

*From the Student's Perspective:  
Redefining Water Resource Education at Tufts*

by Janice Snow

"Creekwalking" in the foothills of Mount Hood below Portland Oregon's pristine Bull Run watershed " is for Sarah Reich a defining image of her interest in water issues, an interest that led her across the country to join the first class of Tufts University's new water program. As a child at summer camp—in a group of 8-10 year olds—Sarah would splash into a stream near the camp, scamper ("creekwalk") up the rocky stream bed for a mile or so to an opening in the densely-wooded bank, then follow the trail back down to camp. Sarah 's love of water and landscape led to an early fascination with topography and maps and later to a dual undergraduate concentration in geography and in environmental economics, policy, and management at Oregon State University (OSU). She interned with a law firm that specialized in water issues—irrigation disputes, water rights and the endangered species act—before enrolling in graduate school at OSU in environmental economics where she found herself spending hours collecting statistics to apply econometric analyses to land use regulations. Sarah realized she had strayed uncomfortably far from her interest in the human side of water policies and she took a leave from graduate school to reassess.

While working at a Portland non-profit focused on preserving the pacific salmon fishery, organizing their conferences and building a GIS atlas of the North Pacific fishery, Sarah began researching graduate programs—at Wisconsin, Maryland, Yale and Tufts—with an integrated water policy or environmental management focus. She selected Tufts where she could pursue a policy degree in the Department of Urban and Environmental Policy and Planning (UEPP) and still focus on water issues in the first class (Fall 2004) of the cross-disciplinary Water Science, Systems and Society (WSSS) program (pronounced "wiss"). "UEPP/WSSS was the most integrated program," Sarah concluded, a "good combination of hydrology and environmental policy."

The WSSS model was devised in the Spring of 2002 in response to a solicitation by the Provost's office and the Council on Graduate Education for program initiatives to build cross-program synergy across Tufts University's seven schools. To Tufts President Lawrence Bacow who instituted the council the "great intellectual challenges" society faces "lie not at the heart of disciplines anymore, but at the edges and intersections of the disciplines." As council member

and academic dean of Tufts Friedman School of Nutrition Science and Policy Beatrice Rodgers considered potential topics, water seemed the ideal unifying, problem-focused topic. Rodgers contacted water resources engineering research professor and Tufts WaterShed Center Director Paul Kirshen and together they brainstormed with colleagues in arts and sciences, engineering, the Fletcher School of Law and Diplomacy, the medical, nutrition, and the veterinary school. They found professors at each school excited by the collaborative potential of water studies. Kirshen and Rodgers (now co-chairs of WSSS) and engineering professor Richard Vogel described in 2004 in the *Journal of Water Resources Planning and Management* WSSS's "founding principle" that " *all disciplinary perspectives relevant to water management*" must be included because water management is a "socioeconomic, institutional, and ethical challenge as well as a biophysical and engineering challenge." This principle informing WSSS's program design would, they said, set Tufts' approach to water resources studies apart from most "integrated water programs." WSSS would address the classic problem of cross-disciplinary projects where experts do not meet until the final phase of a plan and often do not understand one another's professional jargon. The WSSS solution would combine "in depth training in one discipline" through existing departments with "knowledge in the other disciplines and their approach to water management."

When new provost Jamshed Bharucha arrived at Tufts in the summer of 2002 the number of program proposals submitted to the Graduate Council had been whittled down to four. "WSSS had all the right ingredients" says Bharucha; it "played into Tufts distinct cross-school boundaries...to broad university thematic strengths in life sciences and environment... into thematic strengths related to policy, public service, and community service leadership at all levels." He saw WSSS as a "one of a kind" model of interdisciplinary study where students would develop a "nuanced understanding of related fields while not "diluting their expertise" in their primary field. In Bharucha's estimation WSSS had "the right policy focus" and the potential to be "the program in the country combining engineering science, biology, medical science and policy."

While WSSS was still on the drawing board, civil engineers, Eric Chilton and James Limbrunner returned to Tufts looking to combine their engineering studies with policy. Both had studied hydrology as undergraduates at Tufts. "Inspired" by Professor Rich Vogel's undergraduate hydraulics class Jim had worked with Vogel on "project-oriented," "complicated, multifaceted projects ...often with no previously identified answer." (Vogel has adapted his

Water Resource Systems Engineering course for WSSS's non-engineers to introduce them to the basics of system evaluations, simulation modeling and multi-criteria analysis.) Jim loved working with the hydraulic flumes in basement of the Engineering building. He stayed on to earn a master's in hydrology in 1998, then moved to New Hampshire to work for an engineering company investigating hazardous waste sites and developing systems to treat contaminated ground and surface water. In many of the projects Jim's work on the non-technical component was as great or greater than the technical one. Jim found he enjoyed working with lawyers, geologists and public relations professionals as well as other engineering specialists. He realized he wanted to "work on water problems in a broader, different way with a keener sense of the public policy context."

Eric Chilton returned to Tufts in 2003 after testing out two careers paths. An avid cyclist and lover of the outdoors, Eric after getting his bachelor's degree accepted an engineering job where he could work outside. Three years later, while supervising workers at a busy construction site in Boston, he gazed up at the luxury condos his company was erecting and said to himself, "Is this my purpose in life?" He quit, took a part time job at a bookstore in his hometown of Auburn, Massachusetts and rode his bike for the next four months thinking about what he really wanted to do. He had enjoyed the teaching aspects of his engineering job so he got certified to teach and took a job teaching high school physics in Cambridge. He loved constructing open-ended problems to demonstrate to his students the power of structured scientific thinking, but he soon learned that he was expected to devote nearly all his teaching time to presenting pre-packaged kits designed to cover as many standard formulas as possible, a policy he found stifled curiosity and intellectual exploration.

Eric applied to graduate school at Tufts with a "desire for collaboration" and to stay involved in teaching. The year before WSSS began, he enrolled in a dual degree program in Civil and Environmental Engineering and Urban and Environmental Policy and Planning (CEE/UEPP) with "water as a unifying concept." He accepted a National Science Foundation fellowship through Tufts Center for Engineering Educational Outreach to work with teachers at Malden's Beebe Junior High to demystify engineering and to show students how to use analytical methods to solve problems. He took the UEPP standard water resources-watershed management and policy course taught by successful practitioner, Scott Horsley. When WSSS began, says Eric, it "provided a name for what I'm doing; it legitimized my focus." The WSSS framework encourages asking, "what is the larger problem? What is the plan? How do we get

there?" How does the engineer, the health care worker, the policy maker deal with it? "What's cool about the WSSS program is the choices" it offers and the questions it asks; for example, "How do we deal with water demand?" In WSSS "I get to sit down in seminars and interdisciplinary classes with a group with incredible diversity in experiences and backgrounds."

WSSS requires a three month interdisciplinary professional experience and thesis. Eric chose to combine both requirements studying water use and hydrology at the Flathead Indian Reservation in Montana where Tufts has established a partnership with the Salish Kootenai Tribal College Environmental Studies Program. Eric describes a 6 week-summer project gathering data at the Flathead Reservation as developing "a brain exchange" between Tufts and the Tribal College. Using his engineering training Eric plans to study Flathead watershed hydrology and using his policy training to develop a survey protocol "to learn what people do in the river," how water is related to their culture and to understand their plans for the future of the tribal lands. His work will contribute to a WSSS case study on the Flathead assembled by Paul Kirshen and WSSS Research Assistant Martha Fernandes. (Martha's graduate engineering work focused on water and sanitation planning in developing countries.) The Flathead Lake Reservation presents a particularly challenging subject says Eric as U. S. government policy in the early 1900s gave non-Indians the right to purchase land inside the territory of the "sovereign" reservations. The policy created within the Flathead Lake Confederated Tribes land a checkerboard of Indian and non-Indian ownership. Combining the resources of the tribal college in environmental planning, the tribal government and the support of outside resources such as the Tufts partnership may offer some innovative water resource planning and management solutions and a continuing information exchange between Tufts WSSS program and Salish Kootenai.

When he returned to Tufts as a Ph.D. candidate in Civil and Environmental Engineering (CEE) Jim Limbrunner became involved in interdisciplinary water resources field work through Paul Kirshen. In Kirshen's CEE/UEPP water policy course (now one of the four core WSSS courses) Jim learned that a group of four Tufts Medical School students and a Tufts veterinarian were looking for an engineer to assess water resources on a public health team in Siuna, Nicaragua over two weeks in the Spring of 2004.

Sponsored by Bridges to Community, an upstate New York non-profit, the program arranges construction, sustainable farming and medical trips to Nicaragua where participants work alongside the local communities. Many Siuna area residents rely on shallow-dug wells; the town has a shortage of clean water and a high incidence of diarrhea, mosquito-spread diseases—such as malaria and dengue fever—and leishmaniasis (a skin and immune system disease caused by a protozoa spread by the bite of infected sand flies). The Tufts medical students, in coordination with Nicaraguan doctors provided health care services to the drastically under-served population.

Tufts veterinarian Louise Miranda, fluent in Spanish, investigated animal health. Raising livestock is a primary economic activity for many in Siuna. One of Jim's assignments was to look for alternate water supply sources and also to investigate possible water contamination by acid mine wastes, mercury and arsenic tied to previous gold mining in the area. Jim brought home water samples for testing. The test results for metals contamination were inconclusive but other "evidence pointed to bio contamination" of Siuna water as a greater, more immediate health problem to be investigated on future trips. Not able to make this Spring's trip, Jim continues to be involved in water-testing for Siuna with Veterinary professor Miranda and by contributing to the design of a small-scale solar pasteurization project to combat tuberculosis in the region. Other areas of concern to Jim and the team are deforestation and human sanitation. They are collaborating with non-profit partners to improve sanitation, including the construction of latrines. For Jim the "uniqueness of the WSSS program stems from its commitment to build collaboration among the disciplines... creating lasting ties among students of humanities, health, policy, law and diplomacy, science and engineering. I want to understand" he says, "how we can work together and I'm learning that here."

Like Jim Limbrunner, WSSS doctoral student Jamie deLemos has taken an interdisciplinary approach to the social impacts of water contamination. Her work is at the intersection of environmental engineering and epidemiology. Jamie became interested in water quality as an undergraduate in geosciences at Skidmore College where she investigated water quality issues in local lakes and reservoirs.

She was moved to study arsenic in water supplies by the catastrophe in Bangladesh where millions are drinking arsenic-contaminated water and developing fatal cancers and debilitating skin disorders. Deep tube wells dug by UNICEF and private organizations from the 1960s to

1980's to protect people from biologically-contaminated, shallow-well water have turned out to contain naturally-occurring arsenic and other toxic metals many times in excess of safe levels. (Some critics suggests that the narrow focus of water and health professionals delayed widespread recognition of the problem, which was finally accepted as a public health crisis in the mid 90s.) At Dartmouth College where Jamie earned a masters in Earth Science she was part of an multidisciplinary collaborative grant to study the transport and fate of arsenic in groundwater at a capped landfill Superfund site in New Hampshire, a site with no history of arsenic dumping. The team investigated the hypothesis that the geochemical conditions created by landfill remediation were accelerating the movement of natural sources of arsenic from soil sediment to groundwater and threatening local wells.

Following Dartmouth Jamie worked for an environmental consulting firm in Massachusetts doing hazardous waste site remediation. The "dividing line between scientists and engineers," at the firm led Jamie to Tufts' WSSS program where the "collaboration" she sought "was obvious" among WSSS faculty members.

"Many academic programs," says Jamie, "do great research on toxic metals; they gather essential data, but are often detached from affected subjects. Others study public health outcomes but do not teach students the necessary science to accurately understand the suspected sources and mechanisms necessary to evaluate and implement mitigation strategies." As a Tufts doctoral student in environmental engineering and a WSSS program student she is working at the union of these two research areas, where she can assess the complexities of water science and public health outcomes. Jamie is researching arsenic in groundwater with three Tufts professors: engineering professor John Durant who researches the movement of arsenic and other toxins in sediments and water; epidemiologist David Gute, Associate Professor of Civil and Environmental Engineering and professor in community health at Tufts medical school; and Tufts hospital physician Jeff Griffiths, Associate Professor of Public Health & Family Medicine and a specialist in waterborne infectious diseases. Having an epidemiologist like David Gute "is unique in an engineering department," says Jamie.

Gute co-teaches a new WSSS course, Biology of Water, with Griffiths. True to the program's cross-disciplinary roots, the first iteration of the class in the Fall of 2004 was a mix of students from Tufts public health program and WSSS students including Jamie, Sarah, Eric and Martha. One class focused on difficult-to-detect and expensive-to-test drinking water

contaminants. Griffiths had invited his Tufts colleague Dr. Andrey Egorov, a hydrologist turned epidemiologist, to present his research on the incidence of water-borne illness, conducted with a very small budget, in the heavily polluted Russian industrial City of Cherepovets. Egorov and his colleagues offered a small stipend to a randomly selected group of Cherepovets residents to keep daily dairies of their water use and gastrointestinal illness. By correlating resident reports with basic water monitoring data the researchers deduced the likely incidence of cryptosporidium (crypto, for short)—a diarrheal disease resistant to chlorine disinfection and prohibitively expensive to test for directly.

Gute's and Griffiths' goal for this class was to demonstrate that mapping disease was in essence detective work, a search for patterns. Their goal for the course was to train experts in water-borne illnesses with a broad-enough mission definition to avoid the blind spots that have resulted from the narrow focus of many key institutions such as the Center for Disease Control (CDC) and the National Institutes of Health (NIH). The CDC, says Griffiths "does surveillance, not research" (and no surveillance at all for viral diseases in water). The system is set up to "look at the individual case, not at exposure. NIH does research, but not public health research. In their attempt to avoid overlap", he says, CDC and NIH have avoided the crucial intersection of research and public health. "Had we had brilliant people who worked on cholera and molecular biology working together," Griffiths contends, "we might have made more progress by now." The new Biology of Water class, says Griffiths "functions as a way to bridge some of those gaps."

Engineer Eric Chilton says he learned in this class "the difference between gathering environmental data and gathering health data" and "how an epidemiologist approaches a problem," This is the "nuanced understanding of related fields" that sold the provost on WSSS. For Sarah Reich the public poster session at the end of the course also demonstrated the WSSS program's connective power. While one half the class stood by their posters which distilled their course research down to a few blocks of text, images and charts, the other half of the class (along with faculty and guests) engaged the student-presenters in one-on-one discussions. Then the two groups of students reversed roles. Sarah's poster summarized the conflict between the Portland Oregon's Water Bureau and the EPA over its technical standards for finished water. With one of the most pristine watersheds and source water in the country the Water Bureau had resisted the mega structure solution of a filtration plant and covered finished water storage.

Sarah looked at how the standards were set, adapted and met. Jamie deLemos's poster distilled her work to date on arsenic and drinking water.

The public health-water link also drew nutrition student Melissa Rosen to Tufts and the WSSS program. After Melissa earned her undergraduate degree in public health and social science from Johns Hopkins University in 2001, she joined an Americorps (the domestic Peace Corps) group in New Hampshire working at a rape crisis center. The experience reinforced her interests in pursuing a public health-related career and graduate studies. Because her health policy program at Hopkins was social-science based Melissa decided to enroll in post bachelor's science classes at Tufts while she considered health-related graduate programs that would be both intellectually challenging and community oriented. The new WSSS component of the nutrition program convinced Melissa, who has "a passion for water," to apply to Tufts Friedman School of Nutrition Science and Policy. The new combined program name demands abbreviation: the Masters of Science in Food Policy and Applied Nutrition and Water, Systems, Science and Society or FPANWSSS (pronounced f-pan-wiss). The newness of the WSSS program and its integrated team-based approach were also key attractions for Melissa.

Her first WSSS course was Paul Kirshen's Water Resources Engineering. "It's a challenge to think like an engineer," says Melissa, learning the vocabulary, calculating flows, studying technical details for water purification and waste water treatment. An immediate benefit, she says, is "insight into the water engineer's approach to water problems and solutions. Paul gives exceptional support to non-engineers...lets me raise my hand every 5 minutes; his door is always open...Paul is very observant; he picks up if you're getting it and adjusts his teaching to give explanations of engineering concepts that non-engineers can understand." The course's "model approach to learning" also makes it "easier to focus," she says.

Fellow class member Sarah Reich describes Kirshen's team-based assignment and class presentation requirement: a reservoir modeling problem estimating stream flow, calibration and validation using a large data set data from the Lesotho Highlands Water Project (LHWP), a controversial dam and water tunnel project in Southern Africa. Each team's task was to determine safe yields from the project's Katse dam in the mountain country of Lesotho to supply the arid city of Johannesburg in South Africa. Given the treaty-guaranteed water flow rate, each team was to determine how the current level of withdrawal would effect the environment. Sarah's team found a significant environmental price: decreased water and soil nutrient flow

with impacts on natural vegetation, medicine and food supply. LHWP provides a unifying real world case for this first cohort of WSSS students to study across course disciplines.

Team work is key to Paul Kirshen's Spring's Policy of Water class, the fourth of the WSSS core, team-taught courses. Paul Kirshen is the lead instructor supported by Tufts faculty from the water-related policy fields of agriculture, famine relief, environmental economics, nutrition, law and diplomacy. Student-faculty research, a key WSSS program goal, was presented by Fletcher/WSSS student Jonathan Lautze who traveled to Southern Africa last summer to study transboundary water basin treaties. Student teams presented water policy issues, critiques and potential solutions. On one WSSS cross-disciplinary team were Melissa (nutrition), Sarah (environmental policy) Jamie (environmental engineering) and Ayrton Strauch (biology). They critiqued current U.S. and state policy on combined Animal Feeding Operations, the factory farming model where liquid wastes of thousands of cows pigs or chickens, dumped in lagoons and sprayed on fields, end up polluting surface and groundwater.

For WSSS students the integrative experience extends beyond the classroom to field trips, field work, team and individual research and the Friday Seminar Series designed to introduce WSSS students to water-related research going on across Tufts three campuses, across town and across the country. If you want to test the interest and commitment of college students and faculty, schedule a program on Friday afternoons. Attendance at these seminars often exceeds the number of students enrolled in WSSS.

At one seminar presentation Fletcher Professor Bill Moomaw and his graduate student Melissa Birch presented their new research based on existing EPA data estimating the costs and sources of nitrogen pollution in the Chesapeake Bay. They reviewed the data through a cross-disciplinary and cross-media lens. Previous studies had concluded that all chemically identical forms of reactive nitrogen caused the same damage. Moomaw and Birch say the data suggests that the amount of damage depends on the cycle of nitrogen pollution, how and where it is created. "When we recast the problem" says Moomaw, "we found that the damage from the energy sector" which begins as air pollution and ends up as water pollution either by directly entering the water from the air or via an intermediate route through soil to water is "at least as great as a contributor to damage" as agriculture, the focus of EPA nitrogen clean-up for the Chesapeake Bay. Moomaw notes that the EPA's "stovepipe" organizational and funding

structure—where one group studies air pollution, another water, another solid waste—does not encourage thinking across media boundaries.

Integrative thinking was also the theme of the last seminar of WSSS's inaugural year at the Center for Conservation Medicine on the campus of Tufts Veterinary School in the rural, rolling hills of North Grafton, MA. The Center's veterinarians, physicians, ecologists, and conservation professionals study health relationships among humans, animals, and ecosystems. Ray Powell, a 1985 Tufts Veterinary School graduate and former New Mexico Land Commissioner had come to talk about the challenge of his new job as Executive Director of the Valles Caldera National Preserve Trust, an 89,000 acre former cattle ranch in North Central New Mexico and to think with the WSSS and veterinary students about its management. The Preserve's unusual structure—as a wholly owned government corporation, managed by trustees representing diverse community interests—and its mandate to manage the property to be ecologically and financially sustainable by 2015 invites innovative thinking.

Powell's strategy is to "find people who have the skill sets that I don't have and integrate that knowledge" and use his skills and experience to manage the most difficult piece, the "human dynamic." Tufts veterinary training,, he says, "gave me confidence I could learn enough to know when someone else was faking me." He painted a rosy employment picture for students with the WSSS skill set.

Managing the human and cross-disciplinary dynamic, Paul Kirshen told his WSSS water policy students the last week of class, is not easy. His point was painfully demonstrated by this year's case study of the Lesotho Highland's water project which failed to deliver on its promise of Integrated Water Resources Management (IWRM)—failing to protect the environment and failing to reduce poverty in South Africa and Lesotho. For the last class Kirshen asked the students to prepare a critique of IWRM, a concept upon which WSSS is founded and to consider whether IWRM can work. If the answers were clear, if the process and path were easy, Sarah, Eric, Jim, Jamie and Melissa would probably be looking elsewhere for a challenge.