



Investigating Sources of Surface Water Pollution in Dau Sau Canal, Can Tho City, Vietnam

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Abstract

Can Tho city is an economic, cultural and educational center of the Mekong Delta, along with the rapid industrialization and modernization. This can have a negative impact on the environment because of the rapid increase in waste and wastewater. This study aims to investigate the source of surface water pollution in Dau Sau canal, An Binh ward, Ninh Kieu district, Can Tho city through interviewing 30 households and measuring the indicators of pH, electrical conductivity (EC), dissolved oxygen (DO) in the water environment. The study results showed that pH and EC were in the allowable threshold. DO was lower than the permitted threshold of QCVN 08: 2015/BTNMT, column A1 at all three sampling locations. This indicates that the water environment had signs of organic pollution. The sources of waste generation into the water environment are mainly waste, wastewater from residential areas (51%), in addition to other causes such as waste, wastewater from production and trading activities (27%), waste and wastewater from markets (22%). The current situation of domestic waste management and the people's awareness of environmental protection is not good due to the situation of indiscriminate rubbish in the canals. Wastewater from households using stilt houses is directly discharged to the canal. The results of the current study suggested that there is need to construct waste (solid waste and wastewater) collection and treatment systems in the study area to solve the environmental concerns. Raising community awareness of the residents in the protection of surface water is essential. Besides, the law enforcement in environmental protection should also be given proper attention.

1. Introduction

Water is the factor that governs all human activities. Water is used mostly in daily activities from domestic use to industrial production, agriculture, and aquaculture. In the Vietnamese Mekong Delta is a downstream area of the Mekong River where there is an abundant source of water with many rivers and canals passing through which greatly affects the domestic economy in terms of agricultural output and aquaculture. Can Tho city is an economic, cultural, social and educational center of the region, and also a traffic junction of other provinces in the region. Along with the development of industrialization and modernization, the rapid development of this city in the first class city also brings about many negative impacts on the environment. There were several studies on water quality in the Vietnamese Mekong delta. The previous research studied water environment factors influencing phytoplankton composition in Bung Binh Thien (BBT) - a fresh waterbody, An

Phu district, An Giang province in the dry season in 2019 [1]. Water samples were collected at 11 locations including 10 locations inside (ĐT1-ĐT10) and one location outside BBT (ĐT11). The water quality parameters of pH, temperature, depth, dissolved solids (TDS), conductivity (EC), dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), total suspended solids (TSS), nitrate (NO_3^- -N), ammonium (NH_4^+ -N), total nitrogen (TN), dissolved phosphorus (PO_4^{3-} -P), total phosphorus (TP), sulfate (SO_4^{2-}), chloride (Cl^-), and coliform were analyzed. Phytoplankton samples were collected at the same sites and time with those of water samples. Water quality was assessed against the National Technical Regulation on Surface Water Quality (QCVN 08-MT: 2015/BTNMT) [2]. The results showed that BOD, COD, TSS, and Coliform were higher than the permissible levels in QCVN 08-MT: 2015/BTNMT. The previous study evaluated surface water quality in the canals of An Giang province in the period from 2009 to 2016 using water quality monitoring data provided by Department of Natural Resources and Environment of An Giang province [3]. The results showed that surface water quality of the canals was contaminated by organic matter and microorganisms which is not suitable for water supply and conservation of aquatic life. The problem of organic pollution and microorganisms has been taking place over a long period of time and there is no solution to the problem, which leads to a decline in the quality of water, leading to a decline in water quantity. Agriculture is the main activity contributing to pollution of surface water in interior canals along with the activities of daily life, industry and services. Quality of surface water of main and tributary rivers in Can Tho City and to estimate the amount of waste discharged by socio-economic development activities into the rivers was study [1]. The results showed that surface water quality in the rivers in Can Tho city was organically polluted and tended to increase over years. The parameters such as DO, TSS, BOD, COD and coliform were higher than the permitted levels regulated in QCVN 08-MT: 2015/BTNMT. The concentrations of pollutants on the tributary rivers were higher than those in Hau River. The results also indicated that the causes of water quality in the study area were from domestic activity, agricultural production, industrial and service activities. All studies showed that the surface water environment in the Vietnamese Mekong Delta is polluted with suspended solids, organic matter, nutrients and microorganisms. There is very little research on the source of surface water pollution in Can Tho city. This study surveyed the source of surface water pollution in Dau Sau canal, An Binh ward, Ninh Kieu district, Can Tho city to find the cause and propose solutions to the problem.

2. Materials and method

The parameters of pH, conductivity (EC), dissolved oxygen (DO) were measured directly in the field at the beginning position – ĐR (adjacent to the Hau River), middle position– GR (about 1.5 km from Hau river) and end of the Dau Sau canal (about 3 km from Hau river - CR) (Figure 1) using hand-held devices (Table 1). Water quality indicators were presented in the form of average, then compared with national technical regulations on surface water quality (QCVN 08-MT: 2015/BTNMT, column A1) [2].

Table 1. In-situ measurements of certain water quality parameters

No.	Variables	Unit	Hand-held meters
1	pH	-	pH meter (AD12)
2	EC	mS/cm	EC/TDS meter (COM-100 HM Digital)
3	DO	mg/L	DO meter (DOA E9-M072)

Information on the source of water pollution was collected through direct interviews with 30 households living along the Dau Sau canal. The information is collected based on the observations of the local inhabitants (in An Binh ward), who have lived for more than 5 years in the study area. The interview questionnaire included questions about personal information of the respondents and questions related to surface water quality, current water use, main sources of

pollution, pollution levels, and impacts on people's health and solutions to minimize surface water pollution.



Figure 1. Location of water sample measurement

3. Results and discussion

3.1 Water quality at Dau Sau canal

3.1.1 pH

The pH value at the beginning, middle and end of the canal for 5 days was relatively stable, and ranges between 6.53 - 7.4. Previous research showed that pH in canals in An Giang 2006-2009 ranged from 6.9-7.1 [3], on main rivers and tributaries of Hau river in 2016 ranged from 6.3-8.0 [4] and Hau River, An Giang-Hau Giang section, ranged from 6.7-7.12 [5]. pH in the water environment in Hau Giang ranged from 6.8 ± 0.0 to 7.1 ± 0.3 , averaging 7.0 ± 0.1 [6]. In general, pH values in studies have the similarity that pH has little variation in space and time and is within the allowable range of the National Technical Regulation on surface water quality QCVN 08-MT: 2015/BTNMT. The fluctuation range of pH value in the study area is very suitable for the development of aquatic organisms [7].

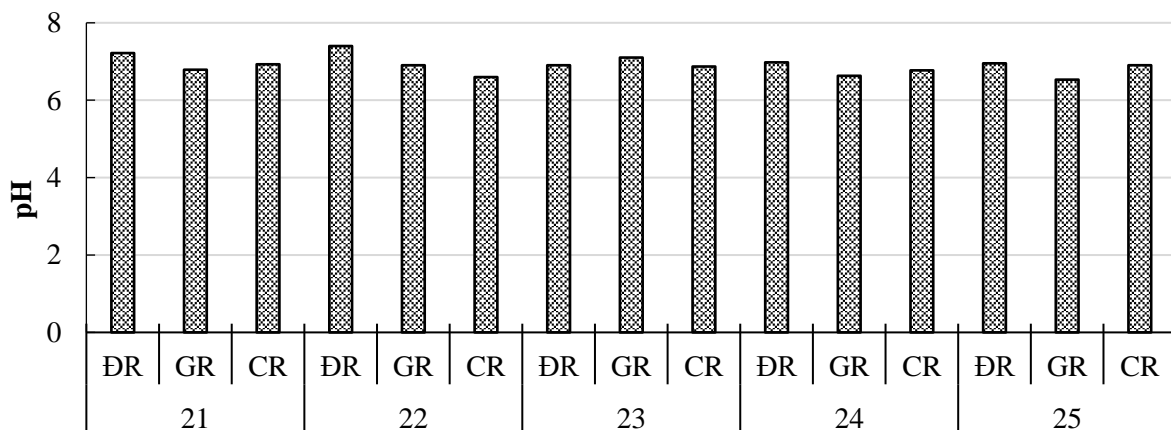


Figure 2. pH in Dau Sau canal

3.1.2 Electrical conductivity

Electrical conductivity analysis results on days have fluctuations, the difference from 0.25 - 0.52 (mS/cm). Previous research also showed that EC usually fluctuated in the range of 123.7-137.267 $\mu\text{S}/\text{cm}$ in fresh water environment [1]. The Food and Agriculture Organization of the United Nations points out that when $\text{EC} < 750 \mu\text{S}/\text{cm}$ is good water quality, an EC between 700-3000 $\mu\text{S}/\text{cm}$ is a good to moderate harm and a serious harm when $\text{EC} > 3000 \mu\text{S}/\text{cm}$. This proves that the conductivity at the study area is still within the safe level recommended by FAO.

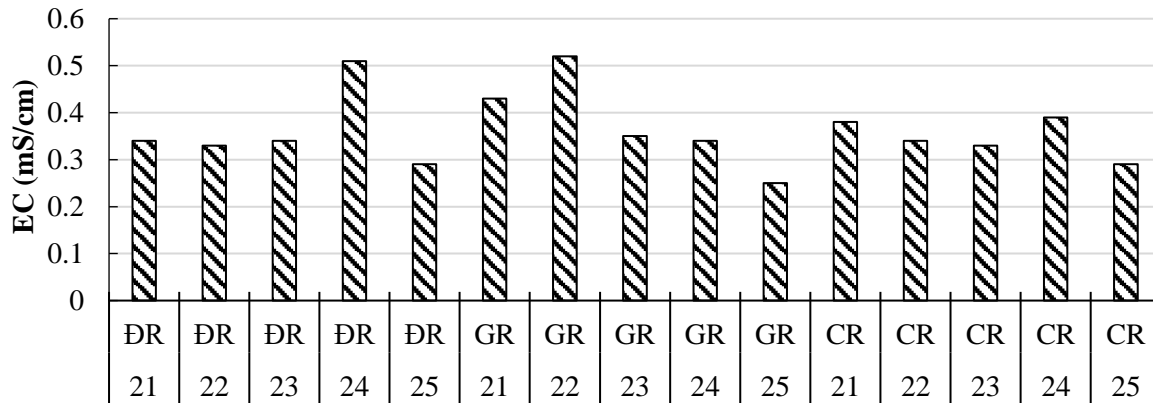


Figure 3. EC in Dau Sau canal

3.1.3 Dissolved oxygen

Living organisms are dependent on the amount of oxygen, depending on the habitat that the organisms will use different forms of oxygen. For water, dissolved oxygen (DO) is a very important factor, in order to maintain metabolism, growth and development. According to the national technical regulations on surface water quality, the DO content is ≥ 6 , ≥ 5 , ≥ 4 , ≥ 2 (mg/L) for columns A1, A2, B1 and B2 respectively. DO has a clear variation between days, DO values in Dau Sau canal area ranged from 0.63 to 2.03 mg/L. The average DO in the upstream waters of An Giang ranged from 4.0-5.2 mg/L [3], and Hau River in 2016 was 4.8 ± 1.1 - 5.5 ± 0.7 mg/L [4], Hau river in 2018 was 5.29 ± 0.33 - 5.56 ± 0.56 mg/L [5]. In canals in Soc Trang province, DO was lower than other studies, ranging from 1.7-6.17 mg/L [8]. Dissolved oxygen in canals in Hau Giang averaged 4.0 ± 0.3 mg/L (ranged in the range of 3.2 ± 0.1 - 5.2 ± 0.8 mg/L) [6]. The results showed that at the beginning and end of the canal, there was a higher dissolved oxygen than the middle area because this area was well-ventilated without being obstructed by water hyacinths and less waste, there were the movements of canoes and boats resulting in the disturbance of the water surface facilitates oxygen diffusion into the water. The cause of the concentration of DO in the middle of the canal was low mainly due to poor flow, water had signs of organic contamination due to waste, wastewater from households living in the area, waste and wastewater from the area, markets and production and business establishments. DO in the study area was lower than the allowable limit of QCVN 08-MT: 2015/BTNMT [2].

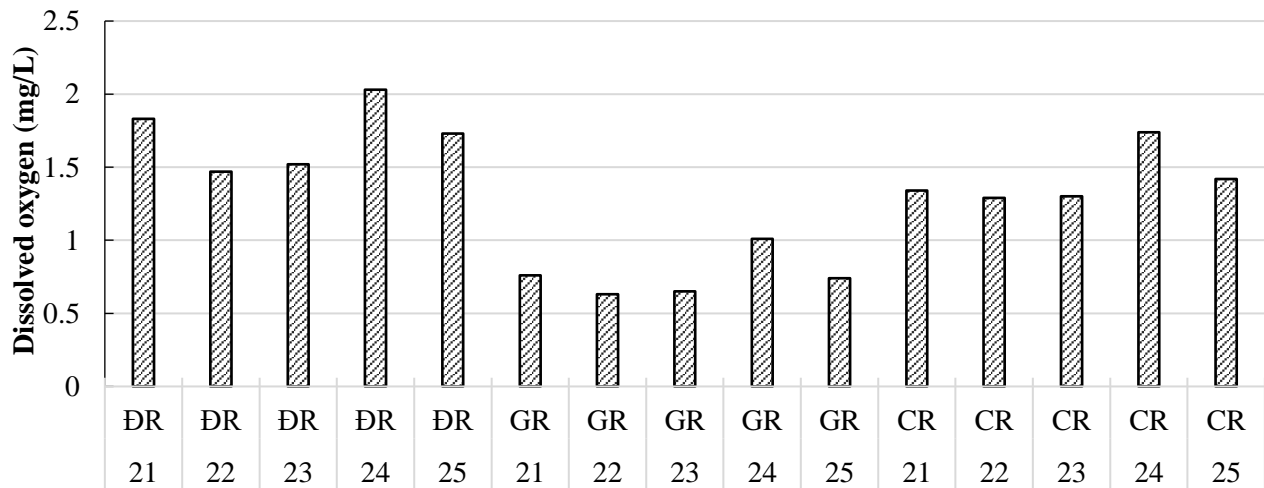


Figure 4. DO in Dau Sau canal

3.2 General information of the interviewees

The education level of the interviewed households was 3% for primary education, 40% for secondary school, 57% for high school. The educational level of people in Dau Sau canal is high, but the awareness of environmental pollution is not high, reflected in the fact that many households litter their rubbish indiscriminately, forming many polluting spots resulting in serious environmental contamination. The number of people living more than 10 years in the study area accounted for 53% and those who have lived less than 10 years were 47%. Most of the interviewed people have lived in the locality for more than 10 years, so the information provided regarding comments and changes in surface water quality in the area would be reliable.

3.3 Solid wastes and wastewater in the study area

The waste from the household in the area is mostly organic waste, accounting for 61%, including leftovers, vegetables, fruits, leaves, fruit peels. This waste is mainly from domestic needs of daily life and it is biodegradable by nature, creating unpleasant odors in hot and humid weather. Inorganic solid waste accounts for 39%, including plastic wrap, plastic cups, plastic straws, foam boxes. These are difficult to decompose components when thrown into rivers, canals causing congestion of sewers, reducing the circulation of water sources that easily pollute the surface water environment in the area. Compared to the previous study [1], the main waste components are organic and easily biodegradable 88.28%, inorganic components include stone bricks 0.23%, nylon wrap 8.6%, paper 1%, plastic 0.93%, glass 0.63% and metal 0.33%. The wastes that can be used for recycling include plastic wrap, paper, plastic, glass and metal, accounting for 11.49%. The study area is an urban area. There are garbage collection routes along the canal. There were 80% of the wastes from households was collected; 10% was burnt and 10% was directly discharged into the canal. The burning and discharging the wastes into the canal cause water pollution, thus influencing aquatic ecosystems and human health. According to the survey, the domestic wastewater of households is flowing into the sewers accounting for 59%. In this area, 35% of the households directly discharged domestic wastewater into canal, and 6% of the households discharged wastewater on the land surface.

3.4 Causes of water pollution at the study area

According to the interview results, the main causes of water pollution at Dau Sau canal were waste and wastewater from residential areas (51%), waste, wastewater from business and production activities (27%), waste and wastewater from market areas (22%) (Table 2). People's living standards are increasingly improved, so the daily living needs of people are increasing, leading to increased waste and wastewater. Wastewater and solid waste are discharged directly to canal, which will reduce water circulation and cause more water pollution. There are wood factories located near the beginning of Dau Sau canal, which discharge sawdust, solvents, dusts, directly into surface water environment in the study area. In addition, solid wastes and wastewater from workers also contributed to the water pollution. The market with crowded people buying and selling varieties of products and services where huge amount of solid wastes and wastewater generated and discharged to water environment without any treatment.

Table 2. Causes of water pollution

Causes	Total	Proportion (%)
Waste and wastewater from residential areas	21	51
Waste, wastewater from business and production activities	11	27
Waste and wastewater from market areas	9	22

3.5 Solutions to water pollution by the interviewees

The survey results showed that the majority of households interviewed said that water in Dau Sau canal was polluted. 40% of the households said that the water source was being polluted and 17% of the households said that the water environment was less polluted because the water has a self-cleaning function, and after a period of time, its quality will be automatically recovered. There were 30% of the interviewed households saying that the water environment in Dau Sau canal was seriously polluted and 13% of the household said that it was very serious. Since the interviewees have lived for long time, so the judgement on water quality could be reliable. Previous studies also showed that surface water in the Vietnamese Mekong Delta was polluted with organic, microbiological, nutritional and suspended solids [4, 5, 8]. The majority of households living around the study area use tap water (up to 81%) because they are aware that the water quality in the canal is not guaranteed and cannot be used for domestic purposes. The few households choose to use both tap water, well water accounted for 14% and the proportion of people using rain water accounted for 5%. From the way people use water, it showed that the surface water has become polluted and is no longer suitable for domestic purposes.

The interviewing results showed that 18% of the residents believed that regularly checking the factory's waste and wastewater treatment operation could help in protecting water sources. 21% of the interviewees suggested the local environmental authorities should well manage waste and wastewater generated from the market areas by placing enough waste bins and collecting wastewater for proper treatments. 24% of the households recommended to fine the violators using current environmental law. 37% of the interviewees proposed to strengthen propaganda and education to raise awareness of the community regarding environmental protection (Table 3).

Table 3. Recommendation of the interviewees for water quality management

Recommendations	Total	Proportion (%)
Regularly check the sewer and discharge systems of the factories	7	18
Manage waste and wastewater generated from the market	8	21
Reminder and sanction if the establishment or individual intentionally commits a violation	9	24
Promote propaganda and education about the environment	14	37

4. Conclusion

The results of the assessment of water quality in Dau Sau canal, Ninh Kieu district, Can Tho city have shown that EC was completely suitable for aquatic organisms in water, pH reached the permitted limit of QCVN 08-MT: 2015/BTNMT. However, DO was much lower than that in QCVN 08-MT: 2015/BTNMT, column B2- used for waterway traffic and other purposes with low water quality requirements. The interviewing results showed that people still treated domestic waste by burning (10%) and discharging it directly to canals (10%). Up to 35% of the households chose to directly discharge domestic wastewater into canals. The findings presented that the main source of pollution was waste, wastewater from residential areas (51%), from production and business activities (27%) and market operations (22%). The interview results revealed that 100% of the households were aware that surface water was polluted. It is necessary to build and complete a synchronous waste collection and treatment system in the study area. Propaganda and education on environmental protection and community awareness should be strengthened to improve surface water quality in Dau Sau canal, An Binh ward, Ninh Kieu district, Can Tho city. Besides, the law enforcement in environmental protection should also be strictly sufficiently.

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