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A review on China's pollutant emissions reduction assessment

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ABSTRACT

China's initiative on pollutant emissions reduction has attracted global attentions. Sustainability responsibilities endorsed by the Chinese central government indicate that pollutant emissions reduction should be one of the top priorities. This paper aims to review the performance changes during different five-year plan stages for emission control, address the major issues and identify options for the future improvement of China's pollutant emissions reduction. The temporal changing of controlled pollutants during variously five-year planning periods was analyzed firstly, followed by policy recommendations including reforming the environmental data system to improve data reliability, perfecting a market-oriented emission trading system toward reducing social costs, promoting investment, and approaching co-benefits for policy integration.

1. Introduction

As the world's most populous country, China's environmental issues began to attract global attention even in early 1980s (Sun, 1983). Thanks to the rapid industrialization and urbanization, China is now the world's second largest economy. However, such a rapid development leads China to become the largest overall greenhouse gas emitter (Guan et al., 2012; Peters et al., 2010). Meanwhile, the intense economic activity has also brought many other challenges, such as air and water pollution, soil erosion, sandstorm, biodiversity loss, solid wastes, acid rain, etc. (Geng et al., 2012a; Xue et al., 2010a; Matus et al., 2012). These negative environmental impacts are affecting China's long-term sustainability (Liu, 2010). For instance, air, water, and soil quality in many Chinese cities exceeds both national standards and international guidelines (Millman et al., 2008; Schreifels et al., 2012; Su et al., 2013). Another example is that in 2006 the total economic loss of the health effects from PM_{10} (*particulate matter whose diameter is below* 10 μm) pollution in Pearl River Delta Region of Southern China (one of the most developed regions in China with over 10% of the national gross domestic product (GDP)) is RMB 29.21 billion, equivalent to 1.35% of the regional GDP (Huang et al., 2012).

During the past decades, numerous suggestions have been raised in order to address these issues, such as community-based environmental management (Liu et al., 2003), administrative system reform (Liu and Diamond, 2008; Liu et al., 2012a), and governmental credibility rebuilding (Zhu, 2012), green government procurement (Geng and Doberstein, 2008), eco-industrial park (Geng et al., 2009), and circular economy (Geng et al., 2013). These measures have significantly improved resource efficiency and reduced pollutant emissions. At the same time, the environmental awareness of the general public has also increased due to their concerns on environmental quality. Regional environmental protests (Wang, 2010) and grassroots involvement on environmental issues (Yang et al., 2013a) frequently occurred, raising the demand for better environmental governance. Under such a circumstance, local governments have to make a trade-off between GDP increase and environmental protection. However, the "*Not in My Backyard*" (NIMBY) notion still dominates in many regions. A systematic effort on controlling pollutant emissions is still yet to be effective. Many local stakeholders do not care such environmental damages if they occur far away from their places (Wang, 2010). Consequently, transferring environmental burden has become popular, especially at the regional level. For instance, many developed provinces or municipalities have relocated their polluting industries to the west China, where "pollution

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first and treatment later" is still popular (Liu et al., 2012b) pollutant emissions.

Due to its large size and imbalanced development, China's pollutant emissions control has to be implemented from both regional and sectoral perspectives. Although both industrial structure and development pattern have been gradually improved during the last couple of years, the environmental performance is still becoming worse. For instance, the notorious heavy haze, mainly caused by sulfur dioxide and PM2.5 (particulate matter with a diameter of below 2.5 μm) emitted from coal-based industrial activities and vehicle exhaust, has frequently happened in north China, especially in 2013. In order to respond such a challenge, China's new administration heightened attention on ecological modernization, green growth, and low carbon development, with a national circular economy (CE) strategy (Geng et al., 2013). Under such a circumstance, it is critical to establish new environmental indicators systems for measuring pollutant emissions reduction since well-designed indicators are valuable for managing environmental development and providing guidelines to improve pollution control policies. This paper targets to review pollutant emissions reduction assessment in China. After this introduction section, we first present the evolutional changes of related indicators, including our main focus is to summarize challenges and provide our recommendations on improving. Finally we draw our conclusions.

2. Performance changes for key pollutants emission

Pollution emissions control has implemented through adjusting economic structure and changing the development path in China since the mid-1990s (Fu, 2008). China's economic and social development is based upon the famous "five-year plan", including various initiatives on responding different environmental challenges. Under such a development mechanism, pollutant emissions control has been associated with the national five-year plan since 1996.

China's 9th five-year plan (1996–2000) clearly stated its intent to 'create conditions for implementing pollutant emissions control' (MEP, 1996). Twelve pollutants, categorized as air pollutants (soot, industrial dust, and sulfur dioxide), water pollutants (chemical oxygen demand, cyanide, lead, cadmium, arsenic, mercury, hexavalent chrome, volatile phenol and petroleum) and solid waste (industrial solid waste), were chosen as targeted pollutants with quantitative control figures. This plan also stated that local governments could add more targeted pollutants by considering their local realities. The reason to release such objectives of pollutant emissions control is that China's natural ecosystem quality was seriously polluted due to its rapid development, especially in the urban areas where many industrial companies locate together. For example, in 1995 the daily average concentration of total suspended particle (TSP) reported by the State Environmental Protection (former body of the current Ministry of Environmental Protection) in China's Northern cities was 392 $\mu g/m^3$ and that in Southern cities was 242 $\mu g/m^3$, while the reference value released by World Health Organization was 60–90 $\mu g/m^3$ (MEP, 1996). Among the global top-ten most TSP-polluted cities at that time, five are Chinese cities, including Beijing, Shenyang, Xi'an, Shanghai and Guangzhou. Moreover, the annual generation amount of industrial solid wastes reached 650 million tons and the accumulative amount of industrial solid waste achieved 6.64 billion tons, and the areas suffered from acid rain was over 29% of China's territory (MEP, 1996). In order to make sure that the planned reduction targets can be achieved, several regulations were released, including the amended "Air Pollution Prevention and Control Law" and "Water Pollution Control Law". Particularly, the revised *Criminal Law* added new items on the "*crime of undermining environmental and resources protection*" and "*crime of misconduct in environmental protection and monitoring*", providing an effective legal base for intensifying law enforcement related to pollutant emissions control. In addition, three national planning documents were approved by the State Council, including "*Blueprint for Ecosystem Development in China*", "*Master plan for Natural Protection Areas (1996–2010)*" and "*State Program for Eco-environmental Conservation*". Such efforts created a solid legal and institutional framework for pollutant emissions reduction. With the serious implementation of this national policy, some achievements had been gained. By the end of 2000, the total discharge volume of the 12 targeted pollutants had been reduced by 10–15% respectively compared to the levels in 1995, while the average annual economic growth rate was 8.3% (State Council, 2001). The decoupling of pollutions emission and economic growth began to occur for the first time.

During the 10th five-year plan period (2001–2005), only six pollutants were remained as targeted ones, including sulfur dioxide, soot, industrial dust, chemical oxygen demand, ammonia nitrogen, and industrial solid waste (MEP, 2002) although no official explanation about such a change was released. Unlike the 9th five-year plan period, pollutant emissions reduction efforts during this stage mainly focused on those regions with fast economic development and higher pollution levels, including the Huai watershed, the Haihe watershed and the Liaohe watershed, the Taihu lake, Chaohu lake and Dianchi lake, main acid rain control region and sulfur dioxide control region, the Beijing municipality and the Bohai Sea, indicating that the evaluation of six pollutants was mainly based on spatial distribution and monitoring. For instance, accurate discharge amount of chemical oxygen demand and ammonia nitrogen (or total nitrogen) emission volume were distributed to three watersheds, three polluting lakes and the Bohai Sea. Several policy initiatives were also released, including cleaner production promotion law, environmental impact assessment law, renewable energy law, national eco-industrial park project, and corporate environmental reporting (Geng et al., 2008). Nevertheless, the planned targets had not been all achieved by the end of 2005. Comparing to the emissions in the year of 2000, the emission of sulfur dioxide increased by 27.8% and the soot emission increased by 1.5%, while the chemical oxygen demand only reduced by 2.1%, far away from the planned target which was 10%. In the key regions, such as the three watersheds and three lakes, only 60% of the tasks for controlling pollution were completed.

During the 11th five-year plan period (2006–2010), only chemical oxygen demand and sulfur dioxide were remained as the targeted items for pollutant emissions reduction (MEP, 2008). The main reason is that to keep drinking water safety and improve air quality became the main environmental concerns by the Chinese central governments. Clear quantitative reduction targets were released for different regions by considering the imbalanced economic development. More developed regions received higher emissions reduction request, while less developed regions (especially the west China) had a relatively less reduction burden. With increasing public environmental awareness, more environmental complains were reported to both the central government and the regional governments, resulting in the generation of a new administrative rule, namely, "veto with only one vote". This means that all the development projects can be rejected if they cannot pass the environmental impact assessment. Also, a local official failing to meet the targets for three consecutive years will be ineligible for promotion during the next five years. Such strong political incentives exist for local officials to execute national environmental policy within their jurisdictions. New regulations, policies and action projects were enacted and approved, such as national circular economy promotion law, water pollution prevention and control law, national pollution inspection decree, e-wastes collection and treatment decree, emission cap and trade policies,