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Review

Evolution analysis of environmental standards: Effectiveness on air pollutant emissions reduction

Xueliang Yuan [a, 1], Mofan Zhang [a], Qingsong Wang [a, *, 1], Yutao Wang [b], Jian Zuo [c]

[a] School of Energy and Power Engineering, Shandong University, Jinan 250061, China
[b] Department of Environmental Science and Engineering, Fudan University, Shanghai 200433, China
[c] School of Architecture & Built Environment, The University of Adelaide, SA 5005, Australia

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ABSTRACT

Environmental standards play a critical role in the environmental protection policy landscape in China. Emission standards have significant impacts on the environmental management, especially on controlling the pollutant emissions and reducing environmental risks. The evolution and improvement of the air pollutants emission standards were critically analyzed, which focus on thermal power plant atmospheric pollutants emission standards, boiler air pollutant emission standards and atmospheric pollutants integrated emission standard. According to the different versions of the Atmospheric Pollutant Emission Standard of Thermal Power Plants, a case study was carried out in Shandong Province, China. Data was quantitatively analyzed to examine the effectiveness of environmental standards on pollutants emission reduction. The results showed that each amendment to the standard has a significant reduction effect on the discharge of pollutants. In Shandong Province, the emission coefficients of sulfur dioxide and soot (dust) in 2013 was only 15.9% and 11.6% of the 1993 level. This research provides a theoretical and practical reference for the formulation or revision of the environmental standards, especially for the developing countries.

Contents

1. Introduction

China has gained rapid economic growth in last decades

* Corresponding author.
E-mail address: wqs@sdu.edu.cn (Q. Wang).
[1] These authors contributed equally to this work.

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whereas the environmental pressure is gradually increasing (Lyu et al., 2016). Economic achievements was at the expenses of significant environmental damage in China (Wang et al., 2017). Economic growth model of "high input, high consumption, and high pollution" presents massive pressure to the environment, which leads to the emissions of main pollutants have exceeded the environmental carrying capacity (Lu et al., 2016). In 2015, 338 municipal cities and provinces in China are monitored according to the new Environmental Air Quality Standard. Only 73 cities achieved the target in terms of the number of days with acceptable air quality (Ministry of Environmental National Bureau of StatisticsMinistry of Environmental Protection, 2015).

Atmospheric pollution is detrimental to the ecological environment and human health (Yuan et al., 2015a,b). With the growing level of industrialization, the biodiversity of the ecosystem is reducing at an unprecedented speed (Wu, 2006). Air pollution is recognized as one of the critical factors for the reduction of biological diversity (Rai, 2016). It also showed that air pollution would affect the forest ecosystem (Selmi et al., 2016). Sicard et al. discovered that the destruction of forest ecosystem resulting in drought conditions and inherit genetic responses (Sicard et al., 2016). Air pollution also presents significant challenges to the human health (Forbes and Garland, 2016). With the growing haze occurrence and more extreme weather events happen (Ma et al., 2016), human health will be badly influenced by the air pollution (Zeng et al., 2017). Taj et al. found that air pollutants had a significant impact on the number of emergency visits and hospital admissions in Sweden (Taj et al. 2016). The increased industrial sulfur dioxide emissions in some Chinese cities led to the increase of lung cancer patients by 3.5% and respiratory disease mortality by 3%. Due to air pollution, the average annual cost of medical care and treatment of diseases exceeded 200 billion RMB, with nearly 100 thousand casualties each year (Chen et al., 2016). As a global issue, many countries have remarkable achievements regards to pollutants control. In the European Union, the emission of sulfur oxides, nitrogen oxides and fine particulate matter in 2014 decreased by 51%, 80% and 36% compared to the level of 1990 (European Environmental Agency, 2016). During 2005–2010, the emissions of SO_2 and PM2.5 in East Asia decreased by 15% and 12% (Wang et al., 2014). In 2014, emission levels of SOx, NOx and PM2.5 were 63%, 33% and 9% lower than in 1990 in Canada (Environmental and Climate Change Canada, 2016).

There are three control targets for air pollution in China, i.e. sulfur dioxide, soot (dust) and nitrogen oxides. As shown in Fig. 1, the emissions of these three kinds of pollutants fluctuated in the last decade. Sulfur dioxide emissions reached a peak of 25.888 Mt in 2006, followed by a steady decrease to 18.591 Mt in 2015. Soot (dust) emissions reached a peak of 27.74 Mt in 1998. Except the rebound in 2014, soot emission showed a general descending trend. Emissions of nitrogen oxides are documented in statistical yearbook since 2006. In 2011, emissions of nitrogen oxides reached the peak of 24.043 Mt. Then it declined to 18.51 Mt in 2015. Excessive discharge of air pollutants is detrimental to the quality of atmospheric environment. The acid rain area in China has reached 729,000 km^2 in 2015, accounting for 7.6% of the total land area (Fig. 2) (Ministry of Environmental Protection, 2016). Acid rain pollution was mainly distributed in the southeast coastal areas, which are also featured with high energy consumption, high urbanization level and economically developed.

As an effective environmental management system, environmental standards play an important role in controlling pollutants discharge as well as improving environmental quality (Smith and Wigley, 2006). The approaches used for setting air quality

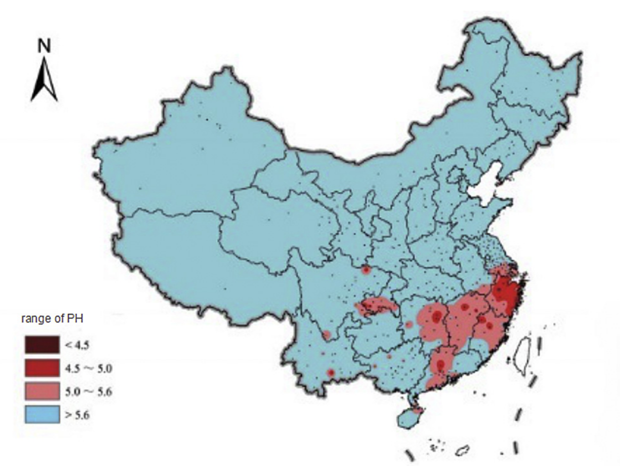

Fig. 2. Distribution of acid rain area in China in 2015.
Source: Ministry of Environmental Protection, 2016

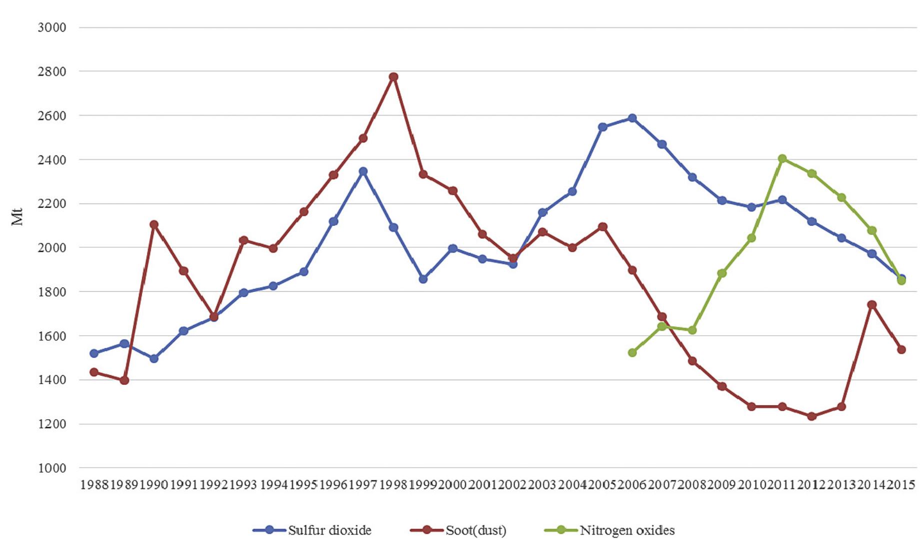

Fig. 1. Air pollutants emissions in China from 1988 to 2015.
Source: Ministry of Environmental Protection; National Bureau of Statistics, 2016).