ICCE 2014 34th International Conference on Coastal Engineering

Prediction of Long-period Big Waves in East Coast of Korea

Suk Jin Ahn*, Byeong Wook Lee, Changhoon Lee***, Seok Jae Kwon******

* GeoSystem Research Corporation, sjahn@geosr.com
** PhD student, Dept. of Civil & Environ. Engrg., Sejong University, Korea, byeongwook@sju.ac.kr
*** Professor, Dept. of Civil & Environ. Engrg., Sejong University, Korea, clee@sejong.ac.kr
**** Korea Hydrographic & Oceanographic Administration, sj79kwon@korea.kr

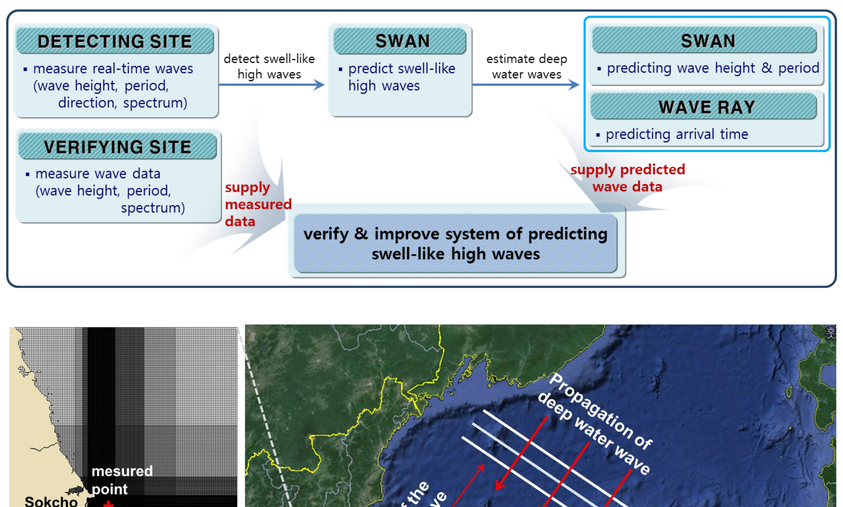
Introduction

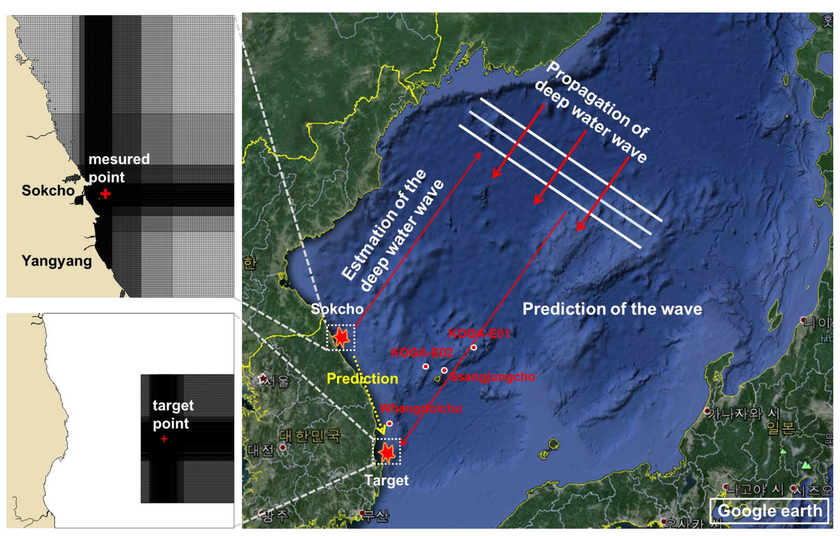
❖ Background

- ✓ Recently, long-period big waves have occurred continuously in the east coast of Korea seasonally, from October to February.
- ✓ Such big waves caused human deaths as well as damages to coastal structures.
- ✓ These big waves were generated due to an atmospherically great valley in the north area of the East Sea.

❖ Summary of this study

- ✓ Korea Hydrographic & Oceanographic Administration installed a real-time wave measurement station near Sokcho which is located at the north end of the east coast of Korea.
- ✓ Every 20 minutes, the station sends the measured data to the control office. These data include directional wave spectrum, peak wave period, direction and significant wave height, etc.
- ✓ In this study, we develop an algorithm to predict long-period big waves in the east coast of Korea using the directional wave gauge which was installed near Sokcho.

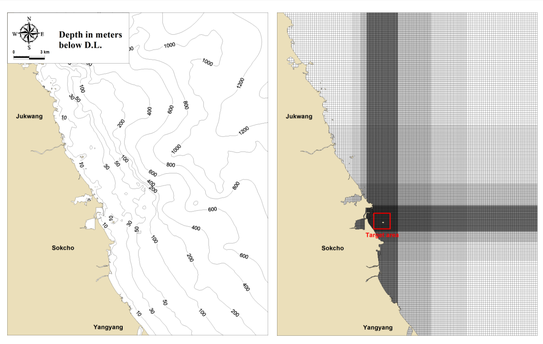




Methodology

❖ Estimation of deep water wave

- ✓ The measurement site is located at the bottom of 18 m water depth. This implies that waves experience shoaling, refraction, and diffraction, etc.
- ✓ The measured data are converted to those in open sea. These data are used to predict waves at other sites.
- ✓ Using SWAN, we estimate wave data in open sea by analyzing wave characteristics and data base between open sea and measured point.

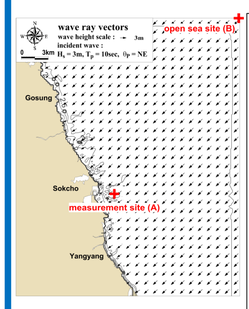


<water depth in domain> <computational grid>

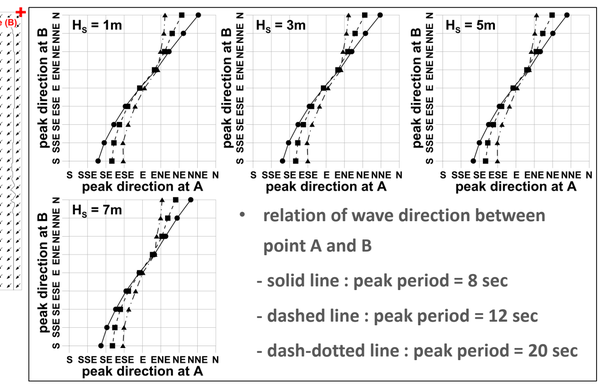
- computational domain : 25 km X 31 km
- number of grid : 118,638 EA (338 X 351)
- grid spacing : 20 ~ 200 m

❖ Relation analysis

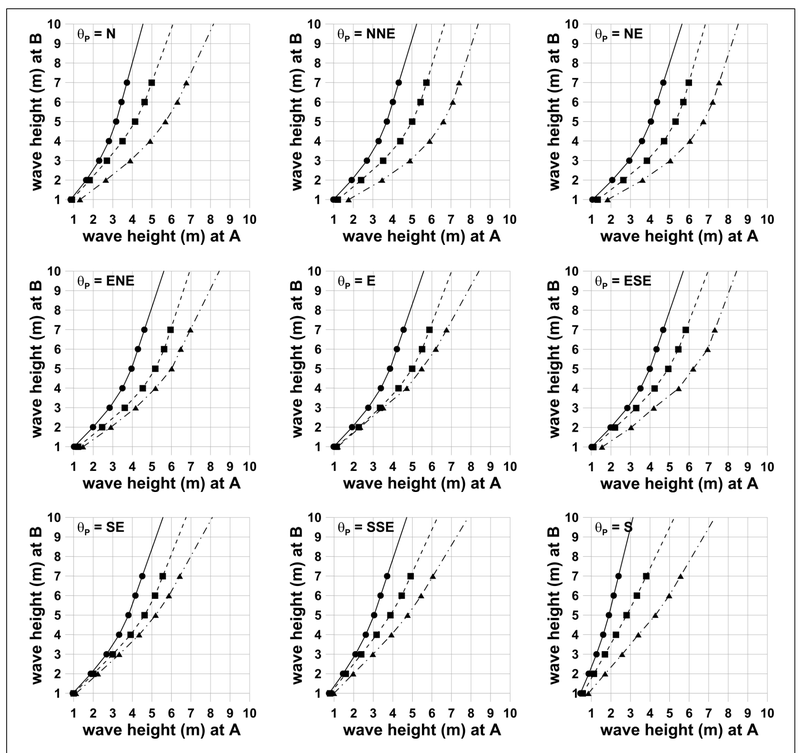
- ✓ We take numerical simulations for 7 significant wave heights, 5 peak periods, 9 wave directions and 4 peak enhance coefficients. (total : 1260 EA)
- ✓ Analysis of the correlation between observation point and open sea is performed. Databases are made for real-time forecasting.



<wave ray vectors>



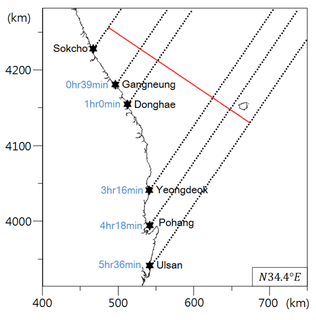
- relation of wave direction between point A and B
- solid line : peak period = 8 sec
- dashed line : peak period = 12 sec
- dash-dotted line : peak period = 20 sec



- relation of significant wave height between point A and B

❖ Estimation of arrival time

- ✓ We predict the arrival time of long-period big waves propagating from the measured point to the target points in the east coast of Korea using wave ray method (Munk and Arthur, 1952; Wilson, 1966). The open-sea wave data are used as offshore boundary conditions.

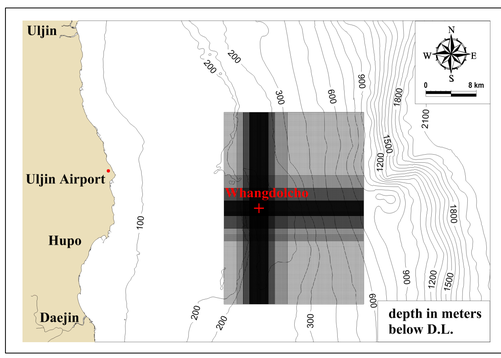


points : wave ray, **red line** : crest line

- ✓ This figure shows difference in arrival time between the measured point (i.e., Sokcho) and the target points (i.e., Gangneung, Donghae, Yeongdeok, Pohang, Ulsan).
- ✓ The arrival time is calculated from the crest line to the measured point or each target point.

❖ Wave estimation at target site

- ✓ We predict significant wave height and peak wave direction at the target point using SWAN which simulates wave propagation in a domain including the target point.

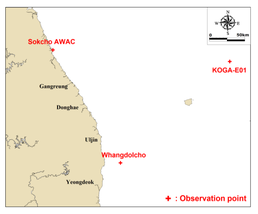


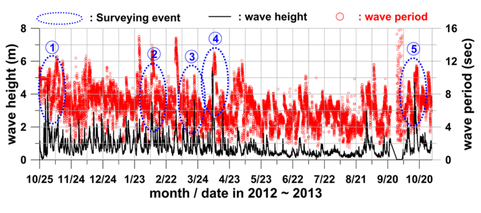
- computational domain : 22.0 km X 30.4 km
- number of grid : 118,638 EA (338 X 351)
- grid spacing : 20 ~ 200 m

Application & Verification

❖ Analysis of measured data

- ✓ Data were recorded from October 2012 to October 2013 at Sokcho and Whangdolcho stations.
- ✓ The data were recorded 5 times when the wave height was higher than 3 m and the wave period was longer than 9 sec at Sokcho.
- ✓ Observed wave directions at Sokcho are N ~ E, period is 8 ~ 12 sec.





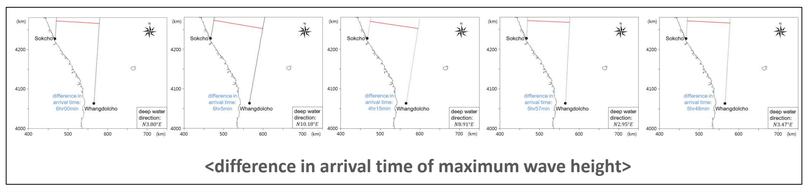
❖ Estimation of deep water data

- ✓ Deep water wave height, period and direction were predicted from the database.
- ✓ Predicted wave directions in deep water are N ~ NE.

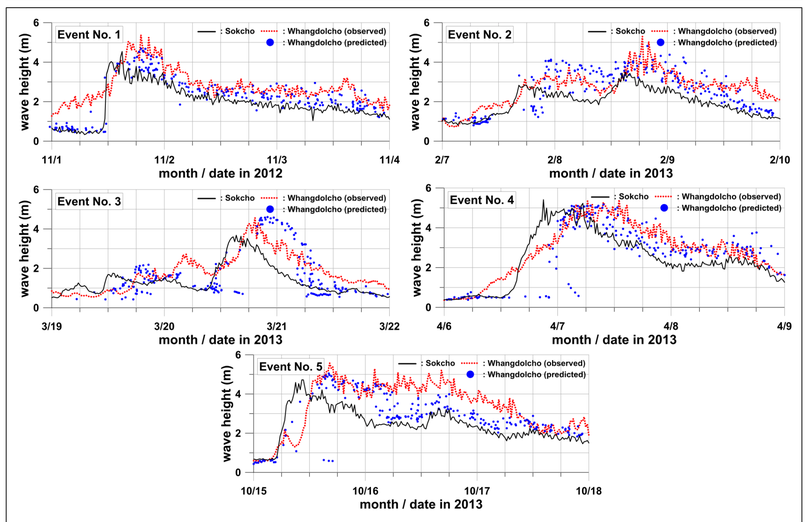
surveying event	observed data				predicted deep water data			
	height (m)	period (sec)	direction (deg.)	γ	height (m)	period (sec)	direction (deg.)	γ
1	4.03	8.50	N29.8° E	0.49	6.07	8.50	N10.2° E	0.49
2	3.51	12.33	N36.1° E	0.76	4.23	12.33	N 9.0° E	0.76
3	3.68	9.53	N25.7° E	1.05	5.72	9.53	N 3.0° E	1.05
4	5.41	9.75	N28.2° E	1.22	9.35	9.75	N 3.5° E	1.22
5	4.72	10.55	N41.8° E	0.86	7.01	10.55	N 2.1° E	0.86

❖ Verification of waves in target site

- ✓ The difference in traveling time between Sokcho and Whangdolcho was 4 to 6 hours. When the peak direction was closer to the North, the travel time became longer.
- ✓ We compare significant wave heights between predicted and measured ones for each event at Whangdolcho. The measured wave heights at Sokcho are shown for reference.



<difference in arrival time of maximum wave height>



<comparison observed data and predicted results>

Conclusions

- ✓ For high waves, predicted wave heights are close to the measured ones verifying the present method.
- ✓ However, at the early stage of low waves, the predicted wave heights are not close to the measured ones due to local wind waves.
- ✓ The prediction method can be improved by installing more measurement sites.

Acknowledgement

This research was supported by Ministry of Oceans and Fisheries in 2013.

SEJONG UNIVERSITY