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Short communication

Characteristics of a landscape water with high salinity in a coastal city of China and measures for eutrophication control

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ABSTRACT

Eutrophication of landscape waters is drawing public concerns in China but few studies have been conducted on the problem associated with high water salinity as what happens at Sino-Singapore Tianjin Eco-city in Tianjin, a coastal metropolis of northern China. In order to find ways for eutrophication control, a comparative study was conducted on three landscape water bodies, namely Qingjing Lake, Jiyun River and Jiyun River Oxbow, which are under varied conditions of salinity, organic, and nutrients intrusion. The spatial and temporal variations of water quality were revealed by water sampling and analyses, and correlative relationships were obtained between water salinity and other parameters related to eutrophication. By utilizing a trophic level index (TLI), the eutrophication status of the three landscape water bodies in different seasons could further be evaluated. As a result, water temperature, as expected, showed the strongest effect on eutrophication because higher TLI together with higher Chl-a concentrations tended to occur in later spring and summer seasons, while nutrient concentration, especially TP, was also the determinative factor to the eutrophication status. Of the three water bodies, the Jiyun River Oxbow showed a salinity as high as 20 g/L or more in contrast with the other two water bodies with salinity as 4–5 g/L. Although its TP concentration was usually very low (about 0.1 mg/L), it was under a moderate eutrophication status almost in all seasons, indicating that high salinity tends to induce alga growth. Dilution of saline inflow and nutrients reduction could thus be proposed as the main measures for eutrophication control of landscape waters in the study area.

1. Introduction

With the rapid development of economy and the improvement in people's living standards, more and more attentions have been paid on the urban ecological environment improvement. Construction and/or restoration of landscape waters are often an important part of urban water elements, not only for beautifying the urban environment, but also providing ecological oxygen sources and atmospheric humidity to the urban zone. Landscape water plays an important role in regulating precipitation, supplementing water resource, reducing the heat island effect, and enhancing the human power against disasters and plagues. Because most of the urban landscape waters are enclosed or semi-enclosed water bodies, their self-purification capacity is weak. When the water bodies receive excessive nutrients, eutrophication may easily happen (Chen et al., 2013; Henny and Meutia, 2014). Impairment of water quality due to eutrophication can lead to a series of problems and result in losses of ecological integrity, sustainability and safe use of aquatic ecosystems (Yu et al., 2014). Although eutrophication of landscape waters has been widely and intensively studied for several decades ((Istvánovics, 2009; Liu et al., 2014), few experiences have been gained on eutrophication control associated with high water salinity, as what often happens in coastal cities, because salinity may also be an indicator of trophic conditions (Gasiūnaitė et al., 2005).

In the northern coastal metropolis, Tianjin, the Sino-Singapore Tianjin Eco-city has been under construction in the coastal zone of the Bohai Sea. An important component of the eco-city construction is the restoration of a water area mainly consisting of three closed or semi-closed water bodies. Due to the limited catchment area and very low rainfall in these regions, these water bodies cannot be well replenished and increasing water salinity is a problem under concern. In order to find ways to cope with the current problem and envisaged problem in the future, a comparative study was conducted on the water quality and eutrophication status of the three water bodies. Attention was paid on the influence of water salinity on eutrophication and the possible measures for eutrophication control.

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2. Materials and methodology

2.1. Study area

Sino-Singapore Taijin Eco-city (N 39°5′14″–39°8′45″, E 117°43′34″–117°46′48″) is located in Tianjin Binhai New Area, which is only 1 km away from the Bohai Sea coastline. Qingjing Lake and Jiyun River, as important parts of Sino-Singapore Eco-city's surface water system, are the typical landscape waters under the influence of saline intrusion in China. The Qingjing Lake is with about 1.1 km^2 water surface and on average about 2 m in depth, and the Jiyun River Oxbow is with a water surface of 2.88 km^2 and an average depth about 2.3 m. At present, Jiyun River Oxbow is a closed water body, and Qingjing Lake is a semi-closed water body. A tidal gate has been installed to separate the Jiyun River Oxbow from another water body at its upstream, which is the Jiyun River as a closed water body in most time throughout the year. In addition to the occasional rainfall, these water bodies receive limited supplemental source on 'as needed' basis from sea water desalination and a reservoir.

2.2. Sample collection and analyses

As shown in Fig. 1, 7 sampling points were selected for collecting water samples from these landscape waters, 1 for Jiyun River Oxbow, 4 for Qingjing River, and 2 for Jiyun River. Monthly water quality monitoring was conducted from November 2013 to June 2014 regarding TP using molybdenum antimony spectrophotometry, TN using alkaline potassium persulfate digestion UV spectrophotometry, Chl-a using acetone extraction spectrophotometry, water transparency using a Plug's disk, COD using permanganate method and BOD_5 using dilution and inoculation method. Portable instruments were also used for measuring conductivity, TDS, pH and temperature. Correlation analysis was conducted by using SPSS 17.0 software.

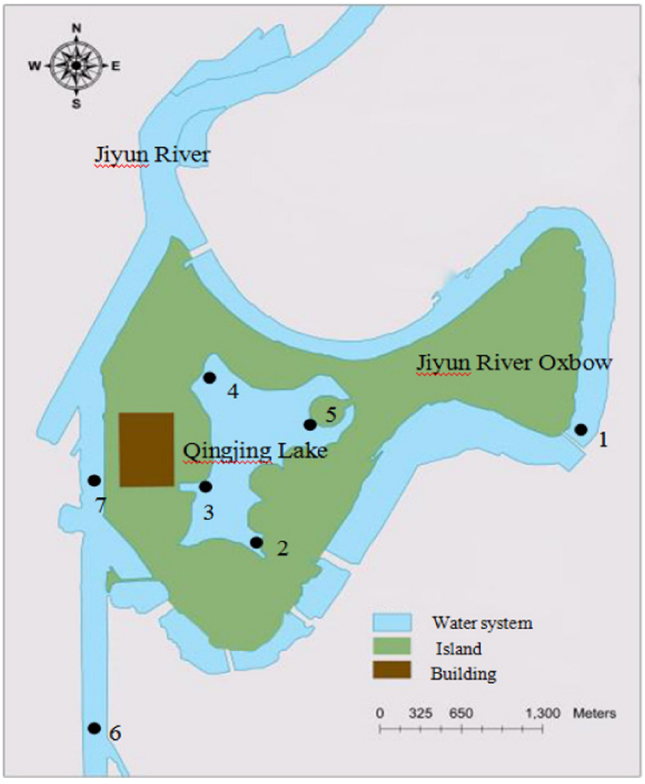

Fig. 1. Location map of the sampling points.

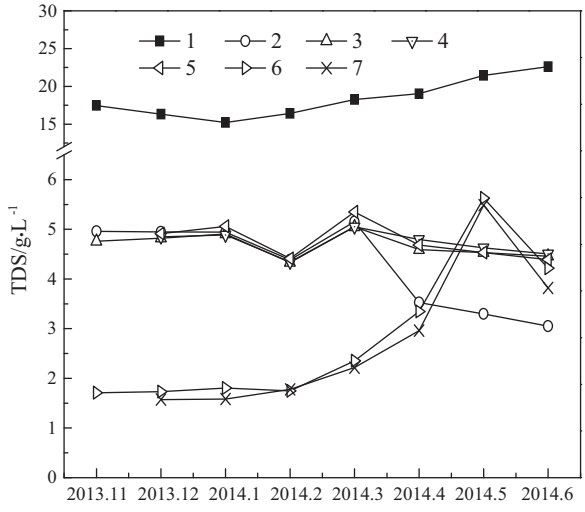

Fig. 2. Spatial and temporal variation of TDS content.

3. Spatial and temporal variation of water quality

3.1. Variations of water salinity

Because the study area is located in the Binhai New Area and the salinity is high in the soil, the salt content in the landscape waters is high as well (Xiao-wen et al., 2013). As shown in Fig. 2, Jiyun River Oxbow showed the highest TDS content, ranging from 15.19 to 22.59 g/L, which was mainly due to the tidal intrusion, resulting in salt accumulation in water and soil of the oxbow. The TDS content of Qingjing Lake was much lower, ranging from 4.33 to 5.53 g/L and with unobvious seasonal variation, which was due to the replenishment using desalinated water, resulting in effective salinity reduction in water and soil. The TDS content of Jiyun River varied between 1.62 and 5.56 g/L, tended to increase after winter and early spring, and reached the peak in May. The intrusion of high salinity water from downstream side through the gate was the reason for the TDS increase.

3.2. Variation of TN and TP

As shown in Fig. 3, the TN content of Jiyun River was higher than that of Jiyun River Oxbow and Qingjing Lake. For Jiyun River, the TN concentration varied with time and two peaks appeared in January

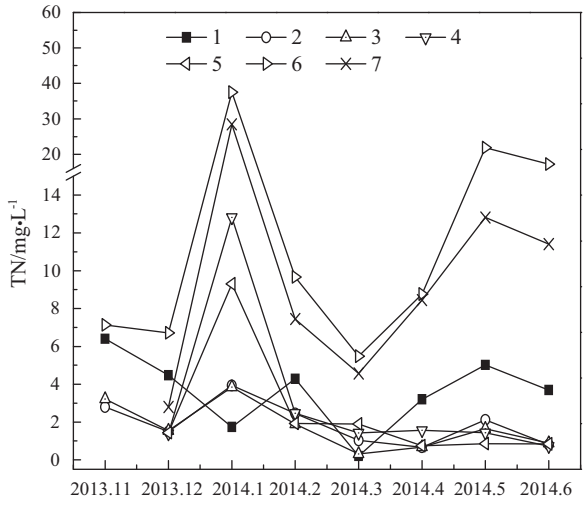

Fig. 3. Spatial and temporal variation of TN content.