



Analysis of the Impacts and Proposal of Pollution Controls, Prevention and Reduction Solutions by the Activities of Industrial Parks in Ho Chi Minh City, Vietnam

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Abstract

Ho Chi Minh City (HCMC), Vietnam has a rapid growth rate, with an open economy with cooperation with many countries around the world, concentrating many industrial parks and export processing zones along with infrastructure development projects, industrial production services related to transportation, communication, water supply and environmental protection, resource exploitation, production and processing of consumer goods and exports. Along with the rapid industrialization and modernization process in Ho Chi Minh City, according to which environmental quality is increasingly reduced, in which the most significant effect is water resources, particularly water sources of rivers and canals. In recent years, there have been many studies related to the quality of surface water sources in Ho Chi Minh City, but there haven't been studies to assess the impacts, affecting the quality of surface water sources due to activities of industrial parks in the City. This study was conducted to assess surface water quality by analyzing the current status of surface water quality in areas related to the operation of industrial parks in Ho Chi Minh City. Thereby assessing the impact on the water quality and proposing solutions to control and prevent pollution due to the operation of industrial parks.

Keywords: pollutions, industrial parks, surface water, Saigon river water

1. Overview of Activities of Industrial Parks and Export Processing Zones in Ho Chi Minh City

Ho Chi Minh City is an economic, commercial, financial and service center of Vietnam, concentrating many industrial and export processing zones with large scale and high growth rate. After nearly 30 years of construction and development (1991-2019), industrial parks and export processing zones have been formed, diversified and actively contributed to the socio-economic and industrial development. However, along with it, the level of environmental pollution caused by IPs and EPZs is increasing, becoming a threat to sustainable economic growth. On article [1] was provided an overview of the current status of operations as well as impacts on surface water from the operation of some industrial parks (IPs), export processing zones (EPZs) in Ho Chi Minh City, Vietnam. Figure 1 shows Map of the location of IPs/EPZs in HCMC and Table 1 represents Number and area of IPs and EPZs in HCMC[2].

The strong development and great contributions of IPs/EPZs are undeniable. However, the process of developing industrial parks in Ho Chi Minh City as well as in Vietnam in the past time still exists with many challenges and shortcomings including the problem of environmental pollution despite many remedial measures, but still going on complicated developments, more and more tend to increase the level of pollution. Out of 42 industrial parks and export processing zones established, put into operation, only 27 industrial parks and export processing zones have built wastewater treatment systems (64.2 %). According to Ho Chi Minh City Export Processing and Industrial Zones Authority (HEPZA), the re-

maining IPs/EPZs do not have a wastewater treatment system or are in the process of construction. It is worth mentioning that even the IZs/EPZs have built a waste treatment system, the operational efficiency is not high, especially for industrial parks with long time of operation located next to Saigon river basins, Dong Nai,... because the wastewater treatment system of these areas has deteriorated.

In addition, many other IPs/EPZs have built a centralized wastewater treatment system, but in fact they do not operate or operate only in response to the inspection [2].

In the following part of this article is described analysis of water quality at some typical ips in Ho Chi Minh City.

2. Results of Water Quality Analysis at Some Typical IPs in Ho Chi Minh City

2.1. Sampling sites

To analyze the quality of surface water in some sections of rivers, canals in Ho Chi Minh City, this study conducted a survey, sampling at the nearby locations in a number of industrial parks. Detailed information on sampling locations is shown in Table 2.

The method of sampling and on-site analysis as well as tools for sample preservation, sample preservation, sample transport, sample reception strictly follow the instructions in the corresponding standards, as follows: TCVN 6492:2011, TCVN 7325:2016, TCVN 6001-1:2008, SMEWW 5220C:2012, SMEWW 6625:2000, SMEWW 4500-NH3.B&F:2012, SMEWW 4500-NO3-.E:2012, SMEWW 4500-P.E:2012, TCVN 6187-2:1996, TCVN 6216:1996, TCVN 6194:1996, SMEWW 3120B:2012.

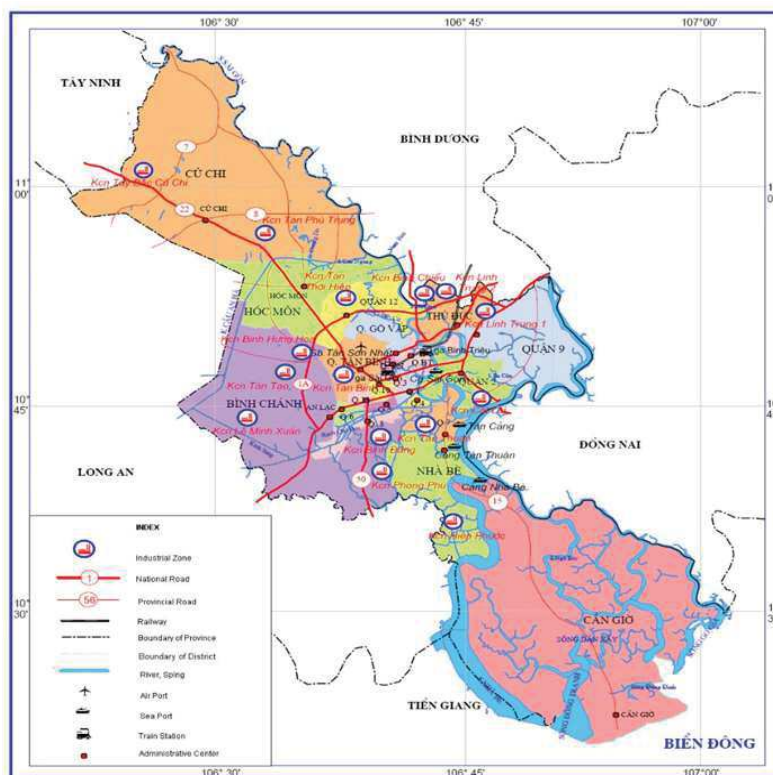


Fig. 1. Map of the location of IPs/EPZs in HCMC. Source: Hochiminh City export processing and industrial parks authority (HEPZA)[2]
 Rys. 1. Mapa lokalizacji IP / EPZ w HCMC. Źródło: Urząd ds. Przetwórstwa eksportowego i parków przemysłowych miasta Hochiminh (HEPZA) [2]

The parameters analyzed in the laboratory are officially recognized in accordance with the requirements of ISO 17025: 2005, requirements of VIMCERTS certification/Ministry of Natural Resources and Environment of Vietnam.

2.3. Data analysis

The results of surface water quality analysis at the sampling locations in this study are detailed in Table 3.

The results of surface water quality analysis at the locations are shown in Table 3, showing that the nutrient content assessed through the parameters N-NO₃, P-PO₄ exceeds QCVN 08:2015/BTNMT [3] on surface water quality. The concentration of N-NO₃ ranged from 7.8-9.8 mg/l (Figure 2), higher 2-5 times than the limits of raw surface water quality standards for water supply (QCVN 08: 2015/BTNMT column A2). Especially, P-PO₄ content ranges from 1.171-1.164 mg/l, much higher than the level permitted by QCVN 08:2015/BTNMT column B2, which is regulated for water sources used for waterway traffic and other purposes with low water quality requirements (Figure 2).

In addition, high concentrations of organic substances measured in water samples were obtained at the analytical sites. Specifically, the COD content in the study sites was from 49.6 to 192 mg/l, nearly 20 times higher than the permitted level of A1 (10 mg/l) and BOD₅ were higher than B1 (15 mg/l), ranging from 18.26 to 97.62 mg/l, the highest concentration near Hiep Phuoc industrial parks, 20 times more than the limits of raw surface water quality standards for water supply (QCVN 08:2015/BTNMT column A1), TSS measured at a high level especially 82.0 mg/l is also found in this area (Figure 3).

Besides, the measured Coliform and Phenol content at the survey sites are almost higher than the allowable levels of A1 and A2 of QCVN 08:2015/BTNMT, respectively (Figure 4). Normally, Phenol has a high content in wastewater from some industries such as plastic, paper, pharmaceutical, pesticide.

Through the survey results and analysis of parameters at the sampling locations, it is shown that surface water sources near industrial parks in Ho Chi Minh City have been polluted quite high by organic substances and nutrition and microorganisms. Therefore, it is necessary to consider, evaluate and come up with suitable solutions to control and improve water quality in areas where production activities are concentrated.

In the study of water quality assessment along the Saigon River in Ho Chi Minh City area, water quality was found to be well represented by DO, organic, nutrient, heavy metals upstream and strongly increased in the urban areas, especially Cr and Hg (higher up to 10 times), are likely to originate from industrial waste [4]. The results of analysis and measurement of water quality indicators show that the concentration of organic, nutrients, chemicals, microorganisms pollutants exceeds the permitted standards and it is possible that they arise from production activities such as food processing, paper, fertilizer, wood, tanning industry, etc. [4]. In addition, EDCs compounds were also identified with relatively high concentrations in water samples taken from Saigon and canals in Ho Chi Minh City [5], this is a compound discharged from the wastewater activation, industrial wastewater and medical waste or by products arising from the processes of plastic, pharmaceutical, cosmetic, plant protection products, cleaning products and chemicals [6]. Through the survey re-

Tab. 1. Number and area of IPs and EPZs in HCMC. Source: Ho Chi Minh City export processing and industrial parks authority (Hepza) [2]
 Tab. 1. Liczba i obszar IP i EPZ w HCMC. Źródło: władze Ho Chi Minh City zajmujące się przetwórstwem eksportowym i parkami przemysłowymi (Hepza) [2]

No.	IPs/EPZs	Area (ha)
1	Hiep Phuoc IP (phase 1)	311,4
2	Hiep Phuoc IP (phase 2)	597
3	Tan Phu Trung IP	542,64
4	Tan Tao IP	380,15
5	Tan Thuan EPZ	300
6	Dong Nam IP	286,76
7	Tay Bac Cu Chi IP	208
8	Vinh Loc IP	203
9	Le Minh Xuan III IP	155,75
10	Tan Binh IP	128,7
11	Cat Lai II IP	124
12	An Ha IP	123,51
13	Le Minh Xuan IP	100
14	Co khi Oto IP	99
15	Linh Trung 1 EPZ	62
16	Linh Trung 2 EPZ	61,7
17	Tan Thoi Hiep IP	28
18	Binh Chieu IP	27,34
19	Da Phuoc IC	116,8
20	Pham Van Coi IC	75
21	Tan Quy A IC	65
22	Tan Quy B IC	97
23	Long Son IC	25,37
24	Handicraft District 2 IC	18
25	Tan Thoi Nhi IC	87
26	Tan Hiep A IC	25
27	Tan Hiep B IC	40
28	Nhi Xuan IC	180
29	Dong Thanh IC	36
30	Duong Cong Khi IC	55
31	Bau Tran IC	95
32	SAGRI IC	89
33	Tran Dai Nghia IC	50
34	Quy Duc IC	70
35	Tan Tuc IC	40
36	Long Thoi IC	57
37	Binh Khanh IC	97
38	Hiep Thanh IC	50
39	Binh Dang IC	33
40	Phu My IC	80

sults reports, the water source on the Saigon River has high nutrient, organic and microbiological content, the pollution on the Saigon River becomes more serious and makes it difficult and expensive in water treatment [7].

According to the results of recent research on water quality of the Saigon River, the raw water quality of Saigon River has been reduced due to the increase of pollutants such as organic, nitrogen and pathogens related to agricultural, industrial and domestic activities [4]. The Saigon River is polluted by organic, BOD and COD content exceed the limits of raw

surface water quality standards for water supply (column A2 QCVN 08:2015/BTNMT [8], [3]).

According to the review report also showed that surface water quality in Ho Chi Minh City is currently polluted by organic substances, nutrients, heavy metals, microorganisms and some other compounds and causes. The main pollution is caused by industrial production activities of the IPs/EPZs [1].

3. Impacts Caused by Polluted Water from the Activities of the IPS/EPZS

Tab. 2. Sampling sites
Tab. 2. Miejsca pobierania próbek

No.	Name	River/canal section	Neighboring industrial parks
1	M1	An Ha canal, the river section passes An Ha bridge	Tan Phu Trung
2	M2	B canal, the section crossing the B canal river bridge	Le Minh Xuan
3	M3	Ba Bo canal, the section nearby Ngo Chi Quoc street	Linh Trung II
4	M4	Ky Ha canal, passing Ky Ha bridge	Cat Lai
5	M5	Kinh river, Dong Dien bridge intersection	Hiep Phuoc

Tab. 3. Results of analysis of water quality indicators at sampling locations. Source: Environmental Monitoring and Assessment Center, Ton Duc Thang University, Viet Nam (May 2019)

Tab. 3. Wyniki analizy wskaźników jakości wody w miejscach poboru próbek. Źródło: Ośrodek monitorowania i oceny środowiska, Uniwersytet Ton Duc Thang, Wietnam (maj 2019 r.)

No.	Parameter	Unit	Result					Test methods
			M1	M2	M3	M4	M5	
1	pH	-	7.74	7.45	7.50	7.29	7.32	TCVN 6492:2011
2	DO	mg/l	7.68	5.11	7.32	7.90	8.91	TCVN 7325:2016
3	BOD ₅	mg/l	18.26	49.19	73.02	25.62	97.62	TCVN 6001-1:2008
4	COD	mg/l	49.6	94.40	140.8	53	192	SMEWW 5220C:2012
5	TSS	mg/l	36.0	5.70	22.30	24.70	82.0	SMEWW 6625:2000
6	N-NH ₄	mg/l	0.03	0.09	0.08	0.05	0.06	SMEWW 4500-NH ₃ ,B&F:2012
7	N-NO ₃	mg/l	8.5	7.8	9.8	8.2	7.8	SMEWW 4500-NO ₃ -E:2012
8	P-PO ₄	mg/l	1.201	1.256	1.464	1.171	1.187	SMEWW 4500-P,E:2012
9	Coliform	MPN/100ml	5000	3000	5000	2100	3000	TCVN 6187-2:1996
10	Phenol	mg/l	0.01	0.01	0.02	0.01	0.01	TCVN 6216:1996
11	Clorua	mg/l	42.295	59.710	-	333.383	771.258	TCVN 6194:1996
12	Fe	mg/l	0.137	-	-	-	-	SMEWW 3120B:2012
13	Mn	mg/l	0.099	-	-	-	-	SMEWW 3120B:2012
14	Pb	mg/l	-	<0.01	<0.01	<0.01	<0.01	SMEWW 3120B:2012
15	Cu	mg/l	-	0.009	0.01	0.013	-	SMEWW 3120B:2012
16	Ni	mg/l	-	<0.01	-	<0.01	-	SMEWW 3120B:2012
17	Zn	mg/l	-	-	0.027	-	-	SMEWW 3120B:2012
18	Cr	mg/l	-	-	0.011	-	0.01	SMEWW 3120B:2012

The problem of environmental pollution due to industrial production activities in general and EPZs/EPZs in particular has been adversely affecting the natural ecosystems and people's lives in the region. Especially, waste water produced without treatment and discharged directly into the environment will directly affect the water ecosystem, causing significant damage to agricultural and fishery production and aquaculture in the surrounding area. In addition, the problem of environmental pollution caused by industrial production also increases the burden of disease, increases the rate of sick people working at the IPs/EPZs and communities living around the area. Alarmingly, this rate has tended to increase in recent years and caused significant economic losses for the locality. Details are presented below.

3.1. Loss of Ecosystem Productivity of Agriculture and Aquaculture

The system of rivers and canals in Ho Chi Minh City is the source for receiving and transporting waste water containing pollutants from IPs/EPZs. Waste water containing organic matter exceeding the permissible limit will cause eutrophica-

tion, reducing the amount of oxygen in the water, leading to some species being killed. The occurrence of toxic substances such as grease, heavy metals, chemicals in the water will affect aquatic plants and animals and enter the food chain of living species, eventually affecting the health of people.

In Ho Chi Minh City, the amount of wastewater from IPs/EPZ operations in recent years is much larger than that of other activities and increases at a rapid rate. According to the general assessment of the PC49 Environmental Crime Prevention Police Department, around 62% of industrial parks nationwide have built centralized wastewater treatment systems but these works are inefficient, leading to The situation of 75% of industrial wastewater discharged to industrial parks still contains high levels of pollutants, exceeding permitted standards many times. This data is quite similar to the data on the status of HCMC (64.2% of IPs /EPZs built wastewater treatment systems). The amount of untreated waste water discharged directly into the environment has caused people in the area around the IPs/EPZs to suffer. Illustrative images for polluted canals in Thu Duc District, HCMC are shown in Figure 5 [9].

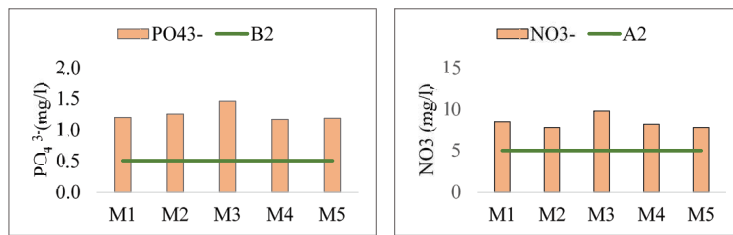


Fig. 2. Concentration of P-PO₄ and N-NO₃ at the locations
Rys. 2. Stężenie P-PO₄ i N-NO₃ w lokalizacjach

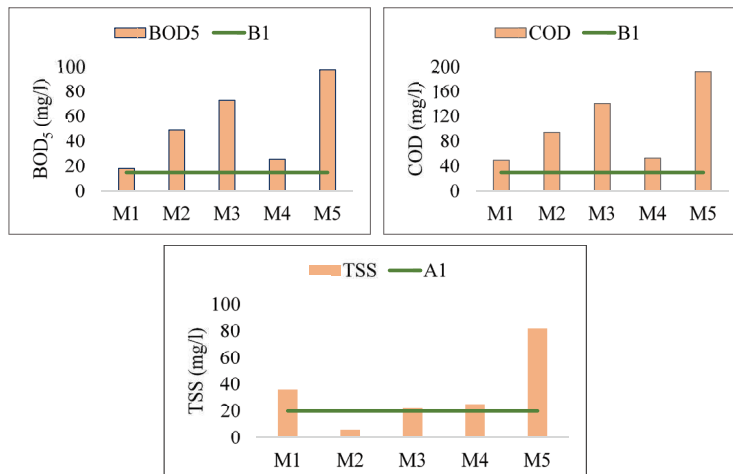


Fig. 3. Concentrations of BOD₅, COD, and TSS
Rys. 3. Stężenia BZT₅, ChZT i TSS

In southern Vietnam, water pollution of Thi Vai river is one of the typical examples of industrial pollution causing direct impacts on water ecosystems, causing significant damage to agricultural production, and fisheries of people in the region. The discharge of pollutants with high concentrations and large flows into river water environments, in the middle and lower reaches of the river (where many large-scale IPs/EPZs are concentrated) cannot be controlled, causing heavy pollution to the environment. In the affected area, shrimp, fish and aquatic species are almost impossible to survive and grow. Ecosystems in this area only exist a few species of zooplankton and phytoplankton; the species of algae that grow mainly are those that adapt to a high nutrient environment and their development also increases the risk of toxicity to the aquatic environment.

3.2. Polluting water, soil and health effects

Wastewater from IPs/EPZs must not be treated, causing pollution to surface and groundwater sources, thereby affecting the quality of water supply and may cause adverse impacts on human health through the food chain. The main diseases related to water quality are intestinal diseases, parasitic diseases, bacteria, viruses, mold..., diseases caused by intermediate insects and micro-elements and other substance.

According to the study, assessing the impact of production activities in metal processing zones on the health of people living around the National Institute of Occupational and Environmental Health in Vietnam, showing the lead content in waste water exceed the permitted standards many times; respectively, the content of lead and arsenic in the soil in the study

area is 1.2–2.5 times higher than the standard, and the content of lead and arsenic in the domestic water is 1.5–6 times higher.

In a study assessing the effect of lead metal (derived from industrial textile dyeing, battery production, bleaching, metallurgy) domestic canal in Ho Chi Minh City to vegetable quality Aquatic plants show that: the content of lead in *Ipomoea aquatica* grown in some specialized areas, growing on canals is relatively high, in comparison with the permitted standards, there are 16/25 vegetable samples on the market with content lead higher than specified. The untreated industrial wastewater discharged directly into the river and canal system has increased the content of heavy metals, including lead and other toxins in vegetables, greatly affecting consumers' health.

3.3. Increasing the burden of disease

Economic losses due to increasing burden of diseases related to water pollution are very large. Statistics from the Institute of Occupational Medicine and Environmental Sanitation on industrial pollution and public health show that from 1976 to 1990 in Vietnam there were 5,497 cases of occupational diseases, but in the period In the period of 2006 to 2016, the number of infected people has tripled with a total of 21,597 people. It is forecasted that the number of new occupational diseases by 2020 will be over 30,000, according to which, the total expenditure on occupational diseases in the period of 2006 to 2016 is calculated at more than 50 billion VND.

This data proves that: environmental pollution has significantly affected the health of people living in the vicinity of factories, IPs/EPZs, thereby causing economic losses for the locality, specifically loss for medical examination and treat-

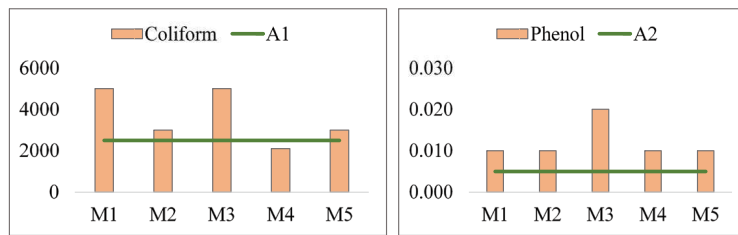


Fig. 4. Concentrations of Coliform and Phenol
Rys. 4. Stężenia pałeczek coli i fenolu



Fig. 5. Untreated wastewater discharged directly to Kenh Ba Bo, Thu Duc District, HCMC
Rys. 5. Nieoczyszczone ścieki odprowadzane bezpośrednio do Kenh Ba Bo, dystrykt Thu Duc, HCMC

ment and other damages caused by illness. It is estimated that the average economic loss for each person in a year in the area affected by the IPs/EPZs is 3.5 times higher than in other regions.

According to a World Bank study [10] "Risks due to water pollution are becoming more serious, causing impacts on human health as well as the economy and the environment, a major threat, and they can cause nearly 6 % of GDP losses by 2035, if no changes are made".

4. Solutions to Control and Prevent Pollution Due to the Operation of Industrial Parks

4.1. Management solutions

Completing institutions on environmental protection; review, adjust and supplement issued policy documents, specific legislation on the environment, the documents guiding the implementation of the law.

Taxes and environmental charges on the principle of "polluters must pay environmental treatment, remedial, renovation and restoration costs", "people benefit from environmental values must be paid" should be applied to promote the role of economic tools, limit activities causing pollution and degradation, promote socio-economic development towards green growth.

Planning and relocating industrial parks to separate areas, suburban areas, far from residential areas, is an essential factor to protect and take measures to isolate and handle environmental safety. The planning must be classified by type of production to facilitate management, especially waste collection, advanced production technology application, construction of waste treatment system.

4.2. Technical solutions

Continuous improvement of environmental waste treatment processes, prioritizing clean, green and clean produc-

tion lines with the living environment to ensure that industrial parks do not negatively affect the surrounding area.

Enhance capacity, fully equip necessary equipment and facilities, maintain regular monitoring activities, detect cases of violation of the law on pollution control.

Focusing on measures to prevent and reduce pollution in industrial parks, strategic environmental assessment and environmental impacts must be improved, ensuring scientific, focused, feasible, public and participatory.

5. Conclusion

Activities of industrial parks have grown rapidly, contributing significantly to the country's economic development process, but there are also many risks of environmental pollution, especially for surface water. The results of analysis at a number of locations near industrial parks in Ho Chi Minh City show that surface water has been polluted, the level is quite high, focusing on organic matter and nutrition content, chemicals and harmful microorganisms. Thus, it is predicted that surface water pollution in HCMC's rivers and canals will become more serious, making it more difficult and expensive to control and manage.

Therefore, the implementation of measures to control and prevent pollution in industrial parks in Ho Chi Minh City is very necessary, in which the completion of institutions in environmental protection activities; reviewing, modifying and promulgating additional environmental policies and legislation, and guiding documents for implementation of laws are very important. When complete policies and institutions can effectively implement the introduction of appropriate technical solutions to contribute to minimizing, controlling and preventing water pollution due to the operation of industrial parks.

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Rozwiązania w zakresie kontroli, zapobiegania i redukcji zanieczyszczeń w działalności parków przemysłowych w mieście Ho Chi Minh, Wietnam

Ho Chi Minh City (HCMC) w Wietnamie charakteryzuje się szybkim tempem wzrostu, otwartą gospodarką i współpracą z wieloma krajami, skupiając wiele parków przemysłowych i stref przetwórstwa eksportowego wraz z projektami rozwoju infrastruktury przemysłowej, usługi produkcyjne związane z transportem, komunikacją, zaopatrzeniem w wodę i ochroną środowiska, eksploatacją zasobów, produkcją i przetwarzaniem dóbr konsumpcyjnych oraz eksportem.

Wraz z szybkim procesem industrializacji i modernizacji w Ho Chi Minh City coraz bardziej obniża się jakość środowiska, w którym najważniejszym czynnikiem są zasoby wodne, zwłaszcza wodne źródła rzek i kanałów. W ostatnich latach przeprowadzono wiele badań dotyczących jakości wód powierzchniowych w Ho Chi Minh City, ale nie przeprowadzono badań oceniających oddziaływanie wpływające na jakość źródeł wód powierzchniowych z powodu działalności parków przemysłowych w mieście.

Badania przeprowadzono w celu oceny jakości wód powierzchniowych poprzez analizę aktualnego stanu wód, zbadano jakość wód powierzchniowych na obszarach związanych z funkcjonowaniem parków przemysłowych w Ho Chi Minh City. W ten sposób oceniono wpływ czynników na jakość wody i proponowano rozwiązania w zakresie kontroli i zapobiegania zanieczyszczeniom wynikającym z funkcjonowania parków przemysłowych.

Słowa kluczowe: zanieczyszczenia, parki przemysłowe, wody powierzchniowe, wody rzeki Sajgon