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Full-Chain Design and Implementation of Integrated Organization for Haze Prevention and Control in China

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Abstract

In recent years, China has been faced with an ever decreasing quality of their atmospheric environment. This paper focuses on the work of the Chinese government in combating air pollution and preventing smog. This paper also outlines the effects of airborne particulate matter on economy and health. The purpose is the global audiences will have a comprehensive understanding of the breadth and range of work of the Chinese government in context of environmental protection, haze prevention and control, and sustainable development.

Keywords: Supply-chain integration; Integrated organization; Haze prevention and control; Air quality; Sustainable development

Introduction

China has been faced with an ever decreasing quality of their atmospheric environment over recent a decade which has required the implementation of a nation-wide program to combat. Large-scale continuous haze events occur in the eastern region of China throughout the year, primarily in locations with which have seen large scale industrial development and population growth. In the western region of China, due to the low emissions of atmospheric pollutants, haze events are less likely to occur, but the hazards of storms cannot be ignored. During these haze events, the concentration of fine particulate matter exceeds national air quality standards. Due to known and potential effects of hazardous haze and airborne particulate matter to the environment and human health, there is a need to better control their occurrence. According to recent data released by the Chinese Environmental Protection Bulletin, environmental air quality in over 70% of 338 prefecture cities and above did not meet national standards in 2017. The primary pollutants are fine particulate matter (PM 2.5), inhalable Particulate Matter (PM 10), and Ozone (O_3), which accounted for 74.2%, 20.4% and 5.9% of the days of heavy pollution and above, respectively [1]. The average annual concentration of PM 2.5 is 43 μg/m^3, the average annual concentration of PM 10 is 75 μg/m^3, and the average of 8 hrs on O_3 is 149 μg/m^3, which is 122.9%, 107.1% and 93.13%. Ambient air quality standards [2], respectively.

Specifically, PM 2.5 particles are of particular concern due to their ability to penetrate the lung barrier and enter the blood system [3]. Due to their ability to enter the systemic system continued exposure of the general population to PM 2.5 particles, such as during haze events, are associated with increased prevalence of a range of cardiovascular and respiratory diseases, and decreased lifespan [4]. Fine particulate matter is composed primarily of elemental carbon, ammonium nitrate, ammonium sulfate, crustal material and trace metal oxides [5,6]. However, the composition of PM 2.5 varies spatially and temporally, throughout the day and among seasons [6]. In addition, it is known that the composition of PM 2.5 affects the observed toxicity and magnitude of effect however the specific contaminants contributing to these effects remain little understood. For example, a range of effects have been observed by use of a number of different *in vitro* assays following exposure to PM 2.5 particles such as reductions in cell viability, oxidative damage, inflammatory effects and genetic toxicity [5]. Therefore, there is a need to better understand the composition of air pollution, its health effects and methods to reduce the concentration of harmful particulate matter in the air. At the same time, it is especially important to conduct a health assessment of respiratory systems [7] and an assessment of people's health care knowledge about particles health prevention [8].

Discussion

The Chinese government has identified haze prevention as a top priority since 2013. The action plan for the prevention and control of air pollution was established in 2013 and set nationwide air quality standards for PM 2.5 particles for the first time. In context of combatting and preventing prevalence of haze events, the Chinese government identified ten measures including; improved comprehensive management, adjustments to the industrial structure, adjusting the structure of the energy industry, and enhancing the innovation ability of science and technology to fight for clean air through centralizing national cohesion. The State Council appointed the Ministry of Science and Technology (MOST) as the department leading scientific institutions. Thus, MOST organizes and coordinates national efforts in the prevention and treatment of air pollution. The effectiveness of these types of approaches in China is demonstrated by realized results. For example, in 2013 China released the air pollution action plan which aimed to improve air quality by setting PM 2.5 targets. Previously, no standards for PM 2.5 particles existed, and therefore this plan established PM 2.5 concentrations for specific regions across China. Ultimately implementation of this plan led to achieved reductions 35% on average across all regions [9]. The air pollution action plan has recently been further improved by introduction of the 2018-2020. Three-year action plan for winning the blue sky war which builds on previous legislation by mandating drops in PM 2.5 concentrations of 18% when compared to 2015 baseline levels by 2020 [10].

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In collaboration with the Ministry of Environmental Protection, the Chinese Academy of Sciences, and the Chinese Meteorological Administration, MOST has formulated the Program for strengthening the scientific and technological support for the prevention and control of air pollution. These organizations developed a unified program to research the causes and means of control of fog and haze. This work has included both applied and basic research in haze prevention and has been characterized by a full-chain design of the research work to include the theory of fog and haze prevention and control, technologies for control, and effect of policy and management controls. This work has set the overall goals and roadmap of study of the prevention and control of air pollution in China before 2017 [11]. Recently, the Ministry of Environmental Protection, the Chinese Academy of Sciences, and the Chinese Meteorological Administration jointly organized research on the prevention and control of air pollution, aimed to identify the main controlling factors of haze formation, established a monitoring and early warning system, formed full-process control techniques, proposed a framework for the evaluation of human health risk, formulated a fine environment supervision policy, and established a joint defense joint control technology demonstration area. Investments such as these continue to contribute to the development of monitoring technologies, such as ground level sampling and special mapping, and aim to improve characterization of this highly variable mixture to support goals identified by MOST [5,6].

In addition, to the implementation of policies, procedures and monitoring programs within China itself, the Chinese government has increased financial support to the National Science and Technology Program to research haze related issues. Key support has focused on basic studies on air pollution prevention and control, research and development of pollution control technologies. This program has focused on the development of vertically integrated research projects aimed at ensuring that scientific research is more pertinent, more effective and a higher level of achievement. To date, more than 10 billion Chinese Yuan have been invested into research on fog and haze pollution for key special and major projects selected from National Science and Technology Programs [12]. Among key special projects of the National Key R&D Plan, study on the cause and control technology of air pollution has been implemented to support technical research on the causes of haze and its effect on health, management decisions, monitoring, and warning. Special attention has been given to secondary formation processes of fine particulate matter and the mechanisms of formation of haze. Another key special project of National Key R&D Plan is the clean and efficient utilization of coal and new energy saving technology which has been implemented to support the development of full-process control technologies for coal combustion, clean coal utilization technologies and industrial energy-saving technologies to strengthen the source control of emissions of industrial pollution sources.

Other key projects and areas of focus of the National Key R&D Plan include investigations to support reduced application of chemical fertilizers, development of more healthy breeding practices for livestock and poultry, and other technologies to enhance emission control of ammonia nitrogen and other pollution throughout agricultural practices including planting and cultivation of crops. These projects form the basis of the program called Research and Development of Comprehensive Technology of Reduction and Synergism of Chemical Fertilizer and Agricultural Chemicals and Research and Development of Comprehensive Technology of Prevention and Control of major epidemic diseases of livestock and poultry and high efficient and safe breeding. These projects have wide ranging implications and cover a number of facets of the agricultural and livestock industries.

In addition, another key project of the National Key R&D Plan is the new energy automobile program which was designed to support research, development, and promotion of new energy automobiles, including electric vehicles, and facilitate replacement of fossil fuel vehicles. In addition to major projects designed to contribute realized improvements by 2030, these projects aim to speed-up the establishment of an innovative and technologically advanced country. As such, the Chinese government plans to launch the Comprehensive Environmental Governance zone of Beijing, Tianjin, and Hebei. As part of this plan, the area encompassing Beijing, Tianjin, and Hebei, will be the focus of intensive study related to the causes of regional air pollution and development of a vertically integrated multi-medium and multi-industry air pollution control scheme. Development of large regional integrated solutions to prevent and control air pollution by the Chinese government are in-line with current WHO goals and tools in development such as the Health Economic Assessment Tool (HEAT), the Green+ tool, the Sustainable Transport Health Assessment Tool (STHAT) and the Integrated Transport and Health Impact Modelling Tool (ITHIM) [3].

In addition to nation-wide programs designed to investigate and develop solutions to control air pollution, the Chinese government has focused on attracting foreign research. To attract foreign researcher participation related to the study of prevention and control of air pollution in China and aims to harness international understanding of haze and pollution control in foreign countries. The plan to support international scientific research related to haze prevention and control has been implemented by the Chinese government through establishment of the Intergovernmental Scientific and Technological Cooperation Program. To support the growth and continued application leading scientists to develop world leading technologies in the prevention and control of air pollution, a special service system of science and technology support was established under the reporting system of the National Science and Technology Program. This program has resulted in a compilation of advanced technologies for the prevention and control of air pollution being published in peer-reviewed journals [13]. The technologies, articles, and patents of air pollution control at home and abroad have been collated comprehensively and further applications are encouraged and open to the public.

In 2014, MOST published preliminary results of the systems research. These results identified a number of haze pollution events which occurred between 2013 and 2014 which were likely due to adverse weather conditions and emission of air pollutants. This report identified atmospheric pollutant burdens as likely due to the rapid economic development of China over recent decades and burgeoning, industrial activity such as chemical, motor vehicle and coal industries, and biomass burning [13]. When the weather is in a static and steady state, haze events occur due to the accumulation of fine particulate matter, of which 30%-40% is from direct emissions, and 70% is formed from secondary reactions of sulfides, nitrogen oxides, volatile organic compounds, and other pollutants. In particular, increasing mean temperatures have resulted in increasing concentrations of ozone at ground level especially in the hot and humid Pearl River Delta and as a result ozone is now of greater concern than PM 2.5 [10]. Combined with the preliminary study results, suggestions on further enhancement of prevention and control of air pollution are proposed, including speeding up the reorganization and vertical integration of the economic and energy structure, promoting the formation of green production and lifestyles, strictly controlling the emission of air pollution at the source and establishment of a refined environmental monitoring system. The above suggestions have become a strategic choice and systematic project for haze prevention and control in China.

Conclusion

The commitment of China's government to reduce particulate matter has achieved tremendous results over a short period of time (2012-2017). Recently, a report by Greenstone amd Schwarz [9], monitored PM 2.5 and other particulate matter across the Beijing-Tianjin-Hebei region of China and observed an average 32% reduction in PM 2.5 particles and 26% in pollution between 2013 and 2017. Continued investment of China into programs, such as the 2018-2020 three-year action plan for winning the blue sky war, to combat elevated levels of pollution and haze has resulted in realized benefits which contribute to the points of action as identified in the WHO roadmap established in 2016 including continued investment into research and development, improved monitoring of pollution and human health trends and development of a national strategy [14]. In addition approaches such as those of the United States Environmental Protection Agency to encourage community based solutions to air pollution offer additional solutions to contribute to the national strategy [15].

While strengthening scientific research, the Ministry of Environmental Protection has also exerted great efforts in regional planning and layout, environmental supervision and management, and industrial structure adjustment. All measures aim to reduce the emission of pollutants in a relatively short period and improve the quality of the atmosphere, such as the latest announcement of the Chinese government on the construction of the Xiong'an New Area [16]. One of purposes of Xiong' a new area is to adjust the industrial structure of Beijing, Tianjin, and Hebei to hasten the improvement of air quality.

Author Contributions

The data was collected and the paper was written by Yanli Cheng; the paper was revised by Joshua S. Fu.

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