Yale-New Haven Teachers Institute

Curriculum Units by Fellows of the Yale-New Haven Teachers Institute
2003 Volume V: Water in the 21st Century

Introduction

This seminar explored the history of water availability and quality, and the laws and policies that govern access to water, and acceptable levels of pollution. Water is necessary to sustain life on earth, yet it is increasingly scarce, and highly vulnerable to pollution. Nearly 70% of the planet's surface is comprised of water, yet nowhere on earth is water now considered safe to drink unless treated. The availability and quality of water will become increasingly important during the 21st century, as population grows, especially in arid regions. Pollution, waste, and other contaminants increasingly threaten water quality and human health. The World Health Organization estimates that nearly four million children die each year in poorer nations from preventable water borne diseases alone. Nearly three million others die from vector borne diseases such as malaria caused by a parasite carried by *Anopheles* mosquitoes that thrive in wet environments.

Human use and abuse of land shapes both water availability and quality. Tropical deforestation reduces the forest's sponge effect, allowing more water to remain on the surface, providing breeding grounds for mosquitoes that may carry diseases such as malaria and dengue fever. Agricultural irrigation when combined with the use of fertilizers and pesticides contributes to the contamination of both surface waters and underground aquifers. Dense residential and commercial development create problems with sewage and storm water runoff that normally contain oil, gas, solvents, tire and brake fragments, and other residues emitted or leaking from the hundreds of millions of vehicles. In many coastal communities, heavy rains now carry a toxic cocktail of chemicals and bacteria through storm drains that empty into rivers, estuaries, lakes and marine environments, threatening the health of those live, work or recreate in the area.

Nearly 15 million people now live in Orange County California, south of Los Angeles. The area was formerly a desert until water was redirected through enormous viaducts and tunnels from the Colorado River and Northern California. Early in the 20th century, this imported water nourished thousands of acres of orange groves in the County. Today the groves have been replaced by densely settled residential communities where homes--often lavishly landscaped--demand far more water per acre than orange groves. Southern Californians' access to the imported water supply is now fiercely contested in courts, as those further upstream claim prior rights to support agriculture and development closer to the water's source.

The use of pesticides has contaminated the drinking water of tens of millions of U.S. residents, especially those depending on wells living in close proximity to agricultural lands such as the corn and soybean fields of the Midwestern U.S., and the cotton and rice fields of the Central Valley of California. The costs of cleaning up contaminated ground water is high enough to dissuade most communities from filtration that would completely remove the residues, leaving many wondering about the health effects of long-term exposure to low doses of toxins in their drinking water.

Our seminar considered many histories of water contamination. With hindsight, most seem highly predictable if not obvious. The consistent source of each problem was the absence of a culture that considered the environmental implications of incremental human development. Leaders failed to think ecologically about the effects of development. It is clear that most, especially in the poorest nations, have had other more basic priorities and threats to command their attention. The neglect of the relations between water, development, and human health has proven costly and avoidable, leading to loss of health and loss of future development potential that requires access to clean water.

We also considered an unusual case of water contamination at a former Naval Base on the island of Vieques in Puerto Rico. The U.S. bombed the island for 62 years, dropping hundreds of millions of pounds of bombs, missiles, rockets, artillery, grenades, bullets, depleted uranium shells, chemical weapons such as Napalm, and herbicides such as Agent Orange. When bombs exploded on the island, plumes of dust carried fragments of lead, mercury, cadmium, aluminum, and arsenic thousands of feet into the air. Trade winds would normally press the clouds toward the island villages where 10,000 people have lived. The Vieques landscape has been badly contaminated. Bomb fragments and residues are washed by heavy seasonal rains toward the beaches, mangrove lagoons and reefs that surround the island. Seven species of endangered sea turtles nest on Vieques beaches, some only yards from unexploded ordnance. Marine crabs and fish carry higher than normal levels of some metals released to the environment. Many of the islanders are fishermen who regularly consume their catch. Given these factors, it is no surprise that preliminary tests of human tissue samples collected from the population demonstrate a similar matrix of metals as those contained in the bombs. Water has been and continues to be the vehicle that transports the metals across the landscape to the ocean. And water is the solvent that makes these persistent elements available to move up the marine food chain, to the Viequenses' dinner tables, and into their bodies.

Nine teachers participated in this seminar where we considered cases just described, while they designed the curriculum units presented in this volume. A brief review of their contents may help guide other teachers to topics relevant to their interests.

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Joanna Ali developed a unit that explores the history of science and policy regarding acid precipitation for students in eleventh and twelfth grade. Her unit, "Acid Rain: Causes, Effects and Possible Solutions," includes a history of the scientific evidence that led to key federal regulations of power plant emissions. She summarizes the science with precision, and includes a series of laboratory exercises that will certainly engage students. She also designed and created a pollution trading rights game, with a board similar to *Monopoly* to allow students to trade sulfur dioxide rights in response to federal regulations. This is an exceptionally creative product and students will certainly enjoy playing the game while learning about one of the more complex areas of air quality science and law.

Ray Brooks teaches independent studies to grades 5-8, and specializes in helping students develop science fair projects. He designed a unit, entitled "Think Before You Drink," that explores the source, movement and fate of New Haven's drinking water. He provides a critical review of well water vulnerability to pollution from surface activities, and also includes a section critical of bottled water standards. His unit includes extraordinary documentation and websites that will benefit anyone hoping to strengthen science curriculum in the area of water resources.

Wendy Hughes teaches seventh grade science, and prepared the unit, "The Journey of New Haven Water." She developed excellent descriptions of the water cycle, an overview of chemical threats to drinking water

(microbes, radionuclides and pollution), treatment options, a comparison of point vs. non-point source pollution, and concludes with practical advice to students and teachers regarding what they can do to conserve water and protect its quality. Students will realize the lengthy journey that water has taken before pouring from their taps, and gain a strong understanding of the problems government faces in its efforts to assure a healthy supply.

Deborah James created a unit entitled, "Water, Water Everywhere, Not a Drop to Drink," for fifth and sixth grade science classes. She has provided a valuable primer on hydrology, and a concise overview of the key threats to water quality. She includes lesson plans covering topics such as scarcity and pollution problems abroad, a description of the water cycle, local watersheds, water usage and purification. This is a very well organized unit that will provide students with a basic foundation of knowledge in the field of water resources.

Sharron Solomon-McCarthy teaches sixth grade students in special education and faces exceptional challenges in teaching science to these students with diverse learning disabilities. Her unit, "Kids Conserve...Water Preserved," is designed to be multi-sensory. Students will prepare a PowerPoint presentation that describes a specific water management problem. She will also use anagrams to teach important vocabulary in the field of hydrology and water resources. Each student will also conduct a household survey of water consumption, to help them understand waste and the potential of conservation. This is well-organized, articulate and very thoughtful unit that will surely command the students' interests.

Roberta Mazzucco teaches third grade and designed the unit, "Water: Our Most Important Beverage." With superb organization, Roberta uses a question-based method to teach basic science about global water availability and cycling, the source of local drinking water, treatment options, basic problems of pollution, and the strengths and limits of government attempts to manage water quality. Each section includes relevant activities. She also discusses what the students can do to conserve and protect their water quality. The unit is clearly written and the documentation should help others who wish to strengthen their curricula.

Joanne Pompano teaches science to visually impaired high school students. Her unit, "The New Haven Oyster Industry and Water Quality" includes accurate overviews of hydrology and ecology. Oysters are especially sensitive to some types of pollutants, and since they are commonly eaten raw, they may cause serious illness if contaminated with bacteria or viruses. Joanne reviews the key threats posed by toxic substances and wastes associated with agricultural and industrial activity. She also explores the special hazards posed by sewage treatment plant overflows that commonly occur during storms, flushing microbes and toxic substances into estuarine environments threatening both ecological and human health.

Laura Pringleton teaches fourth and fifth grade general science and designed a unit entitled, "Water Will, Water Way." She believes the marine environment provides a scientific laboratory to search for new pharmaceutical agents that could treat serious human illness. The abuse of oceans, through the dumping of wastes, release of toxic substances, and the spilling of oils and fuels all threaten this diversity. Air pollution that contributes to climatic warming may make some near-shore environments more habitable for algae that are toxic to humans and marine life. The unit includes a set of very thoughtfully designed games to engage students.

Ralph Russo teaches high school history and international relations. He notes that water normally crosses or forms boundaries of many nations in the world, and that disputes about its availability or quality have been common in human history, especially in arid parts of the world. He cites the United Nations Development Report that notes more than 1,800 international interactions regarding water shared among nations, 21 of which have resulted in military action. In a world where nearly one billion people have no access to clean

drinking water, and two billion have insufficient water for basic sanitation, population growth in arid regions will intensify conflict over water resources. This unit includes a water rights game, strategies for conflict resolution and exceptional documentation.

Collectively these units are impressive in their breadth of topical coverage, creativity in strategies to directly engage students in the materials, and their thorough documentation. The seminar was the highlight of my summer and I thank all of the Fellows for their hard work, thoughtful contributions, and excellent products.

John P. Wargo