THE TRANSECT

Missouri EPSCoR Newsletter

Spring 2017

Citizen scientists learn to gather, interpret, and archive soil health data across Missouri

The second Computer Science Institute for Women is held at the University of Missouri-Columbia

The Community Team promotes resilience through experiential education

Transect research is on display at the St. Louis Science Center's newest exhibit

An international climate change conference offers a Transect researcher opportunities for collaboration, adaptation

MISSOURI EPSCoR

photo credits: Sue Turner, Distance and Continuing Education, Missouri S&T

What is Missouri EPSCoR?

The Established Program to Stimulate Competitive Research (EPSCoR) is designed to fulfilll the mandate of the National Science Foundation (NSF) to promote scientific progress nationwide. Missouri became eligible to apply for EPSCoR funding in 2012. The program aims to provide strategic opportunities to stimulate sustainable improvements in R&D infrastructure, capacity and competitiveness, and to advance science and engineering capabilities for discovery, innovation and knowledge-based prosperity - capabilities that will benefit Missourians from all regions - urban to rural - and from all economic levels.

photo credit: MU CAFNR

Letter from the Director

Collaboration is the heart and soul of the Missouri Transect project. The project brings together experts and resources from across our State to address a shared challenge: climate variability over time and the impact it has on the plants we rely on to live. As you will read in this issue of The Transect, these collaborations are yielding a wide range of benefits across Missouri.

One of those benefits is a scientifically informed citizenry. As you will read, the Missouri Transect is using a wide variety of approaches to engage people of all ages, from all walks of life, and from all across Missouri into its research activities. They are monitoring soils in their backyards and neighborhoods, taking pictures and recording the history of their neighborhoods, tending to community gardens, and helping run the GROW-bot at the St. Louis Science Center new outdoor GROW! exhibit. While they are collecting data that is being used in real research being conducted by Missouri Transect scientists, they are also learning everything from the thousands of organisms that live in and depend on healthy soil to how drones are helping scientists engineer drought resistant crops. New coursework, curricula, and internships are also bringing in hundreds of middle, high school, and university students and teachers across the state to participate in the research of the Missouri Transect.

The scientific enterprise is also benefitting. To date, over 120 scientific articles have been published from investigators involved in the Missouri Transect. These publications detail new discoveries, approaches, and technologies that are advancing science and, as you will read, Missouri agriculture. The research infrastructure put in place by Missouri Transect is helping researchers secure new research grants as well as new equipment. Dr. Bo Svoma's exciting new NASA grant that uses the Doppler radar is highlighted in this issue. In addition, Dr. Joel Burken is hoping to leverage the remote sensing technologies and approaches developed by Missouri Transect investigators to secure a plane to support and advances this line of research. The long-term sustainability of the Missouri Transect research is strengthened by the addition of four new, highly qualified investigators: Dr. Ruthie Angelovici at MU, Dr. Melia Gehan at the Donald Danforth Plant Science Center, Dr. Fengpeng Sun at UMKC, and Dr. Xiong Zhang at Missouri S&T. These individuals add considerable talent, skills, and expertise to our State's research strengths in the plant, climate, and data sciences.

This issue of The Transect highlights that when people with ideas come together and share resources and expertise, we see results.

John C. Walker, Ph.D.
Project Administrator
Missouri EPSCoR

MISSOURI TRANSECT

Climate, Plants, and Community

The Established Program to Stimulate Competitive Research* (EPSCoR) is a National Science Foundation (NSF) program that awards up to $20 million over five years to eligible jurisdictions (U.S. states and territories) for "Track-1" programs to build research infrastructure and improve the jurisdictions' competitiveness on a national-scale for NSF funding.

Missouri NSF EPSCoR's Track-1 program is called the Missouri Transect because it is a statewide collaborative research effort that transects the research of plants, climate and community. Ten institutions and over 150 faculty, students, and technical staff conduct research and outreach programs in the five collaborative Missouri Transect teams: Plant, Climate, Community, Science Education & Outreach, and Cyberinfrastructure.

The Missouri Transect builds on established capacities in plant sciences, remote sensing and imaging, atmospheric and environmental sciences, economics, and the social sciences to better understand and predict the responses of plants and society to climate variability and increasing numbers of extreme weather events.

Infrastructure investments in people, technology, approaches, and ideas will enable us to better understand, model and predict (1) short- and long-term trends in temperature and water availability in the state; (2) the effects of these trends on the productivity of our state's native flora and agricultural crops; and (3) how different stakeholder communities are likely to respond to these changes. In addition to advancing our research capabilities, the Missouri Transect research infrastructure investments are enhancing our educational efforts to develop and diversify Missouri's STEM workforce.

*originally named Experimental Program to Stimulate Competitive Research

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photo credit: MU CAFNR

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Interest in Food - and Science - GROWs at the Saint Louis Science Center

GROW, the newest permanent exhibit at the St. Louis Science Center, highlights more than the journey of food from farm to fork. The science of Missouri Transect researchers is also on display.

At the exhibit's Farm Tech Field, visitors can see how scientists use technology to meet new challenges in agriculture. The field is the site of active drought research experiments being conducted by St. Louis University Professor Wasit Wulamu, a member of the Plant Team. The field is outfitted with thermal and hyperspectral cameras that are taking frequent images of the crops in the field and monitoring their growth and health. In addition, an autonomous ground vehicle, nicknamed GROW-bot, drives around on special tracks collecting temperature and soil moisture data. Every Friday, Prof. Wulamu or a member of his team is on hand to demonstrate the use of GROW-bot to visitors and to talk about the research.

Visitors can learn more about Wulamu's research and GROW-bot at touch screen computers (*pictured bottom left*). In the future, visitors will be able to see how the scientists are using the data being collected in the field. The touch screens also feature the root phenotyping research of Dr. Chris Topp (Donald Danforth Plant Science Center, Plant Team) and the climate studies of Tim Eichler (Saint Louis University, Climate Team).

"Science, technology, engineering and mathematics play a large role in the American agriculture industry. By helping people understand the science behind crops, plants, animals and weather, and how all these elements combine to form a system, we're preparing future generations with knowledge that can be used to innovate and sustain our food supply," said Bert Vescolani, president and CEO of the Saint Louis Science Center in a press release. "Our goal is not only to educate people about the science behind food production, but also to ignite an interest in those who could be the next generation of farmers, scientists, inventors and problem solvers."

Cindy Encarnación, Senior Director of STEM Content at the Science Center, is a member of the Missouri Transect Science Education and Outreach Team. She supervises planning, concept development, and supervision of all exhibit development activities for the agriculture technology exhibits that features Missouri Transect research and technology.

"GROW brings the topic of agriculture to the public in an up-close and very personal way," said Encarnación. "From combines to microbes, GROW presents agriculture to the public in engaging hands-on activities and educational experiences."

Experimentation Meets Exposition

Scientists at St. Louis University, affiliated with the Missouri Transect, are bringing their research focused on the applications of hyperspectral and thermal cameras in montoring plant and soil health to the GROW exhibit! Their GROW-bot (*pictured on the right*), collects soil moisture and temperature data at the experimental plot in the exhibit. It also provides a fun activity for anyone who wants to help collect this vital research data.

photo credits: Cindy Encarnación

The Missouri Transect Supports Women in STEM

A Second Computer Science Institute is held in Columbia

The Computer Science Institute for Women offers unique opportunities to engage a new cadre of female scientists.

Women are significantly underrepresented in computer science. Long before entering the job market, high school girls are outnumbered by boys 4:1 in advanced placement (AP) computer science exams. Educators and researchers on the Missouri Transect Science Education and Outreach Team recognized this disconnect between the growing need for computer scientists and the message girls receive from a young age about their ability to succeed in the STEM fields.

The Computer Science Institute for Women (CSIW) is held each summer. Transect researchers and educators lead this 2-3 day workshop and bring in female scientists at the top of their field to teach female high school and undergraduate students basic skills in computational biology and give them a glimpse into the interdisciplinary nature of Missouri Transect research.

The institute provides the students career training, opportunities to connect with established scientists for future internship and research opportunities, and "minds-on, hands-on" lessons using real datasets to give the students the knowledge base and confidence to pursue an interest in computer science.

The second annual CSIW was held at the University of Missouri in Columbia in June 2016. Researchers in the fields of bioinformatics, climate science, and meteorology illustrated how their research has been shaped by advancements in computer science.

Dr. Pat Guinan (Missouri Transect Climate Team), State Climatologist and Associate Extension Professor in Climatology at MU, met the 14 students at Sanborn Field on the MU campus to show them a weather station that has been collecting hourly data on air temperature, relative humidity, wind direction and speed, soil temperature at two-inch depth, solar radiation, and rainfall for the past 20 years. Dr. Pat Market (Climate Team lead), Department Chair and Professor of MU Atmospheric Sciences, introduced them to the programs used by meteorologists to forecast weather, streaming the continuous data of hundreds of meteorological stations around and above the Earth. Further discussion of atmospheric science focused on climate change short-period forecasting, known as "nowcasting." and climate change variability on a regional scale.

Four scientists, including Dr. Dmitry Korkin from the Worcester Polytechnic Institute in Worcester, Massachusetts, taught students about bioinformatics and machine learning through hands-on use of datasets. Students had the opportunity to use programming language to sort and analyze genetics and biological data.

Several female undergraduates at MU who are conducting research in faculty labs served on a discussion panel to answer questions about pursing a path in STEM. The panelists also gave their impressions of working in STEM as female researchers, suggestions for funding opportunities, and their career and education plans.

The exposure to computer science through CSIW is helpful for any young woman considering a science major. Kathryn Coleman, a freshman Dietetics major at the University of Missouri-Columbia said of her experience, "I felt really encouraged...it was all the sorts of things I want to go back to and pursue."

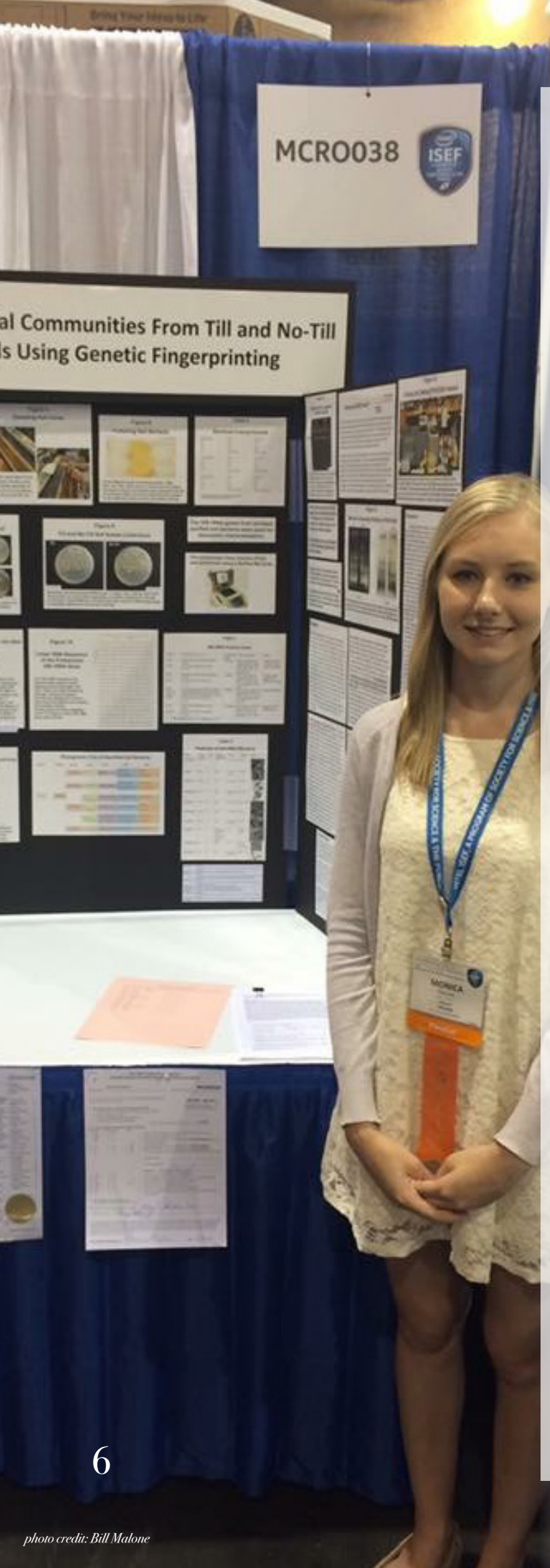
CSIW will rotate among Missouri Transect partners each summer so that each partner can emphasize its own faculty and scientific expertise within the context of Missouri Transect research. The next institute will be at the Missouri University of Science and Technology (Missouri S&T). The institute will be expanded to welcome 50 participants from around the state and focus on computer science applications to research such as precision agriculture using robotics and acoustic monitoring of bees.

photo credit: Emily Hashighi

photo credit: Kate Jacobsen

photo credit: Kate Jacobsen

The 3rd Computer Science Institute for Women will be held at the Missouri University of Science and Technology in Rolla, Missouri from June 28-29, 2017.



Student Highlight: **Monica Malone**

Missouri Transect student researcher Monica Malone takes 4th Place at the Intel International Science and Engineering Fair

St. Louis high school student Monica Malone took her science project on how tilling affects soil microbes to the Intel International Science and Engineering Fair in Phoenix, where she took fourth place in the microbiology category.

The competition drew 1,700 high school students from over 75 countries. Malone was selected to attend and participate in the international science competition after taking first place at the Academy of Science St. Louis Science Fair last February.

Malone collected soil samples from tilled and no-tilled sites. For each sample, she measured various indicators of soil health and also extracted DNA from individual microbe colonies from the samples. Her analyses showed that no-tilled soils have a greater diversity of microbial life than that of tilled soil.

Tilling, which involves mechanically preparing an agricultural field by breaking the ground, is thought to disrupt the microorganisms in the soil and adversely affect soil health. No-till agriculture, in contrast, is thought to provide a more favorable environment for soil microbes and thus contribute to the health of the soil, an assertion that Malone's research appears to support.

Malone carried out the research at the Donald Danforth Plant Science Center under the guidance of Terry Woodford-Thomas. Woodford-Thomas is the director of Science Education and Outreach at the Donald Danforth Plant Science Center. She leads the Missouri Transect Science Education and Outreach Team and coordinates MO DIRT, the Missouri Transect citizen-science project aimed at raising awareness of the importance of soil health.

Malone, who is headed to Case Western Medical Reserve University in the fall, said she is ready to plunge her hands into something other than soil but plans to continue doing research.

"I'm switching my focus to tissue engineering, however, my background in soil science will help me become a better biomedical engineer and eventual doctor," she said, adding, "I'm excited to move on to my next area of study!"

photo credit: Bill Malone

Across Missouri, **Around the World**

Graduate student Ojetunde Ojewola travelled to Hanoi, Vietnam, to present his research about the perception of climate change among employees of Missouri State Parks

Although the work being done through Missouri EPSCoR on climate science is regionally focused, the findings are significant worldwide. Ojetunde (Tunde) Ojewola, a graduate student on the Missouri Transect Community Team, and his advisor and Community Team member, Dr. Mark Morgan, traveled to Hanoi, Vietnam in April 2016 to present his research at the 8th International Conference on Climate Change: Impacts & Responses. This conference brings together a community of researchers to facilitate collaboration on the burgeoning effects of climate change on societies, and current strategies for adaptation. Tunde was able to present his contribution to the Community Team at an international level.

Tunde is currently working on a PhD in Human Dimensions of Natural Resource Management at the University of Missouri-Columbia. In his dissertation, he seeks to examine the perceptions, concerns, level of awareness, knowledge, level of vulnerability and resilience of Missouri State Park employees to climate change. Tunde collected both qualitative and quantitative data through survey and semi-structured interviews of over 500 state park employees, with 81% response rate.

As global ecological resources are affected by natural disasters and climactic variation, those who work in parks and other protected environments are able to gauge and interpret those changes. As Tunde relates, "Unlike the Arctic regions or coastal areas where the glacial melting and coastal degradation associated with climate change can be conspicuous, the Midwest does not show obvious impacts. However, natural resources are good indicators of change over time. Scientists should be able to detect subtle changes more easily in parks, due to the rich and undisturbed ecological resources." Research undertaken to understand employee perceptions will be valuable to assess the widespread impacts of climate change within the park system and hopefully leading to better communication, outreach and collaboration with stakeholders.

Tunde is not new to this type of research. His undergraduate and master's degrees are from the University of Ibadan, Nigeria, in Wildlife and Ecotourism Management. The focus of his work was on ecological consideration for the management of tourism both at his university and a national park in Nigeria. He states, "My bachelors through graduate work has been a continuum in understanding the interaction between human factors and natural resources to address management issues in protected areas from a global perspective." As Tunde works to investigate the way that people perceive natural resources, he hopes to gain a fundamental understanding of human behavior in order to improve conservation and natural resources management.

Tunde is working with Drs. Morgan and Sonja Wilhelm-Stanis, researchers on the Community Team studying the ways that climate change affects visitation and management of Missouri State Parks and Historic Sites. Specifically, they hope to gauge the resiliency of Missouri parks to adapt to long-term climactic changes and increasingly frequent and severe weather events.

Although the survey results of park managers and employees are still being analyzed, Tunde was able to give conference-goers an overview of responses received to date. Beyond that, the conference provided a valuable opportunity for him to network and learn about other research being done around the world. As Tunde shares, "There was a particular presentation that establishes an adaptation framework and model of a coastal city, in central Vietnam, currently experiencing a fast growing rate of negative impacts from climate change related disasters. The presentation gave me an insight into how I can modify my adaptation framework for the Missouri state parks study."

Tunde will present his latest findings at the George Wright Society (GWS) conference in Norfolk, Virginia in April 2017. Other team members will attend the 2017 International Symposium on Society and Resource Management (ISSRM) conference in Sweden this summer to represent the Missouri Transect on an international stage.

photo credit: Dr. Mark Morgan

Helping the Most Vulnerable Become the Most Resilient

Researchers and students at Lincoln University, a Historically Black College and University (HBCU), are engaging communities in the poorest parts of Missouri in training and educational programs to help them adapt to severe environmental conditions

The Missouri Transect Community Team at Lincoln University is using a variety of initiatives to promote community resilience, emergency preparedness, self-sufficiency, and ultimately, a greater sense of security. Jeff Hargrove is leading this initiative and working with some of the most vulnerable rural communities in Cole County (central Missouri) and the Bootheel (southeast Missouri). Scott County in the Missouri Bootheel is categorized as a high vulnerability and low resilience county, according to the County-Level Resilience-Vulnerability Index developed by the Missouri Transect Community Team at the University of Missouri Institute of Public Policy. Hargrove asserts that the "Bootheel area is historically economically depressed, which makes these communities more vulnerable to changing environmental conditions." The estimated median household yearly income is $17,000, and over 50% of the population has a household income of less than $10,000.

Hargrove and his undergraduate students work with community members to provide them with educational resources about sustainability, food production, and emergency preparedness through seminars, classes, and various experiential learning activities. Their aim is to improve food availability and security through increased community participation and local partnerships. Through collaboration with regional groups like the Bootheel Community Development Corporation, county health departments, and community associations, the Community Team at Lincoln is working towards integrating community resilience with community development among the most vulnerable populations.

There are four undergraduate students interning with Hargrove. Emily Scheperle, a freshman Education major, is using surveys to gauge community preparedness to natural disasters. Alanna Wansing, a sophomore Agriculture major, and Ashley Wansing, a senior Psychology major, are teaming up to teach child participants at the Prenger Center/Boys and Girls Club about growing food. They will also conduct pre- and post-surveys to quantify the knowledge retained by students from the course. Finally, freshman Agriculture major Wyatt Hunziker is studying aquaculture systems in Cole County.

Educational workshops and seminars taught by Hargrove offer a large selection of adult education in resiliency subjects and skills. They cover gardening topics (i.e., composting, soil health, plant pathology, and nutrition), production at home (i.e., beekeeping, aquaculture, and vermicomposting), emergency preparedness, renewable energy, and food preservation. This variety of topics attract interest from many who had never before considered the value of self-sufficiency. Hargrove describes it as, "information that people do not know they want to know." When members of communities do not grow up with a focus on principles of resiliency, they do not recognize the enjoyment and sustainability it can bring. But when the opportunity for education is presented to them, it becomes "a Field of Dreams situation," Hargrove says. "If you build it, they will come."

And they have come. Over the course of 73 seminars and educational workshops, the group has educated 1,177 people. Their summer camps and field trips have drawn 182 children, and the seven community gardens built by Hargrove and his team offer continuing chances for community engagement. Through their efforts in the Bootheel and Jefferson City, Hargrove and his team continue to bridge Community Team research on resiliency with on-the-ground application.

photo credit: Jeff Hargrove

photo credit: Jeff Hargrove

photo credit: Ashley Wansing

St. Louis Residents Look into the Past and Find Hope in the Future through Missouri Place Stories

MO Place Stories provides an opportunity for members of Missouri communities to create a collective understanding of history and climate through individual stories.

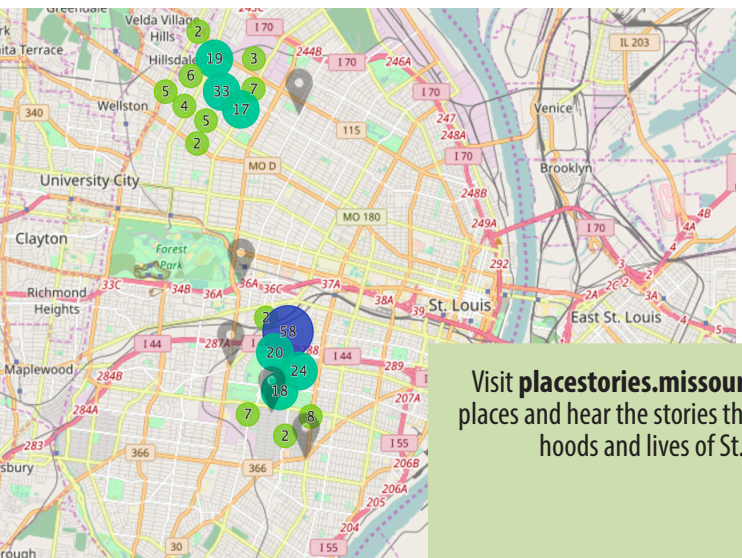
The Missouri Transect Community Team aims to understand how Missouri communities can manage for resilience under a changing climate. The research undertaken by the team will inform understanding of the community-level effects of climate change by considering how diverse stakeholders make decisions in response to drought, storm events, and impacts of vegetation. Within the Community Team, Dr. Andrew Hurley, Professor of History at UMSL, is studying long-term patterns of social response to environmental disruptions by collecting historical and archival data in the city of St. Louis between 1800 and the present. He is also gathering personal accounts of how St. Louis neighborhoods have changed due to major environmental events by collecting stories and photos from local residents.

Dr. Hurley explains his role with the Missouri Transect as, "engaging communities in the St. Louis area in exercises to prepare for climate-related disruptions through the analysis of historical data." His project, Missouri Place Stories, gathers residents' impressions of their neighborhoods through short audio statements, pictures of relevant locations, and text overlaid on an interactive map on the Missouri Place Stories page (placestories.missouriepscor.org).

He and his team canvas neighborhoods in St. Louis and visit community events in order to engage in dialogue with residents about their neighborhoods. Dr. Hurley has found that, "people are eager to share and to talk about their neighborhoods to strangers." Provided with historical data, residents are encouraged to "talk about how a place has changed or how it is now, how it is different than it was before, how they would like to see it revert to, perhaps how it was in the past," he explains.

The qualitative data collected by Dr. Hurley's team is distilled and shared with neighborhood planning organizations and city government. He has found that many residents are concerned about security and redevelopment after major environmental events. Community members also share interest in community gardens to give their neighborhood a cohesive identity, and improve food security, community involvement, and soil health.

By engaging with residents, neighborhood planners, and city government, Dr. Hurley's team is helping to facilitate a network of community partners who are informed and engaged in their own resilience to climate change. The Missouri Place Stories serves as a model for community resilience by using one's own history to create a path towards developing a better future.



Visit **placestories.missouriepscor.org** to see the places and hear the stories that explore the neighborhoods and lives of St. Louis residents!

Indexes Measure Resilience at the County Level

Climate change has increased the likelihood of more and severe weather events, including droughts, floods, heat waves, and storms. When it comes to responding to such events, some communities are more vulnerable than others. As local and state governments plan for climate change, they would benefit from knowing who is most vulnerable and who might require additional support in emergency situations. In a working paper, Missouri Transect researchers on the Community Team offer a multidimensional framework counties can use to assess their resilience and vulnerability to disasters.

The paper presents a set of indicators designed to measure county resilience and vulnerability along social, infrastructure, economic, and environmental dimensions. The researchers calculated county-level values for each indicator and for the set of indicators for each dimension. These values were then used to assign each county to one of four quadrants, according to their relative high or low resilience and vulnerability on that dimension.

According to the authors, "the next steps will be to explore how these indexes can be applied as part of local and regional planning processes and whether the results reflect reality on the ground."

"We know that we are experiencing an increase in the number of extreme weather events that have caused billions of dollars in damages. State and federal level support for these severe events is becoming unsustainable, so it is up to leaders at the community and regional levels to increase their resilience to severe disruptive events," said Erin Meyers, a policy analyst with the MU Institute of Public Policy, the organization that produced the paper. "The Resilience and Vulnerability Indexes offer a starting point for those leaders to identify areas of vulnerability and prioritize where they will work to improve their ability to mitigate the effects of future events."

Meyers is taking the lead on outreach and analysis of the Resilience and Vulnerability Indexes, presenting results to local, state, and national stakeholders.

Read the study: Kathleen K. Miller, Angela Johnson, Brian Dabson. Working Paper IPP/07: Measuring Resilience and Vulnerability in U.S. Counties. 2016 (May). Available online at https://ipp.missouri.edu/wp-content/uploads/sites/2/2016/07/Working-Paper-07-Measuring-Resilience-and-Vulnerability-in-US-Counties-FINAL_w.pdf

Using ENSO Impacts to Forecast Crop Performance

The El Nino Southern Oscillation (ENSO) and the Pacific Decadal Oscillation (PDO) are naturally occurring events that involve fluctuating ocean temperatures in the Pacific. Both phenomena influence regional climate patterns and thus contribute to climate variability. Since changes in weather and climate conditions affect crop performance, can these two climatic events be used to partially or wholly predict crop yields in the United States? That is the question Missouri Transect researchers on the Climate Team answer in a new study published in the October 2016 issue of the International Journal of Biometeorology.

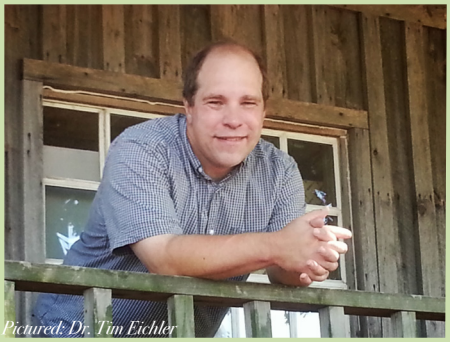
The study included 95 years of data on corn yields and 70 years of data on soybean yields as well as temperature and precipitation data for six climate regions in Missouri. The researchers analyzed the yield and weather data for patterns that corresponded with climate variabilities related to phases of ENSO and PDO events. Their analysis shows a link between average crop yields and times when ENSO is warm and PDO is positive and a link between regional differences in crop yields and cycles of ENSO. The most striking finding is that ENSO events occurring in the fall and winter can directly predict summer crop yields.

"We found that a transition into an ENSO event had a more significant impact on crop yields than the most recent ENSO event. In other words, the forecast for summer crop yields is based on the ENSO event that will occur in the subsequent fall/winter," said Chasity Henson, a doctoral student in the Department of Natural Resource at the University of Missouri and lead author of the study.

The findings suggest these events can be used to develop seasonal forecasts for crop production, which can help farmers make informed cropping decisions.

"The research allows for a forecast of corn and soybean yields for each specific climate region in Missouri based on ENSO and PDO phases, which provides farmers with accurate information to make valuable planting and irrigation decisions," said Henson.

Read the study: Chasity Henson, Patrick Market, Anthony Lupo, Patrick Guinan. ENSO and PDO-related climate variability impacts on Midwestern United States crop yields. International Journal of Biometeorology 2016; doi:10.1007/s00484-016-1263-3



Pictured: Dr. Tim Eichler

Forecasting Future Climate Patterns with Modeling Techniques

Dr. Tim Eichler is a climate/weather enthusiast who has demonstrated his passion for atmospheric science through 20 years of research using climate models and the trends they reveal. He is a faculty member at Saint Louis University (SLU) in the School of Education and is a member of the Missouri Transect Climate Team, engaging in collaborative research with other Transect faculty on the Climate, Plant and Education teams. He brings to the Climate Team expertise, experience, and an indefatigable joy for his work. Through his ongoing research at SLU, focused on the analysis of mid-latitude cyclone activity under climate change, he provides a clearer picture of future changes to the hydrology of Missouri and North America in the coming century.

Dr. Eichler's research investigates the behavior of mid-latitude cyclones generated by climate models. Mid-latitude cyclones are the same low pressure systems shown by TV meteorologists that are often responsible for precipitation across the United States. Climate models run over a period of decades or longer and generate their own cycles of weather based on the model's physical representation of the climate system, which includes the atmosphere, ocean, snow/ice, vegetation, clouds, and land type. To evaluate climate change, climate models are run under a variety of atmospheric carbon dioxide concentrations ranging from historical trends to doubling and even quadrupling the current carbon dioxide concentration. Dr. Eichler investigates how the frequency and intensity of mid-latitude cyclones may change in response to a warmer world. The mean storm track across North America is guided by a river of air called the Jetstream. If the Jetstream shifts position in response to climate change, the storm track and its associated precipitation shifts with it.

Dr. Eichler's research has revealed some intriguing trends in mid-latitude storm tracks. He has found that as the climate warms, the Jetstream and associated storm tracks shift northward. Since the oceans become warmer in a global warming scenario, storms may become more intense over oceans due to greater evaporation from the ocean's surface providing energy for the storms.

Eichler's findings are used by other Transect researchers. He helps bring climate modeling data to the Climate Team, a vision of future hydrologic conditions for the Plant Team, and a foundation for natural disaster resiliency for the Community Team. Through collaboration with the Department of Nutrition and Dietetics at SLU, Dr. Eichler's outreach work combining his expertise in weather and climate with urban gardening is being integrated into the curriculum of a middle school in St. Louis. His climate models are also on display at the GROW! Exhibit at the Saint Louis Science Center.

Changes in storm frequency and intensity will force changes in agricultural management, urban planning, and environmental conservation. Through his research of weather patterns and climate modeling, Dr. Eichler, and the other Missouri Transect researchers, are playing an important role to help communities, governments, and industries adapt to these changes.

photo credit: Mason Maimaitijiang

Techniques For Precision Agriculture Take Flight

Dr. Abuduwasiti Wulamu on the Missouri Transect Plant Team seeks to develop new methods for monitoring crop growth and stress at multiple scales (leaf-canopy-airborne-satellite) using remote sensing technology. He is bringing his research into our everyday lives.

Plant Team researchers on the Missouri Transect are studying abiotic stress in controlled environments and in the field through plant and root phenotyping, deploying sensors to monitor stress that is not visible to the naked eye, and developing algorithms and software to process imaging data. Dr. Abuduwasiti Wulamu was awarded a seed grant from the Missouri Transect in 2015 to carry out his research at Saint Louis University (SLU) Center for Sustainability. His team is enhancing the field phenotyping component of the Plant Team by measuring drought stress and ozone stress (both abiotic stresses on plants) using unmanned aerial systems (UAS) and manned aircraft with RGB (red, green, blue), multispectral, hyperspectral and thermal cameras mounted to collect low-cost real-time imagery data. Dr. Wulamu explains that using UAS to monitor fields allows extending leaf/field level observations to satellite scale, which will have "far reaching effects by helping the farming community understand mechanisms behind regional and global yield declines, and could contribute to techniques for breeding stress-tolerant crops."

Dr. Wulamu uses his research as an opportunity to train students and to teach the public about the importance of UAS technology for the food that they eat. At the Saint Louis Science Center (SLSC) GROW! Exhibit, Dr. Wulamu's team is collecting data and leading demonstrations for thousands of visitors. When they are not at SLSC, his team operates out of the Remote Sensing Lab at SLU, a valuable nexus for students to learn a holistic approach to remote sensing. To prepare students for their own work with unmanned aerial systems, the lab teaches students how to design, manufacture, and analyze the data collected from such systems. Dr. Wulamu is also hosting an intern with the occupational therapy component of the Missouri Transect Education Team. This program, led by Dr. Jessica Dashner at Washington University, is working with undergraduates with Spinal Cord Injury (SCI) to "provide them with a pathway to long and rewarding careers in informatics, biological sciences, and other areas of science." Ty Krewson is an undergraduate in mechanical engineering through the University of Missouri-St. Louis joint partnership with Washington University. He has been working with Dr. Wulamu in remote sensing and is the first intern with SCI to work on the Missouri Transect project.

Precision agriculture using UAS technology is a young industry, and Dr. Wulamu's team is working at the leading edge of it. Through the Missouri Transect seed grant, Dr. Wulamu has made lasting connections with researchers from around the state, has illustrated exciting technologies for precision agriculture to the public, hosted an SCI intern, funds graduate students, and has purchased a hyperspectral camera. Through his work, Dr. Wulamu is helping bring about a truly 21st century agricultural capability that will ultimately help our producers.


photo credit: Matt Schroer


photo credit: Matt Schroer

Missouri's Citizen Scientists Take on a Dirty, but Highly Rewarding Job

Missourians Doing Impact Research Together (MO DIRT) assesses the current status of soil health in the state with citizen scientists.

At the Donald Danforth Plant Science Center in St. Louis, Dr. Terry Woodford-Thomas, Driemeyer Director of Science Education and Outreach and Dr. Sandra Arango-Caro, Education Programs Facilitator, lead MO DIRT. Dr. Thomas is the team lead for the Missouri Transect Science Education and Outreach Team. Dr. Arango-Caro is also on the Education Team and conducts MO DIRT soil health survey trainings regularly around the state. Equipped with training, guidelines, and soil quality test kits, participants across Missouri are actively recruited to seasonally collect and electronically record local data (i.e., GPS coordinates, air temperature, soil temperature, soil type, topsoil depth, clay content, soil moisture, nitrogen, and respiration).


photo credit: Matt Schroer

MO DIRT sparks scientific inquiry among Missouri citizens while also expanding data collection across the state to provide Missouri Transect researchers with information about soil health. Citizen scientists who collect soil data for MO DIRT are contributing to Missouri Transect researchers' predictive capabilities of the effects of climate change on future agricultural productivity. They are helping to answer two questions: 1) to what degree is soil health in the face of climate change effected by drought?; 2) does soil health in the face of climate change remain consistent along geographical climate boundaries, or is soil health driven by site-specific factors?

MO DIRT is also helping to augment scientific curriculum. One professor at Harris-Stowe State University, a Missouri HBCU, is monitoring a site for MO DIRT with his Urban Agriculture students. This group is using the data from other sites to compare results among different habitats and to examine soil health indicators over time. This is the mutual benefit of citizen science; it informs researchers, citizens, and communities about an essential shared natural resource. Everyone benefits from consistent, up-to-date information about the soils on which they live.

MO DIRT has its own platform housed on the Missouri EPSCoR website (http://modirt.missouriepscor.org/) to archive and validate soil health data collected by its volunteers. The data will soon be made available to MO DIRT participants, the general public, and Missouri Transect researchers for teaching purposes, managing lands, and contributing to ongoing Missouri Transect research.


photo credit: Matt Schroer

Since its inception, MO DIRT has trained 170 citizen scientists to conduct soil health surveys. They have distributed 79 soil kits, and 12 of these are also used for outreach and education purposes. Trained citizens monitor croplands, pastures, forests, prairies, and grasslands. Through the analysis of many soil parameters, more than 600 citizens glean a greater understanding of their land, and can form a path forward to improve its health and stability. Combining these trainings with other efforts in K-12 soil science curricula development, independent research projects in high schools, and public outreach events, MO DIRT is fostering communities that care about the health of Missouri soil and support soil conservation efforts across the state of Missouri.

The Keys to Soil Success

After receiving training in the proper methods of soil health monitoring in the field, participants in MO DIRT receive a backpack (pictured below) that contains all of the tools necessary to test soil health anywhere, any time.

Chemical tests, soil handling tools, and reference materials make up this indispensable toolkit for Missouri's citizen soil scientists.

photo credit: Dr. Sandra Arango-Caro

Field Robots Accelerate Genetic Research

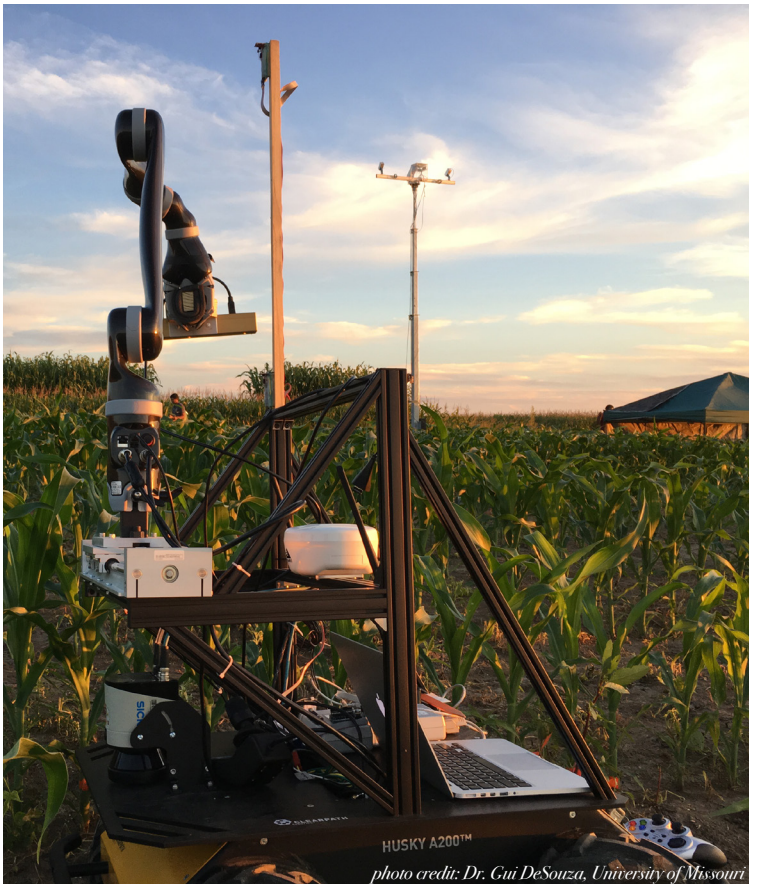


photo credit: Dr. Gui DeSouza, University of Missouri

The genes that underlie complex traits in plants are finally being revealed thanks to the emergence of high-throughput phenotyping technologies and advances in data science. The technologies that allow highly automated collection of basic phenotypic data for small numbers of plants in the greenhouse, however, fall short when used to examine and characterize thousands of plants under real world conditions. A robotic system that can collect multi-modal, multi-character data in real time in the field is described in the January 2017 issue of the journal Sensors.

The system, which was developed by Missouri Transect researchers from the Plant Team, includes two robotic platforms. Vinobot is an autonomous ground vehicle that collects data from individual plants. Vinocular is a mobile observation tower that oversees an entire field, identifying specific plants for further inspection by the Vinobot. In the study, the authors report on preliminary results from algorithms that compare phenotype data collected by the robotic system with phenotype data collected by hand. According to the study's authors, the findings demonstrate "the proposed architecture is cost effective, reliable, versatile, and extendable."

Plant physiologist at MU, Dr. Felix Fritschi is on the Missouri Transect Plant Team and an author on this paper. He explains that this new technology will aid the Missouri Transect's mission to enhance Missouri's capacity to model and respond to the effects of climate change on plants because the "Vionobot and Vinoculer allow us to monitor plant growth and physiological traits continuously and with high temporal resolution. We cannot only use this information to better understand short-term and seasonal plant responses to changing environmental conditions, but we can also leverage it for the development of phenotyping protocols for other platforms such as timing and/or frequency of UAV-based phenotyping platforms." Additionally, this new technology is cost effective and non-distractive to the plants being monitored. Fritschi says, "We expect that three-dimensional reconstruction of individual plants growing in the field will allow non-destructive extraction of features that currently are conducted using time-consuming, destructive approaches."

Read the study: Ali Shafiekhani, Suhas Kadam, Felix B. Fritschi, Guilherme N. DeSouza. Vinobot and Vinoculer: two robotic platforms for high-throughput field phenotyping. Sensors 2017, 17(1), 214; doi:10.3390/s17010214


photo credit: Dr. Gui DeSouza, University of Missouri

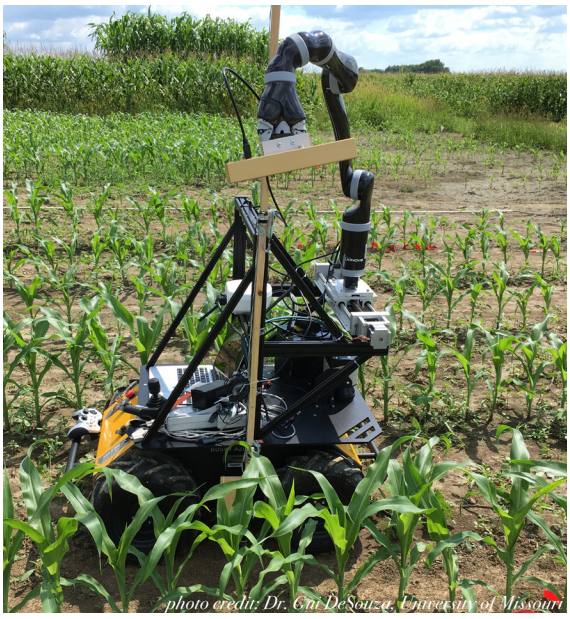


photo credit: Dr. Gui DeSouza, University of Missouri

Missouri Transect Researcher Receives NASA Grant to Study Solar Eclipse

On August 21, 2017, the path of a solar eclipse will pass over the Columbia campus of the University of Missouri for 2 minutes and 40 seconds. Missouri Transect Climate Team members, Bo Svoma and Neil Fox will use every moment to soak up as much science as they can.

Drs. Fox and Svoma, along with Dr. Jeff Wood, will be one of 11 teams of NASA-sponsored researchers gathering information and testing new instruments during the event. They will focus on what happens on the Earth during these uncommon conditions. Specifically, they will be gathering land and atmospheric data, including solar radiation. Their studies will take advantage of MU's Doppler radar – funded by Missouri EPSCoR and the only research Doppler radars in the country in the path of the solar eclipse – to collect data. "The radar will provide information about changes in wind speed and direction in response to the cooling produced by the Moon's shadow," Svoma explains.

According to Steve Clarke, director of the Heliophysics Division at NASA Headquarters in Washington, D.C., "This will be one of the best-observed eclipses to date, and we plan to take advantage of this unique opportunity to learn as much as we can about the sun and its effects on Earth."

This grant is an example of how research infrastructure improvements provided through Missouri EPSCoR are helping enhance research and bring more funding opportunities to Missouri.

photo credit: MU CAFNR

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