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EUTROPHICATION RELATED WATER QUALITY IN UPSTREAM OF HUN RIVER AROUND FARMLAND

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Abstract

Hun river is one of the most important rivers that flow into Dahuofang reservoir. Water quality of the river affects the ecological health, environmental safety and eutrophication status of Dahuofang reservoir. Total nitrogen (TN), total phosphorus (TP) and ammonia nitrogen (NH_4^+-N) concentrations in the water were measured for July, August and September, 2015 at three different sites in the riparian upstream of the Hun river. The TN concentration varied from 1.06 - 2.52 mg/l, NH_4^+-N ranged from 0.15 - 0.69 mg/l, while TP range from 0.07 - 0.20 mg/l. There were significantly higher TN and NH_4^+-N concentrations in August than those in July and September. This showed that the water quality would be worse in the rainy months than that of drought months. The data provided a theoretical guidance to prevent eutrophication and improve the water quality.

Introduction

Eutrophication is a widespread and increasing problem in water resources all over the world (Bennett *et al*. 2001, Pizarro *et al*. 2016). Agricultural non-point source pollution keeps the largest global contributor to surface water eutrophication (Corwin *et al*. 1997, Dabrowski *et al*. 2002). The riparian zone plays an important role in receiving and retaining nutrient inputs from farmland. These inputs could indirectly lead to river eutrophication (Giese *et al*. 2003, McClain *et al*. 2003).

Nitrogen and phosphorus are usually the main limiting factor leading to eutrophication of water bodies (Howarth and Marino 2006, Vass *et al*. 2015). In urban areas, nutrient pollution could be reduced from point and non-point sources (Kaushal *et al*. 2011, Ma *et al*. 2011). In recent years, urban river water quality is deteriorating due to non-point source pollutants from agricultural activity. With the development of the social economy, the phenomenon of eutrophication turns gradually serious. Eutrophication changes the physico-chemical quality of water (Li *et al*. 2010), makes water odorous, reduces transparency to sunlight, dissolved oxygen drops and toxic substances release, destroys ecological balance and brings harm to human health (Peñuelas *et al*. 2012).

With the increasing anthropogenic activities, the water quality of Hun river is strongly affected. At upstream of Hun river, a large amount of nitrogen and phosphorus flow from agricultural production runoff is poured into the river. The situation aggravates during rain. This directly leads eutrophication and water quality deterioration (Hooda *et al*. 2000).

To control the eutrophication of Dahuofang reservoir it is necessary to take measures to reduce the non-point source of pollution of Hun river. Therefore, the specific objectives of the present study were to quantify the spatial and temporal variation of water quality of Hun river and to identify the main driving factors for causing eutrophication in the downstream. To provide a theoretical guidance in order to reduce the pollutants of the river and improve the water quality and safety of Dahuofang reservoir, water quality variables like total nitrogen (TN), total phosphorus (TP) and ammonia nitrogen (NH_4^+-N) concentrations were analyzed.

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Materials and Methods

The study site is situated in the upstream of Dahuofang reservoir in Fushun, Liaoning province, China (124.46°E, 41.99°N, at an altitude of 126 m above MSL). This area is mainly affected by warm-temperate continental monsoon climate. The mean annual temperature is 5.3°C. Extremes have ranged from −37.6 to 37.2°C. Mean annual precipitation is about 806 mm. In 2015, July and September were drought months, while August was rainy month.

For collecting water samples, three permanent stations were set up in the upstream of Hun river. The stations are, here in after, designated as Site-1, Site-2 and Site-3 (Fig. 1). Water samples for analysis were collected in triplicate from each study site (different depth water mix) in each week of July, August and September. The water samples were preserved by adding H_2SO_4 to make the pH lower than 2 and stored in jars prior to laboratory analyses (Lu 1999).

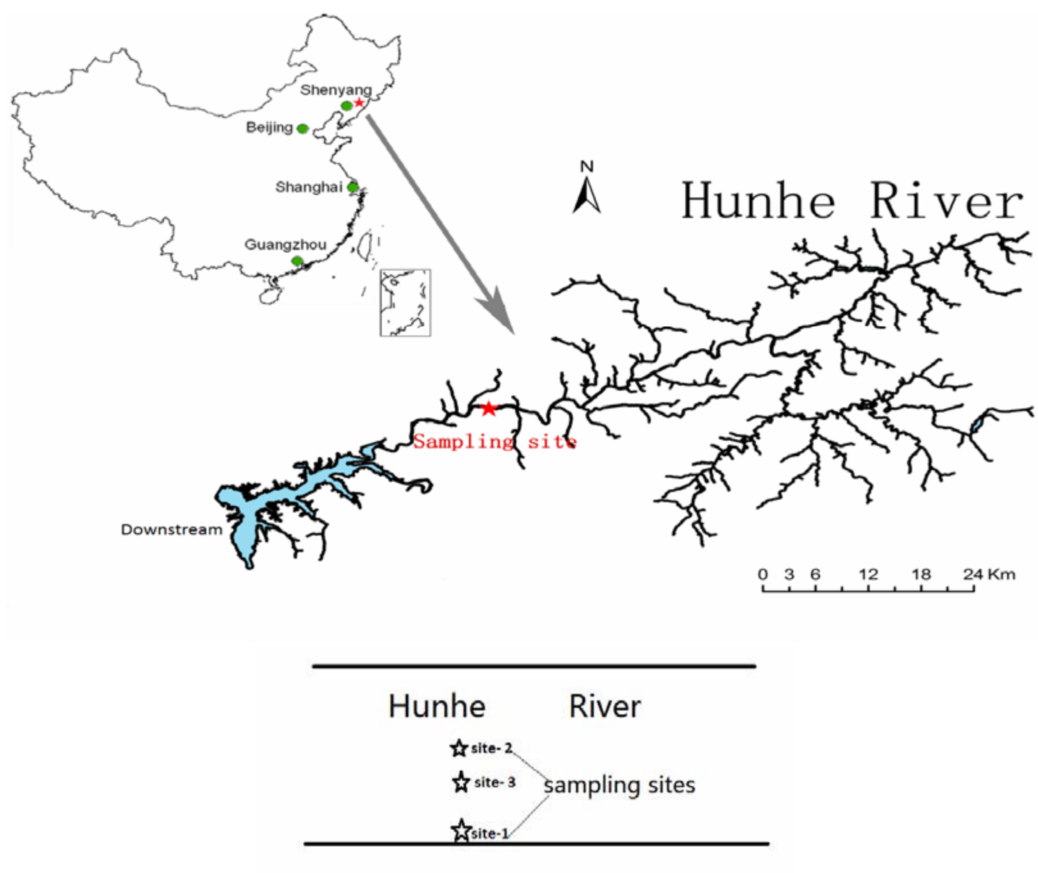

Fig. 1. Location map of the sampling sites.

TN was analyzed by alkalinc potassium persulfate digestion method (GB 11894-89), Nessler's Reagent Spectrophotometry (GB 7479-87) was used for measuring NH_4^+-N and TP was determined by ammonium molybdate method. The extinctions were measured by using a spectrophotometer (GB 11893-89, SHIMADZU UV800, Japan).

Mean values and standard deviations (Sd) were calculated by using Microsoft Office Excel 2007 for all the data. Statistical analysis was carried out by using SPSS (Version 16.0, SPSS Inc., 2007). Standard one-way analyses of variance (ANOVA) were used to test significant differences among three sites. Duncan multiple range test (DMRT) was performed to see the variation in TN, TP and NH_4^+-N of different months and sampling sites. The significant difference was set at $p < 0.05$. All data were presented as mean ± Sd.

Results and Discussion

The TN concentration ranged between 1.0638 and 2.5198 mg/l, NH_4^+-N ranged from 0.15 to 0.69 mg/l, while TP range was 0.07 - 0.20 mg/l. This value was much lower than the value observed in 2008 (Zhao *et al*. 2010).The results showed that the pollution at Hun river was severe. The rank of water quality at all monitoring site were between III and IV grade (GB 3838 - 2002). Understanding the nature of element distributions in surface water, and the reasons of increasing concentrations, are the most urgent areas of environmental research.

Results from DMRT showed that samples in the same month but belong to different sites had significant difference with respect to TN, TP and NH_4^+-N concentration. A regular trend of site-2 > site-3 > site-1 existed (Fig. 2).

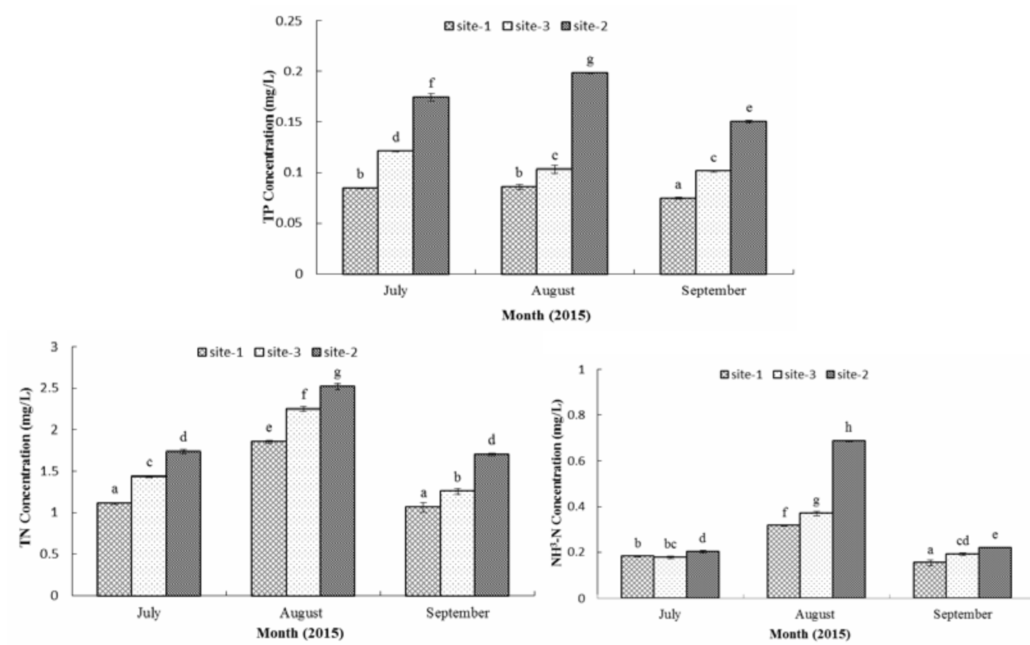

Fig. 2. The mean TN, TP and NH_4^+-N concentrations in three months (July, August and September) at different sampling sites. Error bars denote 95% confidence intervals (n = 3). a, b, c, d, e, f, g and h in the same plot indicate the significance different at $p < 0.05$.

According to the analysis, it was found that the TN, TP and NH_4^+-N concentrations in the different months were quite variable. There was a significantly higher TN ($p < 0.05$), TP ($p < 0.05$) and NH_4^+-N ($p < 0.05$) concentrations in August than in July and September at all sampling sites, except TP at site-3 (Fig. 2). This was mainly caused by rain wash in the rainy month -

August. Pollutions run into river with raining and cause the twice environment pollution (Li *et al*. 2008, Vidon 2010). The main pollution factors at study sites were NH_4^+-N, N and P from the agricultural non-point source pollution (Zhu *et al*. 2011).

In the present study, it was observed that, the river water is loaded with inputs from rainwater, ice melt, snow melt, lake water, swamp and groundwater recharges. Those rainfalls have been serving as the principal source (He *et al*. 2015). Allowing urbanization and lacking sewage treatment plants in the study area, rainfall brings all the washouts from domestic and agricultural establishments into the river causing a relatively higher ammonia-nitrogen concentration (Zhang *et al*. 2015). During the rainy season, and the NO_3-N concentration also reaches its maximum. It is attributable to the fact that there is direct relationship between the rainfalls the types of nutrients flowing into the water (Li *et al*. 2015).

There is too much farmland in upstream of Hun river. This contributes the most pollutants into the river taken by the surface runoff in rainy seasons. Measurements should be taken to prevent agricultural non-point pollution from the water. Ecological ditch system with interception function and reconstruction of riparian forests have been recommended to control the intensity of eutrophication in the study area.

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