"Just about every single person in the world already has the values they need to care about a changing climate. They just haven't connected the dots. And that's what we can do through our conversation with them."—Katharine Hayhoe, climate scientist

A GLOBAL CHALLENGE

Climate change is a complex problem with no easy answers—and everything at stake. As global temperatures continue to rise, Kent State faculty reflect on our ability to mitigate and adapt to a changing planet.

By Kat Braz and Jan Senn

When the United Nations Intergovernmental Panel on Climate Change released its latest report in April 2022, IPCC Chair Hoesung Lee described it as "powerful evidence that we have the potential to mitigate climate change. We are at a crossroads. ... Climate promises and plans must be turned into reality and action, now. It is time to stop burning our planet and start investing in the abundant renewable energy all around us."

The Working Group III report, prepared by 278 scientists from 65 countries, is the third installment of the IPCC's Sixth Assessment Report (AR6), which will be completed this year. "It's now or never if we want to limit global warming to 1.5°C (2.7°F), says IPCC Working Group III Co-Chair Jim Skea. "Without immediate and deep emissions reductions across all sectors, it will be impossible." But there are options in all sectors to at least halve emissions by 2030.

The Working Group II report, released in February 2022, warned that global warming exceeding 1.5°C will lead to "additional severe impacts, some of which will be irreversible" and "would cause unavoidable increases in multiple climate hazards and present multiple risks to ecosystems and humans."

While mitigating actions would substantially reduce projected losses and damages, it's impossible to eliminate them all. Even to slow climate change, the world is running out of time.

In the IPCC's first AR6 installment, released in August 2021, UN Secretary-General António Guterres characterized the situation as "a code red for humanity. The alarm bells are deafening, and the evidence is irrefutable." Human influence has warmed the climate at a rate unprecedented in at least the last 2,000 years. However, Guterres also noted that "Inclusive and green economies, prosperity, cleaner air and better health are possible for all, if we respond to this crisis with solidarity and courage."

> "Inclusive and green economies, prosperity, cleaner air and better health are possible for all, if we respond to this crisis with solidarity and courage."
>
> **UN Secretary-General António Guterres**

Despite the dire warnings and the daunting statistics, faculty at Kent State—designated an R1 research university in February—remain hopeful about opportunities to mitigate and adapt to our changing climate in the coming years. To better understand and address the climate crisis, we asked several faculty members, most of whom participate in Kent State's Environmental Science and Design Research Institute, for their perspective on this existential challenge.

"Physics doesn't care what your spin is."—Bill McKibben, American environmentalist

ANOMALOUS WEATHER PATTERNS

Terms describing severe weather patterns like "El Niño" and "polar vortex" get bandied about on the nightly news without much context or definition. Understanding climates and how extreme weather and climate variability manifest and affect life on Earth helps put rising temperatures and mild winters in perspective.

"We are seeing fewer really extreme cold days," says Scott Sheridan, PhD, professor and chair of the Department of Geography, who published a study of abnormal weather patterns in the *Journal of Geophysical Research* in 2019. "Winter weather has gotten more irregular across the hemisphere but even in a warmed world, that doesn't mean cold weather is going away."

Although the term polar vortex was popularized in recent years, the winter weather condition is nothing new. In stable polar vortex conditions, the cold air forms a dome that circulates in the Arctic. When changes in the jet stream disrupt the polar vortex, it forces unusually cold weather south from the pole. As the Arctic continues to warm, it leads to more chaos in the atmosphere and more wild weather.

The extreme cold wave that swept through Texas in February 2021 brought record-low temperatures, overloading the power grid and bursting pipes. The temperatures were severe, but cold weather in winter is expected. What interests Sheridan are the weather events that are unusual relative to the season.

"In the spring of 2012, we had the warmest outbreak in the history of the Eastern United States for the month of March," he says. "We think nothing of highs in the 80s in summer, but a week of highs in the 80s in March is unusual. This false spring caused trees to bloom early. When normal weather returned a few weeks later, the frost killed all the tree buds."

This kind of mismatch, where the weather pattern doesn't align with the season, can lead to widespread losses, particularly for tree fruits. Less fruit to harvest results in higher prices at the grocery store. Unusual weather can also trigger birds and insects to migrate before food sources are sufficient in their destinations.

"There are a lot of ways in which our lives can be impacted by weather," Sheridan says. "You only need to look at places like California or the Southwest United States to see what happens to water resources when you have anomalous conditions year after year. There's a potential for a lot of the systems that we've relied on for so long to suddenly not work the way that they had before. We're going to have to prepare for challenges to the way we live if it's weather dependent."

> "WE'RE GOING TO HAVE TO PREPARE FOR CHALLENGES TO THE WAY WE LIVE IF IT'S WEATHER DEPENDENT."

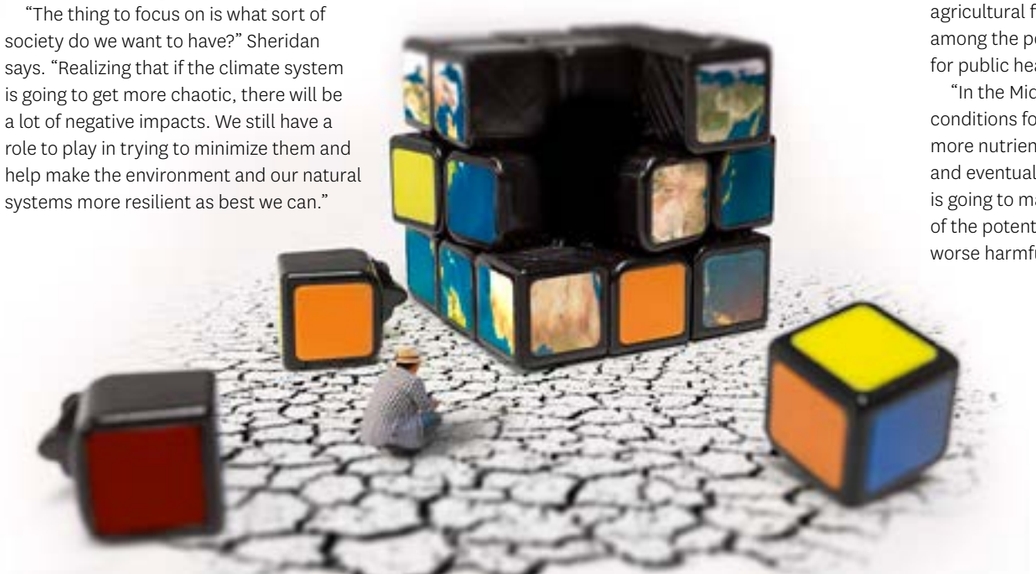
A larger, global push to reduce greenhouse gas emissions is the most critical step necessary to slow the warming of the planet. But even if greenhouse gas emissions were reduced tomorrow, the climate system wouldn't return to normal immediately. Regions that rely on precarious water sources will need to figure out how to adapt in the coming decades regardless.

"The thing to focus on is what sort of society do we want to have?" Sheridan says. "Realizing that if the climate system is going to get more chaotic, there will be a lot of negative impacts. We still have a role to play in trying to minimize them and help make the environment and our natural systems more resilient as best we can."

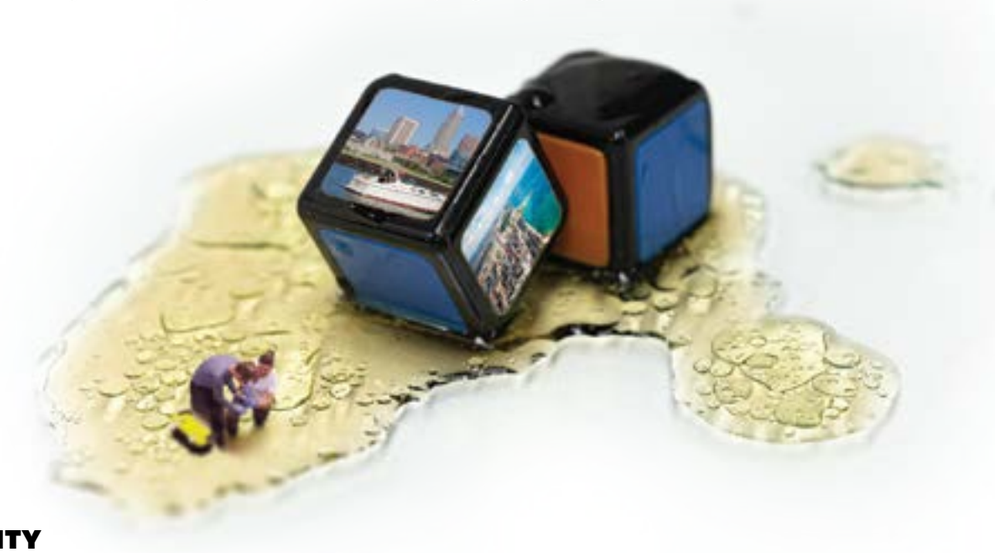
Other climate-related research from Kent State geographers includes:

Weather Whiplash: Cameron Lee, PhD, assistant professor in the Department of Geography, received research funding from the National Oceanic and Atmospheric Administration Climate Program office to explore long-term changes in shorter-term climate variability. He published a paper in the *International Journal of Climatology* in 2021 examining trends in rapid temperature changes—sometimes within 24 hours—and how they relate to the warming climate.

Ecosystem Disturbances: Timothy Assal, PhD, also an assistant professor in the Department of Geography, studies the effects of disturbance (e.g., drought, fire and insects) on forest and shrubland ecosystems, typically by measuring the rate and pattern of environmental change. Of his most recent collaborative project, funded by the Northwest Climate Adaption Science Center, he says, "Our primary goal is to provide sound science to both resource managers and policy makers to help shape ecosystem management and conservation as we move into an uncertain future."



"I think calling it climate change is rather limiting. I would rather call it the everything change."—Margaret Atwood, Canadian poet and novelist



WATER QUALITY

The Great Lakes hold 20% of the world's surface fresh water and supply drinking water for more than 48 million people. This vital resource is threatened by harmful algae blooms that damage the freshwater ecosystem. Not all algae are harmful and identifying toxic ones (such as cyanobacteria) apart from other algae can be challenging. Joseph D. Ortiz, PhD, professor in the Department of Geology (soon to be the Department of Earth Sciences), developed a methodology using satellite remote sensing to identify different strains of algae in Lake Erie.

"The blooms in Lake Erie are predominantly driven by cyanobacteria," Ortiz says. "Cyanobacteria are among the most ancient of living organisms on the planet. They date back billions of years and thrive in warm waters that have a high nutrient content."

Those conditions exist in the western basin of Lake Erie. High amounts of nutrient runoff from agricultural fields result in perennial algae blooms. Differentiating among the potentially toxic algae provides essential information for public health decisions regarding water safety.

"In the Midwest, we're seeing future predictions for wetter conditions for our environment," Ortiz says. "More rain will carry more nutrients, more fertilizer from farms into streams and creeks and eventually the rivers that feed into the lake. If climate change is going to make the environment wetter, we can expect that one of the potential consequences of climate change in our area will be worse harmful algae blooms."

> "IF CLIMATE CHANGE IS GOING TO MAKE THE ENVIRONMENT WETTER, WE CAN EXPECT THAT ONE OF THE POTENTIAL CONSEQUENCES OF CLIMATE CHANGE IN OUR AREA WILL BE WORSE HARMFUL ALGAE BLOOMS."

Graduate student Israel Olaoye modeled the impacts of urbanization and climate change on the area's water quality in a study at Old Woman Creek, which is west of Cleveland. Although only a modest increase in urbanization is predicted for the region through 2100—about 4%—the projected climate-related increase in precipitation would result in much higher nutrient runoff.

"Our best estimates tell us that we need to drop the amount of nutrients getting into the lake by about 40% in order to get these harmful algae blooms to a point where they're manageable," Ortiz says. "And that's with the current precipitation. If we go a few decades into the future, with more CO_2 in the atmosphere and higher precipitation rates, the amount of nutrients flowing into the basin is going to increase."

Mitigation efforts to reduce nutrient runoff include planting vegetation along the riverbanks rather than farming up to the water's edge. The forest strips that develop along the banks also help stabilize the soil and reduce erosion.

"Many of the climate change issues we're facing are having increasingly negative impacts not only on the environment but on society, particularly among the most vulnerable populations such as Indigenous communities or subsistence farming," Ortiz says. "That's a real challenge because we're seeing negative impacts occurring faster than previously anticipated. But there's also opportunity. Every bit of emissions we reduce is one less tenth of a degree of global warming that will help mitigate potential problems coming down the pipeline."

SCIENCE EDUCATION

Bridget Mulvey, PhD, associate professor of science education at the School of Teaching, Learning and Curriculum Studies, can relate to a natural disaster's effect on education. In September 2003, during her first weeks of teaching Earth science at a K-12 school in Williamsburg, Virginia, Hurricane Isabel slammed into the coast.

Many people were evacuated and school was canceled for about a week. When classes restarted, students asked her if assignments were due that day. "I said, 'No, this is a natural disaster; first we're going to make sure we're all okay!'" Mulvey recalls. "We shifted that year's curriculum to start with hurricanes—and we didn't just look at them through a science perspective. We also created newspapers in collaboration with the English teacher to share our stories and those of others in the community.

"Giving students the space and support to process the varied perspectives on that event and what it means for science and for their lives was essential," she says. "I listened to their stories, their questions, their fears—and I shaped learning experiences around what I was picking up from the students."

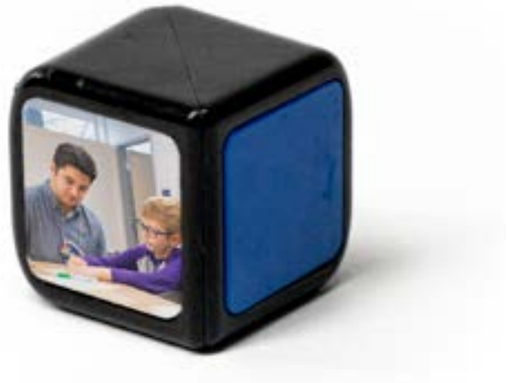
"CHILDREN'S VOICES CAN BE POWERFUL AGENTS OF CHANGE. THEY MOVE PEOPLE IN A WAY THAT DATA OFTEN DOESN'T."

That empathetic approach to education is central to what Mulvey does: "In general, my work is trying to help teachers and students not only learn more about science but also to connect it to their lived experiences and their decision making."

During the pandemic, Mulvey worked with the Wick Poetry Center and its director, David Hassler, to have students in teacher training programs reflect on themselves and science education using model poems in Wick's Earth Stanzas project. "Poetry is an amazing way to support children and older students, to share their voices and try to make a difference in this world," she says. "Children's voices can be powerful agents of change. They move people in a way that data often doesn't. As adults and teachers, we can help inform students and then amplify their voices."

However, teaching students to trust in science and scientists can be challenging in today's polarized environment. Mulvey has been working with Lisa Borgerding, PhD, a fellow professor in the School of Teaching, Learning and Curriculum Studies, on socioscientific issues—controversial, socially relevant, real-world problems that are informed by science and often include an ethical component—like pandemics and global climate change.

"We need to help students come to their own conclusions, rather than tell them what to think," Mulvey says. "Besides helping students and the teachers who work with them understand the science behind the complex issues we're facing, we also need to help them communicate with others about science in ways that aren't judgmental. Genuinely caring about the other person's perspective—asking questions to learn more about why they believe the way they do—can be a powerful way to empathize with others and perhaps spark a discussion."



Mulvey recommends three picture books to help children (and adults) consider varied perspectives:

We Are Water Protectors, written by Carole Lindstrom and illustrated by Michaela Goade (Roaring Brook Press, 2020), 2021 Caldecott Medal

Written in response to the Dakota Access Pipeline protests, the book tells the story of an Ojibwe girl who fights against an oil pipeline to protect the water supply of her people.

"I use this book when asking teachers about the implications of the word 'resources'," Mulvey says. "Resources aren't just things to be mined for human use. We need to consider different perspectives and the marginalization of different groups of people and species."

Mulvey recommends pairing this book with informational texts (which inform readers about the natural or social world without using characters) to consider emphases, omissions and accuracy. See Xochitl Bentley (@dispatches_b222 on Twitter) for guidance on using picture books to begin an inquiry.

They All Saw a Cat, written and illustrated by Brendan Wenzel (Chronicle Books, 2016), 2017 Caldecott Medal and Honor Book

This book explores what a cat might look like from various animals' points of view.

"It's a way for almost any age group to think about the perspectives of others and how our background knowledge and experiences impact our perceptions and actions," Mulvey says. "Teachers can use it to discuss what it means to have empathy and to consider the complexity of who has power, whose perspectives are being valued, and what that means for our own decision making."

Mulvey recommends using this book to set the stage for critical considerations of issues that involve science and society.

Old Enough to Save the Planet, written by Loll Kirby and illustrated by Adelina Lirius (Harry N. Abrams, 2021)

This book shares real accounts of children taking action to protect the planet.

"It aims to foster people's respect for themselves, others and the world—and to empower people to take informed action to positively impact the local and global," Mulvey says. "The real-world examples can inspire children to develop their own action plans."

As with the other books, Mulvey recommends critical examination of the text and pairing it with more in-depth texts that examine varied perspectives and evidence.

ROOF GREENING

Around 56% of the global population lives in cities. In North America, the number jumps to 84%. With increased urbanization comes a focus on environmentally friendly building design. Performance-based design, such as the US Green Building Council's LEED (Leadership in Energy and Environmental Design) rating system, provides a means of measuring a building's performance standards and energy usage.

Kent State has 14 LEED-certified buildings on its campuses. The John Elliot Center for Architecture and Environmental Design on the Kent Campus received the university's first LEED Platinum recognition in 2018. It features a green roof, an element of living architecture—using ecosystems and biology to inform building design—that offers benefits for both the structure and the environment. Although the installation costs are higher than a traditional roof, green roofs prove to be an excellent investment over time.

"A green roof will double or triple the life of the building's waterproofing membrane," says Reid Coffman, PhD, professor in the College of Architecture and Environmental Design, who is a leading figure in the area of living architecture. His research and publications have helped establish the global understanding of green roofs as constructed urban ecosystems.

"Right now, the US roofing industry generates around $14 billion annually just to tear off roofs and replace them with the same traditional roofing materials that come from the carbon petroleum industry," he says. "When the roofing membrane is extended from 20 years to 60 years, that changes the carbon footprint and the economy of the industry quite a bit."

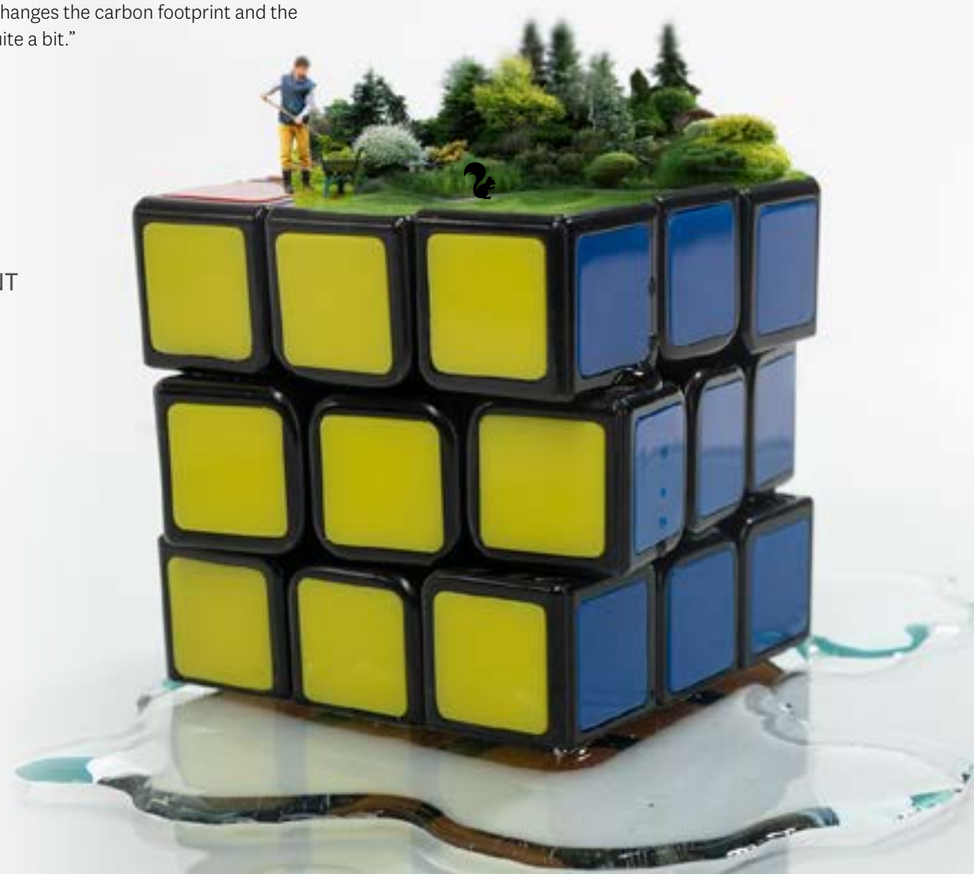
Green roofs absorb peak precipitation and help dissipate runoff, provide insulation for the building and help keep energy costs down. Both large urban structures and small residential properties can benefit from green roofs. The theory of biophilic design posits that building occupants are healthier and happier when they connect with the natural environment.

"The cities we build are destroying habitats and other living organisms," Coffman says. "We can design buildings that cooperate with their environment and give life to other organisms besides people."

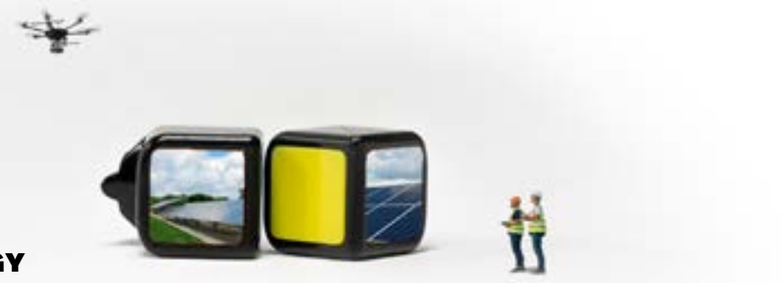
While people have been slow to adopt green roofs on a massive scale, it may be due to the limitations of our imaginations. For most, a green roof means an array of plants. Instead, Coffman advocates for the concept of roof greening. A project could encompass different applications depending on the needs of the occupants and the environment.

"Habitat roofs can be used to reintroduce endangered or threatened plants," Coffman says. "But we can also have recreation roofs or agricultural roofs, such as community gardens. There are roofs being developed that incorporate vegetation and photovoltaics, called biosolar roofs. Hospitals could be building roofs that are oriented toward health and wellness. There are so many roof greening opportunities, things we haven't conceptualized yet."

"WE CAN DESIGN BUILDINGS THAT COOPERATE WITH THEIR ENVIRONMENT AND GIVE LIFE TO OTHER ORGANISMS BESIDES PEOPLE."



"Out of adversity comes opportunity."—Ben Franklin



SUSTAINABLE ENERGY

The typical passenger vehicle emits 4.6 metric tons of carbon dioxide every year, with the number varying based on the vehicle's fuel, fuel economy and the number of miles driven per year. And that doesn't include the carbon dioxide produced by the vehicle's manufacture, upkeep and eventual disposal.

Carbon dioxide is one of the main greenhouse gases (along with methane and nitrous oxide) that trap energy in the atmosphere and result in widespread temperature increase. So we need to drastically reduce or eliminate greenhouse gas emissions to keep global warming from rising further.

If you've been on the Kent Campus over the past six years, you may have seen the ZEV (Zero Emission Vehicle) driven along the Esplanade or parked on Risman Plaza on Earth Day, as it was this year. The ZEV is a repurposed golf cart with an electric engine powered by three sources: a fuel cell, solar panel and batteries. The experimental vehicle converts solar energy to electricity (to directly charge the battery) and to hydrogen (for energy storage).

"It's one way to educate people about renewable energy," says Yanhai Du, PhD, professor in the College of Aeronautics and Engineering and team leader and principal investigator of Kent State University's fuel cell program. It is also a way to get students interested in engineering and sustainability. Du has worked with an interdisciplinary team of students to develop the vehicle since 2016 through the Summer Undergraduate Research Experience (SURE) program. The three-phase project, led by students, is now in its second phase. The goal is to run the cart with zero emissions for its life cycle.

"This zero-emission golf cart is just one example of how we can do something to make a difference," Du says. However, even if we stopped emitting greenhouse gases today, these gases can remain in the atmosphere for different amounts of time, ranging from a few years to thousands of years after being released. Their warming effects on the climate persist over a long time and will affect both present and future generations. That's why it's important to develop new technologies to help bring global temperatures back to safer levels.

> "WE DEMONSTRATED THAT UAVs INTEGRATED WITH OUR ONBOARD HYBRID FUEL CELL BATTERY/CAPACITOR COULD DO MUCH MORE THAN JUST CARRY AND DELIVER A SMALL CAMERA OR A PIZZA."

And that's why Du, an expert on the solid oxide fuel cell (SOFC), continues to work toward enabling the fuel cell industry to replace conventional power sources. He believes that fuel cells are uniquely positioned among power generation systems to effectively provide clean, reliable, quiet power.

He is just wrapping up a project to develop a hybrid fuel cell battery/capacitor that may extend flight time and load capacity for drones, aka unmanned aerial vehicles (UAVs). Kent State University led a team that included several other universities, federal agencies and a company that designs and manufactures drones. Funded through the Ohio Federal Research Network, the project ran from January 2020 to May 2022.

"We demonstrated that UAVs integrated with our onboard hybrid fuel cell battery/capacitor could do much more than just carry and deliver a small camera or a pizza," Du says. "With our technology, UAVs could carry much heavier weight and fly in a continuous operation in a lab setting for 12 hours. That's a long duration for a drone."

The 12-hour flight time also offers huge benefits for military and commercial users. "For example, Amazon and other commercial drones can fly for 20-30 minutes in a single flight. Normally, they deliver a package, then go back to their base to pick up the next package and then deliver it to another customer," Du says. "If we create power cells that enable the drones to fly far and high, as well as carry several packages at a time, it could be more efficient and effective. So, our focus with this project is to increase flight time/distance and the weight that UAVs can carry."

Other potential uses for the technology include surveillance, inspections and emergency response. "The Department of Homeland Security could watch the US Border 24/7 by using two drones that can fly for 12 hours each. This can make the task efficient without having to use helicopters and personnel," Du says. "On the commercial side, a lot of inspectors use drones to do housing and bridge inspections. In California, inspectors might use drones for wildfire inspection. This new technology could potentially be used to deliver medical supplies and other emergency needs after disasters."

Having met most of its goals for the project, Du's team is preparing for a flight demonstration and applying for additional federal and state funding to advance the hybrid fuel cell battery/capacitor technology. They're also looking forward to bringing new products or services to market based on this technology.

In addition, Du is working with the Ohio Clean Hydrogen Hub Alliance to establish a national hydrogen energy hub in Ohio. "Hydrogen can store more electricity than conventional batteries," he says. "And it holds that energy in a more efficient way."

"The world has enough for everyone's needs, but not everyone's greed."—Mahatma Gandhi

SOCIAL VULNERABILITY

Although climate change affects everyone regardless of socioeconomic status, a recent report by the US Environmental Protection Agency shows that its highest impacts will affect communities that are least able to anticipate, cope with and recover from adverse climate events like air pollution, extreme temperatures and flooding. Those at highest risk in the United States include individuals in one or more of the following categories: low income, minority, no high school diploma or equivalent, and ages 65 and older.

"Those themes are similar whether you're talking about global communities or strictly within the United States, says Kathryn Wilson, PhD, professor and chair of the Department of Economics. Her research focuses on poverty, inequality and social mobility. "Climate change happens to all of us, but that doesn't mean it affects all of us equally. Climate change affects the most vulnerable much harder. They're more exposed to it, they're more susceptible to damages from it and they don't have sufficient resources to be able to cope with and recover from those damages."

Wilson says she would be hard pressed to find any economist who thinks that markets are going to work well given climate change. "Basic economic theory recognizes that there are times when markets won't give us the outcome that's best for society," she says. "One of those times is when something called an externality happens. It basically means that there's an impact outside of the people involved in the transaction.

"For example, if a company pollutes, if I pollute when driving my car, that pollution is felt by everybody, particularly those who are low income and living in dense urban areas. But the company and I don't have to pay the cost for that, so we end up with more pollution than is socially efficient. For economists, the solution to an externality is to get the parties involved in the transaction to internalize that cost—perhaps to take that cost into consideration through things like government regulations or imposing a carbon tax."

> "CLIMATE CHANGE HAPPENS TO ALL OF US, BUT THAT DOESN'T MEAN IT AFFECTS ALL OF US EQUALLY. CLIMATE CHANGE AFFECTS THE MOST VULNERABLE MUCH HARDER."

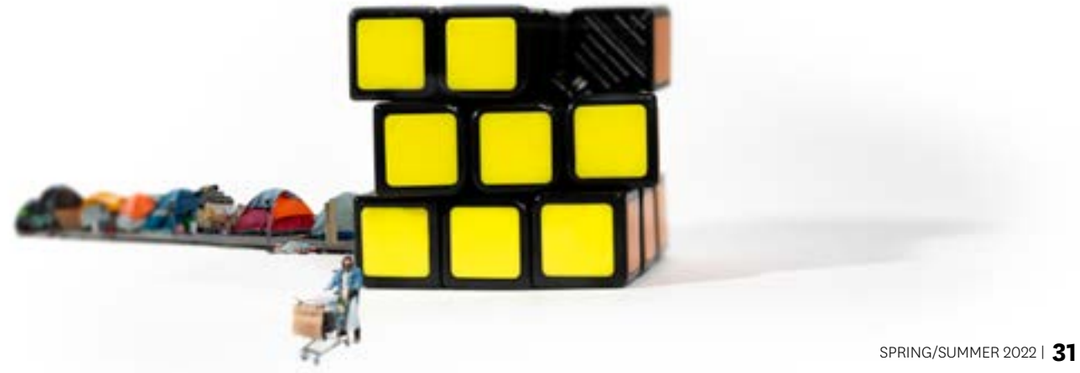
Another aspect of climate change is related to social mobility: How much does the family you were born into influence where you end up? "We have this idea of the American dream, but research into social mobility has found that Americans don't have much social mobility," Wilson says. "If you're born into a wealthy family in the United States, you're much more likely to be wealthy when you grow up. If you're born into a low-income family in the United States, you're much more likely to be low income when you grow up. That's true to some extent in other countries, but it is truer in the United States than in other developed countries we compare ourselves to.

"From society's perspective, that understanding comes with a greater social responsibility to help alter the trajectory for children who are from low-income families. For example, if you look at asthma rates in children and tie that back to climate, as we see more extreme climate events I expect that we will see higher rates of asthma, especially in areas of high population density. That helps me understand that sense of social responsibility."

So what can we do to become socially responsible? When Wilson teaches an intro class in principles of microeconomics, she talks about externalities, efficient outcomes and various theorems about ideal economic conditions. And then she throws in the Ruth Anne Principle. (Ruth Anne is her mother.)

"Maybe when we make decisions, we think about other people as well, because that's certainly what Ruth Anne taught me that I should do," Wilson says. "She always was aware of what others were feeling. So maybe on an airplane I look to see who's sitting behind me before I decide whether to put my seat back or not. Is it a little child with plenty of leg room or someone who's going to be uncomfortable? What I'm ultimately doing, in economic language, is internalizing that externality. I am thinking about the impact on somebody else when making decisions.

"When it comes to climate change, we can still do that. In thinking about what car we're driving or how much food we're wasting, we can think about how our decisions may impact others. My individual decisions aren't ultimately going to change the climate, but collectively a lot of those individual decisions potentially can. Internalizing the impact of our decisions is something all of us could do."



CLIMATE-POSITIVE AGRICULTURE

Individuals can adopt many sustainable practices that add up to make a big difference in mitigating climate change, but those efforts need to be done in concert with policy changes at the institutional level. Sarah E. Eichler, BS '00, PhD, assistant professor in the Department of Biological Sciences and the horticulture program, based at Kent State University at Salem, develops policy recommendations for sustainability efforts in agriculture/horticulture, food systems and climate mitigation.

"Looking at broad-scale solutions, we have to pull in many different seemingly unrelated aspects of our life, our work and our community to make progress toward sustainability," Eichler says. "We're not just talking about planting an environmentally friendly vegetable garden, we're talking about a landscape that is managed to foster a healthy community, healthy local economy and a healthy environment."

While researchers have studied the agricultural industry's effect on climate change for years, farmers are understandably hesitant to take on unfamiliar practices that require new management skills or equipment investments, despite long-term improvements to their bottom line. When speaking with local farmers, Eichler tries to convey how climate-positive practices can benefit the environment and farmers alike. Reduced tillage is one example of a climate-positive farming practice that's been widely adopted over the past 30 years. US Department of Agriculture incentive programs have helped encourage farmers and ranchers to implement such newer methods to minimize impacts on the environment.

By tilling the ground less frequently, farmers allow the soil to stay in place, carbon stays in the soil and provides better absorption and fewer nutrients wash away. The carbon in the soil also dissipates more easily. And, because less fuel is used, it saves energy and money. Some farmers use cover crops to help control erosion and improve soil fertility while reducing the leaching of nutrients—and this means better water quality in rivers and lakes, including major drinking-water sources.

"We've known for years that carefully managing nutrient inputs can be a huge climate positive," Eichler says. "But with recent increases in the price of nitrogen fertilizer and some of the chemical pesticide controls, it now has much larger economic benefits for farmers, too."

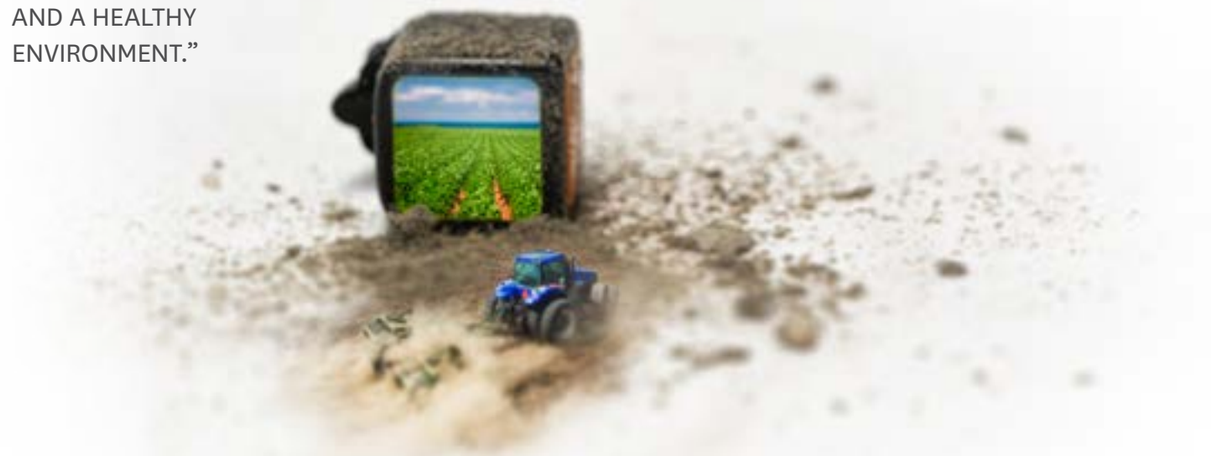
In her current research, Eichler is looking at how managing agricultural fields could affect *albedo*, a surface's ability to reflect solar radiation back into the atmosphere. Increasing the amount of reflected energy helps to counterbalance global warming because the Earth absorbs less heat.

"We're exploring whether practices like reduced tillage and winter cover cropping might increase the amount of energy reflected back," she says. "We don't know enough about it yet to know if it could be a significant climate impact or perhaps an opportunity for farmers to earn better global warming mitigation credits in some future carbon market."

Eichler emphasizes that when it comes to mitigating climate change, personal choices and individual actions can combine to influence business practices. For example, Ohio dairy producers did not readily convert to offer organic milk initially. But when more consumers started buying organic products, farmers realized there was a market and organic dairy products grew from a niche offering to a grocery-store staple. Some climate-forward producers face additional challenges in getting their distinctive product to market. Our purchasing decisions—even the brand of milk we buy—have a real impact on many of the family farmers in our region.

"In terms of policy, it matters who we vote for not just on a national level but on a local level, too," Eichler says. "We can also be thoughtful about the foods we consume. What impact would it have if we purchased more local foods directly from growers? If we consumed one less serving of meat per week and made sure to use those left-over meals? Educating ourselves on the impact of our purchasing decisions is one step towards more sustainable habits."

"WE'RE TALKING ABOUT A LANDSCAPE THAT IS MANAGED TO FOSTER A HEALTHY COMMUNITY, HEALTHY LOCAL ECONOMY AND A HEALTHY ENVIRONMENT."



SUSTAINABILITY IN FASHION

When Noël Palomo-Lovinski, MFA '09, professor and associate director of the School of Fashion, began designing clothes in the 1990s, few in the industry were talking about sustainable fashion. Now, she teaches a course on sustainable concepts and practices in the fashion industry, which is often cited as the second largest polluter after fossil fuels.

"Once you start thinking about the connections between fashion and the environment, you realize how much of an influence designers have on the industry and all the various connected aspects," Palomo-Lovinski says. "And you begin to see that designers need to design differently. As an industry, we are so atrociously unsustainable there's not a single part of the supply chain right now that does not contribute to climate change."

Some consumers focus on the type of material, thinking that buying only natural fabrics and avoiding synthetics is more environmentally friendly. But there are pros and cons to every choice. It's not just the difference between polyester or cotton, which are the two most popular fibers.

"If we did it right, you could indefinitely recycle a synthetic fiber," Palomo-Lovinski says. "Plastic bottles could become sweatshirts, which could become packaging and then perhaps turned back into plastic bottles. We need to think about how we can extend the life of a material so that we no longer rely on digging up fossil fuels.

"Relying too heavily on natural fibers, we run the risk of exacerbating the problems inherent in producing those textiles. The cotton plant leaches nutrients out of the soil, which then requires more nitrogen and chemicals to be applied. That pollutes the water. Cotton is also a monocrop, which means it excludes other plants from growing easily. Many natural fabrics are coated with finishes that are essentially plastic. There are just a lot of different problems."

Water is used throughout the textile production process—spinning, dyeing, printing and finishing fabrics. But some of the most intensive water and energy use occurs once a consumer brings a garment home. Many laundry soaps contain pollutants. Laundering synthetic fibers releases microplastics into the water. Modern washing machines and detergents do a perfectly good job of cleaning clothes with cold water, while hot water consumes more energy and wears the fabric out more quickly. And where do our cast-off clothes often end up? In landfills, where plastics take 500 years to decompose while leaching chemicals into the soil.

"I teach my students that the designer has a responsibility to know where clothing is going after it leaves our hands and gets to the customers," Palomo-Lovinski says. "We have a responsibility to follow it all the way through. We've put this out into the world, we need to make sure we know what becomes of it."

While there are several industry governance organizations gathering metrics on water and energy use and making efforts to systematically reduce the impact, ultimately consumers drive the industry. The impulse to buy fast fashion at cheaper prices leads manufacturers to produce more, which depletes resources and makes clothing more difficult and expensive to produce.

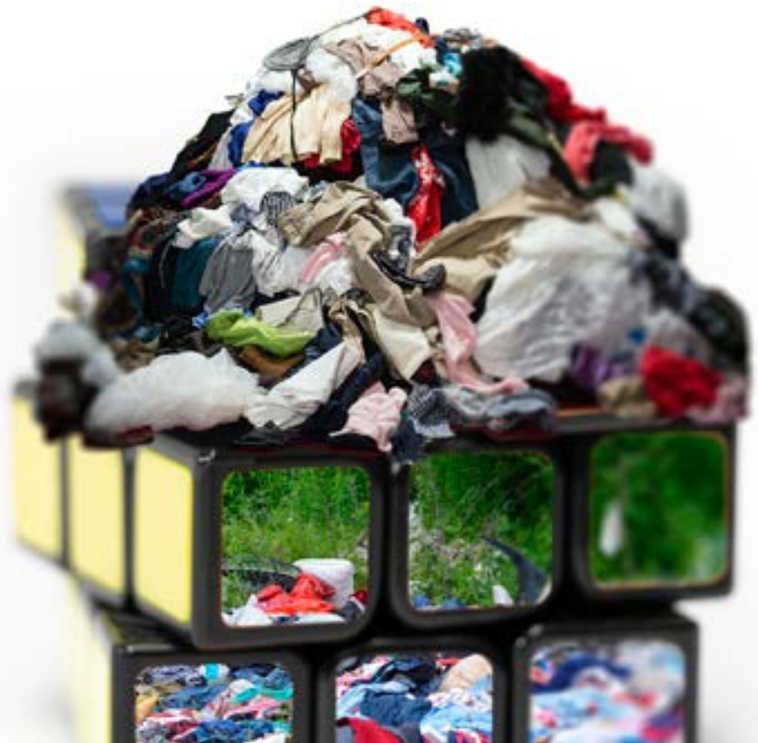
"I tell my students to stop and think before they make a purchase," Palomo-Lovinski says. "Is this something I really need, or do I just impulsively want it at this moment?"

Be Fashion 'Smart'

Emissions from textile manufacturing alone are projected to rise 60% by 2030. Through UN Climate Change's Fashion Charter, more and more businesses (everyone from Adidas to Chanel) are committing to reducing their emissions with the aim of producing net-zero emissions by 2050. As consumers, you can buy fewer clothes and make them last longer, choose local manufacturers who engage in sustainable practices and recycle (and upcycle) your existing clothes.

—Excerpted from "8 Ways You Can Take Climate Action Right Now"

"WE'VE PUT THIS [CLOTHING] OUT INTO THE WORLD, WE NEED TO MAKE SURE WE KNOW WHAT BECOMES OF IT."



MANAGING ANXIETY

For many, the uncertainty surrounding climate change can be summed up with the looming questions of "How bad? How soon?" It's easy to feel overwhelmed in the face of such daunting issues, especially when it feels like individual actions won't have much impact on reducing greenhouse gas emissions on a global scale. Anxiety can manifest when faced with uncertainty in the context of elevated stress. The key is not to let anxiety become so pervasive that it gets in the way of daily living.

"Emotions help us navigate the demands of life," says Karin Coifman, PhD, associate professor in the Department of Psychological Sciences. "Emotions have very clear functions: fear when we encounter something threatening; sadness when there's a loss; joy in moments we share with others. Emotion processing refers to our ability to flexibly change our emotions depending on the circumstances and our needs."

Emotion-related disorders such as depression and anxiety commonly feature a tendency toward rigidity or an inability to regulate emotions relative to circumstances. A person with an anxiety disorder might exhibit a fear response even when there isn't an explicit threat. When a threat is ambiguous, a fear response can be very costly and have negative physiological and psychological consequences.

"Fear responses trigger changes to the cardiovascular system that increase your heart rate, changing blood flow," Coifman says. "Fear also shifts your focus, narrowing your attention to improve your ability to respond. Your body and mind are poised and ready. This is very functional in the short-term, in response to a real threat. But if you remain at this level of constant activation it starts to wear on your system. Your body is not designed to be in that state of readiness all the time."

> "WORRY ON SOME LEVEL IS APPROPRIATE WHEN FACED WITH A REAL THREAT. IT'S BETTER TO ACTIVELY MANAGE THAT WORRY THAN TRY TO DENY IT OR SUPPRESS IT."

Physiological symptoms of anxiety include muscle tension, headaches, difficulty sleeping and digestive issues. A sustained state of readiness makes it difficult to concentrate and focus on anything other than all-consuming worry.

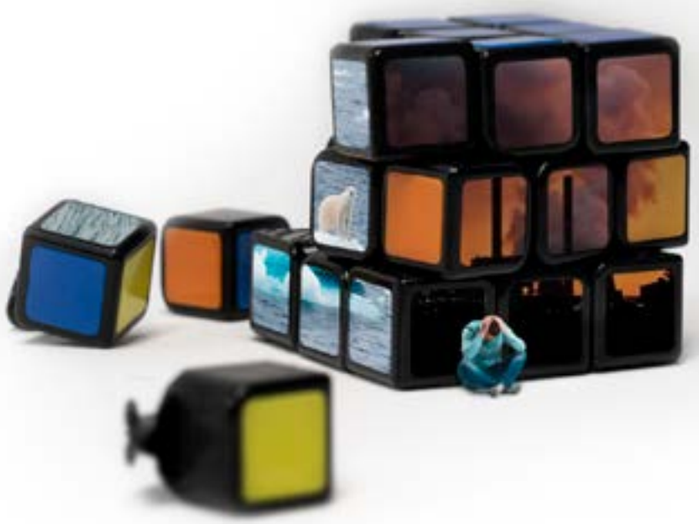
The American Psychology Association defines eco-anxiety as "the chronic fear of environmental cataclysm that comes from observing the seemingly irrevocable impact of climate change and the associated concern for one's future and that of next generations."

Younger generations are more prone to experience eco-anxiety, partly because they've been raised within the context of environmental concerns. There Is also a demonstrated psychological phenomenon that as people age and gain greater perspective, they tend to be less reactionary to negative circumstances. Regardless of whether people are worried about experiencing the effects of climate change during their lifetime or have concerns about what future generations will face, ongoing anxiety over the unknown can be distressing.

"When it comes to climate change, that is a legitimate worry," Coifman says. "The threat to humanity is explicit. The ambiguous part is not knowing how quickly it will impact our lives. Worry on some level is appropriate when faced with a real threat. It's better to actively manage that worry than try to deny it or suppress it because that often leads to backlash."

When faced with an enormous problem that feels out of control, finding little things we can control can help manage anxiety. Activities such as composting, growing your own produce, planting native species or installing rain barrels may offer comfort and reassurance that you are doing your part to mitigate climate change.

"Sometimes you can feel overwhelmed by negative information or a feeling that things aren't changing fast enough," Coifman says. "It may help to pivot toward focusing on your own behavior and your own actions, the things you can control, because you can't control the bigger picture."



Students' advice on how to cope with climate anxiety:

- Recognize your feelings. It's OK to feel bad about climate change.
- Write down your anxieties in a list. Cross off any you can't control.
- Find things that calm you down when you are distressed. It could be a song, exercise or meditation.
- Try to find something—small or big—that you can do. Commit yourself to it.

—Excerpted from "Climate change: Don't let doom win, project tells worriers," BBC News Climate & Science

Act Now

Everyone can help limit climate change. From the way we travel, to the electricity we use and the food we eat, we can make a difference. The United Nations suggests we start with these 10 actions to help tackle the climate crisis.

Save energy at home
Much of our electricity and heat are powered by coal, oil and gas. Use less energy by lowering your heating and cooling, switching to LED light bulbs and energy-efficient electric appliances, washing your laundry with cold water or hang things to dry instead of using a dryer.

Reduce, reuse, repair and recycle
Electronics, clothes and other items we buy cause carbon emissions at each point in production, from the extraction of raw materials to manufacturing and transporting goods to market. To protect our climate, buy fewer things, shop second-hand, repair what you can and recycle.

Walk, bike or take public transport
The world's roadways are clogged with vehicles, most of them burning diesel fuel or gasoline. Walking or riding a bike instead of driving will reduce greenhouse gas emissions—and help your health and fitness. For longer distances, consider taking a train or bus. And carpool whenever possible.

Eat more vegetables
Eating more vegetables, fruits, whole grains, legumes, nuts and seeds, and less meat and dairy, can significantly lower your environmental impact. Producing plant-based foods generally results in fewer greenhouse gas emissions and requires less energy, land and water.

Consider your travel
Airplanes burn large amounts of fossil fuels, producing significant greenhouse gas emissions. That makes taking fewer flights one of the fastest ways to reduce your environmental impact. When you can, meet virtually, take a train or skip that long-distance trip altogether.

Throw away less food
When you throw food away, you're also wasting the resources and energy that were used to grow, produce, package and transport it. And when food rots in a landfill, it produces methane, a powerful greenhouse gas. So use what you buy and compost any leftovers.

Choose eco-friendly products
Everything we spend money on affects the planet. You have the power to choose which goods and services you support. To reduce your environmental impact, buy local and seasonal foods, and choose products from companies which use resources responsibly and are committed to cutting their gas emissions and waste.

Speak up
Speak up and get others to join in taking action. It's one of the quickest and most effective ways to make a difference. Talk to your neighbors, colleagues, friends and family. Let business owners know you support bold changes. Appeal to local and world leaders to act now.

Change your home's energy source
Ask your utility company if your home energy comes from oil, coal or gas. If possible, see if you can switch to renewable sources such as wind or solar. Or install solar panels on your roof to generate energy for your home.

—Source: United Nations

"The trouble is you think you have time."—Buddha

"It is not the strongest of the species that survives, nor the most intelligent that survives. It is the one that is the most adaptable to change."—Charles Darwin

ART OF ECOLOGY

The Cuyahoga River has played a significant role in the history of ecological understanding in the United States. It is famous for having been so polluted that it caught fire in 1969, setting off a movement that eventually led to the founding of the Environmental Protection Agency and the passage of the Clean Water Act. While the Cuyahoga River is in much better health ecologically today than in the 1960s or '70s, it remains a significant point of interaction between humans and the environment.

Taryn McMahon, MFA, associate professor and co-area head of print media and photography in the School of Art, explores the interactions between the human and nonhuman via Northeast Ohio's waterways in her recent print series, *A Series of Entanglements.*

"THE HUMAN AND NONHUMAN CANNOT BE SEPARATED AND ARE CONFLATED AND INTERTWINED IN THE FACE OF UNPRECEDENTED ECOLOGICAL CHANGE."

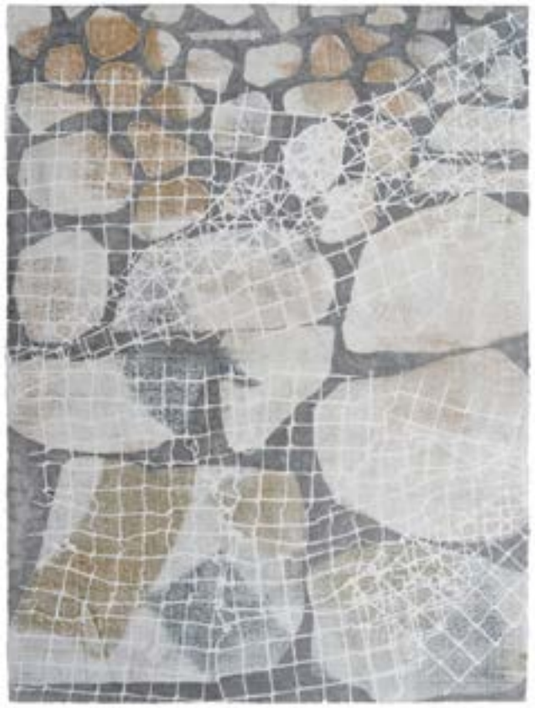
"I began by walking along the shores collecting objects such as consumer plastics and abandoned fishing supplies, in addition to naturally occurring objects such as algae and stones," McMahon says. "The silhouette of each object is translated into a stencil and then printed and layered in different highly transparent colors to create unique prints that weave together the manmade and natural. This results in visual environments that reiterate the entanglement of the current state of ecology, a state in which the human and nonhuman cannot be separated and are conflated and intertwined in the face of unprecedented ecological change."

McMahon is inspired by artists such as Anna Atkins, a British botanist and photographer in the 1800s who used cyanotype—an early photographic process that is both printmaking and photography—to record the ecology of her time. "My works on paper capitalize on the unique potential of print to record objects faithfully while also allowing for artistic license in choice of color, layering and material exploration," says McMahon, who received a New Faculty Outstanding Research and Scholarship Award from the University Research Council in 2020.

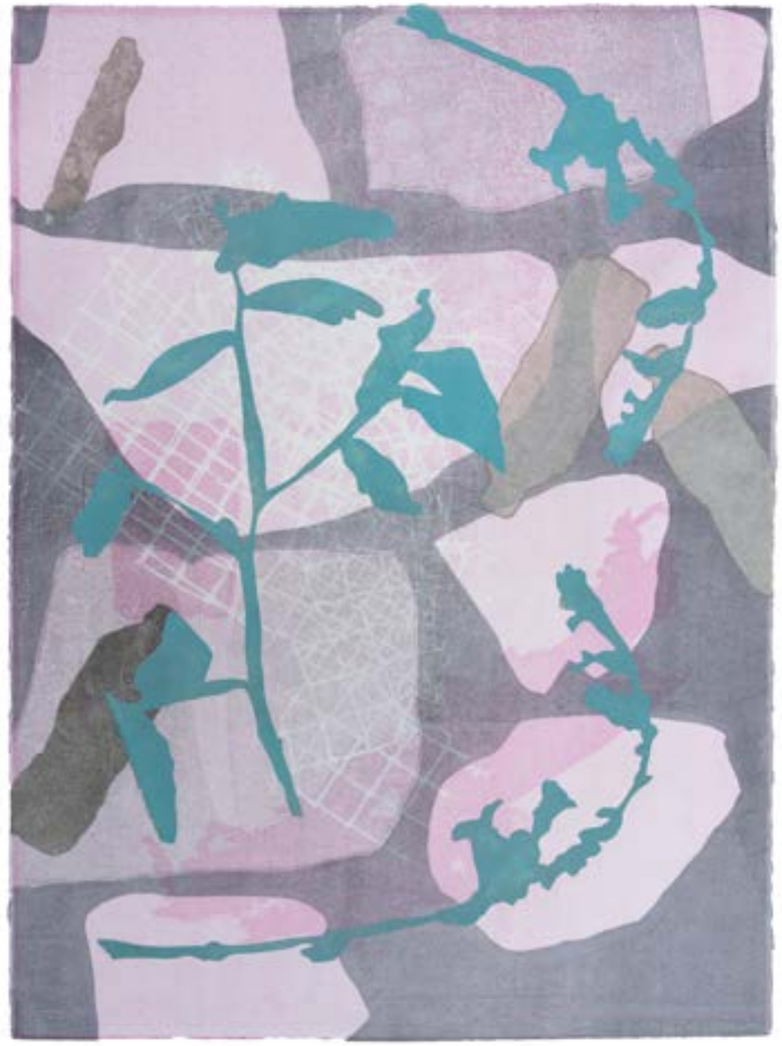
"Within Western art, most depictions and understandings of nature include untouched landscapes or animals or plants and exclude humans or human-generated objects," McMahon says. "That is because we do not see ourselves as fundamentally a part of, and dependent upon, the natural world. This worldview leads us to interact with the world in a dominating and often destructive way.

"My recent artworks—which intermingle plastic water bottles, netting and chunks of Styrofoam with native plants, rocks and bark—forgo a romantic view of "nature" and "landscape" as things separate from ourselves, in order to visually reimagine ourselves as interdependent and reliant upon our surroundings."

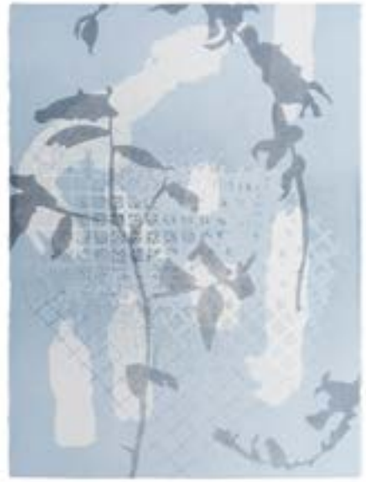
Taryn McMahon, *A Series of Entanglements* 1, 2021. Monotype, 30" x 22"



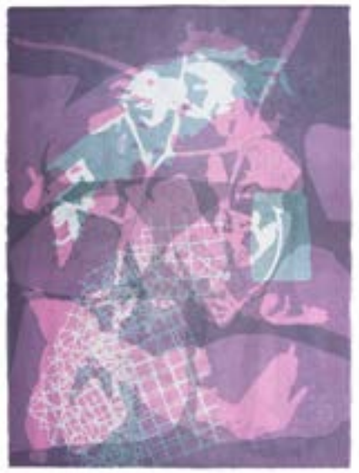
Taryn McMahon, *A Series of Entanglements* 6, 2021. Monotype and graphite, 30" x 22"



Taryn McMahon, *A Series of Entanglements* 11, 2021. Monotype, 30" x 22"



Taryn McMahon, *A Series of Entanglements* 5, 2021. Monotype, 30" x 22"



Taryn McMahon, *A Series of Entanglements* 3, 2021. Monotype, 30" x 22"

Climate Change Resources

If you'd like to learn more, here are some resources to explore.