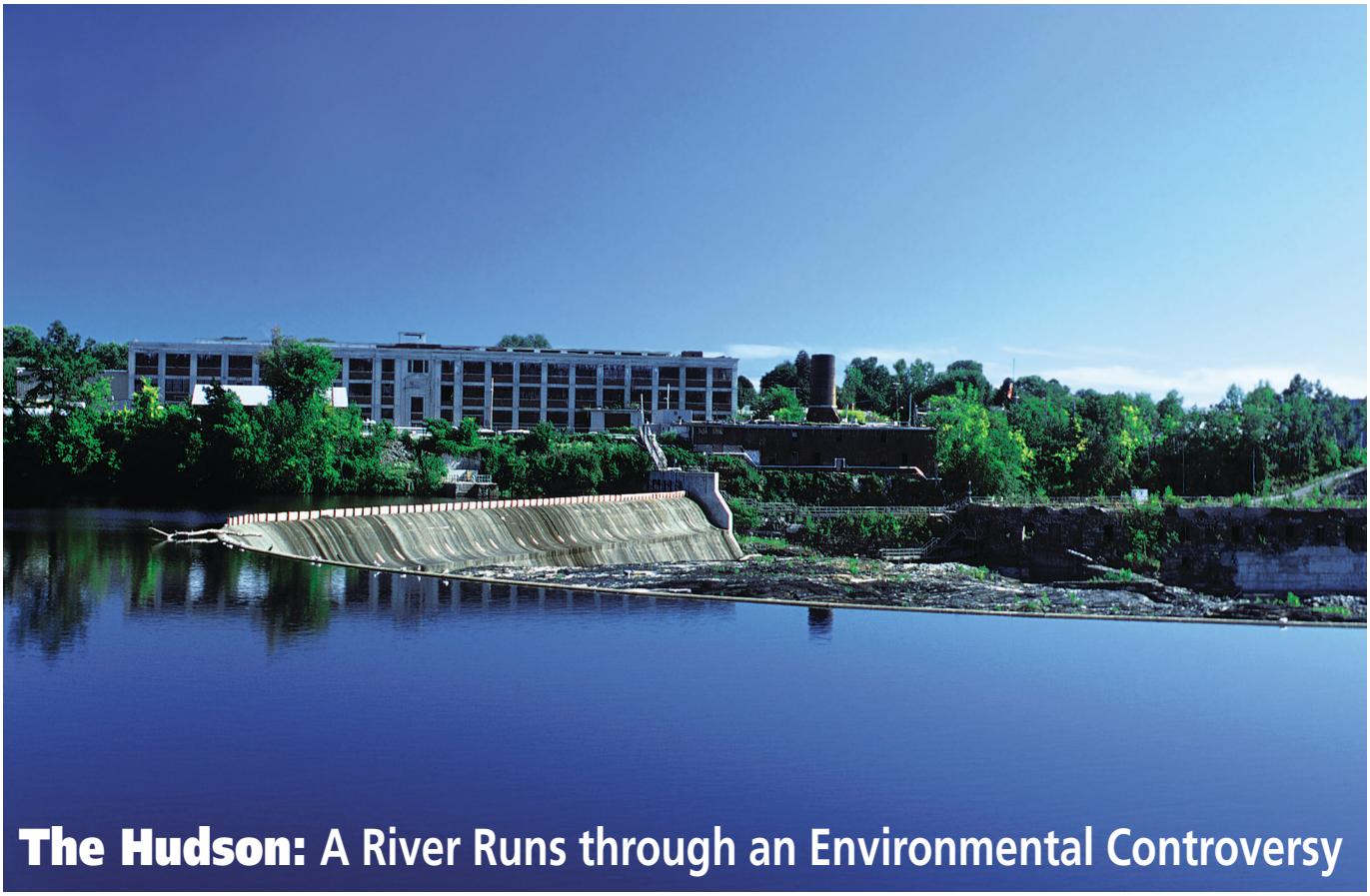


The Hudson: A River Runs through an Environmental Controversy

The Hudson River pours out from Lake Tear of the Clouds, in New York's high peaks of the Adirondack Mountains. The river travels 315 miles through mountains and cliffs, farmlands and industrial parks, towns and cities. Throughout its course, the Hudson feeds fertile lands and thirsty cities. Its beauty inspired the first school of painting in the nation, its waters teem with fish—and its contamination distinguishes it as the longest Superfund site in the United States. Superfund sites are those identified by the U.S. Environmental Protection Agency (EPA) as most seriously contaminated with hazardous waste.

The Superfund Basic Research Program (SBRP) is a joint program of the EPA and the NIEHS. The SBRP currently funds multidisciplinary research in 19 university centers that focus on acquiring new scientific knowledge to advance understanding of human and ecological risks from hazardous substances, and to develop new environmental technologies for cleaning up Superfund sites. SBRPs at a number of institutions, including Mount Sinai School of Medicine in New York City and New York University's Nelson Institute of Environmental Medicine in Tuxedo, are contributing to this body of knowledge through a number of health effects research studies, as well as through an outreach program to train the next generation of environmental scientists, using the Hudson River cleanup as an educational nexus.

Downriver Dilemma

The river was named after Henry Hudson, an Englishman who in 1609 navigated up it thinking it would serve as a quick route to China. Instead, the Hudson became an early avenue for commerce in America. After the building of the Erie Canal in 1825, the river facilitated passage to the Midwest. Railways were laid along its banks that helped industrialization migrate to Upstate New York. Factories proliferated along the river because it was used for transport, power, and waste disposal. Glass, paper, leather, textiles, electrical equipment, and other goods manufactured there further established the Hudson's importance in industrialization and helped develop New York City's premier place as a business capital.

One of the most important industries to establish manufacturing operations on the Hudson was the General Electric Company (GE), formed when Thomas Edison consolidated his patents for incandescent bulbs in 1892. Its manufacturing operations extended along the Hudson Valley as the company took over older paper factories. The company grew as the demand increased for electrical capacitors and transformers, which help transmit electricity to homes over long distances.

At the time, electric companies used coolants made of organic oils in electrical capacitors, but these were not efficient in dispersing heat, and the capacitors tended to explode. This problem was solved with the development of polychlorinated biphenyls (PCBs) in the 1920s. These compounds are created when two phenyl rings, joined by a single bond, are chlorinated. The higher the number of chlorine molecules that are attached to the rings, the more viscous and stable and the less water soluble the compound becomes. With different numbers and arrangements of chlorine atoms, 209 possible compounds can be formed, and these compounds proved to be excellent fire retardants. By 1947, GE had started using PCBs in electrical capacitors manufactured at plants located at Hudson Falls and Fort Edward, along the Hudson River.

Many studies have been conducted and published in the scientific literature to examine the effects of PCBs on human health and the environment. Collectively, the literature

Tom Ligamari/Scenic Hudson, Inc.

suggests that exposure to PCBs is associated with a wide range of toxic developmental, reproductive, endocrine, and carcinogenic effects. In addition, the chemical characteristics that make PCBs such excellent insulators also appear to make them persist in the environment. They have been designated as persistent organic pollutants and are of special concern because they remain for many years in the environment and in the tissues of animals exposed to them. PCBs also accumulate along the food chain, increasing in concentration in the higher predators.

The EPA classified PCBs as "probable human carcinogens" and banned their production in 1977 under the Toxic Substances Control Act. By then, GE had already released PCBs into the Hudson for 30 years. The EPA has estimated that 1.1 million pounds of the chemicals were discharged into the river during this period. A 2001 white paper prepared by a group of scientists assembled by the Hudson River Foundation, an organization dedicated to stewardship of the river and incorporating science into the decision-making process, titled *PCBs in the Upper Hudson River: The Science behind the Controversy*, estimates that the now closed GE facilities continue to leak 3 ounces of PCBs each day.

The U.S. Food and Drug Administration has set the acceptable levels of PCBs in fish sold for human consumption at no more than 2 parts per million. In fish caught in the Upper Hudson River, the EPA has measured average levels of PCBs ranging from 2 to 41 ppm. Isaac Wirgin, a principal investigator at the New York University Nelson Institute of Environmental Medicine's SBRP, has been studying the ecotoxicity effects in Hudson River fish populations for over 15 years. He has found that 90% of a type of codfish caught in the river develop liver tumors by the time they reach adulthood (2 years of age). "Atlantic tomcod from the Hudson have 100-fold higher levels of PCBs than fish caught in cleaner rivers," he says. Wirgin has found that the fish also show DNA damage akin to that found in some human tumors.

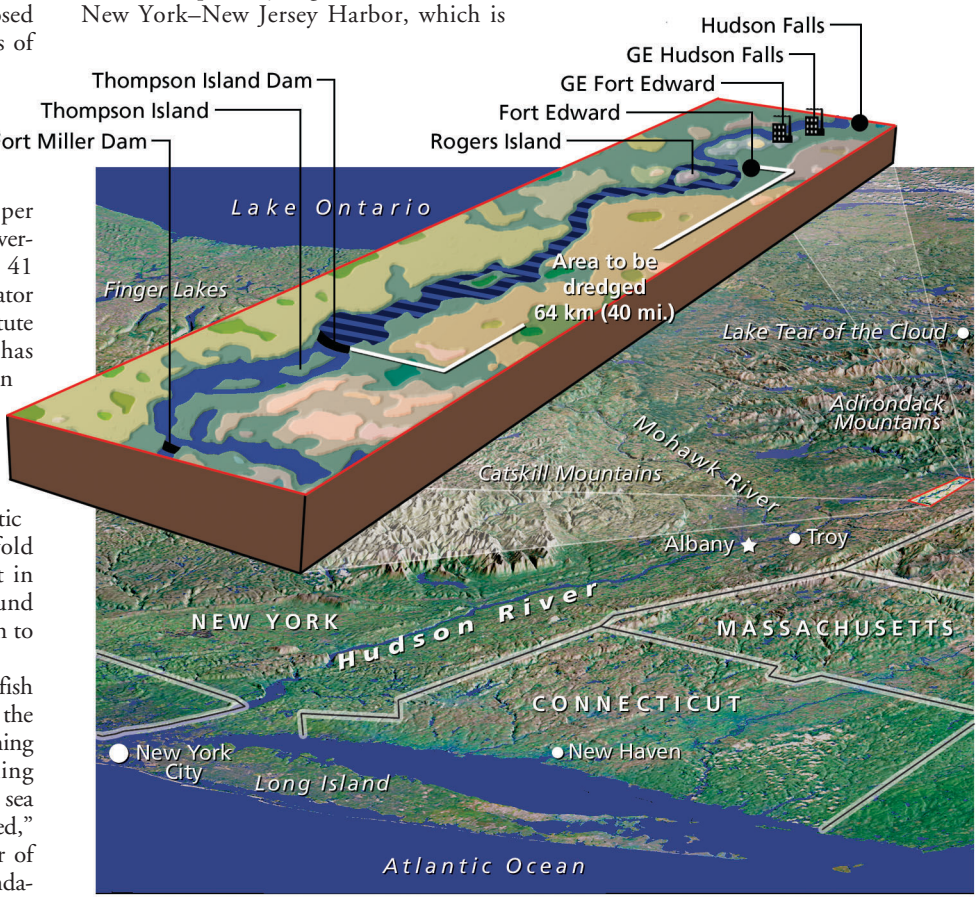
Findings of contamination of river fish have had a negative economic impact on the Hudson River area. "All commercial fishing has been banned except for shad fishing because [shad] spends most of its life at sea [and] so is one of the least contaminated," says Dennis Suszkowski, science director of the Hudson River Foundation. The foundation has recently commissioned a study of the economic impacts of the fishing ban and the contamination of the river.

Fish consumption advisories are also in place for sport and subsistence fishers. These advisories have an unmeasured effect on the economy of local community residents. "Many people will enjoy fishing in Hudson River waters not only for relaxation and recreation, but with the hope of bringing home an inexpensive meal. In doing so, many low-income families are unknowingly endangering the health of their children," says Eliot Spitzer, attorney general of New York.

Even with these fish advisories in place, many people eat fish caught in the Hudson River. A pilot study being conducted by Anne Golden, an assistant professor of environmental and occupational medicine in the Division of Environmental Health Science at Mt. Sinai, shows that anglers who eat fish and crabs from the lower Hudson River watershed have elevated body burdens of PCBs and other persistent environmental pollutants that are present in river sediments. Thus far, the study suggests an association between the levels of biomarkers of exposure to PCBs, the organochlorine pesticide chlordane, and DDT and the reported levels of fish consumption by anglers who fish in the New York–New Jersey Harbor, which is part of the Lower Hudson estuary system. Says Golden, "Our findings suggest that PCBs originally released into the Upper Hudson River are bioavailable downstream and have traveled up the food chain, from fish to humans."

The study is also showing that exposure does not stop with the people who catch the fish. Golden and colleagues are finding that 64% of the anglers interviewed to date share their catch with other people. This increases the possibility that pregnant women and children, who may be more susceptible to the health effects of PCBs, may become exposed to these contaminants.

The data from Golden's and others' work suggest that PCBs do not remain sequestered in the sediments of the river. Instead, they become bioavailable and therefore a source of human exposure through eating contaminated fish. Contaminated sediments directly affect bottom-dwelling organisms and can also be resuspended during floods or other weather conditions that stir the river bottom. "The sediments continue to be a reservoir for potentially toxic substances. PCBs from



Dubious distinction. The Hudson River, contaminated for decades with toxic waste from the General Electric power plants along its banks, is the longest Superfund hazardous waste site in the United States, stretching for over 40 miles.

NASA, Christopher G. Reuther/EHP

these sediments will continue to enter the food chain for decades if no remediation action is taken," says Richard Bopp, an associate professor of earth and environmental sciences at the Rensselaer Polytechnic Institute in New York.

The Decision to Dredge

After more than 10 years of data review, scientific research, and engineering studies and more than 70,000 comments from the public, EPA administrator Christie Whitman signed the Record of Decision on a cleanup plan for the Hudson on 1 February 2002. The plan calls for dredging 2.65 million cubic yards of contaminated sediment from a 40-mile stretch of the Upper Hudson. The dredging project will aim to remove an estimated 150,000 pounds of PCBs. Before dredging can begin, the EPA will conduct a 3-year planning phase that will determine the project's performance standards and will collect additional community input.

Community residents have put forth two main issues as major concerns. One is the possible resuspension of contaminants during dredging. The EPA will address this issue by implementing a set of performance standards to monitor the levels of PCBs that may be released into the water column.

The other issue, which has yet to be decided by the EPA, is what to do with the thousands of pounds of contaminated sediment once it is dredged and dewatered (by sucking the water out to decrease the amount of material). Says Gunther Ohm, chairman of the Greene County Conservation Committee, a community-based organization opposed to the dredging, "I don't see how picking this mess up and putting it somewhere else is going to help the environment." He points out that because PCBs are not water soluble, the dredged material will have a higher concentration of PCBs than now exists in the river sediments. When buried, even with a secure lining, the sediment will always pose the risk of PCBs leaking out and contaminating groundwater that rural communities depend on for their water supplies.

Although the EPA has yet to decide how and where it will dispose of the dredged materials, it has decided that the sediment will not remain in the Hudson River area. "People from the community are concerned that we are going to build a new landfill, but it has been decided that the dredged material will be sent out of state," says Mary Mears, community involvement coordinator for EPA's Region II. She adds that the EPA has responded to many community concerns and will continue to open avenues for community input. To do this, the agency has established a new field office in Upstate New York and hired a neutral independent contractor to identify key issues and key players in the community. "We want to start from scratch without EPA's presence, to take out the argument that EPA is biased, because the decision to dredge has been made," Mears says.

GE contests the dredging decision on two grounds. First, the company claims that naturally occurring processes in the river have and will continue to rid the ecosystem of PCB contamination. According to GE studies published in the December 1994 issue of *Applied Environmental Microbiology*, PCB concentrations in fish and sediment have declined since 1977 and will continue to decline as a result of "source control" implemented by the company. However, a group of academic scientists assembled by the Hudson River Foundation to assess modeling predictions found that the sediments contain sufficient PCBs to support release into the river water for 100 years. "Based on current releases of PCBs from sediments and potential remobilization of 'buried' PCBs during episodic events [such as storms and floods], we do not see monitored natural attenuation as a sufficient remedy," concluded the group in the foundation's white paper. This is consistent with Wirgin's findings in Atlantic tomcod. "Between the late 1970s and early 1990s, levels of PCBs in fish have declined, but they have plateaued in the last 10 years," he says. This may be an indication that the natural washout of PCBs from the river has reached its limit and may not increase unless remediation is implemented. This resuspension of PCBs from the sediments may continue to make the contaminants bioavailable to fish.

Luz Claudio

A river's downfall. The GE Hudson Falls plant was the site of some of the worst toxic dumping into the river, one result of which is that fish living in the river are so toxic they can no longer safely be caught—much less eaten.

For information on the NIEHS–EPA Superfund Basic Research Program (SBRP), log on to:
http://benson.niehs.nih.gov/sbrp/
For information on the SBRP on the Hudson River log on to:
http://www.mssm.edu/cpm/program_outreach.shtml

GE's second argument against the dredging project cites insufficient evidence that PCBs are toxic to humans. The company points to a study published in the 1 March 1999 issue of the *Journal of Occupational and Environmental Medicine* that assessed mortality rates from cancer of over 7,000 workers who may have been exposed to PCBs in the manufacture of capacitors between 1946 and 1977. The GE-funded study suggested that capacitor workers had no increase in mortality compared with regional mortality rates. However, the study was criticized in a letter to the editor by Howard Frumkin, a professor of environmental medicine at Emory University, and Peter Orris, director of the Health Hazard Evaluation Program for the University of Illinois. They pointed out that only one-third of the study's subjects had worked in capacitor manufacturing for more than 5 years. Another flaw in the study was that exposure assessment was not conducted on the workers.

Other literature on PCB toxicity, much of it a result of SBRP research, is more compelling and suggests that the nature of the toxicity may depend on the age at which exposure occurs. Exposure to PCBs in adults has been linked to cardiovascular disease, endocrine disruptions, and cancers such as breast cancer and leukemia. Exposure during gestation and early development has been associated with profound alterations in growth, effects on intelligence and behavior, and changes in fetal development. "The literature on prenatal exposure to PCBs and developmental neurotoxicity is one of the strongest bodies of evidence of human health effects in low-level environmental exposure," says Mary Wolff, a principal investigator at the Mt. Sinai SBRP. Fetuses and infants can be exposed through the placenta or breast milk to PCBs. "The highest creature in the food chain is the human child," says Philip Landrigan, director of the Mt. Sinai program.

The question of whether or not to dredge the Hudson will continue to be debated, and balanced and objective scientific studies will be crucial for illuminating this debate. The work of SBRP scientists will help guide policy decisions regarding the Hudson River. William Suk, NIEHS director of the SBRP, said at the 10 December 2001 meeting of SBRP grantees held at the University of Florida, "The SBRP is here to provide the sound scientific data needed for sound decision making." The result of this integration between science and policy will be a cleaner and safer Hudson River.

Luz Claudio

SPECIAL MEETING REPORT

Human Genetics, Environment, and Communities of Color

The Human Genome Project and other advances in genetics, informatics, and molecular biology have expanded the possibilities new discoveries of how genes determine human susceptibility to disease. But the potential for misuse of genetic information raises many ethical concerns, especially for minority populations.

These concerns were the topics of discussion at the 4 February 2002 conference Human Genetics, Environment, and Communities of Color: Ethical and Social Implications, held in New York City and sponsored by a collaboration between West Harlem Environmental Action, Inc. (WEAct), the NIEHS's Center for Environmental Health in northern Manhattan at the Mailman School of Public Health, Columbia University, and the U.S. Environmental Protection Agency. The organizers hope that "the conference will lead to proactive collaboration on the issues brought on by the study of gene–environment interactions," says Peggy Shepard, executive director of WEAct.

Gene–environment interactions are a major research interest of the NIEHS. In 1997, the NIEHS started the Environmental Genome Project, which will resequence a set of environment-responsive genes that may be involved in disease causation. In his speech at the conference, Kenneth Olden, director of the NIEHS, emphasized the need for the public to have a basic understanding of genomics, its implications, and its promise. To address this need, a satellite meeting titled Genetics 101 provided a basic overview of genetic science and gene–environment interactions for community leaders.

The public's lack of information on genomics is not the only barrier to realizing the promise of genetic research in communities of color. There is also a lack of understanding on the part of scientists. Debra Harry, executive director of the Indigenous Peoples Council on Biocolonialism based in Wadsworth, Nevada, said at the meeting that "genetic material represents our lineage—it is passed down from our ancestors from generation to generation. This lineage is holy." Scientists must learn about these and other important cultural, social, and political implications that genomics has for the populations participating in genetic research, she says.

Another conference discussion of the challenges that have arisen in the field of genomics was the potential for genetic discrimination. Paul Steven Miller, commissioner of the Equal Employment Opportunity Commission, asserted that the potential for genetic discrimination is no longer science fiction. "The mere fear of discrimination can keep people from seeking genetic counseling, and they may miss out on the medical benefits of these technologies," he said. During breakout sessions, participants discussed ways in which many different agencies, including those in employment, health, and insurance areas, could work together to address these difficult questions.

Issues arising from the study of gene–environment interactions add more complexity to the debate on the ethical use of genomics. "Some environmental justice advocates have voiced concern that genetic research shifts the focus from the polluters to the individuals affected by the pollution," said Shepard. This shift in focus may be interpreted to imply that genetic susceptibility is more important in assessing risk than is environmental exposure. But the conference consensus was that both genetic and environmental influences are important in causing disease. "To try to understand genetic influence on disease without the environmental component is truly insufficient," said Monique Mansoura, a genomics policy analyst at the National Human Genome Research Institute in Bethesda, Maryland.

Genomics promises to provide useful tools for disease prevention in all communities. Said Olden, "If existing opportunities in genomics are translated into reality, future generations will live with less pain and less suffering in a world where prevention is not only the highest priority, but is also achievable."**–Luz Claudio**