SEOUL

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It is a rite of spring in Seoul, as familiar—and nearly as ancient—as the cherry blossoms. But the arrival of "Hwang Sa" is not nearly so benevolent a harbinger of the season. "Hwang Sa," or Yellow Dust, originates in deserts and is carried into the atmosphere by strong winds and onto the Korean Peninsula via the jet stream. Millennia ago—the earliest record of Hwang Sa in Korea is from the Second Century AD—the dust brought little more than a passing inconvenience. In the industrial era, however, the sands bring with them pollutants from both local and distant sources..

Small wonder that East Asia's concentrations of $PM_{2.5}$ are the highest in the world, according to World Health Organization rankings. South Korea depends heavily on coal for electricity; in South Korea about 50 coal plants generate electricity, a dozen more are planned by 2021, and the reliance is expected to deepen. According to government plans, most of the increasing demand for electricity in the coming years will be met with new coal and gas plants. Diesel fuel for cars and trucks further contribute to local pollution.

A joint U.S.-Korea study, one of the most intensive air-quality investigations ever, will help clarify the sources of pollution. Known as KORUS-AQ, the study involves more than 580 researchers from 72 institutions, including NASA. Three planes, two ships, and 300 ground-based monitoring sites combine to take air samples from across the Korean peninsula. NASA, for example, flies a DC-8 plane outfitted with sophisticated sensors at low altitudes up and down the length of the Yellow Sea, over rural areas, and straight through crowded downtown Seoul, sometimes flying as low as 1,000 feet.

Whatever the source, pollution in Seoul remains a stubborn problem. South Korea falls short of the WHO standard of 10 micrograms/m^3 for average exposure to $PM_{2.5}$, with average exposure nearly double safe levels. In 2015, the air quality in Seoul over a 24-hour period averaged "unhealthy for sensitive groups" or worse on 53 days. For comparison, Los Angeles counted only seven days in that category, while New York did not have a single day with air quality in that "unhealthy" range. According to researchers at Yale, in April, 2016, Koreans suffered through high levels of $PM_{2.5}$ half of all days.

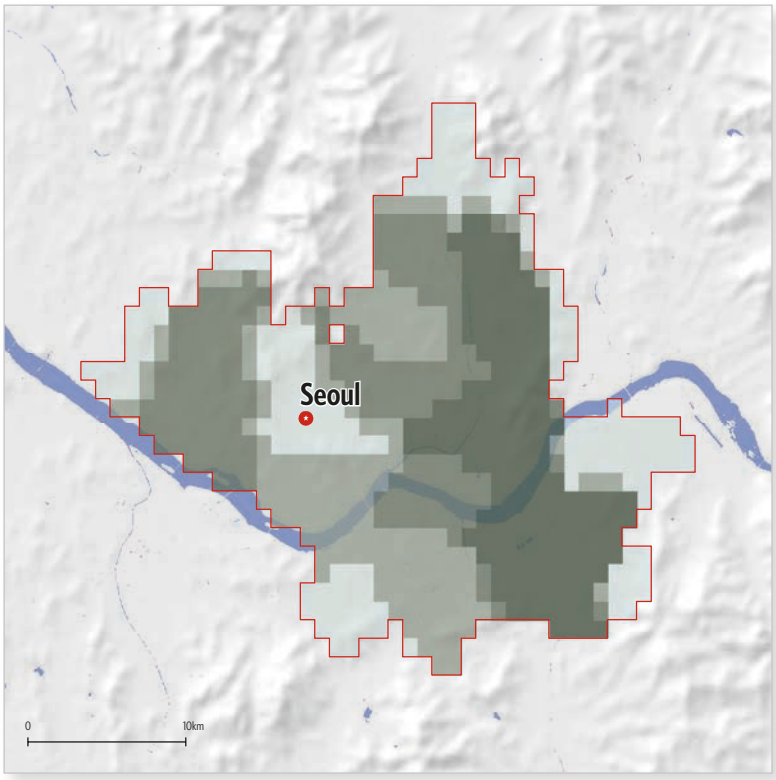
South Korea has implemented a range of policies and management efforts to address air pollution for more than three decades. South Korea promulgated its first regulation on air quality in 1993, the country's first PM_{10} standard in 1995, and further legislation for Seoul in 2003.

Government officials in 2016 said they were considering closing coal-fired power plants that were more than 40 years old in a move to tackle the pollution problem.

To address emissions in the public transportation sector, compressed natural gas buses are being introduced in Seoul and other cities, with the number increasing from just 74 in 2001 to 23,000 in 2010. The Bus Rapid Transit System was also established to create bus lanes in the center of roads for more efficient traffic flows, and congestion fees are collected at specific tunnels.

Seoul is also looking to increase greenspace in the city, setting a goal of more than 800,000 acres by 2020. Our results suggest that tree planting could also have temperature-mitigation benefits. Compared with other global cities, Seoul has a fairly high ROI of tree planting, with the highest ROI in a north-south band running through the center portion of the city. We estimate that an additional annual investment of $1.9 million in street tree planting could give more than 600,000 people a reduction of 1.5° C (2.7° F).

Results from the Seoul study



Map 27. Neighborhood-level ROI for Seoul (temperature reduction).

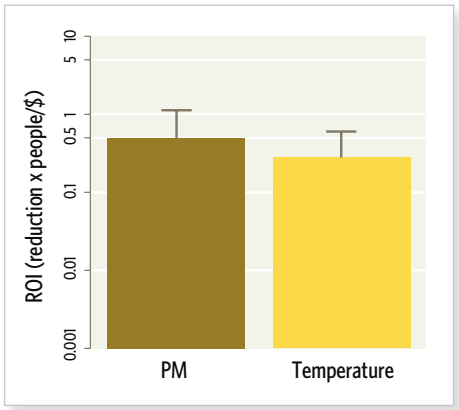


Figure 32. ROI for tree planting for Seoul.

Investment	Annual Cost ($)	> 1 ug/m² $PM_{2.5}$*	1.5 deg C
10% of sites	1,910,000	646,000	647,000
20% of sites	4,050,000	1,210,000	1,200,000
Full Investment	20,300,000	3,590,000	3,590,000

*Note: Most people will receive a reduction of > 10 ug/m² $PM_{2.5}$ in this city

Table 20. Temperature and PM reduction benefits under three investment scenarios for Seoul.

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