Investigation of nutrient and coliform bacteria from non-point source on the Chao Phraya river bank in dry season

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Abstract:
This research tries to investigate the effect of waterfront building, house and wastewater treatment plant on the river bank of the Chao Phraya river in dry season. Water samples from the Chao Phraya river bank were collected during daytime and analyzed for coliform bacteria and nutrient. Results revealed that mean daily of total coliform bacteria (TCB) of 566×10^4 CFU/100mL was found at 25 m from river bank near waterfront housing. The high TCB and fecal coliform bacteria (FCB) from urban which contaminated to the river is risk for human uses; therefore, an efficient water resources sustainable management should be implemented.

Keywords: *Chao Phraya river; coliform bacteria; dry season; non-point source; nutrient*

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1. Introduction

Bangkok is the capital city of Thailand which the Chao Phraya river passes through the central of city. Bangkok is fast growing leading to high population density. The consumption of water is high, whereas the controlling plan and management of wastewater could not cover all areas. Hence, the effect of non-point source from household, community, building and apartment on the river is inevitable. The nutrient and coliform bacteria release from these sources cause the water is not suitable for water supply production. The pollution load in river during wet season is normally higher than dry season due to the runoff from land. However, low water level and low river velocity in dry season has low ability to flush impurities.

2. Methods

2.1 Site selection

Water samples were collected in the Chao Phraya river near Chongnonsi Water Environment Control Plant (WECP). Six sampling points (A1-C2) were selected relating to water depth and river wide as shown in Fig. 1. This plant collects domestic wastewater and treats by sequencing batch reactor which covers the area of 28.5 km^2.

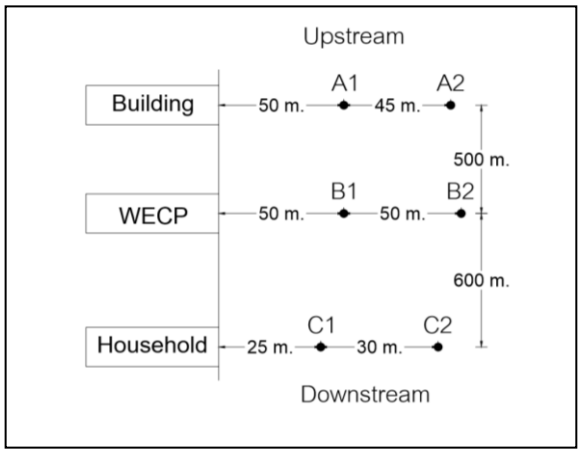

Fig. 1 Sampling points.

2.2 Sampling and analytical methods

Water samples were collected every 90 min during 9.00 - 4.30 p.m. Water samples were analyzed for Total coliform bacteria (TCB), Fecal coliform bacteria (FCB), total Phosphorus (TP), total Kjeldahl nitrogen (TKN), Nitrate (NO_3^-), Nitrite (NO_2^-), Ammonia (NH_3) following standard method for the examination of water and wastewater as shown in Table 1 (APHA, 2005). Total nitrogen (TN) was calculated from the summation of TKN, NO_3^-, NO_2^- and NH_3

Table 1 Parameters and method of analysis

Parameter	Method
Total coliform bacteria	Membrane filtration technic
Fecal coliform bacteria	Membrane filtration technic
Total Phosphorus	Ascorbic acid
Nitrite (NO_2^-)	Modified- *Ilosvay* diazotization
Nitrate (NO_3^-)	Sodium salicylate
Ammonia (NH_3)	Phenate method
Total kjeldahl nitrogen (TKN)	Digestion + Distillation + Titration

3. Results and discussion

Biological results show that at C1 and C2 have highest amount of both TCB and FCB (see Fig. 2). High coliform of these sites because they were near waterfront housing. Each house has onsite sanitary system (septic tank) near the river bank which coliform bacteria can contaminate to the river. The values of TCB and FCB near the building (A) and WECP (B) were lower than household (C) due to parts of wastewater were collected to treatment plants. It was reported that coliform bacteria was related to climate change by increasing of bacteria with high ambient temperature. TCB was reported of 150×10^4 and 358×10^4 CFU/mL in dry season (April) and wet season (June – October), respectively at C1 point (Vinitnantharat et al., 2009). It is lower than this study about 3.8 times which may related to climate. The average temperature of air and water were 34.5 and 32.5°C respectively for this study. Thailand is a tropical country and average temperature in Bangkok was 28.7°C in the year 2009. It was 29.3°C in the year 2010 (Thai Meteorological Department, 2009, 2010) and has risen year by year. It was reported that bacteria may initially grow faster in water with higher temperatures (Schets et al., 2005 cited in Hofstra, 2011).

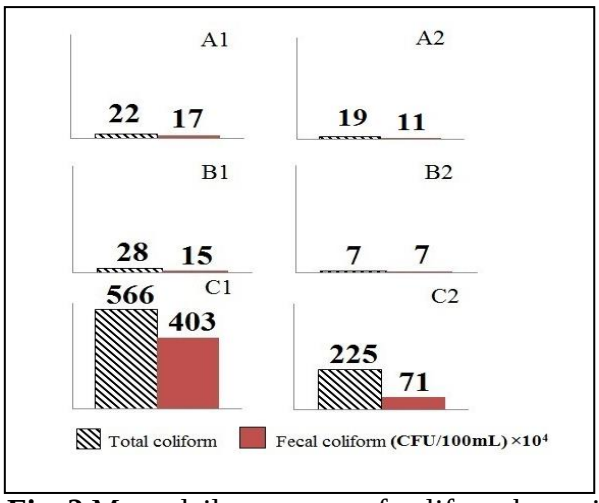

Fig. 2 Mean daily amounts of coliform bacteria.
(A: Building area B: WECP Zone C:household)

Sampling points near the riverbank had high amount of bacteria since the water flow near the river

bank was low (0.11-0.15 m^3/s) leading to the accumulation of sediment. Bottomed and suspended solids may facilitate the coliform bacteria survival growth by adsorbing coliform and protecting them from the adverse factors, such as UV- radiation, metal toxicity and attack by bacteriophage (An et al., 2002; Hong et al., 2010).

It can be seen that C1 had the maximum TP value of 0.870 mg/L at 4.30 PM (see Fig. 3). High phosphorus due to wastewater from human activities such as cleaning, bathing, washing of laundry by detergent from waterfront housing and houseboats released directly into the river. These wastewaters were composed of nutrients and organic substances which stimulate algae growth. Algae Bloom is a major cause aquatic ecosystem imbalance which it is known as eutrophication. From this research study, all sampling points are risk to this phenomenon. Currently, Thailand do not used the total nitrogen (TN) and total phosphorus (TP) into nationality standard of surface water. Report from Prochaska and Zouboulis (2006) indicated the total phosphorus from household of 6-10 mg/L was the cause of eutrophication. However, the less concentration of TP (0.005 mg/L) can be the cause of eutrophication too.

Nitrogen is an essential nutrient for plant growth and is needed to create cells of living organisms. In case of the high quantity of nitrogen, the growth rate of aquatic plants will be high. Floating aquatic plants may obstruct oxygen exchange into the water and shade the underwater-aquatic plants which is an oxygen producer for water. TN concentrations in the river bank near building (A) and household (C) were fluctuated where as they were not difference near WECP (B). TN concentrations near WECP (B) were in the range of 1.24-1.98 mg/L. At 9.00 and 10.30 AM, the highest TN concentrations of 3.8 and 4.8 mg/L were found near building, respectively. The highest TN at 12.00 AM and 1.30 PM were found near household. This implies that human activities play role on TN concentration in the river.

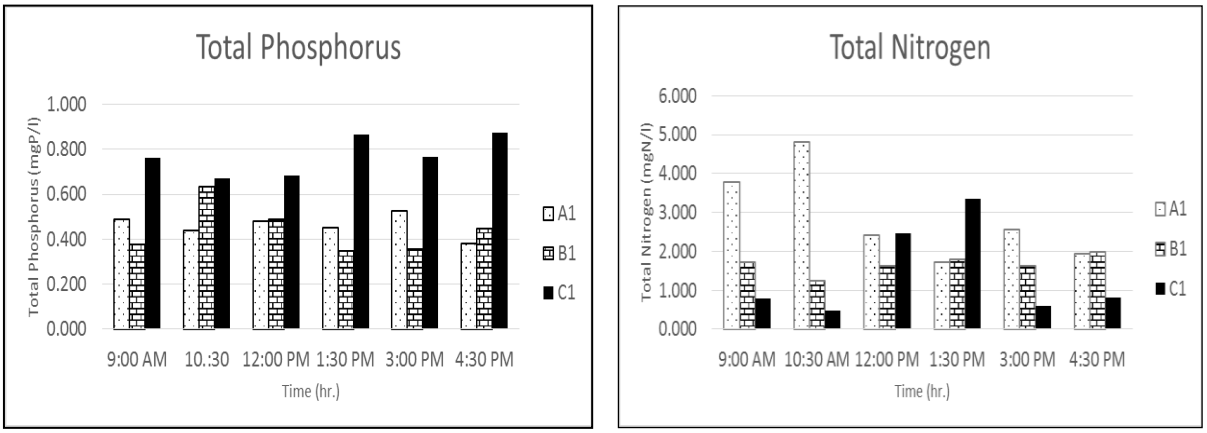

Fig. 3 Daily concentration of TP and TN at the river bank.
(A: Building area B: WECP Zone C:household)

Fig. 4 shows various forms of nitrogen. Over 85% of TN occurs in organic forms (Org-N). The Org-N was low at B1 and B2 because this point was near the effluents of wastewater treatment. The average organic nitrogen concentrations were 2.38, 1.31, 1.81 mg/L for A, B and C sampling points, respectively. It is observed that the value of TN is high when it is near the river bank. In case of point B, the average of Org-N is lower than point A and C, since point B is near the outlet of treated water. The Org-N is high at point A (located at upstream) bring the Org-N at B2 and C2 higher than B1 and C1. The long period of dry season make the river to be shallow and high accumulation of

sediment. This also provides anaerobic zone which organic nitrogen could be degraded to greenhouse gas (nitrous oxide). Thus, sediment dredging and non-point source controlling in urban area should be implemented to assess and protect human health. This will be successful by participation of agencies and public.

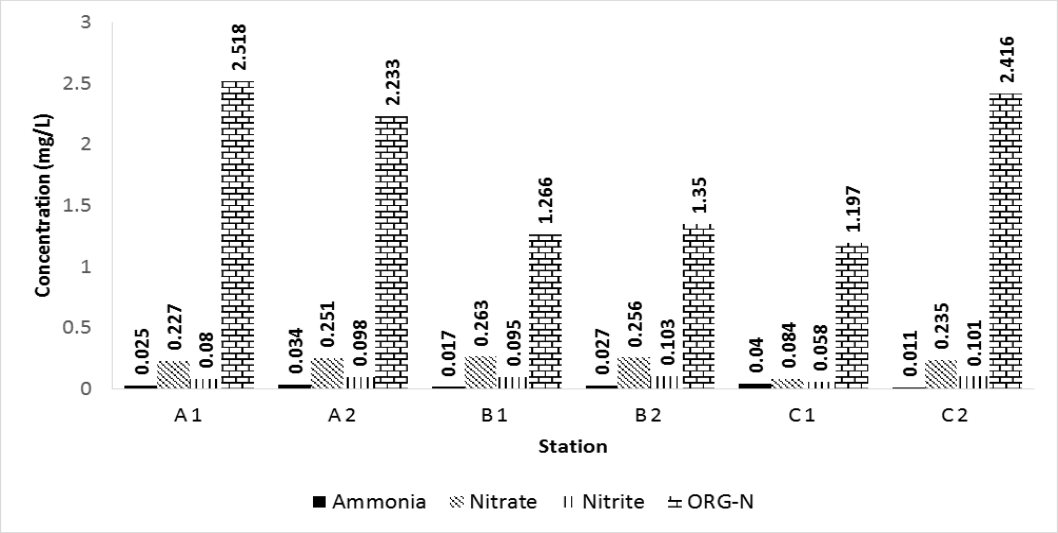

Fig. 4 Different forms of nitrogen.
(A: Building area B: WECP Zone C:household)

4. Conclusion

The values of coliform bacteria and nutrients are related to human activities from the land and river, river depth and distance from river bank. High Coliform bacteria was found near water front housing and nutrients were found near building.

5. Acknowledgement

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