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GREENHOUSE GAS EMISSION

Greenhouse Gas Emissions from Sewage Treatment in China during 2000–2009

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Abstract

Based on the statistics from the *China Statistical Yearbook* (2000–2009) on environment and methods recommended by the IPCC, the amounts of greenhouse gas (GHG) emissions from domestic and industrial sewage treatment in China are estimated for the period of 2003–2009. CO_2 emissions per capita from sewage treatment plants are also analyzed. The results show that the GHG emissions from sewage treatment plants increased steadily from 2003 to 2009; N_2O emissions from domestic sewage are the major source of the total GHG emissions from domestic sewage; CH_4 emissions from domestic sewage increase with the greatest speed; CH_4 emissions from paper and pulp industry are the major source of industrial sewage emissions; CO_2 emissions per capita increase constantly from 2003 to 2009.

Keywords: sewage treatment; CH_4; N_2O; emissions

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1 Introduction

According to the IPCC Fouth Assessment Report [*IPCC*, 2007], the rising greenhouse gas (GHG) concentration in the atmosphere is one of the major causes of global warming [*Qin et al.*, 2007]. Sewage treatment plants are one of the significant sources of GHG emissions [*Sahely et al.*, 2006]. Sewage treatment includes both industrial and domestic sewage treatment. During the sewage treatment, the anaerobic process produces CH_4 while nitrogen removal produces N_2O. Both CH_4 and N_2O are chemically stable and can stay in the atmosphere for a long period. The Global Warming Potential (GWP) for the 100-year scale of CH_4 and N_2O are 21 and 310, respectively [*IPCC*, 1996], thus their emissions can have a lasting impact on climate [*IPCC*, 2007]. CO_2 emissions from sewage are not considered in the *IPCC* [2006], because these are from biogenic origin and should not be included in national total emissions calculations.

Urban sewage disposal in China is great in volume, highly concentrated and widely distributed [*Xie and Wang*, 2012]. In recent years, as China becomes more conscious about environment protection and energy conservation, the number of urban sewage treatment plants as well as sewage treatment capacity is increasing. In 2008, there were 1,692 urban sewage treatment plants in China, 434 more than the previo-

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us year. Generally 57.4% of urban domestic sewage in 2008 is processed, representing an 8.3% increase compared to 2007 [*MEPC*, 2010]. The growing number of sewage treatment plants inevitably leads to high GHG emissions, posing a significant challenge to managing GHG emissions in the sewage treatment sector. So far, there is little research on GHG emissions by sewage treatment plants in China, with the exception of the *NCCC and NDRC* [2007].

In this paper, the authors estimate GHG emissions from sewage treatment plants (CH_4 and N_2O from domestic sewage, and CH_4 from industrial sewage) based on the methodology outlined in the *IPCC* [2000; 2006], which are catered to actual conditions in China [*Gao et al.*, 2006]. In addition, the authors discuss the change in CO_2 emissions per capita of sewage treatment plants. We believe it will help us to understand the current state of GHG emissions from sewage treatment plants and provide insight on reducing GHG emissions.

2 Data and methods

2.1 *Data*

The amounts of organic matter removed from sewage and the national population are taken from the *China Statistical Yearbook on Environment* [*MEPC*, 2000–2009] and *China Statistical Yearbook* [*NBSC*, 1995–2010], respectively. The protein consumption per capita is quoted from the UN *FAO* [2010]. The parameters used in estimating GHG emissions primarily refer to the *IPCC* [2006] and related literatures [*Yang et al.*, 2005; *Tang et al.*, 2001; *Cao*, 2009; *Song et al.*, 2012].

2.2 *Method to estimate CH_4 emissions from domestic sewage*

It is good practice to use default values of emissions factors and activity parameters to calculate the amount of emissions for countries with limited data [*IPCC*, 2006]. Due to the lack of research on factors and parameters of GHG emissions from the sewage treatment sector in China, the authors generally used default values suggested by the IPCC. The amount of CH_4 emissions is a function of the amount of sewage and the CH_4 emissions factor. Any recycled CH_4 should be excluded from the total emissions amount. The simplified formula for calculating CH_4 emissions from sewage treatment is shown as below:

$$E_{CH_4} = \mathrm{TOW} \cdot \mathrm{EF} - R, \tag{1}$$

where E_{CH_4} is the annual CH_4 emissions (in Gg), TOW denotes the total amount of organic matter contained in domestic sewage in a given year (in kg). Since domestic sewage is rarely treated in rural China, we only consider domestic sewage treatment in the urban area. The amount of organic matter in domestic sewage is the product of the amount of chemical oxygen demand (COD) removed from urban sewage (Fig. 1) multiplying by a national average BOD/COD of 0.45 [*Song et al.*, 2012]. EF is the emissions factor, which in this paper has a China-specific value of 0.14 [*Song et al.*, 2012]. R is the amount of CH_4 (in kg) recycled in a given year. Since China has not initiated CH_4 recycling on a large scale, the default value is 0.

2.3 *Method to estimate CH_4 emissions from industrial sewage*

Large amounts of CH_4 are emitted by the industrial sector when industrial sewage, containing high concentration of organic matter, is processed under anaerobic conditions. For calculating CH_4 emissions originating from industrial sewage, we need to first identify sectors that are capable of producing a large

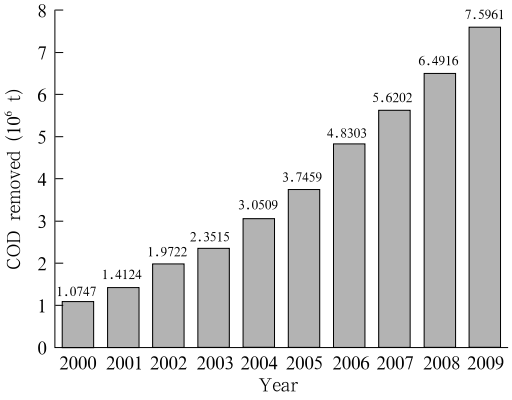

Figure 1 Quantity of COD removed from urban sewage from 2000 to 2009 [*MEPC*, 2000–2009]