TEMPLATE

Preliminary study on pollutant discharge from domestic wastewater and pollutant load in the river: a comparative study between Japan, Thailand and Bangladesh

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Abstract

Flooding control and water pollution abatement have been major problems in the surface water in the Asian countries including Thailand and Bangladesh. We have conducted field surveys and secondary data collection to clarify the relationships between domestic wastewater discharge and pollutant load in the river from October to December in 2006. This paper reports summary data which will be a part of basic data sets for the estimation of pollutant discharge per capita (PDC) and pollutant load per capita flowing into the water body (PLCwb). For the estimation of the pollutant load in the river, river flow fluctuation derived from the tidal level fluctuation was important to be considered in regards to both water quantity and quality, because the river bed in these areas are rather flat.

Introduction

In the context of the Millennium development goals (MDGs), decreasing the population without access to safe drinking water and appropriate domestic wastewater treatment facilities was determined as very urgent tasks of the world community. In regards to the efficiency of domestic investment and overseas development assistance (ODA), it is important to consider and discuss on the efforts of stakeholders in the developed countries such as Japan including national and local governments, private companies, citizens, fisheries and researchers. Tsuzuki (e.g. 2006b) proposed pollutant loads per capita flowing into the water body (PLCwb) as an appropriate indicator of the domestic wastewater contribution to the water pollution in the targeted water body.

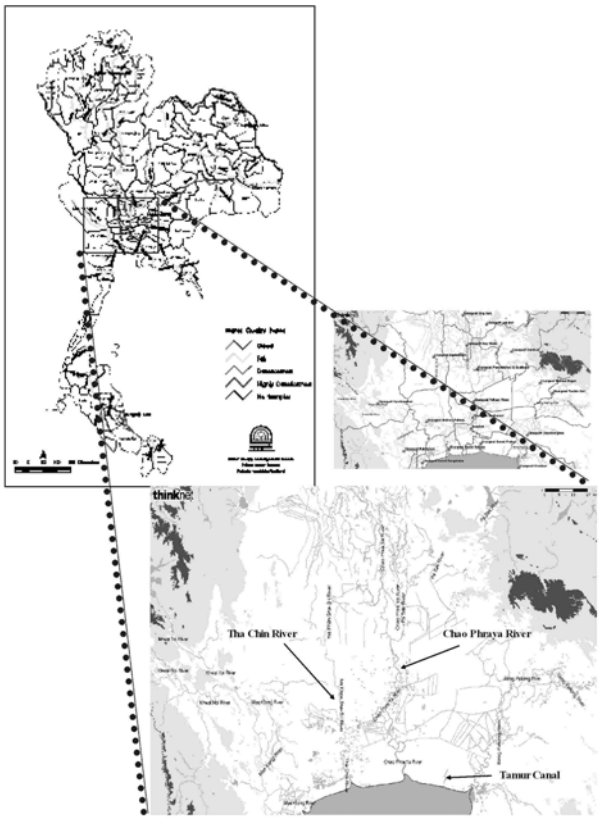

Figure 1 Rivers and lakes in urban and peri-urban area of Dhaka, Bangladesh

Figure 2 Rivers and canals in urban and peri-urban area of Bangladesh, Thailand (Original source: PCD (2006) and Thinknet ®)

We have conducted secondary data collection and field survey in regards to pollutant discharge with domestic wastewater and pollutant load in the rivers, lakes and canals in urban and peri-urban area of Bangkok, Thailand, and Dhaka, Bangladesh in October, November and December, 2006. The purpose of this paper is to present a part of the summary of the secondary data and the field survey results, in order to make comparison of the situations of domestic wastewater treatment between Japan, Thailand and Bangladesh. A conceptual proposal for preparation of the comprehensive basin based domestic wastewater strategies with centralized and decentralized domestic wastewater treatment system will be presented in the future opportunity based on these results. A part of this paper was presented in the International symposium on the 'Restoration and Sustainability of Estuaries and Coastal Lagoons' in January, 2007, Matsue, Japan.

Methods

Secondary information/data collection from documents, papers and web-sites and field surveys were conducted in regards to water quantity and quality in urban and peri-urban area of Dhaka, Bangladesh (Fig. 1), and Bankok, Thailand (Fig. 2). The Sitalakhya River flows west of Narayanganj District, Bangladesh, and flowing into the Dhaleshuari River, which flows into the Megha River at Bandar. The Narayanganj District is one of the highest population density district in Bangladesh with more than 2,000 person km^{-2} (Alam ed., 2005). The Chao Phraya River and the Tha Chin River flow in the central area of Thailand. Pak Kret District (Amphoe) (area: 89.0 km^2, population: 201,399 person in 2004, population density: 2,296.6 person km^{-2}) was located at northeast of Notanburi Province (Wikipedia, 2006). Pak Kret Municipality was located in Pak Kret District as one of the twelve communities (Tambon). Total pollutant discharge and PDC in the Pak Kret Municipality was estimated from Sinsupan (2004).

From October to December, 2006, field surveys were conducted in the Sitalakhya River and lakes in Dhaka City, namely, Dhanmondi, Banani and Gulshan Lakes, Bangladesh, and in the Chao Phraya and the Tha Chin Rivers and the Tamru Canal, Thailand. Water quality was measured with a water quality data logger, Compact-CTD (Alec Electronics, Japan), and water quality monitoring kits, Pack Test (Kyoritsu, Japan), and laboratory measurements. Parameters measured with the Compact-CTD were water depth, water temperature, salinity, electricity, EC25 (electricity calibrated at water temperature of 25 °C), density, sigma-T, chlorophyll-a and turbidity. Parameters measured with the Pack Test were COD_{Mn} and PO_4-P.

Results and Discussion

Figure 3 shows the water quality measurement results with the Pack Test in the Sitalakhaya River and the three lakes, which effectively showed the water quality characteristics in the river and lakes, water quality deterioration near the river side community in the sampling points S2, S3 and S4, and natural purification or dilution in the sampling point S5 were observed. The Dhanmondi Lakes (D1, D2) was in the residential area and used for recreation of the people, however, Banani (B1, B2) and Gulshan Lakes (G1, G2) were in the office and commercial area. The relatively lower concentration of the Dhanmondi Lakes might reflect these characteristics of the lakes. The measurement results with the Compact-CTD in the Sitalakhaya River showed vertical homogeneity of the water quality measured in this study (Figure 4).

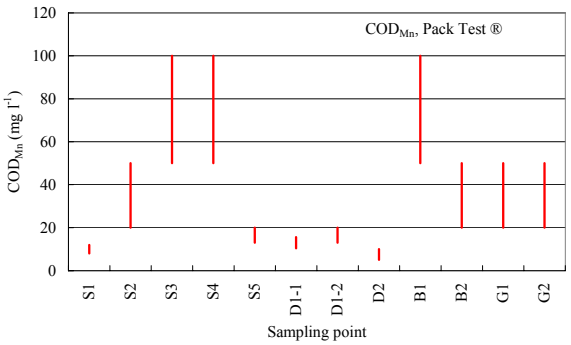

Figure 3 Water quality measurement results with Pack Test ® in the Sitalakhaya River and the three lakes in Dhaka, Bangladesh

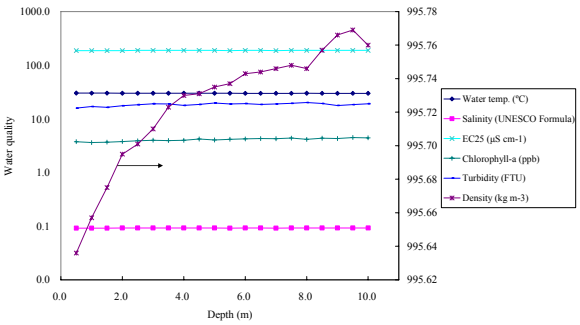

Figure 4 An example of vertical profiles of water quality parameters at the sampling point No.4, the Sitalakhaya River, Bangladesh

The Pack Test water quality measurement results showed the characteristics of water quality in the rivers and canals in Thailand also. The simple water quality measurement was considered to be effective methods especially in the field of community participation. Development of more cost-effective water quality measurement methods might be desirable for these developing countries.

Total pollutant discharge and PDC of the Pack Kret Municipality was estimated as shown in Table 1 based on the MFA results (Sinsupan, 2004). Pollutant load in the Chao Phraya River was estimated with the field survey results of water quality and the flow rate in the secondary data (Table 2). Pollutant load differences between the corresponding monitoring points for Pak Kret Municipality were estimated as 60 – 120 times of the pollutant discharge for BOD and nitrogen. Pollutant discharge and pollutant load estimation should be further

Table 1 Pollutant discharge from the Pak Kret Municipality estimated based on the secondary data

Pollutant	Pollutant discharge kg day^{-1}	PDC kg person^{-1} day^{-1}
BOD	11,935	49.2
TN	3,791	15.6
TP	1,530	6.30

Source: calculated by the authors based on Sinsupan (2004).

Table 2 Pollutant load in the Chao Phraya River calculated with the field survey results and the secondary data of flow rate

	Distance from the river mouth km	Flow rate[a] m^3 s^{-1}	TOC t day^{-1}	TN t day^{-1}	CODcal[b] t day^{-1}	BODcal[c] t day^{-1}
Wat Potongbon	58	1,082	581	117	1,500	89
Wat Tumnuktai	67	955	523	97	1,300	80
Pibulsongkram Bridge	80	784	388	78	970	59

a: Lohani et al. (1980); b: CODcal=2.5*TOC; c: BODcal=0.061*CODcal

investigated. These results would be base data for the calculation of PLCwb in the region. The estimated PDC and PLCwb in the Pak Kret Municipality would be compared to PDC and PLCwb in Japan (Figure 5).

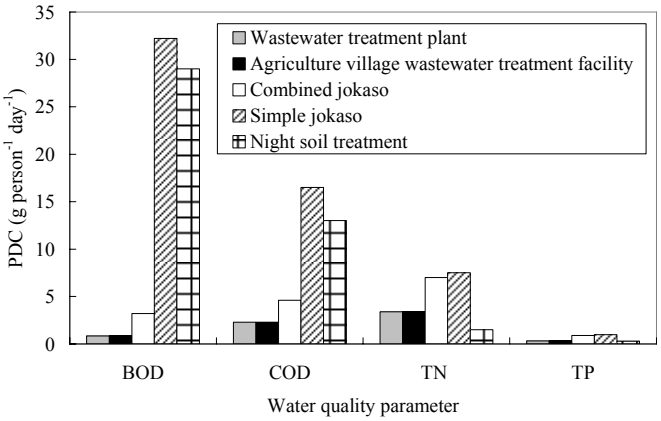

Figure 5 PDC in Japan (Tsuzuki, 2006a)

Pollutant discharge has been investigated in Thailand especially with MFA methods (e.g. Sinsupan, 2004). The river water quality including basic parameters including carbon, nitrogen, phosphorus, bacterial pollution, and heavy metals have been monitored periodically by the Pollution Control Department (PCD) (PCD, 2006a). Water pollution control program by the Thai government has been consisted of 1) wastewater treatment and disposal, 2) waste minimization, 3) cleaner production, 4) legal framework, 5) institutional and financial management, 6) monitoring and enforcement, 7) cooperation with related agencies and local communities, and 8) river basin management approach (Simachaya, 2000). Integral water resource management (IWRM) has been studied in Thailand (Lekphet et al., 2004). Environmental education program has been conducted in the drainage area of the Tha Chin River (Thongnopphakun, 2006). Information dissemination has been conducted by PCD by the web-site (PCD, 2006b). The results of this research would assist the environmental education and dissemination in regards to water environment in Thailand.

Conclusion

Simple water quality measurement with the Pack Test effectively demonstrated the water quality in the rivers, lakes and canals in Bangladesh and Thailand. Integrated river basin management (IRBM) has been widely advocated among the researchers and governments, and material flux analysis (MFA) has also been studied. The results of this research would assist the water environment improvement in the countries.

Acknowledgement

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