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IonE Community Exchange

The IonE Community Exchange is an opportunity to explore and celebrate the diverse work being done within the IonE Community. IonE is comprised of hundreds of students, staff, and faculty from across all 5 UMN campuses. We are leaders, teachers, researchers, and artists. Below are the 23 projects that will be highlighted in this exchange. Learn more about these projects over lunch and the reception at the annual meeting on September 28.

Acara Student Projects
Acara Co-director, Megan Voorhees
Acara will present the "Acara Game Board": an interactive game in which participants can guess which descriptions of Acara student projects are real examples of work done here by UMN students. Prizes included!

Assuring Clean Water and Sustainable Ecosystems Via Improved Agroecological Management
Grand Challenge, Lawrence P. Wackett
We are addressing the Grand Challenges and IonE Initiatives on Water with the goal of protecting billions of gallons of water from contamination while maintaining agricultural productivity. Specifically, we are investigating the fate of nitrogen amendments in agriculture at a fundamental micro-level using computer predictions, experimental measurements, and further modeling to determine the interactions that determine the fate of the chemicals. The chemicals added are to provide nitrogen for the plants. The rate of release of assimilable nitrogen is determined by microbial biodegradation and that can be lowered by optimizing the chemical fertilizer mixtures. This is the basis for this Grand Challenge, and we are bringing to bear genomics, ecology, plant science, business, and policy approaches to solving this large, difficult but, we believe, tractable problem.

Catalyzing Change Across Minnesota: Partners in Progress
Troy Goodnough
The University of Minnesota Morris has worked with Institute on the Environment for the past 8+ years to make sustainability progress in the city of Morris and across Minnesota. This work has catalyzed: work at the Morris EcoStation, new water infrastructure for the city, a new relationship with state government, new climate education outreach, new opportunities for U of M student leaders, and more. The IonE mini-grant program has been critical to launching these efforts.

Commercial Building Efficiency in Minneapolis
Class Project, Andrew Butts, Elizabeth Arnold, Lusine Ghushchyan, Mona Shanbhag, Didi Kim
A student video project from Energy and Environmental Policy investigating what efforts, policies, and opportunities exist to improve commercial building energy efficiency in Minneapolis, and to an extent, broader Minnesota.

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Energy Transition Lab
Ellen Anderson, Barb Jacobs, Aaron Hanson

Environment Reports
GLI and IonE Communications, Barrett Colombo and Peder Engstrom
Published by the Institute on the Environment, Environment Reports is a collaboration among an international group of scientists, writers and designers to create incisive narratives about environmental challenges, backed up by cutting-edge data.
The site is intended for use by public and private sector professionals as well as those in academia who influence or educate environmental decision makers. It will provide several primers and useful visuals covering key aspects of the global food system, including projected future demand and yield trends, environmental sustainability, diet, food waste, climate change and more.
http://www.environmentreports.com/livestock-climate-variability/#section2

ExCITES: Expanding Commercial Implementation of Thermal Energy Storage
PI, Dr. Jane H. Davidson
Increasing electricity production by utility-scale solar and wind is projected to impact the stability of electrical grids. This issue can be ameliorated by increasing the flexibility of conventional thermal power plants by coupling them with thermal energy storage (TES). In this project, we are examining how to best use TES with conventional thermal power plants as a means to increase base-load flexibility and developing advanced phase change materials for this application. In the first year, we have completed a first-law model of a nuclear power plant with integrated TES applied the model to evaluate the behavior of the power plant during charge and discharge. Results show TES has the ability to increase capacity factor of nuclear power plants up to 9.25% compared to more common load reduction methods. The model also provides data to identify operating temperature for development of advanced phase change materials with tunable phase change temperature. Using charge and discharge temperatures from the first-law analysis, a synthesis of metal ligand-free metal nanoparticle (Bi or Pb) distributed in a mesoporous carbon matrix is demonstrated. The melting temperature of the high conductivity metals is tuned through variation in the nanoparticle size. The melting temperature of the nanoparticles is tunable up to 33°C compared to the bulk material melting point. Melting and resolidification temperatures are shown to be stable through multiple melt-freeze cycles. The carbon matrix prevents aggregation of the nanoparticles, accommodates volume change, and prevents leakage during phase change process.

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Geofinancial Analytics

Mini Grant, Nathaniel Springer

Levers beyond governmental policy are needed to improve the odds of averting catastrophic climate change. Financial market pressure is already playing a central role. Yet, while long-term institutional investors such as sovereign wealth and pension funds are integrating climate-change and other sustainability considerations into their investment decisions, such efforts fall well short of the necessary action. One of the main reasons for this shortfall is the difficulty of connecting specific investment assets to the consequences of companies' actions.

We therefore propose a new approach called "geofinancial analytics" to leverage the capital markets to change human impact on the physical world and improve the odds of averting catastrophic climate change and unsustainable development. Our team is building a tool to first test one promising example: live satellite data on methane venting and accidental leaks by publicly-traded fossil fuel producers. We will present an very early alpha version of this this tool, an interactive cartogram called MethaneScan, which shows how satellite data on flaring activities can be linked to production activity and attributed to public companies.

Green Solar Cells: Lead-free Halide Perovskites

Authors: Catherine Clark, Tom Webber, Kamilah Amen, Anna Abfalterer, Fiki Owhoso, Russ Holmes, Matt Aro, Patrick Schoff, and Lee Penn

The earth receives a tremendous amount of solar energy each day. Efficient conversion of solar energy to electricity has the potential to meet worldwide energy needs. However, solar cell technology is currently expensive. In the last decade, halide perovskites (HPs) have emerged as promising materials for thin-film solar cells, which have the potential to be much more cost effective. Methylammonium lead iodide (MAPbI3) is one of these halide perovskites, and solar cells made with this material are nearly as efficient as the widely adopted but expensive silicon-based solar cells. HPs have optimal optoelectronic properties, are composed of inexpensive elements, and are easy to fabricate. In addition, HPs can be used in flexible solar cells, which could increase implementation of solar cells dramatically. The big problem with HP-based solar cells is that all high-efficiency devices contain lead, a toxic element. Our experimental work focusses on synthesizing lead-free HPs for solar cell applications. We are attempting to make a new layered halide perovskite, MA3In2I9. Our goals include producing uniform thin films and single crystals of MA3In2I9. To date, we have made highly-oriented thin films and are getting close to preparing single crystals that would be suitable for single-crystal X-ray diffraction. In addition, we are attempting to make tin-based HPs using a vapor deposition technique we have developed here at the U of MN. This technique enables us to grow high-quality films. To-date, we have synthesized thin films of several different tin-halide perovskites on a variety of substrates, and shown the ability to control film stoichiometry and morphology. Finally, we are performing life cycle analysis on the materials produced in order to determine whether the new materials are actually greener alternatives to the lead-containing cells. While the alternative HPs do not contain the toxic element lead, there are other concerns regarding cell performance and breakdown products upon exposure to air and moisture.

Impact Valuation

Mini Grant, Jeff Standish, Kristi Kremers, Barrett Colombo, Jen Thissen

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Increasing Native Seed Availability for Minnesota's Prairies

PI, Ruth Shaw and Shelby Flint, co-author

Background/Question/Methods: Less than one percent of Minnesota's native prairie remains. There is great interest in restoring Minnesota's prairies, but this depends on seed availability. Concerns over local adaptation and genetic contamination have increased the emphasis on using plant materials that derive from populations near the restoration site. Quantities of seed representing diverse species and geographic areas undergoing restoration are severely limited. We are assessing the obstacles facing the production and use of locally-sourced native seeds by means of focus groups involving participants from government, nonprofit, and private organizations that produce or use seeds of native prairie plants in Minnesota.

Results/Conclusions: The initial focus groups with large-scale users of native seeds revealed that unpredictability in funding results in uncertainty in demand for plant materials. This unpredictability exacerbates risk for producers. Large-scale users recognize the importance of having multiple avenues of seed production, including hand harvesters, bulk harvesters, and agronomic-style producers. The participants note a shortage of small contractors in greater Minnesota. Bureaucratic barriers include differing definitions of 'local' depending on funding source, as well as rules restricting use of seed gathered from public lands as the foundation for commercial production. Cost, available quantities, available species, available source areas, and bureaucratic hurdles remain limiting factors to using locally-sourced native seed to restore Minnesota prairie.

Increasing Student Readiness for Sustainability Careers

Mini Grant, Rebecca Meyer, Nathan Meyer, Linda Kingery, & Rose Clarke

There are a growing array of research, management and innovation opportunities in sustainability and environmental studies, and knowing what organizations will expect in terms of professional competencies and knowledge is important for directing the continued education, growth and development of young adults and professionals. This project proposed to seek subject matter expertise to identify critical technical and "soft" skills needed to ensure success of early-career professionals in the 21st century sustainability and environmental workforce. Our research team interviewed nine conservation professionals representing a wide range of job sectors, including federal, state, county and municipal government agencies as well as higher education and non-profit. We will share results of the study encompassing a list of important skills and mindsets for early conservation career professionals synthesized from a review of literature and review of experienced professionals, as well as professional perceptions of critical skills and mindsets for early career professionals and future trends in conservation for which these professionals should be prepared.

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Identification of "Action Landscapes" to target interventions to promote sustainable agriculture in Latin America

Authors: Paul West, James Gerber

The Nature Conservancy (TNC) is investigating strategies intended to promote productive, resilient, and sustainable agriculture in Latin America. Targeting landscape-scale interventions requires a series of tradeoffs to define where staff and resources have the greatest opportunity to achieve outcomes for nature and people, and where collaboration with partners and other stakeholders will transform the current agricultural system to achieve a mutually-reinforcing relationship with our natural ecosystem. We led a consortium consisting of researchers from TNC, UMN, the International Center for Tropical Agriculture (CIAT), and the Laboratório de Ecologia e Restauração Florestal (LERF) at the University of São Paulo to quantify and assess of these tradeoffs. As part of the effort, we identified 14 "Action Landscapes" for targeting action.

Kawe Gidaa-Naanaagadawendamin Manoomin

Grand Challenge, Crystal Ng, Cara Santelli, Amy Myrbo, Dan Larkin, Mike Dockry, Mark Bellcourt, Mae Davenport

(Not So) Mini Grants: The First 15 Rounds

Jen Thissen

Open Feasts Food Waste Events

Mini Grant, Barrett Colombo

Queer Science

Mini Grant, Mohamed Yakub

Queer Science is the first of its kind program to specifically provide outreach to queer youth interested in STEM fields. Queer Science builds on similar models to "Girls can Code," "Black Girls can Code," and KAYSC's "Youth Science Day" by ensuring that underrepresented minorities get a voice in STEM fields. To help promote queer representation in STEM, we started Queer Science as an outreach to queer high school students. Through hands-on experiments and personal interactions, queer high school students can see possibility models who are successful queer scientists and researchers. We are hosting events and programs spanning 18-months of unique opportunities. This includes our current free day-long events, partnerships with other organization's events, and new programs such as ACT preparation and college application retreats.

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Sustainable Development: Architecture and Planning within the Ecological Footprint of One Planet

Richard Graves, Bonnie Keeler, Liz Kutschke, Chris Notenboom, Maike Hamann

To respond to the Grand Challenges of Assuring Clean Water and Sustainable Ecosystems and Enhancing Individual and Community Capacity for a Changing World, sustainable development must be redefined using a regenerative system approach that connects the use of materials, water, and energy to both the social needs of the community, as well as the carrying capacity of the local ecosystem.

Sustainable development has been a focus for at least the last 25 years. However, the international development community has failed to fundamentally transform the performance of the built environment in the most critical indicator: social-ecological impact. It has also focused on making existing throughput systems more efficient, instead of redesigning the system to function like a living system that continually self-renews and integrates with natural processes to "regenerate."

This is the difference between green design and regenerative design, the latter being a fundamentally new approach explored as part of this Grand Challenges project. We argue that regenerative design is required across multiple scales to achieve sustainable development, from a single building to the whole city.

Syngas from Concentrated Sunlight and Methane

PI, Dr. Jane H. Davidson

The development of sustainable alternatives to petroleum-derived fuels is critical given the increasing level of greenhouse gases in the atmosphere and the expanding demand for liquid fuels. One promising near-term route is the production of syngas (a mixture of H2 and CO) via solar chemical-looping methane reforming (sCL-MR) coupled to gas-to-liquids processes, which convert syngas into liquid hydrocarbon fuels, including gasoline, synthetic diesel, and jet fuel [3]. This approach enables solar energy to be stored in chemical form, upgrading the energy content of the feedstock by up to 28%. Driving the process with solar energy rather than combustion of fossil fuels reduces CO2 emissions by 41% compared to non-solar alternatives. The major outcome of our work over the past year was demonstration of the process in one of six ceria fixed-bed tubular assemblies in a prototype solar thermochemical reactor. We were able to achieve a solar-to-fuel efficiency of 7% and a thermal efficiency of 24%, which are the highest efficiencies reported to date for this process. Based on an energy balance on the reactor, predicted solar-to-fuel and thermal efficiencies for operation with all six tubular assemblies are 30 and 65%, respectively. Ongoing work seeks to further increase efficiency by optimization of operating conditions, including temperature, reactant flow rates, and cycle timing. A series of parametric experiments will be conducted in a bench scale fixed-bed of ceria particles to examine the rates of syngas production over a range of possible conditions. These data will be scaled based on similarity of dimensionless parameters and applied to a thermodynamic process model of the reactor to determine operating conditions that maximize efficiency. The prototype reactor will be demonstrated in the University of Minnesota High Flux Solar Simulator at the optimized operating conditions and reactor performance will be compared to model predictions.

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Talking Arts, Sciences and Sustainability: A Roundtable Discussion Series

Mini Grant, David Syring

Humans have always depended on artistic expression energized by observing and participating in the ecological world. Whether we call it science, traditional knowledge, wisdom of elders, or by some other words, we need the insights of our empirical curiosities to survive; and, we need the ability to communicate those insights through linguistic, graphic, bodily, and musical arts.
Field biologist and award winning writer Gary Paul Nabhan, in Cross-Pollinations: The Marriage of Science and Poetry, presents a credo for reinvigorating the practices of the sciences and the arts. Nabhan writes: "Cross-pollination is not some perk or frill that benefits only an elite few. Tens of thousands of kinds of plants need cross-pollination if they are to yield fertile seeds and plump, ripe, delicious fruit…Artists and scientists also need cross-fertilization or else their isolated endeavors will atrophy, wither, or fall short of their aspirations … The spark that moves between us ultimately has the capacity to sustain us over the long run" (p. 13). For this project, I take a cue from Nabhan and seek, through a series of discussions with artists, scientists, and educators to harvest a multidisciplinary set of stories, metaphors, and perspectives on how the arts collaborate with the sciences to sustain societies.

Understanding the zoonotic risk of echinococcosis for a northern Minnesota tribal community

Mini Grant, Tiffany Wolf

Echinococcus spp. are multi-host pathogens that can cause severe disease in humans. In North America, the life cycle of Echinococcus spp. is predominantly in wildlife hosts such as wolves, foxes, moose, and rodents; however, domestic dogs and occasionally cats also serve as hosts. Due to many ecological factors that are not well understood, prevalence of these parasites has been increasing in both natural and accidental hosts in the last few decades. We recently collected pilot data in a northern Minnesota indigenous community where Echinococcus is known to circulate in wolves and moose. In our pilot project, we surveyed fecal samples of the primary canid hosts present on the Grand Portage Indian Reservation: wolves, foxes, and domestic dogs. We found E. canadensis (genotype G8/G10) in 36% of sampled domestic dogs (n=14). This finding is alarming considering the sample prevalence of dogs approached that of wolves (41%, n=56; foxes = 9%, n=11), and is far higher than other studies of dogs in indigenous communities (6%, n=153). Primary risk factors for E. canadensis infection in dogs were the consumption of scraps from cervid carcasses and lack of veterinary care. This pilot study made clear the need for further work to fully understand the role of domestic dogs and risks of zoonotic Echinococcus transmission in our Minnesota (MN) indigenous communities, and provided a foundation for the recent award of another grant through the Academic Health Center to explore these questions further in other MN indigenous communities.

Utilities Perspectives on Research Collaborations With Universities

Energy Transition Lab, Steve Rose, Andrew Butts, Julia Wilbur, Barb Jacobs

An investigation into utility research collaborations with universities to understand how they come about and what factors lead to either success or failure.

Waste Heat Recovery for Power Generation Enabled by High-Efficiency Thermoelectric Materials

Discovery Grant, Xiaojia Wang, Uwe Kortshagen, and James Kakalios