

Assessment of water quality variant trends on Kenh Doi Kenh Te Canal, Ho Chi Minh City in period 2012-2022

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Abstract: *Ho Chi Minh City (HCMC) has a widespread inner-city canal system. The city's canals play a very important role in regulating, receiving and treating wastewater. With a very high population density, the amount of wastewater increases and the results are that the canal water being seriously polluted. The Kenh Doi - Kenh Te Canal (KDKT) is a large and very polluted canal. The canal flows through many districts of HCMC and has not yet been renovated. The role of KDKT is very important because here it is a densely populated area, it directly receives a wastewater and being an important waterway in the East of the City. In order to assess the trend of water quality changes in the KDKT canal as a basis for environment management and decision-making on implementing canal improvement projects, the study assessed and combined the level of water quality and self-cleaning capacity with establishing a matrix to determine the level of water quality trend changes considering the operation of the tide control sluice system and climate change scenarios. The trend assessment results show that the canal water quality shows no signs of change when the trend level is average. This shows that the pollution level is increasing but the self-cleaning capacity of the canal water is weakening. Thus, there is a need for the solutions to increase the self-cleaning capacity and improve the canal water quality to change and create a changing trend to improve the canal water quality.*

Keywords: *Surface water; water quality index (WQI); self-cleaning capacity; water quality variant trend; pollution water*

1. Introduction

Assessing the trend of the change in the quality of surface water is to consider the increase or decrease in pollution or to show the trend of improving the quality of water resources in the future [13]. Currently, there are many approaches in assessing the trend of the change in the quality of water resources such as (1) forecasting the quality (with simulation of water quality components according to development scenarios), (2) determining the relationship between water quality and time (usually the trend correlation between water quality components and time) and (3) considering the water quality at the assessment time and the potential level of improvement in the future (such as the ability to receive more waste or the capacity to self-improvement/self-cleaning) [2]. According to directions (1) and (2), analyze the trend of water quality data (measured or simulated) to understand the changes in water quality parameters, plan for flows and monitor water quality.

According to Liebetrau (1979) [3], understanding long-term fluctuations in selected water quality parameters is one of the four essential needs of water quality monitoring. In addition, trend analysis determines whether the measured value of a water quality parameter increases or decreases over a period of time [4]. Ferrier et al. (2001) [5] determined the spatial and temporal trends in water quality of rivers in Scotland from 1974 to 1995. In addition, they also studied the relationship between nitrate and orthophosphate. However, with directions (1) and (2), it shows the trend of fluctuating values of quality components. Qualitatively determining how the water quality changes/changes (fast – slow, good – bad) often cannot make a final decision.

To assess the water quality changes of the Day River flowing through Nam Dinh province in the directions (1) and (2), Do Huu Tuan [6] used the methods of assessing water quality (according to individual indexes, compositional indexes) and the trend analysis to assess the water quality changes being in future. However, there are still limitations such as data on the pesticide parameters not being included in the calculation of water quality, at some monitoring locations there is still a lack of monitoring data... This is the exact cause leading to the inaccuracy and lack of representativeness of water quality results. In addition, the study also showed that the trend of water quality changes needs to be considered the impact of external factors such as flow, channel, discharge of socio-economic sectors... [6].

According to the third direction (3), this is a combination of the current and development situations (the development of water quality) with the intrinsic factor (the ability to receive additional waste, self-improvement or self-cleaning). The current and development situations depends mainly on the water quality components (the components causes the water pollution), while the intrinsic factor depends on many different external factors such as the hydraulic regime, the terrain conditions, the geology of the area, and the discharge flow. Determining the development trend of a phenomenon will be through a combination of the two above factors [7]. For example, when it is necessary to determine the development of water quality (current pollution status - intrinsic factors) under the level of pollution/very polluted/good/average... the studies often apply the index methods of assessing water quality such as WQI. When it is necessary to determine whether the trend of water quality has improved or not and to what extent (the internal factor), the studies often apply the assessment methods about the ability/capacity such as the additional receivable ability of waste components and the self-cleaning capacity [7].

To combine the different level classifications with the assessment of the level/capacity, the studies apply the method of assessing the self-cleaning capacity of water resources over the years. The absorption/self-improvement or self-cleaning capacity of the flow is considered the maximum load that can be put into the environmental water without exceeding the loading limitation and changing the water quality state. When the absorption capacity is negative, the amount of waste that needs to be removed to reach the loading limitation [8]. Thus, the assessment of the water quality change trend is a requirement for determining actual state of quality and the "absorption"/self-cleaning capacity of the water source itself.

The water quality and its changing trends depend on many factors and conditions from nature to regional economic development [1]. Therefore, the current trend is to evaluate a certain issue based on its different level classification tables according to the value range [7]. Current water quality is often calculated according to the WQI index with quality levels ranging from unpolluted to severely polluted and the self-cleaning capacity is calculated according to the coefficient (f) between the processes of replenishment and oxygen consumption [9]. Based on two types of classification (water quality and self-cleaning capacity), the trend level is synthesized.

Within the scope of the article, the research results on the assessing water quality variant trend are carried out according to direction (3) by determining levels of pollution according to Decision No. 1460/QĐ-TCMT, the guideline about assessment of surface water quality according to the VN_WQI index and the classification of pollution, and the level of self-cleaning capacity of the water of KDKT canal in Ho Chi Minh City.

2. Geological background

2.1. Research region

The research region is the KDKT canal, HCMC is shown Figure 1 below.

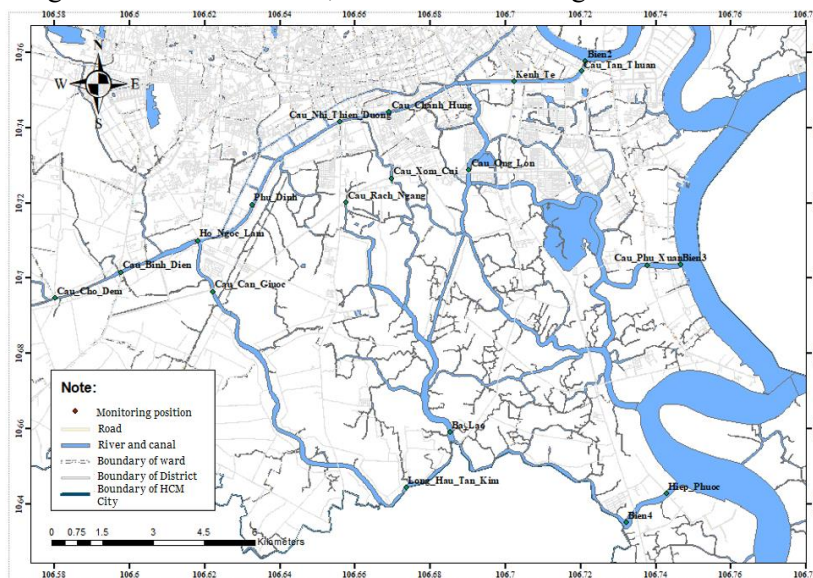


Fig. 1. Kenh Doi - Kenh Te canal and locations of monitoring positions

2.2. Data collected for the study period 2019-2022

The data used in the study included the following components:

- Water quality data set of KDKT canals for the period 2012-2022 at monitoring stations (see Table 1 for an example of Cho Dem Bridge monitoring location in 2022 during a low tide situation).
- The simulation results of flow factors in the Kenh Doi - Kenh Te canal system in the period of 2012-2022 were determined at the monitoring locations with the main parameters of flow, velocity and water depth corresponding to the times of high and low tidal situation (see Table 2 for an example at the Cho Dem Bridge monitoring location in 2022).

Tab. 1. Water quality monitored at Cho Dem Bridge location in 2022

Duration		T°C	pH	TSS	Turbidity	NH ₄	PO ₄	DO	COD	BOD ₅	Coli.	E. Coli
Month	Tide			(mg/l)	(NTU)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(MPN/100ml)
1	Low	28.4	7.08	86	51.0	6.10	0.24	1.10	42	20	9000	2200
2	Low	30.4	7.1	50	24.7	4.77	0.22	0.80	41	14	1700	360
3	Low	30.0	6.62	40	30.3	5.6	0.17	0.60	43	20	1300	200
4	Low	31.3	7.05	32	45.0	5.04	0.33	0.90	42	20	2200	200
5	Low	31.7	7.26	48	42.9	7.00	0.87	0.50	53	26	1100	200
6	Low	30.9	7.15	48	48.7	4.65	0.33	2.38	47	21	14100	2700
7	Low	30.2	7.84	56	68.4	8.04	0.12	7.07	39	22	17000	4600
8	Low	29.7	7.07	67	78.6	4.48	0.16	0.21	73	34	9400	2600
9	Low	29.8	7.04	75	101	3.53	0.09	0.23	69	30	15000	3200
10	Low	29.1	6.93	59	67.5	4.93	0.19	0.15	52	30	14000	3400
11	Low	29.2	7.27	33	59.3	1.99	0.11	0.21	51	30	17000	3400
12	Low	30	7.25	83	108	5.00	0.33	0.43	51	22	14000	2600

(Source: Ho Chi Minh City Center for Natural Resources and Environment Monitoring, 2022)

Tab. 2. Flow parameters at Cho Dem Bridge location in 2022

Name	Month	The flow parameters					
		Q _{t,r low}	H _{t,r low}	U _{t,r low}	Q _{t,l high}	H _{t,r high}	U _{t,r high}
Cau Cho Dem	1	168	1.71	0.65	143	1.72	0.62
	2	169	1.86	0.67	142	1.57	0.60
	3	171	2.05	0.68	140	1.38	0.59
	4	168	1.80	0.65	142	1.62	0.62
	5	169	1.95	0.67	141	1.47	0.60
	6	171	2.15	0.68	139	1.27	0.59
	7	167	1.60	0.65	143	1.83	0.62
	8	169	1.75	0.67	142	1.68	0.60
	9	170	1.94	0.67	140	1.49	0.59
	10	167	1.60	0.65	143	1.83	0.62
	11	169	1.75	0.67	142	1.68	0.60
	12	170	1.94	0.67	140	1.49	0.59

Note: Q_{t,rlow} – low tidal Discharge; H_{t,rlow} – Low tidal depth; U_{t,rlow} – Low tidal velocity
 Q_{t,rhigh} – high tidal Discharge; H_{t,rhigh} – high tidal depth; U_{t,rhigh} – high tidal velocity

2.3. Assessing water quality level according to WQI index

The method of calculating and using WQI in water quality assessment is carried out according to the guidance of Decision 1460/QD-TCMT of the General Department of Environment, Ministry of Natural Resources and Environment.

The natural conditions of surface water in Ho Chi Minh City have an alluvium but mainly on the Saigon River. The TSS component being in the inner-city canal system is not an alluvium. It is a component generated by wastewater in daily life, industrial production and surface runoff. Besides on, the water of inner-city canal system is only used for the irrigation and waterway transportation. Therefore, the calculation formula VN_WQI for Ho Chi Minh City is determined as formula number (1) below. The component WQI_{SI} values are determined according to Decision 1460/QD-TCMT of the General Department of Environment.

$$WQI = \frac{WQI_I}{100} \times \frac{(\prod_{i=1}^n WQI_{II})^{1/n}}{100} \times \frac{(\prod_{i=1}^m WQI_{III})^{1/m}}{100} \times \left[\frac{1}{k} \sum_{i=1}^k WQI_{IV} \times \frac{1}{l} \sum_{i=1}^l WQI_{VI} \right]^{1/2} \quad (1)$$

There are:

WQI_I: The WQI_{SI} is calculated from the pH component (Group I).

WQI_{II}: The WQI_{SI} is calculated from the inorganic components (Group II).

WQI_{III}: The WQI_{SI} is calculated from the heavy metal components (Group III)

WQI_{IV}: The WQI_{SI} is calculated from the organic components (Group IV)

WQI_{VI}: The WQI_{SI} is calculated from the physical components (Group VI)

The water quality levels are determined by WQI values when compared with each arrangement value listed in the classification Table 3. Each level of water quality corresponds to symbols and colors to evaluate the pollution level and characteristic water to meet usage needs, specifically as follows:

Tab. 3. VN_WQI levels and corresponding to the utilization purposes

Range WQI's value	Levels	Corresponding to utilization purposes of water
91 - 100	Very good	Good for domestic water supply purposes
76 - 90	Good (no pollution)	Used for domestic water supply purposes but requires appropriate treatment measures
51 - 75	Normal (light pollution)	Used for irrigation and other similar purposes
26 - 50	Bad (pollution)	Used for navigation and other similar purposes
10 - 25	Heavy pollution	Heavily polluted water, need treatment measures in the future
< 10	Severe pollution	Water is contaminated, need to have measures to fix and treat it

(Source: 1460/QĐ-TCMT)

2.4. Assessing the self-cleaning capacity level of water sources

The self-cleaning capacity of water bodies is evaluated by applying dissolved oxygen decomposition process and the corresponding simulation equation the Street-er-Phelps equation [10]. The Streeter-Phelps equation applied for the study is expressed as follows:

$$D_t = \frac{k_1 L_0}{k_2 - k_1} (e^{-k_1 t} - e^{-k_2 t}) + \frac{k_3 N_0}{k_2 - k_3} (e^{-k_3 t} - e^{-k_2 t}) + \frac{SOD}{k_2 H} (1 - e^{-k_2 t}) + D_o e^{-k_2 t} \quad (2)$$

There are:

$$k_1 - \text{Oxygen depletion coefficient due to the composition BOD}_5; \quad k_1 = k_{1,T(20)} * f(T) \quad (3)$$

$$k_2 - \text{Diffusion coefficient of oxygen into water;} \quad k_2 = k_{2,T(20)} * f(T) \quad (4)$$

$$k_3 - \text{Oxygen depletion coefficient due to the composition NH}_4; \quad k_3 = k_{3,T(20)} * f(T) \quad (5)$$

U and H is the flow velocity and depth simulated by MIKE11 model for inner-city canal system; D_t – Oxygen depletion level in the stream;

L_0 , N_0 , D_0 , SOD is the initial concentration value of BOD₅; NH₄; Oxygen and oxygen demand of bottom sludge [11].

$k_{1,T(20)}$, $k_{2,T(20)}$ and $k_{3,T(20)}$ are empirical numbers/functions of the attenuation and diffusion processes determined in the laboratory under conditions 20°C.

The ratio of the two coefficients of oxygen consumption (depletion) and replenishment (diffusion) (k_1 and k_2) is calculated to determine the availability of dissolved oxygen in water. The higher availability of dissolved oxygen in water (the larger the difference ratio) the better source in the better condition. It means that the conditions are better for the pollutant components' oxidating processes or that the better self-cleaning capacity. The difference ratio formula of oxygen consumption and replenishment is as follows [12]:

$$f = k_2 / k_1 \quad (6)$$

There are

f – the ratio between the coefficients of oxygen consumption (depletion) and replenishment (permeation) in the aquatic environment.

Based on the range values of the ratio (f), the self-cleaning capacity of water sources is classified as shown in Table 4. [12].

Tab. 4. The classification of self-cleaning capacity of water resources

Levels	The limitation ranges	Characteristical level of self-cleaning capacity
1	$10 \leq f$	Very good
2	$4 \leq f < 10$	Good
3	$2 \leq f < 4$	Normal
4	$f < 2$	Weak (polluted water)

(Source: Trinh, 2004)

2.5. Assessment of the water quality change trend

The classification table of water quality change trend level is built on two types of quality and capacity classifications. Thus, the improvement/self-cleaning capacity levels in the assessment of water quality change trend are as follows:

- Water quality level ranges from 1 (very good) to 6 (severely polluted);
- Self-cleaning capacity level ranges from 1 (very good) to 4 (weak, polluted);
- Total max/min score is 10/2;
- Total average level of trend is 5 levels as follows: Level 1 is very likely improving (≤ 3); level 2 is likely improving (4 - 5); level 3 is indeterminate trend or trend is not clear (6 - 7); level 4 is likely degrading - almost no change (8 - 9) and level 5 is very likely degrading/nonrecoverable - there is a tendency to decline in quality (≥ 10).

Classification of the water quality change trend level of surface water based on the classifications of water quality levels and self-cleaning capacity is built and showed in the below table (See Table 5). The meaning of each level of trend shows the situation and self-cleaning capacity of water resource. As an example of the level 3, indeterminate trend, there is insufficient evidence to confidently determine if water quality is showing an improving or degrading trend; the level 4, likely degrading, shows a degrading trend in water quality.

Tab. 5. Matrix for classifying the level of water quality change trends

		self-cleaning capacity levels			
Levels		1	2	3	4
Water quality levels	1	very likely improving	very likely improving	likely improving	likely improving
	2	very likely improving	likely improving	likely improving	indeterminate
	3	likely improving	likely improving	indeterminate	indeterminate
	4	likely improving	indeterminate	indeterminate	likely degrading
	5	indeterminate	indeterminate	likely degrading	likely degrading
	6	indeterminate	likely degrading	likely degrading	nonrecoverable

2.6. Zoning of water quality change trends

After determining the level of water quality change trends at each monitoring location, the study used Mapinfo software to show the level of water quality change trends for the entire Kenh Doi - Kenh canal. From there, a map of surface water quality change trends was built.

3. Methodology

3.1. The current situation of Kenh Doi – Kenh Te canals

Currently, on the KDKT canals, people are living and encroaching on the canal banks bothsides and directly discharging waste, to causing the pollutoin of the water source as well as the loss of urban aesthetics. Kenh Doi - Kenh Te canals belong to waterway corridor No. 2 of the city, playing an important role in transporting goods and passengers, connecting waterway traffic from the inner city of Ho Chi Minh City to the Cho Dem - Ben Luc river to the Vam Co Dong and Vam Co Tay rivers, passing through Dong Thap Muoi to the provinces of the Mekong Delta and vice versa.



Fig. 2. Houses encroach on the canal, discharging waste water directly into the canal.

3.2. The changes of KDKT canal’s water quality in the period 2012 - 2022

The assessment of the KDKT canal’s water quality in the period 2012-2022 is divided into 3 main stages according to the constructing implementation of tidal control sluice system (The Plan 1547) of Ho Chi Minh City. The stages of assessing the KDKT canal’s water quality are as follows:

- Phase 1 – The construction of tidal control sluices (mainly Ben Nghe sluice and Phu Dinh sluice) was not carry out from 2012 to 2016;
- Phase 2 – The construction of tidal control sluices was implemented from 2016 to 2019;
- Phase 3 – The tidal control sluices were completed and put into the operation from 2019 to present (2022).

a. The changes of KDKT canal’s water quality at the monitoring positions in the phase 1 (2012-2016)

During the period 2012-2016, the canal water quality showed signs of gradual improvement as the connecting canals such as Tan Hoa Lo Gom and Tau Hu Ben Nghe were undergoing renovation. After the above canals were renovated, the water quality of KDKT canal was greatly improved and fluctuated from normal to slightly polluted (See Figure 3).

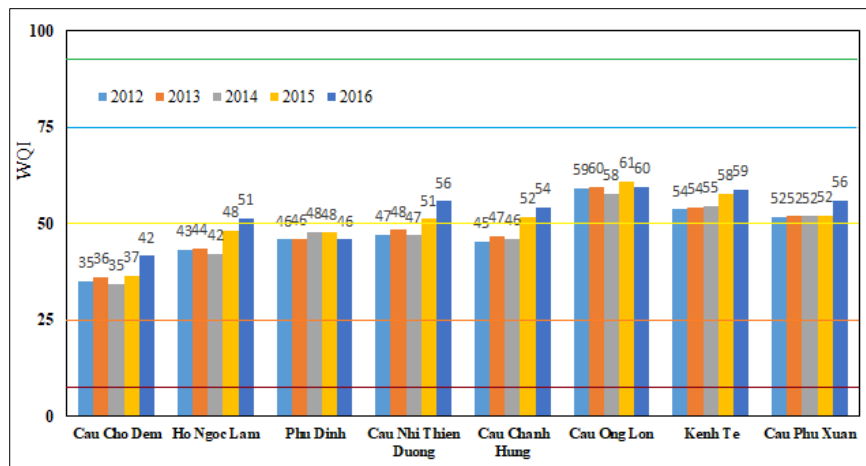


Fig. 3. VN-WQI values at monitoring points of KDKT canal (2012-2016)

At the outlets of KDKT canal to Sai Gon River such as Cau Phu Xuan, Cau Tan Thuan, Kenh Te positions, the water quality levels all reached level 3 (WQI from 50 to 75) – light pollution (see Figure 3). At the connecting locations of KDKT canal with other canals as Tu Hu Ben Nghe (Cau Nhi Thien Duong and Cau Chanh Hung positions) and Tan Hoa Lo Gom (Ho Ngoc Lam position) (see Figure 1), the water quality levels are getting better ever years from level 4 (WQI about 25-50) to level 3 (WQI about 50-75). The pollution levels are from normal to light.

b. The changes of KDKT canal’s water quality at the monitoring positions in the phase 2 (2016-2019)

In early 2016, the tidal control sluice Ben Nghe started construction. In 2017, the tidal control sluice Phu Dinh, along with a series of other sluices, was started. All tidal control sluices were completed construction in 2019. The water quality of KDKT canal being in the middle canal, has changed significantly with a decreasing trend (although, they are still at level 4 (WQI about 25-50) – normal pollution state). The main reason is that the KDKT canal is a long canal with many large and small branches and being not

renovate yet... so this leads to the levels of water exchanged and tidal influence on the canal being quite limited (See Figure 4).

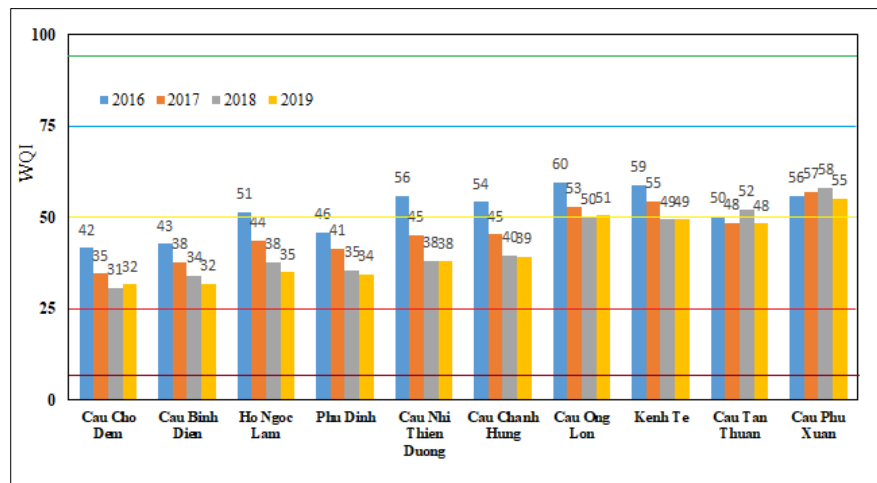


Fig. 4. Water quality of Kenh Doi - Kenh Te canals in phase 2016-2019

The Figure 4 shows that the water quality values of all monitoring positions of KDKT canal are decreased from 2016 to 2019 (most of the tidal control sluices constructed from 2016 to 2019). Only the outlets of KDKT canal (where connect with the Sai Gon River) maintain the water quality at level 3 (WQI about 50-75) such as Cau Phu Xuan, Cau Tan Thuan, Cau Ong Lon and Kenh Te (see Figure 1).

Therefore, all tidal control sluices have an impact on the water quality of the KDKT canal during the construction phase (2016-2019) due to the limitation of flow canal at the construction locations.

c. The changes of KDKT canal’s water quality at the monitoring positions in phase 3 (2019-2022)

At the end of 2019, the tidal control sluice Phu Dinh was completed (early 2020) and partially put into operation, the water quality of the KDKT canal changed significantly with increasing and recovering trends.

Most of the monitoring positions of KDKT canal being near with the outlets (where connect with the Sai Gon River) have the water quality levels reaching level 3 (WQI about 50-75) – light pollution state such as Cau Nhi Thien Duong, Kenh Te, Cau Ong Lon, Cau Phu Xuan and Cau Tan Thuan. All in-net monitoring positions of KDKT canal have the water quality improved and at level 4 (WQI about 25-50) – normal pollution state. (See Figure 5).

The Figure 5 shows that all tidal control sluices have no significantly impacts on the water quality level of KDKT canal in their operation phase. It means, the KDKT canal’s water quality is improved and have increasing trends after all tidal control sluices being constructed completely and put into the operation situation.

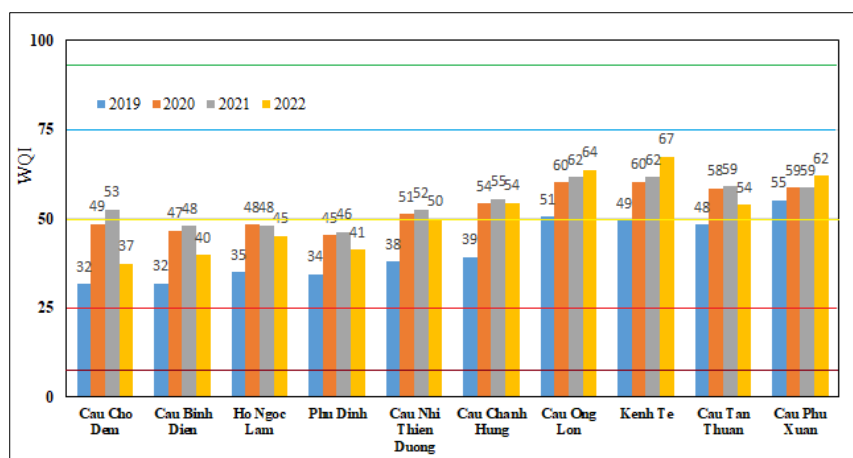


Fig. 5. Water quality of Kenh Doi - Kenh Te canals in phase 2019-2022

d. Assessment of KDKT canal’s water quality in whole period 2012-2022.

Considering the whole period (2012 – 2022) and the entire KDKT canal, the water quality level has improved and better trended due to some other inner-city canals connected to the KDKT canal being

renovated and urbanized such as Tan Hoa - Lo Gom canal or Tau Hu - Ben Nghe canal (See Figure 6). In the whole period (2012-2022), the KDKT canal's water quality level is approached From level 4 to level 3 – situation is slightly polluted.

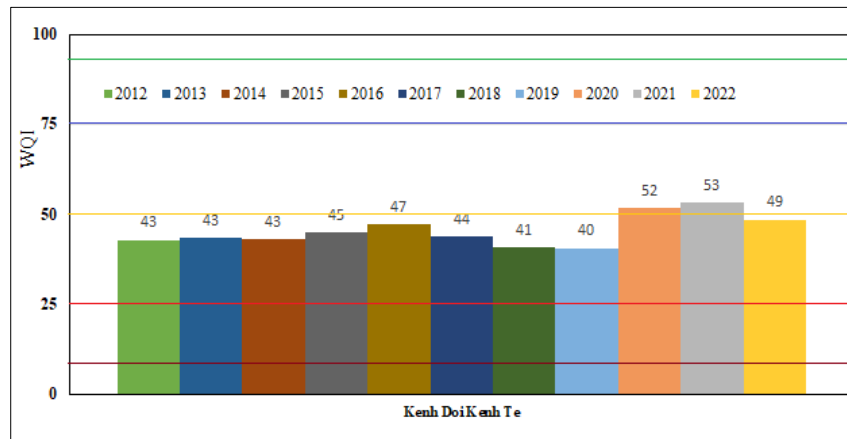


Fig. 6. Water quality change of KDKT canals in the period 2012 – 2022

Through the analysis of the VN-WQI of the KDKT canal in the period of 2012 to 2022 (covering the time before, during and after the construction of the tidal control sluices), the synthesis of water quality of the canals shows that the canal's water quality is polluted in accordance with a level 4 (WQI about 25 – 50) at most inner monitoring positions and slightly polluted in accordance with a level 3 (WQI about 50-75) at all monitoring positions being and closed the outlets such as Cau Phu Xuan, Kenh Te and Cau Tan Thuan (See Figures 3, 4, 5).

According to Figure 6, the water quality of the KDKT canal also changes during the construction of the tide control sluices. Before 2016, the water quality of the canal did not change much and was at level 4. During the period 2016 - 2019, the water quality of the canal decreased due to the construction of the sluices. During the period 2020 - 2022 (completion of the construction of the sluices and the canal renovation projects) - the water quality of the canal recovered and improved significantly, reaching level 3. In 2022, the water quality showed signs of decline, although it was still better than the years in the period 2012-2019.

3.3. Self-cleaning capacity of the channel in the period 2012 - 2022

The assessment of the self-cleaning capacity of the canal water source in the period 2012-2022 is carried out through equation (2) simulating the process of “consuming” and “supplying” oxygen into the decomposing water pollution components with the corresponding coefficients determined through formulas 3, 4, 5. The level of self-cleaning capacity is assessed through the ratio formula (6) and classified according to Table 4.

The results of calculating the f value and the level of self-cleaning capacity of water flow at some monitoring locations of the KDKT canal (see Figure 7) show that the monitoring locations of the connection canals with the Tan Hoa Lo Gom canal or the small branch canals are often lower level of self-cleaning capacity than the monitoring locations on the branch canals connecting to the Saigon River and are at level 3 - average level. However, if considering the entire KDKT canal, there are only 5/16 monitoring locations have a self-cleaning capacity levels at level 3, the remaining monitoring positions reached at level 2 - good self-cleaning capacity.

The fluctuation of self-cleaning capacity of the entire KDKT canal in the period of 2012 – 2022 (see Figure 8) is a little. Although the self-cleaning ability of the KDKT canal water source is still at level 2 (see Table 4), it is also showing a decreasing trend on period 2012-2022. The main reason is that the KDKT canal is a complex and diverse, with many conjunctions with other canals and Saigon River. This leads to the tidal regime deeply affecting the mainstreams of the KDKT canal. At most monitoring locations on the mainstreams of the KDKT canal, the flow's velocity and discharge are quite large, so the wastewater is diluted and decomposed quickly... But, the opposite situation happens at the small branches and end canals (the flow's velocity and discharges are very weak), their self-cleaning capacities are weak and often being at level 3 or a few positions at level 4 (weak self-cleaning capacity). Most of the small branches of the KDKT canal are still encroached upon and wastewater is being discharged directly into them.

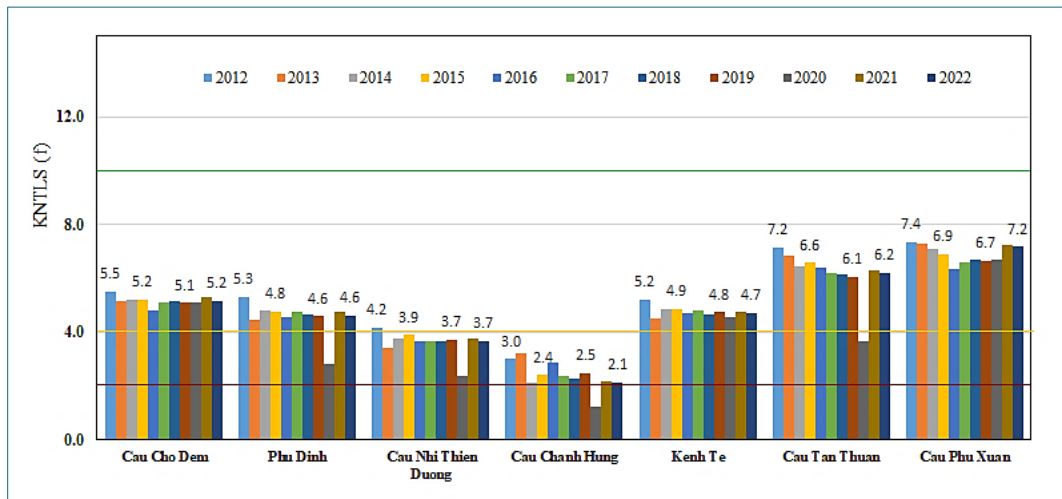


Fig. 7. The *f* values and levels of self-cleaning capacity at the monitoring positions

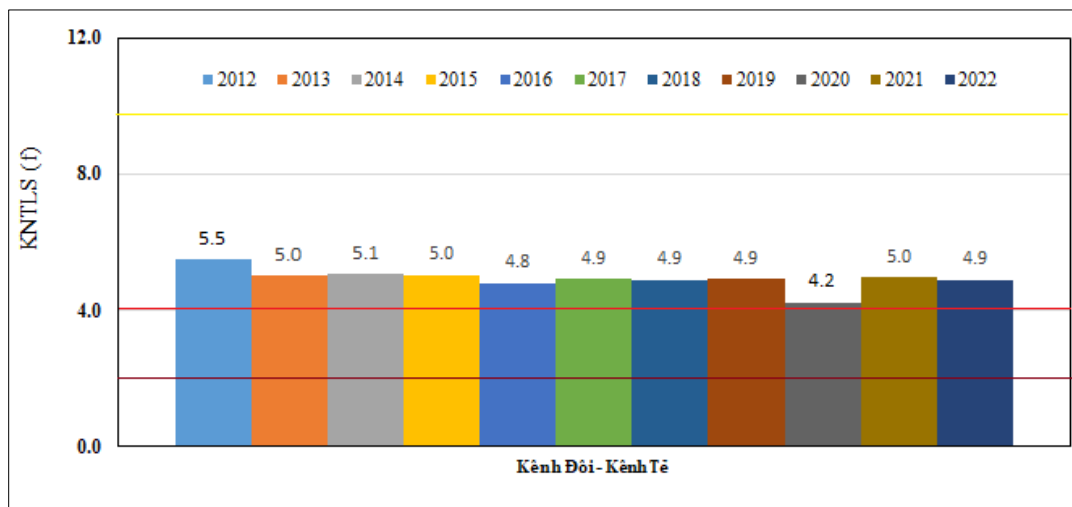


Fig. 8. The *f* values and levels of self-cleaning capacity of KDKT canal

3.4. Trends of the canal water quality changes

From the above results of the assessment of water quality and self-cleaning capacity (SCC) of the KDKT canal being presented in Figure 6 and Figure 8, and based on the classification of trends being on Table 5, the trend's levels of water quality changes of KDKT canal on the period 2012-2022 is determined and classified on the Table 6 below.

Tab. 6. The trend's level of water quality changes of KDKT canal (2012 – 2022)

No	Factors	Years											Whole
		2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	
1	WQI	4	4	4	4	4	4	4	4	3	3	3	3
2	SCC	2	2	2	2	2	2	2	2	2	2	2	2
3	Trends	3	3	3	3	3	3	3	3	2	2	2	2

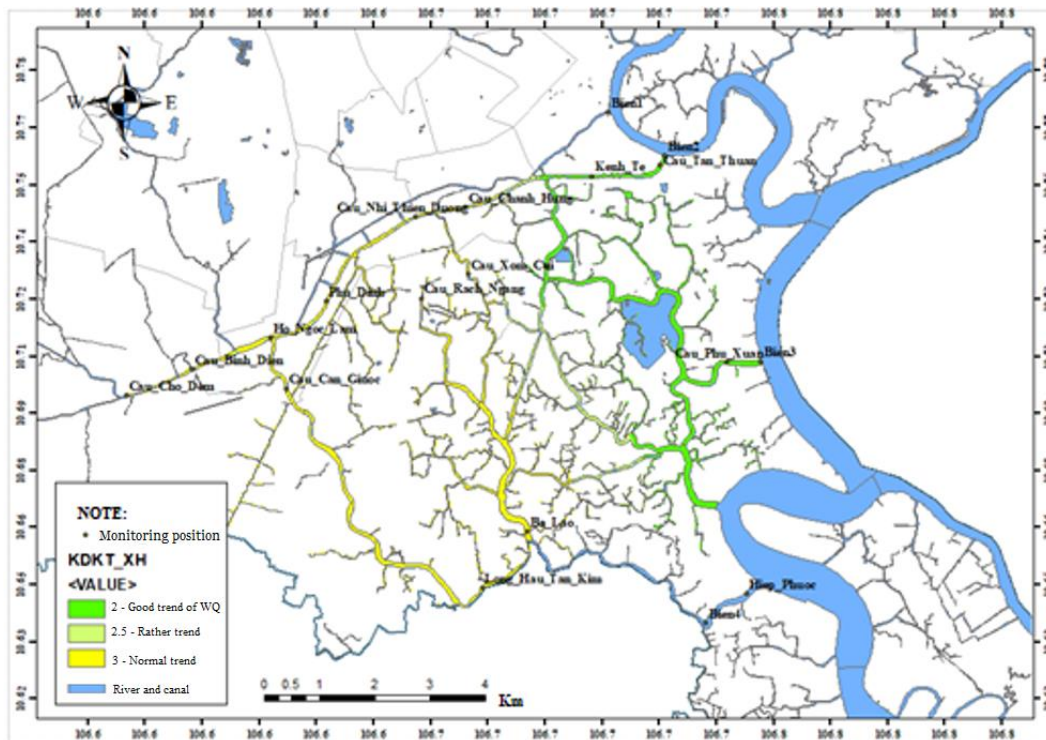


Fig. 9. Zoning of the trend’s level of water quality changes of KDKT canals in the period 2012-2022

Table 6 shows the trend of the KDKT canal’s water quality is improving with the canal’s water quality level being slightly polluted, while its self-cleaning capacity being is at a good level. With the good trend’s water quality changes, it is the basis for showing that the water quality of KDKT canal is gradually improving in a sustainable way (according to Table 5)..

From the results of analyzing the trend of water quality changes at each monitoring location on the KDKT canal, the map of the level of improvement trend of water quality changes in the KDKT canal is shown in Figure 9.

4. Conclusions

The KDKT Canal is one of the five inner-city canal systems of HCM City. The KDKT Canal connects to the Saigon River and many inner city canals plays an important role in draining water for the Ho Chi Minh City and is also a location gets a wastewater from socio-economic activities in the basin. The general inner-city canal system and the particular KDKT canal are being polluted to varying levels due to a wastewater from production, industry, medical and domestic wastewater and other sources that are almost untreated and discharged directly into canals and branches.

The study on the water quality trends of the KDKT canals applied the adjusted WQI water quality assessment method with the self-cleaning capacity of the water source (by Streeter-Phelps equation) to analyze the water quality changing trends (level of self-improvement) of the canal. The assessment results show that the trend of water quality in the KDKT canals has been at a good level in recent years. In addition, the results also show that the level of self-cleaning capacity of the canal is quite stable at a good level and depends greatly on the level of water exchange between the canal and the Saigon River through the tidal regime. This is a sustainable basis for the general assessment that the water quality trends will gradually improve in a sustainable manner.

In the scope of the research of the article, only the Kenh Doi Kenh Te canal is mentioned and not the combination of other connecting canals such as Tan Hoa Lo Gom, Tham Luong Ben Cat and Tau Hu Ben Nghe, therefore, the results achieved are only representative of one canal.

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