Korea's New Comprehensive Plan on Fine Dust and Its Implications for Policy and Research

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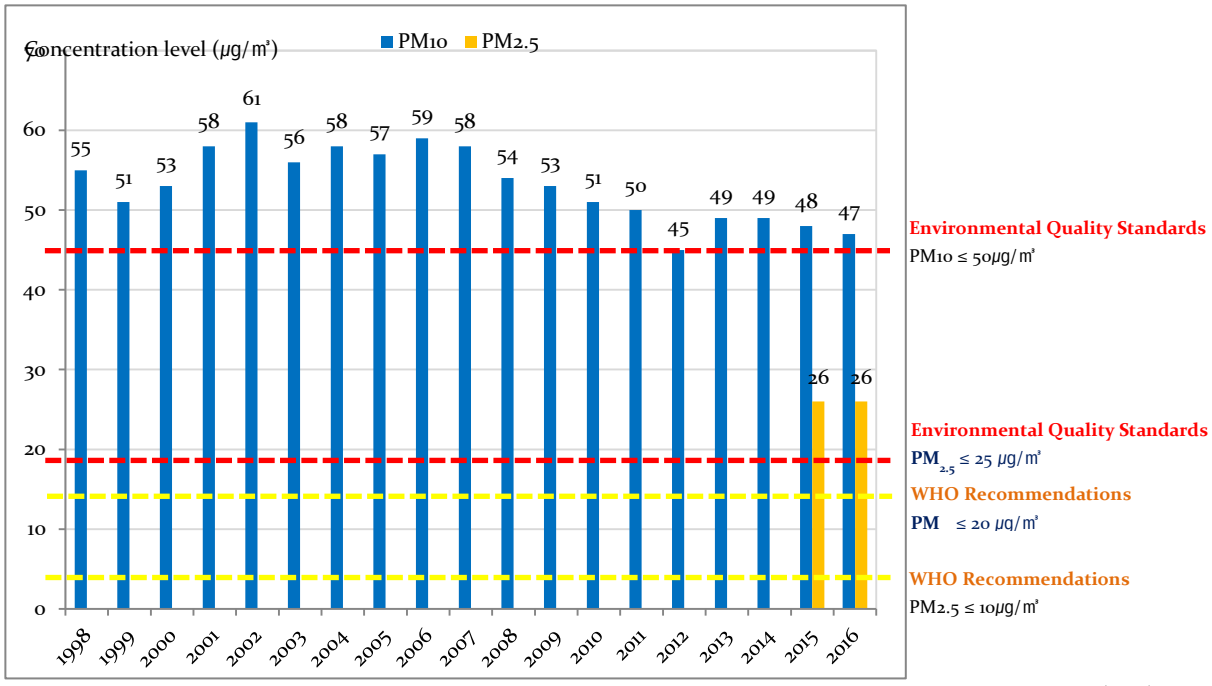
Introduction

Hardly a day has gone by in recent months without alerts for fine air concentrations. In January 2018 alone, a total of 36 alerts were issued nationwide for PM10. The number of alerts issued warning of ultra-fine dust (PM2.5) totaled 81 in the same month, a 68.8 percent increase year-on-year. Furthermore, fine dust concentrations exceeding the Korean daily average air quality standard have been frequently reported lately.

After the introduction in 1995 of the Air Quality Standard (50 $\mu g/m^3$), and a series of subsequent legislations, including Special Law on Atmospheric Environmental Improvement (2003), First Basic Plan for Atmospheric Environment Regulation, Second Basic Plan for Atmospheric Environment Regulation (2013), the PM10 concentration level has been on the decline, although not without occasional increases. The PM10 level, however, has nevertheless been persistently higher than the 20 micrograms-per-cubic meter recommended by the WHO. When it comes to PM2.5, the concentration level is higher than the Korean Air Quality Standard (25 $\mu g/m^3$) and as much as 2.6 times higher than the WHO-recommended 10 $\mu g/m^3$.

[Figure 1] Changes in annual average levels of PM10 and PM2.5 concentration

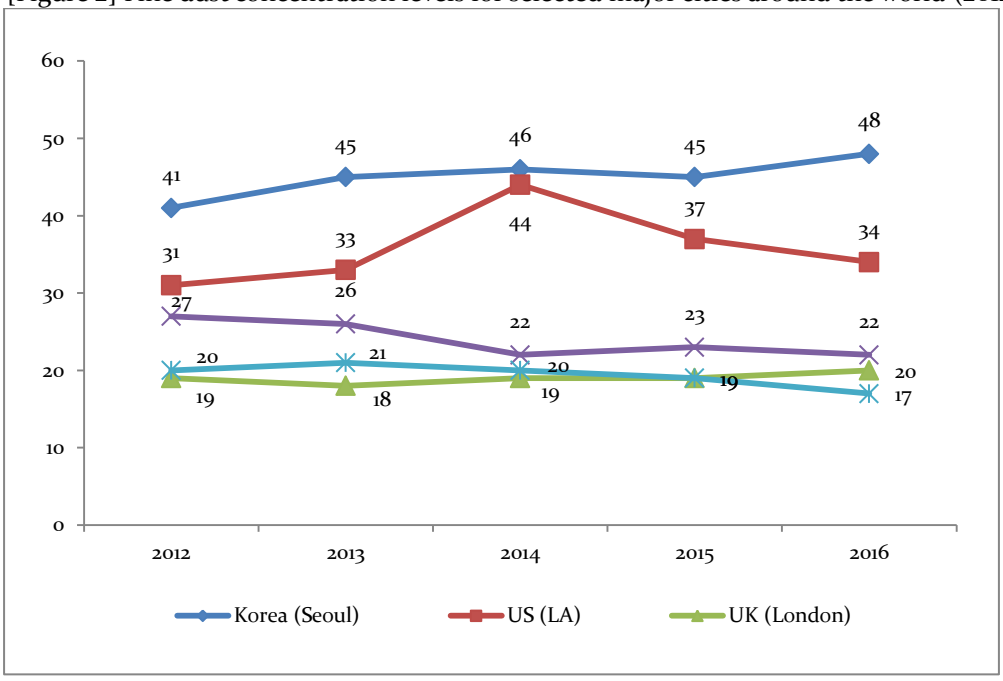


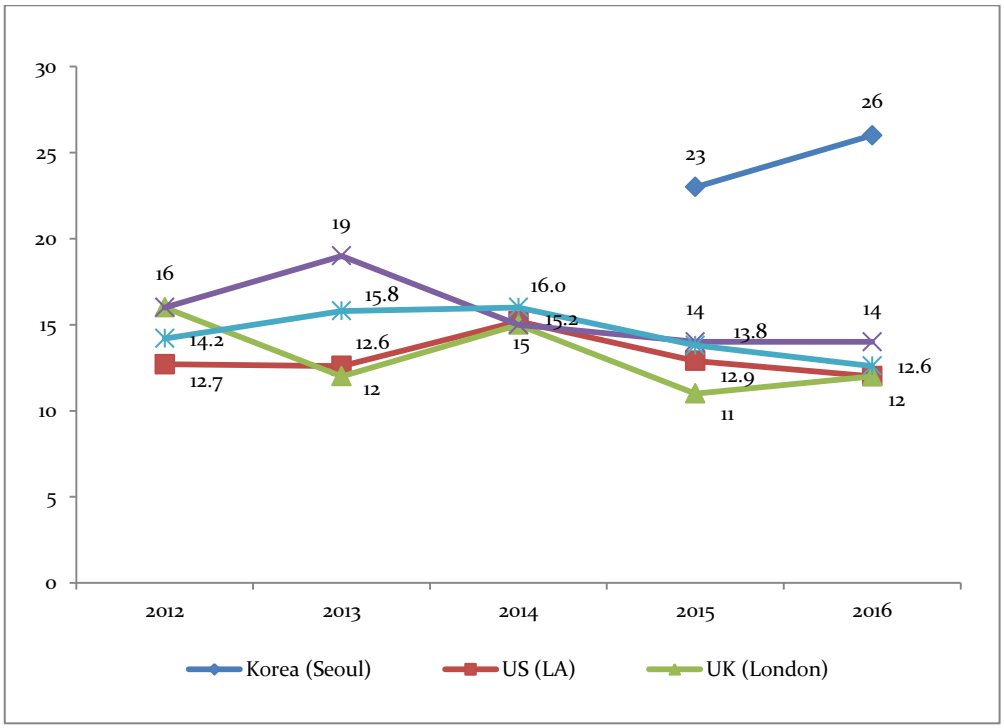
Note: Author's reconfiguration of some of the data on PM10 and PM2.5 in the *Annual Report of Air quality in Korea 2016* (p. 18), National Institute of Environmental Research

Also, the fine dust concentration level is higher in Seoul than in many other major cities around the world: PM10 concentration is 1.4 times, 2.2 times, 2.4 times and 2.8 times higher

than in Los Angeles, Paris, London and Tokyo, respectively; PM2.5 concentration 1.9 times, 2.1 times and 2.2 times higher than in Tokyo, London and Los Angeles, respectively.

[Figure 2] Fine dust concentration levels for selected major cities around the world (2012~2016)





Note: PM2.5 measures were according the Air Quality Standard (since January 1, 2015); the graphs are based on some of the measures in the table on p. 367 of the *Annual Report of Air quality in Korea 2016* of the National Institute of Environmental Research

Fine dust concentrations remain severe in Korea

As fine dust concentrations increased in Korea, so did the number of alerts issued warning of

them. PM2.5 alerts, in particular, have notably increased in frequency ever since the monitoring of the ultra-fine particulate matter started in 2015. In the winter and spring months of January through May, PM2.5 concentration level was 28 $\mu g/m^3$ in 2015, 29 μg in 2016, and 30 μg in 2017. The number of high PM2.5 concentration alerts increased over recent years from 72 in 2015 to 92 in 92. In January 2018 alone, a total of 81 alerts were issued warning of high PM2.5 concentrations. Not only has the number of alerts been on the increase, but also the average time for which alerts last has been getting longer. The number of PM2.5 alerts that lasted more than 24 hours increased from 14 in 2015 to 27 in 2017. The annual longest was 65 hours in 2015 and 72 hours in 2017.

[Table 1] Number and length of PM10 and PM2.5 alerts, 2015~2017

		2015	2016	2017
PM2.5	Concentration (January ~ May)	28$\mu g/m^3$	29$\mu g/m^3$	30$\mu g/m^3$
	Number of alerts (January ~ May)	72	66	92
	Number of alerts that lasted more than 24 hours (January ~ May)	14	8	27
	Longest alerts (January ~ May)	65 hrs.	50 hrs.	72 hrs.
PM10	Number of alerts (January ~ May)	190	195	183
	Number of alerts that lasted more than 24 hours (January ~ May)	47	36	25
	Longest alerts (January ~ May)	73 hrs.	59 hrs.	74 hrs.

Note: Author's calculations based on Air Korea's Annual/Monthly Air Quality Reports

Classed as a Tier 1 carcinogen in October 2013 by the WHO, fine dust is known to cause allergic rhinitis, conjunctivitis, keratitis, bronchitis, alveolar damage, lung emphysema, asthma,[1] myocardial infarction, cerebral apoplexy, abnormal heart rate, and premature death.[2] For every 10$\mu g/m^3$ increase in PM10 concentration, according to the Korea Center for Disease Control and Prevention, hospital admission and mortality in chronic obstructive pulmonary diseases (COPD) increases 2.7 percent and 1.1 percent, respectively. A 10 $\mu g/m^3$ increase in PM2.5 concentration is known to cause a 9-percent increase in lung cancer incidence rate and an 8-percent increase in PM10 concentration.[3] Also, long-term exposure to PM2.5 can increase ischemic disease mortality by 30 to 80 percent.[4] A 10 $\mu g/m^3$ increase in PM10 concentration is found to lead to a 0.69 percent increase in cardiovascular mortality and a 6 percent increase in PM2.5 concentration.[5] The health impact of fine dust is found to be larger in PM2.5 than in PM10 and more deleterious on the aged, young children, pregnant women, and those with heart disease or cardiovascular conditions than on the general population.[6]

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[1] *Once You Understand It, You'll See It: What Fine Dust Is*. Ministry of Environment (2016). pp. 22~23)

[2] Rückerl, R., Schneider, A., Breitner, S., Cyrys, J., & Peters, A. (2011). Health effects of particulate air pollution: A review of epidemiological evidence. *Inhalation Toxicology*, 2011, 23(10), 555-592.

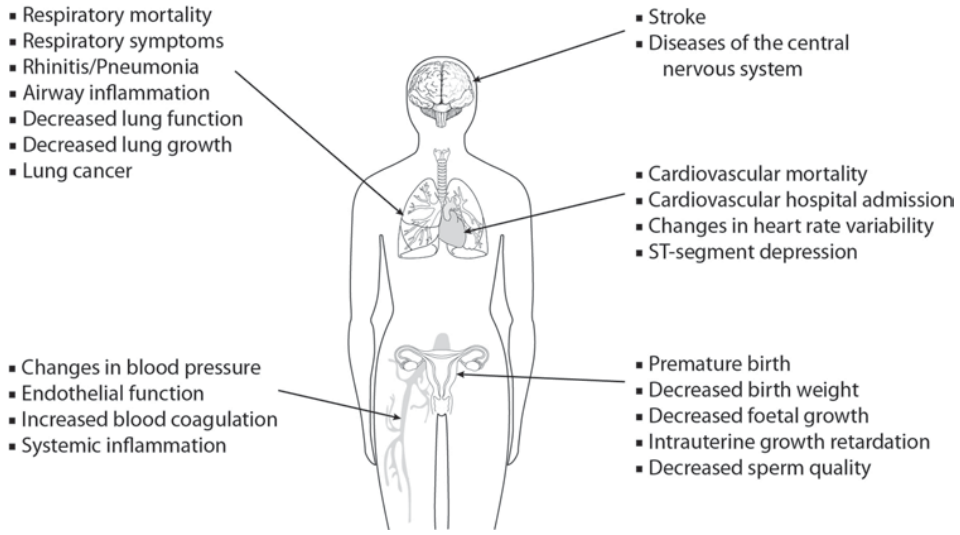
[3] *Once You Understand It, You'll See It: What Fine Dust Is*, Ministry of Environment (2016). pp23~24

[4] Ibid. p. 25.

[5] Myung, Jun-pyo (2016). Health Effects of Particulate Matter. *The Korean Journal of Medicine* 91(2). P. 110.6; *Once You Understand It, You'll See It: What Fine Dust Is*, Ministry of Environment (2016). p. 23.

[6] *Once You Understand It, You'll See It: What Fine Dust Is*, Ministry of Environment (2016). p.23.

[Figure 3] Health effects of fine dust



Source: Rückerl, R., Schneider, A., Breitner, S., Cyrys, J., & Peters, A. (2011). Health effects of particulate air pollution: A review of epidemiological evidence. *Inhalation Toxicology*, 2011, 23(10), p. 575.

Despite the various measures taken of old and late, fine dust concentration has not been reduced to a perceptible extent. The new government, as it took office in 2017, designating fine dust concentration as one of its top priority issues, set up an inter-ministerial task force and announced its "Comprehensive Action Plan on Fine Dust" on September 26.

Recent policy developments in the management of fine dust

The Comprehensive Action Plan on Fine Dust (also known as "September 26 measures") is much more ambitious than its predecessors in many respects, with the aim of cutting fine particulate emissions by 30 percent by 2022 across all sectors. It looks to strengthen Korea-China collaborative anti-pollution efforts and prioritize susceptible groups—certain groups of the population that are more susceptible than others to fine particulate matter—in the implementation of the government's commitment to improving Korea's air quality. Also, if previous anti-pollution measures were in large part limited to controlling certain air pollutants in and around Seoul and other metropolitan cities, the latest batch of measures aims to bring about sweeping reductions in fine particulate emissions throughout all areas of socioeconomic activities (including the industry, development and transportation sectors) centered in and around cities with severe fine-dust concentration levels.

The "total emissions control" program, previously applied only to the Seoul Metropolitan Area, is now extended to cover virtually the entire country (including Chung-cheong, Dong-man, and Gwang-yang), complete with a new charge on emissions of secondary pollutants such as nitrogen oxides (NOx). The September 26 measures target to phase out up to 77 percent of old diesel vehicles before its current term ends. With a view to better dovetailing the anti-pollution drive with the government's energy policies, the Plan also takes as its goals the spread of environment-friendly vehicles, tightening of the control of coal-based power plants that are in operation, and shifting to an energy mix that is environmentally sustainable with reduced coal-based power generation.

To reach its air quality targets, the government, having raised its environmental standards to

a level on par with advanced countries, is continuing its push for a range of fine dust regulations that are more proactive than previous governments' anti-pollution measures.

[Table 2] September 26 measures (2017) and Jun 3 measures (2016) side by side

		June 3 measures	September 26 measures
Targets		14 percent reduction in domestic emissions by 2021	30 percent reduction in domestic emissions by 2022
Power generation	Coal-based power generation	-Prohibition of new coal-fired power plants -Toughened regulations on coal-fired plant emissions	-Plans underway for 9 new plants (strengthened) -Shutting down old plants during the spring season; permanent shutting of old plants before the current government's term ends (new)
	Renewable energy	Increase to 11 percent by 2025	Increase to 20 percent by 2030 (strengthened)
Industry	Dust control	-	Total emission control (new)
	Emission charge	A charge on nitrogen oxide under consideration	Introduced a charge on nitrogen oxide emissions (strengthened)
	Total emission control	Total emission control for the Seoul capital region	Extended total emission control to Chung-cheong, Dong-nam, and Gwang-yang (strengthened)
Transportation	Eco-friendly vehicles	Spread of electric vehicles	-Increased the spread of eco-friendly vehicles including electric and LPG-based cars (strengthened) -Subsidy program for eco-friendly cars (new)
	Ships, construction machineries, 2-wheeled motor vehicles	Reduced harmful emissions from construction machineries	-Tightened regulations on ships and port facilities (new) -Extended target for low-pollution construction machineries (strengthened) -Tightened regulations on 2-wheeled motor vehicles; Distribute 2-wheeled electric motor vehicles (new)
	Old diesel vehicles	Banned old diesel vehicles from driving in the Seoul capital area	-Extended the low emission zone (strengthened)
Susceptible groups	Environmental quality standards	-	-Improved environmental quality standards on fine dust (new) -Indoor fine dust standards for susceptible groups (new)
	Infrastructure build-up	Expansion of fine particulate monitoring network	-Strengthening of monitoring networks in and around education institutions (strengthened) -Air quality monitoring of indoor sports facilities (new)
	Education and environmental services	Air quality education and awareness manual	-Convert school buses to environment-friendly vehicles -Home visiting care services for susceptible groups -Introduction of "Clean Air Zones" program
International cooperation	Agenda level setting	Fine dust issue upgraded to ministerial level (Korea-China-Japan Environmental Ministerial Talks)	Fine dust issue upgraded to summit level (Korea-China Summit)
	Agreement	-	International fine-dust convention under consideration

Source: Comprehensive Action Plan on Fine Dust, Ministry of Environment (September 26, 2017).

New standards are underway for the indoor air quality of facilities used by susceptible groups

like children and elderly people; and air quality monitoring networks will be strengthened around these facilities including schools. The Plan is also aiming to: increase indoor sports facilities; convert school buses running on diesel to environmentally friendly vehicles; provide "home visiting care program" for susceptible groups; and introduce a "Clean Air Zones" program.

What to do from now on

There is much to be done if the government's plan on fine dust is to succeed. First, current fine dust policy designates only children and older persons as susceptible groups. Fine dust susceptible groups are more varied, including, in addition to children and older persons, pregnant women, those with underlying conditions, socially underprivileged groups, those working in professions that are exposed daily to fine dust (transportation workers and motor vehicle mechanics), and residents living in industrial areas or near freeways and other air pollutant sources. According to Jae-Yeon Jang et al., pregnant women exposed to PM2.5 are 6.8 percent more likely to have a premature birth, and residents living around freeway infrastructures, who, exposed as they are daily to heavy fine particulate emissions from diesel-powered vehicles, run a higher risk of cardiovascular and respiratory illnesses and, in turn, an increased risk of hospital admissions and premature mortality attributed to these diseases.[7] The scope of "susceptible groups" should be broadened beyond children and elderly people, and a wider range of measures will need to be developed to help those various susceptible groups to better cope with the health hazards tied to fine dust.

Up until now, regulations on fine dust emissions have been spearheaded mostly by the Ministry of Environment. This in part explains why they are found wanting with respect to the scientific evidence on which they are based. The scientific base for these regulations need to be extended beyond the current focus on fine dust and associated health impact and excess deaths to consider the long-term health impact of fine dust and the different health effects of various levels of fine particulate concentration. Studies should be conducted also on the different levels of health impact that fine dust can have on people with different levels of susceptibility to airborne particulates. Furthermore, the implementation of the September 26 measures will need to be guided by studies of the health effects of ultra-fine dust and secondary pollutants like nitrogen oxides (NOx) and sulfur oxides (SOx).

Although to a limited extent, the September 26 measures have designated air pollution hotspots with a high density of child care centers, kindergartens and long-term care institutions as "fine dust-free zones" and subjected them to special regulatory controls, limiting the access of old diesel vehicles to them and reducing their operation hours on days of fine dust alerts. However, reducing fine particulate concentrations to the extent as envisioned in the September 26 measures would require extending the scope of "fine dust-free zones" beyond regions with a concentration of schools, kindergartens or long-term care facilities. Predicting with accuracy the health impacts of different levels of fine dust concentration will require monitoring of fine dust and mapping of real-time fine dust health risks.

The best way to stave off the health hazards of fine dust is by keeping exposure to fine dust to

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[7] Jae-Yeon Jang et al. (2014). Development of intervention study to prevent health damage from particulate matter and yellow dust. Korea Centers for Disease Control and Prevention.

a minimum. On days forecast to be high in fine dust concentrations, a general rule of thumb would suggest to avoid outdoor activities, keep the windows closed, and use, in case of outing, a dust mask. However, there has been research evidence that indoor-generated fine dust can be more toxic and inflammation-inducing than outdoor fine dust.[8] This suggests that the development of public health guidelines for responding to fine dust should be accompanied by policy attention to indoor air quality management. In fact, the September 26 measures include a proposal to put forward new standards for indoor air quality in buildings used mostly by young children and students. This is a task that should be preceded by research into the health hazards of fine dust. Also, as indoor air quality standards are considered essential for the protection of people's health, such research will have to examine not only facilities that are used by children and students, but also homes, public use facilities (underground stations, private academies, health care institutions, and childcare facilities) and hygiene-controlled establishments (hair parlors and hotels).

The current government has distributed response manuals it designed to help schools, childcare centers and long-term care institutions cope with fine dust according to forecast air quality level. Fine dust is omnipresent. People engaged in outdoor activities are inevitably exposed to it whether they like it or not. In stands to reason that guidelines should be developed to help the general public and susceptible groups better respond to exposure to fine dust inside everyday environments like home, public transportation vehicles, underground space and various commercial facilities.

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[8] Long, C. M., Suh, H. H., Kobzik, L., Catalano, P. J., Ning, Y. Y., & Koutarakis, P. (2001). A pilot investigation of the relative toxicity of indoor and outdoor fine particles: in vitro effects of endotoxin and other particulate properties. Environ Health Perspect, 109(10), 1019-1026.