Journal of Climate Change, Vol. 9, No. 3 (2023), pp. 1-10.
DOI 10.3233/JCC230018

Potential Impacts of Climate Change on Reservoir Water Quality in An Giang Province, Vietnam

Luu Kim Phung[1], Tran Gia Han[1], Tran Thi Thuy An[1], Kim Lavane[1] Pankaj Kumar[2], Nigel K. Downes[1] and Huynh Vuong Thu Minh[1]*

[1]College of Environment and Natural Resources, Can Tho University, Can Tho, Vietnam
[2]Institute for Global Environmental Strategies, Hayama – 240-0115, Kanagawa, Japan
✉ hvtminh@ctu.edu.vn

Received May 24, 2023; revised and accepted July 17, 2023

Abstract: As water scarcity puts over 80% of the world's population at risk, water quality has become a major environmental topic. In particular, climate change has jeopardised the quality of water within the Vietnamese Mekong Delta (VMD), a key agronomic and aquaculture hub. A modest canal system and small to medium-sized reservoirs in the semi-mountain region of An Giang province contribute to a less abundant water supply and a tendency for water quality reservoirs to deteriorate. The water quality index method and descriptive technique were used in this study. The results show that in the period 2017–2020, some water quality indicators exceeded the permissible limits of the Vietnamese standards for domestic surface water in column B1 (NO_3^-, Total Coliform, BOD_5, COD, N-NH_4^+) but are consistent, but are allowed for use in irrigation purposes. Findings show that for many years, WQI values in Tinh Bien and Tri Ton districts have diminished because of wastewater pollution. WQI values near the shores of O Tuk Sa Reservoir (Tinh Bien), Lỗi đánh máy (Tri Ton), and O Ta Soc Reservoir (Tri Ton) diminished over time. According to the WQI index, the water quality at the reservoir monitoring stations has fluctuated throughout the years, so it is advised that people implement water purification techniques for long-term well-being.

Keywords: WQI; Semi-mountain region; Reservoir; Water supply; The VMD; Vietnam.

Introduction

The Vietnamese Mekong Delta (VMD) is one of the most vulnerable regions to the effects of climate change (Parry et al., 2007). The Mekong Delta, in the lower Mekong region, has a low topography and is one of the world's three major deltas most threatened by climate change (Schneider and Nocke, 2014). It should be underlined that climate change is influencing the Mekong Delta, leading to a rise in sea level and amplified utilisation of water by upper Mekong countries, causing the environment in the Mekong Delta to alter, typically: Major inundations have significantly decreased, transitioning to medium and minor floods; An Giang is also one of the Mekong Delta provinces most plagued by water scarcity (Minh et al., 2022). Many studies have been conducted to evaluate the impact of changing rainfall and temperature patterns on both flooding and crop yields (Nam et al., 2022; Thoang et al., 2022).

An Giang is a province with a total population of 1,908,352 people (2019 An Giang province population and housing census). Water is vital to the growth and success of flora and fauna in farming and aquaculture. The semi-mountainous region has a minor canal system, and the reservoirs are small to medium, resulting in

*Corresponding Author

a less plentiful water supply than other districts in An Giang province, thus residents must depend on groundwater or rainwater. That is why reservoirs are used to allocate water for domestic and agricultural uses. Tri Ton and Tinh Bien are in the semi-mountainous province of An Giang, which has recently enlarged the area of its agricultural production. A semi-mountainous region with many high hills and mountains, the area encounters many challenges regarding water for irrigation. The residents of the semi-mountain region are mainly members of ethnic minorities (Khmer ethnic group), who account for 3.9% of the province's total population and approximately 92% of whom live in the province. Most people in this area require groundwater to sustain themselves. There are a few water reservoirs. In the Tri Ton district, they encompass the O Ta Soc Reservoir (620,000 m^3) (Figure 1), the Tuc Dup Reservoir (400,000 m^3), and the O Thum Reservoir (270,000 m^3). O Tuk Sa Reservoir (600,000 m^3) (Figure 1), Thanh Long Reservoir (255,780 m^3), and Thuy Liem 1 Reservoir (270,000 m^3) are all in the Tinh Bien area systems (Tinh Bien portal, 2019; Tri Ton portal, 2019; Vi et al., 2021). The Department of Agriculture and Rural Development 2019-21 claims that all the aforementioned reservoirs provide domestic water for the locals besides assisting in tourism, fire prevention, and fighting systems (Tinh Bien portal, 2019; Tri Ton portal, 2019; Vi et al., 2021). The amount of water stored in reservoirs usually decreases as water demand increases. Water depletion has a range of factors besides the uses for which it is used. The results of the study give scientific insight into how discharge sources impact the quality of reservoirs in the semi-mountainous area. Based on meteorological data from Chau Doc station from 1978 to 2008, the average yearly evaporation of water in this area is relatively high (about 1300 mm/year).

Considering all that has been said, the study on the evaluation of water quality at water reservoirs in mountainous regions of An Giang province was

O Ta Soc Reservoir

O Tuk Sa Reservoir

O Thum Reservoir

Soai Chek Reservoir

Figure 1: Reservoirs sampling 2020: O Ta Soc (a), To Tuk Sa (b), O Thum (c), Soai Chek (d).

implemented in order to analyse surface water quality in reservoirs and suggest suitable methods to restore water quality. In order to prevent contamination and keep a sufficient supply of water, the findings should be used to help manage, exploit, and utilise water sources in ponds and reservoirs.

Methodology

The Study Area

The study assessed the water quality in reservoirs in the districts of Tri Ton and Tinh Bien in An Giang province. The project's scope included the investigation of several water parameters, including pH, biochemical oxygen demand (BOD_5, mg/L), chemical oxygen demand (COD, mg/L), dissolved oxygen (DO, mg/L), total suspended solids (TSS, mg/L), ammonium nitrogen ($N\text{-}NH_4^+$, mg/L), soluble phosphorus ($P\text{-}PO_4^{3-}$, mg/L), and Total Coliform (MPN/100 mL). An Giang is in the southwest of the Mekong Delta and has a total natural area of 3,536.7 km^2, of which agricultural-producing land is 280,658 ha and forestry land is 14,724 ha, accounting for 1.03% of the total area.

Tinh Bien and Tri Ton are two mountainous districts in Vietnam's An Giang province (Figure 2). Tinh Bien district has a natural area of 354.73 km^2, accounting for 10.03% of the province's total area. Tinh Bien district has a sizable Khmer community, which is centered in the communes of An Cu, Tan Loi, An Hao, Van Giao, and Vinh Trung. Tri Ton district is An Giang province's largest and most sparsely inhabited district. It covers a land area of 600.2 km^2, a population of 117,431 people in 2019, and a population density of 196 people per km^2.

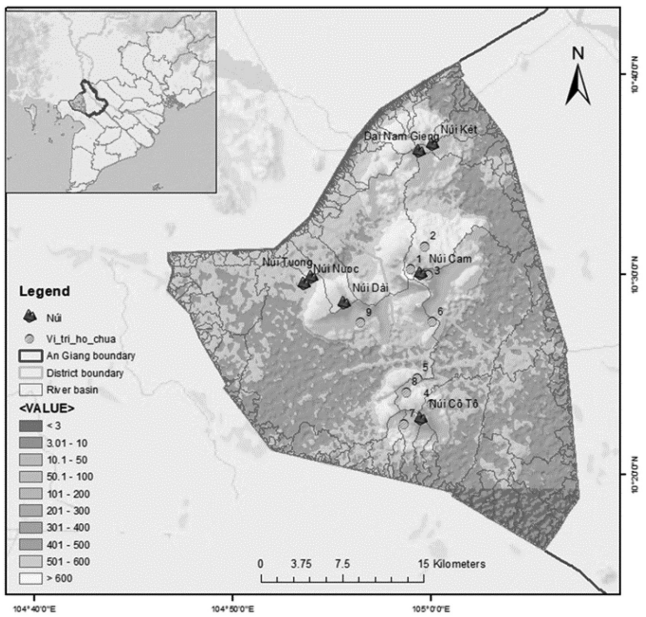

Figure 2: The location of reservoirs in Tinh Bien and Tri Ton districts.

The transitional topography between mountains and plains (the total area of hills and mountains amounts to 4,173 ha) has generated several special natural vistas that are beneficial for tourism development in the Tri Ton district. Tri Ton district has the most forest area in An Giang province with two types of forests: natural forests and cultivated woodlands. The Tinh Bien district features a varied semi-mountainous topography with hills and plains that have distinct tones. Tinh Bien district's terrain is classified into three kinds based on morphology: Alluvial plain terrain (total area of about 20,260 hectares, accounting for 57% of the area), low mountainous terrain (total area of about 6,330 hectares, accounting for 17.81% of the district's natural area), and inclined plain terrain along the foot of the mountain (total area of about 8,953 ha, accounting for 25.19% of the natural area).

The tropical climate is marked by a high altitude, a hot and damp monsoon, plentiful precipitation, and a seasonal pattern. The annual average temperature is quite high and constant at roughly 27.5°C. The maximum average temperature of the year is 28.3°C (around April). The lowest average temperature of the year is 25.5°C (about January). The temperature range between the hottest and coldest months is 2-3°C, which gives an excellent environment for Tri Ton to create and implement strategies for cultivating special fruit trees and forming edible zones.

Methodology Data Collection

Water quality data (DO, BOD_5, COD, $N\text{-}NH_4^+$, $N\text{-}NO_3^-$, pH) were collected from An Giang DONRE from 2017-2020.

Water Quality Index (WQI) Calculation

Study on the calculation of water quality index according to decision No: 1460/QD-TCMT proposed by Vietnam Environment Administration (Equation 1).

$$WQI = \frac{WQI_{pH}}{100}\left[\frac{1}{5}\sum_{a=1}^{5} WQI_a \times \frac{1}{2}\sum_{b=1}^{2} WQI \times WQI_c\right]^{\frac{1}{3}}$$

where WQI_a is calculated using six parameters: DO, BOD_5, COD, $N\text{-}NH_4^+$, $P\text{-}PO_4^{3-}$, $N\text{-}NO_3^-$; WQI_b includes TSS and turbidity; WQI_c is calculated using total coliform parameter; WQI pH is calculated using the pH parameter.

WQI_{SI} is calculated using BOD_5, COD, TSS, $N\text{-}NH_4^+$, $P\text{-}PO_4^{3-}$, turbidity, and total coliform parameter as shown in Equation 2.

$$WQI_{SI} = \frac{q_i - q_{i+1}}{BP_{i+1} - BP_i}\left(BP_{i+1} - C_p\right) + q_{i+1}3$$

where BP_i is the concentration of the lower limit of monitoring parameter value specified in Table 1 (GDE, 2010) corresponding to level i; BP_{i+1} is a concentration of the upper limit of observed parameter value specified in (Table 1) corresponding to level i+1; q_i denotes WQI value at level i corresponding to BP_i value; q_{i+1}: WQI value at level i+1 corresponding to BP_{i+1} value; C_p denotes the value of the observed parameter to be included in the calculation.

Calculate the DO saturation value:

DO saturation = 14,652 – 0,41022T + 0,0079910T2 – 0,000077774T3

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

Calculate DO % saturation value

$$DO = \frac{DO}{DO_{\text{saturation}}}$$

DO: Measured DO (mg/L).

Estimation of WQIDO as shown in Eq. 4

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

where C_p denotes DO% saturation; BP_i, BP_{i+1}, q_i, q_{i+1} are the corresponding values of i, i+1 (Table 2, GDE, 2015).

If DO % saturation ≤ 20 then WQIDO = 1

If 20 < DO % saturation < 88 then WQIDO was calculated as Eq. 4 and Table 2

If 88 ≤ DO % saturation ≤ 112 then WQIDO = 100

If 112 < DO % saturation < 200 then WQIDO was calculated as Eq. 1 and Table 2

If DO % saturation ≥ 200 then WQIDO = 1.

WQI calculation for pH

If pH ≤ 5,5 then WQIpH = 1

If 5.5 < pH < 6.0 then WQIpH was calculated by Eq. 2 and using Table 3 (GDE, 2015)

If 6.0 ≤ pH ≤ 8.5 then WQIpH =100

If 8.5 < pH < 9.0 then WQIpH was calculated by Eq. 1 and using Table 3

If pH ≥ 9.0 then WQIpH = 1

After calculating the WQI, use the table to determine the WQI value corresponding to the water quality assessment level to compare and evaluate specifically in Table 4.

Table 1: The specified values of q_i and BP_i

I	q_i	BP_i						
		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)*	*Total coliform (MPN/100 mL)*
1	100	≤ 4	≤ 10	≤ 0,1	≤ 0,1	≤ 5	≤ 20	≤ 2500
2	75	6	15	0,2	0,2	20	30	5000
3	50	15	30	5	0,3	30	50	7500
4	25	25	50	1	0,5	70	100	10000
5	1	≥ 50	≥ 80	≥ 5	≥ 6	≥ 100	> 100	>10000

Table 2: Specify q_i, BP_i values for DO% saturation

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

Table 3: Specify q_i, BP_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

Table 4: WQI classification

WQI value	*Water Quality Rating Level*	*Colour*
91 -100	Good use for domestic water supply purposes	Blue
76-90	Use for domestic water supply purposes but need appropriate treatment measures	Green
51-75	Use for irrigation and other equivalent purposes	Yellow
26-50	Use for navigation and other equivalent purposes	orange
10-25	Heavily polluted water, requiring future treatment measures	Red
<10	Poisoned water, need to take remedial measures, treatment	Brown

Results and Discussion

Evaluation of Temporal Surface Water Quality in Reservoirs in the Districts of Tri Ton and Tinh Bien, 2017-2020

pH

The graph illustrates the pH value goes up and down irregularly over the seasons and years, with a reasonably significant difference (Figure 3). However, during 2017- 2020 the pH measured at the study sites did not significantly change, and the value ranged from 6.56 to 8.55, which was still within the permissible range of QCVN 08-MT:2015/BTNMT in column B1 and column B2 (5.5-9) for irrigation, irrigation or navigation purposes, and other low-quality water requirements.

BOD_5

The average BOD_5 content from 2017 to 2020 is assumed to be highly erratic (Figure 4). The National Technical Regulation on Surface Water Quality (Vietnamese Standards 08-MT: 2015/MONRE) states that column A2 at monitoring stations has a concentration of 6.0 mg/L, which is significantly greater than the range of 1.2 to 2.2 stated in the regulation. The BOD_5 at O Tuk Sa Reservoir at Soai Chek Reservoir particularly increased above column B1 (15 mg/L) in 2019 and 2020.

COD

Most COD concentrations in reservoirs between 2017 and 2020 were quite high and exceeded the permissible limits of Vietnamese standard 08-MT:2015/MONRE column B1 (30 mg/L) suitable for irrigation or other uses (Figure 5). Similar water quality standards for additional purposes, or usage like B2. In 2019 and 2020, the COD content is high at Soai Chek and O Tuk Sa reservoirs. Because the rainy season has a larger organic matter content than the dry season and a slower rate of mineralisation, the results of the two-season analysis show that the average COD in the rainy season is higher than that in the dry season. This finding is in line with the findings of Sansanayuth's (1998) study.

DO

Between 2017 and 2020, the range of DO concentrations in the reservoirs at monitoring sites was 5.06 to 6.88, all falling within the permissible range of Vietnamese standard 08-MT:2015/MONRE column B1 (4.0 mg/L) (Figure 6). The highest DO value in Tinh Bien was 6.4 mg/L in March 2018 and the lowest was 6.0 mg/L in the

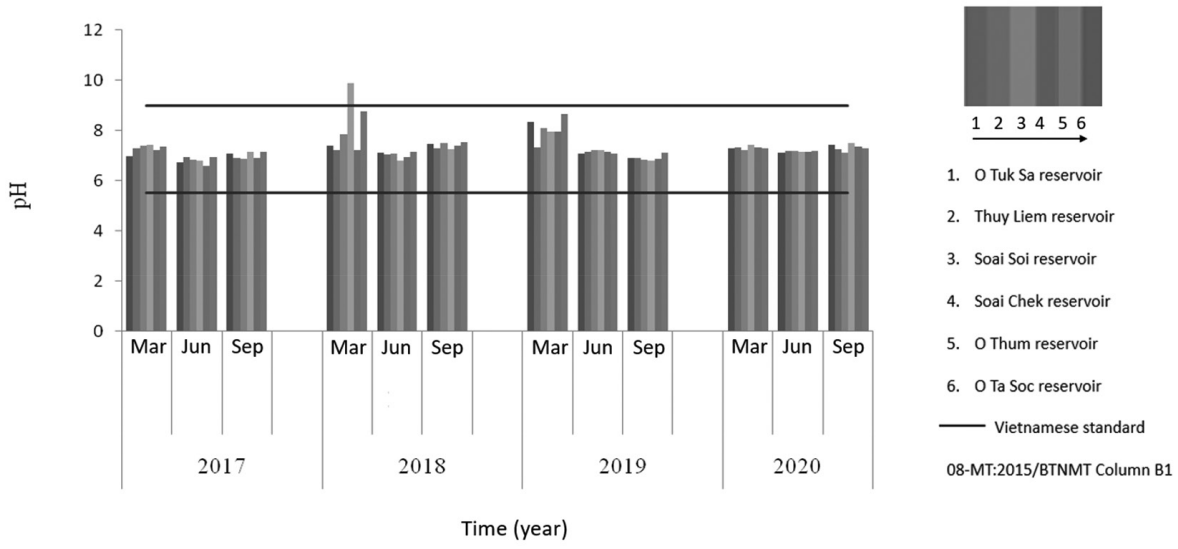

Figure 3: pH at reservoirs in Tinh Bien and Tri Ton from 2017 to 2020.

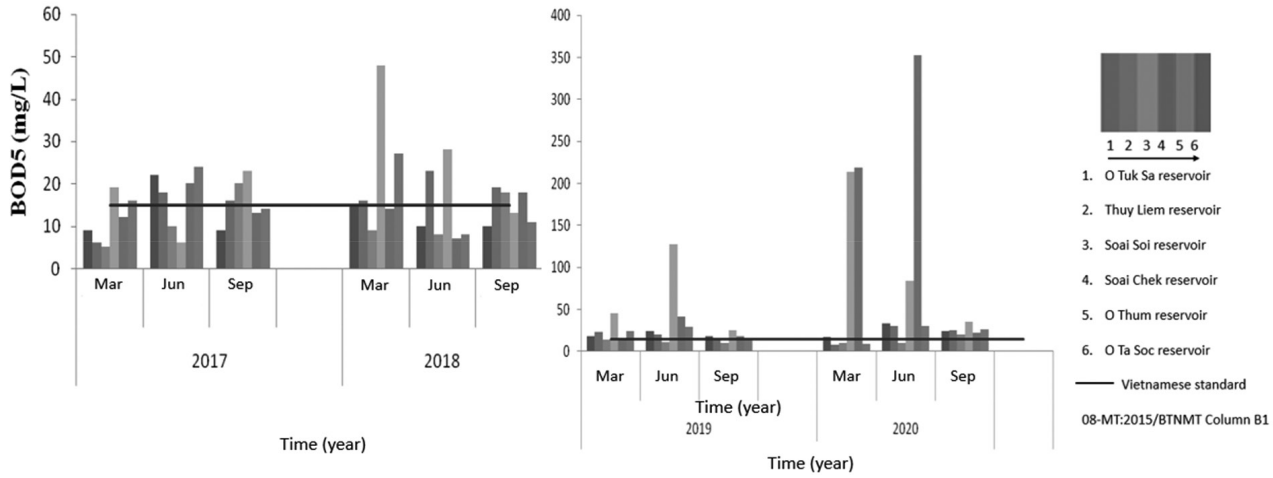

Figure 4: BOD_5 at reservoirs in Tinh Bien and Tri Ton from 2017 to 2020.

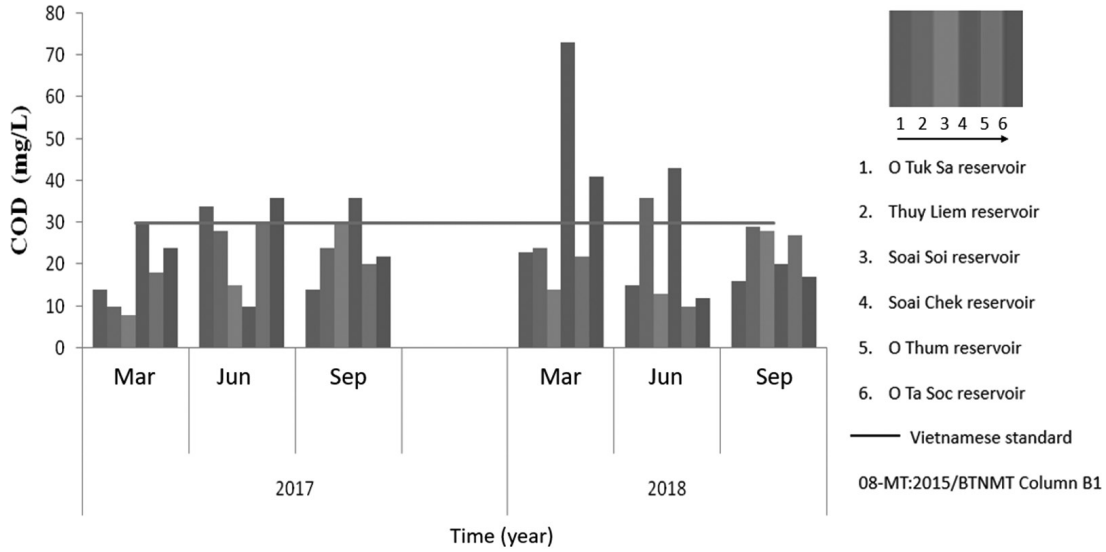

Figure 5: COD at reservoirs in Tinh Bien and Tri Ton from 2017 to 2020.

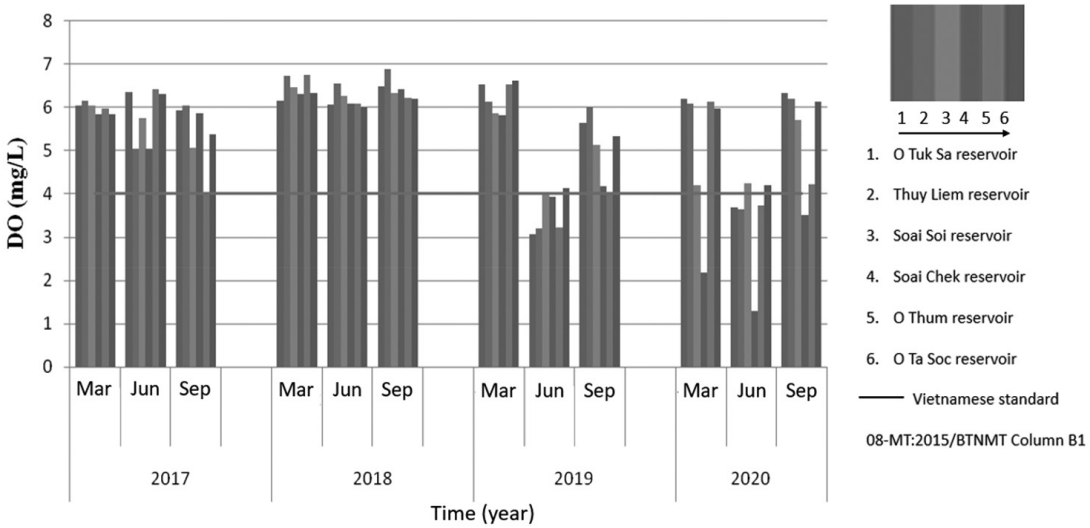

Figure 6: DO at reservoirs in Tinh Bien and Tri Ton from 2017 to 2020.

same month of 2019. At the start of the rainy season, the maximum was 6.2 mg/L in 2018 and the lowest is 3.0 mg/L in 2019. The maximum DO value in Tri Ton and Tinh Bien during the dry season (March 2018) is 6.5 mg/L, while the lowest is 4.8 mg/L at the start of the dry season in 2020.

N-NH_4^+

According to QCVN 08-MT: 2015/BTNMT, the N-NH_4 concentration fluctuated across the two monitoring sites in 2017 and 2018, with the Soai Reservoir recording the highest average value (Figure 7). This fluctuation was within the range of column B1 (0.9 mg/L). During the rainy season (June) in 2019, Need Soai was 11 mg/L, while the lowest average value was 0.2 mg/L. At O Tuk Sa Reservoir, the average N-NH_4^+ value ranged from 0.03 in 2017 to 3.9 mg/L in 2019 throughout the rainy season, with 0.03 being the lowest value. N-NH_4 indicates significant locations in 2019–2020. Because of the dense population and activities, measurements in the following locations: Soai So Reservoir, Soai Chek Reservoir, O Thum Reservoir, and O Ta Soc Reservoir were high and above the permissible level in column B1 (0.9 mg/L). The aquatic environment is impacted frequently by life activities.

P-PO_4^{3-}

The phosphorus content at monitoring sites varies and fluctuates between reservoirs. At Soai Chek and O Tuk Sa Reservoirs in 2019, during the rainy season (June and September), the P-PO_4^{3-} value is higher than what is permitted by column B1. Although the indicators at the reservoirs have altered over the years from 2017 to 2020, most of the readings are still within the acceptable limits in column B1 (0.3 mg/L) suited for water management, except for Soai Chek and O Tuk Sa Reservoirs, and household water (after standard treatment). The P-PO_4^{3-} value increases and decreases unevenly over the years and is especially high in 2019 (Figure 8).

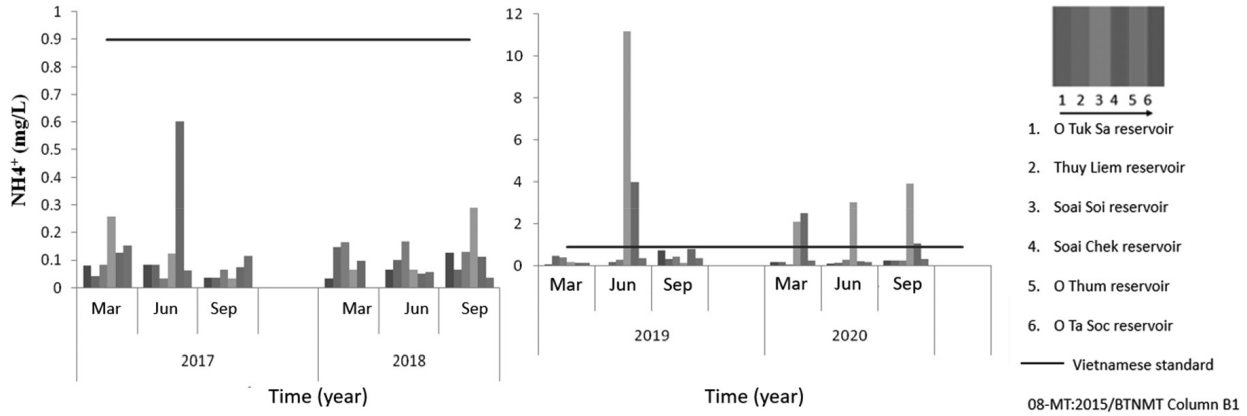

Figure 7: N-NH_4^+at reservoirs at Tinh Bien and Tri Ton from 2017 to 2010.

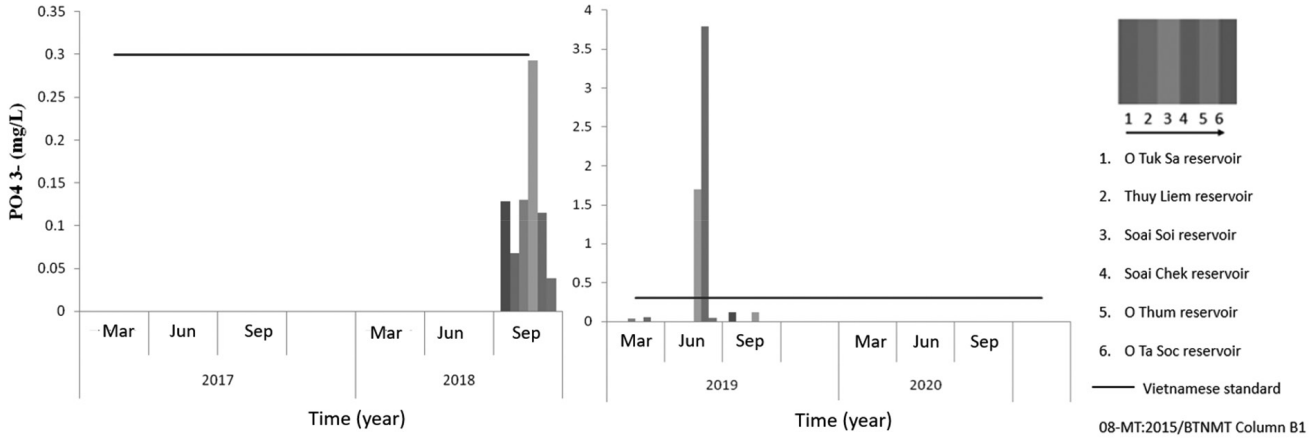

Figure 8: P-PO_4^{3-} at reservoirs at Tinh Bien and Tri Ton from 2017 to 2020.

Total Coliform

Total coliform concentration exceeded the allowed limit of the National Water Quality Technique and achieved the maximum average value in the Tri Ton district at O Tuk Sa Reservoir (150,000 MPN/100 mL) during the rainy season (June) in 2019–2020. In the dry season of 2017, water surface (Vietnamese standard 08-MT:2015/ MONRE) column B1 (7,500 MPN/100 mL) for irrigation or other applications with comparable water quality standards or uses as B2 and as low as (2,000 MPN/100 mL) were found in Thuy Liem Reservoir (Figure 9).

WQI Results

Surface water quality in ponds and reservoirs was analyzed using Decision No. 11/2019 of the Vietnam Environment Administration on criteria for measuring water quality according to WQI from 2017 to 2020 (March, June, and September). According to the findings, the WQI index spans from 0 to 92. In 2017, the lowest WQI value was at O Ta Soc Reservoir in June and September (WQI = 0), and the highest WQI value was at Soai So Reservoir in the Tri Ton district in March (WQI = 92). The average WQI index for three months at a position near the shore of O Tuk Sa Reservoir has a maximum value of 66, showing that the water quality is at an average level suitable for irrigation and other similar applications. In 2018, reservoirs around the coastlines of O Tuk Sa, Soai So, Soai Chek, and O Ta Soc had the lowest WQI values in June and September (WQI = 33), whereas O Thum Reservoir had the highest WQI values in September (WQI = 95). The average WQI index for three months at the O Thum Reservoir location is 74, suggesting that the water quality is average. By 2019, WQI values in almost all reservoirs were lowest in June and September (WQI = 0-39), with only Soai So Reservoir in March having the highest WQI value (WQI = 81); the 3-month average WQI at the O Ta Soc Reservoir location has the highest value of 39, showing poor water quality used for navigation and other equivalent purposes. In 2020, the WQI values at Soai Chek and O Thum Reservoirs were the lowest in all three months (WQI = 0), while the highest WQI values were in June and September near the coastlines of O Tuk Sa and Soai So Reservoirs. WQI = 54); The three-month average WQI at areas near the beaches of O Tuk Sa and Soai So Reservoirs is 44, showing that they only get grade B2. However, the water quality indicators significantly improved in the rainy season. When considering the criteria for water quality from the source replenished into the lake, most indicators of the physical and chemical criteria reached grade A1 in both seasons. According to WQI water quality (in lakes and from additional sources), the rainy season is relatively good, and usable for drinking water purposes. Thanh at el. (2019) found that the average annual WQI results show a substantial discrepancy between the water supply appropriate for residential use and the highly polluted water that will need to be treated in the future. The water quality at the reservoir have fluctuated throughout the years, according to the WQI index, so users are urged to perform water treatment measures for each intended application to ensure long-term health.

According to Vietnam Environment Administration Decision No. 1460/QD-TCMT, dated November 12, 2019, the WQI index is derived using measurable parameters like as temperature, pH, DO, BOD_5, COD, $N\text{-}NH_4^+$, $P\text{-}PO_4^{3-}$, and total coliform. Human activity, production, agriculture, and animal husbandry all impact water quality. Human activity also introduces significant

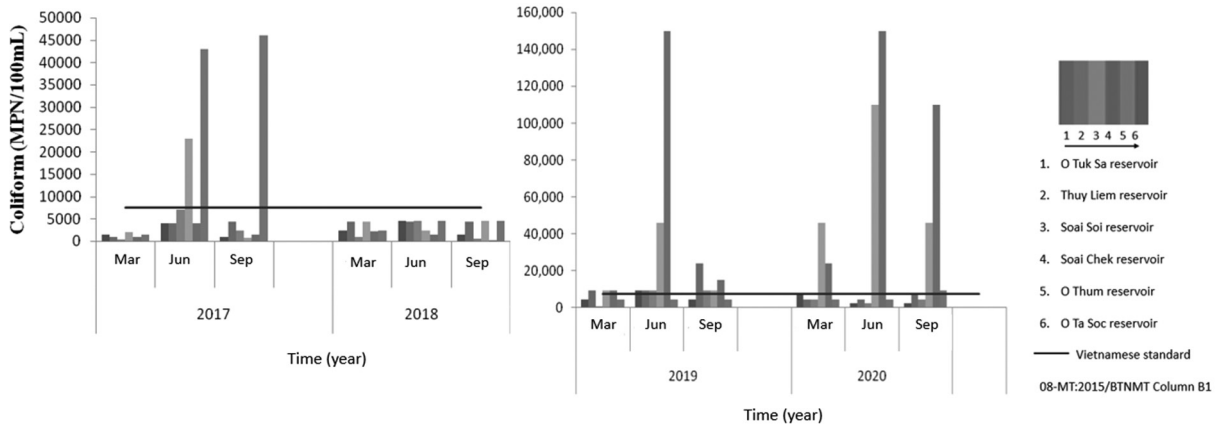

Figure 9: Total coliform at reservoir at Tinh Bien and Tri Ton from 2017 to 2020.

Table 4: Results of WQI from 2017 to 2020 according to Vietnamese standard 08-MT: 2015/MONRE

District	*Name*	*2017*			*2018*		
		Mar	*Jun*	*Sep*	*Mar*	*Jun*	*Sep*
Tinh Bien	O Tuk Sa reservoir	70	45	82	54	33	70
	Thuy Liem reservoir	81.4	45	39	39	39	39
Tri Ton	Soai Soi reservoir	91.4	18	54	81.4	33	90.8
	Soai Chek reservoir	60	0	86	39	52	33
	O Thum reservoir	81.4	45	70	58	70	95.2
	O Ta Soc reservoir	70	0	0	54	33	33
District	*Name*	*2019*			*2020*		
		Mar	*Jun*	*Sep*	*Mar*	*Jun*	*Sep*
Tinh Bien	O Tuk Sa reservoir	39	7	39	25	54	54
	Thuy Liem reservoir	7	7	0	39	39	25
Tri Ton	Soai Soi reservoir	81.4	7	7	39	54	39
	Soai Chek reservoir	7	0	7	0	0	0
	O Thum reservoir	7	0	0	0	0	0
	O Ta Soc reservoir	39	39	39	39	39	7

amounts of trash and pollutants into waterways. Therefore, the demand for water supply for domestic use cannot be met after being treated according to Vietnamese Standard 08-MT:2015/MONRE.

During the rainy season, several natural variables such as algae proliferation, erosion, river bank erosion, flow rate generating soil and rock formation, and suspended solids are affected. This primarily because of the local people, including residential activities and garbage disposal. Agricultural production activities such as fertilising with inorganic fertilisers, fertilising with excess fertilisers, pesticide residues in crop and animal husbandry, and waste from human and animal feces all had a substantial impact on water quality in the studied locations. The water quality in the study regions cannot match the demand for residential water supply after being treated according to the Vietnamese standard 08-MT:2015 /BTNMT because of the significant volume of waste and high concentration of pollutants in the water stream.

Conclusion

The study evaluated according to secondary data compared with QCVN 08/2015-BTNMT and based on the WQI quality criteria to assess the water quality in reservoirs in Tri Ton and Tinh Bien districts, An Giang province. The results show that in the period 2017-2020, some water quality indicators exceed the permissible standards for domestic surface water in column B1 ($N\text{-}NO_3^-$, total coliform, BOD_5, COD, $N\text{-}NH_4^+$) but are consistent with column B1 using column B1 which can be used for irrigation and irrigation purposes. According to the aforementioned assessment and study, the water quality in some reservoirs has changed significantly over the years; however, the overall status of reservoir water quality is on the decline. Aside from the clear direct factors that affect water quality, there are also potential indirect effects. The excessive and unacceptable analytical standards result from untreated direct discharge, which has damaged and degraded water quality.

Surface water quality is bad near the coasts of O Tuk Sa Reservoir (Tinh Bien), Soai Chek Reservoir (Tri Ton), and O Ta Soc Reservoir (Tri Ton), and it degrades over time. The pH, DO, and BOD_5 indices vary the most between reservoirs.

Calculation findings show that for several years, the WQI values in Tinh Bien and Tri Ton districts have shown low water quality levels because wastewater here is extremely polluted and requires curbing measures and adequate treatment. WQI values near the shores of

O Tuk Sa Reservoir (Tinh Bien), Soai Chek Reservoir (Tri Ton), and O Ta Soc Reservoir (Tri Ton) decline. WQI values near the shores of O Tuk Sa Reservoir (Tinh Bien), Soai Chek Reservoir (Tri Ton), and O Ta Soc Reservoir (Tri Ton) decline over time. The more away from the waste source the monitoring point, the higher the water quality; conversely, the closer to the waste source, the smaller the WQI value, the poorer the quality. Water quality at monitoring stations in An Giang province is deteriorated with time. As a result, the evolution of water quality in reservoirs and ponds from 2017 to 2020 shows that, in 2019 and 2020, most monitoring locations had lower values than in 2017 and 2018. Owing to this concern, the necessity to treat and limit residential water supply that becomes severely polluted is required. According to the WQI index, the water quality at the reservoir monitoring stations has fluctuated throughout the years, so it is advised that people implement water treatment processes considering their long-term health. However, the data series of water quality in the reservoirs are limited, thus it is essential to keep monitoring.

References

General Department of Environment (GDE), 2015. Decision No: 1460/QD-TCMT. DoNRNes

Minh, H.V.T. et al., 2022. "Implications of climate change and drought on water requirements in a semi-mountainous region of the Vietnamese Mekong Delta. *Environmental Monitoring and Assessment*, **194(Suppl. 2):** 766.

Nam, N.D.G., Nhu, L., Van Thinh, Y.L., Minh, H.V.T., Kumar, P. and N.V.C. Ngan, 2022. Evaluating reference crop evapotranspiration of the selected field crops grown in different agricultural regions in the Vietnamese Mekong Delta. *Journal of Climate Change*, **8(2):** 1-12.

Parry, M.L., Canziani, O., Palutikof, J., Van der Linden, P. and C. Hanson, 2007. Climate change 2007-impacts, adaptation and vulnerability: Working group II contribution to the fourth assessment report of the IPCC, Vol. 4. Cambridge University Press.

Schneider, E. and Nocke, T., 2014. Intergovernmental Panel on Climate Change. *In:* Image Politics of Climate Change: Visualizations, Imaginations, Documentations, Bielefeld: Transcript Verlag.

Thanh, N.T., Ty, T.V., Minh, H.V.T. and Luan, T.C., 2022. Assessment of current state of water quality in O Ta Soc lake in Luong Phi Commune, Tri Ton District, An Giang province, *In:* Geographic and constructionservice sustainable development, Ha Noi, Viet Nam: Construction Engineering and building materials, pp. 406-441.

Thoảng, T.T. et al., 2022. Assessment of potential rainfall distribution patterns and their relationship with inundation in Tra Vinh Province, Vietnam. *Journal of Climate Change*, **8(4):** 51–61.

Tinh Bien portal, 2019. General information. http://tinhbien.angiang.gov.vn (accessed Sep. 06, 2021).

Tri Ton portal, 2019. General information. http://triton.angiang.gov.vn (accessed Sep. 06, 2021).

Tổng Cục Môi trường, Quyết định số: 1460/QĐ-TCMT". Quyết định số 1460/QĐ-TCMT Về việc ban hành hướng dẫn kỹ thuật tính toán và công bố chỉ số chất lượng nước Việt Nam (VN_WQI), 2019, Bộ Tài nguyên và Môi trường, Hà Nội, Việt Nam

Vi, P.T.T., Minh, H.V.T., Tri, L.H., Khanh, L.H. and Ty, T.V., 2021. Assessment of water supply capacity from Otuksa reservoir for different production models in Tinh Bien district, An Giang province. *Viet Nam Journal of Hydro-Meteorology* **730:** 42-52. doi:10.36335/VNJHM.2021(730).42-52.