EVALUATION OF NUTRIENT LOAD OUTFLOW FROM OTO RIVER BASIN

Toyohashi University of Technology, Student Member, Wong Kar Yee
Toyohashi University of Technology, JSCE Member, Takanobu Inoue, Kuriko Yokota

1. Introduction

Recent years, eutrophication has been occurring in closed water area such as bays, lakes or marshes and the improvement of water quality is yet to be progressing. Eutrophication is the ecosystem's response to the unnatural enrichment with two plant nutrients, phosphorus and nitrogen, through detergents, fertilizers or sewage, to an aquatic system.

In order to grasp how to best prevent eutrophication from occurring, specific sources that contribute to nutrient loading must be identified. There are two categories of pollution sources which causes the occurrence of eutrophication. One of the pollution sources is called the point source pollutant. Point source is any single identifiable source of pollution, from which pollutants are discharged, such as a pipe, ditch or factory. Another pollution source is the non point source. Most non point source pollution occurs as a result of runoff. Non point source is difficult to identify and control because pollution comes from many different sources and location. It also varies over time in terms of the water flow and the types of pollutants it contains.

In this study, the Oto River was chosen as the study area. Rising from Mount Hongu, the Oto River flows through mostly forests before flowing into the Mikawa Bay. The purpose of this study is to reveal nutrient load outflow and runoff characteristics in the Oto River basin.

2. Methodology

2.1 Study area

In this paper, Oto River (男川), which is located in Okazaki City, Aichi Prefecture was chosen as the study area. From Mount Hongū, the Oto River flows east in Okazaki City for 17 km before merging with Oto River (乙川) at a confluence, creating the Yahagi River and flows further into the Mikawa Bay. Water samples were collected from the upstream, midstream and downstream of Oto River, 12 tributaries and 2 point sources from Aisin AW Co. effluents and rural wastewater treatment plant effluents. A total of 4 study surveys have been carried (survey 1:18/5/2015, survey 2:24/7/2015, survey 3:26/10/2015 and survey 4:11/9/2015). In order to compare the results under weather conditions, survey 1 and 3 were conducted on fine weather and survey 2 and 4 were conducted on rainy days.

2.2 Analysis methods

Samples analyses were undertaken either on broad or later in laboratory depending on the study field work condition and the necessity of samples. Field measurements for the study field include pH, EC, water temperature, river depth and velocity. Analyses on determination of total nitrogen (TN), dissolved nitrogen (DN), total phosphorus (TP), dissolved phosphorus (DP), biochemical oxygen demand (BOD) and suspended solids (SS) were also carried out.

3. Results and discussions

3.1 Concentrations of TN and TP

The concentrations of TN on survey 2 appeared to be the highest among all the other surveys (Fig. 1). The high concentration was due to the rainfall (total precipitation of 32.5 mm) on the previous days of survey. Survey 4 which was also conducted on rainy weather showed a slightly lower concentration than survey 2. The total precipitation on the previous day of survey 4 and the exact day were respectively 13 mm and 2 mm. The difference of discharge on both days had influenced the concentrations on both surveys. In spite of different weather condition, from downstream to midstream of the Oto River, the Kobe River and Aoki River have slightly higher concentrations of TN. From upstream to midstream of the Oto River, concentrations of water sample taken from Shima River to Iwata/Hiroomote River were generally higher among all other tributaries.

For concentrations of TP, survey 2 appeared to be the highest among all surveys (Fig. 2). The high concentration was due to the rainfall on the previous days of survey. The TP concentration in Otome River in survey 2 appeared to be the highest among all samples and surveys. Generally, concentrations of TP from Kobe River and Iwata/Hiroomote River were slightly higher in all four surveys.

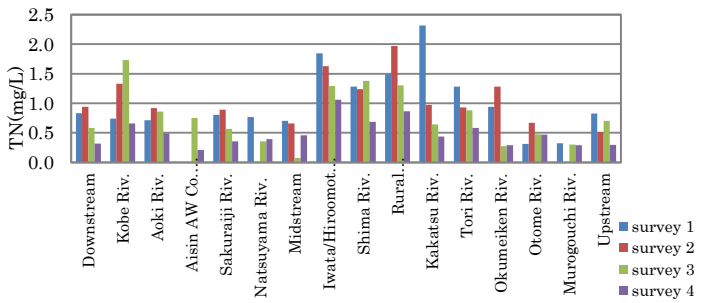


Fig. 1 TN concentrations

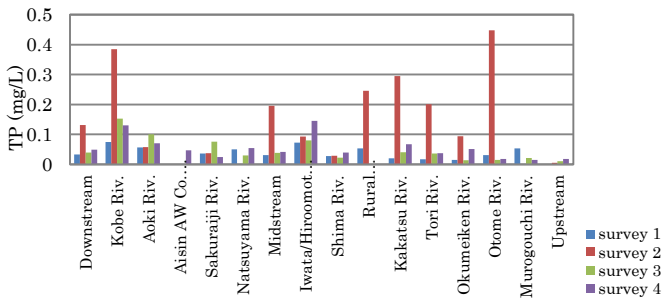
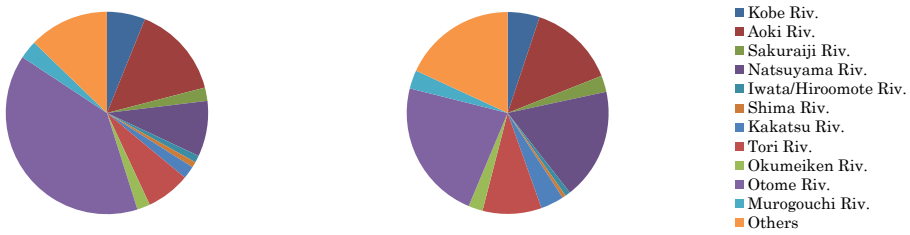


Fig. 2 TP concentrations

3.2 Discharge ratio

Fig. 3 shows the discharge ratio of each tributaries flowing along the Oto River. On the day of survey 2 and 4, high discharge of river water due to rainfall have caused difficulties on measurement of discharge at some sampling sites. Therefore, only results of survey 1 and 3 were used to evaluate discharge ratio during fine weather. In survey 1, the total discharge ratio from all the tributaries was approximately 87%. The maximum of discharge ratio was the outflow discharge from Otome River (39%), followed by Aoki River (15%). The rest of the tributaries generally have less than 10% of discharge ratio. In survey 3, the total discharge ratio of tributaries was approximately 82%. Among all the tributaries, Otome River (23%) was again the maximum and followed by Natsuyama River (18%).



(a) survey 1 (b) survey 3

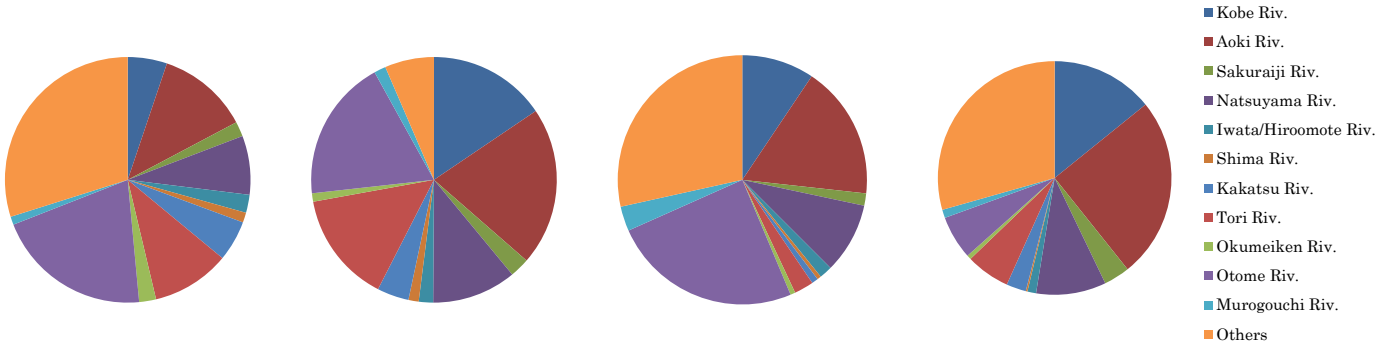
Fig. 3 Discharge ratio

3.3 Nutrient load ratio

As shown in Fig. 4, in survey 1, 70% of TN load ratio was flowed into the downstream of Oto River; in which 30% was the runoff load from unknown sources. The maximum outflow of TN load ratio was from Otome River (21%), followed by Aoki River (12%). In survey 3, total TN load ratio of all tributaries consists of 94%, which was comparatively higher than survey 1.

For TP load ratio in survey 1, 72% of TP load ratio was flowed into the downstream of Oto River; in which 28% was the runoff load from unknown sources. The maximum outflow of TP ratio was from Otome River (25%), followed by Aoki River (17%). The rest of the tributaries generally have less than 10% of TP load ratio. For survey 3, 71% of TP load ratio was flowed into the downstream of Oto River.

TN load ratio of Kobe River and Aoki River were 15% and 21% respectively. However, the discharge ratios of these two tributaries were much smaller than the TN load ratios, which are 5% and 14% respectively. Besides that, the values TP load ratio of Kobe River and Aoki River, 14% and 25% respectively were again clearly larger than the values of discharge ratios of these two tributaries. Therefore, it is suggested that nutrient load outflow from these two tributaries may have a significant influence to the Oto River basin.



(a) TN load (survey 1) (b) TN load (survey 3) (c) TP load (survey 1) (d) TP load (survey 3)

Fig. 4 Nutrient load ratio

4. Summary

In this study, the Oto River was chosen as the study area. In order to reveal nutrient load outflow runoff characteristics in the Otogawa River basin, water sampling surveys and analyses have been carried out. Below are the results obtained:

(1) The concentrations of nitrogen and phosphorus analyzed from river waters flowing at the Iwata/Hiromoto River region were relatively higher.

(2) Tributaries with higher discharge of river water have resulted in higher amount of nutrient load; even thou the concentrations of nutrients were not comparatively high.

(3) The Otome River has the maximum discharge ratio among all the tributaries which was ranged from 23% to 39%.

(4) Nutrient load ratios of the Kobe River and Aoki River were higher than the discharge ratios of both tributaries. Therefore it is suggested that nutrient load outflow from these two tributaries may have a significant influence to the Oto River.