

Technical Report



Prediction of NearShore Wave Height Conditions for Irregular Deep Water Waves Height

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ABSTRACT

NShore model presents state-of-the-art NearShore wave height prediction from irregular deep water wave height techniques developed by [Al-Salem K. 2022] based on Goda (1975a, 1975b). Methods for estimating nearshore irregular wave height conditions for the case of continuously shallowing bottom contours, given the bottom slope and offshore wave height characteristics, are presented. The methods are based on the work of Goda (1975a, 1975b) and Goda, Takayama, and Suzuki (1978). NShore model was developed for running in two operation system [PC version and Internet version at website address WWW.hceatkuwait.net].

INTRODUCTION

Waves are often irregular in height, period, and direction with some or most of the waves breaking or near the point of breaking during extreme wave conditions. Procedures for predicting design wave conditions for irregular waves are not discussed in the Shore Protection Manual (SPM) (U.S. Army, Corps of Engineers, Coastal Engineering Research Center, 1977). Much of the information in this report are supplements state-of-the-art irregular wave prediction techniques developed by Goda (1975a, 1975b) and suggested by Goda, Takayama, and Suzuki (1978). Easy-to-use methods for estimating nearshore wave height, angle of approach, and resulting water level setup for irregular waves are presented. The methods are intended for open sections of the coast with continuously shallowing depth contours. Wave setup due to narrow band frequency spectra and surf beat is considered but other forms of wave-wave and wave current interaction and spectral shape factors have been neglected. Design curves and examples of estimating the nearshore significant wave height are also available in Seelig (1979).

The transformation and attenuation of waves propagating from deep water to a beach is a problem of considerable difficulty because of a lack of field data and a poor theoretical understanding of the complex wave deformation process. The methods presented in this report are empirical in nature with the physics of the actual problem only partially understood. The results, based on laboratory and limited field data, are considered promising enough to recommend their application in selected field calculations. The results of calculations should be carefully examined to assure that the basic assumptions of the method have will be violated.

THEORETICAL ANALYSIS

The directional spreading of a wave energy model suggested by Goda, Takayama, and Suzuki (1978) is used to predict the refraction coefficient and refracted wave height for the nearshore point of interest. The height is then used, as input to the surf zone wave height distribution model developed by Goda (1975a, 1975b) to estimate the nearshore wave conditions and setup. The input information necessary for the application of these prediction techniques includes the deep water significant wave height, wave period of peak energy density and dominant wave direction,

the directional spreading of wave energy parameter, S*, beach slope, and water depth at the point of interest.

The confused sea state in deep water may be described as the sum of wave simultaneously moving in various directions. As this wave move toward the coast, the waves with the largest angles between their crest and the bottom contours refract the most, so that nearshore waves appear to be less confused. The reason for the directional spreading of wave energy in refraction Calculations for the case of straight parallel bottom contours are discussed in this section as:

• Wave Refraction Analysis.

Refraction calculations are based on the energy-weighted superposition of refraction coefficients obtained from linear theory. If E_i and K_{Ri} are the wave energy and refraction coefficient, respectively, for a wave direction, *i*, then the composite refraction coefficient for waves from several simultaneous directions is taken as

$$K_R = \sqrt{\frac{\sum_{i=1}^N E_i K_{Ri}^2}{\sum_{i=1}^N E_i}}$$
[1]

where N is the number of wave directions

The use of equation [1] in the calculation is to obtain a better estimate of refraction coefficients for irregular waves then would be obtained if a single value of the refraction coefficient obtained from linear theory were used.

Calculation of refraction coefficients and nearshore wave direction angles using the design curves as in Fig 1 requires the dominant deep water parameter conditions as

- wave direction angle, α_0 ,
- Type of deep water wave condition S^* .
- Deep water wave period T_s
- Shallow water location depth d
- Acceleration due to gravity $g=9.8 \text{ m}^2/\text{s}$

 E_i is the density of wave energy in a given direction, i.

Longuet-Higgins, Cartwright, and Smith (1963) suggest the following density function for wave energy:

$$E_{\theta} = K[\cos\frac{\theta}{2}]^2 S_*$$
[2]

where

 θ = wave direction angle with respect to the dominant deep water direction, α_0 (Fig. 2; note that α_0 is measured from a line perpendicular to the shoreline)

K = a constant used to define the total wave energy

 E_{θ} = the density of wave energy in a given direction, θ

S* = a parameter that defines the variation of energy level with wave direction. Smaller values of
 S* yield higher amounts of directional spreading of wave energy. Goda, Takayama, and
 Suzuki recommend the values of S* in Table 1 for design purposes.

Table 1. Recommended values of S*.				
S *	Wave condition			
4	Wind waves			
12	Swell (short-to-moderate decay distances)			
37	Swell (moderate-to-long decay distances)			



Figure 1. Design Curve for Wave Refraction For S* = 4



Figure 2. Wave refraction including directional spreading of wave energy

• NEARSHORE WAVE BREAKIN ANALYSIS

Goda (1975a, 1975b) developed a nearshore wave height prediction model for irregular waves that accounts for wave breaking, nonlinear wave shoaling, irregular wave setup, and surf beat. Surf beat is the longer period component of water level oscillation. Goda assumed that the deep water significant wave height, H_0 , and the average period of the significant waves, T_s , are known or can be estimated. The wave heights are assumed to have a Rayleigh distribution in deep water and this distribution is used to characterize wave heights as the waves move into shallower water until a depth is reached where the waves begin breaking. Goda's approach allows the broken waves to reform at a lower height, so that the wave height.

Distribution is no longer described by the Rayleigh distribution. As the waves move into shallower water the nonlinear method developed by Shuto (1974) is used to estimate wave shoaling coefficients. Shuto's method of calculating shoaling coefficients usually gives somewhat higher waves than would be predicted using the conventional linear shoaling method. Nonlinear shoaling is consistent with the observed behavior of waves in shallow water and is

conservative when compared to linear shoaling. The offshore beach profile is assumed to be represented by a straight plane surface. Dissipation of wave energy by bottom friction is usually very small for typical sand beaches; therefore, bottom dissipation is neglected. Wave setup or setdown and surf beat are related to the wave breaking process and are accounted for. The radiation stress of the waves progressing toward the shore causes wave setup which can either increase or decrease the local water depth; a decrease is often referred to as setdown. Setdown occurs seaward of the breaker zone and setup occurs shoreward from the point where a significant number of the waves break. Surf beat is the longer period component of water level oscillation (periods from 20 seconds to several minutes) due to longer period irregularities in wave action. The magnitude of the surf beat is amplified in shallow water. Figure 3 shows the conditions used in this model.



Figure 3. Definition.

The equivalent deep water wave height, H'_0 is determined from

$$H_0' = K_R H_0$$
 [3]

where H_0 is defined as the deep water significant wave height H'_0 should also include diffraction or any other loss coefficients if they are significant.

The shallow water wave height condition parameters prediction by using a design curves obtained from Goda's analytical model (Seelig, 1978). The design curve described the five variables in the nearshore zone as:

- (a) The maximum wave height, H_i , defined as the mean of the highest 1% of the waves.
- (b) the significant wave height, Hs, defined as the mean of the highest one-third waves (the significant wave height is approximately equal to four times the root-mean-square (rms) surface elevation of a water level record).
- (c) The root-mean-square (rms) wave height, H_{rms} .
- (d) The mean wave height \ddot{H} .

(e) the wave setup, S_w

All of these variables are divided by the deep water significant wave height. The five variables are corresponded to the ordinate versus the ratio of the local Stillwater depth, d, to the deep water significant wave height, H'_0 , on the abscissa. The design curves data is available for each wave steepness and for each **beach Slope** [S].

The ratio of the local Stillwater depth, = $\frac{d}{(gT^2)}$ The Offshore Wave Steepness H'_0/L_0 Depth-to-Height Ratio d/H'_0

Where

 L_0 Deepwater wavelength = $1.56 T_s^2$ d water depth at the point of interest

All design curve for all deep water wave types S^* were converted to A Database linked to [NShore model – AL-Salem 2022].

To evaluate the nearshore parameters in NShore model, use the Design curves having the offshore slope, m, and offshore wave steepness (H'_0/L_0) closest to the values of interest. Enter the value of $/H'_0$, and select the curve of the parameter of interest. Five dimensionless parameters option can be predicted are presented as:

- 1. $\frac{S_w}{H'_0}$ Wave Setup / equivalent deep water wave height2. $\frac{H_{rms}}{H'_0}$ Root-mean-square wave height / equivalent deep water wave height3. $\frac{\overline{H}}{H'_0}$ Mean wave height / equivalent deep water wave height4. $\frac{H_S}{H'_0}$ Significant wave height or average of the highest one-third waves / equivalentDeep water wave height
- 5. $\frac{H_1}{H'_0}$ Average of the highest 1-percent waves / equivalent deep water wave height

DISCUSSION RESULT AND MODEL VALIDATION PROCESS

Data source from Goda (1975a, 1975b) developed a nearshore wave height prediction model for irregular waves that accounts for wave breaking nonlinear wave shoaling, irregular wave setup by [NShore model].

Wave Refraction analysis

GIVEN The wave period, $T_s = 10$ seconds The Dominant deep water wave angle $\alpha_0 = 40^\circ$ The Significant wave height, $H_0 = 2.0$ meters. Wave condition selected [S*] is wind/wave data Beach slop [1/100] 0.01 Shallow water depth 1.0 m

SOLUTION for K_R [refraction coefficient]

Run NShore model at interactive option as shown in Fig 4 shows Input Deep water and Shallow water parameters then [RUN} The wave refraction $K_R = 0.80$ The angle of nearshore wave energy vector $\alpha = 5.0^{\circ}$. The deep water equivalent wave height [H'_0] is 1.6 m as shown in Equation 3. Significant wave height at shallow water selected $H_s = 0.747$ m

3. Interactive NearShore Wave		
RUN Edit Back		
Near Shore wave predicti	on From Deep wat	<u>er wave</u>
Input Deep water wave Parameter	Input Shallow water	r Parameter
Wave Height Wo [m] 2	Near Shore Slop	0.01 1 / 100 -
Wave Perid To [sec] 10	Water Depth [m]	1.0
Wave Direction Ao [Deg] 40		
Water Depth [m] 4		
22 Angle Shorline to North 0 Direction		
22 Wave Condition Wind-Wave		
Output Shallow water wave Parameter		
Wave Angle Front makes with the shoreline Aos	[deg]	40
Refraction Coefficient [Kr]		0.8
NearShore angle of the wave energy vector [As]		5
Deep Water Equivalent wave [H''o]		1.6
Wave SetUp Sw [m]		.109
Root mean square wave height Hrms [m]		.654
Mean wave height [m]		.514
Averge Of the highest 1% waves Hi [m]		.993
Significant wave height Hs [m]		.747
Mean water level [m]		1.109

Figure 4. NShore model interactive option page with [H₀:2m T₀:10sec A₀:40°]

Nearshore Wave Heights and Water Level Parameters

GIVEN

The wave period, $T_s = 14$ seconds The Dominant deep water wave angle $\alpha_0 = 0^\circ$ The Significant wave height, $H_0 = 3.0$ meters. Wave condition selected [S*] is wind/wave data Beach slop [1 /100] 0.01 Shallow water depth 6.0 m *SOLUTION for H_s* Run NShore model at interactive option as shown in Fig 5 shows The wave refraction KR = 0.97 The angle of nearshore wave energy vector $\alpha = 2.0^\circ$. The deep water equivalent wave height [**H**'_o] is 2 91 m as shown in Fig

The deep water equivalent wave height $[H'_0]$ is 2.91 m as shown in Equation 3. Significant wave height at shallow water selected $H_s = 3.611$ m

C. Interactive NearShore Wave	
RUN Edit Back	
Near Shore wave predict	ion From Deep water wave
Input Deep water wave Parameter	Input Shallow water Parameter
Wave Height Wo [m] 3	Near Shore Slop 0.01 1/100 -
Wave Perid To [sec] 14	Water Depth [m] 6.0
Wave Direction Ao [Deg] 0	
Water Depth [m] 12	
?? Angle Shorline to North 0 Direction	
?? Wave Condition Wind-Wave	
Output Shallow water wave Parameter	
Wave Angle Front makes with the shoreline Ao	s [deg] 6
Refraction Coefficient [Kr]	0.97
NearShore angle of the wave energy vector [As	2
Deep Water Equivalent wave [H''o]	2.91
Wave SetUp Sw [m]	049
Root mean square wave height Hrms [m]	2.634
Mean wave height [m]	2.336
Averge Of the highest 1% waves Hi [m]	4.737
Significant wave height Hs [m]	3.611
Mean water level [m]	5.951

Figure 5. NShore model interactive option page with [H₀:3m T₀:14sec A₀:0^o]

Sensitivity Analysis for NearShore wave height prediction for a selected Deepwater condition.

Data source from Goda (1975a, 1975b) to develop a nearshore wave height prediction.

In any given design situation the quality of the input information may vary. An important question to ask when predicting nearshore wave conditions is How sensitive are the predicted conditions to errors of uncertainty in the input parameters. The sensitivity of the predicted nearshore significant wave height to input parameters is illustrated below with an examples. A reference condition is chosen and nearshore significant wave heights are estimated. Each of the input parameters is then systematically varied and the results compared to the reference condition.

<u>Case 1</u>

The reference condition was selected to have the following input parameters:

- H_0 = Deep water significant wave height (5.15 meters)
- H'_0 = Deep water equivalent wave height 5.0 m as shown in Equation 3.
- T_0 = Wave period (10 seconds)
- d = Nearshore water depths (1.0 to 3 meters)
- s = Beach Slope (1/100)

From the reference condition the predicted nearshore significant wave height is slightly less than the deep water wave height for water depth of 1, 3 and 5 meters due to wave setdown as shown in Table 2 from God (1975a, 1975b) and Result predicted from NShore model [AL-Salem 2022].

	Goda (1975a, 1975b) [AL-Salem 2022]						
	Model data			NShore Model			
Stillwater depth (m)	1.0	3.0	5.0	1.0	3.0	5.0	
Reference d/H'_0	0.2	0.6	1.0	0.2	0.6	1.0	
Condition							
Reference value	0.96	2.1	3.2	.994	2.187	3.204	Fig-6
Variation							
Water 1 m deeper	1.6	2.7	3.8	1.620	2.614	3.645	Fig 7
1/20 slope	1.3	2.6	3.9	1.286	2.726	3.710	Fig 8
$H'_0 = 6m$	0.9	2.2	3.3	1.158	2.110	3.217	Fig 9
$H_0' = 4m$	0.9	2.1	3.1	0.797	2.082	3.101	Fig 10
$\alpha_0 = 45^\circ, S^* = 4$	0.9	2.0	3.1	0.995	2.174	3.206	Fig 11
$T_0 = 6 \text{ sec}$	0.8	1.9	2.8	0.984	1.878	2.835	Fig 12
$T_0 = 18 \text{ sec}$	1.1	2.3	3.5	1.252	2.356	3.829	<i>Fig</i> 13

Table 2. NShore model interactive option page to predict H_s with Reference Parameters $[H_0:5.15m H'_0:5m T_0:10sec A_0:0^\circ$ and beach slop 1/100] no refraction.

The predicted height decreases in shallow water to a value of 0.96 meter in a 1-meter water depth (still-water level). Systematic variations are made from the reference condition and from the resulting predicted nearshore wave heights given in Table 2. Comparisons with the reference condition and NShore model [Al-Salem 2022] were displayed in Table 2. Figures 6 to 13 display NShore model result with varying input parameter condition showing a good agreement with [Goda (1975a, 1975b)].

Interactive NearShore Wave	×	Interactive NearShore Wave	×
RUN Edit Back		RUN Edit Back	
Near Shore wave prediction From Deep wate	<u>r wave</u>	Near Shore wave prediction From Deep	<u>vater wave</u>
Input Deep water wave Parameter Input Shallow water	Parameter	Input Deep water wave Parameter Input Shallow w	ater Parameter
Wave Height Wo [m] 5.15 Near Shore Slop	0.01 1 / 100 -	Wave Height Wo [m] 5.15 Near Shore Slop	0.01 1 / 100 -
Wave Perid To [sec] 10 Water Depth [m]	1	Wave Perid To [sec] 10 Water Depth [m]	3
Wave Direction Ao [Deg] 0		Wave Direction Ao [Deg] 0	
Water Depth [m] 3		Water Depth [m] 3	
2? Angle Shorline to North 0 Direction 0		22 Angle Shorline to North 0 Direction	
2? Wave Condition Wind-Wave		2? Wave Condition Wind-Wave	
Output Shallow water wave Parameter		Output Shallow water wave Parameter	
Wave Angle Front makes with the shoreline Aos [deg]	6	Wave Angle Front makes with the shoreline Aos [deg]	6
Refraction Coefficient [Kr]	0.97	Refraction Coefficient [Kr]	0.9
NearShore angle of the wave energy vector [As]		NearShore angle of the wave energy vector [As]	2
Deep Water Equivalent wave [H''0]	4.9955	Deep Water Equivalent wave [H''o]	4.635
Wave SetUp Sw [m]	.347	Wave SetUp Sw [m]	.199
Root mean square wave height Hrms [m]	.663	Root mean square wave height Hrms [m]	1.708
Mean wave height [m]	.700	Mean wave height [m]	1.469
Averge Of the highest 1% waves Hi [m]	1.326	Averge Of the highest 1% waves Hi [m]	2.528
Significant wave height Hs [m]	.994	Significant wave height Hs [m]	2.187
Mean water level [m]	1.347	Mean water level [m]	3.199

J Interactive NearShore Wave	
RUN Edit Back	
Near Shore wave pred	liction From Deep water wave
Input Deep water wave Parameter	Input Shallow water Parameter
Wave Height Wo [m] 5.15	Near Shore Slop 0.01 1/1
Wave Perid To [sec] 10	Water Depth [m] 5
Wave Direction Ao [Deg] 0	
Water Depth [m] 3	
Angle Shorline to North 0 Direction	
?? Wave Condition Wind-Wave	•
Output Shallow water wave Parameter	
Wave Angle Front makes with the shorelin	e Aos [deg] 6
Refraction Coefficient [Kr]	0.97
NearShore angle of the wave energy vector	[As] 2
Deep Water Equivalent wave [H''o]	4.9955
Wave SetUp Sw [m]	.075
Root mean square wave height Hrms [m]	2.283
Mean wave height [m]	2.062
Averge Of the highest 1% waves Hi [m]	3.940
Averge Of the highest 1% waves Hi [m] Significant wave height Hs [m]	3.940



Prediction of Near Shore Wave Conditions for Irregular Deep Water Waves [NShore Model]

Interactive NearShore Wave	100 C		Interactive Near	Shore Wave			×
RUN Edit Back			RUN Edit Back				
Near Shore wave prediction	n From Deep water	<u>wave</u>		<u>Near Sho</u>	ere wave predicti	on From Deep wat	er wave
Input Deep water wave Parameter	Input Shallow water P	arameter	Input Deep wat	ter wave Pa	rameter	Input Shallow wate	r Parameter
Wave Height Wo [m] 5.15	Near Shore Slop	0.01 1 / 100 -	Wave Heig	ht Wo [m]	5.15	Near Shore Slop	0.01 1 / 100 -
Wave Perid To [sec] 10	Water Depth [m]	2	Wave Perio	d To [sec]	10	Water Depth [m]	4
Wave Direction Ao [Deg] 0			Wave Dire	ction Ao [Deg]	0		
Water Depth [m] 3			Water Dep	th [m]	3		
?? Angle Shorline to North 0 Direction			?? Angle Show Direction	rline to North	0		
?? Wave Condition Wind-Wave			?? Wave Cond	lition	Wind-Wave 💌		
Output Shallow water wave Parameter			Output Shallow	water wave	Parameter		
Wave Angle Front makes with the shoreline Aos [d	leg]	6	Wave Angl	le Front makes	with the shoreline Aos	[deg]	6
Refraction Coefficient [Kr]		0.97	Refraction	Coefficient []	<r]<="" th=""><th></th><th>0.97</th></r>		0.97
NearShore angle of the wave energy vector [As]			NearShore	angle of the w	ave energy vector [As]		2
Deep Water Equivalent wave [H''o]	4	4.9955	Deep Wate	r Equivalent wa	we [H''0]		4.9955
Wave SetUp Sw [m]		.259	Wave SetU	p Sw [m]			.112
Root mean square wave height Hrms [m]		1.141	Root mean	square wave he	eight Hrms [m]		2.025
Mean wave height [m]		1.141	Mean wave	height [m]			1.878
Averge Of the highest 1% waves Hi [m]		1.952	Averge Of	the highest 1%	6 waves Hi [m]		3.130
Significant wave height Hs [m]		1.620	Significant	t wave height H	s [m]		2.614
Mean water level [m]		2.259	Mean water	r level [m]			4.112
			×				

RUN	eractive NearShore Wave Edit Back		
	Near Shore wave predict	ion From Deep wa	iter wave
Inpu	t Deep water wave Parameter	Input Shallow wat	er Parameter
	Wave Height Wo [m] 5.15	Near Shore Slop	0.01 1 / 100 💌
	Wave Perid To [sec] 10	Water Depth [m]	6
	Wave Direction Ao [Deg] 0		
	Water Depth [m] 3		
<u>??</u>	Angle Shorline to North 0 Direction		
<u>??</u>	Wave Condition Wind-Wave		
Out	out Shallow water wave Parameter		
	Wave Angle Front makes with the shoreline Ao	s [deg]	6
	Refraction Coefficient [Kr]		0.97
	NearShore angle of the wave energy vector [As	1	2
	Deep Water Equivalent wave [H''o]		4.9955
	Wave SetUp Sw [m]		.023
	Root mean square wave height Hrms [m]		2.614
	Mean wave height [m]		2.578
	Annual Of the black and 106 merces. III Incl.		4 529
	Averge Of the highest 1% waves Hi [m]		1.5.2.5
	Significant wave height Hs [m]		3.645

Figure 7. NShore model interactive option page with [H₀:5.15m T₀:10sec A₀:0° at water depth d= 2,4,and 6] beach slop [1/100]

5 Interactive NearShore Wave	×	🔁 Interactive NearShore Wave
RUN Edit Back		RUN Edit Back
Near Shore wave prediction From Deep w	ater wave	Near Shore wave prediction From Deep water wave
Input Deep water wave Parameter Input Shallow wa	ter Parameter	Input Deep water wave Parameter Input Shallow water Parameter
Wave Height Wo [m] 5.15 Near Shore Slop	0.05 1 / 20 👻	Wave Height Wo [m] 5.15 Near Shore Slop 0.05 1/20 💌
Wave Perid To [sec] 10 Water Depth [m]	1	Wave Perid To [sec] 10 Water Depth [m] 3
Wave Direction Ao [Deg] 0		Wave Direction Ao [Deg] 0
Water Depth [m] 3		Water Depth [m] 3
22 Angle Shorline to North 0 Direction 0		22 Angle Shorline to North 0 Direction
22 Wave Condition		22 Wave Condition Wind-Wave
Output Shallow water wave Parameter		Output Shallow water wave Parameter
Wave Angle Front makes with the shoreline Aos [deg]	6	Wave Angle Front makes with the shoreline Aos [deg] 6
Refraction Coefficient [Kr]	0.97	Refraction Coefficient [Kr] 0.9
NearShore angle of the wave energy vector [As]		NearShore angle of the wave energy vector [As] 2
Deep Water Equivalent wave [H''0]	4.9955	Deep Water Equivalent wave [H"o] 4.635
Wave SetUp Sw [m]	.397	Wave SetUp Sw [m] .232
Root mean square wave height Hrms [m]	.918	Root mean square wave height Hrms [m] 1.943
Mean wave height [m]	.808	Mean wave height [m] 1.874
Averge Of the highest 1% waves Hi [m]	1.763	Averge Of the highest 1% waves Hi [m] 3.510
Significant wave height Hs [m]	1.286	Significant wave height Hs [m] 2.726
Mean water level [m]	1.397	Mean water level [m] 3.232

B. Interactive NearShore Wave	
RUN Edit Back	
Near Shore wave predic	tion From Deep water wave
Input Deep water wave Parameter	Input Shallow water Parameter
Wave Height Wo [m] 5.15	Near Shore Slop 0.05 1 / 20 🗸
Wave Perid To [sec] 10	Water Depth [m] 5
Wave Direction Ao [Deg] 0	
Water Depth [m] 3	
?? Angle Shorline to North 0 Direction	
?? Wave Condition Wind-Wave	
Output Shallow water wave Parameter	
Wave Angle Front makes with the shoreline A	Aos [deg] 6
Refraction Coefficient [Kr]	0.97
NearShore angle of the wave energy vector [A	2
Deep Water Equivalent wave [H''o]	4.9955
Wave SetUp Sw [m]	.044
Root mean square wave height Hrms [m]	2.865
Mean wave height [m]	2.534
Averge Of the highest 1% waves Hi [m]	4.849
Significant wave height Hs [m]	3.710
Mean water level [m]	5.044

Figure 8. NShore model interactive option page with [H₀:5.15m T₀:10sec A₀:0° at water depth d= 1,3,and 5] beach slop [1/20]

Prediction of Near Shore Wave Conditions for Irregular Deep Water Waves [NShore Model]

🔁 Interactive NearShore Wave	S Interactive NearShore Wave
RUN Edit Back	RUN Edit Back
Near Shore wave prediction From Deep water wave	Near Shore wave prediction From Deep water wave
Input Deep water wave Parameter Input Shallow water Parameter	Input Deep water wave Parameter Input Shallow water Parameter
Wave Height Wo [m] 6. Near Shore Slop 0.01 1/100	▼ Wave Height Wo [m] 6. Near Shore Slop 0.01 1/100 ▼
Wave Perid To [sec] 10 Water Depth [m] 1	Wave Perid To [sec] 10 Water Depth [m] 3
Wave Direction Ao [Deg] 0	Wave Direction Ao [Deg] 0
Water Depth [m] 3	Water Depth [m] 3
22 Angle Shorline to North 0 Direction	22 Angle Shorline to North 0 Direction
22 Wave Condition	?? Wave Condition
Output Shallow water wave Parameter	Output Shallow water wave Parameter
Wave Angle Front makes with the shoreline Aos [deg] 6	Wave Angle Front makes with the shoreline Aos [deg] 6
Refraction Coefficient [Kr] 0.97	Refraction Coefficient [Kr] 0.9
NearShore angle of the wave energy vector [As]	NearShore angle of the wave energy vector [As] 2
Deep Water Equivalent wave [H''o] 5.82	Deep Water Equivalent wave [H"o] 5.4
Wave SetUp Sw [m]	Wave SetUp Sw [m] 232
Root mean square wave height Hrms [m] .772	Root mean square wave height Hrms [m] 1.592
Mean wave height [m]	Mean wave height [m] 1.393
Averge Of the highest 1% waves Hi [m]	Averge Of the highest 1% waves Hi [m] 2.707
Significant wave height Hs [m] 1.158	Significant wave height Hs [m] 2.110
Mean water level [m]	Mean water level [m] 3.232
C. Interactive NearShore Wave	
RUN Edit Back	
Near Shore wave pro	diction From Deen water wave

npu	t Deep water wave Pa	rameter		Input Shallow wate	r Parameter
	Wave Height Wo [m]	6.		Near Shore Slop	0.01 1 / 10
	Wave Perid To [sec]	10		Water Depth [m]	5
	Wave Direction Ao [Deg]	0			
	Water Depth [m]	3			
<u>??</u>	Angle Shorline to North Direction	0			
<u>??</u>	Wave Condition	Wind-Wave	-		
	Refraction Coefficient []	(r] we energy vect	or [As]		0.97
	Deen Water Fouivalent wa	ve (H''ol	or [rra]		5.82
	Wave SetUn Sw [m]				130
	Root mean square wave he	ight Hrms [m]			2 531
	Mean wave height [m]	(2.317
	Averge Of the highest 1%	6 waves Hi [m]			3.947
		• [m]			3 217
	Significant wave height H	3 1111			

Figure 9. NShore model interactive option page with [H₀:6.1m T₀:10sec A₀:0° at water depth d= 1,3,and 5] beach slop [1/100] H'₀: 6m

Interactive NearShore Wave	X	Interactive NearShore Wave	×
RUN Edit Back		RUN Edit Back	
Near Shore wave pred	iction From Deep water wave	Near Shore wave prediction From Deep	water wave
Input Deep water wave Parameter	Input Shallow water Parameter	Input Deep water wave Parameter Input Shallow w	vater Parameter
Wave Height Wo [m] 4.13	Near Shore Slop 0.01 1 / 100 -	Wave Height Wo [m] 4.13 Near Shore Slop	0.01 1 / 100 -
Wave Perid To [sec] 10	Water Depth [m] 1	Wave Perid To [sec] 10 Water Depth [m]	3
Wave Direction Ao [Deg] 0		Wave Direction Ao [Deg] 0	
Water Depth [m] 3		Water Depth [m] 3	
22 Angle Shorline to North 0		22 Angle Shorline to North 0	
2? Wave Condition Wind-Wave	•	?? Wave Condition Wind-Wave	
Output Shallow water wave Parameter		Output Shallow water wave Parameter	
Wave Angle Front makes with the shoreline	Aos [deg] 6	Wave Angle Front makes with the shoreline Aos [deg]	6
Refraction Coefficient [Kr]	0.97	Refraction Coefficient [Kr]	0.9
NearShore angle of the wave energy vector	[As]	NearShore angle of the wave energy vector [As]	2
Deep Water Equivalent wave [H''o]	4.0061	Deep Water Equivalent wave [H''0]	3.717
Wave SetUp Sw [m]	.326	Wave SetUp Sw [m]	.122
Root mean square wave height Hrms [m]	.620	Root mean square wave height Hrms [m]	1.589
Mean wave height [m]	.532	Mean wave height [m]	1.425
Averge Of the highest 1% waves Hi [m]	1.240	Averge Of the nighest 1% waves mi [m]	2.411
Mean water level [m]	1326	Mean water level [m]	3 122
	1.520		5.122
	r		
	C. Interactive NearShore Wave		
	RUN Edit Back		
	Near Shore wave pred	liction From Deep water wave	
	Input Deep water wave Parameter	Input Shallow water Parameter	
	Wave Height Wo [m] 4.13	Near Shore Slop	
	Wave Perid To [sec] 10	Water Depth [m] 5	
	Wave Direction Ao [Deg] 0		
	22 Angle Shorline to North		
	Direction	_	
	22 Wave Condition Wind-Wave	<u> </u>	
	Output Shallow water wave Parameter		
	Wave Angle Front makes with the shoreline Refusction Coefficient [Ky]	e Aos [deg]	
	NearShore angle of the wave energy vector	[As] 2	
	Deep Water Equivalent wave [H''o]	4.0061	
	Wave SetUp Sw [m]	.013	
	Root mean square wave height Hrms [m]	2.392	
	Mean wave height [m]	2.244	
	Averge Of the highest 1% waves Hi [m]	3.750	
	Significant wave height Hs [m]	3.101	
	Mean water level [m]	5.013	

Figure 10. NShore model interactive option page with [H₀:4.13m T₀:10sec A₀:0° at water depth d= 1,3,and 5] beach slop [1/100] H'₀: 4m

5. Interactive NearShore Wave	S. Interactive NearShore Wave
RUN Edit Back	RUN Edit Back
Near Shore wave prediction From Deep water wave	Near Shore wave prediction From Deep water wave
Input Deep water wave Parameter Input Shallow water Parameter	eter Input Deep water wave Parameter Input Shallow water Parameter
Wave Height Wo [m] 6.25 Near Shore Slop 0.01 Wave Perid To [sec] 10 Water Depth [m] 1 Wave Direction Ao [Deg] 45	1/10C Wave Height Wo [m] 6.25 Near Shore Slop 0.01 1/10C Wave Perid To [sec] 10 Water Depth [m] 3 Water Depth [m] 3 22 Angle Shorine to North 0 0 Direction Wind-Wave • Cutput Shallow water wave Parameter Wave Angle Front makes with the shoreline Aos [deg] 45 Refraction Coefficient [Kr] 0.8 0.8 NearShore angle of the wave energy vector [As] 10 Deep Water Equivalent wave [H''o] 5 Wave SetUp Sw [m] 215 Root mean square wave height Hrms [m] 1.806 Mean wave height [m] 1.474 Averge Of the highest 1% waves Hi [m] 2.500
Significant wave height Hs [m]	Significant wave height Hs [m] 2.174
Mean water level [m]	Mean water level [m] 3.215
Est Interactive NearShore Wave RUN Edit Back Imput Deep water wave Param Wave Height Wo [m] Wave Perid To [sec] Wave Direction Ao [Deg] Water Depth [m] 22 Angle Shortine to North Direction 22 Wave Condition Wave Angle Front makes with Refraction Coefficient [Kr] NearShore angle of the wave er Deep Water Equivalent wave [Bi Wave SetUp Sw [m] Root mean square wave height Mean wave height [m] Averge Of the highest 1% wave Significant wave height [m]	wave prediction From Deep water wave eter Input Shallow water Parameter 6.25 Near Shore Slop 0.01 1/10() 10 Water Depth [m] 3 0 ad Wave 0 ndwave 0 ad Wave 0 Hins [n] 2.285 2.064 es Hi [m] 3.945 3.206 5.075

Figure 11. NShore model interactive option page with [H₀:6.25m T₀:10sec A₀:45° at water depth d= 1,3,and 5] beach slop [1/100] H'₀: 5m

P. Interactive NearShore Wave	×	1 Interactive NearShore Wave	X
RUN Edit Back		RUN Edit Back	
Near Shore wave pred	iction From Deep water wave	Near Shore wave prediction From	Deep water wave
Input Deep water wave Parameter	Input Shallow water Parameter	Input Deep water wave Parameter Input Sh	allow water Parameter
Wave Height Wo [m] 5.55	Near Shore Slop 0.01 1/100 -	Wave Height Wo [m] 5.2 Near Shore	e Slop 0.01 1 / 100 🔻
Wave Perid To [sec] 6	Water Depth [m] 1	Wave Perid To [sec] 6 Water De	oth [m] 3
Wave Direction Ao [Deg] 0		Wave Direction Ao [Deg] 0	
Water Depth [m] 3		Water Depth [m] 3	
?? Angle Shorline to North 0		Angle Shorline to North O	
2? Wave Condition Wind-Wave	-	22 Wave Condition Wind-Wave	
Output Shallow water wave Parameter		Output Shallow water wave Parameter	
Wave Angle Front makes with the shoreline	e Aos [deg] 6	Wave Angle Front makes with the shoreline Aos [deg]	6
Refraction Coefficient [Kr]	0.9	Refraction Coefficient [Kr]	0.97
NearShore angle of the wave energy vector	[As] 2	NearShore angle of the wave energy vector [As]	2
Deep Water Equivalent wave [H''o]	4.995	Deep Water Equivalent wave [H''o]	5.044
Wave SetUp Sw [m]	.244	Wave SetUp Sw [m]	.114
Root mean square wave height Hrms [m]	.729	Root mean square wave height Hrms [m]	1.620
Mean wave height [m]	.693	Mean wave height [m]	1.583
Averge Of the highest 1% waves Hi [m]	1.240	Averge Of the highest 1% waves Hi [m]	2.467
Significant wave height Hs [m]	.984	Significant wave height Hs [m]	1.878
Mean water level [m]	1.244	Mean water level [m]	3.114
	🔁 Interactive NearShore Wave	×	
	RUN Edit Back		
	Near Shore wave predic	ction From Deep water wave	
	Input Deep water wave Parameter	Input Shallow water Parameter	
	Wave Height Wo [m] 5.2	Near Shore Slop 0.01 1/100 -	
	Wave Perid To [sec] 6	Water Depth [m] 5	
	Wave Direction Ao [Deg] 0		
	Water Depth [m] 3		
	22 Angle Shorline to North 0		
	Image: Streetion Wind-Wave ?? Wave Condition	1	
	Output Shallow water wave Parameter		
	Wave Angle Front makes with the shoreline A	Aos [deg] 6	
	Refraction Coefficient [Kr]	0.97	
	NearShore angle of the wave energy vector [/	As] 2	
	Deep Water Equivalent wave [H''o]	5.044	
	Wave SetUp Sw [m]	.055	
	Root mean square wave height Hrms [m]	2.135	
	Mean wave height [m]	1.951	
	Averge Of the highest 1% waves Hi [m]	3.461	
	Significant wave height Hs [m]	2.835	
	Mean water level [m]	5.055	

Figure 12. NShore model interactive option page with [H₀:5.2 m T₀:6 sec A₀:0° at water depth d= 1,3,and 5] beach slop [1/100] H'₀: 5m

Interactive NearShore Wave	×	Interactive NearShore Wave	X
RUN Edit Back		RUN Edit Back	
Near Shore wave pre	ediction From Deep water wave	Near Shore wave prediction From Deep	<u>p water wave</u>
Input Deep water wave Parameter	Input Shallow water Parameter	Input Deep water wave Parameter Input Shallow	water Parameter
Wave Height Wo [m] 5.2 Wave Perid To [sec] 18 Wave Direction Ao [Deg] 0 Water Depth [m] 3 21 Angle Shorline to North Direction 0	Near Shore Slop 0.01 1/10C Vater Depth [m] 1	Wave Height Wo [m] 5.2 Near Shore Slop Wave Perid To [sec] 18 Water Depth [m] Wave Direction Ao [Deg] 0 Water Depth [m] 3 22 Angle Shorline to North 0 Direction 0	• 0.01 [1/10C▼] 3
22 Wave Condition Wind-Wave		22 Wave Condition Wind-Wave	
Output Shallow water wave Parameter Wave Angle Front makes with the shoreli Refraction Coefficient [Kr] NearShore angle of the wave energy vecto Deep Water Equivalent wave [H''o] Wave SetUp Sw [m] Root mean square wave height Hrms [m] Mean wave height [m] Averge Of the highest 1% waves Hi [m] Significant wave height Hs [m] Mean water level [m]	ine Aos [deg] 6 0.97 r [As] 5.044 5.34 920 920 1.951 1.252 1.334	Output Shallow water wave Parameter Wave Angle Front makes with the shoreline Aos [deg] Refraction Coefficient [Kr] NearShore angle of the wave energy vector [As] Deep Water Equivalent wave [H"o] Wave SetUp Sw [m] Root mean square wave height Hrms [m] Mean wave height [m] Averge Of the highest 1% waves Hi [m] Significant wave height Hs [m] Mean water level [m]	6 0.97 5.044 372 2.062 1.620 3.129 2.356 3.372
	D Interactive NearShore Wave RUN Edit Back Near Shore wave pred	iction From Deep water wave	
	Input Deep water wave Parameter Wave Height Wo [m] 5.2 Wave Perid To [sec] 18 Wave Direction Ao [Deg] 0 Water Depth [m] 3 27 Angle Shortine to North 0 Direction 27 Wave Condition Wind-Wave Output Shallow water wave Parameter Wave Angle Front makes with the shoreline Refraction Coefficient [Kr] NearShore angle of the wave energy vector Deep Water Equivalent wave [H''o] Wave SetUp Sw [m] Root mean square wave height Hrms [m] Mean wave height [m] Averge Of the highest 19% waves Hi [m]	Input Shallow water Parameter Near Shore Slop 0.01 1/10C • Water Depth [m] 5 • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • • •	

Figure 13. NShore model interactive option page with [H₀:5.2 m T₀:18 sec A₀:0° at water depth d= 1,3,and 5] beach slop [1/100] H'_0 : 5m

Case 2

Data source from Goda (1975a, 1975b) to develop a nearshore wave height prediction.

The 13 September 1978 storm, a wave gage 2,250 meters beyond the end of the pier was used to record offshore wave height and period. Radar images were used to estimate dominant wave direction. Predicted tides and a profile survey of 8 September 1978 were used to determine water depth along the pier. Deep-water wave input parameter as follows:

• Wave hight H_0 = 1.66 m

- Wave Period T_0 = 4.52 sec
- Wave direction $\alpha_0 = 50^\circ$
- Wave condition $S_* =$ Wind-Wave [4]
- Beach slop $\mathbf{s} = 1 / 80$

Table 3 and Figure 14 shows nearshore wave conditions. Observed and predicted wave height [Goda (1975a, 1975b)] compared to wave predicted from NShore model [Al-Salem 2022] at the FRF, 13 September 1978 shows a good agreements.

Table 3. NShore mo	del interactive option page to predict H_{s} with Reference Parameters	5
[H ₀ :5.15m	H'_0 :5m T ₀ :10sec A ₀ :0° and beach slop 1/100] no refraction.	

		Observed Wave Conditions	Goda (1975a, 1975b)	Al-Salem 2022
Distance	Shallow	Observed wave	Predicted Wave	NShore model
from Shore	Water depth d	height <i>H</i> s	Height H _s	Wave Height H _s
line	m	m	m	m
1.05068	1.24	0.981651	0.770642	0.852
2.348578	4.76	1.146789	1.211009	1.321
4.239802	5.68	1.082569	1.165138	1.321
6.613102	7.11	1.183486	1.192661	1.331
9.925835	9.33	1.422018	1.256881	1.372

Predicted, observed and NShore model wave heights are similar for most of the wave profile as shown in Fig 14, with the observed wave height in the shallowest water higher than predicted and NShore. Results show that the local significant wave height is primarily controlled by nearshore depth





Case 3

Data source from Goda (1975a, 1975b) to develop a nearshore wave height prediction. GIVEN:

Figure 15 display deep wave height condition.

. Deep-water wave input parameter as follows:

- Wave height H_0 = 2.41 m
- Wave Period $T_{\theta} = 6.9 \text{ sec}$
- Wave direction $\alpha_0 = 60^0$
- Wave condition $S_* =$ Wind-Wave [4]
- Beach slop s = 1/100



Figure 15. Deepwater Wave Condition

Table 4. NShore model interactive option page to predict Hs with Reference Parameters[H0:2.41m T0:6.9sec A0:60° and beach slop 1/100]

	Goda (19	Goda (1975a, 1975b) NShore model [Al-Salem 202				alem 2022]	
Water	K_R	H'_0	Hs	K_R	K_R H_0' H_s		
Depth d_{swl}		m	m		m	m	
m							
0.5	0.69	1.66	0.43	0.70	1.687	0.435	
1.0	0.69	1.67	0.620	0.70	1.687	0.696	
2.0	0.70	1.68	1.28	0.70	1.687	1.268	
3.0	0.70	1.69	1.69	0.75	1.8075	1.825	
4.0	0.71	1.70	1.75	0.75	1.8075	1.905	
6.0	0.72	1.74	1.72	0.75	1.8075	1.825	

Results show that the local significant wave height is primarily controlled by depth. In this Case, wave direction, refraction effects, and wave period are relatively unimportant input parameters. Table 4 shows has good agreement with [Goda (1975a, 1975b)] and NShore model [Al-Salem 2022]. Figure 16 display sample result for water depth d_{swl} 2.0 m. Figure 17 shows a good agreement of nearshore wave height prediction between NShore and Goda.

RUN Edit Back Input Deep water wave Near Shore wave prediction From Deep water wave Input Deep water wave Parameter Input Shallow water Parameter Wave Height Wo [m] 2.41 Near Shore Slop 0.01 1/10C Wave Perid To [sec] 6.9 Water Depth [m] 2 Wave Direction Ao [Deg] 60 Water Depth [m] 2 Water Depth [m] 4 ?? Angle Shorline to North 0 Direction Wind-Wave Imput Shallow water wave Parameter 60 Output Shallow water wave Parameter 60 60 60 Refraction Coefficient [Kr] 0.7 0.7 0.7 NearShore angle of the wave energy vector [As] 15
Near Shore wave prediction From Deep water wave Input Deep water wave Parameter Input Shallow water Parameter Wave Height Wo [m] 2.41 Near Shore Slop 0.01 1/100 Wave Perid To [sec] 6.9 Water Depth [m] 2 Wave Direction Ao [Deg] 60 Water Depth [m] 2 Water Depth [m] 4 ?? Angle Shorline to North 0 Direction Wind-Wave Imput 60 60 Output Shallow water wave Parameter Wave Angle Front makes with the shoreline Aos [deg] 60 60 Refraction Coefficient [Kr] 0.7 0.7 0.7 0.7 NearShore angle of the wave energy vector [As] 15
Input Deep water wave Parameter Input Shallow water Parameter Wave Height Wo [m] 2.41 Near Shore Slop 0.01 1/100 Wave Perid To [sec] 6.9 Water Depth [m] 2 Wave Direction Ao [Deg] 60 Water Depth [m] 2 Water Depth [m] 4 ?? Angle Shorline to North 0 Direction 0 Wind-Wave • • Output Shallow water wave Parameter Wave Angle Front makes with the shoreline Aos [deg] 60 Refraction Coefficient [Kr] 0.7 0.7 NearShore angle of the wave energy vector [As] 15
Wave Height Wo [m] 2.41 Near Shore Slop 0.01 1 / 10C Wave Perid To [sec] 6.9 Water Depth [m] 2 Wave Direction Ao [Deg] 60 Water Depth [m] 4 ?? Angle Shorline to North 0 Direction 0 0 ?? Wave Condition Wind-Wave Output Shallow water wave Parameter 60 Wave Angle Front makes with the shoreline Aos [deg] 60 Refraction Coefficient [Kr] 0.7 NearShore angle of the wave energy vector [As] 15
Wave Perid To [sec] 6.9 Water Depth [m] 2 Wave Direction Ao [Deg] 60 2 Water Depth [m] 4 2 ?? Angle Shorline to North 0 0 Direction 0 2 ?? Wave Condition Wind-Wave • Output Shallow water wave Parameter Wave Angle Front makes with the shoreline Aos [deg] 60 Refraction Coefficient [Kr] 0.7 0.7 NearShore angle of the wave energy vector [As] 15
Wave Direction Ao [Deg] 60 Water Depth [m] 4 ?? Angle Shorline to North 0 Direction 0 ?? Wave Condition Wind-Wave Output Shallow water wave Parameter Wave Angle Front makes with the shoreline Aos [deg] 60 Refraction Coefficient [Kr] 0.7 NearShore angle of the wave energy vector [As] 15
Water Depth [m] 4 ?? Angle Shorline to North 0 Direction 0 ?? Wave Condition Wind-Wave Output Shallow water wave Parameter 0 Wave Angle Front makes with the shoreline Aos [deg] 60 Refraction Coefficient [Kr] 0.7 NearShore angle of the wave energy vector [As] 15
?? Angle Shorline to North 0 Direction 0 ?? Wave Condition Wind-Wave Output Shallow water wave Parameter Wave Angle Front makes with the shoreline Aos [deg] 60 Refraction Coefficient [Kr] 0.7 NearShore angle of the wave energy vector [As] 15
?? Wave Condition Wind-Wave Image: Condition Output Shallow water wave Parameter Image: Condition Wave Angle Front makes with the shoreline Aos [deg] 60 Refraction Coefficient [Kr] 0.7 NearShore angle of the wave energy vector [As] 15
Output Shallow water wave Parameter Wave Angle Front makes with the shoreline Aos [deg] 60 Refraction Coefficient [Kr] 0.7 NearShore angle of the wave energy vector [As] 15
Wave Angle Front makes with the shoreline Aos [deg] 60 Refraction Coefficient [Kr] 0.7 NearShore angle of the wave energy vector [As] 15
Refraction Coefficient [Kr] 0.7 NearShore angle of the wave energy vector [As] 15
NearShore angle of the wave energy vector [As] 15
Deep Water Equivalent wave [H''o]
Wave SetUp Sw [m]
Root mean square wave height Hrms [m] .970
Mean wave height [m]
Averge OI the highest 1% waves Hi [m] 1.579
Significant wave neight Hs [m] 1.268
Mean water level [m] 2.020

Figure 16. NShore model interactive option page with [H_0 :2.41 m T_0 :6.9 sec α_0 :60° at water depth d_{sw1} :2.0m] beach slop [1/100]





CONCLUSION

The NShore numerical model for prediction nearshore wave height by applying the methods developed by Goda (1975a, 1975b) and suggested by Goda, Takayama, and Suzuki (1978) for predicting nearshore irregular wave conditions for the case of continuously shallowing bottom contours have been presented in forms convenient for designers. The NShore model was presented by two operation system As PC version and Website version at web dress [http://www.hceatkuwait.net/NShore.aspx].

A sensitivity analysis as shown in case 3 of the methods shows the relative importance of the input parameters on the predicted nearshore wave height. Comparison with observed wave height changes and prediction wave height were presented at [Goda (1975a, 1975b)] and NShore model [AL-Salem 2022] at case 2 for data source from FRF, 13 September 1978 shows a good agreements.

REFERNCE

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- GODA Y., TAKAYAMA, T., and SUZUKI, Y., "Diffraction Diagrams for Directional Random Waves," *Proceedings of the 16th Conference on Coastal Engineering*, Port and Harbour Research Institute, Japan, 1978.

NShore Model Demonstration P.C. Version

NShore model was developed based Coastal information system C.I.S. [Al-Salem 2005] for PC version as shown in Figure P1.



Figure P1. Coastal information system C.I.S

From Figure P1 user can run NShore model by select from drop list at [*Near shore wave*]. Then a new drop list will display as shown in Figure P1 to show that there are two options to run the model which are:

- Interactive NearShore Wave height
- Convert Timeseries Deep water wave height To Shallow Wave height

Option 1 [Interactive NearShore Wave]

If user selects option 1 then new page will display as shown in Figure P2. Then user must input The Deep water wave height Condition as follows:

- Deep water wave Height m
- Deep water Wave Period sec
- Deep water Wave Angle deg
- Angle of Shoreline with respect to True North direction deg. [See Fig 15]
- Beach Slop s
- Shallow water depth [Interest depth location] m
- Wave Condition [For This version used <u>Wind-Wave</u>]

j. Interactive NearShore Wave RUN Edit Back		Â
Near Shore wave pre	diction From Deep water wave	
Input Deep water wave Parameter	Input Shallow water Parameter	
Wave Height Wo [m]	Near Shore Slop Type	•
Wave Perid To [sec]	Water Depth [m]	
Wave Direction Ao [Deg]		
Water Depth [m]		
?? Angle Shorline to North 0 Direction		
?? Wave Condition Wind-Wave		
Output Shallow water wave Parameter		
Wave Angle Front makes with the shoreli	ne Aos [deg]	
Refraction Coefficient [Kr]		
NearShore angle of the wave energy vecto	r [As]	
Deep Water Equivalent wave [H''o]		
Wave SetUp Sw [m]		
Root mean square wave height Hrms [m]		
Mean wave height [m]		
Averge Of the highest 1% waves Hi [m]		
Significant wave height Hs [m]		
Mean water level [m]		

Figure P2

When all input data was entered as shown in Figure P3 user can select [RUN] to start the model. Figure P3 display the output simulation. Figure P4 display the output file created by the model Prediction of Near Shore Wave Conditions for Irregular Deep Water Waves [NShore Model]

Interactive NearShore Wave		Page and A	×
RUN Edit Back			
Near Shore w	vave predictio	n From Deep wa	ater wave
Input Deep water wave Parame	eter	Input Shallow wat	ter Parameter
Wave Height Wo [m] 2	2.41	Near Shore Slop	0.01 1 / 100 🗸
Wave Perid To [sec]	6.9	Water Depth [m]	2
Wave Direction Ao [Deg]	60		
Water Depth [m]	4		
22 Angle Shorline to North Direction	0		
<u>??</u> Wave Condition	d-Wave 💌		
Output Shallow water wave Par	ameter		
Wave Angle Front makes with t	the shoreline Aos	deg]	60
Refraction Coefficient [Kr]			0.7
NearShore angle of the wave en	ergy vector [As]		15
Deep Water Equivalent wave [H	[''0]		1.687
Wave SetUp Sw [m]			.020
Root mean square wave height H	Hrms [m]		.970
Mean wave height [m]			.833
Averge Of the highest 1% wave	es Hi [m]		1.579
Significant wave height Hs [m]			1.268
Mean water level [m]			2.020

Figure P3

📓 NShore.dat - Notepad		
<u>Eile Edit Format View H</u> elp		
Prediction OF NearShore Wave Conditions From Irregular Deep Water Wave		*
Coastal Information System [C.I.S. 2005] Khaled Al-Salem Email: ksms001@gmail.com		
Input Deep water wave Parameter Wave Height Wo : 2.41 m Wave Period To : 6.9 sec Wave Direction Ao : 60 deg Water Depth Do : 0 m Angle Shorline to North Direction Ac : 0 deg Wave Condition Sc : Wind-Wave		
Input Shallow water Parameter Near Shore Slop s : 0.01 Water depth ds : 2 m		
Calculation of Refraction Coefficients and NearShore Wave Direction Angles Wave Angle Front makes with the shoreline [Aos]: 60 deg Refraction Coefficient [Kr]: 0.7 NearShore angle of the wave energy vector [As]: 15 deg Deep Water Equivalent wave [H'o]: 1.687 m		
Calculation of Nearshore Wave Heights and Water Level Parameters Wave SetUp Sw : 0.02 Root mean square wave height Hrms : 0.97 m Mean wave height Hm : 0.833 m Averge Of the highest 1% waves Hi : 1.579 m Significant wave height Hs : 1.268 m Mean water level Dmwl: 2.02 m		*
(4
	Ln 22, Col 59	

Figure P4

Option 2: Convert Timeseries Deep To Shallow Wave

If user selects option 2; this option was linked to Costal information System CIS database [AL-Salem 2005] for extraction Deep water wave height, direction and period data to do that is by the following steps:

- 1. Use deep water wave data file extracted from CIS
- 2. Use Created deep water wave data file by user [H_0 , T_0 , α_0]

For using option 1 for creating Deep water wave Condition file from CIS user must follows:

- Run CIS interface as shown in Fig P1 then select WAVE OUTPUT EXTRACT TIME SERIES WAVE EXTRACT
- Figure P5 for user input require parameter as shown in Fig P5 as Start Time / End time Deep water location [Longitude/Latitude] Then run Extract data
- Then user must select EXPORT FILE to create Deep water wave file by select [NEARSHORE] button.
- Then the wave data file will transfer to NShore model by a default name [Wave1.txt) as display in Figure P6
- Figure P7 display sample of deep water wave height created by CIS interface

C3. Extract Wave Height, Direction and Period in (Time Series)	_	×
Extract Digital Gulf Map Plot Plot Wave ROSE Wave Scatter Diagram Statistic	cal Analysis	
Wave Enegry/Power Occurrence Of Wave Height/Period NearShore Export File	Back Page	Inp-File
Input And Output		
Save in Wave file AS: C:\WAVE\TSwave.bin		
Varible Selection to Extarct Wave Height		
Applying Wave Height Correction Factor		
Grid Location		
Longititude (deg) 48.3 Range (47.40 to 56.80 deg)		
Latitude (deg) 29.3 Range (23.80 to 30.50 deg)		
Select Tower Location Press Here		
Select Bouy Location Press Here		
Time For Extracting Data		
Year Montl Day Starting Time 00 Jan 1 0:00		
<u>Ending Time</u> 00 Jan 31 23:00		
Export Data		1
Save in Wave file AS: C:\WAVE\Exp-Wave txt	Export Fil	•
Close EDIT	KSED	
	GENESIS	
	NewCherr	
	NearShore	<u>'</u>

Figure P5

Prediction of Near Shore Wave Conditions for Irregular Deep Water Waves [NShore Model]

🖪. NearShore	Wave Prediction						
Start Edit Back							
Near Shore wave prediction From Deep water wave							
Input Deep water wave Parameter Input Shallow water Parameter							
Longi	itude [deg]	48.3	Near Shore Slop	0.02 Type 💌			
Latitu	ıde [deg]	29.3	Water Depth [m]	1.0			
Wate	r Depth [m]	13					
?? Angle Direc	e Shorline to North tion	0					
?? Wave	File Name	C					
Start	Date	Jan 1 2000					
End D	late	Jan 31 200					

Figure P6





For using Option 2 for creating Deep water wave height Condition file must follows:

- Cerate text file data format must follow:
 - Number of data records,
 - Deep water wave height, Wave periods, Wave direction,
- A comma after each number is a must
- Then user must enter the created file Path and name in the [Wave file name] as shown in Fig P6.

After deep water wave file name entered, then user must input the following as in Figure P6:

• Input Deep water wave parameter

Longitude of Deep water location Latitude of Deep water location Deep water Depth [not use in Calculation] Angle of Shoreline to True North [See Figure 15]

- Input Shallow water Parameter Beach Slop
 Water Depth at interested location [d]
- Input Wave File name
- Input Start Time
- Input End Time

When all input data was entered as shown in Figure P6 user can select [*START*] to start the model.

Figure P8 display the output file created by the model

CIS Coastal Information System DataBase PREDICTION OF NEARSHORE WAVE CONDITIONS FROM IRREGULAR DEEP WATER WAVES [Al-Salem K. 2005] Email: Ksms001@Gmail.com Tel : 965 99016700 WWW.hceatkuwait.net Time Serious for Significant wave height and Periods Data Records Selected Grid Location Longitude: 48 18.00E Latitude: 29 18.00N Latitude : 29 18.00N Deep Water Depth: 1.0 Date From: Jan 1 2000 Date To : Jan 31 2000 Input Shallow water Parameter Near Shore Slop : 0.02 Shallow Water Depth: 1.0 Total Time Records: 744 Hours Wave Direction Measured From North Clockwise Discribtion of Parameters for Nearshore Conditions Deepwater Significant Wave Height Ho To Wave Period Vave Direction ShoreLine Orintation angle from North Ao Shore : Normal: Normal direction of wave to shore line KR Wave Refraction Coefficient As H'o Angle of Nearshore Wave Energy Vector DeepWater Equivalent Significant Wave Height Wave SetUp Sw Hrms Root-Mean-Square Wave Height Significant Wave Height at Select Water Depth [Shallow] Mean water level Calculation of Nearshore Wave Heights and Water Level Parameters. Hs MUL Ho H'o MWL To Ao Shore Normal KR As Wave Hrms Hs Shore 180.00 180.00 SetUp 00.000 00.000 deg 139.0 m 00.064 00.064 m 00.10 00.10 sec Orint Coefi deg m 00.060 m 00.044 02.00 03.00 001.000 00.00 0.600 140.0 00.060 00.044 001.000 00.00 02.00 141.0 00.00 00.00 0.000 00.00 00.000 00.000 00.000 00.000 000.000 145.0 152.0 162.0 00.00 02.00 00.00 00.00 0.000 00.00 00.000 00.000 00.000 00.000 000.000 00.00 00.00 00.00 00.00 02.00 00.00 $0.000 \\ 0.000$ $\begin{array}{c} 00.00\\ 00.00 \end{array}$ 00.00000.00000.00000.00000.000 00.000 000.000 00.000 00.000 000.000 00.00 02.00 174.0 00.00 0.000 00.00 00.000 00.000 00.000 00.000 000.000 00.00 02.10 184.0 00.00 00.00 0.000 00.00 00.000 00.000 00 .000 00.000 000.000 192.0 197.0 201.0 203.0 00.00 02.10 00.00 00.00 0.000 00.00 00.000 00.000 00.000 00.000 000.000 02.10 02.20 02.20 00.00 00.00 nn nn 0.000 0.000 0.000 00 00 $\begin{array}{c} 00.00\\ 00.00 \end{array}$ 00.00 00 000 00.000 00.000 00.000 000.000 00.000 00.00 00.00 00.000 00.000 000.000 00.000 00 00 00 00 00 00 000 00 000 00 000 000 000 0.0

Figure P8

NShore Model Demonstration

Internet Version

Website: http://www.hceatkuwait.net\NShore.aspx

User must login to website address at: <u>http://www.hceatkuwait.net\NShore.aspx</u> Then Figure V1 will display the main NShore model website page on internet as follows:

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Copyright © 2020 Kholed Al-Soline. Nixons Program.411 rights received Email <u>Ecalem@kisr.edu.com</u>	

Figure V1

Figure V1 to shows that there are two options to run the model which are:

- Interactive NearShore Wave
- Convert Timeseries Deep To Shallow Wave height

Option 1 [Interactive NearShore Wave]

If user selects option 1 then new page will display as shown in Figure V2. Then user must input The Deep water wave height Condition as follows:

- Deep water wave Height m
- Deep water Wave Period sec
- Deep water Wave Angle deg
- Angle of Shoreline with respect to True North direction deg.
- Beach Slop s
- Shallow water depth [Interest water depth location] m
- Wave Condition [For This version used <u>Wind-Wave</u>]

Prediction of Near Shore Wave Conditions for Irregular Deep Water Waves [NShore Model]

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Figure V2

When all input data was entered; User can select [**START** ^(D)] to start the model. Figure V3 display the output simulation.

From Figure V3 user can do the following:

- View the output file created by the model as shown in Figure V4
- Download output file created by model

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Figure V3	

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Figure V4

Option 2: Convert Timeseries Deep To Shallow Wave

If user selects option 2 as shown in Figure V5:

This option user can prediction nearshore wave height data from time series deep-water wave height data file. The data file can be entered or created by the following:

- [1] Use deep water wave data file extracted from Costal information System CIS database [AL-Salem 2005].
- [2] Use Created deep water wave height data file by user as follows: Ndat.

Total records.

Wave height, period, direction, $[H_0, T_0, \alpha_0]$

[3] User can used pre-saved deep wave height data file by select [Default Sample

Deep Water Wave Data *1*] as shown in Figure V6.

For using option 1 for creating Deep water wave Condition file from CIS user must follows: Run CIS interface as shown in Fig P5 then select

WAVE OUTPUT EXTRACT

TIME SERIES WAVE EXTRACT

Then open the file created. User must copy the all data then pass in Data container as shown in Figure V6.

For using option 2 for creating Deep water wave Condition file by user must do following: File data enter format as shown in Figure V6:

[1] Number of Data: Ndat,

[2] Coordinate as $[\mathbf{H}_0, \mathbf{T}_0, \alpha_0,]$

Note: Comma must follow each number

Note: Maximum Wave Data 8784 records

User can Update the input wave height data file by select [Load data 1]

Then user must save the data file by select [SAVE data 🖬]



User input require parameter for both options as shown in Fig V6 as Water depth *d* [at interested location]

Beach slop *s*

Shore line Angle from Normal direction θ

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When all input parameters were entered as shown in Figure V6.

Then user must enter his access code at [*PASSWORD*] to start run the model by select [Run icon P].

Figure V7 will display for user to select from *Output Shallow Water Wave* view options follows:

- View simulation data file [Snapshot from output file shown in Figure V8]. [User must refresh or reload page to update view file it is internet issue]
- Download simulation data \bigcirc [Snapshot from output file shown in Figure V8]

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