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Seasonal Variations in Surface Water Quality, Samut Songkram Province, Thailand

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Abstract**—**The research aims to study the quality of surface water for consumer in Samut Songkram province. Water sample were collected from 217 sampling sites conclude 72 sampling sites in Amphawa, 67 sampling sites in Bangkhonthee and 65 sampling sites in Muang. Water sample were collected in December 2011 for winter, March 2012 for summer and August 2012 for rainy season.

From the investigation of surface water quality in Mae Klong River, main and tributaries canals in Samut Songkram province, we found that water quality meet the type III of surface water quality standard issued by the National Environmental Quality Act B.E. 1992. Seasonal variations of pH, Temperature, nitrate, lead and cadmium have statistical differences between 3 seasons.

Keywords**—**Samut Songkram Province, Surface water quality.

I. Introduction

SAMUT Songkram province is a small province, located at central of Thailand near the mouth of the Mae Klong river. Samut Songkram province is located at 80 kilometers west of Bangkok [1]. With regard to province strategic, the development in this province has been dedicated to ecotourism and hospitality [2].

As a result of SWOT analysis, the strengths of Samut Songkram include magnificent natural resources and environment, diversity of careers, stock of marine and agricultural products, high quality of human resources and local lifestyle conservation. The weakness includes degradation of natural resources and environment, threat of the water pollution from neighborhood and improper water resources management [3].

Pollution of surface water with toxic chemicals and eutrophication of rivers with nutrients are of great environmental concern worldwide. Characterization of seasonal change in surface water quality is an important aspect for evaluating temporal variations of river pollution due to natural or anthropogenic input of point and non-points sources. In addition, water pollutants entering into surface water including water runoff agricultural source, household and atmospheric deposition. These pathways are seasonal-dependent. Therefore, seasonal changes in surface water quality must be considered when establishing the water resource management.

The aim of the study is to evaluate the seasonal variations in surface water quality.

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II. Materials and Methods

A Study Area

Surface water were collected and analyzed in three areas of Samut Songkram Province namely; Muang, Amphawa and Bang Khon Thee Districts as shown in Fig 1.

1) Muang District has 65 sampling sites (3 sites from canals, 1 site from Mae Klong River and 61 sites from small tributary canals.)
2) Amphawa District has 72 sampling sites (9 sites from canals, 2 site from Mae Klong River and 61 sites from small tributary canals.)
3) Bang Khon Thee District has 67 sampling sites (6 site from canals, 2 sites from Mae Klong River and 59 sites from small tributary canals.)

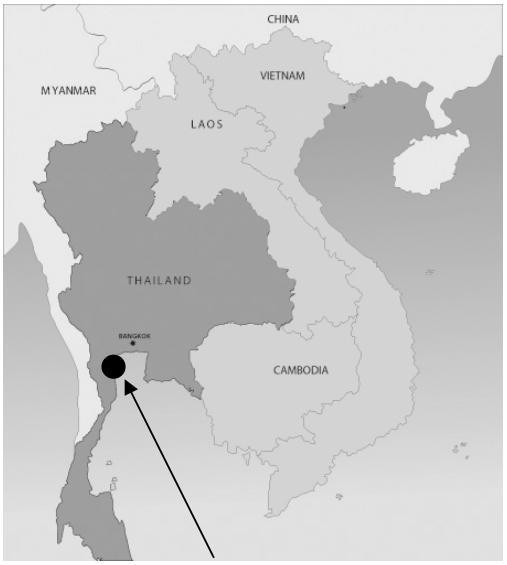

Fig. 1 Study area in Samut Songkram Province [4]

B. Research Equipments

In order to measure water quality parameter, the following equipments have been used;

1) Water sampling and water depth meter
2) Sampling and preservation container
3) pH meter (HANNA HI 98217 model) and HORIBA (D-54 models).
4) Turbidity meter (Lovibond Turbicheck model)
5) Dissolved Oxygen meter (HORIBA, D-54 models).
6) Salinity meter
7) Global Positioning System (GARMIN Etrex 20 model).

8) Atomic Absorption Spectrophotometer (GBC Avanta ver 2.02 model)
9) Spectrophotometer (Thermo model)
10) Ammonia distillation apparatus
11) BOD incubator
12) Cadmium Reduction column
13) Balance
14) Desicator

C. Methodology

A survey research has been conducted in Samut Songkram Province as the following

1) Survey and study water quality in canals by sampling season (3 season; winter, summer and rainy). Date of sampling collection shown in Table I
2) Analyze water quality by using methods and parameters as shown in Table II
3) Statistic analysis of variance to water quality by using T-test

TABLE I
DATE OF SAMPLING COLLECTION

Season	Muang	Amphawa	Bang Khon Thee
Winter	7-8 December 2011	17-18 December 2011	23-24 December 2011
Summer	26-29 March 2012	26-29 March 2012	26-28 March 2012
Rainy	18-19 and 26-27 August 2012	26-27 August 2012	18-19 August 2012

TABLE II
PARAMETERS AND METHODS USED IN WATER QUALITY ANALYSIS

no	Parameters	Method of analysis	Place of analysis	
			Field	Laboratory
1	Turbidity	Turbidity meter	√	√
2	Total dissolved solids (TDS)	Filtration pass GF/C paper and dried at 103-105 ^{o}C for 2 hr.		√
3	Salinity	Salinity meter	√	
4	pH	pH meter	√	
5	Nitrogen in nitrite form	Colorimetric method		√
6	Nitrogen in nitrate form	Cadmium reduction method		√
7	Nitrogen in amonia form	Distillation and titration method		√
8	Dissolved Oxygen (DO)	Azide modification method or DO meter		√
9	Biochemical Oxygen Demand (BOD)	Azide modification method or DO meter at 20 ^{o}C for 5 days		√
10	Lead (Pb)	Atomic Absorption Spectroscopy (AAS) – direct aspiration		√
11	Cadmium (Cd)			√

TABLE III
SEASONAL WATER QUALITY

Parameter		Winter	Summer	Rainy
Temperature (^{o}C)	range	24.0-37.0	28.0 - 52.0	21.9-34.0
	Average ±SD	30.1 ± 3.0	34.2 ± 3.17	29.0 ± 1.2
TDS (mg/l)	range	16 - 400180	52 - 57186	31 – 29200
	Average ±SD	3285 ± 28716	3580 ± 11756	1934 ± 3405
pH	range	5.4 – 8.8	6.1 – 8.7	6.5 – 8.3
	Average ±SD	7.7 ± 0.5	7.6 ± 0.3	7.4 ± 0.3
DO (mg/l)	range	0.62 – 9.50	1.17 – 8.90	0.76- 8.80
	Average ±SD	4.16 ± 1.97	3.91 ± 1.42	4.04 ± 1.48
BOD (mg/l)	range	0.0 – 6.7	0.1 – 8.7	0.0 – 7.5
	Average ±SD	1.9 ± 1.5	3.4 ± 1.5	2.1 ± 1.5
Turbidity (NTU)	range	3.69 – 196.00	0.91 – 93.70	2.07 – 78.70
	Average ±SD	19.43 ± 16.11	24.57 ± 21.33	17.61 ± 13.66
Nitrate (μg/l)	range	0.00 – 9.14	0.00 – 133.55	0.05 - 848.36
	Average ±SD	0.31 ± 0.95	11.33 ± 14.32	65.86 ± 96.97
Pb (mg/l)	range	0.232 – 5.223	2.259 – 4.168	0.026 – 0.603
	Average ±SD	1.633 ± 1.290	3.155 ± 0.636	0.288 ± 0.127
Cd (mg/l)	range	0.471 – 2.792	0.000 – 5.244	0.004 – 0.062
	Average ±SD	1.206 ± 0.824	3.969 ± 1.641	0.020 ± 0.012

III. Results and Discussion

A. Surface Water Quality

Surface water quality was measured from 217 sampling sites from 3 seasons as shown in Table III. Prominent results can be concluded as the following;

Range of water temperature from canal in winter summer and rainy are 24.0 – 37.0°C (average 30.1± 3.0°C), 28.0 – 52.0 °C (average 34.2± 3.17°C) and 21.9 – 34.0°C (average 29.0 ± 1.2°C), respectively. All values meet the surface quality standard type III of Pollution Control Department of Thailand (PCD).

Rang of pH from canal in winter summer and rainy are 5.5 – 8.8 (average 7.7 ± 0.5), 6.1 – 8.7(average 7.6 ± 0.3) and 6.5 – 8.3 (average 7.4 ± 0.3), respectively. All pH values meet the surface quality standard type III of Pollution Control Department of Thailand (PCD) that a range of pH should be 5 – 9 [5].

Total Dissolved Solid values from canal in winter summer and rainy are 16-400,184 mg/l (average 3,285 ± 28,716 mg/l), 52 – 57,186 mg/l (average 3580 ± 11756 mg/l) and 31 – 29,200 mg/l (average 1,934 ± 3405 mg/l), respectively. However, TDS values cannot be compared PCD standard because TDS did not appear in type III standard of surface water quality. From this study, the average TDS values in summer were the highest.

Dissolved Oxygen values from canal in winter summer and rainy are 0.6 – 9.50mg/l (average 4.16 ± 1.97mg/l), 1.17 – 8.90mg/l (average 3.91 ± 1.42mg/l) and 0.76 – 8.80mg/l (average 4.04 ± 1.48mg/l), respectively. Refer for the level of Dissolved Oxygen in all areas. It is compliance with specific standard that should not below 4.00mg/l

Range of Biochemical Oxygen Demand (BOD) from canal in winter summer and rainy are 0.0 – 6.7mg/l (average 1.9 ± 1.5mg/l), 0.1 – 8.7mg/l (average 3.4 ± 1.5mg/l) and 0.0 – 7.5 mg/l (average 2.1 ± 1.5mg/l), respectively. These results have shown that average BOD in summer has the highest value. But all average BOD value lower than surface water quality standard type III of PCD (less than 4mg/l)

Nitrogen content in nitrate form from water canal in winter summer and rainy are 0.0 – 9.14μg/l (average 0.31 ± 0.95 μg/l), 0.0 – 133.55μg/l (average 11.33 ± 14.32μg/l) and 0.05 – 848.36μg/l (average 65.86 ± 96.97μg/l), respectively. Refer to water quality standard type III of PCD, all seasons are acceptable (less than 5mg/l or 5,000μg/l)

Lead (Pb) content from water canal in winter summer and rainy are 0.232 – 5.223mg/l (average 1.633 ± 1.290mg/l), 2.259 – 4.168mg/l (average 3.155 ± 0.636mg/l) and 0.026 – 0.603mg/l (average 0.288 ± 0.127mg/l), respectively. According to surface water quality standard, Lead content in the water higher than standard type III (0ver 0.05mg/l), and Lead in summer season was the highest.

Cadmium (Cd) content from water canal in winter summer and rainy are 0.471 – 2.792mg/l (average 1.206 ± 0.824mg/l), nd – 5.244mg/l (average 3.969 ± 1.641mg/l) and 0.004 – 0.062 mg/l (average 0.020 ± 0.012mg/l), respectively. Cadmium content is therefore much higher than the standard (more than 0.05mg/l)

B. Analysis of Seasonal Variation of Surface Water Quality

Statistical analysis between seasonal variations and surface water quality by paired – sample T-test shown in Table IV. Paired sample T –test analysis have been conducted in order to find out the difference of water quality and seasonal variations. Results revealed that pH and temperature are difference statistically significant at 0.05 level of significance.

Seasonal variations of Total Dissolved Solid between winter and summer, winter and rainy have statistical difference ($\propto$ = 0.008 and $\propto$ = 0.006). However, no statistical difference between winter and rainy ($\propto$ = 0.064).

Seasonal variations of Biochemical Oxygen Demand (BOD) between summer and rainy have statistical difference ($\propto$ = 0.000 and $\propto$ = 0.000). However, no statistical difference between winter and rainy season ($\propto$ = 0.339). Seasonal variations of nitrogen in nitrate form, lead and cadmium have statistical difference as well.

Whereas, Dissolve Oxygen (DO) has no statistical difference between seasonal.

TABLE IV
STATISTIC ANALYSIS BETWEEN SEASON VARIATIONS AND SRFACE WATER QUALITY BY PAIRED SAMPLE T-TEST

parameter	Season	Statistic significant		
		Winter	Summer	Rainy
Temperature N= 198	Winter	-	0.000	0.000
	Summer	0.000	-	0.000
	Rainy	0.000	0.000	-
pH n= 200	Winter	-	0.005	0.000
	Summer	0.005	-	0.000
	Rainy	0.000	0.000	-
TDS N= 196	Winter	-	0.008	0.006
	Summer	0.008	-	0.064
	Rainy	0.006	0.064	-
Turbidity N= 198	Winter	-	0.072	0.010
	Summer	0.072	-	0.000
	Rainy	0.010	0.000	-
Nitrate n= 193	Winter	-	0.000	0.000
	Summer	0.000	-	0.000
	Rainy	0.000	0.000	-
DO N= 196	Winter	-	0.149	0.489
	Summer	0.149	-	0.256
	Rainy	0.489	0.256	-
BOD n= 201	Winter	-	0.000	0.339
	Summer	0.000	-	0.000
	Rainy	0.339	0.000	-
Pb n= 42	Winter	-	0.000	0.000
	Summer	0.000	-	0.000
	Rainy	0.000	0.000	-
Cd n= 86	Winter	-	0.000	0.000
	Summer	0.000	-	0.000
	Rainy	0.000	0.000	-

IV. Conclusion

From the investigation of surface water quality in Mae Klong River, main and tributaries canals in Samut Songkram

province, we found that water quality meet the type III of surface water quality standard issued by the National Environmental Quality Act B.E. 1992.

Seasonal variations of Temperature, pH, nitrogen in nitrate form, lead and cadmium have statistical difference as well.

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