DEVELOPMENT OF SAND BARS AROUND ISLANDS OFFSHORE OF KRABI IN THAILAND AND THEIR PREDICTION

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INTRODUCTION

- When multiple islands composed of sand are located in a shallow sea, the wave-sheltering effect of one island affects the wave field around another island, and sand bars connecting these islands may develop because of their wave-sheltering effect.

- Serizawa et al. (2014) predicted the deformation of multiple, circular islands composed of sand located in a shallow flat sea. Assuming that waves were incident from all the directions between 0° and 360° with an equivalent probability of occurrence.

- In south part of Thailand, Poda and Po Da Nok Islands are located offshore of Krabi, facing the Andaman Sea, and a shallow sea extends offshore of these islands, and sand bars of characteristic shape extend between the islands.

INTRODUCTION

- In addition, a small island named Tup Island is located between Poda and Po Da Nok Islands, in which two rocky islands, i.e., east and west islands, were combined by a sand bar.

- Since a shallow sea extends around these islands, sand bars well develop, and each island affects the wave field of the other island.

- In August 2016, field observation was carried out to investigate the mechanism of elongation of a sand bar between islands. Then, numerical simulation of topographic changes was carried out using the BG model (Serizawa et al., 2014).

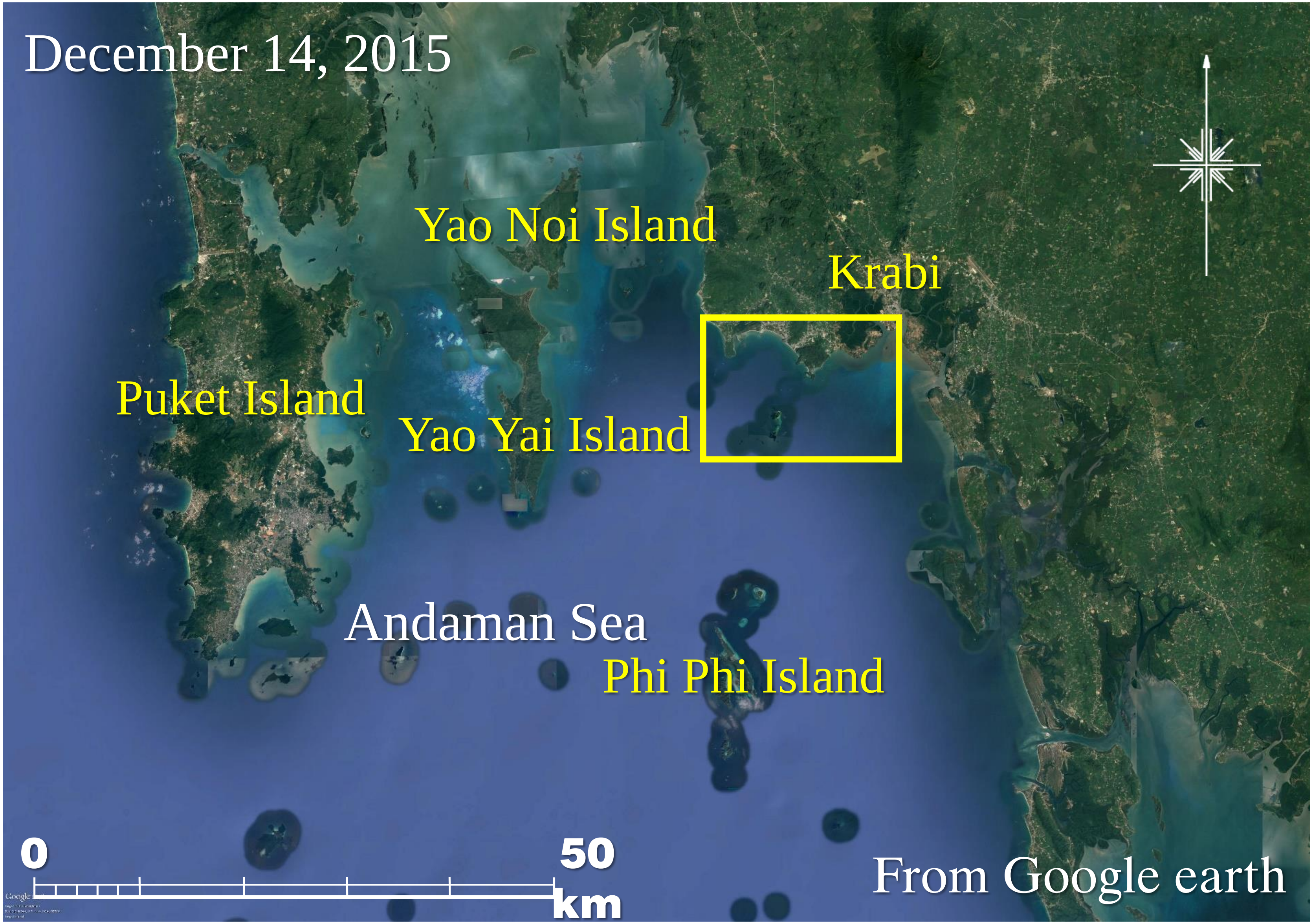


Figure 1. Study area offshore of Krabi in south part of Thailand.

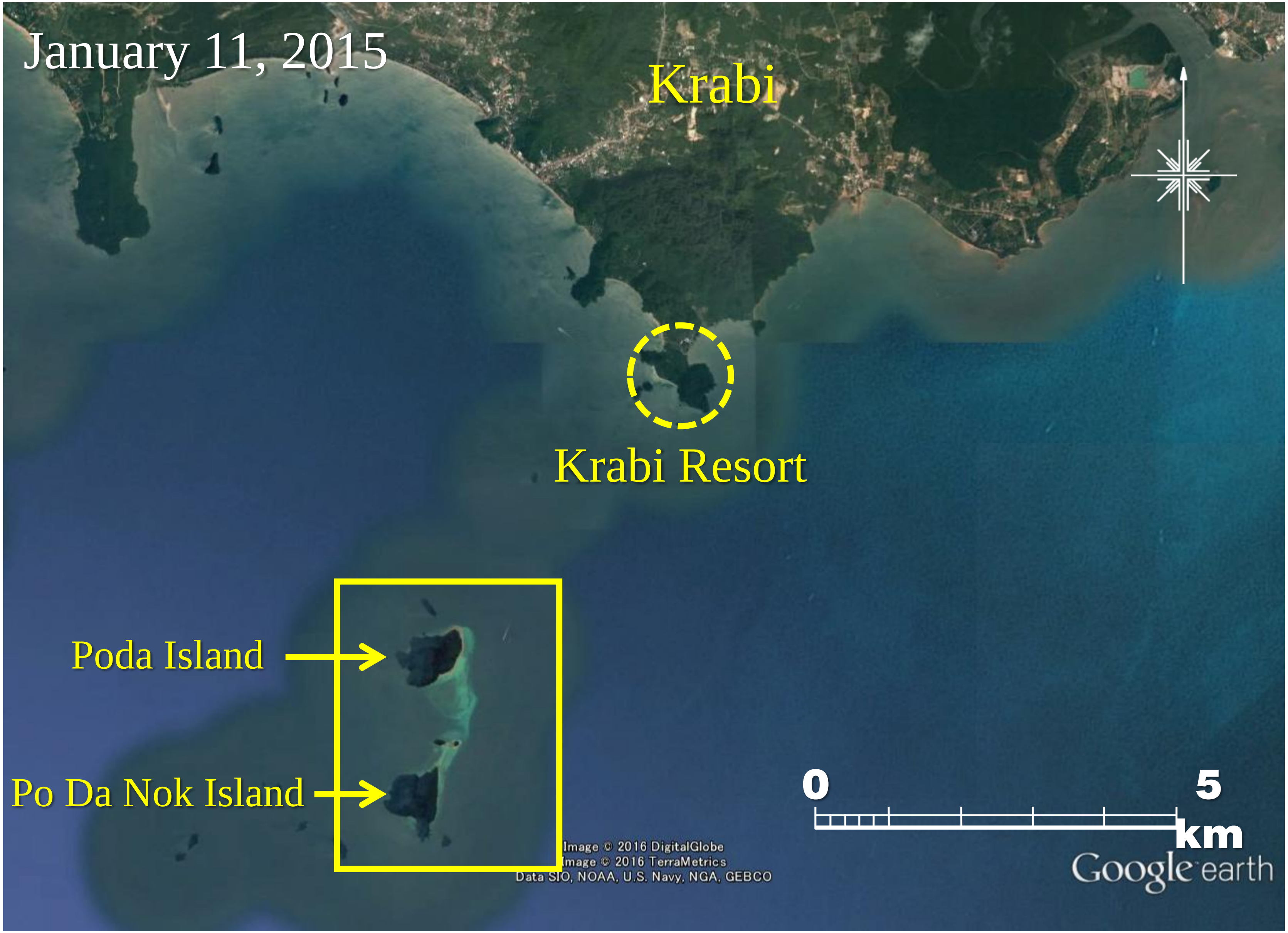


Figure 2. Satellite image of Poda and Po Da Nok Islands.

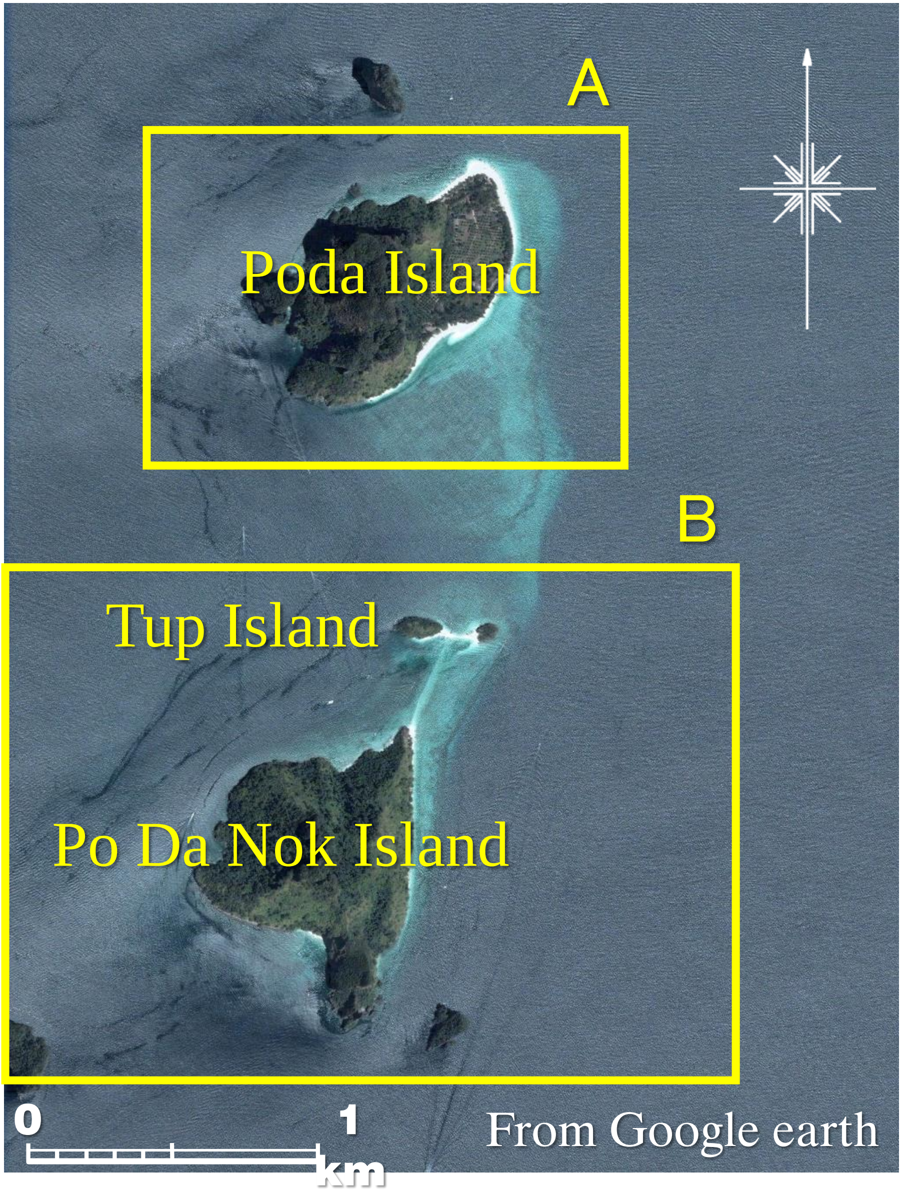


Figure 3. Enlarged satellite image of Poda and Po Da Nok Islands.

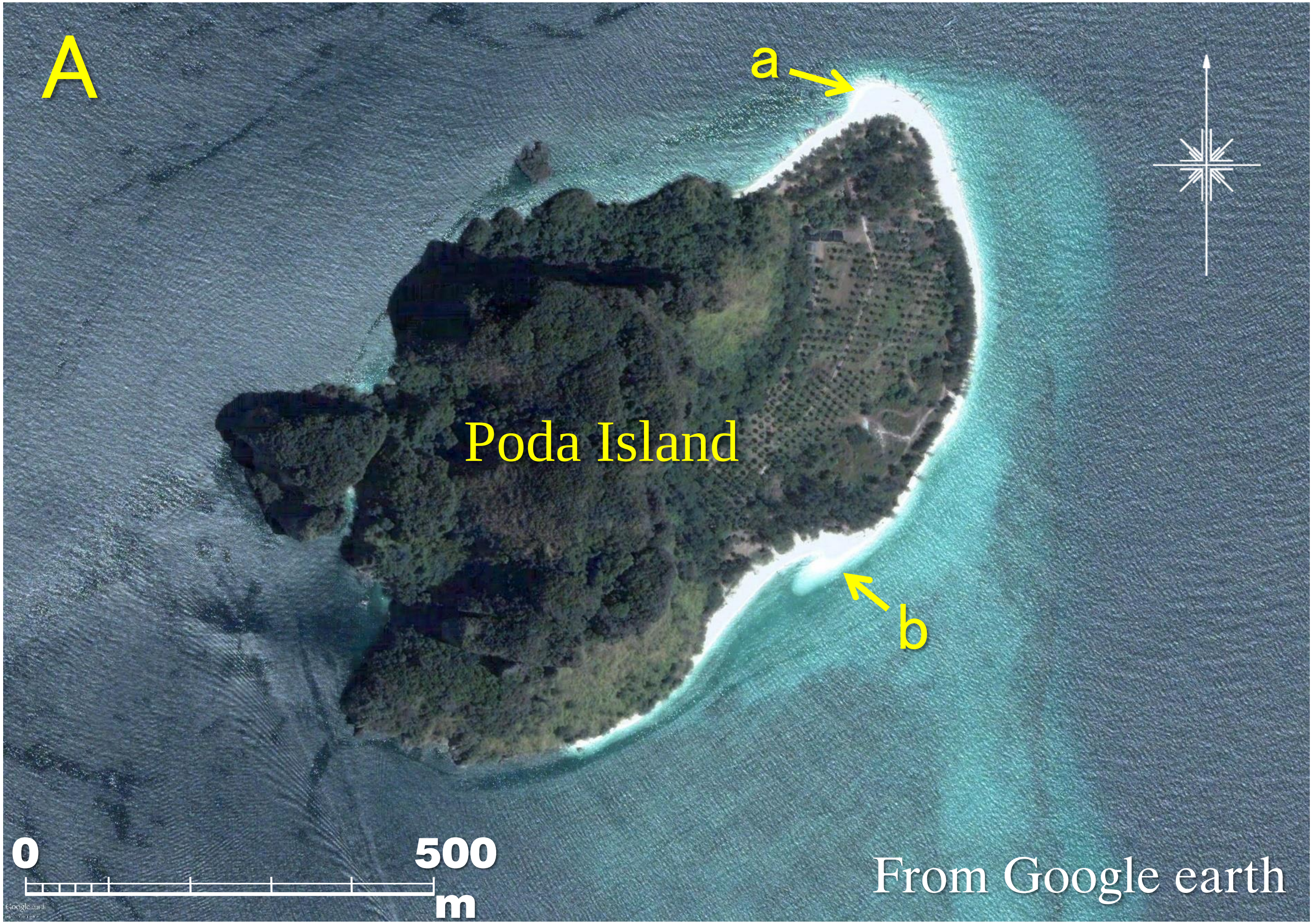


Figure 4(A). Sand spit of Poda Island and enlarged satellite image of Tup Island.

Figure 4(B). Sand spit of Poda Island and enlarged satellite image of Tup Island.

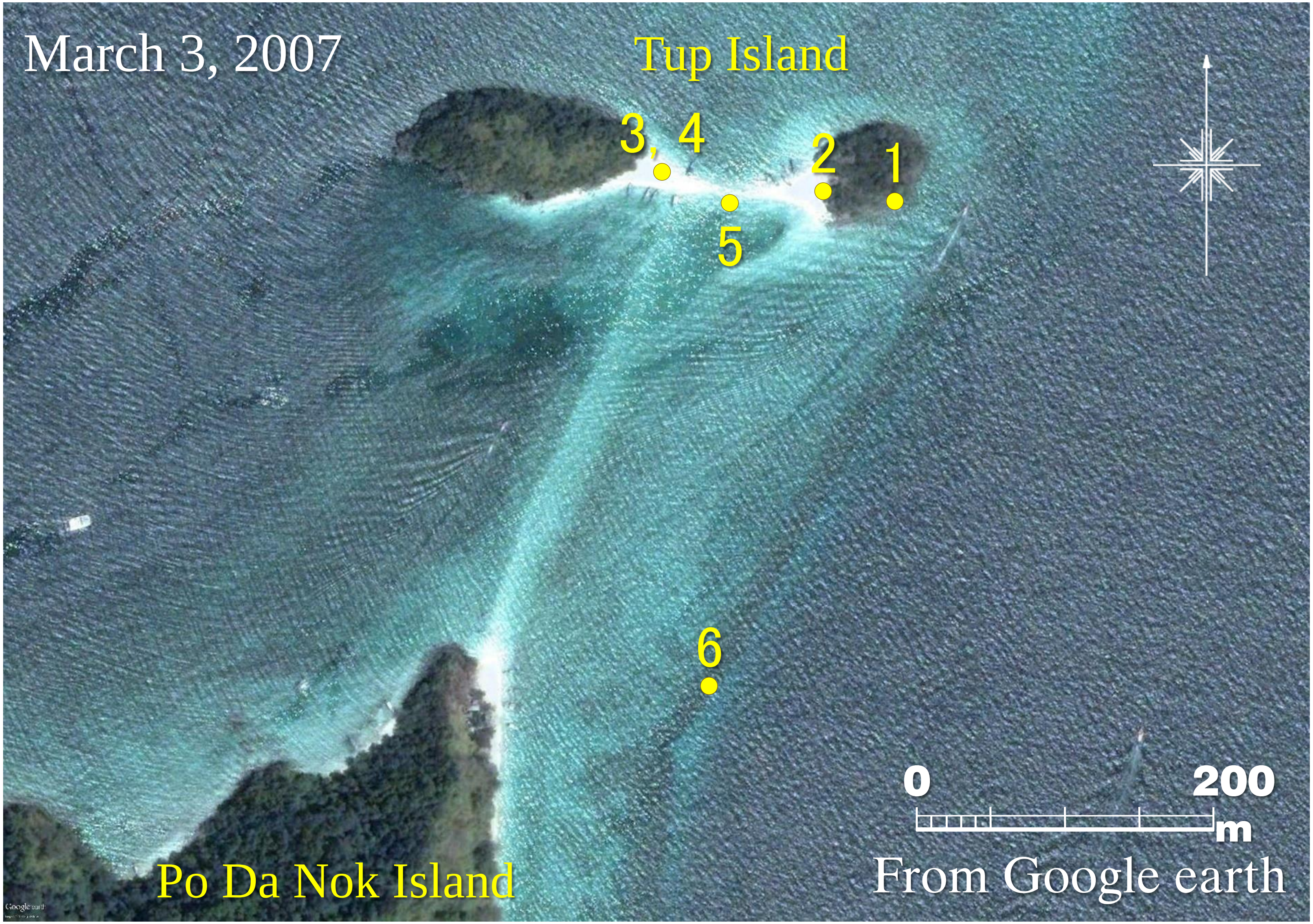


Figure 5. Location of site photographs around Tup Island.

Figure 6. Narrow sandy beach formed at east end of Tup Island.

Figure 7. Sandy beach connecting two small islands of Tup Island.

Figure 8. East island and sandy beach looking from vicinity of west island.

Figure 9. East island looking from on sandy beach.

Figure 10. Po Da Nok Island looking from on south side of cuspate foreland.

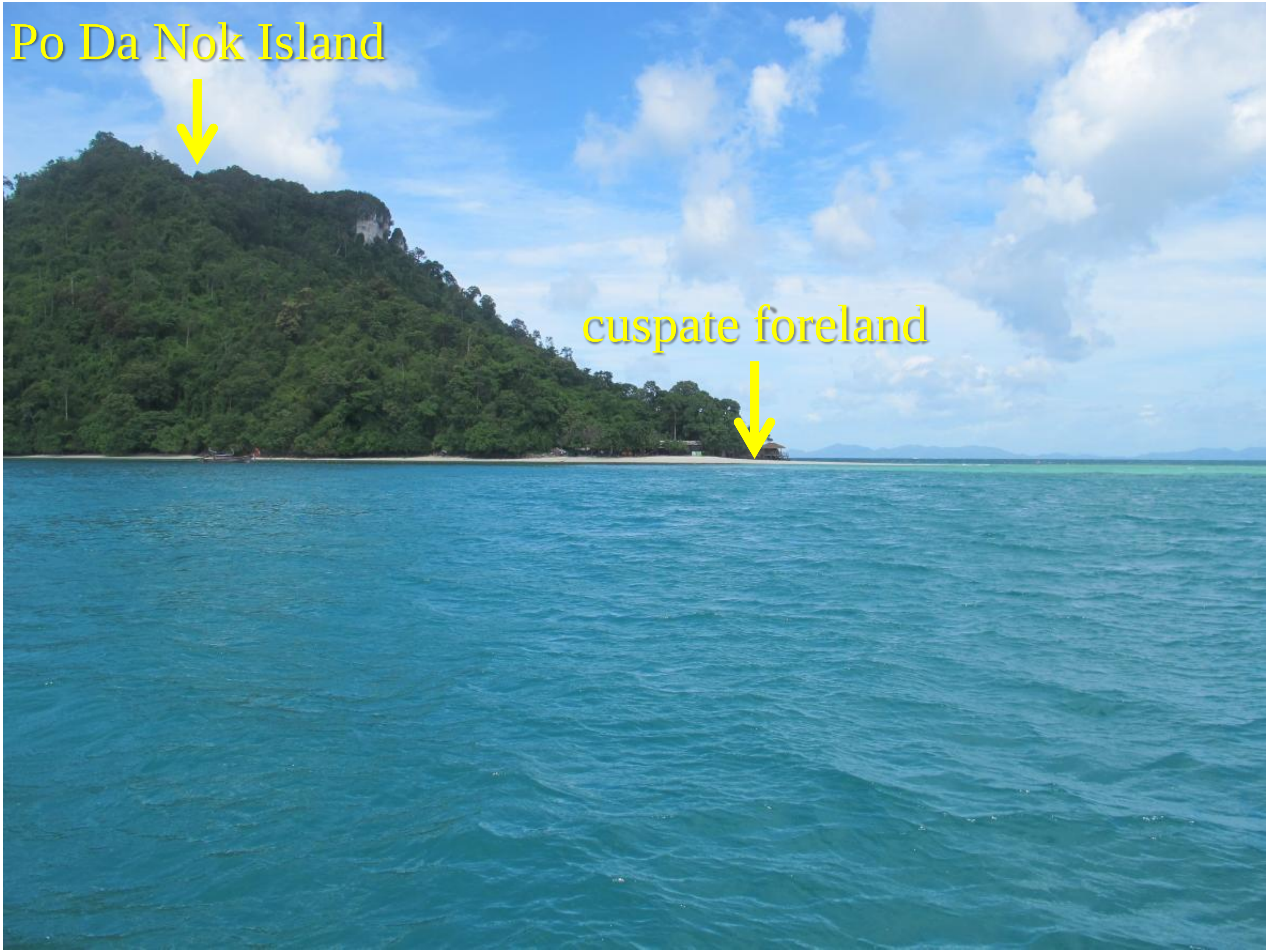


Figure 11. Cuspate foreland extending from north end of Po Da Nok Island.

BG Model (Model for predicting beach changes based on BaGnold's concept)

2. sand transport due to waves

The equation given by Serizawa *et al.* (2006) is used, which was derived by applying the concept of the equilibrium slope introduced by Inman and Bagnold (1963) and the energetics approach of Bagnold (1963).

$$\vec{q_w} = \frac{G_w}{\tan\beta_c}\left[\tan\beta_c \vec{e_w} - \nabla Z\right] \quad \dots\dots\dots\dots (2)$$

$$G_w = C_0 K_1 \Phi = C_0 K_1 \varepsilon(Z)(EC_g)_b \cos^2\alpha_b \tan\beta_c \quad \dots (3)$$

$$\int_{-h_c}^{h_R} \varepsilon(Z)\, dZ = 1 \quad \dots\dots\dots\dots (4)$$

$$\varepsilon(Z) = \begin{cases} = \dfrac{1}{h_c + h_R} & (-h_c \le Z \le h_R) \\ = 0 & (Z < -h_c, h_R < Z). \end{cases} \quad \dots\dots\dots\dots (5)$$

$$C_0 = \frac{1}{(\rho_s - \rho)g(1-p)} \quad \dots\dots\dots\dots (6)$$

$\vec{q_w} = (q_{wx}, q_{wy})$: sand transport due to waves,

$\vec{e_w} = (\cos\theta_w, \sin\theta_w)$:unit vector of wave direction.

$Z(x, y, t)$: sea bottom elevation at a point (x, y) at time t

$\nabla Z = \tan\beta\, \vec{e_n} = (\partial Z/\partial x, \partial Z/\partial y)$

$\vec{e_n}$: unit vector normal to the contour lines (shoreward),

$\tan\beta$: sea bed slope,

$\tan\beta_c$: equilibrium slope

Φ : wave energy dissipation rate per unit time and unit seabed area,

$(EC_g)_b$: wave energy flux at the breaking point,

α_b : breaker angle,

K_1 : coefficient of longshore sand transport,

$\varepsilon(Z)$: depth distribution of the intensity of sand transport,

h_c : depth of closure,

h_R : berm height

C_0 : coefficient through which the sand transport rate, expressed by the immersed weight, is related to the volumetric sand transport rate,

ρ_s and ρ : the sand and water densities,

g : acceleration due to gravity,

p : porosity of the sand,

Stability mechanism of BG Model

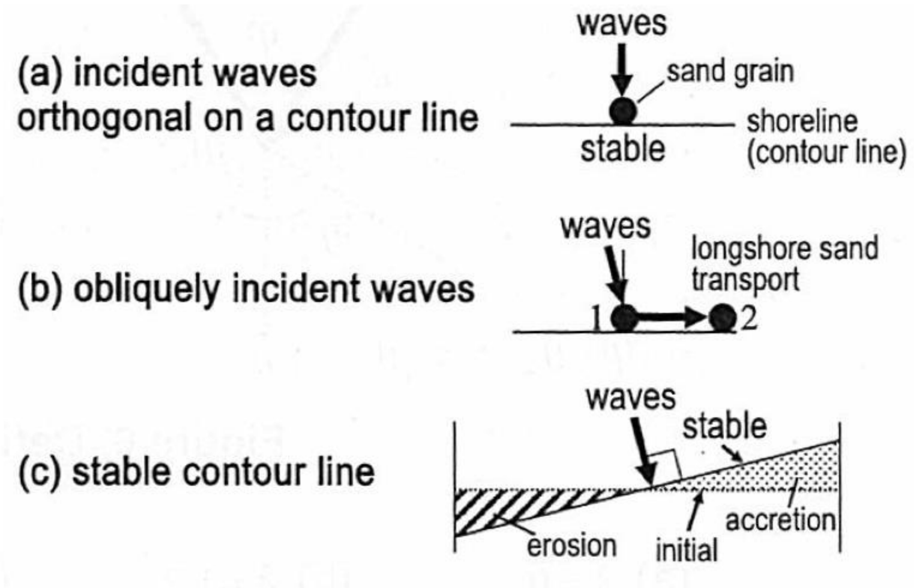


Fig. Stabilization mechanism of contour lines based on wave directions and longshore sand transport.

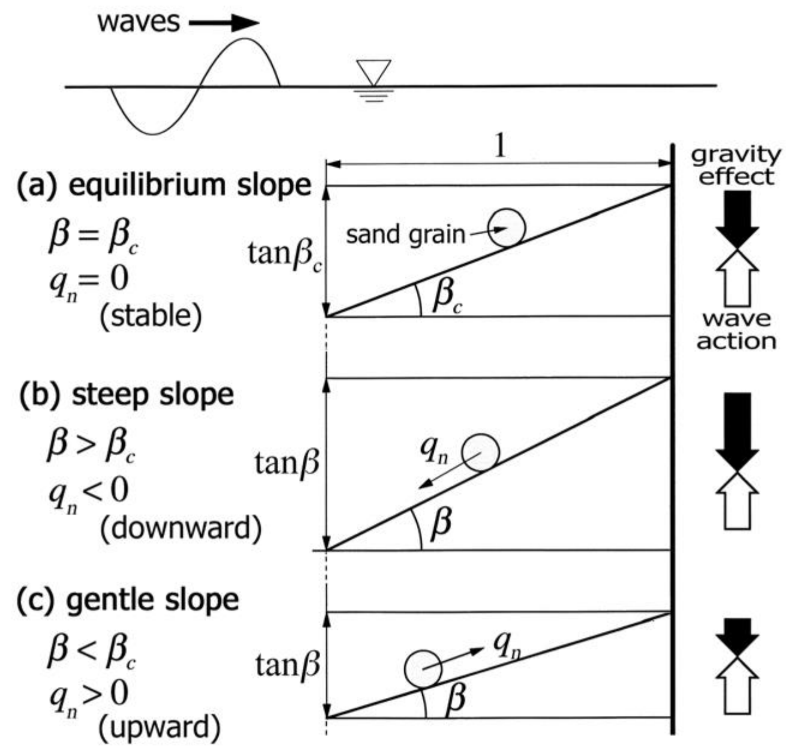


Fig. Stabilization mechanism of beach profile based on equilibrium between gravity effect and wave action.

Table 1. Calculation conditions.

Incident wave height H	H = 1 m
Berm height h_R	1 m
Depth of closure h_c	2 m
Equilibrium slope $\tan\beta_c$	1/10
Coefficient of sand transport	$K_s = 0.2$
Mesh size	$\Delta x = \Delta y = 10$ m
Time intervals	$\Delta t = 1$ h
Duration of calculation	10^4 h (10^4 step)
Boundary conditions	Shoreward and landward ends $q_x = 0$ Right and left boundaries $q_y = 0$

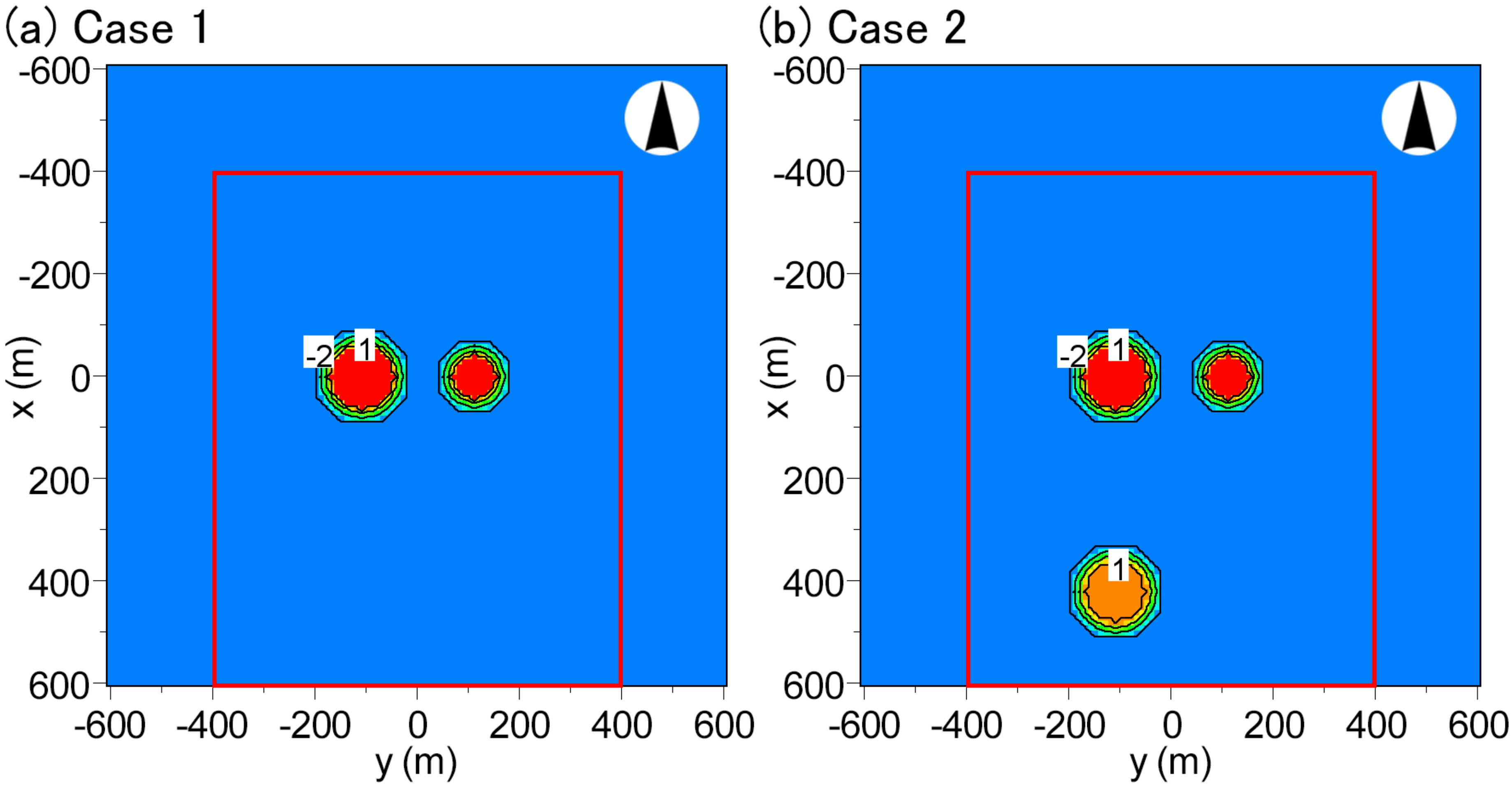


Figure 12. Coordinates for calculation and arrangement of islands in Cases 1 and 2.

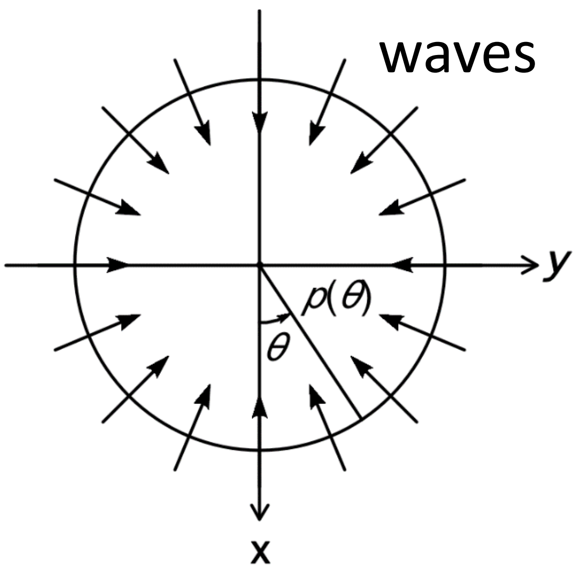
(a) 0 step

Incident wave height

H = 1 m

wave direction = 0~360˚

(random choice)



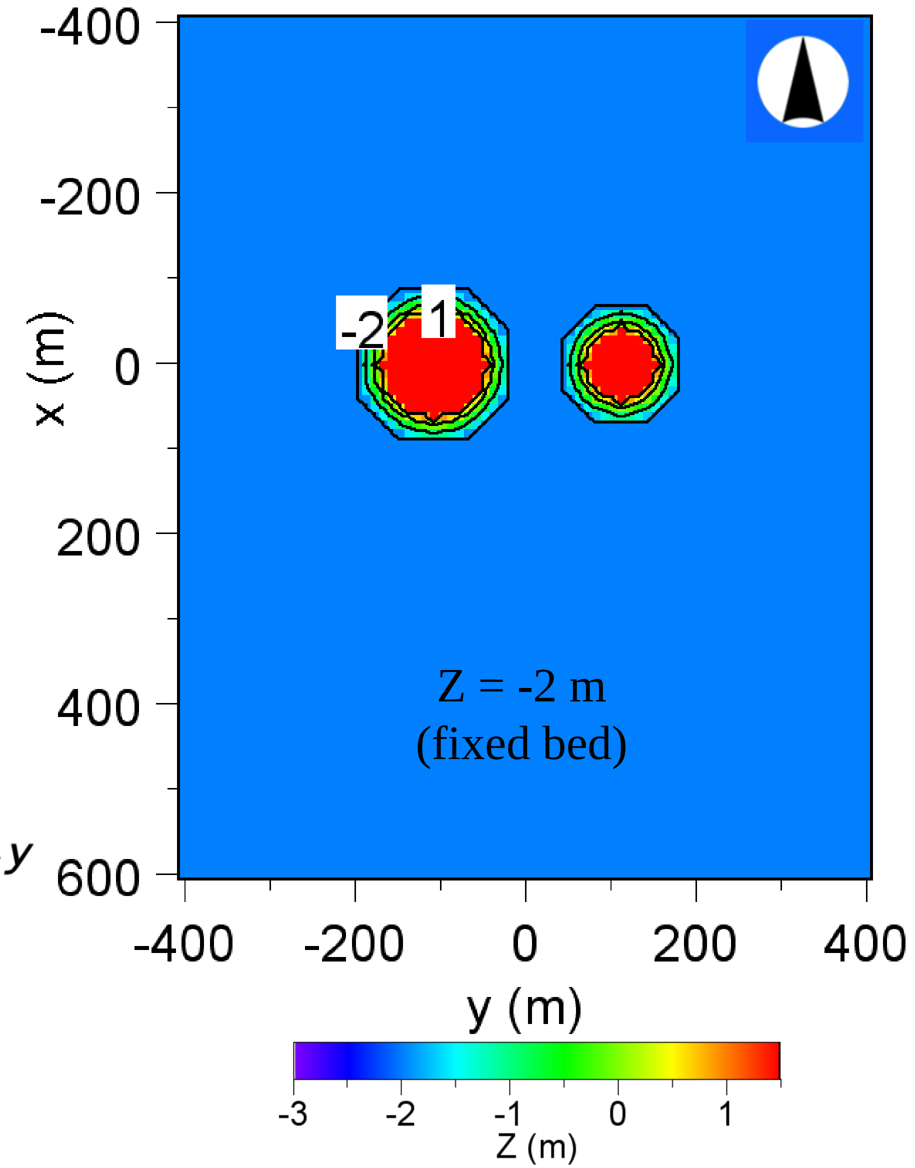


Figure 13(a). Calculation results in Case 1.

(b) 1000 step

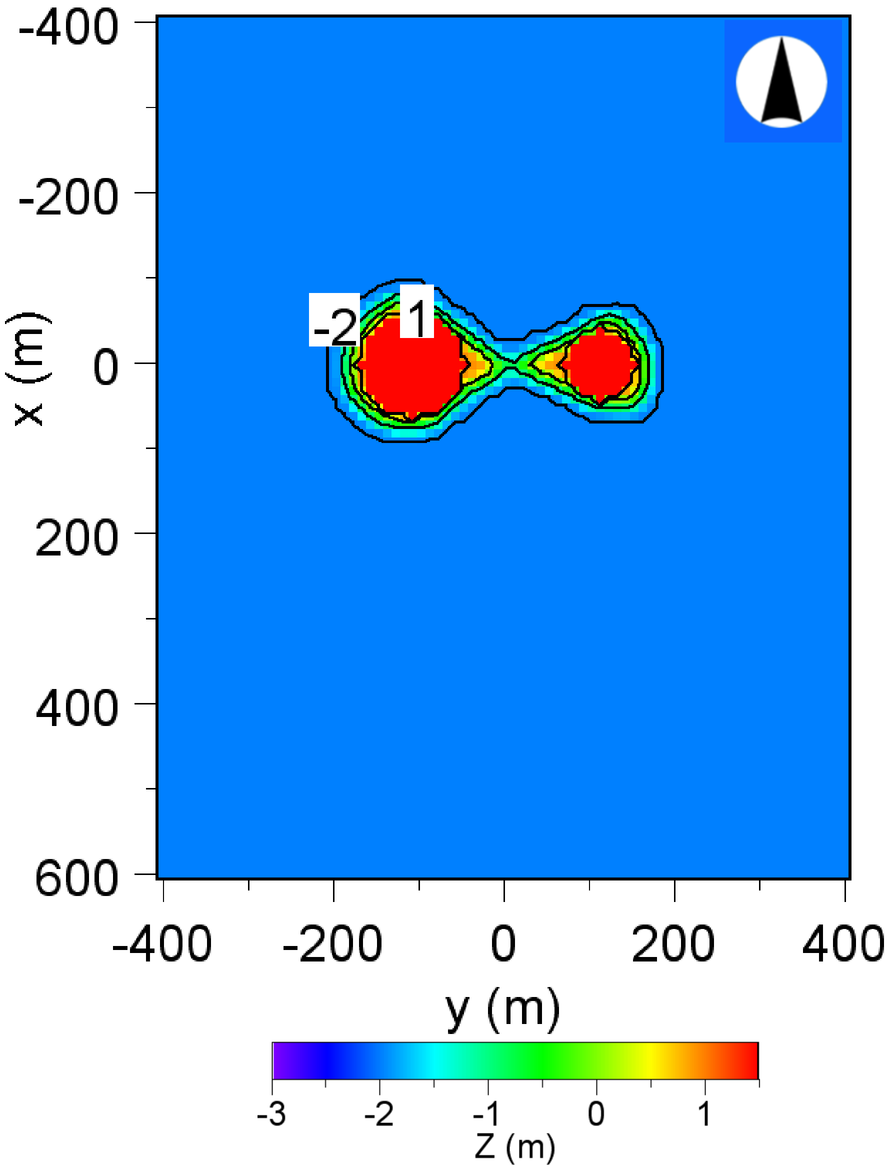


Figure 13(b). Calculation results in Case 1.

(c) 2000 step

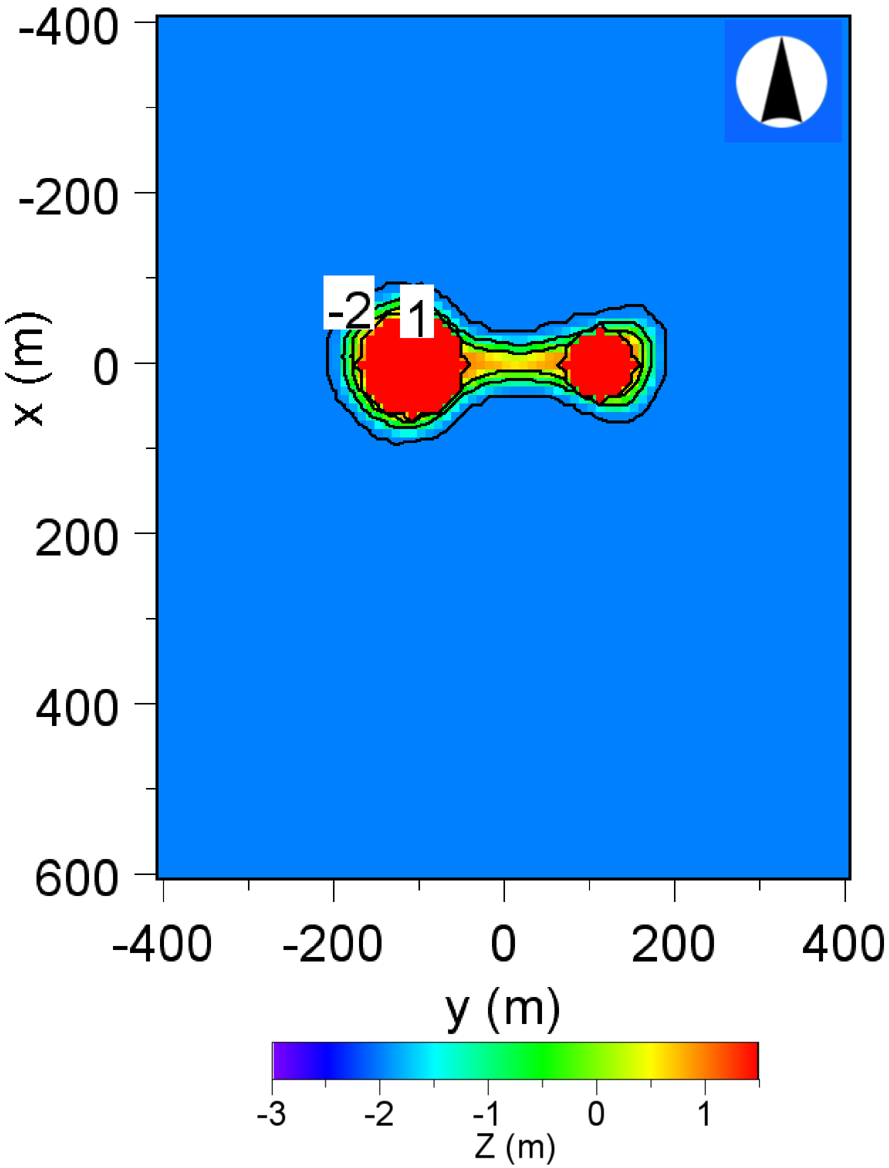


Figure 13(c). Calculation results in Case 1.

(d) 3000 step

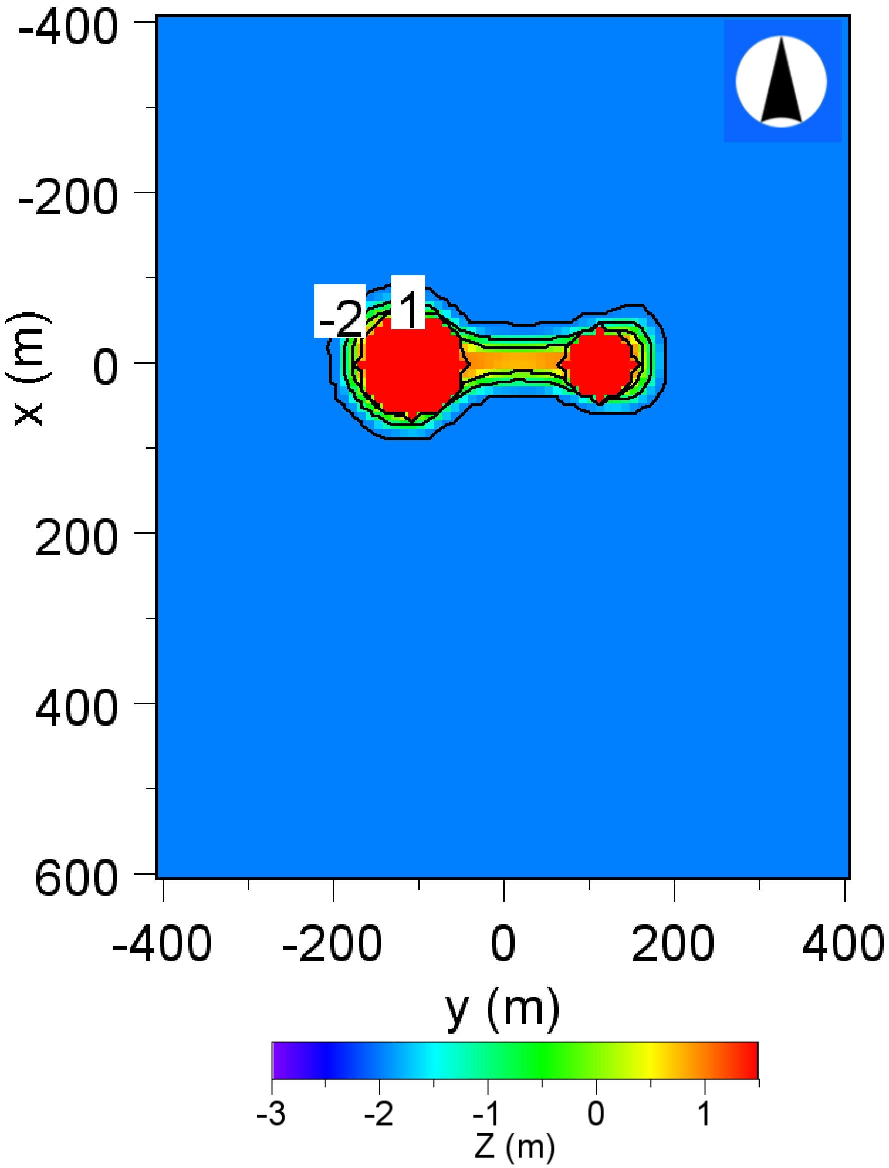


Figure 13(d). Calculation results in Case 1.

(e) 5000 step

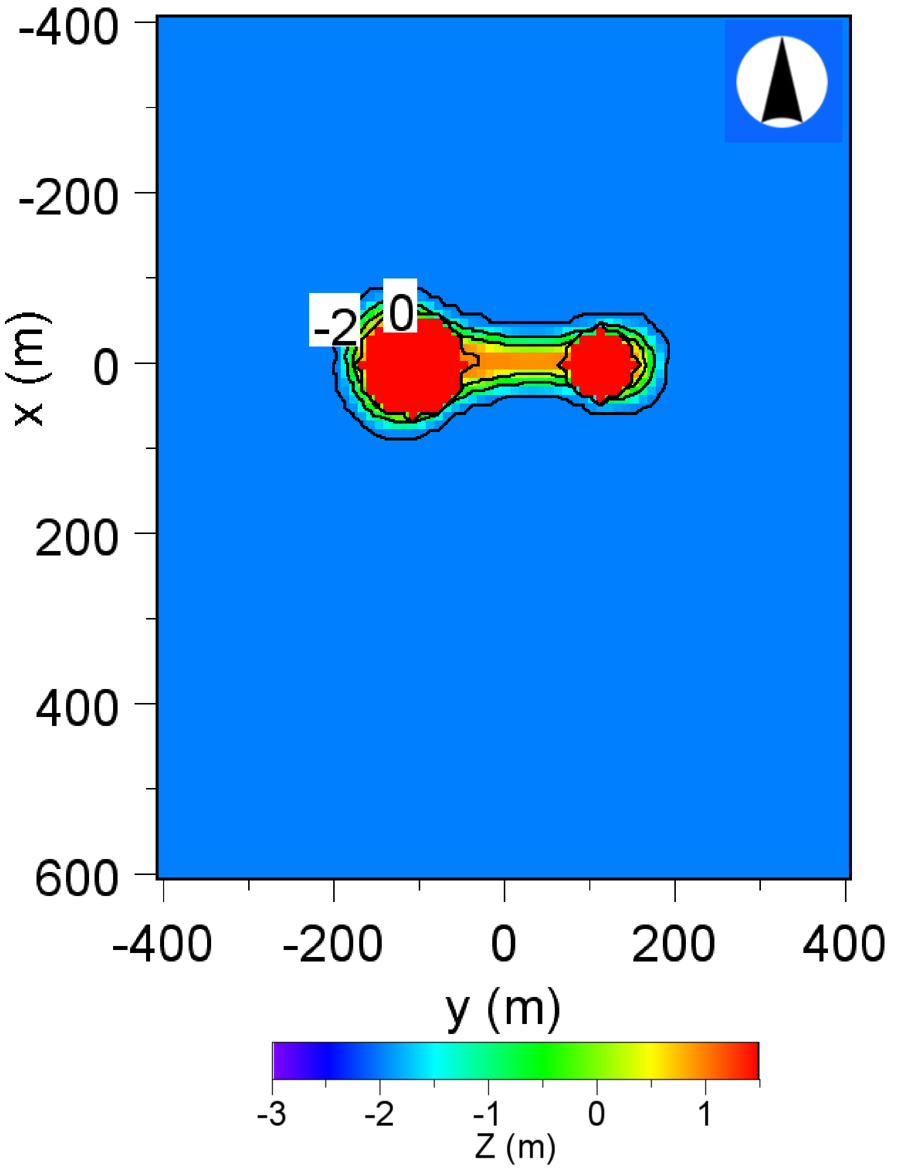


Figure 13(e). Calculation results in Case 1.

(f) 10000 step

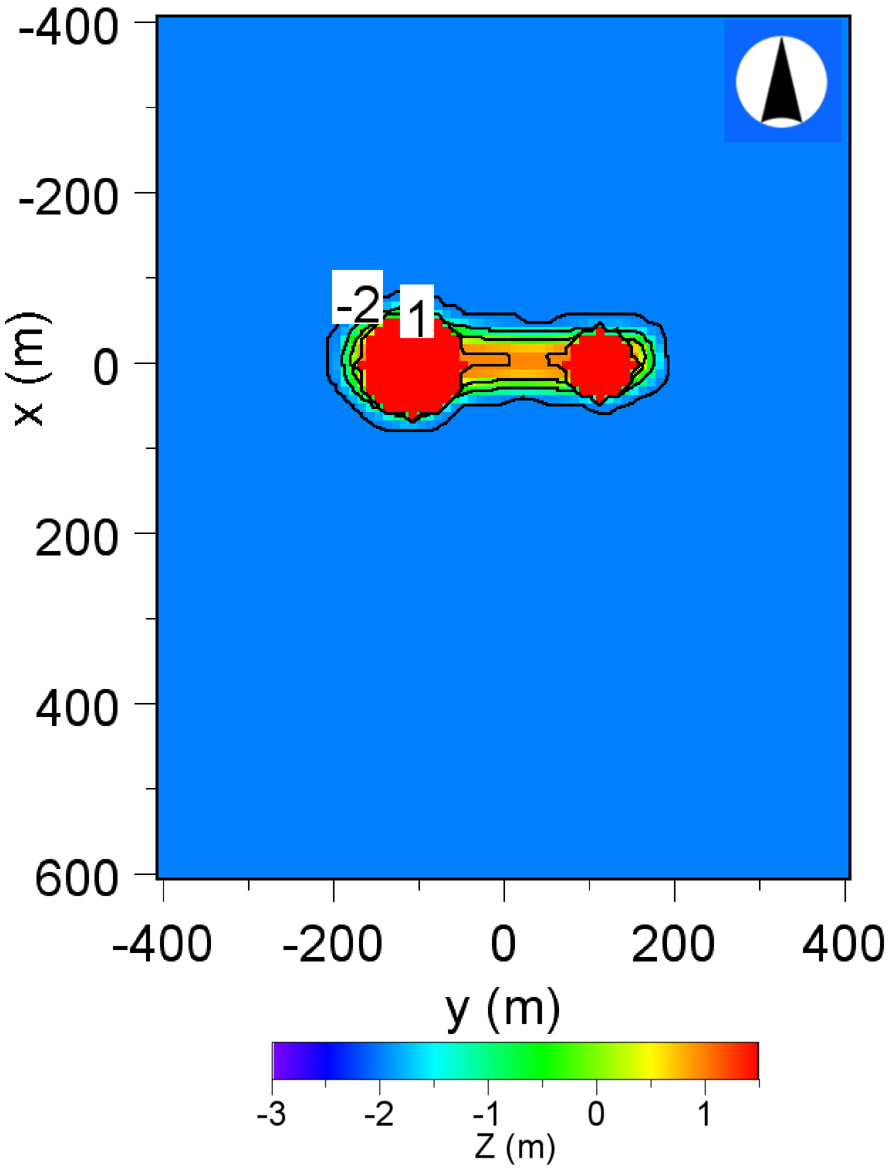


Figure 13(f). Calculation results in Case 1.

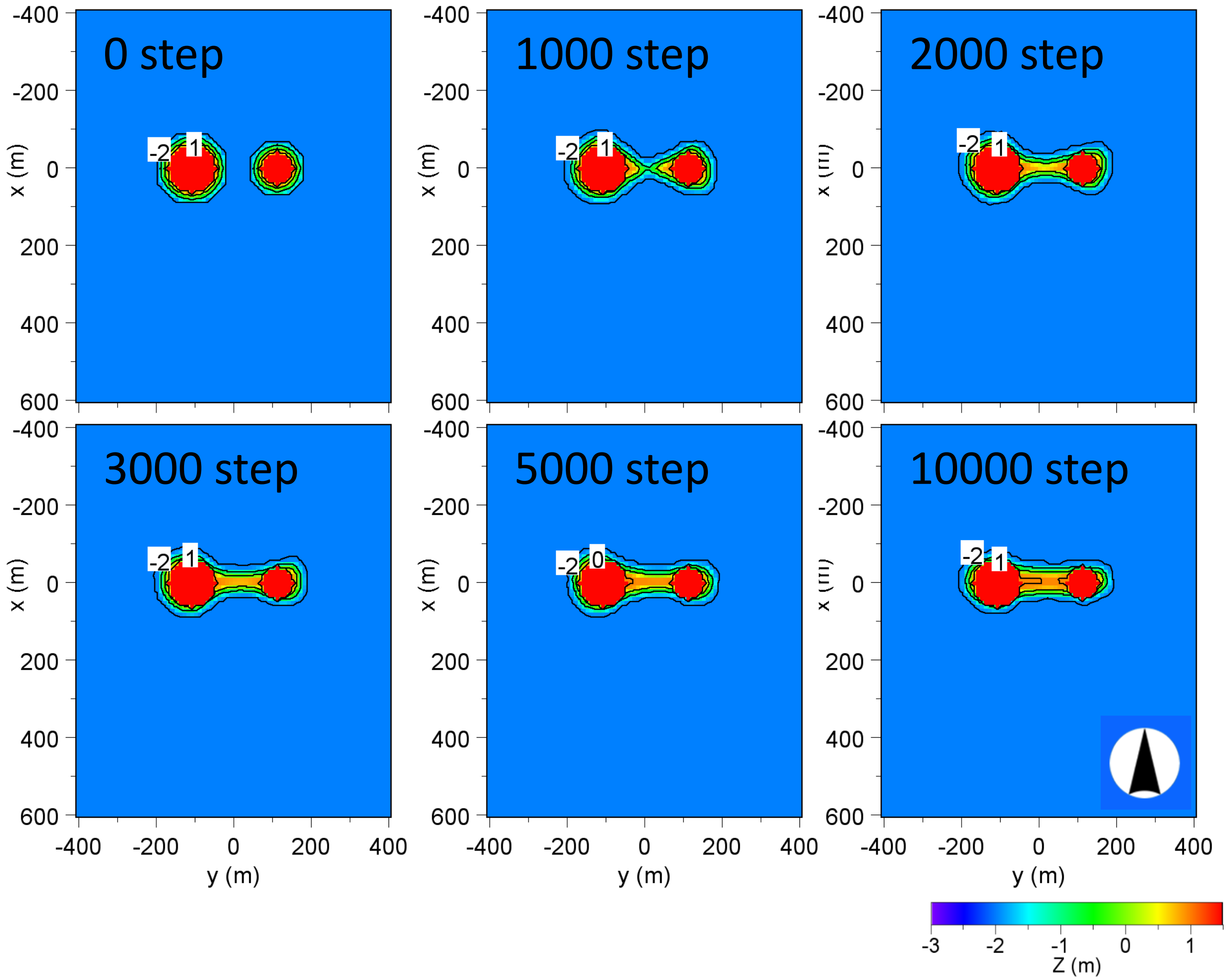


Figure 13. Calculation results in Case 1.

(a) 0 step

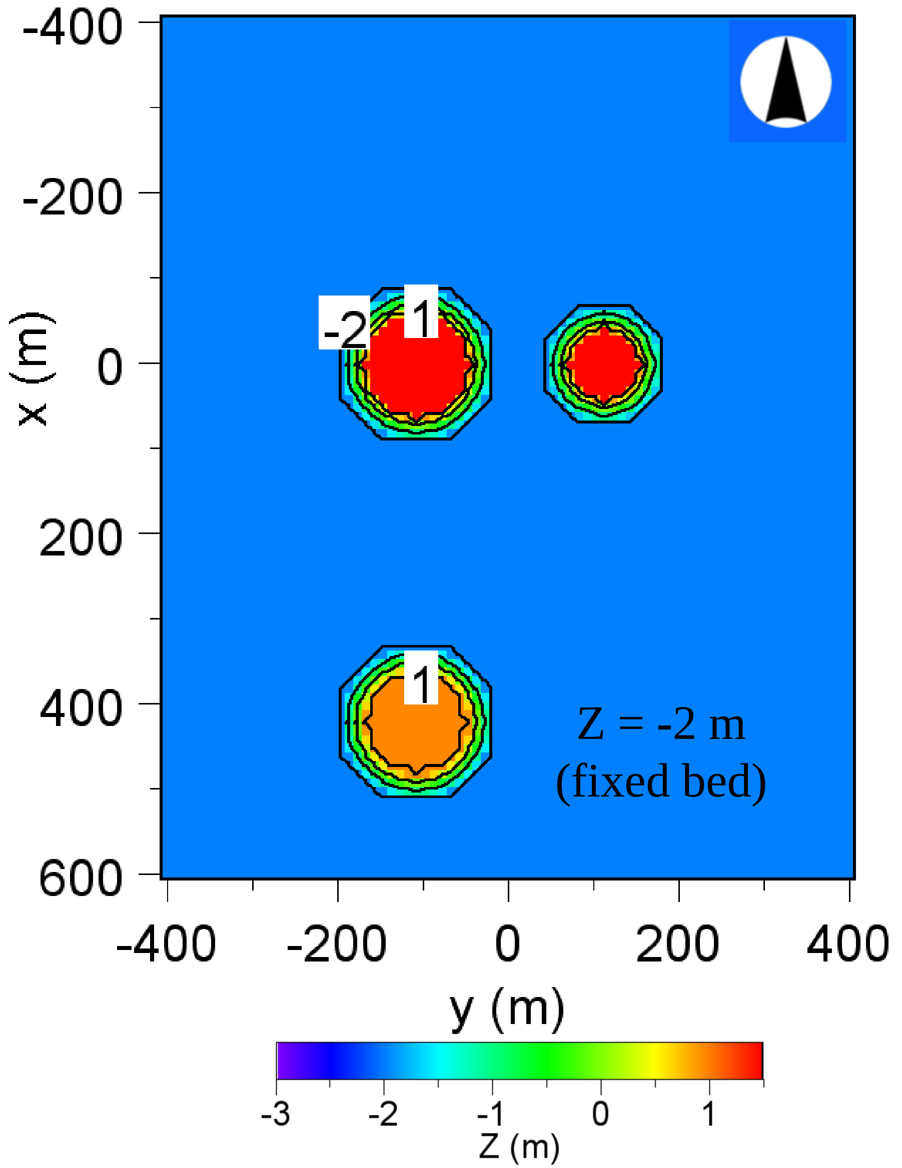


Figure 14(a). Calculation results in Case 2.

(b) 1000 step

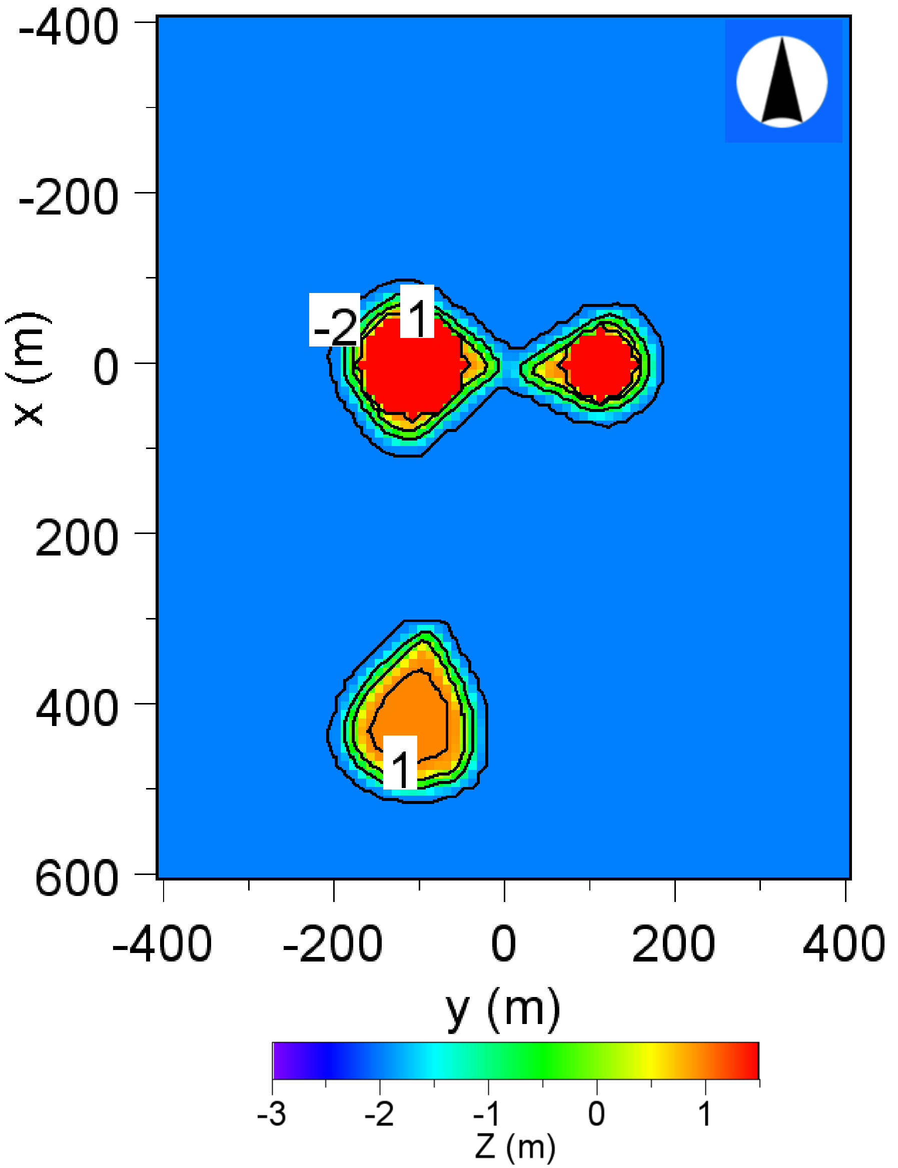


Figure 14(b). Calculation results in Case 2.

(c) 2000 step

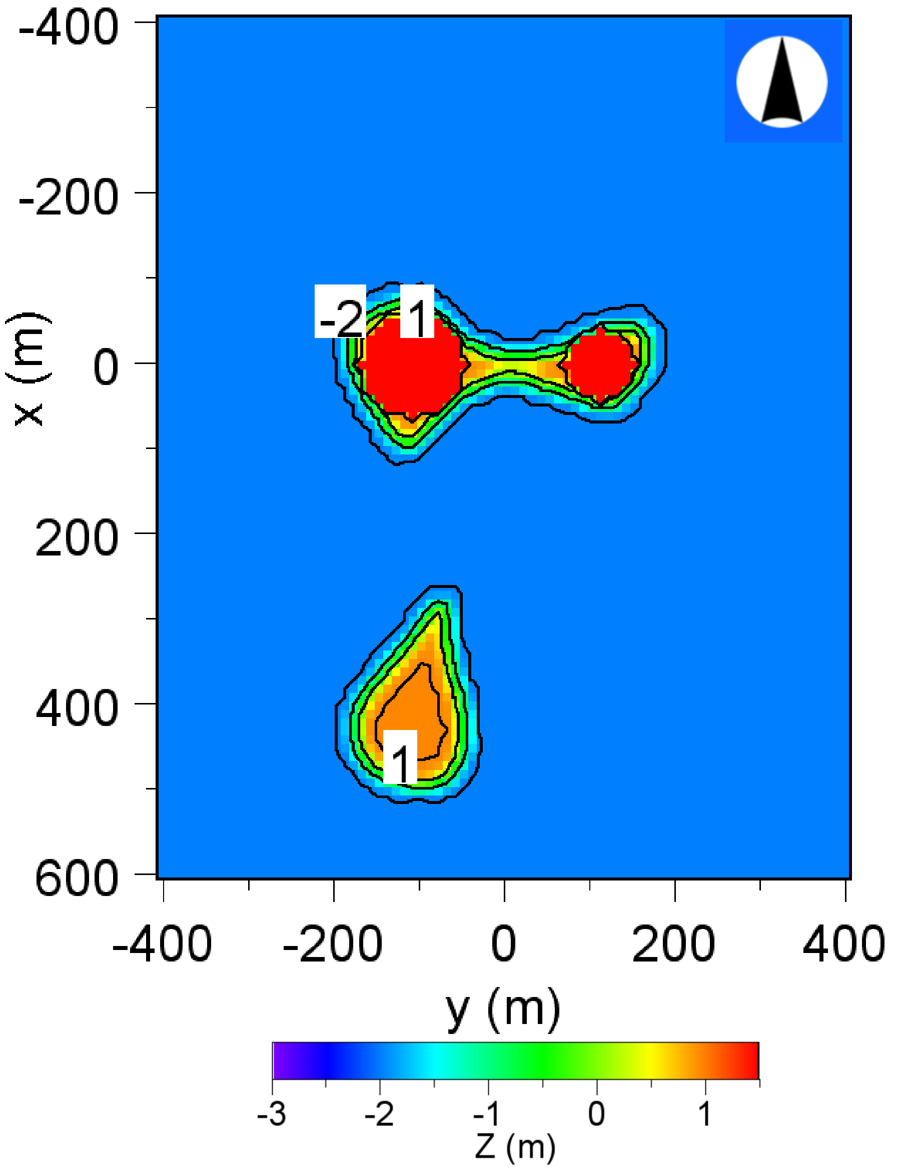


Figure 14(c). Calculation results in Case 2.

(d) 5000 step

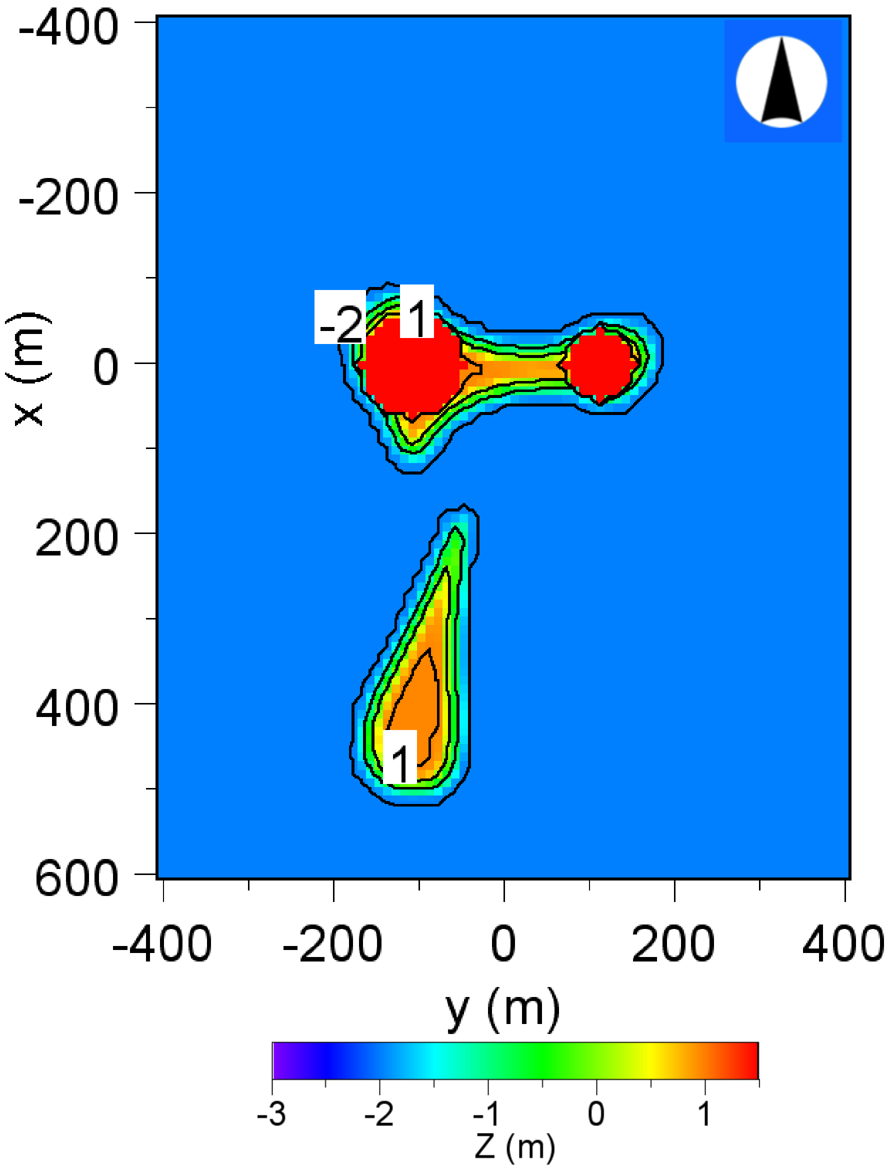


Figure 14(d). Calculation results in Case 2.

(e) 7000 step

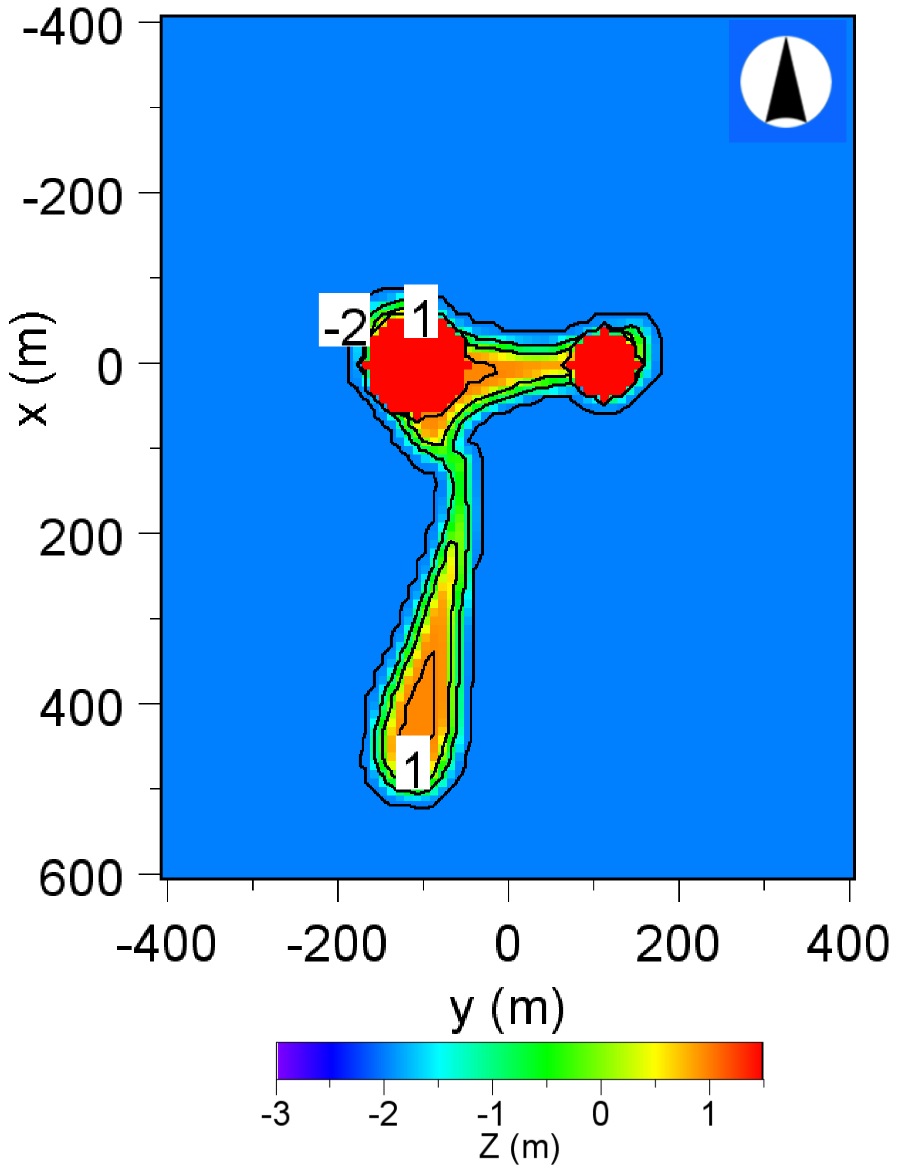
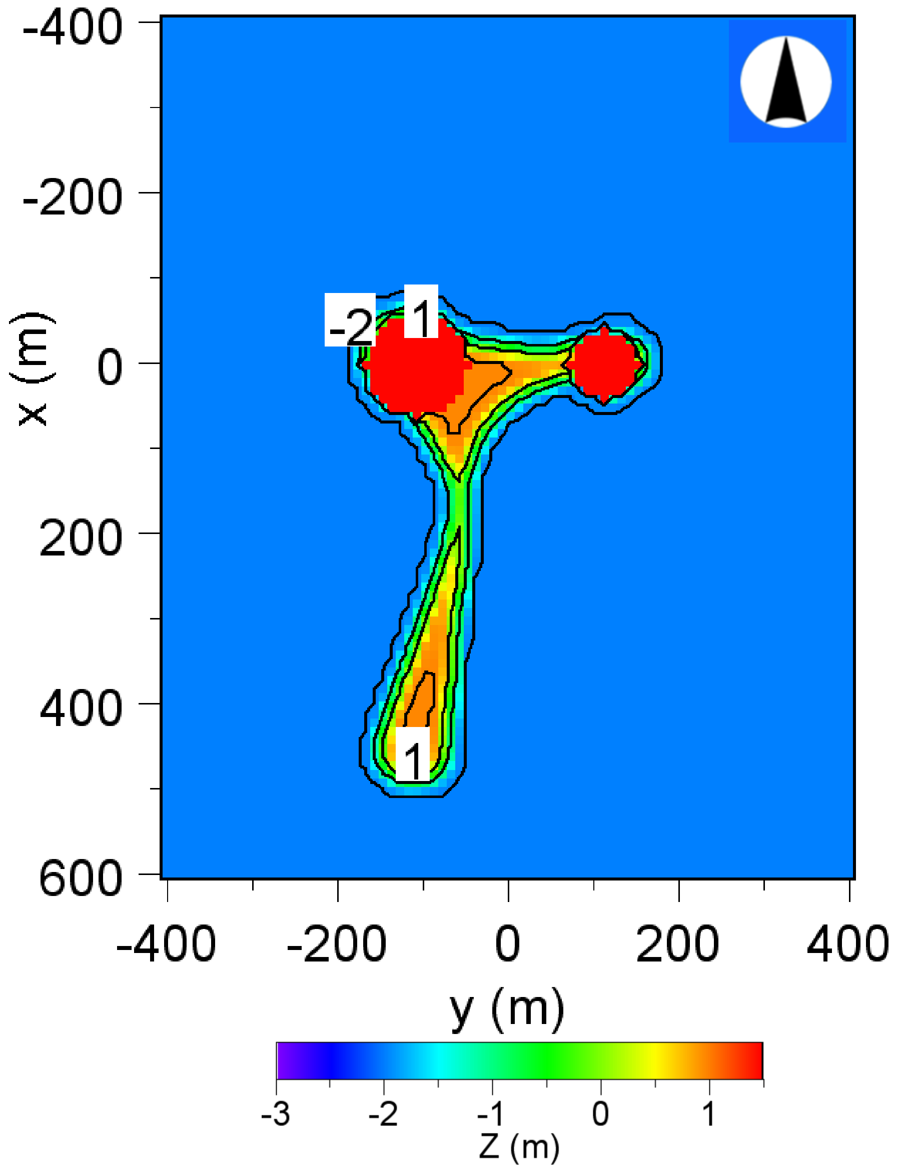


Figure 14(e). Calculation results in Case 2.

(f) 10000 step



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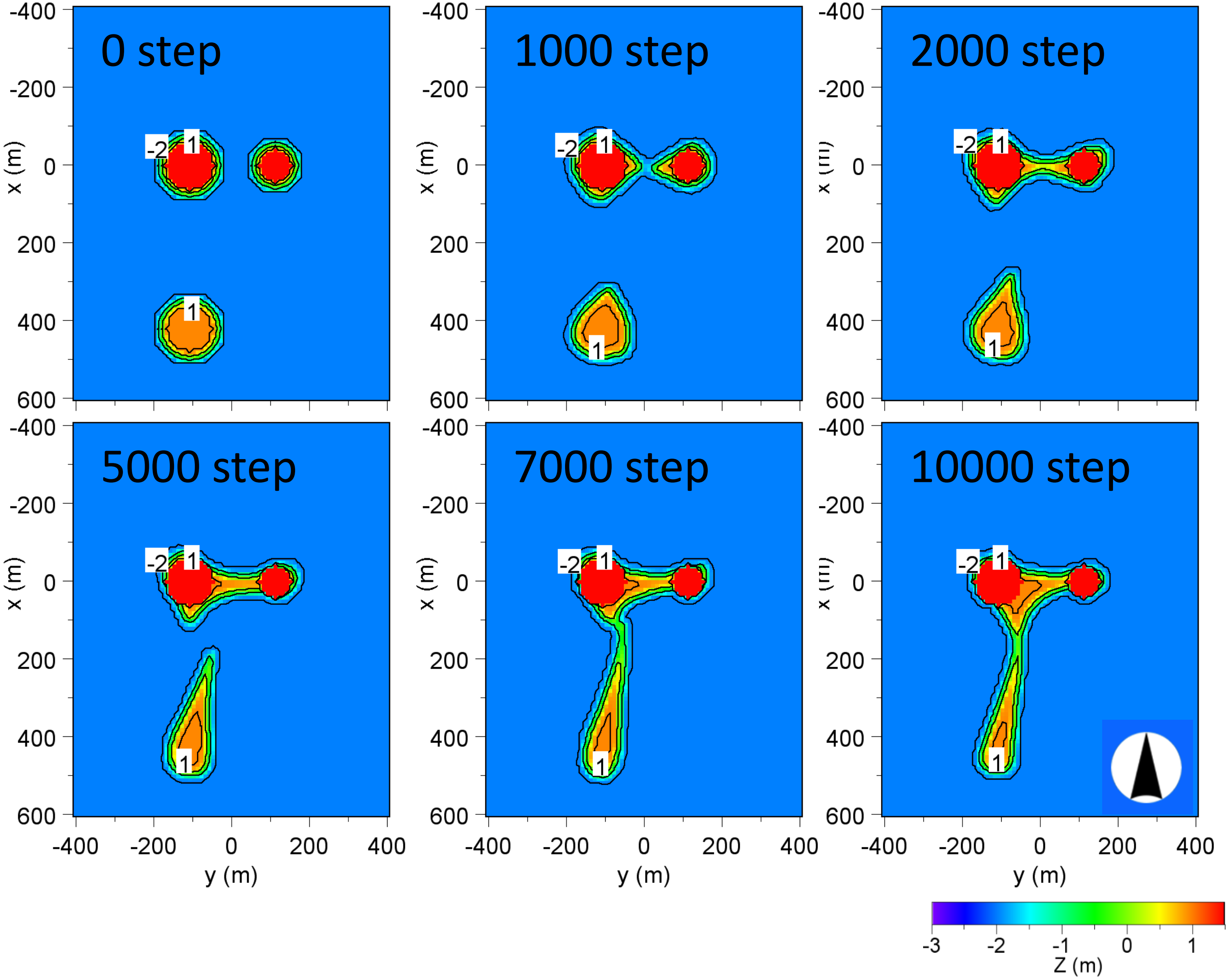

Figure 14. Calculation results in Case 2.

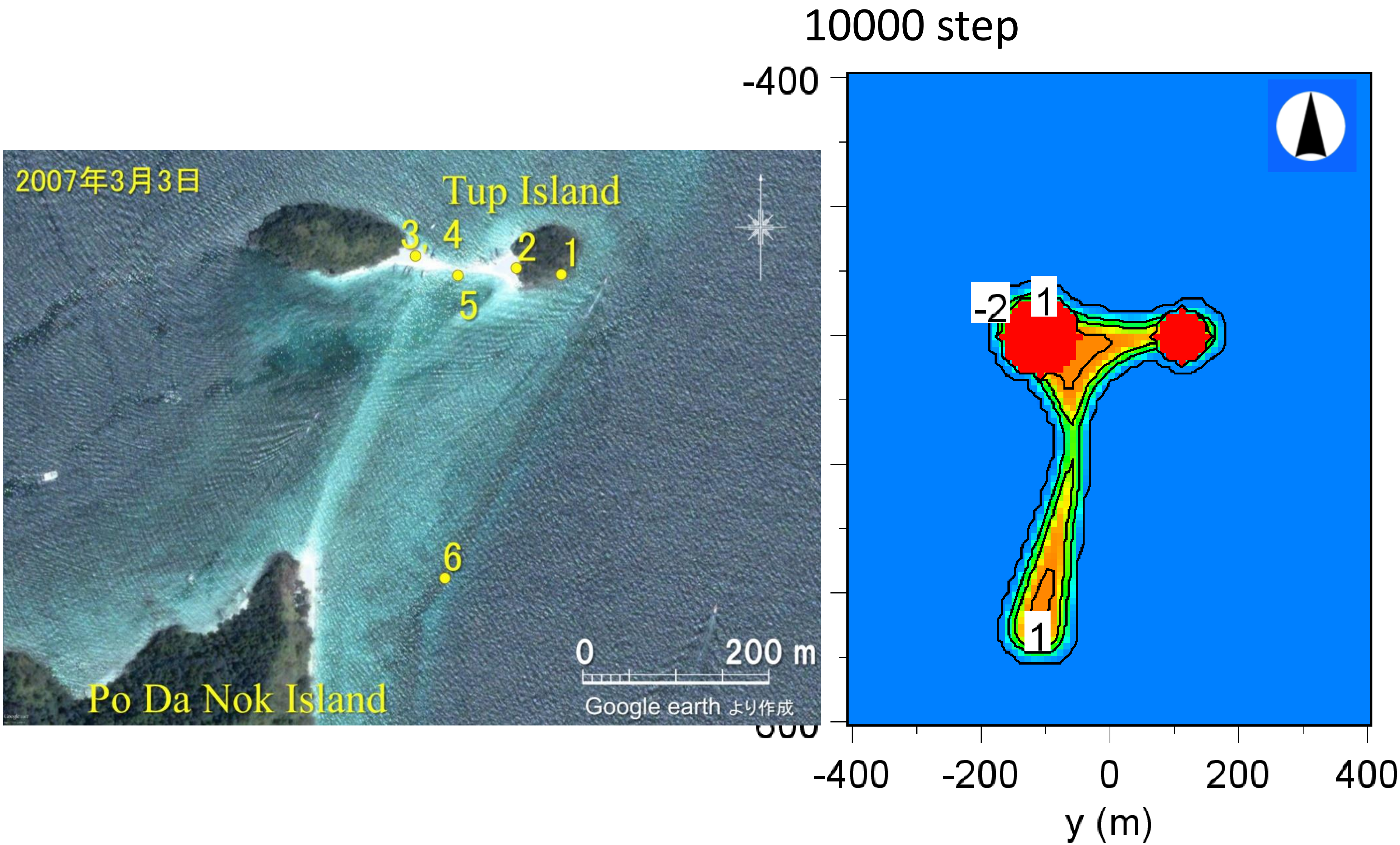

Figure 14. Calculation results in Case 2.

CONCLUSIONS

- The mechanism of elongation of sand bars between islands extending between Poda and Po Da Nok Islands offshore of Krabi in Thailand was investigated by field observation.
- Since a shallow sea extends around these islands, sand bars well develop, and each island affects the wave field of the other island, forming sand bars of characteristic shape.
- Then, numerical simulation of topographic changes was carried out using the BG model. It was concluded that sand bars extended between the islands due to the wave-sheltering effect of the islands.