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Keiji Ujikawa
Mikio Ishiwatari
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Environment and Sustainable Development

Proceedings of the 2022 7th Asia Conference on Environment and Sustainable Development

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Foreword

It is our great pleasure to introduce this volume, the proceedings of 2022 7th Asia Conference on Environment and Sustainable Development (ACESD 2022), which was held in Kyoto, Japan during November 4 to 6, 2022. We would like to express our gratitude to all the participants, all our reviewers, speakers, chairpersons, and sponsors for their continuous support and contributions. We would also like to acknowledge with special appreciation to the following three keynote speakers: Prof. Vincenzo Belgiorno (University of Salerno, Italy), Prof. Eric D. van Hullebusch (University of Paris, France), and Prof. Makoto Usami (University of Kyoto, Japan), for their distinguished lectures about the latest information on environmental science and sustainable development issues.

ACESD was initiated in 2016, which is an annual international conference covering research in the field of environment and sustainable development. It provides the researchers, engineers, administrators, academics as well as industry professionals with an international platform to share new ideas and research findings. The first ACESD was held in Hong Kong in 2016, followed by Tokyo (Japan) in 2017, Singapore in 2018, Yokohama in 2019. From 2020 to 2021, ACESD was held online. The scale of this ACESD conference has grown over time, covering more countries and regions, and that the quality of the papers presented has improved. Moreover, we were able to guarantee equality and free discussion for all participants, regardless of nationality, occupation, social status, age, or gender, with the aim of advancing scientific research. Indeed, we need a borderless debate on the environment and sustainable development.

Since the outbreak of the global COVID-19 pandemic, it has been a challenge for the academic community to organize international conferences due to travel restrictions. ACESD 2022 has combined the in-person and virtual format as a hybrid-style conference, which always tries to feature a platform open for reputable scientists, researchers, administrators, academicians, industrial professionals and postgraduate students globally for scientific communications.

This year ACESD received many submissions from members of universities, research institutes and industries; there are more than 80 participants from 26 different

countries/region over the world. All papers were subject to peer-reviewing by conference committee members and international experts. The acceptance of the papers is based on their quality and relevance to the conference.

This volume of proceedings contains 35 papers. Those accepted papers are grouped into 8 chapters. Topics include wastewater treatment and water analysis, hydrology and water resources management, solid waste management, environmental pollution, climate change, renewable energy, and circular economy. We hope that this volume of the conference proceedings will serve as a valuable reference for researchers, educators, and practitioners.

We would like to express our most sincere appreciation to conference co-chairs, program committee chairs, publication chair, and technical program committee members for their precious efforts. Without their contribution, we would not have achieved so much. Besides, thanks to the high level of international interest in the subject, the conference achieves a complete success. On behalf of the conference organization committee, we sincerely hope that you will think the ACESD2022 beneficial and fruitful for your professional development.

Dr. Mitsuo Yoshida
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Part I
Wastewater Treatment and Water Analysis

Chapter 3
Characteristics of Natural Organic Matter and Trihalomethanes Formation in the Southern Part of Songkhla Lake Basin

Kamonnawin Inthanuchit and Kochakorn Sukjan Inthanuchit

Abstract The characteristics of natural organic matter (NOM) in water sources may be significant for regulating NOM and limiting the production of disinfection by-products. NOM surrogate measures such as dissolved organic carbon (DOC), ultraviolet absorbance at a wavelength of 254 nm (UV-254), specific ultraviolet absorption (SUVA), and fluorescence excitation-emission (FEEM) were utilized to evaluate NOM qualities related to trihalomethanes (THMs) generation by chlorination from diverse water sources in the southern part of the Songkhla lake basin (SLB), such as the water sample of the reservoir (n = 3), the water well (n = 2), and the canal (n = 10). The canal had the highest DOC concentration (5.12–5.89 mg/L), followed by the reservoir (2.05–2.32 mg/L) and the well (2.12–2.23 mg/L). The results for the lowest SUVA values indicated that NOM was present in the water well and that aromatic proteins and SMP-like compounds predominated in the canal. The results of FEEM spectroscopy indicated that tryptophan-like chemicals (240 nm_{Ex}/360 nm_{Em} and 260 nm_{Ex}/360 nm_{Em}) were the predominant DOM in community wastewater discharged into the SLB compared to humic and fulvic acid-like substances (280 nm_{Ex}/410 nm_{Em}, 340 nm_{Ex}/410 nm_{Em}, 330 nm_{Ex}/440 nm_{Em}). The highest concentration of THMs was found in the canal (560–736 μg/L), followed by the water sample from the reservoir (146–390 μg/L), and the lowest concentration was found in the water well (120–312 μg/L). The reservoir had a significantly higher THMs/DOC ratio than the canal and the water well. The mixture of NOM originating from

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terrestrial and microbiological sources contributed to NOM fractions. Low molecular weight NOM, aromatic proteins, and water soluble microbial metabolites can all be used as reactants to make THM.

Keywords Natural organic matter · Trihalomethane formation · Songkhla lake basin

3.1 Introduction

Natural water sources such as rivers, reservoirs, and groundwater are used as raw water sources for the manufactured water supply. The Songkhla lake basin (SLB) in southern Thailand is one of the most important raw water sources. The SLB covers an area of 8,484,35 km^2 and is comprised of 26 districts, 147 sub-districts/municipalities, and 1,247 villages in the provinces of Phatthalung, Songkhla, and Nakhon Si-Thammarat. The SLB was separated into three broad regions based on the physical characteristics of the lagoon [1, 2]. The southern part of SLB is now facing water quality degradation issues. The U-Tapao Canal, a branch canal in SLB, found dissolved organic matter (DOM) and humic substances throughout the year [3, 4], mainly DOM from the watershed area close to the water source. By reacting with chlorine, which is often used to kill microorganisms during disinfection, DOM can make disinfection by-products (DBPs) that could cause cancer, such as haloacetic acids (HAAs) and trihalomethanes (THMs) [5]. Generally, the dissolved organic carbon (DOC) and trihalomethane formation potential (THMFP) values are used to evaluate the efficacy of a water supply treatment plant. However, procedures for detecting DOC and THMFP in water are somewhat complex. In addition, TOC analyzers and gas chromatography (GC) are extremely expensive. Therefore, they could not be employed online in water treatment facilities. In comparison to other DOC and THMFP analytical procedures, three-dimensional fluorescence spectroscopy analysis (the use of a fluorescent excitation-emission matrix) and ultraviolet photometry analysis (the use of ultraviolet adsorption at wavelength 254 nm or UV-254) are more straightforward due to their minimal sample amount, pretreatment, and analysis time requirements.

The purpose of this study was to evaluate NOM characteristics with trihalomethanes (THMs) generation by chlorination from diverse water sources, including reservoir ($n = 3$), well ($n = 2$), and canal ($n = 10$) water samples in the southern part of the Songkhla lake basin (SLB), Thailand. Understanding the properties of natural organic matter (NOM) in water sources could be the key to controlling NOM and reducing the formation of disinfection by-products. The results of this study can also tell us important things about the future effects of chlorinating water from different sources in SLB.

3.2 Material and Methods

3.2.1 Studied Songkhla Lake Basin and Sample Collection

Songkhla lake basin (SLB): The SLB is divided into three distinct parts. The southern part opens with a 380 m wide strait to the Gulf of Thailand at the city of Songkhla. The eastern area is the Sathing Phra Peninsula, and the western area has large cities including Hat Yai city and Songkhla city and sample collection including the water sample of the reservoir, the water well, and the canal in the southern part of Songkhla lake basin (SLB), shown in Fig. 3.1.

Reservoir: Klongla Reservoir (R1), Khlong ChumRai Reservoir (R2), and Sadao Reservoir (R3) are located in the southern part of SLB, Thailand. Water from these reservoirs is used to create the water supply for drinking, bathing, and household usage in the areas surrounding reservoirs.

Water well: Both of W_1 and W_2 are employed in the production of the water supply. The produced water supply is delivered to towns, faculties, offices, and dormitories in the surroundings of Songkhla Rajabhat University for drinking, bathing, and home usage.

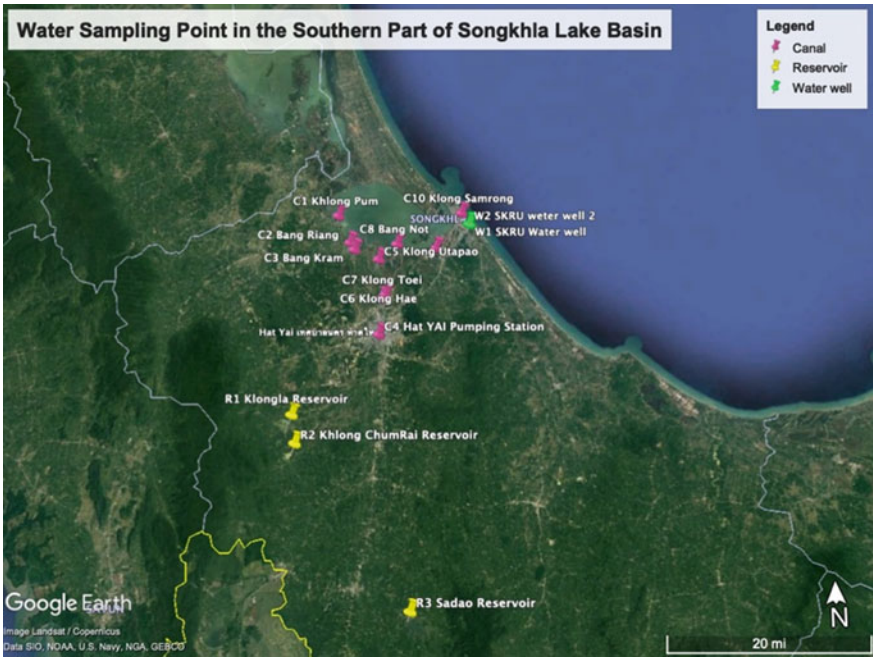

Fig. 3.1 Studied the southern part of Songkhla lake basin and sample collection

Canal: Klong Pum (C_1), Bang Raing (C_2), Bang Kram (C_3), Hat Yai pumping station (C_4), Klong Utapao (C_5), Klong Hae (C_6), Klong Toei (C_7), Bang Not (C_8), Pavong (C_9), and Klong Samrong (C_{10}) are in the southern part of SLB. There are a significant source of raw water supply for the SLB's largest water supply manufacturing operation.

3.2.2 Water Sampling

All sampling was done in Songkhla between February and May (dry season) and June and January (rainy season) [6]. On 8–9 March and 15–16 November 2020, as well as on 15–16 February and 18–19 October 2021, water samples were collected and kept. The Pearson's correlation (r) test, with a value of $p < 0.01$, was used to figure out the relationship between two variables that measure important seasonal and commercial and administrative procedure changes along SLB.

3.2.3 Analytical Methods

The collected water samples were filtered through a Whatman GF/F membrane (pore size 0.7 μm) prior to storage at 4 °C in the dark, added H_2SO_4 to pH 2 in accordance with the standard method 1060B, and analyzed immediately.

DOC were analyzed in accordance with Standard Method 5310D [7] for water using a TOC analyzer (O.I. analytical, College Station, **Texas**, USA). Milli-Q water (ELGA, Lane End, High Wycomebe, UK) was used with every sample to clean the system.

UV-254 was analyzed in accordance with Standard Method 5910B [7] using a UV/VIS spectrometer, Jasco V-350 spectrophotometer (Jasco Corporation, Tokyo, Japan) at 253.7 nm, with matched quartz cells, that provided a path length of 10 mm. All water samples were adjusted to a pH of 7 by H_2SO_4 and NaOH prior to UV-254 analysis.

SUVA was calculated by dividing the UV absorbance of the sample (in cm^{-1}) by the DOC of the sample (in mg/L) and then multiplying by 100 cm/M. SUVA is reported in units of L/mg-M.

THMFP measurements were carried out according to Standard Method 5710B [7]. THMs were extracted with pentane in accordance with Standard Method 6232B [7] before injection to the gas chromatography (GC) system. Agilent Gas Chromatography-6890 with an electron capture detector (ECD) (Agilent technologies Inc., Wilmington, Delaware, USA) and chromatographic column (J&W Science DB-624, DE, USA), with 0.2-mm X 25 m 1.12 μm film was used to analyze THMs. At least two replications of each measurement of DOC, UV-254, and THMFP were performed.

FEEM spectroscopy was measured using Jasco FP-6200 and FP-750 Spectrofluorometers with a wavelength range of 220–600 nm for excitation and emission. FEEM spectra of all water samples were subtracted by the FEEM spectra of Milli-Q water and converted to quinine sulphate units (QSUs). Ten QSUs are equal to the fluorescence spectra of 10 μg/L quinine sulphate solution at 450 nm with an excitation wavelength of 345 nm. FEEM data were discarded when the excitation wavelength (Ex) was greater or equal to the emission wavelength (Em) or Ex × 2 was less than or equal to Em to eliminate the influence of primary and secondary scattered fluorescence and highlight the targeted peaks. Rayleigh and Raman scattering at peak Em ± 10–15 nm of each Ex was also separated from the FEEM spectra.

3.3 Results and Discussion

3.3.1 Variation of DOC, UV254, SUVA and THMFP in Water Sampling

UV-254, DOC, and THMFP are frequently used as substitutes for DOM in water. These arguments may give significantly more precise information about DOM characteristics. DOC could be used to represent the levels of aromatic and aliphatic organic carbons in water. UV-254 represents the aromatic nature of the humic and fulvic acids. Compared to specific ultraviolet absorbance (SUVA), which is the ratio of how much light is absorbed to the amount of DOC (UV254/DOC), SUVA indicates the hydrophobic properties of the sample [8].

Commonly, the THMFP is used to determine the THMs at the end of the reaction between DOM and excess chlorine. Water with a high THMFP value can produce a high concentration of THMs, which has an active ability to produce THMs. THMFP was found to be a good indicator and was used to check the water for the highest possible THM levels.

Table 3.1 shows the average of DOC, UV-254, SUVA, and THMFP during the dry and rainy seasons of 2020 and 2021.

During the dry season, the average concentrations of DOC, UV-254, SUVA, and THMFP in the reservoir water were 2.05 mg/L, 0.64 cm^{-1}, 1.33 L/mg-M, and 146 μg/L, respectively. During the rainy season, the average concentrations of DOC, UV-254, SUVA, and THMFP in the reservoir water were 2.32 mg/L, 1.302 cm^{-1}, 3.02 L/mg-M, and 390 μg/L, respectively. During the dry season, the average concentrations of DOC, UV-254, SUVA, and THMFP in the water well were 2.12 mg/L, 0.48 cm^{-1}, 1.02 L/mg-M, and 120 μg/L, respectively. During the rainy season, the average concentrations of DOC, UV-254, SUVA, and THMFP in the water well were 2.23 mg/L, 0.551 cm^{-1}, 1.23 L/mg-M, and 312 μg/L, respectively. During a dry season, the average concentrations of DOC, UV-254, SUVA, and THMFP in canal water were 5.12 mg/L, 0.46 cm^{-1}, 2.38 L/mg-M, and 560 μg/L, respectively. In the canal water

Table 3.1 Variation of DOC, UV-254, SUVA, and THMFP in water sample

Water sample	DOC (mg/L)		UV-254 (cm^{-1})		SUVA (L/mg-M)		THMFP (μg/L)	
	Dry season	Rainy season	Dry season	Rainy season	Dry season	Rainy season	Dry season	Rainy season
Reservoir (n = 3)	2.05	2.32	0.649	1.302	1.33	3.02	146	390
Water Well (n = 2)	2.12	2.23	0.481	0.551	1.02	1.23	120	312
Canal Water (n = 10)	5.12	5.89	0.465	0.489	2.38	2.88	560	736

during the rainy season, the average concentrations of DOC, UV-254, SUVA, and THMFP were 5.89 mg/L, 0.489 cm^{-1}, 2.88 L/mg-M, and 736 μg/L, respectively.

Table 3.1 demonstrates that the average of all parameters during the rainy season in 2021–2022 is higher than during the dry season. Based on land use type as described by [1, 2], upstream of a reservoir, water well, and canal, where there are numerous activities, followed by urban and developed land. It might identify contamination origins from non-point sources, such as agricultural and community activities, as well as point sources, such as industrial and community activities, with greater attention to detail. The residual organic matter in the reservoir, well, and canal water could still react with chlorine and produce slightly elevated THMFP levels. Therefore, water treatment plants that use reservoir water, well water, or canal water in the southern part of SLB should be cautious about the DBP concentration in their generated water supply.

Figure 3.2 illustrates THMFP species in the reservoir and water well during the dry and rainy seasons. The average proportion of 90–93% chloroform, 4–6% bromodichloromethane, and 3–4% dibromochloromethane, respectively. The proportion of THMFP species is comparable to other reservoirs and water wells in Thailand [9, 10], and [11]. There are THMFP species in the canal water throughout both the dry and rainy seasons. The proportion of chloroform, bromodichloromethane, dibromochloromethane, and bromoform was 79–82%, 13%, 4–6%, and 1%, respectively. The number of species at THMFP is about the same as at other canals in Thailand [12].

The WHO [13] gives suggested guidance values for maximum concentrations of particular THMs in human-consumable water. The guideline values describe the maximum concentration of a substance that poses no significant danger to human health when consumed over a lifetime. These concentrations are as follows: chloroform at 300 μg/L, bromodichloromethane (BDCM) at 60 μg/L, dibromochloromethane (DBCM) at 100 μg/L, and bromoform at 100 μg/L. According to the World Health Organization, the following equation can be utilized to calculate the combined toxicity of all THMs: (1)

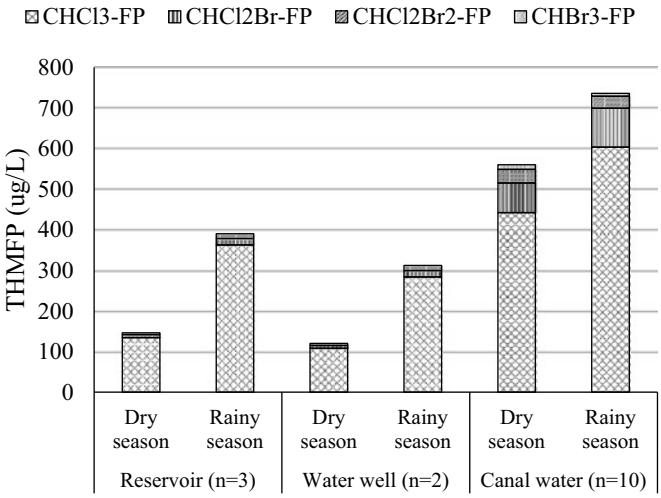

Fig. 3.2 THMFP and THMFP species in water sample

$$\frac{C_{\text{bromoform}}}{GV_{\text{bromoform}}} + \frac{C_{\text{DBCM}}}{GV_{\text{DBCM}}} + \frac{C_{\text{BDCM}}}{GV_{\text{BDCM}}} + \frac{C_{\text{Chloroform}}}{GV_{\text{Chloroform}}} \leq 1 \tag{3.1}$$

where C = concentration and GV = guideline value.

When the values of the four THMs compounds in water samples were compared to WHO as equation requirements (1), it was discovered that water samples from reservoir and water well in the dry season were 0.61 and 0.58, respectively, which followed WHO requirements, while water samples in the rainy season were 1.58 and 1.38, respectively. Furthermore, in both seasons, the water samples from the canals had levels of 3.14 and 3.97, which exceeded WHO standards (define compounds with a value of THMs, each type combined with guidelines of less than 1).

Specific THMFP (THMFP/DOC or STHMFP) indicates the average potential of a sample's carbon to generate THMs; it is a molar measure of the potential THM precursor concentration normalized to carbon [14]. Figure 3.3 demonstrated that THMFP/DOC was substantially higher during the rainy season than during the dry season. In rainy and dry season samples, aromatic chemicals and other types of dissolved organic matter may be significant THM precursors.

3.3.2 Characteristics of FEEM Spectroscopy in Water Sampling

The FEEM was measured by the matrix of fluorescent intensity in coordinates for excitation and emission wavelength. Figure 3.4 shows the results of FEEM spectroscopy performed on the reservoir, water well, and canal water in the southern part

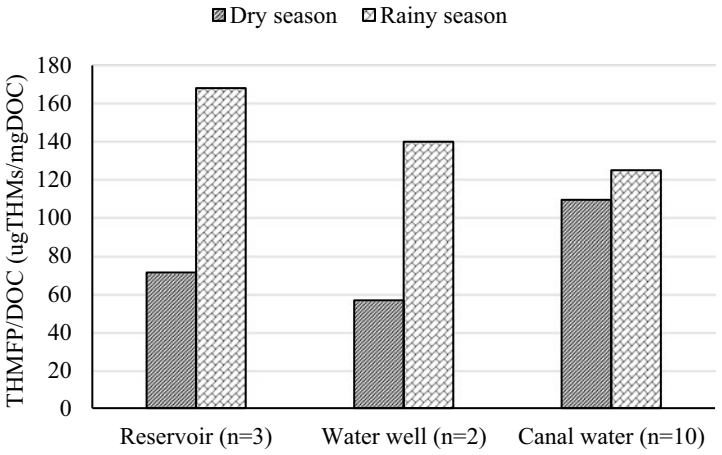

Fig. 3.3 THMFP/DOC in water sample

of SLB during the rainy and dry seasons of 2020 and 2021, with contour intervals of 10 QSU. As presented in Fig. 3.3, the fluorescent excitation-emission wavelengths (Ex/Em) exhibited large fluorescent emission intensities as fluorescence peaks. In the water samples, the peak locations A, B, C, and D of FEEM spectroscopy indicated the presence of natural organic matter and organic matter from non-point source pollution. As (i) humic/fulvic-like organic matter (Ex/Em = 330–350/420–480 nm), (ii) humic-like organic matter peak (Ex/Em = 250–260/420–480 nm), and (iii) protein-like organic matter (Ex/Em = 250–260/250–280 nm) were identified as the three primary fluorescence peaks in water samples by [15, 16].

Figure 3.4 demonstrates that FEEM spectroscopy results can be divided into two regions. In region I, tryptophan-like compounds were detected by the FEEM peak at 240 nm_{Ex}/360 nm_{Em} (peak A) and 260 nm_{Ex}/360 nm_{Em} (peak B) (peak B). In region II, the FEEM peak was found in humic and fulvic acid-like compounds at 280 nm_{Ex}/410 nm_{Em} (peak C), 340 nm_{Ex}/410 nm_{Em} (peak D), 330 nm_{Ex}/440 nm_{Em} (peak E), and 285 nm_{Ex}/460 nm_{Em} (peak F); these peaks were similar to those observed in the previous work [4, 17]. The tyrosine-like and tryptophan-like chemicals as residues that predominantly contribute to protein-like fluorescence in wastewater [18] were identified as indicators for assessing the quality of stream water [19]. While tryptophan-like chemicals were the predominant DOM in community wastewater discharged into the downstream SLB, humic and fulvic acid-like substances were also present in significant amounts. This study showed that the wastewater from the lakeside community was the main source of DOM in SLB.

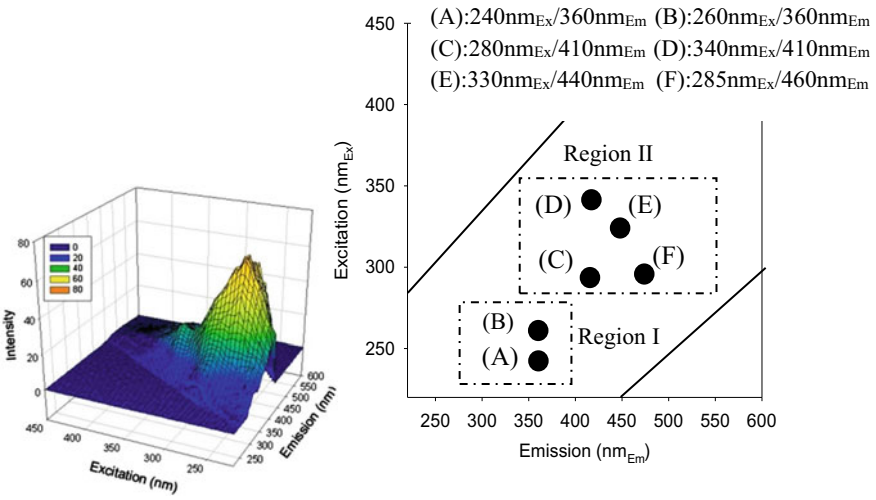

Fig. 3.4 Location of FEEM peak position in water sample

3.4 Conclusion

The highest DOC concentration was found with canal, followed by reservoir, and water well. Results relative indicate lowest SUVA values that NOM have in the water well and the predominance of aromatic proteins and soluble microbial products (SMPs)-like compounds were clearly observed in the canal possibly because of the discharge of untreated wastewater.

The FEEM spectroscopy results indicated tryptophan-like substances were the dominant DOM from community wastewater discharged into the canal water compared to humic and fulvic acid-like substances.

The highest concentration of THMs was detected in canal, followed by reservoir water samples, whereas the lowest concentration of THMs was detected in the water well sample Then, specific treatment processes should be required to eliminate these NOM fractions in water treatment for controlling THMs formation.

Acknowledgements This research is integrated with the subject of watershed and Songkhla Lake Basin (4463206) in the environmental science program, faculty of science and technology, Songkhla Rajabhat University. The author wishes to thank the Natural and Cultural Environmental Conservation Division of Songkhla Province for supporting this project.

References

1. Srichaichana J, Trisurat Y, Ongsomwang S (2019) Land use and land cover scenarios for optimum water yield and sediment retention ecosystem services in Klong U-Tapao Watershed, Songkhla, Thailand. Sustainability 11(10):2895. https://doi.org/10.3390/su11102895
2. Tippayawong S, Somboonsuke B (2013) Dynamics of songkhla lake basin research in the south of Thailand. J Agric Technol 9(5):1081–1096
3. Inthanuchit K, Kunpitak K, Podam N, Suwibul H, Yoyruroob S (2018) Monitoring of carbon and nitrogen loading of onsite wastewater treatment in Songkhla lake basin. EAU Herit J Sci Technol 13(2):225–239
4. Inthanuchit K, Inthanuchit KS (2022) Characterization of dissolved organic matter and humification index in filtered effluent water of lakeside communities around Songkhla Lake Basin, Thailand. J Res Unit Sci Technol Environ Learn 13(1):142–155
5. Marhaba TF, Washington MB (1998) Drinking water disinfection and by-product: history and current practice. Adv Environ Res 2(1):103–115
6. Climate center (2020) Climate of Songkhla. Thai Meteorology Department, Bangkok, pp 1–3
7. American Public Health Association (2017) Standard methods for the examination of water and wastewater, 23rd edn. American Water Works Association. Washington DC, USA, Water Environment Federation
8. Mattaraj S, Kilduff JE (2003) Effect of natural organic matter properties on nanofiltration fouling. The fourth regional symposium on infrastructure development in Civil Engineering. Kasetsart University, Bangkok, pp 1051–1060
9. Homklin S (2004) Removal of hydrophilic and hydrophobic dissolved organic matters in natural waters by alum coagulation. Master thesis. Graduated School, Chulalongkorn University, Thailand
10. Phumpaisanchai A (2005) Removal of hydrophobic and hydrophilic natural organic matters in reservoirs by alum coagulation. Master thesis. Graduated School, Chiang Mai University, Thailand
11. Musikavong C, Wattanachira S, Nakajima F, Furumai H (2007) Three dimensional fluorescent spectroscopy analysis for the evaluation of organic matter removal from industrial estate wastewater by stabilization ponds. Wat Sci Tech 55(11):201–210
12. Inthanuchit K (2008) Removal of hydrophilic and hydrophobic in raw water supply from Utapao canal, Thailand. Master thesis. Graduated School, Prince of Songkla University, Thailand
13. World Health Organization (2006) Guidelines for drinking water quality, 3rd edn. WHO, Geneva
14. Roger F, Anthony JR, George RA, Brian AB (1998) Dissolved organic carbon concentration and compositions, and Trihalomethane formation potentials in waters from agricultural peat soils, Sacramento-San Joaquin, California: Implications for drinking-water quality. U.S. Geological survey, Sacramento, California
15. Chen J, LeBoeuf EJ, Dai S, Gu B (2003) Fluorescence spectroscopic studies of natural organic matter fractions. Chemosphere 50(5):639–647
16. He W, Jung H, Lee JH, Hur J (2016) Differences in spectroscopic characteristics between dissolved and particulate organic matters in sediments: insight into distribution behavior of sediment organic matter. Sci Total Environ 547:1–8
17. Musikavong C, Inthanuchit K, Srimuang K, Suksaroj TT, Suksaroj C (2013) Reduction of fractionated dissolved organic matter and their trihalomethane formation potential with enhanced coagulation. Sci Asia 39:56–66
18. Mohapatra S, Sharma N, Mohapatra G, Padhye LP, Mukherji S (2021) Seasonal variation in fluorescence characteristics of dissolved organic matter in wastewater and identification of proteins through HRLC-MS/MS. J Hazard Mater 413:125453
19. Zhao Y, Song K, Li S, Ma J, Wen Z (2016) Characterization of CDOM from urban waters in Northern-Northeastern China using excitation-emission matrix fluorescence and parallel factor analysis. Environ Sci Pollut Res 23:15381–15394