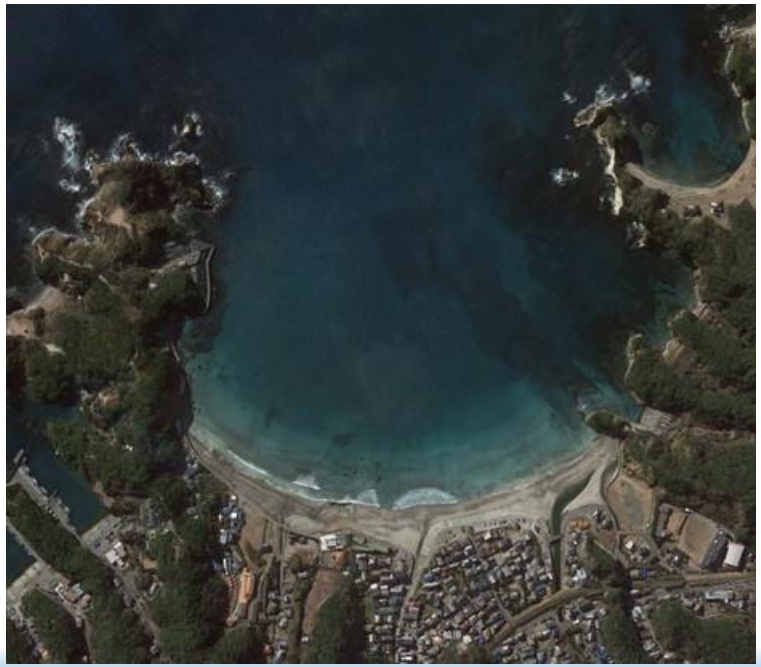


The mouth of a small river flowing into a pocket beach is fixed in the vicinity of one of the headlands at the ends of the pocket beach.

Because of the wave-sheltering effect of the headland the natural headland plays the role of a training jetty.

When considering the wave conditions at such a location, the wave height in the vicinity of the headlands is reduced owing to the wave-sheltering effect of the headlands, resulting in a decrease in the berm height of the beach.

The river flowing into the sea is assumed to easily cross the sandy beach with a lower berm height.

The small river, therefore, preferentially flows through the location with the lowest berm height.

The river meandered northward from the mouth in both years, the shoreline around the river mouth smoothly protruded offshore, forming a cuspate foreland owing to the wave-sheltering effect of the offshore reef.

The opening of the river mouth was located at the tip of the cuspate foreland.

In 2012, the stream directly meandered to the north from the river mouth, leaving a stream of 100 m length north of the river mouth.

The tip of the stream was completely buried with sand and a new stream was formed 44 m south of the tip of the previous stream.

The tip of the new stream was located behind the offshore reef.

In 2014, similarly, the stream of the river meandered northward and the tip of the stream was located behind the offshore reef.

Satellite image of Shiota River flowing into Pacific Ocean in Kita-ibaraki City.

The stream flowed into the sea behind the offshore reef with many scattered rocks, where incident waves lost their energy owing to wave breaking and wave diffraction.

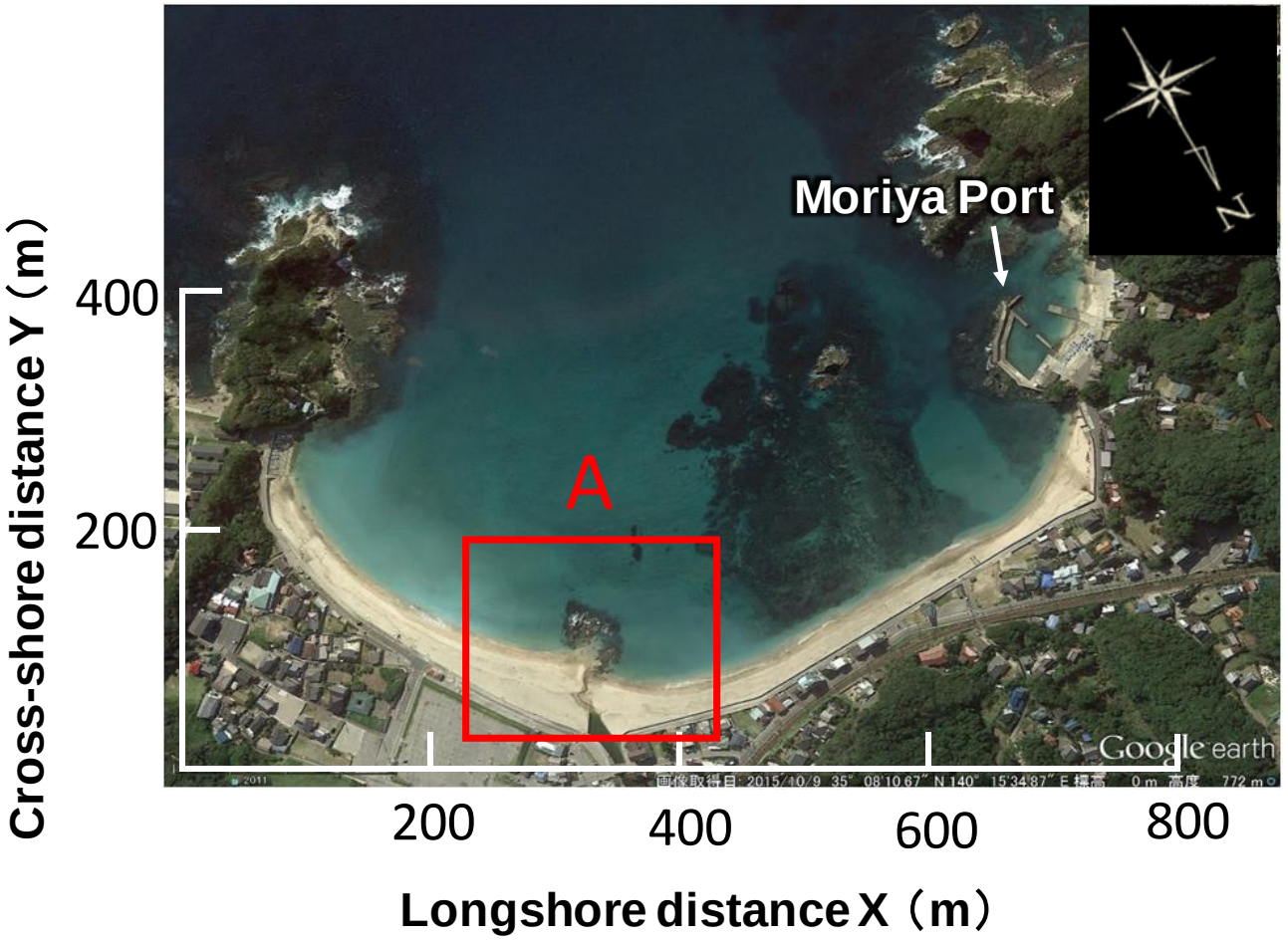
Opening of Shiota River mouth (February 28, 2012).

The stream of the Ochiai River flows down between two offshore reefs.

Many rocks scattered around the river mouth.

These rocks seem to be effective for fixing the river mouth.

Satellite image of Ochiai River.



The coast faces the Pacific Ocean in the SW direction.

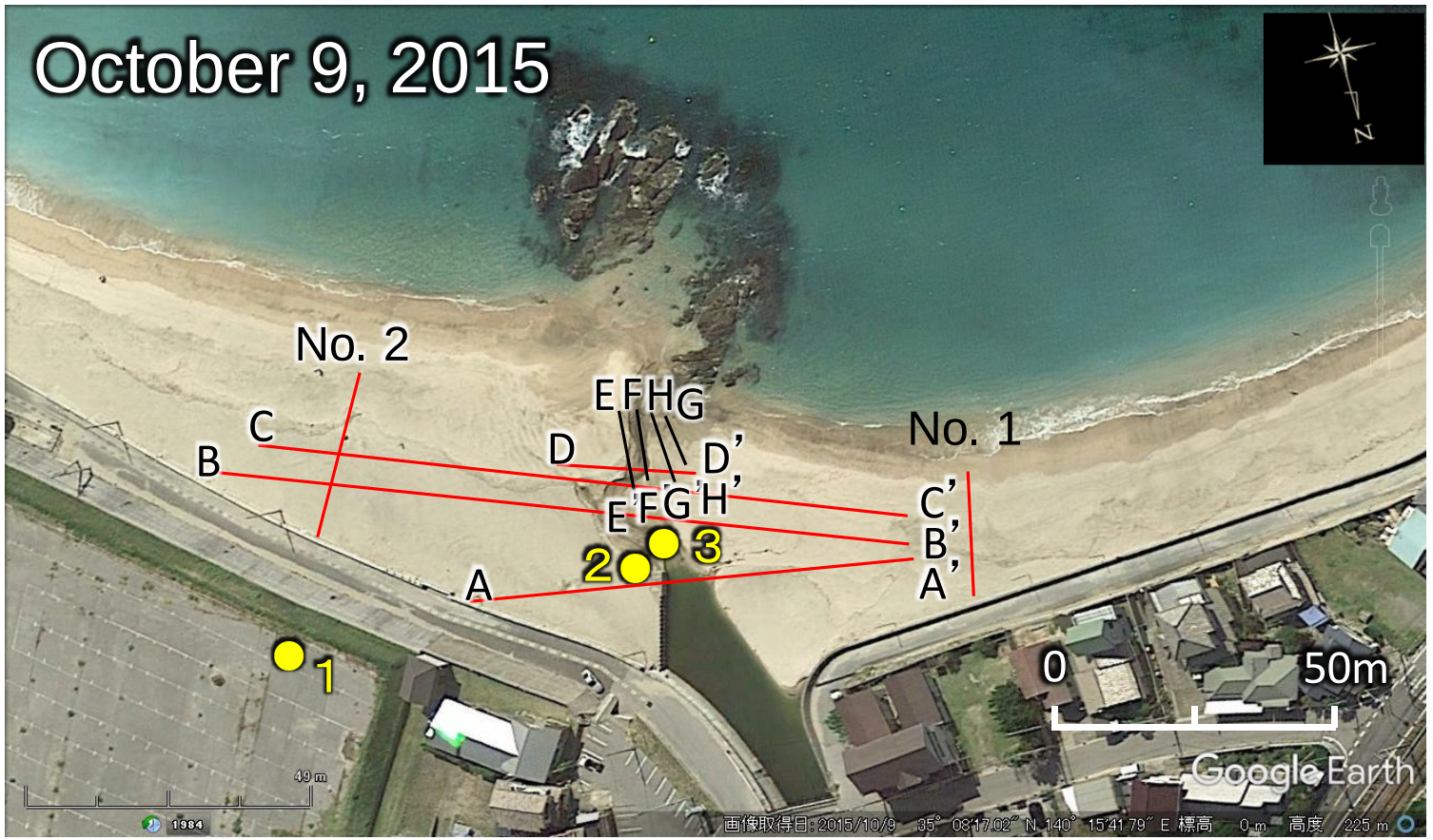
Small rocks are scattered near the center of the pocket beach to form a reef.

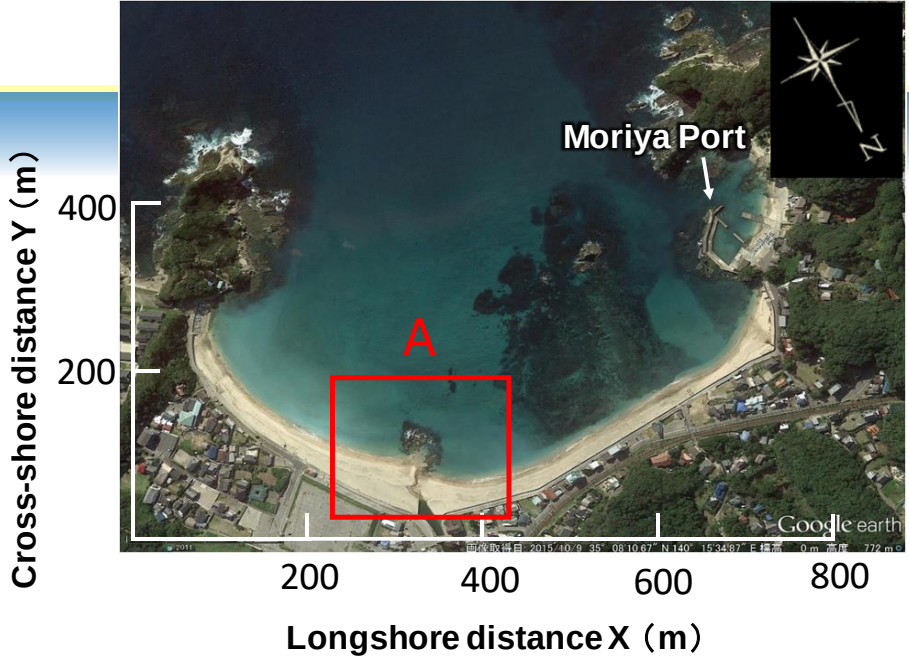
A small river flows down to the sea behind the reef.

These examples clearly demonstrate that the mouth is fixed behind the offshore reef composed of rocks.

The wave-sheltering effect of the offshore reef is important for fixing the river mouth.

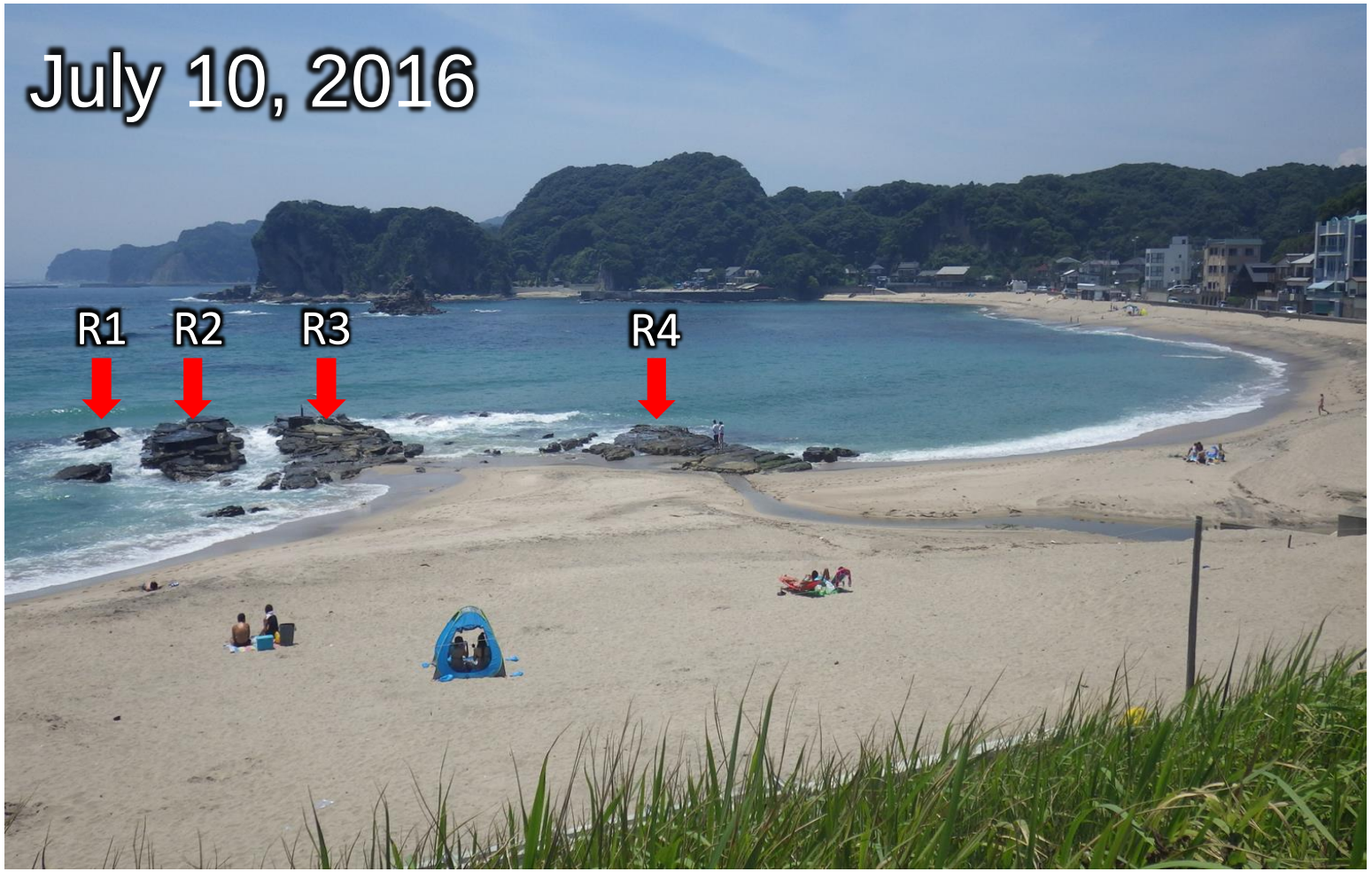
Satellite image of Moriya coast.

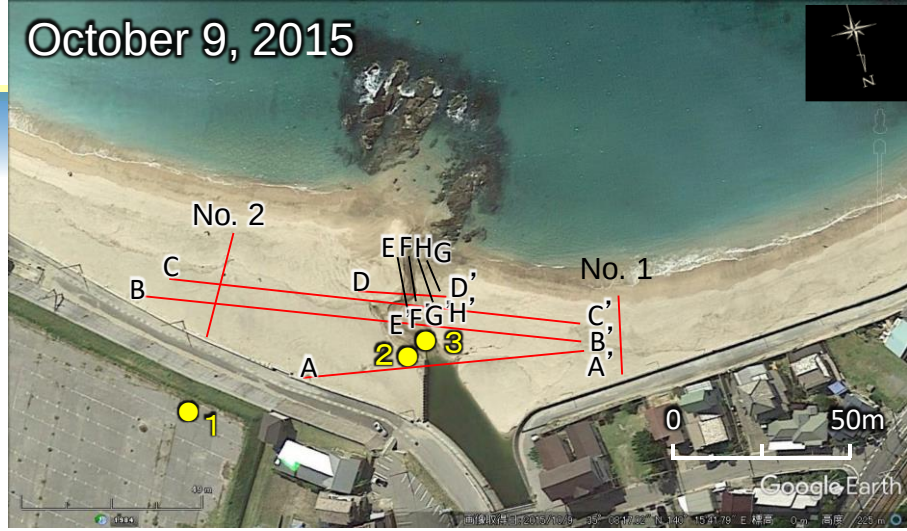




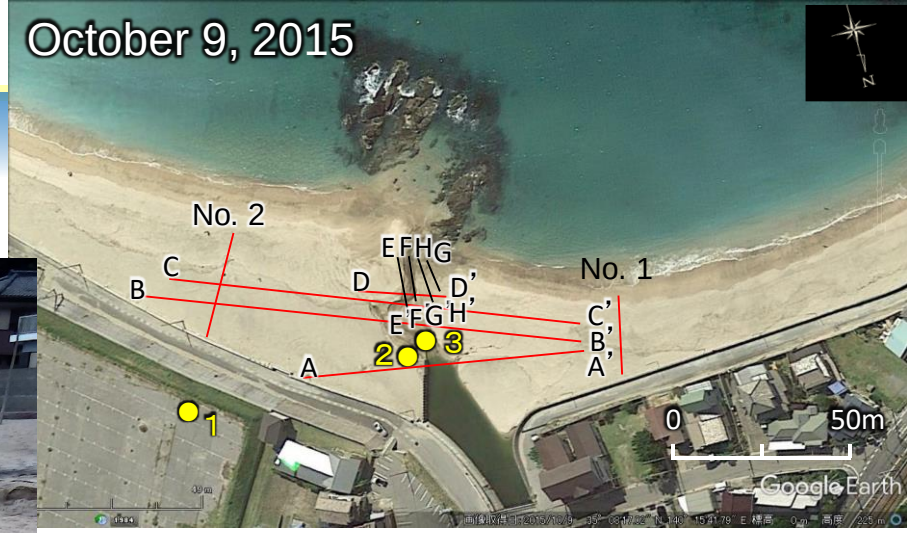
transect
photographing

Enlarged satellite image of rectangular area and arrangement of transects behind reef.





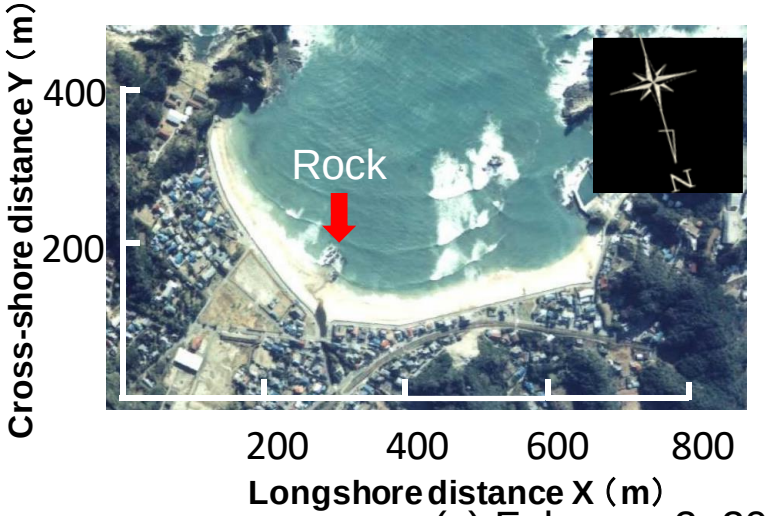
View of rocks and a small river, taken from a hill. (St. 1)



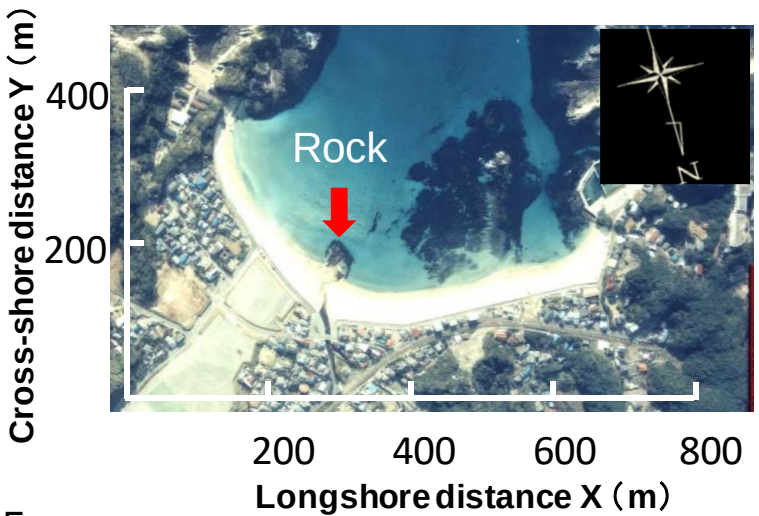
transect
photographing

Stream flowing down to sea behind reef. (St. 2)

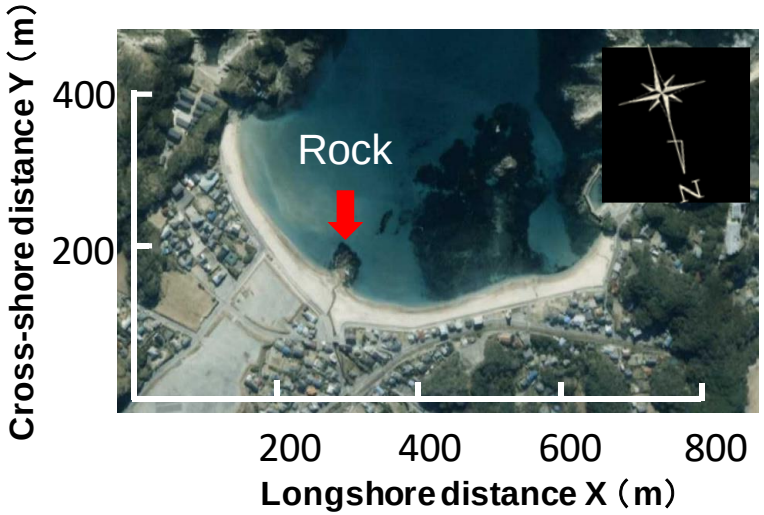
(a) January 24, 1990



(b) January 22, 2000

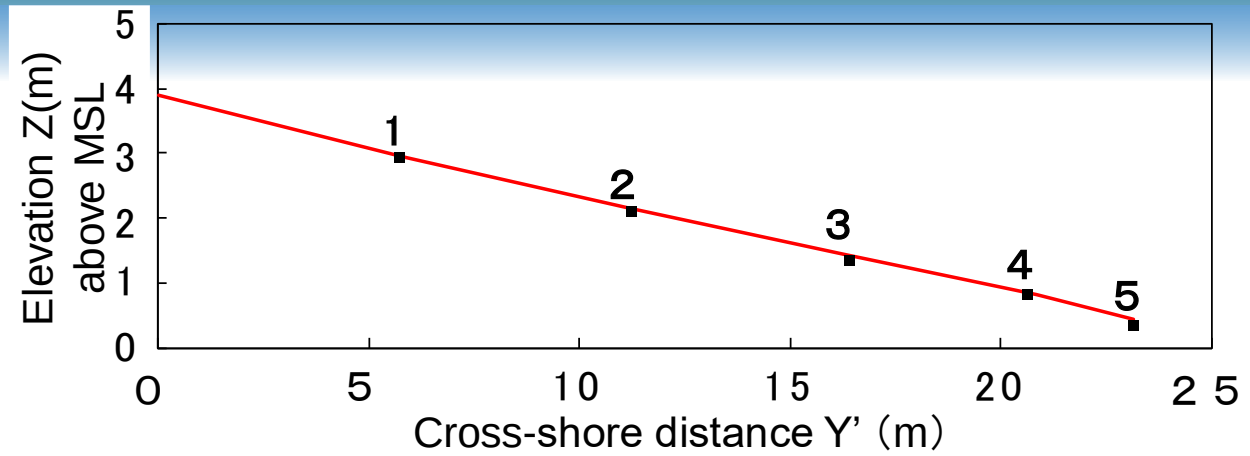


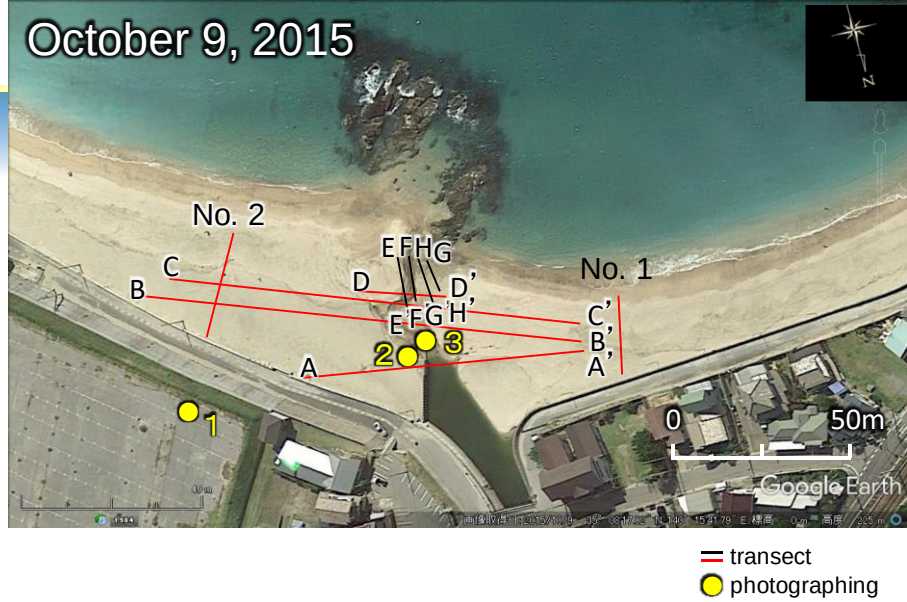
(c) February 2, 2015



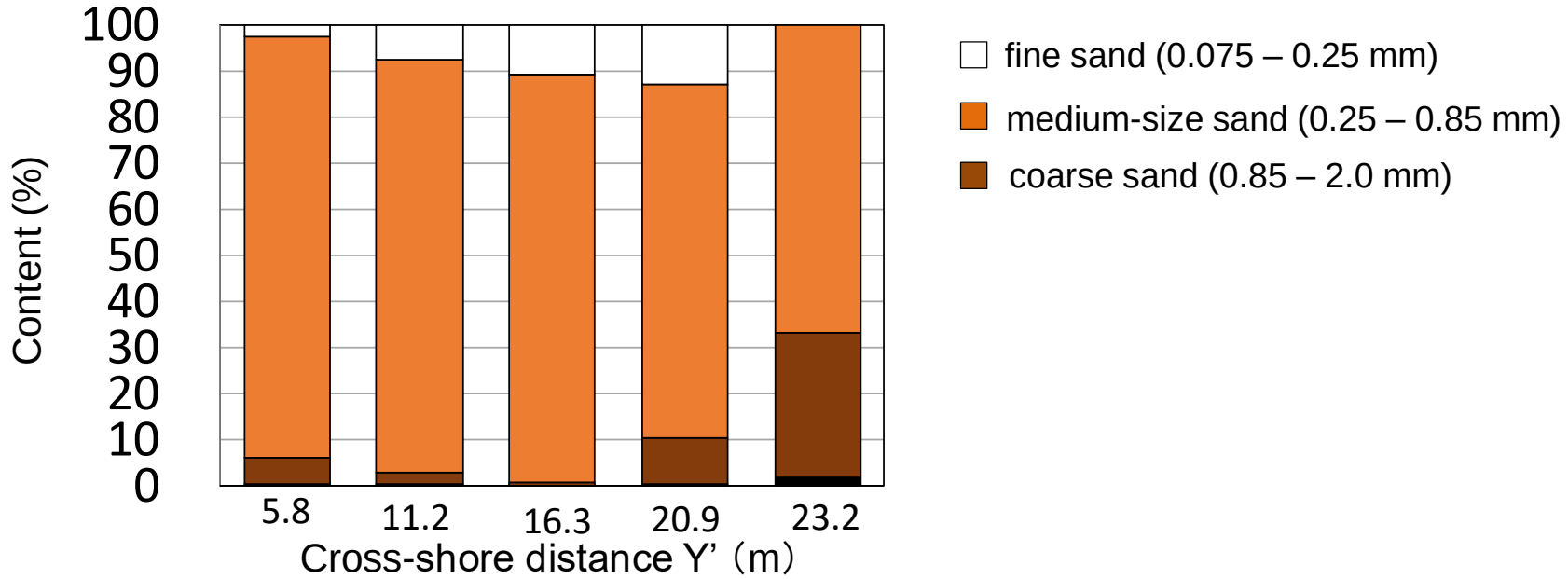
Aerial photographs of Moriya coast.

(a) Beach profile along transect No. 1



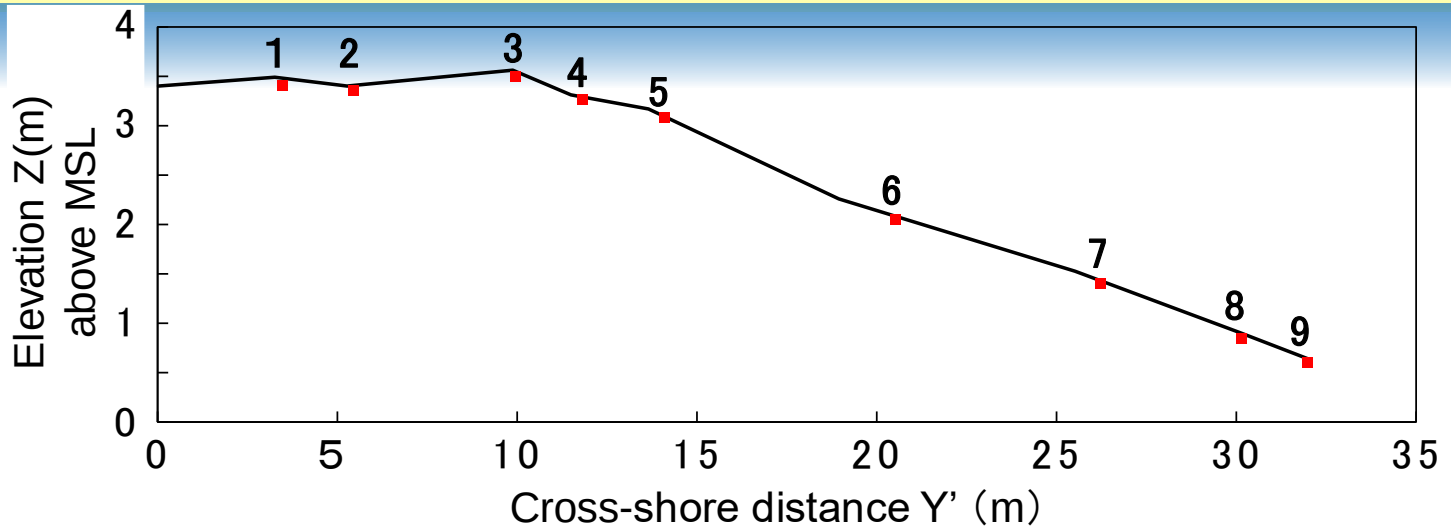


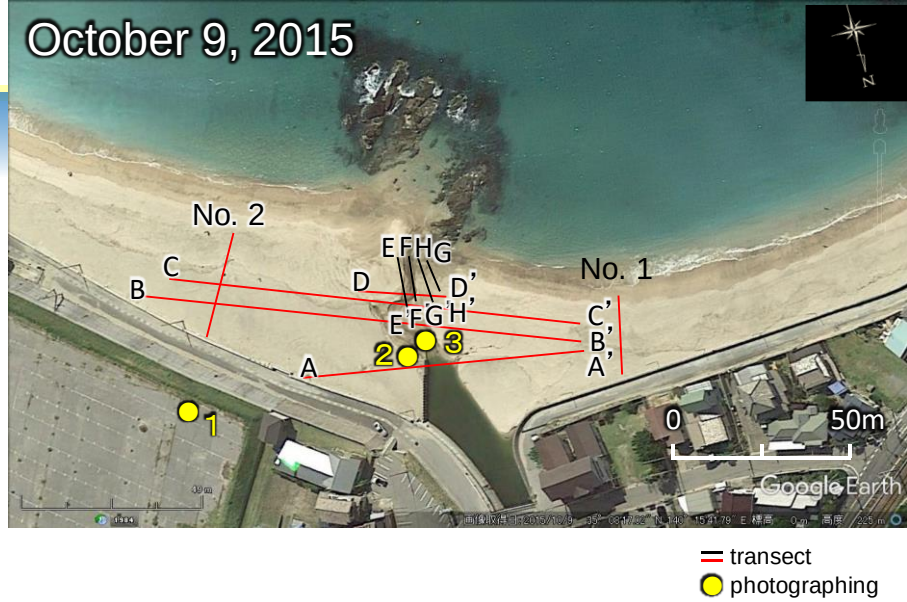
(b) Composition of grain size



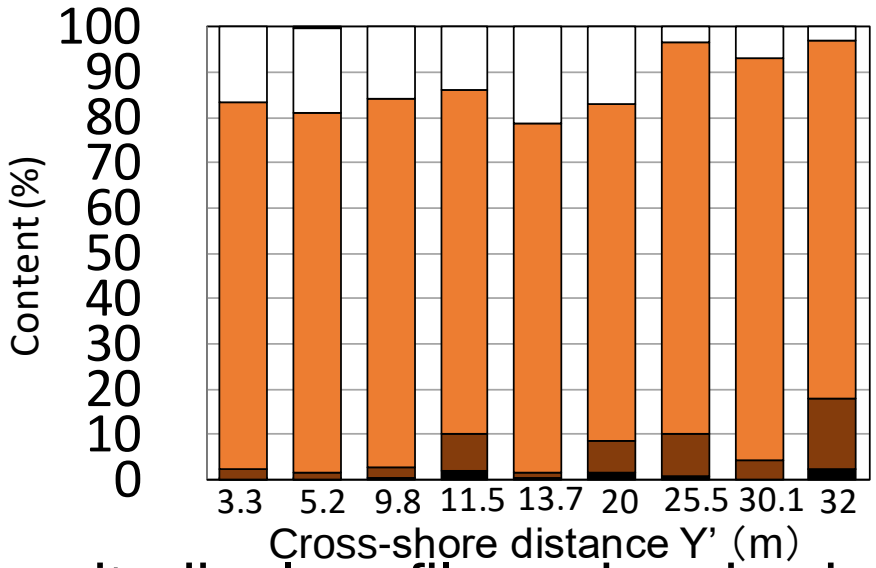
Longitudinal profile and grain size composition along transect No.1.

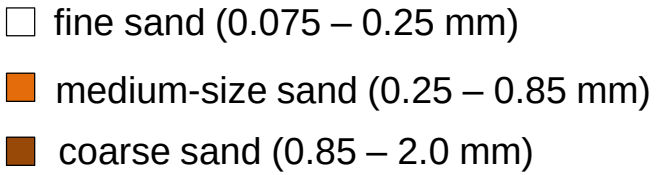
(a) Beach profile along transect No. 2



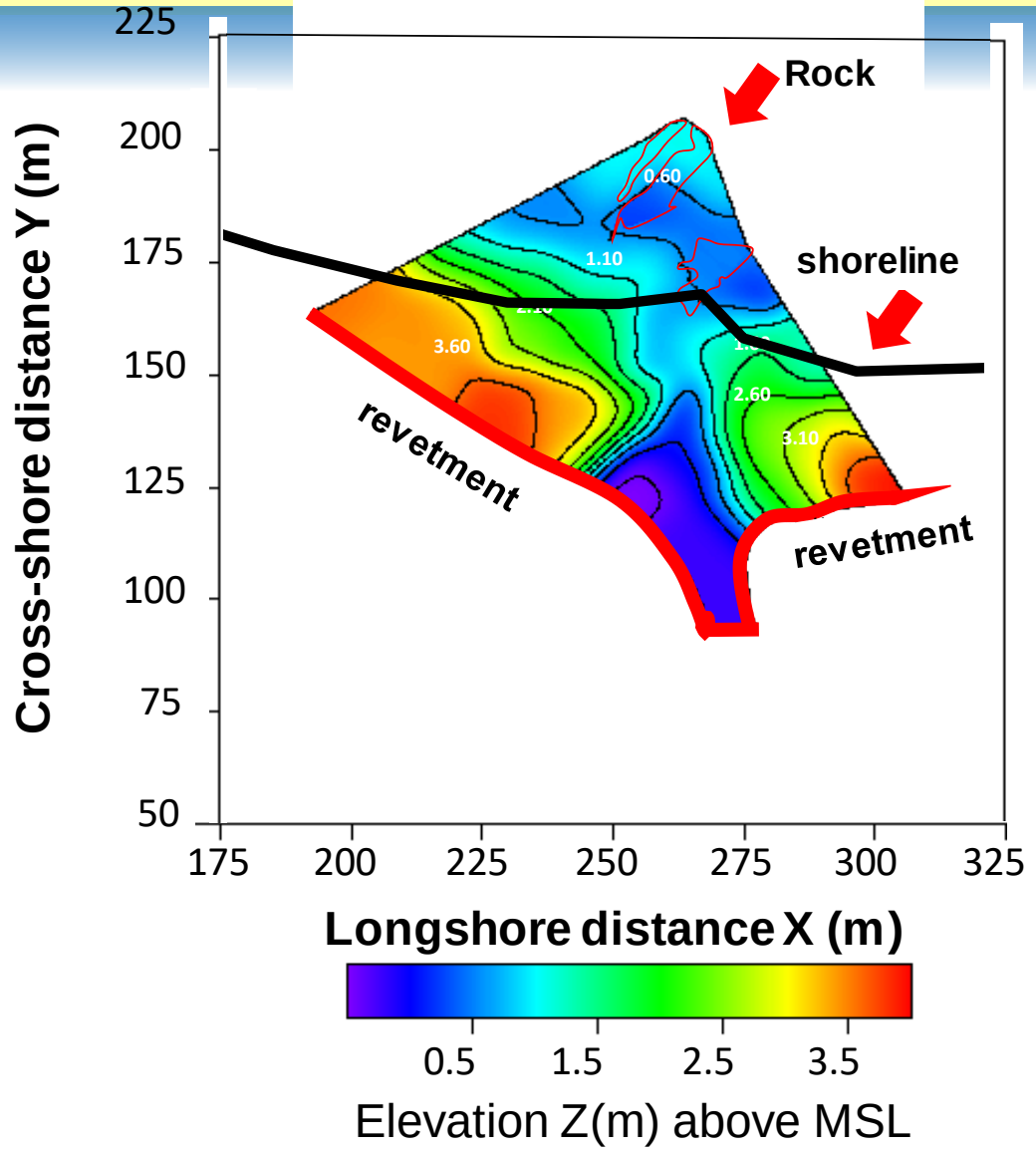


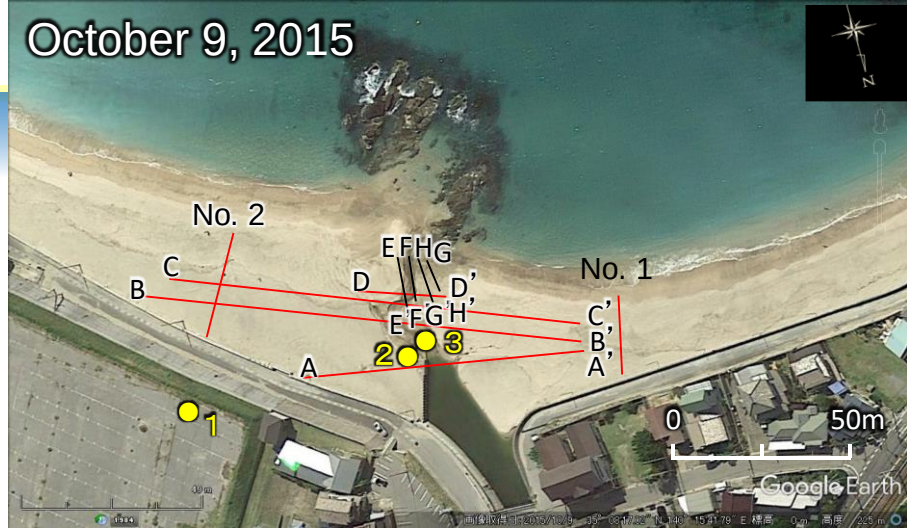
(b) Composition of grain size



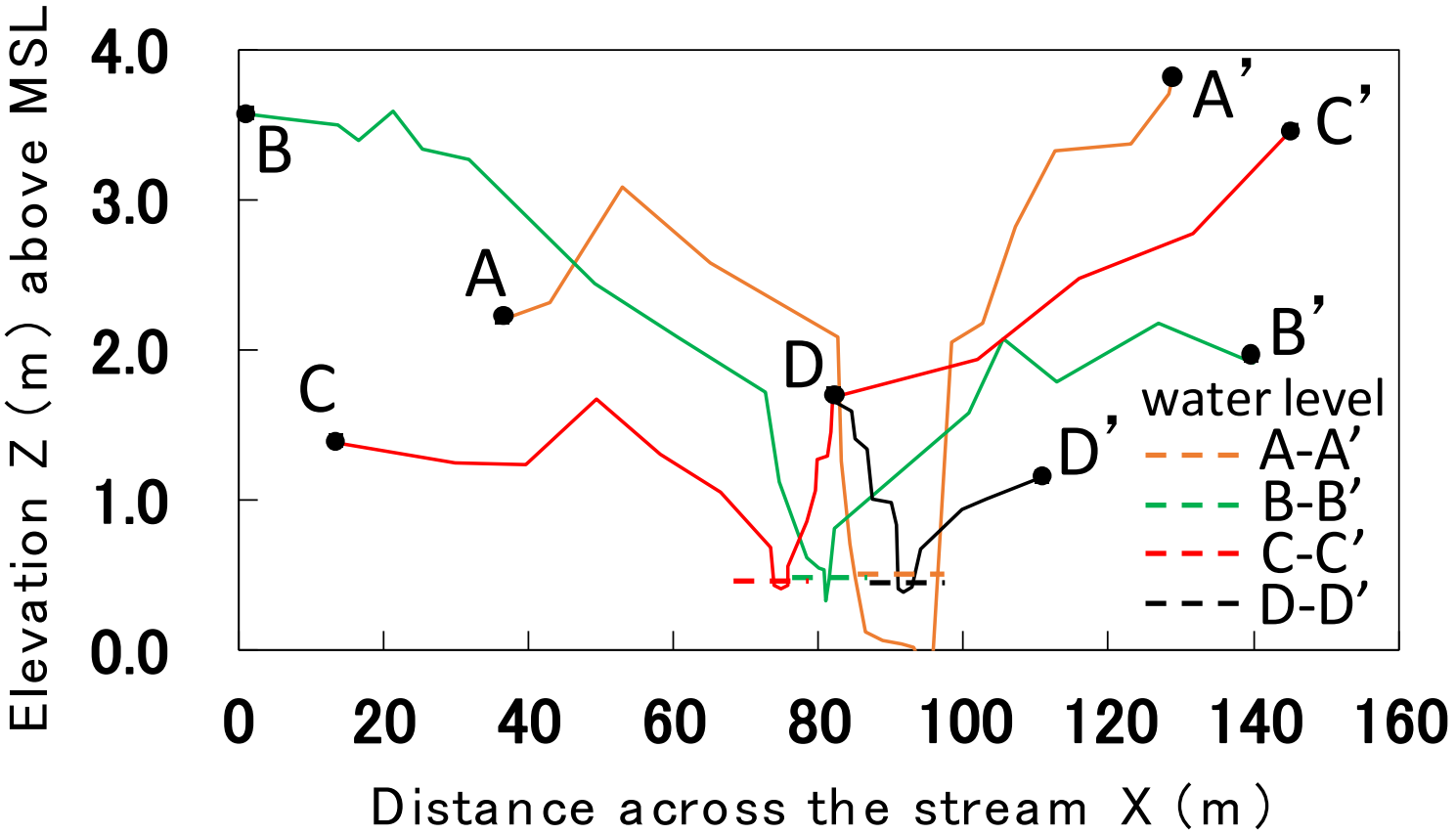


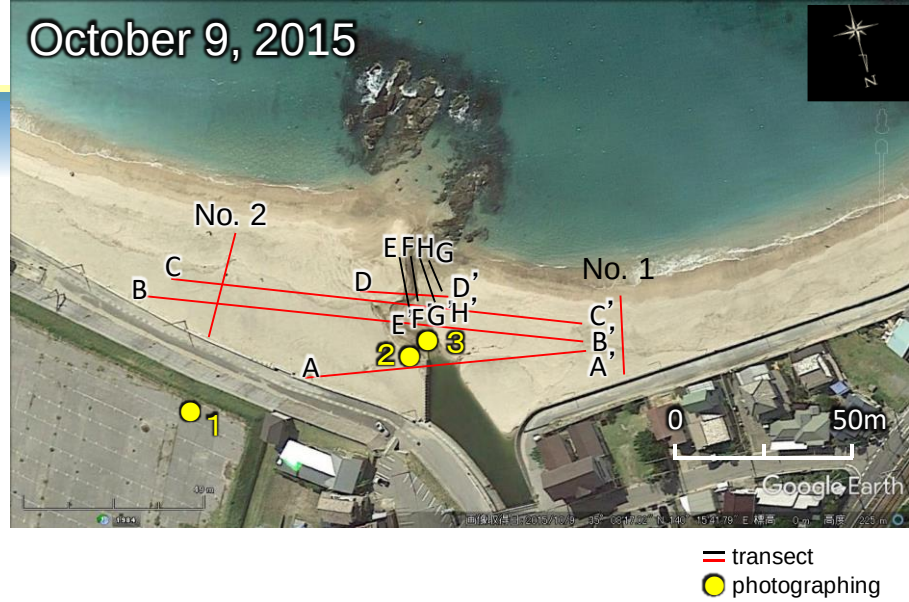
Longitudinal profile and grain size composition along transect No.2.



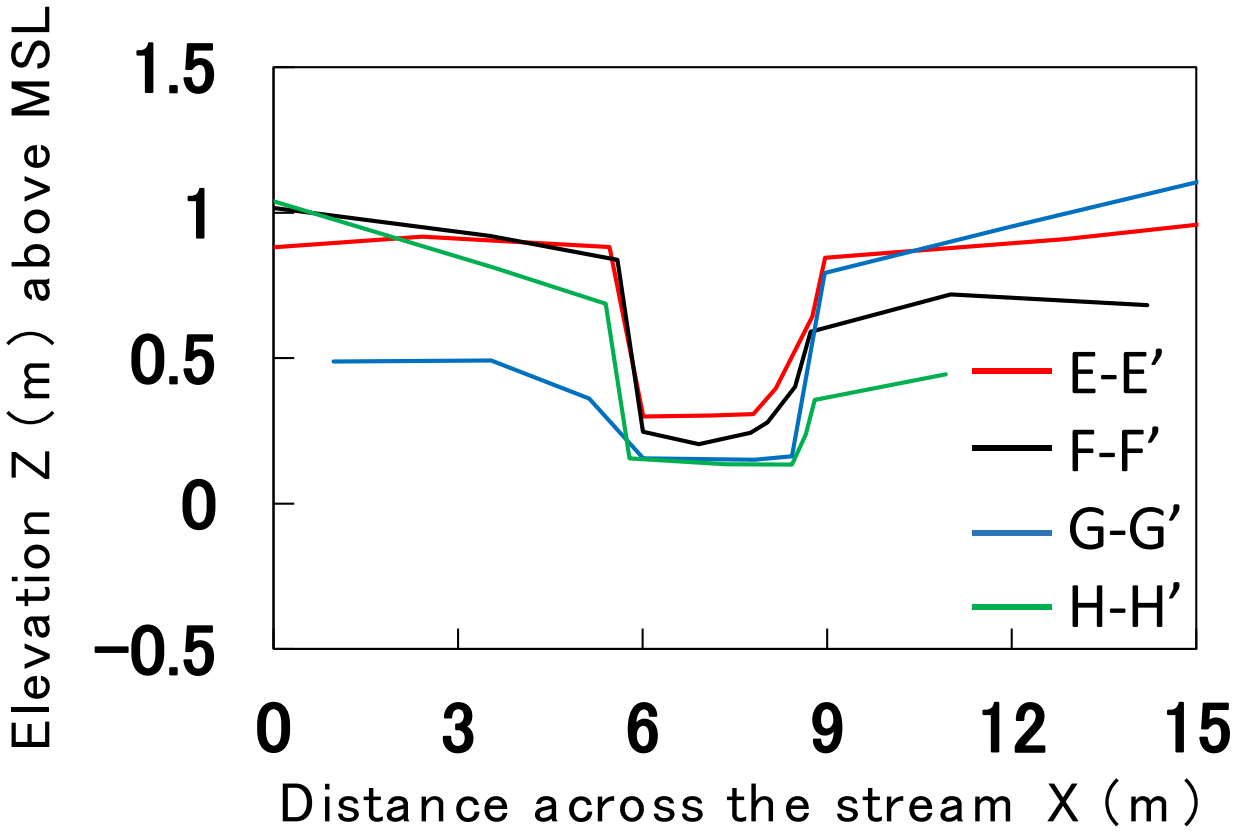


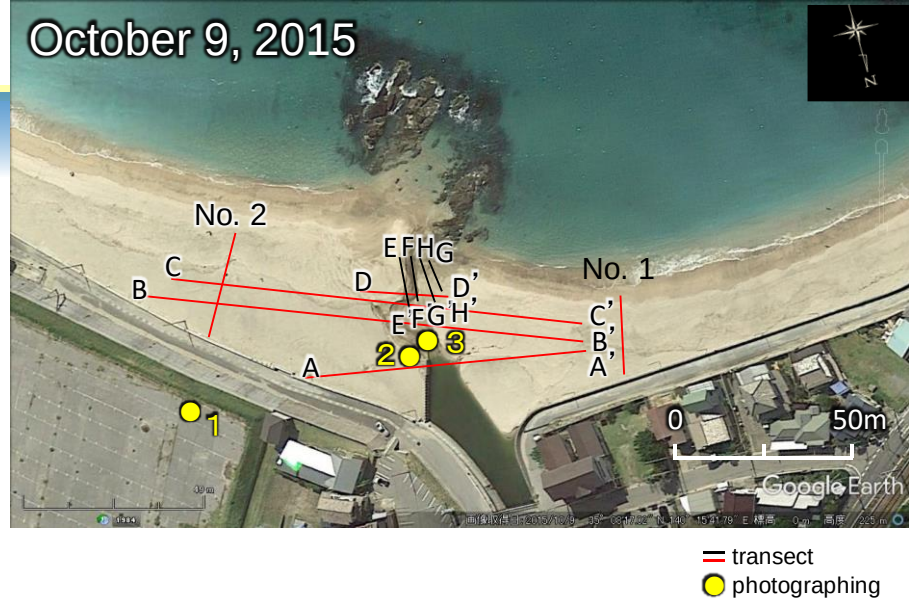
Beach topography behind reef.



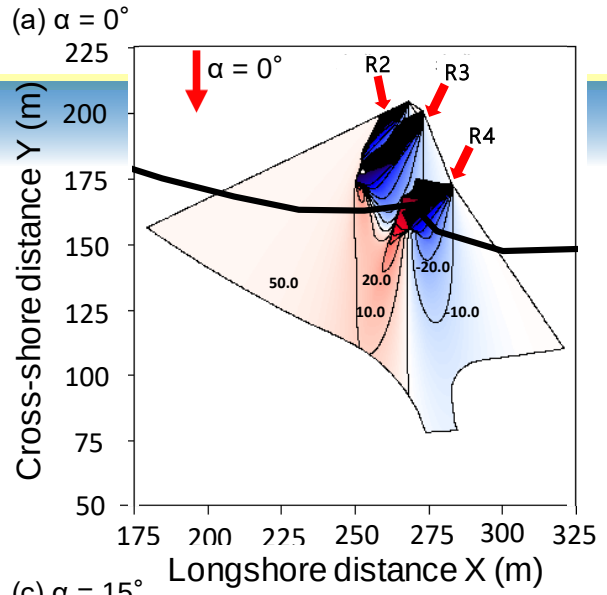


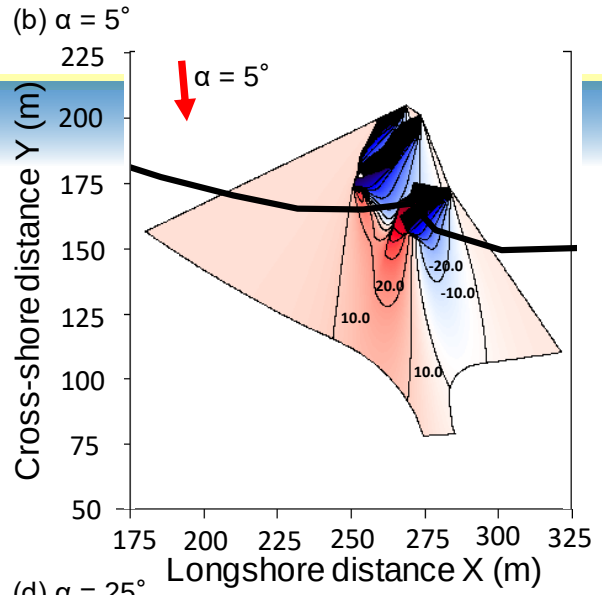
Profile along transects A-A', B-B', C-C', and D-D'.

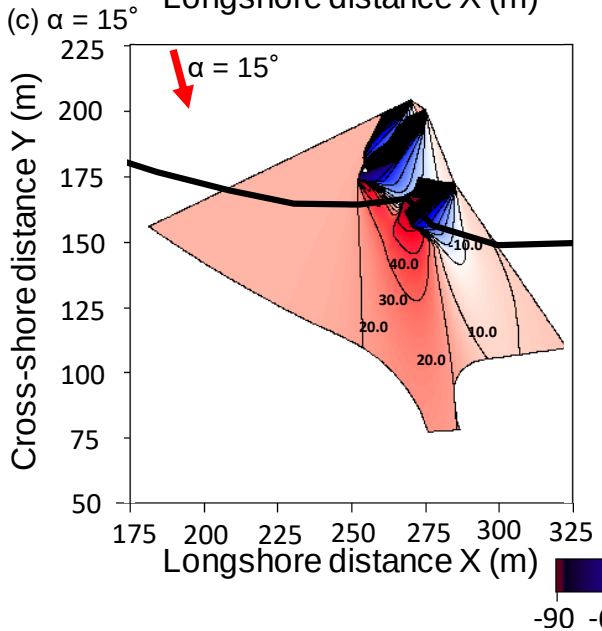


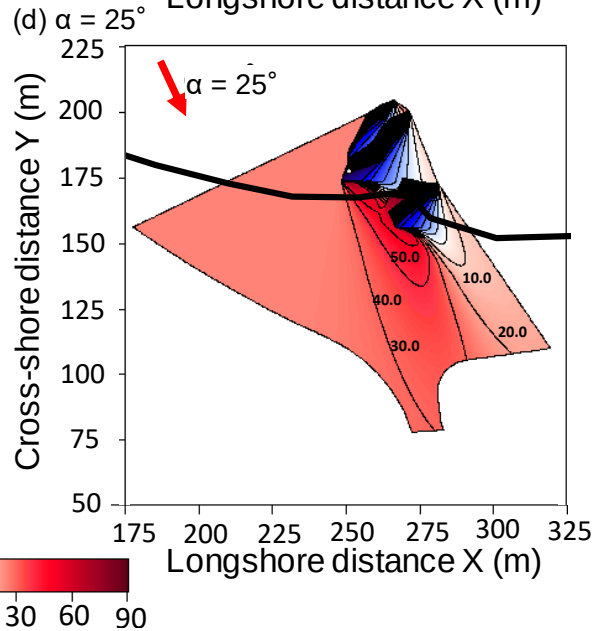


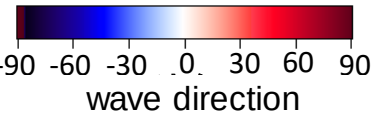
Profiles along transects E-E’, F-F’, G-G’, and H-H’ across the stream.

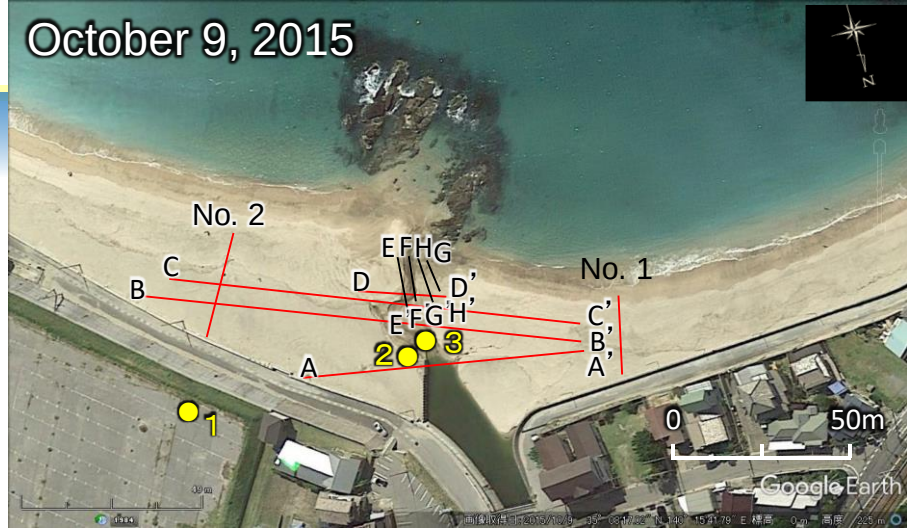




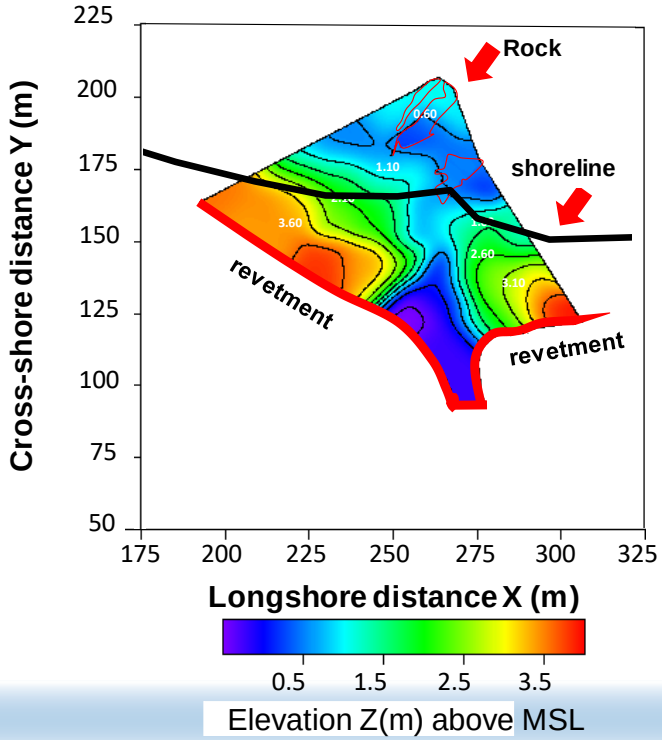




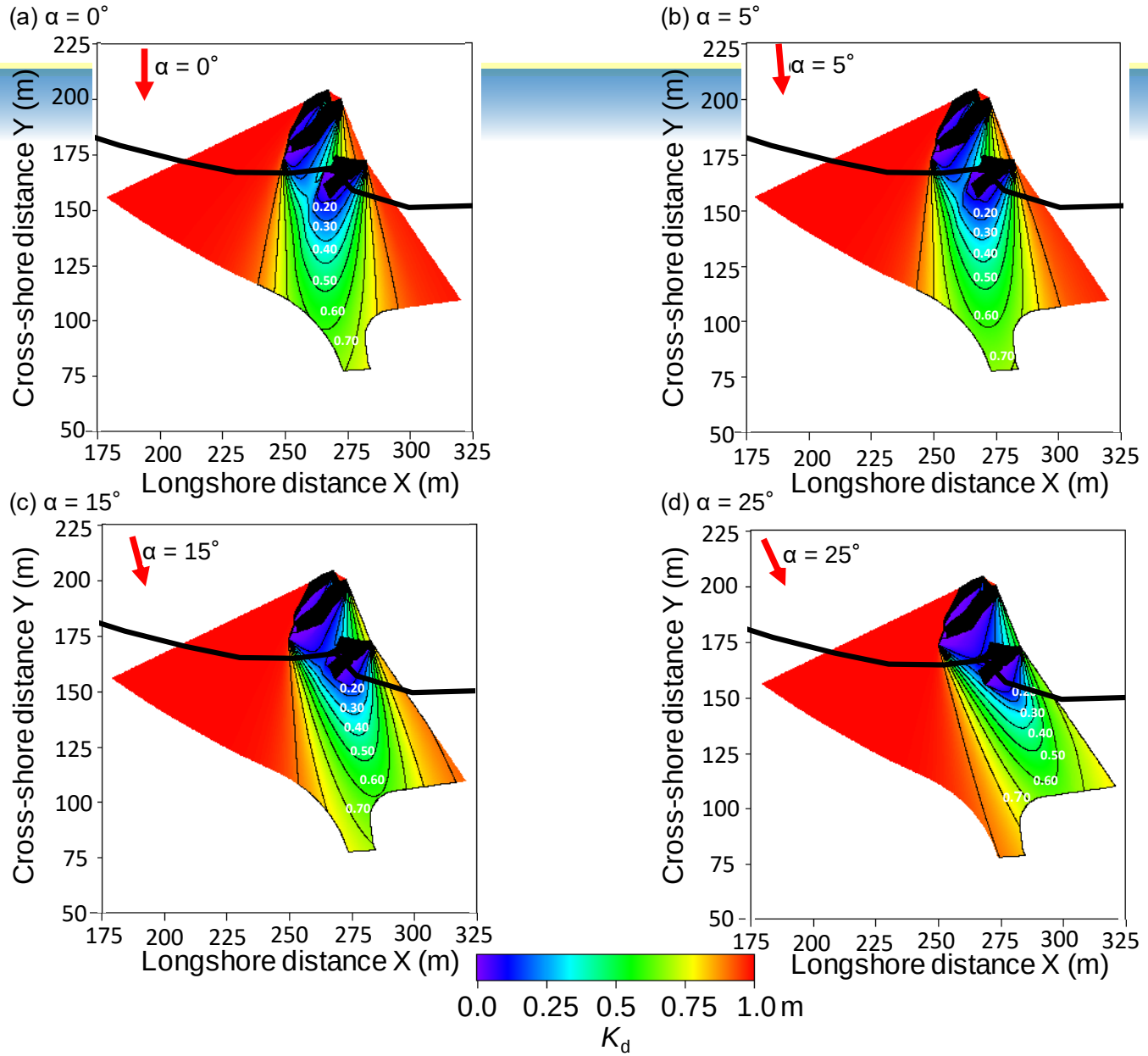


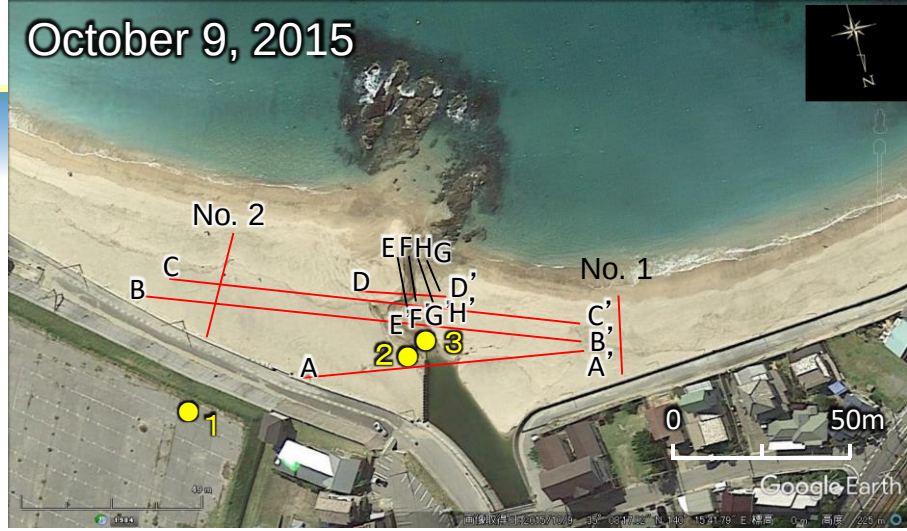


transect
photographing

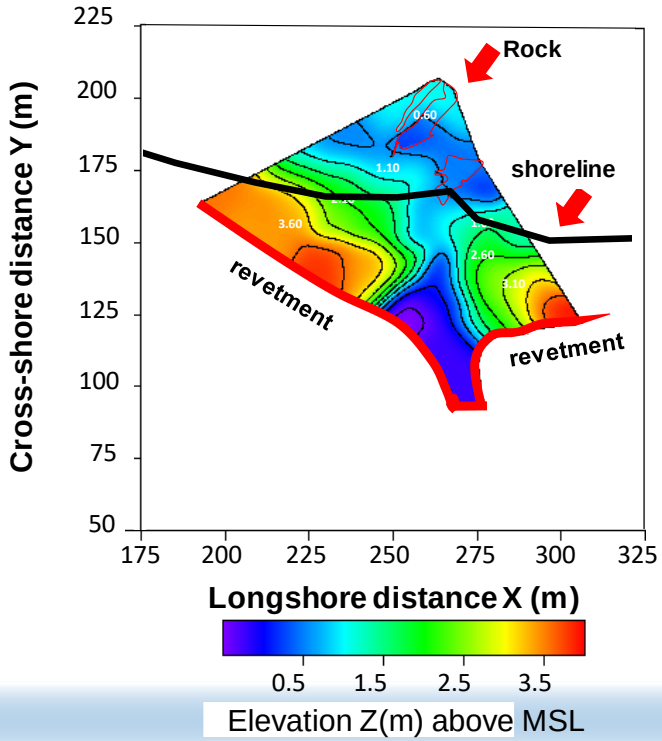


Distribution of wave direction.





transect
photographing



Distribution of K_d value.

When waves are incident from the Pacific Ocean on the Moriya coast, the wave diffraction effect of the reef is determined by the K_d value, and the wave height decreases behind the reef.

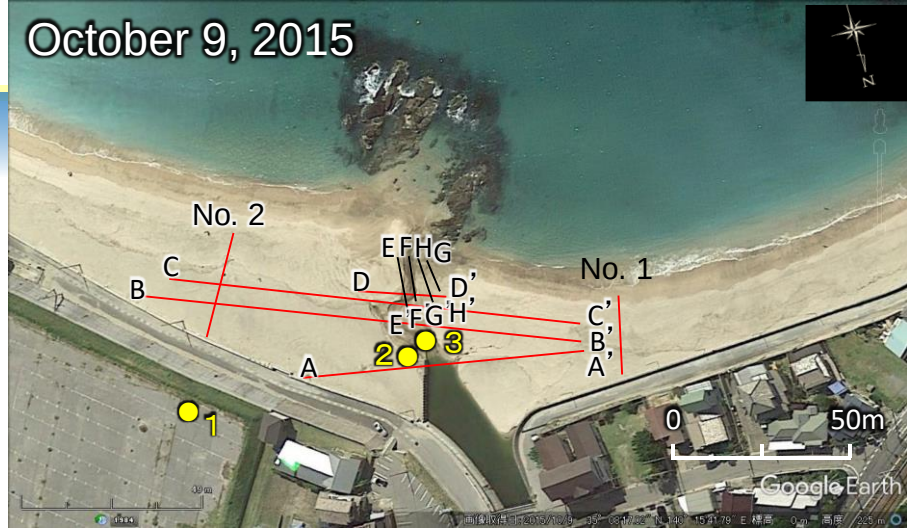
Although the Moriya coast faces the Pacific Ocean, it is a well-sheltered pocket beach, resulting in a mean wave height of 1 m.

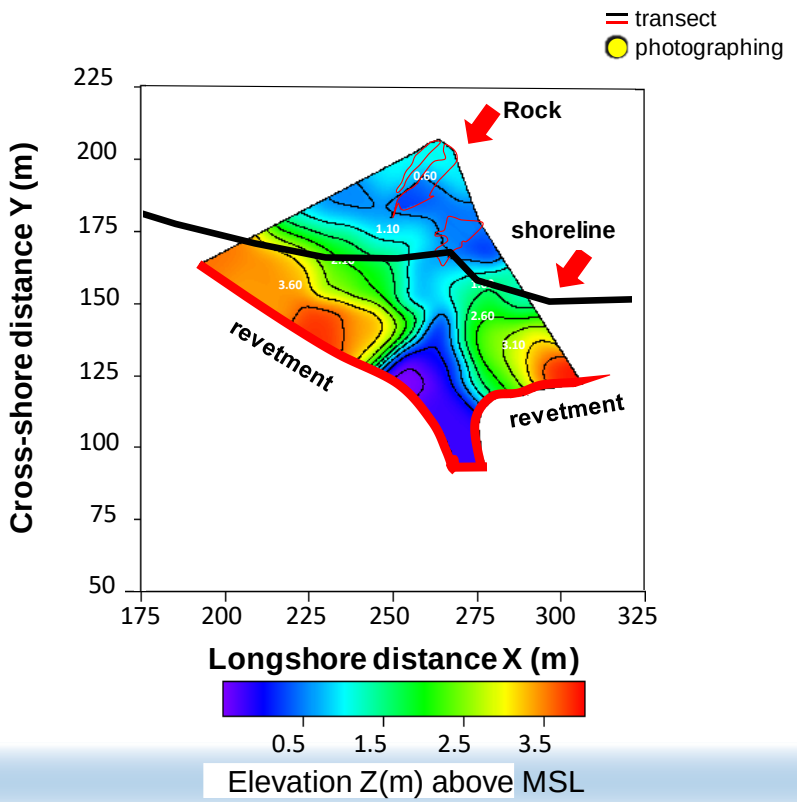
Since the berm height is of the same order as the wave height, the berm height becomes 0.2 m above MSL.

This value has the same order of magnitude as the riverbed elevation behind the rocks, and the wave height behind the rocks decreases, regardless of the wave direction, and the stream was considered to be fixed at this location.

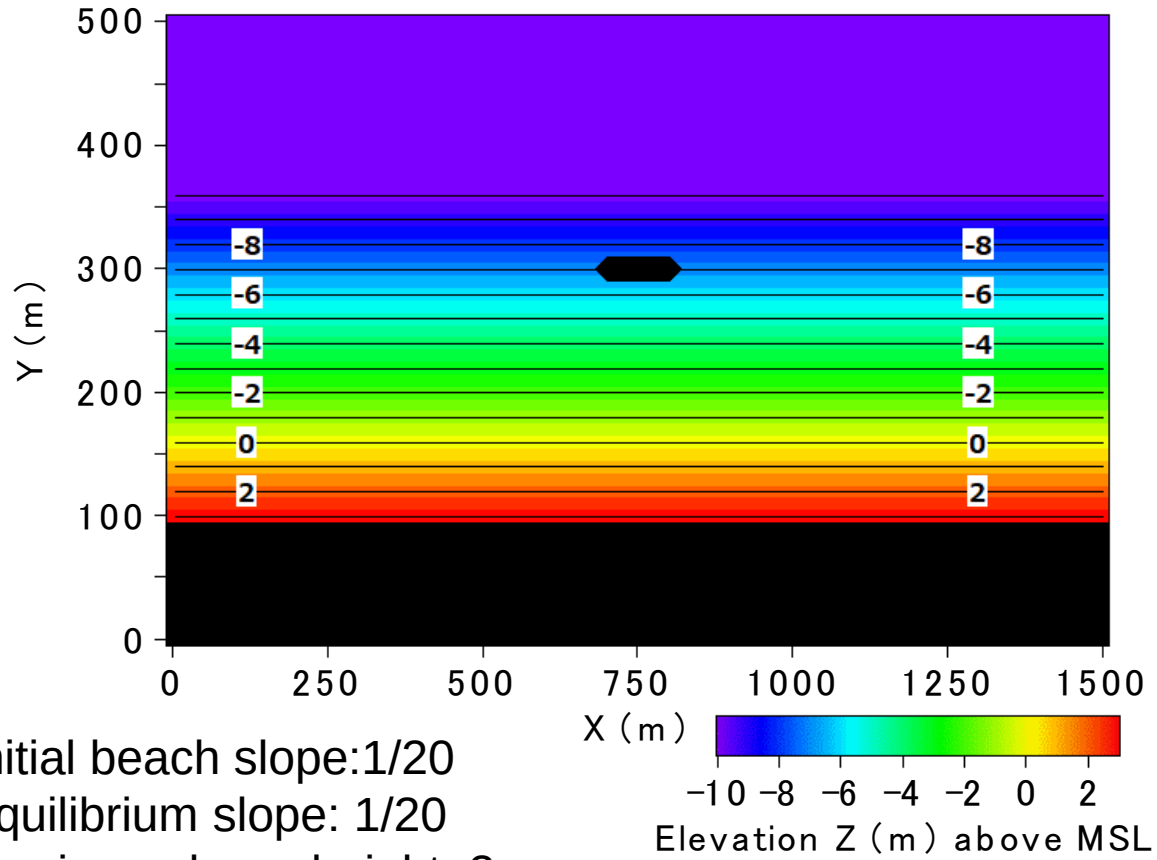
These natural rocks were randomly distributed in the area.

Therefore, the location of the stream is assumed to be stably maintained, even though the wave-sheltering effect alters in response to the changes in the wave direction or wave height or the change in the flow of the small river.

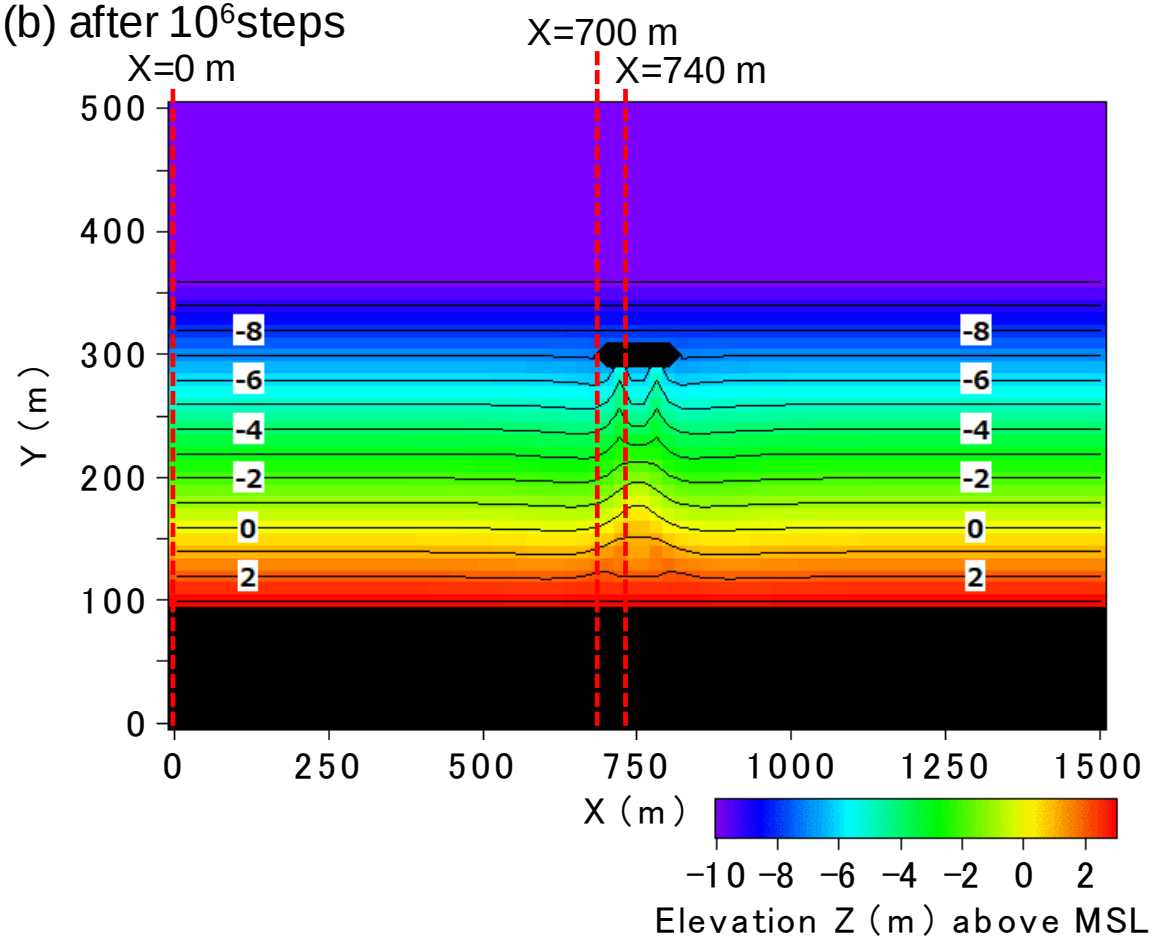




(a) initial

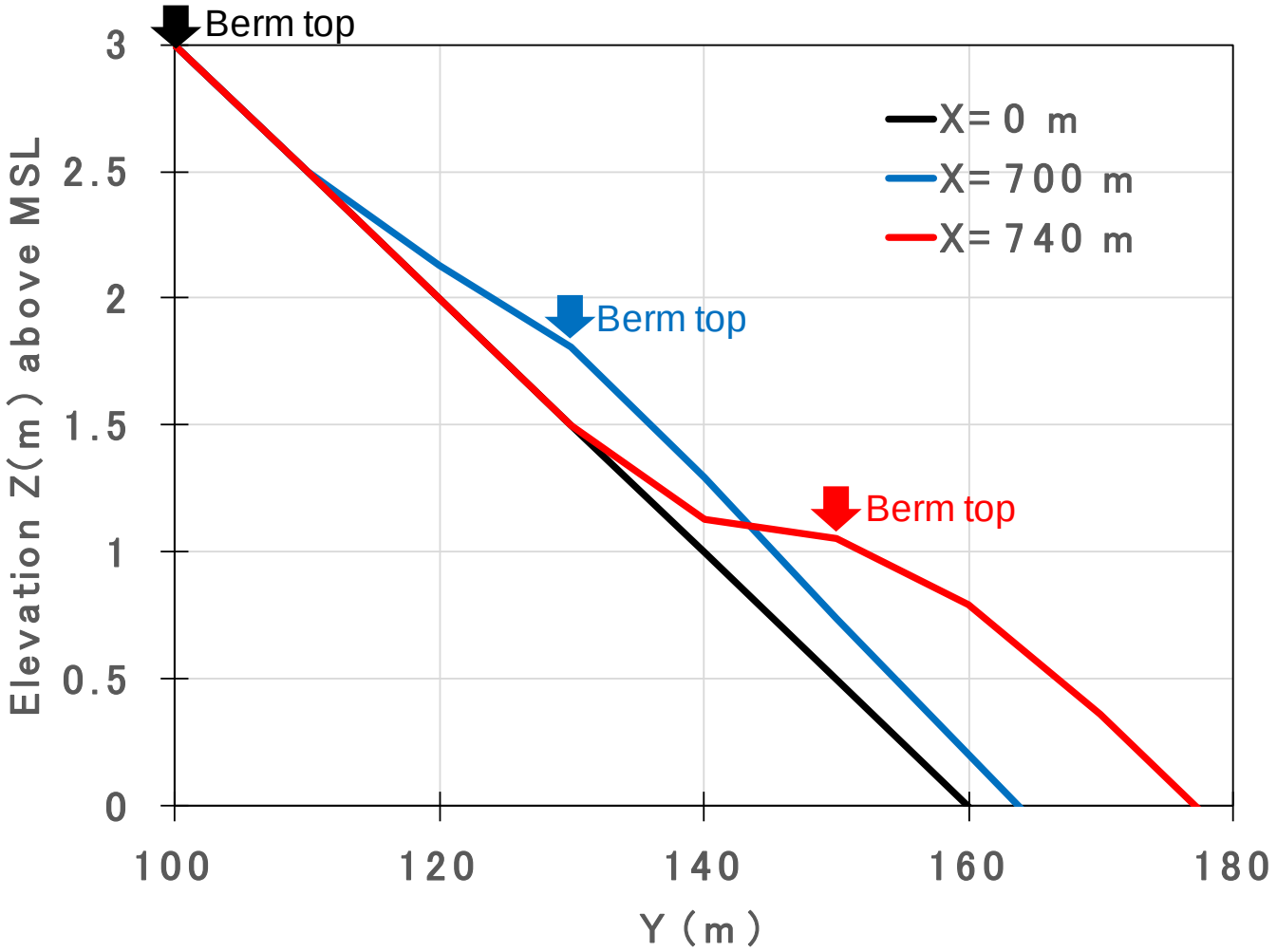


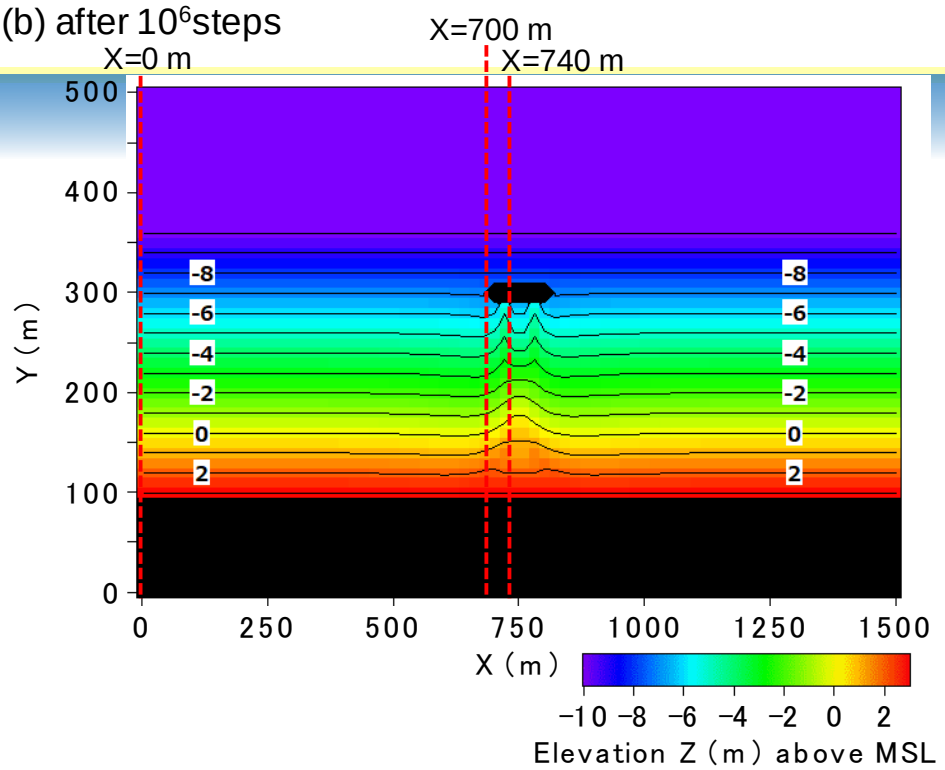
(b) after 10^6steps



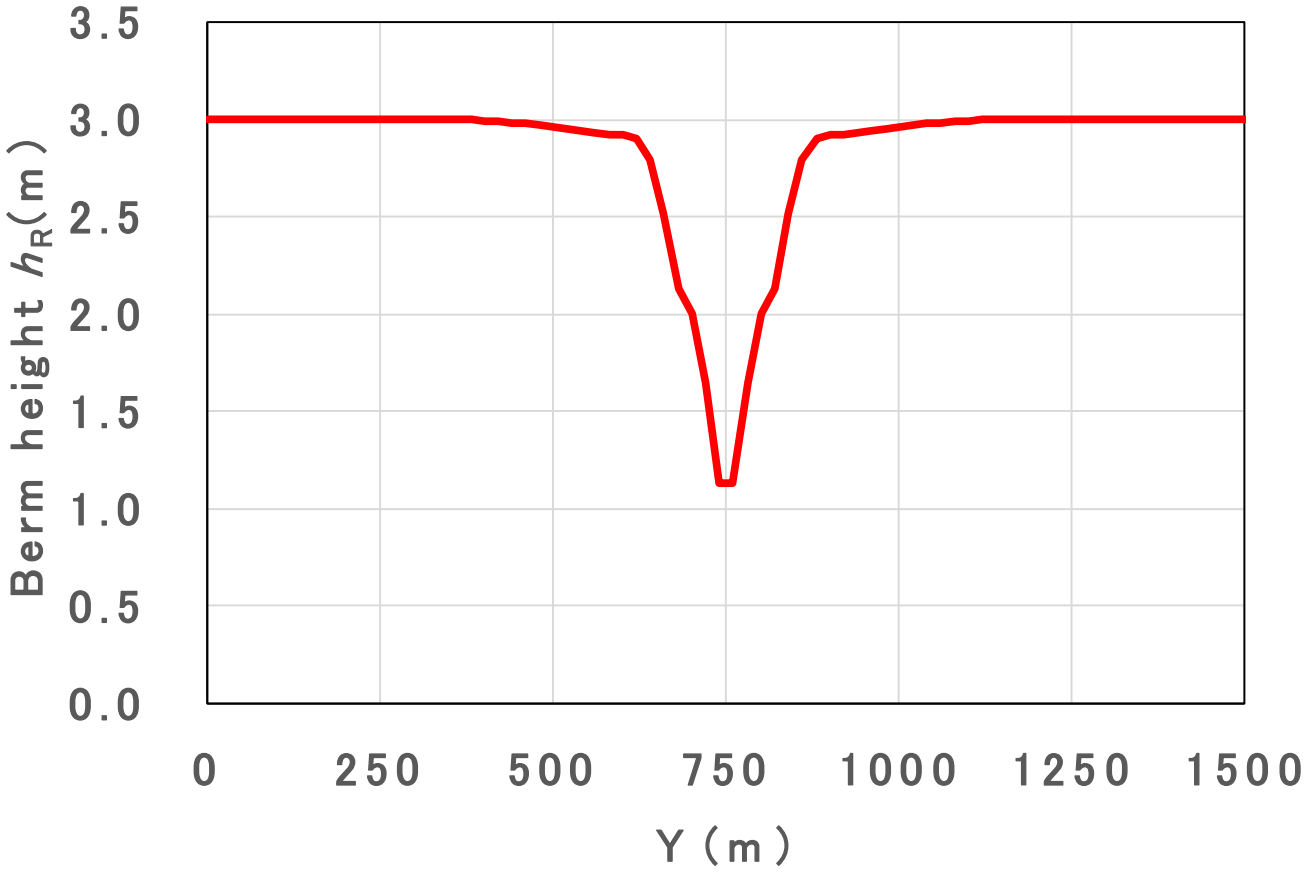
initial beach slope:1/20
equilibrium slope: 1/20
maximum berm height: 3 m
maximum depth of closure: 8 m

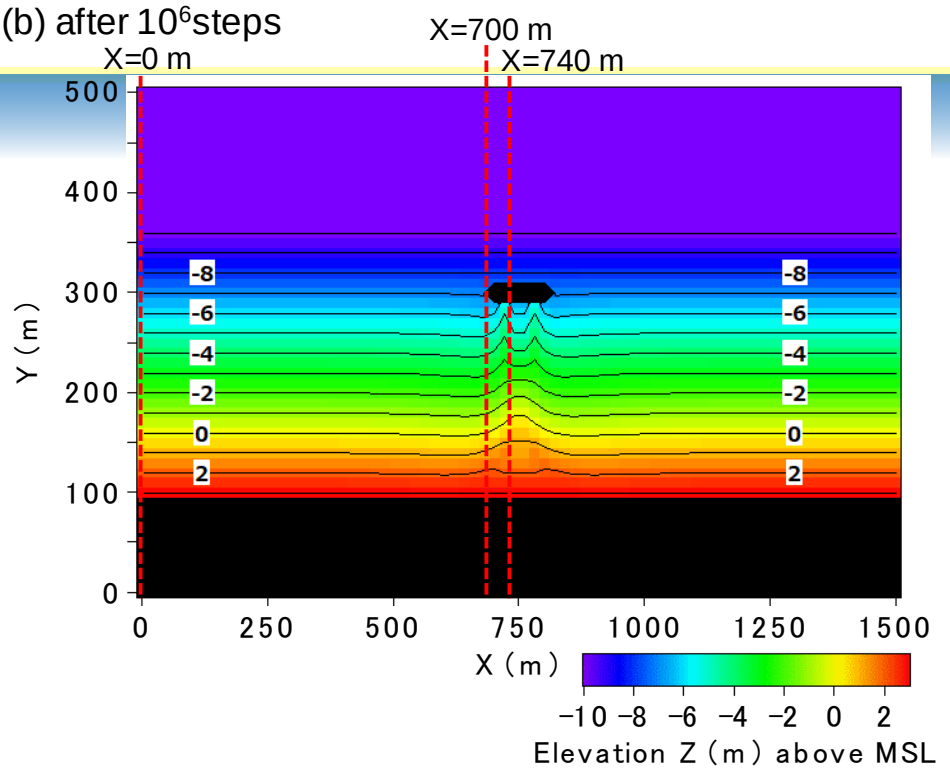
Initial topography and predicted topography behind an offshore breakwater.





Profiles along transects X = 0, 700, and 740 m.





Longshore change in berm height.

Conclusions

At the mouth of a small river flowing into the sea at the central part of the Moriya coast, the stream has been stably maintained at a location behind a reef composed of several rocks.

The primary cause for the fixation of the river mouth behind the reef was found to be the wave-sheltering effect of the reef, by which the height of the sandy beach is locally reduced.

The results of this study suggest that the mouth of a small river can be stabilized by the installation of rocks in front of the river mouth, which can be used as a method of river mouth improvement instead of the ordinary method of using training jetties.

It is not necessary for these natural rocks to have a fixed shape and they may have randomly scattered.

When several rocks are randomly scattered in an offshore area near the shoreline, the stream can be stably maintained, even though the incident wave direction and wave height change or the stream meanders, reducing the necessity of river mouth excavation to maintain the channel.

Therefore, this method it has high flexibility compared with the construction of a river mouth jetty to forcibly maintain the river channel.