Wave Hindcasting Simulation at Ida Beach

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1. Introduction

The objective of this study is to hindcast wave fields at the Ida beach in the Shichiri-mihama coast. In previous studies on beach profile change at the Ida beach, the relationship between beach deformation and wave information was analyzed (e.g., Wada et al., 2001; Mizutani et al., 2003; Vu et al., 2015a, 2015b; Watanabe et al., 2016). Watanabe et al. (2016) surveyed beach topography using UAV-SfM at the Ida beach and analyzed the trend of beach profile change and the relationship with wave information. In this analysis, wave data at the Owase buoy, located the northeastern of the Ida beach was used assuming similar environmental condition. This was because wave data used in these analyses has limitations in terms of observation period, position, and method because of time and cost. However, the relationship between wave fields at the Owase buoy and those off the Ida beach is unclear.

To address the issue, wave fields at the Ida beach are estimated using the SWAN model in this study. It uses forecasted wave and wind data for source, provided by National Ocean Atmospheric Administration (NOAA). Hindcasted results are validated compared with NOWPHAS data observed at Owase and Shionomisaki.

2. Wave model setup

For the hindcast, a sufficiently large domain is necessary to consider the influence of swell generated at the outside of the domain. It is expected to reduce computational error that a coarse grid is spacially and timely interpolated.

The outline of the analysis is shown in **Table 1**, and the computational domain and bathymetry map are shown in **Fig 1**. The south-western boundary was located at 130 degrees east and 24 degrees north, and the north-eastern boundary was located at 150 degrees east and 37 degrees north. The grid size was 0.025 degrees (≈ 2.6 km) in the spherical coordinate system. The bathymetry was configured using the ordinary kriging method from J-EGG 500 and GEBCO 2014 Grid, provided by Marine Information Research Center (MIRC) and GEneral Bathymetric Chart of the Ocean (GEBCO), respectively. In this process, the bathymetry data from J-EGG 500 was used before GEBCO 2014 Grid to avoid the duplication of the bathymetric data spatially. Word Vector Shoreline Plus (WVSP), which was 1:1,000,000 scale, was used to separate the boundary between the land and water grids.

Forecasted one-hour-interval wind, provided by Marine Modeling and Analysis Branch (MMAB) within NOAA, was used to consider wave growth and wind-wave interaction, and forecasted three-hour-interval wave, provided by Environmental Modeling Center (EMC) within NOAA, was used to generate swell grown at the outside of boundary. The shape of the wave spectrum used in the offshore boundary was JONSWAP spectrum, which consisted of 60 frequency bins (0.05~1.0 Hz, df/f = 0.0512) and 72~90 directional bins ($d\theta$ = 4~5˚). Tide and tidal current were excluded in this analyses to focus on the hindcast of the nearshore wave condition at the position of 50 m depth off the Ida beach although the spring tidal range approximating to 1.3 m appeared at the tide stations of Kumano and Urakami.

The computational time step was set at 20 minutes. The wave information at the location of the Owase buoy (136˚15’34”E, 33˚54’08”N) and Sionomisaki (136˚44’50”E, 33˚25’59”N) at the top of the hour was outputted for validation. The hindcast of the one year period of 2015 was carried out to compare the results of Watanebe et al. (2016), and computed wave fields are analyzed in detail.

3. Validation

For validation, the results of the significant wave height and peak wave period during 24 days from 28th Nov. to 22nd Dec. at Owase and Sionomisaki are shown in **Fig 2**. In this period, a wave height of more than 2 m appeared three

Table 1 Outline of hindcasting model.

Objective	•Hindcasting wave fields at Ida beach
Wave model	•SWAN 41.10; Nonstationary (dt= 20 min); Spherical coordinate
Spectrum	•JONSWAP spectrum •Frequency bin: 60 (0.05~1 Hz); Direction bin: 72~90 (0~360˚)
Computational domain	•Longitude: 130˚E - 150˚E; dx: 1.5 min.; nx= 800 •Latitude: 24˚N to 37˚N; dy: 1.5 min.; ny= 520
Source	•Wind: CFSv2 (NCEP, NOAA); 0.205˚×0.204˚; hourly •Offshore wave: WWIII (EMC, NOAA); 0.5˚×0.5˚; hourly
Bathymetry	•J-EGG500 (MIRC); GEBCO 2014 Grid (GEBCO)
Remarks	•Tide: T.P. 0 m (constant)

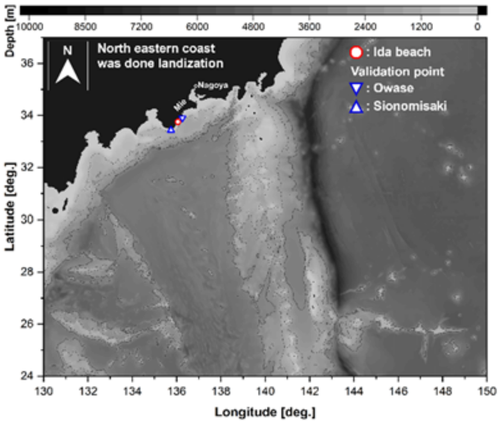

Fig.1 Computational domain & bathymetry map.

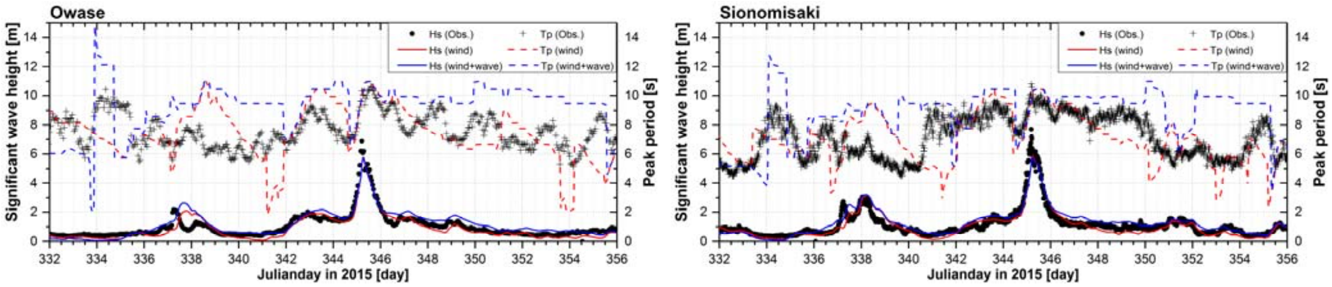

Fig.2 Wave validation (left: Owase, right: Shionomisaki)

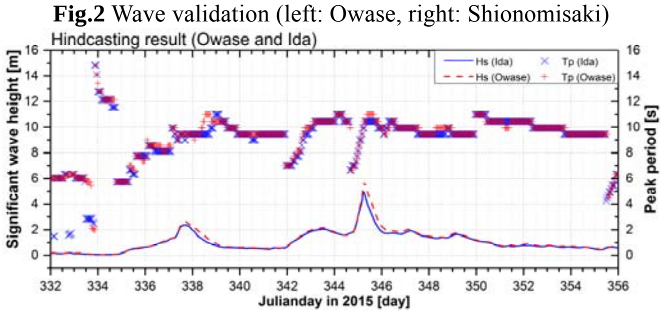

Fig.3 Time series of hindcast result at the Ida beach and Owase

times and one of them exceeded 6 m, i.e., 6.9 m at Owase and 7.0 m at Sionomisaki. The variation trend of the hindcasted significant wave height, including the appearance of high wave, agrees well with the observation data. However, peak significant wave heights of 5.7 m at Owase and 5.8 m at Sionomisaki are slightly underestimated. The root mean square error (RMSE) was estimated to be 0.41 m and 2.6 s at Owase and 0.37m and 2.4 s at Sionomisaki. The RMSE would be reduced through nesting simulation and parameter calibration. The hindcasted result at the Ida beach is shown in **Fig 3**. For comparison, the result at Owase is presented together. The trend of the significant wave height and period is almost similar between the Ida beach and Owase. However, the peak wave period and its phase are different each other, while the difference in the wave height is relatively small.

4. Conclusion

In this study, wave fields around the Ida beach were simulated and compared with NOWPHAS wave data for validation. The hindcasted wave information can be usefully used to evaluate the erosion at the Ida beach.

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