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## WATER QUALITY ASSESSMENT IN HONG XENG CHANNEL, VIENTIANE CAPITAL

Phoummixay Siharath<sup>1</sup>, Somchay Vilaychaleun<sup>2</sup>, Khampasith Thammathevo<sup>3</sup>,  
Chankhachone Sonemanivong<sup>4</sup>, Soulyphan Kannitha<sup>5</sup>, Phetsakhone Nhaovarath<sup>6</sup>,  
Keoduangchai Keokhamphui<sup>7</sup>

Environmental Engineering Department, Faculty of Engineering, National University of Laos<sup>1,2,3</sup>

Civil Engineering Department, Faculty of Engineering, National University of Laos<sup>4,5,6</sup>

Faculty of Water Resources, National University of Laos<sup>7</sup>

phoummixay2011@gmail.com<sup>1</sup>, somchay.v@fe-nuol.edu.la<sup>2</sup>, thammathevok@gmail.com<sup>3</sup>,  
Chankhachone@fe-nuol.edu.la<sup>4</sup>, soulyphan@fe-nuol.edu.la<sup>5</sup>, phetsakhone\_pm@yahoo.com<sup>6</sup>,  
K1.keokhamphui@nuol.edu.la<sup>7</sup>

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### ABSTRACT

In the capital Vientiane, households, communities and factories discharge wastewater into the Hong Xeng canal, which flows into the Thatluang wetland, where it ends up in the Mak Heiw stream and falls into the Mekong River. Water quality assessment is an excellent factor in indicating the existing water condition. Therefore, the aim of this study was to investigate and collect water samples at 3 locations (P1, P2, and P3) to understand the status of water quality, and analyze 12 water samples of the Hong Xeng Canal and also compare the findings with past data by standard. Methods Data was collected and analyzed in the laboratory for two months from 25 August 2008 to 6 October 2008. The results showed that the temperature was 28°C - 31.1°C, Nitrate ion (NO<sub>3</sub><sup>-</sup>) was 3.2 mg/l - 46 mg/l, pH 5.9-6.6, electrical conductivity 87 µS/cm - 283 µS/cm, Total Suspended Solid (TSS) 22 mg/l - 78 mg/l and CODMn 5.5 mg/l - 10.9 mg/l. Therefore, these parameters are recognized and substandard. While turbidity was 42 NTU - 78 NTU, BOD<sub>5</sub> 4.5 mg/l - 9.1 mg/l, Dissolved Oxygen (DO) 9.1 mg/l - 10.6 mg/l and Phosphate (PO<sub>4</sub><sup>3-</sup>) 0.05 mg/l - 0.25 mg/l. this parameter is higher concentration and above standard.

**Keywords:** assessment, bod, cod, tss, water quality.

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Corresponding Author: Phoummixay Siharath

E-mail: phoummixay2011@gmail.com



### INTRODUCTION

Vientiane Capital locates in central part of Lao PDR (Vongpraseuth et al., 2022). The population was 795,000 in 2009 (Sims, 2015). The annual population growth rate was 3.1% in 1985; the whole area is 3,920 km<sup>2</sup>, with a density of 176 people per Km<sup>2</sup> (Hayward, 2017). The infrastructures and services have improved significantly over the last five years, with significant investments in primary roads and drainage funded by Asian Development Bank (ADB), other funding agencies, and the Government, focusing on primary infrastructure constrained the ability of the newly constructed infrastructure to realize its full potential benefits (Citaristi, 2022). In the last decade years, infrastructure projects have been constructed in Laos, especially in Vientiane Capital such as roads, channels, creeks, and many constructions were completed (Sivongxay et al., 2017). Therefore, the Hong Xeng channel is one more extensive channel in Vientiane Capital (Oraboune, 2013). The channel was constructed by concrete. It receives wastewater from households, communities and factories, discharges to drains to Thatluang wetland, then end in the Mak Heiw stream and falls to

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the Mekong River (McCartney et al., 2015). The Hong Xeng channel system flows through three urban districts: Sikhottabong, Chanthaboury and Saysetha (Sychareun et al., 2015). There are three central drainage channel systems in Vientiane Capital such as: Hong Xeng, Hong Ke and Hong Khoua Khao. All system discharge wastewater into the Thatluang wetland (Hayward, 2017). Hong Xeng mainly drains wastewater from the Sikhottabong district and some part of the Chanthabouly district through Nong Duang marsh and Pasak stream, then drains to the Thatluang wetland part of Saysettha district as indicated in Figure 1. Due to the number of population and residents increased continuously and also factors of the social economics development were supported by government and other stakeholders on industrial business, water use and consumption are also increased as well, there are considerable amounts of wastewater drains to the Hong xeng channel (Abdelbaki, 2022). Therefore, the water quality assessment is a part of water prevention and play significant role to waste water management in order to monitor and sustain on the water (Cheng et al., 2020).



**Figure 1. Study Location**

Based on the above background, the purpose of this study was to investigate and collect water samples in 3 locations (P1, P2, and P3) to understand the water quality status, as well as assess and analyze 12 water samples of the Hong Xeng Canal and also compare the findings with previous data with standard.

## **METHODOLOGY**

### **Data collection**

To realize the status of the water quality at site study, the research was designed the locations and also to identify reasonable time between the rainy and dry season to collect the data, therefore, data was collected 4 times over two months from 25 August to 6 October 2008. As Figure 2 shows the site 1 (P1, Hong Xeng bridge), it is at the border between Phone Tong and Savang villages. This site is a point of discharge wastewater from the Hong Pasak channel, which covers part of the Chanthabuly district through rehabilitation of the Sihom area; as indicated in Figure 3, site 2 (P2, Hong Kaikeo) locates in Hong Kaikeo village. This site is the discharge point of the Hong Kaikeo

drainage channel, which covers part of the Chanthabuly and Saysettha districts. The water flood and wastewater from households and factories are discharged into the Hong Kaikao drainage channel. Site 3 (P3) is runoff to Thaluang wetland, as indicated in Figure 4; this area is covered by the paddy fields on both sides of the channel. Therefore, in order to assess and analyze the water quality, there are significant parameters that needs to conduct in the study according to the water quality standard for instance: temperature, Nitrate ion ( $\text{NO}_3^-$ ), pH, Electric Conductivity, Total Suspended Solid (TSS),  $\text{COD}_{\text{Mn}}$ , turbidity, BOD, Dissolved Oxygen (DO) and Phosphate ( $\text{PO}_4^{3-}$ ), they were tested and analyzed based on the methods of the water experiment in the laboratory, and then the results were translated based on the environmental quality guidelines and compared with Chinaimo Water Treatment Plant Laboratory (CWTPL) in 2005, Science Technology and Environment Agency (STEA) laboratory in 2003 and Irrigation laboratory between 1993-1994 (Gorde & Jadhav, 2013).



**Figure 2. Site P1**



**Figure 3. Site P2**



**Figure 4. Site P3**

To ensure that the water sample quality, control was practiced and monitoring personnel were trained in the laboratory. This maintains the same standards and quality for sampling, preservation, analysis, and subsequent interpretation of the results. The researchers followed the advice of WASA's laboratory; the measured parameters include temperature, conductivity, and pH (Roy et al., 2018). Temperature and conductivity were measured by conductivity meter, and pH value was measured by pH paper at sites and the rests were tested in the laboratory (Rafique et al., 2014).

#### **Data analysis**

Water samples were designed and collected at each site and assigned time, the experiment and analysis were completed at Chinaimo Water Treatment Plant Laboratory (CWTPL). Therefore, the results are shown as follows.

**Table 1. Water sample collection on the date 25 August 2008**

| Description of analysis         | Units                   | Site P1   | Site P2    | Site P3      |
|---------------------------------|-------------------------|-----------|------------|--------------|
| Village name                    |                         | Phonetong | Hongkaikao | Viengchalern |
| Temperature                     | °C                      | 30.2      | 30.8       | 31.1         |
| Turbidity                       | NTU                     | 76        | 68         | 84           |
| Nitrate ion ( $\text{NO}_3^-$ ) | mg/l                    | 10.2      | 5.8        | 4.6          |
| pH                              |                         | 5.9       | 6.0        | 6.1          |
| Electric Conductivity           | $\mu\text{S}/\text{cm}$ | 162       | 272        | 185          |
| $\text{COD}_{\text{Mn}}$        | mg/l                    | 8.3       | 8.6        | 8.9          |
| $\text{BOD}_5$                  | mg/l                    | 7.5       | 5.7        | 3.3          |
| Dissolved Oxygen (DO)           | mg/l                    | 9.1       | 9.2        | 9.6          |

| Description of analysis          | Units | Site P1 | Site P2 | Site P3 |
|----------------------------------|-------|---------|---------|---------|
| Total Suspended Solid (TSS)      | mg/l  | 45      | 33      | 57      |
| Phosphate ( $\text{PO}_4^{3-}$ ) | mg/l  | 0.32    | 0.15    | 0.24    |

**Table 2. Water sample collection on the date 8 September 2008**

| Description of analysis          | Units                   | Site P1  | Site P2    | Site P3      |
|----------------------------------|-------------------------|----------|------------|--------------|
| Village names                    |                         | Phontong | Hongkaikao | Viengchalern |
| Temperature                      | °C                      | 29.5     | 30.0       | 30.0         |
| Turbidity                        | NTU                     | 63       | 49         | 71           |
| Nitrate ion ( $\text{NO}_3^-$ )  | mg/l                    | 8.8      | 4.6        | 3.2          |
| pH                               |                         | 6.0      | 6.0        | 6.0          |
| Electric Conductivity            | $\mu\text{S}/\text{cm}$ | 170      | 283        | 197          |
| $\text{COD}_{\text{Mn}}$         | mg/l                    | 10.2     | 10.3       | 10.9         |
| $\text{BOD}_5$                   | mg/l                    | 9.1      | 6.9        | 4.5          |
| Dissolved Oxygen (DO)            | mg/l                    | 10.5     | 10.5       | 10.6         |
| Total Suspended Solid (TSS)      | mg/l                    | 34       | 22         | 35           |
| Phosphate ( $\text{PO}_4^{3-}$ ) | mg/l                    | 0.20     | <0.05      | <0.05        |

**Table 3. Water sample collection on date 22 September 2008**

| Description of analysis          | Units                   | Site P1  | Site P2    | Site P3      |
|----------------------------------|-------------------------|----------|------------|--------------|
| Village names                    |                         | Phontong | Hongkaikao | Viengchalern |
| Temperature                      | °C                      | 28.5     | 28.0       | 29.1         |
| Turbidity                        | NTU                     | 74       | 64         | 78           |
| Nitrate ion ( $\text{NO}_3^-$ )  | mg/l                    | 46       | 33         | 25           |
| pH                               |                         | 5.5      | 6.0        | 6.0          |
| Electric Conductivity            | $\mu\text{S}/\text{cm}$ | 87       | 124        | 100          |
| $\text{COD}_{\text{Mn}}$         | mg/l                    | 8.2      | 7.6        | 8.2          |
| $\text{BOD}_5$                   | mg/l                    | 4.2      | 4.7        | 1.3          |
| Dissolved Oxygen (DO)            | mg/l                    | 9.8      | 9.7        | 9.0          |
| Total Suspended Solid (TSS)      | mg/l                    | 100      | 50         | 50           |
| Phosphate ( $\text{PO}_4^{3-}$ ) | mg/l                    | <0.05    | <0.05      | <0.05        |

**Table 4. Water sample data collection on the date 6 October 2008**

| Description of analysis          | Units                   | Site P1  | Site P2    | Site P3      |
|----------------------------------|-------------------------|----------|------------|--------------|
| Village names                    |                         | Phontong | Hongkaikao | Viengchalern |
| Temperature                      | °C                      | 29.1     | 29.8       | 30.1         |
| Turbidity                        | NTU                     | 55       | 42         | 61           |
| Nitrate ion ( $\text{NO}_3^-$ )  | mg/l                    | 30       | 28         | 31           |
| pH                               |                         | 6.2      | 6.5        | 6.6          |
| Electric Conductivity            | $\mu\text{S}/\text{cm}$ | 90       | 117        | 121          |
| $\text{COD}_{\text{Mn}}$         | mg/l                    | 6.7      | 5.5        | 5.6          |
| $\text{BOD}_5$                   | mg/l                    | 3.6      | 4.2        | 1.0          |
| Dissolved Oxygen (DO)            | mg/l                    | 7.9      | 8.6        | 8.3          |
| Total Suspended Solid (TSS)      | mg/l                    | 88       | 35         | 40           |
| Phosphate ( $\text{PO}_4^{3-}$ ) | mg/l                    | 0.24     | 0.15       | 0.18         |

### Previous water quality

The study was given and supported the availability of previous data from three laboratories as mentioned on section methodology. There were some parameter differences for each laboratory.

### Science Technology and Environment Agency (STEA) laboratory

The sampling station N.13 (Hong Xeng bridge) in 2003 (Flow, 2013). The STEA laboratory monitored for six parameters such as pH, Conductivity, Alkalinity,  $\text{BOD}_5$ , COD and temperature. As indicated in Table 5.

Table 5. STEA laboratory

| Date      | pH   | Conductivity<br>( $\mu\text{S}/\text{cm}$ ) | Alkalinity<br>( $\text{mgCaCO}_3/\text{l}$ ) | BOD <sub>5</sub><br>( $\text{mgO}_2/\text{l}$ ) | COD<br>( $\text{mgO}_2/\text{l}$ ) | Temperature<br>( $^{\circ}\text{C}$ ) |
|-----------|------|---------------------------------------------|----------------------------------------------|-------------------------------------------------|------------------------------------|---------------------------------------|
| January   | 7.38 | 491                                         | 193                                          | 20                                              | 130                                | 19.2                                  |
| February  | 7.62 | 412                                         | 198                                          | 15                                              | 110                                | 19.9                                  |
| March     | 7.58 | 398                                         | 193                                          | 8                                               | 90                                 | 25.5                                  |
| April     | 7.62 | 396                                         | 196                                          | 13                                              | 108                                | 27.0                                  |
| May       | 7.41 | 410                                         | 183                                          | 15                                              | 125                                | 30.0                                  |
| June      | 7.89 | 418                                         | 178                                          | 15                                              | 110                                | 29.5                                  |
| July      | 7.85 | 512                                         | 185                                          | 10                                              | 118                                | 28.5                                  |
| August    | 6.92 | 335                                         | 179                                          | 10                                              | 120                                | 27.2                                  |
| September | 7.63 | 507                                         | 192                                          | 12                                              | 120                                | 26.5                                  |
| October   | 7.53 | 227                                         | 198                                          | 18                                              | 125                                | 24.5                                  |
| November  | 6.98 | 269                                         | 213                                          | 13                                              | 115                                | 22.0                                  |
| December  | 7    | 290                                         | 218                                          | 25                                              | 130                                | 19.7                                  |

#### Chinaimo Water Treatment Plant Laboratory data

There were 12 stations to monitor and investigate in Vientiane Capital in 2005; the Hong Xeng channel was monitored on No. 11 at Viengchalern Village (Phanutda & Ho, 2019). Therefore, more details can be seen the table 6.

Table 6. Chinaimo Water Treatment Plant Laboratory

| Description of analysis          | Units                   | Date to collect water samples |           |           |
|----------------------------------|-------------------------|-------------------------------|-----------|-----------|
|                                  |                         | 14/02/2005                    | 7/05/2005 | 4/10/2005 |
| Air temperature                  |                         | NA                            | NA        | NA        |
| Temperature                      | $^{\circ}\text{C}$      | 30.2                          | 30.8      | 31.1      |
| Turbidity                        | NTU                     | 76                            | 68        | 84        |
| Nitrate ion ( $\text{NO}_3^-$ )  | $\text{mg}/\text{l}$    | 10.2                          | 5.8       | 4.6       |
| pH                               |                         | 5.9                           | 6.0       | 6.1       |
| Electric Conductivity            | $\mu\text{S}/\text{cm}$ | 162                           | 272       | 185       |
| COD <sub>Mn</sub>                | $\text{mg}/\text{l}$    | 8.3                           | 8.6       | 8.9       |
| BOD <sub>5</sub>                 | $\text{mg}/\text{l}$    | 7.5                           | 5.7       | 3.3       |
| Dissolved Oxygen (DO)            | $\text{mg}/\text{l}$    | 9.1                           | 9.2       | 9.6       |
| Total Suspended Solid (TSS)      | $\text{mg}/\text{l}$    | 45                            | 33        | 57        |
| Phosphate ( $\text{PO}_4^{3-}$ ) | $\text{mg}/\text{l}$    | 0.32                          | 0.15      | 0.24      |
| Total-Phosphorus (TP)            | $\text{mg}/\text{l}$    | NA                            | NA        | NA        |
| Alkalinity ( $\text{CaCO}_3$ )   | $\text{mg}/\text{l}$    | NA                            | NA        | NA        |
| Total Dissolved Solids (TDS)     | $\text{mg}/\text{l}$    | NA                            | NA        | NA        |

#### Irrigation laboratory (Department of Irrigation, MAF)

Data was collected during the years 1993 – 1994, they were focused on 11 parameters such as temperature, pH, TSS, conductivity,  $\text{NO}_3$ ,  $\text{NH}_4$ ,  $\text{PO}_4$ , Total Phosphate, silica, DO and COD<sub>Mn</sub>.

Table 7. Data From the Irrigation Laboratory

| SDATE    | T    | pH   | TSS_<br>MGL | CON_<br>MSM | NO32_<br>MGL | NH4N_<br>MGL | PO4P_<br>MGL | TOTP_<br>MGL | SI_<br>MGL | DO_M<br>GL | CODMN<br>_MGL |
|----------|------|------|-------------|-------------|--------------|--------------|--------------|--------------|------------|------------|---------------|
| 13/01/93 | 23.8 | 7.13 | 15.0        | 32.00       | 0.372        | 0.109        | 0.019        | 0.036        | 4.90       | 5.22       | 2.4           |
| 16/02/93 | 25.0 | 7.01 | 4.0         | 30.00       | 0.309        | 0.107        | 0.010        | 0.036        | 4.30       | 3.42       | 1.8           |
| 22/03/93 | 26.2 | 7.04 | 13.0        | 29.40       | 0.083        | 0.234        | 0.026        | 0.034        | 4.10       | 3.81       | 5.0           |
| 18/06/93 | 26.2 | 6.68 | 26.0        | 24.60       | 0.813        | 0.149        | 0.018        | 0.064        | 3.90       | 0.91       | 3.1           |
| 17/07/93 | 26.4 | 6.62 | 30.0        | 20.30       | 0.741        | 0.055        | 0.030        | 0.073        | 4.00       | 2.21       | 3.3           |
| 18/08/93 | 27.2 | 6.82 | 61.0        | 19.70       | 0.470        | 0.020        | 0.042        | 0.042        | 3.80       | 2.34       | 4.8           |
| 16/09/93 | 29.5 | 7.00 | 30.0        | 10.90       | 0.156        | 0.104        | 0.026        | 0.048        | 3.90       | 2.79       | 4.4           |
| 29/10/93 | 28.8 | 6.68 | 14.0        | 30.70       | 0.729        | 0.193        | 0.030        | 0.048        | -          | -          | 3.3           |
| 16/11/93 | 26.4 | 6.20 | 18.0        | 31.80       | 0.653        | 0.970        | 0.054        | 0.079        | -          | 6.40       | 6.7           |

| SDATE    | T    | pH   | TSS_MGL | CON_MSM | NO32_MGL | NH4N_MGL | PO4P_MGL | TOTP_MGL | SI_MGL | DO_MGL | CODMN_MGL |
|----------|------|------|---------|---------|----------|----------|----------|----------|--------|--------|-----------|
| 15/02/94 | 29.4 | 7.23 | 6.0     | 32.40   | 1.401    | 0.026    | 0.110    | 0.164    | 6.20   | 5.12   | 4.8       |
| 17/03/94 | 26.6 | 7.03 | 8.0     | 30.10   | 0.300    | 0.120    | 0.030    | 0.052    | 5.50   | 4.57   | 4.8       |
| 20/04/94 | 27.0 | 7.84 | 11.0    | 30.60   | 0.547    | 0.012    | 0.046    | 0.058    | 5.80   | 4.76   | 4.8       |
| 15/09/94 | 28.8 | 6.68 | 50.0    | 11.50   | 0.215    | 0.192    | 0.036    | 0.081    | 8.20   | 1.92   | 3.9       |
| 17/10/94 | 29.6 | 6.76 | 30.0    | 20.50   | 0.108    | 0.183    | 0.044    | 0.095    | 8.60   | 2.21   | 4.1       |
| 14/11/94 | 29.2 | 7.12 | 35.0    | 30.70   | 0.700    | 0.187    | 0.025    | 0.500    | 7.80   | 3.66   | 3.3       |
| 16/12/94 | 28.4 | 7.37 | 20.0    | 31.80   | 0.651    | 0.972    | 0.050    | 0.066    | 7.60   | 3.01   | 5.2       |

## RESULT AND DISCUSSION

### Water temperature and pH during the rainy season.

Figure 5 indicates the findings of temperature and also pH, between current and previous research. Table 1-7 show that the current and past temperature, they were under the standard, because, the standard of temperature and pH are 40°C and 9, respectively, therefore, the current temperature is 28°C -31.1°C and the past temperature was 22°C in 2003 (STEA laboratory), as well as, the current pH is 5.9-6.6, and the past pH value is 6.68 - 7.63. The pH value fluctuates under the standard range.

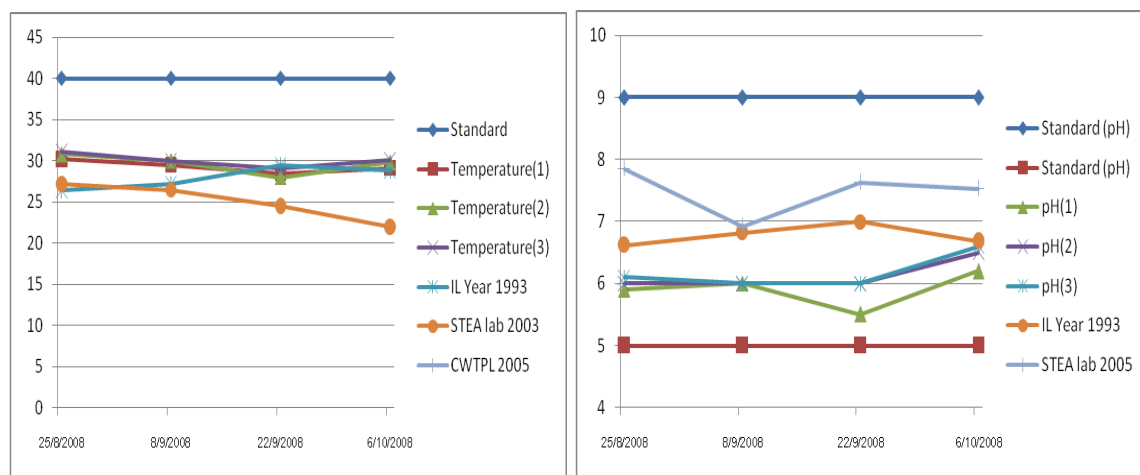
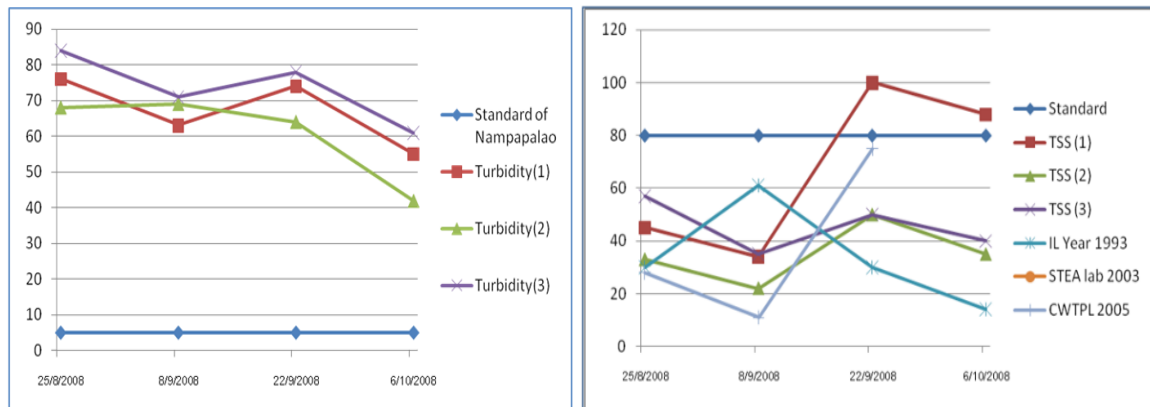


Figure 5. Temperature and pH

### Turbidity and Total Suspended Solid (TSS).

Figure 6 illustrates the findings of turbidity and Total Suspended Solid, between current and previous research, the standard of turbidity and Total Suspended Solid are 5 NTU and 80 mg/l, respectively, the Table 1-7 present that the current turbidity was over the standard, the concentration was 42 mg/l -78 mg/l, because the standard value is 5 NTU, but past turbidity was not available to compare, in the meantime, the Total Suspended Solid (TSS) were under the standard. Therefore, the current Total Suspended Solid (TSS) was 22 mg/l -78 mg/l and the past Total Suspended Solid (TSS) was 17 mg/l -78 mg/l from the mean of three previous study.

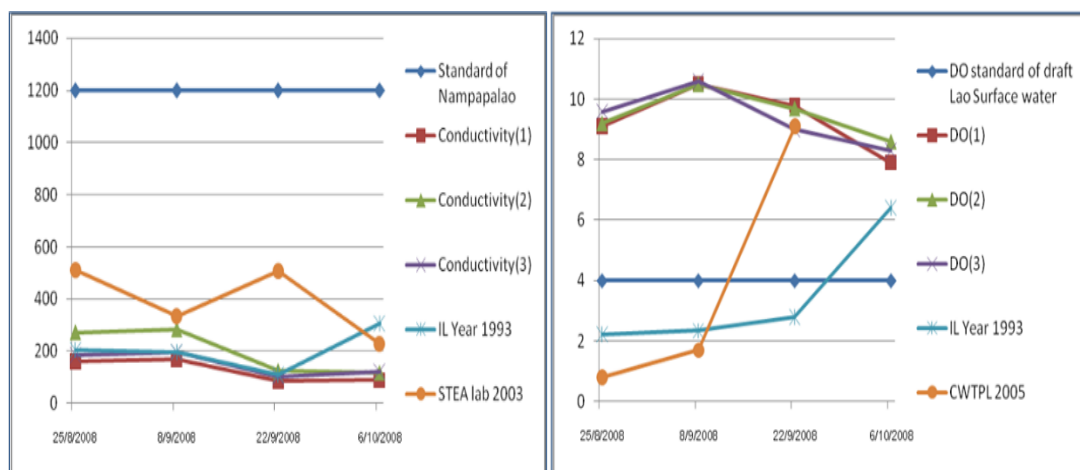




**Figure 6. Turbidity and Total Suspended Solid (TSS)**

### Electric Conductivity and Dissolve Oxygen

Figure 7 shows the findings of electric conductivity and Dissolve Oxygen, between current and previous research, the standard of electric conductivity and Dissolve Oxygen are 12,00  $\mu\text{S}/\text{cm}$  and 4 mg/l, respectively, the Table 1-7 present that the current and past electric conductivity was below the standard, the current electric conductivity was 87  $\mu\text{S}/\text{cm}$  -283  $\mu\text{S}/\text{cm}$  and the past electric conductivity was 162  $\mu\text{S}/\text{cm}$  -512  $\mu\text{S}/\text{cm}$ , meanwhile, therefore, the current Dissolved Oxygen (DO) was 9.1 mg/l - 10.6 mg/l, it was above standard, and the past Dissolved Oxygen (DO) was 0.91 mg/l - 9.6 mg/l, it fluctuated below and above the standard from the two previous study of the Chinaimo Water Treatment Plant Laboratory (CWTPL) and Irrigation laboratory.



**Figure 7. Conductivity and Dissolve Oxygen (DO)**

### Phosphate ( $\text{PO}_4^{3-}$ ) and Nitrate ion ( $\text{NO}_3^-$ )

Figure 8 indicates the findings of Phosphate ( $\text{PO}_4^{3-}$ ) and Nitrate ion ( $\text{NO}_3^-$ ), between current and previous research, the standard of Phosphate ( $\text{PO}_4^{3-}$ ) and Nitrate ion ( $\text{NO}_3^-$ ) are 2 mg/l and 50 mg/l, respectively, the Table 1-7 show that the current and past Phosphate ( $\text{PO}_4^{3-}$ ) was below the standard, the current Phosphate ( $\text{PO}_4^{3-}$ ) was 0.05 mg/l - 0.25 mg/l. and the past Phosphate ( $\text{PO}_4^{3-}$ ) was 0.03 mg/l, simultaneously , Consequently, the current Nitrate ion ( $\text{NO}_3^-$ ) was 3.2 mg/l - 46 mg/l, it was above standard, and the past Nitrate ion ( $\text{NO}_3^-$ ) was 0.08 mg/l - 10.2 mg/l, it is below the standard from one previous study of irrigation laboratory.

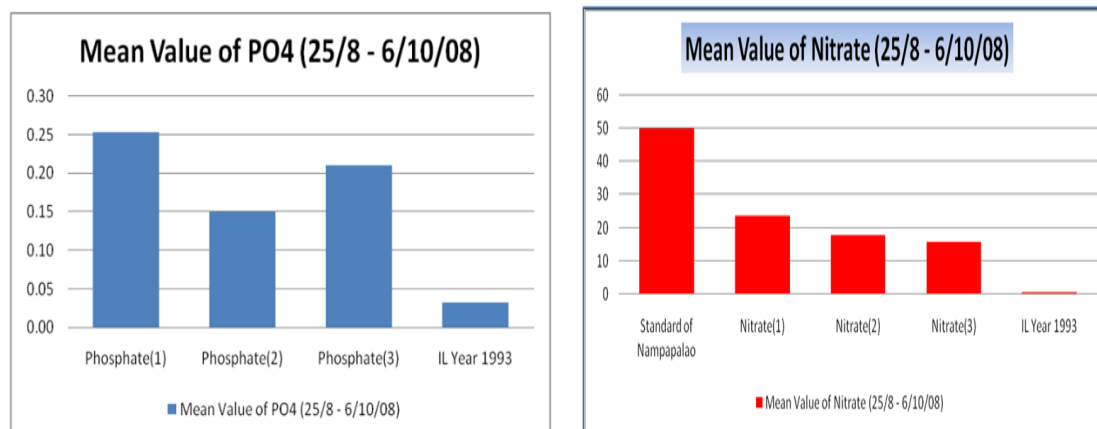


Figure 8. Phosphate and Nitrate ion ( $\text{NO}_3$ )

### Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand

Figure 9 shows the findings of Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand, between current and previous research, the standard of Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand are 2 mg/l and 10 mg/l, respectively, the Table 1-7 show that the current  $\text{BOD}_5$  was 4.5 mg/l - 9.1 mg/l was above the standard and the past  $\text{BOD}_5$  was 18 mg/l - 35 mg/l, meanwhile, Hence, the current  $\text{COD}_{\text{Mn}}$  was 5.5 mg/l - 10.9 mg/l, it was below standard, and the past  $\text{COD}_{\text{Mn}}$  was 1.8 mg/l - 130 mg/l, it is below the standard from three previous study.

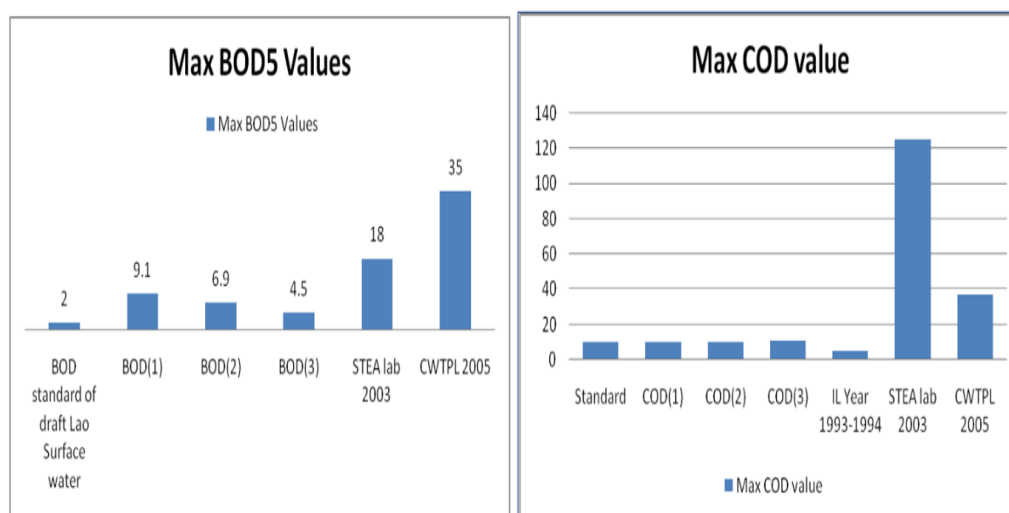


Figure 9. Biochemical Oxygen Demand and Chemical Oxygen Demand

### CONCLUSIONS

In conclusion, the water quality assessment of the Hong Xeng channel revealed that the concentrations of temperature, nitrate ion ( $\text{NO}_3^-$ ), pH, electric conductivity, total suspended solids (TSS), and  $\text{COD}_{\text{Mn}}$  were within acceptable limits and met the standard. However, parameters such as turbidity,  $\text{BOD}_5$ , dissolved oxygen (DO), and phosphate ( $\text{PO}_4^{3-}$ ) exceeded the standard, mainly due to urban runoff and stormwater inputs during the rainy season. These elevated concentrations pose risks to the ecological system, biological life, and nearby communities in terms of water



pollution in the short and long term. Measures should be taken to address the pollution sources and mitigate the potential impact on the environment and human health..

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