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Evaluation of Rainwater Quality in Soc Trang city, Soc Trang province, Vietnam

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Abstract

This study aims at assessing rainwater quality in Soc Trang province in 2021. Water quality parameters include pH, sulphate (SO_4^{2-}), nitrite ($N\text{-}NO_2^-$), nitrate ($N\text{-}NO_3^-$), ammonium ($N\text{-}NH_4^+$), sodium (Na^+), calcium (Ca^{2+}) and chloride (Cl^-) were collected at three locations (Soc Trang city, Vinh Chau town and Nga Nam town) in May and November. Rainwater quality is compared with the National Technical Regulation on quality of clean water used for domestic purposes (QCVN 01-1:2018/BYT). The research results show that the quality of rainwater in the study area can be used for domestic purposes. Rainwater quality parameters have very low values and are within the allowable limits of QCVN 01-1:2018/BYT. Rainwater in the study area can be used as an alternative to other water resources. However, it is necessary to have measures for collection and treatment before recommending to people for effective use so as to ensure health safety. The study provides important information on rainwater quality in Soc Trang province for rainwater quality planning and management.

1. Introduction

The quality of surface water and groundwater in the water bodies of the Mekong Delta is currently facing many pollution problems such as organic and microbiological pollution [1-2]. In addition, the overexploitation of these water sources for socio-economic development and daily life has led to water scarcity and a decline in some provinces in the Mekong Delta [3]. Therefore, it is necessary to find alternative sources of surface water and groundwater for the future.

Rainwater is considered as one of the potential resources, capable of replacing and supplementing other resources in the near future. The average rainfall in the Mekong Delta is estimated to range from 1200 to 2400 mm/year, with the rainy season starting from May to November [4] this can be a major source of fresh water supply for the daily activities and production of people in the area.

Soc Trang is a coastal province and has a dense network of rivers in the Mekong Delta. Currently, surface water in the province is affected by saline intrusion and the subsidence is becoming more and more serious due to over-exploitation of groundwater resources [5]. This has led to many areas in the province experiencing water scarcity for production and daily life, especially in the dry

season. Therefore, the storage and use of rainwater in daily life will solve the problem of water scarcity in the dry season in the province. However, the quality of rainwater may be affected by urbanization and dust from transportation. In addition, when using poor quality rainwater can increase the risk of diarrhea and cholera [6]. Therefore, this study aims to evaluate the quality of rainwater in Soc Trang province in order to have suitable treatment solutions for domestic purposes. Research results provide useful scientific information to contribute to the planning and management of sustainable rainwater sources in the future.

2. Materials and methods

2.1. Rainwater sampling and analysis

Monitoring data are collected from the Department of Natural Resources and Environment of Soc Trang province in 2021. Water samples were collected in major cities in the province including Soc Trang city (M1), Vinh Chau town (M2). and Nga Nam town (M3) (Figure 1) with a frequency of 02 times/year (May and October).

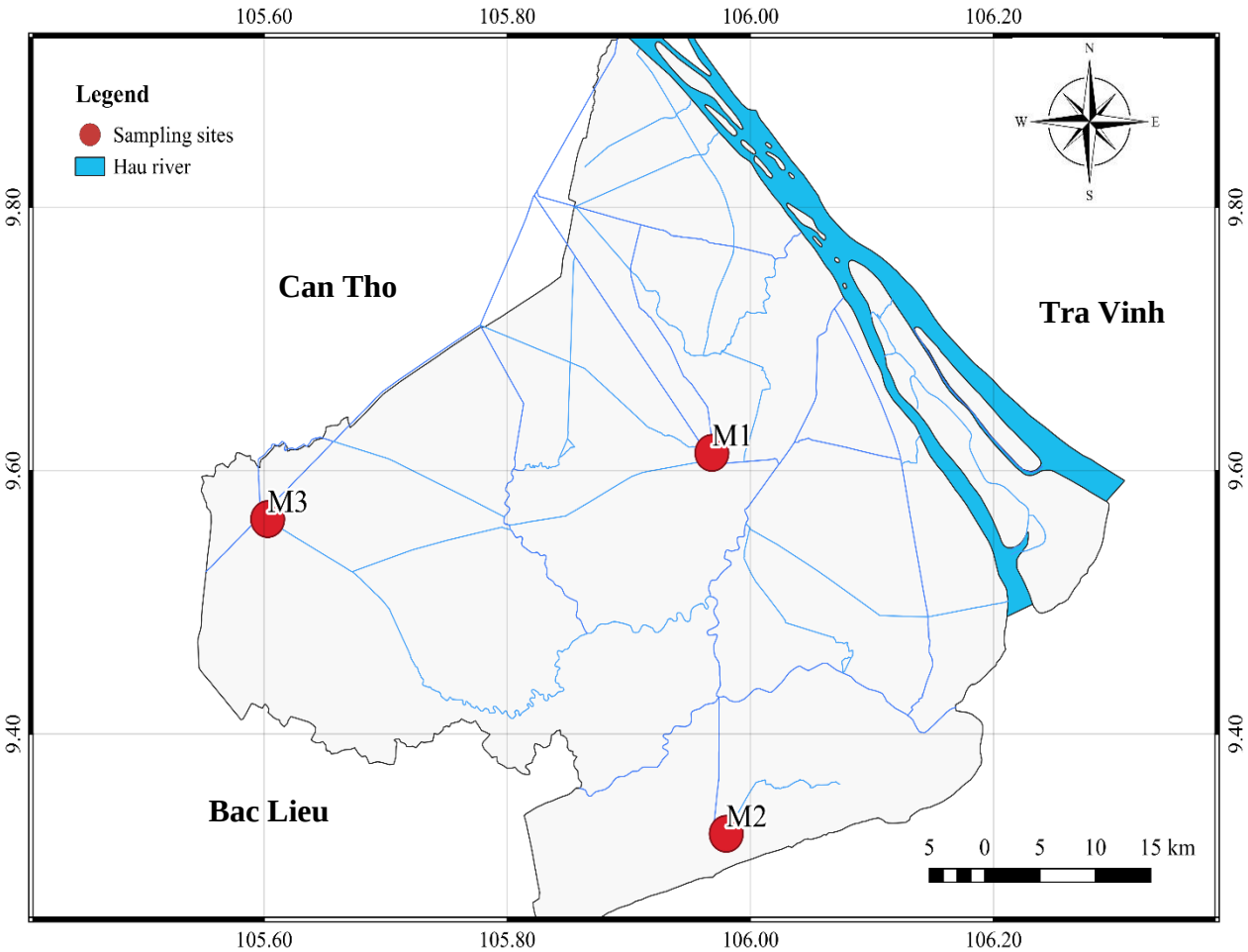

Figure 1. Rainwater quality monitoring location in Soc Trang province

Water quality monitoring parameters include the pH, sulphate (SO_4^{2-}), nitrite ($N\text{-}NO_2^-$), nitrate ($N\text{-}NO_3^-$), ammonium ($N\text{-}NH_4^+$), sodium (Na^+), calcium (Ca^{2+}) and chloride (Cl^-). The pH parameters were measured in the field while the remaining parameters were analysed in the laboratory using standard methods [7].

2.2. Data processing

Rainwater quality data is synthesized, processed and analyzed using Microsoft Excel 2013 software. The analyzed results of each parameter are compared with the National Technical Regulation on quality of clean water used for purposes. activities (QCVN 01-1:2018/BYT) [8].

3. Results and discussion

pH: The average pH value at three sampling locations did not fluctuate much, ranging from 6.81±1.05 - 7.95±0.57 as shown in Figure 2. For rainwater, when the pH is less than 5.6, it is considered as acid rain [9]. It can be seen that the quality of rainwater in Soc Trang province in 2021 is not acidic and within the allowable limits of QCVN 01-1:2018/BYT (6.0-8.5) [8], suitable for use for domestic purposes.

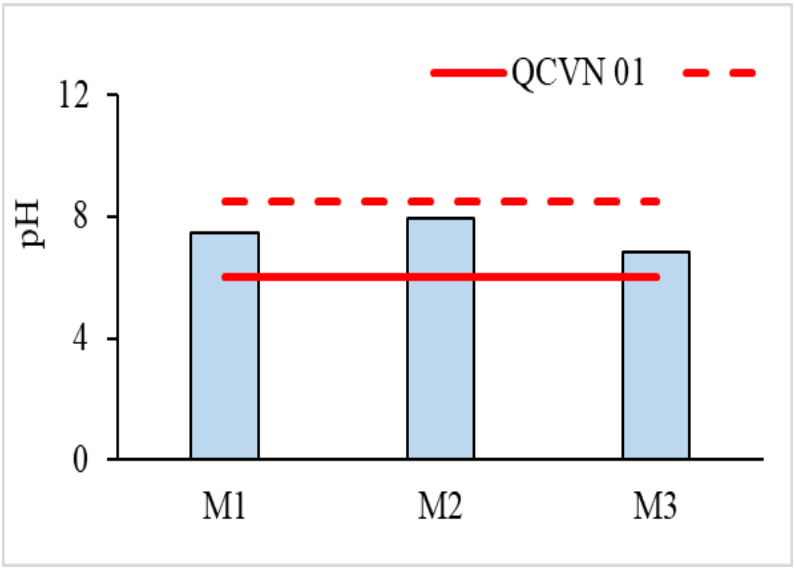

Figure 2. Rainwater pH parameter in Soc Trang province in 2021

Sulphate (SO_4^{2-}): The results of sulphate parameter analysis at the sampling sites are shown in Figure 3. The average SO_4^{2-} concentration at the M1 site (Soc Trang city) is 5.64±0.46 mg/L, the M2 is 13.00±14.85 mg/L and at the M3 site recorded below the detection threshold. SO_4^{2-} value is within the allowable threshold of QCVN 01-1:2018/BYT (250 mg/L) [8]. SO_4^{2-} and SOx-based parameters appear in rainwater, which can be caused by traffic dust, exhaust fumes from industrial parks [10]. It can be seen that SO_x released into the atmosphere from human activities in the study area is only moderate or negligible.

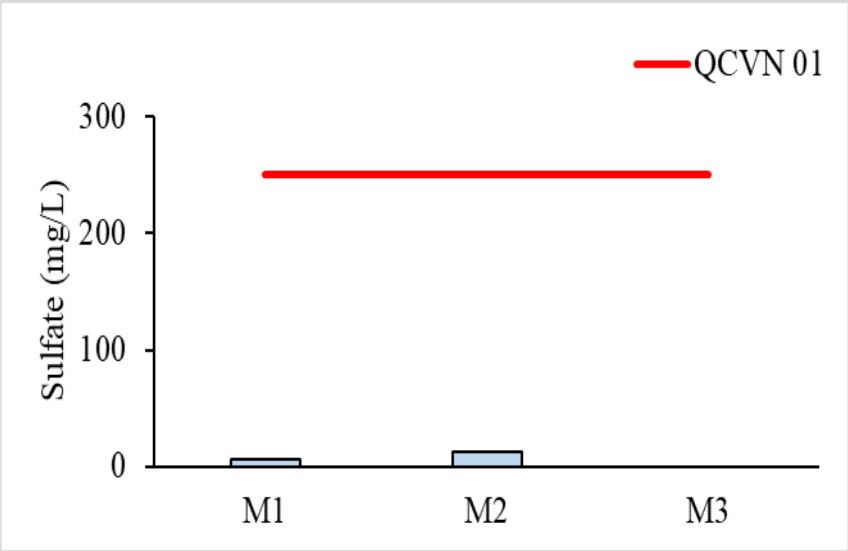

Figure 3. SO_4^{2-} parameter in rain water in Soc Trang province in 2021

Nitrite ($N\text{-}NO_2^-$): Similar to SO_4^{2-} parameter, the average $N\text{-}NO_2^-$ content fluctuated between sampling locations (Figure 4). At the M1 position, the $N\text{-}NO_2^-$ value reached 0.005±0.00 mg/L, the M2 position reached 0.029±0.04 mg/L and the $N\text{-}NO_2^-$ value at the M3 position was still below the detection threshold. The $N\text{-}NO_2^-$ value at three sampling locations is still within the allowable limits of QCVN 01-1:2018/BYT (0.05 mg/L) [8]. When rain water contains a lot of SO_x and NO_x substances, it will easily lead to acid rain, causing many disadvantages to plants, animals, humans and infrastructure [11].

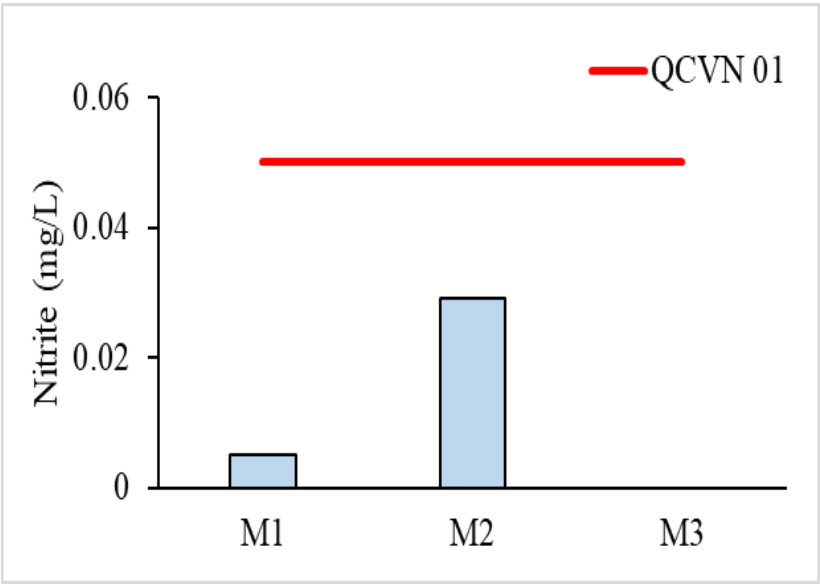

Figure 4. $N\text{-}NO_2^-$ parameter in rainwater in Soc Trang province in 2021

Nitrate ($N\text{-}NO_3^-$): The concentration of $N\text{-}NO_3^-$ in rainwater in the study area varied quite large in the range from 0.035±0.03 to 0.63±0.51 mg/L (Figure 5). In which, the smallest $N\text{-}NO_3^-$ value recorded at the M1 position was 0.035±0.03 mg/L and the largest $N\text{-}NO_3^-$ value recorded at the M2 position was 0.63±0.51 mg/L. The concentration of $N\text{-}NO_3^-$ is still lower than the allowable threshold of QCVN 01-1:2018/BYT (2 mg/L) [8]. According to Cobbina et al. [6], $N\text{-}NO_3^-$ in rainwater is considered a non-accumulative poison.

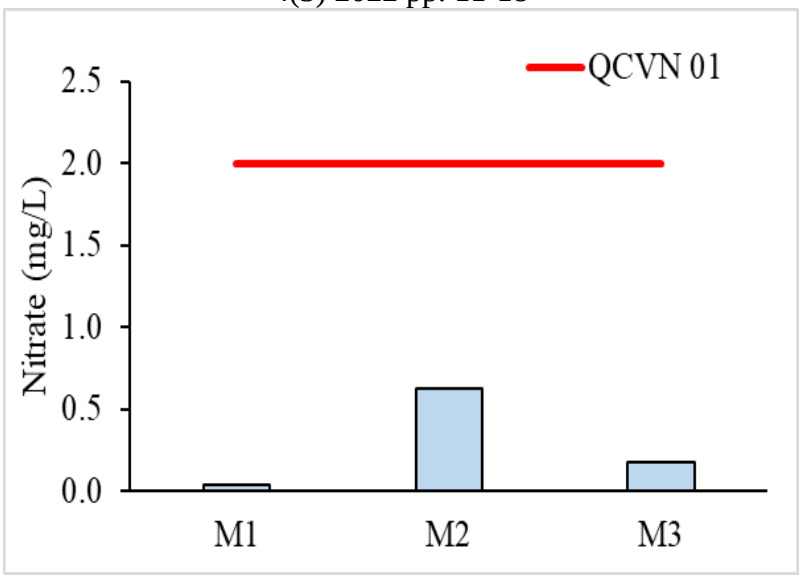

Figure 5. N-NO_3^- parameter in rainwater in Soc Trang province in 2021

Ammonium (N-NH_4^+): The average N-NH_4^+ concentration in the study area did not differ much (Figure 6). Three sampling locations have N-NH_4^+ values of 0.16±0.05 mg/L, 0.11±0.06 mg/L and 0.06±0.01 mg/L, respectively. There is no location where the concentration of N-NH_4^+ exceeds the allowable limit of QCVN 01-1:2018/BYT (0.3 mg/L) [8]. The concentration of N-NH_4^+ in rainwater is mainly related to ammonia emissions, which are commonly found in areas of intensive agricultural production [12]. In addition, when the concentration of N-NH_4^+ in rainwater is high, it will lower the pH and easily cause acid rain [13].

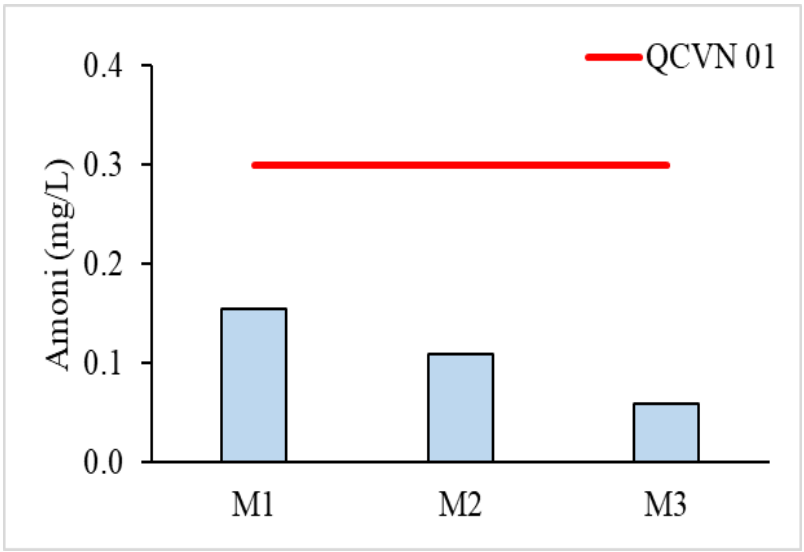

Figure 6. N-NH_4^+ parameter in rainwater in Soc Trang province in 2021

Sodium (Na^+): The concentration of Na^+ did not differ significantly between the monitoring sites, ranging from 0.96±0.68 mg/L to 3.28±0.11 mg/L, the average value being 2.09±1.16 mg/L (Figure 7). The concentration of Na^+ in Soc Trang is still within the allowable range and many times lower than QCVN 01-1:2018/BYT (200 mg/L). However, for people with health problems such as heart disease or high blood pressure, the maximum allowable concentration of Na^+ in drinking and domestic water is 20 mg/L [6].

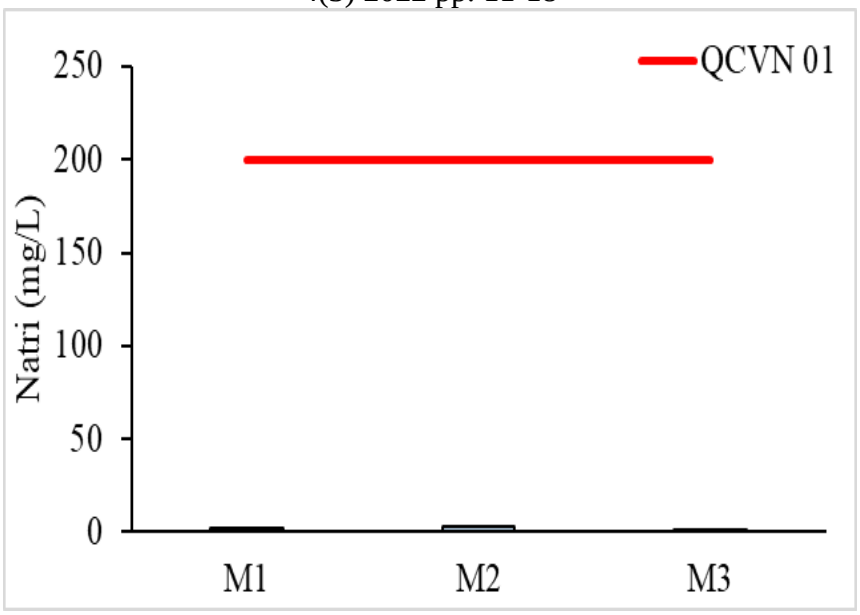

Figure 7. Na^+ parameter in rainwater in Soc Trang province in 2021

Calcium (Ca^{2+}): Figure 8 shows that the average Ca^{2+} concentration at three sampling sites fluctuated quite large. The highest Ca^{2+} value recorded at the M2 site was 9.46±6.57 mg/L and the lowest value at the M3 site was 0.23±0.16 mg/L. Ca^{2+}, K^+, Mg^{2+} and $N\text{-}NH_4^+$ are considered parameters to help neutralize acid in rainwater. When using rain water with low concentrations of micro-minerals, it is easy to cause health problems such as cardiovascular disease in adults and the risk of fractures in children [6]. In addition, these parameters also have a negative correlation with pH in rainwater [9].

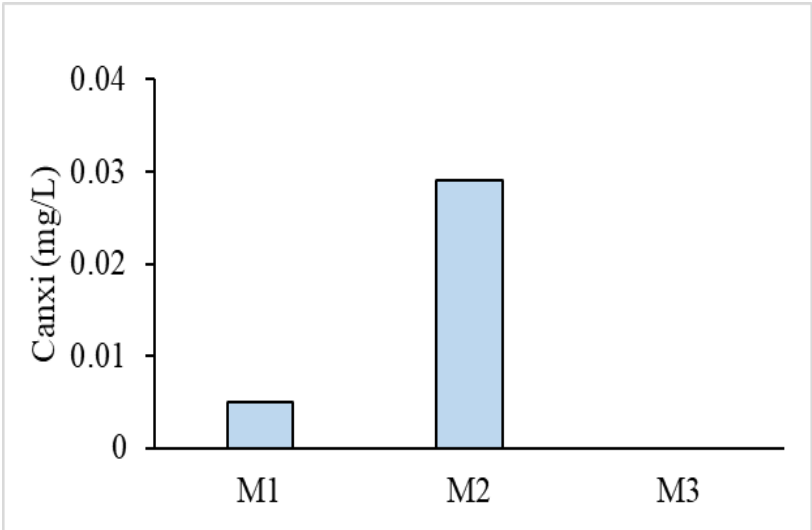

Figure 8. Ca^{2+} parameters in rainwater in Soc Trang province in 2021

Chloride (Cl^-): The results of analysis of Cl^- content at three sampling locations are shown in Figure 9. At the M2 site, the Cl^- concentration reached 5.20±0.28 mg/L. At two positions M1 and M3, the concentration of Cl^- in rainwater was recorded below the detection threshold. The concentration of Cl^- in the study area still reached the allowable limit of QCVN 01-1:2018/BYT (250 mg/L) [8]. When the concentration of Cl^- in rainwater is higher than the allowable threshold, it will make the water taste salty, causing kidney diseases [14]. The low concentration of Cl^- in rainwater may be due to the reduction of industrial emissions in urban areas [6]. In addition, water sources supplied

to households for use in many localities often use Cl^- to eliminate bacteria. However, surplus Cl^- in domestic water could cause harm human beings.

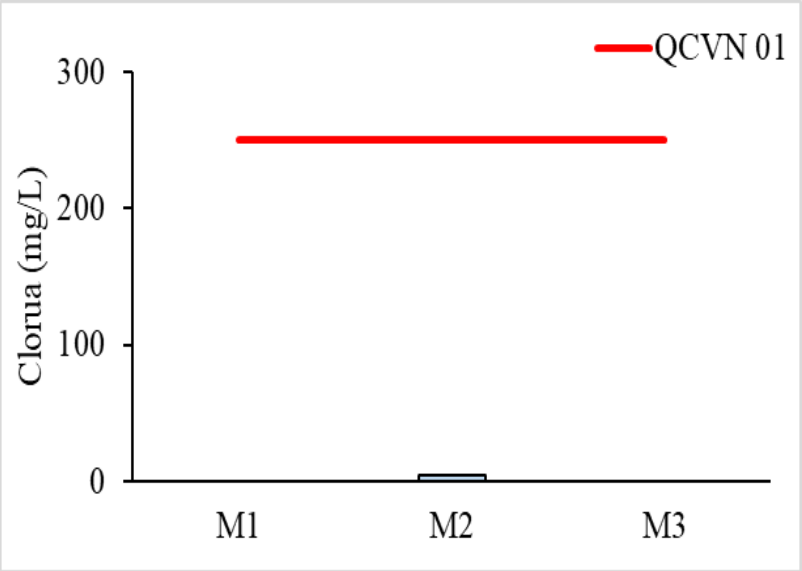

Figure 9. Cl^- parameter in rainwater in Soc Trang province in 2021

4. Conclusion

The study shows that the quality of rain water in Soc Trang province in 2021 is relatively good, all 8 monitoring parameters meet the quality of domestic water according to QCVN 01-1:2018/BYT. Rainwater quality at location M2 tends to be higher than that of location M1 and M3 in most water quality parameters (except $N\text{-}NH_4^+$ parameter). To ensure the safety of people's health when using rainwater in daily life, it is necessary to have appropriate water treatment measures and perform monitoring with more important parameters. In addition, appropriate construction and rainwater collection should also be considered in the study area. Research results provide important information to help environmental management agencies develop planning policies for rational rainwater use and solve the problem of water scarcity in the dry season in certain areas.

Acknowledgement

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