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Surface Water Quality Methods of Determining

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Due to the impact of various types of pollution on the available water resources, inland waters are facing a decrease in water quantity and the quality of surface waters is deteriorating. Tributaries of the Saigon River are an important feature of the river, Ho Chi Minh City. The tributaries selected were mainly located in Binh Chanh District. In this context, assessing the quality of surface waters is an essential, critical and challenging activity to be undertaken to protect these waters. At 31 research sites (n = 31), surface water was collected from upstream to downstream tributaries. Monitoring parameters included Temperature, pH, Electrical conductivity (EC), Total dissolved solid (TDS), Ammonium nitrogen (NH^{4+}-N), Nitrate nitrogen (NO^{3-}-N), Phosphate (PO_4^{3-}), Iron (Fe), Zinc (Zn) and Copper (Cu). In terms of data analysis, the results of this study will provide valuable information for the improvement of water quality in the study area. Ecological and economic zoning through the 31 research sites has been mentioned. The results of these water parameters can be specifically discussed and have comparisons with the previous studies. Finally, the results were synthesised to describe the variation in water quality values across the study area in the wet season.

Keywords: Tributaries, Surface water quality, Water pollution.

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1. INTRODUCTION

Due to various types of pollution affecting the available water resources, inland waters are facing a decrease in water quantity and the quality of surface waters is deteriorating. Freshwater represents just 2.5 % of the total water on earth [1]. Surface water is critical to managing environmental sustainability, growing the economy, and achieving global social welfare. This means being able to provide clean water, protect ecosystems, irrigate and more. In recent years, eutrophication of surface waters has become an issue of global concern. In most developing countries, the discharge of nutrients into surface waters is set to increase significantly and the eutrophication of water bodies will remain a challenge for many years to come. Overall, the development of human activities has made water resources scarce and depleted. As a result, pollution, including litter and industrial waste, is increasingly affecting downstream water bodies. Generally, water resources are misused because people use water indiscriminately and wastefully. Waste water has had an impact on the chemical properties of natural waters and sediments. This has greatly affected biological communities and created many challenges for the unpredictable environment, resulting in a complex ecological condition. Like other countries around the world, Vietnam is no exception. A dense network of rivers is one of Vietnam's vast water resources [2]. Ho Chi Minh City (HCMC) is the largest city in Vietnam, covering 2095 km^2, ranking first in terms of socioeconomic development [3].

It is the process of urbanisation and industrialisation that is taking place most rapidly [4]. And then the activities for the use of water resources have put restrictions within the operational limits of the administrative units (i.e. local governments) [5]. Wastewater from industrial, agricultural and residential activities [4-6], as well as urban floodwater pollution [7] are discharged into many branches of the Saigon River. Many districts in HCMC are facing the phenomenon of water eutrophication due to the rapid increase in water use, which has led to serious pollution and depletion of groundwater and surface water resources [8]. Especially the phenomenon of surface water pollution of the suburban channels of HCMC. For example, additional use of groundwater has taken place in Binh Chanh District, HCMC, where tap water cannot provide enough water for all the people.

In this context, the assessment of the quality of surface waters in this area is essential and critical for the protection of these waters.

2. MATERIALS AND METHOD

2.1 Descriptions of Study Area

The canals, ditches, and tributaries in Binh Chanh district may receive a large amount of untreated waste, making management difficult for local authorities. Binh Chanh District, for example, is one of the districts on the outskirts of HCMC. There are many industrial estates, large and small companies and a high-density population, all contributing to water pollution. Wastewater

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from pig farms and scrap yards can affect water sources. Waste floats on the surface of the water in some places.

HCMC is a megacity, located in the southern part of Vietnam and ranks the first for socioeconomic development. It is clearly affected by equatorial climate with two seasons: dry season (December - April) and wet season (May and ends in November) (https://www.asiahighlights.com/vietnam/ho-chi-minh-city/weather). The Fig. 1 showed the selected tributaries (i.e., from site 1 to site 31). We focused on the wet season study period (e.g., 6 August 2020), with research sites shown from upstream to downstream.

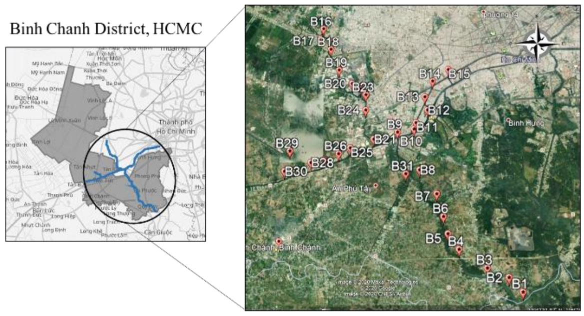

Fig. 1 – Sampling Sites

2.2 Samples Collection and Data Analysis

Surface water samples were collected from 31 sites, as shown in Fig. 1. The water was sampled directly from the tributary, which adds confidence to the analysis, and the samples reflect the conditions at the point of use. Once collected, the samples were analyzed for the following parameters (QCVN 01-1:2018/BYT), The method has also been included on the basis of our previous study on the quality of groundwater in HCMC [9].

A Hanna Instruments HI83399-02 multiparameter photometer was used to measure NH_4^+-N, $NO^{3\,-}$-N, PO_4^{3-}, Cu, Zn, Fe in this study.

We prefer NPI methods because they are localised to national water quality standards [13]. Each NPI value represents the relative contamination contribution of each parameter. The NPI has six classes, as non pollution (NPI ≤ 0.5); safe (0.5 < NPI < 0.7); precaution (0.7 < NPI < 1.0); slight pollution (1.0 < NPI < 2.0); moderate pollution (2.0 < NPI < 3.0) and severe pollution (NPI > 3.0).

The interpretation of the physical and chemical properties of each water sample will be based on the outcome of the correlation analysis (*R* software). A high positive correlation exists between two variables if their correlation coefficients are as $-1 \le r \le +1$. The general meaning of Pearson's correlation coefficient is explained as follows: Low or no linear association ($|r| \le 0.3$), Slight linear association ($0.3 \le |r| \le 0.5$), Medium linear association ($0.5 \le |r| \le 0.7$), and High linear association ($0.7 \le |r| \le 1$). A level of $p < 0.05$ was used to estimate the correlation between two parameters.

3. RESULTS AND DISCUSSION

The main source of irrigation for agricultural activities is surface water (rivers, lakes, canals). Agricultural activities in rural areas are significantly affected if the water quality of this system is polluted [14].

Table 1 showed the mean values of water parameters. The water parameters were compared with Vietnamese national standards [10] as well as WHO standards [11-12]. In this study, NPI results showed could be qualitatively categorized based on the permission limit of Vietnamese national standards.

Table 1 – Summary of descriptive analysis of water quality in selected tributaries

Parameters	Max. Value	Max. Value	Mean. Value (± SE)	National Standards	WHO Guidelines
Temperature	31	35.9	32.4 ± 0.2	–	–
pH	5.2	7.2	6.1 ± 0.1	5.5–9.0 [1]	6.5–8.5 [2]
EC (μS/cm)	913	1905	1374 ± 48	–	2000 [3]
TDS (mg/L)	457	953	701 ± 25	–	< 1500 [3]
DO (mg/L)	1.4	1.9	2.1 ± 0.04	< 4 [1]	< 1 [4]
NH^{4+}-N (mg/L)	0	97.2	21.2 ± 4	< 0.9 [1]	< 0.2-3 [2]
NO^{3-}-N (mg/L)	0	11.3	1.8 ± 0.5	< 10 [1]	< 3 [2]
PO_4^{3-} (mg/L)	0.1	8.8	2.8 ± 0.4	< 0.3 [1]	–
Cu (mg/L)	0	0.8	0.2 ± 0.03	< 0.5 [1]	< 0.05 [3]
Zn (mg/L)	0.01	1.3	0.6 ± 0.04	< 1.5 [1]	
Fe (mg/L)	0	3.18	0.89 ± 0.14	< 1.5 [1]	< 1 [3]

[1] Group B1 (QCVN 08-MT:2015) National Technical Regulation on Surface Water Quality, Vietnam [10].
[2] (World Health Organization: 2011): Guidelines for Drinking-water Quality Fourth Edition [11].
[3] Group A (World Health Organization: 2006): A compendium of standards for wastewater reuse in the East-ern Mediterranean Region from WHO, for Jordanian Standard [12].

By analyzing Table 1, showed the NPIs for the parameters studied in the study area during the study period. The tributaries in the study were classified as slightly polluted for several measured elements according to the NPI classification. Specifically, NH_4^+-N results indicate NPI values that are considered severe pollution (NPI > 23). In this study, if the NPI value is greater than 1.0, it indicates the presence of a contaminant in the water sample and therefore requires some treatment before use for irrigation purposes. Hence, the NPI can be used to describe the quality of the water. This has contributed to the local data and certainly to the environment.

The Pearson correlations between the concentrations of each parameter are very strong positive correlations ($p < 0.05$) as shown in Table 2. The slight and medium positive relationships between these parameters were found for all water samples examined. Following parameter pairs: NH_4^+-N–PO_4^{3-}(0.37) and NH_4^+-N-Cu (0.41), which indicate strong differences in the parameters of the water samples from the selected tributaries. The NH_4^+-N ranges found in the current study were higher than those found in Vietnam and WHO standards.

The results in Fig. 2A show a highly significant relationship between NH_4^+-N and PO_4^{3-} ($r = 0.37$, $p < 0.05$). The (r) correlation is medium, as it is also consistent with the highest values found in the urban water bodies [15]. In general, high levels of ammonia in water come from animal waste, sewage and possible bacterial contamination. Weather phenomena such as rain and flooding are the cause of organically polluted water sources. Sewage and household waste. It is untreated or inadequately treated and discharged into the environment.

Phosphorus levels may be relatively high in relation to the study area. In view of the intensive use of fertilisers in the agricultural areas, it is same that the observed levels of phosphorus are still relatively high [16, 17].

Fig. 2B illustrates a highly significant relationship between NH_4^+-N and Cu (r = 0.41, p < 0.05). Together with ammonia and orthophosphate, copper is an indicator of the human impact on the aquatic environment through domestic and industrial wastewater and agricultural fertilisers [17, 18].

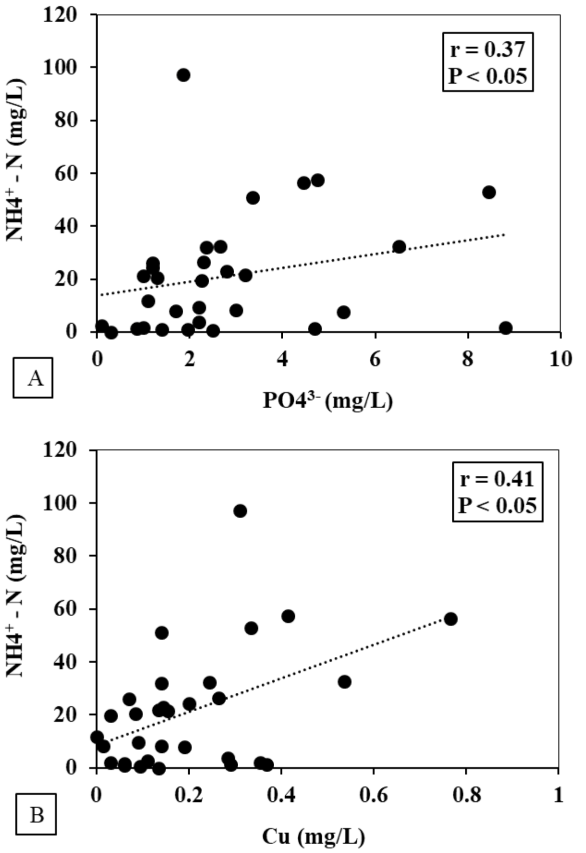

Fig. 2 – In correlation, the r was highly significant, $P < 0.05$ n = 31. Description of the relationship were listed as: (a) between NH^{4+}-N(x) and PO_4^{3-} (y) and (b) between NH^{4+}-N(x) and Cu(y)

Low and closely related DO levels can be caused by untreated domestic, aquaculture and industrial effluent discharged into receiving waters. In particular, industrial and agricultural effluents with high organic content.

Rivers are vulnerable to pollution and their main role is to receive domestic, industrial and agricultural waste water. Protecting the quality of surface water has therefore become a priority for sustainable development. For the management of water resources, monitoring at baseline and in areas affected by different activities will be essential. It shows how surface water quality is changing over time and helps correct any adverse effects quickly. Especially in the area of the upper tributaries (the section flowing through Binh Chanh District), where water quality can be affected by urbanisation and industrial development, this monitoring is very useful. On the positive side, water quality monitoring efforts are on the rise in HCMC. Schemes are in place that can be models for every district in the region and other provincial areas. The efforts of citizens and local authorities to facilitate the monitoring and protection of water quality could be a model for the rest of the region. The potential of phytoremediation in natural wetland systems can address these pollutants [19]. The use of plants appears to be a promising alternative for the treatment of nitrogen (ammonia) and phosphorus waste [20].

In general, one result of managing the density of people living and working in urban areas can be a reduction in sewer congestion. For example, housing, manufacturing and offices cause different levels of congestion and pollution in tributaries, and finding the right balance between uses and locations can be important in protecting and managing water quality. It is important to use drinking water sustainably and to reduce waste water by cleaning drainage systems. One of the most important functions of a local authority is to reduce or mitigate these wastewater treatment costs through the provision of infrastructure (i.e., drainage systems). Careful land-use planning can also have a positive impact, creating significant agglomeration benefits by managing water resources at a manageable level.

In the near future, rapid industrialisation and economic growth have led to a massive shift in population from rural to urban areas, increasing pressure on natural resources. The main sources of water pollution can be the untreated municipal and industrial wastewater. In addition, the quality and quantity of rainfall, groundwater and surface water may be affected by climate change and global warming. To move towards sustainable development, there is an urgent need to focus on environmental protection and natural resource management. Concerns about health effects can be a strong motivator for water conservation. However, it is difficult to sustain as the sole basis for action. For example, based on a global approach to biocontrol solutions, we can apply for biological treatment of wastewater, focusing on the phytoremediation potential of selected aquatic plants, the establishment of eco-gardens and the protection of natural wetlands.

There is considerable concern among the Vietnamese public about the availability of safe drinking water [9]. The construction of hand-pumped wells started the domestic water supply in Vietnam a long time ago. Consumption of polluted groundwater has significant health impacts, causing serious diseases. This paper partly provides a current situation and environmental impacts on surface water in the research area. The paper will also propose strategies for researching and managing water for sustainable development. The hope is that this paper will contribute to the local and global understanding of water, a serious issue now and in the near future.

4. CONCLUSIONS

The results may be explained that high concentration of contaminants of NH_4^+-N, NO^{3-}-N, and PO_4^{3-}, may cause the odor and color of the water quality. The main finding of the work showed that the comprehensive Nemerow`s pollution index (NPI) of NH_4^+-N in the surface water were high, and polluted by a high concentration of NH_4^+-N explained the slight positive correlations of Pearson's correlation (r) values between the following

Table 2 – Pearson correlation coefficient for the analyzed parameters

	Temperature	pH	EC	TDS	DO	$NH4^{+}$-N	$NO3^{-}$-N	$PO4^{3-}$	Cu	Zn	Fe
Temperature	1										
pH	0.26	1									
EC	**0.39**	0.06	1								
TDS	0.32	-0.01	**0.90**	1							
DO	**0.44**	0.32	0.21	0.29	1						
$NH4^{+}$-N	-0.32	-0.09	**-0.56**	**-0.56**	-0.16	1					
$NO3^{-}$-N	0.07	-0.15	-0.30	-0.36	0.16	0.27	1				
$PO4^{3-}$	0.07	-0.22	-0.11	-0.23	**-0.39**	**0.37**	0.12	1			
Cu	0.07	-0.07	-0.17	-0.19	**-0.36**	**0.41**	0.03	**0.39**	1		
Zn	0.07	0.21	0.29	0.30	-0.16	-0.12	**-0.43**	0.01	0.14	1	
Fe	0.07	0.23	**-0.38**	**-0.47**	**-0.43**	0.29	0.13	0.24	**0.53**	0.01	1

Both significantly different from 0 (α=0.05).

pairs of parameters NH_4^+-N and PO_4^{3-} (0.37); NH_4^+-N and Cu (0.41); at a level of $p < 0.05$. Finally, the results have been summarised to describe the water quality values change across the study area in the wet season. This will facilitate effective communication of the importance of protecting surface water quality in managing natural resources to every citizen.

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Методи визначення якості поверхневих вод

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Внаслідок впливу різноманітних видів забруднень на наявні водні ресурси внутрішні води стикаються з зменшенням кількості води та погіршенням якості поверхневих вод. Притоки річки Сайгон є важливою особливістю річки Хошимін. Вибрані притоки в основному розташовані в районі Бінь Чань. У цьому контексті оцінка якості поверхневих вод є важливою, важливою та складною діяльністю, яку необхідно здійснити для захисту цих вод. На 31 дослідницькій ділянці (n = 31) проводився збір поверхневих вод із верхніх до нижніх приток. Параметри моніторингу включали температуру, pH, електропровідність (EC), загальну кількість розчинених твердих речовин (TDS), амонійний азот (NH^{4+}-N), нітратний азот (NO^{3-}-N), фосфат (PO_4^{3-}), залізо (Fe), цинк (Zn) і мідь (Cu). З точки зору аналізу даних, результати цього дослідження нададуть цінну інформацію для покращення якості води на території дослідження. Зазначено еколого-економічне районування через 31 дослідницьку ділянку. Результати були узагальнені для опису коливань значень якості води в досліджуваній зоні.

Ключові слова: Температура, Електропровідність, Якість поверхневих вод, Забруднення води.