Japan-Korea Special Workshop on Impact assessment and Control of Combined Sewer Overflow
Associated Event of the 4th IWA-ASPIRE Conference & Exhibition, 2 October 2011

Pollutant Load for Flood and Non-Flood Periods in Urban Small Tidal River

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1. Introduction

Many urban small tidal rivers in Japan lack natural water sources. Besides at the time of storm, untreated water flows into these rivers through a combined sewer system, causing pollutant load. Sakai et. al. (2008) reported on a method using the *L-Q* equation to evaluate the pollutant load during storm. Meanwhile, the authors have arranged the characteristics of the flood, transition and tide phases based on the behaviour of the water quality parameters. This latest study aims at evaluating the characteristics of pollutant load during storm, focusing on the discharge and pollutant load in storm periods in an urban small tidal river.

2. Observation Method and Conditions

Observation was conducted from 8th to 10th September, 2010 at almost the central point of the river width at the Shin-Ryukei Bridge located some 4.4 km upstream of the river mouth of the Kanda River. The instruments used were a multi-parameter water quality meter and a two-axis electromagnetic current meter. Water samples were collected at the surface to analyse the BOD, COD and SS. At the Tokyo area, the total rainfall of 102.2 mm (67.0 mm/hour between 14:00 and 15:00 on 8th August) was observed in the period from 08:00 to 17:00 on 8th August. By 15:00, the river level had risen by some 1 m because of the storm.

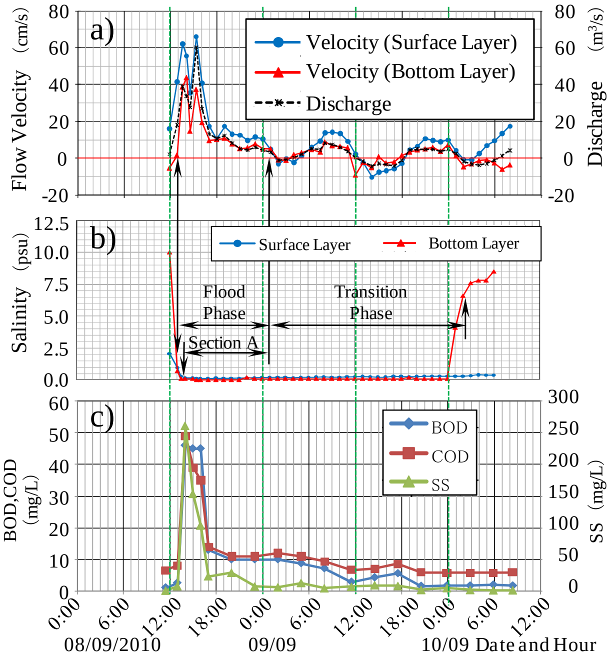

Fig. 1 Change of Flow Velocity, Discharge, Salinity, BOD, COD and SS

3. Results and discussion

Fig. 1 shows the change of a) the flow velocity and the discharge, b) salinity and c) BOD, COD and SS of the surface layer. Following the storm, the velocity of the bottom layer increased. At 14:00 on 8th September, the salinity of the bottom layer was flushed out while the BOD, COD and SS values sharply increased. By around 0:00 on 9th September when the flow velocity had dropped to almost 0 cm/s, the SS value almost returned to its normal level. Section A in Fig. 1-b) indicates the period of the flood phase where the flow velocity gradually decreased to almost 0 cm/s after the flushing out of the bottom water. After Section A (after 02:00 on 9th September) comes the transition phase which links between the flood phase and tide phase.

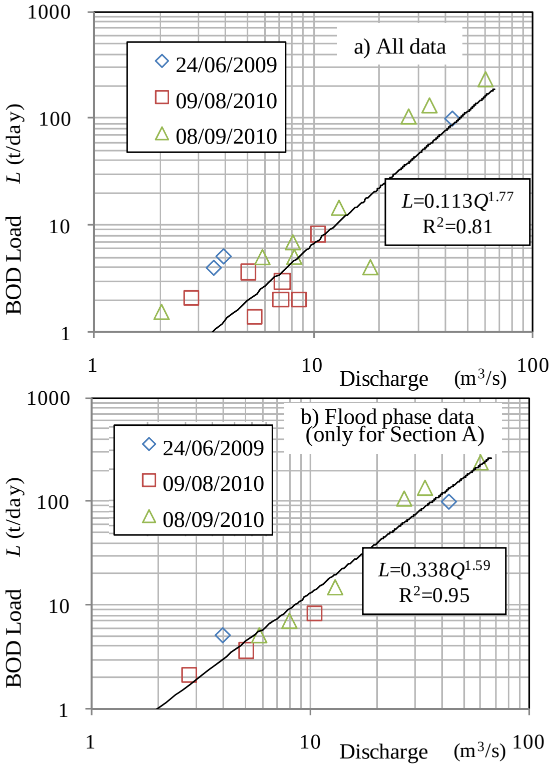

Fig. 2 Relationship between Discharge and BOD Load

The relationship between the discharge Q and pollutant load L is analysed using the L-Q equation ($L = aQ^b$ where a and b are the coefficients). Here, the data for the past storm events at the observation point are also used. Fig. 2 shows the relationship between the discharge and BOD load. When all of the data are plotted as shown in Fig. 2-a), the coefficient of determination (R^2) is high at 0.81 with noticeable scattering in the low discharge range. In contrast, the correlation improves with the R^2 value of 0.95 when only the flood phase data are plotted as shown in Fig. 2-b). When the flood phase data are used, a high level of correlation is also suggested with R^2 values for the COD and SS of 0.96 and 0.94 respectively. This can be explained that the L-Q relationship for Section A is determined only by the load from the upstream with no influence of the load from the downstream (the Sumida River and Tokyo Bay) because the flood water of all layers flows downstream. The analysis also imply that the L-Q equation can well be applicable with high correlation just to the period after the flushing out of the bottom water in the flood phase regardless of the storm magnitude and the sewer deposit amount. To further examine the characteristics of the Kanda River, a comparison is made with coefficients a and b of the L-Q equation concerning the COD load for other rivers reported by Sakai et. al. (2008). The values of coefficients a and b concerning the COD load for the Kanda, Edo, Ara, Tama and Naka Rivers. The value of coefficient a for the Kanda River is much larger than that for the Edo, Tama and the other rivers, indicating the likelihood of a relatively large load being experienced due to small-scale flooding. In the case of coefficient b, its value of 1.54 for Kanda River is larger than 1.24 to 1.35 for the Edo, Ara and Tama Rivers and much larger than 1.12 for the Naka River. These figures suggest that larger flooding may cause a much larger load for the Kanda River than for the other rivers.

4. Conclusions

The study found a high level of L-Q correlation in the period from the flushing out of the bottom water to the point where the discharge becomes zero in the flood phase. Based on this newly confirmed L-Q correlation, the characteristics of urban small rivers where a high level of pollutant loading occurs with small-scale flooding are clearly established.

5. References

Sakai A., Nihei Y., Ehara K., Usuda M., Shigeta K., Ootsuka S. (2008). Nutrient and COD loads in the Edo, Ara, Tama and Naka Rivers under flood flow conditions. In: 52th Conference on Hydraulic Engineering, JSCE, pp.1117-1122.