Wind Waves Hindcasting at the North West of the Arabian Gulf

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Abstract

Historically, wind waves data that covers the north west of the Arabian Gulf has been poor. The Demirbilek and Coworkers (1993) method is used to hindcast the significant wave height on a fully developed sea and period for the duration from1960 to1990 in the north west of the Arabian Gulf .The data of wind speed has been observed at 10 m over sea surface and gathered by Abadan station. Results show that the higher wave height , period ,friction velocity , drag coefficient and wind stress are in Summer (June-September) season in the duration from 1960 to1990 and the manner of increasing is in parallel with wind speed .The higher wind speed gives more energy transfer from the wind to the sea surface.

Key Words: Hindcasting, Wind wave hindcasting, Wind wave prediction.

Introduction

In some situations it is desirable to estimate wave conditions for preliminary considerations in project designs or even for final design in cases where total project costs are minimal. Many meteorological processes (e.g. wind stress and wind wave generation) are important components in coastal and offshore design and planning.

Hindcasting is the prediction of historical wave conditions from recorded wind data. Wave hindcasting method is a conventional method to compute significant wave height and wave period from wind velocity. The significant wave height is the average of highest one-third of all waves occurring during a period. It is the most frequently reported wave statistic and, thus, appears often in sea engineering and studies of sea surface physics. For examples, the expected significant wave height environment is a design consideration for ships and sea structures[12] , is a scaling depth that predicts the region over which bubbles are ejected and sea turbulence is generated when waves break[13] ,can be used to predict the air-sea drag coefficient [11] and [4].Wave effects are critical component of the regional coastal processes. Wave action in the nearshore zone is generally the principle mechanisms of sediment transport and coastal erosion.Locally generated wind waves referred to as sea, are the most important component of the wave climate in the region. The swell component, wave generated from distant sources, is of less importance.

Pierson-Moskowitz wave hindcasting method (PM method) was developed by Pierson and Moskowitz (1964). Silvester and Vongvissesomjai (1971) modified and improved some procedure for better prediction. Muangman (1973) applied PM method to hindcast wave and verify with measure wave data at Naratiwat province , southern part of Thailand. Demirbilek and coworkers (1993) method for wave hindcasting by using friction velocity under fully developed sea conditions .Weesakul and Koontanakulvong (1995) summarised three frequent used wave hindcast methods including PM method and tested with one year wave data in the lower gulf of Thailand This paper presents wind wave hindcasting at the north west of the Arabian Gulf for 31 years from 1960 to1990 by using wind data observed at 10 m above the sea surface gathered by Abadan station. Demirbilek and coworkers (1993) method which is one of the reliable wave hindcasting method will be used . Also, provides the information for the same duration to the wind stress on the sea surface of the study region.The significance of this study is due to the non availability of such relevant study in the area , This study is an introduction for further studies.

Meteorology

When wind blow, wind energy will transfer to the sea and create small wave height with small wave period or high wave frequency. If wind velocity increase or wind duration increase, more energy will be transferred and consequently, wave will be larger in size. This is so called "Duration limit" because wave height can be increased with increase wind duration (constant wind velocity) with no limitation. When wave propagate from a location to another location in the sea (distance is so called "Fetch length") and reach the coast, the sea area which wind energy supplied is limited but wave still can then be increased with increasing wind velocity. This is so called "fetch limit". When supplied energy from wind is equal to dissipating energy due to wave breaking. The sea state will composed with limited high wave. The sea will be rough at this state and it is called "Fully Developed Sea"(FDS). The significant wave height and wave period were theoretically proposed by Demirbilek and coworkers (1993).

The Influence of the Wind on Wave Height in Arabian Gulf

North (Shamal) wind is one of the important atmospheric effect in Arabian Gulf ,this wind is dominant in Summer and Winter as a result to interaction between low pressure zones which are concentrated on Asia on one side, and high pressure zones on Atlantic ocean on the other side. This wind basically blow from northwest at the northern parts of the Gulf, the effects of wind appears in the formation of wind waves , and the Arabian Gulf waves resulted from north west wind is not high and rarely reaches 3 m height.

These wind generally cause pressure on the water surface which make rise of water and causing waves, the study of this phenomena become so very important for the direct relation of waves with the oil industry activities.[8] and [9] .

The Model of Wind Waves Hindcasting

The general equations for the fully developed wave conditions to compute significant wave height and wave period from wind velocity are given by Demirbilek and coworkers (1993) :-

$$gHs/U^{*2} = 2.115 \times 10^2 \quad \text{………………………………………(1)}$$

$$gTp/U^{*} = 2.398 \times 10^2 \quad \text{…………………………………...........(2)}$$

Where:

Hs : significant wave height in unit of (m)

g : acceleration due to gravity=9.8(m/sec^2)

Tp : wave period in unit of (sec)

U* :wind friction velocity in the unit of (m/sec)

U : wind speed at 10 m above sea surface in unit of (m/sec)

The Model of Wind Stress on the Sea Surface

The wind blowing over the sea exerts an effective tangential stress on the sea surface .Surface stress is the momentum flux through the air-sea interaction and stress is approximately constant with height near the surface unlike wind speed there is no need to specify a reference height [1].The most effect of wind stress on the sea is the generation of waves [2]. In this case ,the rate of momentum transfer into a water column (of unit surface area) from the atmosphere can be represented as [14];-

$$WS= CD * Pa*U^2 \quad \text{……………………………………………..(3)}$$

Where.:-

WS : wind stress is usually assumed that it acts in the direction of the wind relative to the sea surface and its magnitude is proportional to the square of the wind speed relative to the sea surface in unit of (N/m^2) .

CD : coefficient of drag for winds measured at 10 m reference level in unit of (m/sec).The value of CD depends on (a) the height at which U is measured ,(b)the stability of the lowest few meters of the atmosphere and (c) the roughness of the sea surface, as affected by waves Which is given by [2] :-

CD= 0.001(1.1+0.035*U) ……..…(4)

Pa : density of air has been taken as 1.25 kg/m^3 [2].

Wind Friction Velocity

Friction velocity is a very important term in some models of air-sea interaction . It is the square root of the kinematics stress (where kinematics stress is the stress per unit density of air). Close to the surface, the friction velocity is not a function of height. And given [1] as follows:-

U* = SQRT (WS/Pa) …… …(5)

Calculations and Results

By using the data of wind speed observed at 10 m over sea surface gathered by Abadan station in the north of Arabian gulf (Iranian of meteorological organization,1960-1990) in the range between the years 1960-1990 as shown in table (1) of the study region (north of Arabian Gulf). Hs, Tp, WS, CD and U* are computing as a function of U from the equations 1,2,3,4and 5 respectively which exhibits in table (1). The higher values of significant wave height , period ,friction velocity , drag coefficient and wind stress are in Summer(June-September) season in the duration (1960-1990) as shown in table(1). Hs with U, shows increase in parallel manner for both of them, where the higher wind speed gives higher significant wave height in same time because the energy transferred into water will increase The values of Tp with U show that both of them increase in parallel manner , where the high value of wind speed gives long time to the water particle to make long vibratonal cycle The value of CD depends on U itself and increases almost in parallel manner with wind speed. The values of WS with U show increase in parallel manner where the high value of wind speed gives more values of the momentum to transfer from the atmosphere to the sea surface and high effect on deformed sea surface will happen.

Table (1) –Wind Seed , drag coefficient, wind stress ,friction velocity, significant wave height and period in the range between 1960-1990 in the study area

Months	U (m/sec) 1960	CD(m/sec)1960	WS(N/m)1960	U* (m/sec) 1960	Hs (m) 1960	Tp (sec) 1960
Jan.	3.75	0.00123125	0.021643066	0.131584395	0.373674167	3.219789595
Feb.	3.4	0.001219	0.01761455	0.118708214	0.304120598	2.904717311
Mar.	3.2	0.001212	0.0155136	0.111404129	0.267847053	2.725990835
Apr	3.55	0.00122425	0.019285763	0.124211958	0.332974607	3.039390575
May	4.1	0.0012435	0.026129044	0.144579511	0.451125939	3.537772116
Jun.	5.05	0.00127675	0.040700396	0.180444775	0.702704798	4.415373171
Jul.	3.2	0.001212	0.0155136	0.111404129	0.267847053	2.725990835
Aug.	4.7	0.0012645	0.034916006	0.167131101	0.602835536	4.089595722
Sep.	3.65	0.00122775	0.020445874	0.127893312	0.353004277	3.129471054
Oct.	2.2	0.001177	0.00712085	0.075476354	0.122943655	1.84686017
Nov.	2.9	0.0012015	0.012630769	0.100521714	0.218074089	2.459704799
Dec.	2.8	0.001198	0.0117404	0.096913982	0.2027016	2.371425816
Months	**U (m/sec) 1961**	**CD(m/sec)1961**	**WS(N/m)1961**	**U* (m/sec) 1961**	**Hs (m) 1961**	**Tp (sec) 1961**
Jan.	3.95	0.00123825	0.024149745	0.138995668	0.416952732	3.401138888
Feb.	2.75	0.00119625	0.011308301	0.09511383	0.195241275	2.327377183
Mar.	4.65	0.00126275	0.034129765	0.165238651	0.589260838	4.04328863
Apr	3.65	0.00122775	0.020445874	0.127893312	0.353004277	3.129471054

May	4.35	0.00125225	0.029619626	0.153934079	0.511391906	3.766672664
Jun.	5.75	0.00130125	0.053778223	0.207418847	0.928497477	5.075412197
Jul.	5.65	0.00129775	0.05178428	0.20353728	0.894071455	4.980432628
Aug.	4.7	0.0012645	0.034916006	0.167131101	0.602835536	4.089595722
Sep.	5.35	0.00128725	0.046055391	0.191948725	0.795160431	4.696867787
Oct.	3.45	0.00122075	0.018162471	0.120540354	0.313580623	2.949548655
Nov.	2.65	0.00119275	0.010470109	0.091520964	0.18076963	2.239461959
Dec.	3.35	0.00121725	0.017075735	0.116878519	0.294817795	2.859945793
Months	**U (m/sec) 1962**	**CD(m/sec)1962**	**WS(N/m)1962**	**U* (m/sec) 1962**	**Hs (m) 1962**	**Tp (sec) 1962**
Jan.	3	0.001205	0.01355625	0.10413933	0.234052806	2.54822564
Feb.	3.9	0.0012365	0.023508956	0.137139218	0.405889326	3.355712692
Mar.	3.5	0.0012225	0.018719531	0.122374936	0.323198438	2.994439764
Apr	5.35	0.00128725	0.046055391	0.191948725	0.795160431	4.696867787
May	2.9	0.0012015	0.012630769	0.100521714	0.218074089	2.459704799
Jun.	5.3	0.0012855	0.045137119	0.190025511	0.779306173	4.649807923
Jul.	2.95	0.00120325	0.013089104	0.102329288	0.225987386	2.50393502
Aug.	2.4	0.001184	0.0085248	0.082582323	0.147183282	2.020738873
Sep.	2.5	0.0011875	0.009277344	0.086150305	0.16017618	2.108045211
Oct.	2.4	0.001184	0.0085248	0.082582323	0.147183282	2.020738873
Nov.	2.15	0.00117525	0.006790741	0.073706127	0.117244229	1.803543796
Dec.	2.35	0.00118225	0.00816122	0.080802077	0.140905954	1.97717735
Months	**U (m/sec) 1963**	**CD(m/sec)1963**	**WS(N/m)1963**	**U* (m/sec) 1963**	**Hs (m) 1963**	**Tp (sec) 1963**
Jan.	2.3	0.0011805	0.007806056	0.079024332	0.134773951	1.933677014
Feb.	3.7	0.0012295	0.021039819	0.129737639	0.363258911	3.174600598
Mar.	5.05	0.00127675	0.040700396	0.180444775	0.702704798	4.415373171
Apr	3.95	0.00123825	0.024149745	0.138995668	0.416952732	3.401138888
May	5.35	0.00128725	0.046055391	0.191948725	0.795160431	4.696867787
Jun.	6.35	0.00132225	0.066645532	0.230903499	1.150655512	5.650067239
Jul.	5.85	0.00130475	0.055814759	0.211309742	0.963658893	5.170620002
Aug.	3	0.001205	0.01355625	0.10413933	0.234052806	2.54822564
Sep.	2.95	0.00120325	0.013089104	0.102329288	0.225987386	2.50393502
Oct.	3.75	0.00123125	0.021643066	0.131584395	0.373674167	3.219789595
Nov.	2.55	0.00118925	0.009666373	0.087938036	0.166892883	2.151789894
Dec.	3.5	0.0012225	0.018719531	0.122374936	0.323198438	2.994439764
Months	**U (m/sec) 1964**	**CD(m/sec)1964**	**WS(N/m)1964**	**U* (m/sec) 1964**	**Hs (m) 1964**	**Tp (sec) 1964**
Jan.	3.9	0.0012365	0.023508956	0.137139218	0.405889326	3.355712692
Feb.	4.35	0.00125225	0.029619626	0.153934079	0.511391906	3.766672664
Mar.	4.5	0.0012575	0.031830469	0.159575609	0.549562787	3.904717454
Apr	4.8	0.001268	0.0365184	0.170923141	0.630501355	4.182384604
May	5	0.001275	0.03984375	0.178535711	0.687914541	4.368659534
Jun.	5.9	0.0013065	0.056849081	0.213258681	0.981516791	5.218309356
Jul.	5.9	0.0013065	0.056849081	0.213258681	0.981516791	5.218309356
Aug.	5.55	0.00129425	0.04983267	0.199665059	0.860376294	4.88568174
Sep.	4.55	0.00125925	0.032587029	0.161460903	0.56262503	3.950849437
Oct.	4.5	0.0012575	0.031830469	0.159575609	0.549562787	3.904717454
Nov.	2.85	0.00119975	0.012181212	0.098716611	0.210312349	2.415535043
Dec.	2.5	0.0011875	0.009277344	0.086150305	0.16017618	2.108045211
Months	**U (m/sec) 1965**	**CD(m/sec)1965**	**WS(N/m)1965**	**U* (m/sec) 1965**	**Hs (m) 1965**	**Tp (sec) 1965**
Jan.	3.2	0.001212	0.0155136	0.111404129	0.267847053	2.725990835
Feb.	4	0.00124	0.0248	0.140854535	0.428179592	3.446624231
Mar.	3.45	0.00122075	0.018162471	0.120540354	0.313580623	2.949548655
Apr	4.05	0.00124175	0.025459755	0.142715817	0.439570472	3.492168661
May	4.05	0.00124175	0.025459755	0.142715817	0.439570472	3.492168661

Jun.	4.65	0.00126275	0.034129765	0.165238651	0.589260838	4.04328863
Jul.	4.45	0.00125575	0.031083737	0.157692706	0.53667023	3.858643958
Aug.	4.4	0.001254	0.0303468	0.155812195	0.523946792	3.812629008
Sep.	4.35	0.00125225	0.029619626	0.153934079	0.511391906	3.766672664
Oct.	3.15	0.00121025	0.015010882	0.10958424	0.259167473	2.681459257
Nov.	3.15	0.00121025	0.015010882	0.10958424	0.259167473	2.681459257
Dec.	3.05	0.00120675	0.01403224	0.105951838	0.242270916	2.592576596
Months	**U (m/sec) 1966**	**CD(m/sec)1966**	**WS(N/m)1966**	**U* (m/sec) 1966**	**Hs (m) 1966**	**Tp (sec) 1966**
Jan.	2.75	0.00119625	0.011308301	0.09511383	0.195241275	2.327377183
Feb.	3.55	0.00122425	0.019285763	0.124211958	0.332974607	3.039390575
Mar.	4.3	0.0012505	0.028902181	0.152058361	0.499005007	3.720774985
Apr	3.75	0.00123125	0.021643066	0.131584395	0.373674167	3.219789595
May	5.75	0.00130125	0.053778223	0.207418847	0.928497477	5.075412197
Jun.	6.2	0.001317	0.06328185	0.225001067	1.092580512	5.505638346
Jul.	4.9	0.0012715	0.038160894	0.174724683	0.658859513	4.275406029
Aug.	4.5	0.0012575	0.031830469	0.159575609	0.549562787	3.904717454
Sep.	3.85	0.00123475	0.022877602	0.135285187	0.394988808	3.310345703
Oct.	2.3	0.0011805	0.007806056	0.079024332	0.134773951	1.933677014
Nov.	2.55	0.00118925	0.009666373	0.087938036	0.166892883	2.151789894
Dec.	3.75	0.00123125	0.021643066	0.131584395	0.373674167	3.219789595
Months	**U (m/sec) 1967**	**CD(m/sec)1967**	**WS(N/m)1967**	**U* (m/sec) 1967**	**Hs (m) 1967**	**Tp (sec) 1967**
Jan.	3.9	0.0012365	0.023508956	0.137139218	0.405889326	3.355712692
Feb.	4	0.00124	0.0248	0.140854535	0.428179592	3.446624231
Mar.	4.3	0.0012505	0.028902181	0.152058361	0.499005007	3.720774985
Apr	5	0.001275	0.03984375	0.178535711	0.687914541	4.368659534
May	4.9	0.0012715	0.038160894	0.174724683	0.658859513	4.275406029
Jun.	7.05	0.00134675	0.083671052	0.258721553	1.444606332	6.330757996
Jul.	4.2	0.001247	0.02749635	0.148314126	0.4747329	3.629155861
Aug.	4	0.00124	0.0248	0.140854535	0.428179592	3.446624231
Sep.	3.25	0.00121375	0.016025293	0.113226474	0.276681589	2.770582492
Oct.	3.8	0.001233	0.02225565	0.133433579	0.38425061	3.265037984
Nov.	4.25	0.00124875	0.028194434	0.150185042	0.486785527	3.674936031
Dec.	2.7	0.0011945	0.010884881	0.093316156	0.187930807	2.283389209
Months	**U (m/sec) 1968**	**CD(m/sec)1968**	**WS(N/m)1968**	**U* (m/sec) 1968**	**Hs (m) 1968**	**Tp (sec) 1968**
Jan.	3.5	0.0012225	0.018719531	0.122374936	0.323198438	2.994439764
Feb.	5.3	0.0012855	0.045137119	0.190025511	0.779306173	4.649807923
Mar.	3.25	0.00121375	0.016025293	0.113226474	0.276681589	2.770582492
Apr	3.05	0.00120675	0.01403224	0.105951838	0.242270916	2.592576596
May	3.75	0.00123125	0.021643066	0.131584395	0.373674167	3.219789595
Jun.	4.8	0.001268	0.0365184	0.170923141	0.630501355	4.182384604
Jul.	5	0.001275	0.03984375	0.178535711	0.687914541	4.368659534
Aug.	4.9	0.0012715	0.038160894	0.174724683	0.658859513	4.275406029
Sep.	4.9	0.0012715	0.038160894	0.174724683	0.658859513	4.275406029
Oct.	2.7	0.0011945	0.010884881	0.093316156	0.187930807	2.283389209
Nov.	3	0.001205	0.01355625	0.10413933	0.234052806	2.54822564
Dec.	3.45	0.00122075	0.018162471	0.120540354	0.313580623	2.949548655
Months	**U (m/sec) 1969**	**CD(m/sec)1969**	**WS(N/m)1969**	**U* (m/sec) 1969**	**Hs (m) 1969**	**Tp (sec) 1969**
Jan.	4.95	0.00127325	0.03899726	0.176629013	0.673299635	4.3220038
Feb.	2.95	0.00120325	0.013089104	0.102329288	0.225987386	2.50393502
Mar.	4.8	0.001268	0.0365184	0.170923141	0.630501355	4.182384604
Apr	5.25	0.00128375	0.044229199	0.18810465	0.763630664	4.602805621
May	5.75	0.00130125	0.053778223	0.207418847	0.928497477	5.075412197
Jun.	6.2	0.001317	0.06328185	0.225001067	1.092580512	5.505638346

Jul.	6.15	0.00131525	0.062182554	0.22303821	1.073600829	5.457608445
Aug.	4.5	0.0012575	0.031830469	0.159575609	0.549562787	3.904717454
Sep.	2.95	0.00120325	0.013089104	0.102329288	0.225987386	2.50393502
Oct.	2.9	0.0012015	0.012630769	0.100521714	0.218074089	2.459704799
Nov.	3.15	0.00121025	0.015010882	0.10958424	0.259167473	2.681459257
Dec.	3	0.001205	0.01355625	0.10413933	0.234052806	2.54822564
Months	**U (m/sec) 1970**	**CD(m/sec)1970**	**WS(N/m)1970**	**U* (m/sec) 1970**	**Hs (m) 1970**	**Tp (sec) 1970**
Jan.	2.95	0.00120325	0.013089104	0.102329288	0.225987386	2.50393502
Feb.	3.95	0.00123825	0.024149745	0.138995668	0.416952732	3.401138888
Mar.	3.7	0.0012295	0.021039819	0.129737639	0.363258911	3.174600598
Apr	4.2	0.001247	0.02749635	0.148314126	0.4747329	3.629155861
May	6.55	0.00132925	0.071285185	0.23880567	1.230760544	5.843428543
Jun.	5.45	0.00129075	0.047923127	0.195802201	0.827407464	4.791159977
Jul.	4.65	0.00126275	0.034129765	0.165238651	0.589260838	4.04328863
Aug.	3.9	0.0012365	0.023508956	0.137139218	0.405889326	3.355712692
Sep.	3.65	0.00122775	0.020445874	0.127893312	0.353004277	3.129471054
Oct.	5.05	0.00127675	0.040700396	0.180444775	0.702704798	4.415373171
Nov.	3.25	0.00121375	0.016025293	0.113226474	0.276681589	2.770582492
Dec.	3.45	0.00122075	0.018162471	0.120540354	0.313580623	2.949548655
Months	**U (m/sec) 1971**	**CD(m/sec)1971**	**WS(N/m)1971**	**U* (m/sec) 1971**	**Hs (m) 1971**	**Tp (sec) 1971**
Jan.	3.3	0.0012155	0.016545994	0.115051271	0.285671647	2.815234166
Feb.	3.5	0.0012225	0.018719531	0.122374936	0.323198438	2.994439764
Mar.	4.35	0.00125225	0.029619626	0.153934079	0.511391906	3.766672664
Apr	5.4	0.001289	0.04698405	0.193874289	0.811194006	4.743985157
May	4.35	0.00125225	0.029619626	0.153934079	0.511391906	3.766672664
Jun.	4.6	0.001261	0.03335345	0.163348584	0.575857524	3.997039849
Jul.	4.6	0.001261	0.03335345	0.163348584	0.575857524	3.997039849
Aug.	4.65	0.00126275	0.034129765	0.165238651	0.589260838	4.04328863
Sep.	4.85	0.00126975	0.037334618	0.172822725	0.644593608	4.228866278
Oct.	3.8	0.001233	0.02225565	0.133433579	0.38425061	3.265037984
Nov.	3.85	0.00123475	0.022877602	0.135285187	0.394988808	3.310345703
Dec.	5.1	0.0012785	0.041567231	0.182356204	0.717670972	4.462144656
Months	**U (m/sec) 1972**	**CD(m/sec)1972**	**WS(N/m)1972**	**U* (m/sec) 1972**	**Hs (m) 1972**	**Tp (sec) 1972**
Jan.	4	0.00124	0.0248	0.140854535	0.428179592	3.446624231
Feb.	3.75	0.00123125	0.021643066	0.131584395	0.373674167	3.219789595
Mar.	6.3	0.0013205	0.065513306	0.228933713	1.131107288	5.601867796
Apr	4.6	0.001261	0.03335345	0.163348584	0.575857524	3.997039849
May	5.35	0.00128725	0.046055391	0.191948725	0.795160431	4.696867787
Jun.	5.5	0.0012925	0.048872656	0.197732458	0.843801371	4.83839219
Jul.	5	0.001275	0.03984375	0.178535711	0.687914541	4.368659534
Aug.	5.05	0.00127675	0.040700396	0.180444775	0.702704798	4.415373171
Sep.	5.3	0.0012855	0.045137119	0.190025511	0.779306173	4.649807923
Oct.	4	0.00124	0.0248	0.140854535	0.428179592	3.446624231
Nov.	5	0.001275	0.03984375	0.178535711	0.687914541	4.368659534
Dec.	4.05	0.00124175	0.025459755	0.142715817	0.439570472	3.492168661
Months	**U (m/sec) 1973**	**CD(m/sec)1973**	**WS(N/m)1973**	**U* (m/sec) 1973**	**Hs (m) 1973**	**Tp (sec) 1973**
Jan.	3.95	0.00123825	0.024149745	0.138995668	0.416952732	3.401138888
Feb.	4.5	0.0012575	0.031830469	0.159575609	0.549562787	3.904717454
Mar.	5.15	0.00128025	0.042444288	0.184269994	0.73281363	4.508973931
Apr	4.95	0.00127325	0.03899726	0.176629013	0.673299635	4.3220038
May	5.55	0.00129425	0.04983267	0.199665059	0.860376294	4.88568174
Jun.	8.15	0.00138525	0.11501471	0.303334416	1.985764179	7.422407452
Jul.	8.35	0.00139225	0.121338938	0.311562435	2.094953914	7.623742021

Aug.	4.05	0.00124175	0.025459755	0.142715817	0.439570472	3.492168661
Sep.	5.7	0.0012995	0.052775944	0.205476897	0.911192825	5.027893855
Oct.	3.15	0.00121025	0.015010882	0.10958424	0.259167473	2.681459257
Nov.	6.55	0.00132925	0.071285185	0.23880567	1.230760544	5.843428543
Dec.	4.65	0.00126275	0.034129765	0.165238651	0.589260838	4.04328863
Months	**U (m/sec) 1974**	**CD(m/sec)1974**	**WS(N/m)1974**	**U* (m/sec) 1974**	**Hs (m) 1974**	**Tp (sec) 1974**
Jan.	4.1	0.0012435	0.026129044	0.144579511	0.451125939	3.537772116
Feb.	4.35	0.00125225	0.029619626	0.153934079	0.511391906	3.766672664
Mar.	4.95	0.00127325	0.03899726	0.176629013	0.673299635	4.3220038
Apr	5.05	0.00127675	0.040700396	0.180444775	0.702704798	4.415373171
May	5.8	0.001303	0.05479115	0.20936313	0.945985978	5.122987598
Jun.	6.8	0.001338	0.0773364	0.24873504	1.33523662	6.086394136
Jul.	6.3	0.0013205	0.065513306	0.228933713	1.131107288	5.601867796
Aug.	7.75	0.00137125	0.102950879	0.286985545	1.77747844	7.022360584
Sep.	4.9	0.0012715	0.038160894	0.174724683	0.658859513	4.275406029
Oct.	3.2	0.001212	0.0155136	0.111404129	0.267847053	2.725990835
Nov.	4.65	0.00126275	0.034129765	0.165238651	0.589260838	4.04328863
Dec.	4.7	0.0012645	0.034916006	0.167131101	0.602835536	4.089595722
Months	**U (m/sec) 1975**	**CD(m/sec)1975**	**WS(N/m)1975**	**U* (m/sec) 1975**	**Hs (m) 1975**	**Tp (sec) 1975**
Jan.	4.25	0.00124875	0.028194434	0.150185042	0.486785527	3.674936031
Feb.	4.6	0.001261	0.03335345	0.163348584	0.575857524	3.997039849
Mar.	4.95	0.00127325	0.03899726	0.176629013	0.673299635	4.3220038
Apr	5.3	0.0012855	0.045137119	0.190025511	0.779306173	4.649807923
May	5.8	0.001303	0.05479115	0.20936313	0.945985978	5.122987598
Jun.	8.25	0.00138875	0.118152246	0.307443974	2.039934698	7.522965802
Jul.	8	0.00138	0.1104	0.29718681	1.906089796	7.271979288
Aug.	8.3	0.0013905	0.119739431	0.309502092	2.067337935	7.573326702
Sep.	5.15	0.00128025	0.042444288	0.184269994	0.73281363	4.508973931
Oct.	6.25	0.00131875	0.06439209	0.226966235	1.111749143	5.553724814
Nov.	5.25	0.00128375	0.044229199	0.18810465	0.763630664	4.602805621
Dec.	5.25	0.00128375	0.044229199	0.18810465	0.763630664	4.602805621
Months	**U (m/sec) 1976**	**CD(m/sec)1976**	**WS(N/m)1976**	**U* (m/sec) 1976**	**Hs (m) 1976**	**Tp (sec) 1976**
Jan.	4.1	0.0012435	0.026129044	0.144579511	0.451125939	3.537772116
Feb.	5.55	0.00129425	0.04983267	0.199665059	0.860376294	4.88568174
Mar.	4.25	0.00124875	0.028194434	0.150185042	0.486785527	3.674936031
Apr	5.05	0.00127675	0.040700396	0.180444775	0.702704798	4.415373171
May	5.5	0.0012925	0.048872656	0.197732458	0.843801371	4.83839219
Jun.	7.6	0.001366	0.0986252	0.280891723	1.702794269	6.873248485
Jul.	8	0.00138	0.1104	0.29718681	1.906089796	7.271979288
Aug.	7.1	0.0013485	0.084972356	0.260725689	1.467073743	6.379797986
Sep.	6.15	0.00131525	0.062182554	0.22303821	1.073600829	5.457608445
Oct.	4.55	0.00125925	0.032587029	0.161460903	0.56262503	3.950849437
Nov.	4.4	0.001254	0.0303468	0.155812195	0.523946792	3.812629008
Dec.	4.05	0.00124175	0.025459755	0.142715817	0.439570472	3.492168661
Months	**U (m/sec) 1977**	**CD(m/sec)1977**	**WS(N/m)1977**	**U* (m/sec) 1977**	**Hs (m) 1977**	**Tp (sec) 1977**
Jan.	4.55	0.00125925	0.032587029	0.161460903	0.56262503	3.950849437
Feb.	5.05	0.00127675	0.040700396	0.180444775	0.702704798	4.415373171
Mar.	5.6	0.001296	0.0508032	0.2016	0.8771328	4.933028571
Apr	6.35	0.00132225	0.066645532	0.230903499	1.150655512	5.650067239
May	6.15	0.00131525	0.062182554	0.22303821	1.073600829	5.457608445
Jun.	8.1	0.0013835	0.113464294	0.301282982	1.958995766	7.372210101
Jul.	8.8	0.001408	0.1362944	0.330205269	2.353164539	8.079920778
Aug.	6.15	0.00131525	0.062182554	0.22303821	1.073600829	5.457608445

Sep.	5.4	0.001289	0.04698405	0.193874289	0.811194006	4.743985157
Oct.	5	0.001275	0.03984375	0.178535711	0.687914541	4.368659534
Nov.	4.35	0.00125225	0.029619626	0.153934079	0.511391906	3.766672664
Dec.	4.1	0.0012435	0.026129044	0.144579511	0.451125939	3.537772116
Months	**U (m/sec) 1978**	**CD(m/sec)1978**	**WS(N/m)1978**	**U* (m/sec) 1978**	**Hs (m) 1978**	**Tp (sec) 1978**
Jan.	4.75	0.00126625	0.035712207	0.169025932	0.616582187	4.135961066
Feb.	5.7	0.0012995	0.052775944	0.205476897	0.911192825	5.027893855
Mar.	4.7	0.0012645	0.034916006	0.167131101	0.602835536	4.089595722
Apr	5.85	0.00130475	0.055814759	0.211309742	0.963658893	5.170620002
May	5.75	0.00130125	0.053778223	0.207418847	0.928497477	5.075412197
Jun.	6.65	0.00133275	0.073671921	0.242770544	1.27196827	5.940446569
Jul.	7.2	0.001352	0.0876096	0.264740779	1.512606563	6.478044773
Aug.	6.9	0.0013415	0.079836019	0.252722803	1.378393303	6.183972254
Sep.	5.85	0.00130475	0.055814759	0.211309742	0.963658893	5.170620002
Oct.	4.8	0.001268	0.0365184	0.170923141	0.630501355	4.182384604
Nov.	4.1	0.0012435	0.026129044	0.144579511	0.451125939	3.537772116
Dec.	5.6	0.001296	0.0508032	0.2016	0.8771328	4.933028571
Months	**U (m/sec) 1979**	**CD(m/sec)1979**	**WS(N/m)1979**	**U* (m/sec) 1979**	**Hs (m) 1979**	**Tp (sec) 1979**
Jan.	6	0.00131	0.05895	0.217163533	1.017789796	5.313858692
Feb.	5.85	0.00130475	0.055814759	0.211309742	0.963658893	5.170620002
Mar.	5.3	0.0012855	0.045137119	0.190025511	0.779306173	4.649807923
Apr	5.7	0.0012995	0.052775944	0.205476897	0.911192825	5.027893855
May	5.3	0.0012855	0.045137119	0.190025511	0.779306173	4.649807923
Jun.	6.5	0.0013275	0.070108594	0.236826677	1.210446333	5.795003793
Jul.	6.45	0.00132575	0.068943143	0.234849983	1.190324468	5.746635291
Aug.	6.1	0.0013135	0.061094169	0.221077667	1.054809526	5.409635166
Sep.	5.8	0.001303	0.05479115	0.20936313	0.945985978	5.122987598
Oct.	5.3	0.0012855	0.045137119	0.190025511	0.779306173	4.649807923
Nov.	3.95	0.00123825	0.024149745	0.138995668	0.416952732	3.401138888
Dec.	4.25	0.00124875	0.028194434	0.150185042	0.486785527	3.674936031
Months	**U (m/sec) 1980**	**CD(m/sec)1980**	**WS(N/m)1980**	**U* (m/sec) 1980**	**Hs (m) 1980**	**Tp (sec) 1980**
Jan.	5.2	0.001282	0.0433316	0.186186143	0.748133339	4.555860938
Feb.	7.5	0.0013625	0.095800781	0.276840432	1.654029815	6.774115886
Mar.	5.65	0.00129775	0.05178428	0.20353728	0.894071455	4.980432628
Apr	5.75	0.00130125	0.053778223	0.207418847	0.928497477	5.075412197
May	5.2	0.001282	0.0433316	0.186186143	0.748133339	4.555860938
Jun.	6.25	0.00131875	0.06439209	0.226966235	1.111749143	5.553724814
Jul.	5.7	0.0012995	0.052775944	0.205476897	0.911192825	5.027893855
Aug.	5.95	0.00130825	0.057894151	0.215209945	0.999560236	5.266055604
Sep.	5.2	0.001282	0.0433316	0.186186143	0.748133339	4.555860938
Oct.	4.95	0.00127325	0.03899726	0.176629013	0.673299635	4.3220038
Nov.	4.05	0.00124175	0.025459755	0.142715817	0.439570472	3.492168661
Dec.	4.45	0.00125575	0.031083737	0.157692706	0.53667023	3.858643958
Months	**U (m/sec) 1981**	**CD(m/sec)1981**	**WS(N/m)1981**	**U* (m/sec) 1981**	**Hs (m) 1981**	**Tp (sec) 1981**
Jan.	4.55	0.00125925	0.032587029	0.161460903	0.56262503	3.950849437
Feb.	4.45	0.00125575	0.031083737	0.157692706	0.53667023	3.858643958
Mar.	4.2	0.001247	0.02749635	0.148314126	0.4747329	3.629155861
Apr	4.7	0.0012645	0.034916006	0.167131101	0.602835536	4.089595722
May	6	0.00131	0.05895	0.217163533	1.017789796	5.313858692
Jun.	5.35	0.00128725	0.046055391	0.191948725	0.795160431	4.696867787
Jul.	6.55	0.00132925	0.071285185	0.23880567	1.230760544	5.843428543
Aug.	5.6	0.001296	0.0508032	0.2016	0.8771328	4.933028571
Sep.	4.2	0.001247	0.02749635	0.148314126	0.4747329	3.629155861

Oct.	4	0.00124	0.0248	0.140854535	0.428179592	3.446624231
Nov.	4.4	0.001254	0.0303468	0.155812195	0.523946792	3.812629008
Dec.	3.9	0.0012365	0.023508956	0.137139218	0.405889326	3.355712692
Months	**U (m/sec) 1982**	**CD(m/sec)1982**	**WS(N/m)1982**	**U* (m/sec) 1982**	**Hs (m) 1982**	**Tp (sec) 1982**
Jan.	4.6	0.001261	0.03335345	0.163348584	0.575857524	3.997039849
Feb.	9	0.001415	0.14326875	0.338548372	2.473578827	8.284071382
Mar.	4.45	0.00125575	0.031083737	0.157692706	0.53667023	3.858643958
Apr	5.8	0.001303	0.05479115	0.20936313	0.945985978	5.122987598
May	5.55	0.00129425	0.04983267	0.199665059	0.860376294	4.88568174
Jun.	6.25	0.00131875	0.06439209	0.226966235	1.111749143	5.553724814
Jul.	5.45	0.00129075	0.047923127	0.195802201	0.827407464	4.791159977
Aug.	6.75	0.00133625	0.076103613	0.246744586	1.31395218	6.037688947
Sep.	4.95	0.00127325	0.03899726	0.176629013	0.673299635	4.3220038
Oct.	5.7	0.0012995	0.052775944	0.205476897	0.911192825	5.027893855
Nov.	3.25	0.00121375	0.016025293	0.113226474	0.276681589	2.770582492
Dec.	3.4	0.001219	0.01761455	0.118708214	0.304120598	2.904717311
Months	**U (m/sec) 1983**	**CD(m/sec)1983**	**WS(N/m)1983**	**U* (m/sec) 1983**	**Hs (m) 1983**	**Tp (sec) 1983**
Jan.	3.45	0.00122075	0.018162471	0.120540354	0.313580623	2.949548655
Feb.	4.45	0.00125575	0.031083737	0.157692706	0.53667023	3.858643958
Mar.	4.3	0.0012505	0.028902181	0.152058361	0.499005007	3.720774985
Apr	3.5	0.0012225	0.018719531	0.122374936	0.323198438	2.994439764
May	4.4	0.001254	0.0303468	0.155812195	0.523946792	3.812629008
Jun.	6.5	0.0013275	0.070108594	0.236826677	1.210446333	5.795003793
Jul.	6.25	0.00131875	0.06439209	0.226966235	1.111749143	5.553724814
Aug.	5.6	0.001296	0.0508032	0.2016	0.8771328	4.933028571
Sep.	4.65	0.00126275	0.034129765	0.165238651	0.589260838	4.04328863
Oct.	3.3	0.0012155	0.016545994	0.115051271	0.285671647	2.815234166
Nov.	4.05	0.00124175	0.025459755	0.142715817	0.439570472	3.492168661
Dec.	3.3	0.0012155	0.016545994	0.115051271	0.285671647	2.815234166
Months	**U (m/sec) 1984**	**CD(m/sec)1984**	**WS(N/m)1984**	**U* (m/sec) 1984**	**Hs (m) 1984**	**Tp (sec) 1984**
Jan.	3.55	0.00122425	0.019285763	0.124211958	0.332974607	3.039390575
Feb.	4.95	0.00127325	0.03899726	0.176629013	0.673299635	4.3220038
Mar.	3.6	0.001226	0.0198612	0.126051418	0.342909698	3.084401026
Apr	4	0.00124	0.0248	0.140854535	0.428179592	3.446624231
May	5.05	0.00127675	0.040700396	0.180444775	0.702704798	4.415373171
Jun.	5.05	0.00127675	0.040700396	0.180444775	0.702704798	4.415373171
Jul.	4.85	0.00126975	0.037334618	0.172822725	0.644593608	4.228866278
Aug.	4.85	0.00126975	0.037334618	0.172822725	0.644593608	4.228866278
Sep.	4	0.00124	0.0248	0.140854535	0.428179592	3.446624231
Oct.	3.95	0.00123825	0.024149745	0.138995668	0.416952732	3.401138888
Nov.	6.35	0.00132225	0.066645532	0.230903499	1.150655512	5.650067239
Dec.	5.25	0.00128375	0.044229199	0.18810465	0.763630664	4.602805621
Months	**U (m/sec) 1985**	**CD(m/sec)1985**	**WS(N/m)1985**	**U* (m/sec) 1985**	**Hs (m) 1985**	**Tp (sec) 1985**
Jan.	4.7	0.0012645	0.034916006	0.167131101	0.602835536	4.089595722
Feb.	6.7	0.0013345	0.074882131	0.24475642	1.292862919	5.98903974
Mar.	6.2	0.001317	0.06328185	0.225001067	1.092580512	5.505638346
Apr	5.8	0.001303	0.05479115	0.20936313	0.945985978	5.122987598
May	6.65	0.00133275	0.073671921	0.242770544	1.27196827	5.940446569
Jun.	7.8	0.001373	0.10441665	0.289021314	1.802785427	7.072174604
Jul.	7.75	0.00137125	0.102950879	0.286985545	1.77747844	7.022360584
Aug.	6.4	0.001324	0.0677888	0.232875589	1.170394384	5.698323088
Sep.	5.8	0.001303	0.05479115	0.20936313	0.945985978	5.122987598
Oct.	5.6	0.001296	0.0508032	0.2016	0.8771328	4.933028571

Nov.	4.45	0.00125575	0.031083737	0.157692706	0.53667023	3.858643958
Dec.	3.95	0.00123825	0.024149745	0.138995668	0.416952732	3.401138888
Months	**U (m/sec) 1986**	**CD(m/sec)1986**	**WS(N/m)1986**	**U* (m/sec) 1986**	**Hs (m) 1986**	**Tp (sec) 1986**
Jan.	3.7	0.0012295	0.021039819	0.129737639	0.363258911	3.174600598
Feb.	4.1	0.0012435	0.026129044	0.144579511	0.451125939	3.537772116
Mar.	4.35	0.00125225	0.029619626	0.153934079	0.511391906	3.766672664
Apr	4.9	0.0012715	0.038160894	0.174724683	0.658859513	4.275406029
May	5.9	0.0013065	0.056849081	0.213258681	0.981516791	5.218309356
Jun.	6	0.00131	0.05895	0.217163533	1.017789796	5.313858692
Jul.	4.75	0.00126625	0.035712207	0.169025932	0.616582187	4.135961066
Aug.	3	0.001205	0.01355625	0.10413933	0.234052806	2.54822564
Sep.	3.9	0.0012365	0.023508956	0.137139218	0.405889326	3.355712692
Oct.	4.05	0.00124175	0.025459755	0.142715817	0.439570472	3.492168661
Nov.	2.8	0.001198	0.0117404	0.096913982	0.2027016	2.371425816
Dec.	2.95	0.00120325	0.013089104	0.102329288	0.225987386	2.50393502
Months	**U (m/sec) 1987**	**CD(m/sec)1987**	**WS(N/m)1987**	**U* (m/sec) 1987**	**Hs (m) 1987**	**Tp (sec) 1987**
Jan.	3.45	0.00122075	0.018162471	0.120540354	0.313580623	2.949548655
Feb.	3.75	0.00123125	0.021643066	0.131584395	0.373674167	3.219789595
Mar.	4.15	0.00124525	0.026807898	0.146445615	0.46284656	3.583434536
Apr	4.05	0.00124175	0.025459755	0.142715817	0.439570472	3.492168661
May	4.95	0.00127325	0.03899726	0.176629013	0.673299635	4.3220038
Jun.	5.4	0.001289	0.04698405	0.193874289	0.811194006	4.743985157
Jul.	4.35	0.00125225	0.029619626	0.153934079	0.511391906	3.766672664
Aug.	6.35	0.00132225	0.066645532	0.230903499	1.150655512	5.650067239
Sep.	4.75	0.00126625	0.035712207	0.169025932	0.616582187	4.135961066
Oct.	3.95	0.00123825	0.024149745	0.138995668	0.416952732	3.401138888
Nov.	3.95	0.00123825	0.024149745	0.138995668	0.416952732	3.401138888
Dec.	3.45	0.00122075	0.018162471	0.120540354	0.313580623	2.949548655
Months	**U (m/sec) 1988**	**CD(m/sec)1988**	**WS(N/m)1988**	**U* (m/sec) 1988**	**Hs (m) 1988**	**Tp (sec) 1988**
Jan.	3.45	0.00122075	0.018162471	0.120540354	0.313580623	2.949548655
Feb.	3.35	0.00121725	0.017075735	0.116878519	0.294817795	2.859945793
Mar.	4.6	0.001261	0.03335345	0.163348584	0.575857524	3.997039849
Apr	4.15	0.00124525	0.026807898	0.146445615	0.46284656	3.583434536
May	4.25	0.00124875	0.028194434	0.150185042	0.486785527	3.674936031
Jun.	5.3	0.0012855	0.045137119	0.190025511	0.779306173	4.649807923
Jul.	4.45	0.00125575	0.031083737	0.157692706	0.53667023	3.858643958
Aug.	4.8	0.001268	0.0365184	0.170923141	0.630501355	4.182384604
Sep.	5	0.001275	0.03984375	0.178535711	0.687914541	4.368659534
Oct.	5.35	0.00128725	0.046055391	0.191948725	0.795160431	4.696867787
Nov.	3.65	0.00122775	0.020445874	0.127893312	0.353004277	3.129471054
Dec.	3.9	0.0012365	0.023508956	0.137139218	0.405889326	3.355712692
Months	**U (m/sec) 1989**	**CD(m/sec)1989**	**WS(N/m)1989**	**U* (m/sec) 1989**	**Hs (m) 1989**	**Tp (sec) 1989**
Jan.	4.55	0.00125925	0.032587029	0.161460903	0.56262503	3.950849437
Feb.	4.65	0.00126275	0.034129765	0.165238651	0.589260838	4.04328863
Mar.	5.35	0.00128725	0.046055391	0.191948725	0.795160431	4.696867787
Apr	3.7	0.0012295	0.021039819	0.129737639	0.363258911	3.174600598
May	6.95	0.00134325	0.081102916	0.254720107	1.400266679	6.232845078
Jun.	6.75	0.00133625	0.076103613	0.246744586	1.31395218	6.037688947
Jul.	5.45	0.00129075	0.047923127	0.195802201	0.827407464	4.791159977
Aug.	5.25	0.00128375	0.044229199	0.18810465	0.763630664	4.602805621
Sep.	4	0.00124	0.0248	0.140854535	0.428179592	3.446624231
Oct.	5.3	0.0012855	0.045137119	0.190025511	0.779306173	4.649807923
Nov.	3.15	0.00121025	0.015010882	0.10958424	0.259167473	2.681459257

Dec.	4.2	0.001247	0.02749635	0.148314126	0.4747329	3.629155861
Months	**U (m/sec) 1990**	**CD(m/sec)1990**	**WS(N/m)1990**	**U* (m/sec) 1990**	**Hs (m) 1990**	**Tp (sec) 1990**
Jan.	4.05	0.00124175	0.025459755	0.142715817	0.439570472	3.492168661
Feb.	4.35	0.00125225	0.029619626	0.153934079	0.511391906	3.766672664
Mar.	4.6	0.001261	0.03335345	0.163348584	0.575857524	3.997039849
Apr	4.95	0.00127325	0.03899726	0.176629013	0.673299635	4.3220038
May	5.05	0.00127675	0.040700396	0.180444775	0.702704798	4.415373171
Jun.	6.95	0.00134325	0.081102916	0.254720107	1.400266679	6.232845078
Jul.	6.35	0.00132225	0.066645532	0.230903499	1.150655512	5.650067239
Aug.	6.6	0.001331	0.07247295	0.24078696	1.251267667	5.891909485
Sep.	5.5	0.0012925	0.048872656	0.197732458	0.843801371	4.83839219
Oct.	4.75	0.00126625	0.035712207	0.169025932	0.616582187	4.135961066
Nov.	4.85	0.00126975	0.037334618	0.172822725	0.644593608	4.228866278
Dec.	4.2	0.001247	0.02749635	0.148314126	0.4747329	3.629155861

Conclusions

1-Demirbilek and cowrkers hindcast method can be used to compute significant wave height and period in the north west of Arabian Gulf (1993).

2-The data of wind speed which is Gathered by Abadan station gives fairly results to the hindcasts of significant wave height and wave period at the north west of Arabian Gulf because this station coverage nearly all the study region.

3-The higher values of wind speed gives more energy transfer from the wind to the sea surface and gives large size in the wave volume leading to increase the wave height

4-Wind speed data not under the hurricane conditions so that the friction velocity have small values.

5- Wind wave data coverage the north west of Arabian Gulf region has been poor from the historic point of view.

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التنبؤ الخلفي بارتفاع امواج الرياح في شمال غرب الخليج العربي

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الخلاصة

على مدى التاريخ, كانت البيانات عن امواج الرياح في منطقة شمال غرب الخليج العربي قليلة. وقد استخدمت طريقة Demirbilek and Cowrkers عام 1993 للتنبؤ بارتفاع امواج الرياح المميز في بحر متنامي الامواج تماما والزمن الدوري للامواج لفترة من الزمن تراوح بين (1960–1990) في الشمال الغربي للخليج العربي باستخدام بيانات سرعة الرياح مقاسة على ارتفاع 10 متر فوق مستوى سطح البحر والتي جمعت من قبل محطة عبادان. وقد بينت النتائج ان اعلى ارتفاع للموجة وزمنها الدوري وسرعة احتكاكها ومعامل السحب وقوة قص الرياح في فصل الصيف في الاشهر (حزيران–ايلول) للفترة من (1960–1990) وان طريقة الزيادة طردية مع سرعة الرياح.وان الرياح ذات السرعة العالية تعطي اكثر نقل للطاقة منها الى سطح البحر.