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Assessment of Water Quality for Drinking and Agricultural Usages in Klong Namdang Community, Bangkok, Thailand

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Abstract

Klong Namdang is one of the important canals in Bangkok of Thailand used as agricultural area and local lifestyle since time immemorial. Nowadays, factories are increasing around the canal that may affect to environment and human health. The objectives of this research were to study quality of consumed and canal water then assess suitability for consumption and agriculture. Therefore, this work focused on determination of physical, biological and chemical qualities of 21 drinking water samples, namely tap water, rainwater and bottled drinking water from 21 households, and 6 canal water samples from Klong Namdang community. It was found that total coliform bacteria of 27% of tap water, 100% of rainwater and bottled drinking water were out of standard quality of drinking water with <3-2,400, 347.50±434.38 and 1,204.50±1,690.69 most probable number/100 ml, respectively. There were very strong correlations among electrical conductivity, hardness, calcium, magnesium, and sodium in drinking water with probability value <0.001. However, chemical qualities of canal water comprising magnesium, sodium, potassium, and manganese were out of standard of quality for agricultural water. Moreover, a correlation between total coliform bacteria and fecal coliform bacteria in the canal water was found with correlation coefficient of 0.9971 at probability value <0.001. Besides, water quality index of the canal was 53.83±2.86 meaning that it was type 4 surface water and may not be suitable for agriculture.

Keywords: Water quality, Drinking, Agriculture, Namdang

1. Introduction

Nowadays, increase of world population, technological advance, and industrial extension are main factors of worldwide environment pollution, especially water pollution. In Thailand, people use several types of water such as rainwater, bottled drinking water, tap water, surface and ground drinking water for 34.6%, 31.6%, 23.9 and 10%, respectively (Phakham, Wilachai, Silprasit, & Thummajitsakul, 2016). However, it has been reported that surface and ground water are deteriorated by salinity, nitrate, coliform bacteria and volatile organic compounds (Polprasert, 2007). Heavy metals and other pollutants in water can be also absorbed by plants (Khamsorn & Chirak, 2013) and transferred to consumers via food chains (Shan et al., 2013). Therefore, deteriorated water can affect to the environment (Wang, Chen, & Xia, 2010) human health (Phakhaem et al., 2016) and agriculture (Nateewattana et al., 2014). Various evidences on effects of contaminated water have been reported previously. Deteriorated chemical water quality of Bohai Sea, China showed environmental risks (Wang et al., 2010). Misleading water consumption behavior of a community in Nakhonnayok province, Thailand caused waterborne diseases (Phakhaem et al., 2016). Moreover, use of deteriorated agricultural water showed negative effects on ion toxicity, and growth of plants (Khamsorn & Chirak, 2013). Klong Namdang is one of the important canals of Bangkok, capital city of Thailand, and has been used for agriculture such as flowers and fruits production. Development and growth of the city (i.e. the presence of many industrial factories) lead to water pollution, and can affect to health of the people living in the city around the canal. The objectives of this research were to study quality of consumed and canal water then assess suitability for consumption and agriculture. Thus, this work aims to identify water qualities from the community and assess the suitability of tap water, rainwater, and bottled drinking water for drinking. The suitability of canal water for agriculture was also determined. The data gained from this work might be used for raising awareness and surveillance of waterborne diseases for the people living nearby the Klong Namdang canal.

2. Materials and Methods

2.1 Water samples

Klong Namdang canal is inhomogeneous. The canal width is 5-10 m and the length is 5.41 km with around 40 households. The area of interest is the location of agriculture, housing estates, a large drain and factories located between Bangbon 4 and Bangbon 5 Road with a length of 2.03 km and 21 households as shown in Figure 1. Six canal water samples were randomly collected from W/4, W/2, 3W/4 at 0.2D and 0.8D from 6 points in areas of agriculture, housing estates, a large drain, and factories, where W and D were width (5 m) and depth (3 m) of the canal, respectively (Maimunkongsook, 2017). Each drinking water sample was collected from 21 households in Klong Namdang community. However, sampling of drinking water was varied by water sources. All samples (1.5 l) were collected on February 11, 2018 in a polyethylene bottle and kept on ice.

2.2 Water quality analysis

Physical qualities (electrical conductivity (EC), and total dissolved solid (TDS), biological qualities (total coliform bacteria (TCB), fecal coliform bacteria (FCB), and chemical qualities (dissolved oxygen (DO), pH, biochemical oxygen demand (BOD), hardness (HN), and 14 metals including calcium (Ca), potassium (K), magnesium (Mg), sodium (Na), arsenic (As), cadmium (Cd), cobalt (Co), copper (Cu), iron (Fe), manganese (Mn), chromium (Cr), nickel (Ni), lead (Pb), and zinc (Zn) in the canal and drinking water samples were analyzed.

Water samples were divided into 3 parts. Firstly, DO was measured by DO meter (DO-31P), and kept for physical quality analyses. EC and TDS were analyzed by laboratory method 2510 B. and 2540 C., respectively (Rice, Baird, Eaton, & Clesceri, 2012). Chemical qualities viz. pH, HN and BOD were analyzed by Laboratory of Environmental Research Institute Chulalongkorn University (ERIC) using electrometric method 4500-H+ B., EDTA tritimetric method 2340 C., and 5-days BOD test 5210 B. (Rice et al., 2012). Secondly, pH of each sample was adjusted to < 2 and 14 metals were analyzed by the ERIC laboratory. The Cr content was measured in the form of Cr^{6+} (National Environment Board, 1994) with colorimetric method 3500-Cr D. (Rice et al., 2012) at the minimum detection limit of 0.01 mg/l.

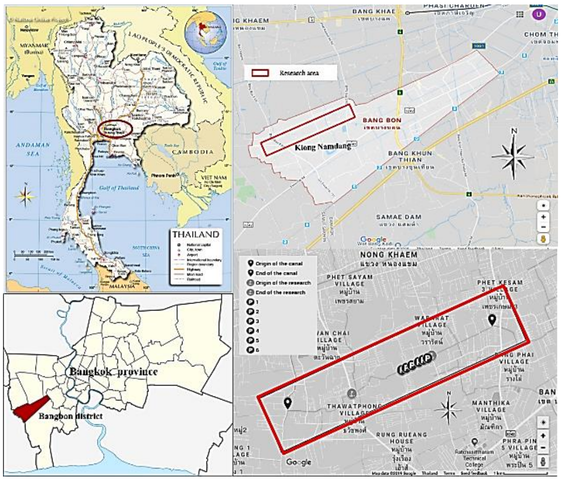

Figure 1. Research area of Klong Namdang in Bangbon district in Bangkok province, Thailand.

The content of Ca, Mg, Na, and K were analyzed by atomic absorption spectrometric method 3500 B. (3111 B.) (Rice et al., 2012) at the minimum detection limit of 0.1 mg/l. Other comprising 9 metals i.e. As, Cd, Co, Cu, Fe, Mn, Ni, Pb, and Zn were assessed by inductively couple plasma method using optical emission spectrometry (ICP-OES) (Rice et al., 2012) at the minimum detection limit of 0.005 mg/l. Finally, water samples were put into sterilized glass bottles, and kept at 4°C for TCB and FCB analyses using total coliform procedure 9221 E. and *Escherichia coli* procedure 9221 F. (Rice et al., 2012) at the minimum detection limit of 3 MPN/100 ml.

2.3 Statistical analysis

Analysis of variance (ANOVA) in completely randomized design (CRD) used for water sampling with no replication mean comparison by Fisher's least significant difference (LSD) among types of drinking water, and Pearson's correlation were calculated by R program (R 3.5.0) for water quality factors.

2.4 Environmental risk quotient (RQ)

The equation *(1)* was used for calculating RQ from values of measured environment concentration (MEC) of Cu, Zn, Ni, Pb and Cd and predicted no effect concentration (PNEC) (Nateewattana et al., 2015) where PNEC of Cu, Zn, Ni, Pb, and Cd were 1.0, 1.7, 0.4, 1.2, and 1 µg/l, respectively (Kallqvist, 2007). RQ < 0.1 means low risk, RQ < 1.0 means moderate risk, RQ > 1 means high risk, and RQ > 10 means very high risk.

$$RQ = MEC/PNEC \qquad (1)$$

2.5 Health risk index (HRI)

The equation (2) was used for calculating HRI. The metal reference dose (RfD) (Nateewattana et al., 2015) and chronic daily intake (CDI) were calculated from heavy metal contents, average daily drinking water, and average weight. HRI>1 means high risk for the health to have various diseases, with an exception for cancer.

$$HRI = CDI/RfD \qquad (2)$$

2.6 Water quality index (WQI)

Some qualities of the canal water were selected to calculate WQI using the equation (3), where pH, DO, BOD, FCB, and TDS were weighted to be sub-WQI (Thongthammachart, 1997). The WQI can be used to identify types of surface water (Thongthammachart, 1997) that were classified into 5 levels, namely very good, good, moderate, poor, and very poor according to WQI ranges of 91-100, 71-90, 61-70, 31-60, and 0-30, respectively. The WQI is commonly applied to evaluate the suitability of agricultural usage of the canal water (National Environment Board, 1994).

$$WQI = ([pH][DO][BOD][FCB]TDS])^{0.2} \qquad (3)$$

3. Results and Discussions

3.1 Suitability for drinking

The results showed significant differences among physical qualities of drinking water i.e. tap water, rainwater, and bottled water groups (*P-value* < 0.01, Table 1) and that electrical conductivity (EC) and total dissolved solid (TDS) in tap water were higher than those of bottled water and rainwater. Each average of EC and TDS was ranged in standard quality of drinking water of EC (<1,500 µs/cm) and TDS (<500 mg/l), respectively. The results indicated that ions and dissolved solid contents were in acceptable range for consumption similar to a report on risk assessment of water quality for drinking of King Initiation Royal Project at Mae Pok reservoir, Lamphun, Thailand (Nateewattana et al., 2015) and Mae Puem reservoir, Phayao, Thailand (Nateewattana et al., 2014).

Each average of total coliform bacteria (TCB) from rainwater and bottled water were 347.50±434.88 and 1204.50±1690.69 MPN/100 ml, and those of tap water from selected households were in the range of <3- 2400 MPN/ 100 ml, indicating that they were out of the standard.

Table 1. Quality of drinking water compared with standard of water quality for drinking.

Qualities	**Unit**	**Mean^a or Range**			**F^b**	**Standard^c**
		Tap water	**Rainwater**	**Bottled water**		
EC	µs/cm	190.00a±13.07	71.83b±58.38	96.15b±128.48	16.29**	<1,500
TDS	mg/l	110.53a±21.68	41.00b±38.56	52.50b±61.52	11.34**	<500
TCB	MPN/100 ml	**<3-2400**	**347.50±434.88**	**1204.50±1690.69**	-	<1.8
FCB	MPN/100 ml	**<3-23**	**<3-4**	**<3-4**	-	<1.8
DO	mg/l	5.88±1.56	6.06±0.91	7.28±0.13	0.84ns	>3
pH	-	7.61±0.31	7.43±0.72	7.30±0.42	0.68ns	6.5-9.0
BOD	mg/l	0.72±0.29	0.97±0.15	0.81±0.32	1.32ns	-
HN	mg/l $CaCO_3$	103.32a±7.93	39.85b±31.66	50.80b±69.02	16.12**	<150
Ca	mg/l	28.46a±2.98	14.34b±9.64	16.77ab±17.01	9.94**	<300
Mg	mgl	11.85a±1.75	0.94b±0.74	6.01b±7.77	34.25**	<300
Na	mg/l	4.68±6.05	0.97±0.37	2.01±0.88	0.88ns	<200
K	mg/l	1.08±0.28	<0.1-0.84	BDL	-	<411
Fe	mg/l	<0.005-0.16	<0.005-0.15	BDL	-	<0.3
Mn	mg/l	BDL	BDL	BDL	-	<0.4
Cu	mg/l	BDL	BDL	BDL	-	<2
Zn	mg/l	<0.005-0.22	<0.005-0.23	BDL	-	<3
Ni	mg/l	BDL	BDL	BDL	-	<0.07
Co	mg/l	BDL	BDL	BDL	-	<0.011
Pb	mg/l	BDL	BDL	BDL	-	<0.01
Cr	mg/l	BDL	BDL	BDL	-	<0.05
Cd	mg/l	BDL	BDL	BDL	-	<0.003
As	mg/l	BDL	BDL	BDL	-	<0.01

^{a}Letter a and b are from mean comparison by Fisher's least significant difference (LSD) and BDL means below detection limit.

[b] Statistic F from analysis of variance (ANOVA), and ns and ** are non-significant difference and highly significant difference at $p < 0.01$, respectively.

[c] Standard quality of drinking water created by World Health Organization (WHO) (Nateewattana et al., 2015).

TCB of tap water samples was 27% over the standard, and below the minimum detection limit by 73%, while rainwater and bottled water samples exceeded their standard values by 100% (data not shown). These values showed that the water used for consumption in this community was contaminated with coliform bacteria and may cause health effects to the people. The bacterial contamination in rainwater can arise from insufficient cleaning of the water in the selected households. Furthermore, use of reused bottles may also cause the contamination in the bottled drinking waters. To reduce the risks of the contamination, water filtration might be employed to remove the bacteria as shown in previous report that tap water filtrated by ceramic filtering showed the TCB and FCB values of 1.2 and 0 MPN/100 ml, which were in standard range (Pattana & Pongsaksri, 2002). Additionally, vegetative bacterial cells, fungi and virus were able to be eliminated from water by using boiling method (Suwanpinij & Suwanpinij, 2017).

Differences of dissolved oxygen (DO) and pH among 3 groups of drinking water were not found but remained in the standard values of >3 mg/l and 6.5-9.0, respectively. Similar report indicated that DO of consumed water in Mae Pok reservoir, Lumpun, Thailand was in the standard (Nateewattana et al., 2015). In contrast, Nimrat, Suechamnongkitchakarn, Supannapan, and Vuthiphandchai (2015) suggested that pH of 7 drinking bottled water samples from Buriram, Thailand were out of the standard. Water with high DO has been known to be appropriate for drinking and less contaminated with organic matters, which was unquestionably not a cause of water pollution (Nateewattana et al., 2014). According to a specification from United States Environmental Protection Agency (EPA), pH evaluation is a secondary drinking water standard and might not directly affect to the health (Nimrat et al., 2015). However, pH is known to be crucial for metabolisms in all organisms. It is reasonable that consuming water with pH abnormality may cause long-term health problems. In this study, differences of hardness (HN) were highly significant among 3 groups of drinking water, while the standard value was reported at <150 mg/l $CaCO_3$ (Nateewattana et al., 2015). Mean of HN of tap water was 103.32±7.93 mg/l $CaCO_3$, while that of rainwater and bottled water were 39.85±31.66 and 50.80±69.02 mg/l $CaCO_3$, respectively. Accordingly, rainwater and bottled water were identified as soft water, whereas tap water was identified as moderate hard water, which had no effect for drinking but showed some effects for daily consumption, such as producing less soap bubbles and making slag in metal containers (Prasertsin, Waiyaka, Kornochalert, & Pukumpuang, 2017).

The metal elements i.e. Ca, Mg, and Na were used to calculate means of metal contents while others were under the minimum detection limit, thus they were not used for comparing 3 groups of drinking water. The differences of Ca and Mg concentrations among three groups were significant with *P-value* < 0.01, while that of Na was insignificant with *P-value* > 0.05. However, means of all 14 metal contents were in the standard quality of drinking water (Table 1).

There were highly significant correlations among EC, TDS, HN, Ca, Mg, and Na with *P-value* < 0.001 (data not shown). EC was correlated with TDS, HN, Mg, and Na with r=0.9746, 0.8102, 0.8782, and 0.8044. TDS was correlated with HN, Mg, and Na with r=0.7906, 0.8578, and 0.8039, respectively. Besides, HN was correlated with Ca and Mg with r=0.7927 and 0.8663, respectively. This indicated that EC, TDS, and HN were associated with the three ions.

Table 2. Environmental risk quotient (RQ).

Water source	No.	RQ[a]					Note[b]
		Cu	Zn	Ni	Pb	Cd	
Tap	1	BDL	BDL	BDL	BDL	BDL	-
	2	BDL	**129**	BDL	BDL	BDL	*
	3	BDL	BDL	BDL	BDL	BDL	-
	4	BDL	BDL	BDL	BDL	BDL	-
	5	BDL	BDL	BDL	BDL	BDL	-
	6	BDL	BDL	BDL	BDL	BDL	-
	7	BDL	**65**	BDL	BDL	BDL	*
	8	BDL	BDL	BDL	BDL	BDL	-
	9	BDL	BDL	BDL	BDL	BDL	-
	10	BDL	BDL	BDL	BDL	BDL	-
	11	BDL	BDL	BDL	BDL	BDL	-
	12	BDL	BDL	BDL	BDL	BDL	-
	13	BDL	BDL	BDL	BDL	BDL	-
	14	BDL	BDL	BDL	BDL	BDL	-
	15	BDL	BDL	BDL	BDL	BDL	-
Rain	1	BDL	BDL	BDL	BDL	BDL	-
	2	BDL	**118**	BDL	BDL	BDL	*
	3	BDL	**135**	BDL	BDL	BDL	*
	4	BDL	BDL	BDL	BDL	BDL	-
Bottle	1	BDL	BDL	BDL	BDL	BDL	-
	2	BDL	BDL	BDL	BDL	BDL	-
Canal	1	BDL	**259**	BDL	BDL	BDL	*
	2	BDL	BDL	BDL	BDL	BDL	-
	3	BDL	BDL	BDL	BDL	BDL	-
	4	BDL	BDL	BDL	BDL	BDL	-
	5	BDL	BDL	BDL	BDL	BDL	-
	6	BDL	BDL	BDL	BDL	BDL	-

[a] BDL means below detection limit.

^{b}RQ was not an exact number because of detection limit, so risk of some samples cannot be predicted.

*Very high risk

The environmental risk quotient (RQ) of drinking water of 3 groups is shown in Table 2. Most of the metal contents showed below detection limit (BDL). It was found that RQ of Zn of rainwater collected from 2 households were 118 and 135. Moreover, those of tap water were 129 and 65, which indicated a very high risk for household usage. Zinc is considered to be relatively nontoxic, particularly if taken orally. However, low amount of zinc has been suggested to interfere with the utilization of Cu and Fe and to adversely affect HDL cholesterol concentrations (Fosmire, 1990). Moreover, toxicity symptoms such as nausea, vomiting, epigastric pain, lethargy, and fatigue could occur with extremely high zinc intakes (Fosmire, 1990). The environmental risks of this study were similar to findings on RQ of Mae Pok reservoir, Thailand (Nateewattana et al., 2015) showing the high risk of Pb and As, and RQ of Mae Puem reservoir, Thailand (Nateewattana et al., 2014) which showed the high risk of Fe and Mn.

Health risk index (HRI) was calculated from each heavy metals (Table 3). HRI of Fe and Zn from tap water and rainwater were compared between children and adults. The values were between 0.0045-0.1022, which was less than 1, meaning that this level of heavy metals does not cause health risk of diseases.

3.2 Suitability for agriculture

Physical qualities of canal water from Klong Namdang, such as EC and TDS were 581.50±18.96 µs/cm and 371.67±23.54 mg/l, respectively (Table 4), which corresponded to the TDS value in the standard of water quality for agriculture (<2,000 mg/l). Furthermore, the suitability of EC and TDS for irrigation were less than 700 µs/cm and 450 mg/l as specified by Food and Agriculture Organization of United Nations (FAO) (Ayers & Westcot, 1994). Thus, according to these results, the quality of water from this canal was suitable for agriculture.

Means of biological qualities are shown in Table 4. It was found that means of total coliform bacteria (TCB) and fecal coliform bacteria (FCB) were out of the standard quality of type 3 surface water, a suitable type of surface water for agriculture. Similar reports were found such as a research on 4 main canals in Bangkok, Thailand that indicated an exceeded TCB in comparison with the standard (Rojjanaburanont, 1983). and a research on Klong Ong Ang, Bangkok, Thailand, that showed exceeded TCB and FCB compared with the standard (Sompong, 2018). Besides, TCB and FCB were positively strong correlated with high significance (r=0.9971, *P-value* < 0.001), which may result from presence of fecal coliform bacteria, such as *E. coli* in this canal, thus FCB directly affected TCB. FCB and TCB might have slight effects to agricultures since there is no limitation of these values in the standard of agricultural water. However, use of the water with high TCB and FCB for agricultural processes may cause a transfer of bacterial contamination in the harvested products, which subsequently cause health problems in case of insufficient cleaning of post-harvesting or cooking process.

All chemical contents were in two standards except biological oxygen demand (BOD) which showed 6.94±0.98 mg/l, indicating that it was out of the standard quality of type 3 surface water. Additionally, Mg, Na, K, and Mn were out of the standard of water quality for agriculture. The value of BOD was similar to a study on Klong Ong Ang, which showed an exceeded BOD compared with the standard (Sompong, 2018). Moreover, metal contents were similar to the research on Mae Puem reservoir water, Thailand where exceeded K and Mn were observed (Nateewattana et al., 2014). The K is the major element for all plants, therefore an excess K does not affect to agriculture but may affect to over growth of water plants that cause water pollution.

The water quality index (WQI) value showed 53.83±2.86, indicating that it was not suitable for agriculture because the value was out of the standard quality of type 3 surface water (Table 4). However, the water was in the standard quality of type 4 surface water and able to use for consuming with sterilization as well as industrial usages (National Environment Board, 1994). Similar result was found on Wat Rachatiwas canal in Bangkok, Thailand whereby WQI was 51 and the canal water was identified as type 4 surface water (Choo-in, 2012). On contrary, investigation on Klong Ong Ang has identified the canals as type 5 surface water that was suitable for only transportation (Sompong, 2018).

Table 3. Health risk index (HRI) of drinking water.

Water source	**No.**	**HRI**															
		Children								**Adults**							
		Fe	**Mn**	**Cu**	**Zn**	**Ni**	**Co**	**Cd**	**As**	**Fe**	**Mn**	**Cu**	**Zn**	**Ni**	**Co**	**Cd**	**As**
Tap	1	**0.0210**	BDL	BDL	BDL	BDL	BDL	BDL	BDL	**0.0045**	BDL	BDL	BDL	BDL	BDL	BDL	BDL
	2	**0.0229**	BDL	BDL	**0.0210**	BDL	BDL	BDL	BDL	**0.0049**	BDL	BDL	**0.0978**	BDL	BDL	BDL	BDL
	3	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
	4	0.0305	BDL	BDL	BDL	BDL	BDL	BDL	BDL	**0.0065**	BDL	BDL	BDL	BDL	BDL	BDL	BDL
	5	0.0229	BDL	BDL	BDL	BDL	BDL	BDL	BDL	**0.0049**	BDL	BDL	BDL	BDL	BDL	BDL	BDL
	6	0.0210	BDL	BDL	BDL	BDL	BDL	BDL	BDL	**0.0045**	BDL	BDL	BDL	BDL	BDL	BDL	BDL
	7	BDL	BDL	BDL	**0.0105**	BDL	BDL	BDL	BDL	BDL	BDL	BDL	**0.0489**	BDL	BDL	BDL	BDL
	8	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
	9	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
	10	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
	11	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
	12	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
	13	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
	14	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
	15	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Rain	1	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
	2	BDL	BDL	BDL	**0.0190**	BDL	BDL	BDL	BDL	BDL	BDL	BDL	**0.0889**	BDL	BDL	BDL	BDL
	3	**0.0286**	BDL	BDL	**0.0219**	BDL	BDL	BDL	BDL	**0.0061**	BDL	BDL	**0.1022**	BDL	BDL	BDL	BDL
	4	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Bottle	1	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
	2	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL

BDL means below detection limit.

Table 4. Quality of canal water compared with standard of water quality for agriculture.

Qualities	**Unit**	**Mean**[a]	**Standard water quality for**	
			Agriculture[b]	**Type 3 surface water**[c]
EC	µs/cm	581.50±18.96	-	-
TDS	mg/l	371.67± 23.54	<2,000	-
TCB	MPN/100 ml	**173,150±371,188.34**	-	<20,000
FCB	MPN/100 ml	**45,900±95,476.99**	-	<4,000
DO	mg/l	5.30±0.56	-	>4
pH	-	7.72±0.08	6.5-8.5	5-9
BOD	mg/l	**6.94±0.98**	-	<2
HN	mg/l $CaCO_3$	184.83±4.54	-	-
Ca	mg/l	**28.63±12.80**	<40	-
Mg	mg/l	**24.48±1.45**	<1	-
Na	mg/l	**46.86±4.35**	<40	-
K	mg/l	**70.78±7.10**	<2	-
Fe	mg/l	0.58±0.16	<5	-
Mn	mg/l	**0.33±0.01**	<0.2	<1
Cu	mg/l	BDL	<0.2	<0.1
Zn	mg/l	BDL	<2	<1
Ni	mg/l	BDL	<0.2	<0.1
Co	mg/l	BDL	<0.05	-
Pb	mg/l	BDL	<0.05	<0.05
Cr	mg/l	BDL	<0.1	<0.05
Cd	mg/l	BDL	<0.01	<0.05
As	mg/l	BDL	<0.1	<0.01
WQI	-	53.83±2.86	-	61-70

[a] BDL means below detection limit.

[b] Standard water quality for agriculture created by Food and Agriculture Organization of United Nations (FAO) (Nateewattana et al., 2015).

[c] Standard quality of type 3 surface water (National Environment Board, 1994).

The environmental risk quotient (RQ) of canal water from Klong Namdang is shown in Table 2. The RQ of Zn of samples from W/4 at 0.2 D was 259, which was at very high risk (RQ>10) and not suitable for agricultural usages. The high RQ of the canal water may result from various canal crooks, main drainages from communities on Bangbon 4 and 5 Roads and inhomogeneous mixing of the canal water. The results of this study were similar to a research on Bohai Sea in the North of China, which suggested that RQ of Pb and Hg were more than 1 or at high risk (Wang et al., 2010).

4. Conclusion

Rainwater and bottled water in Klong Namdang community are not suitable for drinking in terms of biological quality. Moreover, environmental risk was found in Zn of tap water and rainwater. Thus, cleaning processes are necessary for these types of water. According to WQI results, Klong Namdang was identified as type 4 surface water or low water quality. In addition, some metal contents such as Mg, Na, K, and Mn in the canal were found to exceed the maximum limit concentrations. Thus, the canal water is not suitable for agricultural usages.

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