Testimony of Devra Lee Davis, Ph.D., M.P.H.
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Subcommittee on Energy and Mineral Resources
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Introduction

Thank you for inviting me to testify today before this committee, as you consider the challenges that regulatory agencies face in relying on environmental science. I have worked as an expert and professor on environmental health to scientific and regulatory agencies in this country and abroad for nearly three decades. I have served as a Lead Author of the Intergovernmental Panel on Climate Change for the United Nations Framework Convention, and have chaired, organized and edited proceedings from an international expert meeting for the IPCC and the Organization for Economic Cooperation and Development on the Ancillary Benefits of Climate Change. I am an epidemiologist and toxicologist, who has written more than 170 scientific publications. I received my B.S. and M.A. degrees from the University of Pittsburgh in 1967, my Ph.D. in science studies from the University of Chicago in 1972, and a post-doctoral Masters in Public Health, from Johns Hopkins University, where I held a Senior National Cancer Institute Post-Doctoral Fellowship in Cancer Epidemiology. I also held a National Science Foundation Post-Doctoral Fellowship at Catholic University in the History, Philosophy and Sociology of Science.

I have worked in the administrations of Presidents Carter, Reagan, George H. W. Bush, and Clinton and served on numerous national, state and international advisory committees on public health and the environment. I was confirmed by the United States Senate to the Presidentially appointed position as member of the National Chemical Safety and Hazard Investigation Board in 1994, a post which I never formally held and from which I officially resigned in 1999. I was also appointed by the Speaker of the House of Representatives to the Mickey Leland Air Toxics Board, on which I served from 1994-2000.

I am currently Visiting Professor at Carnegie Mellon University’s Heinz School, and an advisor to the University of Pittsburgh Medical Center, Cancer Institute, and to the World Health Organization. From 1983 to 1993, I worked at the U.S. National Research Council of the National Academy of Sciences as founding director of the Board on Environmental Studies and Toxicology, and as the only woman to have been appointed Scholar in Residence there. I was founding director of the non-profit, bi-partisan World Resources Institute, Program on Health, Environment and Development from 1993-1999.

In 2002, a book I wrote, When Smoke Ran Like Water, made me the first writer on the environment to become a National Book Award finalist in nonfiction since Rachel Carson. These written remarks provide the basis of my oral comments before this committee, and are drawn from my book and recent publications. Where my book is the source of specific materials, these appear in italics and are taken from When Smoke Ran Like Water, Basic Books, 2002.

Overview

In my testimony today, I will:

First discuss some of the inherent limitations of science as these relate to public policy, and the social and political factors that can influence science.

Then, I will contrast how environmental health research deals with great, big, acute and sudden disasters that hit in a short period of time as compared with how research studies sometimes small, complex and chronic events that can take years to become evident. I will also comment on some of the historic problems scientists have had conducting research free from political and economic pressures.

Finally, I will comment on some specific developments regarding energy policy in my two home states of Pennsylvania and Wyoming, as these are of some direct relevance to this committee’s overall purview.

And I will make a few brief observations on the chilling effect that the Administration's proposed budget for research and development will have on the capacity to conduct research relevant to environmental science overall.

Science and public policy—the shotgun wedding

Science is an inherently uncertain institution, which is continually under development. Relying on replicable methods of study, science proceeds by comparing, analyzing, and extracting information in systematic ways to clarify the basic nature of the world in which we live. Advances in science have created powerful tools that allow us to live longer, better, healthier and cleaner lives. Where direct observations are not feasible, science depends on the use of models that estimate relationships among variables being studied.

As a result of major advances in science and technology, we no longer must avoid horse dung in our major cities, nor need we fear that drinking water routinely subjects us to lethal epidemics of typhoid, both of which were common at the turn of the last century. Philosophers sometimes distinguish between the normal, puzzle solving work of science in well established disciplines and the cutting-edge, revolutionary work that takes place in fields as they are under development.

Those of us who are privileged to work on environmental health sciences recognize that none of us can master all of the separate disciplines that are involved in understanding how the ways in which we live today affect our health and that of the planet. The field of environmental science encompasses many different disciplines, including toxicology, epidemiology, exposure assessment, modeling, meteorology, climatology, geology, and chemistry. Research on global climate and public health issues is a vibrant, challenging and exciting enterprise today. We have devised a number of tools to assist in this process, some of which you will be hearing about today. These include relying on risk assessments, based on experimental findings and models, to predict and prevent harm from taking place.

When risk assessment methods were first being standardized at EPA, in 1976, I worked to set up the Office of Health and Environmental Assessment that created many of the protocols that have been used to evaluate animal toxicology evidence as part of the regulatory process, and I worked to coordinate efforts to control toxic substances with the FDA, OSHA and CPSC, which led to the founding of the National Toxicology Program. The NTP has championed the creation of appropriate animal models that can be used to indicate potential hazards from chemicals. Like all scientific enterprises, Later, I worked with the Science Advisory Board of EPA in the Reagan Administration of U.S. EPA Administrator, William D. Ruckelshaus. Ruckelshaus once remarked that he felt as though he was presiding over a shotgun wedding of law and science, with each party being forced into a marriage that neither would have chosen if they had any say in the matter.

For environmental sciences and their use in law and regulation, this metaphor of the shotgun wedding remains apt today. Science works with uncertainty as one of the accepted characteristics of the enterprise. Regulation and law, in contrast, often assume that uncertainty does not exist, or if it does that it can be ignored. These different assumptions can lead to conflicts that sometimes result in awkward accommodations.

Environmental laws were crafted some three decades ago, when we were all more naïve about the limitations and strengths of science. Our laws are often written with the expectation of precision and rigor, while science on environmental health, must be regarded as an ever evolving set of information that is continually advancing through the process of research, review and publication in the peer-reviewed literature. Peer-review should be understood as a process that has evolved to address the need for scientific evidence to be subject to independent tests of confirmation and validation. It is a cumbersome and complex system that has advanced along with improvements in our speed of electronic information processing and on-line publication. But, it is not therefore a system that needs additional layers of scrutiny applied to it. One could argue, as the editors of Science, Nature, and the Lancet, recently have, that the placing of added review to a process that is already protracted and complex will have no positive benefit to science, nor to the society in which that science is conducted. .

In fact, the peer review process by which scientists assess and criticize one another's work to decide what is fit for publication is somewhat like what Winston Churchill said of democracy. It is the worst form of scrutiny, excepting any other form that has been tried.

As will become clear from the remainder of my testimony, when it comes to matters of environmental health, we do not have the luxury of waiting for definitive proof, because by the time we can be certain about any number of threats to human health, it is often far too late to take action to prevent or reduce these hazards from happening.

Big disasters easily studied, cumulative impacts are more difficult to assess

The relentless American focus on health sustains popular magazines and fills the airwaves with health claims for cereals, vitamins, pills and exercise equipment. We are told how to eat the right foods and avoid the wrong ones, practice safe sex, work out properly, get regular checkups, think healthy thoughts, and accept responsibility for our own destinies. But no matter how carefully we take care of ourselves, no matter how often we say no to unsafe sex or dangerous drugs or choose the salad instead of the hamburger, we cannot control the influences of the world around us. Where you live and work, what you eat and drink and breathe, what happened to you just before birth—all these things play critical roles in determining your prospects for health. But when illness is not a matter of personal prevention, scientists and media alike become strangely reticent.
When it comes to hazards in the workplace and environment, the safe response, which has come to be accepted as scientifically responsible, is to say nothing and do nothing until we have clear proof that the hazard has actually made people sick. When we can't marshal definitive statistical proof of a toxin's specific harmful effect, backed by a clear theory of the mechanism of that effect, it has become standard to say that we simply don't know whether the toxin is harmful or not. The absence of evidence of harm—even when no effort has been made to gather such evidence—becomes grounds for not acting. The fact that levels of certain toxic chemicals are not always elevated in women with breast cancer, for instance, is taken as proof that other chemicals do not cause the disease. But not acting to reduce or control our use of suspected materials is a form of acting.

To whom, exactly, are we being responsible when we remain silent and passive in the face of environmental hazards? I would like to advance another notion of responsibility: the same one we employ every day when, as parents, we send our children out with umbrellas if it looks rainy and lunch money if they will need to buy lunch. We don't wait for them to go hungry or get rained on before we acknowledge that these misfortunes should be prevented. Yet when it comes to environmental health, we are expected to wait until after the fact—until there are dead bodies or ill people to count—before taking action to prevent those harms from happening. Sometimes not even then.

In When Smoke Ran Like Water, I argue for a fundamentally new way of thinking about health and the environment. We must move beyond inflicting guilt on individuals for the things they failed to do, and instead appreciate the importance of the things that happen to all of us. Where the health of large numbers of people is at stake and the harm is potentially irreversible, it is far better to err on the side of caution. We accept this principle in many areas of public life: we do not wait for buildings to fall down or bridges to collapse before inspecting them for safety, or wait for boats to sink before requiring that they carry life jackets.

Our knowledge of the health consequences of both local and global pollution is more detailed and accurate than it has ever been. We are now in a position to make informed choices as a society about what risks we will accept and how much we're willing to pay to change them. Some have argued that a dirty world is the unavoidable price of economic growth. This claptrap is too often used as an excuse for doing nothing and learning nothing by people who have a vested interest in not changing the causes of pollution.

Here I show some of what we've learned about the health consequences of air pollution, about environmental contaminants and cancer, and about the effects of the environment on the sex of our children and our own reproductive health. I explain why it has taken us so long to reach this point of addressing environmental concerns about human health, and I recount the struggles of those who have tried to raise these concerns. Not everybody plays fair.

Donora, Pennsylvania, 1948, America's first recorded lethal smog

I know firsthand about big disasters and about the big prices small towns pay when short term profits trump longer term concerns about health. I lived through a major public health disaster that few people have ever heard of. The town I grew up in, Donora, Pennsylvania, was famous in the way that Jack the Ripper and the Son of Sam were famous. So, it was not surprising that nobody ever talked about what had gone on there. At the end of October in 1948, a massive inversion of polluted coal smoke and fumes from the local zinc plant, steel mills and rolling mills settled over the Monongahela Valley for five days. Within one twenty four hour period, eighteen people had dropped dead. In these days before television had spread to small towns, the first indications that something were wrong came about when some usual supplies began to run out. The local funeral homes ran out of caskets. The florist shops ran out of flowers. The pharmacies ran out of medicines for lung problems.

Half the town fell ill, but people were eager to get back to work. Most folks worked in the local steel mills, or helped to take care of those who did. Within days of this disaster, the mills had switched many operations from burning coal to burning natural gas. An official committee came in to study the town two months later, spending the fortune at that time of $250,000. No final report was ever issued. Some people warned that what had happened in Donora would be a disaster if it ever hit a much larger urban area.

London, 1952-53, a massive lethal smog kills 12,000

Four years later, these warnings about the lethal impacts of polluted air were proved to be correct. A massive inversion of smoky coal fumes settled over the Thames Valley, hitting what was then the world's largest city—London. From its one million chimneys, smoke ran like water, giving the air a sotted, smoky flavor. The Sadler Wells opera and many movie theatres closed, because smoke obscured the stage. Within one week three thousand more deaths than usual occurred. Again undertakers ran out of caskets. Flower shops and pharmacies were left bare.

My colleague, Dr. Michelle Bell, of Yale University, and I have shown that the true toll of this London 1952-1953 smog did not end that week, but extended till the end of February. The government at the time seized on the notion that a sudden, massive flu epidemic had hit the town. This explanation had the effect of discouraging more detailed research into any of the more subtle, longer term impacts of air pollution at the time. The only problem with the idea that flu had took hold on London, is that there is no evidence to support this claim.

In looking back at the complete records of an astute clinician who worked in London from the 1940s through the period of the smog, we found no evidence that flu had afflicted one out of every three people in the town. In a series of peer reviewed papers, which are attached to this testimony, we have provided strong proof that the death toll from London's smog entailed 12,000 deaths more than normal. This graph summarizes our findings.

The belief that an epidemic accounted for the continuing poor health problems in London fostered a short sighted look into air pollution for years later. This belief led to the notion that only large amounts of pollution in a small period of time posed a problem for public health. People worry about catastrophic things, such as plane crashes. In fact, small risks such as those tied with the air we all must breathe more than 20,000 times a day, can have tremendous impacts on public health, as thousands of studies have now made clear.

Studying chronic effects of pollution: the development of models in toxicology

The longer term lessons of Donora and London are not just that brief, intense episodes of visible air pollution from industrial sources or coal fires can quickly fell the weak. It is that daily exposure to low levels of pollution that could not be seen or smelled can ruin the health of millions. The new science of toxicology that arose with the industrial era rested on the notion that dose made the poison—that substances that could kill at high doses could be expected to be harmless at lower ones. Dispelling this assumption of the universal safety of lower doses took many years of work by dedicated, innovative, and sometimes lonely scientists.

Another woman from Allegheny County, Professor Mary Amdur, paid a major role in seeing the field of toxicology develop methods for studying air pollution. …After Donora made the news in 1948, Amdur… wanted to use the tools of toxicology to understand what had caused the sudden and unexplained deaths and illness in this small mill town. In 1952, she and Drinker published two important experimental studies in the Archives of Industrial Hygiene and Occupational Medicine that looked into what could have happened in Donora. These studies directly challenged one of the central tenets of toxicology—the notion that the greater the dose, the more the damage.

For their first study, they showed that the age at which animals were exposed to a toxin could determine how much exposure would be toxic. They focused on very young and mature guinea pigs—animals known to be quite sensitive to respiratory toxins. Unlike other rodents, which breathe only through their noses, guinea pigs can be forced to breathe through their mouths—just like people—forcing pollutants more deeply into their lungs. To approximate the conditions of Donora, Amdur and Drinker invented a machine that produced regular amounts of one of the key agents known to have been common there, sulfuric acid mist. This acid is freely created when sulfur, oxygen, and water vapor combine during coal-burning, coke or steel making, or when oils or other sulf-containing fuels are burned. Acid mist could be fanned into a chamber full of guinea pigs, where humidity and air flow were tightly monitored, and released in droplets just a single micron in diameter -- small enough get deep into the lower lung.

Using their own invention, the two scientists exposed equal numbers of young and mature animals to the same levels of pollutants. They performed LD 50 tests to find how much acid it took to kill half the animals. Amdur and Drinker showed that the young animals succumbed at a dose one third the size needed to kill the older animals. At autopsy, the lungs of all the dead animals—young or mature-- were bloodied, as were some of their noses. Whatever killed these animals worked the same way in young and old. It was just that it took a lot less to kill younger animals. This work made it clear that it was not simply the dose that made the poison: the age of the animal when exposed could be even more important.

The two scientists then tackled another big question in toxicology. What happened to animals at less than lethal doses ? It was then believed that most inhaled toxicants worked by causing spasms of the lungs or larynx, and that without this literal cramping of the lungs no serious damage could occur. Amdur and Drinker showed that lungs that did not convulse could still become impaired. They found that a smaller daily dose given over a longer time produced much more extensive and deep-seated lung damage than did a higher dose delivered for a shorter time. Moreover, the damage from this longer but lower dose appeared permanent. This pioneering work showed that a toxic response reflected two things—the amount of time the exposure lasted, and the concentration or dose of the agent being tested. Lower doses--even one tenth the lethal amount-- if administered over long periods of time could cause irreparable damage.

These important results gave Amdur and Drinker a benchmark for looking at similar effects in humans. They treated a small number of “healthy men of various ages” just like guinea pigs, for periods of up to five days using levels of acidity well below those found to kill the animals. I cannot be sure where these human guinea pigs came from. But it would not be surprising if graduate students, who then as now held positions of indentured servitude, had been tapped for the role. To calculate the speed and amount of air moving into and out of the lungs before, during and after exposure to sulfuric acid mists, they used a piece of equipment called a pneumotachograph—literally lung measuring instrument. They also collected acid vapors deposited from exhaled breath onto paper filters to get some sense of how much acid remained in the body.

Not surprisingly, much of the inhaled acid remained within the body. Almost as soon as exposure began, the subjects’ breathing became shallower and faster, even at the very lowest, imperceptible dose. This may have been the lungs’ automatic defense. Short, fast breaths draw in enough oxygen to meet the body’s needs, but they prevent acid-filled air from penetrating to the lungs’ deeper regions. In effect, the body’s response to acid mist is to use only part of the lungs and protect the rest. Amdur and Drinker noted in their 1952 paper that they had no idea what such exposures would do to people with lung or heart ailments, which lessen the body’s reserve capacity. Nor did they discuss whether these conditions, if sustained over long periods, could induce such damage.

Politics and science: the good old days

As a senior professor and an eminent authority in the evolving field of industrial medicine, Drinker received direct funding from American Smelting and Refining Company (ASARCO), a large producer of sulfur compounds, throughout the 1950s. Amdur, in working with sulfur dioxide and sulfuric acid, was involving herself in the company’s principal emissions and the key toxic pollutants in mill towns throughout the Midwest. Since they were funding Drinker’s research in an era when such support was hard to come by, and since Drinker was supervising Amdur, ASARCO’s managers assumed they held some sway over what she would publish. They were wrong.

The year after she and Drinker had established the living guinea pig as a model for testing inhaled toxins, Amdur extended this work. Again she established a wholly original method. Using guinea pigs she had purchased on her own and running the studies in their backyard over the long July 4 weekend of 1953, she and her husband determined how combined exposures to two key pollutants released by burning coal--sulfuric oxide and particles--affected the lungs. After exposing the animals to controlled amounts of these gases much like those they would have encountered in Donora, Amdur painstakingly examined their lungs. The lungs of a guinea pig are about the size of two human thumbs. But when carefully unpacked from the chest cavity, they can be dissected, stained and measured for traces of chemicals and tracks of damage. With just a few days of exposure to acids and aerosols, the linings of the rodents' lungs tended to thicken and scar.

About 98% of air pollution consists of five substances: sulfur oxides, carbon monoxide, nitrogen oxides, hydrocarbons, and particulate matter. How do these pollutants get into the air in the first place? Many of them are natural, even essential for life. But the burning of fossil fuels can create these compounds in concentrations that can be sickening, even deadly. Most people think of air pollution as something you can see coming out of a smokestack or tailpipe. But any material that gets into the air can become a pollutant, provided it remains in circulation. Some pollutants occur as particles, 50 times smaller than a human hair is round. The smaller the material, the longer it can stay aloft, the farther it can range, and the deeper it can travel into the fragile, spongy architecture of the lung. Other pollutants are gases that form when an element such as nitrogen or sulfur combines with oxygen. Still others can switch back and forth between being particles and gases, depending on temperature, humidity and other conditions. Particles can also settle on mists of liquid droplets, where they can create yet other agents. For instance, water droplets can mix with hydrogen sulfide to yield corrosive sulfuric acid aerosols. In the presence of sunlight and gaseous hydrocarbons, pollutants such as nitrogen dioxide and volatile organic compounds often react to form still other pollutants, such as ozone. Ozone is a gas that contains three highly reactive oxygen atoms that can break down cell walls, thicken mucus, and gum up the delicate tree of airways and passages in the lungs. Those who have asthma, when exposed to ozone, experience a sensation much like breathing through a straw. Try it sometime and you will see why on days when ozone is just a bit higher than usual, asthma sufferers keep their inhalers within easy reach.

Consider carbon monoxide. Any time carbon is burned, whether in wood, coal, gasoline or garbage, it binds with oxygen. Sometimes carbon bonds with a single atom of oxygen, in which case carbon monoxide results. Other times a single atom of carbon connects with two of oxygen, producing carbon dioxide. Both forms are invisible; both cannot be smelled. At high enough levels, both forms can kill you. But it takes a lot less carbon monoxide to do the job. The first symptoms of carbon monoxide poisoning in adults resemble nothing so much as flu—lethargy, nausea, tingling, perhaps an upset stomach. Pregnant women who regularly breathe air with more than fifty parts per million of carbon monoxide, either from polluted air or from cigarette smoke, will have babies of lower than normal birth weight.

How it is possible that gases that cannot be seen or smelled affect not only our lungs and hearts but also the size and thus the health of babies? Amdur's work laid the groundwork for understanding that anything that can be inhaled, such as carbon monoxide and very small particulate air pollutants, can reach every organ of the body. They get there the same way any other agent does, by going through the bloodstream. Once inhaled, particles that are very, very fine can slip directly through cell walls into the blood. The effect is like adding flour to gravy: the blood of people breathing polluted air can literally become thicker.

What Amdur found in her studies in 1952 was pretty straightforward: The more acid in the air, the more damage to the lungs. The smaller the particles involved, the more deeply they penetrated and the greater their impact. She found strikingly similar effects in both animals and people—heavy scarring and thickened linings deep inside the lower lung. In December of 1953, at the annual meeting of American Association for the Advancement of Science, Amdur presented these findings showing that the combined effects of air pollutants, even when they were not lethal, could be quite toxic. She also argued that people exposed to levels like those in the Donora smog could suffer permanent damage. Her work was clear; so were its implications. Regular breathing of acids and particulates in the air of Donora and dozens of other mill towns throughout the country could damage the ability of the lungs to function, forcing them to work harder and faster than usual.

By the early '50s, physiologists had a reasonably good understanding of the shape and function of many of the components involved in breathing. Humans breathe by first taking air and smaller particles through the nose or mouth into the lungs. The typical adult inhales about sixteen breaths each minute while awake and about half as many when asleep. Heavy exercise or stress can increase the rate to as high as 100 breaths a minute. Although the total volume of the adult lung is about 5,000 cubic centimeters, a single normal breath typically exchanges only about ten percent of that. Even after the most challenging exercise, panting or gasping, the lungs never empty, holding about 1,000 cubic centimeters of air. Pollutants in either gases or particles enter the body with each breath. Particles 10 microns in diameter and larger are filtered out by the nose hairs; those between about 2.5 and 10 microns generally land in the mucous lining of the nose and throat. But where particles are smaller than 2.5 microns, the body has no special filter for keeping them out. Those who work out intensely during periods of pollution are basically conducting stress tests on their own hearts, pulling ultra fine particles as well as other pollutants deep into the lungs. Particles this fine resemble gases in that they can slide into the bloodstream from the small sections deep in the lung.

The respiratory tree contains more than 50,000 divisions. When air is taken into the body it moves through a web of smaller and smaller tubes until it reaches, at the very end, small cul de sacs called alveoli. Millions of microscopic blood vessels surround each single alveolus. Here is where the rubber hits the road and all things inhaled get exchanged. Oxygen, which we need to live, and contaminants, most of which we do not need at all, both diffuse through the thin skin of the alveoli's exquisitely complicated system. The tiniest particles can also pass through the alveoli into spaces in between the cells called interstitial space and thence into the bloodstream.

If your lungs were removed from your chest and spread out in flat sheets, they would take up nearly the space of a tennis court, about 50 square meters. The internal architecture of the lungs encompasses more than 2400 kilometers of airways—the distance from New York to Florida. Each year, the average adult breathes about 7 million liters of air, give or take a few million. Whether they think about it or not, an active person takes in 7 to 14 liters of air each minute, some 10 to 20 thousand liters every day. Those who work or exercise vigorously may inhale up to 50 liters per minute. If this air contains only minute levels of pollution, quite large amounts of it still pass through the lungs. For those whose hearts are already damaged, whose airways are a bit narrowed by other disease, or whose lungs are still growing, regular breathing of dirty air can be especially tough to handle. Children live lower to the ground, often playing right at the level of the tailpipes of cars and buses. They also breathe faster than adults, putting them at greater risk from airborne toxins.

Smokers' lungs are just as complicated as those of non-smokers but they do not have the same capacity to recover from stress or to exchange good and bad air. Lungs damaged by regularly taking in smoke lose their resilience. A thin layer of mucus provides a shield against such agents. An invisible escalator of cilia, or fine hairs, regularly shuttles about 100 cubic centimeters of viruses and bacteria trapped in this mucus out of the lungs every day. This elevator gets slowed and can even shut totally when a person has bronchitis or pneumonia or is a heavy smoker. That is why sick people and smokers cough so hard and often. Their lungs are in a constant state of auto-rebellion. Because guinea pigs cannot cough, their lungs bleed more easily than those of humans.

Everybody must breathe. Even when we lose consciousness, the brain makes sure the body gets enough oxygen to keep us alive. The work of the lungs is monitored and controlled for us by the autonomic nervous system, working at a speed that is hard to imagine. Even severely brain- damaged people can continue to breathe, provided the breathing control center atop the spinal cord, the medulla oblongata, remains intact. This respiratory control system operates like the body's own airport flight controller, constantly sensing and adjusting the traffic of breathing. If the blood accumulates too much carbon dioxide, this control center calls for more rapid and deeper breathing. As oxygen levels rise, the rate and volume of breathing involuntarily slow down. In detecting changes in the pace and intensity of the breathing patterns of guinea pigs and their human counterparts, Amdur was in effect recording the brain's reading of pollutants in the air.

By creating a model for studying how pollutants affected living guinea pigs, Amdur opened up a whole new world of research. Unfortunately, this was not the sort of work ASARCO thought it was funding. After she presented her findings at a meeting of the AAAS in 1953, word began to get out that her work was pointing to serious health hazards. Some fairly heavy-handed efforts to suppress her research ensued. A former colleague, Adel F. Sarofim, who later directed research with Amdur when she worked at MIT in the 1980s and is currently Presidential Professor in the College of Engineering at the University of Utah, recalled that Amdur faced enormous pressure.

At the Chicago meeting of the American Industrial Hygiene Association, in April 1953, Amdur, who was a small woman, was accosted as she got onto an elevator. She was on her way to a meeting room where she was scheduled to present her findings on how the lungs of guinea pigs and humans fared under polluted air. Two fairly large, tough-looking guys wearing leather jackets got on with her. They moved in closer than was comfortable. Amdur told Sarofim these strangers looked at her hard and called her by name. "'Hey, Mary, where you going? You are not going to present that paper, are you?" Amdur did not budge. The elevator doors opened and she stepped off, went to the meeting room and presented her findings. She did not change a single word

Not until years later did she speak about these efforts to stifle her work. In addition to Serofim, she also told her son, David, and Terry Gordon, one of her last graduate students, about the incident. “Though I was not physically assaulted,” she said, “I felt as though hands were about to close round my neck.”

After Amdur returned from this meeting, she learned that the bullying did not stop with muscle men on an elevator. Whatever was said to Drinker we can only imagine. But clearly, someone big and powerful got to him or to Harvard. Surely phone calls were made. Perhaps private meetings were held. A batch of telegrams and correspondence that Amdur kept from this period provides evidence of intense negotiations regarding precisely what would be published about this work.

David Amdur remembers that when he graduated from college, his mother told him just how vulnerable her work had been throughout her career, “You know, dear, you were raised on soft money.” Hard money was guaranteed and came with tenure. The mostly male professors with whom she worked could rely on it. Soft money, of the sort that supported Mary, had to be earned over and over again through grants and contracts.

According to Gordon and Daniel Costa, who had been her graduate fellows at MIT, Amdur told them that when she returned to Boston, Drinker ordered her to take his name off the paper the two of them had jointly prepared on the work she had just presented in Chicago. He also told her to withdraw the paper from the Lancet, where it had recently been accepted for publication. When she refused, her position with Drinker was eliminated. To this day, no one knows what happened to the paper. The Lancet never published it, and it seems to have disappeared.

After nearly a decade of working with the eminent Professor Drinker and producing work that was widely recognized as novel and important, Amdur suddenly found herself unemployed. Science does not reward those who take on big, expensive issues without permission. The academy can be especially tough on those who step outside the bounds of whatever is considered normal behavior at the time. In the 1950s, American industry supported research with the explicit written understanding that sponsors would control what got published, when it was released, and whether the research the sponsors funded saw the light of day. Then as now, it was unseemly for a scientist to seem too eager for public attention. It is not o.k. to fuss about your work in public or issue calls for action based on your findings.

After she was fired by Drinker , Amdur’s senior colleague at Harvard, Dr. Alice Hamilton, sent a handwritten note on July 9, 1953, that was found among Amdur’s papers after her death in 1998. Hamilton expressed sympathy for the rough manner in which Amdur had been treated, but also conveyed understanding for the position in which Drinker had been placed. “The trouble with this branch of medical science is that it is always tied up more or less with somebody’s pocketbook-- Maybe the companies, maybe the insurance people, maybe the doctor in charge… Looked at that way, realize that Philip Drinker has wife and children who are ‘hostages…to fortune, an impediment to all great enterprises, whether good or evil’”

The role of peer review then and now

Another scientist who trained later at Harvard, (and who would go on to win awards from the Heinz Foundation for his own pioneering research on air pollution) John Spengler, recalls watching Amdur work in the 1970s: “I used to think that in science, it was sufficient to publish an important finding once. Amdur’s work showed how foolish this notion was. At every step along the way, people tried to pull the rug out from under her. In fact, she got it right years before the rest of us. The world only caught up with her several decades later, by which time so many people had confirmed what she found that it could no longer be discounted…It is not enough to be right. You have to publish your findings on something subject to controversy over and over and over again.”

Public health researchers have not always realized how easy it was to exploit their legitimate admissions of scientific uncertainty. We always need to know more in science. But if we always insist that we should do nothing until the damage is absolutely certain, the only certainty is that we will cut short millions of lives and bring misery to millions of others.

For years, life, death, climate and sex were all believed to be beyond our control. We now understand that each of these complex and exquisitely important aspects of life is subject to more human influences than have been imagined. Global warming is not just some vague and fuzzy thing that may someday make it possible to grow flowers outdoors in New York year round and improve the value and amount of shore front properties in Canada. It turns out that the things that are changing our climate are the same things that caused so much pain in Donora, London and throughout the world. Those confused hermaphroditic polar bears and whales in the Canadian Arctic with high levels of PCBs in their fat show that other kinds of pollution now have global reach as well. Even though diseases affect people as individuals, there are patterns of exposures and conditions that influence how these diseases arise that can be addressed through social action to reduce or control such conditions..

Corporate Greens

The good news is that here and there, people are beginning to act on this evivdence of environmental influences. More than a decade ago, the Swedish oncologist Karl-Henrik Robert, devised the Natural Step program aimed at using less toxic agents in daily life. Convinced that cancer and other diseases were connected to environmental conditions, his work is no longer radical or revolutionary. Mitchell Gaynor, the charismatic director of the Sanford Weill Center for Alternative and Integrative Medicine at Cornell Medical School, routinely tells cancer patients to reduce their uses of suspected hazardous agents in order to improve their prospects of living longer and better. Gaynor is also leading a campaign to stop the construction of what would become North America's largest cement industrial city of more than twenty buildings atop an 1800 acre ridge in the Hudson Valley, adjacent to the heritage river site near his home. The plant would release 1.47 million pounds of particles each year from a stack that will be one of the tallest structures from New York to Montreal and dwarf the Statue of Liberty. Deborah Axelrod, the breast cancer surgeon, who wrote Bosom Buddies with Rosie O'Donnell , knows how to use humor to diffuse the trauma of cancer and is equally adamant in her clinical practice about the need to look beyond pills and traditional medical interventions to reduce the chance the disease will recur. Andrew Weill counsels those who want to stay healthy to read labels of their foods, look at what is under their kitchen sinks and get involved in keeping their communities clean.

Efforts to recycle, renew and conserve have moved out of the backwoods and into the mainstream. The Ford Motor Company recently announced that its vast River Rouge plant in Dearborn, Michigan --one of the great landmarks of the American Industrial Revolution -- will now be more environmentally friendly, with energy-efficient buildings, an on-site wetlands to help process wastes, and many other innovations. As recently as 1999, a massive explosion in the outdated coal-fired power plant of the facility's 1,100 acres site, .killed six workers and injured fourteen . The smokestacks will be torn down, giving way to what is being billed as an ecologically designed facility. .If Ford can do it, other businesses can learn that pro-environment is not anti-growth.

The 30th anniversary of Earth Day, celebrated on April 22, 2000, on the mall in Washington, D.C., was remarkable as much for what did not happen as for what did. American activists accustomed to being resented and resisted found themselves frustrated by the realization that they had won the war on rhetoric and on many other fronts as well. They were like the dog that has been chasing the car for years and finally catches it, and does not have a clue about what to do. Environmental awareness is now embraced by the more enlightened factions of big business. Not just Ford, but Toyota, Honda, and other major firms sponsored parts of the huge party and handed out information boasting of their efforts to do something important for the environment. The environmental movement is learning that it can no longer treat these people as the enemy. We need them to show others that you can be a good corporate citizen and still make money; even more, we need their help. It is great that so many car companies have figured out how to market themselves as green. It will be even greater when they commit to producing and marketing cars that use less fossil fuels more efficiently, and ultimately use none at all

Global and Regional Energy Policy: Recent Developments in Wyoming, Kentucky and Pennsylvania
In Washington, D.C. this year, my forsythia have bloomed three times. Whether or not the major shifts in temperature and weather that have characterized our recent summers and winters are good for certain flowering plants, they certainly play havoc with the growing season of commercial crops. In addition such big swings in temperature, heat waves and ice storms also pose major problems for commercial travel and other normal activities. This Administration has chosen the path of private actions to address the problems posed by current energy policy. While the good deeds of individuals are always to be applauded, there is no evidence that such a calling to our higher angels has ever produced sufficient numbers of benefits to stave off a problem that affects the entire globe.

In fact, there are troubling signs that the absence of programs involving mandated federal policies on energy are fueling practices at the state level that will leave problematic legacies for public health locally, regionally and globally.

Whether we like it or not, human life constitutes an unprecedented experiment with more variables than can ever be studied at once. Right now the equivalent of two SUVs worth of warming soot spews into the atmosphere every year from the activities of each citizen of the North American continent. Nations can set policies on greenhouse gases, but the warming impact of these emissions does not depend on where they came from.

We can look with some relief at the smoldering planet of Venus, and the frosty one of Mars, which we have recently been able to see in ways never before imagined, and be grateful that we appear to be the Goldilocks planet—just right, so far. Some have suggested that by the time research could be certain we had reached a planetary tipping point, we would have no exit.

Frequent big swings of weather like those that hit the Northeast last month and incapacitating ice storms that shut down power in the south last winter--are here now. Levels of carbon dioxide, the most common warming greenhouse gas, are 30% higher than before the Industrial Revolution. Over the last century, average land surface temperature rose about 1.0 degree Farenheit, and nearly 4 degrees in some Arctic tundra. The tundra of Siberia may become more hospitable—something that President Putin joked about when pulling Russia out of its commitment to reduce greenhouse gases under the Kyoto Protocol. But a number of small island nations, supplies of fresh water, coral reefs and some species of animals will disappear as sea level rises and climate changes.

In Crawford, Texas, the President and Mrs. Bush built an impressive ranch several years ago, using passive solar design, recycled waste water, and consuming 25% less energy than other homes of comparable size. In many urban areas, new buildings and retrofits start out with green building designs that incorporate warmth from the sun, cooling from the earth, heat pumps and things that only years ago seemed like comic-book fantasies. In Manhattan a number of skyscrapers are being revamped to become net energy exporters. Is all this simply a matter of private virtue—of folks having enough money to be able to do the right thing? Hardly. If we wait for individuals and global corporations who care enough and have enough money to protect the planet, it will be a cold day in hell before any real progress is made. Gases of carbon dioxide released into the atmosphere today will warm the earth for the next century and determine the burden on public health of air pollution in our cities now. Decisions made now about how to fuel, feed, clothe and transport ourselves leave pretty big and deep tracks on our lungs and those of the planet.

Recent developments in the Middle East have made it clear that, as a nation, we cannot act alone on matters that affect the entire world. We may well lead, but at some point, we also have to be sure that others will follow. The case of global climate provides another stark reminder that no matter how well intentioned some of our leaders may be in their personal lives, national leadership in the public and private spheres is required. The diversity of groups that are supporting federal action on climate is phenomenal, including the National Religious Partnership for the Environment, National Farmers Union, the Ski Resort Association of America, and Swisse Re.

Global and Regional Energy Policy: Recent Developments in Wyoming, Kentucky and Pennsylvania

Dr. Wilma Subra is a Macarthur genius, selected for her work as an environmental scientist . She has recently informed me of the following development, where cleaner sources of energy from Louisiana are being replaced by dirtier sources of energy from Wyoming and Kentucky, relying on perfectly legal loopholes that have been created as part of recent energy policy for this country. Wilma Subra President of Subra Company, P. O., Box 9813 New Iberia. LA 70562 337 367 2216 All the power plants in Louisiana, before the nuclear ones, were all natural gas fired. Louisiana has huge quantities of natural gas. When natural gas prices started going up all the electric utilities that were previously burning natural gas added coal-fired units at their existing facilities. These changes resulted in more emissions of carbon and other pollutants, but did not require formal approval, as they fell under what is called minor mod—minor modification of an existing facility.

The Louisiana utilities got together and bought two trains that go and come to Wyoming to bring back Powder River Basin Coal to Louisiana. The Power River has seen some 5,000 new wells drilled over the past two years, resulting in so much damage to the local environment that farmers have organized to complain. While Wyoming has generous amounts of coal and natural gas, it lacks major quantities of water. As these minerals are being extracted at growing rates, the ground water is being contaminated, resulting in deaths of cattle and major damage to the surrounding environment.

Dr. Subra reports that in Louisiana there is a lignite mine north of central Louisiana and there's one power plant that uses the surface mine lignite there. Lignite is one of the dirtiest and least efficient means of generating electricity in the modern world. There's being another lignite mine mouth plant proposed in Red River Parish at this point. Then in Kentucky, the Thoroughbred, coal-fired power plant one was the largest projects proposed in Region 4 of EPA in decades. This Kentucky plant was going to burn Powder River Basin coal and Kentucky coal. By combining coal from Wyoming with that of Kentucky, when they burned Kentucky coal then they could take the ash and use it for mine reclamation. If they only bought Powder River Basin coal, they couldn't use the mine space as reclamation to get rid of the ash from the power plant.

Long-wall mining in Pennsylvania: new problem with old techniques
Long-wall mining operations gouge scars in the land, by stripping coal from broad veins that are thousands of feet long. As the machines that conduct this operation move along invisibly below the earth's surface, they leave a rolling, jagged landscape of uneven terrain. After these operations are finished the earth above these seams can drop as much as four feet, creating uneven landscapes, that can look uncannily like that of Mars. A proposal is being pitched to help the financially distressed city of Pittsburgh by creating a race track on an undeveloped hill near the city. Leaving aside the observations of social scientists that those who gamble at racetracks tend to be the working poor and others with little to lose, there is one part of this plan that has not received adequate public attention. In order to level the ground for this track, long-wall mining has been proposed to remove one of the richest coal seams remaining in the region. The impacts of this ill-advised new coal mine on the environment would extend from further damaging the wetlands of the area to creating subsidence damage to surrounding homes and communities.

The Federal Budget, 2005

The Administration has expressed rhetorical support for what it calls "sound science" No one at this date can claim to be familiar with the President's freshly proposed budget. But, one glaring fact stands out from a first and cursory read of the newly released budget figures: This Administration's federal budget for competitive research grants at the Environmental Protection Agency, is one third less than last years. In general, funding for science and technology at EPA in the new budget is nearly $100 million dollars less than the preceeding year, falling from $782 million in 2004 to $689 million in this proposed budget.

In many aspects of life, the watchword is don't listen to what they say, watch what they do. While the support for science that comes from this Administration's public utterances is admirable. It seems that support does not extend to the practical challenges of much of environmental health research, including support for the development of information on environmental monitoring and pollution, and enhancing the capacity of state departments of health to track health and environmental information.

The President wants to send men to Mars. This may prove to be a far better idea than any of us can imagine. We only have one planet. Policies that are being pursued now with respect to energy and the environment will leave legacies that can only be modeled at this time. Figuring out how to make the world in which we now live work better and when and how we may need to move to another one, is a challenge our grandchildren may have to reckon with much sooner than any of us can currently imagine.