ISSUE 27 Spring 2016

NU SCI

climate

Staff

President
Cayman Somerville

Editor in Chief
Katie Hudson

Chief Design Officer
Naomi Stapleton

Chief Marketing Officer
Maria Bazante

Webmaster
Matt DelMastro

Editing
Emily Ashbolt
Shannon Jones
Adanya Lustig
Megan Pinaire
Ashwini Rao
Gwen Schanker
Sage Wesenberg

Design
Manny Barros
Cassandra Johnson
Annie Lee
Juliette Paige
Jennifer Shum

Marketing
Vita Anes
Fernanda Fiszner
Ronan Talty
Daniela Zea

Staff Writers
Jameson O'Reilly

Photography
Scott Liu

Data Visualization
Diana Morel

Letter From the Editor

Ten years ago, the climate change debate was dominated by pictures of polar bears stranded on icebergs. Today, climate change has evolved from a subject of debate to a scientific fact. Similarly, the conversation has shifted from saving the polar bears to saving the planet. In this, the first NUSci issue of 2016, we cover a subject that is not a stranger to our pages – the new climate discussion that we, as scientists and science journalists, will tackle in our lifetimes.

Last year was the hottest year on record. In this issue, you'll learn about what kind of consequences this may have on our planet and discover the array of consequences the scientific community is already observing as a result of climate change – from the northward migration of tropical diseases to (dare I say it) more severe snowstorms. We also investigate what kind of methods we can employ to start slowing the effects climate change, like building more efficient energy grids for renewable energies and carbon sequestration both on land and at sea. In addition, we take a step back to see how our peers and faculty are making strides in climate and sustainability research, both on campus and on co-op.

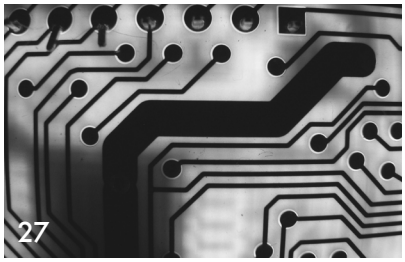
If I haven't scared you off just yet, I want you to know that this issue of NUSci isn't all doom and gloom! We take a break from discussing climate and take a trip to the International Space Station and beyond. Our writers explore the research behind Noble Prizes, cell-powered microchips, and why your cellphone keeps you up at night. As always, we have articles both in this magazine and on our website that discuss a plethora of fields to fuel every interest.

With a new year comes a new semester and, in the spirit of Northeastern University and our ever-changing climate, a new e-board here at NUSci. It has been a pleasure to return to NUSci and work with both the returning and new members of our e-board, editor and design teams, and, of course, our writers, without whom, this, or any issue of NUSci, would not be possible. As always, I am forever thankful for all of their hard work on the magazine.

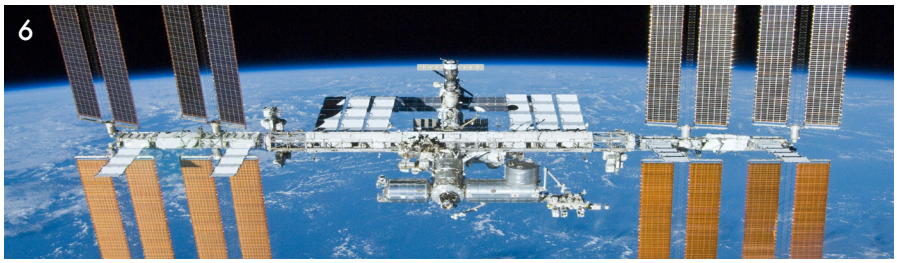
In addition, I am grateful to you, our readers, whether you be a current student of Northeastern, parent, staff or faculty member – thank you for picking up this issue of NUScience Magazine. I hope you find this issue's topics as hot as we do.

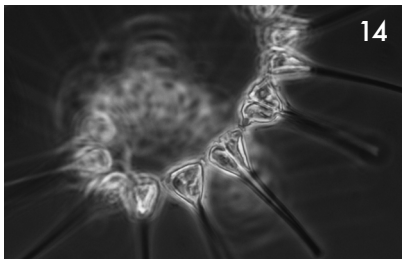
Sincerely,

Katie Hudson
Editor-in-Chief



Northeastern University's Student Science Magazine





Trending this month:

Catching up with the latest news in science.

BY NAOMI STAPLETON, PSYCHOLOGY, 2016

PHOTOS BY NEPHRON, CURTIS CLARK, NASA JOHNSON, MASS. OFFICE OF TRAVEL AND TOURISM, & THE WORLD ECONOMIC FORUM

human microbiome

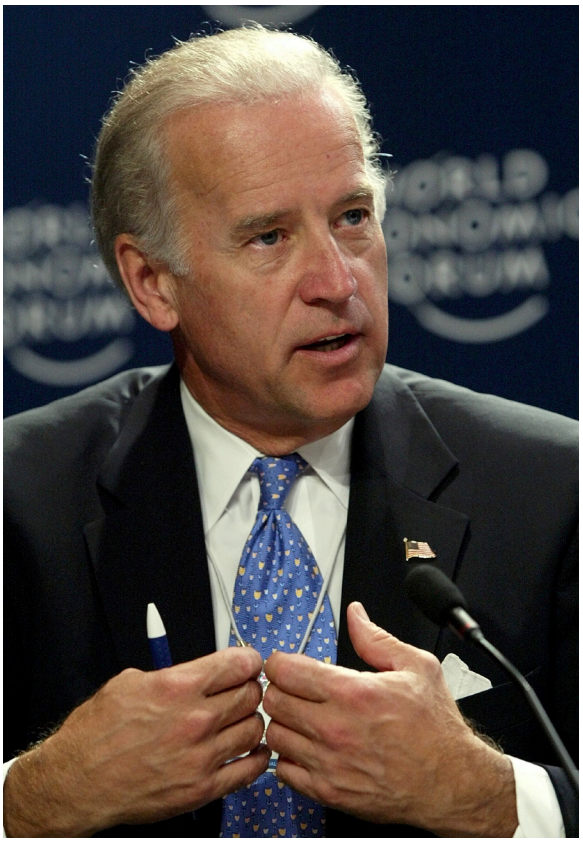
The human microbiome has become a major talking point in research, since the first paper was published on the subject in 2006. Microbiome refers to all of the genes of the microbes in a community, which, in this case, is the human body. Research in this area has many applications: for example, the Antimicrobial Discovery Center at Northeastern is studying the relationship between the human gut microbiome and mental health.

CDC advice

The Centers for Disease Control and Prevention controversially recommended that sexually active women not using birth control should not drink alcohol. Alcohol use during pregnancy increases the risk of giving birth to a child with fetal alcohol spectrum disorder, which can stunt growth and lead to chronic disabilities. However, many sources, like the American Beverage Institute, criticized the CDC's report for being unrealistic and puritanical.

valkyrie

NASA awarded a Northeastern robotics team a prototype humanoid robot called Valkyrie. The team, led by associate professor of electrical and computer engineering Taskin Padir, will prepare the robot for a Mars mission in the 2030s. They will advance the R5 robot's perceptual and locomotive skills so it can identify and solve problems before the astronauts arrive.



The Carnegie Classification of Institutions of Higher Education has ranked Northeastern among the 115 universities in the "highest research activity" category. NEU received $127.5 million in external research funding in 2014-15, compared to $48.7 million in 2005-06.

cancer moonshot

Vice President Joe Biden has promised to increase resources and facilitate better coordination of cancer research as part of his cancer "moonshot," which President Obama endorsed in his State of the Union address this year. Biden plans to work with top-tier research and technology institutes across the country to promote the sharing of data, which he says are currently trapped in "silos."

embryo editing

UK regulators from the Human Fertilisation and Embryology Authority approved Kathy Niakan, a biologist at the Francis Crick Institute, to use Crispr gene editing with donated embryos. Niakan hopes that this research will improve scientists' understanding of healthy development, and thus improve in-vitro fertilization success in the future.

zika virus

The number of babies born with microcephaly (a defect that causes abnormally small heads and underdeveloped brains) has skyrocketed in Brazil over the last few months. Health officials theorize that this is linked to an outbreak of Zika Virus in May. Spread by mosquitos, Zika causes a mild infection that currently has no treatment. The World Health Organization declared Zika a global emergency on Feb. 1, with cases emerging around the world.

An international team of astrophysicists detected evidence of gravitational waves for the first time, confirming the last element of Einstein's theory of relativity. The team used a detector devised by MIT and Caltech scientists called the Laser Interferometer Gravitational-Wave Observatory.

The International Space Station: Climate Central

BY SAMANTHA GLASSNER, MECHANICAL ENGINEERING, 2020 DESIGN BY MANNY BARROS, MECHANICAL ENGINEERING, 2020

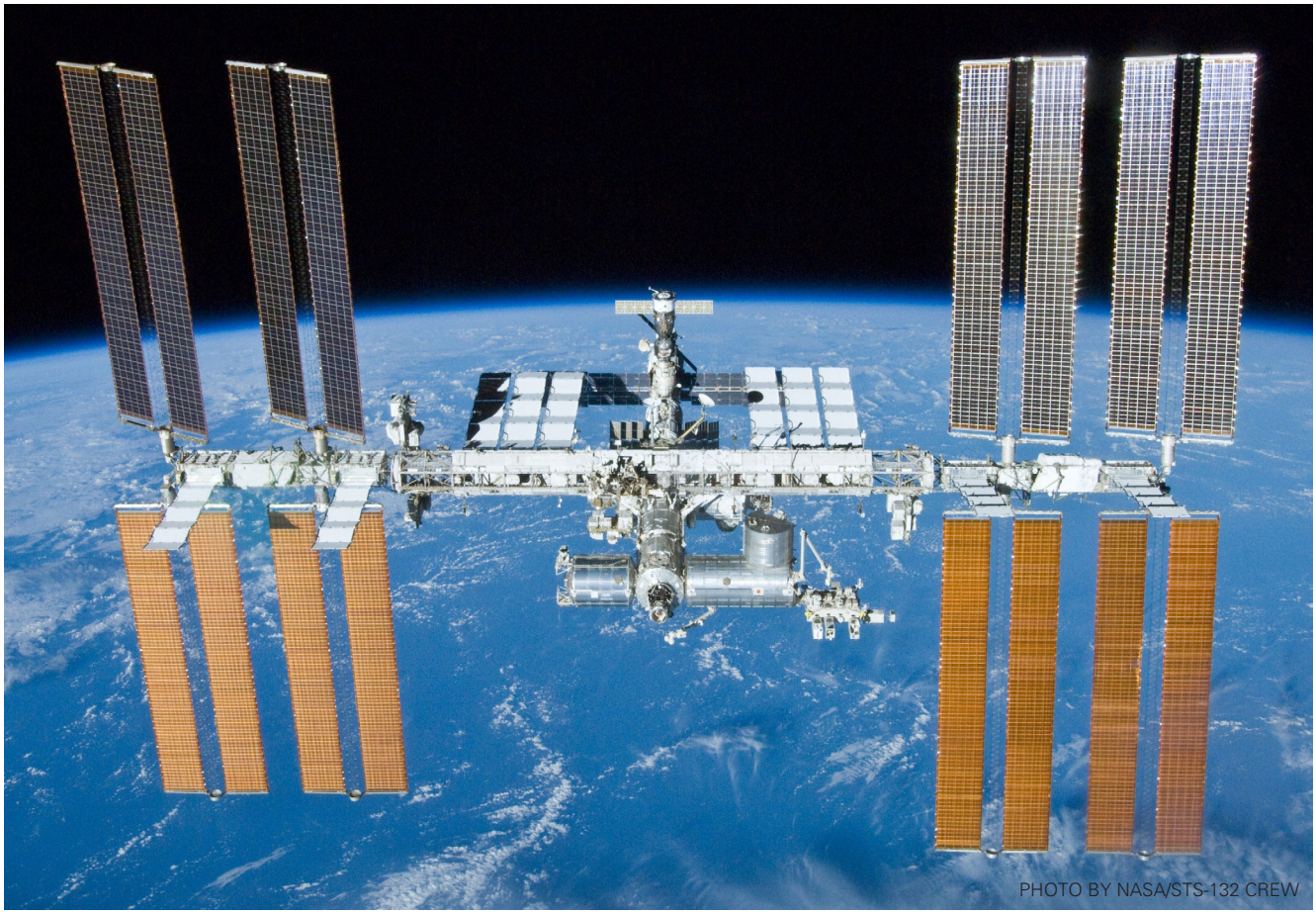


PHOTO BY NASA/STS-132 CREW

Scott Kelly was just one of many astronauts who helped produce a video urging climate action for the 2015 United Nations Climate Change Conference in Paris. "From our vantage point 250 miles above the Earth, we can see how precious the Earth really is," he emphasized in the video. Astronauts have a perspective that very few get to experience, and while all astronauts share a general passion for exploring the unknown, many are also bound over their common devotion of protecting our own planet. There are many wondrous missions that NASA and other space agencies embark on that venture into the depths of outer space, but it is the ones closer to home that can have the largest impact.

With its unique and constant observations of the earth, The International Space Station (ISS) has a valuable perspective of how things have changed over the years since its launch in 2000. The ISS's motto, "Off the Earth, For the Earth," reflects the station's ideology that even though they are in space and able to explore worlds far, far away, it is their mission to better the planet they came from that really keeps them going. With new technology being added to their ranks almost every year, the station keeps improving its ability to monitor and collect data. Here is the docket of the newest additions to the ISS's arsenal of scientific equipment set to launch in 2016 that will further aid the advancement of our understanding of Earth's climate.

New ISS Earth Observation Missions Launching in 2016:

Stratospheric Aerosol and Gas Experiment-III (SAGE-III)

SAGE III is the continuation of the nearly thirty-year-old Stratospheric Aerosol and Gas Experiment line of remote-sensing- satellite apparatuses that constantly gather data on the measurements of stratospheric ozone concentrations, water vapor aerosols, and other trace gases. The main objective of SAGE-III is to in the long-term execute global measurements of specific attributes of the Earth's atmosphere, such as the distribution of ozone and aerosols vertically from the stratosphere down to the upper troposphere.

Lightning Imaging Sensor (LIS)

The LIS is a compact, solid state optical imager that identifies lightning from low earth orbits, logging the location and time of the event and measuring the radiant energy. Its main objective is to monitor and evaluate the global dissemination and irregularity of all lightning and to advance the general understanding of the hidden, interconnecting processes. This sensor specializes in collecting data imperative to researching the degree of convective activity (hail or thunderstorms) and total volume of rain, as well as the alterations in lightning occurrence due to changes in regional climate environments. By generating global lightning climatology, the correlation between the variability and distribution in the frequency of lighting can be studied and relationships between changes in sea and land surface temperature and the dissemination of thunderstorms and other extreme weather events can be assessed. In addition, the LIS is able to gather data on the transport, distribution, and production of the gases resulting from lighting and determine their contribution to the global quantity of trace gasses.

Multi-User System for Earth Sensing (MUSES)

MUSES is an Earth imaging platform produced to operate earth-viewing apparatuses as a part of digital imaging business based in space. This commercial platform, installed and operated by US cooperation Teledyne Brown Engineering, Inc., will aid the ISS in its research capabilities by enabling it to utilize its easily serviceable and upgradable Earth observation instruments such as high resolution digital cameras. An example of one of the camera systems integrated into the MUSES platform is known as DESIS, DLR Earth Sensing Imaging Spectrometer, and it specializes in detecting changes in atmosphere, lands surfaces, and oceans in order to develop an effective way to measure change in environment and climate.

The Search for Earth II: Electric Boogaloo

BY JAMESON O'REILLY, PHYSICS AND MATH, 2019

PHOTO BY NASA/APOLLO 8 CREW

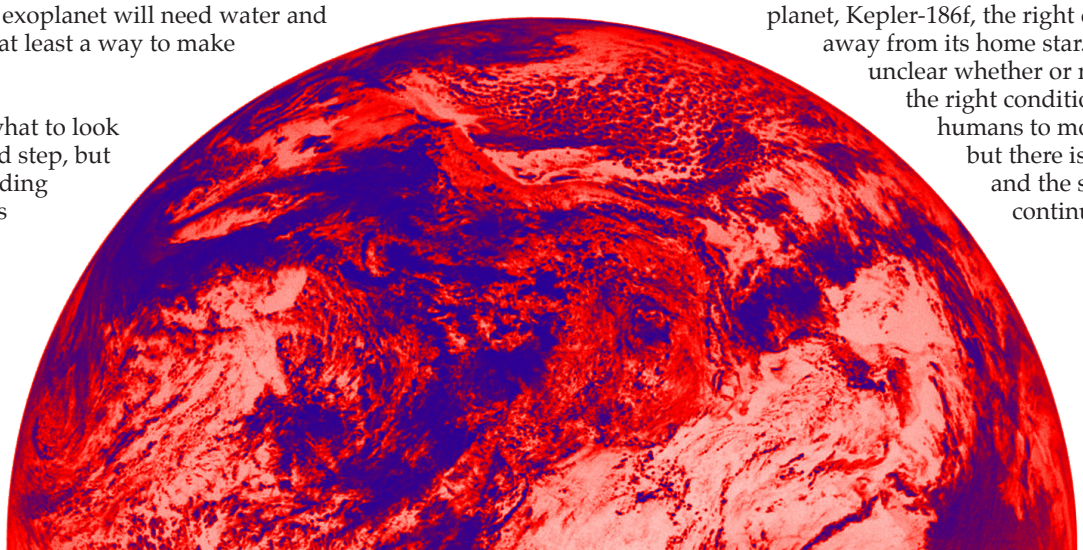
Many of the best and brightest scientists are working on ways to lessen or even reverse the destructive consequences of climate change and pollution, but our situation is still dire. Humans are already seeing the consequences of not acting quickly enough and things will only get worse while most of the people with the power to direct the united effort that our planet needs continue to deny that it is even happening.

Should Earth become uninhabitable, humans need to have a back-up plan: a step-mother Earth. While there are many planets orbiting other stars outside of our solar system, called exoplanets, scientists have yet to find one with the perfect combination of characteristics needed to support human life. Humanity is in a Goldilocks situation. This new home cannot be too big or too small so that its gravity will be similar to Earth's. It cannot orbit too close or too far from its star so that it will be the right temperature for liquid water and metabolic processes. Its atmosphere cannot be so thick that it will crush organisms but also not so thin that it will not protect the surface from solar radiation. Finally, the exoplanet will need water and oxygen, or at least a way to make both.

> "Should Earth become uninhabitable, humans need to have a back-up plan: a step-mother Earth.

Knowing what to look for is a good step, but actually finding these things has proven difficult. Currently, there are a few different techniques that astronomers use to try to measure these properties of distant exoplanets. One way is to measure the tiny movement of the star due to the exoplanet's gravitational pull, which can be used to calculate the approximate mass and orbit radius of the exoplanet. Another is to watch for dips in brightness of a star, which indicates that an exoplanet is passing in front of it. They can find the approximate size of the star by matching the light coming from it to where it is in its life cycle, so by comparing that size to how much light is blocked they can measure the size of the exoplanet. Also, by analyzing the light coming through the atmosphere compared to the light coming straight from the star, astronomers can learn about the contents of the atmosphere and whether or not it might be hospitable to humans.

Despite all of these techniques and the thousands of exoplanets found so far, astronomers have yet to discover a suitable replacement for our home planet. Last year, NASA announced that it had found an earth-sized planet, Kepler-186f, the right distance away from its home star. It is still unclear whether or not it has the right conditions for humans to move there, but there is hope and the search continues.



What Does It Cost?

How Chemistry and Biotechnology Cut Costs of One of the Most Important Medicines

BY JAKE GANLEY, CHEMISTRY, 2017

GRAPHICS BY JULIETTE PAIGE, MECHANICAL ENGINEERING, 2020

黃帝素問宜明論方卷

What do ancient Chinese texts and blue light have to do with an international crisis that kills almost 650,000 people, mostly children under the age of five, every year? More than you might think.

Artemiflow, a new company founded by German chemist Dr. Peter Seeberger, is scaling up a system to produce a treatment for malaria at a lower cost than current methods. The story, however, doesn't start here, but with fevered soldiers in the Vietnam War.

In 1969, Youyou Tu and coworkers scoured traditional Chinese medicinal literature for any treatments of fever. One common ingredient appeared in hundreds of recipes: Artemisia annua, or sweet wormwood. Following a series of diligent extractions, Tu isolated a unique compound that showed remarkable activity against the malaria parasite. Because of her efforts, the world received artemisinin and, eventually, artemisinin combination therapies (ACTs), the most effective known treatment for malaria, and Tu received the 2015 Nobel Prize in Medicine.

According to the World Health Organization, about 3.4 billion people are at risk of being infected with malaria at any given moment. Today, 330 million doses, or 300 metric tons of artemisinin, are required yearly to treat those infected with the parasite. Historically, artemisinin is extracted directly from the sweet wormwood plant in much the same way that Yu did, with a 0.04 to 1 percent yield. Like with any crop, sweet wormwood is susceptible to both supply and price fluctuations, which destabilize the market for one of the world's most important medicines. Using Yu's extractive method, artemisinin can be produced for about $350 per kilogram, amounting to $5 per dose. This price point is too high for many of the poor families that live in the areas most affected by malaria, namely Africa. In order to make ACTs more accessible, the price needed to be lowered.

In 2006, scientists at Amyris Biotechnologies genetically modified simple baker's yeast to biosynthetically produce artemisinic acid (which can be chemically converted to artemisinin) in concentrations that far surpassed sweet wormwood. Amyris then licensed this technology to Sanofi, which converts artemesinic acid to artemisinin and its derivatives. While this process stabilized global supplies, it did little to help the price - the Sanofi process produces artemisinin for $450 per kilogram.

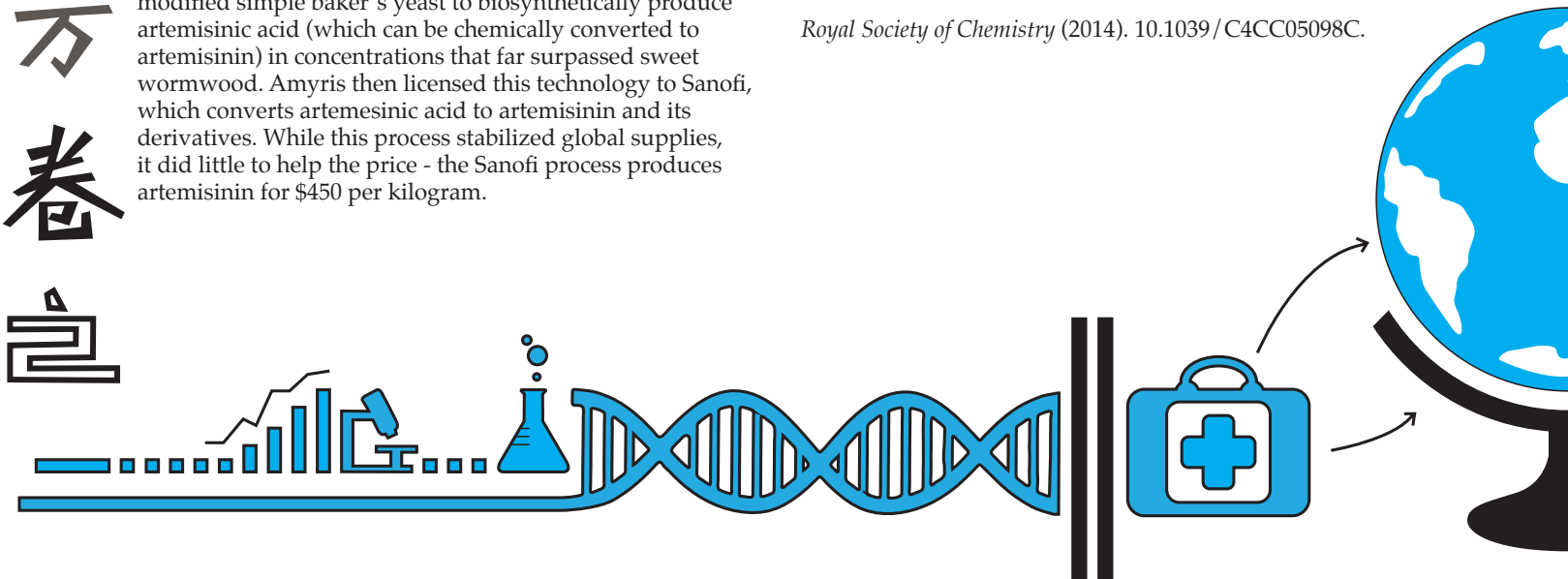
Recognizing the need for a more efficient and cheap process, Seeberger, the Director of the Department of Biomolecular Systems at the Max Planck Institute of Colloids and Interfaces in Germany, saw an opportunity to help a lot of people.

"Chemistry…is one of the few subjects where an individual can change the lives of millions of people. It contributed decisively to the greatly increased life expectancy over the past century," said Seeberger.

While oxygen is a fairly unreactive molecule, when subjected to blue light it undergoes a photochemical reaction which produces singlet oxygen, an extremely reactive species. This singlet oxygen can be combined with artemisinic acid to produce artemisinin. Traditionally, chemistry is done by sloshing around starting materials in a glorified bucket until they combine to form the product. The problem with this approach in the context of producing artemisinin is that blue light, needed to convert triplet oxygen to reactive singlet oxygen, does not penetrate very far into the reaction mixture. Large reactors have a poor surface area-to-volume ratio, so a lot of time and mixing is required to expose all the reactants to the light. This results in many side reactions and a low yield, both of which negatively affect the ultimate price of the product.

Seeberger recognized that if the reactants instead flowed through thin tubing and then were irradiated with blue light then the greater surface area-to-volume ratio would allow for faster, cleaner, and cheaper reactions. He then started Artemiflow, which utilizes this flow chemistry technology with the singular goal of lowering the cost of artemisinin. While Artemiflow is not quite ready to produce enough artemisinin to meet the global supply, they are projecting to be able to produce a kilogram of artemisinin below the previous $350 price point. Thanks to the power of biotechnology and chemistry, some day families will not have to weigh the cost of a child's life.

Royal Society of Chemistry (2014). 10.1039/C4CC05098C.



Changing the Carriers

Climate Change Brings Risk of New Vector-borne Diseases to the U.S.

BY CICELY KREBILL, BIOLOGY, 2019

DESIGN BY JULIETTE PAIGE, MECHANICAL ENGINEERING, 2020

Climate change and the concept of a "carbon footprint" has long been in the forefront of the public's eye. A new focus, however, in the realm of climate change is now being brought to the table for discussion: the risk of vector-borne diseases coming to new regions in the United States. Vectors, like ticks and mosquitoes, carry diseases that are familiar to most people in the United States, like Lyme's disease and West Nile Virus. They also carry diseases that are endemic in other parts of the world, like Dengue fever and Chikungunya. One of the reasons why the United States has not yet had to worry about diseases like Dengue fever is because the vectors generally remain in the climates that best suits them.

Although an influx of mosquitoes and ticks is usually just seen as a nuisance, what they are potentially bringing to the United States and exposing the population to is much more alarming. Dr. Mary Susan Potts-Santone, a professor in the College of Science, worries that, "Dengue fever is going to be a big issue in the U.S., and the Chikungunya virus as well. It's because we've got this invasive Asian Tiger mosquito who is definitely going to spread with climate change. They are already thinking we're going to see pandemics of it." Both of these viruses lack preventative vaccines and treatment. As a result, they would pose a very real threat if brought to the U.S.

Part of the problem regarding climate change is that it affects the vector species' survival and movement by affecting the species' access to food resources as well as prevalence of its competitors and predators.

The triatomine species, commonly known as "kissing bugs," are the vectors that carry Chagas disease to humans when they bite and infect them. They are particularly sensitive to climate change. When the temperature increases, the bugs feed more to avoid dehydration, thus increasing the spread the disease. Although there is an effective treatment for the disease, it is still potentially life threatening if not caught early on. Many people do not know that they have been infected because the disease is often asymptomatic and is only diagnosed when severe cardiac disorders or digestive alterations appear later in life and can lead to death.

Chagas disease currently affects between six and seven million people in Latin America, where the vector lives in cracks of homes. Because of the proximity of the vector's natural habitat and the potential severity of an untreated infection, there was previous fear that this species would migrate up to the U.S., bringing Chagas disease with them. Recent findings, however, by military scientists in Texas suggest something different: the vector carrying the disease is already here. Similarly, the Center for Disease Control reports that the vector has been found as far north as New York. Few reports of new cases of Chagas disease have been made. This could be because the disease can be asymptomatic and therefore leading it to be under diagnosed. "It's something that our physicians haven't had to recognize and deal with that frequently. It's not their first thought, but in fact we may be seeing more of it in the not so distant future," Potts-Santone says.

Many of the diseases that have the potential to migrate to the U.S., including Chagas, Dengue fever, and the Chikungunya virus, are considered neglected tropical diseases – meaning that they cause substantial illness globally, affecting the world's poorest people. Yet, they receive disproportionally less research and funding. Potts-Santone thinks this might change if these diseases migrate to the U.S.

Potts-Santone believes that if these diseases start to become endemic, the funding will change. One of the problems is that these diseases primarily affect people in poverty and immigrants with limited access to healthcare. This adds a lot of political pieces to the discussion, but Potts-Santone thinks, "They absolutely should be funding it." Many researchers have echoed these sentiments as well, including a research group from the University of Texas-Pan American who believes that more funding should be contributed to understanding the movement of these vectors to better alert regions of risk.

Although the exact regional risks and predictions of which diseases are most likely to come in is still relatively unknown, Potts-Santone said the likelihood is that "if conditions get warmer and remain humid, some vectors that haven't been here previously could now move into our areas, bringing in whatever they've got."

PLOS Neglected Tropical Diseases (2014). DOI: 10.1371/journal.pntd.0002818

Interview with Professor Tarik Gouhier

Statistics, Modeling, and Climate Change

BY LUCAS COHEN, MARINE BIOLOGY, 2019 DESIGN BY ANNIE LEE, GRAPHIC DESIGN, 2019

PHOTO BY PEDRO FERNANDEZ

Analyzing past trends, predicting future outcomes, and offering solutions to many of the complex problems facing the world's ecosystems—all are within the grasp of computational biology: an interdisciplinary field that applies elements of biology, mathematics, programming, and statistics to better our understanding of biotic systems. For many, it's a field that defies expectation; who knew that math, computer science, and biology are so intertwined?

Dr. Tarik Gouhier, an assistant professor in Northeastern's Department of Marine and Environmental Sciences, knows this well. At the Marine Science Center (MSC) in Nahant and beyond, Gouhier and his colleagues utilize intensive computational and mathematical techniques to both generate predictive models or simulations, and conduct in-depth analyses on large datasets. Gouhier specializes in modeling marine community ecology.

"I'm interested in basically using mathematical models to describe the distribution of species in space and time," he says. "The use of mathematical and computational tools, based on logic, rational decisions, and general understanding—using those to address biological problems; that's my niche."

As an undergraduate biology student at McGill University in Montreal, Gouhier grappled with finding a balance between his interest in ecology and his enthusiasm for problem solving. Gouhier recalls becoming increasingly frustrated with the endless "rote memorization" he says thrives in biology classrooms.

"The lack of a challenge was no good," he says.

However, this changed when Gouhier took a summer field course with a new professor.

"He was doing things that I didn't even know were possible," he says. "He was a mathematics guy, a computational guy; he was doing ecology—which I loved—and biology in general, but he was using the tools that I actually understood and cared about: math, computer science, and programming in general. It was a perfect match."

Dr. Gouhier went on to earn his master's degree and PhD under the same professor, before moving on to the east coast in 2012. Alongside associate professor Dr. Steve Vollmer at the MSC in 2014, Dr. Gouhier investigated the susceptibility of coral ecosystems and their microbiome to diseases that are associated with climate change.

"Coral ecosystems are particularly interesting because we think they're highly vulnerable to climate change—they're also the source of biodiversity in the sea, and so if those systems collapse, many other species will go down in response," he says. "We're trying to gain an understanding of that— what is the relative importance of the corals' response to disease versus the microbial response to disease, and when we put

these two things together, can we understand how corals will fare under climate change?"

During his ongoing collaboration with Dr. Auroop Ganguly, an associate professor in Northeastern's Department Civil and Environmental Engineering, Gouhier has studied climate change more directly. For instance, Gouhier and his colleagues have studied upwelling: the process by which cooler, nutrient-rich deep-ocean water flows upwards and displaces warmer surface waters. This process is largely driven by surface winds, which are, themselves, heavily influenced by the earth's climate. In 1990, oceanographer Andrew Bakun proposed a hypothesis for how upwelling should change with the shifting climate.

"The idea was that climate is simply going to introduce a greater thermal difference between the cool ocean and various land masses, which are going to warm faster than the ocean," says Gouhier. "That differential is going to create greater wind stress; that greater wind stress is going to create more upwelling."

In their analysis of four eastern boundary current systems, known for high levels of upwelling, Gouhier and his colleagues found that Bakun's hypothesis held up in three of the four systems. In the fourth, however, they saw an unexpected decrease in upwelling.

Gouhier employed an incredible 39 different computational models of the global climate to test Bakun's hypothesis, calculating the mean level of upwelling across all 39. He says that although these

PHOTO BY TARIK GOUHIER

models are all parameterized to replicate "the same earth and the same system," individual models can make very different predictions. In other words, taking the average across all 39 isn't exactly ideal, because it discounts some of the uncertainty associated with the individual predictions.

"Our planet is probably, most likely one of these models—one of the 39," he says. "It's not the average of the 39. We just don't know which one it is, so there is that sort of irreducible uncertainty at some point that just makes it really, really hard to get a clear picture of what is going on."

> "There is great uncertainty associated with using broad-scale climate predictors, and the models that rely on these variables are often just as uncertain.

Balancing the trade-off between the generality and specificity of computational models poses an immense challenge to climate analysts and statisticians in general. There is great uncertainty associated with using broad-scale climate predictors, and the models that rely on these variables are often just as uncertain.

However, uncertainty and inaccuracy are not one and the same. We use intensive versions of these models to produce weather forecasts, typically for a 10-day time frame, but these models are highly susceptible to slight variations in measurements. Climate models, on the other hand, are more robust, allowing us to make strong predictions many years into the future.

"Sure, there's a lot of noise around those patterns, but the signal is strong enough for you to capture it," says Gouhier. "And that's what climate does; very, very broad temporal scales turn out to be an asset, not a liability, because the signal becomes clearer at the broad-scale as noise is essentially cancelled out to a certain degree."

Ultimately, modeling and statistical analysis are imperative in addressing and possibly mitigating the effects of climate change. In Gouhier's words, statistics converts data into useful information, generating predictions that are then used to produce preventative measures. It is effectively a bridge between raw science and the everyday, without which the world would be unaware of the changing climate in the first place.

For a complete transcript of, go to nuscimag.com.

I Am Iron Ocean

Open-Ocean Iron Fertilization: A Viable Climate Strategy or an Embarrassment?

BY SHANNON JONES, MARINE BIOLOGY, 2016

With the rise of global carbon dioxide levels, many researchers are looking to reduce anthropogenic climate change in order to reduce global biosphere change. The rise in temperature occurring currently is considered irreversible for at least 1,000 years after anthropogenic emissions stop. One method of reducing atmospheric carbon, carbon sequestration, removes the carbon dioxide in the atmosphere and stores it in various ways. With this method, the world could ultimately reach a "carbon neutral" state, in which the carbon output into the atmosphere is cancelled out by carbon intake by various sources.

One of the most popular suggestions for storing carbon is to take it from the air and move it into the deep ocean using biological mechanisms. Open-ocean phytoplankton are an excellent candidate for this – if allowed to grow, plankton can hypothetically take in carbon, store it in their bodies, and then when they die, sink to the bottom with that carbon still in their cells. Normally, when an area is devoid of phytoplankton, it signals that they are lacking in some necessary nutrient. Large patches of the ocean are high in nitrates and phosphates, the critical fuel for life, but low in chlorophyll, which shows a lack of phytoplankton activity. Evidence suggests that the limiting nutrient in these systems is iron. Dr. John Gribbin was the first to suggest that by adding iron to these high nitrate, low chlorophyll (HNLC) sites, "a 'technological fix' to remove carbon dioxide from the air might be practicable."

Since then, experiments have shown that when iron is added to HNLC locations, plankton populations can suddenly expand to huge amounts. Researchers theorize that releasing iron will cause carbon to be taken in by phytoplankton, which will die and subsequently sink, effectively removing carbon from the air. There isn't a consensus on this idea. Some researchers think that "fertilizing" the ocean with iron will work, while other researchers think fertilizing could be disastrous for the ecosystem.

Modifying the natural order on such a massive scale has a tendency to make governments nervous, and virtually every large-scale fertilization experiment in the last few years has been followed by inquiries by both national and international authorities. In fact, the United Nations Convention on Biological Diversity requested in 2008 that all member countries restrict iron fertilization experiments to smaller-scale experiments. Currently, research in the field is divided between those who intend to follow the UN decision and those who do not.

Some researchers study natural fertilization events, which happen when iron-rich dust or runoff enters the ocean from the land. These natural-based experiments allow data to be gathered by researchers without endangering ecosystems. Other researchers have chosen to proceed with experiments despite sanctions, taking the risk that officials will not be able to police pelagic (open sea) areas. The size of the open ocean, conflicting regulations between countries, and oversight in international waters are all working against regulatory forces. Some companies have declared their intention to do large-scale experiments simply because becoming the people who solved the world's carbon problem would be an enormously profitable enterprise.

The oceans remain vulnerable to those who conduct unregulated iron fertilization experiments. In 2012, a group of scientists from the Haida Salmon Restoration Corporation (HSRC) dumped 100 tons of iron sulfate off of fishing boats, resulting in a phytoplankton bloom that spanned thousands of miles and lasted for several months. This caused consternation in the scientific community, many of whom were horrified at the scope of the experiment, the proximity to land, and the lack of regard for others in the area. The HRSC group thought that by increasing the phytoplankton in the area, they would provide a bottom-up motivation for the expansion of the natural fishing stocks, and be able to restore salmon populations. Instead, the phytoplankton bloom that resulted had far-reaching effects in both Canadian and US waters, and though data from this experiment has been made public, no legitimate scientists want to be affiliated with the situation. Many people considered this to be a violation of the UN sanctions, which are not legally binding. The HSRC is under investigation and has been disgraced the scientific community, but so far, no charges have been made.

The difficulties in regulating iron fertilization make the future of carbon sequestration using phytoplankton uncertain, even though this remains one of the few viable carbon sequestration strategies available to researchers. Hopefully scientists and legislators can find a way to strike a balance between what is healthy for ocean ecosystems and what is necessary to save the planet.

Science (2008). DOI: 10.1126/science.1079033

Diving In: Surveying the Globe's Coral Reefs

BY STEPHANIE WASIUK, BIOLOGY, 2017

PHOTO BY UNDERWATER EARTH / CATLIN SEAVIEW SURVEY

Picture it – the warm rays on your face, the smell of sunscreen in the air, and the sand between your toes. A day at the beach under the sun is exactly how you might choose to spend your time. From your sandy little perch up on the beach, however, you're missing out on an acidic battle going on between the changing climate and the creatures of the coral reef below the surface.

Temperatures are rising throughout the globe and one of the biggest areas that is being affected is the ocean. Not only are sea levels rising, but the pH of the water is becoming more acidic and the circulation of currents is changing patterns. This can affect the severity and frequency of tropical storms that would force you out of your reclining beach chair and back into the resort.

> "About one third of all human-produced CO_2 makes its way into oceans every year.

On top of the amount of CO_2 that ocean waters normally absorb, about one third of all human-produced CO_2 makes its way into oceans every year. With CO_2 emissions on the rise, that means the chemical composition of the water is changing drastically. When CO_2 is absorbed into the water, the mixture becomes very acidic, which in turn decreases the rate of calcification that is possible for corals. Thus, the more CO_2 in the atmosphere, the fewer corals that are able to survive.

Diminishing corals mean more than just less to see on your all-expense-paid diving outing. Reefs provide food and shelter for all of the diverse organisms that gather there, which affects the maintenance of the aquatic food chain. They also serve as a barrier between serene beaches and crashing waves further out in the ocean.

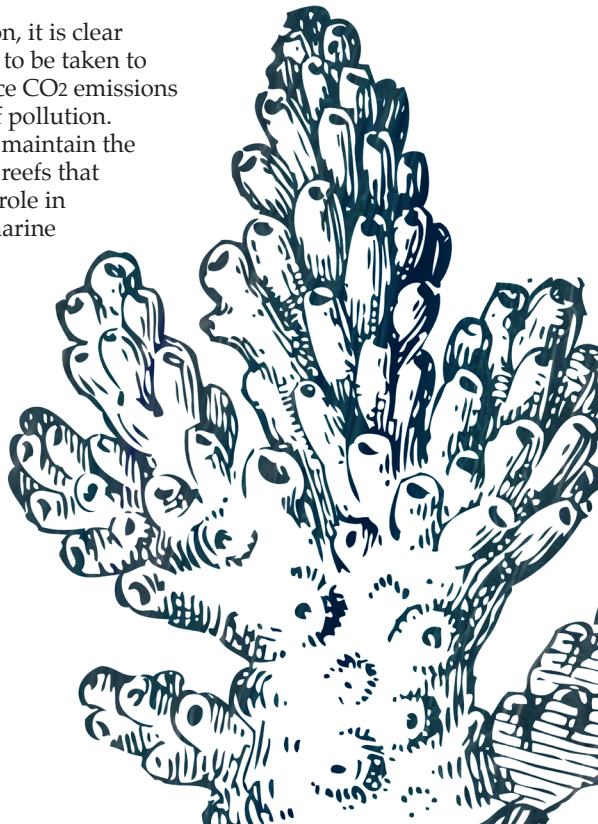
There is hope on the horizon, however. Not only are efforts to reduce CO_2 emissions gaining serious momentum, but also NASA recently launched funding for a new research program, called the Coral Reef Airborne Laboratory (CORAL). With NASA, the sky is the limit – and that's exactly where they're taking this research. Using new Portal Remote Imaging Spectrometer (PRISM) technology, scientists will be able to survey the size and relative health of coral reefs using planes. The results gained from PRISM will also be checked by technology used in the water, making measurements significantly more accurate.

Before this technology, very few of the world's reefs were surveyed and the process was expensive with large margins of error. This three year program will allow for the creation of a large-scale, detailed database, which can be used to monitor the changes in size and health of many coral reefs as the conditions of the waters shift.

Unfortunately, the team believes they will only be able to survey and record data on about three to four percent of the globe's reefs during the three-year period. Nevertheless, they aspire to have satellite technology able to do high quality work on a more massive scale within ten years.

NASA is doing a great job addressing the decline of coral reefs and their inhabitants, but that doesn't mean you don't have to. It is predicted by the National Oceanic and Atmospheric Association that if temperature change continues with the momentum it has now, ocean temperatures will increase by 4.0 degrees Celsius in the next century. This could lead to further acidification, less calcification, and a deteriorating population of tropical coral reef fish.

With this prediction, it is clear that steps do need to be taken to dramatically reduce CO_2 emissions and other forms of pollution. Doing so can help maintain the health of the coral reefs that play such a major role in many aspects of marine and terrestrial life. So the next time you're sipping that raspberry smoothie and getting that perfect bronze glow, take a minute to appreciate what you can't see and make an effort to preserve what is left of it.



Climate Change by the Numbers

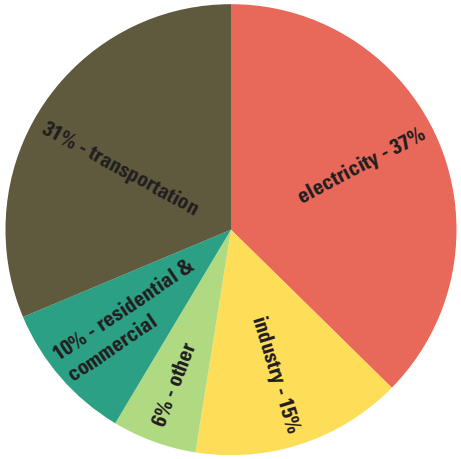
How screwed are we?

BY CAYMAN SOMERVILLE, ENVIRONMENTAL SCIENCE, 2016 DATA VISUALIZATIONS BY DIANA MOREL, MATHEMATICS AND FINANCE, 2017

The voices of global climate change advocates around the world were finally recognized with the signing of the 2015 Paris Agreement. The Guardian declared the international compromise as "historic, durable and ambitious." In addition to setting ambitious climate action plans for each nation, the mitigation efforts include an agreement to immediately assume rapid emission reductions "in accordance with the best available science." Despite the UN's urgent efforts and the successful deal, scientists claim emission caps are still too lax and that future emission scenarios indicate a 2.7 to 3.0 degrees Celsius warming—catastrophically above the 2.0 degrees Celsius threshold. This scenario forecasts irreversible disasters, with serious social, economic and environmental consequences.

The primary greenhouse gas emitted into the atmosphere is carbon dioxide (CO_2). In 2013, about 82 percent of all greenhouse gas emissions originating from human activities were CO_2. Anthropogenic-related emissions alter Earth's natural element cycles, resulting in increased levels of CO_2 from the atmosphere since the Industrial Revolution. Unfortunately, deforestation and land use changes are impacting the ability of forests – natural carbon sinks – to extract atmospheric CO_2. A carbon sink is a natural system that absorbs CO_2 from the atmosphere and stores it in a different form – another example is the ocean. Furthermore, the combustion of fossil fuels, including coal, natural gas, and oil, is the most significant carbon emitting human activity.

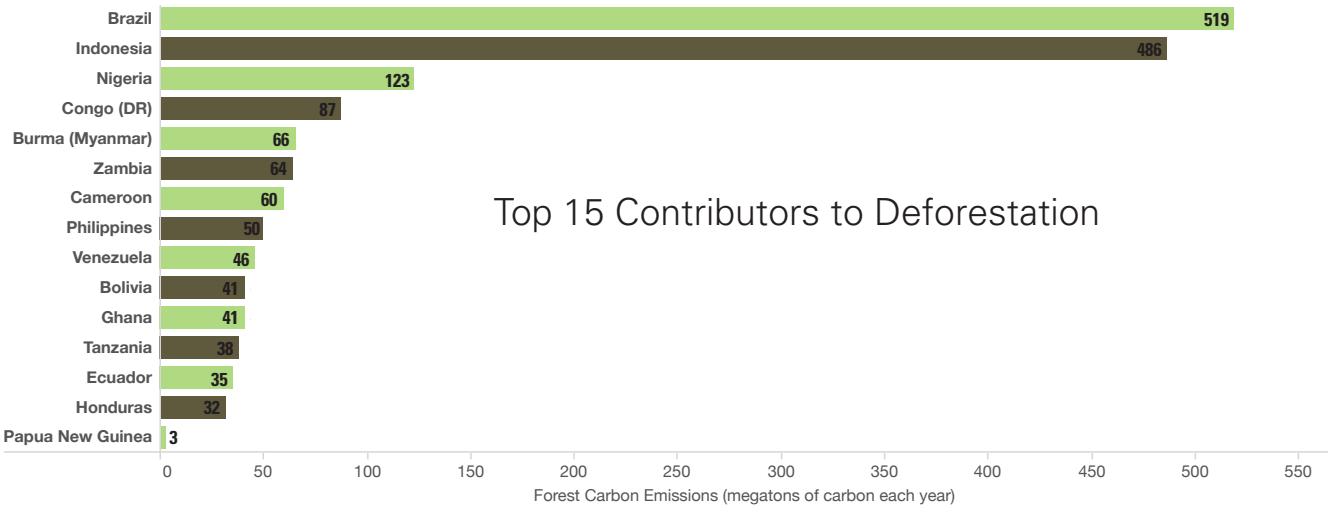
In the U.S., the main sources of CO_2 emissions are electricity, transportation and industrial processes. The most significant source of CO_2 emissions in the U.S. stems from electricity used to power buildings and industry. In 2013, fossil-fueled electricity represented 31 percent of total U.S. greenhouse gas emissions. Additionally, transportation of people and goods require gasoline and diesel composed 26



Sources of CO_2 Emissions in the U.S.

percent of total greenhouse gas emissions in the U.S. Between 1990 and 2013, U.S. emissions increased by 7 percent, largely due to population growth and the increasing number of motor vehicles. Last, industrial processes emitted 12 percent of greenhouse gas emissions in the nation.

One method to mitigate global climate change and to offset the substantial carbon dioxide increases is carbon (CO_2) capture and sequestration (CCS), or the storage of atmospheric CO_2 into a different form like biomass or geologic storage. Reforestation, or replanting trees, is a well-known approach to absorb emissions, since trees use CO_2 to grow. Despite emission trends, conservation efforts have also increased since 1990. Plants and trees remove CO_2 from the atmosphere – acting as sinks – and store them as biomass. As a result, about 13 percent of total emissions were offset through conservation methods in 2013. Each



Top 15 Contributors to Deforestation

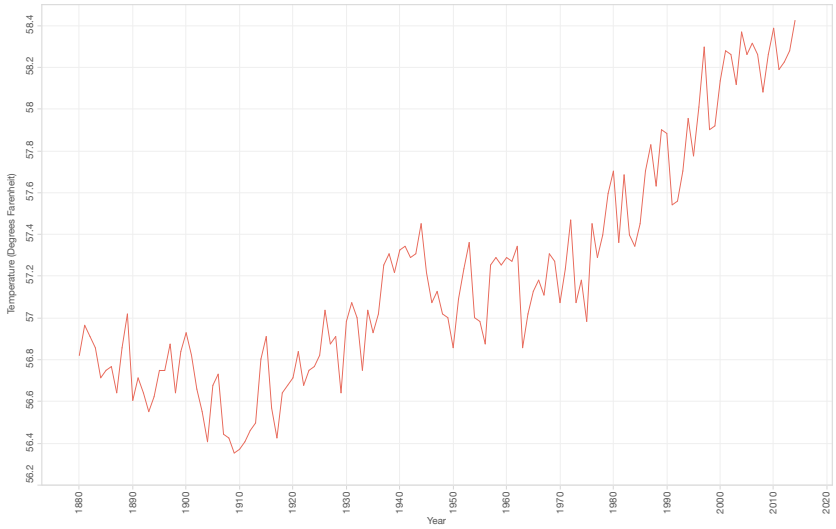
year, a mature tree is estimated to absorb 48 pounds of CO_2. To offset the total coal power plant emissions over its 40-year lifetime, it is anticipated that 52 million trees must be planted. Better yet, CCS can include technologies that involve seizing CO_2 from these immense industrial sources including fossil fueled power plants which can reduce CO_2 emissions by 80-90 percent. Assuming a 90 percent reduction rate, the emissions avoided by CCS technology are equivalent to planting 62 million trees or taking 300,000 homes off the grid. This carbon is then injected and stored into underground impermeable rock formations.

Despite the benefits of this technological innovation, their ability to offset emission should be compared to the enormous amounts of emissions released from airplanes. For example, there are over 9,024 flights each year that travel between New York City and San Francisco. Those flights' total jet fuel usage could release nearly 1.4 billion pounds of CO_2 a year, which would require annually planting 28.3 million trees to offset. More innovative technology, such as CCS, is thus critical in avoiding the catastrophic effects of global climate change.

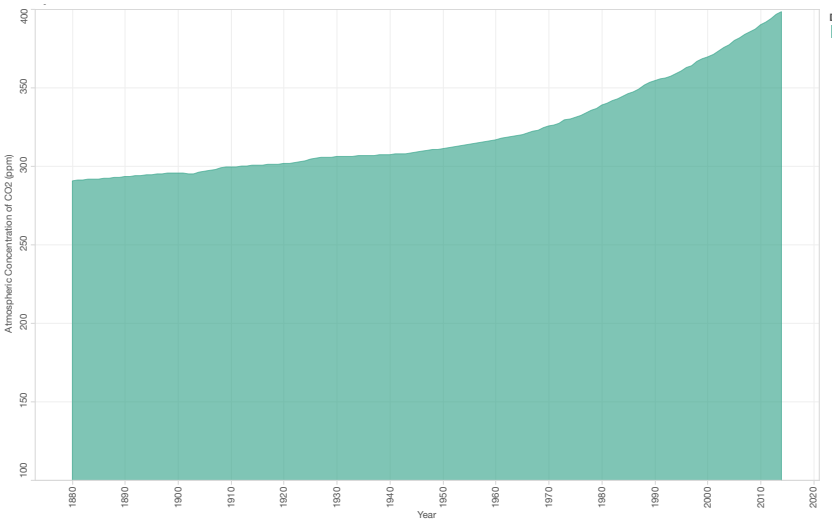
Another way to decelerate the accumulation of atmospheric greenhouse gases is to reduce consumption of fossil fuels through energy efficient measures and clean energy technological investments. According to the Solar Energy Industries Association (SEIA), the boom in solar industry will fuel rapid development in the efficiency of solar energy technology. By the end of 2015, there was a total installed capacity of 24.1 gigawatts (GW) of solar photovoltaics (PV) – equivalent to the amount needed to power 5 million houses in the US. Although this is nearly 1/27th of the total number of American homes, the residential solar industry alone has grown 70 percent over the past year and is expected to continue its record-shattering projection. Even more, the extension of the solar Investment Tax Credit (ITC) is predicted to sustain this growth. Currently, 26.6 million tons of CO_2 are offset each year through the U.S. solar energy. Furthermore, SEIA reports that more than 100 million tons of carbon emissions will be offset through solar by 2021 – equivalent to the removal of 20 million cars off the road and retiring of 27 coal power plants.

Massachusetts has been a leader in clean energy efforts and is notably home to the largest clean energy incubator in America. Greentown Labs, located in Somerville, MA, has a community of around 47 cleantech companies. Their portfolio includes a range of clean energy technologies or energy efficient platforms. For example, Loci Controls, one of their startups, developed an automated monitoring platform that controls the collection of methane gas from landfills. WrightGrid manufactures solar-powered cellphone charging stations. Grove designed a sustainable indoor growing system that is sensor-automated and has influential potential in the urban farming movement. Other Greentown companies have innovative and sustainable solutions that will revolutionize energy industries and help industries and states achieve the strict standards enforced by the EPA and President Obama. The President's Clean Power Plan sets ambitious targets, such as a 32 percent reduction of carbon dioxide by 2030. As the National Oceanic and Atmospheric Administration (NOAA) claim temperatures were 0.29 degrees greater from 2015 to 2014, innovation and collaboration are our best hope of mitigating the catastrophic events predicted from global climate change.

Global Temperature



Atmospheric Concentration of CO_2



Stumped by Trees

PHOTO BY ICEERS

BY EMILY ASHBOLT, BIOMEDICAL PHYSICS, 2017

DESIGN BY JENNIFER SHUM, MECHANICAL ENGINEERING, 2018

Wood you be able to guess how many there are?

How many trees are there in on your road? In Boston? In the US? Could you estimate? Where would you go to find out?

If you answered "I don't know" to any or all of the above questions, you are not alone. As it turns out, only a small group of people even thought they knew. Data from a fall 2015 survey reveals that it's likely that even this select group of people were very, very wrong.

A few years ago, there was a number floating around claiming that there were about 400 billion trees on earth. That seemed like a big number, breaking down to about 61 trees per person. This number was based on satellite images from NASA, taking photos of parks and forests and estimating based on average trees that could be seen per square mile calculated from that image.

However, soon after that number was published, someone actually counted the trees per square mile for a parcel of land in the Amazon basin- and their math calculated to show over 390 billion trees in that Amazon basin alone. Obviously, there was a disconnect somewhere. But what could be better than satellite images when it came to optimizing time and efficiency? Enter Thomas Crowther.

Crowther was a Postdoctoral Research Fellow at the Yale School of Forestry and Environmental Studies when he began pondering this question. He had a friend who was trying to combat climate change by planting a billion trees. But was a billion trees even that many? "They didn't know if planting a billion trees was going to add 1 percent of the world's trees, [or] add 50 percent of the world's trees," said Crowther to NPR in September of 2015. The data just wasn't there.

Crowther's solution was the one that brought such unexpected results from the Amazon basin: people. His team contacted and sent out people all over the world, nearly half a million, to count trees in various climates, hundreds of thousands of them, and then used this data to calculate the number of trees in all the different parks, forests and jungles on this earth.

The number they came up with? Over 3 trillion. This is 7.5 times more trees than previously estimated - billions and billions more trees. Crowther and his team were astonished, but they were also concerned.

While this figure, and the fact that all those trees were hiding in plain site is amazing, not all of Crowther's discoveries were happy. Estimates from his study put the number of trees being cut down each year at 15 billion. Since human civilization began, Crowther's team suspects the earth has lost 46 percent of its tree cover. This is bad news, since trees, and their multitude of species, are essential to biogeochemical and water quality cycles, as well as being the backbone of most ecosystems.

> "Since human civilization began, Crowther's team suspects the earth has lost 46% of its tree cover. This is 7.5 times more trees than previously estimated - billions and billions more trees.

What this means is that while there are more trees in this world than we ever imagined, it is still very important to take care of the ones that we have. You might never have guessed the sheer number of tree around you, but there's no denying we would all miss them if they were gone.

Nature (2015). doi:10.1038/nature14967

PHOTO BY ICEERS

A Stormy Co-Op:
Investigating Hurricane History

BY GWEN SCHANKER, JOURNALISM AND BIOLOGY, 2018

You can't predict the future without taking a good look at the past.

As the effects of climate change become increasingly more obvious, some scientists have turned to examining past weather events to see how previous conditions compare to what we're experiencing today. Enter Kristen Esser and Max Besser, two Northeastern co-ops at the Woods Hole Oceanographic Institution (WHOI) in Woods Hole, Massachusetts.

Esser and Besser, third year environmental science students, are both embarking on their first co-ops. They're spending six months interning in WHOI's Coastal Systems Group, where they examine sediment levels in cores collected from four key locations – the Northeast, Florida, the Bahamas and the Marshall Islands. Greater coarseness of the cores, measured by a combination of weighing and sieving the samples, indicates where hurricanes have hit.

"What we actually core are very stable ecosystems," Besser said. "It's a very good indicator of both sea level rise and storms."

Combined with data from carbon dating, the measurements Esser and Besser make can be used to construct a general timeline of extreme hurricanes throughout history. This can help inform knowledge of future climate scenarios, contributing to a better understanding of how our world is changing on both a regional and global scale.

The pair spends their days in the lab alongside their advisor Stephanie Madsen, a former teacher who oversees all major projects in the lab. She also does outreach for students and policymakers, and enjoys articulating the importance of the team's research within the larger picture of climate change.

"I always knew I didn't want to be glued to a desk," Madsen said. "I like the intellectual stimulation and the physical aspect of using my hands. This job is perfect because it combines both."

The lab also houses graduate students who are part of the MIT/WHOI Joint Program in Oceanography. "Everyone's really friendly," Besser said.

Esser and Besser's daily routine is generally the same, though they're collecting data from two different locations: Besser's cores are from the Bahamas while Esser's are mainly from the Northeast.

The pair will also be going on a boat excursion to Louisiana and Mississippi in March, where they'll assist other members of the team with collecting cores.

"Every so often, we get pulled out to learn a new thing and then we're put back on the track (of sampling)," Besser said. He also mentioned that while the sampling process is very Zen, making it easy to zone out, it's important to pay attention in case a problem arises.

Besser and Esser work through their cores – each of which is around 130cm long – one centimeter at a time. They begin by cutting out a block of sediment, and then weigh, sieve and dry it in a series of cycles, taking time to record the final weight as the "percent coarseness" of the sample. Esser, who minors in environmental geology, also burns her samples to extract organic compounds, a process she says is sometimes excruciating due to the offensive smell of the core – it reminds her of rotten eggs.

Both students view this experience as an opportunity to try something new and to see what it's like to have a career in research. Not to mention that they're spending six months at a renowned research institution with a beautiful location – WHOI is located right on the southwestern edge of Cape Cod. "I always wanted to be by the ocean," Besser said.

Esser particularly enjoys having the chance to do hands-on work. "I pick it up a lot faster than studying," she said. "There's a lot of freedom, so it's a nice break."

In addition to their daily tasks, Besser and Esser attend weekly lab meetings and participate in a biweekly "lab report club," where Madsen gives them a study to read and discuss – like one by the project's principal investigator Jeff Donnelly.

"It's important to me that the students feel like they are part of the intellectual discussions, because they're a huge part of the research," Madsen said.

Whether they're splitting cores, measuring sediment or attending lectures, Besser and Esser are sure to find their WHOI experience to be a memorable one.

Sustainability on Campus

BY LEILA HABIB, BEHAVIORAL NEUROSCIENCE, 2019

DESIGN BY JULIETTE PAIGE, MECHANICAL ENGINEERING, 2020

After devouring their Rebecca's sandwiches, students face a tough decision – where to put their trash. When they get to the bins, they'll see signs with illustrations above each container, all trying to inform students about what items to recycle, compost, or send to the landfill.

Additions such as these are part of Northeastern's compost program. According to Northeastern's Update on Sustainability 2015-2025 report, there has been a 275 percent increase in food composted at Northeastern since 2007 with over 550 tons of food composted in 2014.

Sophomore environmental studies and international affairs major Yvette Niwa, president of the Husky Environmental Action Team (HEAT), believes that the compost program at Northeastern is a strong start but there is still room for improvement.

"They've come a long way. They have the pieces in place, but I would say enforcement is the biggest problem," said Niwa. "People are not putting the correct things in the compost bin, or the recycling. No one follows the rules, and the signs in the dining halls are really confusing."

Compost is just one of the various sustainability initiatives Northeastern has implemented on campus. Over the past few years, Northeastern received several awards for its environmental friendliness, including the Leadership in Energy and Environmental Design (LEED) Gold Certification for three of its buildings: George J Kostas Center for Homeland Security, Dockser Hall, and International Village. LEED awards buildings with certifications based on performance in several categories such as location and transportation, materials and resources, water efficiency, and sustainable sites, according to the U.S. Green Building Council website.

According to Northeastern's sustainability website, all of the dining halls also buy locally-grown produce when possible, which "reduces the overall carbon footprint of the food and supports the local farmers who use more sustainable growing practices."

Niwa believes that Northeastern should also limit the use of plastic bags at campus retail locations like Outtakes.

"We should be encouraging kids to either use paper or bring their own bags," said Niwa. "What we like to say is: plastic is forever. You can't get rid of plastic. It's not going to degrade."

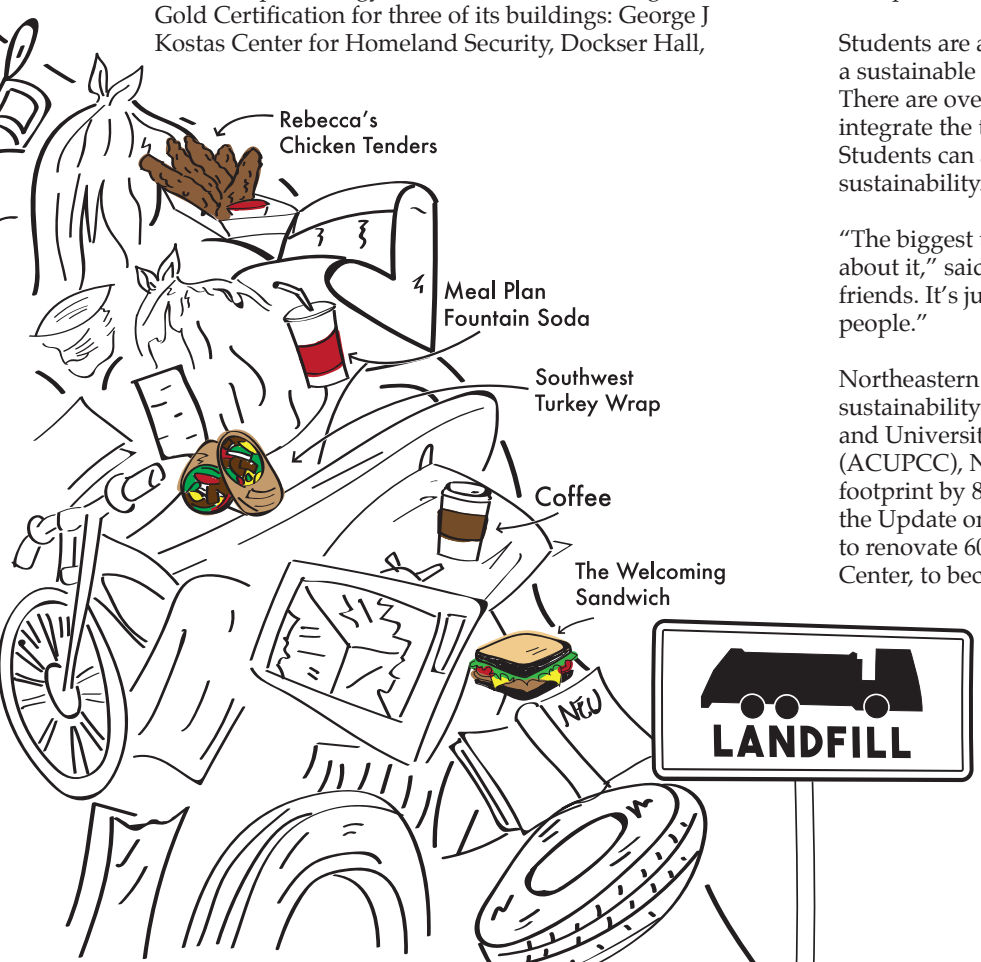
Northeastern also plans to increase public transportation usage by encouraging staff and students to take advantage of the two T stops on campus and the public busses. According to the Update on Sustainability report, Northeastern increased bike storage by 82 percent since 2005 and added two bike-repair stands in an attempt to encourage the community to bike. According the the report, 55 percent of employees walk, bike, or use public transportation to get to and from campus.

Students are also exposed to ways they can help promote a sustainable environment through their formal education. There are over 163 courses offered at Northeastern that integrate the topic of sustainability, according to the report. Students can also get involved with clubs that promote sustainability.

"The biggest thing is to get educated and talk to friends about it," said Niwa. "If you know how to recycle, tell your friends. It's just about spreading the correct practices to people."

Northeastern plans to continue working toward new sustainability measures. As part of the American College and University Presidents' Climate Commitment (ACUPCC), Northeastern promised to reduce its carbon footprint by 80 percent by 2050 relative to 2005 according to the Update on Sustainability report. Northeastern also plans to renovate 60 more buildings, including the Egan Research Center, to become more sustainable.

More information about Northeastern's initiatives can be found on Northeastern's sustainability website and in the Update on Sustainability 2015-2025 report.



NU Students Keep an Eye on the Changing Beaches

BY ADANYA LUSTIG, LINGUISTICS, 2018

PHOTO BY CAMS TEAM

A week before winning the Electrical and Computer Engineering Capstone Design competition, a team of students stood on a beach in Nahant, Massachusetts, testing their Coastal Automated Monitoring System (CAMS) for the first time. CAMS, created by Douglas Franklin, Federico Beckhoff, Mitchell Kucia, Taylor Wilson, and Benjamin Gowaski, measures the erosion and accretion of a beach for about seven times less money than current methods.

CAMS uses Lidar, RADAR-like technology that measures distance by analyzing reflected light, to measure erosion rates. Gowaski described Lidar as "eyes for robots," adding that advanced versions of the technology can discern what material is in front of the robot. By perching on a dune and aiming towards the water, CAMS takes readings every fifteen minutes or so with Lidar to produce a drawing of the slope of the beach at that location. Lidar isn't the only technology involved -- the team also included sensors for wind speed, barometric pressure, temperature, and relative humidity to get a broader picture of the coast.

An Arduino board controls and powers all these sensors, and a Raspberry Pi processes the raw data from the Lidar and auxiliary sensors, converting the data into graphs and understandable metrics. Then, the information flows to the user through a cellular modem via a mobile carrier network. The modem was an integral part of the design, because there's no need for a router, Bluetooth, or an app. Anywhere there is cell service, a user can "just put it on a beach and turn it on, and you'll get data from it," as Kucia said. Powering all of this is a 12-volt battery, about the size of a small car battery, charged by a solar panel.

This system was created after going back and forth with their contact, Lauren Josephs, S'15, at the Marine Science Center. The design changed over the course of their project. "They just wanted a stick in the sand they could leave there and get data," said Kucia. "Then that evolved to having a portable tripod that can move around."

However, creating that stick in the sand was harder than it sounds. The team met difficulty with the mechanical engineering side of things, as their team is all electrical and computer engineers. "Where other groups might have had a CAD drawing, we had a nice google paint drawing," said Kucia.

Working with their hands turned out to be a welcome challenge, and they were happily surprised by the success of the design. "A lot of people came up to us saying: that's really good," said Kucia. "It came down to us being like well let's make a triangle, and a couple rectangles, and glue them together, and we're set." Wilson added that the best successor to their project would be a Mechanical Engineering student. "They could probably overhaul the design and make it much more compact and robust," he said. "Maybe lightning-proof."

A patent is in the works for CAMS and ownership of this patent will be split between the students and Northeastern University. Northeastern pays for the process and gets a large percentage of ownership. Two members of the team have graduated, and the rest are finishing up their semester and looking for full-time jobs.

If someone did pick up the project, it could be useful for contractors, real estate companies, or insurance companies. The current methods of measuring erosion are either expensive or unreliable, costing upwards of $7,000 for a one-time flyover reading. Although this model cost them around $1,000, the team believes they could get the cost down to around $600, making this a viable consumer product.

The Conflict with Climate

How Climate Got Mixed Up in the Crisis in Syria

PHOTO BY CSIRO

BY GEMMA AQUILINA, ENVIRONMENTAL STUDIES, 2017

DESIGN BY JENNIFER SHUM, MECHANICAL ENGINEERING, 2018

Yesterday skies were clear; today the snow floats down, covering the world in a blanket of white. It's not difficult to stick an arm out a window or check your local weather app to determine what today's climate conditions mean for your choice of apparel and, perhaps, plans for the day. Everywhere people are making decisions based on the current climate. Zoom out to a macro view of the climate and we have climate change and the predictions for the future of climate around the world. How climate change will impact people around the world is critical knowledge for international leaders and decision makers. An area of growing attention is what impacts the predicted effects of climate change will have on conflict. While the United Nation's Intergovernmental Panel on Climate Change (IPCC)'s fifth assessment report concludes that it is too early to quantify these effects, scientific research documents global climate change as a threat multiplier that indirectly amplifies factors such as poverty and economics that can drive further conflict.

In 2011, when Syria unexpectedly erupted and joined the Arab Spring's wave of revolution headlines were quick to flash headlines suggesting climate change as the trigger. The Syrian crisis is an excellent example of the importance of having an awareness of the social, political, economic and environmental complexities underlying a conflict and where global climate change fits in. Four years prior to the conflict, Syria suffered the effects of a severe drought. To many, it was easy to correlate the consequences of a severe weather phenomenon; however, this conclusion ignores the fact that the drought did not predate the Syrian humanitarian crisis at hand. Many scholars will argue that decades of resource mismanagement contributed to the extent to which Syria was affected by the drought and the Syrian government's failure to adapt to changing conditions and lack of responsibility for the humanitarian crisis that ensued.

For many years, agriculture contributed a large segment of Syria's economy, and it was a self-sufficient producer of staple crops such as wheat. However, agricultural policies were largely driven by the supply-side and ignored the constraints of a region that is, by nature, water-stressed. Encouraged by the government, the traditional and highly inefficient flooding method was implemented on 80 percent of Syria's irrigated land and farmer pumped groundwater with little-to-no government regulation. The majority of agriculture is concentrated in the north-east region of Syria, which also holds a largest concentration of populations living in poverty. The rapidly depleting resources and transition from a central economy - which heavily subsidized agriculture - to a social market economy all compounded by the drought had huge consequences for Syrian farmers. With no economic alternative to agriculture, tens of thousands of desperate families migrated from the north-east leaving large portions of villages deserted. Years before the uprising, the Syrian population was disenfranchised.

> "Many scholars will argue that decades of resource mismanagement contributed to the extent to which Syria was affected by the drought and the Syrian government's failure to adapt to changing conditions....

While this is focusing purely on impacts and consequences to the agricultural sector, it disputes that climate change was a direct trigger to the crisis. At the same time, it illustrates how existing vulnerabilities can be intrinsically linked to the environment and that climate change will inevitably exacerbate the core instability. Identifying regions that are bound by a relationship to the environment can serve as an indicator to where conflict could potentially erupt if the balance of social, political, economic and environmental factors is disrupted. Warming temperatures and changes in weather patterns among other predicted impacts of global climate change, so taking measures to prevent these vulnerabilities should be the first defense for our international decision makers.

Middle Eastern Studies (2014). DOI: 10.1080/00263206.2013.850076

Shelter From the Storm

Climate Change Could Make Winter a Wonderland for Ticks


PHOTO BY TORANGE.BIZ

BY MATT DEL MASTRO, BIOLOGY, 2017

The punishing onslaught of a New England winter offers few redeeming qualities for residents to take solace in and the changing global climate may soon eliminate one of the precious few. *Ixodes scapularis*, better known as the deer tick, is an all-too-familiar pest for those New England residents fond of venturing outdoors. Many a hiker has lamented ending his day on the trail by finding a diminutive creature, no bigger than a sesame seed, with its jaws firmly entrenched in his flesh. Though the tick itself may prove itchy and frustrating to remove, it's what may be lurking inside that makes the little brown bloodsuckers more than simple pests. Deer ticks are transporters for the bacteria responsible for numerous diseases, including babesiosis, anaplamosis, and Lyme disease. Dog ticks, a pest of the same family, can transmit Rocky Mountain Spotted Fever. These infections often go unrecognized by patients and physicians and they can cause chronic and debilitating symptoms if left untreated.

> "Given their penchant for this particular form of precipitation, ticks may have a lot to look forward to in the coming years.

A common assumption among those living in tick-infested areas is that the frigid winter months provide a period of respite, but there has been little hard data to corroborate this conventional wisdom. Enter Dr. Thomas Mather, also known as "the Tick Guy," director of the Center for Vector-Borne Disease at the University of Rhode Island. On his institution's website, Mather has chronicled an investigation that began by simply subjecting deer ticks to the low temperatures of his freezer; he found that temperatures of -2 degrees Fahrenheit proved lethal to deer ticks within just 24 hours. The results seemed promising, but the facts didn't seem to line up. Through the university's TickSpotter program, in which volunteers from around the region self-reported encounters with the parasites, Mather noticed that a significant number of encounters were still taking place during the colder months.

Evidently, the realities of the relationship between ticks and cold weather was much more complex than the freezer experiment could model. Mather took the logical next step and moved the trial outside into the tick's actual living space. Temperatures were still cold, but now the ticks were living alongside soil, leaves, and snow. The results were a blow to the tick-fearing multitude - in addition to surviving the duration of the experiment, the arthropod test subjects sprung out of their dormant state ready for a feast as soon as they felt the heat of Mather's skin.
This impressive survival rate may have a counterintuitive culprit. The massive accumulation of snow that many take for a deer tick death sentence may in fact be a source of protection. The key lies in the creation of the subnivean zone, a hidden world that forms beneath the powdery white. When snow piles up, a space develops between the soil and the various leaves, branches, and other surface elements that the snow settles on top of. The natural warmth of the Earth's core is preserved in this insulated area, which creates an ideal home for any creature trying to weather a rough winter. Temperatures under the snow tend to hover around 32 degrees Fahrenheit. That falls just short of the 40 degrees Fahrenheit ticks prefer for active feeding, but, as Mather demonstrated, it's certainly warm enough to keep them happily hibernating.

Given their penchant for this particular form of precipitation, ticks may have a lot to look forward to in the coming years. Last year, The Washington Post reported on an emerging theory that global warming will cause an upsurge in the amount of snow the Northeast experiences. As global temperatures increase due to climate change, sea surface temperatures off the coast increase, which drives up the levels of moisture in the air. In the case of a storm, the wind cools the moisture and brings it to the ground as snow. Thus, as the oceans warm, the snow piles up. The Post cites data from the U.S. National Climate Assessment that describes a 71 percent increase in extreme precipitation since 1958. New Englanders won't need statistics to remind them of the momentous 2015 snowfall. Perhaps it is no coincidence that Mather, speaking to AccuWeather, described a "virtual explosion" of tick encounters reported to TickSpotter the following spring. He referred particularly to dog ticks, the number of which was "up at least a third over what we saw last year [at the] same time."

While climate change seems to have extended its unwelcme fingers into yet another aspect of life, there are some cautions that can be heeded to protect against tick exposure, be it in the sun or in the snow. Insect repellant should be applied when heading into the woods or long grass, and self-examinations should be performed after such excursions. Legs should be completely covered, with pants tucked securely into long socks. If 2015 was any guide, the latter suggestion will be more than welcome this winter.

Let it Snow, Let it Snow, Let it Snow

Why a Winter Wonderland Doesn't Disprove Global Climate Change

BY KATIE HUDSON, MARINE BIOLOGY, 2017

DESIGN BY MANNY BARROS, MECHANICAL ENGINEERING, 2020

It's hard to forget that Boston saw a record-breaking winter in 2015. Logan Airport saw a grand total of 110.6 inches during the 2014-2015 season, according to The Weather Channel. As the city of Boston continuously dug itself out, the MBTA ceased moving, and classes were canceled on nearly a weekly basis, many kept asking themselves the same question: How is global warming possible in these conditions?

In addition to having the worst winter on record, 2015 was also the hottest year on record, according to the United Nations – not just for Boston but for the entire planet. For example, heat waves in Pakistan and India reached peak temperatures of 45 degrees Celcius (113 degrees Fahrenheit!). The average temperature for 2015 was 0.9 degrees Celcius (1.62 degrees Fahrenheit) above 20th century averages. This is more than 20% higher than previous deviations from these averages. Last year surpassed the previous record set in 2014 by nearly a third of a degree. This is the fourth time a global temperature record has been set since 2000. With data like this, it is nearly impossible to deny the existence of global warming and global climate change, even though this is a daily occurrence in the United States government.

If the planet has been warming, how is it possible that four of the five snowiest years in Boston have occurred in the past 25 years? According to NOAA, increased global temperatures have led to increased evaporation. This leads to increased levels of moisture in the atmosphere, leading to increased precipitation. This process, according to NOAA, can be extremely significant for the development of the nor'easters that strike Boston every winter. In addition, this increased precipitation has been shown to increase the amount of lake effect snow in the Great Lakes region.

In addition, global climate change has affected a phenomenon known as the North Atlantic Oscillation. Similar to the relatively well-known El Niño Southern Oscillation that occurs off the coast of Chile, the North Atlantic Oscillation is caused by a shift in atmospheric pressure in the northern Atlantic Ocean. When this shift occurs, the direction and relative strength of the jet stream can be affected. The jet stream, in addition to being a vital part of air travel, has a large impact on temperature and weather patterns in the eastern United States and Canada. As the planet has warmed, the shifts in the North Atlantic Oscillation have significantly increased in magnitude similarly to El Niño Southern Oscillation events. Experts believe that a shift in the North Atlantic Oscillation was one of the major contributing factors to the record-breaking winter in Boston last year.

> "According to NOAA, the increased global temperatures have led to increased evaporation.

Another major global warming-related factor to last year's winter was the weakening of the polar vortex. A term that was coined by meteorologists across the country in the past few years, the polar vortex is a mass of high-altitude winds that confines cold Arctic air in the northern latitudes. When the polar vortex is strong, the bitterly cold air is retained in the higher latitudes and does not force Northeastern students to retreat to the tunnels to get to class. Alternatively, as the planet warms, more heat is added to and retained in these northern latitudes. This retained heat weakens the polar vortex and, as a result, causes the cold air to move south. It is believed that this is what caused the extremely cold temperatures that accompanied the plentiful nor'easters last year and in 2014.

GRAPHICS BY JETRO CABAU AND RALF SCHMITZER FROM THE NOUN PROJECT

DATA BY THE FARMER'S ALMANAC

So what does this mean for the winter of 2016? Should we expect to have so many snow days that we will be forced to make up class on Patriots' Day? Not exactly – the North Atlantic Oscillation was a major component of the record-setting winter last year and, as the name suggests, the magnitude of this phenomenon fluctuates every year. It is too early to tell how strong this year's North Atlantic Oscillation will be. While El Niño is predicted to be strong in 2016, there is little to no evidence to suggest a strong positive correlation between the two oscillation events. As a result, there may be some reason to hope that this winter may be a mild one.

Polonsky, A. B. et al. *Pacific Oceanography* (2004).

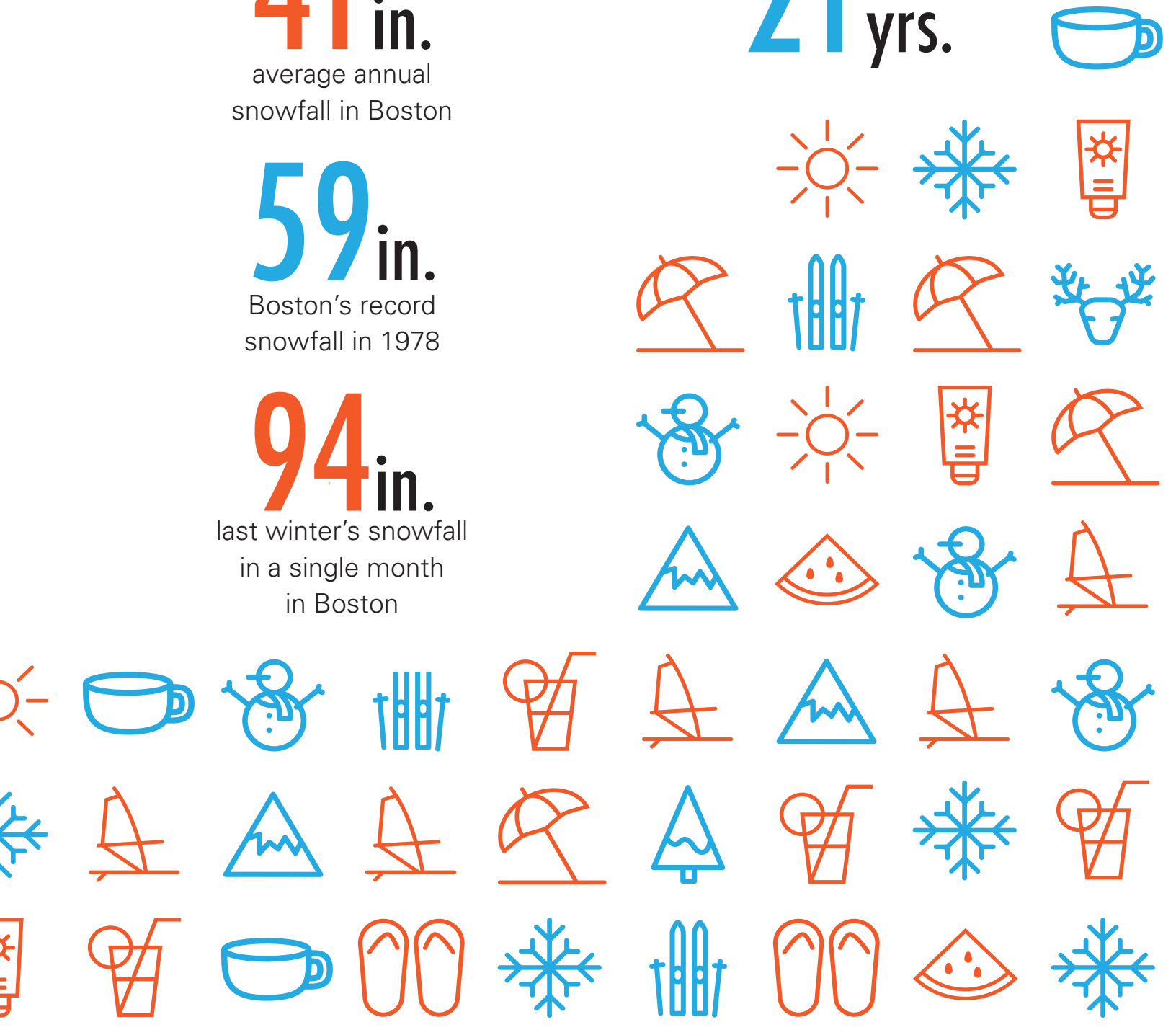
41 in.
average annual snowfall in Boston

59 in.
Boston's record snowfall in 1978

94 in.
last winter's snowfall in a single month in Boston

4 out of 5
of Boston's snowiest winters have happened in the last

21 yrs.



Blue Light or Boo Light

Discussions About Blue Light and its Impact on Health

BY NATALIE GRACE SCHULZ, BIOLOGY AND HISTORY, 2017 DESIGN BY CASSANDRA JOHNSON, CHEMICAL ENGINEERING, 2018

Over the past decade, technology has been dramatically incorporated into daily life. Screens are commonplace - smartphones in hand, computers for homework, and tablets to check people into events are seen every day. The tools have undeniably changed the way that the average person lives. However, researchers are concerned with the unintended consequences of these increases in technology. A series of recent articles have highlighted the potential detrimental effects of blue light.

Blue light is the high energy portion of the visible light spectrum because of its shorter wavelength and higher frequency. This high energy makes blue light so interesting to researchers concerned about the effects of increased screen time.

Unfortunately, recent studies have shown that several of these concerns are valid, linking blue light to regulation of circadian rhythms and a particular form of macular degeneration.

Circadian rhythms, deriving from the Latin roots circa, meaning about, and diam, meaning day, are the body's natural daily cycles. The body constantly checks its internal clocks and adjusts its cycle according to external stimuli received by the melanopsin retinal ganglion cells. These cells in the eye are particularly sensitive to blue light, invariably linking blue light to the body's internal clock. With the increased use of fluorescent lighting and LED screens, our bodies absorb blue light beyond the range of daylight, confusing the natural circadian rhythm. A study published in Environmental Health also found that exposure to blue light in the time before bed will delay the start of REM sleep a half-hour. This shift in sleep can lead to severe health problems, or worse, fatigue.

Blue light has also been linked to age-related macular degeneration – the slow loss of vision in one or both eyes. While several other contributing factors, including smoking, diet, and genetics have been known for years, a study in the Review of Optometry shows that blue light contributes to this disorder. Its unique ability to bypass the body's natural filtering mechanism and penetrate to the back portion of the eye can cause direct damage to the retina, foyea, choroid and optic nerve, accelerating the macular degeneration process.

Fortunately, as these studies link these problems to a specific wavelength, phone and computer companies are starting to incorporate updates and apps to protect the user's eyes. The majority of these apps are focused on regulation of the sleep cycle by limiting blue light to daylight hours. Apple will incorporate a night shift option in the iOS 9.3, filtering out blue light as the geolocation marks sunset. Android users will be pleased to hear that an app, named Twilight, is already available. The app switches the phone's color palette to a series of warmer colors from sundown to sunrise. Similarly, computer apps exist to help people avoid blue light prior to bedtime.

While these apps may prove effective in limiting exposure to blue light, many researchers fear that it will not be enough, and it is likely that several long-term effects have simply not become apparent yet. We can only hope that the time spent writing late-night lab reports will not lead to any unforeseen future problems.

Environ Health Perspectives (2010). 10.1289/ehp.118-a22

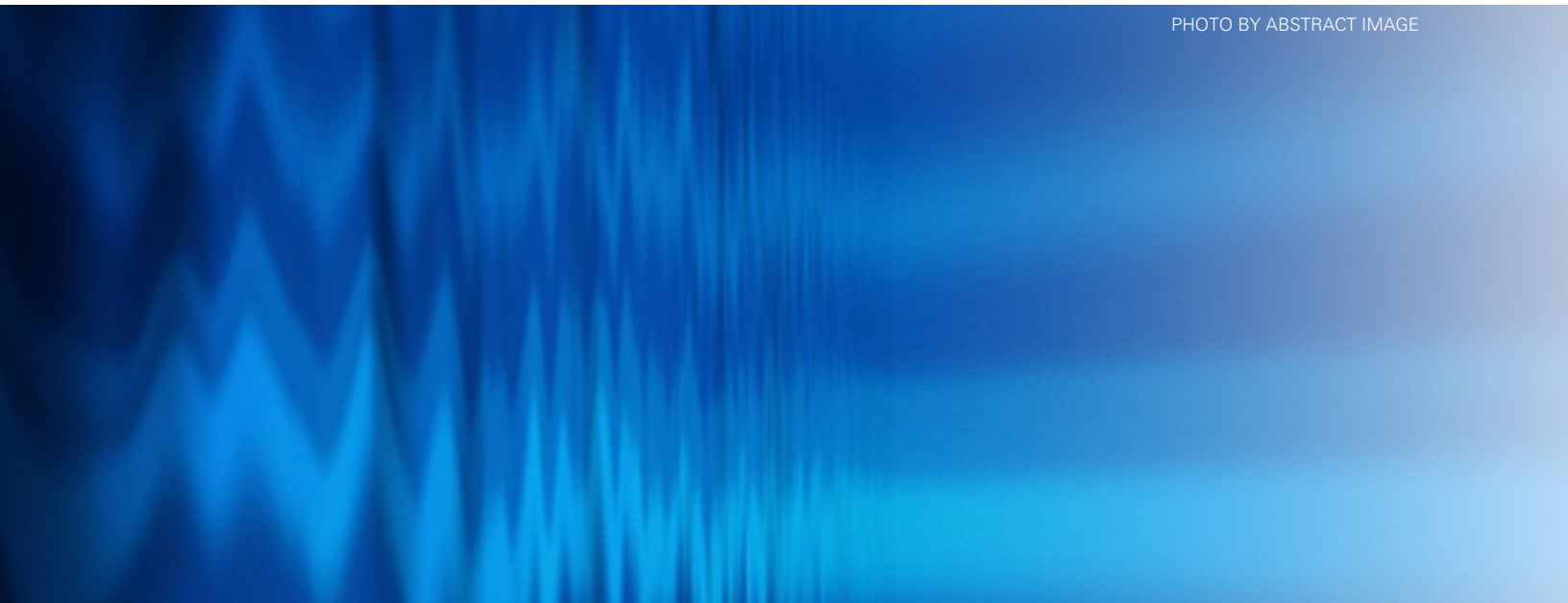


PHOTO BY ABSTRACT IMAGE

Hybrid Electronics: Building Bio-Powered Microchips

BY JOYCE ZHOU, BIOCHEMISTRY, 2019

Working at the interface of biology and solid-state electronics, researchers at Columbia University recently designed a microchip that harnesses the energy stored in adenosine triphosphate (ATP), commonly referred to as the fuel of life. With energy stored in its phosphate bonds, ATP is broken down by nearly all biological organisms to perform cellular work. This newest feat by Columbia researchers marks the first time a single biological mechanism has successfully been isolated to power a hybrid circuit-biocell system.

One of the most critical features of cells is the maintenance of a transmembrane potential. This refers to a voltage difference across the cell membrane generated by differences in the ion concentrations inside and outside of the cell. Transmembrane potentials typically fall in the range of -40 to -80 millivolts, indicating that the interior of the cell usually has an excess of negatively charged ions. Most cells maintain a nonzero membrane potential by regulating the movement of ions between their internal and external environments. This rate of ion flux is dependent upon a class of proteins embedded in the membrane called ATPases that catalyze the hydrolysis of ATP, thus releasing energy that can be used by the cell.

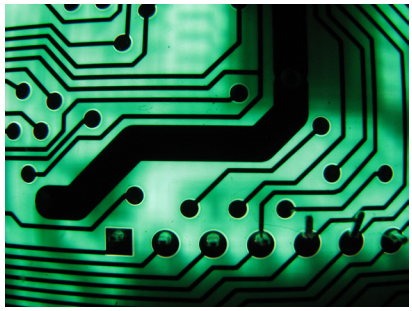


PHOTO BY PETER SHANKS

Batteries also operate on a voltage difference across their positive and negative terminals to generate power. A sustained transmembrane potential allows the cell to behave like a battery, generating a driving force that can be used to power movement such as the secondary active transport of glucose across the cell membrane. In excitable cells such as neurons, a potential gradient can also drive the relay of electrical signals.

Dr. Kenneth Shepard's and his team's hybrid system is comprised of a biocell attached to a complementary metal-oxide-semiconductor (CMOS) integrated circuit (IC), which is commonly used in computers to store startup and hardware information. The biocell contains two fluid chambers separated by two series-stacked suspended lipid bilayers, each embedded with over one hundred thousand active sodium-potassium ATPases purified from pig brains. Each ATPase enables the exchange of three Na+ ions and two K+ ions between the chambers, producing a net charge movement of one cation per molecule of ATP. The surface of the chip is coated with a thin silver/silver-chloride electrode that acts as an electrochemical converter and turns ions into electrons.

Just the stacking of two membranes alone generates the minimum start-up voltage of 145 millivolts required to power the IC, overcoming the need for an external energy source that is typically required in low-voltage systems. The biocell charges a storage capacitor in a cyclic manner: the IC operates until the voltage drops below a certain minimum voltage, at which point the capacitor is charged again. This cyclic operation allows the system to shut down for long durations of time and is effective in negotiating the discrepancy in power dissipation between the circuit and the biocell.

All together, the embedded ion pumps are able to generate a maximum voltage of 156 millivolts, and despite the loss of potential due to the absence of a high ion concentration gradient, the total efficiency of the hybrid system in converting chemical to electrical energy is 14.9 percent. Biological systems, of course, are able to use ATP at a much higher efficiency because the ion concentration gradient is considerably higher, but Shepard predicts that even higher membrane potentials can be achieved by making adjustments in the membrane resistance and number of active ion pumps.

The concept of utilizing a biological transmembrane potential to power CMOS ICs is hardly new. Prior efforts have produced a variety of hybrid bio-powered circuits powered by membrane potentials, ranging from an IC powered solely by a connection to big leaf maple trees to an implanted biofuel cell powered by a snail. These efforts, however, attempt to integrate whole living systems with microelectronics. In comparison, the Columbia project is the first reported success of integrating an isolated biological component in an artificial system.

The prospects of designing such creative hybrid systems to power electronics have far-reaching potential. The gradual end of technology scaling necessitates the use of more imaginative methods to power electronic devices. Shepard and his team are now looking to find ways to scale down their artificial hybrid system, envisioning that bio-powered microchips will one day be able to fit and operate in the ATP-rich environments inside individual cells. Such an implant working inside a cell could be extremely useful, for instance, as a microscopic self-governing medical device. In addition, future hybrid chips integrated with sensory membrane proteins and having the ability to "taste" and "smell" could prove useful for developing high-throughput drug-screening platforms. For bio-powered electronics, the future is only just beginning.

Nature Communications (2015). DOI: 10.1038/ncomms10070.

Breaking the Ice

PHOTO BY CHASE DEKKER

The Changing Face of Climate Change in Mass Media

BY ERICA YEE, UNDECLARED, 2019

For many years, the media has framed the reality of global climate change as controversial and uncertain. In a 1950 article titled "Is the World Getting Warmer?", the Saturday Evening Post spearheaded mass media coverage of climate change. However, the presented theories failed to mention the effects of human activity on global temperature, reflecting the general consensus that Earth could easily absorb the outputs of industrialization. Consistent media coverage of global warming did not take off until 1988—when Dr. James Hansen, a NASA scientist, reported the agency was 99 percent certain global warming was anthropogenic and caused by a buildup of artificial gases in the atmosphere.

Since the 1990s, mass media coverage of climate change has been characterized by spurts of increased reporting when there are big stories—exemplified through the international attention brought by the loss of Arctic habitat due to rising temperatures. While polar bears resembled a key symbol of global climate change, Al Gore's activism in the early 2000s marked a turning point in public awareness of climate change. Later, the 2007 UN Intergovernmental Panel on Climate Change's Fourth Assessment Report unequivocally confirmed the consensus that global warming was man-made. Furthermore, major policy initiatives—such as the American Clean Energy and Security Act of 2009—have heightened public interest.

An increase in coverage of environmental issues over the years has increased public awareness. However, intrinsic differences in scientific and journalistic ways of thinking can complicate reporting of controversial issues, such as global warming. While often many people carry out scientific research over many years, the media responds to high impact or breakthrough research. Media outlets report on issues while they are considered relevant, sometimes before understanding the complex scientific discoveries, and may oversimplify or misrepresent results. False balance in news coverage can give the erroneous impression of scientific uncertainty and is a chief challenge for the science community. As journalists strive to represent opposing sides of an issue, they can be too objective when covering science by giving the megaphone to skeptics.

Thus, minority views—not supported by scientific evidence—can overpower facts and lead to misconceptions. According to a 2004 study published in Global Environmental Change, many mainstream news organizations' focus on maintaining balance "leads to biased coverage of both anthropogenic contributions to global warming and resultant action." Even as legitimate climate scientists were more and more certain about human-induced changes, outlets gave ink and space to the marginal views of deniers. Climate change coverage has since improved, but the challenges of reporting effectively remain.

> "Intrinsic differences in scientific and journalistic ways of thinking can complicate reporting of controversial issues, such as global warming.

John Wihbey, assistant professor of journalism at Northeastern University, explained how good reporters must "be creative, put the issues in context, and show the public their stake." Wihbey cited NBC coverage of a prominent 2012 study about melting ice sheets as a compelling example. Instead of merely summarizing this report's findings that rising sea levels be attributed to melting ice, the NBC anchor made the statistics relevant and more comprehensible to the public. For example, they compared the annual 344 billion metric tons of ice melting in Antarctica and Greenland to the "weight of more than a million Empire State buildings."

Other media outlets have also found creative and compelling ways to discuss climate change. For example, Last Week Tonight host John Oliver physically staged an

accurately balanced debate about anthropogenic climate change with 97 scientists opposing 3 skeptics. The NY Times published "Short Answers to Hard Questions about Climate Change" to remediate and increase public knowledge. This piece simply—but thoroughly—presents the scientific consensus, explains reasoning behind skepticism, recommends everyday actions, and provides the opportunity for people to ask further questions. Offering visuals—not just confusing graphs—can also pique the public's interest.

For most people, the reality of science is what they read or watch in the press. Therefore legitimate and effective science journalism requires a combination of vetted facts and often relevance to people's everyday lives. As science issues – especially climate change – become increasingly important to modern society, the mass media has the responsibility of informing public awareness. Reporters must tell stories proportional to the scientific consensus and be patient about breaking news. On the flip side, news consumers need to understand that the scientific method, though well vetted and usually applied with good intentions, is not perfect. Data can be skewed and longstanding "facts" can be refuted. Healthy skepticism of the news must be balanced with an underlying trust that both scientists and journalists are trying to do their jobs and make the world a better place.

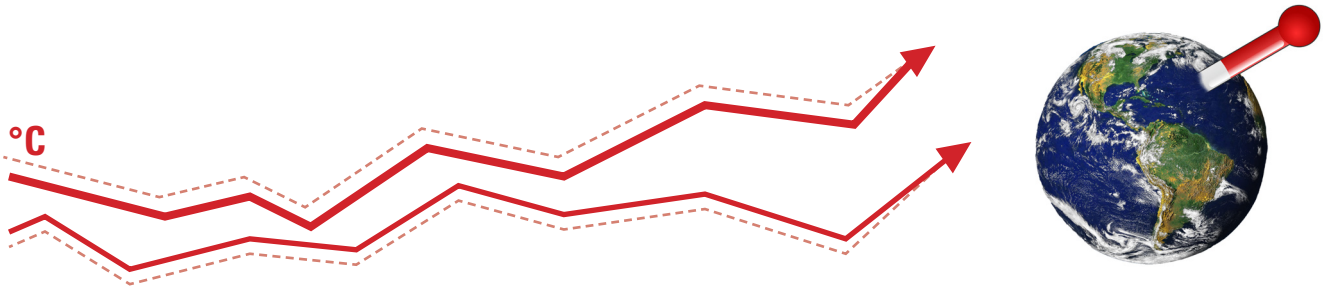
Global Environmental Change (2004). doi:10.1016/j.gloenvcha.2003.10.001

Huge Strides Taken With Our Global Carbon Footprint in Mind

The International Climate Summit set goals to limit temperature rise

BY SAGE WESENBERG, BIOCHEMISTRY AND JOURNALISM, 2019

DESIGN BY CASSANDRA JOHNSON, CHEMICAL ENGINEERING, 2018



The United Nations Framework Convention on Climate Change (UNFCCC) collectively called it "the single most important collective action for addressing climate change ever agreed upon".

This past fall, from November 30 to December 11, 2015, the 21st Conference of the Parties to the UNFCCC was held in Paris, France in order to reach global agreements in goals for tackling the ever growing issue of climate change. The 2014 summit, which was held in Lima, Peru, resulted in a decision to allow each country decide for itself how they wanted to deal with climate change, known as an intended nationally determined contribution (INDC). The purpose of these INDCs was to initiate guidelines for each country that they would be able to stick to and accomplish. Now, a year later, 192 nations unanimously voted on adopting an agreement that sets a goal to limit the world's rise in average temperature. The agreement says the participating countries will attempt to limit temperature rise to "well below 2 degrees Celsius above preindustrial levels [while] pursuing efforts to limit the temperature increase to 1.5 degrees Celsius." This goal will be attained by turning the INDCs into NDCs, or declarations that will be set in stone of how each country will contribute towards reducing its global emissions. Additionally, developed countries will help developing countries use greener energy and adapt to climate change by contributing $100 billion per year.

This agreement is a huge advancement in our pursuit to slow climate change. As the agreement document states, "climate change represents an urgent and potentially irreversible threat to human societies and the planet and thus requires the widest possible cooperation by all countries."

The next steps for this agreement are for all 192 governments to adopt it within their country. There is a plan for a five-year update to see what progress has been made for countries' work towards lowering the change in temperatures, help towards developing countries to become greener, and the overall agreement's effect on the whole globe.

Are we there yet? Building the grid of the future

BY DAVID ROSENBERG, CHEMICAL ENGINEERING, 2020

The 2015 Paris Climate Conference ratified a global consensus that coal, oil, and natural gas combustion will need to fall dramatically in the coming decades. Nevertheless, the debate over how to power an increasingly energy-hungry world continues to rage. Technologies that directly harvest sunlight and wind are some of the least controversial and best developed. While these provide far more energy than global demand requires, the power available at any location can change widely and rapidly. Adding variable sources into a grid built around easily controlled combustion will require an overhaul of energy collection and distribution. Fortunately, a wide variety of systems have been developed to meet this need by rethinking the way we handle transmission, communication, storage and consumption.

Though they seem spontaneous from the ground, wind and sunlight tend to move across the landscape. Distributing and linking power plants over a wide area ensures energy distributers have a more constant overall supply. Expanding the grid will also allow access to more concentrated and reliable energy resources in remote regions such as deserts and oceans. Alternatively, solar panels and small-scale wind turbines allow local communities and homeowners to produce their own electricity, further integrating power across regions with different climate conditions. To do this, generators will have to measure and communicate available resources much more frequently than in current networks and utilize more effective and standardized weather forecasting.

Even with perfect management, maintaining enough wind and solar plants to guarantee sufficient power in any conditions would be prohibitively inefficient and expensive. Fortunately, a wide variety of batteries have been developed that store electricity over various timespans and release it as needed. Cheaper but less efficient options include using heat or electricity to melt or boil substances that can later release that energy turning a generator or heating a building, and electrically forming hydrogen from water in a reaction that can be reversed in a fuel cell. Large scale and long term storage can be achieved by using excess energy to power a pump that moves water uphill for later release through a hydroelectric dam.

According to a 2015 Stanford study, with effective transmission in place the United States can meet about 55 percent of its total energy needs with wind and solar power alone, achieving 100 percent renewable energy using hydroelectric dams. Combining low-cost storage, enhanced transmission and flexible power usage by consumers and industry could enable global energy reform.

PNAS (2015). 10.1073/pnas.1510028112

What the flood? NUSci explains El Niño

BY GAURI NARAYAN, BIOLOGY, 2018

The climate phenomenon known as El Niño comes around every few years and dominates those all too familiar, awkward conversations about the weather. However, the need to understand it in the context of abnormal flooding and climate change has become as important as ever. The effects of El Niño have been gradually worsening since 1980 and according to the research conducted by a research team from Utah State University, this can explain the extreme flooding that occurred over the southern Great Plains in May of 2015.

In May of last year, Texas and Oklahoma experienced extreme precipitation that led to record-breaking floods while areas like Kentucky and Tennessee experienced abnormal dry spells. Although it is expected that El Niño increases precipitation around the Great Plains while simultaneously causing dryness in the southeastern regions, the two extremes experienced and the subsequent damages caused in these areas were beyond what anyone was prepared for. According to the data collected by the USU team, the intensification of El Niño is linked to the ever-present issue of global warming.

El Niño is a cycle where ocean temperatures warm every few years as a result of weakening trade winds. This causes the waters on the equator and South American coasts to warm and thus impacts weather patterns across the western hemisphere. According to the study, the heightening effects of El Niño are associated with the increase in atmospheric temperatures due to greenhouse gasses. This conclusion was drawn after researchers performed regressions between all the different factors and compared these across different time periods. The combination of a strengthening El Niño and gradually increasing greenhouse gas emissions is predicted to cause even more extreme weather events like the floods in Texas and Oklahoma. Not only are more of these environmental disasters in our near future, they are said to continue to worsen as time goes on.

This research can be extremely beneficial when it comes to making more accurate predictions about the weather during periods of El Niño. According to news reports in Texas, for example, the floods caused a whopping $45 million worth of damage in Houston alone. As a result, if states can be prepared for what is to come, then devastating economic and social losses can be reduced.

Geophysical Research Letters (2015). doi:10.1002/2015GL065211

IMAGE BY PENGUIN

HAPPY CITY

BY EMILY ASHBOLT, BIOMEDICAL PHYSICS, 2017

A friend of mine had been encouraging me to read Happy City for months, even going so far as to lend me her precious copy, but summer turned into fall, and I still hadn't started it.

I even went and saw the author, Charles Montgomery, when he came to Northeastern in December. I was fascinated by his presentation, and by how he said "a-boot" like the good little Canadian he is. But I had still never cracked the spine.

My co-op was passing fast, and there were surely more books coming for the holidays, and still Happy City sat on my bedside table, taunting me with it's peaceful, light-blue cover. Days of lazy leisure over the winter break did nothing to inspire me to open it.

It was looking from an escape from the first week of classes that finally got me reading. "Just the first chapter," I thought. "Just to get a taste. Useful procrastination."

One hundred pages later, I was well, well past the first chapter, and wasn't planning on stopping any time soon.

Happy City is an interesting book, for a variety of reasons. Part history, part sociology, part environmental science, and part psychology, it is, to sum it up in one sentence, an expose on how our cities got to be the way they are, and how changing them could have a positive impact on just about every aspect of modern life today.

It is meticulously researched and goes all over the world - from the inside of the American Auto Industry lobbying to the architectural and environmental reasoning behind some of Latin America's newest bike lanes, and is full of fascinating anecdotes and factual tidbits that will have you tugging on the sleeves of people around you saying, "Did you know that..?". What makes Happy City more interesting than just the breath of the subject matter is that Montgomery places all of his literary force behind the key idea of the book- that by redesigning cities, we could, as a people, become happier.

Happiness as a crux of a movement seems to be given little thought in these activist-filled times. The idea that groups of people could spend countless amounts of time and money to make themselves happier when there are so many who are hungry, who are homeless, seems frivolous at first. But that is the magic of the book - Montgomery shows that this happiness does so much more than just make people smile more. A "happy" city benefits everyone- more green space, more places to walk, more interesting and essential places within walking distance, and so much more- these factors improve the quality of life for everyone, by making cities affordable, clean and friendly places to be.

If it sounds like a utopia, something too naive to be true, just read the book. Montgomery weaves his and other New Age Urbanists' research together in a marvelous call-to-arms that has actually started its own movement. The Happy City is an organization that does consulting, workshops and speaking events all over the world to encourage urban planners, city leaders, local artists, and citizens to fight for their own happy cities, wherever they live.

It is a powerful, beautiful, optimistic book that will make any reader want to throw their current life plans away and devote themselves to the pursuit of bike lanes and green spaces. To save the climate, our sanity, and the city ideal that in Boston we know and love so well, it may well be our only hope.

NUSCIMAG

NUSCIENCEMAGAZINE

NUSCIMAG.COM

NUSCIMAG

Supported by the
Student Activity Fee