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Distribution and loadings of polycyclic aromatic hydrocarbons in the Xijiang River in Guangdong, South China

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Abstract

The Xijiang River is the major tributary of the Pearl River, South China, and is the major source water system for more than 4.5 million of urban population and 28.7 million of rural population. We initiated a systematic study on detection and quantification of organic pollutants in both water and suspended particulate matter (SPM) for samples collected in a span of 12 months. Our results showed that total concentrations of 15 polycyclic aromatic hydrocarbons (PAHs) varied from 21.7 to 138 ng l^{-1} in water and from 40.9 to 665 μg kg^{-1} in SPM. The organic carbon normalized distribution coefficients (K_{OC}) computed for the PAHs were correlated well with their octanol–water partition coefficient (K_{OW}). The estimated annual loadings of Ant, B*a*A, and B*ghi*P and the total PAHs in the Xijiang River were 1620, 330, 177 and 19400 kg, respectively. Further analysis of the data showed that combustion may be the major source of PAHs and that direct leakage of petroleum products may be insignificant.

Keywords: PAHs; Water; SPM; K_{OC}; The Xijiang River; China

1. Introduction

The rapid deterioration of air and water quality due to fast economic growth and lack of rigorous and effective environmental regulations has raised great concerns from the public and the regulators in China. Many local governments have set up goals of "blue sky", "clear water", and "green open space" for their "window dressing" developmental programs. One pressing environmental issue that is far beyond the aesthetic standards the local government officials are now concentrating on is the pollution of source water by micropollutants via loosely regulated industrial, agricultural and domestic activities. This is largely because many water utility companies in China can not afford advanced technologies for addressing trace-level contamination of organic and inorganic chemicals. Companies supplying water to smaller cities with population under a million often may not have sophisticated analytical capabilities for monitoring micropollutants in both source water and treated water. Inventory survey on major source water systems for micropollutants is highly needed in order to establish stringent environmental regulations and to improve infrastructures for treating and protecting drinking water for Chinese citizens.

The study presented in this paper is a part of an ongoing research program funded by the National Natural Science Foundation of China for addressing water quality issues in Guangdong Province of South China. Being adjacent to Hongkong, Guangdong has enjoyed the fastest growth of economy due to large and steady influx of capitals from Hongkong over the past twenty five years. However, its natural environments in many places have been adversely impacted. The goal of our ongoing project is to provide

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background information on environmental pollution of the source water systems for the City of Guangzhou, the largest city in Guangdong. This study focused on the Xijiang River, the major tributary of the Pearl River—the third longest river in China. The Xijiang River flows throughout Yunnan, Guizhou, Guangxi, Guangdong Provinces. It joins the other two major tributaries of the Pearl River at Sanshui of Guangdong Province, and enters the Pacific Ocean near Hongkong. Geographically, the Xijiang River Basin is located in the south tropical and semitropical area. The mean temperature and rainfall over the last two decades varied from 14 to 22 °C and from 1200 to 2200 mm, respectively. The hydrology of the Xijiang River is characterized by well-defined dry period from October to March and a flooding season from April to September. In the flooding season, the water discharge accounts for 72–88% of annual runoff and the outflow tends to dominate and the suspended particulate matter (SPM) maximum can be formed. The basin covers a catchment area of 350 000 km^2, about 78% of the total area of the Pearl River. The Xijiang River is currently the major source water for several major cities with a total urban population of about 4.5 millions. It also serves as the major drinking water supply and source water for agricultural and industrial activities in 86 counties with a total population of 28.7 millions. The results of our research program will be used for future planning of urbanization and industrialization that could help protect water quality of the Xijiang River. The study will provide important information for decision making on utility infrastructure improvement in water companies located in both the upstream and downstream of the Xijiang River.

This paper summarized the results on the distribution and loadings of polycyclic aromatic hydrocarbons (PAHs) in the Xijiang River. PAHs are among the most carcinogenic, mutagenic and toxic contaminates found in aquatic systems (Kennish, 1992). They are also among the so-called persistent organic pollutants, some of which are classified as priority pollutants by both the US EPA and the European community. Their distributions in aquatic environments and potential human health risks have become foci of water quality research (Keith and Telliard, 1979; Clean Water Act, 1993). PAHs are introduced into the environment mainly by means of incomplete combustion of organic matter in natural and anthropogenic processes. The sources of PAHs include automobile exhaust and tire degradation, industrial emissions from catalytic cracking, air-blowing of asphalt, coal coking, domestic heating emissions from coal, oil, and wood, waste incineration and biomass burning (Nikolaou et al., 1984; Baek et al., 1991; Manoli et al., 2000). Direct incidental release or leakage of oil and oil products may also contribute to the total PAH burden (Simpson et al., 1996; Fernandes et al., 1997).

Our working objectives were to examine seasonal and depth variations of PAH concentrations in both SPM and water, to evaluate possible sources of PAHs, and to estimate the total loading of PAHs from the Xijiang River to the Pearl River.

2. Materials and methods

2.1. Sample collection

Water samples were collected between August 2003 and July 2004 at the Gaoyao Hydrological Station of the Xijiang River (Fig. 1). We chose this station as our sampling site simply because it is most downstream hydrological station away from the influence of sea tide. During each sam-

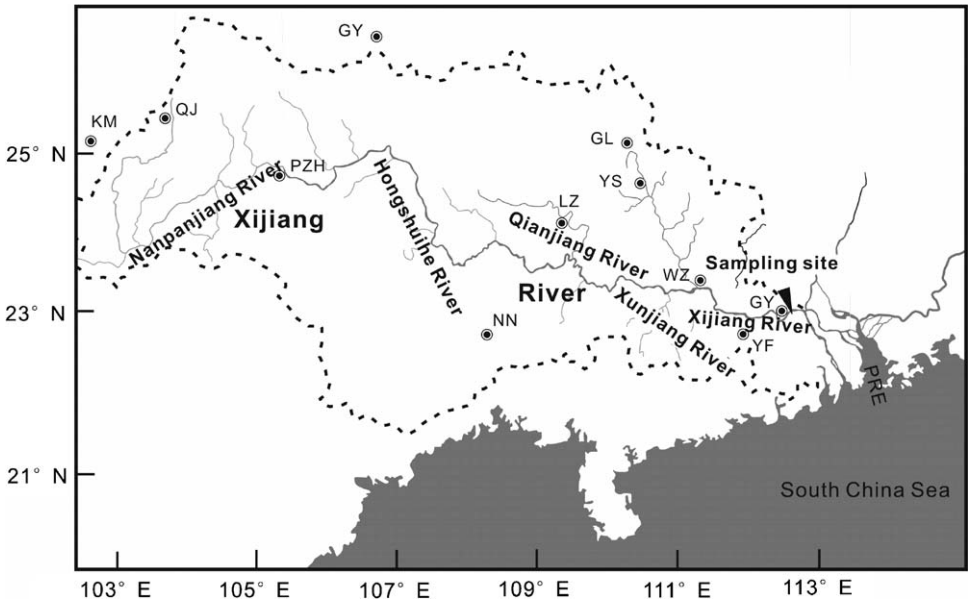

Fig. 1. The study area and the sampling location. QJ: Qujing, KM: Kunming, PZH: Panzhihua, GY: Guiyang, NN: Nanning, LZ: Liuzhou, GL: Guilin, YS: Yangshuo, WZ: Wuzhou, YF: Yunfu, GY: Gaoyao, PRE: Pearl River Estuary; ▶: sampling site.