



WATER QUALITY OF CO CHIEN ESTUARY, TIEN RIVER

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Abstract

The Cuu Long delta is affected strongly by mass water from rivers of the MeKong river system such as Tieu, Dai, Ham Luong, Co Chien, Cung Hau, Dinh An and Tranh De (Hau river). The estuaries of Cuu Long delta are large with a huge amount of sediment (about 100 million tons per year) and high tide (about 4.2m) made the large tidal flats with high level of biodiversity, which is an important resource for aquaculture. With the aim of serving the sustainable development of the local fishing and aquaculture industry, in this study, water quality at the Co Chien estuary was surveyed 3 times from June 2017 to June 2018. The results showed that water quality at Co Chien was polluted by organic matter, heavy metal and total oil.

Keywords: Co Chien estuary; Water quality; Physio-chemical parameters

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1. Introduction

Co Chien river is the southern branch of Tien river, which belongs to the Cuu Long river system. Co Chien river starts from Vinh Long city, Vinh Long province, flows through Tra Vinh and finishes at 2 estuaries: Cung Hau estuary (Tra Vinh province) and Co Chien estuary (Ben Tre province) [1]. Co Chien river in general, Co Chien estuary in particular has had a very important position for the fishing and aquaculture industry in the region. In addition to the socio-economic development in recent years, the quality of the water environment and ecosystems in this water body have fluctuated. With the aim of serving the sustainable development of the local fishing and aquaculture industry, water quality at Co Chien estuary was studied in the period from June, 2017 to June, 2018.

2. Subjects and methods

2.1. Subjects, sampling points and times

2.1.1. Subjects

Physico-chemical parameters of water include: Temperature, pH, Conductivity, Salinity, Turbidity, Dissolve Oxygen (DO), Chemical oxygen demand (COD), Biological Oxygen Demand (BOD₅); nutrition parameters: NH₄-N; NO₃-N, PO₄³-P, SiO₃-Si; heavy metals: As, Hg, Fe, Zn, Cu, Cd, Pb, Mn and total oil in surface water of Co Chien estuary.

2.1.2. Sampling points

Sampling points and coordinates were shown in Fig. 1 and Tab. 1, sampling points from CC1 to CC5 belong to Thanh Phong commune, Thanh Phu district, Ben Tre province, and points CC6 to CC8 belong to Long Hoa commune, Chau Thanh district, Tra Vinh province.



Figure 1: Diagram of sampling points

(Source: google map)

Table 1. Coordinates of sampling points

Point	Latitude	Longitude
CC1	9°47'33.16"N	106°37'50.54"E
CC 2	9°47'27.51"N	106°36'47.27"E
CC 3	9°48'19.02"N	106°36'17.07"E
CC 4	9°49'27.83"N	106°35'13.08"E
CC 5	9°51'57.80"N	106°32'46.31"E
CC 6	9°51'07.93"N	106°32'27.79"E
CC 7	9°50'49.71"N	106°32'46.96"E
CC 8	9°50'24.28"N	106°32'43.37"E

2.1.3. Samping time

Phase 1: 10 - 16 Jun 2017; Phase 2: 31 Oct - 7 Nov 2017; Phase 3: 5 - 12 Jun. 2018

2.2. Research methods

2.2.1. Field research

- Parameters: Temperature, pH, DO, Conductivity, Salinity, Turbidity were determined by Water quality checker (WQC - 22A, of TOA company, made in Japan).

- $\text{NH}_3\text{-N}$ (ammonia), $\text{NO}_3\text{-N}$ (nitrate), $\text{PO}_4^{3-}\text{-P}$ (phosphate) were determined by Test Sera made Germany at the field by reagents.

- Water samples were collected by standard method of TCVN 5998:1995 (ISO 5667-9:1987) [2].

- Water samples to determine heavy metals (As, Hg Fe, Zn, Cu, C, Pb and Mn) were acidified with HNO_3 65% to pH <2.

- Phytoplankton samples: Using phytoplankton net to collect the sample. With quantitative sample: Filter 20 liters of river water through phytoplankton net.

2.2.2. Laboratory research

- As and Hg were determined by SMEWW 3125:2012 method, and analysis on the ICP-MS (model Elan DRCE, Perkin Elmer) [3].

- Fe, Zn, Cu, Cd, Pb, Mn were determined by SMEWW 3111B:2012 method and analysis on the atomic absorption spectrometer AAS-A6800 [3].

- Total oil was determined by SMEWW 5520B:2012 [3] method.

- COD was determined by Kalium pemanganat method of TCVN 4565 - 1988 [4], BOD_5 by TCVN 6001-2:2008 [5]. $\text{NO}_2\text{-N}$ by photometric method with Griss reagent[6]; Silicate dissolve SiO_3^{2-} by splitting method (CFA và FIA) and measure by TCVN 9244:2012 [7].

2.2.3. Data processing methods

- The statistics were processed by Excel

- Parameters of water were compared with the standard: QCVN 10 - MT: 2015/BTNMT

- National technical regulation of water quality of marine [8].

3. Results and disscussion

3.1. Basic physico-chemical parameters

Research results showed that: Temperature in the water in phase 2 (ranged from 23.4 to 26.1°C) was lower than phase 1 (ranged from 27.3 to 28.9°C) and phase 3 (from 28.2 to 30.3°C) (Table 2).

pH ranged from 7.1 to 8.5. This result was suitable for aquaculture and aquatic conservation based on the standard QCVN 10 - MT: 2015/BTNMT.

Table 2. Basic physico-chemical parameters

		pH	Salinity ‰	Turbidity (mg/l)	DO (mg/l)	BOD ₅ (mg/l)	COD (mg/l)	NO ₃ -N (mg/l)	NH ₄ -N (mg/l)	PO ₄ -P (mg/l)
CC1	Min	7.4	10	10	4.64	1.75	40	0.2	0.1	0.2
	Max	8.5	15.3	116	5.84	32.6	47.2	5.5	0.25	1.0
CC2	Min	7.1	10	10	4.29	1.95	5.6	5.0	0.1	0.3
	Max	8.3	17.5	617	5.2	7.2	42.4	5.5	0.3	1.2
CC3	Min	7.4	10	8.69	4.02	3.29	9.6	0.2	0.1	0.4
	Max	7.9	17.0	247	5.11	5.68	41.6	5.0	0.4	1.5
CC4	Min	7.4	8.6	13	4.10	1.15	5.6	2.0	0.1	0.25
	Max	8.1	10	200	5.2	3.4	35.2	5.0	0.7	1.8
CC5	Min	7.1	2.0	20	4.02	2.85	8.5	2.0	0.1	0.25
	Max	7.75	6.5	320	5.42	8.0	46.4	4.5	0.5	2.0
CC6	Min	7.1	2.0	19	4.22	1.25	7.2	2.0	0.2	0.05
	Max	7.83	9.0	711	6.34	9.2	44.8	5.0	0.6	2.0
CC7	Min	7.7	4.0	21	4.44	2.05	16.0	2.0	0.1	0.5
	Max	7.84	8.8	236	6.72	12.4	46.4	5.0	0.7	1.6
CC8	Min	7.1	6.0	18	4.22	3.45	14.4	2.0	0.1	0.2
	Max	7.96	15	473	5.71	6.8	42.4	5.0	0.6	1.5
QCVN 10-MT:2015*		6.5 - 8.5			≥5				0.1	0.2

QCVN10-MT:2015*: The National technical regulation for sea water quality, limited value applied for aquaculture and aquatic conservation.

Salinity ranged from 2.0 ‰ to 17.5‰. In which, salinity of phase 3 was the highest with average 11.03 ± 3.2 , phase 2 was 10.13 ± 5.6 ‰ and phase 1 was the lowest 7.88 ± 4.7 ‰ (Tab. 2). Salinity at CC1, CC2, CC3, CC4 and CC8 points (position near the sea) were higher than at CC5, CC6 and CC7 in three phases (Tab. 2, Fig. 1, Fig. 2). The increased salt concentration in phase 3 may be related to saline intrusion into the continent.

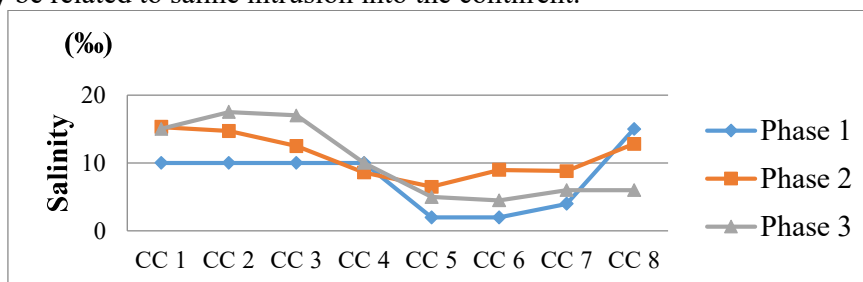


Figure 2: Salinity at the sampling points

Water turbidity was different among sampling points, ranging from 8.69 mg/l to 617 mg/l. Average water turbidity of phase 2 was 2.28 times higher than phase 1 and 19.7 times higher than phase 3 (table 3.1).

Dissolved Oxygen (DO) concentration in the water at Co Chien estuary was different among 3 phases. Phase 1: DO ranged from 4.22 to 5.26 mg/l, DO at CC1, CC2 and CC4 was suitable for aquaculture and conservation aquatic life. Phase 2: DO (from 4.02 to 4.46 mg/l) was not suitable for aquaculture and conservation aquatic life at all sampling points. Phase 3, DO in most of sampling points (from 4.46 mg/l to 6.72 mg/l) was suitable for aquaculture and conservation aquatic life (based on the QCVN 10-MT- 2015/BTNMT) (Table 2).

BOD₅ in the water of Co Chien estuary ranged from 1.25 to 32.6 mg/l, with an average of 5.68 mg/l. The average BOD₅ of phase 1 (10.16 ± 9.56 mg/l) was 4 times higher than phase 2 (2.57 ± 1.25 mg/l) and 2.37 times higher than phase 3 (4.32 ± 2.09 mg/l). The large value of BOD₅ at CC1 in phase 1 is the main cause of this discrepancy (Table 2).

COD in all sampling points of 3 phases ranged from 5.6 to 47.2 mg/l, with the average of 27.36 ± 15.88 mg/l. Average COD of phase 2 (42.3 ± 3.7 mg/l) was 1.76 times higher than phase 3 (24.06 ± 14.66 mg/l) and 2.69 times higher than phase 1 (15.72 ± 13.3 mg/l) (Table 2).

3.2. Concentration of nutrition of Co Chien estuary

$\text{NO}_3\text{-N}$ in this area ranged from 0.2 to 5.5 mg/l. $\text{NO}_3\text{-N}$ average of phase 2 (5.0 ± 0.27 mg/l) was 2.17 times higher than phase 1 (2.3 ± 1.84 mg/l) and 1.43 times higher than phase 3 (3.5 ± 1.44 mg/l).

The average of $\text{NH}_4\text{-N}$ concentration of phase 1 and phase 3 ranged from 0.1 to 0.3 mg/l, while this parameter of phase 2 was from 0.2 to 0.7 mg/l (2.38 times higher than phase 1 and 3.57 times higher than phase 3). The average of $\text{NH}_4\text{-N}$ of phase 2 was also 5 times higher than the limit value of the standard QCVN 10-MT:2015/BTNMT.

The average $\text{PO}_4\text{-P}$ of phase 2 was (1.53 ± 0.32 mg/l) 1.17 times higher than phase 1 (1.31 ± 0.33 mg/l), 5.66 times higher than phase 3 and 7.65 times higher than the limited value of the standard QCVN 10 - MT: 2015/BTNMT (Table 2).

$\text{SiO}_3\text{-Si}$ concentration in study area ranged from 2.06 to 4.29 mg/l: average value of phase 1 was 3.43 ± 0.64 mg/l; phase 2: 3.21 ± 0.36 mg/l; and phase 3: 3.26 ± 0.83 mg/l) (Fig. 3).

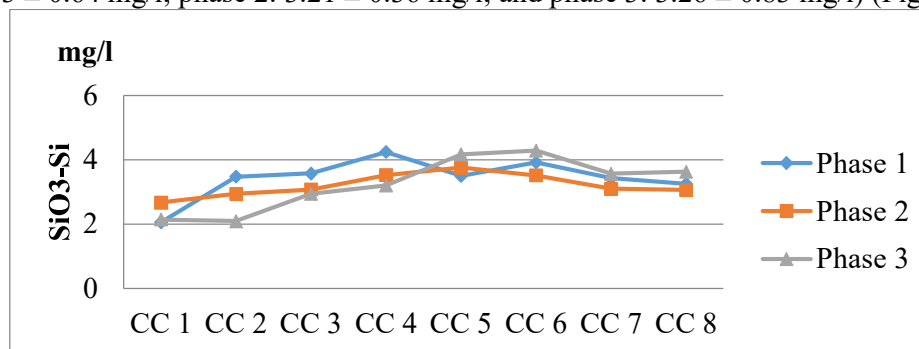


Figure 3: $\text{SiO}_3\text{-Si}$ concentration in the water at Co Chien estuary

3.3. Concentration of some heavy metals in the water at Co Chien estuary

Arsenic concentration at all points of phase 1 and phase 2 were higher than the limited value of the standard QCVN 10-MT: 2015/BTNMT; Fe and Zn level at some points were higher than the limited value of the standard QCVN 10-MT: 2015/BTNMT (Table 3).

**Table 3. Concentration of some heavy metals in water at Co Chien estuary
(P1, P2, P3: phase 1; phase 2; phase 3)**

Points	As (mg/l)			Fe (mg/l)			Zn (mg/l)			Cu (mg/l)		
	P1	P 2	P 3	P1	P 2	P 3	P1	P 2	P 3	P1	P 2	P 3
CC1	0.137	0.159	<0.002	1.40	2.26	1.031	3.89	4.95	1.391	0.246	0.337	0.024
CC2	0.184	0.115	<0.002	1.56	1.89	0.804	3.67	4.18	1.204	0.221	0.291	0.018
CC3	0.216	0.208	<0.002	3.20	3.72	0.904	3.58	5.26	1.511	0.17	0.214	0.073
CC4	0.192	0.273	<0.002	4.76	3.18	1.257	3.21	4.43	0.938	0.128	0.157	0.105
CC5	0.250	0.307	<0.002	5.31	3.35	2.059	3.13	5.74	1.385	0.114	0.236	0.037
CC6	0.177	0.208	<0.002	4.10	5.84	0.878	3.04	4.90	1.008	0.089	0.123	0.055
CC7	0.143	0.124	<0.002	8.24	4.41	1.761	2.91	4.56	1.024	0.075	0.182	0.042
CC8	0.169	0.201	<0.002	7.94	6.86	2.093	3.72	4.62	1.197	0.05	0.261	0.027
Average	0.19 ± 0.05			3.28 ± 2.24			3.14 ± 1.56			0.14 ± 0.09		
QCVN 10-MT 2015*	0.02			0.5			0.5			0.2		

QCVN10-MT:2015*: The National technical regulation for sea water quality, limited value applied for aquaculture and aquatic conservation.

Arsenic concentration in the water of Co Chien estuary was different among phases: This value ranged from 0.137 to 0.25 mg/l in phase 1 and from 0.115 to 0.307 mg/l in phase 2. Comparing to the QCVN10-MT:2015/BTNMT applied for aquaculture and aquatic conservation, arsenic level in both phases was 6.85 to 15.35 times higher than the limite of the standard.

Zn and Fe concentration of all sampling points of three phases were higher than the limited value of the QCVN10-MT:2015/BTNMT applied for aquaculture and aquatic conservation (Table 3). Especially, Fe ranged from 1.06 to 16.48 times higher than the limited of this standard and tended to increase from sea to river (Table 3).

Zn (from 0.938 to 5.74 mg/l) ranged from 1.87 to 11.4 times higher than QCVN10-MT:2015/BTNMT applied for aquaculture and aquatic conservation. Zn at phase 3 (1.21 ± 0.21 mg/l) was lower than phase 1 (3.39 ± 0.33 mg/l) and phase 2 (4.83 ± 0.53 mg/l).

In addition, Cu concentration at CC1 and CC2 sampling ponits in phase 1 and phase 2 was higher than QCVN10-MT:2015/BTNMT applied for aquaculture and aquatic conservation (Table 3).

3.4. Concentration of total oil in the water at Co Chien estuary

Concentration total oil in the water at Co Chien estuary was ranged from 0.5 to 9.0 mg/l, the average total oil was 3.56 ± 1.92 mg/l (2.4 to 18 times higher than the limited value of the QCVN10-MT:2015/BTNMT applied for aquaculture and aquatic conservation). The average total oil increased from phase 3 (2.93 ± 1.14 mg/l) to phase 1 (4.3 ± 2.56 mg/l) and from sea to river (Table 3).

4. Conclusion

The water of Co Chien estuary has shown pollution caused by organic material, some heavy metals and oil.

- *Organic pollution*: $\text{NH}_4\text{-N}$ ranged from 0.1 to 0.7 mg/l, higher 2 to 7 time than the limited value of the QCVN 10-MT:2015/BTNMT. $\text{PO}_4\text{-P}$ ranged 0.02 to 2.0 mg/l higher 1 to 10 times than the limited value of the QCVN 10 - MT: 2015/BTNMT for aquaculture and aquatic conservation, and $\text{PO}_4\text{-P}$ concentration of phase 2 > phase 1 > phase 3.

- *Heavy metals pollution*: Concentration of Arsenic (As), Iron (Fe) and Zinc (Zn) in the water of Co Chien estuary were higher than the limited value of QCVN 10 - MT: 2015/BTNMT for aquaculture and aquatic conservation from 1.87 to 16.48 times.

- *Oil pollution*: Total oil in the water of Co Chien estuary ranged 0.5 to 9.0 mg/l, average 3.56 ± 1.92 mg/l, higher 2.4 to 18 times than the limited value of QCVN 10 - MT: 2015/BTNMT for aquaculture and aquatic conservation. Total oil concentration has tendency to increase from sea to river.

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