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Imagine a vast flatness stretching in all directions. Now fill that space with bird songs, the rustling of bull rushes, and the drone of a float plane vanishing into the distance. In July 2018, I found myself perched on the edge of a lake in the Yukon Flats Wildlife Refuge with a pile of gear at my feet, watching the tiny dot of the plane disappear south into the foothills of the Crazy Mountains.

Our group had come to the Yukon Flats Wildlife Refuge as part of NASA's Arctic-Boreal Vulnerability Experiment (ABoVE), a 10-year field experiment to understand the fate of permafrost release in a warming world. David Butman (UW), two USGS collaborators, and I were dropped by floatplane at a remote cabin in the middle of the Flats to investigate the role arctic lakes play in biogeochemical feedbacks in this changing landscape.

Between 1,400 to 1,850 billion metric tons of carbon are locked up in the soils of the circumpolar North, which is almost twice the amount of carbon in the atmosphere. At the project's start, the prevailing understanding was that lakes acted as reactors, processing and releasing previously frozen carbon from permafrost soils into the atmosphere as greenhouse gases. As the Arctic continues to warm at a rate double the global average, this creates a positive feedback loop that accelerates climate change.

However, new research published by our group and others this year in *Nature Climate Change* suggests the majority of these lakes are cycling mostly modern carbon. My work explores how spatially synchronous lakes are across the landscape by linking field measurements of productivity to satellite remote sensing.

Regardless of carbon source, arctic lakes experience seasonal boom-and-bust cycles of
Preliminary research from our group shows a strong link between rates of gross primary productivity and satellite observations of lake color. Every summer, lakes change color as they warm and fill up with life. Flying over the lakes, the colors are striking and can provide clues into ecological conditions. One lake might be pea-soup green from cyanobacteria, while its neighbor is yellow-brown from mats of submerged aquatic plants.

The lakes are remote; summer access is by float plane only. At each site, we collected water samples and deployed sensors off the pontoon of the plane to measure lake optics. One lake was too small for a normal take-off; our pilot Jim Webster demonstrated his experience and skill by instead slingshotting along the edge of the lake to get up to speed. Each day we would return to the cabin, which was studded with nails to keep the bears out, to filter samples and charge up equipment for the next day.

Our measurements would provide a ground truth for an airborne hyperspectral sensor called AVIRIS-NG, which collects images of the earth from an aircraft and was coordinated by NASA to fly over the lakes during our trip. Airborne remote sensing observations are crucial for mapping this remote landscape. The research flights would give us a birds-eye view of the thousands of lakes dotting the landscape.

At the cabin, filtering water samples into the broad sunlight of the late evening gave me time to ponder the scale of the surrounding landscape. As one human, it is hard to comprehend the sheer size of this carbon pool, just as it is hard to understand the size of the problem of climate change. Each lake filter I collected was just one tiny clue in this bigger puzzle. Accumulating and interpreting these clues is the work of science. NASA’s ABoVE campaign can amplify the work of scientists from many disciplines by bringing us to work side-by-side in our efforts to understand this rapidly changing landscape.

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Hacking Communications Solutions Following Natural Disasters

By Jimmy Phuong (UW School of Medicine)

On a recent trip to Puerto Rico, I had the opportunity to engage with stakeholders, community members, and researchers directly affected by Hurricane Maria in fall 2017. Many of these people described how they understood the water quality and health issues following Maria, but disrupted communications channels made communicating these risks slow, irregular, and delayed. Community response required faster communications to be effective.

At this time, I learned about the upcoming Meshing with Data hackathon, which would bring together computer scientists, software engineers, and other scientists to innovate solutions to major communications problems following natural disasters. This event is designed to crowd-source existing engineering expertise through applied interactive workshops. When I learned about this event, I was excited because if anyone could come up with helpful solutions, I thought, it would be the engineering community, problem-solvers that they are. Workshops at the hackathon included lectures on blockchain technologies, internet of things, decentralized architecture, crowd-source platforms, and design thinking, all of which might be creatively applied to mass communications problems.

But looking at the event schedule, I realized that representation for domain expertise focused on computer engineering only. After Hurricane Maria, many communities spent months concerned about drinking water availability. Without power, hospitals and medical aid were severely exhausted, and aid could not be deployed to many places due to remoteness, broken roads, or flood. This needed to be addressed, so with the help of Dr. Christina Bandaragoda, we wrote a successful Earth Science Information Partners (ESIP) Lab proposal that supported my travel to attend the Meshing with Data hackathon as an advocate for water and health sciences. Other parts of the award include support for community participation in cyberinfrastructure design by Puerto Rican stakeholders, as well as travel for Puerto Rican colleagues to attend the Freshwater Hackweek on UW campus (planned for UW Spring Break 2019).
The Meshing with Data hackathon took place in Bayamón, Puerto Rico at a facility known as Engine-4. Engine-4 is an incubator space for start-up companies, but following Hurricane Maria, Engine-4 served as an “internet plaza,” an oasis with generator-powered electricity and internet access. Beside it stood a weather-damaged stadium that is currently used as a FEMA disaster recovery center. Strewn about the parking lot were remnants of fallen lamp posts.

On the first day of the hackathon, I was struck by the diversity of expertise and career stage in the room. I stumbled through pleasantries in Spanish with undergraduate students, other graduate students, mid-career software engineers, and a few people in cryptocurrency technologies. Hoping to put my water and health science expertise to use, I formed an awesome team with a motley crew: a CEO for a cryptocurrency company, an undergraduate in chemical engineering turned computer engineering, and an undergraduate in computer engineering with drone expertise.

Together, we sprinted through the 43-hour hackathon, working to develop a minimum viable product that might serve as a solution to communications problems following natural disasters. Like other hackathons that I’ve completed in the past, teams were motivated by a monetary prize for the most innovative, functional, and feasible product. 43-hours is a long time; that sort of sprint takes its toll on the body by way of mental and physical exhaustion. Tums were necessary!

Once the hackathon started, our team designed our product iteratively. We thought about ways to use drones to establish a mesh communication network over a large region. For example, with drones flying over affected areas, distributed community members might report their current condition, which would be relayed from the drone back to response teams: flooded, not flooded, downed trees, food needed, medical attention required, etc. We thought it might be easy for community members to communicate these messages with visual codes, or emojis, and then translate those messages into a visual map of high-level need areas for dispatch responders.

With each passing hour, our product idea was refined further. Meshing with Data hackathon mentors were available around the clock to bounce ideas and provide feedback, which was invigorating! Ultimately, our unfinished end product used a open-source mesh network software called Byzantium. Though more accomplished entries won the cash prize, our diverse team ended up generating some great ideas that still have many possibilities left unexplored.

Thanks to the ESIP funding, I am excited to propose similar contingency projects at future
Fieldwork in Forks

By Amanda Manaster (CEE)

Summer is one of the busiest times for scientists doing field work, and I'm no exception—I get out to the field regularly during the summer. At the end of June, I was in Forks, Washington calibrating tipping buckets for my research project.

In the world of freshwater, I am interested in sediment (mud) transport (movement). For the sediment to move anywhere, you need some sort of driving force, and, in the case of my research, that driving force is water.

To understand the process of sediment transport, quantifying the amount of sediment and the amount of water is incredibly important. This is where the tipping buckets come in! In our field set up, the tipping buckets are placed on a platform on the hillslope below the road surface (along with a sediment tub and a turbidity tank), and water is routed through the tipping buckets, so we can get a measurement of the flow. The tipping buckets work like this:

1. Water goes in through the top of the tipping bucket
2. One side of the bucket is filled until it tips over
3. The other side of the bucket is filled until it tips over
4. Repeat

Inside the tipping bucket, we have a tip counter. We take the number of tips multiplied by the amount of water it takes to tip, and voilà! We have the quantity of water we were looking for.

I spent my week at the end of June calibrating the tipping buckets (i.e., determining how much water it takes for the tipping buckets to tip). To do this, we used a fire truck (which I got to ride in!) with an attached flow meter and spent hours (and hours and hours…) counting tips, doing basic math, and lifting heavy sheet metal boxes.

Though it may sound boring and monotonous (which, honestly, it could be at times), I still firmly believe that **a bad day in the field is better than any day in the office.** Happy field-working!
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