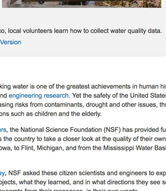
Discovery

Tapping communities for water research

NSF-funded citizen scientists and engineers dive into water quality monitoring



In Veracruz, Mexico, local volunteers learn how to collect water quality data.
Credit and Larger Version

March 22, 2018

Access to safe drinking water is one of the greatest achievements in human history, largely thanks to science and engineering research. Yet the safety of the United States' drinking water system faces increasing risks from contaminants, drought and other issues, threatening vulnerable populations such as children and the elderly.

For the last two years, the National Science Foundation (NSF) has provided funding to enable communities across the country to take a closer look at the quality of their own water systems, from Des Moines, Iowa, to Flint, Michigan, and from the Mississippi Water Basin to Maine's estuaries.

For World Water Day, NSF asked these citizen scientists and engineers to explain what excites them about their projects, what they learned, and in what directions they see solutions to water flowing. Below are excerpts from their responses, in their own words.

Alan S. Kolok of the University of Idaho and Shannon Bartelt-Hunt and Ann Fruhling of the University of Nebraska at Omaha studied water quality in the Mississippi River Basin.

> A concerned populace in possession of cellphones and easy-to-use-and-interpret data collection devices is about to revolutionize water resource research.
>
> A trained and equipped collection of citizen scientists can fill gaps where data currently does not exist. While this can be important in developed countries, see as those found in North America or Western Europe, it may be more important in developing nations, where the scientific infrastructure to conduct water quality analysis may be minimal or altogether lacking.
>
> Our research provides solid evidence that crowdsourced science can be a major component of a sustainability program relative to water resources in developing countries. And to use this knowledge to ensure clean water for future generations.

Alexandria Boehm and Wiley Jennings of Stanford University mapped freshwater plumes from two watershed outlets along the central coast of California: San Pedro Creek and San Lorenzo River.

> It is exciting to work with citizen scientists on understanding the factors that impact clean water at the beach. Engaging with these local residents helps us understand their motivations for maintaining clean and healthy beaches and how we, as researchers, can leverage our science to promote sustainable and healthy beaches for all.

Andrea Hicks and Matthew Seib of the University of Wisconsin-Madison inventoried titanium dioxide in personal care products.

> Clean water is a vital resource and a lack thereof will have devastating impacts on both human and environmental health. Sustainability seeks to manage consumption and anthropogenic impacts to ensure resources for the future, such as clean water.
>
> Titanium dioxide is one of many potential environmental contaminants due to its large production volume and widespread applications. The global titanium dioxide market was valued at $13.3 billion in 2015 and is expected to grow at 8.9 percent annually from 2016 to 2025.
>
> Due to the wide application of titanium dioxide in consumer products, and the challenges that sewage treatment plants have with removing this contaminant, it is critical to understand the sources of titanium dioxide in the sewage stream.

Christopher Jones, Keith Schilling and Ibrahim Demir of the University of Iowa tested a new tool that uses a smartphone app to test water quality.

> About 70 percent of Iowa's land area is used for crop and livestock production. This has had consequences for water quality on the local, state and regional scale.
>
> For example, the state's largest city, Des Moines, operates the world's largest nitrate removal facility in their drinking water treatment plant. Iowa is also a large contributor to Gulf of Mexico hypoxia.
>
> Iowa has numerous impaired water bodies and the state is working with farmers on cost-share programs to help reduce agricultural pollution.
>
> Agriculture drives much of Iowa's economic activity, and if that is to continue, scientists and policymakers must devise strategies that facilitate production in a sustainable way that minimizes stressors on our water quality resources. Poor water quality indicates that we are not producing crops and animal protein in a sustainable way. Tracking water quality progress provides a window into the effectiveness of conservation practices.
>
> There's a perception about science that you have to have formal training or you have to be brilliant to be a scientist. Those things are helpful but are not requirements. You just have to be curious.

Kelly Jones and Theresa Selfa of Colorado State University studied citizen science data reliability and volunteer retention.

> Our project provides a unique opportunity to combine social science research on what motivates and retains citizen science volunteers with physical science research on watershed hydrology that will take advantage of the citizen science data.
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> Our enhanced understanding of watershed hydrology will ultimately lead to informed recommendations on land use policies. Few projects have looked at both the social and physical science aspects of citizen science in the same location, and this work will allow us to integrate those results.
>
> The project is contributing valuable knowledge to on-the-ground organizations, including Global Water Watch-Mexico and Mexico's national payment for hydrological services program. Our work will inform their programs for using citizen scientists to monitor and evaluate clean water in Mexico.

Kimberly Huguenard of the University of Maine measured storm surge interactions with estuaries in three Maine communities.

> This project provides the unique opportunity not only to capture storm surge associated with extra-tropical cyclones and hurricanes, but also to develop a baseline understanding of storm tide behavior in four estuaries in Maine, something that has previously never been completed.
>
> These findings can inform future decision-making by providing communities with critical information for climate change adaptation planning, a key sustainability challenge. Our project also provides community members with an opportunity to collect data (as citizen scientists), and to participate in a dialogue about how such data might inform local planning to meet sustainability goals.

Patricia Culligan of Columbia University is part of a group that's developing high-performance "green" infrastructure systems to sustain coastal cities.

> We are investigating how green infrastructure can prevent coastal zone pollution. The dominant source of coastal zone pollution today is the discharge of wastewater, sewerage and urban runoff from coastal cities. This pollution damages wetlands, triggers fish kills and algal blooms, and threatens human health by releasing water-borne pathogens into recreational water bodies.
>
> Green infrastructure, such as green roofs, green streets and rain gardens, are designed to help reintroduce vegetation back into the hardscape of our coastal cities. By soaking up rainfall before it enters an underground sewer system, these vegetated infrastructures can help mitigate the harmful impacts of urban runoff, storm water discharge and combined sewage overflow.
>
> Our project is collaborating with the Citizen's Water Quality Testing Program in New York City. Every year, from May to October, more than 50 sites around New York City's coastline are sampled on a weekly basis by an army of dedicated citizen scientists who are helping to build a multiyear database describing the water quality surrounding our city. We use this database to pinpoint the factors influencing coastal zone pollution, and to understand how green infrastructure can help reduce that pollution. At the same time, citizens use the database to make informed decisions about when it is safe (or unsafe) to use the local water bodies for recreation.
>
> Using the citizens' data and data we ourselves collect year-round, we have found that concentrations of fecal indicator bacteria in the city's local water bodies are more likely to exceed recreational water quality criteria during the warmer months, when recreation is most popular, than the colder months. Specifically, more than 30 percent of collected water quality samples eclipsed safe thresholds for fecal indicator bacteria from May to October, compared to only 10 percent from November to April.
>
> By working together on projects like this, NSF-funded researchers and citizen scientists can help build the knowledge and capacity needed to ensure that the waters surrounding our coastal cities are clean and healthy for the benefit of all.

Weiwei Mo of the University of New Hampshire developed a contest-based, crowdsourced way to recruit and reward people to monitor water quality.

> Lead and copper can enter drinking water as it travels through the pipeline system and jeopardize public health in a situation like the Flint, Michigan, water crisis. In the U.S., source and treated water quality are regularly monitored under the Safe Drinking Water Act.
>
> Conversely, federal requirements for water quality monitoring at the consumer tap are far more limited. Our project aims to address these limitations by engaging the public in monitoring their own household water quality.
>
> We test different crowdsourcing schemes for participant recruitment. While the participants are not paid to collect water samples, we reward those who collect the most samples at different locations or introduced the largest number of new recruits into the program.
>
> The ultimate goal of this project is to cultivate a community of citizens that are responsive and engaged in household water quality monitoring activities. Through this project, we will be able to identify and understand the key program design and demographic factors that influence motivation, data quality, use of science in decision-making, as well as participant's scientific literacy and social network changes.

For more on NSF-funded water research, visit NSF's Cleaner Water, Cleaner Future page.

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A volunteer conducts a focus group with the Nebraska Watershed Network.
Credit and Larger Version

Volunteer Mikael dips a nitrate test strip into a stream.
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Wiley Jennings samples water from San Pedro Creek.
Credit and Larger Version

New York City residents sample water bodies as part of the Citizen's Water Quality Testing Program.
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Undergraduate research assistants Kyah Lucky and Dylan Schlichting deploy a water-level recorder.
Credit and Larger Version

Investigators
Weiwei Mo
Alan Kolok
Kelly Jones
Mark Becker
Andrea Hicks
Ann Fruhling
James Malley
Matthew Seib
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Laura Rickard
Pluruz Richard
Theresa Selfa
Wade McGillis
Gregory Yetman
Bridie McGreavy
Keith Schilling
Michael Gerrard
Alexandria Boehm
Christopher Jones
Patricia Culligan
Kimberly Huguenard
Shannon Bartelt-Hunt

Related Institutions/Organizations
University of Iowa
Columbia University
Stanford University
University of Maine
Colorado State University
University of New Hampshire
University of Nebraska at Omaha
University of Wisconsin-Madison

Related Awards
#1644595 EAGER: Citizen science as a tool for temporal water quality assessment at the major watershed scale
#1743997 EAGER: PPER: Development of a Contest-based Crowdsourcing Scheme for Public Water Quality Monitoring
#1644300 EAGER: Determinants of citizen science participation and data quality in coastal water quality monitoring
#1743891 EAGER: PPER: GOALI: Down the drain - using citizen science to inventory titanium dioxide in personal care products
#1325676 Coastal SEES (Track 2), Collaborative: Developing High Performance Green Infrastructure Systems to Sustain Coastal Cities
#1743991 EAGER: PPER: Validation and Utilization of a New Tool for Citizen-Led Water Quality Monitoring in Agricultural Watersheds
#1644691 EAGER: Sensing storm surge: A citizen science approach to measuring storm surge-estuarine interaction in three Maine communities
#1644862 EAGER: Collaborative Research: Role of Citizen Science in Watershed Hydrology Research: Relationships between Volunteer Motivations, Data Quantity and Quality, and Decision-Making

Total Grants
$3,355,296

Related Websites
NSF Cleaner Water, Clearer Future: https://www.nsf.gov/eng/special/water/