



Poor Visibility on China's Air Pollution

by Vaclav Smil



WHEN I LIVED in Hong Kong in the year 2000 the first thing I did every morning right after getting up, usually between 5:50-6:00 AM, was to check the Air Quality Index on the Hong Kong's Observatory Web site. This was a ritual, rather than an informative, exercise: chances were very high that even at that early hour most stations would already have high readings which in Hong Kong means the index of suspended particulate matter and nitrogen oxides was 55-85. Only Tap Mun Chau (a small island in the territory's northeastern waters, far away from major urban sources of pollution) would sneak in sometimes with low readings, particularly if there was a brisk southeast wind. Seven years later, I checked the Observatory's air quality readings from Canada at 5:30 a.m. of Hong Kong time: every station, including Tap Mun Chau, already had high air-pollution readings, and Mong Kok's nitrogen oxides were already very high.

This unwelcome reality is explained by a two-fold nature of Hong Kong's air pollution problem. The region itself is still a

considerable source of particulates and sulfur and nitrogen oxides (especially from inadequately controlled emissions from cars and diesel-fueled trucks and ships) and as a day progresses traffic congestion results in repeated rise of concentrations in the most densely inhabited neighborhoods during the late afternoon hours when photochemical atmospheric reactions create exceptionally high levels of smog. But even in 2000 it was clear that whatever steps Hong Kong will take to reduce its own considerable emissions such steps would not suffice to make the region's air fairly clean again. Only massive reduction of emissions that are transported from Guangdong could do that, as at least 80-85% of all pollutants in Hong Kong's air now originate in China.

But, as everybody concedes, such a step is unlikely to take place in the near future. Guangdong's cities and countryside within a radius of about 200 kilometers from Hong Kong are the single largest source of

Mr. Smil is a professor in the Faculty of Environment at the University of Manitoba, and author of 25 books on energy, the environment and China.



The famed skyscrapers of Hong Kong's Central district blanced by smog on one of the increasingly frequent bad air days.

China's manufactured exports and transforming that region into an area of low emissions will be a very costly task that would take decades to accomplish. This means that Hong Kong's citizens will continue to live with the new "normal" and will find it increasingly impossible to see Kowloon across the Strait from the Central. So will the tourists—instead of a stunning panorama from the Peak, they may see no further than high rise apartment buildings a few hundred meters below their platform.

But Hong Kong does not have China's most polluted air. Several northern cities are contenders for that title, and the capital is not far behind. When temperature inversions limit the mixing layer above Beijing, tall apartment blocks on the other side of a multilane thoroughfare often appear as just ghostly silhouettes, and rare is the summer day when Xishan (Western Mountains, about 30 kilometers west of the downtown) can be clearly seen from Meishan (Coal Hill, just north of the Forbidden City).

Research has shown that the psychological impact of closed horizons and visibly dirty air is considerable, and the economic impact on lost tourist income is self-evident. Why visit a place that can be more sensed than seen?

Limited visibility may be the most immediate indicator of China's poor air qual-

ity, but by far the greatest damage done by polluted air is to human health, to plants and to economic activity. We can now get a better appreciation of how bad some of these impacts are, and how difficult it is to assess the damage they create, thanks to a series of quantitative studies published in *Clearing the Air: The Health and Economic Damages of Air Pollution in China*, a new book edited by Mun S. Ho and Chris P. Nielsen and published by the MIT Press in 2007.

Contributions in this book are a part of the China Project whose various programs have been conducted by the Harvard University Center for Environment since the late 1990s. Assessment studies in the book deal with estimating health effects of air pollution in China, with local population exposures to pollutants from different sources (industrial, transportation, electricity generation), with economic value of air-pollution-related health risks and with sector allocation of emissions and damage and policies to control them. Those who are familiar with similar studies done in Western countries will immediately realize how challenging, and how inherently uncertain, many of these assessments are.

The standard approach in assessing health damage has been first to identify all sources and atmospheric concentrations of offending pollutants in a study region. Then estimate as accurately as possible the actual extent of population exposure to the effects of air pollution (in this case to suspended particulate matter and sulfur and nitrogen oxides derived mostly from coal combustion). And finally express the resulting health and economic damage by using a suitable valuation method. Every step has its own problems, and one of the book's strengths is that it makes clear the extent of the uncertainties encountered.

Certainly the best illustration of why the results of this kind of studies have to be interpreted with a great deal of caution

China's energy consumption growth rate means a study is of historical interest only in a few years.

is a comparison of air-pollution health-damage assessments for China published during the past 10 years. A World Bank study in 1997 put the total number of premature deaths due to air pollution at 178,000 a year in cities and at 110,000 in the countryside (mostly due to poor indoor air quality from inadequately vented stoves). In contrast, a 2003 study led by Stefan Hirschberg estimated as many as one million premature deaths a year, while the Harvard project (by Messrs. Ho and Jorgenson) put the excess mortality due to particulate matter and sulfur dioxide at about 94,000 in 1997. Such discrepancies make it virtually impossible to use these dose-response studies in formulating any effective policies.

Another obvious problem with studies that inevitably take some time to complete is the truly mad rate of China's energy consumption growth—it makes everything of historical interest in just a matter of years. The Harvard book contains an interesting study that deals with the population response to pollutants from electricity generation based on emissions in 2003. During that year China's electricity generating capacity reached 391 gigawatts, of which 290 gw were from thermal (mostly coal-fired) stations; three years later the total rose to 622 gw with 484 gw from thermal stations, the latter capacity being 67% higher than it was in 2003. This means that between 2003 and 2006 China added nearly 200 gw of thermal capacity, or more than the *total* installed capacity in France and the U.K.

A study based on 2003 data is thus already obsolete. If the capacity increase was matched by emissions increase, we could simply prorate the results. In reality, increased use of flue-gas desulfurization in

China's large coal-fired power plants means that for some stations emissions of sulfur dioxide emissions have actually declined substantially, while in other regions concentrations of new and uncontrolled power plants have resulted in a serious deterioration of air quality. And in all regions continuing urbanization has exposed a larger percentage of population to potentially harmful concentrations.

Moreover, there is no reliable way to assess long-term nationwide trends. Not surprisingly, official statistics make the situation look better. The latest report on the nation's air quality in 2006, issued by the State Environmental Protection Agency in 2007, notes an overall improvements in urban air quality as about 63% of 559 cities with regular monitoring now meet or surpass the criteria for urban air (Category II and I in Chinese grading).

But the proportion is different in terms of people affected. As most of the large cities do not meet the minimum requirements (belonging to category III or worse), in 2006 the split between population subjected to acceptable and unacceptable levels was 52/48, with nearly 170 million urban residents living in cities that even by China's relaxed standards are too polluted.

The reality is much worse because the Chinese standards have been far too relaxed. Particulate concentrations of 200 micrograms/m³ are acceptable in residential areas, while the World Health Organization's limit used to be just 90 micrograms/m³. Used to be, because the WHO set this limit aside and no longer sets guidelines for total suspended particulates. Its latest air quality guidelines issued in 2005 set levels for particles smaller than 10 micrograms annual mean no higher than 70 micrograms/m³. Particles smaller than

2.5 micrograms can penetrate deeper into lungs and their chronic effect is mostly responsible for premature mortality (studies have shown that every additional microgram increase of these particles increases the probability of air pollution-related mortality by 1%). WHO's maximum annual mean for these particles is no more than 35 micrograms/m³—but in Chinese cities their concentrations are commonly between 50–150 micrograms/m³.

A misleading impression of reality can be obtained by checking SEPA's Website, which shows a daily air quality index for China's major cities. On the day I checked the Hong Kong air pollution index, the SEPA's air pollution index for Beijing stood at 159, in the "lightly polluted" category. But this classification allows daily concentrations of particulates smaller than 10 micrograms to be as high as 350 micrograms/m³—while WHO's new guidelines for 24-hour mean level are no higher than 150 micrograms/m³, less than half the Chinese value. Consequently, by WHO's standard Beijing would be anything but "lightly polluted." Even more importantly, while high levels of particulate continue to be a major problem, China is unique among the world's major economies in having now the worst of both major air pollution types.

As the Western countries (and Japan) got richer, they relegated coal combustion to generation of electricity in large power plants with highly efficient electrostatic precipitators that remove up to 99.99% of all particulates, and later they equipped many of those plants with efficient desulfurization. As a result, classical (London-type) smog consisting of high levels of particulates and sulfur dioxide has been virtually eliminated in all affluent countries whose principal air pollution problem is now photochemical smog, a product of complex, long-chained atmospheric reactions that start with emissions of carbon

monoxide, volatile hydrocarbons and nitrogen oxides. By far the largest source of these pollutants is automotive traffic, and sunny climates promote frequent formation of the smog. This means that the phenomenon is seasonal in Toronto and Paris, but it persists for most of the year in subtropical and many tropical cities with high concentrations of vehicular traffic, and also with high frequency of flights (jet engines emit a great deal of nitrogen oxides).

During winter months, when households and apartment blocks in northern part of China use coal for heating and when limited mixing layer keeps pollutants from poorly controlled small coal-fired power plants near the ground, many Chinese cities still experience high levels of classical (particulate-sulfur dioxide) smog characterized by visible black dust fall and acrid sulfurous smell. But in summer the same cities, now full of congested and poorly controlled vehicular traffic, have recurrent high levels of photochemical smog.

Unfortunately, the Harvard studies have completely ignored the already severe and a rapidly worsening problem of China's urban photochemical smog. The main product of these complex atmospheric reactions is ozone, a highly reactive compound that has a number of adverse effects on living organisms and on materials. Ozone impairs lung function, injures cells, limits work and exercise capacity and lowers the resistance to bacterial infections; its effects on plants include lower yields of both annual and tree crops (already documented in China), damaged leaves (coniferous species are particularly susceptible), and reduced tree growth. High levels of ozone also contribute to the deterioration of fabrics and rubber.

The best argument for reversing this decline of air quality would be to have a reasonably accurate estimate of annual damages that would prove the benefits of remedial actions. Coming up with such val-

ues is an extraordinary challenge and wide ranges of values came out even in the most sophisticated Western studies. A study in the Harvard book shows that one tool often used in economic valuations of environmental impacts would not work in China: a survey of contingent valuation, the willingness to pay in order to reduce health risks of air pollution, found that the Chinese respondents were willing to pay (in relative terms) only 1/10 to 1/1,000 of sums that Americans were prepared to spend for the same purpose, and a surprisingly large percentage would not pay anything.

As for the aggregate annual cost of China's air pollution, the Harvard study offers a central estimate equivalent to about 1.8% of China's GDP in 1997, and the range of uncertainty as wide as 0.65% to 4.7% of the annual GDP a decade ago. Truly there is nothing new under the sun—in 1995 I was the first Westerner to perform an exploratory assessment of economic costs of China's environmental degradation (published by the East-West Center in Honolulu in 1996) and my conservative estimate ended up with 0.6% of GDP as an equivalent annual cost of China's air pollution in 1990. Can we assume that such conservative estimates worth less than 1% of China's GDP are applicable today, a decade after Harvard's study benchmark year?

Higher urbanization and hence greater exposure of larger number of people to high air pollution levels should have worsened the impact, but some successes in emission control have lessened it—and a net result could not be established without further complex studies. But by the time these are finished China's GDP, and emissions and exposure may be substantial

multiples of today's situation.

Consequently, it is unlikely that those inherently uncertain and easily disputable monetizations of air pollution effects will have a decisive role in setting long-range policies. Nor am I sure that international pressure can change anything. Even though the Pacific Ocean may be more than 10,000 kilometers across, on some days one-quarter of all particulates in Los Angeles air can be traced to China, and this flux will certainly increase in years ahead. But the U.S. has no leverage in these matters. That polluted air in California is just another part of a destructive bargain (next to large domestic job losses in manufacturing and a perilously deepening trade deficit) that the country has so unwisely struck in exchange for cheap and contaminated Wal-Mart-type merchandise from China.

There is no doubt that new, more efficient techniques and new pollution controls have combined to reduce the relative growth of China's air pollution during the past 15 years. From 2001-06, the amount of sulfur dioxide removed from combustion gases nearly doubled and the capture of particulates went up by nearly 70%.

These are considerable achievements but have been insufficient to prevent further absolute rises in overall emissions—by 2006 sulfur dioxide releases were up by 30% and those of particulate by about 10%. And because of runaway urbanization this means that the population exposed to harmful air pollutant levels (as defined by WHO and not by SEPA) has increased. Unfortunately, as bad as China's air quality is, an old cliché applies only too well: matters will have to get worse before they will get better. ■