We'll never know the worth of water till the well go dry.
Scottish proverb

URBAN ISSUES

City Ecosystems

An ecosystem is traditionally defined as a community of organisms functioning as an ecological unit in nature. Ecologists often study sites as far away from human influence as possible to get closer to nature. Likewise, when urban educators teach ecology, they often take their students outside the cities to study nature's ecosystems. However, leaving the city limits may no longer be necessary as both ecologists and urban educators begin to look at cities as a part of nature, nurturing their own ecosystems.

The goal of this new approach to ecological study is an interdisciplinary understanding of the relationships between cities and natural ecosystems. Alan Berkowitz, head of the Education Program at the Institute of Ecosystem Studies (IES)—a nonprofit research and education institution in Millbrook, New York, whose focus is the study and dissemination of knowledge about ecosystems—says that researchers take the same basic approach to the study of both natural and urban ecosystems. The difference lies in the studies' objectives and foci. With urban ecosystems, the questions are more people-centered. Berkowitz also says that in a city it's hard to see the natural aspects of the ecosystem, and in a forest it's difficult to see the social aspects within the ecosystem. The approach chosen depends on the questions being asked, Berkowitz explains.

Berkowitz also explains that the study of city ecosystems is very similar to studying a stream in a natural environment in the sense that it's also a high throughput system. Says Berkowitz, "It would be hard to understand a stream by only studying what's in it. By also studying what's going in and out of it, you can obtain a more complete understanding of how it functions." The same is true of urban environments. An IES press release says that "interdisciplinary systems thinking by scientists and citizens alike may be necessary in the coming century for life to be sustainable on this planet." Understanding urban ecosystems was the subject of a conference held at the IES on 27–29 April 1999. The conference was the eighth in an IES series called the Cary Conferences, which bring together for the first time ecologists, economists, anthropologists, geographers, and top educational leaders to develop strategies for better understanding cities as ecosystems. Conference attendees included over 80 representatives from the National Environmental Education and Training Foundation, the National Research Council of the National Science Foundation, the National Aeronautics and Space Administration, the United Nations Educational, Scientific and Cultural Organization, the U.S. Department of Education, and the National Forest Service, as well as scientists and educators from around the world.

Diana Wall, president of the Ecological Society of America in Fort Collins, Colorado, and director of the Natural Resource Ecology Laboratory of Colorado State University, says, "The Cary Conferences have been extremely important in focusing science on new, emerging fields in ecology, bringing together notable scientists in a process of assessment and synthesis that is unique among conferences."

Other research efforts have already added to the urban ecosystems trend. The National Science Foundation recently added two urban ecology projects to their Long-Term Ecological Research effort to fund environmental research. This program has 18 sites around the United States dedicated to the focused study of ecological changes over time. The two new projects are seeking public help in monitoring the urban environment. For example, teenagers will help scientists interpret satellite images of the city by identifying trees on computer maps of the city.

Speaking of the focus on cities as ecosystems, Berkowitz says, "Our challenge is to understand these novel—in evolutionary terms—and increasingly universal systems so that we can make them healthy places for all living things that dwell there, and so we can integrate them with the fewest possible impacts into other ecosystems, both nearby and distant, that they are linked to." **–Lindsey A. Greene**

RESEARCH INITIATIVES

Biomedical Research Goes Green

Voluntary standards for "greening" the biomedical research industry were the focus of a 1–2 November 1999 conference held at the National Institutes of Health (NIH) campus in Bethesda, Maryland. The conference was organized by the National Association of Physicians for the Environment (NAPE), the Association of Higher Education Facilities Officers, the NIEHS, the Environmental Protection Agency (EPA), and some 60 other sponsors. NIEHS director Kenneth Olden described the conference—attended by physicians, education specialists, federal scientists and managers, and industry and academic professionals—as a triggering event that should catalyze worldwide efforts to reduce waste and increase energy efficiency within the biomedical community. In addition, training in green research will have a major impact as postdoctoral students begin to move into the industry.

Although the biomedical research community produces less than 0.1% of all the dangerous wastes regulated by the EPA, some biomedical wastes such as mercury from fluorescent lights, dioxin, chemical reagents, the cadmium in red biohazardous waste bags, infectious wastes, and di(2-ethylhexyl) phthalate leaching from the polyvinyl chloride plastics in tubing can persist in the environment and are hazardous to human health. Moreover, biomedical laboratories use five times more energy and water per square foot, on average, than typical office spaces, said speaker Romulo L. Diaz, Jr., an assistant administrator at the EPA. Some scientists believe that all that fossil fuel use may contribute to global warming, ultimately affecting human health in a negative way, Diaz said.

A new look for labs. New guidelines mean biomedical research processes will be healthier for the environment.

A legislative push by Representative John E. Porter (R–Illinois) to increase biomedical research funding by 15% annually over the next three years has raised the possibility of tighter environmental controls to counteract the resulting increase in biomedical research projects. Other helpful measures to prevent excess waste include improved biomedical facility design, laboratory substitutions, scaled-down experiments, and recycling of reagents. NIH environmental health specialist Edward H. Rau said that training efforts at the NIH, for instance, effectively cut radioactive waste from a high of 2,000 liters per month in the early 1990s to about 200 liters monthly today.

In the coming months, committees established by conference participants will develop an online clearinghouse of "environmental best practices" for researchers and laboratory managers, to be housed at the NAPE Web site (**http://www.napenet.org/**). Samuel H. Wilson, deputy director of the NIEHS, said that online tracking of environmental regulations affecting the biomedical research community should also be considered.

Conference participants also will push for research focusing on biomedical waste disposal and energy-efficient facilities while promoting education and training for scientists, said NAPE president Byron J. Bailey. Such efforts may draw on existing resources such as the NIEHS Worker Education and Training Program and the Howard Hughes Medical Institute's environmental health and safety initiative.

Several speakers suggested that new regulations might be unnecessary if the industry embraces voluntary strategies for improving environmental practices, such as selecting mercury-free fluorescent lights and planning experiments to use fewer potentially hazardous reagents. Voluntary goal-setting efforts already in place include the EPA's Laboratories for the 21st Century initiative (which calls for improved energy efficiency in all EPA facilities), an American Hospital Association/EPA program to reduce mercury waste by 50% by the year 2010, and projects by the activist coalition Health Care Without Harm to eliminate nonessential incineration of medical wastes and phase out the use of polyvinyl chloride plastics, thereby reducing dioxin production and concentrations of di(2-ethylhexyl) phthalate. A monograph based on papers presented at the conference will be published as a supplement to *EHP*. **–Ginger Pinholster**

Healthier Hotel Rooms

New measures offer hope for better traveling conditions for allergy sufferers. Cleaning solutions, dust mites, improperly maintained ventilation systems, and even dyes in hotel room carpet can all trigger allergic reactions, forcing some people to pack their own linens, carry disinfectants, or limit their hotel stays. Now, several hotel chains are addressing these problems. The Sheraton Rittenhouse Square Hotel in Philadelphia, Pennsylvania, is designed to be allergen-free: guest rooms feature filtered air, recycled carpet, dye-free linens made of organically grown fibers, and natural soaps and shampoos. All guests must sign agreements that they will not smoke in the hotel, and the cleaning staff uses only environmentally friendly cleaning products. Similarly, U.S. Franchise Systems in Atlanta, Georgia, has recently started offering chemical-free rooms in several of its hotels and will extend the program nationwide if it proves successful.

Fighting Cancer with Nuclear Waste

A cancer treatment that uses a by-product of nuclear weapons production has been developed and patented by researchers at Pacific Northwest National Laboratory. The treatment's main component, an ultra-pure form of yttrium-90, is extracted from strontium-90 and linked with peptides that target cancerous cells. Once the preparation has been injected and enters the tumor, the peptides bind to the cancerous cells and emit potent doses of radiation.

The treatment causes few side effects, can be delivered on an outpatient basis, and minimizes the radiation's damaging effects on healthy tissue surrounding the tumor. Clinical trials are being conducted on brain cancer patients at University Hospital in Basel, Switzerland.

The High Price of Water

At its August 1999 meeting in Stockholm, Sweden, the World Commission on Water for the 21st Century presented findings from an ongoing project that suggest that poor people in developing countries pay an average of 12 times more per liter of water than citizens connected to municipal water systems. Despite the price, these people get water of inconsistent quality—often bacteria-infested—that they can seldom afford to sanitize.

The commission found that in Bangladesh, boiling water costs the poorest families a staggering 11% of their income. In Peru, where citizens are warned to boil their drinking water for 10 minutes due to an outbreak of cholera, the cost has prevented many from doing so.

The cost of providing universal water access by 2010 is estimated to be $25 billion annually. The poorest developing countries are unlikely to be able to finance such development.

HAZARDOUS WASTE

Making Fake Sludge

With all the real waste lying about, it might seem strange for chemists to create artificial waste. But that's exactly what's being done as part of the effort to ameliorate the seemingly intractable problem of radioactive contamination at Hanford Nuclear Site in southeastern Washington State.

Cleaning up 55 million gallons of radioactive waste stored in tanks is a key task at the Hanford site, which the site's owner, the Department of Energy (DOE), calls "the world's largest environmental cleanup project." The Hanford site houses aging reactors and other leftovers of a 40-year project to make plutonium for nuclear bombs, including tanks full of sludge, mixtures that formed from dissolved solid radioactive wastes, such as spent fuel rods, and the solutions used to process the wastes. The 177 tanks at Hanford contain different types of sludges resembling wet plaster, concrete, or peanut butter, says Jim Krumhansl, a geochemist at Sandia National Laboratories in Albuquerque, New Mexico.

The huge tanks were not designed as permanent storage. The DOE says at least one million gallons of liquid from the tanks has already reached groundwater and may eventually threaten local groundwaters bisecting the Hanford site. In October 1999, the DOE's Office of River Protection reported finding high levels of radioactive technetium-99 in groundwater near one group of tanks.

Real tank sludge

Photo credit: Jun Liu/Pacific Northwest National Laboratory

The tanks present a dilemma. Doing nothing perpetuates the threat to groundwater. But mixing or moving the sludge carries all the risks of working with large quantities of highly radioactive material (including spills and exposures to humans and the environment). And laboratory research is hobbled by expensive radiation-protection precautions. The cleanup costs at Hanford—for tanks and other projects—totaled $1.6 billion in FY 1999 alone.

In order to research the chemistry needed to decommission the tanks, Krumhansl and colleagues have started brewing artificial sludge. The work is an outgrowth of the DOE's Environmental Management Science Program, started in 1996 to provide a basic research perspective on nuclear waste cleanup problems that might ultimately cut the cost of remediation. In addition to cutting costs, the research aims to answer two critical problems: what will happen to radioactive isotopes remaining after cleaning and how can their migration at a later date be minimized?

Coinvestigator Kathryn Nagy, a geochemist at the University of Colorado at Boulder, is making simple sludge—chiefly iron and aluminum—in a basic, high-nitrate system. To represent technetium-99, an isotope found in tanks and groundwater at Hanford, Nagy is using the safer, nonradioactive rhenium, which behaves like technetium in chemical reactions.

One goal of her work is to learn whether the radioisotopes are more concentrated in the liquid or solid portion of the sludge. She says this information will be useful in determining whether chemical or physical treatments are needed to maximize radioisotope removal from the tanks.

The investigators are also trying to learn what will happen to radioisotopes in the sludge that remains after the tanks have been emptied. "The tanks will be sluiced, sloshed, and squirted, but people won't be sent inside to clean them up," says Krumhansl. "There will be some percentage that sticks to the bottom and sides." Krumhansl has made artificial sludge in which nonradioactive isotopes of cesium and strontium substitute for radioisotopes of those elements. "I try to come up with what it is about sludge that holds onto radioisotopes, and how much will leach out [from residual sludge]," he says. "This is a tool to figure out what is going to be left, and how much of that radiation will leave to get into the groundwater."

Krumhansl says that doing this research on nonradioactive artificial sludges is much less expensive than working with the real thing, as well as immeasurably safer. "Once this information is available," he says, "we can assess just how clean we need to get the tanks, and not spend any more than necessary on the project."

–David J. Tenenbaum

WATER POLLUTION

Menace of Microbes

Scientists and policy makers from throughout the environmental health community are engaged in a debate on the focus of government water hazard research and the direction of efforts to protect the safety of the nation's drinking water. Joan B. Rose, a professor of marine sciences at the University of South Florida in St. Petersburg and coauthor of *Microbial Pollutants in Our Nation's Water Supply: Environmental and Public Health Issues*, a report issued by the American Society for Microbiology in January 1999, says, "We think a lot more needs to be done up front to prevent water contamination, to look at water quality and safety from a microbial standpoint before you get to the outbreaks." Proponents of this idea base their position in part on information contained in the report, which says that a constellation of scientific, legal, and perceptional problems are permitting harmful microbes to threaten the safety of the nation's drinking water.

One key problem in understanding and combating the spread of microbial diseases is the uncertainty about their prevalence. Contrary to estimates by the Centers for Disease Control and Prevention (CDC) of up to 900,000 cases of waterborne infection and possibly 900 deaths annually in the United States, a meta-analysis presented at the 1994 International Symposium on Groundwater, held in Rome, concluded there may be more than seven million cases per year. One possible reason for the disparity is the CDC's use of passive surveillance by relying on state health departments to report infections, says Erik Olson, a senior attorney with the Natural Resources Defense Council who is familiar with the report. Olsen says such reporting fails to provide a good snapshot of the extent of a disease.

For too long, says Rose, the emphasis has been on cancer and on chemicals such as industrial solvents and pesticides rather than on chronic and severe outcomes such as myocarditis, reactive arthritis, neurological impairments, and microbial diseases caused by environmental contamination with poorly treated sewage, septic tank leakage, stormwater, and animal waste. While counseling balance, Dennis Juranek, associate director of the Division of Parasitic Diseases at the CDC, agrees that new tools are needed to look for waterborne viruses and protozoa. He observes that few studies have been funded to look at the microbial risk of waterborne disease. Stephen Schaub, a senior microbiologist in the EPA's Office of Water, notes that the EPA is funding drinking water microbial epidemiology studies, some of which will be conducted by the CDC. In addition, the EPA, with others, is now evaluating viruses, protozoa, and indicator data to estimate national pathogen occurrence levels in drinking source waters.

Compounding the scientific and technical problems is a perception problem, says Schaub. "For the most part, people don't consider the United States to have any really major problem associated with microbial waterborne disease. They are more aware of chemical hazards being a concern," he says. Rose says that many people view infections as "natural" and treatable. Carcinogenic chemicals are seen as much more frightening even though, she says, microbes can pose a greater risk.

Juranek points out that it is only relatively recently that scientists have begun to realize that some microbes are capable of eluding even modern treatment equipment in big cities. Viruses can elude barriers such as sand and soil and taint well water, which is used by about half the population. This, argues Olson, means stricter attention must be paid to well contamination from sources such as feedlot runoff and manure lagoons, which can contaminate groundwater. Schaub says that the EPA is aware of the potential for viruses to migrate to groundwater and plans to propose future rules to address the problem. **–Harvey Black**

Water Environment Federation

Each year, wastewater treatment plants in the United States process more than 11.5 trillion gallons of sewage water, enough to fill Utah's Great Salt Lake more than twice. This sewage has the potential to cause catastrophic environmental damage, and it is up to the people who operate the 16,024 wastewater treatment plants in the United States to ensure that it does not harm the lakes, rivers, and seas that will eventually receive it.

The Water Environment Federation (WEF) helps professionals at wastewater treatment plants in this country and abroad exchange information and keep abreast of new technologies and regulations. In addition, the organization works to raise public awareness of water pollution and ways to fight it. A key resource for achieving these goals is the WEF's Internet site, located at **http://www.wef.org/**.

Water quality professionals who visit the WEF Web site can seek advice from colleagues on everyday workplace issues—from handling complaints about odors to reusing effluent—by participating in the technical discussion groups found on the site. Each of the 17 discussion groups allows visitors to read and post messages on a particular subject such as air quality and water reclamation.

Also available is information about the WEF's 47 technical committees. Each committee concentrates on a particular area of expertise, such as disinfection technologies or wastewater treatment in Latin America. Committee volunteers plan conferences and workshops and write and review articles for WEF publications. For example, the Collection Systems Committee is developing a series of public information brochures on sanitary sewer overflows.

The Government Affairs link on the home page leads to updates on pertinent legislation and the WEF's own legislative activities. The full text of the WEF publication *This Week in Washington* is available through the Publications link on the Government Affairs page. Information about other WEF publications is available by following the Periodicals link. Here visitors find subscription information and author guidelines for *Water Environment Research*, the WEF's peer-reviewed journal, and nine other WEF periodicals. Over 350 other publications, targeted toward everyone from researchers to students, can be ordered from the WEF through the Technical Resource Catalog link.

Free information and learning activities for students can be found by following the WEF for Students link on the navigation bar. Included here are coloring exercises for young elementary school children, meter-reading exercises for middle school students, and information about operating a wastewater treatment plant for high school students. Clicking the College/University link brings up information on applying for scholarships and joining student chapters of the WEF.

The Public Information link takes visitors to resources that include a glossary of water environment terms and fact sheets on various water quality issues, such as how to dispose of household hazardous waste. Another link here takes visitors to a calendar of WEF events. The WEF holds a large annual conference that attracts thousands of people each year. Information on the annual conference is available through the WEFTEC (WEF Technical Exchange Conference) Conference & Exposition link. Links on the WEFTEC page take visitors to information on other WEFTEC activities. Further down the WEFTEC page is a link to information on WEFTeach, a workshop for high school teachers that coincides with the conference. WEFTEC 2000 will be held 14–18 October 2000 in Anaheim, California. **–Christopher G. Reuther**

Assault on Arsenic Poisoning

On 2 October 1999, the Bangladeshi government announced it is implementing a three-step plan to stop widespread arsenic poisoning in its nation, where groundwater contaminated by naturally occurring arsenic is found in over 90% of the districts and 20 million people are at risk for poisoning.

The government's plan, already launched in six districts, calls for nationwide testing of tubewells for contamination, identifying arsenicosis sufferers and referring them to health centers, and educating the community through television and radio commercials, manuals, brochures, posters, and music and dance performances in villages.

Over 34 support agencies, including the World Bank and UNICEF, have joined the government on this project. Field schools have been set up to train agency workers, and a database has been developed to supply information about arsenic screening results.

Seven-a-Day Could Keep TB Away

Doctors affiliated with Partners In Health, a Cambridge, Massachusetts–based nonprofit health organization, have developed an effective weapon against multidrug-resistant tuberculosis (TB). Doctors Paul Farmer and Jim Yong Kim conducted their research in a low-income area of Lima, Peru, and found that a two-year daily regimen of seven drugs has an 85% effectiveness rate and costs less than conventional treatments.

This breakthrough is important as TB kills over two million people a year worldwide and its multidrug-resistant form continues to spread, especially in Russia, China, India, and Latin America, according to a 9 November 1999 *Washington Post* article.

Following an international meeting of TB experts in New York City, plans were adopted to begin pilot treatment programs in Russia, Latvia, and Kazakhstan.

Polluting Pets

A study on urban bacterial water pollution published in the December 1999 issue of the *Journal of Environmental Engineering* concurs with previous research that found pet waste is the probable source of such contamination. Using methods to test water for fecal streptococci, bacteria unique to animal feces, researchers at Vanderbilt University in Nashville, Tennessee, found high numbers of the bacteria in runoff from lawns and roadways.

The study found a high correlation between housing density and the level of contamination. Coauthor Edward L. Thackston says, "One of the things associated with housing density is the number of pets per acre." Another factor is the urban environment—animal fecal matter washes off paved roads and sidewalks into storm drains or into nearby open waterways.