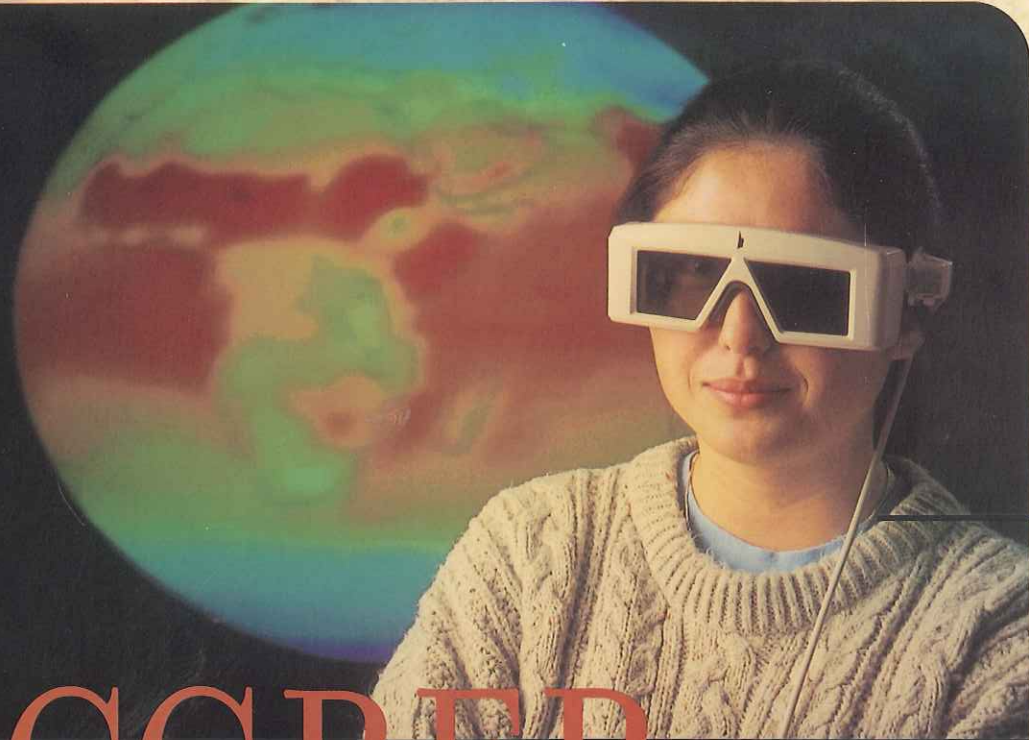


THE CENTER FOR GLOBAL AND REGIONAL ENVIRONMENTAL RESEARCH



1999

ANNUAL REPORT

CGRER

THE UNIVERSITY OF IOWA

THE CENTER FOR GLOBAL AND REGIONAL ENVIRONMENTAL RESEARCH

The Center for Global and Regional Environmental Research — CGRER — was established in 1990 with the intent of promoting interdisciplinary efforts that focus on global environmental change. Housed on the University of Iowa campus in the Iowa Advanced Technology Laboratory, CGRER is supported by revenues generated from public utilities, as mandated by the State of Iowa's Energy Efficiency Act. Funds are used to support research and provide services to faculty members and students across the state who are interested in environmental change. CGRER membership consists of faculty and professional staff members from Iowa's colleges and universities. CGRER currently is composed of 65 members from 22 departments.

While environmental change is constant and natural, CGRER focuses on the human-induced *acceleration* of such change caused by modern technologies. Concerns about global change encompass multiple issues including its effects on natural ecosystems, environments, and resources, and on human health, culture, and social systems. Because global change promises to touch virtually every aspect of life and require the interpretation of many fields of science and engineering, the humanities, medicine, and law, an understanding of global change requires collaborative efforts among the many disciplines involved. CGRER's mission is to foster such collaborative interdisciplinary actions in three ways:

- by promoting dialogue among specialists and agencies,
- by educating students and the general public, and
- by fostering and supporting relevant research projects.

This annual report summarizes CGRER's activities in each of these three areas. Because CGRER's output is commensurate with that of its many members, a summary of which would require a small book, this annual report includes only a sampling of significant projects and efforts. Yet this sampling provides a vision of CGRER's multiple efforts to achieve its ultimate goal: assisting Iowa's agencies, industries, and citizens to assess and prepare for global change and its effects.

EXECUTIVE SUMMARY

In this Annual Report for 1999, we relate some of CCRER's many activities in the areas of research, education, and outreach dialogue. Our primary mission continues to be that of promoting interdisciplinary research with a focus on environmental change at the regional and global scale, research that includes features of natural ecosystems, agroecosystems, engineered environments, and human dimensions of global change. We sponsor research through the seed grant program; we initiate and write new research proposals for external funding; and we collaborate with other universities to forge new alliances with multidisciplinary expertise to attract research support.

Four seed grants were awarded by CCRER in 1999 to researchers at Iowa and Iowa State University. These seed grants will allow examinations of the details of ancient climates and global climate models; they also will fund the establishment of two research

facilities, an Iowa Atmospheric Measurement Station and an atmospheric reaction chamber.

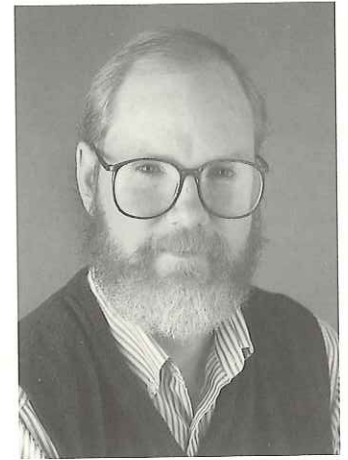
Research continued on Phases 2 and 3 of the Greenhouse Gas Action Plan for the State of Iowa. Several related projects have been sponsored by the U.S. Environmental Protection Agency and funded through the Iowa Department of Natural Resources, Energy Bureau. Phase 1 focused on developing Iowa's Greenhouse Gas Action Plan. In Phase 2, a series of public meetings with agricultural

specialists and farmers was held to determine how to reduce Iowa's agriculturally-generated greenhouse gas (GHG) emissions. (Since agriculture contributes more than 20% of the emissions in question, agricultural practices could potentially profit from GHG emission reductions). Phase 3 is attempting to implement one of the ideas in the Action Plan:



Jerald L. Schnoor

setting the stage for a carbon trading and verification scheme in Iowa, so that farmers and others will receive carbon credits if they sequester carbon dioxide



Gregory R. Carmichael

Professor Paul Greenough. Sometimes it is difficult to state with words, or even with pictures, the great amount of good done through human interactions in a remote but

SOMETIMES IT IS DIFFICULT TO STATE WITH WORDS, OR EVEN WITH PICTURES, THE GREAT AMOUNT OF GOOD DONE THROUGH HUMAN INTERACTIONS IN A REMOTE BUT IMPORTANT PLACE SUCH AS NEPAL.

from the atmosphere, capture methane at hog lots, or plant riparian zone buffer strips to incorporate more carbon into Iowa's rich soils.

In this annual report, you will learn about a wonderful educational trip taken by faculty and students to Nepal, a trip sponsored by a Fulbright-Hays Group Projects Abroad grant to

important place such as Nepal. The group's participants are certainly more knowledgeable and also humbled by the experiences of this trip, which focused on the precious commodity water.

Dialogue with community leaders and researchers takes many forms. In 1999, it included a CCRER-sponsored symposium entitled "The Science of Global Climate Change," held in Iowa City in

March. Approximately 200 people attended from all over the state and nation. Both sides of the climate story were presented: 1) the theory that global warming is real, formidable, and at least partially caused by human activities, and 2) the concept that if any warming has occurred, it is quite probably caused by natural perturbations in Earth-surface processes. We did not resolve that debate, but the divergent opinions certainly were laid out plainly for policymakers and citizens to see.

Dialogue also included a dozen outside researchers presenting CGRER seminars and over fifty talks to community groups throughout the state on environmental change.

We are pleased to conclude that research activities at CGRER are leading to an enhanced research portfolio in the State of Iowa. More universities and colleges are interested in and collaborating on research

related to environmental change than ever before. In 1999, CGRER researchers accounted for over \$16 million in external funding through the leveraging of \$443,000 in state funding. We are grateful for the support of the state, and we pledge to meet our obligations as research leaders in coming years.

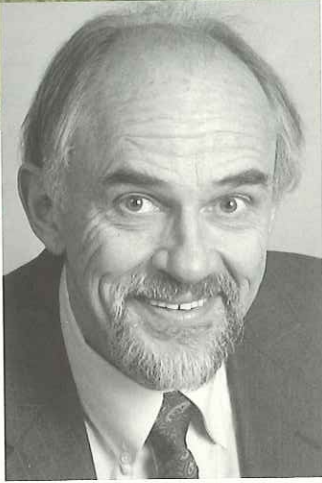

Gerald L. Schnoor
Co-director


Gregory R. Carmichael
Co-director



In October 1999, CGRER co-director Jerry Schnoor received one of engineering's highest honors. He was inducted into the prestigious National Academy of Engineering (NAE). Schnoor (center), shown here with NAE president William Wulf and NAE chair Robert Eaton, was cited for "research and engineering leadership in development, validation, and utilization of mathematical models for global environmental decision-making." As an NAE member, he will consult with the government and the National Research Council on these subject areas.

MESSAGE FROM THE ADVISORY BOARD



Anniversaries are sprouting everywhere as we close the millennium, and CGRER has its own. The year 2000 will mark the tenth year of the state-created, novel funding stream that supports this center. Iowa's 1990 Energy Efficiency Act designated that one-tenth of one percent of all gas and electric utility bills be used to fund CGRER and the Iowa Energy Center at Iowa State University.

Since electricity generation produces about a third of all U.S. greenhouse gas emissions, this assessment on utilities is a logical source of funding for research on global warming. As the state contemplates a deregulation or restructuring law for the electric power industry, the funding for CGRER has been included in all drafts of the proposed bill. This inclusion is one mark of CGRER's success.

During the last year, CGRER has continued to pursue its mission to investigate the consequences of accelerated global climate change as well as ways to address the problem. CGRER has been engaged in research to measure the possibility of sequestering carbon in Iowa's soils. Work is proceeding on the next phase of a greenhouse gas reduction plan for the state.

CGRER also works to educate others about global change issues, an effort exemplified by a CGRER-sponsored symposium last spring that brought many of the nation's best climate scientists to Iowa City.

CGRER remains committed to giving policymakers in Iowa information about global change issues. I feel that the state's investment in this center is paying great dividends.

A handwritten signature in black ink, appearing to read "David Osterberg".

David Osterberg
Environmental Consultant
Iowa Department of Natural Resources

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Natural Resources

Dorothy Paul
United Nations Association,
Iowa Division

CGRER PROMOTES INTERDISCIPLINARY DIALOGUE TO ADDRESS IOWA'S NEEDS

CGRER facilitates discourse among researchers and students concerned with the complex, interdisciplinary nature of global change problems. In 1999, the sharing of thoughts and techniques among individuals and disciplines was promoted through a CGRER-sponsored trip to Nepal, as well as through seminars and visits from researchers from other institutions and countries.

Nepal Sojourn

CGRER received a Fulbright-Hays Group Projects Abroad grant to fund a 30-day travel seminar to Nepal in June-July 1999. This \$52,000 grant allowed a dozen University of Iowa faculty/staff and students to tour urban and rural sites throughout central Nepal, focusing all the while on the multifaceted aspects of drinking-water programs and problems. The grant proposal was developed and the tour was led by historian Paul Greenough, a member of CGRER's Executive Committee. Anthropologist Mike Chibnik, geologist Luis

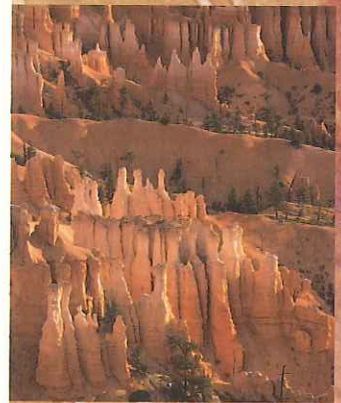
Gonzalez, and *IoWatch* editor Connie Mutel accompanied Greenough, as did eight graduate students from a variety of disciplines (American studies, international studies and Third World development, public health, engineering, geology, and geography).

Participants toured a variety of sites (mountains and lowland plains, city water plants and village wells, research institutes and educational centers, polluting industries and simple water purification schemes...) and spoke with a variety of people (water users and water providers, governmental bureaucrats and non-governmental organization directors, villagers and city residents). This broad-based learning, and the interdisciplinary dialogue that it stimulated among the group's participants, lay at the core of the trip's intended purpose: to focus a diverse array of scholars on a single issue, in a setting that lacked routine distractions. By doing so, the trip strove to engender the interdisciplinary melding of

ideas and approaches so critically important to dealing with complex global change problems, which are commonly rooted in human culture and activities.

A more detailed description of the trip, its outcomes, and Nepal's drinking-water situation has been included in the Fall 1999 *IoWatch*.

This trip meshes well with CGRER's ongoing efforts in Nepal. Dr. Sharad Adhikary, director of Nepal's Himalayan Climate Center (HCC), hosted the travel seminar and made many of the group's local arrangements. CGRER is committed to joint efforts with the HCC, and Dr. Adhikary has visited CGRER several times. CGRER's Greg Carmichael and Luis Gonzalez have current research projects in Nepal, and Jerry Schnoor is assisting with broadening Nepal's engineering curricula. This tour promises to spawn additional Nepal-based research efforts among the trip's participants.





UI participants in a travel seminar to Nepal learned a great deal about the complex problems associated with the provision and quality of drinking water in this developing nation. Here they examine a rural water supply system.

Visiting Researchers

Thirteen visitors appeared at CGRER's doors in 1999. Most were associated with Greg Carmichael's efforts to understand air-pollutant transport and acid deposition in Asia.

Jasim Ahmad, coordinator of the Center for Environmental Studies, Jahangirnagar University, Bangladesh, visited CGRER to explore ways to establish strategic linkages between the two centers.

Giuseppe Calori

(a research scientist from the Polytechnical University of Milan) resided in Iowa City

for the entire year to work on two ongoing CGRER projects. He modeled the interannual variability of acid deposition in Asia (looking at the effects of weather changes on deposition). He also helped to organize and conduct a study in which eight different numerical models in use in Asia were compared to determine how they vary in their estimates of the transport of air pollution (and resulting acid deposition) from one Asian country to another.

Hsu-Cherng Chiang and Luke Chen (environmental engineering professors from Tamkang University in Taiwan) both came to Iowa

City for a week to adapt a large-scale Asian acid deposition model to small-scale use in Taiwan.

Seog Yeon Cho (an environmental engineering professor at Inha University, South Korea) spent the entire year at CGRER, extending the capabilities of a comprehensive air pollution modeling system and completing an air pollution forecasting system for Seoul.

Corinne Galy-Lacaux (of the Aerological Laboratory at the University of Paul Sabatier) returned to France in February 1999, completing a four-month collaborative effort to model data on acid deposition in Africa.

Tracey Holloway (a doctoral student from Princeton University) visited Iowa City for a week in April to work on her thesis by modifying numerical models to include the effects of increasing numbers of internal combustion engines on nitric acid release and acid deposition in Asia.

Hans Peter Kohler

(an environmental microbiologist from the Swiss Federal Institute of Technology) returned to Zurich in July 1999, completing a year-long examination of natural degradation patterns of chiral molecules, elements of synthetic organic pesticides.

Y.C. Lee (a doctoral candidate and employee of the Environmental Protection Agency in Hong Kong) was here for a week to discuss the long-range transport of air pollutants in Asia and to model the specific impacts of imported air pollutants on Hong Kong.

Changsheng Li (research scientist at the Complex Systems Research Center, University of New Hampshire), in a brief visit to CGRER, worked to interface his model of farming practices and carbon and ammonia storage in (as well as emissions from) the soil with CGRER models of atmospheric chemistry and transport. The coupling of the models will allow a more comprehensive trace of the fate of nitrogen emissions through air pollution feedback channels.

Mark Milke (professor of environmental engineering at the University of Canterbury, Christchurch, NZ) came to CGRER for four months to consult with Jerry Schnoor about an introduction to environmental engineering textbook that Milke is writing.

Yifen Pu (a research scientist at Beijing's Centre for Environmentally Sound Technology Transfer) came to Iowa City for one day during a longer stint at Argonne National Laboratory, to discuss and coordinate the Chinese estimates of air pollution emissions used in numerical models of long-range pollutant transport.

Sjaak Slanina (chief of the environmental group at ECN, The Netherlands, and professor at Beijing University) visited CGRER several times in 1999 to establish a collaborative study that will assess the effects of aerosols on climate and air pollution in China.



CGRER Seminars, 1999

Speaker	Affiliation	Title of Seminar
Glenn Goodfriend	Department of Geology, George Washington University	Holocene Climate History of the Southern Great Plains, Based on Stable Isotopes in Snail Shells from Archaeological Sites
Lee Kump	Earth System Science Center, Pennsylvania State University	Glacial Events During Greenhouse Periods: An Example from the Ordovician
Changsheng Li	Institute for the Study of Earth, Oceans, and Space, University of New Hampshire	Modeling Nitrous Oxide Emissions at Regional Scale
Greg Ludvigson	Department of Geoscience, University of Iowa	Assessment of Cretaceous "Greenhouse World": Insights from Continental Isotopic Records
Peter McMurry	Department of Mechanical Engineering, University of Minnesota	Physical Chemical Properties of Atmospheric Aerosols
Mark Milke	Department of Civil Engineering, University of Canterbury, New Zealand	Landfill Gas: Progress and Prospects
Arthur Murphy	Department of Anthropology, Georgia State University	Socioeconomic Impacts of Hurricane Paulina on Mexico's Pacific Coast
Jeffrey A. Nystuen	Applied Physics Laboratory, University of Washington	Rainfall Measurements Using Underwater Sound
James R. O'Neil	University of Michigan, Professor Emeritus	180/160 Variations in Biogenic Phosphate: Application to Paleobiology and Paleoclimatology
Kenneth Rahn	Center for Atmospheric Chemistry Studies, University of Rhode Island	Some Thoughts On Whether China's Aerosols Could Have Regional Elemental Signatures
Beverly Z. Saylor	Department of Geological Sciences, Case Western Reserve University	Global Events in Terminal Proterozoic Earth History: The Kalahari Perspective
Eric Weber	National Exposure Research Laboratory, U.S. Environmental Protection Agency	Reductive Transformations of Organic Pollutants in Anoxic Environments: Development of Predictive Models

Look For Yourself



CGRER's home page provides considerable information on topics such as pollutant distribution and atmospheric models. It is also an excellent way to keep up with CGRER research projects, seminars, and other activities. Tune in at <http://www.cgrer.uiowa.edu/>

CGRER PROVIDES EDUCATION TO ADDRESS IOWA'S NEEDS

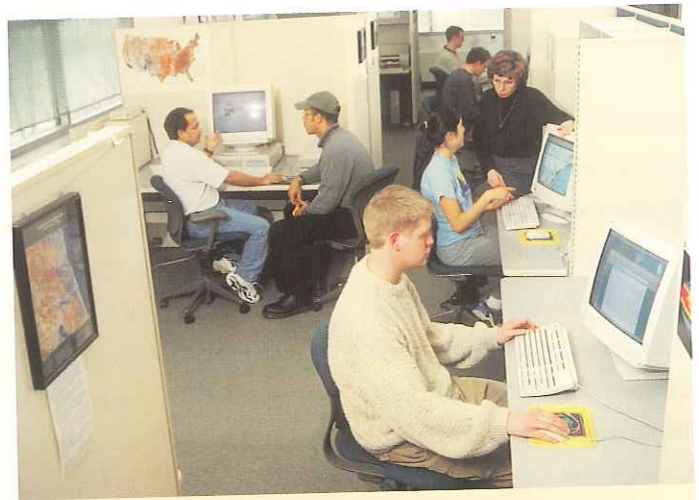
CGRER trains tomorrow's experts to deal with broad-scope, multifaceted global change problems. In 1999, approximately 18 masters degrees and 14 doctoral degrees were awarded to students working with CGRER members.

CGRER's members and activities also encouraged many other students, a variety of professionals, and the lay public to consider the multidisciplinary aspects of change-related environmental problems. Co-director Jerry Schnoor may win the prize for the largest number of public lectures: in 1999, he made about sixty presentations on global change issues and sustainable development to diverse groups across the Midwest that are outside the University campus. As a Sigma Xi Distinguished Lecturer, he

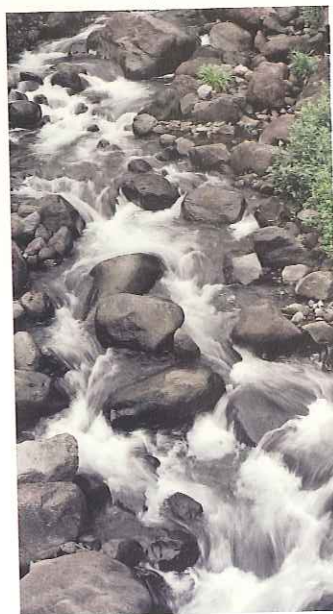
gave a dozen additional talks about global change and phytoremediation on campuses across the U.S.

A CGRER-sponsored climate-change symposium fulfilled its educational goal of "promoting dialogue with students and the general public through a review of what is known about climate change and its impacts and identifying current research frontiers." CGRER's newsletter *IoWatch* (which in 1999 focussed on educational efforts for global change issues) reaches both professionals and the lay public and serves a similar educational function.

In 1999, CGRER agreed to become one of four sites to offer geographical information system (GIS) training to the broader University of Iowa community (see photo). Doing so promises to make CGRER's computer laboratory a major campus training site.



In 1999, CGRER agreed to become one of four sites on the University of Iowa campus to train UI faculty, staff, and students in the use of GIS software. The demand for use of versatile GIS programs such as ArcView and ArcInfo is steadily increasing. Through an institution-wide site license with the Environmental Systems Research Institute, CGRER has become committed to installing software and offering short courses and training materials that will make increasingly-popular GIS programs accessible to a broad constituency across campus.



CGRER-Sponsored Climate Change Symposium

In 1999, the Iowa United Nations Association held a year-long program entitled "Taking On the Challenge of Climate Change." CGRER was instrumental in planning the first of four sessions, "The Science of Global Climate Change: The State-of-the-Science." This one-day symposium, held March 5 on the University of Iowa campus, was organized by geographer George Malanson, a member of CGRER's Executive Committee. About a dozen renowned scientists from across the country (including, for example, ecologist Margaret Davis from the University of Minnesota, meteorologist Richard Lindzen from MIT, and EPA's Global Change Research Program director Joel Scheraga) spoke about research efforts that help us understand past climates and today's climate models, and about our resulting ability to read future climate changes and their impacts.

The symposium, which drew attendees from the general populace as well as students, faculty, and staff, served well to summarize current understandings of climate change for the lay public as well as technical experts. By doing so, it worked toward the program's overall goal: creating a broad-based debate, and finding a common ground, for an Iowa future that is both economically and environmentally sustainable.

CGRER was also involved with other segments of the larger program. Jerry Schnoor spoke at the third session (the "Iowa All Energy Expo" held in Cedar Rapids in September), and David McGinnis spoke at the concluding session ("A Public Hearing Seeking Innovative Solutions," held at our State Capitol in November). CGRER also co-sponsored this final session.



CGRER FOSTERS GLOBAL CHANGE RESEARCH TO ADDRESS IOWA'S NEEDS

CGRER fosters research that deepens our understanding of global change issues and strengthens our ability to deal with resulting problems. Research projects are advanced through the seed grants that CGRER awards, as well as through grants from other sources that are received by CGRER itself or by CGRER's 65 members. Incoming grants have been both diverse and prodigious: since CGRER's formation in 1992, members have brought in over \$33.5 million of external funding. CGRER also provides state-of-the-art research facilities and equipment to its members and their students.

CGRER-Sponsored Research

CGRER awarded four seed grants for the period 8/1/99 to 7/31/2000. The grants, summarized below, are described in more detail in the Fall 1999 *IoWatch*. Each grant was intended to foster the commencement of significant environmental research that could then pull in new funding for project continuation.

Raymond Arritt, an agricultural meteorologist at Iowa State University, received \$19,172 for examining the ability of mathematical global climate models to simulate regional climatic fluctuations. If the global models are able to capture the general behavior of regional fluctuations, then output from global models can be used as input for regional models to provide more detail.

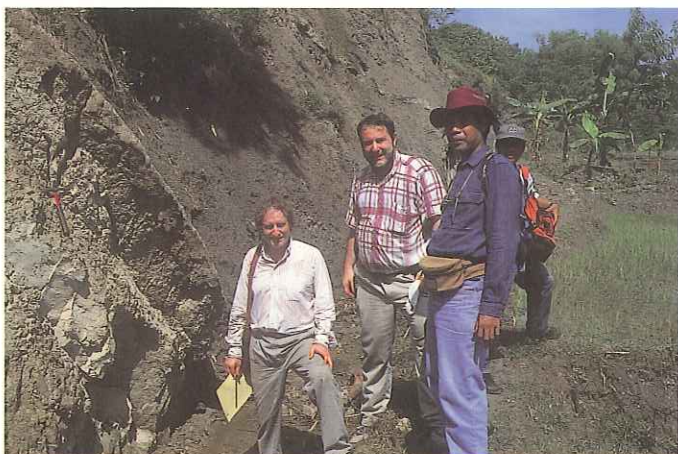
Luis Gonzalez and Greg Ludvigson, geologists at the University of Iowa, received \$17,055 to investigate the formation of sphaerosiderites (tiny nuggets of the mineral siderite that are present in wetland soils). Understanding the growth of these nuggets in the distant past may enhance our understanding both of ancient environments and of the impacts of climate change. This research will be performed in the Paul H. Nelson Stable Isotope Laboratory, which also has received CGRER funding (see photo, page 13).

Keri Hornbuckle and Bill Eichinger (UI, Civil and Environmental Engineering and Iowa Institute of Hydraulic Research) received \$20,000 to establish an Iowa Atmospheric Measurement Station. The permanent station will house sophisticated equipment for the long-term, fine-tuned monitoring of specific atmospheric and climatic

traits, such as the fluxes and relative concentrations of organic pollutants moving between the earth and atmosphere. The station will provide a training and research tool for researchers in multiple disciplines.

Mark Young, chemist at the University of Iowa, received \$19,856 to complete an atmospheric reaction chamber on the UI campus and initiate its use. The chamber will be dedicated to detailed analyses of interactions between atmospheric gases and aerosolized mineral particles that are potentially significant to climate change. Interdisciplinary research utilizing the chamber will involve several other UI scientists, including Paul Kleiber (Physics and Astronomy), Vicki Grassian (Chemistry), and Greg Carmichael (Chemical and Biochemical Engineering).





In 1998, CGRER awarded UI anthropologist Russell Ciochon (shown here with archaeologist Roy Larick on left and geologist Yahdi Zaim on right) a seed grant that partially funded his travel to Java, where he investigated the environmental context and use of tools of Asia's first human inhabitants. The many spin-offs of that original \$5560 grant demonstrate the multiple results possible when seed grants are invested wisely. During his two research expeditions to Java, Ciochon was able to establish a formal agreement for collaborative investigations with Java's Institute Technology Bandung. His research expanded to encompass the paleoenvironmental history of central Java. In particular, he now is asking when Java's volcano-derived habitats became inhabitable and when humans first colonized the scene. His work currently embraces the efforts of Javanese, Dutch, and U.S. colleagues, including CGRER member and geologist Mark Reagan, who is analyzing the project's volcanic rock samples. *Natural History Magazine* (July-August, 1999 edition) has already published one article on his studies, as have professional journals in Java and the U.S.

CGRER Research Focus: Controlling Iowa's Greenhouse Gas Emissions

In the year 2000, Iowa will emit an estimated 93 million tons of CO₂ (up 6 million tons from a decade ago), a quantity several times the amount captured annually by the state's plants and soils.

These rising atmospheric CO₂ levels may contribute to global climate change. Since 1994, CGRER has been receiving U.S. Environmental Protection Agency (EPA) funding, routed through the Iowa Department of Natural Resources, for projects related to the control of greenhouse gases and their negative effects. Specific efforts funded through this larger initiative are outlined below.

One such CGRER project (completed in 1999 by Richard Ney and Jerry Schnoor) has examined the environmental impacts of burning switchgrass to generate electricity (see photo, page 12). CGRER determined that the growing, harvesting, and substitution of switchgrass for 5% of the coal normally burned in Iowa's Ottumwa Generating

Station may reduce CO₂ emissions by 177,000 tons per year. The precursor to acid rain, SO₂, would also decrease significantly. The next step is to perform a trial switchgrass burn, an effort scheduled for the winter of 2000-2001.

Agriculture accounts for about a fifth of Iowa's release of greenhouse gases. In 1999, CGRER's Malva Mancuso and Jerry Schnoor completed a literature review of the impacts of global climate change on Iowa's agriculture. The 36-page summary report outlines agricultural sources of greenhouse gases and also details the benefits and potential techniques for managing and reducing agricultural gas emissions.

Outlining greenhouse gas reduction techniques is a far cry from actually reducing gas emissions. Accomplishing the latter requires

techniques that are both feasible and acceptable to producers. In a third 1999 CGRER project, Karen Mumford and Cheryl Contant organized workshops and invited individuals involved in agriculture to discuss strategies for reducing agriculturally-generated greenhouse gases, barriers and incentives for adopting these strategies, and future research needs. Workshop participants pinpointed and ranked a number of helpful gas-reducing activities, such as improving the integration of crop and livestock production and developing farm-level models for validation of carbon sequestration efforts.

CGRER also commenced a new two-year project, one intended to position Iowa for the trading of carbon credits should these credits emerge as economically viable options in the near future. Basically, this new project focuses on developing methods to evaluate the quantity of carbon that

farmers are removing from the air through specified farming practices, so that farmers could be reimbursed for their sequestration of carbon in green plants or in the soil. To this end, Jerry Schnoor and Richard Ney have prepared preliminary maps of the state's current soil carbon levels and of the flux in carbon (both in and above the soil) between the mid-1970s and 1990. They are currently engaged in a case study to determine how farmers can assess and certify changes in their farm's stored carbon. And they are just beginning to examine potential land use scenarios for Iowa for the next 50 years, and to evaluate how the outlined scenarios would affect carbon sequestration.

CGRER Research Focus: Understanding Airborne Pollution

A variety of efforts contributed to CGRER's continuing attempts to decipher the flow and deposition of Earth's atmospheric gases and pollutants. CGRER's 1999 completion of the NASA-funded China-MAP study (carried out jointly with Georgia Tech, Argonne



Partial replacement of coal with switchgrass as fuel for the generation of electricity could decrease greenhouse gases and acid rain, produce other environmental benefits such as reducing soil erosion and improving wildlife habitat, and create a new market crop for Iowa's farmers.

National Laboratory, the Geophysical Fluid Dynamics Laboratory, NCAR, and a host of Chinese institutions) yielded some unexpected results. This research examined China's changing greenhouse gas and pollution emissions, their direct effects on climate, and their indirect effects on agriculture. While complex computer models calculated that

aerosols could indeed alter agricultural potential by cooling the atmosphere, a larger and more direct connection was found through a straightforward calculation of aerosols' scattering of visible light. This scattering decreases the photosynthetic energy reaching plant surfaces by a full 25%, potentially causing a significant decline in photosynthesis and crop

productivity. "This study illustrates today's global connectivity," stated co-principal investigator Greg Carmichael. "If rising aerosol emissions in China decrease that country's ability to feed its billion-plus citizens, China's resulting purchase of crops on the world market would affect Iowa's farm economy in a major way."

The year found CGRER at the midpoints of two ongoing research efforts. The Japan Trust of the World Bank has been funding a study of potential mixes of fuels and technologies that Asia could use to meet its future energy demands, along with an assessment of resulting health and environmental risks. And the U.S. Department of Energy Atmospheric Chemistry Program has been funding an investigation of the complex interactions of aerosol surfaces and natural processes in oxidant cycles leading to ozone production. Two CGRER post-doctoral research associates, Ping Li and Grant Underwood, have been assisting with the latter

study. Both projects were described in more depth in CGRER's 1998 annual report.

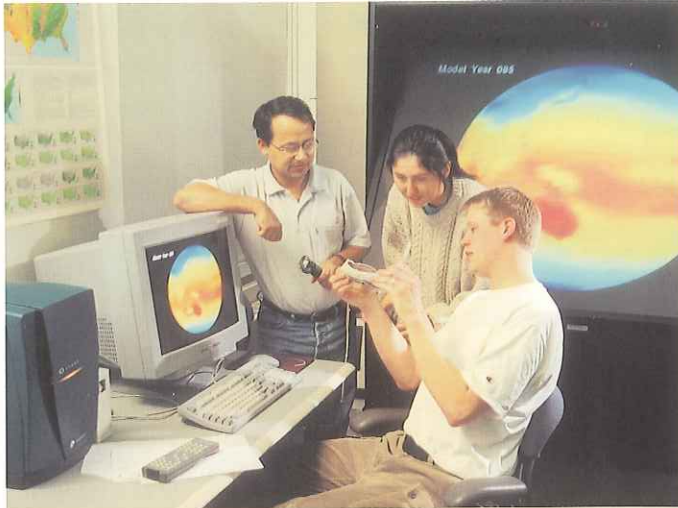
CGRER also commenced two new atmosphere-related projects in 1999. The U.S. Department of Energy has awarded CGRER and Argonne National Laboratory funding for a one-year preliminary integrated assessment of energy, policy, and environmental impacts in Asia. The project aims at designing a computer model that could be easily applied to science-based energy decisions by Asian policymakers. More specifically, this model would allow policy makers to look simultaneously at air pollution and greenhouse gas scenarios and to decide what control measures would yield the most beneficial results: how would the environmental benefits of controlling local emissions (such as sulfur dioxides) compare with benefits of regional and global efforts to limit greenhouse gas emissions?

The World Meteorological Organization (WMO) in 1999 awarded CGRER a grant to provide scientific guidance to a new research program

focusing on urban environments. Greg Carmichael will chair an advisory group that will assess how the WMO can develop pilot projects aimed at technology transfer, management tools, and other such aids for assisting developing countries with air- and water-related environmental problems in urban environments.



The Paul H. Nelson Stable Isotope Laboratory held its grand opening on November 3, 1999. A seminar presented by the world-renowned isotope geochemist James O'Neil was followed by a reception and laboratory tours. CGRER has supported the establishment of this laboratory through funding equipment acquisition and through making a five-year commitment to assist with laboratory administration. CGRER also has helped support Timothy White, a post-doctoral research associate whose investigations focus on using the laboratory for his Cretaceous paleoclimatic research. And lastly, CGRER has awarded a seed grant for one of the laboratory's major new research initiatives (see "CGRER-Sponsored Research," page 10).



CGRER's ImmersaDesk, a virtual reality research tool that displays gridded numerical data sets as three-dimensional images that change over time, allows researchers to "immerse" themselves in complex mathematical models of the changing natural world. The ImmersaDesk is used primarily to visualize wind patterns and pollutant dispersion in the atmosphere.

CGRER's Aids to Researchers

The Iowa Advanced Technology Laboratories on the University of Iowa campus continue to provide office, meeting, and laboratory space to CGRER members. CGRER offers an increasing number of additional facilities to researchers who investigate a variety of global change questions. Three of 1999's seed grants (see "CGRER-Sponsored Research," page 10) will enable CGRER members to develop or use new research facilities: the Paul H. Nelson Stable Isotope Laboratory (see photo, page 13), the Iowa Atmospheric Measurement Station, and a UI atmospheric reaction chamber. CGRER also offers members equipment such as a mapping-grade global positioning system (GPS) and outdoor stations for field-related teaching and research.

CGRER's GIS and visualization computer laboratory, which houses a variety of computer equipment, was updated in 1999 through the addition of a second server. The HP Visualize B-1000, installed in November, is faster and also more reliable than the

previous server (which is still being used as a compute server). Use of CGRER's ImmersaDesk (see photo) and additional projects that interface GIS with other computer software are placing CGRER at the cutting edge of visual display technologies.

The departure of computer laboratory manager Glenn Larson in June led to the hiring of his replacement, Jeremie Moen. Moen, who graduated from the University of Iowa in May 1999 with a bachelor's degree in geography (environmental studies emphasis) and extensive studies in meteorology, is looking forward to helping CGRER member David McGinnis develop a CGRER-based weather page for the UI that will import and present real-time data from federal institutes such as NCAR. Moen also is excited about participating in the Environmental Systems Research Institute's professional training sessions, which will enable him to teach GIS techniques effectively to graduate students.

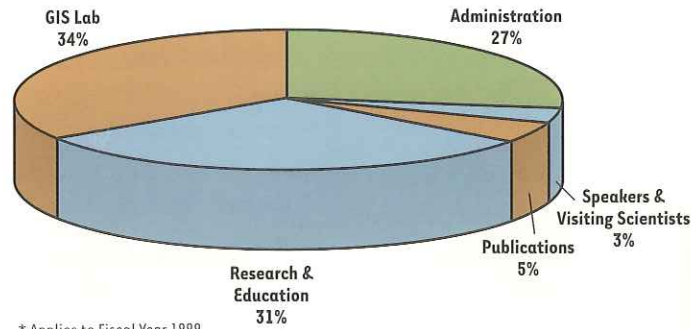
GENERAL INFORMATION

Budget

In fiscal year 1999 (July 1, 1998- June 30, 1999), nearly three-fourths of CGRER's \$443,090 of funding was spent on research, education, and outreach directed toward global change issues (Figure 1). Administrative costs consumed the remaining quarter of the budget.

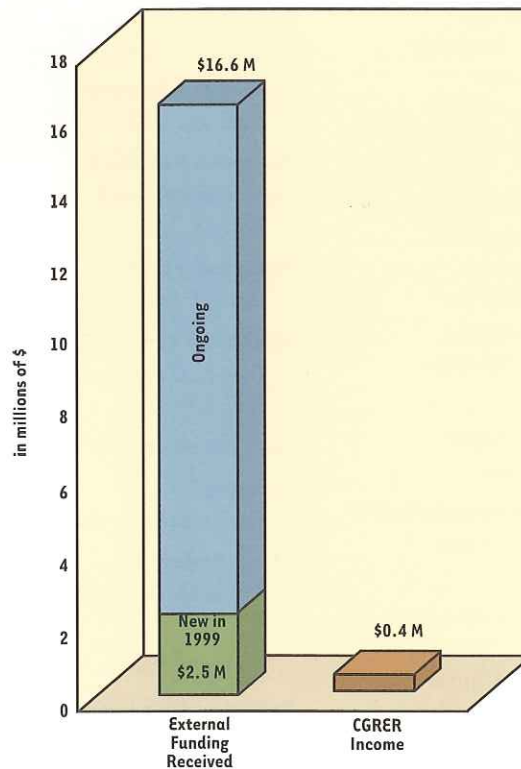
This funding, received in total from an assessment on Iowa's gas and electric utilities through the State Department of Commerce, was magnified many times in the millions of dollars of external grants and contracts awarded to CGRER members (Figure 2). In calendar year 1999, CGRER members were performing research that brought in a total of \$16.6 million in external funds. This included both those grants awarded to CGRER directly and other grants awarded to CGRER members through their respective departments. Of this amount, \$2.5 million was new funding that was initiated in 1999, while the remaining \$14.1 million came from ongoing projects.

Figure 1. CGRER'S Expenses*



* Applies to Fiscal Year 1999

Figure 2. 1999 Leveraging of CGRER'S Income*



* Applies to Calendar Year 1999

Administration and Membership

CGRER is directed by University of Iowa professors Gregory Carmichael (Department of Chemical and Biochemical Engineering) and Jerald Schnoor (Department of Civil and Environmental Engineering). Center activities are guided by an elected Executive Committee that consists of ten members plus the two co-directors. The Executive Committee meets monthly to plan initiatives and chart CGRER's course. An Advisory Board of eight members from outside the academic community meets annually to lend oversight to CGRER's activities (see page 4 for Advisory Board members).

Since 1992, CGRER has employed two full-time staff members. Administrative assistant Jane Frank oversees office operations. Jeremie Moen manages CGRER's computer facilities with the aid of services contracted from the Iowa Computer Aided Engineering Network. CGRER reports directly to the UI's Vice President for Research, Dr. David Skorton.

CGRER Members

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

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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

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

Geology

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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

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* Paul R. Greenough

Law

Burns H. Weston

Mechanical Engineering

V.C. Patel
Theodore F. Smith

Microbiology

Lacy Daniels

Physics & Astronomy

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

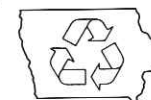
Geological & Atmospheric Sciences

William J. Gutowski
Eugene S. Takle

Hydrologic Research Center, San Diego, CA

Konstantine P. Georgakakos

* Executive Committee
Members



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