

***A Study on the Water Quality of the Saen Saeb Canal: A Case Study on the SWU
Joint Conservation of the Saen Saeb Canal Project***

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Abstract

This study had four purposes: 1) to evaluate the water quality of the Saen Saeb Canal according to five parameters (i.e. biochemical oxygen demand (BOD), dissolved oxygen (DO), positive potential of the hydrogen ions (pH), suspended solids (SS), and phosphate (PO_4^{3-})), 2) to compare such water quality parameters with the water quality standards in surface water types.3, announced by National Environment Board No. 8 (1994), 3) to compare such water quality parameters with the water quality in the same period last year, and 4) to investigate the attitude of residents living along the canal toward Saen Saeb Canal conservation. The results were as follows: 1) the quality of water in the Saen Saeb Canal was assessed by analysing the mean values of BOD, DO, pH, SS and PO_4^{3-} , which were 10.50 mg/l, 2.25 mg/l, 6.25 mg/l, 25.40 mg/l, and 0.48 mg/l, respectively, 2) these figures corresponded to the standard values, except those of BOD and DO, which were lower than the standards, 3) comparison of current water quality to that in the same period last year showed that the average BOD value had decreased and the average DO had increased. With regard to SS and PO_4^{3-} , averages did not exceed the standard in either time period, and 4) the attitudes of residents living along the Saen Saeb Canal toward conservation of the Saen Saeb Canal were designated as being at a “good level”.

Keywords: water quality of the Saen Saeb canal; attitude toward conservation of the Saen Saeb Canal.

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Introduction

The Saen Saeb canal was built on the order of King Rama III during the conflict between Siam and Annam over Cambodia, in order to establish water transport for taking soldiers and weapons to Cambodia. Construction started in 1837 and was completed three years after. [1] The Saen Saeb Canal was once filled with an abundance of lotus; King Rama IV, as the fourth monarch of Siam (1851-1868), built Sra Pathum Palace (Lotus Pond Palace) in the Siam district. The Saen Saeb starts at Mahanak Canal (or Khlong Mahanak), near Mahakan Fort in Bangkok, and terminates into the Bang Pakong River in Chachoengsao province. [1]



Fig.1 The Saen Saeb Canal in 1890

In the past, canals in Bangkok played an important role in boat transport, commerce, agriculture and domestic consumption, and there were many communities along the canals. At present, the current social and economic situations are changing as the urban society is expanding from the inner areas to the outer areas. In the metropolitan area, buildings are packed closely together along the canals, which have become residential and business areas as well as key routes for water transportation. Such rapid changes have made the water quality poor in all canals, including the Saen Saeb Canal. [2]



Fig.2 The Saen Saeb Canal in 2016

There are various factors affecting the water quality in the Saen Saeb Canal, and the following factors contribute to the problems: 1) excessive organic inputs from tributaries, households, businesses and industries, from both point- and non-point sources; 2) too much sediment in the water and at the bottom of the canal, which generates a high oxygen demand for the water; 3) resuspended sediments due to the

shallow depth of the canal and turbulence from boats; and 4) waves from the boats which are not dissipated due to the fast speed of the boats and the vertical nature of the canal walls, which as a result, last for an excessively long time and exacerbate the resuspension of sediment. [1]

The poor condition of the water in the Saen Saeb Canal has a great impact on the people who live along the canal and those who do not, in terms of health and economic problems which can be summarized as follows. 1) Health problems: Besides the strong odors which the Saen Saeb Canal produces, it has a very high level of coliform bacteria, which can cause diarrhea, and many other types of bacteria and microorganism. This is due to its very low oxygen levels, which can cause many other diseases. Moreover, regular water transport also causes noise and air pollution for both the residents along the canal and the commuters. In addition, the government has to tackle the health problems caused by the water pollution by allocating a large budget. 2) Economic problems: The Saen Saeb Canal has a lot of potential to generate more income for the local communities as well as the whole country, such as the potential to turn the canal into a recreation area or ecotourist attraction such as a floating market. 3) Thailand's reputation: This water problem could also cause the country to gain a bad reputation due to the negligence in maintaining people's quality of life and environment. [2]

Therefore, there are two ways to solve the problems and reduce their impact: 1) encourage all office buildings in Bangkok to effectively operate sewage systems in the entire area; and 2) educate people, residents and students about maintaining the water quality in the canal, generating enthusiasm for long-term canal conservation. [3] [4]

Due to the problems, Srinakharinwirot University has highlighted the importance of doing activities that encourage people to participate in the conservation of the Saen Saeb Canal, by organizing the "SWU Joint Conservation of the Saen Saeb Canal as a Good Model for the Community" project. The project aims to encourage the people living along the Saen Saeb Canal to conserve their environment so that the quality of the canal is improved. [5] Therefore, the following activities have been performed:

- 1) Creating awareness of the Saen Saeb Canal, conducted by the university.

Lecturers, students and people along the canal have joined our boat to put microorganisms into wastewater and microorganisms into the sludge in the canal, departing from the pier of Srinakharinwirot University and terminating at the pier of Vajitwittaya School. Additionally, there has been a campaign to encourage water conservation among the public, where microorganisms were distributed to the communities along the canal every month for putting in the latrines and grease traps.



Fig. 3 Assoc. Prof. Dr. Chanwit Tiamboonprasert, president of the project, speaks at the opening of the campaign for the conservation of the Saen Saeb canal.



Fig. 4 Lecturers, students and people along the canal join our boat to put microorganisms into wastewater and microorganisms into the sludge in the canal.

2) Awareness of conserving the Saen Saeb Canal was increased by displaying a monthly report on the Saen Saeb Canal water quality at the pier so that people would know the water quality and its impact on the community.



Fig. 5 The report on water quality in the Saen Saeb Canal at the pier

3) Creation of the Saen Saeb Canal conservation network, which is a selection of organizations located along the Saen Saeb Canal, consisting of schools, hotels, and dormitories in Wattana District. In order to reduce waste in the Saen Saeb Canal,

these 15 organizations have put microorganisms into sewage, latrines, drains, grease traps and wastewater treatment systems.

4) Training on how to measure oxygen dissolved in water (DO) has been conducted. This training involved teaching students in five schools located along the Saen Saeb Canal how to measure dissolved oxygen correctly, in order to monitor water quality in canals. [6]



Fig. 6 Training on how to measure oxygen dissolved in water

5) Training on how to make microorganisms used in waste treatment was carried out to educate people in five communities along the Saen Saeb Canal how to prepare microorganisms used in household wastewater treatment and perform proper waste management.

6) Training on "The Basics of Wastewater Management for Students Along the Saeb Canal" provided knowledge on basic household wastewater treatment to students in five schools located along the Saen Saeb Canal, in order to reduce the amount of wastewater discharged into the canal.



Fig. 7 Training how to make microorganisms used in waste treatment

In doing so, the "SWU Joint Conservation of the Saen Saeb Canal to be a Good Model for the Community" project is of importance. It can serve as for the environment in the area along the canal, and also encourage the public and young people to be enthusiastic about keeping the Saen Saeb Canal in a state of equilibrium. [7] This will lead to sustainable development in the future.

Research objectives

This study had of four purposes:

- 1) To evaluate the water quality in the Sean Saeb Canal according to five parameters (i.e. biochemical oxygen demand (BOD), dissolved oxygen (DO), positive potential of the hydrogen ions (pH), suspended solids (SS), and phosphate (PO_4^{3-}),
- 2) To compare such water quality parameters with the water quality standards in surface water types.3, announced by the National Environment Board No. 8 (1994),
- 3) To compare such water quality parameters with the water quality in the same period last year, and
- 4) To investigate the attitude of residents living along the canal toward Saen Saeb Canal conservation.

Method

The research was conducted by carrying out the following steps:

- 1) The quality of water in the Saen Saeb canal was evaluated by sampling the water at a total of five piers: 1) Prasarnmit Pier; 2) Italthai Pier; 3) Bann Don Mosque Pier; 4) Thonglor Pier; and 5) Vijitwittaya School Pier, all located within a total distance of 6.8 kilometers. The samples were collected 28 times (once a week) from December 2016 to June 2017.
- 2) The water quality in the Sean Saeb Canal, according to the five parameters (i.e. biochemical oxygen demand (BOD), dissolved oxygen (DO), positive potential of the hydrogen ions (pH), suspended solids (SS); and phosphate (PO_4^{3-}), was analyzed by using standard methods for the examination of water. [8]
- 3) The researcher analyzed water quality values according to the five parameter value sets and compared them to the water quality standards in surface water types.3, announced by the National Environment Board No. 8 B.E. 2537 (1994). [9]
- 4) Then, such water quality parameters were compared with the water quality in the same period last year.
- 5) A total of 200 people living along the Saen Saeb Canal were randomly selected to investigate attitudes toward Saen Saeb Canal conservation.
- 6) The investigation of the attitudes of residents living along the canal toward Saen Saeb Canal conservation was conducted. In the survey on their attitudes, the evaluation criteria consisted of three levels as follows: 0 = bad; 1 = average; and 2 = good. [10]

Results

The key findings of the study were as follows:

1. The average water quality of the Saen Saeb Canal samples from the five piers compared to the water quality standards in surface water types.3, announced by the National Environment Board No. 8 B.E. 2537 (1994), is shown in Table 1.

Table 1.

Water quality	BOD	DO	pH (mg/l) at the various piers	SS (mg/l)	PO ₄ ³⁻ (mg/l)	(mg/l)	(mg/l)
Prasarnmit Pier			0.38	9.24	2.50	6.34	23.30
Italhai Pier			0.42	10.78	2.24	6.39	26.50
Baan Don			0.44	9.84	2.43	6.21	23.30
Mosque Pier							
Thonglor Pier			0.62	12.28	1.94	6.13	28.60
Vijitwittaya			0.54	10.40	2.14	6.18	25.30
School Pier							
Average			0.48	10.50	2.25	6.25	25.40
Standard			>>0.6 water quality	>>2.0	<<4.0	5.0-9.0	>>30
Results from			St. the comparison	<< St.	<< St.	St.	St.

Notes

1. >> = higher than
2. << = lower than
3. St. = standard

Table 1 shows the water quality of Saen Saeb Canal water samples taken at the five piers, with details as follows:

- 1) The BOD, DO, pH, (SS) and (PO_4^{3-}) of water samples collected at Prasarnmit Pier were 9.24 mg / l, 2.50 mg / l, 6.34 mg / l, 23.30 mg / l, and 0.38 mg / l, respectively. The figures corresponded to the standard values, except those of BOD and DO, which were lower than the standards of surface water quality types.3, announced by the National Environment Board No. 8 B.E. 2537 (1994).
- 2) The BOD, DO, pH, (SS) and (PO_4^{3-}) of water samples collected at Italhai Pier were 10.78 mg / l, 2.24 mg / l, 6.39 mg / l, 26.50 mg / l, and 0.42 mg / l, respectively. The figures corresponded to the standard values, except those of BOD and DO, which were lower than the standards of surface water quality types.3, announced by the National Environment Board No. 8 B.E. 2537 (1994).
- 3) The BOD, DO, pH, (SS) and (PO_4^{3-}) of water samples collected at Baan Don Mosque Pier were 9.84 mg / l, 2.43 mg / l, 6.21 mg / l, 23.30 mg / l, and 0.44 mg / l, respectively. The figures corresponded to the standard values, except those of BOD and DO, which were lower than the standards of surface water quality types.3, announced by the National Environment Board No. 8 B.E. 2537 (1994).
- 4) The BOD, DO, pH, (SS) and (PO_4^{3-}) of water samples collected at Thonglor Pier were 12.28 mg / l, 1.94 mg / l, 6.13 mg / l, 28.60 mg / l, and 0.62 mg / l, respectively. The figures corresponded to the standard values, except those of BOD and DO, which were lower than the standards of surface water quality types.3, announced by the National Environment Board No. 8 B.E. 2537 (1994).
- 5) The BOD, DO, pH, (SS) and (PO_4^{3-}) of water samples collected at Vjittwittaya School Pier were 10.40 mg / l, 2.14 mg / l, 6.18 mg / l, 25.30 mg / l, and 0.54 mg / l. The figures corresponded to the standard values, except those of BOD and DO, which were lower than the standards of surface water quality types.3, announced by the National Environment Board No. 8 B.E. 2537 (1994).
- 6) As for the total average quality of the water samples from the Saen Saeb Canal, the mean values of BOD, DO, pH, (SS) and (PO_4^{3-}) were 10.50 mg / l, 2.25 mg / l, 6.25 mg / l, 25.40 mg / l, and 0.48. mg / l, respectively. The figures corresponded to the standard values, except those of BOD and DO, which were lower than the standards of surface water quality types.3, announced by the National Environment Board No. 8 B.E. 2537 (1994).

2. The comparison of such parameters of the current average water quality of the Saen Saeb Canal with the water quality in the same period last year is shown in Table 2.

Table 2.

water quality	BOD (mg/l)	DO (mg/l)	pH	SS (mg/l)	PO ₄ ³⁻ (mg/l)
Dec. 2016	12.50	1.60	6.25	28.60	0.62
Dec. 2017	9.40	2.40	6.50	24.50	0.44
Jan. 2016	12.85	1.55	6.28	28.50	0.59
Jan. 2017	10.15	2.35	6.20	24.90	0.47
Feb. 2016	14.60	1.33	6.35	28.90	0.58
Feb. 2017	9.60	2.29	6.50	24.80	0.48
Mar. 2016	17.50	1.18	6.32	30.40	0.68
Mar. 2017	11.70	1.95	6.22	25.60	0.53
Apr. 2016	20.40	0.80	6.22	35.80	0.75
Apr. 2017	12.30	1.70	6.20	27.70	0.52
May. 2016	16.30	1.18	6.25	29.80	0.69
May. 2017	10.75	2.18	6.40	25.90	0.47
Jun. 2016	17.20	1.20	6.18	32.90	0.68
Jun. 2017	9.60	2.50	6.45	24.80	0.45
Average 2016	15.90	1.26	6.26	30.70	0.65
Average 2017	10.50	2.25	6.25	25.40	0.48
Standard water quality	>>2.0	<<4.0	5.0-9.0	>>30	>>0.6

Table 2 shows the comparison of parameters of the current average water quality of the Saen Saeb Canal with the water quality in the same period last year.

1) With regard to the total average quality of the water sampled in 2016 from the Saen Saeb Canal, the mean values of BOD, DO, pH, (SS) and (PO₄³⁻) were 15.90 mg / l, 1.26 mg / l, 6.26 mg / l, 30.70 mg / l, and 0.65. mg / l, respectively. The figures did not correspond to the standard values, which were lower than the standards of surface water quality types.3, announced by the National Environment Board No. 8 B.E. 2537 (1994).

2) With regard to the total average quality of water sampled in 2017 from the Saen Saeb Canal, the mean values of BOD, DO, pH, (SS) and (PO₄³⁻) were 10.50 mg / l, 2.25 mg / l, 6.25 mg / l, 25.40 mg / l, and 0.48 mg / l, respectively. The figures followed the standard values, except those of BOD and DO, which were lower than the standards of surface water quality types.3, announced by the National Environment Board No. 8 B.E. 2537 (1994). However, the comparison with the water

quality in the same period last year showed that the average BOD had decreased and the average DO had increased. With regard to SS and PO_4^{3-} , averages did not exceed the standard in either time period.

3. Results of the investigation into attitudes of residents living along the canal toward Saen Saeb Canal conservation is shown in Table 3.

Table 3				
average score	n	\bar{x}	SD	Level
post-test	200	2.89	0.24	Good

Table 3 shows the average post-test score of attitudes of residents living along the canal toward Saen Saeb Canal conservation. The average value was 2.89 (good level).

Conclusions

The results were as follows:

- 1) The results of this study indicated that the quality of water sampled from the Saen Saeb Canal was assessed by analysing the mean values of BOD, DO, pH, SS and PO_4^{3-} , which were 10.50 mg/l, 2.25 mg/l, 6.25, 25.40 mg/l, and 0.48 mg/l, respectively.
- 2) The figures corresponded to the standard values, except those of BOD and DO, which were lower than the standards.
- 3) Comparison of the current water quality with water quality in the same period last year showed that the average BOD had decreased and the average DO had increased. With regard to SS and PO_4^{3-} , averages did not exceed the standard in either time period.
- 4) The attitudes of residents living along the Saen Saeb Canal toward conservation of the Saen Saeb Canal were designated as at a “good level”.

Discussion

Overall, the average BOD of the Saen Saeb Canal water samples from the five piers did not meet the required standards. This may be due to the amount of oxygen dissolved in the water used in the microbial decomposition of organic matter in the water. This shows that there is plenty of such organic matter which accumulates in the water at the collection points, leading to high BOD and dirty water. Therefore, BOD values indicate contamination of water, and are an important factor in highlighting the pollution of water sources. The analysis revealed that the BOD of each point where water was collected was higher than the set standard, and differed greatly from it due to the dumping of sewage into the water. This caused the microbes in the water to

remain untreated and meant the water was unable to return to a normal state [11], especially at Thonglor Pier, where BOD went up to 12.28 mg/l. Also, the water was very black and many dissolved solids were found in the water, so the turbidity pretty much hindered the diffusion of oxygen into the water. This may be the reason why the BOD of the water in the Saen Saeb canal was unable to meet the required standards. However, comparison with the water quality in the same period last year showed that the average BOD had decreased because people had been encouraged to participate in the conservation of the Saen Saeb Canal through the organization of the “SWU Joint Conservation of the Saen Saeb Canal to be a Good Model for the Community” project.

Overall, the average DO of the Saen Saeb Canal water sampled from five piers did not meet the required standards. This may be due to organic compounds such as proteins, fats and carbohydrates released into the canal, of which a large quantity of such substances are a result of household and community activities, such as cooking, washing, dumping trash and releasing sewage. The large amount of organic matter in the water exceeded the amount of microorganisms which consume dissolved oxygen in the water to decompose organic matter and reduce waste water problems. [12] This may be the reason why the DO levels of the water in the Saen Saeb canal did not meet the required standards. However, the comparison of water quality with that in the same period last year showed that the average levels of DO had increased. Due to the decreasing BOD value, the oxygen consumption of organisms which decompose organic matter has decreased, resulting in a higher DO level in the water. In addition, the activities of the “SWU Joint Conservation of the Saen Saeb Canal to be a Good Model for the Community” project had also had an effect on the DO level in the water.

Overall, the average pH of the Saen Saeb Canal water, sampled at five points along the canal, met the required standards. This may be due to the decomposition of organic matter to carbon dioxide by microorganisms in the water. The gas reacts with the water to produce carbonic acid (H_2CO_3), which made the water in the Saen Saeb Canal soft [13] with a pH equal to 6.25. Another factor that affected the water's pH was the presence of matter which led to alkaline soluble contaminants in the water, such as those from chemicals, soaps and detergents. This was able to lessen the impact of the harsh acid conditions and as a result, the pH of the water in the canal met the standards set.

The average level of suspended solids (SS) in the Saen Saeb Canal water, sampled at five points along the canal, met the required standards. This may have been due to communities located along the Saen Saeb Canal treating wastewater prior to discharge into the canal. Additionally, according to “SWU Joint Conservation of the Saen Saeb Canal to be a Good Model for the Community” project, the amount of sludge had been reduced, resulting in a reduced amount of SS. As a result, the level of SS in the canal water met the standards set.

The attitudes of residents living along the Saen Saeb Canal toward canal conservation were designated as being at a “good level”. This may be because people who live

along the canal were very keen to find out the results of water quality analysis, which the public could see at piers while they were waiting for boats from December 2015 to June 2017. Another reason is the activities of the “SWU Joint Conservation of the Saen Saeb Canal to be a Good Model for the Community” project. [14]

Also, most of them had probably been affected by putrid odor, and as such, they had positive attitudes toward Saen Saeb Canal conservation. Thus, the results revealed their attitudes toward such conservation were at a “good level”.

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