Tạp chí Khoa học và Công nghệ biển T11 (2011). Số 3. Tr 31 - 44

SOME METEO - HYDRO - DYNAMICAL FEATURES IN MEKONG RIVER MOUTH AREA

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Summary: *This paper provides some meteo-hydro-dynamical features in Mekong River Mouth area which were based on statistical results from longtime measurement data such as wind, wave, sea water level, and river discharge. Study results show that distribution features of wind and wave characteristics are corresponding to seasonal variation. Predominant wind and wave directions during NE Monsoon period is NE, and in W, SW directions during SW Monsoon period. NE Monsoon period is from November to April (strongest in December and January), SW Monsoon period is from June to September (strongest in August). During NE Monsoon period the wind velocity and wave height were higher than that of SW Monsoon period. Variation of SWL at Vungtau Station shows that the tide is semi-diurnal with maximum value occurred during NE monsoon period (highest in November), and minimum value occurred during SW Monsoon period (lowest in June). Variation of river discharge is similarly at two stations (Mythuan and Cantho). During flood season (from July to December) average monthly discharge was ranged from 4,000 to 15,800* m^3/s*. During dry season (from January to May) average monthly discharge at both stations was less than 4,000* m^3/s*. Statistical data show that Mekong River Mouth area is a region of strong and complicated hydro-dynamical interaction processes between river and sea.*

Key words*: Monsoon, North-East (NE), South-West (SW), Sea Water Level (SWL), River discharge, Mekong River.*

I. INTRODUCTION

Mekong River Mouth area is the most important region for economical development and environmental protection of Vietnam. The hydro-litho-dynamical processes are resulted from the interaction between land and sea such as wave, current, river discharge, SWL, and topography. To assess the hydro-litho-dynamical processes, the first work is to collect the longtime measured data of the above mentioned processes and related parameters. Therefore, longtime measured data on SWL, wave, wind, river discharge, rainfall in the Mekong River Mouth area have been collected. This paper is based on the results of analyzing of the above mentioned collected data. However, the observed wave data from Condao Station is only for referential purpose. Because, the wave observed station was

located in nearshore region, therefore, incident waves will be affected by nearshore topography and coastal morphology. This information is a useful reference to study on hydro-litho-dynamical processes and environmental protection measures in study area.

II. MATERIAL AND METHOD

1. Material

The collected data include wind, SWL, river discharge, wave, rainfall at different meteo-hydrology stations in Mekong River Mouth area such as Cantho, Mythuan, Vungtau and Condao from National Center for Meteo-hydrological Forecasting. The information of collected data and observed stations is described in Tab. 1 and Fig. 1.

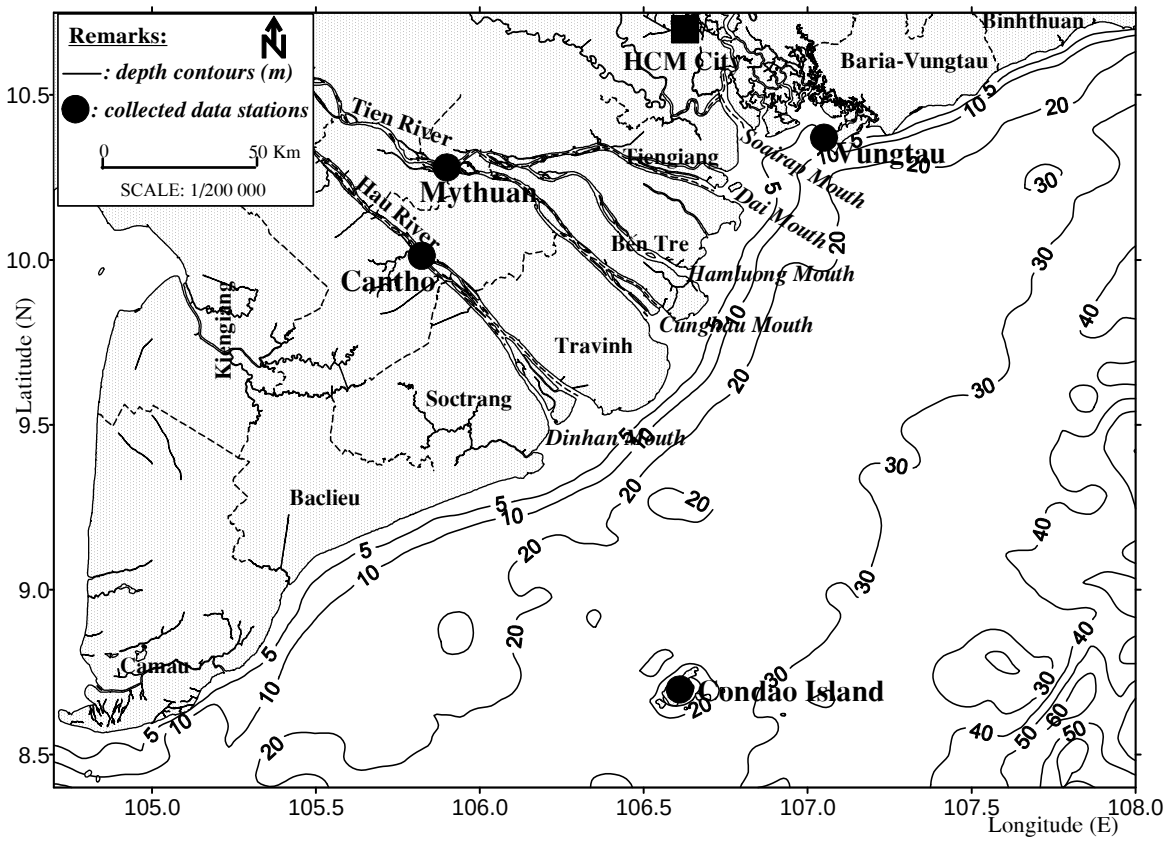


Figure 1: Study area and location of collected data stations

Table 1: Information of collected data and observed stations

Serial N_o.	Stations	Observed parameters	Longitude (E)	Latitude (N)	Remarks
1	Condao	Wind (1989 - 2008); Wave (1989 - 2007)	106^o 36’	8^o 41’	Observed at 1h, 7h, 13h, 19h for wind; and at 7h, 13h, 19h for wave
2	Cantho	Hau River Discharge (1997 - 2007) Rainfall (1989 - 2008)	105^o 47’	10^o 02’	Daily
3	Mythuan	Tien River Discharge (1997 - 2007)	105^o 54’	10^o 16’	Daily
4	Vungtau	SWL (1987 - 2006)	107^o 04’	10^o 20’	Hourly

2. Methods

- Tidal harmonic constants are calculated using least square method (Foreman, 1977).
- Extremely values of SWL are calculated using Gamble Function (CEM, 2002).
- Extremely values of wind velocity are calculated using Weibull Function (Edgar and James, 1986).

III. STUDY RESULTS

1. Wind characteristics at Condao Station

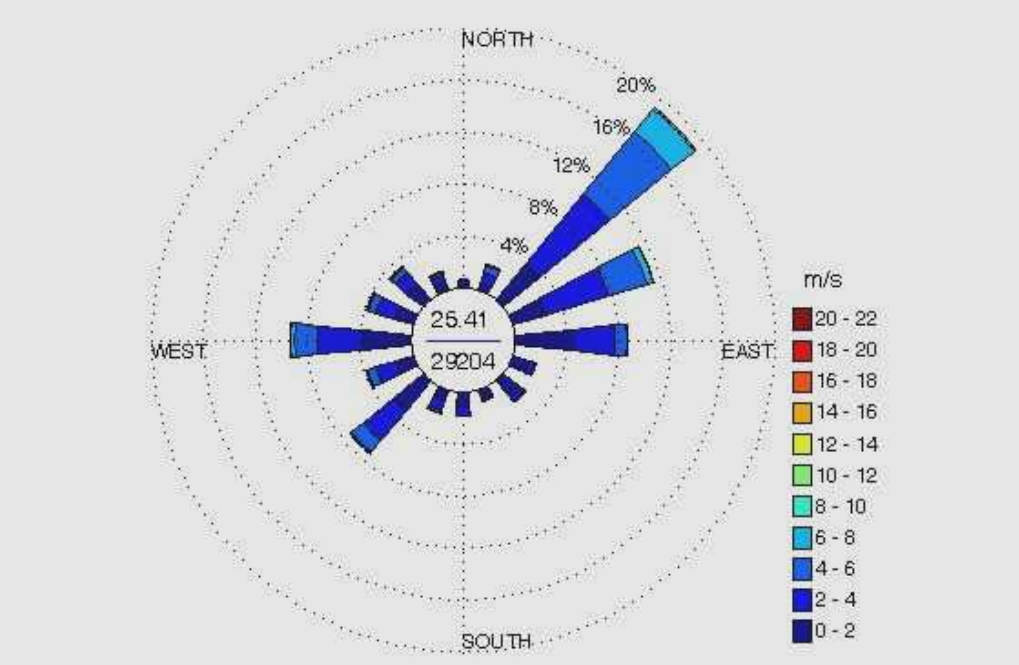
Statistical results of measured wind data at Condao Station (1989 - 2008) are shown in Tab. 2 and Fig. 2. There are two main monsoons in Condao Station, which are NE and SW. Wind directions vary in NE, NNE, ENE and E directions during NE Monsoon period; and in SW, W, SSW and WSW during SW Monsoon period. The appearance of NE Monsoon is longer than that of SW Monsoon. NE Monsoon starts in November and ends in April of the next year, greatest wind velocity occurred in December and January. SW Monsoon from June to September, greatest wind velocity occurred in July and August. Occurrence probability of NE wind direction for 20 years period is the highest (17.86%), then ENE, W, E directions with probability of 10.57%, 8.70%, 8.10% respectively. Maximum wind velocity was 21 m/s (November 2002). Most of mean velocity was less

than 4 m/s with probability of 55%. Maximum monthly wind velocity during NE Monsoon period was higher than that of SW Monsoon period. Similarity, monthly mean wind velocity during NE Monsoon was higher than that of SW Monsoon period. Maximum mean monthly wind velocity during NE Monsoon period was in December and January with NE direction. Maximum mean monthly wind velocity during SW Monsoon period was in August with W direction.

Table 2: Statistics of wind characteristics at Condao Station (1989 - 2008)

Months	**Number of data**	**Maximum wind velocity (m/s)**	**Wind directions (Times)**	**Mean wind velocity (m/s)**
1	2480	10	NE(14)	3.9
2	2260	10	NE(8); N(1); ENE(1)	3.2
3	2476	16	NE(1)	2.4
4	2400	8	NE(5); ESE(1); E(1)	1.6
5	2475	12	NW(1)	1.5
6	2400	14	W(1)	2.0
7	2478	12	W(2); WNW(1); SW(1)	2.4
8	2479	12	W(1)	2.8
9	2397	16	W(1)	2.3
10	2480	12	NW(1); NE(1)	1.6
11	2399	21	NNE(1)	3.1
12	2480	16	NE(1)	3.9
Mean		13.3		2.6
Maximum		21		3.9
Minimum		8		1.5

Notes: Times = number of occurrence



Legends: In the cycle: percent of windless (upper) and number of data (below)

Figure 2: Wind rose diagram at Condao Station (1989 - 2008)

2. Variation of Sea Water Level at Vungtau Station (1987 - 2006)

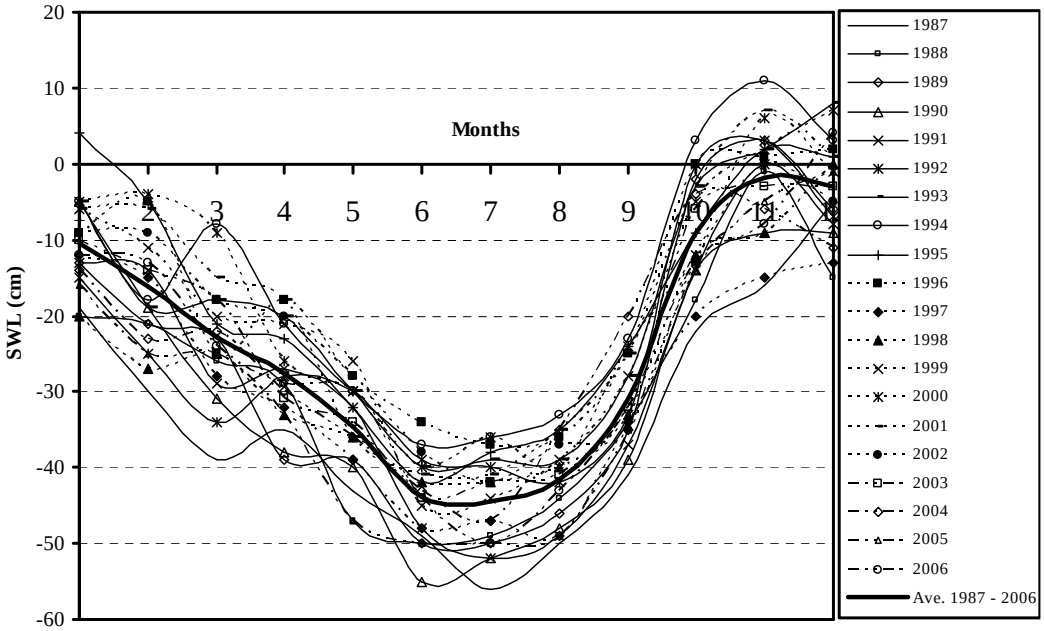


Figure 3: Variation of monthly average value of SWL at Vungtau Station (1987 - 2006)

The monthly variation of average value of SWL at Vungtau Station is described in Fig. 3. The maximum and minimum values of SWL occurred in November and June respectively. The different value is at about 45 cm. The difference shows the effect of monsoons on hydro-dynamical processes in the study area.

Table 3: Tidal harmonic constants at Vungtau Station ($107^0$04'E; $10^0$20'N)
(1987 - 2006)

No.	Components	Phased speed (degree)	Amplitude (cm)	Phased angle (degree)
1	M2	28.984	73.006	37.086
2	K1	15.041	67.993	313.770
3	O1	13.943	56.453	262.367
4	S2	30.000	29.416	79.861
5	SA	0.041	20.577	349.234
6	P1	14.959	18.558	308.714
7	N2	28.440	14.831	13.578
8	K2	30.082	12.814	91.836
9	Q1	13.399	10.378	239.583
10	SSA	0.082	6.154	93.468
11	OO1	16.139	3.589	39.602
12	NO1	14.497	3.246	342.086
13	MK3	44.025	3.170	198.820
14	J1	15.585	2.601	359.103
15	NU2	28.513	2.472	29.576
16	MO3	42.927	2.398	136.854
17	L2	29.528	2.326	63.597
18	H2	29.025	2.230	235.100
19	MU2	27.968	2.199	340.614
20	RHO1	13.472	2.128	247.223
21	2N2	27.895	2.103	345.255
22	SO3	43.943	2.010	191.511

The tidal harmonic constants are an important parameter to predict SWL, which is computed by least square method (Foreman, 1977) based on the hourly SWL data at Vungtau Station (1987 - 2006). Tab. 3 presents the first 22 main components from 68 tidal components at Vungtau Station. Results indicate that the study area is an irregular semi-diurnal tidal regime region.

Prediction of extremely values of SWL corresponding to different return periods for design and construction of hydro-structures was carried out using the Gamble Function (CEM, 2002) with different returned periods. The predicted results are shown in Tab. 3.3.

Table 4: Extremely values of SWL (cm) at Vungtau Station (1987 - 2006)
(Corresponding to "0" National level)

Repeat Periods (Years)	5	10	20	30	40	50	60	70	80	90	100
Max. (cm)	139.1	144.4	149.5	152.4	154.5	156.1	157.4	158.5	159.4	160.3	161.0
Min. (cm)	-313.6	-317.5	-320.3	-321.7	-322.5	-323.2	-323.7	-324.1	-324.4	-324.7	-324.9

Notes: "-"is minus values

3. Variation of Mekong River discharge

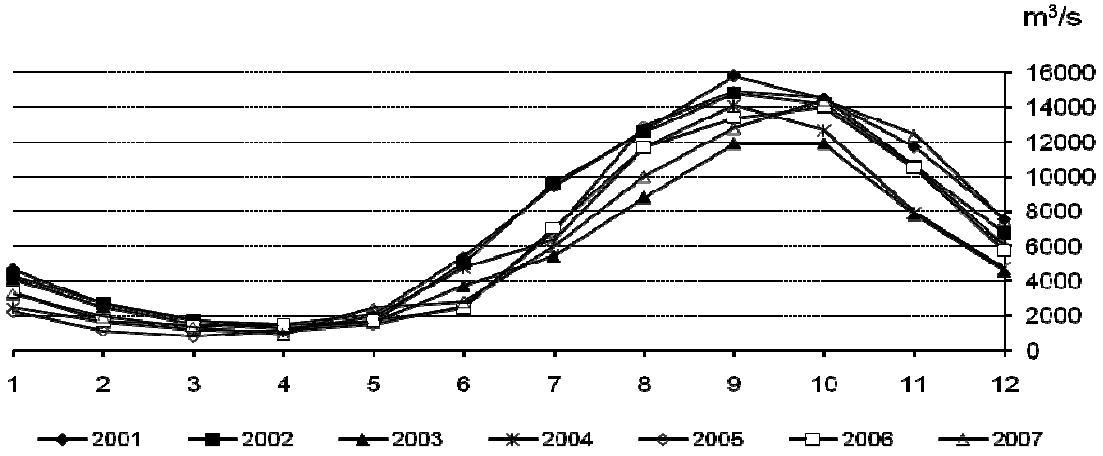


Figure 4: Variation of monthly river discharge at Mythuan Station from 2001 to 2007
(Vertical axis: River discharge; Horizontal axis: months)

Mekong River in Vietnam was divided into two main branches that are Hau and Tien Rivers. River discharge data (from 1998 to 2007) at two above mentioned river branches were collected (Mythuan Station on Tien River; Cantho Station on Hau River). Analysis results show that the variations of monthly river discharge at two stations were similarly with the peak in September and the bottom in March and April (Fig 4 and 5). In the flood season from July to December, the discharge ranges about from 4,000 to 15,800 m^3/s, in the dry season from January to June the discharge value was less than 4,000 m^3/s. The minimum value of discharge was 760 m^3/s in April 2004 at Cantho Station and 800 m^3/s in March 2005 at Mythuan Station.

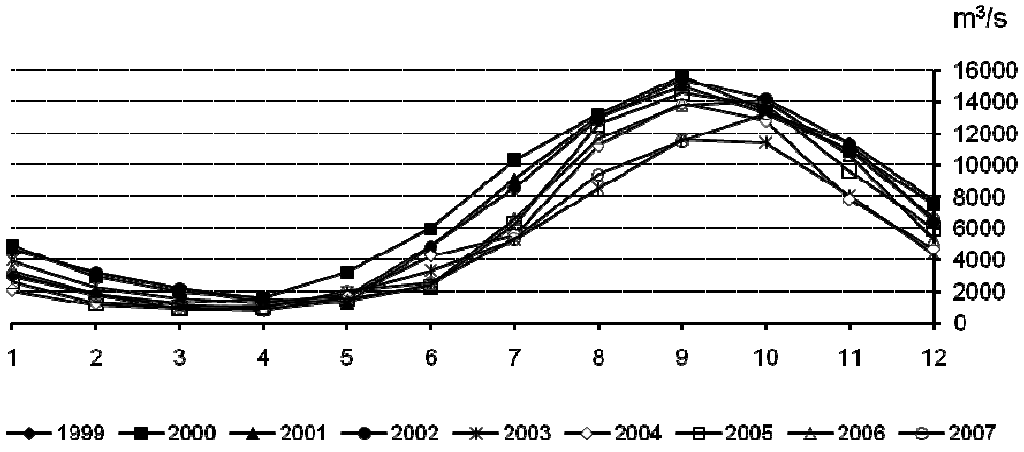


Figure 5: Variation of monthly river discharge at Cantho Station from 1999 to 2007 *(Vertical axis: River discharge; Horizontal axis: months)*

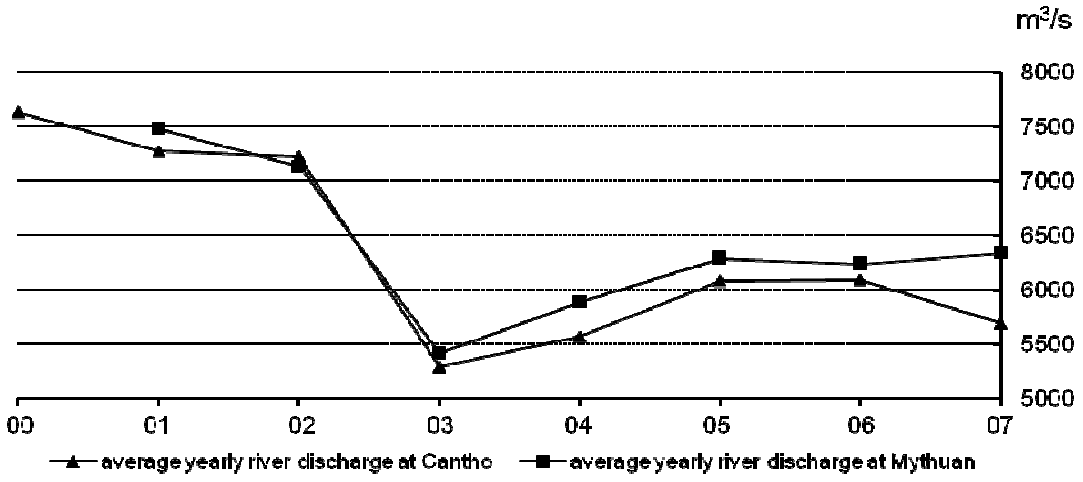


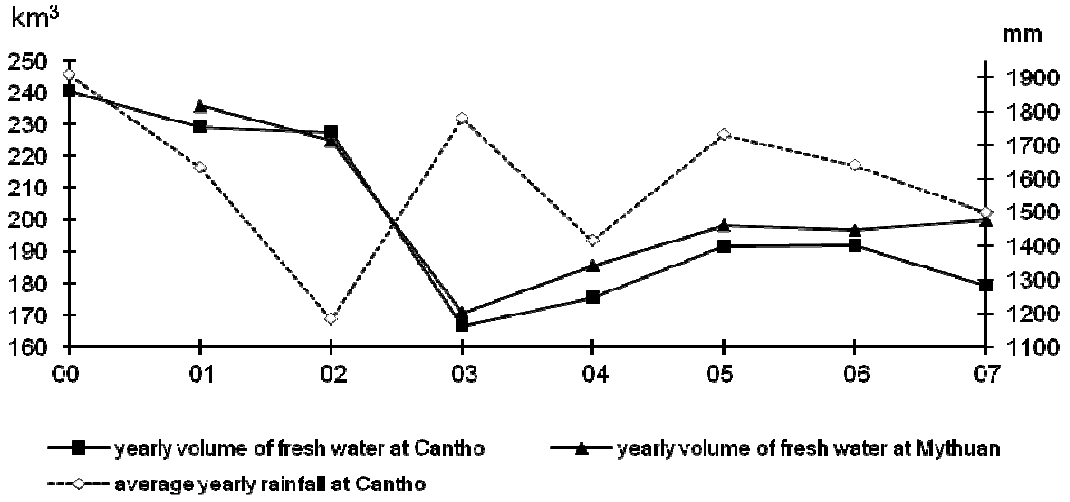
Figure 6: Variation of average yearly river discharge at Mythuan and Cantho Stations from 2000 to 2007 *(Vertical axis: River discharge; Horizontal axis: months)*

Variation of average yearly river discharge from 2003 to 2007 at both stations was also similar with discharge ranged from 5,300 to 7,600 m^3/s (Fig. 6). However, the discharge from 2000 to 2002 was larger than that of from 2003 to 2007.

The yearly volume of fresh water discharge at each station was approximately of 200 km^3 (Tab. 5). This fresh water was yearly supplied to Mekong River Mouth area.

Table 5: The yearly volume of fresh water discharge at Mythuan and Cantho Stations (From 2000 to 2007)

Years	Yearly volume of fresh water discharge	
	Mythuan (km^3/year)	Cantho (km^3/year)
2000	---	240.62
2001	235.89	229.27
2002	224.85	227.69
2003	170.93	166.83
2004	185.75	175.66
2005	198.36	191.74
2006	196.78	192.05
2007	199.94	179.44
Mean	200.41	201.79



(Notes: Horizontal axis showing the collected data years)

Figure 7: Relationship between yearly rainfall at Cantho Station (right axis) and yearly volume of fresh water discharge at Mythuan and Cantho Stations (left axis)

The correlation between yearly rainfall at Cantho Station and yearly volume of fresh water discharge at Mythuan and Cantho Stations is not significant value (Fig. 7). Because, the yearly volume of fresh water which discharges at Mythuan and Cantho Stations is not only supplied by rainfall in the Mekong River delta but also by rainfall over the whole Mekong River valleys.

4. Variation of wave characteristics

The monthly variation of wave characteristics is shown in Tab. 6. It indicates that during NE Monsoon period wave height was larger than that of SW Monsoon period. From November to March the mean wave height was ranged from 0.36 m to 0.54 m in NE direction. Whereas, from April to October the mean wave height was ranged from 0.20 m to 0.34 m with varying direction. The lowest mean wave height was occurred in May and October with the value of about 0.2 m. In general, the regimes of wave and wind in the study area are similar.

Table 6: Monthly maximum and mean values of waves at Condao Station (1989 - 2007)

Months	Maximum wave height		Mean wave height (m)
	Height (m)	Direction	
1	1.50	NE	0.53
2	1.75	NE	0.45
3	1.50	NE	0.36
4	1.25	NE	0.27
5	1.25	NW	0.20
6	1.25	W	0.24
7	1.50	SW	0.30
8	1.25	W	0.34
9	1.00	SW	0.27
10	1.25	NE	0.22
11	1.50	E	0.42
12	1.50	NE	0.54

The join distribution between wave heights and directions are shown in Fig. 8. It shows that the predominant wave directions at Condao Station during NE Monsoon period are in NE, whereas, during SW Monsoon period its direction are in SW and W.

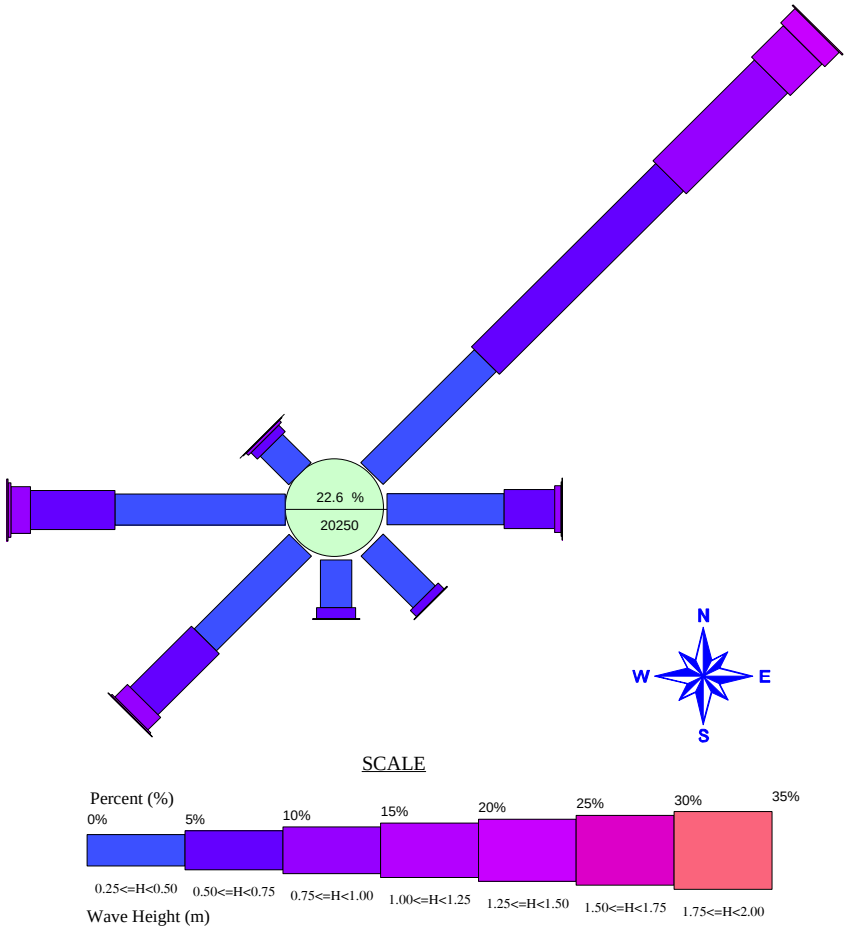


Figure 8: Wave rose diagram at Condao Station (1989 - 2007)

The highest probability of wave direction is 32.26% in NE, 14.25% in W and 12.35% in SW. The probability of the observed wave heights is 38.08% for 0.25 m to 0.5 m wave height, 26.11% for 0.5 m to 0.75 m wave height and 13.65% for wave height greater than 0.75m. (Fig. 9 and 10).

Because the location of wave measured station was in nearshore region. The measured wave data were impacted by transformation effects such as refraction, diffraction, bottom, etc. The above remarks of wave distribution features are only for reference purpose.

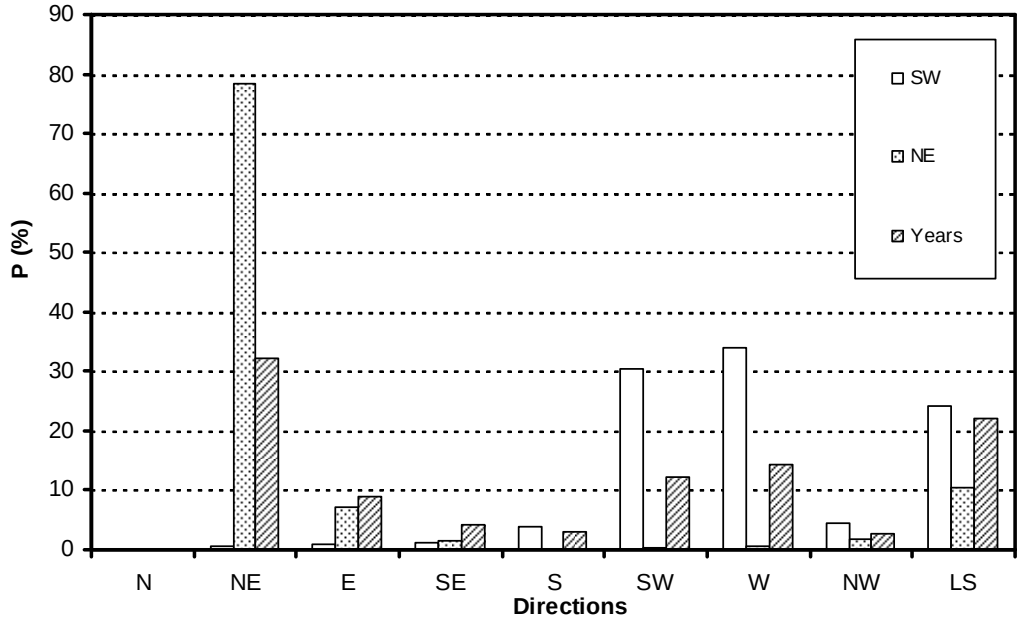


Figure 9: The probability (%) of wave directions in NE, SW Monsoons (1989 - 2007) at Condao Station

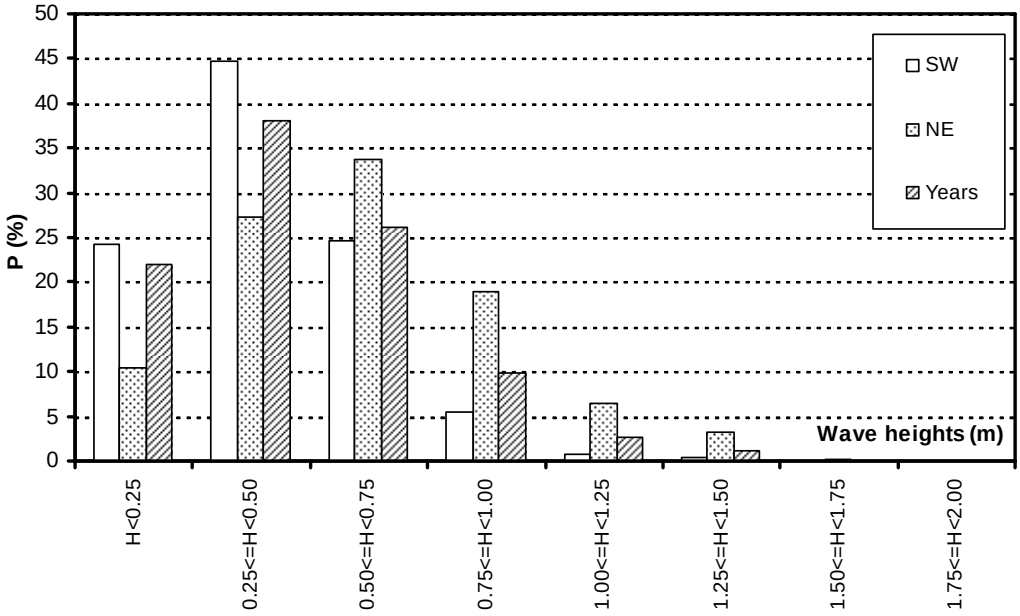


Figure 10: The probability (%) of wave heights in NE, SW Monsoons (1989 - 2007) at Condao Station

IV. CONCLUSIONS

From study results it can be stated that:

1. Distributions of wind and wave characteristics are corresponding to seasonal variation. Predominant wind and wave directions are NE during NE Monsoon period and W, SW during SW Monsoon period. During transition period the wind and wave are varying. The wind velocity and wave height during NE Monsoon period were higher than that of SW Monsoon period. Maximum wind velocity was 21 m/s and occurred in NNE direction.

2. Variation of SWL at Vungtau Station shows that maximum SWL occurred during NE Monsoon period (the highest value occurred in November), and minimum value occurred during SW Monsoon period (the lowest in June) and the tide regime is irregular semi-diurnal.

3. Variation of monthly river discharge at Mythuan and Cantho Stations was similar with a peak in September and a bottom in March and April. In the flood season from July to December, the discharge ranged from 4,000 to 15,800 m^3/s. In the dry season from January to June, discharge was less than 4,000 m^3/s. Rainfall and river discharge in Mekong River delta does not coincide.

4. The area at the Mekong River Mouth is the region of strong and complicated hydro-dynamical interaction processes between river and sea.

REFERENCES

1. **Edgar, G.P., James, J.O., 1986.** "Weibull Statistics of Wind Speed over the Ocean", Journal of Climate and Applied Meteorology, Vol. 25, 324-332pp.
2. **Foreman, M.G.G., 1977.** "Manual for tidal heights analysis and prediction", Pacific Marine Science Report 77(10), Institute of Ocean Sciences, Patricia Bay, Sidney, BC, 97pp.
3. **U.S. Army Corps of Engineers, 2002.** Coastal Engineering Manual (CEM)

MỘT SỐ ĐẶC ĐIỂM KHÍ TƯỢNG - THỦY VĂN TẠI VÙNG BIỂN CỬA SÔNG MÊ KÔNG

LÊ ĐÌNH MẦU, PHẠM SỸ HOÀN, VŨ TUẤN ANH, NGUYỄN CHÍ CÔNG, NGUYỄN BÁ XUÂN

Tóm tắt: *Bài báo cung cấp một số đặc trưng thống kê từ chuỗi số liệu đo đạc nhiều năm về các quá trình khí tượng-thủy văn tại vùng biển cửa sông Mê Kông như gió, sóng, mực nước, lưu lượng nước sông. Kết quả nghiên cứu cho thấy rằng, trường gió và trường sóng biến đổi theo hai mùa rõ rệt. Hướng gió và sóng trong thời kỳ gió mùa NE là NE và W, SW trong thời kỳ gió mùa SW. Mùa gió NE từ tháng 11 đến tháng 4 năm sau (mạnh nhất vào tháng 12 và tháng 1), mùa gió SW từ tháng 6 đến tháng 9 (mạnh nhất vào tháng 8). Mùa gió NE, tốc độ gió và độ cao sóng lớn hơn mùa gió SW. Dao động mực nước thể hiện tính chất triều bán nhật không đều với mực nước lớn nhất xuất hiện vào tháng 11 và nhỏ nhất vào tháng 6. Biến trình lưu lượng nước sông Mê Kông tại 2 trạm Mỹ Thuận và Cần Thơ là giống nhau. Mùa lũ (từ tháng 7 đến tháng 12) giá trị lưu lượng trung bình tháng dao động trong khoảng 4.000 m^3/s - 15.800 m^3/s. Vào mùa kiệt (từ tháng 1 đến tháng 5) lưu lượng trung bình tháng tại hai trạm ít khi vượt quá 4.000 m^3/s. Những dữ liệu thống kê trên chỉ rõ vùng biển cửa sông Mê Kông là khu vực có các quá trình tương tác thủy động lực học mạnh mẽ và phức tạp giữa sông và biển.*

Từ khóa: *Gió mùa, đông bắc (NE), tây nam (SW), mực nước biển (SWL), lưu lượng nước sông, sông Mê Kông.*

Ngày nhận bài: 25 - 10 - 2010

Người nhận xét: TS. Võ Lương Hồng Phước