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Research Article

USING WATER QUALITY INDEX (WQI) AND GEOGRAPHIC INFORMATION SYSTEM (GIS) TO ASSESS WATER QUALITY DURING THE RAINY SEASON OF 2020 IN O LOAN LAGOON, PHU YEN PROVINCE, VIETNAM

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ABSTRACT

The research studies the water quality of O Loan Lagoon, which has been active in aquaculture in recent years. Based on the water quality index (WQI) calculations of 15 water samples collected in 3 periods from September 2020 to October 2020, spatial and temporary polluted distribution maps were established using ArcGIS software. The results indicate that the WQI value ranges from 1 to 80, reaching an average of 58. This estimation shows that the water quality of O Loan Lagoon is only average during the rainy season in 2020. Water quality distribution maps show that the southern region's water quality is poorer than the rest. This result demonstrates the negative impacts of aquaculture activities on the coastal lagoon's water environment, and local authorities need appropriate solutions for sustainable aquaculture activities in this area.

Keywords: aquaculture activities; GIS; O Loan Lagoon; water quality; WQI

1. Introduction

A lagoon is a body of water separated from larger bodies of water by a natural barrier (Dang, Nguyen, & Nguyen, 2010). The nine lagoons are situated in Central Vietnam with diversity in typology, scale, shape, size, stability of inlets, water features, and geological and geographical distribution (Giuliani et al., 2008). The biological and ecological resources are typical values of the coastal lagoon of Vietnam (Phan et al., 2018). The coastal lagoons of Central Vietnam are under the human impact (Giuliani et al., 2008). In particular, aquaculture activities are developing very strongly (Dang et al., 2015). Although these

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activities have promoted agricultural economic development for these localities (Tran & Le, 2012), they also have impacted the natural environment in the coastal area.

The O Loan Lagoon, one of nine lagoons in Central Vietnam, is a brackish water lagoon in the Phu Yen Province. It covers an area of about 1,570 hectares (ha) that stretches in the North-South direction. For decades, thousands of residents have lived by fishing on the O Loan Lagoon. These activities for a long time have had certain effects on the water quality of the lagoon. In particular, many fishermen also use fishing gear and destructive chemicals to exploit. This has contributed to pollution and the depletion of aquatic resources in the lagoon. While fishing is developing strongly, plans and studies to protect the water quality of the O Loan Lagoon have not been focused. In the period 2008-2009, Pham Huu Tam pointed out that the O Loan Lagoon has seasonally variable water quality and better water quality in the rainy season than in the dry season (Pham et al., 2012). In recent years, the losses of aquaculture fishermen in the lagoon have begun to be recorded. Therefore, this study was conducted during the rainy season of 2020 to assess the change in water quality during the rainy season period. The results are expected to provide valuable data for the planning, protection, and rational use of this important lagoon resource in Phu Yen Province.

2. Materials and Methods

2.1. Study site

O Loan Lagoon is a brackish water lagoon in the coastal area of Phu Yen province, with geographical coordinates from 109°14'30" and 109°17'30" East longitude; 13°13'50" to 13°19'00" North latitude. The lagoon has a reasonably shallow depth, an average of 11 m, and the water surface area is about 1,570 ha. The topography of the O Loan Lagoon basin is relatively complex: hills and valleys are interspersed. The hills are low, less than 200 m, but steep, composed of granite and basalt. Particularly in the lagoon's east is a sandbar comprising many low dunes. In the rainy season, these hills will be a significant source of materials for the lagoon (Romano et al., 2012). This place has a rather unique shape: alternating inland outcrops protruding from the lagoon and lagoon waists deeply ingrained in the continent. The North and South ends of the lagoon are two isthmuses that go inland into the continent. The local climate consists of two distinct seasons, the dry season from January to August and the rainy season from September to December. The annual average rainfall is less than 1,500 mm/yr, which fluctuates abnormally: ranging from 900 mm/yr to 2,000 mm/yr. Water from rivers and streams contributes little to the lagoon. The most extensive diurnal tidal range is 1.4 - 2.4 m, and the average sea level is 1.2 - 1.4 m.

2.2. Sampling and data analysis

Surface water was sampled in 3 periods: September 17, 2020; September 28, 2020; and October 10, 2020. These were the beginning of the rainy season in the study area. A total of 15 surface water samples were collected at 5 monitoring locations: South of Lagoon (OL 01, 11, 21); Phu Tan Bridge (OL 02, 12, 22); Le Thinh Estuary (OL 03, 13, 23); An Hai

Estuary (OL 04, 14, 24); and North of Lagoon (OL 05, 15, 25) (Fig. 1). The sampling sites were 3 m from shore and 0.5 m deep. Water samples were stored in plastic bottles washed with distilled water and stored at 4°C before being analyzed in the laboratory. Coliform samples were collected separately in a 1 L bottle, stored at 4°C, and sent for analysis at the Center for Natural Resources and Environment Monitoring of Phu Yen Province. The chemical parameters were analyzed at the Laboratory of Geochemistry and Environmental Geology of the Faculty of Geology, University of Science, Vietnam National University Ho Chi Minh City (Eaton, Clesceri, Rice, Greenberg, & Franson, 2005). The parameters are:. pH and temperature measured with a HI 991300 meter, dissolved oxygen (DO) measured with a YSI 5000 benchtop, total suspended solids (TSS) measured gravimetrically at 105°C, chemical oxygen demand (COD) measured by the dichromate oxidation and titration method, biochemical oxygen demand (BOD_5) measured by the Winkler method, salinity measured with a Master-S/Mill Alpha-2491 refractometer, turbidity measured with a TB200 Turbidimeter, and Ammonium [$N\text{-}NH_4^+$], Nitrate [$N\text{-}NO_3^-$], and Phosphate [$P\text{-}PO_4^{3-}$] measured by a spectrophotometric method.

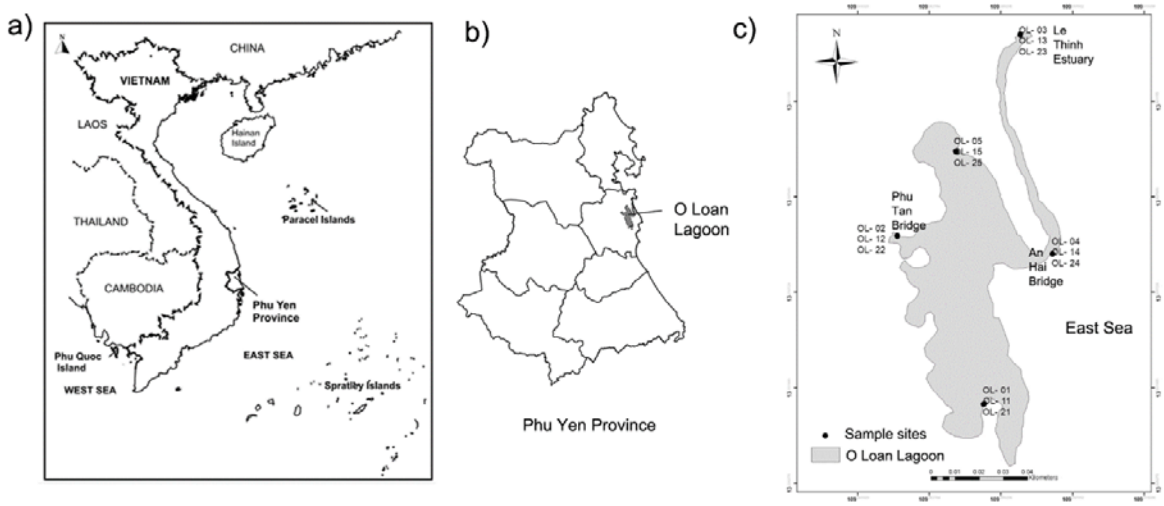

Figure 1. *O Loan location (a, b) and sampling sites (c)*

2.3. Calculating WQI parameters

The estimation is based on the technical guidance for the calculation and publication of the Vietnam water quality index (VN-WQI) 1460 QD/TCMT 2019.

2.3.1. WQI_{SI} estimation. WQI estimation for parameters BOD_5, COD, $N\text{-}NH_4^+$, $P\text{-}PO_4^{3-}$, TSS, Turbidity, and Total Coliform according to the following formula:

$$WQI_{SI} = \frac{q_i - q_{i+1}}{BP_{i+1} - BP_i}\left(BP_{i+1} - C_p\right) + q_{i+1} \quad (1)$$

Where:

WQI_{SI}: WQI for parameters;

BP_i: Lower limit concentration of monitoring parameter values specified in Table 1 corresponding to level i;

BP_{i+1}: The upper limit concentration of the observed parameter value specified in Table 1 corresponds to the level i+1;

q_i: WQI value at level i given in table corresponding to BP_i value;

q_{i+1}: The WQI value at i+1 given in the table corresponds to the value BP_{i+1};

C_p: The value of the monitored parameter is included in the calculation.

Table 1. *Specifying the values of q_i, BP_i*

i	q_i	Specified BP_i value for each parameter						
		BOD_5 (mg/L)	**COD (mg/L)**	**$N\text{-}NH_4^+$ (mg/L)**	**$P\text{-}PO_4^{3-}$ (mg/L)**	**Turbidity (NTU)**	**TSS (mg/L)**	**Coliform (MPN/100mL)**
1	100	≤4	≤10	≤0,1	≤0,1	≤5	≤20	≤2,500
2	75	6	15	0,2	0,2	20	30	5,000
3	50	15	30	0,5	0,3	30	50	7,500
4	25	25	50	1	0,5	70	100	10,000
5	1	≥50	≥80	≥5	≥6	≥100	>100	>10,000

Note: In case the C_p value of the parameter coincides with the BP_i value given in the table, the WQI of the main parameter can be determined by the corresponding q_i value.

2.3.2. WQI_{DO} estimation. It is calculated through the $DO\%_{Saturated}$ value.

Calculate the saturation DO value:

$$DO_{Saturated} = 14.652 - 0.41022 * T + 0.0079910 * T^2 - 0.000077774 * T^3 \quad (2)$$

$$DO\%_{Saturated} = \frac{DO_{Dissolved}}{DO_{Saturated}} * 100 \quad (3)$$

Where:

T: water temperature at the time of monitoring (°C).

$DO_{Dissolved}$: The observed DO value (mg/L).

Calculate the WQI_{DO} value:

$$WQI_{DO} = \frac{q_{i+1} - q_i}{BP_{i+1} - BP_i}\left(C_p - BP_i\right) + q_i \quad (4)$$

Where:

C_p: $DO\%_{Saturated}$

BP_i, BP_{i+1}, q_i, q_{i+1} are the values corresponding to levels i, i+1 in Table 2.

Table 2. *Specifying BP_i and q_i values for $DO\%_{Saturated}$*

i	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
BP_i	≤20	20	50	75	88	112	125	150	200	≥200
q_i	1	25	50	75	100	100	75	50	25	1

If $DO\%_{Saturated} < 20$ or $DO\%_{Saturated} > 200$, then $WQI_{DO} = 10$.

If $20 < DO\%_{Saturated} < 88$, then WQI_{DO} is calculated using Equation 4 and Table 2.

If $88 \leq DO\%_{Saturated} \leq 112$, then $WQI_{DO} = 100$.

If $112 < DO\%_{Saturated} < 200$, then WQI_{DO} is calculated using Equation 1 and Table 2.

2.3.3. WQI_{pH} estimation. If pH < 5.5 or pH > 9, then WQI_{pH} = 10. If 5.5 < pH < 6, WQI_{pH} is calculated using Equation 2 and Table 3. If 6 ≤ pH ≤ 8.5, then the WQI_{pH} is 100. If 8.5 < pH < 9, WQI_{pH} is calculated using formula 1 and Table 3.

***Table 3.** Specifying BP_i and q_i values for pH parameter*

I	1	2	3	4	5	6
BP_i	≤5.5	5.5	6	8.5	9	≥9
q_i	1	50	100	100	50	1

2.3.4. VN-WQI estimation. After calculating the WQI for each of the above parameters, the VN-WQI calculation is applied based on following formula:

$$VN\_WQI = \frac{WQI_{pH}}{100}\left[\frac{1}{5}\sum_{a=1}^{5} WQI_a * \frac{1}{2}\sum_{b=1}^{2} WQI_b * WQI_c\right]^{1/3} \quad (5)$$

Where:

WQI_a: Calculate WQI value for five parameters: DO, BOD_5, COD, $N\text{-}NH_4^+$, and $P\text{-}PO_4^{3-}$

WQI_b: Calculate WQI value for two parameters: TSS and Turbidity.

WQI_c: The calculated WQI value for the Total Coliform parameter.

WQI_{pH}: Calculate WQI value for pH parameter.

After calculating the VN-WQI, Table 4 was used to determine the VN-WQI value corresponding to the water quality assessment level to compare and evaluate, specifically as follows:

***Table 4.** VN-WQI levels and suitability for use*

VN-WQI range	Water quality	Suitable for use
91-100	Very good	Suitable for domestic water supply
76-90	Good	Used for domestic water supply but need appropriate treatment measures
51-75	Medium	Use for irrigation and other equivalent purposes
26-50	Poor	Use for navigation and other equivalent purposes
10-25	Very poor	The water is heavily polluted and needs future treatment measures
<10	Extremely poor	Water is poisoned, and need to take remedial and treatment measures

2.4. VN-WQI value-based mapping method

From the VN-WQI value, ArcGIS version 10.3 is applied to map the water quality partition of the study area by the interpolation method of Inverse Distance Weighted (IDW). The IDW method determines the value of unknown VN-WQI values by calculating the distance-weighted average of the known VN-WQI values in each location's vicinity. The farther away from where the value needs to be calculated, the less effect it has on the calculated value. The method is applied because of its stability regardless of the number of sample locations (Shiode & Shiode, 2011).

3. Results and discussions

3.1. Water quality parameters

Table 5. *Statistical analysis of the O Loan quality parameters and its coherence with Vietnam national technical regulation on marine quality (QCVN-10:2015/BTNMT) and brackish water shrimp culture farm (QCVN 02-19: 2014)*

Para-meters	Unit	Vietnam national technical regulation		Statistical analysis of the observed values									
		on marine quality	on brackish water shrimp culture farm	Dry season 2009*			Rainy season 2009*			Rainy season 2020			
		QCVN-10:2015	QCVN 02-19: 2014	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	SD
pH		6.5 - 8.5	7.0 - 9.0	6.75	8.25	7.70	6.89	8.30	7.70	7.52	9.02	8.65	0.37
T	^oC	-	18 - 33	31.10	38.50	34.98	27.60	31.20	29.52	27.60	32.80	30.27	1.31
DO	mg/L	≥ 5	3 - 5	3.99	6.54	5.40	5.38	7.94	6.94	6.54	12.05	9.05	1.91
TSS	mg/L	50	-	32.2	61.1	45.9	20.1	30.3	24.6	12.0	258.0	56.0	63.0
BOD_5	mg/L	-	-	0.77	3.23	2.07	1.49	4.23	2.96	1.52	16.16	6.70	4.96
N-NH_4^+	mg/L	0.1	0 - 3	0.00	0.15	0.02	0.01	0.11	0.02	0.04	0.25	0.12	0.07
P-PO_4^{3-}	mg/L	0.2	-	0.02	0.08	0.04	0.00	0.03	0.01	0.00	0.03	0.01	0.01
N-NO_2^-	mg/L	-	-	0.00	0.01	0.01	0.00	0.01	0.00	0.00	0.03	0.01	0.01
Coli-form	MPN /100ml	1000	-	-	-	1,992	0	46,000	9,402	23	4,600	947	1,587
Salinity	‰	-	5 - 35	0	8	4.9	5	27.5	13.1	3.0	33.0	23.9	9.3
COD	mg/L	-	-							40	560	272	187
Turbi-dity	NTU	-	-							0.01	5.25	0.60	1.34
Number of samples				14			14			15			

*(Pham et al., 2012)

3.1.1. pH. In the rainy season, the average pH value is 8.65, fluctuating from 7.52 to 9.02. The pH values during the rainy season in 2020 were higher than those in 2009 (Table 5). The spatial pH partition is shown in Figs 2a, 3a, and 4a. The southern area and Le Thinh estuary have a higher pH than others. A total of four out of five monitoring locations have pH levels exceeding the allowable limit of QCVN-10:2015. However, compared with QCVN 02-19: 2014/BNNPTNT (pH = 7 – 9), it is still guaranteed for water supply for shrimp farming.

3.1.2. Temperature. The results of temperature partitioning are shown in Figs 2b, 3b, and 4b. The temperature fluctuates between the sampling locations. The temperature fluctuates in the rainy season of 2020 from 27.6 to 32.8°C. High temperature is distributed mainly in the lagoon mouth, north of the lagoon. When compared with QCVN 02-19: 2014/BNNPTNT, it was found that 100% of the area in the study area had a temperature perfectly suitable for supplying water for shrimp farming (18-33°C). The temperature during this period fluctuated insignificantly compared to the rainy season in 2009 (Table 5).

3.1.3. DO. In the rainy season, the average dissolved oxygen concentration is 9.05 mg/L, ranging from 6.54 to 12.05 mg/L. The results of DO partitioning are shown in Figs 2c, 3c, and 4c. One hundred percent of the area is suitable for aquaculture according to QCVN 02-19: 2014/BNNPTNT (DO $\geq$ 3.5 mg/L). The DO value had a more positive change compared to the 2009 rainy season. Specifically, the average DO increased from 6.94 to 9.05 mg/L (Table 5).

3.1.4. TSS. The concentration of total suspended solids is high in the northern part of the lagoon (Figs 2d, 3d, and 4d). The most significant value recorded is 258 mg/L. All five monitoring locations (on September 17, 2020) with TSS content exceeding the allowable limit of the standard 10-MT: 2015/BTNMT, with the highest being 5.16 times. The average TSS value was higher than the dry and rainy seasons in 2009.

*3.1.5. BOD_5.*The BOD_5 concentration in the rainy season fluctuated from 1.52 to 16.16 mg/L, with an average of 6.70 mg/L, more than two times higher than in 2009. This marks a negative change in surface water quality. The BOD_5 zoning is shown in Figs 2e, 3e, and 4e. Most BOD_5 values fluctuate from time to time and are highly distributed in the North, South, and Phu Tan Bridge areas. Therefore, treating organic matter carefully when taking it into the shrimp pond is necessary.

3.1.6. $N\text{-}NH_4^+$. The average concentration of N - NH_4^+ in the rainy season of 2020 is 0.12 mg/L, ranging from 0.04 to 0.25 mg/L. Although the $N\text{-}NH_4^+$ value is quite low and has not changed much compared to 2009, it has exceeded the regulations of coastal water (Table 5). The spatial distribution of N - NH_4^+ is illustrated in Figs 2f, 3f, and 4f. N - NH_4^+ concentration is high, mainly around the sea mouth and south of the lagoon. All five monitoring sites (on September 17, 2020) with the content of N - NH_4^+ exceed the allowable limit of the standard, with the most value being 2.5 times. However, these values are still within the allowable limits of water used for shrimp farming.

3.1.7. $P\text{-}PO_4^{3-}$. The average phosphate concentration in the rainy season in 2020 is 0.01 mg/L. This value is almost unchanged from 2009 (Table 5). The $P\text{-}PO_4^{3-}$ spatial distribution is shown in Figs 2g, 3g, and 4g. It can be seen that the phosphate concentration in the southern and northern regions of the lagoon is higher than in the rest.

3.1.8. $N\text{-}NO_2^-$. $N\text{-}NO_2^-$ has an average concentration of 0.01 mg/L, shown in Figs 2h, 3h, and 4h. The $N\text{-}NO_2^-$ value has also remained insignificantly compared to 2009 (Table 5). Most of the NO_2^- content is high in the south of O Loan lagoon. The highest value recorded was 0.03 mg/L.

3.1.9. Coliform. The coliform content is high in the west and An Hai bridge, ranging from 23 – 4,600 MPN/100 mL. The highest value recorded at An Hai bridge is 4,600 MPN/100 mL. Three out of five monitoring locations with coliform content exceeding the allowable limit of the standard 10-MT: 2015/BTNMT with the highest of being 4.6 times. The results of total coliform spatial distribution are shown in Figs 2i, 3i, and 4i. Although the values wre still significant. The results show a positive change in the reduction of microbial contamination. If in 2009, both the dry season and the rainy season exceeded the coastal water standard, by 2020, the average value has reached the standard. Except for some locations, it exceeded the standard from 2.4 to 4.6 times, but all of them decreased by many times compared to the rainy season in 2009 (Table 5).

3.1.10. Salinity. The range of salinity fluctuations in the rainy season of 2020 is quite extensive (3 - 33‰) and is mainly distributed at the lagoon mouth (Le Thinh estuary). There is a significant difference between the salinity at the location of Phu Tan bridge and the Le Thinh estuary (Figs 2j, 3j, and 4j). In addition, the substantial intrusion of seawater due to the tidal regime also made the middle of the lagoon have relatively high salinity on September 28, 2020 (Fig 3j). According to research by Pham Huu Tam et al., 2012, salinity in the rainy season is higher than in the dry season 2009 (Table 5). An Hai estuary near An Hai bridge is usually deposited in the dry season (Tran & Le, 2012; Tran, Tong, Nguyen, & Pham, 2015). The water exchanges insignificantly between the lagoon and the sea at this time because water has to run through a long creek before reaching Le Thinh estuary. Meanwhile, the opposite phenomenon occurs in the rainy season when the discharge water flows heavily from upstream. As a result, An Hai estuary was eroded in the rainy season (Tran & Le, 2012; Tran et al., 2015). The seawater can then intrude directly into the lagoon explaining the higher salinity in the rain rather than in the dry season. By the rainy season in 2020, the average salinity is much higher than in 2009 (Table 5). Compared with QCVN 02-19: 2014/BNNPTNT, however, the salinity of the O Loan lagoon is suitable for collecting water for shrimp farming in the rainy season of 2020.

3.1.11. COD. The average COD concentration in the rainy season is 272 mg/L, ranging from 40 to 560 mg/L. COD concentration is high in the northern part of the lagoon (Figs 2k and 3k) and high concentration in the southern part of the lagoon (Fig 4k).

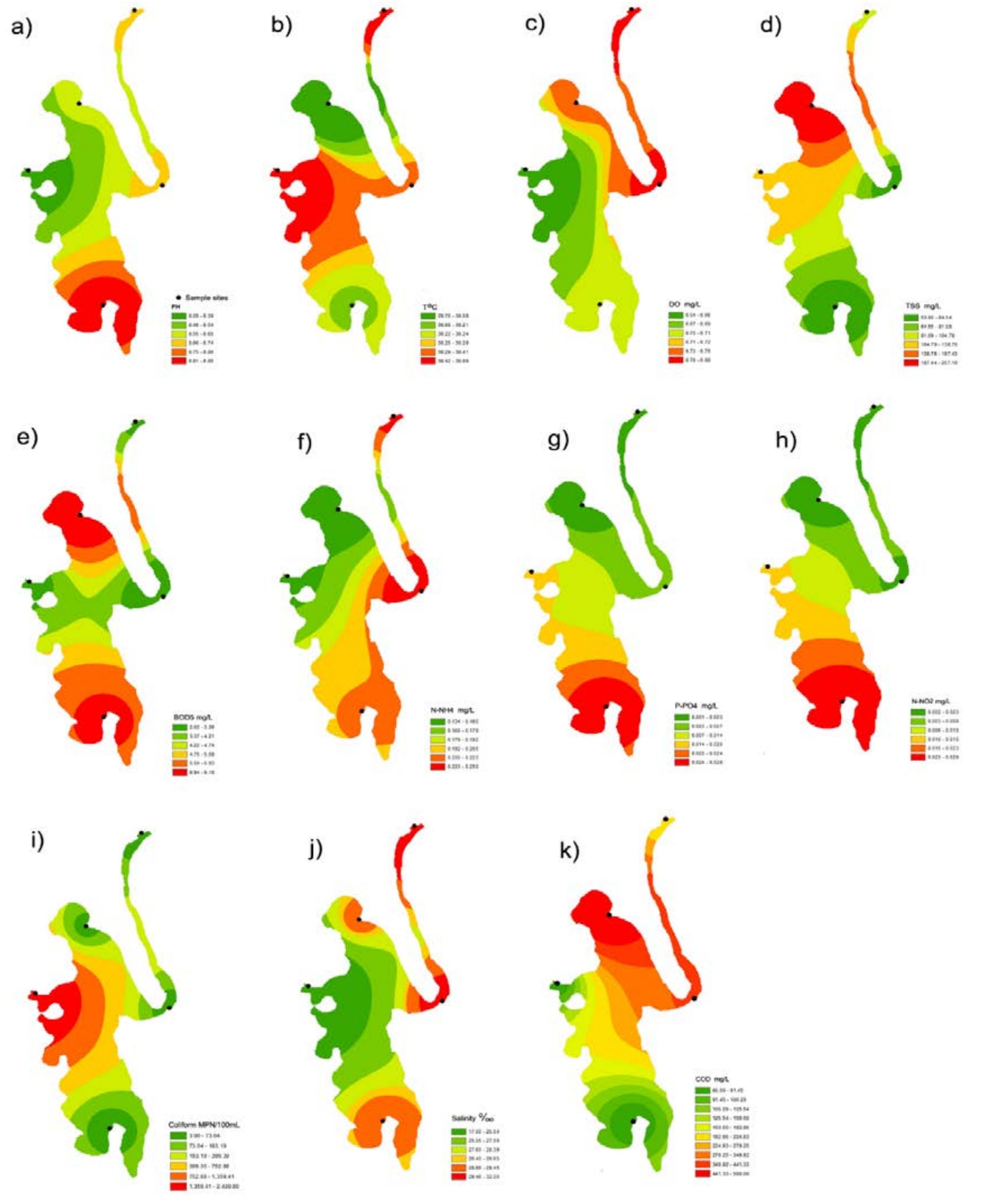

Figure 2. *Parameters on spatial distribution maps on September 17, 2020 by a) pH, b) Temperature, c) DO, d) TSS, e) BOD_5, f) $N\text{-}NH_4^+$, g) $P\text{-}PO_4^{3-}$, h) $N\text{-}NO_2^-$, i) Coliform, k) Salinity, and l) COD*

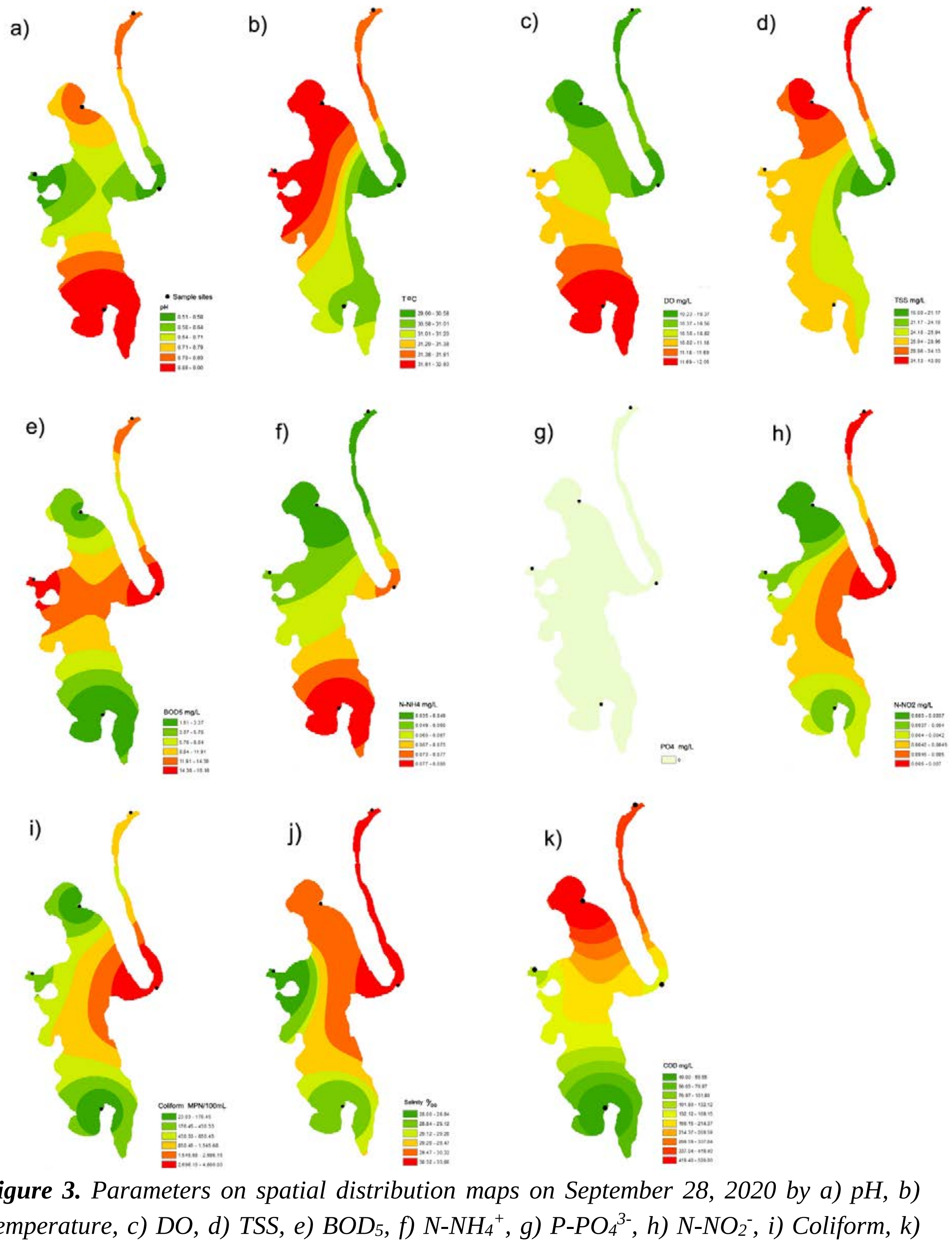

Figure 3. *Parameters on spatial distribution maps on September 28, 2020 by a) pH, b) Temperature, c) DO, d) TSS, e) BOD_5, f) N-NH_4^+, g) P-PO_4^{3-}, h) N-NO_2^-, i) Coliform, k) Salinity, and l) COD*

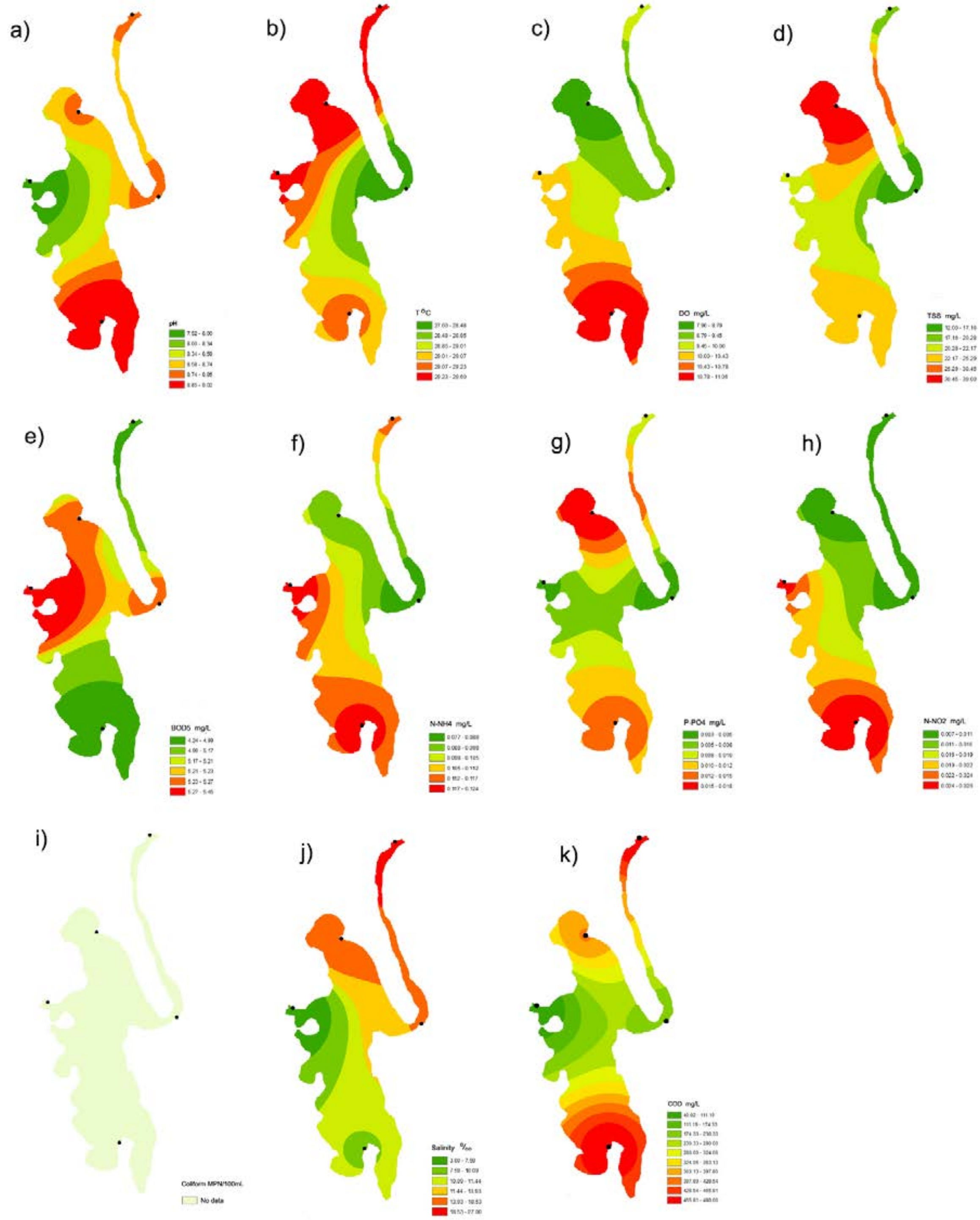

Figure 4. *Parameters on spatial distribution maps on October 10, 2020 by a) pH, b) Temperature, c) DO, d) TSS, e) BOD_5, f) N-NH_4^+, g) P-PO_4^{3-}, h) N-NO_2^-, i) Coliform, k) Salinity, and l) COD*

3.2. WQI

From the analysis results, the WQI index was estimated. Because the 3rd sample collection lacked Coliform criteria, the WQI value was only calculated for the first and second periods. The results are shown in Table 7.

Table 7. *VN-WQI values of monitoring locations on the O Loan lagoon in the rainy season in 2020*

Monitoring locations	1st period		2nd period	
	VN-WQI	Water quality	VN-WQI	Water quality
South of Lagoon	52	Medium	1	Extremely Poor
Phu Tan Bridge	73	Medium	80	Good
Le Thinh Estuary	60	Medium	51	Medium
An Hai Bridge	66	Medium	75	Medium
North of Lagoon	67	Medium	57	Medium

The results of VN-WQI calculation at ten monitoring locations show that there are 8/10 monitoring locations with VN-WQI values from 51 to 75, 1/10 monitoring locations with a VN-WQI value from 76 to 90, and 1/10 monitoring locations with a VN-WQI value < 10. These results were then applied to the GIS map by the IDW interpolation method to show the spatial distribution of VN-WQI index (Fig 5).

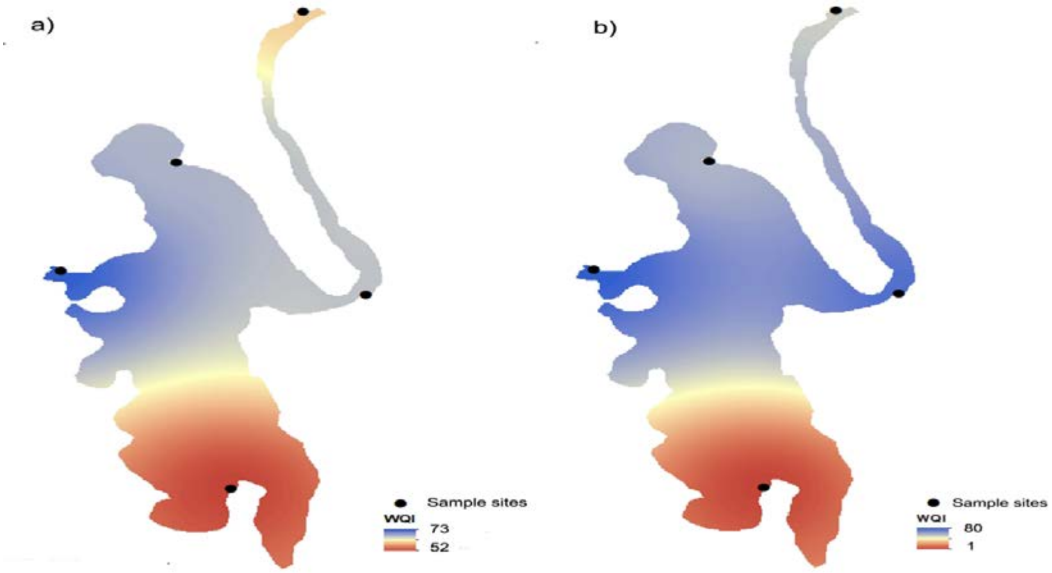

Figure 5. *VN-WQI maps of the O Loan Lagoon on September 17, 2020 (a) and on September 28, 2020 (b)*

Because of the well-flowed current, most areas are still capable of self-cleaning during daily tidal regimes. On the opposite, we can see that the area south of O Loan Lagoon has the lowest water quality index compared to other locations during the survey. There is a time when the water quality index is very low (WQI = 1 – the second period and WQI = 52 – the first period). At the south O Loan Lagoon, the population is high-density, and the direct discharge of waste into the environment is inevitable. At the same time, aquaculture activities here are also quite dense (mainly shrimp farming), which is also a reason. In addition, it can be seen that this place is an enclosed area in the lagoon, so the water circulation is also complicated. This result is consistent with the study of Pham Huu Tam et al., 2012. It indicated the high organic N and P content in the south of O Loan lagoon, in which the rainy season has a decrease compared to the dry season. Thus, this area's water quality has deteriorated after more than ten years. Specifically, the water quality is very polluted even in the rainy season.

The local authorities need to control domestic waste, waste from farming areas, and aquaculture ponds along the lagoon. Especially in a vulnerable area such as the south of the lagoon, it is necessary to increase the density of periodic environmental monitoring to observe and prevent contaminant risks due to aquaculture activities.

4. Conclusions

The calculation results of the VN-WQI water quality index in the rainy season in 2020 in O Loan Lagoon show that almost all monitoring locations have medium water quality, except for the southern part of the lagoon, with polluted water quality very poor. The study should be supplementary to a dry season to monitor seasonal water quality changes. From there, the government will have more specific measures to manage aquaculture activities in the locality. Although the number and survey sites are limited, the research results also show a certain change in the water quality of O Loan Lagoon over time. This result is expected to be valuable data for managing and rationalizing local water resources.

❖ ***Conflict of Interest:*** *Authors have no conflict of interest to declare.*

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ỨNG DỤNG CHỈ SỐ CHẤT LƯỢNG NƯỚC (WQI) VÀ HỆ THỐNG THÔNG TIN ĐỊA LÍ (GIS) ĐỂ ĐÁNH GIÁ CHẤT LƯỢNG NƯỚC TRONG MÙA MƯA NĂM 2020 TẠI ĐẦM Ô LOAN, TỈNH PHÚ YÊN, VIỆT NAM

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TÓM TẮT

Bài báo nghiên cứu chất lượng nước đầm Ô Loan, một trong những khu vực đang có hoạt động khai thác, nuôi trồng thủy hải sản mạnh mẽ trong những năm gần đây. Căn cứ trên kết quả tính toán chỉ số chất lượng nước (Water Quality Index – WQI) của 15 mẫu nước được thu thập trong 3 giai đoạn từ tháng 9/2020 đến tháng 10/2020, các bản đồ phân vùng ô nhiễm theo không gian và thời gian được thành lập bằng phần mềm ArcGIS. Kết quả chỉ ra giá trị WQI dao động từ 1 đến 80, trung bình đạt 58. Điều này cho thấy chất lượng nước đầm Ô Loan chỉ đạt mức trung bình trong mùa mưa năm 2020. Các bản đồ phân vùng chất lượng nước cho thấy chất lượng nước khu vực phía nam kém hơn các khu vực còn lại. Điều này thể hiện các tác động tiêu cực của hoạt động nuôi trồng thủy sản lên môi trường nước vũng vịnh ven biển và chính quyền địa phương cần có các giải pháp thích hợp cho hoạt động khai thác thủy sản bền vững tại khu vực này.

Từ khóa: hoạt động nuôi trồng thủy sản; GIS; đầm Ô Loan; chất lượng nước; WQI