



# Variation of Some Marine Environmental Factors in Can Gio, Ho Chi Minh, South Vietnam

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**Abstract:** The paper presents the results of monitoring some basic environmental factors in the Can Gio environmental monitoring station in the period 2009-2019. The environmental parameters like temperature, salinity and pH, total suspended solids, dissolved oxygen, biochemical oxygen demand, nutrient concentrations ( $\text{NH}_4^+\text{-N}$ ,  $\text{PO}_4^{3-}\text{-P}$ ) were collected and analyzed twice a month (both of high tide and low tide). Based on the results at the two monitoring stations, the coastal water quality in the study area changes seasonally, especially depends on the tide. The combination of rainy season and the low tide created a falling in the parameters of salinity and dissolved oxygen, whereas total suspended solids was high. Water temperature was found to be in the range of 27-30.6°C; salinity ranged between 20 and 29.5‰. The pH were found to be neutral and had decreasing features in recent years, whereas salinity was opposite. The recorded variation dissolved oxygen concentration in the study area was 3.9–5.9  $\text{mg.l}^{-1}$ , with the lowest level at low tide. Generally, the environment in the study area was not polluted yet. However, at Long Hoa station C2, the value of biochemical oxygen demand, phosphate and ammonia were higher than these which in Cau Den station C1. This shows that Can Gio area has a potential risk of partial pollution.

**Keywords:** Environment, Monitoring, Can Gio, Vietnam

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## 1. Introduction

Can Gio is the only coastal district of Ho Chi Minh city, located in the Southeast, about 50 km from the city center. Can Gio approaches the East Sea, where mangroves are luxuriant with many endemic species of flora and fauna in the coastal region of Vietnam [5]. Currently, the socio-economic development in the areas of Ho Chi Minh, Vung Tau city, and Dong Nai province is actively happening, Can Gio is directly influenced by the Sai gon and Dong Nai rivers, deep-water ports, transportation activities, tourist service areas. Since 2018, the People's Committee of Ho Chi Minh city has approved the planning project of Can Gio marine urban tourism, with an area of 2,870 hectares in Long Hoa commune and Can Thanh town, Can Gio district [2]. In recent years, aquaculture activities have been increasing in Can Gio. Besides the economic benefits, aquaculture has the

risk of affecting water resources and ecosystems [15]. Some investigations into natural resources and the environment, forecasting of the impacts of industries, fishing activities on water quality in Can Gio area are mentioned in previous studies [6, 8-13]. The Can Gio Mangrove Biosphere Reserve has its own distinctive features, always potentially partial pollution risk [14]. In order to conserve biodiversity in the Can Gio mangrove area, it is necessary to coordinate closely with research institutions and local government in implementing environmental quality monitoring. Can Gio environmental monitoring station is responsible for monitoring a number of marine environmental factors in Can Gio, Ho Chi Minh city. This paper presents some basic environmental monitoring results in the period 2009 - 2019. These data have contributed a part to the management of environmental protection in the south of Ho Chi Minh city.

## 2. Material and Methods

### *Study site:*

The study sites selected for this investigation were Cau Den (C1) at latitude  $10^{\circ}25.235'N$ , longitude  $106^{\circ}57.530'E$ , and Long Hoa (C2), at latitude  $10^{\circ}22.662'N$ , longitude  $106^{\circ}52.479'E$ , located in Can Gio, Ho Chi Minh city,

Vietnam (Figure 1). The sampling was carried out at Cau Den station (C1) for a period of eleven years from 2009 - 2019 and station Long Hoa (C2) for a period of one year from April to September 2019. The average depth of C1 is about 6 m (spring tide). Station C2 is positioned at 12.4 km away from station C1 and the average depth is 5 m (spring tide). The bottom of two stations is muddy.

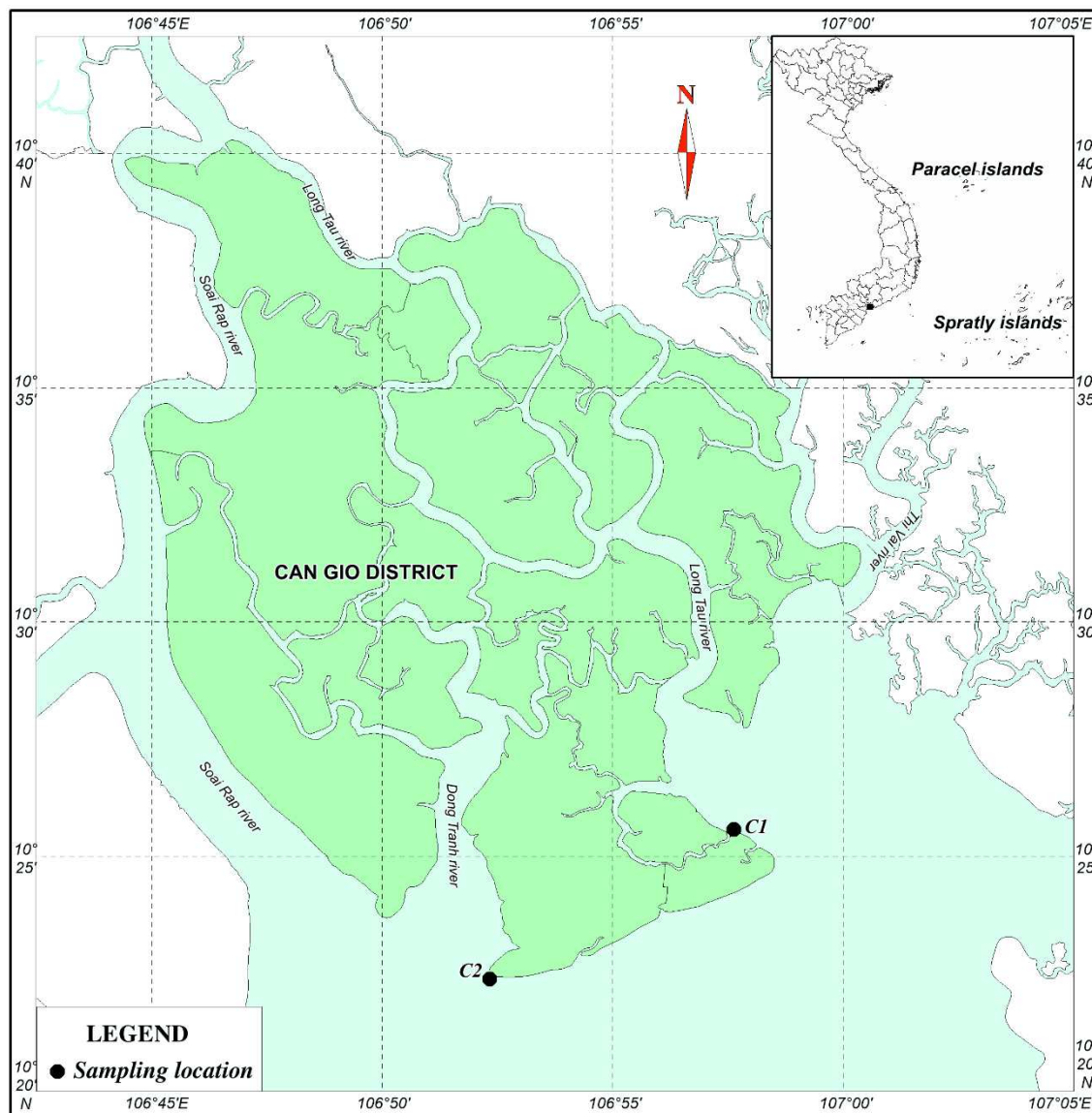


Figure 1. Map showing the sampling locations in Can Gio.

### *Water sample collection and analysis:*

The water samples were collected twice a month (both of high tide and low tide), using 5 L plastic vertical water sampler. The environmental basic parameters like temperature, salinity and pH were recorded at the field itself using Multi-parameters Gauge (YSI Professional Plus, USA). Dissolved oxygen was measured by Winkler's titrimetric method [7]. For the analysis of total suspended solids (TSS), biochemical oxygen demand (BOD), nutrient concentrations ( $NH_4^+-N$ ,  $PO_4^{3-}-P$ ) water samples were treated and measured according to APHA [1]. National technical regulation on

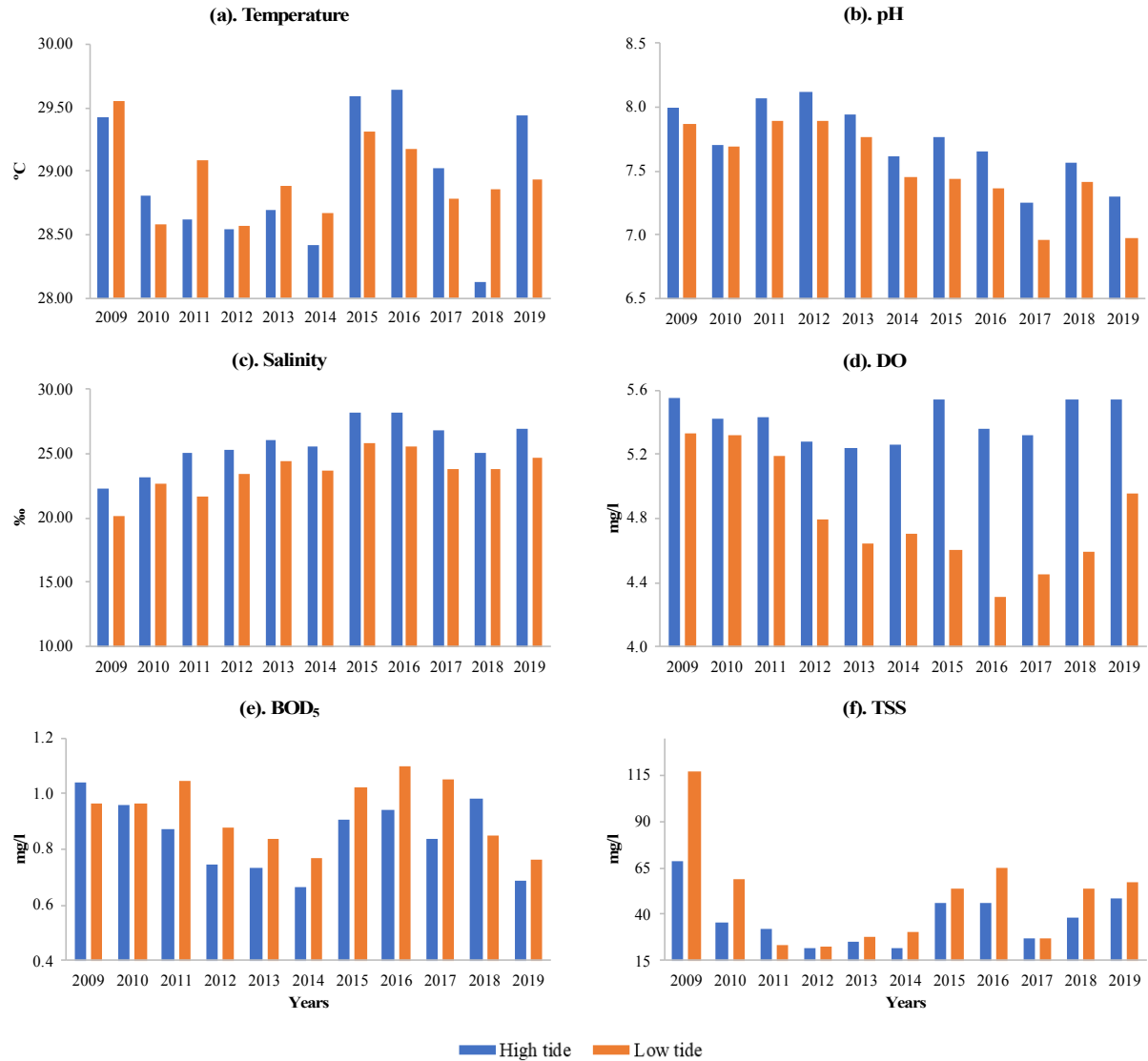
marine water quality, 2015 [4, 5] were used as references for accessing the environmental quality. Rainfall data were obtained from Southern regional hydro-meteorological center, the rainy season is from May to October and the dry season is from November to April next year.

## 3. Results and Discussions

The results of the monitoring data of some basic water environmental factors in the period from 2009 to 2019 at station C1 were gained, as shown in table 1. Not much

variation was observed in the values of environmental factors between the high tide and low tide except salinity, dissolved oxygen and total suspended solids. Water temperature was found to be in the range of 27-30.6°C. The maximum (30.6°C) was notice at high tide in 2016 and minimum (27°C) at low tide. Salinity ranged between 20 and 29.5‰,

recording the maximum 29.5‰ at high tide and minimum 20‰ at low tide. Salinity was low in 2009 and had increasing trends in recent years, reaching the highest level in 2016. pH in water was ranged between 6.9 and 8.1. Generally, pH had decreasing features in recent years, with the lowest pH in 2017 and highest in 2012.



**Figure 2.** Yearly variations in average physico-chemical characteristics of Can Gio coastal waters during 2009-2019 at station C1. (a). Temperature, (b). pH, (c). Salinity, (d). DO, (e). BOD<sub>5</sub>, (f). TSS.

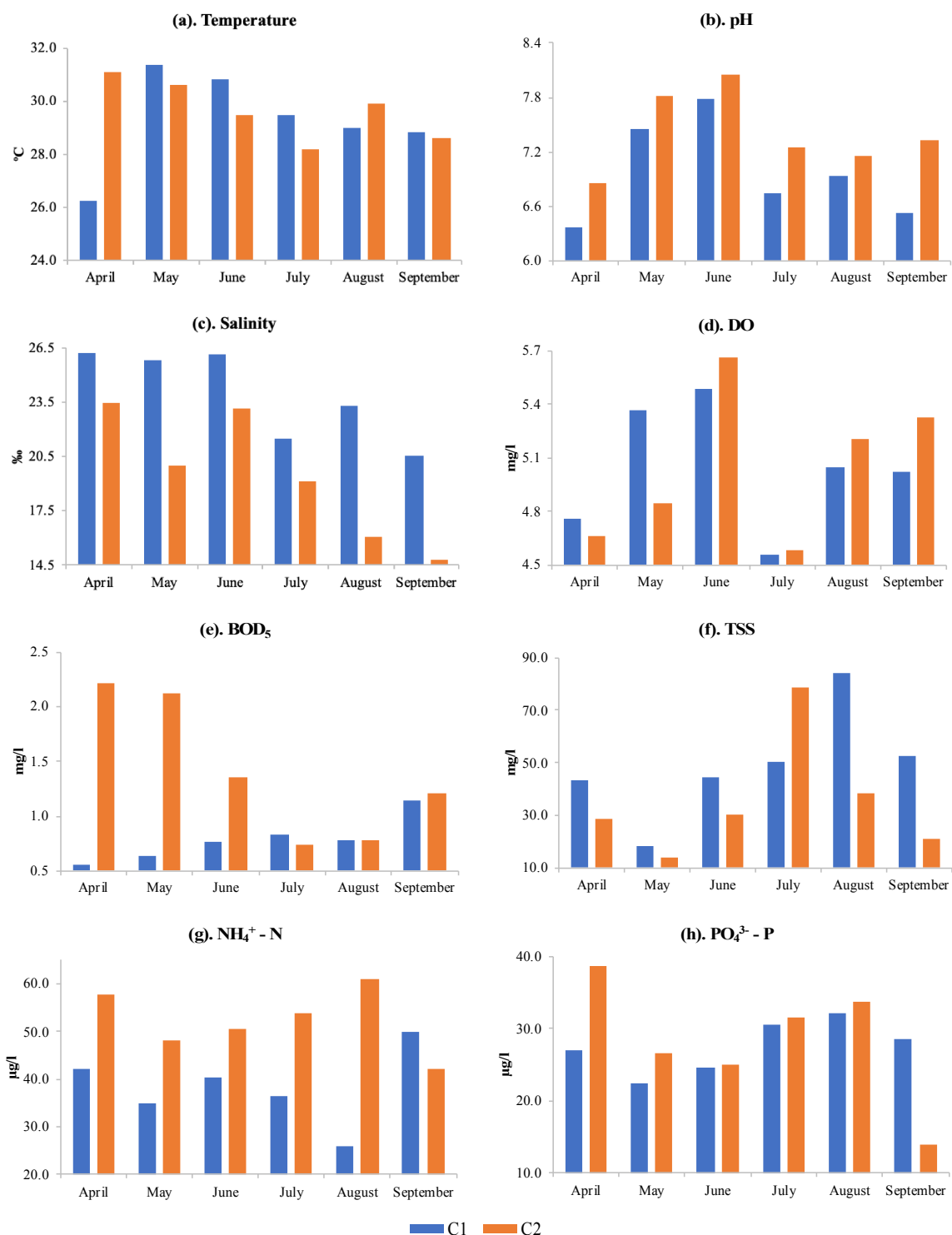
**Table 1.** Annual average value in physico-chemical characteristics of Can Gio coastal waters during 2009 – 2019 at station C1.

Phase	Value	Temperature (°C)	Salinity (‰)	pH	DO (mg/l)	BOD <sub>5</sub> (mg/l)	TSS (mg/l)
High tide	Average	28.9	25.95	7.67	5.41	0.99	61.8
	Max	30.6	29.5	8.1	5.9	1.81	137.1
	Min	27.6	22.3	7.2	4.6	0.61	21.6
	n	240	240	240	240	240	240
	SD	0.76	2.11	0.24	0.32	0.34	34.91
Low tide	Average	28.9	23.7	7.50	4.70	0.92	66.3
	Max	31.2	28.0	7.9	5.3	1.63	163.1
	Min	27.0	20.0	6.9	3.9	0.64	23.0
	n	240	240	240	240	240	240
	SD	0.82	2.08	0.26	0.39	0.21	36.48
Standard	-	-	-	6.5 - 8.5 (*)	≥ 5 (*)	4 (**)	50 (*)

(\*) QCVN 10-MT: 2015; (\*\*) QCVN 08-MT: 2015.

The recorded variation in dissolved oxygen concentration in the study area was 4.6–5.9 mg.l<sup>-1</sup> at high tide and from 3.9–5.3 mg.l<sup>-1</sup> at low tide. Not much variation was observed in dissolved oxygen concentration at high tide. Dissolved oxygen concentration at low tide had decreasing trends in recent years, and the minimum (3.9 mg.l<sup>-1</sup>) was recorded in

2016. Biochemical oxygen demand ranged between 0.61 and 1.81 mg.l<sup>-1</sup>. Total suspended solids fluctuate strongly between two tidal phases, total suspended solids at low tide changes higher than at high tide, with a maximum values of 163.1 mg.l<sup>-1</sup> at low tide and a minimum of 21.6 mg.l<sup>-1</sup> at high tide (Table 1, Figure 2).



**Figure 3.** Monthly variation in average physico-chemical characteristics of Can Gio coastal waters in 2019 at stations C1 and C2. (a). Temperature, (b). pH, (c). Salinity, (d). DO, (e). BOD<sub>5</sub>, (f). TSS, (g). NH<sub>4</sub><sup>+</sup>-N, (h). PO<sub>4</sub><sup>3-</sup>-P.

**Table 2.** Annual average in physico-chemical characteristics of Can Gio coastal waters in 2019 at stations C1 and C2.

Stations	Value	Temp. (°C)	Salinity (‰)	pH	DO (mg/l)	BOD <sub>5</sub> (mg/l)	TSS (mg/l)	NH <sub>4</sub> <sup>+</sup> -N (µg/l)	PO <sub>4</sub> <sup>3-</sup> -P (µg/l)
(C1)	Average	29.3	23.9	6.97	5.04	0.79	48.87	38.25	27.58
	Max	31.4	26.3	7.8	5.5	1.14	84.40	50.00	32.10
	Min	26.3	20.6	6.4	4.6	0.55	18.05	26.00	22.40
	n	6	6	6	6	6	6	6	6
	SD	1.79	2.51	0.55	0.35	0.20	21.36	8.00	3.65
(C2)	Average	29.7	19.5	7.41	5.05	1.41	35.12	52.15	28.30
	Max	31.1	23.5	8.1	5.7	2.22	78.60	61.00	38.80
	Min	28.2	14.8	6.8	4.6	0.74	13.70	42.00	14.00
	n	6	6	6	6	6	6	6	6
	SD	1.12	3.57	0.45	0.42	0.64	22.91	6.84	8.57
Standard		-	-	6.5 - 8.5 (*)	≥ 5 (*)	4 (**)	50 (*)	100 (*)	200 (*)

(\*) QCVN 10-MT: 2015; (\*\*) QCVN 08-MT: 2015.

Variations in physico-chemical characteristics of the Can Gio in 2019 at two stations C1 and C2 are shown in table 2 and figures 3. Temperature varied from 26.3 to 31.4°C. The maximum (31.4°C) was notice at station C1 in rainy season and minimum (26.3°C) in the end of dry season at station C1. The water temperature decreased from June to September because of the low solar radiation and freshwater incursion, the temperature was low in September because of high rainfall, the highest monthly rainfall was approximately 240 mm.

Salinity ranged from 14.8–26.3‰. During July - September, heavy rain fall and a large amount of fresh water inflow from land reasonably reduced the salinity, specially, station C2 is affected in the estuary area. The salinity was found to be high during April - June at station C1. pH value was ranged between 6.4 and 8.1. The pH were found to be alkaline at both the stations with high value during May – June. The recorded high pH in May – June might be due to the influence of seawater incursion (high tide). During April, July – September pH values were neutral. Generally, variation in pH during the study period of the year was attributed to factors such as rainfall, decrease of salinity and temperature. The recorded variation in dissolved oxygen content ranged from 4.6 to 5.7 mg.l<sup>-1</sup> with the lowest level in July at station C1 and C2 and reached the peak in June at station C2. Biochemical oxygen demand ranged 0.55–1.14 mg.l<sup>-1</sup> at station C1 and varied from 0.74–2.22 mg.l<sup>-1</sup> at station C2. In the rainy as well as the dry season, value of biochemical oxygen demand of station C2 was higher than the same thing located at station C1. Total suspended solids changed unobviously. The highest range of total suspended solids (84.4 mg.l<sup>-1</sup>) was detected in Augst at station C1 and minimum (13.7 mg.l<sup>-1</sup>) in May. Generally, value of total suspended solids was high in the rainy season and entirely different from the dry season.

The recorded phosphate concentration ranged from 14.0–38.8 µg.l<sup>-1</sup>. The highest concentration of inorganic phosphate (38.80 µg.l<sup>-1</sup>) was revealed during dry season at station C2, and lowest (14.0 µmol µg.l<sup>-1</sup>) during rainy season at station C2. Ammonia values ranged between 26.0 and 61.0 µg.l<sup>-1</sup>, with a minimum and maximum values of 26.0 at station C1 and 61.0 µg.l<sup>-1</sup> at station C2.

Both of dry and rainy seasons, the value of biochemical oxygen demand, phosphate and ammonia of station C2 were higher than themselves in station C1 (Figures 3). Currently, aquaculture activities have been increasing in Long Hoa area, the cultured species are mainly brackish water shrimp, oysters, blood cockles, kinds of fish. These activities made some bad impacts on the quality of the environment in this area and adjacences. In 2019, monitoring results were shown that some parameters of station C2 were affected by aquaculture activities, the values of biochemical oxygen demand, phosphate and ammonia were high. This shows that the water environment in Can Gio is taking the risk of partial pollution. Generally, monitoring results of some environmental factors in the period 2009-2019 of two stations in Can Gio described their values were still within the limits of the specified standards (QCVN 10-MT: 2015/BTNMT and QCVN 08-MT: 2015/BTNMT) [3, 4], apart from dissolved oxygen of the ebb tide in 2016 (3.9 mg.l<sup>-1</sup>) and total suspended solids in the rainy season.

## 4. Conclusions

Based on the monitoring results of some environmental factors conducted in the two study stations in the period 2009-2019: The environment in the research area changes significantly by seasonal element and depends on the tide. A combined with rainy season and low tide resulted in low dissolved oxygen and salinity, whereas total suspended solids was reversed. Water temperature was found to be in the range of 27-30.6°C; salinity ranged between 20 and 29.5‰; pH were found to be neutral and had decreasing features in recent years, whereas salinity was opposite. The recorded variation dissolved oxygen concentration ranged from 3.9–5.9 mg.l<sup>-1</sup>, with the lowest level at low tide. The concentrations of inorganic nutrients viz., phosphate (14.0–38.8 µg.l<sup>-1</sup>), ammonia (26.0–61.0 µg.l<sup>-1</sup>) and biochemical oxygen demand (4.6–5.7 mg.l<sup>-1</sup>) varied independently. Generally, the environmental quality in this area has not been polluted yet, the values were still within the limits of the specified standards (QCVN 10-MT: 2015/BTNMT and QCVN 08-MT: 2015/BTNMT), apart from dissolved oxygen

of the ebb tide in 2016. In 2019, monitoring results were shown that several of factors at station C2 were affected by aquaculture activities, the values of biochemical oxygen demand, phosphate and ammonia were high. This shows that the water environment in Can Gio is taking the risk of partial pollution. In the future, Can Gio will become a marine urban tourism. The balance between economy and conservation, sustainable development is not a simple problem. In order to protect the environment, conserve biodiversity in the Can Gio mangrove area, environmental monitoring needs to be implemented on a large-scale, with the support of central, local authorities and communities.

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