IOWATCH

THE CENTER FOR GLOBAL AND REGIONAL ENVIRONMENTAL RESEARCH

FALL 1999

This issue of *IoWatch* focuses on two CGRER-sponsored non-traditional educational efforts to broaden understanding of global change issues.

Imagine rising one morning to find that your access to one of the most basic gifts of nature, water, has disappeared. You can't take the normal shower or shave. You can't fix your cup of coffee, mix a pitcher of juice, cook your cereal, or rinse the dishes. Your plans to throw a load of clothes into the washer are now impossible. You're unable to revive your drooping house plants, wipe up the spill on the kitchen floor, replenish the dog's water bowl, or brush your teeth. Every turn of the faucet yields frustrating nothingness. In an instant, the comforting patterns of your daily routine have become impossible and much of your household — from dishrag to sink to hose to pitcher to bathroom and laundry room — has lost its function.

Imagine rising *every* morning to find that one of your assumed environmental constants, clean abundant water, has become a rarity to slave for, treasure, and allot for use only with utmost care, drop by drop. If you live in a rural area, you may have to walk for six hours on steep slopes to fill your water jug and then carry the weighty jar back home. Or you might send your children to fetch the water, but then they won't have time to attend school that day. If you're in a city, you may rise at 2:00 a.m. to queue up at the common tap so that you can catch your portion of the flow during the few hours each day that the water runs. In either case, your supply is limited to a few liters per day. Perhaps you are one of the few lucky

Water Connections—Nepal

ones to have a tap in your home fed by a private water tank on your rooftop. That means that you have a steady supply of gravity-fed water, although you must have the tank refilled regularly. Even then, however, you have no guarantee that the water is safe. In fact, if you looked

"Today we saw our first public water tap. It is now rather run down, but looked like it was beautiful at one time. The spouts were decorated with dragon heads. While we were there a woman with an aluminum jar came to collect some water to take home with her." Annette Dietz

into the matter, you would learn that contaminated water is responsible for a full 80% of the country's illness, that around 40,000 children die anually from waterborne illness before the age of five, that gastroenteritis is a part of daily life, and that waterborne diseases like dysentery, hepatitis, and even cholera are not uncommon.

These are the daily circumstances of life in Nepal, as well as in many other developing countries. This is why Nepalese, when asked what single factor would most improve their lives, overwhelmingly pinpoint the availability of water. And this is why a dozen University of Iowa faculty and students traveling in Nepal this past summer focused for an entire month on drinking-water problems.

The Trip Described

The trip, funded by a Fulbright-Hays Group Project Abroad grant to CGRER, was led by Professor Paul Greenough, a member of CGRER's executive committee and historian of health who specializes in South Asian and global health studies. Following a weekend of orientation sessions led by Cornell University anthropologist Kathryn March, the group spent four weeks abroad: two in Nepal's capital city of Kathmandu and two touring the rural countryside by bus, with Kumar Rajbhandari (an administrator for the Himalayan Climate Center, HCC) and Okendra Budhathoki (a government employee and associate member of the HCC) acting as guides. Connections for multiple investigatory visits across the country had been arranged by HCC director Dr. Sharad Adhikary, who graciously served as host for this travel seminar, and consultant Judith Amtzis.

The word "diversity" describes the trip perhaps more than any other. First of all, participants were purposefully chosen from a variety of backgrounds and disciplines. The eight graduate students represented the UI's geology, geography, and American studies departments as well as medical and engineering colleges. Senior participants included Paul Greenough (UI, history), Luis Gonzalez (UI, geology), Mike Chibnik (UI, anthropology) and Connie Mutel (UI, Iowa Institute of Hydraulic Research). This breadth was

"We are a mobile learning team of faculty members and students who are new to Nepal and who have been learning about the country quickly through the lens of a single issue: drinking water." Paul Greenough

contrived to encourage one of the primary goals of the trip: investigating the diverse ways in which different disciplines "know" an empirical reality. Put another way, the trip was designed to stimulate CGRER's goal of interdisciplinary discourse, by focusing a diverse array of scholars on a single issue, in a setting without other distractions. Such interdisciplinary melding of approaches and ideas is crucially important to dealing with global change environmental problems, which often have their origins in human activities and culture. For this reason, CGRER has been striving to increase involvement of social scientists in its activities.

In addition to divergent training, participants brought with them a broad array of agendas. Students Kathleen O'Reilly (geography) and Mike Lewis (American studies), who are both involved with doctoral work in India, wanted to compare their field studies to the situation in Nepal. Annette Dietz, now winding up her doctorate in environmental engineering, saw the trip as a way of integrating her undergraduate major in Global Studies with her current engineering emphasis. Gillian Dorner, working for a master's degree in public health (MPH) with an emphasis on global health studies, also saw the trip as an amazing opportunity to blend the old with the new — for her, to combine her undergraduate studies in land use changes and environmental quality with her graduate work in human health and international issues. Alexis Grey (who just completed her master's in occupational and environmental health) and Naoko Kiyan (working for a master's degree in third world development) had never traveled in a developing country before. They approached Nepal as a sort of initiation to work they would be doing in the future: Alexis as a Peace Corps volunteer in Latin America, and Naoko as a scholar of development, women's studies, and South Asia.

Once in Nepal, participants were fortunate in their diversity of local contacts. Visits were made to government officials, academicians, environmental journalists, water supply managers, private researchers, non-governmental organization (NGO) staffers, and others. Of particular interest were those visits that allowed conversation with ordinary Nepalese water users. Participants also paid visits to many types of water-related sites such as municipal water plants, rural water taps, and research and educational institutions, in a variety of communities ranging from urban centers to tiny villages accessed only by footpath. The sites were sprinkled throughout the extremely diverse environments and ecosystems boasted by Nepal, with its elevations ranging from near sea level to the top of Mt. Everest, each with its own human cultures, adaptations, and water problems. The dozens of site visits and contact personnel allowed participants to examine the source, delivery infrastructure, use, and health consequences of water from many vantages.

Water — A Complex Problem

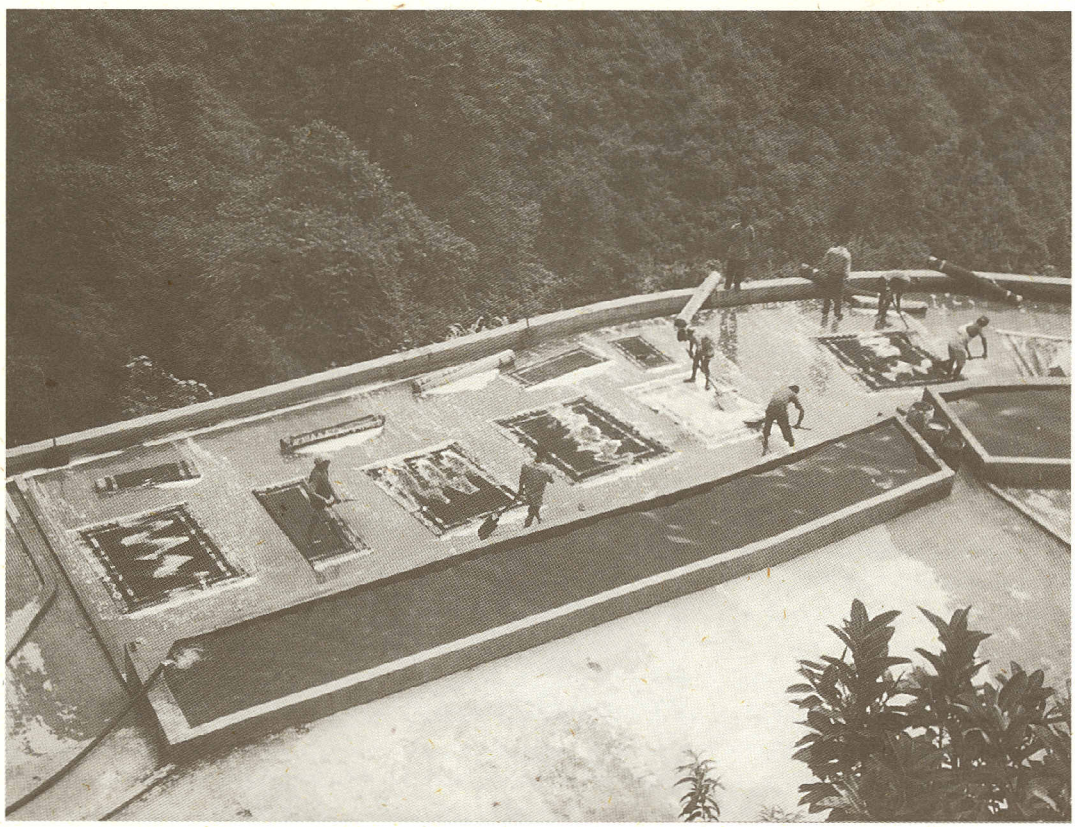
Perhaps bewilderment is normal when residents of one of the world's wealthiest nations struggle to comprehend environmental problems in one of the world's poorest, along with interacting traditions, expectations, resource availability and allotments, population pressures, educational levels, and governmental organizations. In any case, the participants' understanding both expanded and hazed as the complexities of water's flow saturated their imaginations.

Naoko wondered whether "girl trafficking" – which refers to the sale of girls from remote areas of Nepal to India's brothels — would be increased by a large tunnel project to bring water from the mountains into the Kathmandu Valley. "If the project takes farmers' land and makes the villagers poorer, trafficking will increase because the villagers will need extra income to survive," she feared. Mike Lewis realized that many consider wetland conservation

"In the U.S., we talk about chlorination by-products and the possibility of developing cancer thirty years from now. We must keep in mind that a large percentage of the world's population is at great risk of becoming ill tomorrow from the water that they drink today." Alexis Grey

a "full-stomach issue" that can only be enacted after basic human needs have been met. But considering the many benefits that wetlands deliver (such as water storage and purification), he concluded that "their conservation should be advocated so that local populations can reap the benefits of actions which they, as of yet, may not support."

Gillian worried that "because of the lack of basic sanitation procedures — for example keeping cattle and goats away from tapped springs — the possibility exists that the water delivery system will turn into a waterborne disease delivery system." Kathleen stated that the numerous NGOs now implementing water development schemes need to be studied for their influence on changing local environments and social relations, in particular women's roles. And Corey Anderson (who just received a master's degree in preventive medicine and environmental health) presented his vision of the trip as a "hands-on experience with the problems of inadequate health policy formation" and spoke of the need for integrating administrative health policies with water delivery systems.



Chemical toxins from the washing of hand-loomed rugs are now flowing into the Kathmandu Valley's rivers, along with human and animal wastes and other pollutants.

The travel team. Front row, left to right: Luis Gonzalez, Naoko Kiyan, Vionette de Choudens-Sanchez, Alexis Grey, Kathleen O'Reilly, Connie Mutel, Gillian Dorner; back row, left to right: Annette Dietz, Mike Chibnik, Paul Greenough, Corey Anderson, Mike Lewis.

As the trip proceeded, these types of issues interwove with other observations that became increasingly enigmatic: how rivers and lakes are often both receptacles for raw human waste and a primary drinking water source; how disease is not commonly linked in people's minds with poor sanitation practices or low water quality; how the stark need for water supply often excludes water quality issues from the discussion table; and how such a wet country can have so very many dry taps. As Annette aptly summarized, "It's that old thing of the more you learn, the more you realize you don't know. When I started studying engineering, I thought it would be very helpful in developing countries. Now I feel my current research on chlorinated solvents in groundwater really is not important in Nepal right now. The people simply want water." Thus over time, the seemingly straightforward question of how to assure water availability became a web tied to nearly every other societal and environmental factor in the country, from educational programs to political structures to foreign aid delivery to gender status and more.

Aftermath

Certain outcomes of the trip were prearranged: student participants wrote papers and received class credit; all participants kept journals of their observations, which fed into a final half-day session of presentations and discussions with Nepalese contacts; seminars will be presented on campus, and a new UI class, "Water in South Asia," is tentatively scheduled for the year 2000.

However, many of this trip's benefits were intangibles – the friendships that blossomed between participants and Nepalese contacts, for example. There was also a certain tempering of the minds of students now shaping their careers. "It's easy to assume that modern technology alone can solve problems of water supply and contamination. But the tour emphasized how social, political, and economic issues are all related to engineering, and how effective solutions must combine aspects from each of these areas," stated Annette. Naoko stated that despite her readings, she never had imagined how hard women worked in Nepal. She was thankful that the trip had converted her abstract knowledge into a concrete connection with her development studies.

Vionette de Choudens-Sanchez, a geology graduate student who delighted in Nepal's faults, folds, and rocks, felt that the trip helped her see the human side of her future profession. She and her academic advisor Luis were able to apply their expertise during a visit to a mountain village whose schoolhouse

Additional CGRER-Nepal Connections

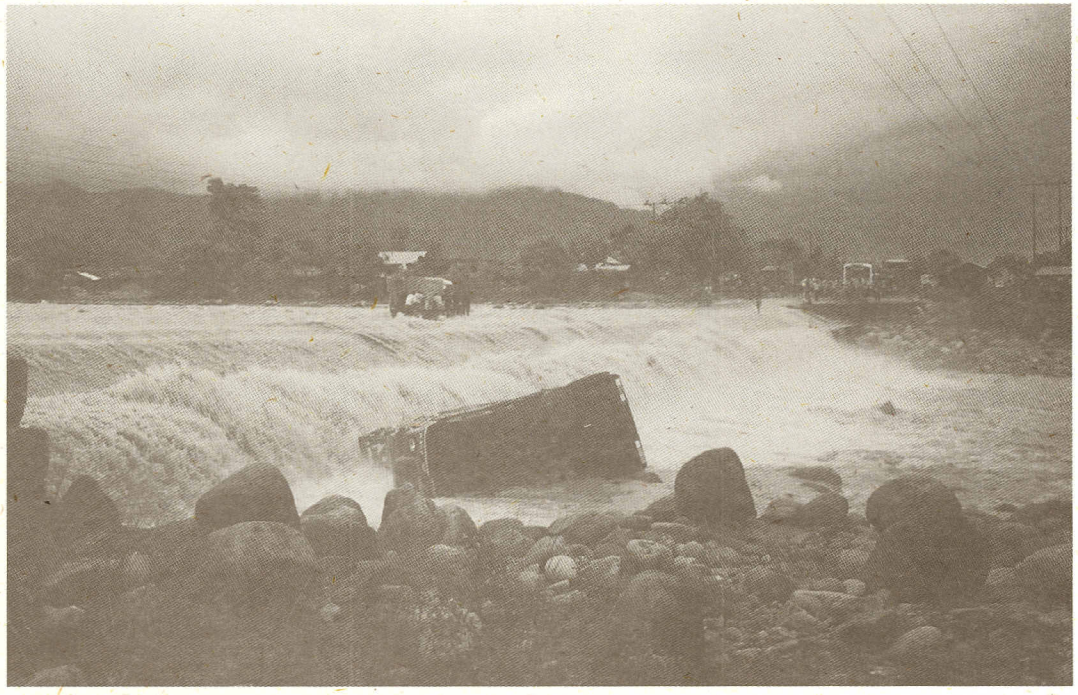
Even before this trip, CGRER had established ongoing professional relationships with Nepal. Dr. **Sharad Adhikary**, who was instrumental in establishing the Kathmandu-based environmental research institute the Himalayan Climate Center (HCC), helped put together the proposal that funded the travel seminar. CGRER has a standing letter of agreement with the HCC, which formally commits both institutions to such types of joint efforts. Dr. Adhikary has traveled to Iowa City several times to participate in CGRER symposia, present seminars, and contribute to joint research proposals. The seminar participants carried with them a gift from CGRER to the HCC: a computer workstation identical to those used at CGRER. This "mirror" computer and its software will stimulate future collaboration by allowing HCC researchers to carry on efforts parallel to CGRER's, and will provide a method for rapid data processing and transfer between Nepal and the U.S.

The HCC has been instrumental in assisting CGRER's **Greg Carmichael** with his research delineating the extent, severity, and source of trace gas pollutants in Nepal. Greg has been collecting data on pollutants such as ozone, sulfur dioxide, and ammonia at four sites, using unique samplers developed for his remote and untended Nepalese sites: the samplers require neither electricity nor calibration. His data are being utilized to validate numerical atmospheric transport models, which in turn will help determine whether Nepal's air pollution is generated primarily by local sources or whether (as many think) the pollution is blown into Nepal from nearby India.

The HCC has also assisted **Luis Gonzalez**, one of the travel seminar participants, identify data collection sites for his research on the fluctuating history of the region's monsoons — the seasonal torrents that bring the vast majority of Nepal's rainfall. (This research has been partially funded by CGRER.) By identifying and dating the isotopes in the stalagmites found within Nepal's numerous caves, Luis is hoping to provide data that will feed into computer models of monsoon cycles and will help determine whether these cycles are natural or are related to global warming. An understanding of past monsoon cycles should allow prediction of how the monsoons may change in the near future, which in turn will help Nepal manage its water resources in coming decades.

CGRER's **Jerry Schnoor** is an adjunct faculty member at Nepal Engineering College near Kathmandu, where he is actively advising about the establishment of the nation's second environmental engineering curriculum. This undergraduate program will help Nepal develop its own expertise to deal with water problems and other environmental issues. And CGRER member **Jacob Odgaard** (UI, IIHR and Civil and Environmental Engineering) recently served as a consultant on the IIHR and design and placement of Iowa vanes, large concrete panels strategically placed in a river to guide the flow of the river's water. The 30-or-so vanes in Nepal's Kosi River have eliminated the problem of sediment flowing into and blocking the intake for a large irrigation system in southern Nepal.

It's easy to assume that modern technology alone can solve problems of water supply and contamination. But the tour emphasized how social, political, and economic issues are all related to engineering, and how effective solutions must combine aspects from each of these areas.



Too much water can be as problematic as too little water. The majority of Nepal's precipitation falls during the monsoons, when very heavy rains can produce floods and landslides.

was poised to slide downhill into a ravine. The villagers, short on information and raw materials, had been trying to avert the threatening landslides by throwing basketfuls of rocks down the slope. Luis and Vionette returned to their hotel and wrote up a simple mitigation procedure for controlling the landslides, complete with easily understood sketches. Vionette, who is committed to making her geological efforts relevant, recently heard that certain of their suggestions were being implemented, and felt "so very happy to help the people who had received us so kindly."

Perhaps other participants will be able to make similar contributions in the future. Gillian may return to Nepal next summer to complete the required practicum for her MPH, and is considering returning to Nepal as a physician once her medical training is completed. Naoko is determined to further study of Nepal's girl trafficking. Vionette hopes to return to study and numerically model the groundwater hydrology of the Kathmandu Valley.

Foreign exchanges such as this student-faculty tour often stimulate future collaborative arrangements. Mike Lewis and Kathleen both established new professional relationships that they may draw on as South Asian scholars. And this fall Okendra Budhathoki is on the UI campus, commencing studies for a master's degree in environmental engineering. He is working with Jerry Schnoor and assisting with CGRER-related research on carbon sequestration.

UI students are likely to hear more about Nepal from Mike Chibnik, who states that he now looks forward to including Nepalese examples in his classroom lectures. Mike, an anthropologist specializing in Latin America, says, "I've talked about rice paddies for years, but never seen one. This trip gave me the chance to become familiar with an entirely new region, and also to learn a lot about water delivery systems." Mike also feels that he now has sufficient knowledge and connections to help graduate students doing research in South Asia.

Luis Gonzalez, who is already involved in research in Nepal (see "Additional CGRER-Nepal Connections"), announced that "the trip made me, as a physical scientist, aware of many water issues that I wouldn't consider on my own." Luis explained that although his research deals intimately with Nepal's future water availability, he had not considered the complexity of political, social, and foreign aid aspects influencing this topic. Luis also is excited about feeding information gathered in

"Local sentiment in Nepal often runs strongly in favor of clearing and draining natural wetlands and converting them into agricultural land. Until people are educated to recognize the benefits of conservation, they will not support it." Mike Lewis

Nepal into his teaching of a 400-student Introduction to Environmental Studies class.

Paul Greenough, who organized the seminar, expressed satisfaction that students and faculty alike had found the trip worthwhile and that all had returned to Iowa without mishap. Paul will return to Nepal in March, 2000, to continue working on a number of health and culture issues stimulated by the 1999 travel seminar.

Researcher and writer Connie Mutel is already starting to feed her experiences in Nepal into her writing and publications.

The trip's most lasting influence, present and future, may well be the participants' appreciation of the overwhelming difficulty of solving seemingly straightforward environmental problems. This appreciation could only grow from observing the complexity of Nepal's water problems *in situ*. Observing the tremendous variability that characterizes human life around the globe may also stimulate comprehension, at a visceral level, of what difficulties could lie ahead for us if our own pressures on climate and environment continue to rise unabated.

Until sanitation and health issues become linked with water quality in the peoples' minds, water systems may serve as perfect mechanisms for spreading diseases such as gastroenteritis, hepatitis A, and cholera.

On a related note. . .

These students participated in a second water-related travel seminar, this one to Taiwan and Japan for two weeks this past summer. The trip, conceived by Virendra C. Patel (UI, Mechanical Engineering and director of the Iowa Institute of Hydraulic Research – IIHR) and led in part by Jacob Odgaard (UI, Civil and Environmental Engineering and IIHR), both of whom are CGRER members, is part of an ongoing IIHR travel abroad program that invites students to consider the numerous complex conditions that impact the planning and management of water resources projects around the globe.

Fossil fuel combustion, greenhouse gases, changing climate, changing lifestyle, changing expectations. Predictions of global warming and its impacts have become common parlance. But just how *do* these various components fit together anyway? And how *is* the lay person to learn enough about this complex problem to help aim the bow whose bowstring is being pulled by the collective human race?

The Science of Global Climate Change Symposium

This year, a four-parted program entitled "Taking On the Challenge of Climate Change," organized by the Iowa United Nations Association, has attempted to provide the groundwork for answering these questions. The first session of this program, entitled "The Science of Global Climate Change: A Symposium on the State-of-the-Science," was held on March 5, 1999, on the UI campus. The symposium was well attended by persons from within and outside of academia. CGRER co-sponsored this symposium, with CGRER's **George Malanson** (UI, Dept of Geography) playing the role of principle organizer.

The symposium's intent was straightforward: to invite the nation's experts to summarize current understandings of climate change so that all – lay public to technical expert – could understand and learn. Three sessions, each with three speakers and a panel of questioners, addressed these basic concerns:

- How can we gather information on climate change in the past?
- What do we know about today's climate?
- What impacts can we expect from accelerating climatic changes in the future?

A sampling of their comments is presented below.

Looking Backward: Paleoclimates

Knowledge of past climates and climatic change provides the baseline for interpreting today's climatic variations. But given that detailed weather records have been kept in this country for only about a century, how can one determine the climates of past centuries or eons? The answer lies in recently-advanced intricate research techniques for dissecting nature's climatic records. These are hidden within the Earth and the remains of its ancient inhabitants — minute changes in concentrations of pollen for example, and rings formed during the growth of trees and stalagmites.

Margaret Davis (ecology professor at the University of Minnesota) studies pollen deposits from past millennia. Through identifying and counting each species' pollen grains, she is able to track and pace the long-term migration of trees – the westward movement of beech over thousands of years through Michigan and into Wisconsin, for example. Because each tree species inherits specific climatic requirements, tree movement tracks climate change. Davis pointed out that anthropogenic climate shifts will indeed force large-scale changes in tree distribution. The habitat for sugar maple, for example, is predicted to move hundreds of miles to the north. However, her studies have identified a major problem: rapid changes in temperature and moisture are likely to overwhelm trees' innate ability to disperse and reestablish forest communities.

Malcolm Hughes (Laboratory of Tree Ring Research, University of Arizona) and **Luis Gonzalez** (UI Geology Dept) explained their use of other natural barometers. Hughes, an expert in dendrochronology, is able to use the annual growth rings within the trunks of trees to determine and date the maximum temperature of a particular growing season, late winter moisture, and other weather traits. By cross-comparing his data with actual weather events, the growth of corals, and ice core samples, he has been able to reconstruct climate accurately for about the past 2,000 years. Using tree ring and other data collected from around the world, he is now attempting to recreate a global grid of annual temperature variations that dates from the present back through the 15th century. Gonzalez's intricate analyses of the calcite deposits that form stalagmites likewise can be used to determine climatic variations (see CGRER's 1998 Annual Report, page 12).

Looking Around Us: Climate Modeling and Monitoring

Is climate indeed changing as we watch? Precise and abundant climatic data are needed to answer this question. These voluminous data ideally feed into numerical models capable of reliably predicting future climatic trends.

While we have fairly good long-term measurements of surface temperature and precipitation, **Witold Krajewski** (Civil and Environmental Engineering and IIHR, UI) explained that these alone are far from sufficient for our needs. Analysis of the complex phenomenon that we call "climate" necessitates measurements of numerous external components (such as solar energy, trace greenhouse gases, and aerosols) and of feedbacks between the Earth and atmosphere, all of which influence temperature and precipitation. Uncertainties that creep into any measurement or transformation of any of these data sets can magnify inaccuracies in our climatic interpretations. The problems with collecting accurate and detailed weather data are thus major drawbacks to any interpretation of climatic change. To improve the situation, Krajewski emphasized that we need to develop a well-coordinated

Fossil fuel combustion, greenhouse gases, changing climate, changing lifestyle, changing expectations. Predictions of global warming and its impacts have become common parlance. But just how *do* these various components fit together anyway? And how *is* the lay person to learn enough about this complex problem to help aim the bow whose bowstring is being pulled by the collective human race?

The Science of Global Climate Change Symposium

This year, a four-parted program entitled "Taking On the Challenge of Climate Change," organized by the Iowa United Nations Association, has attempted to provide the groundwork for answering these questions. The first session of this program, entitled "The Science of Global Climate Change: A Symposium on the State-of-the-Science," was held on March 5, 1999, on the UI campus. The symposium was well attended by persons from within and outside of academia. CGRER co-sponsored this symposium, with CGRER's **George Malanson** (UI, Dept of Geography) playing the role of principle organizer.

The symposium's intent was straightforward: to invite the nation's experts to summarize current understandings of climate change so that all – lay public to technical expert – could understand and learn. Three sessions, each with three speakers and a panel of questioners, addressed these basic concerns:

- How can we gather information on climate change in the past?
- What do we know about today's climate?
- What impacts can we expect from accelerating climatic changes in the future?

A sampling of their comments is presented below.

Looking Backward: Paleoclimates

Knowledge of past climates and climatic change provides the baseline for interpreting today's climatic variations. But given that detailed weather records have been kept in this country for only about a century, how can one determine the climates of past centuries or eons? The answer lies in recently-advanced intricate research techniques for dissecting nature's climatic records. These are hidden within the Earth and the remains of its ancient inhabitants — minute changes in concentrations of pollen for example, and rings formed during the growth of trees and stalagmites.

Margaret Davis (ecology professor at the University of Minnesota) studies pollen deposits from past millennia. Through identifying and counting each species' pollen grains, she is able to track and pace the long-term migration of trees – the westward movement of beech over thousands of years through Michigan and into Wisconsin, for example. Because each tree species inherits specific climatic requirements, tree movement tracks climate change. Davis pointed out that anthropogenic climate shifts will indeed force large-scale changes in tree distribution. The habitat for sugar maple, for example, is predicted to move hundreds of miles to the north. However, her studies have identified a major problem: rapid changes in temperature and moisture are likely to overwhelm trees' innate ability to disperse and reestablish forest communities.

Malcolm Hughes (Laboratory of Tree Ring Research, University of Arizona) and **Luis Gonzalez** (UI Geology Dept) explained their use of other natural barometers. Hughes, an expert in dendrochronology, is able to use the annual growth rings within the trunks of trees to determine and date the maximum temperature of a particular growing season, late winter moisture, and other weather traits. By cross-comparing his data with actual weather events, the growth of corals, and ice core samples, he has been able to reconstruct climate accurately for about the past 2,000 years. Using tree ring and other data collected from around the world, he is now attempting to recreate a global grid of annual temperature variations that dates from the present back through the 15th century. Gonzalez's intricate analyses of the calcite deposits that form stalagmites likewise can be used to determine climatic variations (see CGRER's 1998 Annual Report, page 12).

Looking Around Us: Climate Modeling and Monitoring

Is climate indeed changing as we watch? Precise and abundant climatic data are needed to answer this question. These voluminous data ideally feed into numerical models capable of reliably predicting future climatic trends.

While we have fairly good long-term measurements of surface temperature and precipitation, **Witold Krajewski** (Civil and Environmental Engineering and IIHR, UI) explained that these alone are far from sufficient for our needs. Analysis of the complex phenomenon that we call "climate" necessitates measurements of numerous external components (such as solar energy, trace greenhouse gases, and aerosols) and of feedbacks between the Earth and atmosphere, all of which influence temperature and precipitation. Uncertainties that creep into any measurement or transformation of any of these data sets can magnify inaccuracies in our climatic interpretations. The problems with collecting accurate and detailed weather data are thus major drawbacks to any interpretation of climatic change. To improve the situation, Krajewski emphasized that we need to develop a well-coordinated

international commitment to collect data on numerous climatic variables, over a long time period, with sufficiently numerous and high-quality instruments.

Given the problems with collecting the raw data, how valid and significant are numerical models based on these data? The answer to this question depends on whom you ask. **Warren Washington** (head of Climate Change Research at the National Center for Atmospheric Research) stated that NCAR models now can accurately represent a number of climate-affecting features — changes in greenhouse gases, sulfate aerosols, biomass burning, and even ocean currents (and thus El Nino) to name a few. The higher resolution made possible by more powerful computers is even allowing simulations of eddies in the Gulf Stream, although other features such as cloud cover are notorious for their uncertainty. Thus for certain climatic features (including tropospheric warming, sea ice and snow cover decrease, increased tropical water vapor, and increased nighttime temperatures), NCAR's models are now accurately representing measured and observed climate patterns.

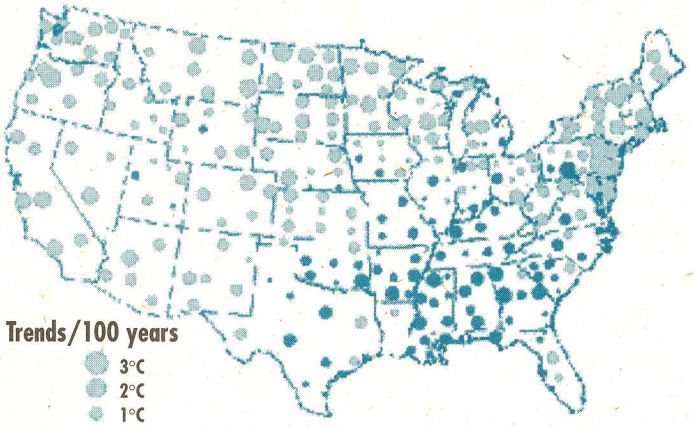
The outspoken critic **Richard Lindzen** (meteorology professor at MIT) then drew the weaknesses of both weather observations and certain numerical models into a spirited challenge of current greenhouse gas theory. He stated that the importance of small increases in CO_2 and other human-generated greenhouse gases are dwarfed by the warming effects of humidity and clouds, which are quite variable and complex to assess. Climate measurements may be only 30% accurate, and models of cloud cover are notably invalid. Thus probable errors in our climatic projections are larger than the greenhouse effect itself, Lindzen concluded, bringing into sharp focus the difficulties of drawing conclusions about complex climatic phenomena from masses of variably precise and accurate weather data.

Looking Forward: Impacts of Climate Change

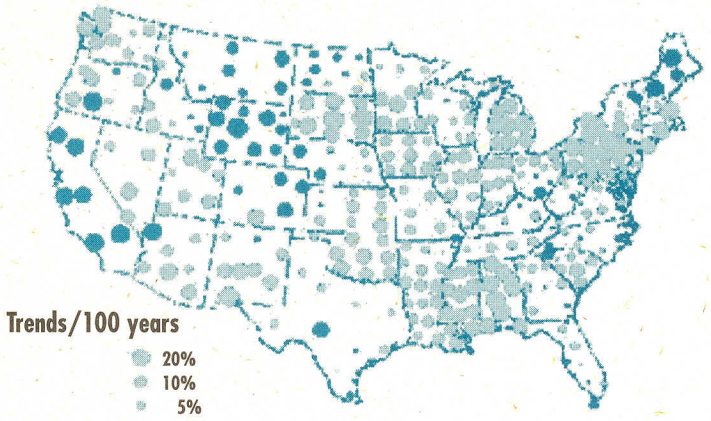
Climate changes constantly of its own accord, and the results of these natural climatic changes are often quite obvious. Thus certain impacts of human-accelerated climate change can be enumerated with relative ease. The final panel summarized predicted impacts in three areas. **Jonathan Patz** (director of the Program on Health Effects of Global Environmental Change at Johns Hopkins) discussed probable shifts in human health concerns, such as more numerous deaths from heat stress in inner cities, northern movement of disease vectors such as malaria-carrying mosquitoes, and the complex production of "environmental refugees" fleeing devastation from sea level rise and other degradations of their homelands. These health-related concerns have been previously discussed in depth in *IoWatch* (spring and fall, 1997 issues). **Herman Shugart**, professor and director of the University of Virginia's Global Change Program, summarized the complexities and importance of modeling ecosystems to predict changes in vegetation – a challenge magnified by vegetation's ability both to respond to and create its own local climate.

David McGinnis (UI Geography Dept) described alterations in water resources expected from climate change. Models predict an enhanced hydrologic cycle, with more intense storms and global increases of 4-6% precipitation. Hydrologic patterns would also be

Temperature Trends, 1900 to Present



Precipitation Trends, 1900 to Present



NOTE: Light dots represent increases, dark dots represent decreases.

Geographer David McGinnis explained that climatic factors across the U.S. have displayed distinctive regional trends throughout the 20th century. While temperatures have increased 1 to 3°C in most locations, the southeastern states have witnessed cooling trends. These may be due to an increase in cloud cover and the influence of sulfate aerosols emitted by power plants; sulfate aerosols decrease the solar radiation reaching the earth's surface. Changes in precipitation (up to plus or minus 20%) have also occurred with the same kind of patchy regional differences. Note that while Iowa experienced little temperature change during the past 100 years, our state exhibited a clear rise in precipitation of 10-20%. (Source: Tom Karl, NOAA)

affected by higher temperatures accelerating the melting of high-altitude snowpacks and glacier masses, a process already being observed. However precipitation patterns would vary greatly from season to season and place to place, as would environmental problems caused by these variations. In North America, increases in winter and spring runoff and decreases in summer moisture would increase the number of both floods and droughts. Nepal and other Himalayan countries are already concerned about the observed melting of glaciers; intensification of this melting would increase floods and landslides for a period, after which flow, irrigation supply, and hydropower would plummet. Social parameters – a growing human population and per capita water use – would also significantly affect the quality and quantity of available water.

The evening banquet speaker **Joel Scheraga**, who is Director of the U.S. Environmental Protection Agency's Global Change Research Program, described how EPA's assessment program is trying to maximize public input. Reiterating that the climate does indeed seem to be changing, and that the impacts and adaptations to such change can be significant, he then pushed forward into consideration of policy issues dealing with climate change problems.

Dorothy Paul of the Iowa United Nations Association – USA concluded the daytime portion of the symposium by reiterating the importance of political initiatives such as the Kyoto Protocols, which move us forward "an inch at a time." However Paul also challenged listeners to become players in transforming society and ourselves so that we shape a world habitable for our children.

Her call to invoke us all to work at the local and national level went out well beyond the walls of the symposium room. The symposium talks were broadcast live over the internet. In addition the symposium, along with the three other segments of the Climate Change program, are being summarized by Dorothy Paul. The summary, available in December, 1999, may be requested from: Iowa Division, United Nations Association – USA, 20 East Market St., Iowa City, Iowa, 52245, or by phone (319-337-7290) or email (unaiowa@inav.net).

While CGRER's climate change-related educational and research efforts continue, life proceeds as usual for most of the world. Which means that everything and nothing seem to be happening simultaneously.

On the one hand, levels of greenhouse gases continue to climb at an annual rate of about 0.5%. The evidence regarding global warming mounts year by year, although there is still some disagreement about how much of this warming is attributable to human activity.

On the other hand, the chance of the U.S. Congress voting to adopt the Kyoto Protocols (which would limit the rate of increase of greenhouse gas emissions) seems doubtful, even though other nations around the globe are moving forward with their own legislative limitations.

However other less comprehensive greenhouse gas-related bills have been introduced in Congress, and certain voluntary industrial initiatives related to carbon emissions appear to be moving forward. For example a growing number of industries have joined the Business Environmental Leadership Council, which is a part of the Pew Center on Global Climate Change. Members of the council accept that "enough is known about the science and environmental impacts of climate change for us to take actions to address its consequences," and the council develops relevant policy studies in response. As CGRER's Jerry Schnoor explains, "We know that CO_2 emissions are increasing. There's growing strong concern about an unstable atmosphere and climate variability. Industry is recognizing that it makes good economic sense to increase energy efficiency and decrease greenhouse gas emissions now, not later. Some industries believe that doing so will give them a competitive advantage in the future, and some industries are starting to act."

Two CGRER-related efforts serve to contrast this "all-and-nothing" scenario. CGRER members **Dick Baker** and **Frank Weirich** (both UI, Geology) accepted the Union of Concerned Scientists' invitation to join about 50 other scientists and visit Washington D.C. this past June, there speaking with legislative representatives and their aides about the science of global warming. While there, Dick became discouraged about the general lack of legislative concern regarding climate change, but he also stated that he was impressed by the Iowa legislators and their aides whom he visited. "We had been warned only to raise the most basic three ideas: 'Science demonstrates coming climate change, the implications of this are bad, and we need to do something about it.' However Iowa's congressmen were quick, involved, and asked their own questions," Dick stated.

On a more proactive note, **Jerry Schnoor** and his graduate student Richard Ney have been gearing up to assist new industrial initiatives regarding greenhouse gas emissions. "There are no current regulations requiring reductions in greenhouse gas emissions," explains Richard. "However there's a real belief that these are coming. A new Des Moines firm, CQuest, has been formed to trade CO_2 credits – in effect to broker the rights to emit CO_2 between companies that produce little CO_2 and those that produce voluminous quantities. CQuest just completed its first such sale. CGRER hopes to remain involved with greenhouse gas-reducing activities by providing scientific verification of emission reductions. We will be able to show that someone actually *did* reduce CO_2 emissions, and by how much."

What's Up at CGRER?

CGRER has become one of four sites on the University of Iowa campus to train faculty and students in the use of Geographical Information System (GIS) software. The university has signed an institution-wide site license with the nation's largest producer of GIS software, the Environmental Systems Research Institute (ESRI), for use of its software and products. CGRER has committed $1000 to license fees, as well as the salary of a half-time research assistant to ensure the proper teaching and use of this GIS software.

An official naming ceremony was held on October 8 for the Paul H. Nelson Stable Isotope Laboratory, which was established and is maintained in part with funds from CGRER. This laboratory will provide a broad range of relatively inexpensive and fast isotope analysis services to researchers across Iowa (see CGRER's 1998 Annual Report, page 12, for more details). The lab started collecting data this past September, once the equipment had been installed and calibrated. A grand opening ceremony, to include a talk by the world-renowned isotope geochemist James O'Neill, will be held November 3. O'Neill, now retired from the USGS and University of Michigan, most recently has explored the use of phosphate found in bones and teeth for examining paleoenvironmental change. His talk will be followed by an open house for the entire university community.

Best wishes and many thanks were extended to Glenn Larson, expert manager of CGRER's computer laboratory, when he left for a position in Lacrosse, Wisconsin, in June. Jeremie Moen has recently been hired to replace Glenn.

CGRER bids a fond farewell and extends thanks for years of service to Advisory Board members Paula Dierenfeld (representing the Iowa Utilities Board) and Robert Holmes (representing Alliant Energy). Warm welcomes go to their respective replacements, Susan J. Frye and Jim Christensen.

CGRER has welcomed two new members since September, 1998. They promise to broaden CGRER's skills and relevance in manners described below.

Faculty Focus

Michelle Scherer came to The University of Iowa's Department of Civil and Environmental Engineering in September, 1998, after completing her doctoral work at the Oregon Graduate Institute of Science and Technology in Portland. Prior to that, Michelle worked as an Environmental Systems Analyst for the U.S. Environmental Protection Agency in Washington, D.C. As part of her doctoral work, Michelle examined the chemistry of using iron metal to clean up contaminated groundwater. This innovative technique, now used at over a hundred field sites around the world, involves the construction of a permeable "iron wall" – a trench that is filled with granular iron, strategically placed to intercept the flow of groundwater. The iron in the trench transforms many organic pollutants (and some inorganic pollutants also), converting them to less toxic or less mobile chemicals. Michelle evaluated the physical and chemical steps that are controlling the rates of transformation in these "iron walls."

She is now expanding her work to examine the reactivity of iron minerals with both organic and inorganic pollutants. This process occurs naturally in some mineral-bearing soils, and may be contributing to the natural attenuation of pollutants. If Michelle's efforts confirm that iron minerals are sufficiently successful and rapid in their reactions with pollutants, these minerals too might find their way into commercial use. She believes that her membership in CGRER will aid this and similar efforts by furthering her interdisciplinary collaboration with faculty members in the chemistry department who, like Michelle, are using molecular techniques to study reactions at mineral-water interfaces.

Raymond Arritt, an associate professor of agricultural meteorology in Iowa State University's Department of Agronomy, has been at that institution for six years. Prior to that, he completed his doctoral and post-doctoral work at Colorado State University and taught at the University of Kansas. Much of Ray's research concerns atmosphere-earth surface interplay and its effect on regional weather and climate. More specifically, he examines how processes such as soil moisture, transpiration by plants, and snowmelt interact with the atmosphere to shape climate. He may, for example, explore how atmospheric conditions determine the speed of snowmelt, which in turn determines the probability of spring flooding. Although much of Ray's work focuses on the development and use of numerical models, he also does observational work on regional wind patterns and storm systems.

Ray has just received a CGRER seed grant to further his work on the validity of regional climate models (see "Seeds," page 13.) He also received a CGRER seed grant in 1994 to evaluate the impact of potential greenhouse gas increases on Great Plains precipitation patterns.

Ray already collaborates with ISU's CGRER members Gene Takle and Bill Gutowski. He hopes that his membership in CGRER will spur similar collaborations with researchers at The University of Iowa, such as Greg Carmichael and Allen Bradley, who also study regional climate and hydrology.

Seeds

This year the awarding of unsolicited seed grants was reinstated and four grants were awarded for the period 8/1/99-7/31/2000. Each of the four promises to provide preliminary results that will pull in major research funding for continued efforts.

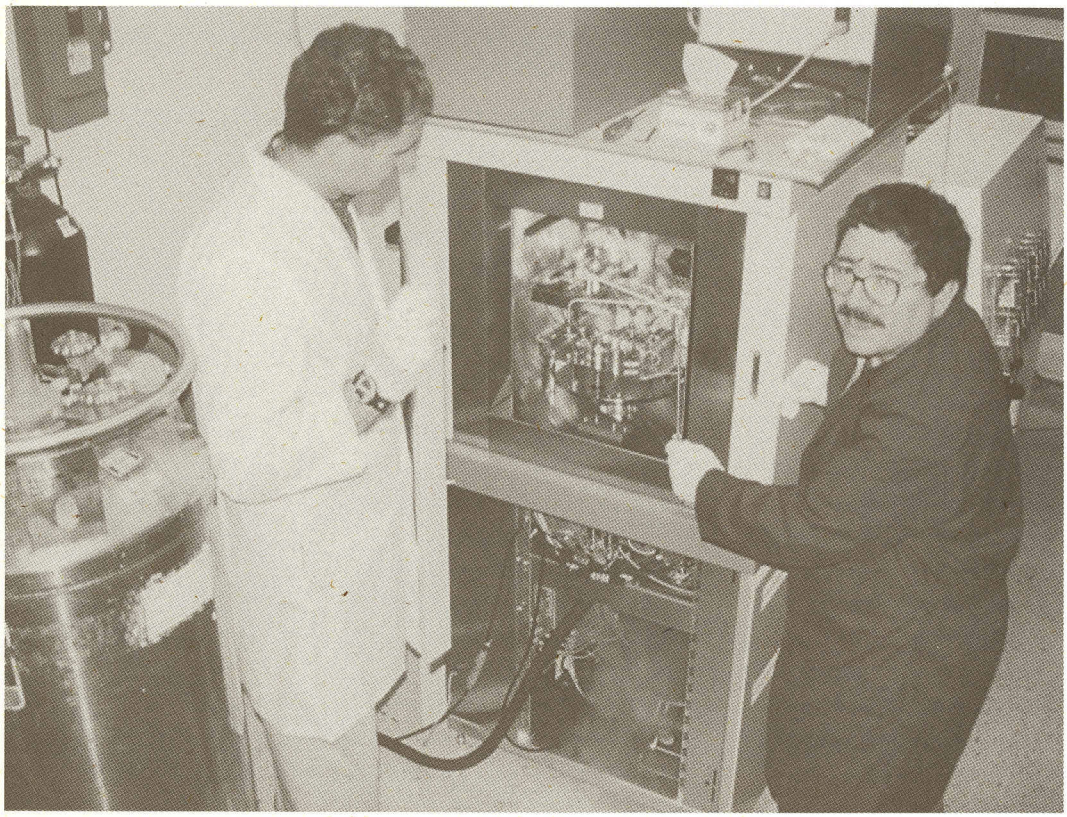
Ray Arritt, a new CGRER member (see "Faculty Focus," page 12), received $19,172 for examining the ability of global climate models (GCMs) to capture regional climatic fluctuations. Said another way, Ray wants to evaluate whether GCMs can reliably reproduce aspects of weather systems that are important to the shaping of regional climate. A positive answer to this question would suggest that we can use regional numerical climate models to focus on these systems in more detail.

More specifically, Ray will be extracting data from two of the better GCMs and determining their accuracy in representing two continental-scale circulation patterns, the Great Plains low level jet (LLJ) and the North American monsoon system (NAMS). These circulation patterns are important determinants of the quantity of Iowa's summertime precipitation. Since the NAMS has a sudden onset over only a few days and the LLJ almost always occurs at night, Ray is using six-hourly data from the models instead of the monthly average values used in most climate studies. If the GCMs perform well for the current climate, this fact would give us some confidence (but doesn't guarantee) that the models can be used to predict how the LLJ and NAMS will be altered by future changes in greenhouse gas concentrations.

Ray admits to letting his enthusiasm for the project carry him away. Hearing that the seed grant would be awarded, he performed some of the research before the money arrived and has already submitted a paper to *Geophysical Research Letters*. You can see the text of the paper at the following web address: http:/www.mesoscale.iastate.edu/files/HADCM2-NAMS-abstr.html

CGRER's **Luis Gonzalez** and **Greg Ludvigson** (both UI, Geology) received a $17,055 grant to stretch use of the new Paul H. Nelson Stable Isotope Laboratory into a new area. Researchers have known for years that sphaerosiderites could be used as indicators of environmental conditions of ancient times. These tiny nuggets of the iron carbonate mineral siderite, up to a few millimeters in diameter, are abundant in wetland soils of the distant past. However the formation of these ancient sphaerosiderites is not well understood, and thus their encoded messages about past temperatures, rainfall, and soil chemistry cannot be easily deciphered.

Luckily sphaerosiderites are still being formed. Luis and Greg will be using the Isotope Laboratory to determine the sphaerosiderite carbon and oxygen isotope chemistry in order to grasp how hydrology, climate, and vegetation affect sphaerosiderite growth in modern soils. Then they can apply their findings concerning modern sphaerosiderites to the formation of ancient sphaerosiderites, and extrapolate information about ancient environments in the process. In particular, they are striving to outline thoroughly the environmental parameters of the mid-Cretaceous, the most recent period that experienced both atmospheric CO_2 concentrations and global mean temperatures similar to — and even greater than — those predicted for the near future. The sphaerosiderites that were deposited in the Midwest at that time will help us create scenarios of what Iowa's



Luis Gonzalez (right) and Nelson Stable Isotope Laboratory manager Scott Carpenter place sphaerosiderite samples into the mass spectrometer for isotopic analysis.

temperature and precipitation patterns may become in the future, if through global warming we return to temperatures and climates similar to those of the Cretaceous.

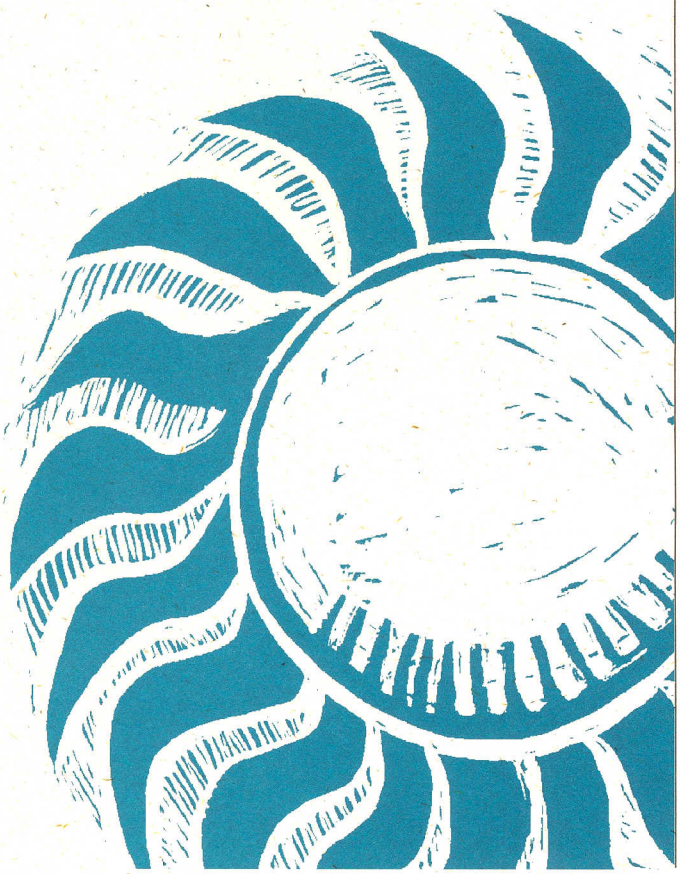
CGRER members **Keri Hornbuckle** and **Bill Eichinger** (both UI, Civil and Environmental Engineering and Iowa Institute of Hydraulic Research) received $20,000 to establish the Iowa Atmospheric Measurement Station (IA-AMS). This permanent monitoring station, to be located near Iowa City, will allow the long-term measurement of a variety of very specific atmospheric and climatic traits. As one example, Keri's primary interest lies in the transport of persistent organic pollutants (POPs), which are air toxins such as dioxins, herbicides, and byproducts of combustion. Although these compounds continue to float around the globe, being deposited and then returning to the air time and time again, little is know about how climate, changing land use patterns, or changes in diurnal, seasonal, and global temperatures affect their movement or changing concentrations in the air or soil. Her collaboration with Bill (who can produce a planar picture of the atmosphere using optical radiometry) promises to produce a detailed picture of the fluxes and relative concentrations of such pollutants between air and terrestrial surfaces. Keri and Bill hope to be able to describe vertical transport of both particle-bound and gaseous POPs.

The IA-AMS would have the potential of pulling together a diverse group of researchers from within and outside of the UI, all of whom observe and measure or numerically model atmospheric or climatic variables in different manners. It would provide an excellent resource for student training and research projects in chemistry or meteorology. It could provide the nucleus for an expanded research station in future years. And it could become part of an international web of sampling stations that are comparing atmospheric changes across the continent. In anticipation of this last goal, Keri has already submitted an NSF grant to establish similar stations in Mexico and Canada.

Mark Young (UI, Chemistry Department) received funding to perform a very different type of detailed atmospheric analysis. Mark's $19,856 grant will allow the completion of an atmospheric reaction chamber on the UI campus and the initiation of its experimental use. This chamber will be dedicated to analyses of the interactions between aerosolized mineral particles and atmospheric gases, interactions that have been recognized as potentially important to climate change. Researchers have determined that the chemistry of gas phase species, including the effects of pollutants, may be altered when they become adsorbed on mineral particles (such as iron or silicon oxides). Conversely the gases may alter the form or chemistry of the mineral particles. These complex interactions have been little investigated, in part because of the sophisticated equipment and interdisciplinary analysis required.

This CGRER grant will encourage multidisciplinary collaboration that will broaden and deepen our understanding of the gas-particle interplay in a very detailed manner, looking at the interaction gas by gas, mineral by mineral, always in a controlled environment. Mark and **Paul Kleiber** (UI, Physics and Astronomy) have designed the reaction chamber and its instrumentation and have outlined experimental protocols. CGRER member **Vicki Grassian** (UI, Chemistry) is an expert on the chemistry of such interactions, while CGRER's **Greg Carmichael** (UI, Chemical and Biochemical Engineering) will feed the resulting data into his numerical models of atmospheric chemistry and transport, which in turn will be fed into global models.

This unusual integration of disciplines and approaches, coupled with the difficulty and specificity of the measurements and the fine-tuned capabilities of the instrumentation and reaction chamber, will make the work done here globally unique. However it will remain relevant to Iowa because Iowa's environment abounds both in the emission of gaseous pollutants and in the aerosolization of mineral particles from agriculture and industry.



CGRER Members

Co-Directors

Gregory R. Carmichael
Jerald L. Schnoor

Executive Committee

Richard G. Baker, Geology
Garry R. Buettner, ESR Center
Robert Ettema, Civil & Environmental Engineering
Luis Gonzalez, Geology
Vicki H. Grassian, Chemistry
Paul R. Greenough, History
Stephen D. Hendrix, Biological Sciences
Gregory A. Ludvigson, Geology
George M. Malanson, Geography
David L. McGinnis, Geography

Members

The University of Iowa

Anthropology
Michael S. Chibnik
Russell L. Ciochon

Biological Sciences
Stephen B. Heard
Stephen D. Hendrix
Diana G. Horton
John D. Nason

Chemical and Biochemical Engineering
Gregory R. Carmichael

Chemistry
Vicki H. Grassian
Sarah C. Larsen
Josef B. Simeonsson

Civil & Environmental Engineering
Pedro J. Alvarez
A. Allen Bradley
William E. Eichinger
Robert Ettema
Keri C. Hornbuckle
Witold F. Krajewski
Lou Licht
Wilfrid A. Nixon
A. Jacob Odgaard
Gene F. Parkin
Michelle Scherer
Jerald L. Schnoor
Richard L. Valentine

Economics
Thomas F. Pogue
John L. Solow

Electron Spin Resonance Facility
Garry R. Buettner

Geography
Marc P. Armstrong
George M. Malanson
David L. McGinnis
Michael L. McNulty
Tad Mutersbaugh
Claire E. Pavlik
R. Rajagopal
Rebecca S. Roberts
Gerard Rushton

Geology
Richard G. Baker
E. Arthur Bettis
Robert S. Carmichael
Lon D. Drake
Luis Gonzalez
Gregory A. Ludvigson
Mark K. Reagan
Holmes A. Semken, Jr.
Frank H. Weirich
You-Kuan Zhang

History
Paul R. Greenough

Law
Burns H. Weston

Mechanical Engineering
V.C. Patel
Theodore F. Smith

Microbiology
Lacy Daniels

Physics & Astronomy
John D. Fix
Louis A. Frank
Donald A. Gurnett
Thomas C. Hasenberg
John S. Neff
Steven R. Spangler

Physiology & Biophysics
G. Edgar Folk

Preventive Medicine & Environmental Health
Peter S. Thorne

Public Policy Center
David J. Forkenbrock

Statistics & Actuarial Science
Dale L. Zimmerman

Iowa State University

Agronomy
Raymond W. Arritt

Animal Ecology
Diane M. Debinski

Botany
James W. Raich

Geological & Atmospheric Sciences
William J. Gutowski
Eugene S. Takle

Hydrologic Research Center, San Diego, CA
Konstantine P. Georgakakos

The University of Iowa's Center for Global and Regional Environmental Research (CGRER) promotes interdisciplinary efforts that focus on the multiple aspects of global environmental change, including its regional effects on natural ecosystems, environments, and resources, and on human health, culture, and social systems. Center membership is composed of interested faculty members at any of Iowa's colleges and universities.

Center goals are promoted by encouraging interdisciplinary research and dialogue among individuals whose disciplines touch upon any of the multifaceted aspects of global change. More specifically, the Center awards seed grants, fosters interdisciplinary courses, provides state-of-the-art research facilities and equipment, and holds seminars and symposia. The Center encourages students to broaden their studies and research through considering the multi-disciplinary aspects of global and regional environmental problems. Through such activities, the Center attempts to assist Iowa's agencies, industries, and citizens as they prepare for accelerated environmental change that may accompany modern technologies.

Housed in the Iowa Advanced Technology Laboratory at the University of Iowa, the Center was established by the State Board of Regents in 1990 and received funding from a public utility trust fund, as mandated by the State of Iowa's Energy Efficiency Act.

IoWatch is published each fall. Comments, questions, and requests for additional copies should be directed to:

Jane Frank, Admin. Asst.
CGRER
The University of Iowa, 204 IATL
Iowa City, Iowa 52242
319-335-3333
FAX 319-335-3337
jfrank@cgrer.uiowa.edu
http: www.cgrer.uiowa.edu/

Written and edited by Connie Mutel
Designed by The University of Iowa Printing Department
Illustrations by Claudia McGehee
10718/10-99

Printed on Recycled Paper

IOWATCH

THE CENTER FOR GLOBAL AND REGIONAL ENVIRONMENTAL RESEARCH