

BACKS TO THE FUTURE...

AIR POLLUTION RISKS TO CHILDREN

A GLOBAL ENVIRONMENTAL HEALTH PROBLEM

*Morning in Donora, Pennsylvania
October 1948*

by Devra Lee Davis

This article is adapted from Devra Davis's book *Uninformed Consent—How the Environment Shapes Sex, Life, and Death*, a work in progress.

The fog closed over Donora on the morning of Tuesday, October 26th. The weather was raw, cloudy, and dead calm, and it stayed that way as the fog piled up all that day and the next. By Thursday, it had stiffened adhesively into a motionless clot of smoke. That afternoon, it was just possible to see across the street, and except for the stacks, the mills had vanished. The air began to have a sickening smell, almost a taste...

Funeral services for most of the victims of the fog were held on Tuesday, November 2. Monday had been a day of battering rain, but the weather cleared in the night, and Tuesday was fine. "It was like a day in spring," (funeral director) Schwerha says. "I think I have never seen such a beautiful blue sky or such a shining sun or such pretty white clouds. Even the trees in the cemetery seemed to have color. I kept looking up all day."

Berton Roueche, *New Yorker*, 1955



The town I grew up in was famous in the way that the Son of Sam and Jack the Ripper were famous, so it was not surprising that nobody ever talked about it. Everybody in the small steel community of Donora, in the Monongahela Valley of southwestern Pennsylvania not far from Pittsburgh,

either worked in the local mills or took care of those who did. The town prospered. "It smells like money," my Dad used to say.

In October 1948, those smells proved deadly when a lethal fog of coal, coke, and metal fumes darkened the homes and streets of the town. Cooler, heavier air blanketed lighter, warmer zinc, fluoride, and sulfur-laden gases from the local plants and coal fumes from home furnaces and stoves. Smothered under a toxic cloud for nearly a week, the town ground to a halt. Black and blue air made travel impossible and sickened half the town. On one Saturday in Donora so many people had dropped dead that the local funeral homes ran out of coffins, and the community center became a temporary morgue.

John Volk, one of those who ported oxygen tanks from door to door to revive ailing residents, told a reporter:

There was never such a fog. You couldn't see your hand in front of your face, day or night. Hell, even inside the station the air was blue. I drove on the left side of the street with my head out the window, steering by scraping the curb...this fog was so bad you couldn't even get a car to idle....I found people laying in bed and laying on the floor. Some of them were laying there and they didn't give a damn whether they died or not. I found some down in the basement with the furnace draft open and their head stuck inside, trying to get air that way.¹

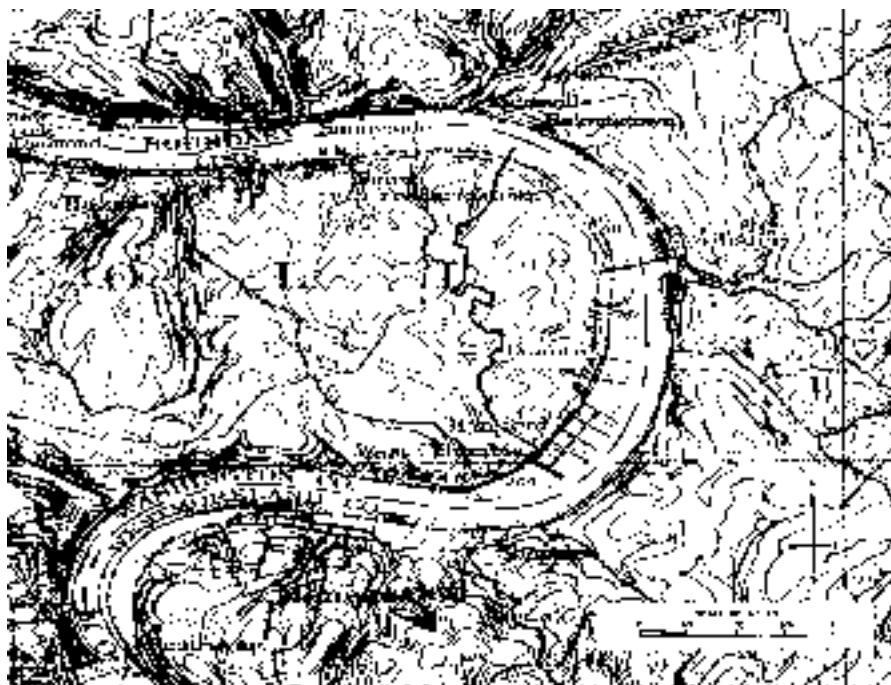
Situated along a horseshoe bend on the Monongahela River, Donora was home to a massive iron and steel works, a large rolling mill, numerous coke ovens, and a zinc plant, which obscured the view of the river. The zinc works yielded a stifling amount of heat and smoke. At the plant, large sets of parallel pipes lay on their sides, efficiently funneling toxic zinc and other metal fumes and molten metal out of the hot furnaces, which were fed by ore. At the

time, it was proudly said that Donora had the world's largest zinc works. Left unsaid was the fact that the plant's technology was out of date from the start. Short smokestacks guaranteed that the pungent plume of heavy metals never made it out of the low-lying valley floor which sat about 400 feet below the surrounding hills.

The notion that the same materials that kept folks employed could also convey serious health risks was not easily entertained in the Mon Valley. The millhands used to say, "It ain't a healthy

the killer smog had lifted at least 50 more people had died. The idea that any of these deaths could be considered "excess" and related to the smog episode was a strange notion at the time. When you are dead, you are dead, my Mother always said. Statisticians cannot tell us who will die, but they can predict the number of people expected to expire in a population over a given period of time, and whether a group of deaths is occurring that should not.

For years following the incident, nobody tallied the deaths that continued



A geological survey map of Donora and vicinity.

environment if you can't feed your family." In the months that followed, the crippling smog was chalked up by many as a freak occurrence of nature, spawned by the heavy, loping fogs that regularly gripped the mill valley and nestled against the low-lying hills on both sides. By the spring of 1949, the zinc plants, steel mills, and coke ovens were back at full throttle, and a local forecasting service was hired to warn of any future weather patterns that could cause a similar event.

Nobody talked about it then, but it turned out that for about a month after

to mount in Donora. Only upon examination years later did people realize that the morbid effects of the smog extended well beyond October 1948. Can we know whether the twenty-fifth and final heart attack that killed my grandmother seven years later had anything to do with the smog? The official investigation of the incident was limited and focused only on the short-term effects of the pollution. Inquiries were hampered by some of the townspeople, who, with an interest in protecting their livelihoods, interfered with the investigation. In the rougher part of Donora, for example,

investigators were threatened with handguns. Like many early environmental assessments, the early study of Donora was inconclusive by design. All we know is that during that dark Halloween week of 1948 most of the people who died were between age 52 and 85. Within 12 hours, 20 people suddenly died, 10 times more than is statistically normal.² All of them had various health problems before they died. Did the smog kill them? Did repeated exposures to lower levels of pollution increase deaths for years afterwards?

AIR POLLUTION AND HEALTH

Debates about whether the smog that hit Donora was a bizarre event ended when a more massive and undeniably lethal smog struck London in early December 1952. Within two weeks 4703 people died, compared with 1852 during the same period the previous year.

The exact number of additional deaths tied to the London episode over the next several months was never disclosed because the British Cabinet at the time secretly agreed not to record or release such information. A recent British BBC documentary revealed that the Cabinet had ordered that no deaths after December 20 would be attributed to the episode, but would be blamed on a flu epidemic. However, there was no flu epidemic elsewhere in Britain, and the World Health Organization (WHO) did not note one at the time. If the continuing elevated mortality in London was related to the fog, then the number of excess deaths was at least 8000 and possibly higher, according to Dr. David V. Bates, professor emeritus at the University of Vancouver Medical School and one of the world's leading researchers in this area.³

These dramatic and sudden deadly atmospheric events in industrialized countries made clear decades ago that high levels

of coal-based and other industrial air pollution can kill the vulnerable. However, these episodes left uncharted the more difficult and important question of what regular, daily exposure to lower levels of polluted air means for the health of the general population. An active person takes in 10–20 thousand liters of air every day, about 7–14 liters each minute. Those who work or exercise vigorously can inhale up to 50 liters of air per minute. If that air contains minute amounts of pollution, breathing it over a lifetime can cause illness or even death.⁴

Using sophisticated statistical models, public health researchers have devised powerful tools for examining patterns of pollution and health, finding that lower levels of air pollution today are tied with demonstrable increases in death and disease in a number of megacities. As recently as the winter of 1991, London recorded well above average hourly concentrations of NO₂ for four days, which included some of the highest levels ever recorded in the city's history. Ross Anderson and colleagues reported that it caused 160 more deaths than normal. Compared with the same time period of the previous year, the number of deaths from respiratory disease was 22% higher, while those from cardiovascular disease was 14% higher.⁸ More than 30 different studies have been completed in as many countries, all showing that moderately elevated levels of pollutants, such as particulates, NO₂, SO₂, and CO can worsen existing respiratory ailments and can also significantly increase death rates.⁹

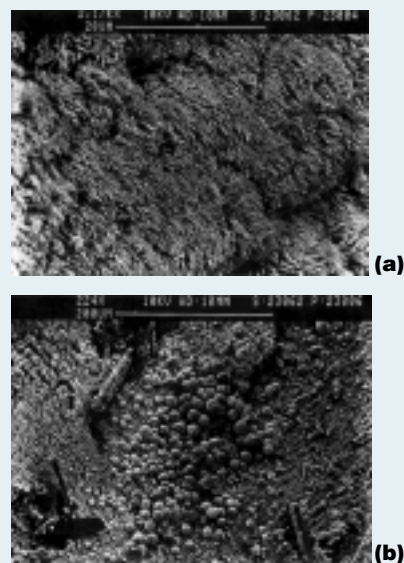
As the understanding of air pollutants increases, means to control these substances also improves. For one of the most well studied pollutants, particulate matter, scientists now realize that fine and ultra-fine particles smaller than a few microns may pose the gravest danger. A product of incomplete

Brazilian Rat Studies Reveal Pollution's Toxic Effects

Immediately following the Donora episode, scientists began studying what happened to rodents exposed to air pollutants under controlled conditions. Unlike people, rats breathe through their noses, thus filtering the air they inhale. Despite this major difference, some studies in animals have yielded clear and convincing evidence of the lethal capacity of air pollution. Laboratory studies in the United States by Godleski and colleagues found that rats exposed for three days to air from Cambridge, MA, will live perfectly well, if they are healthy at the start. But, if the rats have lungs damaged either by chemicals or bronchitis, then one in three of them will die.⁵ Studies conducted with dogs yielded similar results.⁶

Recent research by Professor Paulo Saldiva and his team of environmental health specialists at the University of São Paulo has revealed that caged lab rats raised in a church steeple located in the heart of São Paulo developed lung damage typical of that produced by cigarette smoking. Rats sent to live in the cleaner countryside of Atibaia, Brazil, had much healthier lungs.⁷

The photos at right show two enlarged electron micrographs depicting the internal surfaces of the lungs of the rats in the Brazil study. Healthy ciliae in the lung of a rat raised in the countryside filter out pollutants, bacteria, and viruses (a). In contrast, the lung of a rat reared in the center of São Paulo lacks protective ciliae that defend against pulmonary damage (b).



combustion, ultra-fine particles are increasing in importance in industrialized countries, where coarser particulate levels are lower. Ultra-fines may explain the baffling growth of asthma in industrial countries worldwide. Professor George Thurston of New York University and others are investigating one possible reason. While overall direct emissions from modern cars have declined, finely shredded latex (known to be highly al-

lergenic)¹⁰ and other byproducts from car tires have certainly increased, as has the proportion of vehicles producing diesel exhaust in many large cities today.

As for fine particles, which can be more than 50 times smaller than the diameter of a human hair, their danger could derive from the fact that they attract other pollutants to their surface, such as toxic metals, hydrocarbons, and volatile materials.

It is also possible that these very fine particles can cross cell membranes and enter the bloodstream, where they thicken the blood, interfere with circulation, and prevent the body from taking in the oxygen it needs and getting rid of what it does not need. Dr. Annette Peters led a team of German investigators who reported to the *Lancet* that on days when air pollution was elevated, the plasma of people randomly sampled was much more viscous. Increased "serum viscosity" could well represent part of a chain of reactions that lead to higher rates of hospitalization and heart-related deaths. Recently, Peters led another team of researchers who found increased rates of cardiac irregularities requiring defibrillation linked with elevated levels of particulate pollution.¹² Cardiac wards in Teheran hospitals overflowed with afflicted individuals and the government closed kindergartens and elementary schools during a week of heavy smog this past December.¹³

In addition, these fine particulates do not respect national boundaries and can travel thousands of miles across the world. Particles from specific smokestacks in Beijing have been tracked across Mauna Loa, a pristine volcanic observatory in Hawaii, to the U.S. Northwest.¹⁴ Professor Thurston and colleagues from New York University reported that acidic pollution generated in the United States produced an array of serious health problems hundreds of miles away in Canada.¹⁵

CHILDREN AT INCREASED RISK

Children are at greater risk from air pollution for a number of important reasons.¹⁶ Physiologically, their organ systems continue to develop through their first few years of life. A child's lung, for example, grows most rapidly in the first two years of life and continues to grow until the late teen years. Developing organs can be extremely sensitive to the toxic effects of air pollutants. Children also tend to absorb pollutants more readily than adults and retain them in the body for longer periods of time. Because they breathe at a higher rate than adults (both at rest and at play), children are exposed to greater levels of pollutants relative to their smaller body weight and are generally more sensitive to their effects on a pound-for-pound basis.¹⁷ Each day, a three-year-old child inhales twice as much air per unit body weight as an adult.¹⁸ That child therefore absorbs double the amount of pollutants for his or her weight than an adult. In a study of deaths in the first month of life in the United States, infants living in areas with greater PM₁₀ exposure encounter a 45% higher risk of dying from respiratory illness than those living in less polluted areas.¹⁹

Already, air pollution in the developing world is responsible for at least 50 million cases of chronic cough in children under age 14.²⁰ Respiratory disease is now the leading cause of death in children worldwide.²¹ As urbanization expands, more children will be exposed to hazardous pollutants in the air, driving the proportion with serious respiratory illness upward.

Children living in megacities in rapidly developing countries are in double jeopardy from poverty and degraded environments. Environmental pollution only adds to the burden of food deprivation, microbial diseases, and lack of preventive care or medical treatment that many children face in the developing world.

It has long been known that air pollution can aggravate illnesses such as bronchitis, asthma, and chronic obstructive pulmonary disease.²² Children with diets deficient in vitamins, minerals, and protein are especially vulnerable to toxic effects of chemicals. When their immunity is reduced, they cannot easily transform pollutants to more benign substances in their bodies and tend to retain toxic materials for longer periods of time.²³

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The earlier in life that a child encounters pollution, the greater the damage will be in later years. While the full social and economic impacts of air pollution on children's health cannot be precisely gauged at this time, the long-term effects are likely to be considerable. These include diminished productivity stemming from shortened life spans and reduced lung capacity, increased numbers of sick days, greater incidence of a variety of age-related chronic diseases, and a reduced overall quality of life. In addition, toxic pollutants, such as lead, which can be carried on airborne particles, permanently diminish their intelligence and health.

WHO has determined that fine particulate pollution is responsible for one out of every 10 of all respiratory infections in European children, and one out of five in the most polluted

by Dr. Victor Borja, has produced some troubling results.²⁶ They found that more babies died following periods when air pollution was elevated. Equally disturbing results have been reported in other cities.²⁷ Professor Saldiva's group in São Paulo found that pregnancies of those living in more polluted zones were nearly 30% more likely to terminate at eight months than those living in the least polluted regions of the city.²⁸

Scientists do not know the lifetime consequences of so many young people regularly breathing such polluted air as they grow up. Nearly nine out of every 10 of the world's children live in developing countries; half of them reside in urban areas.²⁹ The proportion of these populations exposed to heavy pollution is without precedent. Children will live more years of life under these conditions than will adults.

Those exposed to air pollution when young will have more time for the effects of pollutants to accumulate and to develop health problems triggered by such early environmental exposures.

THE STATUS OF AIR POLLUTION TODAY

Today, air pollution in the United States is generally not visible, except in areas with regular meteorological inversions or higher altitudes. Emission standards for cars and power plants have drastically reduced many air pollutants. Between 1931 and 1932 the U.S. Public Health Service found that the average level of particulates for the year in cities was $510 \mu\text{g}/\text{m}^3$. By 1957, the average had dropped nearly 5 fold to 120. Today that number is below 100. But, even at these levels, there is clear evidence that what people cannot see can still hurt them. These annual averages can tell us nothing about what happens during occasional incidents, such as those that regularly plague Bay View Hunters Point, near Oakland, CA, or Lake Charles, LA, when an industrial operation goes haywire and thousands of gallons of toxic waste are released into the air or water.

Our understanding about air pollution is light years ahead of what it was during the time of Donora's disaster. Since then, a host of federal and state scientific and regulatory groups has formed and devised a fairly sophisticated system for naming and measuring key pollutants in the air. Today, carbon monoxide, sulfur oxides, nitrogen compounds, particles, and volatile materials have been singled out for regular study in most major metropolitan zones of the United States and in many other countries. In addition, data from monitoring stations around the United States and the world are available to the public over the Internet, along with information on the health and environmental dangers of pollution and how to minimize its effects. The United States has several national (e.g., <http://www.epa.gov/oar/oaqps>) and regional (e.g., <http://www.aqmd.gov/>) Web sites



A commemorative plaque memorializing the victims of the pollution episode was mounted on the 50th anniversary of the disaster.

cities.²⁴ A new study from the Czech Republic by Bobak and Leon found that infant deaths were clearly more common in babies who had lived in more polluted zones. From 1990 to 1992, they looked at all births and compared living infants with those who died but were born on the same day and of the same sex. Assessing total air pollution exposures throughout the lives of these infants, they found that the risk of dying from respiratory causes was nearly twice as high for infants living in more polluted regions, compared to those born on the same day (with similar birth weights) living in less polluted zones.²⁵ Increases in infant deaths have also been demonstrated. A team of researchers working in Mexico City, led

that offer a wealth of information (www.climate.org). In Mexico, daily reporting on pollutant levels is also available on the Web (www.sima.com.mx).

While the air is generally much cleaner in most developed countries today, more complex and challenging problems remain. The risks posed by yesterday's factories have now been largely supplanted by even more challenging risks tied to trucks and cars (possibly including latex emissions from tires) and power plants, and leaks, fires and accidents of industrial boilers and incinerators.

DONORA 2000

Donora became a vast industrial deconstruction project following the demise of its major plants. The zinc works was the first to go, in 1956. By 1960, the mills were finished. One resident recalls, "First, they tore down the big plants. They even built a McDonald's and no one came. So, they boarded that up and built a parking lot. Now, nobody parks there either."

Today, the town has 6000 residents. For the most part, the young people move on as soon as they can. Attorney Arnold Hirsch is among those who stayed. "Most people with any get up and go in my generation left Donora long ago. For me, it was just easier to stay. My parents lived here. My father gave me a window and a desk to start my law practice above his furniture store after the Depression." A town leader throughout his adult life, at age 80 Hirsch is still a respected lawyer in the Valley, working with his wife, Rina, on Donora's two-block-long main street. They live in his parent's former home on Prospect Avenue. Sweeping views of the now green valley can be seen from the front door.

The small, well maintained Jewish cemetery where my grandparents are buried sits on one of the prettiest bluffs in the area, with a panoramic vista. Hirsch and others keep it locked and tidy, with small gray headstones marking the graves of Donora's former residents.

Donora provides a parable of what can go wrong when, as Professor Robert Proctor once noted, we fail to appreciate "not just how ignorance can invite knowledge, but also how knowledge can abide ignorance, despite all our efforts to clear a path from the one to the other."³⁰ The former company town paid a price that left it nearly one quarter its original size.

WHO has determined that fine particulate pollution is responsible for 7–10% of all respiratory infections in European children, with the number rising to 21% in the most polluted cities.

As for Donora's mills, for years nothing marked the fact that so many people had died in what became one of the first publicly understood episodes of deadly air pollution. On the fiftieth anniversary of the smog, this past October, the state Historical and Museum Commission erected a bronze plaque near the mill's former center, as a memorial to the "about 20" who died from air pollution in 1948. No plaques have ever been mounted for those who, like my grandmother, did not succumb at the time of this episode, but went on to premature deaths or spent the rest of their lives a bit sicker because they breathed toxic air.

In Donora and much of the Monongahela Valley today, autumnal fogs are still a fact of life, but no longer mix with fluoride, zinc, and sulfur as they did when more than 40 mills, mines, smelters, and coke ovens marked the landscape of Washington and Allegheny counties.

Today, nobody knows what happened to those of us who grew up in Donora. Most are long gone.

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