Chapter 11
Air Pollution Prevention and Control Policy in China

Cunrui Huang, Qiong Wang, Suhan Wang, Meng Ren, Rui Ma, and Yiling He

Abstract With rapid urbanization and development of transport infrastructure, air pollution caused by multiple-pollutant emissions and vehicle exhaust has been aggravated year by year in China. In order to improve air quality, the Chinese authorities have taken a series of actions to control air pollution emission load within a permissible range. However, although China has made positive progress on tackling air pollution, these actions have not kept up with its economy growth and fossil-fuel use. The traditional single-pollutant approach is far from enough in China now, and in the near future, air pollution control strategies should move in the direction of the multiple-pollutant approach. In addition, undesirable air quality is usually linked with the combination of high emissions and adverse weather conditions. However, few studies have been done on the influence of climate change on atmospheric chemistry in the global perspective. Available evidence suggested that climate change is likely to exacerbate certain kinds of air pollutants including ozone and smoke from wildfires. This has become a major public health problem because the interactions of global climate change, urban heat islands, and air pollution have adverse effects on human health. In this chapter, we first review the past and current circumstances of China's responses to air pollution. Then we discuss the control challenges and future options for a better air quality in China. Finally, we begin to unravel links between air pollution and climate change, providing new opportunities for integrated research and actions in China.

Keywords Air quality • Climate change • Control policy • Human health • Co-benefits

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11.1 Introduction

China's economy has developed rapidly during the past three decades and now ranks as the second largest economy in the world. The country has also become the second largest energy consumer on a global scale, which fossil-fuel consumption occupied the major proportion of total energy use [5]. In many cities, energy consumption is the leading contributor of anthropogenic air pollutants [30]. With rapid urbanization and development of transport infrastructure, air pollution caused by multiple-pollutant emissions and vehicle exhaust has been aggravated year by year [29].

Today, beyond 75% of urban population are under exposure of multiple air pollutants that fail to meet the national ambient air quality standards. In particular, the severe pollution haze that affected northern China in early 2013 has drawn public's intense concern. The Chinese government has taken a variety of actions to control air pollution and improve air quality [27, 31]. In this chapter, we will first review the past and current circumstances of China's responses to air pollution. Then we discuss the control challenges and future options for a better air quality in China. Finally, we begin to unravel links between air pollution and climate change, providing new opportunities for integrated research and actions in China.

11.2 China's Responses to Air Pollution

11.2.1 Legislation for Air Pollution Prevention and Control

China has gradually developed a holistic legislation framework for air pollution control since the People's Republic of China was established. In order to reduce the harmful effects of silica dust, the State Council promulgated the *Decision on Preventing Silica Dust in Mining Companies* in 1956. It was the first legal document issued by the government aiming at air pollution control. Afterward, the Cultural Revolution had completely affected China's society, leading to the temporary stagnancy of legislation. When China restored its legitimate seat at the United Nations in 1971, the government was aware of the importance of environmental protection and recognized serious problems in nationwide air quality [7]. Then the government began to take strict actions in prevention and control of air pollution. The main structure of China's environmental control system is based on a "two committees, one bureau" model, and the structure is similar in every level of China's administrative system (Fig. 11.1).

In 2000, China revised the *Air Pollution Prevention and Control Law*, and this revision strengthened control on SO_2 emissions particularly caused by coal burning. It also reinforced control of emissions from vehicles, including the prohibition of production and trading of vehicles that did not meet the discharge standards [7]. With the automobile ownership elevated steadily, China's air pollution is currently

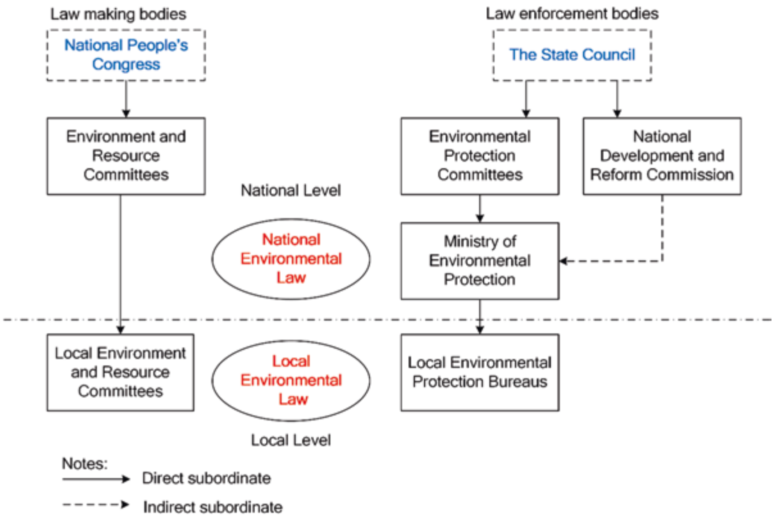

Fig. 11.1 Environmental governance structure in China (Adapted from Ref. [3])

caused by a combination of emissions from coal combustion and voiture exhaust. Since 2013, frequently occurring haze events have made the government strengthen the control of dust haze, particulate matters, and nitrogen oxides. The severe haze pollution was also one major factor promoting the 2014 revision of the *Environmental Protection Law*. The 2014 revision added measures such as information disclosure, public participation, and daily penalties for air pollution control. Other supporting legal documents include the *Rules on the Standard for Compulsory Retirement of Motor Vehicles*, 2012 *Ambient Air Quality Standards*, and Ministry of Environmental Protection's Guidelines for *Joint Prevention and Control of Air Pollution in Key Regions*.

11.2.2 Ambient Air Quality Standards

In 1982, *Ambient Air Quality Standards* in China was originally formulated, which was China's first official document aiming to protect human health and ecological environment. The Ministry of Environmental Protection issued the revised *Ambient Air Quality Standards* in 1996, 2000, and 2012, respectively (Fig. 11.2). The first amendment in 1996 included three grade standards (Grades I, II, and III) and recommended the guideline values of SO_2, NO_x, NO_2, CO, O_3, PM_{10}, and TSP. The second amendment in 2000 deleted the standard of NO_x pollutant and relaxed the guideline values of NO_2 and O_3 [31]. The third amendment was made in 2012, which set new control standards of $PM_{2.5}$ and O_3 and frapped the limit values of NO_2 and PM_{10}.

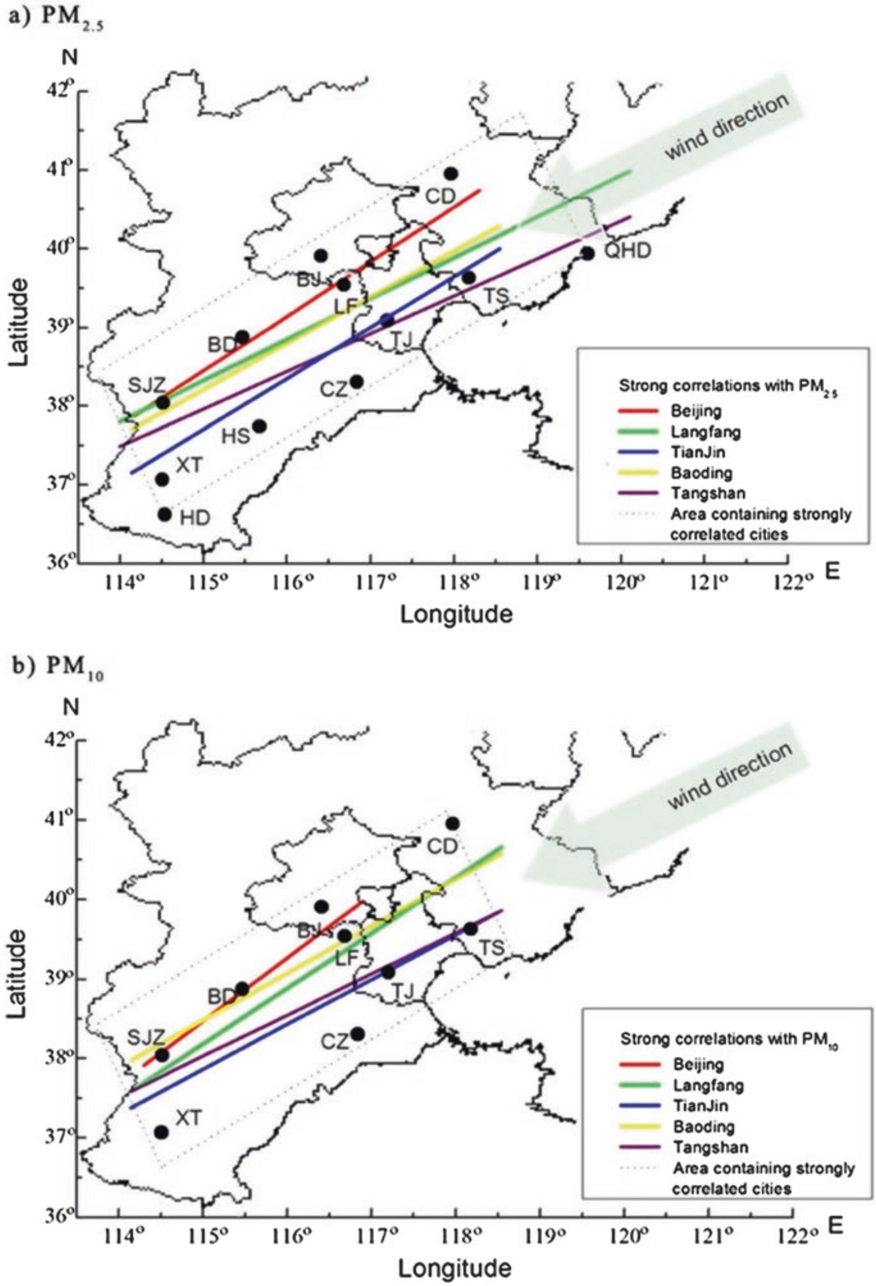

Fig. 11.2 The distribution of cities with strongly correlated (**a**) $PM_{2.5}$ and (**b**) PM_{10} values. The wind direction arrow represents the dominant wind direction during the autumn study period (Source: Ref. [26])

Table 11.1 National ambient air quality standards in China (GB3095-2012, third amendment)

Pollutants	Time interval	NAAQS guideline value (GB3095-2012)		Unit
		Grade-I	Grade-II	
SO_2	1-h	150	500	μg/m^3
	Daily	50	150	
	Annual	20	60	
NO_2	1-h	200	200	μg/m^3
	Daily	80	80	
	Annual	40	40	
CO	1-h	10	10	mg/m^3
	Daily	4	4	
O_3	1-h	160	200	μg/m^3
	Max 8-h	100	160	
$PM_{2.5}$	Daily	35	75	μg/m^3
	Annual	15	35	
PM_{10}	Daily	50	150	μg/m^3
	Annual	40	70	

Table 11.2 $PM_{2.5}$ and PM_{10} guideline values of National Ambient Air Quality Standards in China, WHO, the USA, and the EU

Pollutants	Time interval	China (2012)		WHO (2005)			USA (2006)	EU (2008)
		Grade-I	Grade-II	Target-I	Target-II	Target-III		
$PM_{2.5}$	Daily	35	75	75	50	37.5	35	25
	Annual	15	35	35	25	15	15	20
PM_{10}	Daily	50	150	150	100	75	150	50
	Annual	40	70	70	50	30		40

In the 2012 Standards, the guideline values of Max 8-h O_3, daily $PM_{2.5}$, and daily PM_{10} are 100, 35, and 50 μg m^{-3} for Grade-I and 160, 75, and 150 μg m^{-3} for Grade-II, respectively (Table 11.1). Currently, the $PM_{2.5}$ and PM_{10} Grade-II standards are in consistent with the WHO's recommended interim target-I standard, and $PM_{2.5}$ Grade-I standard is also in accordance with US recommended guideline values of $PM_{2.5}$ (Table 11.2) [31]. Because fine particles $PM_{2.5}$ have a severe effect on human health, China would have far-reaching benefits to its air quality if the 2012 Standards can be properly implemented. However, achieving this goal will be challenging, as $PM_{2.5}$ concentrations in a great number of cities are well above the recommended standard at present [33].

Fig. 11.3 Three key regions and six city clusters identified for regional air pollution control (Source: Ref. [27])

11.2.3 Policies on Air Pollution Prevention And Control

Air pollution and its reduction are often regional (i.e., transboundary) rather than local (Fig. 11.2) [26]. In May 2010, the State Council issued the *Joint Prevention and Control of Air Pollution*, aiming to establish a cooperative prevention and control system for regional air pollution. As shown in Fig. 11.3, this regulation designated three key regions and six city clusters [26].

In addition, the State Council issued the first national *Action Plan on Air Pollution Prevention and Control (2013–2017)* in September 2013. The Action Plan requires that by 2017, PM_{10} levels to be decreased by ≥10% compared with 2012 levels in urban areas and the blue sky days to be increased year by year [4]. Another target of the plan is annual $PM_{2.5}$ concentrations to be reduced by ≥25%, 20%, and 15% in the Beijing-Tianjin-Hebei, Yangtze River Delta, and Pearl River Delta region, respectively [31].

In order to accomplish the proposed targets, the Action Plan indeed sets some important mandates and initiatives. It manages to establish the mechanism of regional coordination and general layout for regional environmental management. It also tries to clarify how the government, enterprise, and society should take responsibilities and encourage the public to involve in environmental protection [31]. In particular, the Action Plan proposes less share of coal and more share of non-fossil fuels in total energy consumption. It also sets specific goals for $PM_{2.5}$ in the three key regions, and PM_{10} shall be considered as a compulsory index in the development of our society and economy [7].

11.2.4 Air Pollution Control Challenges

In recent years, China has made positive progress on tackling air pollution. However, the prevention and control of air pollution are still in a race with the economy [6]. The country has maintained an annual economic growth rate of more than 8% for many years, and its per-capita GDP energy consumption was 1.4 times higher than average level of the world. There has been a steep rise in emissions of air pollutants in the past decades, from extensive industrial development, coal-dependent energy consumption, and increasing number of vehicles [4]. Although the government has made remarkable efforts to control air pollution, these actions have not kept up with its economy growth and fossil-fuel use [32].

In particular, the low priority given to environmental protection and the lack of cooperation among various government agencies hindered progress on air pollution control. The Ministry of Environmental Protection manages pollutant discharge, but it is a weak player within the government system. Currently, local governments still prefer to promote heavy industry to stimulate their economies, and in some areas, even factories owned by governments might be the largest polluters. Local environmental protection agencies are also in difficult situations because they are affiliated to local governments [33].

It is generally believed that critical factors affecting the effectiveness of air pollution control measures are issues concerning implementation of laws and policies. Nonetheless, the underlying problems of legislation and policy should not be overlooked [7]. The *Air Pollution Prevention and Control Law* requires local governments to be accountable for local air quality in the administrative areas under their jurisdiction. However, it is not clear how the local governments take responsibility for air quality, how such responsibilities should be assessed, and who should take responsibility if air quality failed to meet air quality standards. Therefore, local government officials who favor economic development may disregard their responsibilities for environmental protection [7].

At present, there is still a lack of cost-effective evaluation of air pollution control policies in China. The design of targets and measures for air pollution control should be accompanied by corresponding assessment methods, in order to track and evaluate the implementation and effectiveness of the measures. At this stage, China has not established a comprehensive or complete system for air quality management and also has not applied the cost-effective evaluation mechanism in environmental planning [6]. International experience is a valuable guideline for China to innovate management methods and gradually enrich and develop air pollution prevention and control strategy in the country.

Furthermore, there is a defective integration among laws and policies. To some extent, they are not mutually supportive. For instance, the proposed goals of Action Plan have been profoundly difficult to achieve, as some concrete measures (e.g., increasing clean energy supply, accelerating technological transformation, linking $PM_{2.5}$ reduction targets to performance evaluations of local governments) will be less effective if they remain at the policy level. In addition, there is a consistency problem among legislation and policies. For example, in current energy-use policies, total air pollutant load goals have no specific regional emission restrictions, unlike those in the *Air Pollution Prevention and Control Law*. Therefore, in order to make them mutually supportive, certain items of policies should be established through legislation [7].

Over the next decade, China will complete the capital-intensive industrialization and experience population boom. Pushed by the public, the willingness of Chinese government for addressing the problem of air pollution has never been so strong. A range of laws and policies were established and have already played important roles in protecting air quality [6]. Hence, there is a golden opportunity to make a change—to free China from the dilemma between economic development and environmental protection [33].

11.3 Future Options for a Better Air Quality in China

11.3.1 Moving Toward a Multiple-Pollutant Approach to Air Quality

In recent years, air pollution in China has become growing complicated, and the problem of secondary pollutants (i.e., NO_x, PM_{10}, $PM_{2.5}$, O_3, and CO_2) is becoming much more urgent. Actually, many of the pollutants share the same emission source, for example, emissions of SO_2, NO_x, and CO_2 are all strongly associated with fossil-fuel consumption. Huang et al. [12] investigated the chemical components during severe pollution periods in four typical cities in China and observed that secondary aerosol contributed 50–75% of $PM_{2.5}$ in eastern cities (Beijing, Shanghai, and Guangzhou) and 30% of $PM_{2.5}$ in a western city (Xi'an).

At the very beginning, China's air pollution control policies gave priority to dealing with the air pollutants one by one, covering a few major pollutants. Every Five-Year Plan starting with the twentieth century targeted to reduce the national NO_x, PM, SO_2, and CO_2 emission, and each set a different demand separately. On the basis of the US Environmental Protection Agency Air Quality Index (AQI), the *Ambient AQI Technical Provisions (Trial)* (HJ 633-2012) was released in 2012, and it was implemented in the *Ambient Air Quality Standard* (GB 3095-2012). The AQI level is assessed by the concentrations of six criteria pollutants including SO_2, NO_2, CO, O_3, $PM_{2.5}$, and PM_{10}. Basically, the AQI acts as a forewarning index for the government to inform the public to take proper health protection actions.

Currently, the traditional single-pollutant approach is far from enough in China. Figure 11.4 shows the number of days of severe and extremely serious pollution (AQI > 200) and the multiple pollutants in 31 provincial capital cities [11]. Previous epidemiological studies reported the negative effects of air pollutants on human health, usually on the account of a single air pollutant while adjusting for other air pollutants exposure [15, 17, 28]. The AQI system has its defectiveness in practice,

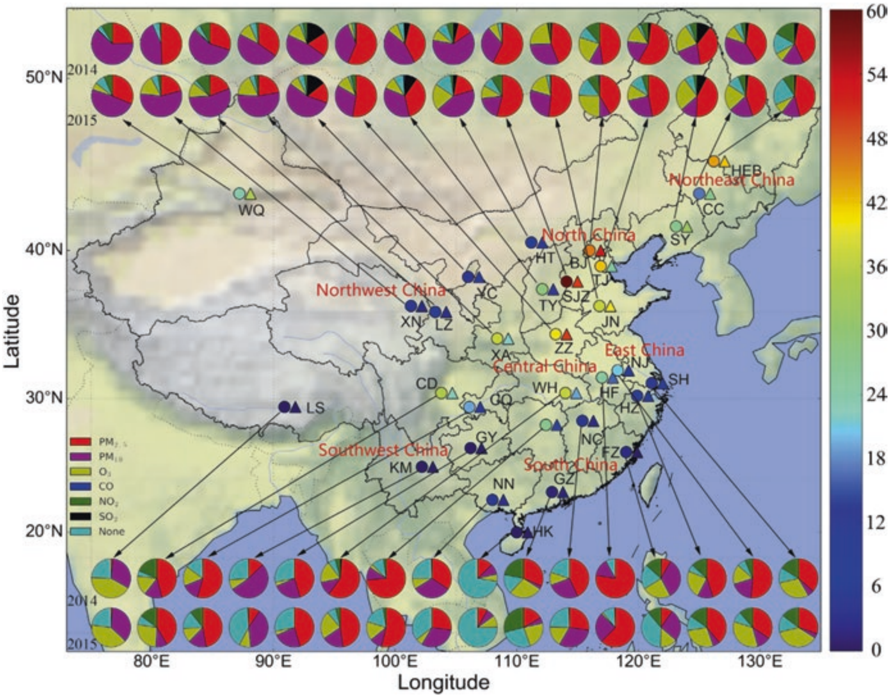

Fig. 11.4 The number of days of severe and very serious pollution and the rate of major pollutant in 31 provincial capital cities in China (2014–2015). The *circles* and *triangles* represent the total days of severe and very serious pollution in 2014 and 2015, respectively. The category "None" means the rate of AQI less than 50 in total days (Source: Ref. [11])

for it simply sums each unit ignoring the combined health effects of exposure to multiple air contaminants [14]. Thus, future epidemiological studies are urgently required to estimate the health impacts associated with multi-pollutant exposure and revise more scientific air quality index standards.

In the near future, China's air pollution control strategies should move in the direction of the multiple-pollutant approach. "Co-control" is now commonly used in the Chinese government documents, which refers to "coordinated control" or "synergetic control." There is no doubt that SO_2, NO_x, and PM emission loads, as well as VOC and CO_2 discharge, should be reduced simultaneously to mitigate the harmful health and environmental effects of air pollution in China over the next few years (Fig. 11.5). Emissions controls of NO_x, SO_2, NH_3, and NMVOC synergistically are highly needed in the future because multiple pollutants impact on $PM_{2.5}$ and O_3 concentrations nonlinearly, as well as atmospheric oxidation capacity. The key problems to be addressed are the acid rain, haze, photochemical smog, etc.

As meteorological conditions are the primary factors causing the day-to-day variations in pollutant concentrations [10], an effective global response to climate change also should be taken into consideration. This can be considered as a kind of

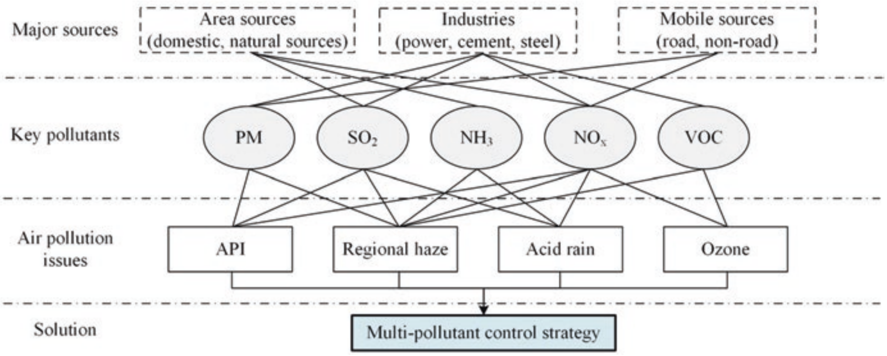

Fig. 11.5 Schematic diagram of the multi-pollutant approach (Adapted from Ref. [27])

multiple-pollutant control strategy. The purpose of co-control strategy is to tackle the adverse impacts of general air pollutants in the company of global climate change mitigation. Generally, policymakers in China pay close attention to multiple-pollutant approach due to it can reduce costs and increase effectiveness at the same time. Moreover, they believe that multiple-pollutant approach should focus on synergies between air pollution and energy use for more cost-effective co-control. Thus, contribution to the mitigation of climate change by the control on fossil-fuel use and expand the use of clean fuels should be taken into account.

11.3.2 Promoting Climate-Friendly Air Pollution Control Strategies

Climate change is a challenging problem in the new century, one to which the whole world has attached great importance. Actions were taken around the world to enhance resilience to the global climate change, such as the *United Nations Framework Convention on Climate Change* (UNFCC), the *Kyoto Protocol*, the *Copenhagen Declaration*, and the *Paris Agreement*. Climate-friendly air pollutant controlling strategy calls for the combination among techniques, policies, and regulations. This joint controlling measure aims at promoting reductions of toxic pollutants and greenhouse gas (GHG) emission loads at the same time. This strategy puts forward based on the theory that climate change and air pollution are closely interrelated problems.

Recent studies demonstrated that significant cost-effective and synergistic benefits could be achieved by joining the reduction local air pollution and GHGs together (Fig. 11.6). Climate-friendly measures, such as improvements of energy efficiency, combined of heat and electricity generation, fuel replacement, and integrated coal gasification combined cycle (IGCC) plants, can reduce SO_2, NO_x, and

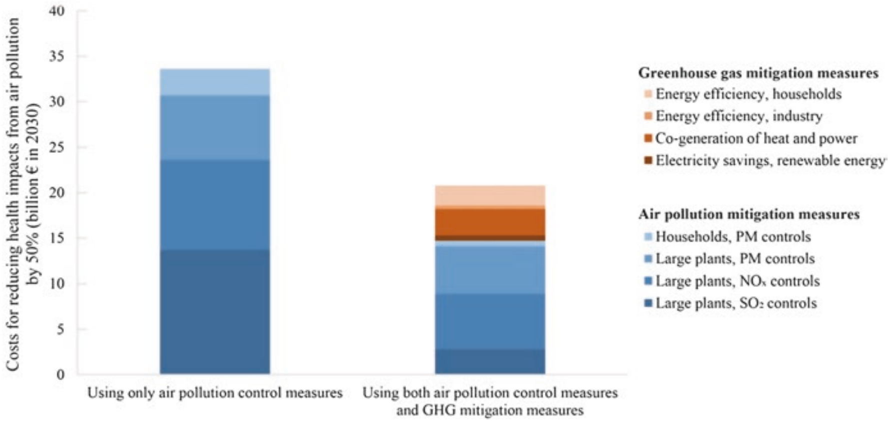

Fig. 11.6 Cost reduction from controlling air pollution and greenhouse gases simultaneously (Source: Ref. [16])

$PM_{2.5}$ emissions without any extra spending. An estimated 1 % of adverse impact by PM would significantly decrease when reducing the CO_2 emission by 1% [16].

Many countries or cities have put proposals to promote the climate-friendly air pollution control strategy. In the USA, the joint administration of GHG discharge and air pollutants has been put forward over a decade ago when the first guideline for state and local air quality officials (ALAPCO 1999) was released by the national association of air pollution regulators (then called STAPPA/ALAPCO). What's more, *New York's Air Quality Management Plan* adopted a multi-pollutant approach, involving GHG emission, to underline the importance of energy conservation and emission reduction by the state's improvement of energy efficiency and implementation of renewable energy plan.

Introduced by the Ministry of Environmental Protection, the regional air quality management rule was approved by China's state Council on May 11, 2010. Along with the *Joint Prevention and Control of Air Pollution to Promote Regional Air Quality*, *Guidelines for 12th Five-Year Plans for Joint Prevention and Control of Air Pollution in Key Regions* was approved by the Ministry of Environmental Protection successively to demonstrate the government's determinations to implement the climate-friendly air quality controlling. The coordination and cooperation of environmental and energy policy formulation is the foundation to realize the climate-friendly air pollution management. It's a cost- and time-saving way to reduce pollutant discharge. Therefore, an ingenious integration of measures to lessen air pollutants and GHG emissions in parallel will help tackle air pollution and climate change less expensively than dealing with either issue separately.

11.4 Climate Change and Air Pollution: Measures with Co-benefits

11.4.1 Links Between Climate Change and Air Pollution

Climate change and air pollution are closely linked (Fig. 11.7), for instance, a large extent of CO_2 and the main air pollutants stem from the same sources. Nevertheless, they were studied separately in most literatures, due to their complex and highly variable relationships. In the past few years, climate change researches have been primarily concerned with the roles of CO_2, CH_4, N_2O, HFCs, PFCs, and SF_6, and some of them only make up less than 1% of the atmosphere but contributing much to climate change. Few researches investigated the effects of major air pollutants due to their temporal effects on climate change, e.g., ozone and particulate matter. On the other hand, pollutants at local and regional scales draw more and more attentions in the field of air pollution research. On the whole, there have been relatively few studies on the contribution of background concentrations and the influence of climate change on atmospheric chemistry in the global perspective [23]. However, undesirable air quality is usually linked with the combination of high emissions and severe weather conditions. As to the rapid climate change now we are facing, further research is needed to better understand the inextricable overlap between climate change and air quality.

The two major air pollutants influencing human health are ground-level ozone and particulate matter in terms of climate change. Ozone is a double-edged sword for human health. The ozone layer located in the stratosphere protects human from harmful ultraviolet radiation; however, ground-level ozone has innumerable adverse health effects. As a powerful oxidant, it can impair lung function and irritate the respiratory system. Summer is at high risk of ozone pollution because strong ultraviolet light and high temperature are vital to the generation of ozone. Several observations have confirmed the strong correlation of elevated ozone with temperature in

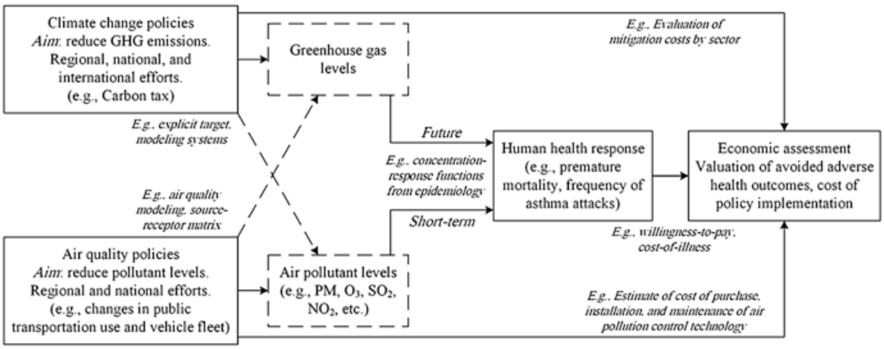

Fig. 11.7 Policies framework between climate change and air quality (Adapted from Ref. [1])

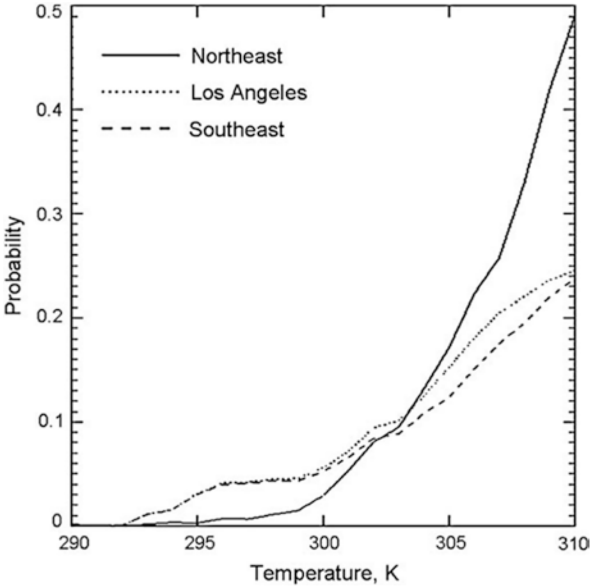

Fig. 11.8 The probability of ozone exceeding the 80 ppb as a function of daily maximum temperature for three US regions (Source: Ref. [13])

polluted regions (Fig. 11.8). The correlation is mostly showed under certain conditions, i.e., when ozone is above 60 ppb, and significant correlation with lower background ozone concentrations has not been observed [13].

The principal components of particulate matter are usually common. For example, sulfate, nitrate, organic carbon, and elemental carbon are mostly present as fine particulate matter ($PM_{2.5}$), and they have drawn much concern about human health. The size of the particulate matter is the main determinant of its health effects. Current studies have recognized the effects of inhaling particles on respiratory diseases, cardiovascular disease, etc. Sulfate, nitrate, and organic carbon are the oxidation products of SO_2, NO_x, and NMVOCs. Process of combustion can also emit carbon particles directly. Nitrate and organic carbon have both solid and gas phases, depending on environmental temperature. Precipitation is the main and efficiently way of atmospheric sinking of PM; thus the lifetime of PM varies with cumulative rainfall (Fig. 11.9), and pattern changes of precipitation could also influence PM distribution. Particles have either a cooling effect on the atmosphere through scattering of shortwave radiation or a warming effect through absorption of shortwave radiation according to their nature and thus have a bidirectional effect on temperature. This shows the complexity of PM compositions and the diverse effects of its components [13].

Although further research is needed, available evidence suggested that climate change was likely to exacerbate certain kinds of air pollutants including ozone and smoke from wildfires (Fig. 11.10). Meanwhile, O_3 and PM can interact with solar and terrestrial radiation, and the importance of these as climate forcing agents has been recognized. A study based on the panel of the United Nations Framework Convention on Climate Change (UNFCCC) classified countries shows that both the

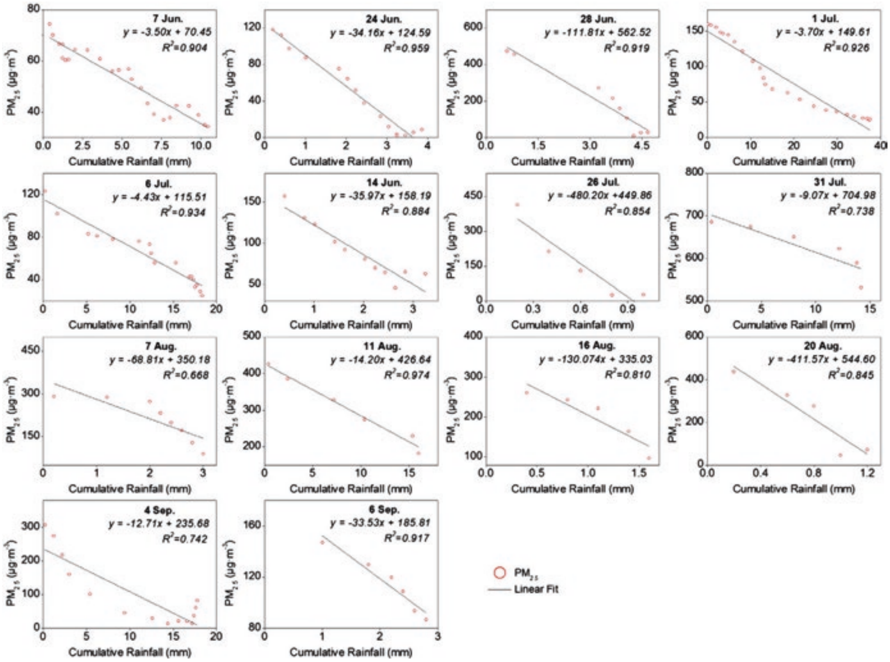

Fig. 11.9 Correlations between $PM_{2.5}$ concentrations and accumulated rainfall (Source: Ref. [18])

energy consumption and air quality indicators have a positively significant relationship with the climate change [19]. Because of the dual effect, the relationship between climate change and air pollution should be discussed in a broader context of chemistry-climate interactions. The variation of atmospheric chemistry puts an effect on both air quality (O_3 and PM) and climate (O_3, PM, and methane). Again, climate change can also influence air quality via affecting natural emissions (biosphere, dust, fires, lightning) [22]. Chemistry-climate interactions include several potential pathways, and further studies need to validate the current results [6].

11.4.2 Health Co-benefits of Improved Air Quality as a Result of Climate Change Mitigation

Excess morbidity and mortality related to extremely hot weather and poor air quality have been widely investigated in cities worldwide. This has become a major public health problem because the interactions of global climate change, urban heat islands, and air pollution have adverse effects on human health [9]. A large extent of air pollutants (e.g., PM, NO_2, and SO_2) and greenhouse gases (e.g., CO_2) stem from the same fossil-fuel combustion processes. Thus, reducing emissions of air

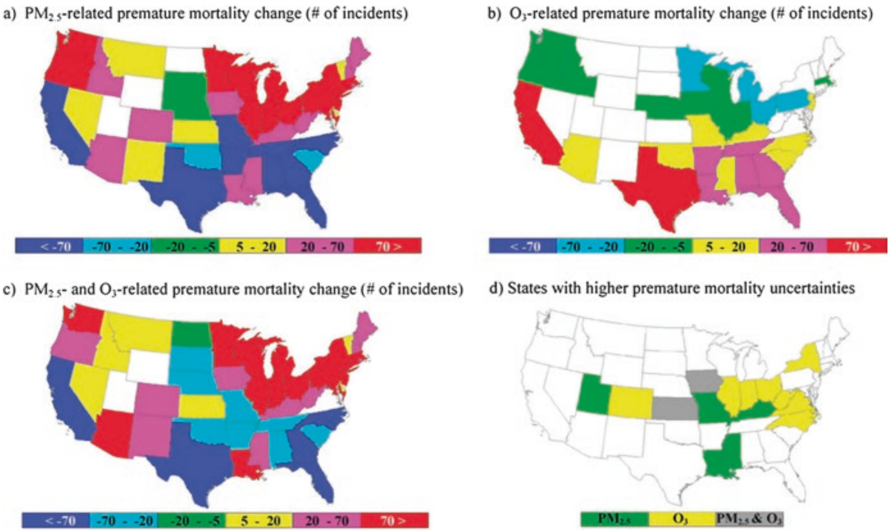

Fig. 11.10 Potential impact of climate change on air pollution-related human health effects in the USA. Estimated changes of (**a**) $PM_{2.5}$-related, (**b**) O_3-related, and (**c**) both pollutants-related premature mortality in 2050 compared to 2001. (**d)** States with higher premature mortality uncertainties due to $PM_{2.5}$- and O_3-related effects from uncertainties in meteorology forecasting (Source: Ref. [24])

pollutants to slow the pace of climate change will benefit public health. The health benefits and air pollution reduction benefited from GHG mitigation have been widely investigated. According to current studies, energy scenarios, emission control, and climate change and air quality modeling systems are closely related to the short-term gains in public health, and environment could benefit from GHG mitigation policies [1].

Several studies suggested reducing GHG has significant health benefits. By taking the control policy scenario over the 20-year period, as compared to current pollution practices, a study identified almost 153,000 adult deaths and more than 3700 infant deaths are avoidable in three Latin-American cities [2]. A synthesis of research on China's Clean Development Mechanism potential showed domestic environmental benefits of saving 3000–40,000 lives annually through co-benefits of abated air pollution [1]. A study focusing on Beijing estimated population exposure to air pollutants under various energy scenarios and calculated chronic and short-term excess deaths [20].

It is a challenging task to estimate the health benefits of improved air quality resulted from GHG mitigation policies. Due to existing of unquantified effects, current studies may underestimate the benefits, because clear exposure-response associations only show in a portion of the health impacts. The US EPA noted numerous unquantified effects in 1999; since then, some of the effects have been identified [21]. There are already some available approaches to estimate health co-benefits of improved air quality as a result of GHG mitigation. Although there is no well-recognized measurement of their health effects, consistent results from previous studies suggested that the health co-benefits from improved air quality are substantial. These published studies will provide useful information for the scope, design, and timing of climate change policies [1], and further researches need to investigate the added benefit of improving health outcomes related to air pollution.

11.4.3 Implementing the Paris Agreement to Tackle Climate Change and Air Pollution

The 2015 UNFCC conference was held in Paris, France. It was the 21st annual session of the Conference of the Parties (COP21) from the 1992 United Nations Framework Convention on Climate Change (UNFCCC). Stakeholders in the public health and government arenas hammered out strategies to reduce emissions of influential climate pollutants. On 22 April 2016 (Earth Day), 174 countries signed the Paris Agreement in New York and began adopting it within their own legal systems. The key result of the Paris Agreement was to limit global temperature rise to 2 °C comparing to preindustrial levels and to pursue efforts to limit the increase to 1.5°C. To achieve this, countries submitted Intended Nationally Determined Contributions (INDCs) outlining actions they intended to take and the level they intended to reach individually. The Paris Agreement entered into force on 4 November 2016—and the INDCs became the Nationally Determined Contributions (NDCs). To raise the level of ambition over time, a 5-year submission cycle for NDC was introduced, and new NDC must be more ambitious than previous one.

The Paris Agreement is the first climate agreement that covered all countries and won unanimous consent. The agreement is expected to serve as a solid basis for further cooperation. According to the agreement, developed and developing countries must assume their respective obligations and make their respective contributions in a unified institutional framework and a differentiated manner. China is part of the landmark Paris Agreement. The transition to cleaner energy will contribute to tackling air pollution challenges and put the country's future growth on a low-carbon pathway [25].

Climate change mitigation strategies, such as reducing the dependency on fossil fuels and increasing the portion of clean and renewable energies usage, have synergy with environmental protection and public health. China has nationally determined its actions by 2030, such as to achieve the peaking of carbon dioxide emissions around 2030 and to lower carbon dioxide emissions per unit of GDP by 60–65% from the 2005 level, according to submitted INDC on 30 June 2015, *Enhanced actions on climate change: China' s intended nationally determined contributions*. Therefore, the implementation of the Paris Agreement will further promote China's actions in addressing global climate change and also improvement of air quality [8].

11.4.4 Summary

China has maintained an annual economic growth rate of more than 8% for many years, and its per-capita GDP energy consumption was 1.4 times higher than average level of the world. There has been a steep rise in emissions of air pollutants in the past decades, from extensive industrial development, coal-dependent energy consumption, and increasing number of vehicles. Today, most of the urban population are under exposure of multiple air pollutants whose concentration exceeded discharge standard.

In order to improve air quality, the Chinese authorities have taken a series of actions to control air pollution emission load within a permissible range. The *Air Pollution Prevention and Control Law* and *Ambient Air Quality Standards* were formulated and revised for multiple times aiming to protect human health and ecological environment. Although the government has made remarkable efforts to control air pollution, these actions have not kept up with its economy growth and fossil-fuel use. In particular, the low priority given to environmental protection and the lack of cooperation among various government agencies hindered progress on air pollution control. The design of targets and measures for air pollution control should be accompanied by corresponding assessment methods, in order to track and evaluate the implementation and effectiveness of the measures. Furthermore, there is defective integration among laws and policies.

At the very beginning, China's air pollution controlling policies gave priority to dealing with the air pollutants one by one, covering a few major pollutants. The traditional single-pollutant approach or local air pollutant control is far from enough in China. In the near future, China's air pollution control strategies should move in the direction of the multiple-pollutant approach. "Co-control" is now commonly used in the Chinese government documents, which refers to "coordinated control" or "synergetic control." Policymakers in China seem to be particularly interested in multiple-pollutant approach due to its potential to reduce costs and increase efficiency, and they also believe that multiple-pollutant approach should focus on synergies between air pollution and energy use for more cost-effective co-control.

Undesirable air quality is usually linked with the combination of high emissions and adverse weather conditions. However, there have been relatively few studies on the influence of climate change on atmospheric chemistry in the global perspective. Although further research is needed, available evidence suggested that climate change was likely to exacerbate certain kinds of air pollutants including ozone and smoke from wildfires. This has become a major public health problem because the interactions of global climate change, urban heat islands, and air pollution have adverse effects on human health. Reducing emissions of air pollutants to slow the pace of climate change will benefit public health. This can be considered as a kind of multiple-pollutant control strategy, for the purpose of it is to tackle the adverse impacts of general air pollutants in the company of global climate change mitigation.

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