THE CENTER FOR GLOBAL & REGIONAL ENVIRONMENTAL RESEARCH

GRER

2020 ANNUAL REPORT

(photo by Celine Hartwig)

WWW.CGRER.UIOWA.EDU

The names of CGRER members and those affiliated with CGRER are highlighted in boldface throughout this report.

Cover photo: Damage to grain silos by the 2020 derecho. (photo by Celine Hartwig)

Top: Earth (photo by NASA)

This page: CGRER is housed in the Iowa Advanced Technology Laboratories on the University of Iowa campus. (photo by Mary Moye-Rowley)

Photo page 1: Solar panels in Iowa damaged by the August 2020 derecho. (photo by Amy Infelt)

CGRER

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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 Laboratories, CGRER is supported by the rate-payers and utilities of Iowa, a program begun by the State of Iowa's Energy Efficiency Act of 1990. Funds are used to support research and provide services to faculty members and students across the state who are interested in environmental change.

While environmental change is constant and natural, CGRER focuses on the human-induced acceleration of such change caused by modern technologies, lifestyles and population growth. 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 requires the reinterpretation of many fields of science and engineering, the humanities, health 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 in assessing and preparing for global change and its effects.

promote dialogue among specialists and agencies

educate students and the general public

foster and support relevant research projects

EXECUTIVE SUMMARY

The year 2020 reminded us that the world is a fragile place. The COVID-19 pandemic, the defining global health crisis of our time, impacted all of us at home and at work. As we prepare this report, amidst continued pandemic disruptions, we are also reminded of the resilience CGRER members, students, and staff have shown in response to the challenges presented.

Arguably the most important legacy of CGRER is made through the accomplishments of the students we have the privilege to train.

COVID-19 altered every facet of CGRER. It changed how we teach, it moved the majority activities from the office to the home, it restricted work in research laboratories, and cancelled most field studies.

This report offers first-hand reflections on how CGRER members addressed and worked to overcome these challenges. Additionally, CGRER members received grants focused directly on COVID-19 recovery. These grants allowed members to conduct studies on how the virus dries on surfaces. These studies proved instrumental in the development of new, more efficient face maks.

Stay at home mandates and other restrictions advanced in response to COVID-19 offered experiments of opportunity to study how large scale interventions impacted society and the environment. Due to declines in transportation activity and slow-downs in manufacturing, the emissions of air pollutants and greenhouse gases decreased markedly in 2020. Greenhouse gases in the states declined by 10%! As a result, air pollution in cities around the world improved. CGRER continues to be involved in studies focused on understanding and communicating that these changes provide a representative look into the future. This experience has taught us that we can achieve and sustain better air quality and reduced greenhouse gas emissions if we move quickly to electrify transportation systems.

The second most-costly disaster in the United States in 2020 was the western wildfires. The frequency and severity of wildfires is on the rise and is expected to continue to increase as the climate warms. In addition to the devastation they cause due to loss of homes and habitats, smoke from fires has become a major source of severe air pollution and a driver for a host of negative health outcomes. CGRER is actively involved in various research studies focused on fires. In this report we highlight Jun Wang's innovative use of satellite observations to better characterize types of fires (smoldering vs. flaming) and heights of smoke plumes. This information is needed to guide firefights, improve forecasts of where smoke plumes will travel, and necessitate evacuations and road closures.

Fire plumes in California.

Climate change was also front and center in 2020. The decade of 2011-2020 was the warmest on record with six of the hottest years occurring since 2015. At the same time we were faced with COVID-19, weather related disasters were at an all-time high. The United States experienced 22 distinct billion-dollar disasters in 2020. The third largest of these events, with an $11 billion impact, was the derecho. Justin Gilsan, State Climatologist for Iowa, reviews and explains the storm and we hear a first-hand account from CGRER Executive Committee member Louis Licht on the personal, city, and state-wide toll of the storm damage.

There are important lessons to be learned from our battles with the COVID-19 pandemic and climate change. These are powerfully discussed in this year's Iowa Climate Statement. They include the need to listen to the science and invest in prevention and preparation. 2020 reinforced the reality that many people living in our communities are extra vulnerable to disasters and that the harshest impacts of these events tend to fall disproportionately on poor and racial minorities. Building community resilience against multiple threats is critical now more than ever. We have the opportunity to achieve better resilience as we invest in recovery from these disasters. Smart investments in public health, climate mitigation, and adaptation will create more resilient communities in the future.

"The time for small steps in the right direction is long gone."
– Greta Thunberg

"All of us bring light and exciting solutions never before tried."
– Amanda Gorman

As we enter 2021, there is hope that we will tame COVID-19 and the disruptions related to the pandemic will dissipate. There is also hope that there will be significant increased efforts to address climate change. The youth will continue to play a critical role in this process. "The time for small steps in the right direction is long gone," climate activist Greta Thunberg said at the 2021 World Economic Forum. In her poem "Earthrise," Amanda Gorman writes that "All of us bring light and exciting solutions never before tried." These statements echo the sentiments we hear from CGRER students. Arguably the most important legacy of CGRER is made through the accomplishments of the students we have the privilege to train.

Jerry Schnoor and Greg Carmichael

We are proud to share with you the accomplishments of CGRER faculty, staff, and students in this year's report.

Gregory R. Carmichael
Jerald L. Schnoor

CGRER Co-Directors

Top: Amanda Gorman, United States Youth Poet Laureate. (DOD photo by Navy Petty Officer 1st Class Carlos M. Vazquez II).
Top Right: Greta Thunberg speaking at the 2021 World Economic Forum.
Right: Tree damage by derecho in Iowa. (photo by Celine Hartwig)
Below: WMT-AM radio tower near Marion, Iowa downed by the derecho's 130 mph winds. (photo: wikipedia commons)

EXECUTIVE COMMITTEE

ADVISORY BOARD MESSAGE

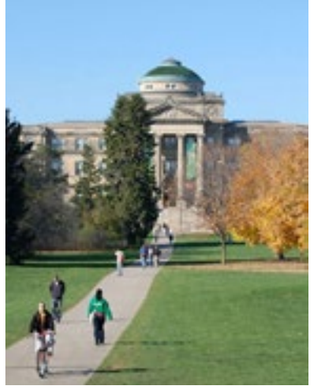
The University of Iowa, Iowa State University, and the University of Northern Iowa have an important track record as leaders in climate, agricultural, water, atmospheric, and social science research. This research will underpin our future efforts to address the grand environmental challenges of the 21st century.

Created for the public good, each institution has consistently represented the state of Iowa on both the national and international stage to great effect. I am proud of the quality and the contributions we make and in our collective ability to advance knowledge in service of our mission for the state of Iowa and for all of humanity. The Center for Global and Regional Environmental Research (CGRER) has been an important contributor to this success and will play an even more crucial role in the coming years. Here's why.

As we enter the third decade of the 21 century, projections about mid-century climate impacts, biodiversity loss, and other associated environmental impacts don't feel very distant anymore. The science is clear: my daughters, indeed all our children, will inherit an irreversibly diminished future unless we act with urgency over the next few years. We must resist the temptation to declare defeat and instead gather force around the singular pursuit of solutions that will give current and future generations a fighting chance at a livable future.

This effort will require deep cooperation across political boundaries, as well as between and within institutions. To this end, public research universities fill an important institutional role in expanding our scientific understanding of the challenges we face, and will play an increasingly important role in finding and implementing the solutions needed to change our trajectory. Centers like CGRER exist within universities to identify, support, and magnify these efforts.

The science is clear: my daughters, indeed all our children, will inherit an irreversibly diminished future unless we act with urgency over the next few years.



Iowa State University

What makes grand environmental challenges like climate change so difficult to address is that they cut across so many areas of society and, subsequently, academic disciplines. While we may recognize the importance of intradisciplinary collaboration when it comes to researching and addressing problems such as climate change, it is also true that our universities often lack mechanisms to foster and encourage critical interdisciplinary collaboration. Likewise, brilliant ideas that exist within the university often need to be incubated and funded internally well before they can be competitive for the kind of external funding and support that drives innovation and solutions to fruition.

For 30 years, CGRER has enabled interdisciplinary and cross-institutional collaboration amongst researchers, has provided important seed grants for emerging and established researchers alike to advance their research, and has acted as a convening space for collaborative innovation across Iowa's public universities. In spite of the historical success these state institutions have had in advancing critical applied research, they will be less prepared to address the current spate of grand environmental challenges facing society without a strong and well supported center like CGRER.

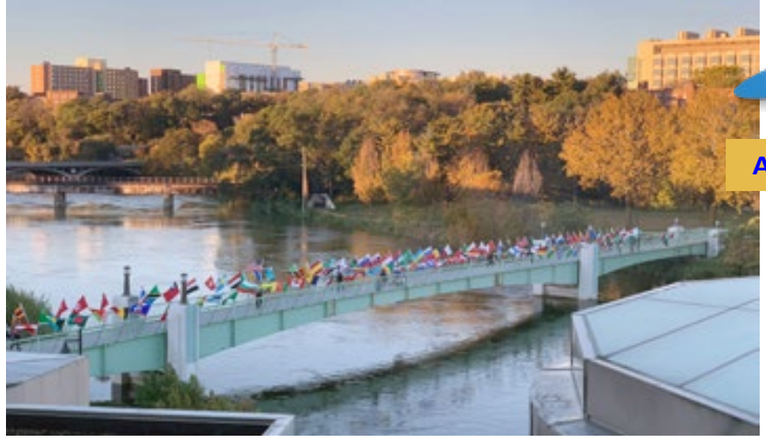
Iowa is a great place to be for a variety of reasons. Here we can work together to address the increasingly important environmental challenges that will require deep, collaborative, solutions-oriented research from our public universities. I am proud to be a part of our university system and honored to be a Board Member for CGRER as it continues to play an indispensable role in advancing both the research and the solutions needed for a better future for Iowans and the world.

Stratis Giannakouros

UI Office of Sustainability and the Environment

(photo by Tim Schoon)

University of Northern Iowa



University of Iowa (photo by Amy Parker)

CGRER

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Stars over Iowa (photo by Celine Hartwig)

OUTREACH

IOWA CLIMATE STATEMENT 2020:
WILL COVID-19 LESSONS HELP US SURVIVE CLIMATE CHANGE?

The current SARS-CoV2 pandemic is a social, humanitarian, and economic crisis that was predicted by experts but made worse by a failure to act proactively on those warnings. As scientists teaching and studying climate and its impacts, we believe there are three important lessons from the current pandemic that apply to our understanding of climate mitigation and adaptation in Iowa:

1. The best available science as described by professional organizations remains by far the most reliable source of information. In the face of political polarization, some have taken up the strategy of de-legitimizing science when it leads to conclusions that go against their policy goals.

But distrust in expert guidance and delayed action led to increased deaths and economic loss in the US. In climate science, as elsewhere, our rigorous peer-review process is designed to reduce errors and bias over time and produce results with high levels of confidence. Consensus science such as publications from the national academies and Intergovernmental Panel on Climate Change is by far the most reliable information available to decision-makers.

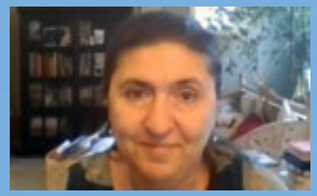
2. The cost of late action far outweighs the costs of prevention and preparation. Congress has allocated trillions of dollars in emergency funds to respond to the economic contraction caused by COVID-19. However, economic costs and deaths in many countries that had invested early in preventive or protective measures were greatly reduced. Similarly, researchers have identified multiple areas where preventive spending today can offset much higher costs to address climate impacts later, especially in the areas of emissions reductions and investments in resilience.

3. Building community resilience against multiple threats is critical, especially for the most vulnerable among us. The disproportionate number of poor people and racial minorities who have suffered severe illness or death from this pandemic has highlighted deep inequities that weaken our entire society. Many of the same actions that reduce vulnerability to pandemics and natural disasters will also increase resilience to climatic changes. Policies and design choices encouraging healthy interactions within communities can improve supportive relationships among community members during times of crisis. Inequity reduces resilience, leaving poor communities, particularly communities of color, disproportionately vulnerable to the impacts of climate-related natural disasters, just as they are to disease. Society's increasing exposure to compound hazards (where different factors combine to make a problem worse) multiplies dangers. Examples include flooding, which displaces families during a disease outbreak, extreme heat that increases vulnerability and death among those who lack access to air conditioning or after a loss of electricity, and drought-induced food losses.

COVID-19 recovery plans have revealed unprecedented opportunities to address climate change while simultaneously rebuilding the economy. Nations around the world are now developing "green economic stimulus plans" that will direct recovery funds. Energy efficiency programs, alternative transportation, renewable energy, green jobs, electric and smart vehicles, education, research and development, and the like, are programs shown to return many times more than was spent. Our leaders should adopt comprehensive rebuilding concepts in Iowa: our smart investments now will better prepare us for the coming decades when extreme climate events (such as floods, damaging winds, heat, and drought) will become more common and more severe.

IOWA CLIMATE STATEMENT 2020

Dave Courard-Hauri, chair of Environmental Science and Sustainability, Drake University.



Silvia Secchi, associate professor of Geographical and Sustainability Sciences, UI.

Eric Tate, associate professor of Geographical and Sustainability Sciences, UI.

(below) An Iowa barn damaged by the August 2020 derecho. (photo by Celine Hartwig)

The lead authors of the 2020 statement include: **David Courard-Hauri**, Drake University chair of Environmental Science and Sustainability; **Greg Carmichael**, CGRER co-director; **Ulrike Passe**, Iowa State University associate professor of Architecture and director for the Center for Building Energy Research; **Silvia Secchi**, UI associate professor of Geographical and Sustainability Sciences; **Gene Takle**, Iowa State University professor emerita of Agronomy; and **Eric Tate**, UI associate professor of Geographical and Sustainability Sciences.

Also contributing to the statement were: **Bill Gutowski**, Iowa State University professor of Meteorology, Geological and Atmospheric Sciences; **David Osterberg**, UI professor emerita, College of Public Health; **Jerry Schnoor**, CGRER co-director; **Elizabeth A. Stone**, UI associate professor of Chemistry; and **Peter S. Thorne**, UI professor of Occupational and Environmental Health, associate director, Environmental Health Sciences Research Center College of Public Health.

The 38 Colleges and Universities statement endorsers:

Central College
Clarke University
Clinton Community College
Coe College
Cornell College
Des Moines Area Community College
Des Moines University
Dordt College
Drake University
Ellsworth Community College
Grandview University
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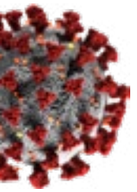
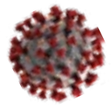
Endorser affiliations are for identification purposes only and do not reflect views of their academic institutions.
Past Iowa Climate statements available at iowaenvironmentalfocus.org.

LESSONS LEARNED FROM THE IOWA CLIMATE STATEMENT

Joe Bolkcom





The Iowa Climate Statement suggests a path forward towards addressing climate change based on the lessons learned from the COVID-19 pandemic. These valuable insights can inform our ability to tackle the significant and unrelenting challenges of climate change that face all Iowans.

"The first lesson the pandemic has taught us is the best plan for addressing both the pandemic and climate change is to rely on the best available science," said **Dave Courard-Hauri**, Drake University chair of Environmental Science and Sustainability. "Professional public health and climate change experts are the most reliable source of information for decision-makers and citizens in making informed choices that protect life and property. Unfortunately, in the face of political polarization, some have taken up the strategy of de-legitimizing science, but this distrust in expert guidance has led to preventable deaths and economic damage to working people and businesses."

"The second lesson," said **Silvia Secchi**, UI associate professor of Geographical and Sustainability Sciences, "is that the cost of not being prepared for the pandemic has far outweighed the costs of prevention and preparation. The cost of ignoring climate change is no different. Proactive efforts to address climate change have been proven to save lives and money."

"The pandemic has revealed how incredibly vulnerable many people and families are living in our communities," said **Eric Tate**, UI associate professor of Geographical and Sustainability Sciences. "The disproportionate number of poor people and racial minorities who have suffered severe illness or death from this pandemic has highlighted deep inequities. Inequity reduces resilience, leaving poor communities, particularly communities of color, disproportionately vulnerable to the impacts of climate-related natural disasters, just as they are to disease."

"The third lesson is that smart investments in public health and climate mitigation and adaptation will create more resilient communities and people," said Tate. "Building community resilience against multiple threats is critical, especially for the most vulnerable among us."

"As we consider policies to deal with the 2020 recession, our leaders should adopt comprehensive rebuilding strategies that invest in energy efficiency programs, alternative transportation, renewable energy, electric and smart vehicles, education, research and development." said Secchi. "These smart investments now will better prepare us for the coming decades when extreme weather events will become more costly, more common and more severe."

SEED GRANTS

In 2020, CGRER awarded a total of $120,000 to four projects.

"A unified information-driven model for CO2 reduction chemistry," **James Shepherd**, UI professor of Chemistry, $30,000.

"Decarbonizing Building Thermal Control in Iowa and the Upper Midwest," **Charles Stanier**, UI professor of Chemical and Biochemical Engineering; **H. S. Udaykumar**, UI professor of Mechanical Engineering; and Jerry Anthony, UI associate professor of Planning and Public Affairs, $30,000.

"Advancing tools to assess the impact of garbage burning on air quality," **Elizabeth Stone**, UI associate professor of Chemistry, $30,000.

Garbage piles in Nepal destined for burning. (photo by Elizabeth Stone)

Brian J. Wisley's bee sampling apparatus, with Phlox pilosa flowering in the background. (photo by Nathan Soley).

"Addressing global bee decline through prairie restorations," **Brian J. Wilsey**, Iowa State University professor of Ecology, Evolution and Organismal Biology, $30,000.

LEGISLATIVE BREAKFAST RECEPTION

In March of 2020, CGRER and the UI Center for the Health Effects of Environmental Contamination (CHEEC) hosted the annual Legislative Breakfast reception at the Iowa State Capitol.

Craig Just, associate professor of Civil and Environmental Engineering, UI, updates legislators on the Iowa Small Community Wastewater Technology Park and Training Program.

CGRER members Silvia Secchi, associate professor of Geographical and Sustainability Sciences, UI; David Cwiertny, director of CHEEC and professor of Civil and Environmental Engineering, UI; State Representative Chuck Isenhart; and Darrin Thompson, associate director of CHEEC, discuss efforts to address the high lead levels in drinking water in Iowa schools.

(Left) Dave Cwiertny and Representative Cecil Dolecheck. (Right) Craig Just and Representitve Dave Kerr.

CGRER 2020 INTERNS

Top left, Joe Bolkcom serves as Director of CGRER Outreach and Community Education, top right, Thomas Robinson, bottom left, Nicole Welle, bottom right, Maxwell Bernstein.

Nicole Welle is a fourth-year student at the UI pursuing a BA in Cinema and a BA in Journalism and Mass Communication. While at Iowa, Welle was a member of the Quidditch Club. Her creative and journalistic work has focused on environmental and human rights issues. After graduation, Welle plans to pursue a career in multimedia journalism.

Maxwell Bernstein is a fourth-year student at the UI pursuing a BA in journalism with a minor in physics. Bernstein participates in research with the department of Physics and Astronomy where he studies aurora. There he analyzes how water quality is framed in Iowa newspapers through mass communication research at the School of Journalism and Mass Communication. Bernstein plans to attend graduate school to study science communication in order to foster connections between scientists and the public.

Thomas Robinson is a fourth-year UI PhD candidate working with **Michelle Scherer** to explore how iron minerals can degrade contaminants in the environment. In 2016, Robinson graduated with a BA in Chemistry from Grinnell College. Robinson is passionate about communicating science effectively and is currently working with Senator **Joe Bolkcom** to learn how science is applied to state level policy.

DERECHO DEVASTATES IOWA

Justin Gilsan, State Climatologist for Iowa

(photo by Meaghan Anderson)

August 10, 2020 will be recorded as a significant weather date in Iowa's history. That was the day a derecho propagated through Iowa's central west-to-east corridor.

Corn flattened by the derecho.

The term "derecho" was coined by Dr. Gustavus Hinrichs at the UI in the late 1800s and is derived from a Spanish word that can be interpreted as "direct" or "straight-ahead." Today we define a derecho as a convectively, or a thunderstorm, initiated straight-line windstorm.

The derecho that hit Iowa was formed in the early morning hours in the southeastern corner of South Dakota. From there, a line of thunderstorms moved across Nebraska and into Iowa where the storm strengthened significantly just east of Carroll as downbursts began to form.

Downbursts occur when moist air that is high up in a thunderstorm interacts with the surrounding drier air. This interaction forces atmospheric water vapor to evaporate quickly. The rapid evaporation then cools the surrounding air thereby producing a relatively large volume of cold, dense air. The bubbles of dense air drop rapidly, hit the surface and spread out thereby creating straight-line winds that can produce widespread damage. Downbursts are key in the formation of low-level, strong straight-line winds.

As the derecho entered central Iowa, the middle of the storm line pushed out creating a bow echo. This feature indicated rapid strengthening as downburst clusters became more numerous. The system expanded north and south as it moved through east-central Iowa where a broadening swath of damage was later discovered in satellite images. The derecho held together for 770 miles and for over 14 hours before losing strength as it entered western Ohio.

The damage done to crops, grain bins, homes, businesses, schools, and other major structures was catastrophic. The derecho impacted the D3 (Extreme Drought) region in west-central Iowa where it inflicted agricultural damage to already stressed corn and soybean fields. USDA Risk Management Agency data indicated that around 8.2 million acres of corn and 5.6 million acres of soybeans across 57 counties may have been impacted by the derecho. Urban areas from Des Moines to Cedar Rapids, from Iowa City to the Quad Cities reported substantial and long-lasting power outages along with severe damage to trees and structures from extremely strong, sustained winds.

Recorded wind gusts along the derecho's path ranged from 58 mph to well over 100 mph. According to the National Weather Service, maximum recorded wind speeds were around 110 miles per hour over portions of Benton and Linn Counties. A personal weather station in Atkins, located in Benton County, reported a gust of 126 mph.

Grain bins destroyed by the derecho in Luther, Iowa. (photo by Justin Glisan)

DERECHO FIELD REPORT

Louis Licht, Ecolotree, Inc.

(photo by Celine Hartwig)

The damage from the August 10th derecho that hit Iowa was disastrous. Everything exposed to the powerful Category 3 hurricane force winds was damaged in one way or another.

I live near Mid River Marina, a few miles away from the Eastern Iowa Airport where winds were measured at 120 mph. From my home, I watched as the wind speed accelerated from 0 to 60 mph in 90 seconds. Mature 90-foot tall forest and landscape trees bent and broke as people sheltered in place. In 70 minutes, all of the roads were blocked by the more than 200 large trees that had fallen. Our neighborhood was fortunate in that there were no lives lost and no serious building damage occurred. Power was restored to our community within a day. Many others had to suffer through extended power outages lasting for days or weeks. With the support of my neighbors, I worked for four weeks to remove damaged and destroyed trees that had fallen on my property.

The impact of the storm was immediate. But so too was the response. In Clarence, an enormous 150-year-old oak tree was uprooted then dropped onto surrounding homes. Utility companies require tree debris to be removed before overhead powerlines can be repaired. The citizens of Clarence pulled together local equipment and worked to safely remove debris from roads and powerlines. Across Iowa, communities like Clarence did not have complete power service for two weeks.

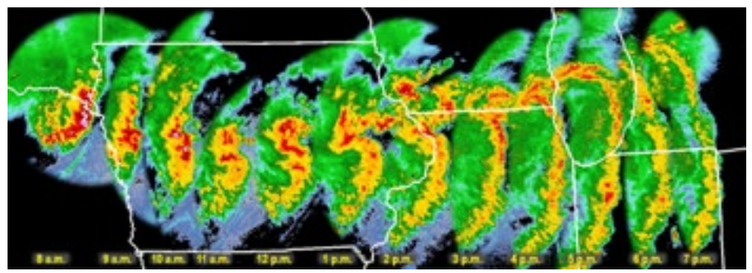
Resiliency is an important part of urban design. As we have recovered from the damage caused by the derecho, certain destruction patterns have emerged. When it comes to trees, species determines movement and response. When exposed to extreme storms, the branches of hickory trees break and bark is ripped away. The branches and roots of maple and cherry trees also break, but with these trees, the roots remain firmly in the ground. Oak and ash trees uproot entirely with limited trunk breakage. The specific location of trees on a landscape matters as well. Windbreaks formed by trees tend to protect buildings and other landscape features. Hills and crop row orientation have the ability to impact corn stem breakage.

Urban street trees planted in rock-filled utility corridors tend to have poor root development. When these streets are paved, the tree root expansion under the roads is reduced significantly. As a result, these trees tend to be blown over when exposed to 120-mph winds.

In Cedar Rapids, the town near where I live, it is estimated that 65% of the mature trees were lost as a result of the derecho. Damage that extensive requires a long recovery period. In the face of it all, we have an opportunity to practice resilience by replanting with trees that perform multiple roles of ambiance, privacy, wildlife habitat, runoff cleanup, energy conservation, and community spirit building.

My company, Ecolotree, is busy preparing kits of fast-growing poplar and willow trees to replace the trees that were damaged and removed because of the storm. These pioneering trees can start the succession to a mixed-species hardwood forest for a single lot, golf course, park, or farmstead. By partnering with eastern Iowa entities such as Trees Forever, various plant nurseries, K-12 education systems, community colleges, and community leaders, it is possible to replant 50,000 trees in 2021.

There will continue to be weather extremes stimulated by climate change. Done well, damage repair is an investment that can lead to a more resilient future for all.



A radar composite of the August 10, 2020 derecho, from 8 am to 7 pm CDT showing lowest angle NWS radar reflectivity at one-hour time steps. (image by weather.gov)

UI RESPONDS TO COVID-19 WITH INGENUITY

The UI's response to COVID-19 has been marked by great resilience, adaptability, and ingenuity among research faculty, staff, and students.

"Despite the need to halt or significantly scale back research activities on campus in the spring and early summer of 2020, with many millions of dollars in funding and the continuity of hundreds of studies on the line, researchers across disciplines demonstrated tremendous flexibility and collegiality," said UI's Stephen Pradarelli, director of Strategic Communications, Office of the Vice President for Research.

"Many researchers worked from home while public health officials tried to understand the virus and its behavior," Pradarelli continued. To help guide this process, the Office of the Vice President for Research developed a website in an effort to supply necessary tools and resources. Some faculty initiated or joined nationwide protocols to find effective vaccines and treatments for COVID-19.

Kevin Legge and Stanley Perlman in the UI Carver College of Medicine partnered with Iowa State University to develop safe, effective, mucosal-based nanoparticle vaccines against respiratory virus infections to the community.

Pat Winokur, executive dean and professor of internal medicine in the Carver College of Medicine, received funding from Pfizer, Inc. and BioNTech SE to study the effectiveness of messenger ribonucleic acid (mRNA) vaccines in potentially preventing COVID-19.

H. S. Udaykumar, professor of mechanical engineering in the College of Engineering, is using a National Science Foundation Rapid Response Research grant to develop a physics-based model for studying how droplets dry on different kinds of surfaces under different seasonal conditions, and the implications for the variation on COVID-19 survival.

Dan McGehee, director of the National Advanced Driving Simulator, has provided national leadership by offering guidance on safely conducting human subjects research during the pandemic.

Even student researchers are getting in on the act. Several of the 52 graduate and undergraduate students featured in the Office of the Vice President for Researcher's annual Dare to Discover banner campaign (held virtually this year) are engaged in some form of COVID-19 research, including the development of treatments and the improvement of tools used for batch testing.

UI 2030 SUSTAINABILITY GOALS

On November 9, 2019, the President's Office charged the UI campus community with developing a new set of campus-wide sustainability goals to be achieved by 2030. In response, faculty, staff and students from across campus came together to design this framework for institutional goal setting.

Moving forward, the 2030 Sustainability Goals Task Force will be working with the UI Sustainability Charter Committee to engage with the broader campus and partners to craft specific, measurable goals for each of the following six framework objectives.

1. Reduce greenhouse gas emissions by 50% compared to 2010 baseline and continue to pursue a renewable energy supply strategy. The UI will continue to pursue greenhouse gas emissions (GHG) reductions and a renewable energy supply strategy aligned with science-based targets. The campus will have a comprehensive decarbonization plan employing best practices and aggressive energy conservation efforts.

2. Institutionalize and embed sustainability into campus culture. The UI will establish sustainability goals that promote a culture of sustainability and reduce negative environmental and social impacts of campus operations. Each unit on campus will develop a plan to meet the campus sustainability goals.

3. Expand sustainability research, scholarship and solutions opportunities. The UI will develop goals to build the capacity for students and researchers across campus to work on sustainability grand challenges of the 21st century. The goals will encourage use-inspired, interdisciplinary research.

4. Use our campus as a Living Laboratory for sustainability education and exploration. The UI will develop goals to increase opportunities for students and researchers to use the UI campus as an educational and research laboratory for improvement of campus sustainability and ecosystems.

5. Prepare students to live and work in the 21st century through sustainability education. The UI will develop goals to raise sustainability literacy as a universal outcome and to develop the capacity for students to graduate with an appreciation for and ability to apply sustainable practices.

6. Facilitate knowledge exchange among the campus community and the State of Iowa, the Nation, and the World. The UI will develop goals to grow sustainability outreach and engagement; these will feature partnerships and community-engaged education and research.

An in-depth analysis of the Sustainability Goals, including the principles underpinning the 2030 goals, the background and goal setting process, as well as a list of the campus wide governance and the task force members, can be found at: sustainability.uiowa.edu/our-vision/ui-2030-sustainability-goals-framework-proposal.

Some of the insects in a typical day's catch, as seen through a microscope.

The insects through the base of the collection container attached to the trap. (photos by Andrew Forbes)

COVID-19 FIELD REPORTS

Andrew Forbes
Associate professor of Biology, UI

Prior to the COVID-19 pandemic, our lab was planning a summer of continent-traversing travel for fieldwork. On top of that, we were looking forward to hosting a cohort of 10 Research Experiences for Undergraduates (REU) students. The REU program exposes undergraduate students to scientific research in faculty labs for 10 weeks. We use this time to teach students about science and how to navigate careers in the scientific field. Quite a few of us participated in REU when we were in college, so it is a great way to pay-it-forward now that we are faculty.

In spite of the lost plans, we made the best of the situation. One major highlight was that with the help from a crew of enthusiastic undergraduates and the UI Office of Sustainability and the Environment, we had time to conduct a large-scale insect collection effort at the UI's Ashton Prairie. These collections will inform several ongoing research efforts, provide material for my Entomology lab course, and provide a baseline for studying faunal changes as the prairie restoration matures.

An informational sign created by The Office of Sustainability and the Environment.

Undergraduate Ian Fefchak-Robinson (left), Andrew Forbes, and his daughter Samantha setting up the "Malaise" trap, which passively collects insects that fly into it. (photo by Mike Fallon)

BES Water Solutions moving-bed bioreactor.

Craig Just
Associate professor of Civil and Environmental Engineering, UI

COVID-19 has accelerated my outdoor fieldwork on community-based wastewater treatment studies in rural Iowa. An upstart Iowa company, BES Water Solutions, has a moving-bed bioreactor (MBBR) project in Middletown that is focused on improving cold-weather ammonia treatment. I have leveraged the resources of the Iowa Flood Center to provide real-time monitoring of physical, chemical, and biological parameters to remotely assess the performance of the Middletown MBBR. These data are available on the Iowa Water Quality Information System and I use them to assist BES with their design and operation decisions.

Linda Shenk
Professor of English, ISU

I was a key collaborator on the implementation of the grant-funded outreach "Women in Watersheds: Beyond One-Day Trainings." The program required a major overhaul due to COVID-19. What was designed to be a three day, in-person workshop series was transformed into a fully online series that included four group sessions as well as a separate, individual session with each of the participants. The online format allowed participants from all around Iowa as well as in other states to join and the workshop series. The program was so successful that participants chose to continue meeting with each other and with the co-facilitators for months after the official workshop ended.

EDUCATION

BANNAVTI WINS THREE MINUTE THESIS AWARD

Moala Keshei Bannavti

I am a third-year UI PhD candidate in Civil and Environmental Engineering (CEE). My research analyzes the concentrations, distributions, and emission characteristics of airborne polychlorinated biphenyls in minority-predominant, low-income, public schools.

During the fall of 2020, I had the honor of participating in the Three Minute Thesis (3MT) competition. CEE requires PhD candidates to complete four semesters of Coaching Seminar on Communicating Water Science. The class ensures students are equipped to complete rigorous science and also understand how to communicate it to less technical audiences.

It was through this course that I was introduced to the world of 3MTs. Growing up in New Jersey, I learned the art of "to-the-point" explanations. But my Cameroonian upbringing also taught me to appreciate a well-told story. Successful 3MTs are the perfect balance of both skills.

In September of 2020, I successfully defended my comprehensive exam. This experience, combined with three previous semesters of Coaching Seminar, gave me self-assurance that I was ready to share my work with a broader audience. The time was right to enlist in the university-wide 3MT competition.

The biggest challenge was getting over imposter syndrome. Presenting to the whole university was intimidating and I kept thinking to myself, "What if someone else's research is just more engaging than mine?" and "What if I can't explain my research as well as I think I can?"

I would love to say I entered the competition for the experience but deep down I was like everyone else who wants to win something they worked hard to achieve. And what does a graduate student work harder on than conducting rigorous research? I attended drafting workshops and received feedback from other contestants. It was a supportive environment that shifted my perception of the process from being a competition against other students to a growth experience for myself.

When I submitted my 3MT video, I was exhausted but also proud. You never know how much work it takes to boil two and a half years of research into two and a half minutes until you try to do it. I was shocked to learn I had won the competition and the people's choice award. The competition reinforced that the work we do as graduate students really does matter. This experience truly changed my life and reignited my passion for research communication.

MOLITOR RECEIVES IOWA SPACE GRANT CONSORTIUM AWARD

Hannah Molitor, a National Science Foundation Graduate Research Fellow in Civil and Environmental Engineering, was awarded The Iowa Space Grant Consortium Award. The award supports outstanding graduate students pursuing NASA-aligned research opportunities in science, technology, engineering, and math disciplines.

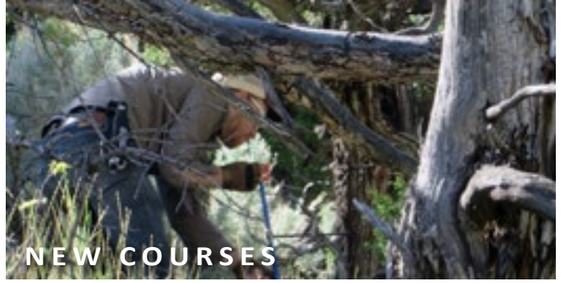
Molitor, who received the award last year as well, says of her research that "conventional agriculture places significant demands on natural resources and is generally inefficient."

"Microalgae, or single-cell photosynthetic microorganisms, are a promising alternative to conventionally grown soy for more rapidly and sustainably produced protein-rich animal feed."

Molitor's research addresses how microalgae can use carbon dioxide from combustion emissions and the nutrients from wastewater to produce biomass. "However," she says, "there are significant barriers to growing nutritious salable microalgae, recovering nutrients from wastewater, and fixing carbon dioxide from power plant emissions in full-scale sustainable operations, which my research seeks to address."

Molitor uses a photobioreactor, a vessel to grow microorganisms that uses light for energy, to cultivate *Scenedesmus obliquus*, a nutritious green microalga. Her first publication showed that this particular species can tolerate the high carbon dioxide levels characteristic of power plant or industrial emissions while maintaining favorable protein contents and amino acid profiles. Her subsequent publications focused on enhancing microalgal growth rates and harvestability by leveraging the sulfur in combustion emissions, and safely growing microalgae with toxic gases.

Molitor's current work addresses microalgal growth on wastewaters and energy-efficient harvesting of microalgal biomass from its culture media. She notes that "successful scale-up of this research could reduce fertilizer and freshwater resources use, offset wastewater treatment costs, and mitigate greenhouse gas emissions."



NEW COURSES

Matthew P. Dannenberg (above) taught two new UI courses in 2020. Ecological Climatology (GEOG:4470) is an introduction to global energy, water, and carbon cycles, that highlights biosphere-atmosphere interactions across scales ranging from leaf to globe. Ecosystem Ecology (GEOG:3315) focused on terrestrial ecosystems as integrators of biological, physical, and ecological processes. It also highlighted flows of energy, carbon, water, and nutrients within ecosystems; spatial and temporal patterns and processes of Earth's ecosystems; and sustaining ecosystems in the face of global change.

Linda Shenk launched a graduate course in the literary humanities at Iowa State University that involved significant work on climate change and public-facing work on resilience. The course examined strategies distinctive to the humanities and drama that are useful in empowering communities in the face of vulnerability and uncertainty. Course participants had the opportunity to create and engage in a public-facing project based on an issue of importance.

Jun Wang launched Applied Statistics for Chemical and Natural Resources Engineering (CBE:3020) at UI. This course focused on the statistical and computational analysis of weather and climate data, univariate and multivariate statistics, hypothesis testing, statistical forecasting, forecast verification, time-series analysis, trend analysis, and principal component analysis.

GRANT AWARDED
UNH 2020 SUSTAINABILITY FELLOWSHIP

Amina Grant, a UI PhD candidate studying sustainable water development in Civil and Environmental Engineering, was awarded the University of New Hampshire 2020 Sustainability Fellowship. The program pairs students and recent graduates from across the nation with municipal, educational, corporate, and non-profit partners in New England to work on sustainability initiatives.

"The fellowship was valuable because I learned firsthand how a local government addresses sustainability and how data science can influence policy and action," Grant said.

During her fellowship, Grant worked with the city of Concord, New Hampshire to define the baseline greenhouse gas emissions through two separate lenses: local government operations and community-wide accounting.

In addition to producing two reports, Grant presented her work to the University of New Hampshire, the Concord's City Council, and the City of Concord Energy and Environment Advisory Committee. She concluded that Concord released about 496,000 metric tons of carbon dioxide equivalent in 2019.

AWARDS, ACHIEVEMENTS, AND APPOINTMENTS

Matthew P. Dannenberg received the John Russell Mather Paper of the Year Award from the Climate Specialty Group of the American Association of Geographers for his 2019 paper "Reduced tree growth in the semiarid United States due to asymmetric responses to intensifying precipitation extremes," which was published in Science Advances.

Gregory H. LeFevre was honored as the UI Early Career Scholar of the Year. He also received the ACS Environmental Chemistry Division Environmental Science & Technology James J. Morgan Award (Honorable Mention). LeFevre was selected to the Environmental Science and Technology Early Career Advisory Board; was an National Institute of Environmental Health Sciences Early Stage Investigator Invited Speaker; and presented research at Science Cafe.

Sara E. Mason is senior personnel working alongside Robert Hamer on The NSF Center for Sustainable Nanotechnology. The Center's five-year, $20-million budget was renewed in the fall of 2020.

Maurine Neiman was appointed UI Provost Faculty Fellow in Diversity, Equity, and Inclusion for spring 2021.

Ulrike Passe presented at two virtual conferences this year. In May, Passe presented at Vienna, Austria's Proceedings of Symposium on Simulation in Architecture and Urban Design, and in September, at Coruna Spain's Passive Low Energy Conference.

Elizabeth A. Stone received the 2020 Distinguished Mentor Award from the Iowa Center for Research by Undergraduates. Stone also led a National Science Foundation major research instrumentation grant to acquire a high resolution mass spectrometer for the UI. The instrument was installed in the High Resolution Mass Spectrometry Facility and is accessible to Iowa researchers and the surrounding community.

Jun Wang was appointed as a senior review panel member for NASA's Earth Science. Wang, alongside postdoctoral research scholar Huanxin Zhang, was recognized by the Centers for Disease Control as being among the nation's best for their "exceptional approach to solving a public health problem."

RESEARCH

SUPERFUND RESEARCH PROGRAM AWARDED FUNDING

The Iowa Superfund Research Program (ISRP) was awarded five years of additional funding (2020-2025) from the National Institute for Environmental Health Sciences, an institute of the National Institutes of Health. The ISRP is a unique collaboration between UI faculty, students and staff in the Colleges of Engineering, Public Health, Medicine, Pharmacy, the School of Planning and Public Affairs. **Keri Hornbuckle**, Bently Professor of Engineering at UI, is the director.

The ISRP focuses on polychlorinated biphenyls (PCBs). PCBs were widely produced in the mid-20th century and were used in thousands of products, from common household items to construction materials, until the chemicals were banned 40 years ago. Today, people are still exposed to PCBs indoors and in communities surrounding superfund sites.

Recent ISRP research demonstrated that airborne PCBs present an especially urgent problem. Inhalation of airborne PCBs may be the most significant route for human exposure to these human carcinogens. The ISRP's long-term goal is to develop recommendations to prevent and/or limit human exposure to airborne PCBs and to improve the health and well-being of the population. The ISRP renewal will focus on PCBs in air, particularly in schools and in communities that surround PCB-contaminated water.

Over the next five years, the ISRP will conduct five major projects. Two projects will address how PCBs and their metabolites are risk factors for altered neurodevelopment during adolescence and the mechanisms by which these compounds interfere with lipid metabolism. A third major project will work with cohorts of mothers and adolescents to measure individual exposure to airborne PCBs. Another project will investigate sources of airborne PCBs emitted from building materials, consumer products, and contaminated water. The fifth project will utilize a new approach to capture and break down PCBs in contaminated sediments.

The projects are supported by six additional components of the center that will synthesize PCBs for laboratory studies; analyze environmental and laboratory samples for PCBs and their breakdown products; manage and analyze the data produced by the center; train students and post-doctoral researchers; and engage with communities affected by PCB exposure.

LICHT PATENTS WATER TREATMENT SYSTEM

Louis Licht, CGRER Executive Committee Member and founder of the Iowa-based company Ecolotree, received a patent for Phytoremediation Treatment System And Containerized Method Of Treating Pollutants In Water Inventor.

This patent is the first of its kind to use tree roots for treating pollutants in water that violate state and federal laws defining water quality in groundwater and wastewater.

Phyto Attached Growth Reactor (PhAGR) is now federally trademarked and joins six other federal trademarks owned by Licht; the first of which, Ecolotree, evolved from his work as a UI PhD student and was developed with the support of **Jerry Schnoor**.

The research Licht conducted at Iowa has been the basis for his work using plants to remove regulated pollutants in water and was foundational in the creation of the International Phytotechnology Society (IPS), a nonprofit society of individuals and institutions engaged in the science and application of using plants to address environmental problems. The organization now has global phyto science involvement and a peer-reviewed journal. UI is a leader in the definitive research in phyto treatment technology.

The first PhAGR system was built in 2020 and is permitted to treat septic wastewater effluent found under the strictest nitrogen discharge regulations in the United States at Panelview RV Park in Hermiston, Oregon. Ecolotree, Licht's company that installs forests of poplar trees near sites that leak pollutants, is working to develop a market for applications in military, landfills, small community waste systems, and brownfield groundwater plume treatment.

Licht is the owner of nurseries in Lowden, Iowa and on Washington's Whidbey Island. The poplar and willow trees from these nurseries manage water pollutants at landfills and industrial brownfields. They also work to mitigate chemical spills and small waste water treatment sites in 37 states.

UNPRECEDENTED FIRE SEASON

Jun Wang

This past year, on August 27, NASA's Terra satellite detected several small and isolated fires triggered by lightning in and around Glenn County, California. These fires marked the beginning of what would eventually become the first megafire in California's history. Known as the August Fire Complex, this megafire burned over one million acres of land before it ended on November 12.

California was not alone. Fanned by strong winds and fueled by dry canopy, Washington and Oregon experienced record setting fires as well. As a result, each state was forced to declare a state of emergency. Between August and November, around 8.2 million acres (33,000 km2) of land were burned during the 2020 Western United States wildfire season.

To a degree, both the unprecedented extent of this year's fire season and the normalization of fires in general as part of California's weather phenomenon, can be attributed to the increased frequency of drought as a result of global warming.

Global warming is not only an overall increase of global temperature by 1-2°C. It entails the change of regional weather patterns that trigger natural hazards such as floods and fires. Some of these natural hazards can further accelerate global warming and exacerbate its consequences. Nearly 90% of fuel mass burned by fires is released into the atmosphere in the form carbon dioxide (CO2); a greenhouse gas largely responsible for global warming. The fires release soot particles that can warm the atmosphere by absorbing solar radiation, as well as carbon monoxide that is oxidized by the atmosphere into CO2. These byproducts of combustion are capable of traveling great distances, impacting the air quality and public health in downwind regions.

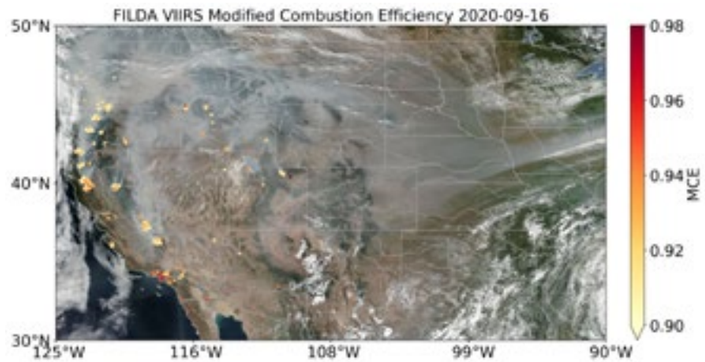
The burn scar left by the fires can be seen clearly from satellite images. These scars darken the land and causes it to absorb more solar energy by making the soil dry and hotter. It takes several decades for forests to fully recover from burn scars. These marks are a reminder that global warming can severely change our fragile planet.

Detection of wildfires from space is paramount to proper allocation of fire management resources. This detection affords the opportunity to predict fire weather patterns and understand fire impact on climate. The unusual fire season of 2020 was predicted well in advance of its arrival. In July, satellite data revealed the formation of La Niña over the Pacific Ocean. In the months after it is observed, this weather pattern typically results in drier weather in the western United States.

My UI research group has developed a novel method to detect fire phases and smoke layer height from space. This distinction, between smouldering versus flaming fires, can lead to the earlier detection of fires and at the same time offer a more accurate estimate of fire emissions and surface air quality.

Flaming fires, the ones firefights seek to suppress, emit more CO2 and soot particles than smoldering fires as a result of more complete combustion. If smoke plumes are well above the ground, they will have much less effect on surface quality and cause more warming in the upper atmosphere.

Insightful observations like this have been made available through a satellite remote sensing algorithm that was developed at Iowa. This method of detection can help air quality models to better predict how much and how high the fires are injecting their emissions into the atmosphere. This research effort is led by a collaboration between my group and **Gregory Carmichael**.



This figure, courtesy of Meng Zhou, is representative of Wang's wildfire research.

A SAMPLING OF PUBLICATIONS BY CGRER MEMBERS

Webb, D. T., M. R. Nagorzanski, M. M. Powers, **D. M. Cwiertny**, M. L. Hladik, and **G. H. LeFevre**. Differences in Neonicotinoid and Metabolite Sorption to Activated Carbon Are Driven by Alterations to the Insecticidal Pharmacophore. *Environmental Science and Technology*, doi.org/10.1021/acs.est.0c04187.

Wang, X., **M. P. Dannenberg**, D. Yan, M. O. Jones, J. S. Kimball, D. J. P. Moore, W. J. D. van Leeuwen, K. Didan, and W. K. Smith. Globally consistent patterns of asynchrony in the phenology of optical, microwave, and fluorescence satellite data. *Journal of Geophysical Research: Biogeosciences*, doi.org/10.1029/2020JG005732.

Dannenberg, M. P., X. Wang, D. Yan, and W. K. Smith. Phenological characteristics of global ecosystems based on optical, fluorescence, and microwave remote sensing. *Remote Sensing*, doi:10.3390/rs12040671.

Zhi, H., D. W. Kolpin, R. D. Klaper, L. R. Iwanowicz, S. M. Meppelink, and **G. H. LeFevre**. Occurrence and Spatiotemporal Dynamics of Pharmaceuticals in a Temperate-Region Wastewater Effluent-Dominated Stream: Variable Inputs and Differential Attenuation Yield Evolving Complex Exposure Mixtures. *Environmental Science and Technology*, doi.org/10.1021/acs.est.0c02328.

Thompson, D. A., H. J. Lehmler, D. W. Kolpin, M. L. Hladik, J. D. Vargo, K. E. Schilling, **G. H. LeFevre**, T. L. Peeples, M. C. Poch, L. E. LaDuca, **D. M. Cwiertny**, and R. W. Field. A Critical Review on the Potential Impacts of Neonicotinoid Insecticide Use: Current Knowledge of Environmental Fate, Toxicity, and Implications for Human Health. *Environmental Science Process and Impacts*, doi.org/10.1039/C9EM00586B.

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Abbaspour, A., J. L. Tamijani, L. Bjorklund, J. Augustine, G. Catalano, and **S. E. Mason**. DFT + Thermodynamics of Inner-Sphere Oxyanion Adsorption on the Hydroxylated alpha-Al2O3(001) Surface. *Langmuir*, doi:10.1021/acs.langmuir.0c01203.

Rushworth, C. A., R. S. Baucom, B. K. Blackman, **M. Neiman**, M. Orive, A. Sethuraman, J. Ware, and D. R. Matute. Who are we now? A demographic assessment of the evolution societies. *Evolution*, doi.org/10.1111/evo.14168.

Bankers, L., D. Dahan, **M. Neiman**, C. Adrian-Tucci, C. Frost, G. D. D. Hurst, and K. C. King. Invasive freshwater snails form novel microbial symbioses. *Evolutionary Applications* doi.org/10.1111/eva.13158.

Passe, U., M. Dorneich, C. Krejci, D. M. Koupaei, B. Marmur, **L. Shenk**, J. Stonewall, **J. Thompson**, and Y. Zhou. An urban modelling framework for climate resilience in low-resource neighbourhoods. *Building and Cities*, doi org/10.5334/bc.17.

Kunwar, N., K. S. Cetin, **U. Passe**, X. Zhou, and H. Li. Energy Savings and Daylighting Evaluation of Dynamic Venetian Blinds and Lighting through Full-Scale Experimental Testing. *Energy*, doi:10.1016/j.energy.2020.117190.

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Islam, M. R., T. Jayarathne, I. J. Simpson, B. Werden, J. Maben, A. Gilbert, P. S. Praveen, S. Adhikari, A. K. Panday, M. Rupakheti, D. R. Blake, R. J. Yokelson, P. F. DeCarlo, W. C. Keene, and **E. A. Stone**. Ambient air quality in the Kathmandu Valley, Nepal during the pre-monsoon: Concentrations and sources of particulate matter and trace gases. *Atmospheric Chemistry and Physics*, doi:10.5194/acp-20-2927-2020.

Saikawa, E., Q. Wu, M. Zhong, A. Avramov, K. Ram, **E. A. Stone**, C. E. Stockwell, T. J. Jayarathne, A. K. Panday, and R. J. Yokelson. Garbage Burning in South Asia–How important is it to regional air quality? *Environmental Science & Technology*, doi.org/10.1021/acs.est.0c02830.

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Wang, J., S. Roudini, E. J. Hyer, X. Xu, M. Zhou, L. Castro Garcia, J. S. Reid, D. Peterson, and A. Da Silva. Detecting nighttime fire combustion phase by hybrid application of visible and infrared radiation from Suomi NPP VIIRS. *Remote Sensing of Environment*, doi.org/10.1016/j.rse.2019.111466.

Wang, J., M. Zhou, X. Xu, S. Roudini, S. Sander, T. Pongetti, S. Miller, J. Reid, E. Hyer, and R. Spurr. Development of a nighttime shortwave radiative transfer model for remote sensing of nocturnal aerosols and fires from VIIRS. *Remote Sensing of Environment*, doi.org/10.1016/j.rse.2020.111727. org/10.1029/2020GH000281.

GRANTS AWARDED TO CGRER MEMBERS

Matthew P. Dannenberg was PI, working alongside co-PIs Mallory L. Barnes, William K. Smith and collaborators Joel Biederman, Russell Scott, John Kimball, Dong Yan, and Xian Wang on a $502,893 NASA grant titled "Leveraging SMAP soil moisture and multi-source Earth observations to quantify variability and drivers of global dryland carbon and water fluxes" (2020–2023).

Matthew P. Dannenberg (above) was co-PI along with Connie Woodhouse, Edward R. Cook and Erika K. Wise (PI) on a $113,853 National Science Foundation grant titled "Multi-century perspectives on current and future flow in the Lower Missouri River Basin, Paleo Perspectives on Climate Change (P2C2)" (2020-2023).

Matthew P. Dannenberg was PI alongside co-PIs **Susan Meerdink**, **Mary Skopec**, and Adam Skibbe on a $35,497 Scalable Solutions for a Sustainable Future Project funded by UI Office of Sustainability and the Environment titled "A hard rain's gonna fall: Responses of Iowa's bur oak to increased precipitation variability" (2021).

Matthew P. Dannenberg was PI on a $6,000 grant funded by the UI Public Policy Center titled "Contributions of anthropogenic warming to drought-induced loss of vegetation health" (2020).

Greg LeFevre was PI on a USDA and National Institute of Food and Agriculture $499,953 grant titled "Bioaccessibility of Conjugated Plant Metabolites from Contaminants of Emerging Concern in Recycled Irrigation Water" (2021-2024).

Maurine Neiman was co-PI on a $300,000 (249.957,44€) Portugese funded grant titled "Global change and Biological Invasions: Potamopyrgus antipodarum as a case study (GOBIG)" (2021-2024).

Maurine Neiman was co-PI alongside Curt Lively, Jason Rohr, and Ana Bento (PI) on a $200,000 grant funded by Indiana Clinical and Translational Sciences Institute titled "The Senegal snail-human schistosomiasis system: interrogating the molecular basis and transmission of a complex human disease" (2020-2022).

See Linda Shenk's grant "Women in Watersheds: Beyond One-Day Trainings"

Linda Shenk was PI on a $70,616 USDA Natural Resources Conservation Service grant titled "Women in Watersheds: Beyond One-Day Trainings" (2019–2021).

Janette Thompson was PI working alongside co-PIs Matthew Liebman, Yuyu Zhou, Baskar Ganapathysubramanian, Nick Schwab, Michael Dorneich, Philip Gassman, Kurt Rosentrater, **Ajay Nair**, **Ulrike Passe**, and Caroline Krejci on a $2.5-million NSF grant titled "Social and biophysical models to integrate local food systems, climate dynamics, built forms, and environmental impacts in the urban FEWS nexus" (2020–2023).

Jun Wang was co-PI on a $230,000 NASA Remote Sensing Theory grant titled "Retrieval of Aerosol Vertical Distribution from Measurements in O2 A and B Bands and Polarimetric Data in Blue Bands: Synergetic Analysis and Algorithm Development" (2020-2023).

CGRER UPDATES HIGH PERFORMANCE COMPUTING ENVIRONMENT

CGRER provides high-performance computing resources to support the interdisciplinary research done by its members and their students. CGRER research is conducted on a shared high-performance computing cluster capable of delivering extensive computing resources in a parallel computing environment. This computing cluster, known as Argon, is located at the Information Technology Facility on Iowa's Oakdale campus.

CGRER has invested in the Argon cluster in order to provide researchers necessary resources when conducting research and analysis. The Argon cluster is continually evolving and now includes built-in machine learning and artificial intelligence capabilities.

CGRER purchased a 400 terabyte high-performance storage server in 2020 to use in conjunction with the computer cluster, ensuring CGRER researchers access to vast amounts of data storage space in the years to come. Iowa has an unlimited site-wide license for all Environmental Systems Research Institute products. **Jeremie Moen** is on the campus GIS Technical Advisory Committee and facilitates campus requests for support.

The Argon Computing Cluster on the UI campus. (photo by Ben Rogers)

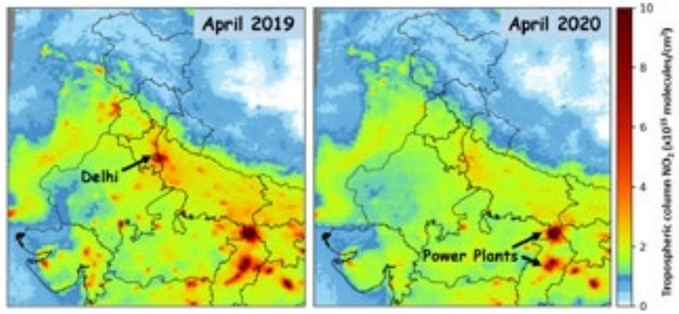
INTERNATIONAL EFFORTS

CGRER LEADS WMO COVID-19 STUDY

CGRER is leading a World Meteorological Organization (WMO) COVID-19 study.

The Global Atmospheric Watch program at the WMO coordinates measurements of atmospheric composition around the world. In response to the COVID-19 pandemic, it is conducting a global study to better understand the behavior of key air pollutant species in relation to differences in regional and local meteorology that existed during the pandemic period of exceptionally low emissions across the globe. The aim of the study is to identify lessons for formulating future air quality management policies.

With contributions from all of the seven United Nation regions, the analysis focuses on ground-based air quality observations from approximately 450 stations located in 50 cities covering 20 countries. This comprehensive observational analysis is the first to adopt a globally consistent approach. The analysis focuses on regional changes in urban concentrations of PM2.5, PM10, PMC (coarse fraction of PM), NO2, NOx, CO, and O3 during pre-lockdown, partial-lockdown, and full-lockdown; as well as the two partial relaxation periods spanning from January to September of 2020.



Nitrogen dioxide (NO2) concentrations over northern India averaged over April 2019 and 2020 seen from space via TROPOMI on board the Copernicus Sentinel-5 Precursor satellite. April 2020 was a lockdown period in India, where many economic and personal activities except power generation industry were significantly decreased.

As a global and regional overview of the raw changes in ambient concentrations of key air quality species, this study estimates decreases of up to 65% in NO2, 30-40% in PM2.5, and smaller increases in magnitude for O3. It also notes that some cities showed a much larger change when comparing the 2020 lockdown periods with the mean of equivalent periods between 2015 and 2019. The study will be published in 2021.

ROOZITALAB AWARDED NCAR FELLOWSHIP

Behrooz Roozitalab, a UI PhD candidate in Chemical and Biochemical Engineering, was awarded the Ralph Cicerone Fellowship in Earth System Science from the National Center of Atmospheric Research (NCAR). The two-year fellowship is awarded to a single student each year and is part of the Atmospheric Chemistry Observations and Modeling (ACOM) lab at NCAR.

The fellowship is intended for graduate students with experience in, or working with, underrepresented communities. It provides financial support for four months, divided over the course of two years, working with NCAR scientists in the ACOM laboratory in Boulder, Colorado.

Typically, fellowship recipients would travel to NCAR to stay for three consecutive months in the summer of the first year to focus on a self-defined research project in the field of atmospheric chemistry then return for a one month period the following year to complete the project. As a result of COVID-19, Roozitalab was unable to physically travel to NCAR for the fellowship. To accommodate, NCAR transitioned to an entirely remote format which allowed Roozitalab to participate virtually in the program. He plans to visit the lab when it is safe to do so.

"We have started exploring a recently developed multi-scale model called MUSICA which was developed at ACOM," Roozitalab said. "MUSICA is a one-of-a-kind global earth system model with the ability to study the air quality over a refined region with high resolution."

At Iowa, Roozitalab works as a graduate research assistant with **Gregory Carmichael**. He is currently researching extreme pollution events in Delhi, India.

MEMBER SPOTLIGHT: GREGORY LEFEVRE

Assistant professor of Environmental Engineering **Gregory LeFevre** was honored as the UI Early Career Scholar for 2020.

LeFevre completed his BS in Environmental Engineering at Michigan Technological University then received his MS and PhD at the University of Minnesota. He was a postdoc at Stanford University. LeFevre had an eclectic mix of internships throughout college and before graduate school that honed his perspectives as a scientist. He worked as an environmental engineer for the Indian Health Service on the Navajo Nation; a seasonal hydrologist in the Teton Valley of Idaho; a water policy intern for the World Wildlife Fund; and a research aide in South Africa.

"I have always been drawn towards work to protect the environment, but these experiences highlighted the need to develop solutions that consider the needs of people alongside water and wildlife. I also learned that while policy is important and is the way to impact change, I wanted to focus my contribution on developing scientific understanding and solutions to inform policy, but not to be directly involved in policy myself, because it doesn't fit my personality."

In graduate school, LeFevre was a National Science Foundation (NSF) Graduate Research Fellow where he studied the fate and biodegradation of hydrocarbons in green stormwater systems such as bioretention. "The thing that attracted me to this area," he said, "is the use of low-energy nature-based treatment systems to improve water quality, while also better integrating human habitats and green spaces."

LeFevre participated in the NSF Integrative Graduate Education and Research Training program where he was afforded the opportunity to work with ecologists, engineers, and scientists in an interdisciplinary environment. His PhD thesis was awarded the Paul V. Roberts Association of Environmental Engineers and Science Professors Best Dissertation Award. While at Stanford, he worked at the NSF Engineering Research Center for Re-Inventing the Nation's Urban Water Infrastructure, where his foundational stormwater treatment work was scaled up to large-scale stormwater capture-treatment-recharge systems.

"The idea was to use some of the same passive stormwater treatment approaches, combined with innovative technologies and enhanced storage capacity to deal with the highly episodic nature of California semi-arid storms, to recharge aquifers. Rain is freshwater, and if it is cleaned up before recharging, this could be a future water supply and is much less energy intensive than desalination. Although this might seem like a uniquely coastal problem, stormwater capture-treatment-recharge could be a viable solution for heavily depleted groundwater aquifers that tend to ring larger Midwestern cities where their metro suburban areas draw groundwater. Ensuring that stormwater quality is good is important for surface waters and groundwater sustainability."

LeFevre joined UI in 2016 as an assistant professor of Civil and Environmental Engineering and as a researcher at IIHR-Hydroscience & Engineering. "Iowa's program has always been well-respected with great people doing great work. As a person who is passionate about plant processes, it's been humbling to work in the same program as **Jerry Schnoor**. The opportunities at IIHR continue to allow for my growth as a researcher and help to sustain me in this work."

The focus of the LeFevre Lab is elucidating novel fate and transformation processes and products of emerging organic contaminants, such as pharmaceuticals and new-market pesticides. The goal of this work is to help inform the design of so-called "engineered natural treatment systems" to improve water quality for non-point sources, like urban stormwater and agricultural runoff. This process fuses the experiences of ecological restoration and engineering to generate new scientific understanding to improve passive treatment systems, like stormwater bioretention. Concentrating on the biological products and pathways discovery is what has made LeFevre's work complementary to colleague **David Cwiertny**'s research on abiotic processes, with whom LeFevre has extensively collaborated and considers an exemplary mentor.

"When I think about the challenges that Iowa faces in the context of global change, it is somewhat of a microcosm of the world. As a working landscape that is largely rural and yet highly transformed from its pre-Columbian ecosystem, there are really important challenges to research in terms of informing resilient water quality that works with the needs of people in a changing climate. Water can be a way that better connects people to the land, in a Leopold-land ethic sense."

NEW MEMBERS

Gregory Friedstad is a UI associate professor of Chemistry with research interests in asymmetric synthesis, free radical chemistry, organosilicon chemistry, new synthetic methods with transition metal reagents and catalysts, and medicinal chemistry. The Friestad Lab focuses on the development of new synthetic tools for introducing complexity in small molecule synthesis, and has applied these tools to develop synthetic routes to biologically active natural products and drug candidates. Ongoing research includes application of new asymmetric synthesis methods to synthesize and evaluate new antimalarial compounds with potential to address drug resistance and climate-related expansion of malaria.

Susan Meerdink is a UI assistant professor of Geographical and Sustainability Sciences. Her research focuses on the intersection of machine learning, remote sensing, and ecology to understand our functioning natural environment. Meerdink develops algorithms and methodologies for image processing to better understand the relationships between pixels and processes.

Jessica Meyer is a UI assistant professor of Earth and Environmental Sciences and is affiliated faculty in IIHR Hydroscience & Engineering. Meyer's research focuses on field-based characterization of groundwater flow systems in heterogeneous geologic settings with emphasis on understanding the relationship between the hydraulic and geologic structure of the subsurface. Meyer's current projects include developing new techniques for delineating aquitards in fractured, sedimentary rock; evaluating flow system controls on the natural attenuation of organic contaminants in fractured sandstones; and characterizing iron mass discharge from groundwater into an urban lake.

WHERE ARE THEY NOW?

The Lasting Impact of CGRER

Marcelo Mena

In 2003, Ori Sivan brought together a series of visionary speakers and engineering students for a lecture titled "The Green Awakening." At the time, I was new to CGRER and will admit to feeling overwhelmed at the challenges of working on air quality forecasting and modeling. But Sivan's lecture prompted me to action.

That is how I found myself in Xicotepec, Mexico working to spread the Iowa Department of Natural Resource's program on pollution prevention. We taught the community to use *in situ* water treatment technology through purification packets that were deployed in collaboration with Procter and Gamble. Years later, during a tsunami recovery, I would work with my students to deploy 100,000 doses of these same packages to compensate for the shattered water treatment systems.

It seems the lessons we learned at Iowa ended up having real-life impacts down the road.

Back on campus, as student leaders, we were relentless in making our university more sustainable. We organized the Progressive Career Fair and launched Sustainable Systems, a course tailored to address our emerging interests that were not yet covered in textbooks. We founded then hosted Engineers for a Sustainable World. We attended the World Modeling Air Pollution Conference in support of aircraft measurement campaigns. We sat on committees that demanded UI reduce energy use and we completed projects that ended up saving the university hundreds of thousands of dollars in energy costs.

I went on to become a professor but understood that I needed to put on gloves because, as Stephen Schneider said, science is a contact sport. I took the advice of **Jerry Schnoor**, **Rich Valentine**, **Greg Carmichael**, and **Craig Just**, and used my research to inform policy. I was named minister and vice minister of the environment for Chile where I was able to deploy air pollution control programs that reduced pollution radically and helped prevent 500,000 emergency room visits a year due to respiratory disease. I was able to implement the first carbon tax in South America, create the largest national park network in the Americas this century, and oversee the creation of over one-million kilometers of protected ocean parks. I am home now after a stint at the World Bank, having delivered a new report on Latinamerica COVID-19 recovery.

None of this would have been possible if not for my time at Iowa. From the beginning, ours was cutting edge work that made incumbents uneasy. But our mentors defended us so that ground-breaking work was possible. CGRER played a crucial role in all of this. It existed at the epicenter of our campus life, housed in the most emblematic of buildings, shining a light of knowledge and sustainability for the midwest and the world.

Elliott Campbell

When my partner and I packed up our station wagon to make the 2000 mile drive to Iowa, I had a good feeling. We had our two mice, our favorite yellow chair, and, thankfully, air conditioning. The outlook was good! But it wasn't until I landed at CGRER as a graduate student that I began to realize how Iowa would be the beginning of an exciting new chapter in my life.

The lessons I learned from my mentors and classmates at CGRER set the stage for a career in climate science. Jerry Schnoor introduced me to the idea of using farming to take CO2 out of the air and trap it in the soils. **Greg Carmichael** and **Charlie Stanier** guided me in the use of computer models that could track CO2 in the atmosphere.

My peers from Engineers for a Sustainable World opened my eyes to how UI could lead the way in climate action. It was an exciting time to be a student at Iowa with so many of us working together, pushing each other towards the same sustainability goal.

These days I work as a professor in my hometown at the University of California, Santa Cruz. My climate research continues to draw on many of the core techniques I learned from my CGRER mentors. And the motivation gleaned from my Engineers for a Sustainable World peers continues to push me to better translate research into real sustainability action.

Forrest Meggers

Growing up on a small Iowa farm and then graduating at the top of my class, I thought the world was my oyster. I was prepared to spread my wings and get out of Iowa. But the presidential scholarship I received solidified Iowa as my best option. Looking back, I can't imagine ever having made a different choice.

Initially, I was going to design bicycles. That was before my senior year when I became involved in Engineers for a Sustainable World; a decision that changed the course of my career and provided the mooring for my passion for the environment. This new trajectory would not have been possible without the backing of **Jerry Schnoor** who supported my transition from being a mechanical engineer who wanted to study buildings to an environmental engineering student.

I've never felt as unstoppable as I did during my time at Iowa. Working with my peers, we brought together partners from The James Gang, Engineers for a Sustainable World, KRUI, and other campus groups to host events like the Progressive Career Fair, the Exodus Music Festival, and the Recycling Committee. We traveled to Xicotepec to both teach and learn about water quality. We participated in the second USGBC Greenbuild conference.

Beneath all this action was always the knowledge, friendliness, and unwavering support of **Jerry Schnoor**. I didn't leave Iowa after high school like I once thought I would. But thanks to Jerry, I was given the opportunity to continue research in Switzerland, complete my PhD program, and travel to Singapore as a postdoc. I am now faculty at Princeton University jointly appointed between the School of Architecture and the Andlinger Center for Energy and the Environment.

Chris Mutel

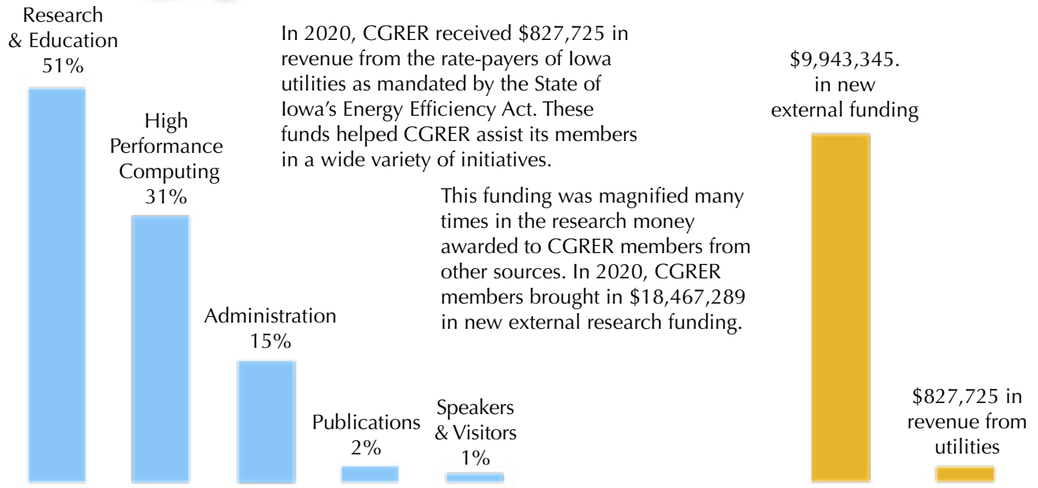
It is not an exaggeration to say that my time as a graduate student at UI was foundational for the life I now live.

It was in the department of Environmental Engineering and at CGRER that I first learned about sustainability analysis. At this point in my career, my focus is on making sustainability analysis better through more detailed and innovative data sources, new methods for including spatial and temporal aspects, and the development of open, transparent, and reproducible software for Life Cycle Assessment (LCA).

I was first exposed to LCA at Iowa and I continue to value the critical approach prioritized by this particular curriculum. Not everyone learns how to ask critical questions, how to question assumptions, or how to remain unsatisfied with assertions that seem to just feel right. In addition to LCA, I also learned computer programming. This is a skill I continue to use now as I now turn abstract ideas into elegant computer logic on a daily basis. Looking back, I can see how almost everything I learned in the College of Engineering and through my involvement in extra curricular activities like Engineers for a Sustainable World has contributed to my current position.

I am a scientist at the Paul Scherrer Institute, the national energy lab of Switzerland. I am fortunate to have an academic position where I can choose my students, research themes, and teaching activities. The work of my team helps inform national policy and I get to collaborate with colleagues across Europe and around the world. Even though my meetings now require I take fast trains to European capitals instead of short drives to Des Moines, I know for certain that I wouldn't be here were it not for my time at Iowa.

CGRER BUDGET & FUNDING



In 2020, CGRER received $827,725 in revenue from the rate-payers of Iowa utilities as mandated by the State of Iowa's Energy Efficiency Act. These funds helped CGRER assist its members in a wide variety of initiatives.

This funding was magnified many times in the research money awarded to CGRER members from other sources. In 2020, CGRER members brought in $18,467,289 in new external research funding.

CGRER MEMBERS

University of Iowa

Anthropology
Margaret E. Beck
Michael S. Chibnik
Russell L. Ciochon
James G. Enloe
Matthew E. Hill, Jr.
Meena Khandelwal

Biological Sciences
Andrew A. Forbes
Stephen D. Hendrix, Emeritus
Maurine Neiman

Chemical & Biochemical Engineering
Gregory R. Carmichael
A. Umran Dogan
Charles O. Stanier
Jun Wang

Chemistry
Tori Z. Forbes
Gregory K. Friestad
Sarah C. Larsen
Sara E. Mason
Scott K. Shaw
Elizabeth Stone
Mark Young

Civil & Environmental Engineering
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David M. Cwiertny
William E. Eichinger
Keri C. Hornbuckle
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Kathleen E. Stewart
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Tyler Priest

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Wei Zhang

Iowa Geological Survey
Keith E. Schilling

Journalism & Mass Communication
Kajsa E. Dalrymple

Law
Jonathan Carlson

Mechanical & Industrial Engineering
Geb Thomas
H.S. Udaykumar

Occupational & Environmental Health
Kelly K. Baker
R. William Field

CGRER ADMINISTRATION

CGRER is directed by UI's **Gregory Carmichael**, professor of Chemical and Biochemical Engineering, and **Jerald Schnoor**, professor of Civil and Environmental Engineering. Center activities are guided by Carmichael and Schnoor along with an elected Executive Committee that consists of 10 members (page 3). The Executive Committee meets monthly as needed to plan initiatives and chart CGRER's course. An Advisory Board of 10 members (page 5) from outside the academic community meets annually to lend oversight to CGRER's activities.

Joe Bolkcom, Jerry Schnoor, Jeremie Moen, Amy Parker and Greg Carmichael.

CGRER employs two full-time staff members. **Amy Parker** is Research Support Coordinator. **Jeremie Moen** manages the computer facilities with the support of Engineering Computer Services. In addition, **Joe Bolkcom** serves as half-time Director of Outreach and Community Education. CGRER reports directly to the UI Vice President for Research.

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Peter S. Thorne

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Paul D. Kleiber
Steven R. Spangler

Sociology
Jon B. Vasi

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Kate Cowles
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Animal Science
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Architecture
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Biomedical Sciences
College of Veterinary Medicine
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Civil & Environmental Engineering
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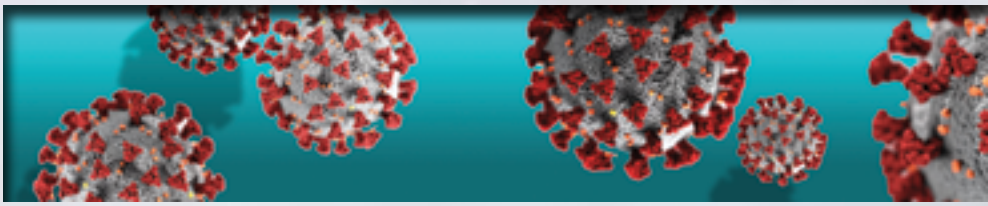
THE CENTER FOR GLOBAL & REGIONAL ENVIRONMENTAL RESEARCH

CGRER 2020 ANNUAL REPORT



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California wildfires (photo by Tim Williams, NASA Armstrong Flight Research Center)