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Evaluating Coastal Water Quality in Soc Trang province, Vietnam

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Abstract

The study was conducted to assess the changes of coastal sea water quality in 2021 in Soc Trang province, Vietnam. Monitoring of coastal sea water quality was carried out with a frequency of 4 times/year at three locations NB1, NB2 and NB3. At each monitoring location, 14 parameters were collected, respectively, including temperature, pH, turbidity, salinity, conductivity (EC), suspended solids (TSS), chemical oxygen demand (BOD), mineral oil, phosphate ($P\text{-}PO_4^{3-}$), nitrate ($N\text{-}NO_3^-$), nitrite ($N\text{-}NO_2^-$), ammonium ($N\text{-}NH_4^+$), iron (Fe) and coliform. The results of each monitoring parameter were compared with the National Technical Regulation on Sea Water Quality (QCVN 10-MT: 2015/BTNMT) for the purpose of aquaculture and conservation of aquatic species. The results show that the coastal water quality in Soc Trang province is still relatively good. Most of the coastal water quality monitoring parameters do not appear to be polluted. Only 2 out of 14 monitored parameters, TSS and Fe, respectively, appear to be contaminated with high concentrations. The high content of TSS and Fe in the water poses many risks of harm to aquatic organisms in the study area and costs a lot to treat before use. The cause of pollution in the coastal area of Soc Trang may stem from the natural conditions of the area, influenced by the amount of surface water from the estuaries into the sea.

1. Introduction

Coastal provinces in the Vietnamese Mekong Delta are expanding and developing aquaculture, tourism, non-agricultural industries in order to adapt well to saline intrusion in the context of climate change [1]. Soc Trang is a coastal province in the Mekong Delta region, with a coastline of about 72 km and three large estuaries pouring into the East Sea. According to the data from the General Statistics Office [2], the marine economic sectors have been strongly invested and developed recently. Similarly, the tourism activities have now been increasing that is indicated through the increasing number of tourist boats and the amount of finance investment. Along with social-economic development in the coastal area, surface water and groundwater resources are becoming scarcity due to the increase in water consumption [3]. Coastal water is currently becoming important for such social-economic development in the coastal area since the coastal water can be used for coastal aquaculture and tourism. As can be seen that coastal water play a key role in creating economic values for coastal dwellers. However, the social economic development in the coastal areas may result in coastal water degradation. Therefore, the monitoring and evaluation of coastal water quality is urgently needed. Maintaining and preserving coastal water quality is a long-term activity that can be achieved through constantly monitoring of coastal surface water for appropriate mitigation action. This study was carried out to evaluate coastal water quality in Soc Trang province

in 2021 in order to provide scientific and necessary information for the planning and use of coastal water sources appropriately.

2. Materials and methods

2.1. Water sampling and analysis

The study synthesized monitoring data of coastal sea water quality at three locations, respectively NB1, NB2 and NB3. The coordinates of the sampling locations are shown in Figure 1. Sampling frequency at each location was carried out four times per year. The sampling and analysis of coastal water were performed by relevant laboratory from the Department of Natural Resources and Environment of Soc Trang province.

Figure 1. Map of location of coastal water sampling in Soc Trang province in 2021

Coastal seawater in Soc Trang is monitored with 14 parameters including temperature, pH, turbidity, salinity, electrical conductivity (EC), suspended solids (TSS), chemical oxygen demand (BOD), and chemical oxygen demand (BOD), mineral oil, phosphate ($P\text{-}PO_4^{3-}$), nitrate ($N\text{-}NO_3^-$), nitrite ($N\text{-}NO_2^-$), ammonium ($N\text{-}NH_4^+$), iron (Fe) and coliform to assess water quality. In which, the parameters of temperature (^oC), pH, turbidity (NTU), salinity (‰) and EC (mS/cm) were measured at the field. The remaining parameters include TSS (mg/L), mineral oil (mg/L), BOD (mg/L), $N\text{-}NH_4^+$ (mg/L), $P\text{-}PO_4^{3-}$ (mg/L), $N\text{-}NO_3^-$ (mg/L), $N\text{-}NO_2^-$ (mg/L), Fe (mg/L) and coliform (MPN/100mL) were collected, handled, stored and analyzed according to current standard methods [4].

2.2. Data analysis

The data of each monitoring parameter are synthesized, processed and analyzed on Microsoft Excel 2013 software. The value of each parameter is also compared with the allowable limit of the national technical regulation on water quality (group of coastal seawater quality) corresponding to the purpose of aquaculture and aquatic conservation (QCVN 10-MT:2015/BTNMT) [5].

3. Results and discussion

Temperature: The average temperature at the coastal sea water quality monitoring locations is 29.2 ^oC (NB1), 29.9 ^oC (NB2) and 29.6 ^oC (NB3), respectively (Figure 2). The temperature in the

study area hardly changes and tends to be balanced among the monitoring locations. This helps the growth and development of aquatic organisms can take place normally.

Salinity: The average salinity in the study area ranges from 9.31 to 16.9‰ (Figure 2). At site NB1, salinity reached the highest value and position NB2 reached the lowest value. The difference in salinity between sites can be caused by mixing with fresh water, timing of tides, strong winds or seasonality [6].

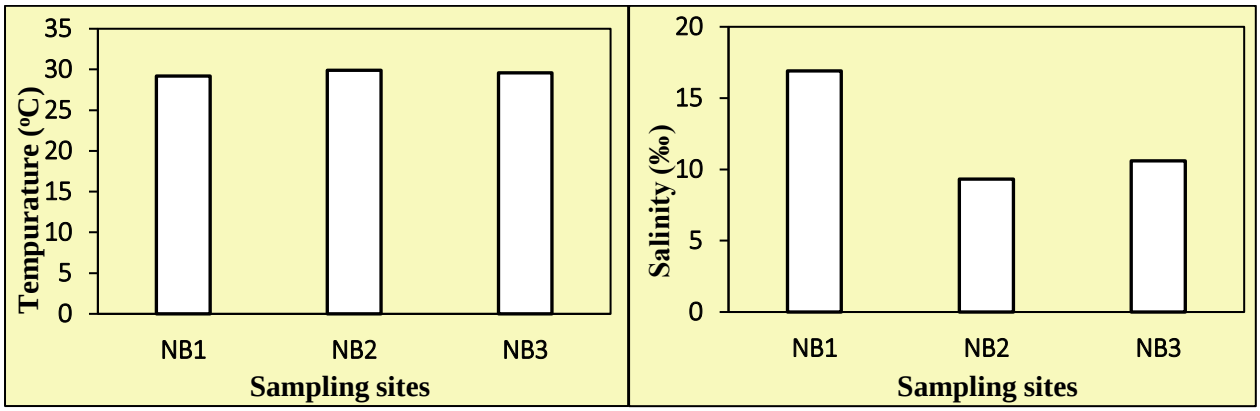

Figure 2. Evolution of temperature and salinity in the study area

pH: The pH parameters at the monitoring locations do not fluctuate or are too different from each other and are almost balanced. Specifically, the pH in the study area is at neutral level, ranging from 7.64 to 7.68 (Figure 3) and within the allowable threshold QCVN 10-MT:2015/BTNMT for aquaculture use and aquatic life conservation.

Electrical conductivity: The average electrical conductivity (EC) at the study area ranged from 17.1 to 39 mS/cm reaching the highest value at position NB1 and the lowest value at position NB3 (Figure 3). There is a large EC difference between the sampling sites. Conductivity in the study area tends to decrease in the direction from North to South.

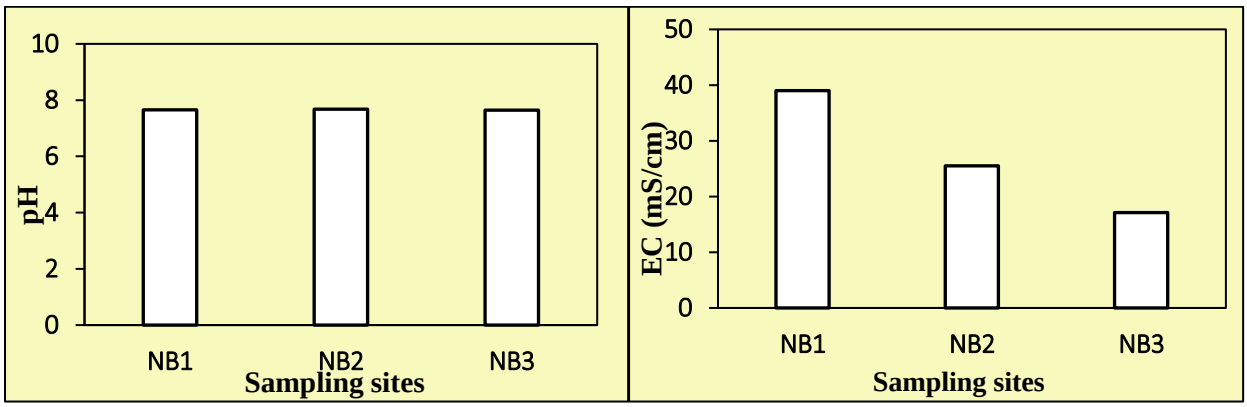

Figure 3. Evolution of pH and conductivity (EC) in the study area

Total suspended solids: The monitoring results showed that the total suspended solids (TSS) in the study area ranged from 82.6 to 162.9 mg/L (Figure 4). The current TSS is much higher than QCVN 10-MT:2015/BTNMT (50 mg/L). At position NB1, TSS was 2.76 times higher than the allowable threshold (137.8 mg/L), NB2 was 82.6 mg/L, 1.65 times higher and NB3 (162.9 mg/L) was 3.26 times higher than allowable threshold for aquaculture and conservation purposes. According to MCF [7], high TSS concentration in surface water in river basins is a common situation of the whole Mekong Delta region. Therefore, the amount of surface water flowing into the sea is likely to carry a large amount of TSS in the water. This may explain why TSS parameters

in coastal seawater reach high values. In addition, at the time of sampling, there were large waves that stirred up the sediment below the surface, causing the TSS value to increase [8]. TSS in the study area is too high, seriously affecting the uses of coastal seawater, especially aquaculture and conservation of aquatic species.

Turbidity: The analysis results in Figure 4 show that the turbidity in coastal seawater in Soc Trang province ranges from 83.7 to 156.2 NTU (Figure 4). There is a variation between locations in the study area, specifically position NB2 (83.7 NTU) tends to be lower than the other two locations, NB1 (132.6 NTU) and NB3 (156.62 NTU). Turbidity and suspended solids are closely related, so TSS content in the study area is very large leading to high turbidity values.

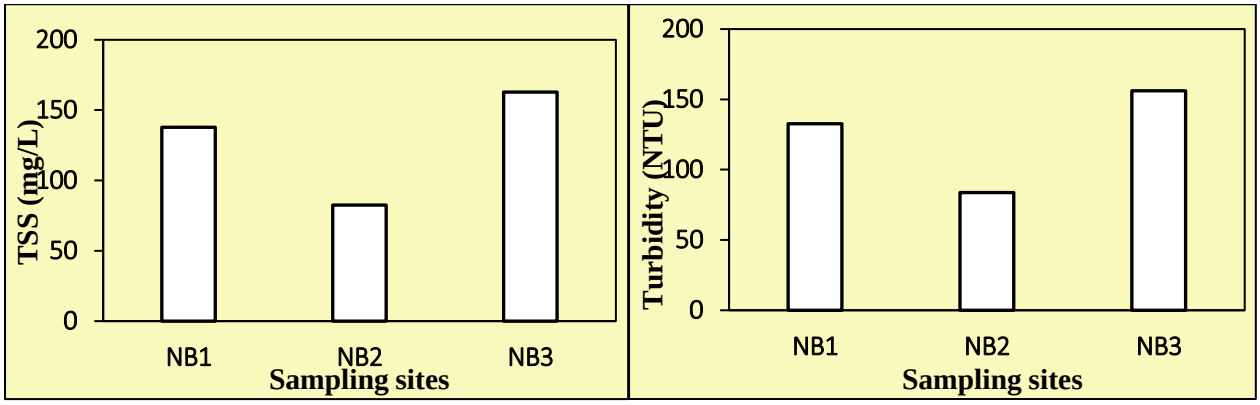

Figure 4. TSS evolution and turbidity in the study area

Oil and grease: According to QCVN 10-MT:2015/BTNMT, the limit of mineral oil and grease parameters is 0.5 mg/L for the purpose of aquaculture and conservation of aquatic species. Analysis results at monitoring locations in Soc Trang province show that all are below the allowable threshold. At NB1 position, mineral oil and grease parameters were not detected during the monitoring period. The NB3 position reached the highest value (0.48 mg/L), followed by NB2 with the mineral oil value of 0.36 mg/L (Figure 5).

Biochemical oxygen demand (BOD): The analysis results of Figure 5 show that the BOD concentration in the study area ranges from 2.0925 to 2.34 mg/L (Figure 5). Highest value was at NB1 and lowest was at NB2. The BOD concentration at the locations tends to be equal, there is not too much difference in value between the sampling sites. In the study area, TSS content reached a very high value but BOD was low, showing that the water quality here is less polluted by organic matter.

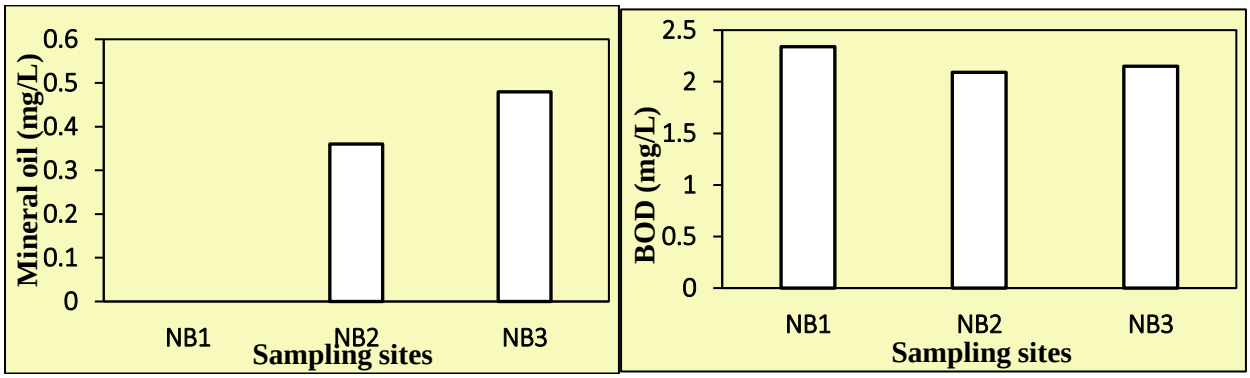

Figure 5. Evolution of mineral oil and grease in the study area

Nitrate: In the study area, the concentration of N-NO_3^- ranged from 0.055 to 0.104 mg/L (Figure 6). The positions have volatility relative to each other, NB1 has the lowest and highest value

at NB3. The concentration of $N\text{-}NO_3^-$ tends to decrease gradually from the south to the north. Compared with the results of the study in Rach Gia monitoring station in the period 2012 to 2016, the concentrations of both $N\text{-}NO_2^-$ and $N\text{-}NO_3^-$ (0.0028 to 0.139 mg/L and 0.178 to 1.303 mg/L) have higher values than the fluctuation threshold in the study area [9]. Nitrate is a nutrient source that could facilitate the growth of phytoplankton that is the primary source of food for other living organisms in the coastal waters.

Nitrite: The concentration of $N\text{-}NO_2^-$ in the study area ranged from 0.008 to 0.031 mg/L (Figure 6). In which, NB1 reached 0.012 mg/L, NB2 was 0.008 mg/L (the smallest) and NB3 was 0.031 mg/L (the largest). The range of oscillations of $N\text{-}NO_2^-$ in the study area is relatively narrow and the difference between locations is very small. Nitrite is the intermediate product of nitrification. It can be toxic to living organisms in high level by forming HNO_2.

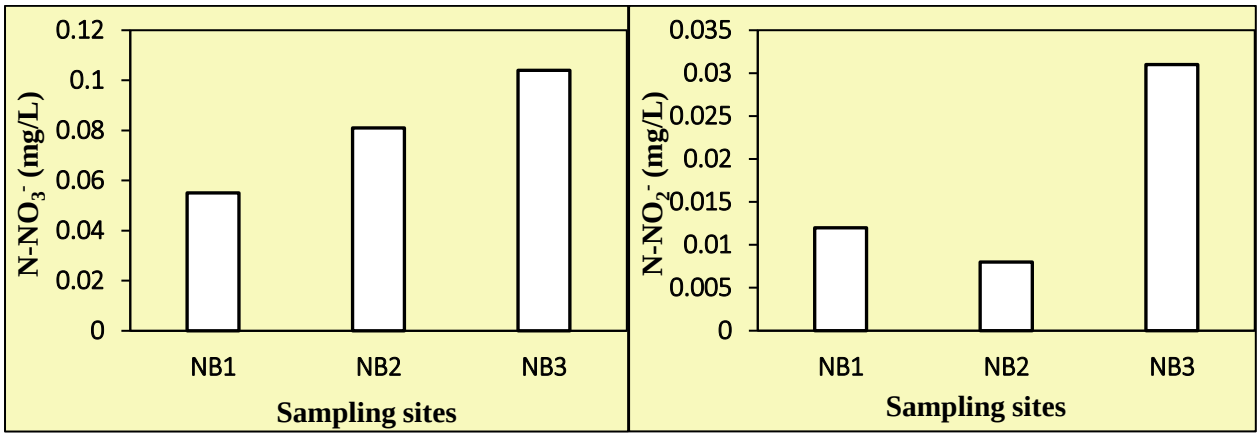

Figure 6. Evolution of nitrate and nitrite in the study area

Ammonium: The results of Figure 7 show that the concentration of $N\text{-}NH_4^+$ in the study area has little variation, the $N\text{-}NH_4^+$ value here ranges from 0.048 to 0.055 mg/L. All monitoring locations are below the allowable threshold according to the Technical Regulation on coastal water quality (QCVN 10-MT:2015/BTNMT). Low $N\text{-}NH_4^+$, suitable for activities using coastal seawater quality for farming and conservation purposes.

Orthphosphate: The results of analysis of Phosphate parameters ($P\text{-}PO_4^{3-}$) in Figure 7 show that all values are below the allowable threshold compared to the regulation of 0.2 mg/L according to QCVN 10-MT:2015/BTMNT. At NB1, $P\text{-}PO_4^{3-}$ reached 0.035 mg/L, NB2 was 0.085 mg/L and NB3 was 0.048 mg/L. The value of $P\text{-}PO_4^{3-}$ at the locations fluctuated but was not significant. The results of the nutritional indicators in the area also show that the coastal sea water quality does not currently receive many waste sources from farming activities or daily life of the people, which can be used for the purpose of cultivating or conserving aquatic species in the study area.

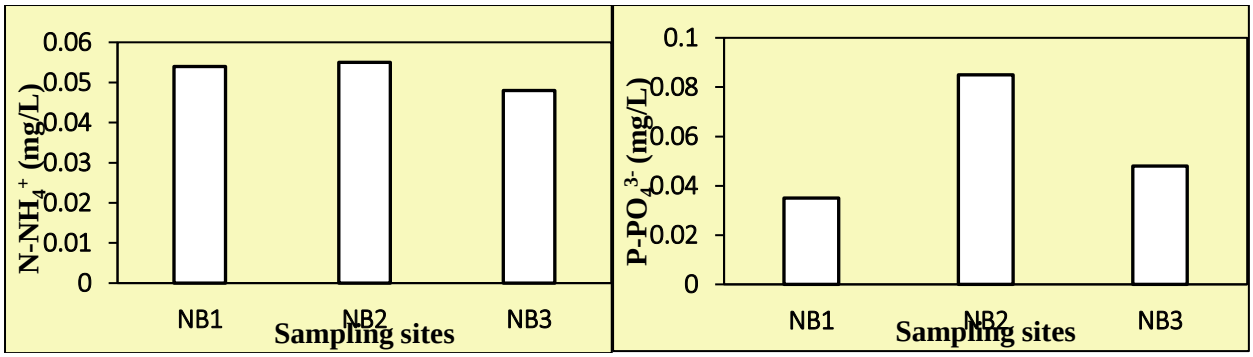

Figure 7. Evolution of ammonium and phosphate in the study area

Iron: The content of iron metal (Fe) in coastal seawater in Soc Trang is at a high level. Fe content ranges from 1.03 to 2.64 mg/L (Figure 8), 2.06 to 5.28 times higher than QCVN 10-MT:2015/BTNMT. In which, position NB2 has the lowest value and the highest value belongs to position NB3. The high Fe content in the study area is similar to the TSS parameter when the high and low values tend to be the same. So, it is very likely that the suspended solids in the water contain Fe metal compounds. In addition, the cause of high Fe in coastal seawater may come from acid sulfate soil contaminated surface water pouring into the sea.

Coliform: The results of the analysis of Coliform criteria in the study area at all locations are below the prescribed threshold and much smaller than QCVN 10-MT:2015/BTNMT. Specifically, at position NB1 the coliform concentration reached the lowest value (22 MPN/100mL) 45.45 times lower than the norm, NB2 reached the highest value (670 MPN/100mL) which was 1.49 times lower than the allowable threshold. times and NB3 (260 MPN/100mL) is 3.85 times lower (Figure 8).

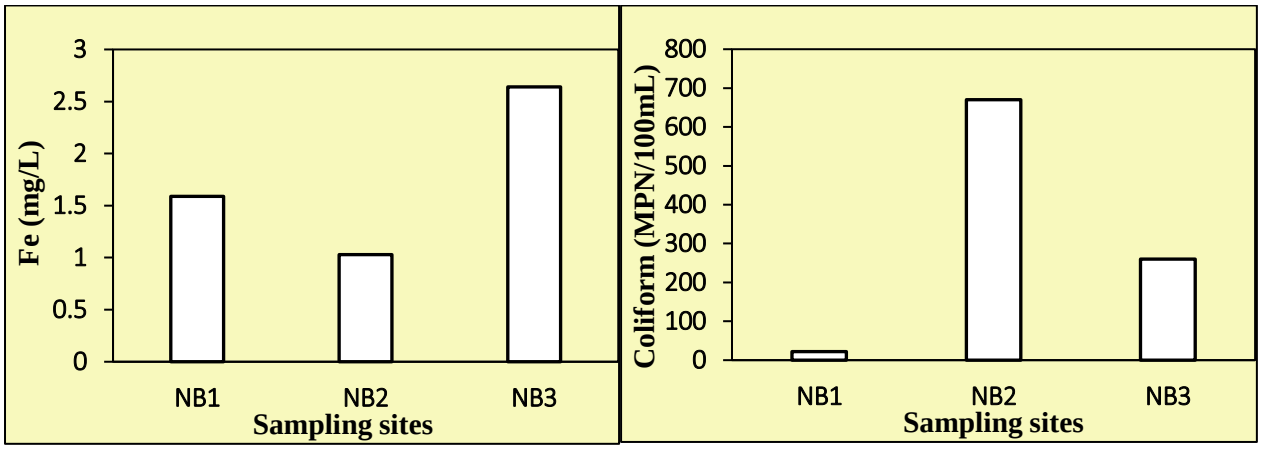

Figure 8. Evolution of iron (Fe) and coliform in the study area

4. Conclusion

The results show that the coastal water quality in Soc Trang province in 2021 is at a relatively good level. Most of the monitoring parameters were below the allowable thresholds according to QCVN 10-MT:2015/BTNMT for the purpose of aquatic life conservation and aquaculture. TSS and Fe exceeded the allowable limits. The cause of the high TSS may be due to phytoplankton, river bank erosion and hydrology. The high Fe content in the area may stem from the natural conditions, for example acid sulphate soil. Coastal water quality should be maintained at good level for maintaining economic activities and coastal biodiversity conservation. Appropriate measures should be taken to improve coastal water quality, particularly focus on the threshold exceeding parameters.

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