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POSSIBILITY OF OFFSHORE DISCHARGE OF NOURISHMENT SAND IN TERMS OF SAND VOLUME AND GRAIN SIZE COMPOSITION

Dr. Toshinori ISHIKAWA
Public Works Research Center, Japan

Dr. Takaaki UDA
Public Works Research Center, Japan

Toshiro SAN-NAMI
Coastal Engineering Laboratory Co. Ltd., Japan

Jun-ichi HOSOKAWA
Kanagawa Prefectural Government, Japan

Tetsuyuki TAKO
Kanagawa Prefectural Government, Japan




STUDY AREA


Chigasaki fishing port
Yanagishima area
Sagami River
Hiratsuka New Port

INTRODUCTION

- As a measure against beach erosion, beach nourishment using materials composed of sand of different grain sizes and dredged from the reservoir upstream of the dam has been carried out since 2005.

- Nourishment sand carried by prevailing eastward longshore sand transport was blocked by breakwaters, resulting in shoreline advance upcoast.

- Apart from the sand deposition near the shoreline, part of the nourishment sand was considered to be transported offshore, devaluing the effect of beach nourishment.

- Also, local fishermen feared the damage to the offshore fishing ground rich in kelp and abalone owing to the coverage of the exposed rocks by nourishment material.

FIELD INVESTIGATION

1. Beach changes were investigated using the Narrow Multi-Beam survey data, which have been collected once a year since 2002.

2. The depth distribution of grain size composition of the seabed material was measured.

3. Numerical simulation of nearshore current was carried out to investigate sand movement in the offshore zone.

METHOD OF FIELD OBSERVATION

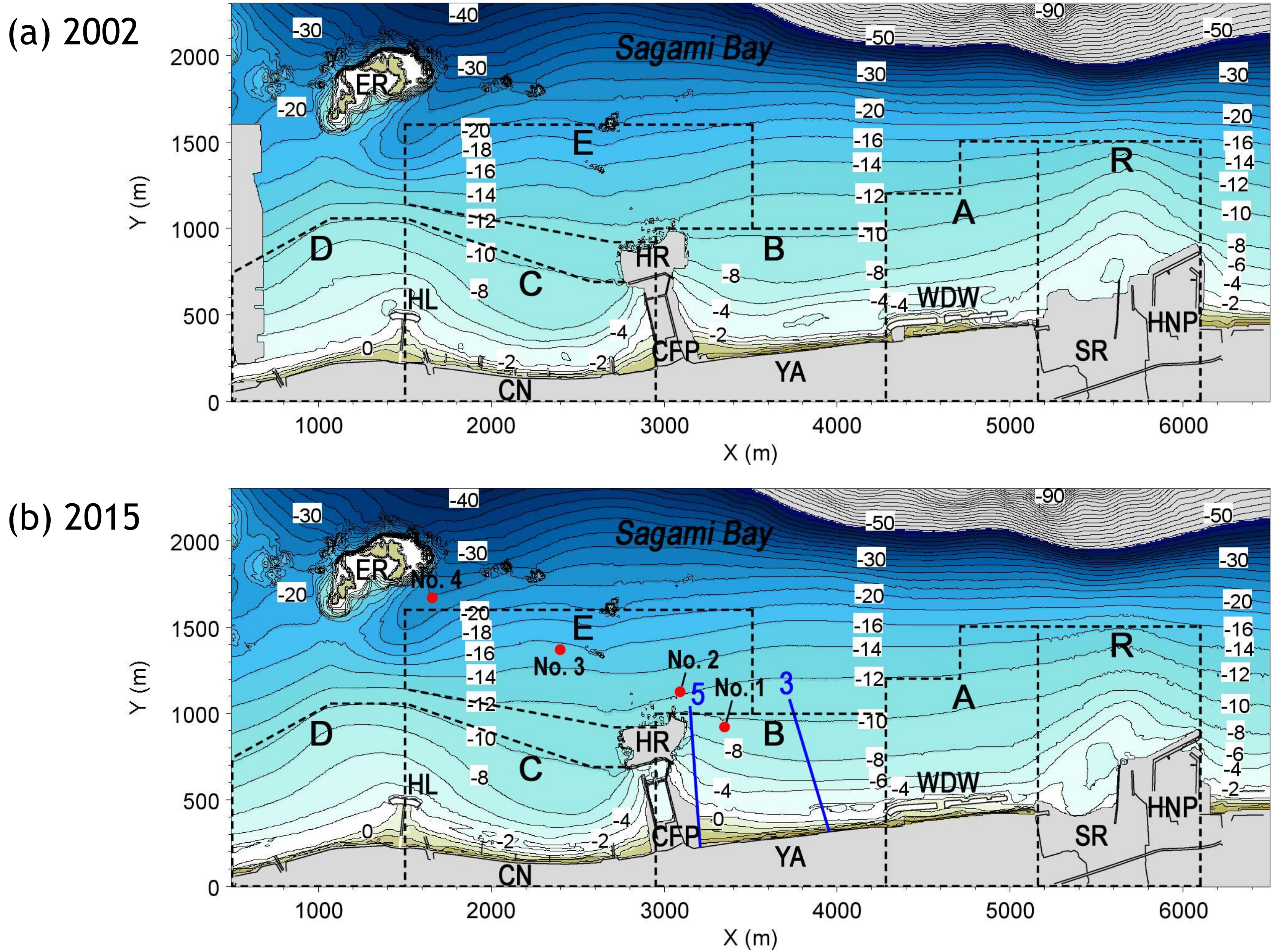


Figure 1. Bathymetries of study area measured in 2002 and 2015.

ER: Eboshi Rock
CFP: Chigasaki fishing port
SR: Sagami River
HNP: Hiratsuka New Port
HL: Chigasaki artificial headland
WDW: Waver dissipating works
HR: Hirashima Rocks
YA: Yanagishima area
CN: Chigasaki-naka

BEACH NOURISHMENT

Figure 2. Sand mound for beach nourishment in Yanagishima area (August 16, 2016).

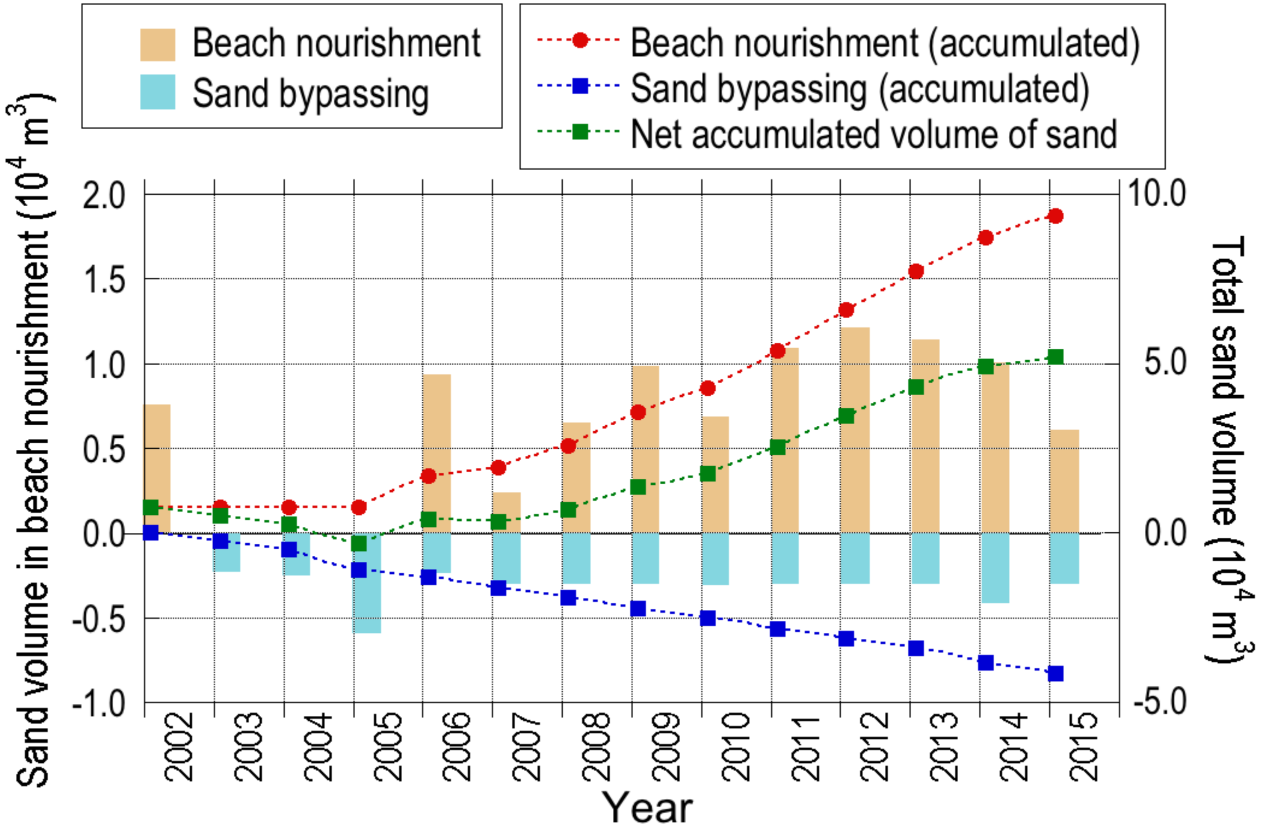


Figure 3. Change in sand volume for beach nourishment and sand bypassing since 2002 in Yanagishima area.

90×10^3 m^3 of sand supplied since 2002

40×10^3 m^3 of sand was used for sand bypassing

50×10^3 m^3 of sand increased (net)

BEACH NOURISHMENT

Figure 4. Material composed of gravel and sand for beach nourishment (August 16, 2016).

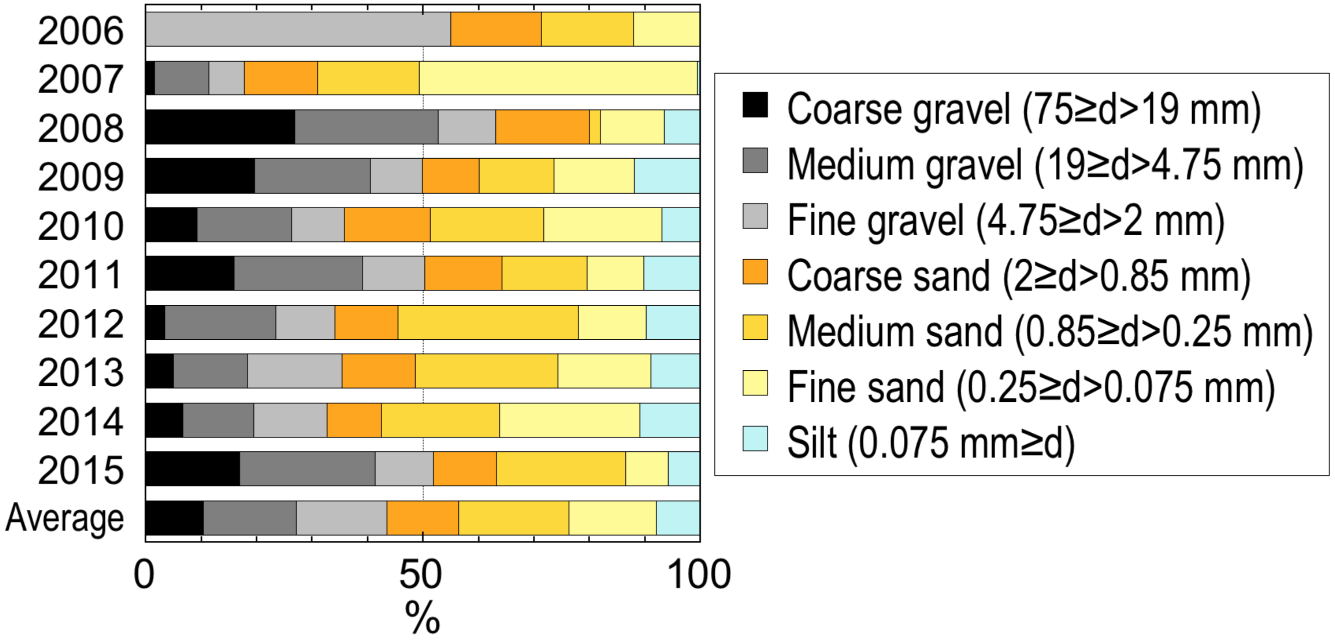


Figure 5. Grain size composition of beach nourishment material in Yanagishima area.

Content of fine material: 23.8%

RESULTS OF ANALYSIS OF BATHYMETRIC SURVEY DATA

Topographic changes until 2004

(a) 2004

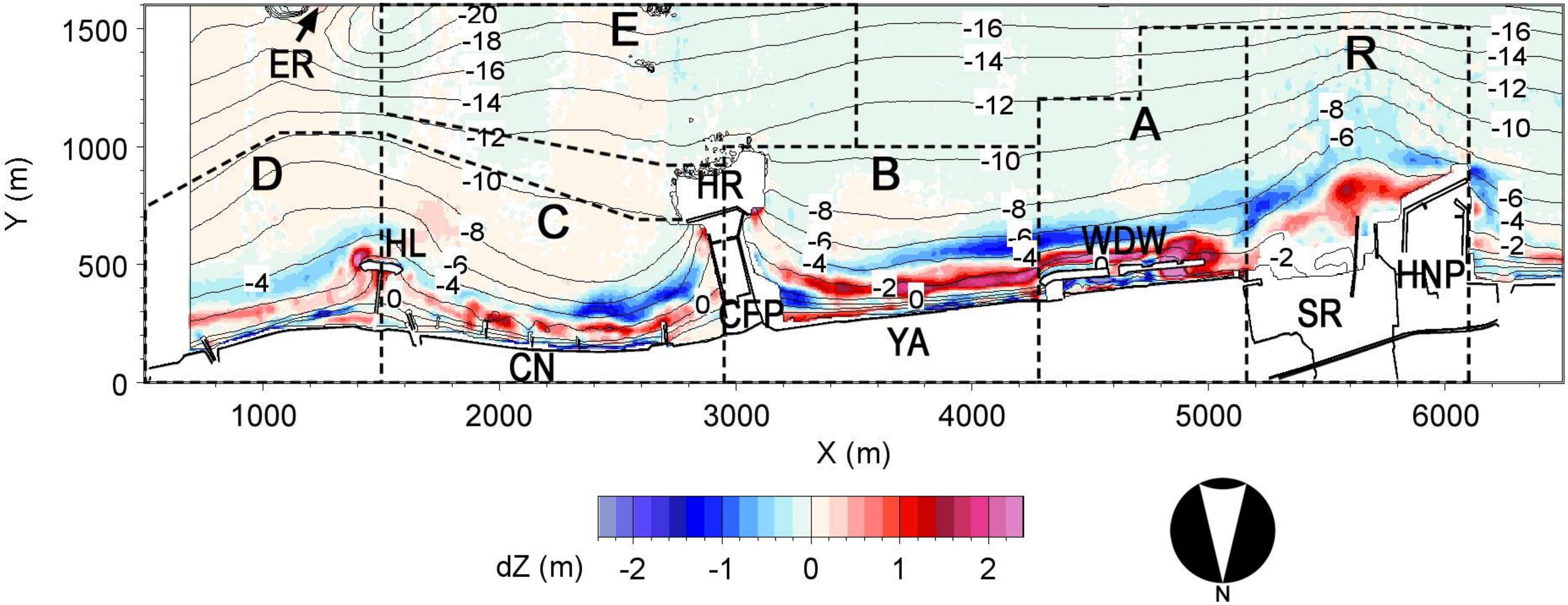


Figure 6. Bathymetries and bathymetric changes in 2004 relative to bathymetry in 2002.

RESULTS OF ANALYSIS OF BATHYMETRIC SURVEY DATA

Topographic changes until 2008

(b) 2008

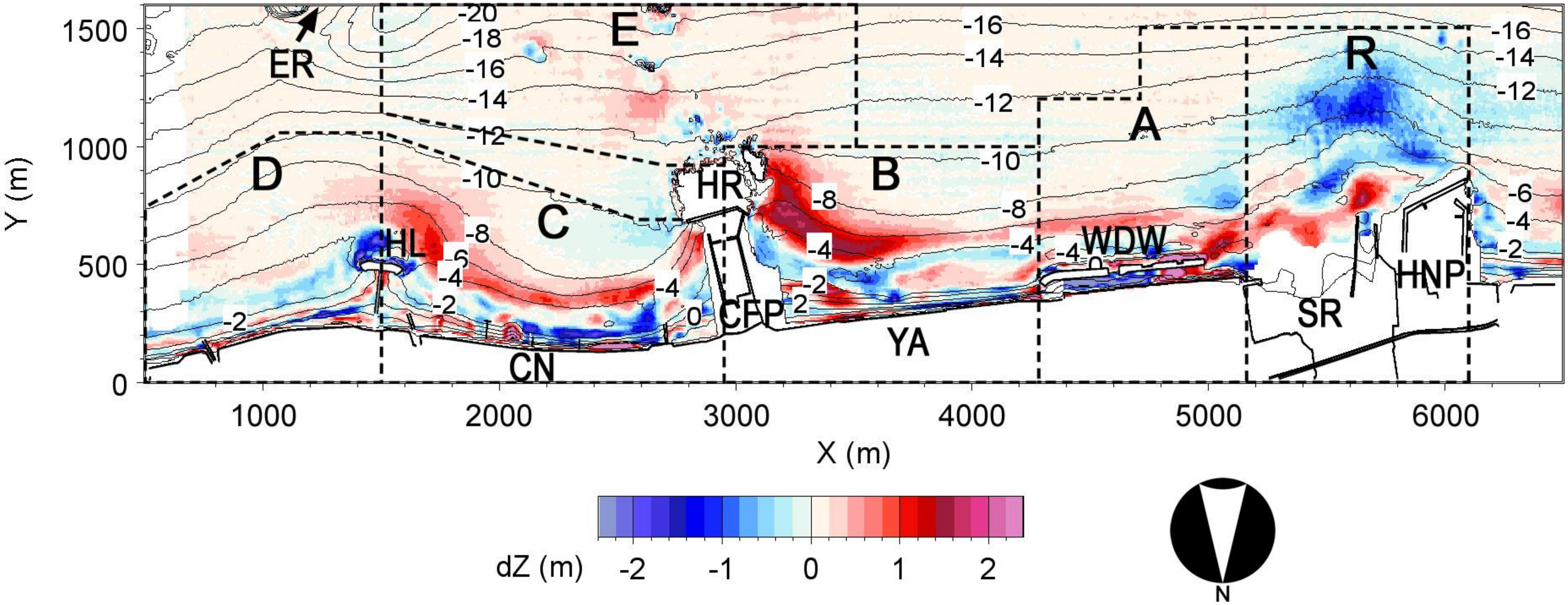


Figure 7. Bathymetries and bathymetric changes in 2008 relative to bathymetry in 2002.

RESULTS OF ANALYSIS OF BATHYMETRIC SURVEY DATA

Topographic changes until 2011

(c) 2011

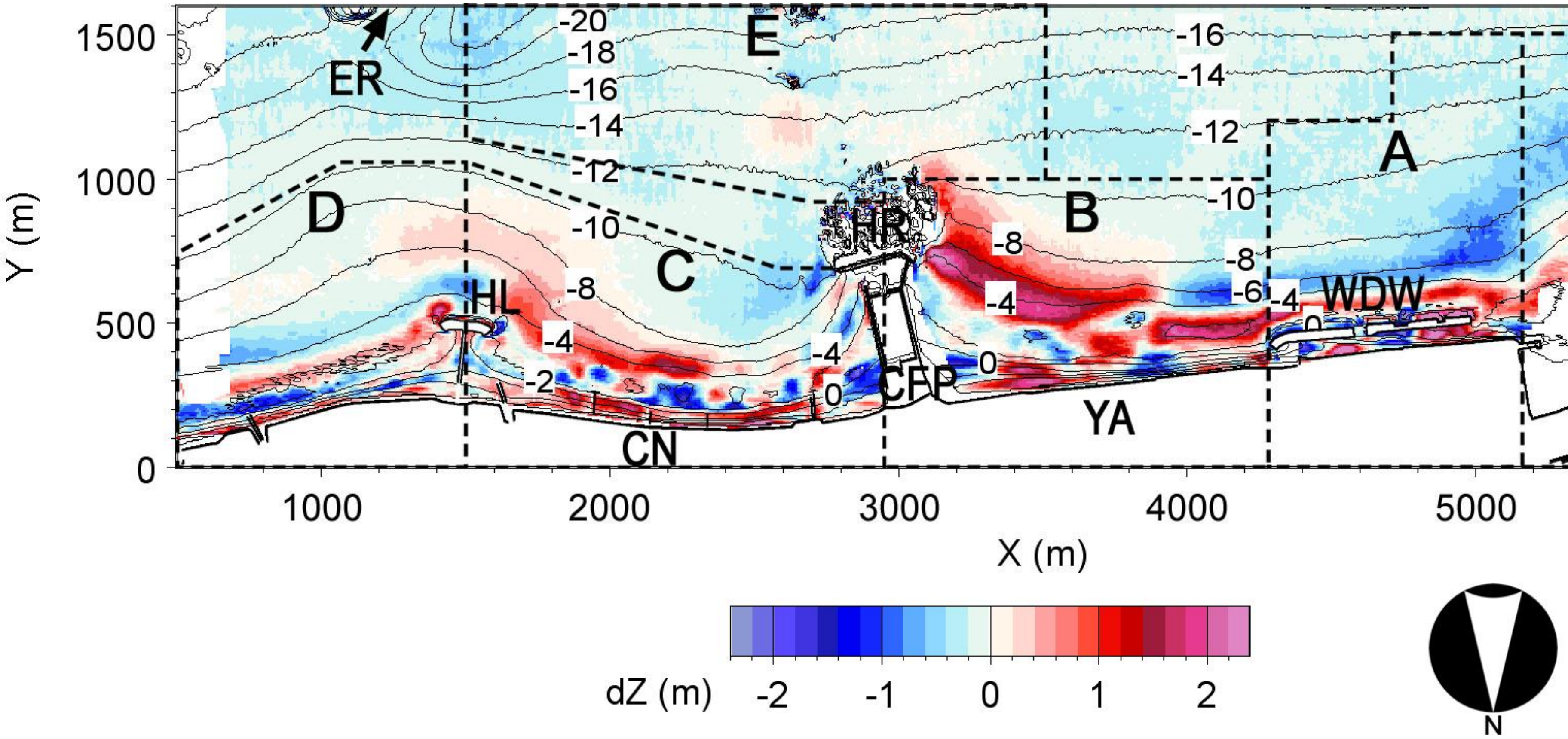


Figure 8. Bathymetries and bathymetric changes in 2011 relative to bathymetry in 2002.

RESULTS OF ANALYSIS OF BATHYMETRIC SURVEY DATA

Topographic changes until 2015in entire study area

(d) 2015

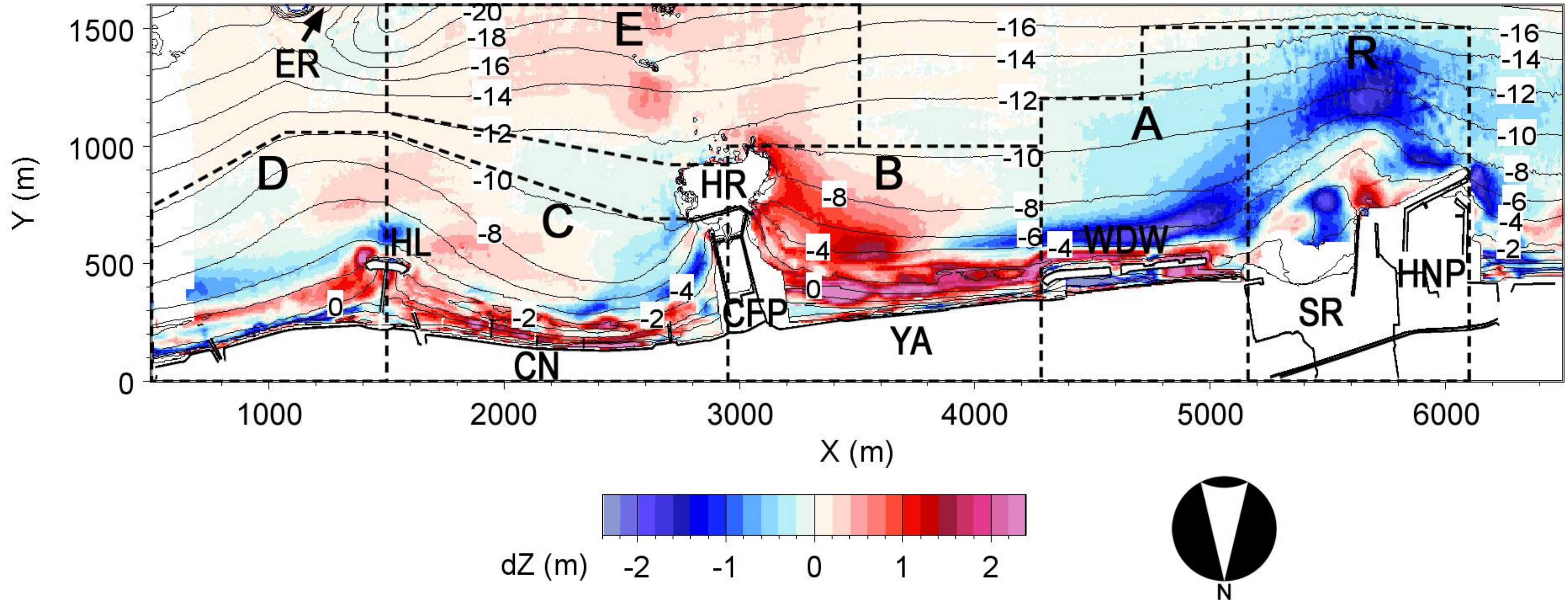
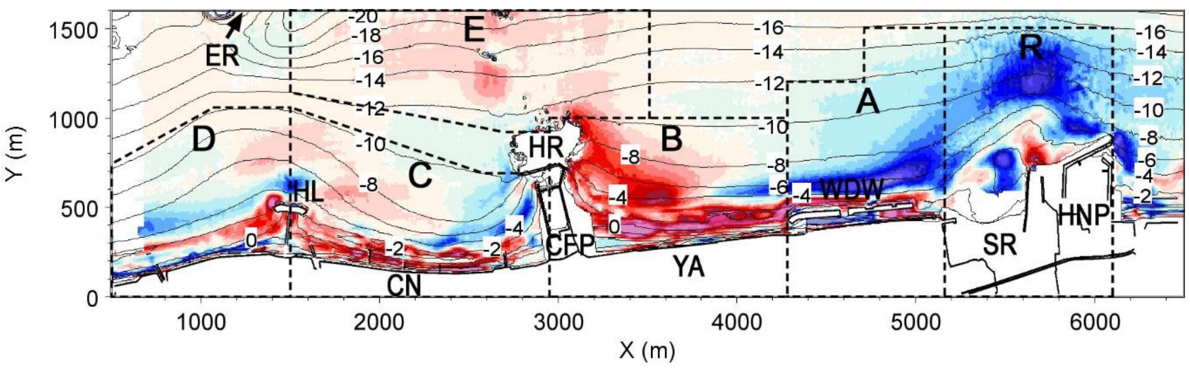


Figure 9. Bathymetries and bathymetric changes in 2015 relative to bathymetry in 2002.

RESULTS OF ANALYSIS OF BATHYMETRIC SURVEY DATA

Changes in sand volume in areas R and A



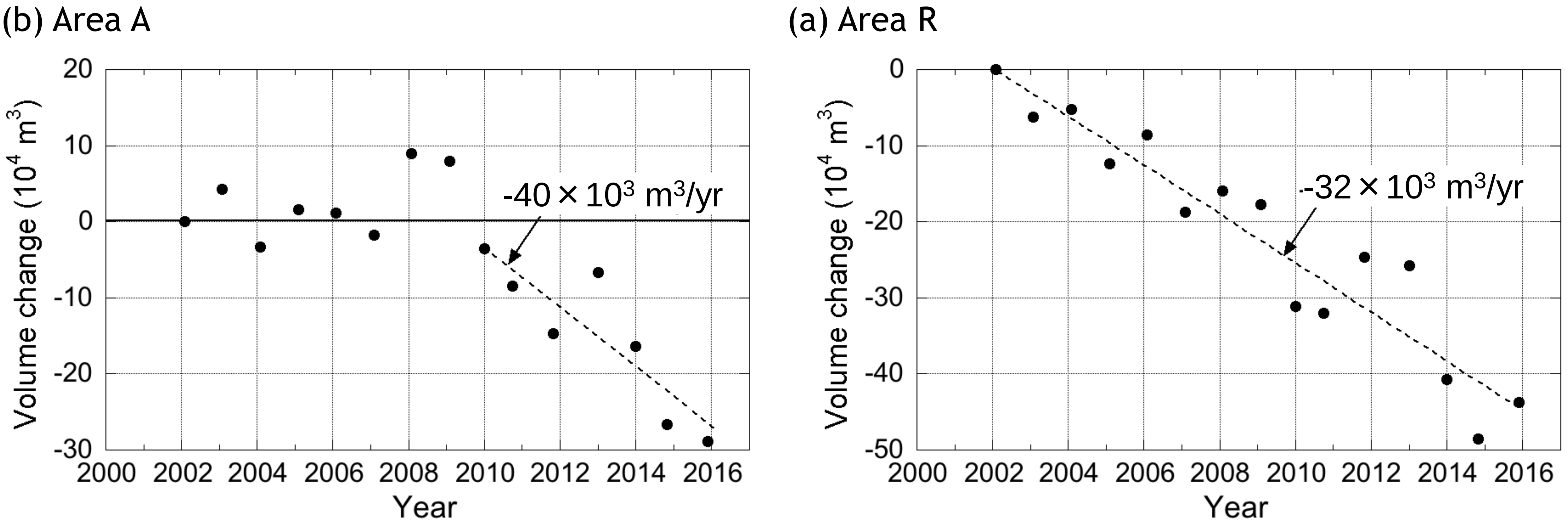


Figure 10. Change in sand volume in areas R and A.

RESULTS OF ANALYSIS OF BATHYMETRIC SURVEY DATA

Changes in sand volume in areas B and E

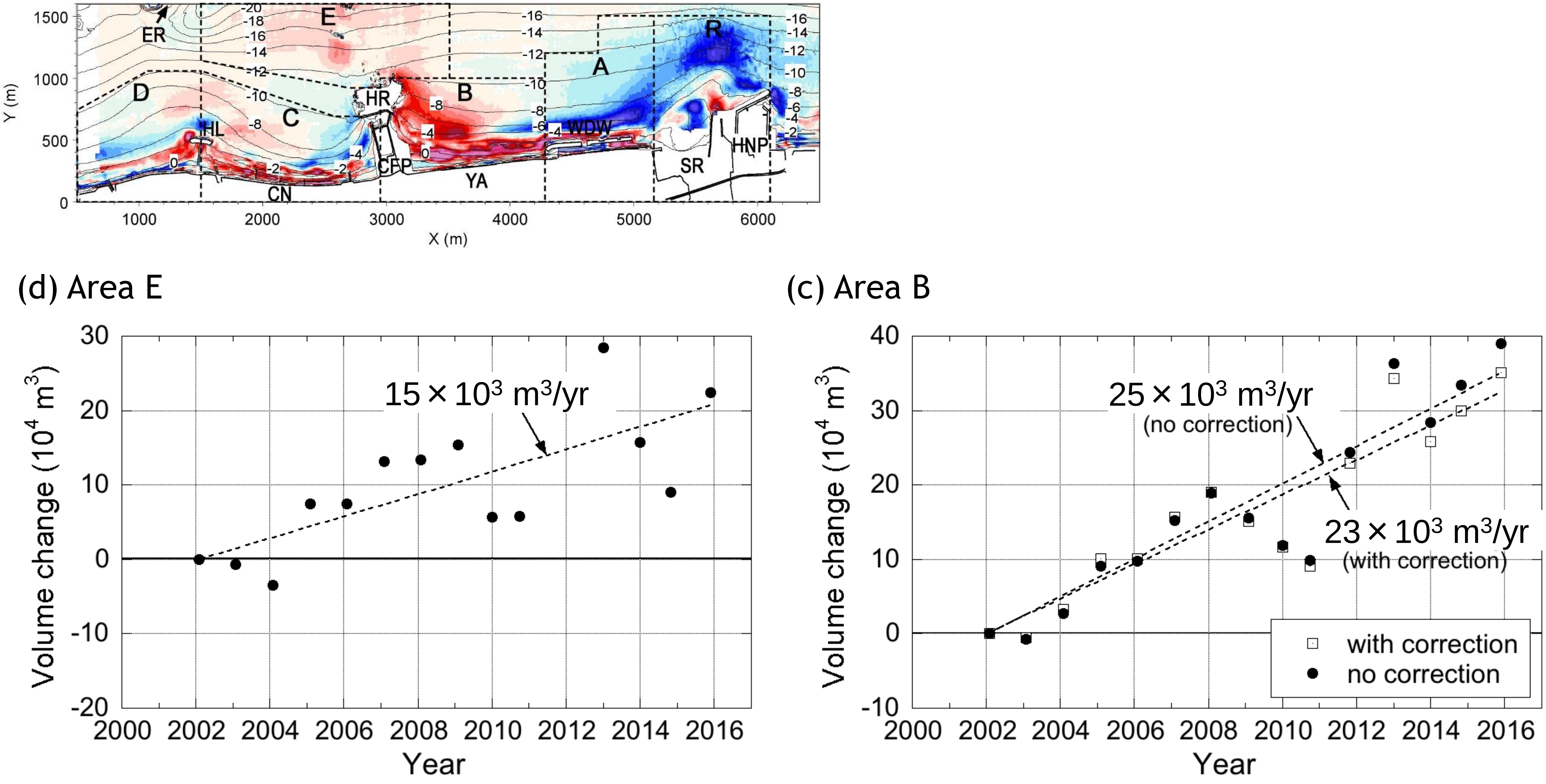
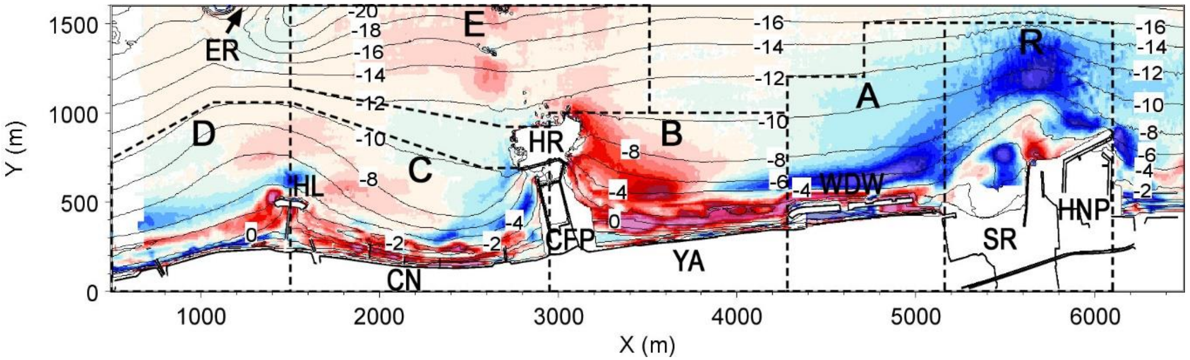


Figure 11. Change in sand volume in areas B and E.

RESULTS OF ANALYSIS OF BATHYMETRIC SURVEY DATA

Comparison of sand volume in areas R+A and B+E



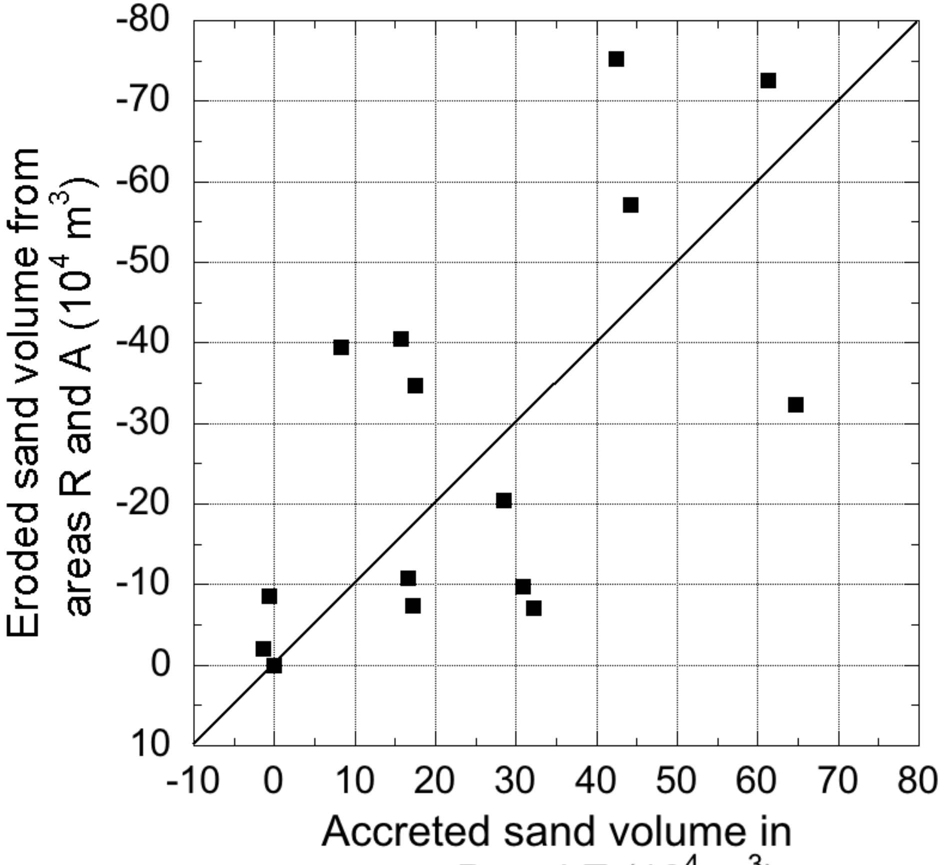
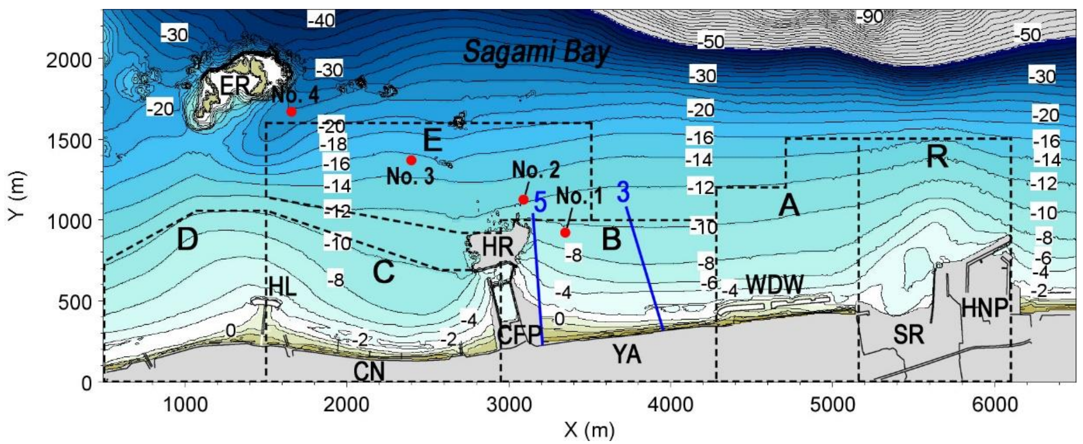


Figure 12. Relationship between sand volume eroded in area R+A and that accreted in area B+E.

RESULTS OF ANALYSIS OF BATHYMETRIC SURVEY DATA

Grain size composition of seabed material in area E and along transect Nos. 3 and 5



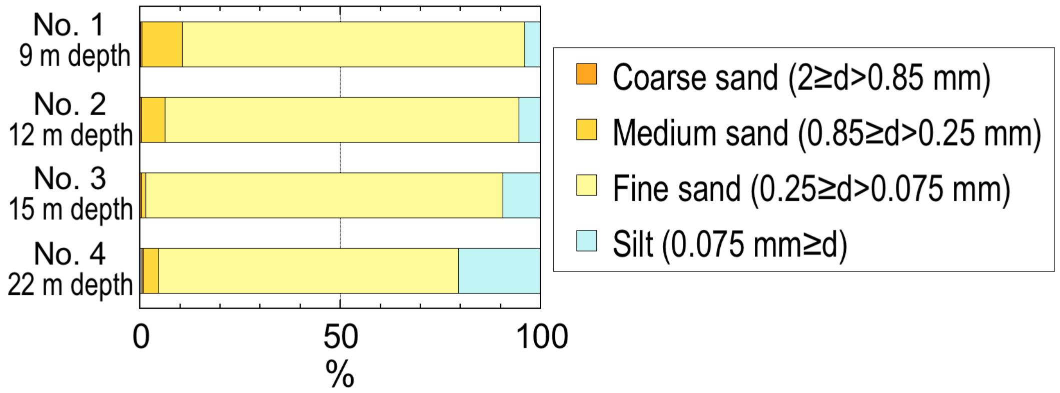


Figure 13. Grain size composition of bed material in offshore deposition zone measured on July 6, 2016.

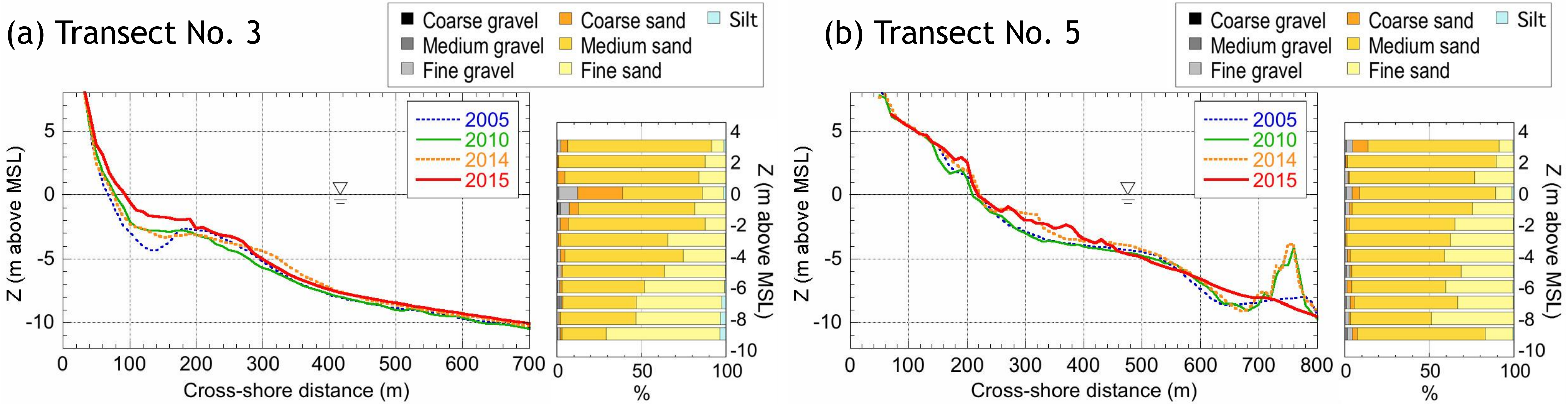


Figure 14. Longitudinal profiles and depth distribution of grain size composition along transect Nos. 3 and 5 (January, 2016).

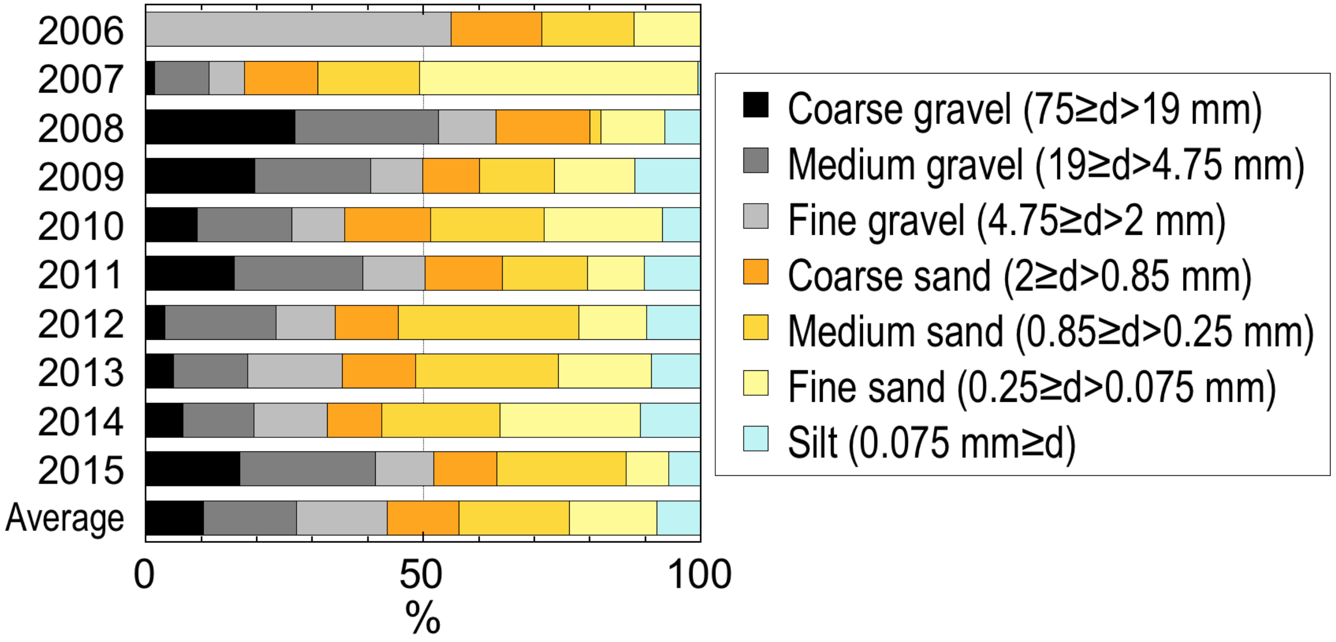


Figure 5. Grain size composition of beach nourishment material in Yanagishima area.

Fine sand & silt content: 23.8%

DISCUSSION

- The volume of sand has increased at a rate of 5×10^3 m^3/yr between 2002 and 2015 at Yanagishima area by beach nourishment.

- Because the content of fine material was 23.8% of all the beach nourishment, the rate of increase of the total volume of the fine material was 1.2×10^3 m^3/yr.

- This is only 8% of the rate of deposition of 15×10^3 m^3/yr in area E, even though the entire volume of the material smaller than fine sand contained in the nourishment material is discharged.

- This clearly explains that

the coarse material was deposited only in the nearshore zone shallower than 9 m depth, and that the fine material deposited in the offshore zone did not originate from the nourishment material but was transported from the river mouth area.


NUMERICAL SIMULATION OF NEARSHORE CURRENT

Table 1. Calculation conditions.

Calculation domain	8.5 km alongshore and 2.6 km cross-shore
Bathymetry	Topography in 2016 + sounding map of offshore seabed produced in 1983 by Japan Maritime Agency
Wave conditions	Incident waves: H_I = 3.44 m and T = 14.2 s Storm wave condition with the probability of occurrence of several times a year (upper 0.1%) was employed on the basis of wave observation data measured at Hiratsuka wave observatory between 1988 and 2015.
Sea level	0.0 m above MSL
Calculation cases	Case 1: wave direction N180°E, Case 2: N190°E, Case 3: N200°E
Mesh size	$\Delta x = \Delta y$ = 10 m
Calculation of wave field	･Energy balance equation (Mase, 2001) ･Term of wave dissipation due to wave breaking; Dally et al. (1984) model ･Wave spectrum of incident waves; directional wave spectrum density obtained by Goda (1985) ･Total number of frequency components N_F = 3, and number of directional subdivisions N_θ = 16 ･Directional spreading parameter S_{max} = 25 ･Coefficients of wave breaking K = 0.17 and Γ = 0.35 ･Imaginary depth between minimum depth h_o and berm height h_R; h_o = 1 m ･Wave energy = 0 where $Z \geqq h_R$
Calculation of nearshore current	･Two-dimensional shallow water momentum equation and continuity equation (Horikawa et al., 1988) ･Explicit finite-difference method ･Friction coefficient C_f = 0.01 ･Lateral diffusion coefficient N = 0.5 (Larson and Kraus,1991) ･Minimum water depth h_{min} = 1 m ･Time interval Δt = 0.2 s ･Duration of calculation 20,000 steps

NUMERICAL SIMULATION OF NEARSHORE CURRENT

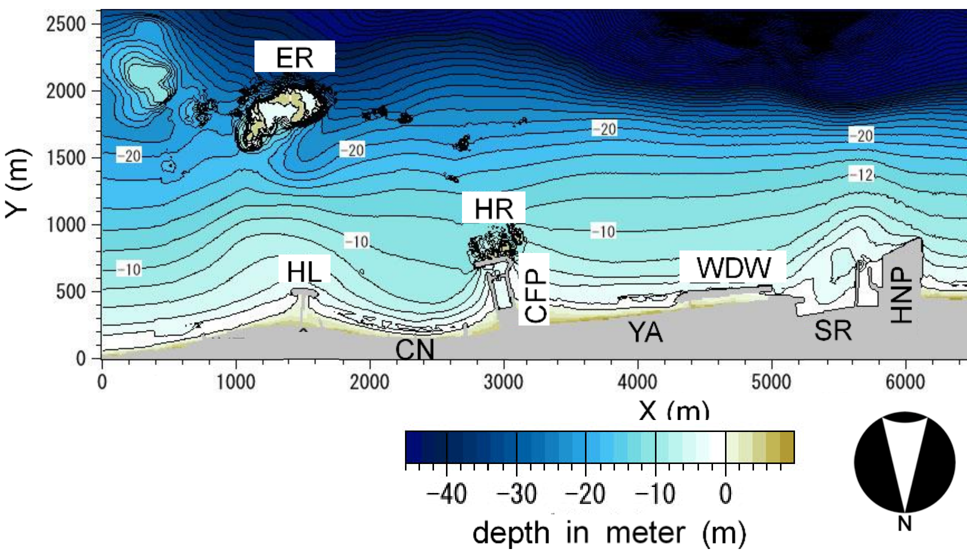


Figure 15. Calculation domain of nearshore currents and location of Hiratsuka wave observatory (water depth: 20 m).

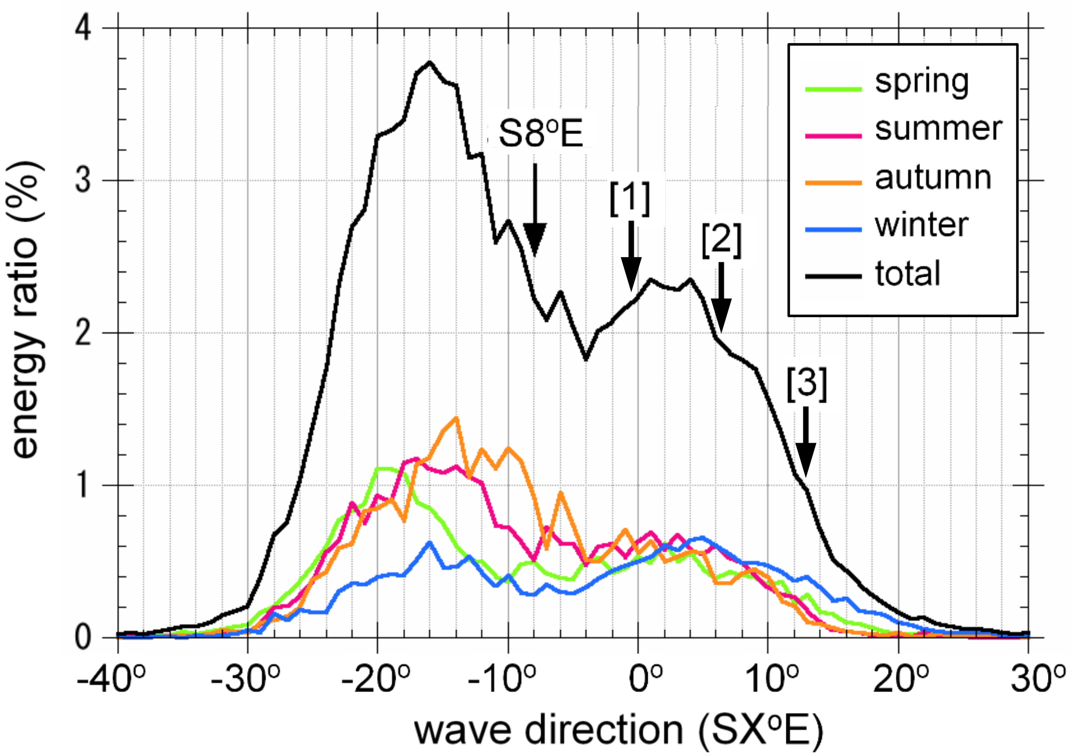


Figure 16. Probability of occurrence of wave direction measured between 1988 and 2015 at Hiratsuka wave observatory.

NUMERICAL SIMULATION OF NEARSHORE CURRENT

(c) Case 3: wave direction of N200ºE

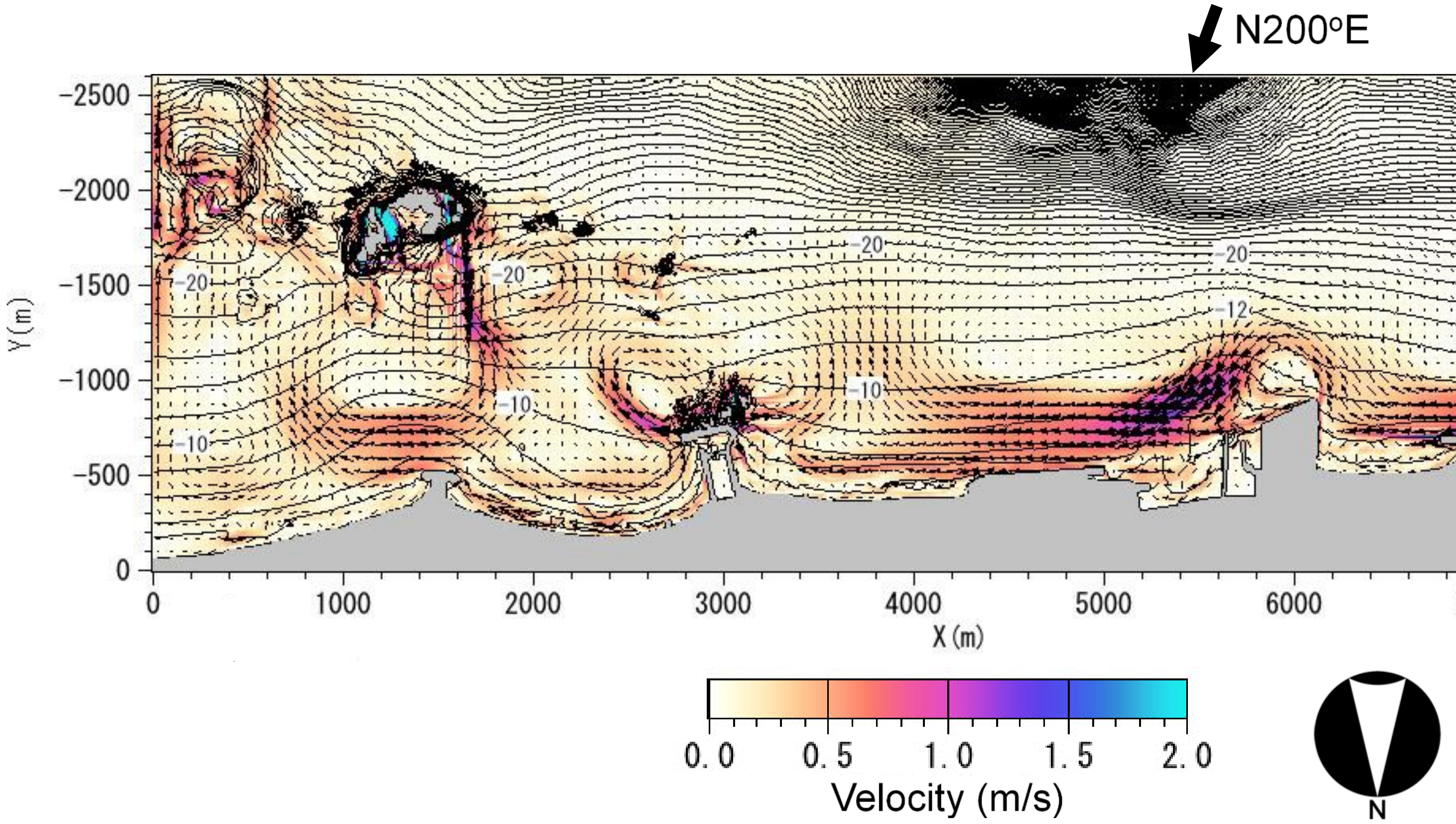


Figure 19. Calculated nearshore currents given wave direction of N200° E.

CONCLUSIONS

- From the analysis of the sand volume and grain size composition in the subareas, it was concluded that the effect of the beach nourishment on the deposition of fine sediment in the offshore zone was negligible, and that the fine material in the offshore zone mainly originated from the erosion of the river mouth terrace.

- The local fishermen’s fear that the damage to the offshore fishing ground rich in kelp and abalone owing to the coverage of the exposed rocks by nourishment material was cleared.

- We learned that

not only the investigation of the volumetric changes but also the changes in grain size composition is important in the investigation of beach changes after beach nourishment.

NUMERICAL SIMULATION OF NEARSHORE CURRENT

(a) Case 1: wave direction of N180°E

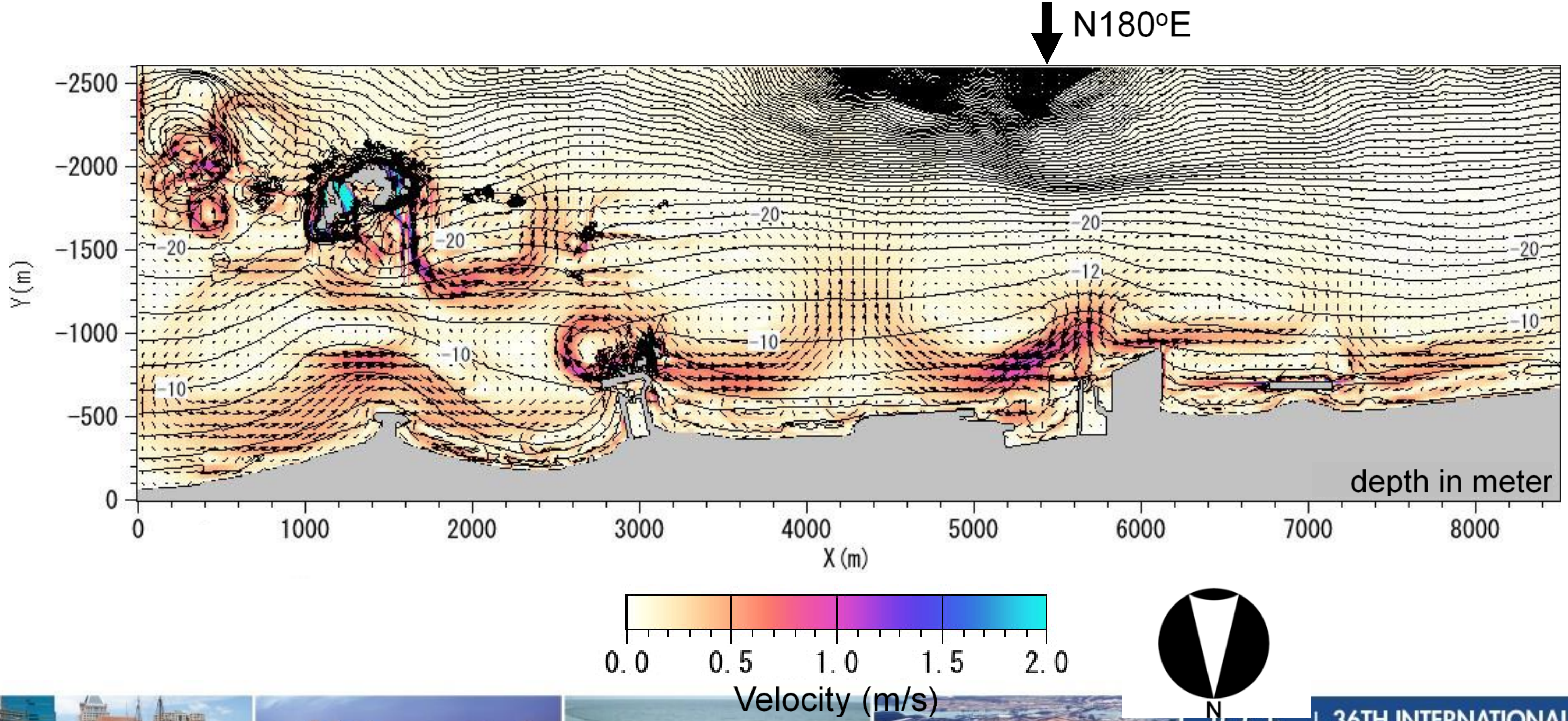


Figure 17. Calculated nearshore currents given wave direction of N180° E.

NUMERICAL SIMULATION OF NEARSHORE CURRENT

(b) Case 2: wave direction of N190ºE

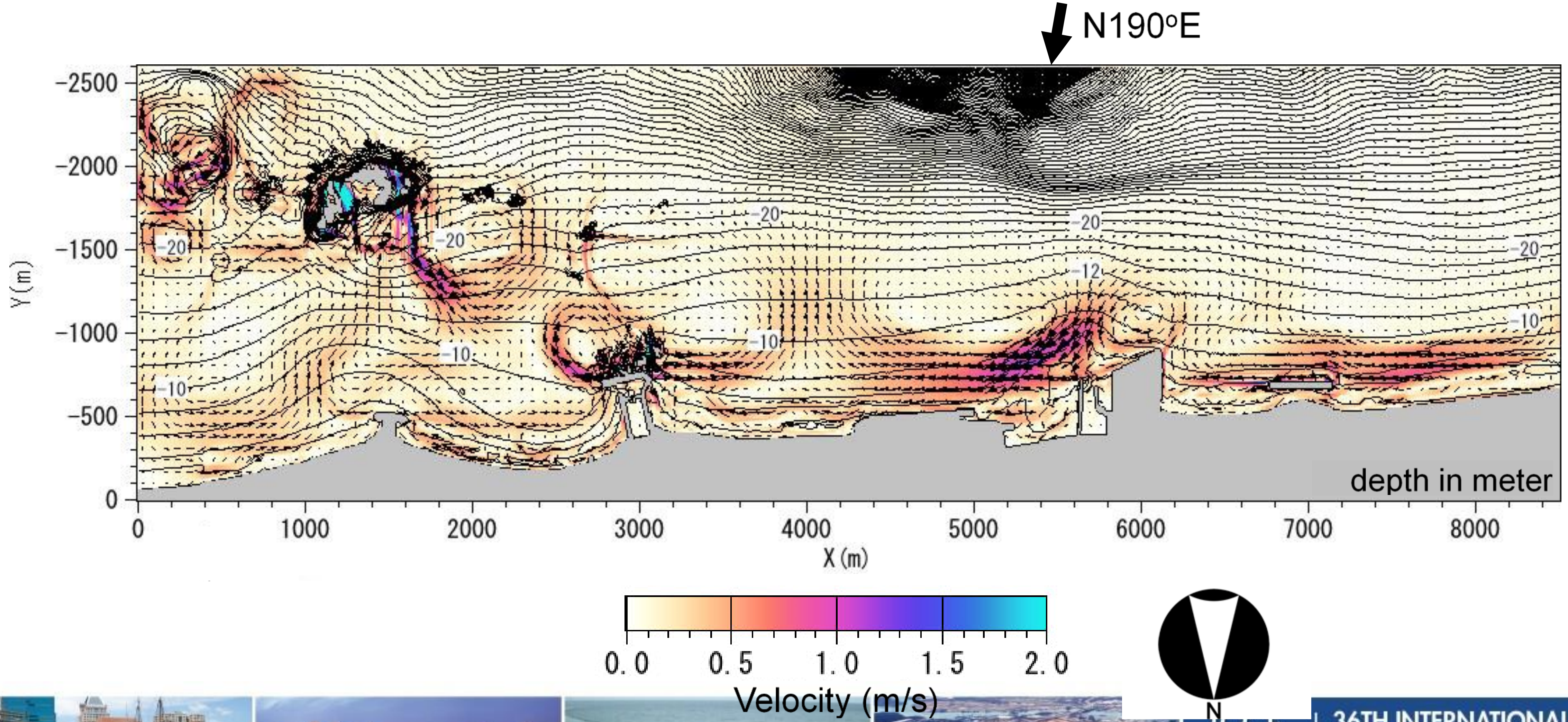


Figure 18. Calculated nearshore currents given wave direction of 190° E.