

Arsenic and Lead Scavenger Hunt

Making a
Better Nail

Handwashing 101



There's a deeply rooted necessity to turn disaster into opportunity.
 Lawrence Vale, MIT Department of Urban Studies and Planning
 Newsweek article on the rebuilding of New Orleans, 12 September 2005

HEALTH DISPARITIES

Crisis Not Over for Hurricane Victims

Thousands of Gulf Coast families displaced in 2005 by Hurricanes Katrina and Rita are the victims of an unprecedented epidemic of chronic medical and mental health problems, yet are receiving little appropriate care, reveals a report released 17 April 2006 from the Mailman School of Public Health. "A year after Katrina, over half of the New Orleans population has not returned—perhaps as many as three hundred thousand people," says principal investigator David Abramson, acting director of research at the Columbia University National Center for Disaster Preparedness. Many families still live in FEMA-subsidized trailer parks.

Even before the hurricanes hit, Louisiana and Mississippi ranked 50th and 49th in the nation, respectively, in terms of overall health status, according to the United Health Foundation's *America's Health: State Health Rankings 2004*. Today, post-hurricane reconstruction has hardly begun. With the loss of hospitals, clinics, pharmacies, medical records, and (for many people) employer-subsidized medical insurance, thousands of residents of what was already one of the nation's most medically underserved regions could be facing serious long-term health consequences.

Under the auspices of the Louisiana Child & Family Health Study, Abramson's team used multistage random sampling to select 820 households from 14 FEMA-financed housing sites across Louisiana. More than three-quarters of the households responded, representing 1,171 adults and 488 children. Respondents were interviewed at their homes about chronic medical conditions suffered by their family members, their children's emotional and behavioral status, their previous and current access to health care services, medical insurance coverage, and the family's post-hurricane displacement history.

Respondents had moved an average of 3.5 times—some as many as 9 times—with the consequent loss of stability. Thirty-four percent of the children had at least one diagnosed chronic medical condition, a rate one-third higher than the general U.S. child population, with asthma and developmental delays among the most-cited problems. Nearly half the children who had a personal doctor before the hurricanes no longer had one.

Almost 50% of the parents said at least one of their children had emotional or behavioral problems they did not have before they became displaced. And the children aren't alone: a standardized test given at the time of the interview indicated that more than two-thirds of the mothers interviewed may be suffering depression or anxiety disorders.

Though these families are in acute need of medical surveillance, access to health care resources remains limited. According to a white paper accompanying the report by the Children's Health Fund, which lobbies for comprehensive health care for all children, only 3 of 9 acute care hospitals that existed in New Orleans before Katrina are now operating at full capacity, and only 19 of 160 clinics remain open. Some 44% of respondents had no medical insurance—about twice as many as before Katrina. In addition, people who were earning above the threshold for receiving Medicaid before Katrina hit were still ineligible for that program since eligibility depends on the previous year's income.

The white paper calls for Congress and President Bush to establish a "health care Marshall Plan" to address the urgent needs of displaced families. "National leaders need to be aware that this is an unprecedented situation," says Irwin Redlener, director of the National Center for Disaster Preparedness and president of the Children's Health Fund. "There needs to be an emergency effort to bring health care professionals to the Gulf region, to rebuild hospitals, to get people's medical conditions into databases that can be used wherever they end up, to increase mental health benefits under Medicaid, and to bring school-based health services fully online."

Senator Susan Collins (R–Maine), chairwoman of the Senate committee that investigated the government response to the Katrina disaster, says, "Nearly a year after Hurricane Katrina, Gulf Coast residents are still struggling to return to a sense of normalcy. It is extremely important that the government do all that it can to help address not just this immediate health crisis but all of the long-term needs of those who survived this terrible natural disaster."

Adds Senator Mike Enzi (R–Wyoming), "We must build on the private and public sector investments in New Orleans and the Gulf Coast, attracting medical personnel as hospitals and health centers are rebuilt, and give survivors the necessary and appropriate assistance to reclaim their lives."

The authors plan to publish the full text of *On the Edge: Children and Families Displaced by Hurricanes Katrina and Rita Face a Looming Medical and Mental Health Crisis* in a peer-reviewed journal. In the meantime, the report is available free of charge by contacting Abramson at dma3@columbia.edu. —Adrian Burton



Adding insult to injury. Children play in the Baker, Louisiana, FEMA trailer park where they have been living since Hurricane Katrina forced them from their New Orleans homes. A new study shows that many children displaced by the hurricane have lost what small access to health care they had to start with, and therefore are not being treated for a host of medical conditions.

Greg Henshall/FEMA

OCCUPATIONAL HEALTH

An Ugly Picture for Flower Workers and Their Children

Every year, Americans spend nearly \$20 billion on fresh flowers, about 70% of which come from abroad, mainly from Latin America, according to the Society of American Florists. While this can represent an economic boon for some countries, overuse of pesticides and lack of protections for female workers can cause serious health effects for those women's children, according to a paper in the March 2006 issue of *Pediatrics*.

The study of female workers in Ecuador's flower industry and their children found that a mother's work exposure to pesticides during pregnancy was associated with neurological impairment, including a significant decrease in visuospatial performance. After accounting for other factors such as malnutrition, the researchers concluded that "prenatal pesticide exposure may adversely affect brain development."

The authors, led by Philippe Grandjean, an adjunct professor at the Harvard School of Public Health, also found that children whose mothers were exposed during pregnancy tended to have higher blood pressure than unexposed children, a finding with broader implications. "Increased blood pressure, when present in childhood, is a risk factor for cardiovascular disease in later life," the researchers noted.

The researchers looked at schoolchildren under the age of 10 in the Andean community of Tabacundo. Physical exams checked each child's blood pressure and certain neurobehavioral functions, such as motor coordination, dexterity, attention, short-term memory, balance, and spatial perception and performance. Mothers were interviewed about their own exposure history and background as well as their children's medical history and health. The data analysis took into account each family's housing and nutritional situation, as well as maternal education. The researchers also measured current pesticide exposure among the children.



Nipping hazards in the bud. Use of protective equipment while pregnant can curb ill effects in the children of floriculture workers.

Of 72 children included in the analysis, 37 were considered to have been exposed prenatally—they were born to women who had worked in the floriculture industry while pregnant. All of these mothers reported following normal safety precautions, and none had worked as pesticide applicators. Nineteen of the exposed children's fathers and 16 of the unexposed children's fathers also had worked in floriculture during the pregnancy, while most other fathers worked in construction trades.

Prenatal exposure was associated with significantly higher systolic blood pressure and substantial deficits on spatial performance. In this regard, the researchers concluded that pesticide toxicity may add to the adverse influence of malnutrition. Also, the effects of prenatal pesticide exposure seemed to last longer than those known to be associated with pesticide exposures in adults. However, the investigators found no link between prenatal exposure and stunting.

Elizabeth Guillet, an anthropologist at the University of Florida who has studied the health effects of pesticides in Mexico, says Grandjean's study reinforces earlier findings. "Pesticide use is definitely impacting the offspring in terms of mental and neurophysical abilities," she says.

Such concerns motivated the founders of Organic Bouquet, which since January 2001 has marketed flowers produced with fewer toxic pesticides. It sells flowers online and in natural food stores such as Whole Foods, using only producers certified by one of three programs. VeriFlora, one of the three certification programs, sets criteria for U.S.-sold flowers that include low pesticide residue and compliance with local labor laws.

As for traditional flower farms, Guillet says much better education is needed—not just on safe use at work, but also safe practices in the home, such as washing exposed clothes separately and minimizing in-home pesticide use. Grandjean agrees that education would help, but only if industry and individuals follow through with less extensive fumigations at work, use of less-toxic chemicals at work and at home, and use of protective equipment.

"I'm optimistic we can do something and change," says Guillet, "but action needs to be taken now." —David A. Taylor

Tax Schemes for Environmental Payoff

A new policy brief from the World Resources Institute and the Brookings Institution examines how different fiscal strategies can both raise money and benefit the environment. The brief discusses state-level initiatives that tax septic systems and gasoline consumption as well as the federal law signed in 1989 that taxes certain ozone-depleting chemicals. This law brought about the 38% reduction in use of those chemicals in the year 1990 and raised almost \$3 billion in its first five years. The brief also points out tax schemes that have had unintended adverse environmental effects. The authors propose water pollution, nitrogen fertilizer, and carbon as viable options for taxation. The brief is available online at http://pdf.wri.org/greening_the_tax_code.pdf.



WTO Kills European GMO Moratorium

In May 2006, the World Trade Organization ruled that the European Union moratorium on genetically modified (GM) foods was illegal. The case was brought by the United States, Canada, and Argentina, the world's biggest producers of GM foods. The ruling also came down against six individual European member states that had their own bans on certain GM products, stating they had provided no scientific evidence to justify their moves. The case did not address the safety of GM foods or whether they can be compared to conventional products. The ruling can be appealed by both parties.

Ironic Breeze

Researchers at the University of California, Irvine, confirm in the May 2006 issue of the

Journal of the Air & Waste Management Association that indoor air purifiers used in small, poorly ventilated areas can add to indoor ozone levels, creating concentrations that exceed regulatory standards. In the study, ozone levels reached levels higher than 350 ppb, which would trigger a Stage 2 smog alert if it occurred outdoors. Ozone can cause lung damage and aggravate chronic lung diseases such as asthma. No agency has the authority to govern the amount of ozone that air purifiers can produce. However, the U.S. EPA and the California Air Resources Board have issued advisories discouraging the use of these machines.



CHEMICAL EXPOSURES

PFOA Alters Liver Gene Expression

In the latest of a series of strikes against perfluorooctanoic acid (PFOA), the chemical has been found to affect gene expression in the livers of lab rats. PFOA is used in the manufacturing of fluorotelomers, which include nonstick substances such as DuPont's Teflon®. PFOA is released when these fluorotelomers break down in the environment or the body. PFOA is stable in the environment, has been found in wildlife thousands of miles from an identifiable source, and bioaccumulates.

PFOA has been implicated in increasing in "bad" LDL cholesterol, while leaving "good" HDL cholesterol unaffected. Other studies have linked PFOA exposure to increased risk of stroke. PFOA is being phased out of use in the United States under a January 2006 agreement. DuPont will eliminate its PFOA use by 2015, and 3M has already phased it out of its Scotchgard™ line entirely. However, use of PFOA is increasing in Asia with the growth in industry there, especially in the Pearl River Delta of Southern China.

In the study, published in the January 2006 issue of *Toxicological Sciences*, Keerthi S. Guruge and colleagues exposed five groups of seven-week-old rats to daily doses of PFOA ranging from 1 to 15 mg/kg body weight. A control group received no PFOA. When the rats' livers were tested the scientists found that the

expression of more than 500 genes changed significantly at at least one dose level, and 144 were affected at all dose levels. The total number of genes affected peaked at the 10-mg/kg dose.

The largest category of genes affected were those that control how the liver transports and metabolizes lipids, especially fatty acids, says coauthor Paul K.S. Lam, a professor of biology at the City University of Hong Kong. Lam and Guruge—a senior scientist at Japan's National Institute of Animal Health in Tsukuba—emphasize that these studies were conducted with hyperdoses of 100 to 1,000 times what might be found in environmental exposure.

Nonetheless, this work could be an important step toward explaining the increases in LDL seen with PFOA exposure, says Tim Kropp, a senior scientist for the nonprofit Environmental Working Group. "It starts to give you a clearer picture of what may be going on," Kropp says. He adds that more animal studies are needed to put this work in context.

A related chemical, perfluorooctane sulfonate (PFOS), has been studied more extensively than PFOA, Lam says, but it's important to look at the possible culprit itself. "There is a temptation for people to use existing data on PFOS for PFOA because there are some similarities in terms of the structure," he says. "[But] no matter how similar they are, they are different."

The team is now starting to look at how PFOA affects the kidneys, and they have expanded to the avian world with a chicken study to look for similar genetic effects. "If [the models] behave similarly," Guruge says, "that means they must have some kind of common biomarkers." —**Scott Fields**

PHARMACEUTICALS

An Outbreak of New Sources of Avian Flu Drug

Worldwide, 228 people have been infected with H5N1 avian influenza, largely through exposure to sick birds; of these, more than half have died. Although only limited human-to-human transmission has been confirmed, scientists fear a worldwide pandemic could erupt if the virus mutates to a highly pathogenic form that humans can efficiently pass among themselves. Now scientists are finding faster, cheaper ways to produce more of the only drug proven capable of combating avian flu.

Tamiflu (oseltamivir phosphate) reduces flu mortality by inhibiting the virus from spreading among cells. For several years Roche Pharmaceuticals has made the drug with shikimic acid from the pod of the star anise tree, a native of Asia. Extracting the acid is slow and expensive, but productive enough to meet the demand for regular seasonal flu. Recent "shortages" occurred when countries started stockpiling the drug in anticipation of a potential pandemic.

In the 17 May 2006 *Journal of the American Chemical Society*, two separate



Sweetgum surprise. Researchers are finding new sources of shikimic acid.

teams describe new methods for synthesizing oseltamivir phosphate without using shikimic acid. "We came up with a very efficient route," says Harvard University chemist Elias Corey of his petrochemical-based method. "The yield is twice as much as with the present process." In the other new method, Masakatsu Shibasaki and colleagues at the University of Tokyo use 1,4-cyclohexadiene, a benzene derivative, as a catalyst.

Other researchers are taking another tack: finding new sources of shikimic acid. Chemistry professor Thomas Poon of Claremont McKenna College has extracted

the acid from the seeds of sweetgum trees, while Canada-based Biolyse Pharma found a source in the needles of discarded pine, fir, and spruce Christmas trees. Neither of these methods has been published.

Roche has significantly expanded its Tamiflu production capacity over the past several years, and will be able to produce up to 400 million treatment courses annually by the end of 2006—a more than 10-fold increase over 2004 capacity. Production is getting a boost in part as Roche replaces most of the star anise extraction with *Escherichia coli* fermentation. The bacteria produce shikimic acid quickly and cheaply from glucose. Roche and its partners plan to substantially increase their fermentation capacities over the coming years.

Roche spokesman Terence Hurley wouldn't say whether the company anticipates adopting any other new methods. He did point out that a new process would require approval of the FDA and its foreign counterparts.

If Roche doesn't use his technique, Corey hopes another manufacturer does. This could happen despite Roche's patent rights—if it ever does come down to a human pandemic, the 2001 Doha Declaration of the World Trade Organization states that countries facing a public health crisis may grant licenses for production of patented drugs. —**Cynthia Washam**

ehpnet

UNEP Finance Initiative

Around the time of the Rio Earth Summit, the UN Environment Programme began raising awareness of environmental and sustainability issues among the financial industry. Today, the program's Finance Initiative (UNEP FI) helps more than 160 firms—including some of the world's largest banks, insurers, and fund managers—to integrate sound environmental and sustainability practices into their operations. The UNEP FI website, located at <http://www.unepfi.org/>, provides an in-depth look at the organization's activities.

Signatories commit to upholding the principles outlined in one of the two UNEP FI statements of principles (one is specifically for



financial institutions, the other for insurers). These voluntary, non-binding statements reflect the belief that sustainability is not just a responsibility but also a sound business practice. Each signatory pays an annual fee, attends UNEP FI General Meetings, and submits a brief annual report on steps the institution has taken that year to advance its commitment to the relevant UNEP FI statement. Signatories may also participate in training and workshops, task force meetings, global roundtables, and themed conferences sponsored by the initiative. The Our Signatories section of the website lists the UNEP FI signatories and includes the text of the two UNEP FI statements of principles.

The UNEP FI sponsors regional activities, work groups that focus on finding creative ways to link finance and sustainability, training programs, and research. The Work Programme section of the website describes the core activities that the UNEP FI focuses on. The Climate Change Working Group examines carbon finance (which includes the use of tradeable "carbon credits"), policy and regulation debates, and renewable energy. The UNEP FI is also conducting four projects related to finding ways to link social, environmental, and governance issues with responsible investment practices. A third core activity is sustainability management and reporting, the development of environment and social performance indicators specially tailored to the finance industry. The UNEP FI is also exploring ways to invest responsibly in politically risky nations, and to leverage water-related issues to the benefit of both resource sustainability and business.

The Regional Activities section details the work of task forces that the UNEP FI has established in the African, Asian/Pacific, Central/Eastern European, Latin American, and North American regions. These task forces are responsible for overseeing UNEP FI activities of local signatories and for facilitating relationships among signatories that allow them to interact and share information.

Visitors to the site can also sign up to receive the UNEP FI e-bulletin, which contains a rundown of news, events, and new publications. Back issues of the e-bulletin are available, as are all issues of the quarterly UNEP FI newsletter, *0.618...* (the name refers to the golden ratio and reflects the ratio of risk to reward inherent in sustainable development). This newsletter features articles written by experts in the field. —Erin E. Dooley

Sunscreen Ads Miss Men

A Boston University review of 24 popular magazines found that publications aimed at groups at high risk for skin cancer rarely contain advertising for sun protection products. Middle-aged and older men are both the least likely to use sunscreen and the most likely to die from melanoma, the deadliest form of skin cancer. But of almost 800 sun-care product ads that appeared in six years' worth of the 24 magazines, three-quarters were found in women's magazines. The researchers noted that women's magazines ran an average of four sun-care product ads per issue, while parenting and family magazines carried less than one per issue, and outdoor recreation magazines aimed at men ran ads just once every six issues.



Wal-Mart Aims for Organic

The summer of 2006 will see the food shelves of the world's largest retail chain, Wal-Mart, getting an organic boost. The company will begin selling a wide range of organic foods at relatively affordable prices—possibly just 10% higher than conventional food. Wal-Mart, already the biggest seller of organic milk, is now pressing its suppliers for organic versions of well-known brand-name products. Critics worry that the move will force more industrialization of organic farming in ways that may not be true to traditional organic principles—for example, by forgoing the field rotation used by small farms. Further, because supply for organic goods already lags behind demand, Wal-Mart may have to turn to suppliers overseas, which will cause more transportation-related pollution.

Random Acts of Sustainability

Random House, a publisher with 13% of the U.S. adult book trade, announced in May 2006 that it plans to raise the amount of recycled paper it uses to print books from 3% to 30% by the year 2010. Random House is the first major U.S. publisher to commit to such a change. By 2008, the company also aims to use at least 10% recycled materials for glossy items such as art and cookbooks. More than 500,000 trees could be saved yearly thanks to the switch. Luckily for book buyers, the cost for switching to recycled paper should be in the range of cents, not dollars.



Gene-Environment Studies: Who, How, When, and Where?

With the sequencing of the human genome completed, the question becomes: what now? Many common diseases are known to be associated with genetic variants, or changes in single nucleotides of the DNA making up the human genome. However, scientists still have many questions about how individual gene variants, and interactions between variants and environmental factors, contribute to an individual's risk of developing common diseases such as cancer, obesity, and heart disease.

Some scientists believe the only way to answer those questions is through a large prospective cohort study, collecting DNA samples and information about exposure to a variety of environmental factors from 500,000 to 1 million participants and following this random sampling of the population over a number of years. But such a study would require a huge investment of time, effort, and money; the DHHS Secretary's Advisory Committee on Genetics, Health, and Society (SACGHS) estimates the cost at roughly \$3 billion, possibly more. In addition, such an endeavor would likely raise significant social, legal, and ethical issues concerning privacy, consent, public involvement, and communication.

Now a new draft report by the SACGHS examines the policy issues related to such a study. The report concludes that, although conducting a large prospective study presents major challenges, it also has the potential to result in significant health benefits.

Examining the Angles

In 2004 the SACGHS decided to address the question of whether the United States should undertake a large cohort study in this country. The committee formed the Large Population Studies Task Force to dig into the issues that would be involved in such a study. Since a large population project could potentially have significant ethical, regulatory, scientific, and public health implications, NIH director Elias A.

Zerhouni asked the committee to focus its inquiry on the associated policy issues.

Through consultation with experts in the field, fact-finding research, and deliberation, the committee identified several specific policy issues. In May 2006, the committee issued a draft report (available at http://www4.od.nih.gov/oba/SACGHS/public_comments.htm) that discussed these key policy issues and made recommendations for how they might be addressed. The report was then opened to the public for comment through the end of July 2006.



The report devotes an entire chapter to the need for public involvement in all stages of the decision making, planning, and execution of such a study. Suggested populations to consult include the scientific and international communities, representatives of populations that might be involved in the research, health care providers and their institutions, and those who volunteer to participate in the project as research subjects. The report also stresses the need to include in the study populations who are underinsured or who are underserved by the health care system. Since such a study would require a large

investment of public money, states the report, it is only reasonable and fair that the benefits should be equitably distributed among the population.

Honing the Tools

The report notes that some scientists raise the question of whether scientific methods to determine gene-environment interactions are mature enough to obtain maximum value from a large prospective study. Current methods of measuring exposures allow scientists to determine that an environmental exposure is correlated with disease, but it is still difficult to understand the mechanisms underlying such associations, said NIEHS director David Schwartz during a June 2006 presentation to the SACGHS.

Schwartz is co-chairman, with National Human Genome Research Institute director Francis Collins, of the NIH Coordinating Committee for the Genes and Environment Initiative, a just-launched research effort that aims to develop more precise tools that could be useful in a large cohort study. Tools such as biological sensors and biomarkers would allow scientists to determine not just what a person has been exposed to, but whether the person's body is responding to an exposure, Schwartz said during his presentation.

Other concerns focus on issues of study design. John Hewitt, director of the Institute for Behavioral Genetics and a professor of psychology at the University of Colorado, also made a presentation before the SACGHS in June 2006. Hewitt suggested that the committee consider highlighting the need for a smaller substudy of identical twins, which could serve to confirm apparent associations between disease and either environmental factors or gene-environment interactions.

"The big concern is that a large-scale national study has a very wide geographic and demographic range, so it's very difficult to sort out what are truly environmental differences and what are truly genetic differences," Hewitt says. "When you study genetically identical pairs, you know that the environmental differences within that pair aren't correlated with genetic differences, because there are [no genetic differences]."

A substudy of twins may also help keep the larger study honest. “You could certainly take things that appear to be interesting in the large study and get an immediate check [in a twin study] on whether those environmental associations held up when you controlled for the genotype,” Hewitt says.

How and When to Return Results

Richard Sharp, an assistant professor of medicine with the Center for Medical Ethics and Health Policy at Baylor College of Medicine, praises the report’s commitment to reaching out to the public and to underrepresented communities. But he expresses surprise that the report didn’t pay more attention to what he calls “relatively obvious” ethical issues surrounding informed consent and communicating research results to participants.

“If you’re a patient in a clinic in a hospital, and someone comes up to you and says ‘we want to enroll you in this twenty-year study,’ or however long it ends up being, what would you need to know before you felt like you could say yes or no?” Sharp asks. He and NIEHS health administrator Pat Chulada conducted a study with participants in the NIEHS’s Environmental Polymorphisms Registry to answer these questions. The data from that study are now being analyzed.

Sharp also stresses the importance of establishing a process for communicating research results to participants. For instance, if certain genes are found to greatly increase risk for certain diseases, should study participants be informed about these results and their genetic status? If so, when and how? The report suggests that any large prospective study should include a standing committee to address such ethical issues but doesn’t outline a specific process for returning results. “We don’t really know what to do in terms of returning results of unclear value,” Sharp says.

Task force chairman Huntington F. Willard, director of the Institute for Genome Sciences & Policy at Duke University, emphasizes that the draft report has not yet been approved by the full committee. With the comment period now completed, the task force will consider the comments, modify the draft, and present it to the SACGHS for its consideration and action, most likely at the committee’s November 2006 meeting. However, even as many scientists express enthusiasm for the benefits of such a study, the SACGHS and others will still need to explore the many other challenges to be addressed, not the least of which is the uncertain availability of funding. —Angela Spivey

Headliners

NIEHS-Supported Research

Public Health



Inadequate Housing May Put Immigrant Farmworkers at Risk

Early J, Davis SW, Quandt SA, Rao P, Snively BM, Arcury TA. 2006. Housing characteristics of farmworker families in North Carolina. *J Immigr Minor Health* 8(2):173–184.

Even though rates of substandard housing for the general U.S. population are relatively low, percentages for subpopulations such as immigrants are disproportionately high. In this report NIEHS grantee Thomas A. Arcury and colleagues at Wake Forest University School of Medicine describe specific housing conditions for immigrant farmworker families in North Carolina, and identify housing features that leave the occupants vulnerable to environmental exposures.

Inadequate housing is a known contributor to poor health. Overcrowding and lack of proper sanitary facilities can lead to higher incidences of infectious disease, and substandard housing with structural or electrical problems poses the danger of physical injuries and exposure to toxic substances such as lead and polychlorinated biphenyls. Inadequate housing can also have negative effects on psychological health.

The researchers analyzed data from four surveys of North Carolina farmworker communities conducted in 2001 and 2003 by specially trained interviewers fluent in Spanish. From the survey responses, the researchers documented housing conditions for 234 households of immigrant Latino farmworkers, most of whom (90%) had immigrated from Mexico. All participating houses had at least one adult farmworker and one child. The investigators considered three main features in the participants’ houses that could affect their health: characteristics of the dwelling itself, characteristics of the people comprising the household, and housekeeping behaviors.

Compared to 7% of the U.S. population as a whole, 54–70% of the immigrants surveyed lived in mobile homes, and many (36–46%) lived in crowded conditions. Most of the homes had only one bathroom. Most respondents did not own their own dwellings, and therefore had no control over how often necessary repairs were addressed.

Many respondents reported living in households that included more than the traditional nuclear family (two adult parents and children). Most reported that they dusted, swept, and mopped their floors daily. Many did not own a working vacuum cleaner, and cleaned carpets with water or brooms. Over a third of respondents did not have a working clothes washer or dryer in the home, and up to 44% lived adjacent to agricultural fields; both conditions potentially left them susceptible to pesticide exposure.

The authors conclude that the health of these families may be at risk due to inadequate housing. They add that research focusing on farmworker perceptions and decisions regarding their housing situations as well as more information on housing availability, affordability, and quality is needed. —Tanya Tillett

BEYOND THE BENCH

Flagging Environmental Health Awareness on Beaches

During the summer months, folks flock to the beach to enjoy the combined pleasures of sun and sea. Smart beachgoers know that before they take a dip, they should check whether any warning flags are flying, indicating hazardous conditions such as rip currents or the presence of jellyfish. Now, Galveston swimmers can look for a new “environmental alert” flag. The new flag warns beachgoers of air and weather conditions that could pose a health threat, especially to particularly vulnerable populations such as asthmatics, the elderly, and people with heart or lung disease.

The new flag reflects the translation of research findings into concrete community health education by investigators in the Asthma Pathogenesis Core of the University of Texas Medical Branch (UTMB) and codirectors of the Asthma



For better beachgoing. A new orange flag indicates when Galveston beaches are experiencing poor air quality conditions that might affect vulnerable populations.

Community Outreach and Education Core (COEC), in partnership with the Galveston Sheriff's Office Beach Patrol, the Galveston Park Board of Trustees, and the Texas Commission on Environmental Quality.

Three years ago, investigators Sharon A. Petronella and Edward G. Brooks initiated the Gulf Coast Study of Urban Air Quality and Respiratory Function (GC SURF) to study pulmonary function in a cohort of lifeguards in Galveston. During the summers of 2003 through 2005 they



collected pulmonary effects data on the GC SURF cohort by using portable spirometers, which measure the amount of inhaled and exhaled air. This allowed them to evaluate exposure to and effects of air pollutants and weather conditions including nitric oxide, nitrogen dioxide, ozone, particulate matter, wind speed, outdoor temperature, relative humidity, and solar radiation.

The data gathered helped the investigators determine particular times of day when changes in air quality could affect breathing health. Now, whenever the Texas Commission on Environmental Quality deems that air quality conditions exist that might affect vulnerable populations, the city's 26 lifeguard towers and 7 free-standing beach stations deploy an orange flag and display information on posters and in

brochures describing the particular environmental issues and guidelines for protecting health.

The program, which the COEC believes to be the first in the nation to enlist lifeguard participation in an environmental health public warning system, provides educational materials on ozone, fine particulates, and, as needed, red tide. The group has now also developed a partnership with the Galveston County Health District to display the environmental flags at each tower when water quality is less than optimal.

Petronella says the alert program is the result of a true collaborative effort between the partner organizations and is a solid indication of what can happen when a community comes together. The developers, who hope the orange flag alert program can be used as a model for other beaches, presented it at the annual meeting of the U.S. Lifesaving Association in Galveston in 2004.

In addition to the GC SURF flag alert program, the Asthma Pathogenesis Core of the UTMB COEC is also involved in other projects that focus on building connections between research, education, and community health. One of these, the Texas Emergency Department Asthma Surveillance Project, is a collaborative effort coordinated by Charles Macias of Baylor College of Medicine that links the databases of Baylor and three other Texas hospitals to track asthma-related emergency room visits. The results will aid in the development of an educational intervention program. Another project, Communities Organized Against Asthma and Lead, is an environmental justice consortium combining the educational outreach efforts of the COEC with community social services and health care providers. COEC investigators are also involved in a school asthma surveillance project.

“As researchers involved in the UTMB NIEHS Center Asthma Pathogenesis Core, we work in and with our community to identify problems and potential solutions related to our environment,” says Petronella. “Our COEC, however, allows us to take our work one crucial step further—by actually assisting the community with education, intervention, and development of policies that will effect positive change in the health of our residents and all visitors to our part of the Gulf Coast.”

In essence, Petronella says, the COEC forms the bridge from basic science to the public. “This is essential to our success,” she adds, “since the key to any public health research program is the use to which the data are put.” —Tanya Tillett





The Apple Bites Back

Claiming Old Orchards for Residential Development

As the U.S. population continues to grow, increasing demand for housing and related community resources means more land is being converted from agricultural uses to residential applications. According to the revised 1997 National Resources Inventory conducted by the USDA Natural Resources Conservation Service, more than 6 million acres of American farmland were converted to developed uses between 1992 and 1997. That is an annual conversion rate of roughly 1.2 million

acres per year—a 51% increase over the average annual rate reported for the preceding decade.

Naturally, many of these areas were routinely treated with pesticides and other chemicals during their agricultural lifetimes. Although this legacy has been problematic in a wide variety of land conversion scenarios, one in particular seems to have attracted the attention and concern of environmental officials and property buyers in several states across the country: the residential development of



You spray, you pay? Spraying of arsenical pesticides on apple orchards was routine from the late 1800s through the 1940s. Lead arsenate was not banned, however, until 1988.

historic orchard properties. In state after state, these old orchards (which most often produced apples, but also peaches, cherries, pears, and other tree crops) are metamorphosing into highly desirable subdivisions—desirable, that is, until it emerges that the soil beneath the feet of the proud new residents may be contaminated with lead and arsenic. These toxic by-products are left from the days before DDT and before organophosphates, when arsenical pesticides, particularly lead arsenate (LA), were the treatment of choice to prevent the ravages of insect damage.

They Loved LA

LA was introduced in 1892 in Massachusetts for use against the gypsy moth. Two other arsenical pesticides (copper acetoarsenite, known as “Paris green,” and calcium arsenate) also were in use, although LA largely replaced them in the 1930s due to lower cost, greater efficacy, and lower phytotoxicity. Even though arsenic residue was recognized as a problem as early as 1919, LA was the most widely used pesticide in the nation—recommended by the USDA and applied to millions of acres of crops—until the late 1940s, when DDT (considered at the time to be safer and more effective) became available. LA continued to be used in some locations into the 1970s, and was ultimately banned in 1988.

LA was perhaps most commonly applied in apple orchards, due to its excellent control of the codling moth, a major apple pest. Today, apple orchard properties that were in production during the heyday of LA use are the focal point of environmental concerns; given the nature of the pests peculiar to orchard crops, growers tended to apply the chemicals frequently and in high concentrations, often over many years. “In some cases, they dusted the apple trees or peach trees every week, whereas most field crops may have had one

or two applications during the growing season,” says Kevin Schick, a bureau chief with the Site Remediation and Waste Management Program in the New Jersey Department of Environmental Protection.

LA and the other arsenical pesticides were designed to be persistent, and it is that persistence that is causing environmental contamination problems decades after their use ended. “These chemicals have just tremendously long half-lives in the ground,” says North Carolina state toxicologist Ken Rudo. “They bind very tightly to the soil.”

Once LA reached the soil through overspray, spillage, rainfall wash-off, or simply fallen fruit and leaves, the lead arsenate underwent hydrolysis, separating into lead and arsenic bound to organic particles in the soil. The lead, being poorly soluble, was immobilized, typically within the top 12 to 18 inches of topsoil. The fate of the arsenic was similar, but a bit more complicated. “Arsenic, as arsenate, even though somewhat sparingly soluble, *is* soluble, and it will move in water,” says Washington State University soil scientist Frank Peryea. “I’ve seen some sites where almost all of the arsenic is still in the topsoil, in the tillage zone, and I’ve seen sites where I’ve measured arsenic movement as deep as a meter or so.”

Carl Renshaw, a hydrogeologist at Dartmouth College, published a study in the January/February 2006 issue of the *Journal of Environmental Quality* showing that arsenate in the soil can be remobilized by being disturbed. He compared two fields in the same historic New Hampshire orchard. One field had never been disturbed, whereas the other had been tilled and replanted in the early 1990s. “What we found was that in the field that had been replanted, there was somewhat less arsenic on it than in the undisturbed field,” he says.

Given the assumption of virtually identical application rates over the years, the

discrepancy apparently arose from a portion of the arsenic in the disturbed field having been mobilized and removed by surface water. Renshaw found arsenic in the sediment of a nearby stream in amounts that very closely matched the arsenic missing from the tilled field.

“The implication from our study,” says Renshaw, “is that if you’re not really careful about erosion, you’re going to end up sending a lot of arsenic down into the stream

channel.” To date, researchers have seen no evidence of direct health effects in humans, animals, or plants exposed to this stream-bound arsenic. However, more study is needed to fully understand the ramifications—if any—of the mobilization.

How Dangerous?

The potential danger posed to human health by lead and arsenic contamination in historic orchards is a complex issue, fraught with scientific uncertainties and competing interests. Arsenic is a known human carcinogen. Exposure to lead, especially prenatally and in childhood, can lead to neurological damage. There is no doubt that excessive exposure to either substance can adversely impact health, but in this case any risks are almost exclusively long-term—virtually no instances of acute adverse health effects have been documented in people living on historic orchard properties.

Regulatory agencies such as the EPA and state health and environmental departments determine allowable levels of chemicals in soils and water based upon formulas that take into account criteria such as toxicity, exposure, and naturally occurring background concentrations of the chemicals. For carcinogens such as arsenic, the calculations are based upon the amount of a chemical that is predicted to result in 1 additional cancer case occurring in 1 million people exposed over their lifetimes. But there is some flexibility in the standards based on local conditions and practical considerations. In New Jersey, for example, where background arsenic concentrations are often high, the criterion for residential soil cleanup is set at 20 ppm—50 times the EPA’s level of 0.4 ppm.

In historic orchard properties, cleanup action is often triggered when a so-called “hot spot” is discovered—typically an area where the pesticides had been mixed and

loaded or stored, and where repeated spills or disposal of excess materials may have occurred. The contaminant concentrations in those hot spots can be significantly higher than in the tree crop areas. But locating hot spots after many decades can be very difficult.

The ATSDR is often called in to analyze the health risks at contaminated historic orchard properties. “We look at the contaminants, the concentrations, the pathway, how long [residents] are exposed to it—all of the different aspects of an exposure,” says Robert Safay, an environmental health scientist with the agency. “For example, when you’re looking at lead contamination in the soil, you’re primarily concerned about young children playing out in the soil.”

In all but the most extreme cases, the health risks of living atop contaminated historic orchard soil are ultimately characterized as very low and manageable. Exposure is the critical element. “The real issue here is direct contact—you want to limit the direct contact,” says Lori Bowman, director of the Agrichemical Management Bureau in the Wisconsin Department of Agriculture, Trade, and Consumer Protection. As Safay explains, there must be a completed exposure pathway for there to be even the potential for health effects. Ultimately, the amount of risk depends on the level of contamination and the use of the land.

For the most part, residents are advised to limit their direct exposure to the soil if it’s unremediated and to take simple measures such as wearing gardening gloves and wiping their feet before entering the house. Peryea says there is little risk from eating plants grown in this type of soil, but advises that home gardeners rinse off produce before bringing it into the home, then wash it again with a detergent and scrub brush to remove any remaining soil particles, paying particular attention to rough vegetables like broccoli and leafy vegetables like lettuce, which can trap and retain dust. He also advises paring root and tuber crops such as potatoes, carrots, and radishes, and not composting the peelings or other unused plant parts.

The risks involved may be modest and long-term in most cases, but low risk is not the same as no risk, and regulatory agencies across the country are finding themselves in a thorny situation as more and more contaminated historic orchard properties are developed. They are caught between their duty to protect public health and the environment, and the fact that the risks presented by most of these properties pale in comparison to those associated with other, more acute contamination sites, such as lands near smelters or toxic waste dumps. Naturally, budgets are limited, and priorities must be set. Yet the orchard situation cannot be ignored, and several states have been wrestling with how to deal with this issue for several years.

The sheer scope of the phenomenon adds another layer to the challenge of how to most effectively deal with it. “The magnitude of the problem is just staggering,” says Peryea. Millions of acres across the nation are involved. In the state of Washington alone, Peryea says, some 188,000 acres are affected. In Wisconsin, 50,000 acres may be affected, and in New Jersey, up to 5% of the state’s acreage is estimated to be impacted by the historical use of arsenical pesticides. Both New Jersey and Washington have had multistakeholder task

forces examine the problem and issue recommendations and guidelines.

Wisconsin is likely to convene a similar task force later in 2006, according to Bowman. “We want to develop a protective, economical, and practical strategy to address potential residues of lead and arsenic in soils related to historic orchard use,” she says. “The charge of the task force would be to evaluate the health and environmental impacts, and [also evaluate] what kind of alternatives and strategies we could put into place to limit exposure and to educate and provide outreach to homeowners and developers as to what types of precautions can be taken at these orchard sites to mitigate any risk.”

What Can, Should, or Must Be Done

Because contamination can be spread over large areas, remediation measures vary widely, depending upon the level of contamination, the current or intended use of the property, and state or local regulations. Each method has its advantages and its drawbacks, and each site has its own unique circumstances that will often dictate how, when, and even if the situation will be dealt with.

Excavation is the quickest and most thorough remediation method. This involves scraping up the contaminated topsoil,



A blooming problem? Land that was once home to fruit orchards is now being turned into subdivisions, raising questions about pesticides that may still be present in the soil and the potential risks they pose to residents.



Soil survivors. Some experts recommend that homeowners have their soil tested for arsenic and lead, although no perfect method exists for remediating soil that is found to still be contaminated.

hauling it away to an approved landfill, and replacing it with clean dirt. Realistically, says Peryea, removal is the only way to eliminate risk, “but it’s very expensive.” Such total remediation can cost \$1 million per acre or more. And it’s a huge undertaking. Peryea does the math for 1 acre: “If you have contamination down to three feet, you’re looking at getting rid of three acre-feet of soil—that’s twelve million pounds of soil.”

Capping, which involves simply putting a 12- to 18-inch layer of clean soil over the contaminated soil, has been used in some locations. However, this requires enormous amounts of clean dirt. Further, capping cannot be considered a permanent solution—plants will grow on the soil caps, their roots will penetrate the contaminated soil, and the vegetation will eventually redistribute the lead and arsenic to the clean soil. Also, it is common for the soil caps to be disturbed by construction activities.

Soil blending is another alternative, and one that is growing in popularity, particularly when contaminant concentrations are only minimally in excess of actionable levels. This involves bringing clean soil to a site and mixing it with the existing topsoil, with the intent of reducing concentrations below levels that require health-protective actions. Although relatively effective, blending can be a hit-or-miss operation. The main reason is that operators can’t always achieve 100% blending, and it very much matters where the subsequent samples are taken—even a few inches can make a difference. Sometimes it is necessary to repeat the procedure, which, of course, drives up costs. Also, disturbing the soil in this way could actually mobilize the arsenic, as Renshaw’s research showed. Regardless of its shortcomings, however, blending is an option many states have chosen in recent years.

In some instances, a simple solution can be adequate. “What seems to do a good job of reducing exposure in areas where people aren’t digging in the soil is just to keep turf on it, or keep it vegetated somehow,” says Peryea. At some sites, simply moving the contaminated soil to another location on the site and capping it—for example, by burying it under a roadway—has been acceptable, although this option requires that a deed notice be executed, so that all of the records of the sampling and disposal of the contamination become part of the property’s permanent title record.

Thus far, other remediation methods have proven to be ineffective, impractical, or counterproductive on these sites. Researchers such as David Butcher, a professor of analytical chemistry at Western Carolina University in Cullowhee, North Carolina, have explored the possibility of phytoremediation of these properties, in which plants are used to suck the contaminants out of the soil, after which the contaminated biomass is destroyed. But this

method, though effective in certain remediation situations, doesn’t appear to hold much promise in lead- and arsenic-contaminated orchard soils. Phytoremediation is quite slow, potentially taking decades or longer to effectively remove contaminants. Butcher also was unable to discover a method of removing the lead from the soil without the addition of other chemicals (such as EDTA) to release the tightly bound element.

One way to release the lead is by adding phosphorus to the soil, but this also mobilizes the arsenic. “That creates an even bigger problem,” Peryea says. “If you get the arsenic moving, and it moves down into the groundwater, cleanup becomes much more difficult than trying to keep it in the topsoil.”

According to Peryea, you can scratch microbial volatilization as well. In that method, native soil microorganisms are stimulated to volatilize arsenic. The gaseous arsenic can then be trapped. But for this method to be effective, soils must be kept quite wet. Many of the historic orchard properties are well-drained, sloping sites, where it would be difficult to keep the soil adequately flooded. Plus, of course, as Peryea points out, “if you are evolving arsenic off your soil, and it flows down and contaminates your neighbor’s property, that’s going to create some problems.”

Cleanup and real estate disclosure issues are usually handled at the state and local levels, where approaches vary considerably. As public awareness of the potential contamination of historic orchards increases in the affected areas, state agencies are fielding more and more calls from concerned property owners or prospective buyers. Chuck Warzecha, a risk assessor with the Wisconsin Department of Health and Family Services, fields 10 to 15 such calls a year. He tries to give concerned citizens a balanced message. “My first statement is that it’s not a real scary issue and doesn’t have to be a big problem on their property,” he says. “It’s something that now that they know about it, it’s worth doing something about, but they shouldn’t be concerned that past exposure is going to be a real serious issue for their families.”

If callers haven’t had their soil tested yet, Warzecha recommends that they do so. Then he advises them on how to manage the problem if there is one. If contamination hot spots are identified, cleanup may be required under Wisconsin’s Agricultural Chemical Cleanup Program. In such cases the property owner would pay a 25% deductible, with the rest of the costs covered by the state, according to Bowman.

In Washington, the Model Toxics Control Act requires the reporting, study,

and cleanup of sites where hazardous substances are above state-set cleanup levels. In residential developments, the state is working to increase awareness of the potential for contamination on historic orchard lands, particularly among developers. The goal is to get developers to incorporate that consideration at the outset of projects, when there are opportunities to deal with problems more easily than could be done once housing is in place. As in other states, several departments are involved in providing consultation, health assessment, and technical assistance on a case-by-case basis.

Washington has also chosen to be proactive in its cleanup efforts at sites where children are especially likely to be affected. “We have elected to focus on schools, child care facilities, and parks where groups of young children might be present, trying to take steps to reduce exposures for kids,” says Dave Bradley, a toxicologist and risk assessor with the Toxics Cleanup Program in the Washington State Department of Ecology. “We’ve focused on a handful of counties, and have further focused on schools, trying to integrate with existing community processes such as school construction, and then trying to prioritize how we use either our authority or funds out of the state Superfund to actually perform some of the cleanup actions.”

In New Jersey, the recommendations and guidelines put forth in the 1999 report of the Historic Pesticide Contamination Task Force set the agenda. Schick, whose department handles historic orchard contamination cases, says there’s no excuse for ignorance on the part of New Jersey developers at this point, and it should be a standard element of their due diligence.

“It’s common knowledge, the guidance is out there, it already involved the real estate agents, the bankers, the insurers, the farm bureau,” Schick says. “It’s been out there long enough that anyone making any kind of investment in developing farmland should have known about it, and they will be held at fault for not coming to the department or cleaning prior to development.”

Paradise Lost, Paradise Regained?

Today, Barber Orchard, a 500-acre subdivision located a few miles west of Waynesville, North Carolina, is “not a place where it looks like there are any problems,” says Butcher. “It’s not a place like where there’s been a lot of mining and it looks like a

moonscape. It looks beautiful up there.” It may look beautiful, but that doesn’t change the fact that Barber Orchard has had a troubled history.

Barber Orchard was a commercial apple orchard from 1903 until the mid-1980s, when the operation went bankrupt and the land was parceled off for development. In 1999, a pregnant resident heard rumors of birth defects from neighbors and friends in the area. She contacted Rudo, who, with the county health department, initiated an extensive investigation that included soil and water sampling and a series of public meetings with residents. In late 1999 through mid-2000, the federal EPA conducted a \$4 million emergency removal of a foot of topsoil from 28 residents’ yards.

Reflecting the tremendous variation in contamination typical of historic orchard sites, the EPA found only trace amounts of lead and arsenic in some sampling locations, but several others were well in excess

of the agency’s cleanup goals of 40 ppm arsenic and 400 ppm lead. Samples came in as high as 400 ppm arsenic and 1,200 ppm lead. The highest levels were detected at spots where trees were still located, or had been cultivated in the past, reflecting the cumulative impact of long years of pesticide applications.

In 2001, the site was placed on the National Priorities List under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), an unusual step for a historic orchard. “CERCLA authority is hobbled when it comes to normal use of pesticides,” says James Bateson, branch head of the Superfund Site Evaluation and Removal Branch of the North Carolina Department of Environment and Natural Resources. “In cases where [a pesticide has] been spilled or dumped in large quantities or misused, that’s when CERCLA can have some authority. At Barber Orchard, the case was made that there was enough spillage associated with the way they handled things up there that it wasn’t normal application of pesticide.”

“The way they handled things” was by distributing the pesticides through a unique underground high-pressure piping system, with aboveground nozzles at the tree sites where sprayers were hooked up. The system left pesticide hot spots at several locations throughout the orchard property. “If there was spillage at a particular location aboveground where that particular distribution



Landscaping. A bulldozer scrapes a layer of contaminated soil from a yard in the Barber Orchard subdivision in North Carolina, once the site of a large apple orchard. Due to contamination with former agricultural chemicals, the subdivision was designated a Superfund site in 2001. EPA-supervised cleanup, mainly by removing soil, is on hold pending further funding.

pipe was located, or if there was a fracture in the pipe, or a joint in the pipe that got a crack or leak in it, then we may have contamination locally at that one particular site, or along the connections along the way,” explains Haywood County Health Department director Carmine Rocco. According to Bateson, the EPA has in fact found several places where pesticides had leaked into the soil because of poor maintenance of the piping system.

In 2004 the EPA issued a record of decision (a document specifying how the agency planned to clean up the site) for the orchard’s

ing the situation continually. Residents have been advised to filter their well water since the problem was uncovered, and city water is now available to the site, although not all of the current homeowners have elected to hook up to the service.

Since the problem arose, the ATSDR has also been involved at Barber Orchard, evaluating the health situation. In April 2002, the agency released its official public health assessment for the site, which concluded that “current exposures to site contaminants are not likely to result in adverse health effects. . . . The exposure pathways for lead

contamination at the site and thinks the whole situation has been overblown. “I haven’t changed the way I live,” he says. “I work in the garden just about every day, I’ve planted a vegetable garden and eaten the vegetables, I’ve planted some fruit and eaten the fruit. So it has not affected me or my wife in any way.”

So it appears that Barber Orchard was paradise lost for a time, but is now paradise regained. Now, however, some neighbors just down the road may be facing a similar situation. In May 2006 residents of the Tan Woods and Orchard Estates subdivisions, built on what was once Francis Orchard, were notified that soil samples from a vacant lot at the site had tested positive for lead, arsenic, and other pesticides—a mix similar to that found at Barber Orchard. And like Barber Orchard, Francis Orchard was equipped with an underground pesticide piping system.

It’s still early in the process, and the results of more thorough sampling and testing are not yet available, so it’s too soon to predict whether Francis Orchard may eventually become a Superfund site. But this time around, according to Bateson, both residents and involved officials can benefit from the Barber Orchard experience. At Francis Orchard, he says, “the residents are well schooled after seeing what’s gone on at Barber Orchard, and of course the county and state people have been around the block now too.”

Questions Remain

Despite the large scale scope of the problem, it appears that living on a historic orchard property contaminated by lead and arsenic does not constitute an immediate threat to human health. So it is still an open question whether it’s really necessary to spend huge amounts of money, often from tax dollars, to ameliorate these sites.

Peryea thinks that what is needed is a solid epidemiologic study to document whether there really is a problem with people living on these arsenical pesticide-contaminated soils. “If that sort of study was done,” he says, “and it was to show that there’s no problem, or that the problem is controllable by setting up some sort of engineering controls or behavioral controls, like they do with urban lead nowadays, that would probably take care of a lot of the problem. The response—rather than trying to force a cleanup that would probably be wildly impractical, very expensive, and potentially ruin property values—would be that people would change their behavior a bit and end up minimizing the risk.”

Ernie Hood

Online Resources

New Jersey, Washington, and Wisconsin offer detailed advice to residents, developers, and other interested parties about what to do if they suspect or know their land is contaminated. Wisconsin has posted a variety of publications (http://www.datcp.state.wi.us/arm/agriculture/pestfert/pesticides/accp/lead_arsen_resources.jsp), including tips for safe gardening in lead- and arsenic-contaminated soil. Washington provides a comprehensive toolbox of resources stemming from its Area-Wide Soil Contamination Project, a task force that addressed not only historical orchard contamination, but also lead and arsenic contamination over widespread areas of the state from smelters and leaded gasoline combustion; see http://www.ecy.wa.gov/programs/tcp/area_wide/area_wide_hp.html. New Jersey offers the report of the Historic Pesticide Contamination Task Force (<http://www.state.nj.us/dep/special/hpctf/index.html>) and i-MapNJ, an environmental mapping tool that lets residents obtain detailed contamination information for specific locations (<http://www.state.nj.us/dep/gis/dep splash.htm>).

soil, calling for much more removal of contaminated dirt, mainly from vacant lots on the property. “What we’re doing right now is waiting for funding to implement the cleanup for soil,” says Jon Bornholm, the EPA’s project manager for the Barber Orchard site. That phase of the cleanup, which should take less than a year, is projected to cost \$20 million, and there’s no telling when the funds will be released by the EPA for it to take place.

The EPA is expected to render a record of decision for dealing with groundwater contamination on the site before the end of 2006. Bornholm expects that the agency will opt for “monitored natural attenuation”—in other words, let Mother Nature take care of the problem, and hope that contaminant concentrations will decrease over time through natural processes such as biodegradation and dispersion. He guesses that could take 30 to 50 years, with the EPA monitor-

and arsenic were disrupted within a relatively short time frame, so past exposures are not likely to lead to health effects at this time.”

Meanwhile, Barber Orchard’s tax values have increased, and buying and selling of homes in the subdivision has not been hurt by the site’s Superfund status. “The heat of the moment has passed, and I think we’ve gotten over the panic mode,” says Ellis Morris, president of the Haywood County Board of Realtors. “Initially, people were tentative about buying in to that particular neighborhood, but that’s been resolved, there’s a comfort level now, and the real estate there is keeping pace with all of the other areas of Haywood County in terms of days on the market and selling price.”

David Miller would agree with that assessment. He and his wife retired to Barber Orchard from Florida in 1997, and his 1.4-acre lot was one of the properties cleaned up by the EPA. He is unconcerned about the

A Risky Environment for Investment

Floods in Europe. Heat waves in the United States. Snowfall in the deserts of the United Arab Emirates. These are among the unusual weather conditions witnessed in different parts of the world in the past five years, conditions that demonstrate how climate change is beginning to impact people. While governments negotiate targets for cutting down emissions of greenhouse gases—seen by bodies such as the Intergovernmental Panel on Climate Change as the most viable mitigation measure to slow down the processes causing global warming—the fallout from rapid climate change has already set alarm bells ringing in the financial sector.

Institutional investors are realizing that taking environmental, social, and corporate governance, or ESG, issues onboard is in the long-term interest of the investments they hold. Not doing so could pose a financial risk to their investments.

Yet, in the absence of any pressure from market regulators to disclose information on environmental issues, and given the focus of markets on short-term profit, companies are not always forthcoming with full disclosures on environmental risks. According to a May 2006 report titled *Climate Risk and Energy in the Auto Sector: Guidance for Investors and Analysts on Key Off-Balance Sheet Drivers*, by the Ceres network for socially responsible investment (SRI), investors and analysts are finding it difficult to assess automotive companies due to lack of disclosure from companies and uncertainty about the future course of U.S. energy and climate change policies.

At the same time, market research firms—which give investors “buy” and “sell” advice—need to be educated about climate change and other nonfinancial risks. In the February 2004 study *Values for Money: Reviewing the Quality of SRI Research*, the European action groups SustainAbility and

Swedish Foundation for Strategic Environmental Research showed that only 3 of 35 stock market research firms specializing in SRI actually analyzed the link between ESG issues and material impacts on investment value drivers. Most used generic research methodologies and gathered data primarily from the companies themselves with little, if any, verification.

Today a number of initiatives seek to weave ESG factors into virtually every segment of the market. Most recently, the UN launched the Principles for Responsible Investment (PRI), and a pact for financial institutions known as the Equator Principles was just revised to broaden its scope and thereby extend environmental protection. The blending of sustainability and profitability can, however, seem at times an uneasy marriage, at others a battle royale.

The Economics of Disaster

The frequency of floods, droughts, severe heat waves, and violent windstorms has increased significantly in the last decade. Between 1998 and 2004, Europe suffered more than 100 major damaging floods that killed 700 people, displaced half a million others, and caused more than US\$31 billion in insured economic losses, according to the European Commission. The European Environment Agency’s 2004 report *Impacts of Europe’s Changing Climate* pointed out that climate change is likely one of the causes of flooding in Europe.

The losses due to natural calamities, many of them related to climate change, grew to \$46 billion per year in the 1990s, up from \$4 billion per year in the 1950s. By 2004, the figure had more than doubled to \$107 billion, then spiked to \$123 billion in 2005, mainly due to Hurricanes Katrina and Rita, according to *Climate Change Futures: Health, Ecological and Economic Dimensions*, a November 2005 report prepared by

the Center for Health and the Global Environment at Harvard Medical School. Resurgence of infectious diseases such as malaria and dengue, shortage of drinking water, and reduced agricultural production due to outbreaks of pests and diseases are among long-term impacts of climate change pointed out in the report.

Insurance companies are beginning to look at climate change as a long-term risk, while banks are revising their lending guidelines to align them with risks related to climate change. The insurance industry could play a key role in devising mitigation strategies. “[I]nsurers founded the early fire departments and owned the equipment . . . , helped establish the first building codes and stand behind consumer-safety organizations such as Underwriters Laboratories. Loss prevention is ‘in the DNA’ of the insurance industry,” observed the authors of the Harvard report.

Big corporations in sectors like electric power and the automotive industry are under greater scrutiny from bankers, shareholders, and action groups with regards to their strategies to cut greenhouse gas emissions and other environmental risks. They are under pressure to disclose enough information on these matters so that investors can take into account risks to their portfolios.

In the first half of 2006, about 180 ESG-related shareholder resolutions were either listed or presented in corporate meetings in the United States, according to data collected by the Social Investment Forum, an SRI trade body. Of 32 resolutions that related to global warming issues, 12 were withdrawn after the receiving firms committed to produce or disclose the requested information.

“All these actions are significant because they have influenced the companies to review the issue more closely and to report more fully to shareholders and the public.



Blinkstock

That is the necessary first step for companies to understand and reduce their climate change risks,” says Meg Voorhes, director of social issues services at Institutional Shareholder Services, a firm providing proxy voting services.

Climate change is not the only environment-related financial risk that active shareholders are concerned about. At the annual shareholders meeting of Dow Chemical Company on 11 May 2006, a group of investors forced voting on a resolution that asked Dow to take steps to address ongoing environmental and health problems relating to the 1984 Bhopal gas disaster. The investors—which included the New York City Fire Department Pension Fund, the New York State Common Retirement Fund, and Boston Common Asset Management—feared that if Dow did not take any action, it could be risky for its reputation and business in India and Asia. The resolution received 6.3% of the vote—not enough to pass, but enough to ensure it is presented again next year.

“The longer Dow Chemical fails to address the lingering human issues related to the Bhopal tragedy, the greater the potential negative impact to its long-term profitability,” observed Alan G. Hevesi, sole trustee of the New York State Common Retirement Fund, in a press release issued by Amnesty International USA. “As a fiduciary, I am concerned that if Dow does not put this problem to rest, it could hurt the company’s current and future business relationships in India’s huge and rapidly expanding market and around the world.”

Creating New Tools for Investors

Since the 1992 UN Conference on Environment and Development, the UN has been working with businesses and industries to make their activities environmentally sustainable. A number of international

treaties and agreements are under implementation or negotiation. At the same time, the UN Environment Programme (UNEP) also began working with banking and financial sectors to help them integrate environmental considerations into their operations and services as well as to boost investment in eco-friendly technologies. In 1995, a similar drive was launched for the insurance sector.

social screening process of the International Finance Corporation.

“An evaluation of financial sector engagement shows a significant shift in the way financial institutions view these issues,” observes Paul Clements-Hunt, head of unit for the UNEP FI. “They have moved from a largely public relations focus of the early 1990s to the commencement of mainstreaming of sustainability and social

Annan at the launch of the PRI at the New York Stock Exchange.

Behind the PRI

The PRI were founded on the premise that institutional investors have a duty to act in the best long-term interests of their beneficiaries. As Clements-Hunt puts it, “PRI provides the thinking and guidance, while individual funds provide the meat on the bone in terms of their own national or regional context.”

Jon Sohn, a senior associate at the World Resources Institute, elaborates upon this role: “What PRI does at its core is send a top-down signal to asset managers of funds to integrate these issues into how they pick stocks and analyze companies. . . . This is an indirect way to influence companies, as it impacts valuation decisions, which in turn impacts what companies think is important to investors. The key challenge is demonstrating the ‘materiality’ of sustainability issues and linking that to all the money behind these investors. The potential is great.”

Under the PRI, institutional investors would incorporate ESG issues into their investment analysis and decision-making processes as well as into ownership policies and practices of institutional investors. Investors would seek appropriate disclosure on ESG issues by the entities in which they are investing. They would also promote the principles within the investment industry and monitor progress in their implementation. Finally, they would work together to enhance the effectiveness of implementing the principles.

The principles suggest 35 possible actions that institutional investors and asset managers can take to integrate ESG considerations into their investment activities. These include requesting that investment service providers (such as financial analysts and brokers) integrate ESG factors into evolving research and analysis; developing an active ownership policy consistent with the PRI and exercising voting rights or monitoring compliance with voting policy; asking investment managers to work with companies on ESG-related issues; asking entities in which institutional investors invest for standardized reporting on ESG issues; and requesting information from companies regarding adoption of and adherence to relevant norms, standards, codes of conduct, or international initiatives. Signatories to the PRI are required to report on implementation or provide an explanation if they do not comply with the principles.

The PRI Investor Group, the UN-formed body that developed the principles, is now working on a set of specific short- and intermediate-term tools to support their

All these actions are significant because they have influenced the companies to review the issue more closely and to report more fully to shareholders and the public. That is the necessary first step for companies to understand and reduce their climate change risks.

—Meg Voorhes, Institutional Shareholder Services

Since 2003, the banking/finance and insurance programs have operated under a common umbrella—the UNEP Finance Initiative (FI). This initiative is based on the belief, outlined in its mission statement, that “sustainable development is best achieved by allowing markets to work within an appropriate framework of cost-efficient regulations and economic instruments.” At present, the UNEP FI has more than 230 signatory institutions from 45 countries. [For more information on the UNEP FI, see “EHPnet: UNEP Finance Initiative,” p. A465 this issue.]

Participants in a separate UN program called the Global Compact have developed a set of 10 principles in areas such as human rights, labor, environment, and anticorruption. Whereas the UNEP FI concentrates on financial institutions, the Global Compact, begun in 2000, works with industry and business directly. The Global Compact acts as a body to promote corporate social responsibility based on common principles for businesses.

There have been other, non-UN initiatives as well, like the Equator Principles. Ten leading banks from seven countries first adopted the Equator Principles in June 2003. These principles are a set of guidelines developed by the banks for managing ESG issues related to the financing of development projects with capital costs of US\$50 million or more (this cap was reduced to US\$10 million on 6 July 2006). Under the principles, investment projects are vetted using a process based on the environmental and

responsibility issues in their core business lines.”

The UN’s PRI, launched on 27 April 2006, represents one of the latest efforts to integrate sustainability and profitability. The PRI are specifically intended for pension funds and large institutional investors. So far about 50 U.S. and European asset owners and fund managers representing funds to the tune of US\$4 trillion have signed on to the PRI. Pension funds from developing countries will also be encouraged to sign up in the future.

Public and private pension funds constitute an important segment of financial markets, accounting for up to 35% of total global investment. The PRI stemmed from the recognition that while investors are becoming aware of risks posed to their investments due to ESG issues, they do not have a framework or common guidelines to work on these issues with the companies they are investing in. Also, companies that take proactive measures on these issues are insufficiently rewarded by markets, which continue to be driven by short-term considerations.

These newest principles—which were developed by an international group of more than 20 leading pension funds, foundations, and special government funds—are an attempt to correct this disconnect. “They provide a framework for achieving better long-term investment returns and more sustainable markets. If implemented, they have tremendous potential to more closely align investment practices with the goals of the UN,” noted UN secretary general Kofi

interpretation and implementation. These are likely to include means of assessing and comparing the extent to which fund managers are dealing with ESG issues in their investment processes and contact with companies; an online resource for signatories, with advice on different means of implementing the PRI for different asset classes and investment styles; and a platform for collaborative engagement with companies in which signatories jointly invest.

The principles are voluntary and thus represent a self-reporting system. “The voluntary nature was necessary in order to achieve consensus in a sufficiently large group. We considered voluntary guidelines to be more flexible and thus better able to adapt to changing circumstances,” explains Colin Melvin, chairman of the PRI Investor Group. “The higher standard of definitional clarity required by mandatory guidelines would have been impractical to achieve in the time frame available to us, given the very many asset classes and investment styles represented by the signatories’ activities.”

But translating commitments into action will require significant policy changes at the investor level. In May 2006, South Africa’s Government Employee Pension Fund announced new measures following its adoption of the PRI. Fund chairman Martin Kuscus says the fund will now promote increased investor activism and elect independent directors to the boards of companies in which it holds significant investments. It will also monitor and rate companies for their performance on ESG issues, according to a 26 May 2006 report in the business magazine *Personal Finance*.

Other experts and action groups feel that the principles need to be accompanied by policy changes at the national level in order to be effective. “Some of the major electric generating companies have come out in favor of policies to control emissions. But it is clearly hard for them to take steps to reduce emissions voluntarily if it makes them less competitive in the marketplace,” says Ashok Gupta, air and energy program director at the Natural Resources Defense Council. “These principles are helpful in moving the market in right direction, but they are not a substitute for meaningful government policies.” He adds, however, that some companies are voluntarily pursuing measures to make themselves more efficient and reduce their costs.

What’s Next?

Right now investors are focused on disclosures—getting information from companies on environmental issues. But making a difference on the ground demands going beyond disclosures and investing in cleaner

technologies and sustainable growth. Often pressure from civil society and consumer groups can bring faster results.

For example, in April 2006 Greenpeace reported on its investigation into how Amazon rainforests are being cleared up to make way for production of soybeans, meant for use as feed for chickens and pigs in Europe. These animals become fast food products sold by McDonalds, KFC, and other restaurant chains. Greenpeace alleged that the International Finance Corporation wrongly assessed a loan to Grupo Andre Maggi, which controls major soybean production in Brazil, as being of “low environmental risk.” And based on this assessment, Rabobank lent more than US\$330 million to the Brazilian company.

Responding to the criticism, McDonalds has assured corrective action. “We are very committed to purchasing practices that do not impact the valuable Amazon biome. We have a strict policy regarding this in beef. New developments have shown possible linkages to soya production affecting the

earlier. ABN AMRO—the global banking group that led the implementation of the Equator Principles—and the European Bank for Reconstruction and Development are in the thick of a controversy over their proposed lending for the Sakhalin II oil and gas project in the Russian Far East. If the Equator Principles allow lending to a project with an environmental risk as significant as the potential disappearance of an entire whale species, as is the case of Sakhalin II, the very relevance of such principles is at stake, pointed out *Principles, Profits, or Just PR?*, an April 2006 report by Banktrack, a Netherlands-based network of NGOs that tracks the impact of private finance. In the end, some groups feel that divestment is a better strategy than engaging with a company and trying to change its environmentally damaging ways.

The marriage of profitability and sustainability has only just begun. “[T]he logic of responsible investment—i.e., the deliberate incorporation of material social and environmental considerations in investment

An evaluation of financial sector engagement shows a significant shift in the way financial institutions view these issues. They have moved from a largely public relations focus of the early 1990s to the commencement of mainstreaming of sustainability and social responsibility issues in their core business lines.

—Paul Clements-Hunt, UNEP Finance Initiative

Amazon, so we are now working with our suppliers so that if this is the case, our supply of soya ingredients will not come from such areas,” says Bob Langert, senior director of corporate social responsibility at the company.

Still, some green groups doubt that programs such as the PRI will actually achieve very much. In the 28 April 2006 edition of the British newspaper *The Guardian*, Friends of the Earth corporate campaigner Craig Bennett said, “It seems we get some kind of funky new initiative every other week. Voluntary initiatives make very little difference, if at all. Do we really think that in the boardroom when it comes to crunch decisions about competitiveness, lowering costs, and sourcing, that they have any impact?”

This response may reflect these groups’ experience with other programs launched

decision-making—has yet to be embraced by the wider investment community,” noted the authors of *Mainstreaming Responsible Investment*, a study commissioned by the World Economic Forum in 2005. “Responsible investing remains a boutique segment of the industry despite widespread, if largely anecdotal, evidence that social and environmental factors affect market valuations both positively and negatively.”


Attention to nonfinancial factors within the wider investment community remains largely reactive and episodic. Changing this to put social and environmental concerns in the forefront remains a daunting challenge. The multitrillion-dollar question is: can profitability and sustainability coexist? The answer from the PRI signatories is: they must.

Dinesh C. Sharma



Shiny Science

A New Substitute for Hexavalent Chromium



Although perhaps more familiar to those of us of a certain age who remember when all cars had sparkling mirror-finish bumpers, chromium still plays a big part in industry. Chromium is valued for its brightness, durability, resistance to corrosion, and hardness. It is used as a pigment in paint, inks, and plastics, as an anticorrosion agent in protective coatings, and in chrome plating on such things as aircraft engine components, tool and die parts, railroad wheel bearings, and, of course, the “brightwork” that trims motorcycles, cars, and trucks. As more and more scientific studies have revealed, however, chromium also has a darker side.

The chromium used in the plating industry is primarily hexavalent chromium, which is a very different animal from the trivalent form required by the human body. Hexavalent chromium is a potent human carcinogen, and can also cause dermal irritation and kidney and liver damage. Now, in an effort to find safer alternatives, researchers are looking at tailored nanostructures that offer the appearance and durability of hexavalent chromium without the hazards.

How Electroplating Works

Electroplating involves immersing the metal parts to be plated in a bath of chromium trioxide (CrO_3), typically prepared by dissolving crystalline CrO_3 in a mix of distilled water and sulfuric acid. A direct current is passed through the solution, and the resulting reaction leaves a deposit of chromium on the piece being plated.

One problem in this process is the production of hydrogen and oxygen at the electrodes. The gas bubbles to the surface, creating a mist of the plating solution (which contains hexavalent chromium) that must be controlled. Additionally, mechanical agitation of the bath (used to improve plating quality) can also result in the release of this hazardous mist.

According to Steve Smith, a supervising industrial hygienist with the California Occupational Safety and Health Administration, the permissible exposure limit (PEL) for workers in the chrome-plating industry is set for airborne concentrations based on the average over an eight-hour workday. In February 2006, the federal PEL for hexavalent chromium was reduced from $52 \mu\text{g}/\text{m}^3$ to $5 \mu\text{g}/\text{m}^3$. Although the federal government mandates PELs, states have the individual authority to regulate substances of concern more strictly.

Smith says different chromium compounds are regulated to a greater or lesser extent than others, depending upon the other substances involved. Lead chromate, for example, contains not one but two substances of marked concern, and thus is regulated at lower exposures. Similarly, strontium chromate (used in paint) has a much lower PEL in California ($0.5 \mu\text{g}/\text{L}^3$) than hexavalent chromium because of studies showing that it's far more toxic than its chromium constituent alone.

Nick Stubbs/Shutterstock

Health and industry officials are somewhat at odds over the level at which hexavalent chromium should and can reasonably be regulated. “I’m not an alarmist,” says Neal Langerman, principal scientist with the consultancy Advanced Chemical Safety. “On your car bumper, chromium is a very low-risk substance, but certainly the act of plating carries a much higher risk. Hexavalent chromium is a confirmed carcinogen, and ingestion or inhalation over a period of time can cause serious, ultimately fatal, impacts.” Smith says the recent decision to go to $5 \mu\text{g}/\text{m}^3$ represented the best possible solution to both health concerns and industry economic concerns.

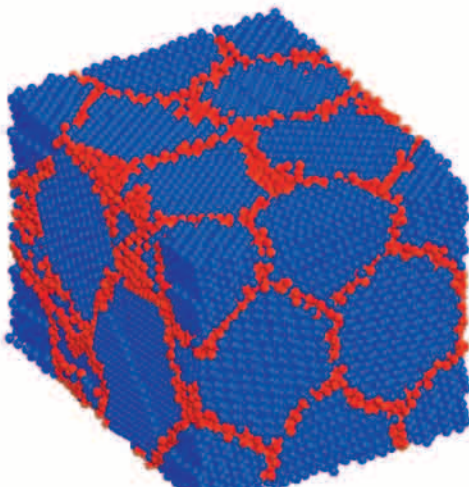
The Search for Alternatives

Industry has tried using other substances in place of hexavalent chromium to achieve the same results. Any alternative would need to duplicate the desired properties of the original chemical without requiring an extensive revamping of the entire plating process. Trivalent chromium is used to some extent, but the industry still has some concerns with color issues, which matters when a bright, reflective surface is desired. Further, unless extensive preparations are used, corrosion resistance is not as high as with hexavalent chromium. For some uses, the industry has begun experimenting with thermal spraying using a tungsten carbide substitute as an alternative to chrome baths. However, retooling a shop for this method can be expensive.

Other researchers are thinking smaller—much smaller. Christopher Schuh, an associate professor in the Department of Materials Science and Engineering at the Massachusetts Institute of Technology (MIT), and former MIT researcher Alan Lund are manipulating nickel and tungsten at the atomic level to create a more environmentally friendly alternative to hexavalent chromium. Working with them is Andrew Detor, a graduate student in the MIT Department of Materials Science and Engineering.

Schuh says his goal was to “address some of the shortcomings in our current suite of metals. There has been a lot of work in tailored nanostructures to develop new materials with new properties, and this seemed like an ideal application.” He and Lund formed the Medford, Massachusetts-based Xtallic Corporation to take the technology into the commercial arena.

Schuh points out that the chromium coating industry is a multibillion-dollar industry, and the problems associated with hexavalent chromium account for a significant percentage of the process cost. “We’ve developed the ability to control the structure of metals at the nanoscale level,” he says.



Metal by design. A view of nickel-tungsten nanocrystalline alloy shows atoms within grains (blue) and at the grain boundary (red). Grain size helps determine hardness, abrasion, and resistance.

“Metals are, in general, composed of many crystal grains, and our work has been centered around controlling the size of these grains, enabling us to create new metals that deliver the properties of chromium without chromium’s environmental baggage. . . . We looked at the suite of properties that make chromium valuable and used nanoscale manipulation to duplicate those properties without hexavalent chromium.”

A good deal of the information regarding Schuh’s process is confidential under the proprietary interests of the new company. However, he can say that the basic plating process is little different from the conventional chrome plating process: “It’s in the design of the alloy and its structure that the art becomes new.”

Atomic Energy

Schuh explains that tungsten atoms are about 10–12% larger than nickel atoms. “Because the atoms are of different sizes,

it’s harder to pack them efficiently in a crystal,” he says. “Adding tungsten promotes the formation of more and smaller grains; as you add more mismatch to the system, you promote the formation of intercrystalline regions. And by controlling the grain size, you can have a direct impact on the properties of hardness, abrasion resistance, and so on.”

Schuh says his new coating hasn’t yet been tested across the broad spectrum of chromium’s applications. But tests to date have been promising. “We have looked at several of chromium’s key properties—reflectivity, for example. Side by side, I can’t tell the difference,” he says. “We’ve also tested our coating for use in a marine environment, where chromium is valuable because it protects steel against the corrosive effects of saltwater. In a side-by-side test, our coating outlasted chromium by a factor of more than ten.”

Anytime a new process is substituted for something that has been in proven use for some time, there may be a few snags. According to Schuh, the chemicals traditionally used in chrome plating are relatively inexpensive (mainly because of volume), while “our chemicals, because of not being used in the same volume, are somewhat more expensive.” However, he thinks that will change as the new process is scaled up to a commercial level—something he expects within a year or two.

He adds that in other cost-related areas, the new process is already better or has the potential to be so—for example, by saving on power costs through greater efficiency, and on labor costs through less finish work in many applications. Schuh explains that it can be quite difficult to get uniform coverage with chromium, especially on parts of complex geometry. The new coating goes down much more evenly, which reduces the need for post-plating grinding, machining, and buffing.

Suggested Reading

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Schuh points out that his team deliberately designed a process that would work as a drop-in replacement. “In developing a process like this, you waste many of the benefits if you make it overly complex, or something that requires extensive retooling or redesign of existing process lines,” he explains.

The new process is not without its own potential hazards, however. There is a good deal as yet unknown about the emerging science of nanotechnology and the possible interaction of nanoscale materials with the environment and with the human body. According to NIOSH, materials exhibit unique properties at the nanoscale that affect their physical, chemical, and biological behavior.

Nickel, too, has its own regulatory issues. “Nickel is a very potent sensitizer, and we’ve seen it can cause a very serious allergic response,” says Langerman. “Of course, it all depends upon the end use. If you’re using it for corrosion control on aircraft parts, for example, it’s not going to be an issue. But you’ll still need employee protection against exposure, and you’ll have to be concerned about any end user contact.”

Still, says Smith, while nickel definitely has its own regulatory concerns, it’s conceivably less hazardous than hexavalent chromium. “The general concept of substituting a less toxic product for a more toxic one is always one of the best methods of controlling employee exposure,” he says.

Little Structures with Big Potential

Schuh and colleagues see their new technique as a springboard, not an end point. “What we’ve done is to develop a process to make and put down new coatings using highly tailored nanostructures, so I could easily imagine new coatings with different metals,” Schuh says. “For example, many people are working with cobalt-based coatings because of their applications in biological fields, so that’s a possibility, and my sense is that it would be every bit as easy to use cobalt as to use nickel. And there are many other metals that could be equally applicable.”

Kent Peaslee, a professor of metallurgical engineering at the University of Missouri in Rolla, says based on what he’s seen, “Schuh is applying a new technology to try and solve a problem that a lot of people have done research on over the years. Anything you can do to reduce or eliminate the need for these types of coatings is a plus because it not only solves the problem of the plating, but it also eliminates the problem of disposal of the spent plating solutions. While I haven’t seen evidence of success yet, this looks like a process with real potential.”

Lance Frazer

Hexavalent Chromium Exposure A Regulation Under Attack?

According to OSHA, some 550,000 workers are exposed to hexavalent chromium on the job. Are these workers being protected as well as they could be? David Michaels, head of the Project on Scientific Knowledge and Public Policy at the George Washington University School of Health, and colleagues from George Washington University and the watchdog group Public Citizen claim the chromium industry mounted an active campaign to weaken proposed standards and knowingly kept critical data from OSHA during the comment phase of the hearings to set new standards. Their report appeared 23 February 2006 in the online journal *Environmental Health: A Global Access Science Source*.

The occupational permissible exposure limit (PEL) for hexavalent chromium had been set at 52 $\mu\text{g}/\text{m}^3$ since the 1940s. In 1997 and 2002, OSHA was sued to lower the exposure level to 0.25 $\mu\text{g}/\text{m}^3$, leading to a 2002 order by the U.S. Court of Appeals to issue a final standard by January 2006 (later extended to February 2006). “Faced with the threat of stronger regulation,” Michaels and colleagues wrote, “the chromium industry initiated an effort to challenge the scientific evidence supporting a more protective standard.”

Michaels claims a 1998 study commissioned by a group of chromium manufacturers known as the Industrial Health Foundation found a significantly elevated risk of lung cancer at exposures just over 1 $\mu\text{g}/\text{m}^3$. The research, he says, was finished by 2002 but the sponsors did not provide the study to OSHA during the hearing period. Additionally, Michaels says, the industry’s epidemiologists claimed the study had to be presented as separate cohorts—which rendered each component statistically underpowered—because of different exposure measurement methods, “when the original proposal said specifically that [they had] the methodology to combine these cohorts. A post hoc analysis led to a reshuffling and change of results. That’s not considered an ethical approach.”

In their article, Michaels and colleagues suggested that studies funded by private sponsors that seek to influence public regulatory proceedings should be subject to the same access and reporting provisions as those applied to publicly funded science. Parties in regulatory proceedings should be required to disclose whether the studies were performed by researchers who had the right to present their findings without the sponsor’s consent or influence, and to certify that all relevant data have been submitted to the public record, whether published or not.

Kate McMahon-Lohrer, an attorney with Kelley Drye Collier Shannon (formerly Collier Shannon Scott) who represented the chromium industry during the regulatory hearing process, characterizes Michaels’s allegations as false and misleading. “The primary allegation is that the chromium industry hid data,” she says, “but OSHA did get the relevant study, which was actually supplied by Public Citizen, and OSHA stated in their final ruling that they had considered the study, and it didn’t change their risk assessment conclusions.”

McMahon-Lohrer was also quoted in the 23 February 2006 edition of *USA Today* as saying that “OSHA knew of the research, but wouldn’t have accepted it until it was published in a peer-reviewed journal.”

Michaels replies that “this is simply false. Regulatory agencies want to see all relevant data and know how to weigh submitted literature differently if it’s not peer-reviewed. Claiming that OSHA insists on a peer-review process is merely a convenient excuse for not submitting relevant data.”

OSHA would not comment on the decision-making rationale behind its final PEL of 5 $\mu\text{g}/\text{m}^3$ beyond referring to the listing in the 28 February 2006 *Federal Register*, which states, “The PEL established by this rule reduces the significant risk posed to workers by occupational exposure to [hexavalent chromium] to the maximum extent that is technologically and economically feasible.”

While preferring to avoid what he calls “a politicized shouting match,” Neal Langerman, principal scientist with the consultancy Advanced Chemical Safety, says, “I do feel that all good, nonpolitical science indicates [the need for] much lower levels of exposure—even below the 5 $\mu\text{g}/\text{m}^3$ PEL—“and I also know that exposure control engineering becomes more expensive at lower levels, so the whole thing of setting exposure levels seems a money-driven issue.” —Lance Frazer

A Liquid Path to Lung Disease Early Arsenic Exposure and Effects in Young Adults

Increased rates of cancer and mortality have been documented in areas of the world where drinking water contains high concentrations of naturally occurring arsenic. A new study by a group of Californian and Chilean researchers now provides strong evidence



A big gulp of news. The link between early arsenic exposure and later lung disease is the first such association to be confirmed in humans.

of a link in humans between prenatal and early childhood arsenic exposure and significantly higher rates of lung disease in young adulthood [*EHP* 114:1293–1296; Smith et al.].

Both malignant and nonmalignant lung disease are known to develop with exposure to arsenic in drinking water. Recent evidence from a project in India by the same research group showed decreased lung function similar to that of smokers in adults exposed to the semimetallic carcinogen.

The current study took advantage of a unique opportunity to study the long-term health effects of a discrete prenatal and early

childhood exposure. From 1958 to 1970, the water supply for the neighboring Chilean cities of Antofagasta and Mejillones was supplemented with water from rivers with arsenic concentrations near 1,000 µg/L, 100 times the current acceptable standard for arsenic concentration in the United States. With the 1971 activation of an arsenic removal plant, however, levels plummeted to about 90 µg/L and have continued to drop ever since.

The research team studied mortality data obtained from Chile's Ministry of Health for the years 1989 through 2000 for all 13 regions of the country. They divided the population into two groups: individuals born between 1958 and 1970 (who likely would have had prenatal arsenic exposure if their mothers lived in Antofagasta or Mejillones) and those born between 1950 and 1957 (who likely would have had childhood but not prenatal exposure if they lived in either of the two cities). The researchers also divided overall deaths for Chile into two groups: residents of Antofagasta and Mejillones, and residents of all other regions. They used the *International Classification of Diseases, Ninth Revision*, to code causes of death, including lung cancer and bronchiectasis, a form of chronic respiratory disease.

The investigators' findings show a distinct connection between prenatal and early childhood exposure to arsenic and lung disease–related mortality before age 50. Lung cancer death rates for those exposed to arsenic in early childhood were 7 times higher than those for the rest of the Chilean population, and bronchiectasis death rates were 12 times higher. In cases where exposure occurred both prenatally and in early childhood, lung cancer death rates were 6 times higher and bronchiectasis death rates were 46 times higher than those for the rest of the population.

The authors believe these results describe the highest increase in death rates for arsenic-related lung cancer and bronchiectasis ever documented among young adults, and add that this study is one of the first to provide evidence of human adult disease resulting from prenatal and early childhood exposure to any environmental toxicant. They conclude that an increase in young adult mortality should be of concern to public health officials, and should influence future decisions regarding sources of drinking water. **–Tanya Tillett**

Ultrafines' Quick Neurological Hit Particles Take a Direct Route to the Brain

Proof of the penetrating capabilities of tiny particles continues to emerge. A team of U.S. researchers has just added to and clarified the existing evidence by documenting significant, rapid accumulations of inhaled ultrafine manganese oxide particles in the lung and many brain regions [*EHP* 114:1172–1178; Elder et al.]. They also demonstrated that particles don't need to dissolve to spread, and that inhalation pathways can be more efficient than circulatory ones.

The researchers evaluated the translocation and tissue distribution of manganese oxide ultrafines in rats that had inhaled a nearly insoluble form of these solid particles for six hours per day, at a concentration in the mid-range typically experienced by welders. After 12 days of exposure, the manganese concentration in the olfactory bulb (a region of the brain that abuts the nasal cavity) had increased about 3.5-fold. At the same time, lung manganese concentrations doubled, and there were small but significant increases in other brain regions, such as the cerebellum, the frontal cortex, and the striatum.

The inhaled ultrafines didn't cause obvious lung inflammation. However, in the brain several markers of inflammation and

stress response, including tumor necrosis factor and macrophage inflammatory protein, increased by anywhere from about 2- to 30-fold.

To determine how inhaled manganese oxide ultrafines spread, the team closed the right nostril of several of the rats and had them inhale manganese oxide solely through the left nostril. They found that the vast majority of manganese quickly accumulated in the left olfactory bulb. This suggested that very little of the accumulation was due to other routes, such as dissolution and distribution via the circulatory system; otherwise, the manganese would have appeared in both olfactory bulbs.

The negligible role of the circulatory system contrasted with the findings of another manganese study, but that study utilized poorly soluble manganese phosphate particles that were several orders of magnitude larger than the approximately 30-nm manganese oxide agglomerates used here. The particles in the current study were about one-sixth the diameter of the olfactory neurons, along which the agglomerates moved into the brain.

These findings, as well as those of other studies of tiny particles such as carbon, gold, poliovirus, and engineered nanoparticles, suggest to the researchers that much more research is needed to determine if other inhaled ultrafines can also rapidly disseminate and cause effects throughout animal bodies. **–Bob Weinhold**

Hearing Loss, Loud and Clear Combined Effect of Noise and Toluene in Workers

Animal studies have clearly shown that simultaneous exposure to noise and toluene, a clear organic solvent widely used in various manufacturing industries, causes hearing loss. Studies of this interaction in the workplace have been limited, however, and their results inconclusive. Research now establishes, for the first time, a strong correlation between hearing loss in workers and their simultaneous exposure to noise and toluene [*EHP* 114:1283–1286; Chang et al.].

Conducted in a Taiwan adhesive factory, the study included three male study groups: 58 workers exposed only to noise (an average of 85 A-weighted decibels), 58 workers exposed to both toluene and noise, and 58 administrative workers. Air samples were collected from the working areas of the three groups, and sound pressure level meters were used to assess noise levels in the same areas. The researchers also calculated the time-weighted average of noise levels for each group.

The researchers collected data through interviews and physical examinations of the participants, including information on lifestyle



Stereophonic impact? New human data confirm the interactive effect of toluene and noise.

and sociodemographic variables such as age, whether respondents smoked or drank, and use of hearing protection. They also administered hearing tests in a soundproof room. A physician conducted an otopharyngeal exam to screen for otitis and other ear problems.

Toluene exposure appeared to increase the risk of hearing loss by as much as six times when compared to loss related to noise exposure only. The workers with the lowest toluene exposure had only a slightly lower risk of hearing loss when compared with those with higher levels of toluene exposure.

The authors acknowledge that the study had three limitations: the small sample size, the inability to measure exposure to high levels of toluene over a long work history, and the lack of available data for estimating hearing loss caused by exposure to toluene alone. They conclude, however, that their study does prove that workers face a greater risk of hearing loss when simultaneously exposed to toluene and noise compared to exposure to noise alone.

The authors believe the current established workplace standard for toluene of 100 ppm does not, by itself, protect against hearing loss for those workers exposed simultaneously to noise. They suggest that effective intervention is needed to improve the occupational safety of such individuals. —Ron Chepesiuk

PAHs and Cognitive Impairment Prenatal Exposure Catches Up with Toddlers

Previous studies have documented reduced fetal growth and developmental impairment resulting from exposure to environmental toxicants such as tobacco smoke. Now researchers at the Columbia Center for Children's Environmental Health implicate another prenatal exposure in causing health effects, demonstrating for the first time that exposure to airborne polycyclic aromatic hydrocarbons (PAHs) *in utero* may affect cognitive development during childhood [*EHP* 114:1287–1292; Perera et al.].

PAHs are introduced into the environment by combustion—car, truck, or bus exhaust, power generation, and cigarette smoking are just a few sources—and are transferred across the placenta. Urban populations have greater exposure to PAHs and therefore may be especially at risk for subsequent adverse health and developmental effects.

As part of the broader multiyear Mothers and Children Study, the researchers studied a cohort of 183 children of nonsmoking women living in the Washington Heights, Central Harlem, and South Bronx neighborhoods of New York City. They obtained demographic, residential, health, and environmental exposure information by administering a questionnaire during the mothers' last trimester of pregnancy. They also monitored the mothers' personal air exposures during the third trimester using backpack monitors.

Umbilical cord blood was collected and analyzed for cotinine, heavy metal, and pesticide content. Lead concentration was analyzed in a subset of 135 subjects. During postnatal follow-up interviews, the research team recorded any changes in residence, tobacco smoke exposure, or other conditions. The children's cognitive and psychomotor development was assessed at 1, 2, and 3 years of age using the Bayley Scales of Infant Development—Revised; the mothers also answered questionnaires on their children's behavior.

Although they noted no significant effect on behavior or cognitive or psychomotor development at ages 1 or 2, the Columbia

investigators found that the 3-year-olds who had higher prenatal exposure to PAHs scored on average 5.69 points lower on cognitive tests than the less-exposed children, even when controlling for other exposures and socioeconomic factors. The higher-exposed children also had twice the odds of developmental delay, suggesting an increased risk for performance deficits in language, reading, and math in the first years of school.



Thought leader. Prenatal exposure to PAHs may affect cognitive development later on.

The authors acknowledge some limitations of the study, including small sample size, lack of air monitoring data for all three trimesters, and lack of postnatal data for personal air PAH concentrations and lead exposure. They conclude that additional studies should be conducted to confirm their results, especially since limited performance in the early school years can provide an indication of future suboptimal school performance. —Tanya Tillett