SNRU JST

Sakon Nakhon Rajabhat University
Journal of Science and Technology

Journal home page: snrujst.snru.ac.th

The assessment of domestic waste-water quality for the guideline of water treatment and remediation in urban area

Kanittada Thongkao*

Faculty of Sciences and Technology, Suan Sunandha Rajabhat University, 1 U-tong Nok Road, Dusit District, Bangkok, 10300, Thailand

* **Corresponding Author**: kanittada.th@ssru.ac.th

Received: 24 June 2015; **Revised:** 1 September 2015; **Accepted:** 18 December 2015; **Available online:** 20 April 2016

Paper selected from Sakon Nakhon Rajabhat University - International Conference 2015 (SNRU-IC 2015)

DOI: 10.14456/snrujst.2016.22

Abstract

The purposes of this research aim to survey the water quality and to construct effective domestic wastewater treatment system of Wat-pracharabuetam and Saphan-kesakomol community, Dusit district in Bangkok. The observation of water quality in daily load of representative 24 hr composite samples for 5 months (January 2015-May 2015) is described. The dissolved oxygen (DO), biochemical oxygen demand (BOD), Total nitrogen, Total phosphorus, Total solids (TSS), Suspended solids (SS) and pH have been analyzed. However, the effluent of wastewater such as DO and BOD exceeded the average of effluent standard at 1-1.5 and 84-87 mg/l, respectively. The results showed that the sources have caused water pollution in those areas including domestic market, household sewage and industrial factory with an average of 161,600 l/day, 1,616 m^3/day or 6.73 m^3/h (BOD loading average of 0.58 kg/h). The questionnaire concerning knowledge participation of wastewater management was conducted through the samples, drawn from population sampling technique. The samples were ranged in the pre-training (n = 500 people) and the post-training (n = 200 people). The results revealed that their knowledge participation was at a good level (35%, 83.15%), a moderate level (23%, 16.85%), and a needs improvement level (42%, none), respectively. Furthermore, we suggest an Aerobic-anaerobic facultative pond model, which is an appropriate method in the selected urban area because pH and BOD values can be monitored on this system. However, this system requires cooperation from Dusit district office and Department of drainage and sewerage in planning to eliminate obstructions and to control the opening of floodgates. The water resource has been developed and improved in the appropriate criteria of effluent-quality standard in this study.

Keywords: Waste water management, Water quality, Participation

1. Introduction

Wat-Pracharabuetam and Saphan-Kesakomol communities are located in Dusit district, Bangkok, Thailand, encompass approximately 10.08 hectares. The effects of pollution become the problems for livelihood of people in this community especially waste-water pollution. The rising of waste-water flow affects environmental status of city, and may become worse situation according to domestic waste-water production in Bangkok about 2.5 million cubic meters per day or more [1]. At the standing point, the management of waste-water and determination of urban water qualities to develop planning on water pollution control is necessary in small communities, which will be the practical model for urban area [2]. There can be performed the good criteria of guideline for reduction of waste-water pollution by reducing accumulation of contaminated water, which is related to government strategy in order to conduct proper water resource management and meet water quality standard [3]. Nowadays, several types of waste-water treatment systems have been used for treatment and remediation including stabilization pond, aerated lagoon (AL), constructed wetland, activated sludge process, oxidation ditch and rotating biological contactor (RBC), which are suitable for use in domestic waste-water treatment due to low cost of operation and maintenance, and contents of regulation [1]. However, the selection criteria for those systems should be considered by people who living in such area in terms of suitability and cost effectiveness of the electricity equipment supply during operation. In addition, the water quality index of urban waste-water such as pH, DO, total suspended solid, suspended solid, BOD, total nitrogen and total phosphorus values does not meet the water quality standard, especially DO and BOD. The public participation toward waste-water treatment is one of most stringent criteria to evaluate knowledge and decision of people living nearby waste-water canals in order to plan for a waste-water treatment model. Through public involvement and cooperation, people with limited knowledge, experience and intention to adopt usage of wasteware treatment would improve their knowledge and gain practical experience in reducing water crisis in their community [4]. This research aimed to determine waste-water quality in urban area of Bangkok (Wat-Pracharabuetam and Saphan-Kesakomol communities), to assess knowledge of waste-water management, and decision of waste-water treatment system of sampling people living nearby selected areas. The findings of this study can be used to set up effective waste-water treatment system and perform better practice guidelines for villagers and local government who have direct responsibility for water quality control and improvement in this urban area. In addition, the findings can be a water management model for other communities with similar behaviors, attitudes, and living environment such as residence type, waste-water discard, and drinking and consuming source.

2. Materials and Methods

This research was conducted from January to May, 2015 according to academic services of Faculty of Science and Technology, Suan Sunandha Rajabhat University, which provided financial support. The researcher team cooperated with leaders of Wat-Pracharabuetam and Saphan-Kesakomol communities, who assisted to collect filled questionnaire from villagers and water samples from canals nearby community, and promoted water management system training. The research activities were divided into four phases:

Surveying knowledge of villagers through questionnaire and observation

The sampling population, obtained through random sampling technique, lived in Wat-Pracharabuetam and Saphan-Kesakomol area, which was located in Dusit district, Bangkok, Thailand. The samples were divided to pre- and post-training for waste-water management system, which were 500 and 200, respectively. All participants were asked to fill a questionnaire comprising three parts as follows:

Part 1 - General information of each household included gender, age, education, duration for residence, the number of family members, amount and monthly payment for water consumption, water consuming sources in household and/or office, type of water usage, type of waste-water discard, status/position in local community.

Part 2 - Knowledge of waste-water management included gathering information, causes, effects, prevention, control, and solutions of water pollution.

Part 3 - Levels of participation in waste-water management involved knowledge which was related to water remediation, waste management, and waste-water management system and associated benefits. This part of the questionnaire was evaluated by 3 level of rating scales (5 = good; 4 = medium; 3, 2, 1= need improvement, respectively).

Three parts of filled questionnaire were determined and concluded for the important causes to solve, planning for management and activities, and follow-up and project evaluation.

General information from questionnaire was shown in frequencies and percent. The statistical analysis for different waste-water management knowledge system between pre- and post-training groups was employed. The means of participants' knowledge and participation were interpreted as good (4.51-5.00), medium (3.51-4.50), need improvement (3.5-1.00), respectively.

Quantitative analysis by interviewing

Quantitative data was collected from waste-water management experts' interviews (N = 5) and collecting data was evaluated by content analysis and presented as descriptive data. The development criteria characteristics of attitudes, comprised cooperation, observation, intellection, responsibility, attempt, and creation were also collected.

Water sampling and evaluation of water quality

Water samples were collected from waste water discarded at 3 points, including Wat-Pracharabuetam canal, Wat-Pracharabuetam community and Saphan-Kesakomol Camp through composite sampling method. Water collections were continued for 5 months (a total of 2 days a month; once on a working day and once on a weekend). The chemical parameters of water quality were determined pH by using pH meter, DO by using test-kit (Mahidol University, Thailand). BOD was measured by azide modification method or dissolved oxygen detector at 20 ^{o}C during the 5-day test. Total suspended solid and suspended solid were determined by dried weighing. Total nitrogen and total phosphorus were determined by Association of official agricultural chemists (AOAC) methods. The parameters of water quality were evaluated according to National Surface Water Quality Standards of Ministry of Natural Resources and Environment, Thailand.

The way for water management system training

Leaders and villagers from participating communities attended a training program on water management system on 7th-8th March 2015, held by researcher team and experts. Data collection comprised surveyed data from questionnaires and chemical parameters for water quality for 5 months. After training, a group discussion was conducted to analyze important problems of water pollution and related causes, and to brain-storming for appropriate guidelines for community. The discussion included the following details: 1) planning decision support from communities, 2) occurrences of water pollution in community and present methods for reducing pollution, the prior activity was begun by overflow of canals nearby communities and removed the discarded sources, 3) draft of water management participation guidelines, 4) appropriate water quality guideline, a level of participation and attitudes, and 5) guidelines for related government office, such as, department of drainage and sewerage in Dusit district, Bangkok and Pollution Control Department, Thailand.

3. Results and Discussion

On this present study, participants from Wat-Pracharabuetam and Saphan-Kesakomol communities were 267 males (53.4%), and 233 females (46.6%). The majority of them completed primary education (74.2%), with 6-10 years (95%) of residence. The average amount of water consumption level was 200 liters a day per person. In addition, the results revealed that the participants usually used tap water. The several methods of household water treatment before draining to community canals were septic tank, grease trap and biological fertilizers. The percentage of participants receiving water pollution and management information (Table 1) was at most knowledge level (score = 4.82-4.83). However, the trash was discarded in the canals nearby the community blocking water flowing and could eventually result in blocked drains and slow down the water flow to the river. The finding may be implied that the knowledge on waste-water management of people in community did not correspond to water quality status of water resources. Then, after the training program, they concerned about water pollution and showed their commitment on the water treatment activities. All post-training participants reported increased levels of knowledge when comparing pre-training participants' scores (Table 1).

Parameters of water quality in community area during 5 months, including pH, DO, BOD, total suspended solid, suspended solid, total nitrogen and total phosphorus were mean±SD, 7.79 $\pm$ 0.39, 1-2 mg/l, 79.72 $\pm$ 6.34 mg/l, 415.2 $\pm$ 79.67 mg/l, 65.2 $\pm$ 10.85 mg/l, 0.26 $\pm$ 0.11 mg/l and 0.11 $\pm$0.01 mg/l (Table 2). After evaluation of all parameters in accordance with the National Surface Water Standard and waste-water quality of the National Environment Board for being considered whether the locality be designated as pollution control area, the results revealed that the quality was below standard and at a severe risk level on the first and second months [5]. However, the parameters were trended to lower on the fourth and the fifth month, which may due to improvement of participant behavior and practice on water pollution after participating in water management system training program.

Table 1 The recognition and understanding of participants after attending a water management system training program

Level score	5	4	3	2	1	Average
Knowledge and understanding	good	medium	need improvement			
Recognition of water pollution information	188	12	-	-	-	4.94
Recognition and understanding of knowledge from training program	170	30	-	-	-	4.85
Recognition and understanding of concerned information from training program/ activity	178	22	-	-	-	4.88
Recognition and understanding of participial activities	168	32	-	-	-	4.81
Completed joining to participial activities	128	72	-	-	-	4.64
Summary	832	72	-	-	-	4.82
Utilization of knowledge	good	medium	need improvement			Average
Knowledge can be daily apply and transfer to the others	180	20	-	-	-	4.9
Knowledge can be daily apply in long period	163	37	-	-	-	4.81
Knowledge can be expand in the further activity	170	30	-	-	-	4.85
Knowledge can be apply to occupational benefits by own and family	158	42	-	-	-	4.79
This activity can be get more connection to other community/sociality	160	40	-	-	-	4.8
Summary	831	169	-	-	-	4.83

(n=200)

After training, group discussion was conducted to analyze important water pollution issues which involved a lack of cooperation from person in charge, limited budget providing from government, inappropriate technology support for water treatment and management. Appropriate guidelines for community to put into practice involved 1) increasing recognition and understanding of knowledge among community members by performing supportive activity on “effects from water pollution causing from inappropriate waste-water treatment”, 2) adjustment of water management system, especially grease trap utilization, and 3) setting up more efficient water management systems to suit waste-water production from household. The suggestion for water treatment system selection was summarized in (Table 3). We also suggested that aerobic-anaerobic facultative pond model corresponding to previous study [6] would be appropriate for this urban area.

Table 2 The water quality parameters in water resources nearby community area

Parameter	Averages of water quality					Mean ± SD	Point of risk to pollution are	
	Jan 2015	Feb 2015	Mar 2015	Apr 2015	May 2015		Weight × point	point
pH	8.43	7.8	7.7	7.5	7.5	7.79±0.39	0.5×2	1.0
DO (mg/l)	1	1-2	2	2	2	1-2	0.5×4	2.0
BOD (mg/l)	84	87.9	78.9	75.8	72.0	79.72±6.34	2.5×4	10.0
Total suspended solid (mg/l)	426	351	549	372	378	415.2±79.67	-	-
Supended solid (mg/l)	60	70	80	51	65	65.2±10.85	-	-
Total Nitrogen (mg/l)	0.25	0.22	0.44	0.14	0.23	0.26±0.11		
Total Phosphorus (mg/l)	0.11	0.11	0.11	0.10	0.10	0.11±0.01	-	-
The nessessary for using water resouce						Dinking and consumption	2.0×4	8.0
						Total	21	

Note:

6.5 < pH <7.5, DO >5, BOD<2 and transportation (×1) =low risk = point<8

7.5 < pH <8.0 or 6 < pH<6.5, 3<DO<3, 3<BOD<4 and living of aquatic animals (×2) = trend to severe risk = 11 < point < 16

8.0 < pH < 8.5 or 5 < pH < 6.0, 2<DO<3, 3<BOD<4 and living of aquatic animals (×3) = trend to severe risk = 11 point < 16

pH > 8.5 or pH<5, DO<2, BOD>4 and drinking and consumption(×4) severe risk = point ≥20

Because of the use of pH and BOD values in this research finding, water from community had high BOD. Thus, biological water treatment is a good choice due to the fact that it decreases a level of BOD prior to improvement of other water quality parameters, and reduces amount of microbial until the water becomes waste stabilization pond [7]. Septic Tank of latrine in household and buildings were low efficiency for waste-water treatment, which should be incorporated with anaerobic filter within septic tanks in order to removal BOD, oil and grease and odor from microbial and the facultative bacteria [8]. Moreover, the combined sewer system was design for central wastewater treatment such as BOD value 65-110 and Suspended solids 40-110 mg/l. This project provided recirculation system to oxygenate the entire canal with aerators for canals at Khlong Prem Prachakon, Khlong Samsen and Khlong Prapa [9].

Table 3 The criteria for selection of appropriate wastewater treatment system

parameters	Type of wastewater treatment system					
	Aerobic low-rate	Aerobic high-rate	Aerobic maturation	Aerobic-anaerobic facultative	Anaerobic pond	Aerated lagoon
Pond size, acre	<10	0.5-2	2-10	2-10	0.5-2	2-10
Detention time, day	10-40	4-6	5-20	5-30	20-50	3-10
Depth, ft	3-4	1-1.5	3-5	4-8	8-16	6-20
pH	6.5-10.5	6.5-10.5	6.5-10.5	6.5-8.5	6.5-7.2	6.5-8.0
Temperature range, °C	0-30	5-30	0-30	0-50	6-50	0-30
Optimum temperature, °C	20	20	20	20	30	20
BOD_5 loading, lb/acre.d	60-120	80-160	$\leq$ 15	50-180	200-500	
BOD_5 conversion, %	80-95	80-95	60-80	80-95	50-85	80-95
Effluent suspended solids, mg/l	80-140	150-300	10-30	40-60	80-160	80-250

4. Conclusion

In conclusion, our water management system training program intends to improve knowledge and understanding of villagers to transfer knowledge into their daily practice to solve water pollution problems by performing activity, guidelines provided and setting up appropriate water management system in community. The follow up of water management system training program is also needed to ensure further surveillance and water quality control. The needs to pass on this knowledge or model to other community in Bangkok are also required in order to encourage public participation and cooperation in community.

5. Acknowledgement

The authors express their sincere appreciation to Suan Sunandha Rajabhat University, Bangkok, Thailand for the grant support. I would like to express my great thank to leaders of Wat-Pracharabuetam and Saphan-Kesakomol communities which assisted to collect filled questionnaire from villagers, water samples in canals nearby community and promote water management system training. I would like to express my sincere thanks to Dr. Yuttachai Sarathai at the Pollution Control Department for advice and suggest of wastewater treatment system model.

6. References

[1] Thailand state of pollution report 2008, www.pcd.go.th/indexEng.cfm, 1 June 2015.

[2] Policy and implementation on water environment in Thailand, www.wepa-db.net/pdf/0712forum/paper06.pdf, 15 July 2015.

[3] T. Kuyama, Results of Questionnaire on Domestic Wastewater Treatment Water Environment Partnership in Asia (WEPA) 2nd Phase, Institute for Global Environmental Strategies, Tokyo, 2010.

[4] L. Wijarn, Criteria development for categorizing people toward community wastewater treatment knowledge transfer, Ph. D. Environmental Science, Kasetsart University, Bangkok, 2009.

[5] Designating pollution control area: Preparation of action *plan* for reduction and eradication of pollution in pollution control area, www.pcd.go.th/info_serv/en_pol_controlzone.html, 1 June 2015.

[6] S. Panpattrapong, Treatability Study in Municipal Wastewater by Lagoon Treatment Changwat Phetchaburi, M.Sc. Degree Environmental Science, Kasetsart University, Bangkok, 1997.

[7] E.F. Gloyna, Waste Stabilization Ponds, World Health Organization, Geneva, 2000.

[8] T.R. Bounds, Design and performance of septic tanks, in: M.S. Bedinger, J.S. Fleming, A.I. Johnson (Eds.), Site Characterization and Design of On-Site Septic Systems, American Society for Testing and Materials, 1997, 217-230.

[9] Wastewater management in urban area, www.wepa-db.net/pdf/1003forum/7_thai_wijarnsimacha.pdf, 15 July 2015.