ISSUE 2 | Winter 2016/17

MISSION: water

Who's Minding the Planet?

Corvette Catastrophe
Studying Car-Swallowing Sinkholes

Ecologists without Borders
Waterkeepers at the Roof of the World

Sustainable Development
Coastal Terraforming in Lusail City, Qatar

LIFE AFTER HORIZON

Remediation Efforts on the Gulf Coast

Cover Photo: Sunrise at Low Tide
Credit: Larry Brandt

Share your story in our next edition!
Contact us at MissionWater@Xyleminc.com

In this Issue

Welcome to the 2nd edition of MISSION: Water, a magazine featuring the organizations and researchers tackling the world's most challenging water issues. I'd like to give a special thanks to all the participants in our inaugural edition who helped make the magazine's launch such a success – and another thank you to the contributors telling their story in this issue.

I'm excited to see MISSION: Water feature stories from around the globe, with topics ranging from climate change in the arctic to grassroots monitoring coalitions in the Himalayas. This edition also puts a spotlight on the work of environmental professionals confronting the lingering effects from some of the world's worst environmental disasters, including the Deepwater Horizon spill and the Gold King Mine incident in Colorado.

We hope you enjoy the magazine, and let us know if you're interested in joining us for the next issue!

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Water Blogged

Sharing in the love of water, join us for more stories at: **YSI.com/blog**

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Sea Level Rise Research: Clam Bayou Estuary

In Pinellas county, surrounded by Gulfport, St. Petersburg, and Boca Ciega Bay, lies a 170-acre estuary — Clam Bayou. Due to urban development constructed prior to stormwater monitoring regulations, the Clam Bayou habitat is now facing environmental repercussions affecting water level and quality.

Monitoring sea level rise and water quality—with the ability to accurately report water level data over low current, continuous operation—is a key component in managing the Clam Bayou resources, but it isn't without its challenges.

"A specific challenge we face with this site is the amount of hard fouling that occurs," explains Mike Lizotte. "I knew that the bubbler would have the same challenges, so… we came up with a method that is protecting the orifice tube from fouling by installing an anti-fouling protection pipe."

The lessons learned from the site, have produced numerous product enhancements that, in-turn, make work easier and the data quality higher for researchers, notes Lizotte.

The result of the latest Xylem brand technology paired with monitoring efforts at the Clam Bayou site, will provide greater understanding...

Get the full story: bit.ly/sealevelclambayou

7 Tips to Fight Fouling and Extend Sonde Deployments

The goal of every monitoring program is to gain a better understanding of an environment. That deeper understanding can lead to better water management tactics or better decision making. Ultimately, to better understand water – we simply need more data – and the more the better.

Some organizations only have the resources to monitor on a weekly basis with handheld water quality sampling equipment, and while that is a great first step to collect water quality data, a more robust monitoring schedule of even daily sampling can shed light on events occurring there.

Ultimately, however, we can't be at the site 24/7, 365 days a year to maintain the high resolution data set we need via handheld instrumentation. That's why sondes are critical to building a global water quality data set.

For those of you who are new to water quality monitoring, a sonde (EXO) is a piece of instrumentation that can autonomously record water quality data in-situ for weeks or months at a time. This equipment can be installed throughout a watershed to capture key parameters on the health of a waterbody...

Get the full story: bit.ly/7foulingtips

Real-Time Stormwater Monitoring System for NPDES Compliance

After receiving a text via telemetry indicating a real-time spike in ammonium and conductivity, field technicians dropped what they were doing to track the potential illicit discharge. Something unusual was going on near one of the stormwater monitoring stations in the Reedy Watershed. The team quickly mobilized and drove to the station.

Using a portable water quality sonde from YSI, the team began taking readings around the station, and then continued to take readings as they hiked upstream in search of changes in the water chemistry. First they found a small pipe dumping water in the river; they traced the pipe back to a small tributary. Finally, they pinpointed the source to a small drainage ditch where a sanitary sewer manhole was blocked and overflowing. Just as they arrived on the scene, a citizen was calling in to report the sewer problem.

The real-time alerts from the continuous monitoring station had given the team fast insight into a suspicious discharge and they reacted quickly to address it.

Recognizing the need for more data to meet permit requirements, the county - a Phase 1 Municipal Separate Storm Sewer System (MS4) permit holder - transitioned from a grab sampling program to a continuous monitoring program five years ago...

Get the full story: bit.ly/realtimestormwater

LAKE MEAD

The discolored 'ring' is a clear reminder of our water scarcity issues.

How are water quality professionals safeguarding a critical reservoir in America's driest state?

MISSION: WATER STAFF

Lake Mead, located approximately 25 miles (39 km) southeast of Las Vegas, Nevada, is an impoundment of the Colorado River and is one of the most intensely used reservoirs in the western United States.

It provides water to the states of Arizona, Nevada, and California, serving nearly 22 million people – including 1.8 million residents of Nevada and tourists. Not only does it serve as a drinking water source, it also provides recreational water activities (boating, fishing, and swimming), water for industrial uses, and irrigation water for farmland. It is crucial to maintain the quality and level of this water to guarantee a reliable and safe resource for its many uses.

Lake Mead, formed following the realization of Boulder Dam (now called Hoover Dam) in 1935, was the largest artificial lake in the world at the time of completion. It is one of several reservoirs along the Colorado River; however, due to increases in population and agricultural operations in recent decades, this once-expansive lake in the desert is becoming more compromised.

While inflow into Lake Mead is primarily from the Colorado River, a small percent is also from rivers on the northern side of the lake and from Las Vegas Wash on the northwest side. Las Vegas Wash transports treated municipal wastewater effluent, urban runoff, and shallow groundwater seepage from the Las Vegas area to Boulder Basin in Lake Mead. Wastewater effluent flow rates have more than doubled in recent years, prompting concern over potential effects to reservoir water quality, especially since some of the water is pumped to the municipal water treatment plant at Saddle Island for distribution to residents.

Background Photo: Outfall from the Hoover Dam flows into Lake Mead, just outside of the Las Vegas area. Since its peak in 1983, the level of Lake Mead has dropped considerably, leaving a white ring mark around its shores. The level is expected to continue to drop below historic lows amid the western drought.
Background photo: Kunal Mehta

The recreational area of Lake Mead shows the same discoloration and lowering water line.
Photo: Songquan Deng

" Preserving [Lake Mead's] quality and volume is critical to the population and agriculture of this region... "

Monitoring the watershed and analyzing water quality data are crucial steps to ensure Lake Mead is attaining the state's water quality standards. If parameters such as dissolved oxygen or temperature fall outside of the specified ranges, then the lake's beneficial uses are adversely affected. These uses include: propagation of aquatic life, including a warm water fishery; recreation; irrigation and watering of livestock; and municipal drinking water supply.

For example, as the level of the lake continues to drop due to high volume usage and reduced inflow, the elevation of the thermocline, a zone that separates a layer of cool water from a layer of warm water, is also lowered. As a result, the drinking water intakes, which are located at fixed elevations, may be drawing in warmer lake water, which is associated with poorer quality water. This may require increased efforts to treat the drinking water, which would lead to higher treatment costs.

Managing Data in a Changing Environment

Near real-time monitoring can reveal a lot about water quality. Population growth in Las Vegas has increased the flow and volume of water through the Lake Mead region, leading to flooding and allowing additional pollutants to enter the lake. These pollutants include bacteria, oil, grease, pesticides, sediment, nutrients (nitrogen and phosphorus), and heavy metals, which affect the quality of water.

In recent years, researchers have even studied the effect of pharmaceutical compounds on aquatic organisms in Lake Mead and the Las Vegas Wash.

Efforts are currently underway to improve the region's water. Several organizations are working to reduce erosion and silt in the Las Vegas Wash Channel, build wetlands to reduce nutrient loading, perform environmental monitoring, and promote public awareness about this important watershed.

"Lake Mead and water distribution in general in the southwest play a key role in population growth, agriculture, and politics. Preserving its quality and volume is critical to the population and agriculture of this region," notes Michael Strobel, Ph.D., in the USGS publication *Water in Nevada*.

For historical water quality and meteorological data from the Lake Mead monitoring platforms, please visit:

nevada.usgs.gov/lmqw/index.htm

LEAD

An accumulating problem

Lead is a naturally occurring element found in the earth's crust.[1] It is one of the best-studied toxic substances, and shares a long history with human civilization due to its desirable properties.

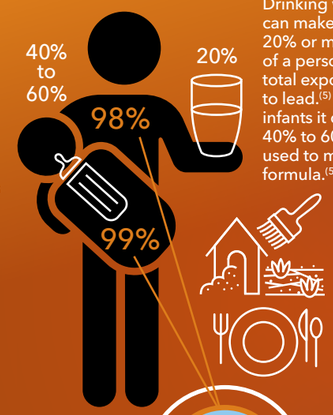
Some historians suggest that the Romans' high exposure to lead in wine urns, utensils, and aqueducts contributed to their empire's decline. Ironically, lead poisoning was then a disease of the affluent; today, it is primarily an affliction of poorer communities.[2]

By the Numbers

Lead can be ingested from lead paint, house dust, soil, drinking water and food.[6]

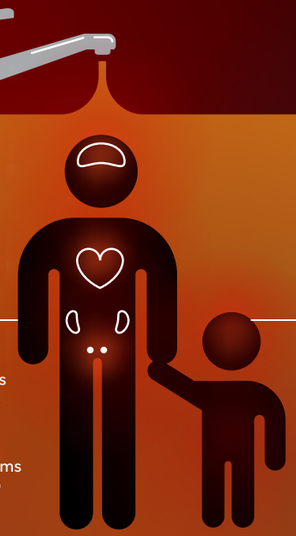
Extremely low doses of lead can cause neurobehavioral deficits.[3]

Overall, 98% of adults and 99% of children affected by lead live in low- and middle-income countries.[4] It is an ongoing issue worldwide.



Drinking water can make up 20% or more of a person's total exposure to lead.[5] For infants it can be 40% to 60% if used to mix their formula.[5]

Health Impacts of Lead



In adults, lead can induce:

- cardiovascular issues
- high blood pressure
- decreased kidney function
- reproductive problems (male and female) [4]

Lead exposure causes **674,000** deaths globally per year.[1]

The U.S. EPA's goal is zero lead in drinking water.[4]

In children, lead induces:

- behavior and learning problems
- lower IQ and hyperactivity
- hearing problems
- anemia [4]

Focus on Flint

8,000[3]

$395 million[3]

8,000 children were exposed to lead poisoning when the city switched its water source to the Flint River to save money.[3]

The city switched back to Detroit's municipal water system in Oct. 2015.[3]

The social cost is $395 million.[3]

Taking Action

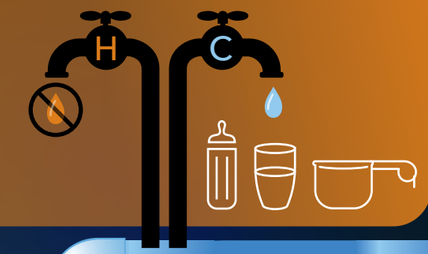
Lead is required to be at safe levels when it leaves the treatment plant, but it can be redissolved in plumbing if water is not properly treated.

Water is less corrosive when it is high in calcium carbonate and has a pH over 7. Cold water is also less corrosive than warm water.[5] If water sits for a long time in lead pipes, the resulting corrosion can add lead to tap water.[7]

Take action if lead in drinking water exceeds 15 ppb at the tap, which can be determined at home with a simple, inexpensive test.

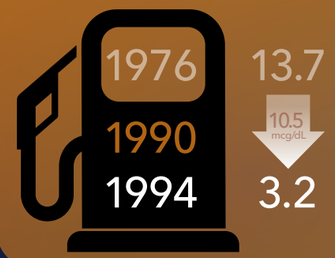
Protect Yourself

Before using water from a faucet that hasn't run in at least 6 hours, flush your pipes by running your water until it is as cold as it can get.[4]



Get the Lead Out

The removal of lead from gasoline in 1990 is one of the public health triumphs of the 20th century. Between 1976 and 1994, the mean blood lead concentration in children dropped by 10.5 mcg/dL; the clear result of a consistently applied public health policy.[2]



Sources

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3 http://www.reuters.com/article/us-michigan-water-idUSKCN10J26Q

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Durango, Colorado - August 6, 2015,
Animas River early in the day, the same day the Gold King Mine spill occurred in Silverton, Colorado, 50 miles north.

THE GOLD KING MINE

CHALLENGING COLORADO MINING LEGACY

Luke Giroux

Durango, Colorado - August 7, 2015,
Animas River one day after the Gold King Mine spill.
Photos: Barbara K Powers

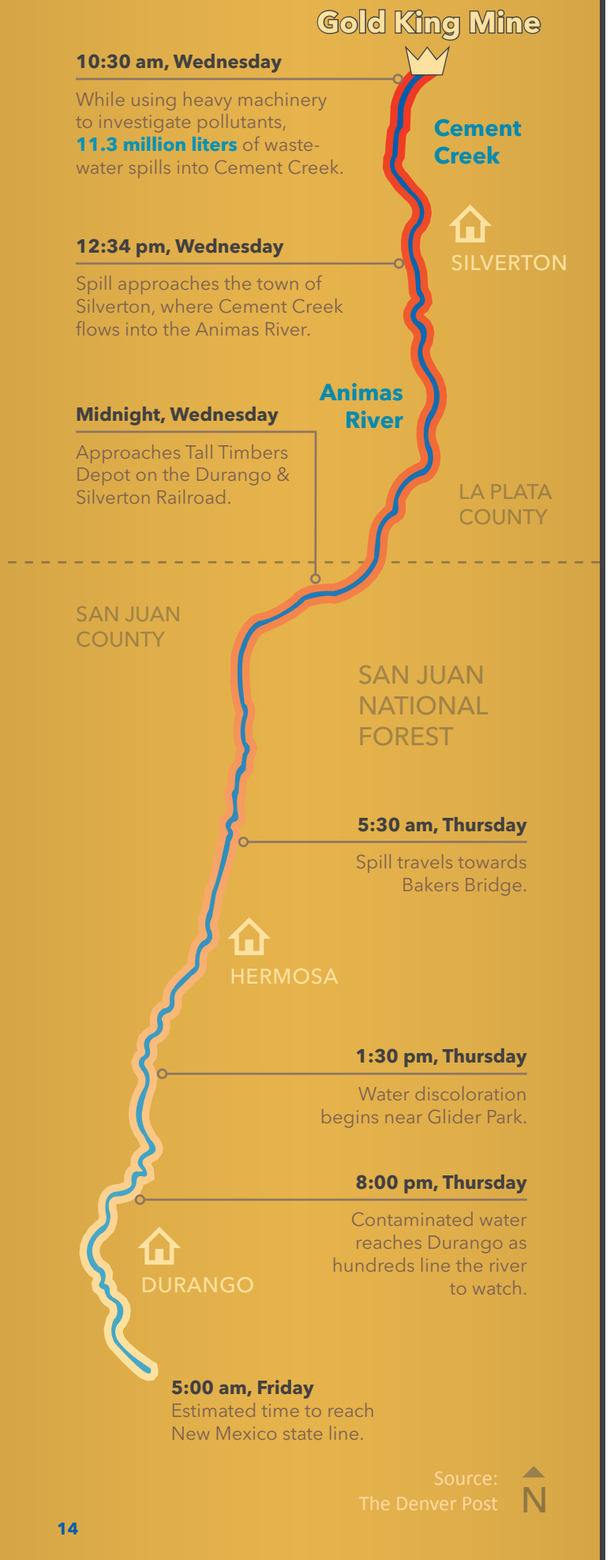
For many, Southwestern Colorado is known for its four-season recreation activities such as rafting and kayaking on rivers that flow out of world famous snow-packed ski areas. In the high-country, hiking, backpacking, and mountain biking trails extend off of old logging and mining roads, which are also used by locals and visitors for four-wheeling. Fun mountain towns like Durango, Silverton, and Pagosa Hot Springs have enough entertainment and commerce between backcountry trips to support locals and tourists alike. Even the many old mines scattered throughout the region offer historic interest in the early regional mining industry.

However interesting these old mines are as remnants of the wild west and the early Rocky Mountain natural resource extraction, many are also unsealed and remain as unresolved water and land pollution sources. In the state of Colorado alone, there are approximately 23,000 of these abandoned mines.

For decades, state and federal agencies have worked to remediate and close over 6,000 of these inactive mines, but many thousands more remain open. A few older Colorado mines are still active, but most are no longer producing.

Early mineral mining in the United States had rampant interest and activity with little regulation that controlled the excavations, resulting in such environmental effects as heavy metal polluted rivers and streams, and open unsafe tunnels, or adits (a horizontal access or drain tunnel).

The remnants of negligent mining practices aren't the only environmental offenders, as naturally occurring seepage from the region's mineral rich soils and geology also contributes to the high contaminant waters. Colorado's Gold King Mine incident last year stands as a glaring reminder of these original mining practices still left unresolved.



There are about 400 of these abandoned mines in the greater San Juan River watershed of southwestern Colorado, which includes the Animas River watershed where the Gold King Mine is located. This inactive gold and silver mine, located northeast of Silverton, was established in 1887 and closed in 1922. Unfortunately, on August 5, 2015, the Environmental Protection Agency (EPA) inspectors discovered just how tenuous the conditions of these inactive mines are. While conducting a mine inspection, a water reservoir above the mine adit collapsed, releasing an estimated 11.3 million liters of acid mine drainage and heavy metals-rich water into nearby Cement Creek and the Animas River. The Animas feeds the San Juan River, which flows through New Mexico and ultimately into Lake Powell in Utah. The irony in this situation is that EPA inspectors were on site to evaluate additional remediation steps for the mine when the plugged water reservoir broke through.

Though initial communication to EPA management and local community officials was challenged by limited satellite and cell phone capabilities, inspectors soon warned communities and officials downstream. EPA management cautioned restricted water use across the spectrum for fishing, drinking, agriculture, and recreation purposes in Colorado, New Mexico, Utah, the Ute Mountain Ute tribe, the Southern Ute Tribe, and the Navajo Nation. Immediately down river, Silverton's public drinking water was not affected, but further downstream, Durango closed its Animas River intakes before the plume arrived. The EPA was able to supply drinking and irrigation water to users in Colorado's San Juan and La Plata counties. In New Mexico, authorities recommended closing water intakes along the Animas and San Juan rivers, and the EPA provided irrigation and livestock water at eight regional sites and delivered hay to Navajo and New Mexico ranchers.

EPA staff also quickly established numerous filtering and treatment ponds just below the adit rupture site to reduce toxic overflow from continuing downstream. Unfortunately, the construction of these ponds happened after the initial plume of contaminated water pushed through. But once they were put in place, officials were able to effectively control and treat whatever water was still flowing before it entered the Animas River and beyond. The pond treatment included lime to reduce acidity and raise pH, and sodium hydroxide solution, which aided metals sedimentation within the ponds.

EPA staff further established monitoring and testing of the contaminant plume during and after the incident. Though the initial plume passed through and dissipated in about an hour, residual contamination continued. River monitoring used pre-spill contaminant levels as baseline determination, and within weeks, river contaminant levels had returned to pre-spill conditions, ultimately allowing the Animas River to re-open for recreation purposes on August 14th, only nine days after the incident. It is important to note, however, that these monitored contaminant levels are complicated by historically high baseline levels which are found in the watershed from abandoned mines and naturally occurring sources not connected to mining.

Surface water testing, which still continues in 2016, includes the following parameters: salinity, turbidity, temperature, pH, dissolved oxygen (DO), conductivity, and oxidation reduction potential (ORP). During the weeks and months after the Gold King Mine incident, the EPA supported the involved states and downstream communities with substantial staff and funding to handle clean up, agricultural needs, ongoing testing and monitoring, and other issues resulting from the spill.

In addition to water testing for contaminants, the EPA contracted with the Mountain Studies Institute (MSI) out of Durango to assess the possible harm to benthic macroinvertebrates (BMI) from the discharge. BMI, such as immature and adult stages of invertebrate flies, beetles, worms, and snails, occur in relatively small numbers in the Animas watershed, and have historically contained high concentrations of metals. MSI concluded, in part, that the increase in copper, aluminum, and iron at some of the testing sites did not significantly affect these BMI populations, and must also be considered within the historic data of the region. Colorado Parks and Wildlife also concluded that Animas River fish populations, which are historically challenged by the watershed's water quality, were also not adversely affected by the Gold King Mine release.

The Gold King Mine clean up effort has prompted the EPA to add many other active and dormant mines in the region, and throughout the U.S., to the National Priorities List, which is supported by federal Superfund clean-up regulations and parameters. This plan includes additional efforts for inactive mine remediation to further reduce the possibility of an incident of this type occurring again. Though very well intentioned in this instance, and with similar issues among all of these mines, it is also very difficult to anticipate every variable in working with abandoned sites.

In 2016, the EPA's clean-up contractors have continued their stabilization efforts of the Gold King Mine adit and waste pile. These efforts include operating the Gladstone Interim Water Treatment Plant (IWTP) downstream, securing the adit and waste pile at the incident site, and removing and disposing solids from the treatment ponds.

Abandoned mines, established when regulations and oversight were often minimal or non-existent, present many challenges to modern attitudes and remediation efforts. Federal and local agencies have been left "holding the bag" of thousands of toxic water reservoirs and naturally occurring drainages, a seemingly Herculean clean up task to resolve. However, with this significant mishap at the Gold King Mine, federal and local officials and communities have been reminded of the tenuous nature of the situation, prompting public and private cooperation and action to restore the region's need for clean and safe flowing waters.

epa.gov/GoldKingMine

Above: Treatment ponds close to the Gold King Mine.
Below: Water Monitoring in the Animas River with a YSI handheld multiparameter meter.

Below: Lime is added to a settling pond to assist in the pH adjustment of the water prior to discharge to Cement Creek on August 14th, 2015.
Photos: Eric Vance / EPA

WATERKEEPERS® at the Third Pole

Co-written by
Sharon Khan, International Director
and Marc Yaggi, Executive Director

WATERKEEPER® ALLIANCE

THE HIMALAYAN GLACIERS, which stretch east from northern Afghanistan, Pakistan, and India, through Nepal and Bhutan, and into the neighboring Tibetan Plateau and China, are the source of fresh water for nearly four billion people in Asia.

The melting of snow in the Arctic and Antarctic due to global climate change is reported frequently, but the melting of the Himalayas' glaciers has gone largely unreported, even though far more people are affected. The glaciers of the Himalayas are, in fact, the "Third Pole." They feed the giant rivers of Asia that support half of the world's population.

Three major rivers – the Indus, the Ganges and the Brahmaputra – arise in the Himalayas and flow directly into Pakistan, India and Bangladesh. The Yellow, Yangtze, Mekong, Irrawaddy and Salween Rivers arise from the Tibetan Plateau and flow directly into China before continuing into Myanmar, Laos, Thailand, Cambodia, and Vietnam.

These rivers are the source of water for drinking, washing, irrigation, fishing and industry, and have also been the source of many local and international disputes about their quality and flow from one community into another, within and across borders. But 65 Waterkeepers and Affiliates in these communities do not recognize borders when they apply their passion and commitment to the health of river ecosystems.

In January 2016, Waterkeeper Alliance launched an initiative to protect the Himalayan waters and its growing network in India, Nepal, and Bhutan, and work with Waterkeepers throughout the region – and across the globe – to protect the "Third Pole."

Water monitoring equipment training on the Zanskar River.
Credit: Waterkeeper Alliance

Panoramic view of confluence of the Zanskar river from left and Indus rivers from right - Leh, Ladakh, Jammu and Kashmir, India.
Photo: Candy Halls

"Do not dirty the sacred rooftop of the world."

His Holiness the Gyalwang Drukpa

Pangong Lake, an endorheic lake in the Himalayas situated at a height of about 4,350 m (14,270 ft).

Ladakh, India

High up on "the sacred rooftop of the world," on the Indus River in the Ladakh region of India, Himalayan Glacier Waterkeeper was founded in 2013 by His Holiness the 12th Gyalwang Drukpa, head of the Drukpa lineage of Buddhism, who has over 27 million followers around the world. He is an award-winning humanitarian and environmentalist who advocates respect for nature as one of the steps on the path to enlightenment. He was the recipient of the 2010 United Nations Millennium Development Goals Award for his cross-border humanitarian work and India's 2010 Green Hero Award for his work in sustainable development.

The Indus and its tributaries, fed by glacial-melt waters, sustain communities throughout Jammu and Kashmir, a single state that contains Ladakh and that is a locus of dispute involving India, Pakistan and China. The headwaters of the Indus originate in the plateaus of Tibet and run through India and Pakistan to the Arabian Sea near the port city of Karachi. Along its way, its river-systems support temperate forests, plains, arid countryside and countless communities.

The natural habitat and the way of life of Himalayans are seriously affected by the forces of modernization and climate-change. In Ladakh, although increased tourism and new roads have facilitated distribution of goods, there is virtually no awareness of the dangers of plastic litter in the wild.

There are no means of disposing of this waste, which is migrating into the region's rivers, its primary source of drinking-water. In addition, the rapid melting of glaciers caused by warmer weather is contributing to the drying up of springs and rivers used for drinking-water.

Ladakh, at an altitude of 9,800 feet, also has been facing extreme-weather, including rare and catastrophic flash floods, made worse by rapid deforestation that has removed nature's flood-defense mechanisms. In August 2010, flash floods in Ladakh damaged over 71 towns and villages, and claimed 225 lives. Floods in September 2014 killed more than 550 people in the Kashmir region and devastated the lives and livelihoods of survivors. These incidences, which are expected to become more common, have been termed "Himalayan tsunamis."

Less disturbing but also very significant is the threat of such events to Ladakh's spiritual and cultural heritage. Its nearly 1,000-year-old Hemis Monastery of the Drukpa Lineage houses its largest collection of Buddhist relics, rare murals and texts, many of which define the sacred and sophisticated administration of traditional water rights.

Stewards without borders, the **WATERKEEPER®** ALLIANCE work beyond political lines to solve water issues. Credit: Rinchen Wacher

In July 2016 the Waterkeeper Alliance held their first training exercise in the former Buddhist kingdom of Ladakh, India, where Himalayan Glacier Waterkeeper has been leading communities, and especially young people, to protect the region's water resources. Himalayan Glacier Waterkeeper currently includes 20 Waterkeeper Affiliates based at Drukpa monasteries in streamside villages throughout Ladakh.

At the Druk Padma Karpo School our experts trained the Himalayan Glacier Waterkeeper team and its 20 Affiliates on the use of water-quality monitoring field equipment. Drukpa nuns and students from the school were also trained on how to test water quality using monitoring kits. With these tools, Himalayan Glacier Waterkeeper's community is able to monitor the baseline physical and chemical water-quality conditions of their local waterways and advocate for the protection of clean water.

By the end of our tour, we had tested water quality at 10 sites northwest and southeast of Leh.

To launch the Himalayan Glacier Waterkeepers' water-quality monitoring program, we chose equipment from YSI to measure dissolved oxygen (DO), conductivity, and pH and supplemented these instruments with other tools to measure for nutrients, turbidity and E. coli.

Credit: Rinchen Wacher

Initial testing found the water quality of glacial streams to be generally good (dissolved oxygen at levels supportive of aquatic life, slightly alkaline, low conductivity, high clarity, no excessive nutrients). For the Indus and the Zanskar Rivers, both larger river systems, the main difference was low clarity and highly turbid water resulting from excessive suspended sediments in the water. Ongoing water-quality testing will help to establish baseline characteristics of these waterways and allow Waterkeepers to assess and address any changes that may occur from pollution or climate change.

WATERKEEPER® ALLIANCE engages monks and citizens at the top of the world to make positive impacts. Credit: Waterkeeper Alliance

Nedup Tshering

A charismatic authority who inspires citizens and leaders across the country, is the founder and executive director of Clean Bhutan, an NGO with a mission to achieve a "zero-waste Bhutan" by 2030. It was established in February 2014 in celebration of the 60th birthday of the previous king, who conceived the "Gross National Happiness Index," by which welfare is measured by good health, environmental preservation, clean air, clean water and other factors. Clean Bhutan advocates behavioral change and awareness of its programs. In September 2015, Clean Bhutan welcomed Thim Chu Waterkeeper to Thimphu.

Bhutan

Bhutan is a small Himalayan kingdom east of Nepal, north of India and southwest of China. It contains the least impacted rivers in the Himalayan region. It is roughly 75 percent forested, and its constitution requires that it remain at least 60 percent so. These conditions have allowed the country to be one of the few in the world that acts as a carbon sink that beneficially absorbs more carbon than it releases.

Prime Minister Tshering Tobgay promises that Bhutan will remain carbon neutral – while it is in fact, carbon negative. Bhutans strong conservation ethic was established by King Jigme Singye Wangchuck, who reigned until 2006, and has been carried forward by his son, King Jigme Khesar Namgyel Wangchuck, the prime minister and the Buddhist leadership. "Where we live," the current king has declared, "must be clean, safe, organized and beautiful, for national integrity, national pride, and for our bright future. This too is nation-building."

Bhutan's main economic generator is hydroelectricity, 75 percent of which is exported to India. But as climate-change advances, more caution is required in dam building. A 2012 UN report on glacial-lake outburst-floods noted that the country's 677 glaciers and 2,794 glacial lakes had experienced more than 21 glacial lake outburst floods in the last forty years. It also identified another 25 glacial lakes as potentially dangerous – ticking time bombs whose outbursts could have devastating impacts on dams downstream.

Bhutan, long closed to the outside world, opened its doors to tourism in 1974, and is now rapidly modernizing. As imports of packaged foods and other commodities have increased, so have littering and unsustainable practices such as dumping and burning of waste, this includes the burning of plastics, which releases toxic fumes. Waterways are becoming polluted, especially in the capital city, Thimphu.

A recent letter to the editor of Kuensel, the national newspaper, lamented the lack of proper controls of erosion and sediment on road-construction projects. And, though automobiles remain fairly scarce in Bhutan, their growing number has brought more repair-shops, which discharge waste-oil and other pollutants directly into the city's Olarongchu River, tributary of the Thim Chu.

Several acts and plans have been established to address waste-management in Bhutan, including the National Environmental Protection Act and the National Strategy and Action Plan: Integrated Solid Waste Management in 2007, the 2009 Waste Prevention and Management Act, and the 2014 National Integrated Solid Waste Management Strategy. Unfortunately, implementation of these plans does not appear to have reached beyond Thimphu yet.

The Ministry of Health, which administers parts of the 2011 Water Act, has begun to focus more on water quality. It oversees a modest hospital-based aquatic laboratory, but it severely lacks equipment and training for monitoring and analyzing all the pollutants that are caused by rapid development.

Punakha Dzong "the palace of great happiness" is the administrative centre of Punakha District in Punakha, Bhutan.
Photo: MC Noppadol

Credit:
Waterkeeper Alliance

Last November, Waterkeeper Alliance staff traveled to Bhutan with a team of scientists from Stroud Water Research Center of Avondale, Pennsylvania to conduct physical, chemical and biological assessments of water quality in three Bhutanese rivers, the Thim Chu, Paro Chu, and Punakha Chu, and various streams. Working alongside Thim Chu Waterkeeper and partners from the National Environment Commission and the HydroMet Division of the Ministry of Economic Affairs, they installed the country's first three real-time water-quality monitoring sensors.

Conclusion

Protecting the Himalayan glaciers and rivers and the countless communities that depend on them is a colossal challenge, but the Waterkeepers in the Himalayas are optimistic. They are dedicated to strengthening community efforts to monitor the quality of their waterways and inform themselves to advocate for the abundance and purity of freshwater that sustains billions of people.

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About WATERKEEPER® ALLIANCE

Waterkeeper Alliance strengthens and grows a global network of grassroots leaders protecting everyone's right to clean water.

We're the largest and fastest growing nonprofit solely focused on clean water. We preserve and protect water by connecting local Waterkeeper organizations worldwide. Our goal is drinkable, fishable and swimmable water everywhere.

Waterkeeper Alliance is a global movement uniting more than 300 Waterkeeper Organizations and Affiliates on six continents and focusing citizen advocacy on issues that affect our waterways, from pollution to climate change. Waterkeepers patrol and protect more than 2.4 million square miles of rivers, streams and coastlines in the Americas, Europe, Australia, Asia and Africa.

WATERKEEPER® ALLIANCE

CORVETTE CATASTROPHE

A car-eating sinkhole opens a window into Kentucky's subterranean caves

STEVE WERBLOW

At 5:38 a.m. the morning of February 12, 2014, security cameras registered a strange movement at the National Corvette Museum in Bowling Green, Kentucky. The grainy footage shows a half-dozen candy-colored sports cars appear to settle just slightly in the play between spotlight and shadow. Then, under a muscular, orange T-top, a panel of floor tiles drops away. And another.

For 30 long seconds, the car hangs on by its tail light before more floor disappears and the car, along with the white one parked in the next spot, disappear into the earth. The footage is silent, but you can almost hear the sound of a crash and breaking glass in your imagination.

By 5:39 a.m., eight classic 'Vettes, worth a total of about $1 million, were swallowed by a collapsing cave that left a yawning hole, 12 by 18 meters across and 9 meters deep, in the center of the museum's atrium.

In geologic terms, it was just one more sinkhole among hundreds in south central Kentucky's Warren County. The region sits atop karst, an eroded limestone formation riddled with ever-expanding caves and channels. But instead of becoming just another farm pond, weedy pit or temporary road hazard, the National Corvette Museum sinkhole became global news—and a prime opportunity to learn and teach about the karst geography that Bowling Green is built upon.

In February 2014, a 30-foot-deep sinkhole opened up beneath the National Corvette Museum and swallowed $1 million worth of classic Corvettes.
Photo: National Corvette Museum

Common Geology

Most people don't think much about karst landscapes, though 25 percent of the world's population lives on top of them. In fact, karst covers about 12 percent of the earth's ice-free land surface. But as much as the story of karst is written in stone, the heart of the subject is water.

Karst aquifers provide 20 to 25 percent of mankind's drinking water. Because groundwater is connected directly to the surface by sinkholes, caves and fissures in the rock and flows quickly through subterranean rivers and tunnels, karst aquifers are extremely vulnerable to pollution. And water—slightly acidic and capable of dissolving limestone—continues to carve new tunnels and enlarge existing caves that make karst formations look like Emmenthaler cheese or bubble-riddled pizza crust.

The unique and fragile nature of karst geography generally comes to light when new sinkholes form in populated areas, opening the earth in a scene straight from the Bible and giving people on the surface a window into the porous world below.

"Most of them are slow-forming subsidence sinkholes that take thousands of years to form," notes Jason Polk, associate professor of geosciences at Western Kentucky University in Bowling Green and a global authority on sinkholes. "There's not too much to worry about as far as cars or people. We don't have many reports of big, catastrophic sinkholes like the Corvette Museum.

"At the National Corvette Museum, after the sinkhole occurred, we could see that there was just a few feet of distance between concrete and the roof of the cave," Polk adds. "The ceiling had migrated upward over hundreds of years, thousands of years. Little by little, water continues to move. Storms can undermine the system because rain continues to erode away the ceiling. The weight of the water as it's sitting there, making the clayey soils and overlying rock heavier, can be an issue."

Heavy rains and deep freezes in February 2014 created the perfect conditions to break the cave ceiling lying just a few feet beneath the museum's car collection, Polk explains. The weathered rock was stretched to its limit, spanning a cavern more than 12 meters wide. The massive weight of water-laden soil and rock, frozen in place, stressed it further. Then a thaw created a pulse of meltwater, possibly eroding away the last millimeters of structure that held up the roof. That's when the first Corvettes started dropping 9 meters to the floor of the cave, along with 160 truckloads of limestone, soil and debris. "It was a perfect storm," Polk says.

"It was a perfect storm."

Above: Drone footage of the sinkhole.
Below: The heartbreaking aftermath.
Photos: National Corvette Museum

A geologist uses an EXO sonde to monitor changes in water quality in a sinkhole adjacent to the Corvette Museum.
Photo: Dr. Jason Polk

Sinkhole Study

The day of the collapse, Jason Polk and a team of his graduate students and colleagues found themselves in the museum's Skydome, peering into the sinkhole. A WKU engineering student piloted a drone into the hole, using a camera on board to help spot buried Corvettes and look for signs of an underground river that could have caused the collapse.

Meanwhile, Polk and his team went to an old sinkhole on the museum's property—used as a retention pond for drainage from the building and parking lot—to look for more insight into conditions that could explain the collapse and perhaps warn of further problems.

Their key tool was an EXO multiparameter water quality sonde from YSI, a Xylem brand. Logging measurements of water turbidity (TSS, or total suspended solids), specific conductance, pH, temperature and level every 10 minutes, the monitoring sonde was Polk's eyes and ears as he searched for indications that the old pond and the new sinkhole could be connected. He and his team also monitored whether runoff from the museum was making its way to the pond or undermining other areas of the lot or buildings.

While crews at the museum were drilling foundation structures and filling the sinkhole, turbidity and level were the key parameters on Polk's mind. A spike in turbidity could indicate that sediment-enriched drilling water was flowing from the museum sinkhole into the pond, or that other water was somehow making the trip. That would have been fascinating. It would have also raised a huge red flag, indicating that a blowout or further collapse could be imminent.

Throughout the rainy spring, level and water quality readings in the pond showed that gutter and parking lot runoff indeed drained straight into the retention pond, but no other sources of water seemed to be flowing into the depression. That was good news.

Photo: National Corvette Museum

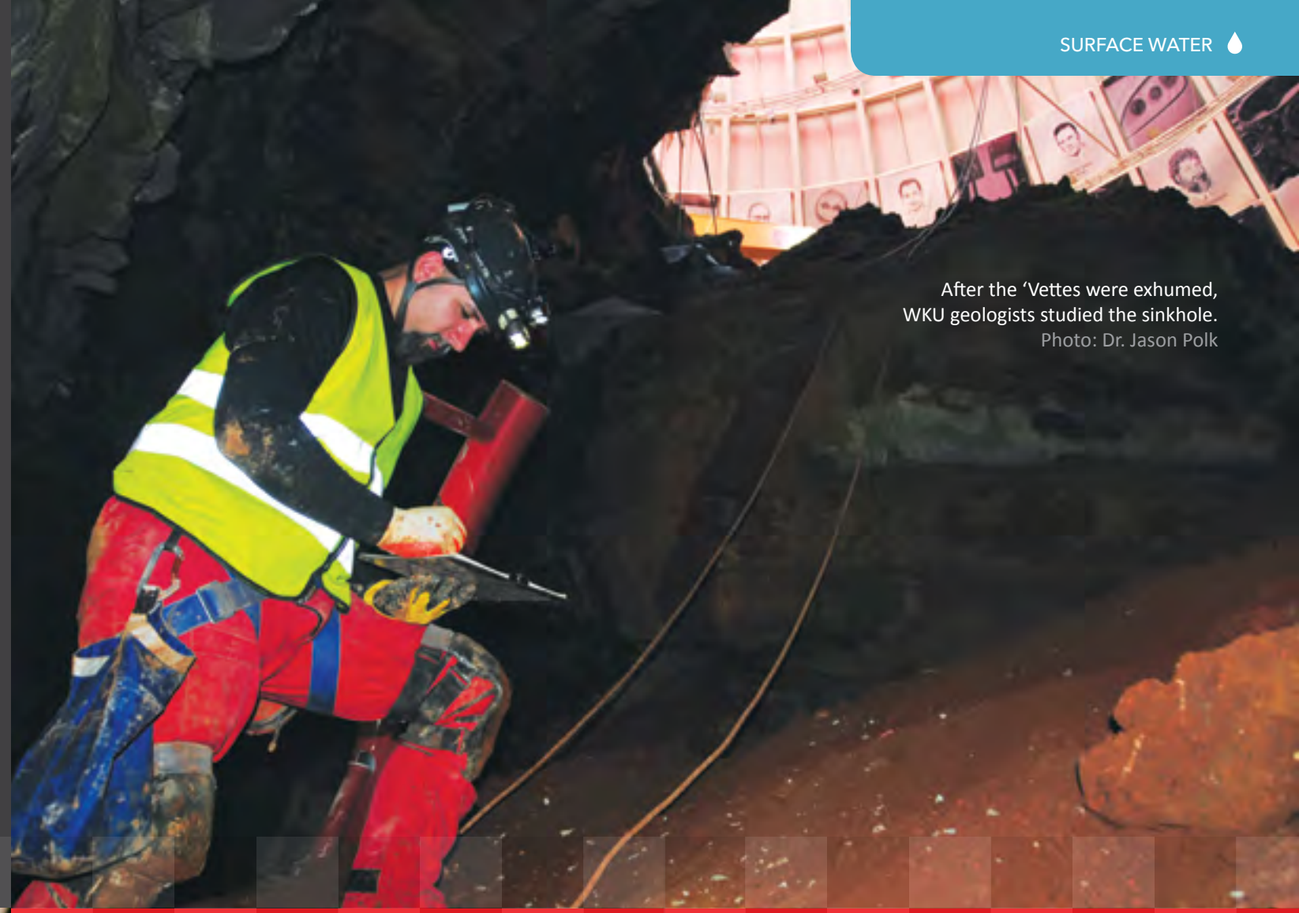
Better Than Ever

When the excavation was complete and the site deemed safe, Polk—an accomplished caver—and some of his colleagues went into the sinkhole. It was surprisingly dry, without the underground river most geologists expected to see. It was also surprisingly extensive, part of a cave system that was more than 60 meters long, 12 meters wide and as deep as 27 meters beneath the surface. Mapping the cave gave Polk a chance to ground-truth the observations he and his team made with the EXO sonde at ground level.

"It gave us very different investigative techniques from beginning to end," he notes.

The National Corvette Museum spent about $5 million digging out the Corvettes, restoring some (with the help of General Motors), filling the sinkhole and rebuilding the Skydome floor. Katie Frassinelli, marketing and communications manager for the museum, says the repair project utilized 3,977 tons of crushed limestone fill, and a grid system of concrete beams connecting 72 micropiles to underpin the new floor. Those micropiles are high-strength steel rods drilled deep into the bedrock beneath the cave, each capable of holding up 150,000 pounds. The deepest micropile reaches 25 stories beneath the museum.

Visitors to the National Corvette Museum peer into a still-open portion of the sinkhole.
Photo: National Corvette Museum



After the 'Vettes were exhumed, WKU geologists studied the sinkhole.
Photo: Dr. Jason Polk

Educational Opportunity

As crews excavated the sinkhole in the National Corvette Museum, rescued buried sports cars and filled in the massive cave, visitors flocked to the museum to see not only the car collection, but the sinkhole itself.

"When it first happened, it was so unbelievable people just came to see the sinkhole," says Katie Frassinelli, the museum's marketing and communications director. "It was in our best interest to show people what had happened. People started peering through the PlexiGlass window, watching them dig those cars out.

"We had a 67-percent increase in tourism the year it happened, and kept growing from there," she adds.

With annual visitor numbers approaching 250,000 in 2014 and 2015, the National Corvette Museum has turned the sinkhole disaster into a teaching moment. A new Corvette Cave-In exhibit, inaugurated on the second anniversary of the appearance of the sinkhole, includes interactive displays, exhibits of the restored cars as well as the remaining wrecks extracted from the debris, and detailed information on karst geography and sinkholes. Visitors can peer into a manhole cover to the bottom of an unfilled portion of the sinkhole. There's even a sculpted area that gives guests a sense of what it's like to be at the bottom of a sinkhole.

Frassinelli admits that the events of February 12, 2014 gave her "a little bit of a panic attack." But the museum survived, and is thriving. General Motors volunteered to restore two of the most valuable cars, including the one-millionth Corvette to roll off the assembly line. And Bowling Green remains a great place to live and work, she says. In fact, Bowling Green residents talk about sinkholes like Los Angelenos describe earthquakes or Miami residents discuss hurricanes.

"Sinkholes are really common here," Frassinelli tells visitors. "What is uncommon with us is that it was in a building, and Corvettes fell into it. This is a safe place to work and live and drive."

Extensive System

Water quality monitoring at the museum site is complete, but Polk and his team rely heavily on continuous, long-term monitoring sondes to study the water running through the karst formation beneath Bowling Green. (He also studies Florida karst formations and aquifers in Central America and elsewhere.)

Polk uses his cellular telemetry systems to report on key testing sites in near-real time. Rapid changes in level and temperature can indicate the presence of floodwater mixing with karst groundwater. Shifts in specific conductance and turbidity can signal a wash of pollutants from the surface. Monitoring data are posted to a website and mobile app for easy access by scientists, city officials and the public as part of the Under Bowling Green educational initiative.

Through the **underBGKY.org** website, the Under Bowling Green team educates residents about the connections among houses and roads on the surface, caves and sinkholes, and groundwater. Text and illustrations emphasize the proper treatment of caves and sinkholes to minimize pollution.

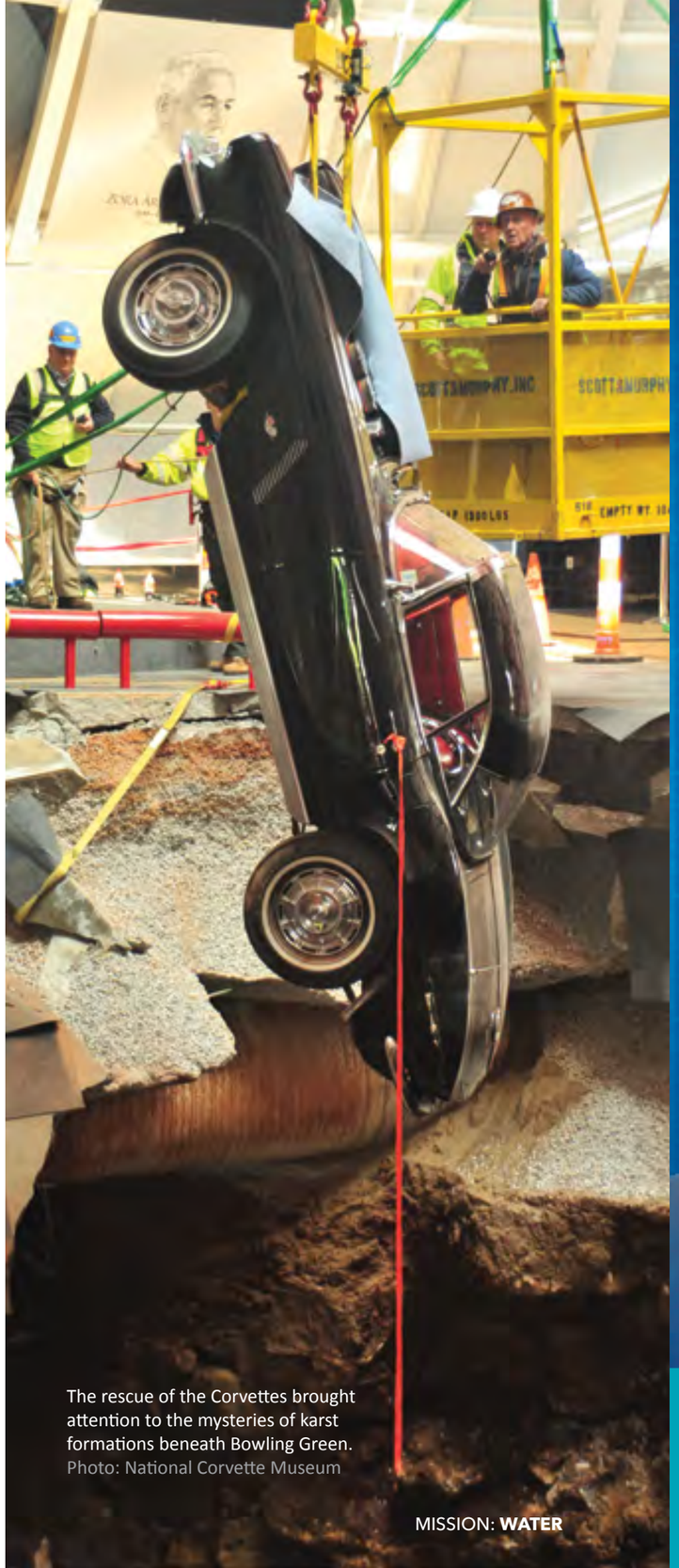
The scientists and policymakers behind Under Bowling Green are also using the EXO2 data to glean a better understanding of the dynamics of stormwater, pollution and flooding in the system, which is constantly subject to change as new caves collapse or old sinkholes clog up.

“As water makes its way underground, [the karst] is like a bathtub,” Polk explains. “The holes the water goes into eventually become holding chambers. There are many spring outlets, most of which eventually feed into the Barren River, the hydrologic border of the city. There are over 2,000 injection wells in the city, draining down the surface water and filling up the karst just as fast. They could plug with sediment, or they could collapse some more, or an injection well could flood.

“Every time we build, every time we change the hydrology, every time we pave over a surface, these are all potential risks,” he emphasizes.

underBGKY.org

@WKU



The rescue of the Corvettes brought attention to the mysteries of karst formations beneath Bowling Green.
Photo: National Corvette Museum

LIFE AFTER HORIZON

Remediation Efforts on the Gulf Coast

Releasing a dolphin back into the wild. Assessing the damage to marine mammals was a key component of Gulf Coast remediation.
Photos: Audubon Nature Institute

On Tuesday, April 20, 2010 the largest oil spill in history occurred when a sudden explosion and subsequent fire occurred on the Deepwater Horizon Platform, located 50 miles southeast of Venice, Louisiana. Lisa Landry, Gulf Coast Applications Specialist for Xylem Inc., was on the ground the weekend after the explosion, serving as an oiled wildlife transporter.

"When I first arrived, I couldn't get over how the quiet fishing community had transformed into ground-zero, a bustling staging area for oil spill response workers. It was as though the population of Venice and the small surrounding communities had more than quadrupled their population overnight," recalls Landry. Field crews worked extremely long hours surveying impacted areas, and bringing oiled wildlife ashore where they would be transported to nearby facilities for examination and cleaning. "It was organized chaos."

Serving as a state biologist for the Louisiana Department of Wildlife and Fisheries, Lisa was a member of the Marine Mammal and Sea Turtle Stranding Team. "We responded to reports of stranded dolphins and sea turtles across the Louisiana coast."

If the animals were alive, they worked with the Audubon Society to transport the animals to their rehabilitation center, and those that were deceased were collected for necropsy.

"Years after the Deepwater Horizon event, we were still working alongside federal and state partners to conduct marine mammal health assessments in Barataria Bay to assess the impacts of the oil spill on the local dolphin populations." There were extremely long days and Landry says she will never forget the sights and smells she experienced working alongside the stranding team.

At the end of her tenure with the state, Landry served as a member of the multi-agency Restoration Planning Team tasked with developing restoration plans to offset the damages incurred from the Deepwater Horizon Disaster. "It was a rewarding job, and I truly learned a lot. Although I've since transitioned to a new role with Xylem, I still feel deeply invested in the future of the Gulf of Mexico, and I am very excited about the restoration projects taking place across the gulf coast."

> **" It was organized chaos. "**

LISA LANDRY
Gulf Coast Region Applications Specialist

Workers attempt to clean oil from the beach area on June 23, 2010 in Pensacola Beach.
Photo:Cheryl Casey

HORIZON
SIX YEARS LATER

In April 2010, the oil rig, Deepwater Horizon, exploded off the coast of Louisiana, killing 11 workers and dumping an estimated 795 million liters of oil into the Gulf of Mexico. Six years later, scientists are still totaling the damage.

1 An estimated **102,400 birds** lost as a result of the spill and disaster-response efforts.[1]

2 Scientists reported oil along more than **1,300 miles of shoreline** spanning from Texas to Florida. [2]

3 **1,000 dolphins stranded** (95% stranded dead) from Louisiana to Alabama following the oil spill.[1]

4 It is estimated that **2 to 5 trillion larval fish** and **37 to 68 trillion invertebrates** were killed in the surface waters as a result of floating oil and mixing of that oil into the upper water column. [1]

5 Over **770 square miles** of sea floor around the wellhead was damaged by oil.

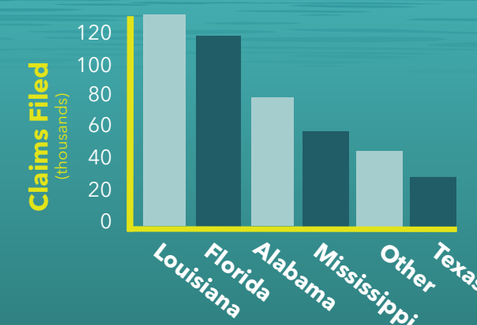
These deep water impacts include damage to reefs, where corals can be hundreds of years old.[1]

THE CRUDE PERSPECTIVE

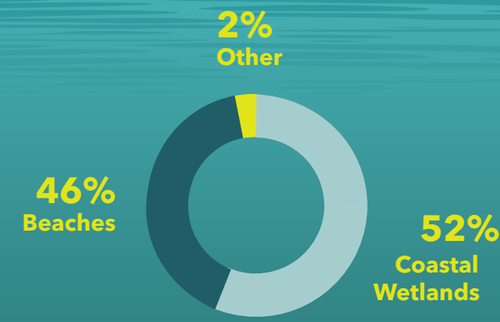
An estimated 795 million liters of oil leaked out into the Gulf of Mexico. With the oil that leaked:

311 Olympic-size swimming pools could be filled [3]

13,208 homes could have been heated for one year [3]



Economic and property damage claims filed by state are reported highest in Louisiana. [4]



Today the highest percent of oiled shoreline still affected are coastal wetlands. [5]

TRANSFORMING A TRAGEDY

37 of 50 states have renewable energy standards or goals. [6]

Increased number of students are insisting their universities **divest in fossil fuels** [7]

BP will spend an estimated **$62 Billion** on court fees, penalties, claims, and clean up costs. [8] In addition, as part of the settlement, BP Exploration and Production (BPXP) is providing $7.1 billion to the United States and the five Gulf states over 15 years for natural resource damages.

SOURCES:
[1] NOAA
[2] Oceana
[3] Popularmechanics.com
[4] Deepwater Horizon Claims Center
[5] National Geographic
[6] NCSL
[7] Associated Press
[8] The Guardian

Aerial footage, coastal Louisiana.
Photo: The Institute

BATTLING WETLAND LOSS in Coastal Louisiana

THE WATER INSTITUTE OF THE GULF

When The Water Institute of the Gulf

(the Institute) was founded in 2011 in Baton Rouge, Louisiana, it set out a mission to provide independent research and technical expertise to ensure resilient coastal communities and sustainable water systems worldwide.

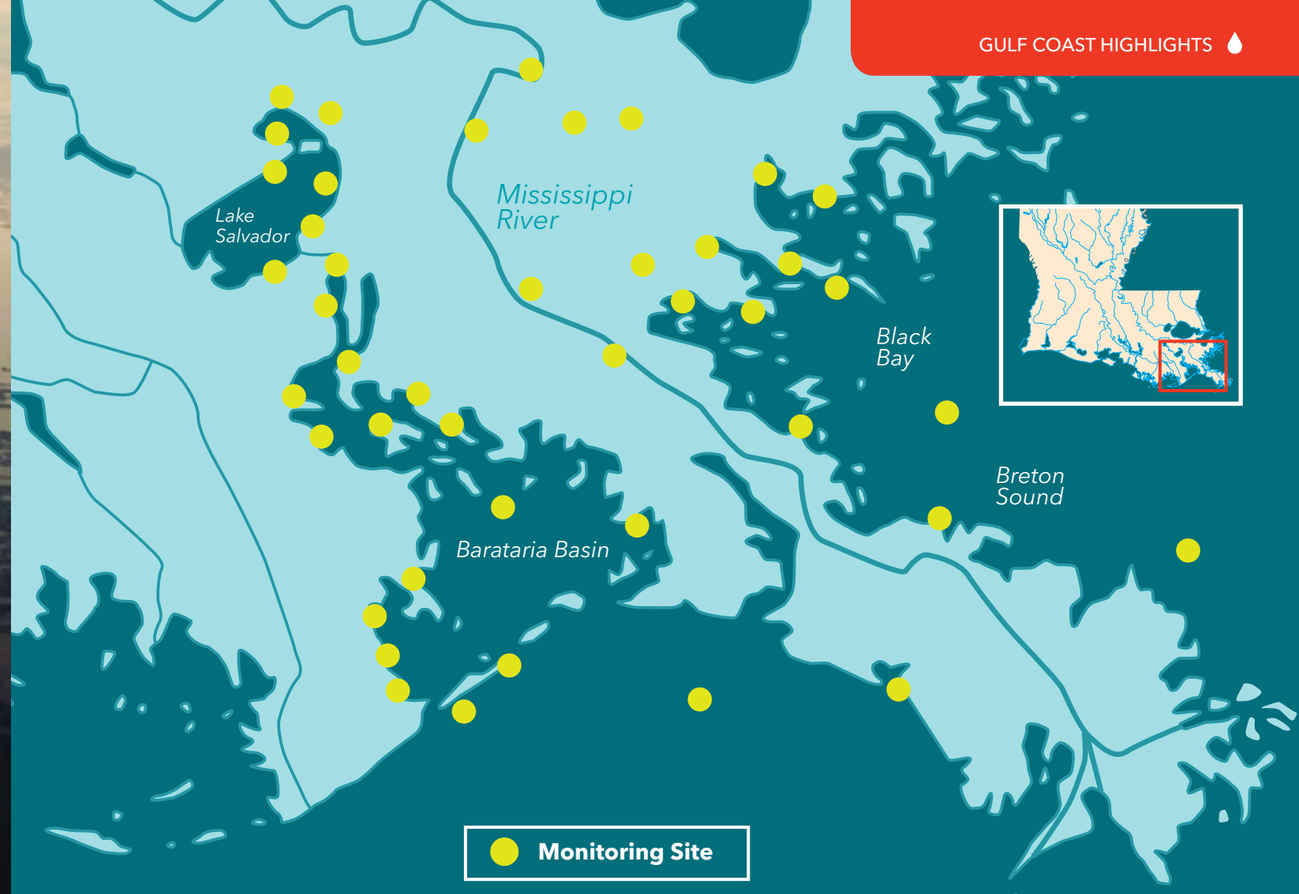
Created through a collaborative effort involving the State of Louisiana, Senator Mary Landrieu, and the Baton Rouge Area Foundation (BRAF), the Institute connects academic, public, and private research providers and conducts applied research to serve communities and industry. In all endeavors, the Institute's goal is to increase understanding of natural and human aspects of deltaic, coastal, and water systems; to develop tools that apply knowledge to restore coasts and ecosystems; and to reduce risk for people and infrastructure.

As stated by President and CEO Charles "Chip" Groat, Ph.D., the expertise knowledge base being built today at the Institute is exportable. "Today, we are actively engaged in projects in other locations in the U.S. and around the world, including the Mekong River Delta and Latin America," said Dr. Groat. "This initial portfolio of work is critical and will serve as a foundation for diverse future opportunities."

However, located on the Mississippi River Delta, the Institute has to look no further than its home state to confront the harsh reality that wetlands are disappearing at an alarmingly swift rate – a phenomenon occurring across the globe.

At the rate of a **football field disappearing every hour**, land loss in Louisiana is more than a local concern, it is a national dilemma. In addition to being called home by millions of residents, Louisiana's coast and wetlands greatly support America's energy industry and an interlaced port system that carries over 25% percent of all US waterborne commerce, and creates international business and trade opportunities.

The state's wetlands house recreational and economically important fisheries – blue crabs, shrimp, oysters, menhaden, and more – comprising 25% of America's seafood. Also, these wetlands provide the critical benefits of physical protection from storms and hurricanes. Unless restoration activities are successfully planned and implemented, land loss will continue to threaten, reduce, and eliminate these valuable assets and the communities they support.



To assist in restoration projects designed to restore and sustain lands in the delta and along the coast, the Louisiana Coastal Protection and Restoration Authority (CPRA) tasked the Institute with developing and applying a basin-wide integrated biophysical model. In order to create such a model, one that links water, sediment, and nutrient dynamics of the Mississippi River to complex processes of the estuary, an advanced set of tools and technology was needed.

For example, the Institute used many YSI multiparameter sondes in the estuaries of the Breton Sound and Barataria basins to collect water quality data such as salinity, temperature, turbidity, and oxygen.

This helped produce a calibrated and validated model capable of simulating critical coastal processes and predicting the effects on land change, vegetation, and nutrient dynamics resulting from proposed sediment diversions – engineered crevasses in the lower Mississippi River where riverine sediment is discharged into the basins to help build land. The model output findings were then used by CPRA to understand how different sediment diversions and their operations could slow down predicted wetland loss.

Breton Sound, June 2014.
Photo: The Institute

Above: Leland Moss, research associate, records data for NOAA from a YSI EXO multiparameter sonde handheld.

Photos:
The Institute

Below: Cyndhia Ramatchandirane, research associate, performing maintenance on a YSI EXO sonde used for long-term monitoring.

The Water Campus in Baton Rouge.

"The YSI...sonde was essential in collecting the varied hydrological data necessary for validating our decision..."

"The YSI multiparameter sonde was essential in collecting the varied hydrological data necessary for validating our decision support tool," said Melissa Baustian, Ph.D. co-principal investigator for this work and a coastal ecologist with the Institute. "The outputs of our integrated model have already been used by CPRA to decide which coastal restoration diversion projects they will pursue – that's huge for the future of rebuilding Louisiana's coast. The model continues to inform critical decisions on an ongoing basis."

Through a cross-disciplinary approach, the Institute integrated links between data, models, and end users to continuously deliver high quality information to help sustain coastal Louisiana and its most valuable resources. As with its projects involving YSIs, the organization works to develop and apply tools that support effective and transparent decision making and that ensure livable communities and thriving economy and environment.

The Institute serves as the RESTORE Act Center of Excellence for Louisiana and will soon join CPRA and the Louisiana State University (LSU) Center for River Studies as the first tenants of The Water Campus in Baton Rouge, fostering an international destination for research, unprecedented views of the Mississippi River, and a collaborative culture to better understand and manage the complex relationship between water, land, and people.

Governmental agencies, business, and industry interests can thoughtfully plan for sustainable infrastructure, ecosystems, economies, and emergency preparedness by leveraging the Institute's knowledge and capabilities, and the organization welcomes opportunities to apply its expertise with new partners to face new challenges.

For more information about the Institute's research capabilities and how they can benefit your organization:

thewaterinstitute.org

Gulf Coast Solutions

Xylem's long history of technical support in the Gulf Coast region has helped ecologists, fish farmers and businesses gain a better understanding of water characteristics.

1 Atchafalaya Basin, LA

The Atchafalaya River Basin is used heavily for shipping and industry, and as a result the Great Swamp Forest that surrounds the river has suffered. To address this challenge head on, The Nature Conservancy purchased 5,359 acres in the Bayou Sorrel region, and has monitoring sites – equipped with YSI EXO2 sondes – for water quality monitoring. Data from the sites will assist the team as they work to restore habitats for fish and wildlife.

Photo Credit: Nature Conservancy

2 Moss Point, Mississippi

The Grand Bay National Estuarine Research Reserve (NERR), is part of the National Oceanic and Atmospheric Administration's (NOAA) National Estuarine Research Reserve System (NERRS). The NERR's System-wide Monitoring Program measures short and long-term changes in estuarine conditions. Continuous water quality data are collected at four long-term monitoring sites throughout the reserve.

Photo Credit: Grand Bay NERRS

3 Mobile, Alabama

When Deepwater Horizon sank about 100 miles off the mouth of Mobile Bay in 2010, Dr. Webb put his Jag Ski – outfitted with a SonTek acoustic Doppler Profiler (RiverSurveyor M9) and a Portable Sea Keeper water quality testing system – to work, studying the movement of oil from the spill in the rich fishery. Data collected offer insight into the Mobile Bay estuary, and the performance of practices designed to repair the barrier island at the mouth of the Bay.

Photo Credit: Dr. Bret Webb

4 Dauphin Island, Alabama

The mission of the Mobile Bay National Estuary Program (MBNEP) is to promote wise stewardship of the water quality characteristics and living resource base of the Mobile Bay estuarine system. As a division of the Dauphin Island Sea Lab, it monitors water quality at eight stations throughout the area with YSI sondes. They work with a variety of agencies, to implement their Comprehensive Conservation Management Plan (CCMP).

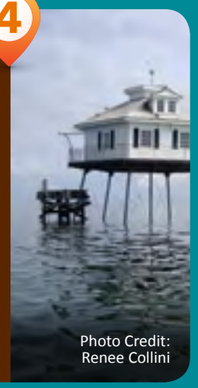


Photo Credit: Renee Collini

5 St. Petersburg, Florida

Due to urban development prior to stormwater monitoring regulations, the Clam Bayou habitat is now facing environmental repercussions affecting water level and quality. To determine the level of impact the Bayou faces, the Coastal Ocean Monitoring and Prediction System (COMPS) installed a monitoring site to collect data. The COMPS system was upgraded with several Xylem brand instruments to monitor the sea level rise with a geodetic reference.

Photo Credit: Mike Lizotte

6 Kissimmee, Florida

The City of Kissimmee developed a stormwater, watershed monitoring plan and contracted YSI's Integrated Systems & Services to design, supply, and install 19 stations throughout the city. Each station utilized YSI data collection and telemetry systems, YSI water quality sondes, level sensors, rain gauges, and SonTek flowmeters. The data help the city to better understand the baseline conditions entering, and within, their boundaries.

Photo Credit: Kevin Simpson

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MEET OUR Gulf Coast TEAM

Kyle Waits

Gulf Coast Team Lead

- 13 years of consulting experience with water level, flow and quality instrumentation.

Lisa Landry

Applications Specialist

- 12 years field experience with environmental agencies in the Gulf.
- Restoration planning team member.

Kevin Labbe

Application Engineer

- 13 years of consulting experience with flow instrumentation.
- 17 years field experience with the USGS.

Mindy Joiner

Team Coordinator

- 7 years field experience, and served as Product Coordinator for BP oil spill natural resources damage assessment.

Jason Bullock

Senior Repair Technician

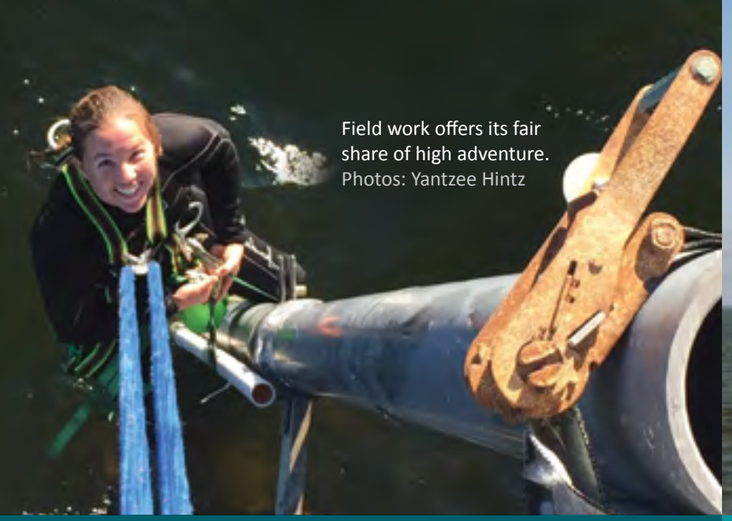
- 10 years experience with service, repair and technical support for water quality instrumentation.

*Leverage Xylem's **72 YEARS** of combined experience in the Gulf with your next project!*

Water Heroes Interview

Renee Collini

Dauphin Island Sea Lab



Field work offers its fair share of high adventure. Photos: Yantzee Hintz

About Dauphin Island Sea Lab

Founded in 1971 by the Alabama State Legislature, Dauphin Island Sea Lab (DISL) is the administrative home for Alabama's Marine Environmental Sciences Consortium. Located on the eastern tip of Dauphin Island, a barrier island in the northern Gulf of Mexico, the DISL is surrounded by Mobile Bay, Mississippi Sound and the waters of the Gulf, making it a perfect location to conduct marine science activities.

Renee's Role

Program Manager, Alabama Real-Time Coastal Observing System (ARCOS)

Coordinator, Northern Gulf of Mexico Sentinel Site Cooperative

Alma Mater

University of Texas at Dallas, B.S. Biology
University of South Alabama, M.S. Marine Science

Q. Tell us a little about Dauphin Island Sea Lab and your role within the organization.

A. Dauphin Island Sea Lab has been around since the early 70s, and in some rendition even before that. Our goal has always been to gain a deep understanding of our region's marine and coastal environments, and to educate those in our communities about the importance of environmental stewardship and the impacts we all can have on our world.

In conjunction with research, education is a big mandate for our team, and we have a number of initiatives that include K-12 field programs, teacher-training, and public engagement. One of our most popular programs is the BayMobile, DISL's traveling classroom, which allows Sea Lab educators to bring marine science lessons to schools all across the region.

My current role at the lab is to support our researchers with access to real-time water quality data and observations. It's a program manager position that lets me take more of a leadership role on the team and ensures the valuable environmental data we're collecting gets in the right hands.

Q. How long have you been with Dauphin Island Sea Lab?

A. I've been with DISL for several years and worked in a number of positions. I started out maintaining our network of water quality monitoring sites, collecting the data. These days I'm behind a desk, but I am doing equally important work securing funding for our work at the lab.

Q. Do you miss your days on the front lines as a technician?

A. *(Laughter)* That's a tough one! The transition was difficult in some respects, but a breeze in others. The devil's in the details when it comes to collecting high quality data, so it was challenging to pass the torch when I didn't want to see anything overlooked. It was also difficult to let go of being out in the field day in and out. It's just so beautiful out there… at least when it's not freezing!

But, I knew someone had to be a champion for our field work and support funding efforts for the organization. I had the experience to grasp both the importance of the data we collect and what it takes to make it happen.

Q. Why are the data collected by your team so important?

A. As an organization we continue to champion monitoring at a bigger scale. Continuous data inform **EVERYTHING**! Data help us make good policy decisions and also help us to relate environmental change to the general public.

As environmental professionals, we are sentinels. We are the people watching and observing the world on a daily basis, and it's our responsibility to understand ecosystem dynamics and to educate the people around us. Data help us do this.

Katrina Cut Station, one of many Gulf Coast sites studied by Renee.

Q. What are some of the challenges currently facing DISL?

A. Like most organizations right now, I'd say our biggest challenge is finding funds. Transitioning from grant to grant often times puts a lot of stress on the team.

It's becoming difficult to get the money necessary for even basic ecosystem monitoring these days. It isn't cheap to gather baseline data, but it's absolutely critical to understand changes in our environment. You have to fight for every cent. Aside from funding, it's balancing the needs of stakeholders, from restoration efforts to gulf-wide monitoring projects. Like all monitoring organizations, we have limited resources to go around. Everyone wants your time…for free. And while all these opportunities are worthwhile investments of our time, we have to prioritize. We can't be everything to everyone, so we try to support as many folks as we can.

Q. What tips or tricks can you share for securing funding for monitoring efforts?

A. BE CREATIVE! As practitioners we inherently know the primary audience that would benefit from our data and often times we'll target the same groups over and over again with requests for funding. This is the starting line, not the finish line. It's not easy to break outside of our traditional sources, but we've had success looking at public health agencies, tying our water quality data to things like seafood safety. There are lots of public health opportunities where we can all benefit.

Another recommendation is to thoroughly understand your end users. You want to make sure you're catching all the opportunities available to you and that starts by learning everything you can about the people using your data and educational services. Whenever my team makes field visits, we always introduce ourselves to the fishermen and tell them what we do. Whenever we go to a community meeting, we market our capabilities. Make use of every touch point to convey your value because you never know who'll line up to support you next.

> **" As environmental professionals, we are sentinels. "**

Q. The amount of effort required to collect a continuous data set is often under appreciated. How does your team pull it off?

A. You need dedicated people from top to bottom in an organization – and even then you have to battle. You need people who are driven to put in effort even in their spare time, on weekends. You have to be willing to stay up all night to deal with the problems that will inevitably arise, and you have to be enthusiastic about field trips in rain or incredibly hot weather.

Maintaining a high quality data record is a never-ending job. It requires a network of people to make it happen. Most folks don't often think about that when they're looking at the graphs and spreadsheets.

Q. Thanks for your time Renee! Is there anything else you'd like to add?

A. Yes! I'd like to take this opportunity to thank all the marine field technicians that have helped DISL get to this point.

I'd also like to highlight our brilliant data manager, Lei Hu, who works her miracles to provide the general public with an amazing view of our local waterways at www.mymobilebay.com

Lastly, I'd like to acknowledge Mike Dardeau! He built our network from the ground up and gave myself and all the other members of the team the opportunity to do this fun and important work. *(And my Mom! She strong-armed me into taking a NSF research experience at DISL and it's turned out to be one of the best experiences of my life. Love you Mom!)*

mymobilebay.com

GULF COAST HIGHLIGHTS

CLEARER VIEWS

Flow data will help steer springs' recovery

STEVE WERBLOW

Since the 1870s, the crystal clear waters of Silver Springs have provided millions of visitors a glimpse into primeval Florida, a world of buried caverns, bubbling springs and cruising alligators, manatees and long-nosed gar.

Florida's oldest tourist attraction, **Silver Springs** is one of the largest artesian springs ever discovered.

But the once-pristine springs and the Silver River that flows from them are threatened by Florida's growing population. Spring flows have declined due to a combination of climate change, surface drainage alterations and groundwater pumping. High levels of nitrates and other nutrients flow into the aquifer from lawns, farms, septic systems, faulty sewers and urban runoff—background concentrations of nitrates in the river jumped 20-fold, from 0.05 mg/l to 1 mg/l, during a 50-year study.

Invasive plants, including hydrilla, have upset the ecological balance of the plant community. And algae, fueled by nutrient-enriched flows, coat native eelgrass and floats on the water's surface, dulling the system's sapphire glow.

Mitch Wainwright, hydrographer for the St. Johns River Water Management District (SJRWMD) in Palatka, Florida, grew up visiting Silver Springs. Now he is collecting data that will help inform restoration efforts for the springs.

"As a kid in the early '60s, I remember how clear it was," Wainwright says. "I've seen a difference in my lifetime. It's amazing."

" I remember how clear it was... "

SUNRISE - SILVER SPRINGS, FLORIDA.
Towing a SonTek HydroSurveyor for flow data.
Photo: SJRWMD

Mysterious Foundations

Silver Springs—a network of two dozen or more springs in central Florida—bubble up through central Florida's Karst formations, limestone beds that have been carved by acidic groundwater and rain into baroque networks of caves, channels, domes and tunnels. Channels in the matrix flow with underground rivers and provide quick conduits between surface water and shallow groundwater. As domes collapse and sinkholes form, ancient paths are rerouted beneath the surface.

That makes flow studies incredibly complex, and makes the once-pristine Silver Springs and Silver River system highly sensitive to pollution.

"The Karst geology is a great transporter of water from surrounding areas," says Mitch Wainwright, hydrographer for the St. Johns River Water Management District. "The underground 'rivers' efficiently move water throughout the aquifer. Rainfall is a constant contributor, but it also has the effect of washing nutrients and other pollutants into the upper Floridian aquifer."

In fact, that effect can take place much more quickly than scientists once assumed. Wainwright describes a dye test in the aquifer near Silver Springs to track the travel time of a marked sample of water through the system.

"It's really quite amazing—they were expecting it to take six months, but it got there in two weeks," he says. "It can move a lot faster than we thought."

In Central Florida, karst limestone's channels and caves intimately link aquifers and crystal-clear rivers. It's a natural wonderland–and an ecosystem in peril.

Photo: SJRWMD

Hydrographers with the St. John River Water Management District (SJRWMD) geared up quarterly for an extensive study of a six-mile reach of Florida's Silver River.
Photo: SJRWMD

Go with the flow

Wainwright's exploration of the springs goes far beyond childhood memories and casual observation. Over the past two years, he has carefully measured velocity and flow quarterly in a six-mile stretch of the Silver River, which connects Silver Springs to the Ocklawaha River. Those measurements comprise a database of flow and vegetation characteristics that will help scientists understand the dynamics of the river and build a model to predict its behavior.

One of the biggest challenges in collecting data, he says, is the thick, submerged aquatic vegetation—some natural, some invasive—that grows in the river and can alter water movement.

"The vegetation can be a couple of inches to four or five feet high," Wainwright notes. "It changes by the season, but there are times when it gets so thick you can't paddle through it. It can alter the velocity pattern and changes based on where the velocity is in the channel."

Several years ago, during an extremely hot summer, the river surface was completely covered with vegetation. Wainwright and his colleagues were not able to document whether the thick mats of plants had dammed the river's flow that season, but the situation alerted them to the need for an in-depth study of the physics and biology of the river.

The timing was perfect: the SJRWMD was launching a comprehensive springs research effort with the University of Florida, and the State of Florida initiated significant funding to help implement restoration projects. Understanding the vegetation dynamics would be a critical step.

"The aquatic vegetation is a very good indicator of water quality," Wainwright says. "Seasonal changes are important due to the variation of sunlight and discharge patterns."

Submerged aquatic vegetation does more than alter water flow—it also interferes with Wainwright's ability to measure flow and velocity all the way to the bottom of the river. "Basically, we're getting a picture of the top of the canopy," he explains.

Comparing canopy depth data with true-bottom readings by divers and surveyors along four lateral transects in the river, analysts will be able to calculate the waxing and waning of the submerged vegetation from season to season. GPS-pinpointed permanent markers hammered into the riverbed provide fixed references for river bottom reading sites, with surveys providing bed angles and the slope of the bank. They also guide the divers and kayak-paddling hydrographers along the transect paths.

Florida’s spring-fed rivers are home to a host of wildlife species, including alligators… adding urgency and a bit of excitement to data collection.
Photo: SJRWMD

In total, Wainwright conducts 11 transects across the Silver River every three months to profile flow, velocity and canopy depth using RiverSurveyor M9 systems produced by SonTek, a Xylem brand. The RiverSurveyor systems are equipped with a hydroboard floating platform and a power and communications module that includes an integrated GPS system.

Wainwright and his team from the district also conduct 12 longitudinal transects every quarter, profiling flow, velocity, direction and canopy depth along a six-mile reach. The district uses four RiverSurveyors in the massive data-gathering effort. Wainwright designed a lightweight PVC frame that attaches to each RiverSurveyor’s hydroboard on one end and a kayak on the other, which allows a hydrographer to steer the instrument without interfering with how it floats.

User-Friendly Instruments

Wainwright says the RiverSurveyor M9—which uses nine transducers and multiple acoustic frequencies to measure flow and velocity at depths of a few centimeters to 40 meters—is ideally suited for the complex bathymetry and dense aquatic forests that make the Silver River a challenging place to profile.

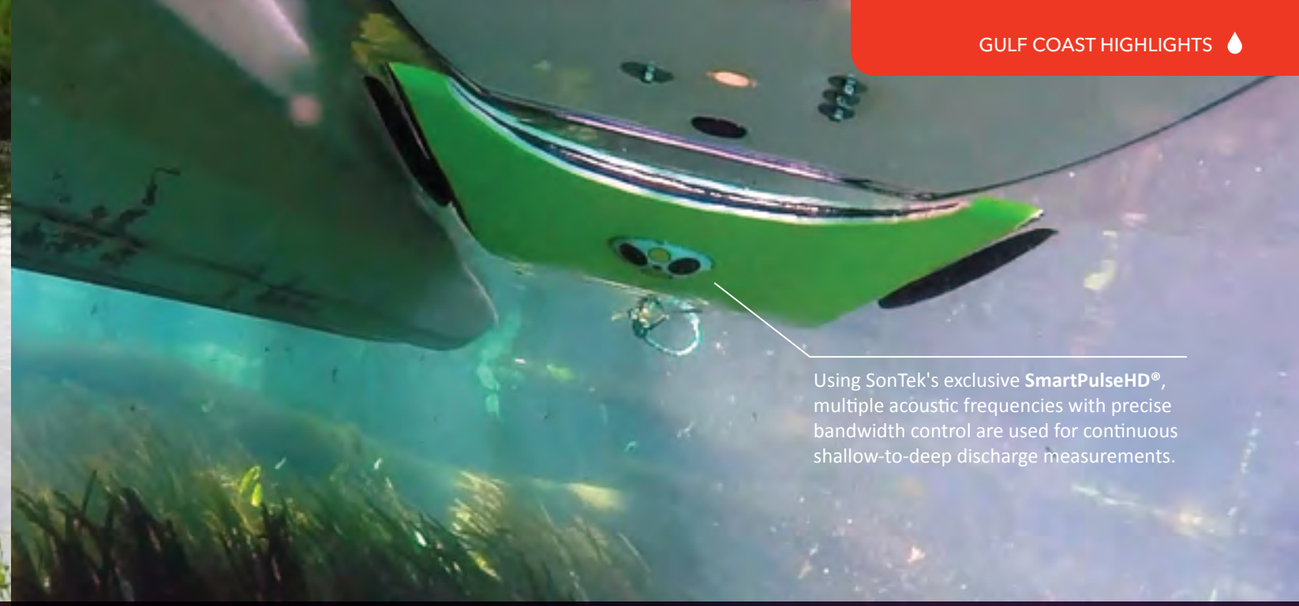
“The RiverSurveyor has been extremely reliable during all conditions,” he says. “I was especially amazed to see the integrated GPS system pick up numerous satellites through heavy tree canopies during the summer season.

With its multiple acoustic frequencies, the system will switch from measuring in shallow water to deep water automatically, and it autoconfigures in the field. Calibration takes five minutes—it’s a simple self-test.

SonTek product manager, Isaac Jones, says Wainwright and the SJRWMD team have tapped into the versatility and performance features of the RiverSurveyor M9 in a cluttered, complex environment.

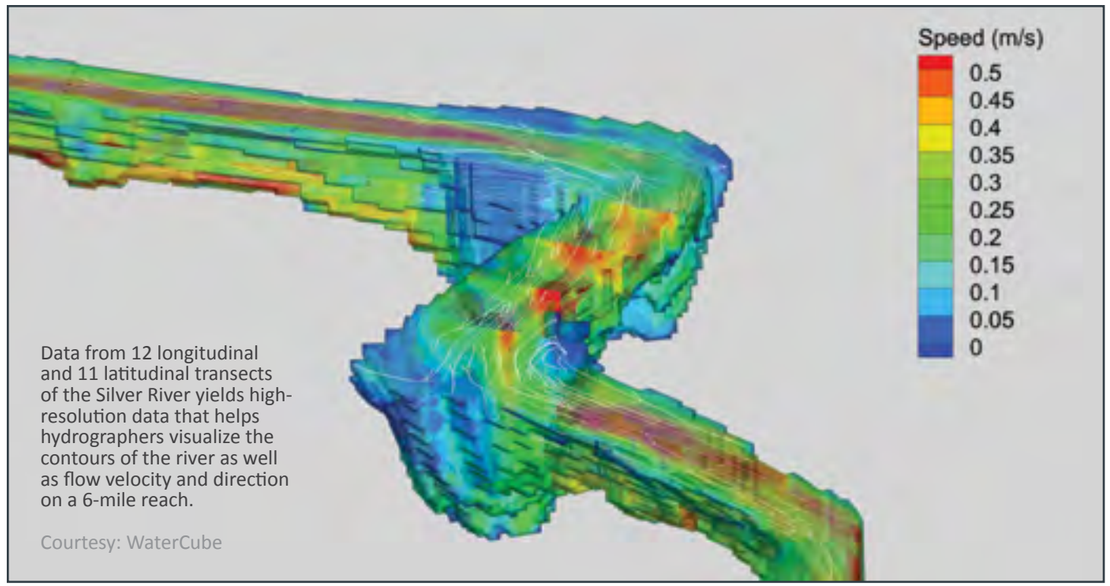
“Mitch and his colleagues provide an amazingly detailed look at the characteristics of the channel—dominated by vegetation, logs and a maze of cypress tree roots—and their impacts on flow through the river,” Jones says. “They have harnessed the capabilities of the RiverSurveyor’s SmartPulse system to automatically select the optimum frequency, ping rate and processing techniques to provide valuable data as the river’s depth and velocity change in a very challenging application. Working in a heavily vegetated environment, they rely heavily on the RiverSurveyor telemetry and GPS package."

“The tool works well, but nothing works perfectly in an environment like this,” Jones adds. “Mitch and his team have overcome many obstacles through hard work, creativity, ingenuity and collaboration with other experts. The insight they are providing on flow and detailed channel bottom features will complement the growing understanding of water quality parameters and pollution to provide a deep look into this fascinating environment.”



Using four RiverSurveyor M9s, Mitch Wainwright and the SJRWMD team mapped changes in underwater vegetation and river flow every three months for two years, providing insight into the mysterious world of Florida’s spring-fed river systems.
Photo: SJRWMD

Mitch Wainwright of the St. John River Water Management District (SJRWMD) figures he paddled more than 200 to 300 miles while measuring depth, flow and velocity of a six-mile reach of the Silver River in 2015 and 2016.
Photo: SJRWMD



Data from 12 longitudinal and 11 latitudinal transects of the Silver River yields high-resolution data that helps hydrographers visualize the contours of the river as well as flow velocity and direction on a 6-mile reach.

Courtesy: WaterCube

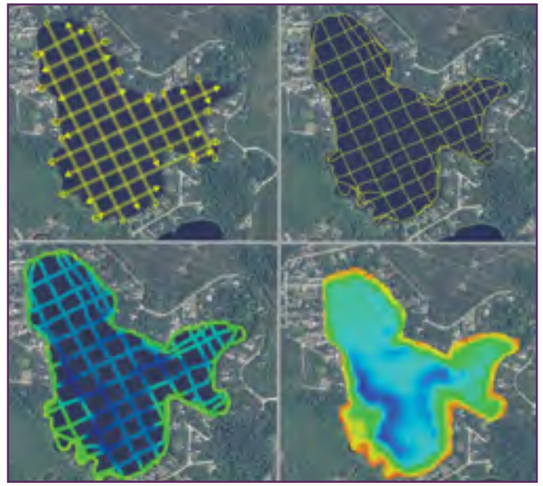
Data Visualization

The immense amount of data collected during the SJRWMD's quarterly transects was processed through WaterCube, which combines data sets from multiple Acoustic Doppler Current Profilers (ADCPs) and filters the data to yield highly accurate visualizations of the Silver River. Wainwright and his team capture details in cells as small as two centimeters in area and velocity measurements accurate to 0.001 meters per second, providing WaterCube with high-definition (HD) data to create pin-sharp graphics.

"WaterCube processing has been a giant plus," Wainwright says. "They are able to screen out the questionable data that is generated from situations like side lobe interference, GPS multipath from dense tree canopy, and bottom-tracking issues when dealing with subsurface aquatic vegetation. For me to do that manually would take 10 years. And their 3-D and cross-section velocity visualization helps us explore the data set rapidly."

Ultimately, SJRWMD's Silver River flow data will form the basis of a hydrodynamic model that will allow scientists to predict the flow of water. That insight will be combined with research currently being conducted by collaborators at the University of Florida on water quality, ecology and aquifer transport to provide a clearer view of the workings of the mysterious, complex and compellingly beautiful world of Florida's spring-fed rivers.

sjrwmd.com



In four panels from SonTek Hydrosurveyor software, SJRWMD's Silver Lake team goes from survey line plan to path to detailed data.
Data Courtesy: SJRWMD

SJRWMD's RiverSurveyor transects are complemented by SonTek CastAway-CTD readings of conductivity, temperature and depth.

PHOTO CONTEST

This year Xylem Analytics put out a call for your best environmental monitoring photos.
We were humbled to receive dozens of wonderful photos - and here are some of the best!

Send in your monitoring photos:

MissionWater@Xyleminc.com

CROOKED CREEK NEAR KLAMATH FALLS, OREGON
RiverSurveyor M9 being used to quantify flow as part of a statewide streamflow monitoring program done by the Oregon Water Resources Department that provides real-time data to the public.
Photo: Garrett Steensland

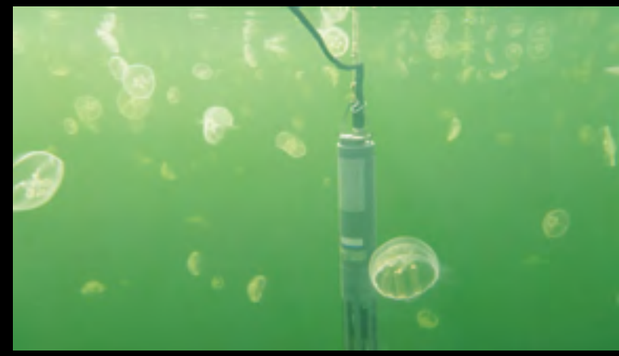
BEST PHOTO

Photo Contest Winner
Garrett Steensland

Garrett was the recipient of an iPad Mini for his submission!

Honorable Mentions

Norm Ponferrada monitoring water quality using a YSI Model 556 at Guadalupe Reservoir in California.
Photo: Norm Ponferrada



Wallagoot Lake, an estuary on the southern NSW coast, Australia. Jellyfish were prolific in the estuary during this monitoring round.
Photo: Andrew Roberts

Melissa using an EXO2 off the Island of Barbuda, Lesser Antilles. This lagoon houses the largest colony of frigate birds in the world.
Photo: Dr. Nancy E. Todd, Manhattanville College

Lusail City

Qatar Aims to Score on the World Stage with Grand Project

LUKE GIROUX

With an ever-expanding world population, civilization has been pushing the envelope to develop locations for domestication and commerce on lands previously considered undevelopable. The world has seen massive scale development in the name of progress countless times before. As a species, in many ways it is what we do.

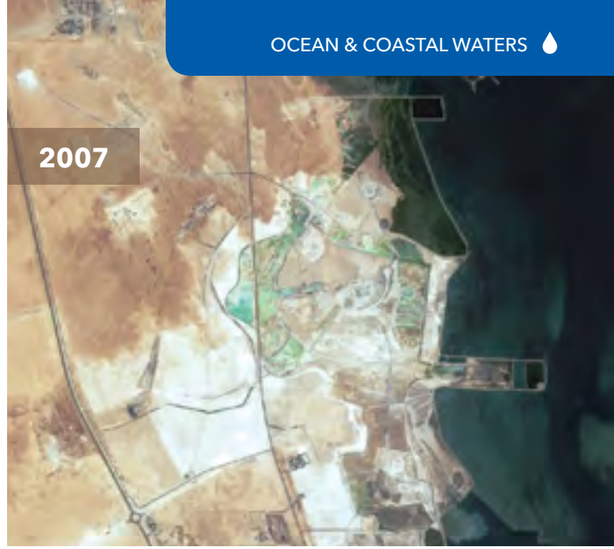
It is possibly no surprise that these developments often have dubious construction and sustainability track records, and there are countless examples around the globe, where we have stepped over a line or lines of what is acceptable, all in the name of progress. Add the numerous repercussions of warming marine environments to this mix, and massive construction and development projects in increasingly sensitive natural environments become a questionable endeavor.

New development, similar challenges

One of the newest and most ambitious locations being developed is in Qatar, on the Arabian Gulf, a place where civilization is stretched to its limits, due to the existing hot and arid climate. Qatar's new coastal development project, Lusail City – just north of the capital city of Doha – is a new city being built along the coast, with a planned population of 450,000. With the aggressive goal of hosting the FIFA World Cup in 2022, construction of new waterways, land transportation and infrastructure systems, and residential, commercial, and entertainment areas are in an enormous all-out effort.

Lusail stadium- a modern indoor sports arena in Lusail.
Photo: Phillp Lange

The Goal is Sustainable Development, not just FIFA World Cup 2022.



Satellite imagery detailing almost a decade of development. Turbidity monitoring is an essential part of the Lusail project.
Photos: Lusail.com

However, the project also faces numerous water-related issues, including the extensive dredging and disruption of the surrounding marine ecosystems, as well as drinking water and water treatment. Desalinization, a common practice in the Arabian Gulf, can oftentimes adversely affect an increasingly fragile marine environment. With this type of project, there is no action without a repercussion.

Competing resources

Other than the minimal border it shares with Saudi Arabia, Qatar is a peninsula, completely surrounded by the waters of the Arabian Gulf. The government of Qatar has established a Qatar Marine Zone (QMZ), which encompasses its entire 350 miles of coastline. Qatar marine life is notable for its active though tenuous coral beds, dugong (a manatee relative) and whale shark populations, as well as other marine life and habitats. When it comes to modifying these coastal areas (a key component of the Lusail City endeavor), marine environments and ecosystems need to be continuously monitored, in order to observe and address any changes that take place as a result of human disruptions.

Fisheries have been stressed for many years in Qatari waters, but traditional methods are allowed, as they are viewed as sustainable for this ideally renewable resource. Oil drilling and natural gas extraction, the latter of which Qatar is the world's third largest producer, ultimately drive the development economy here. On the strength of these varied and competing resource environments, and major commercial and residential developments, Qatar is continuing to establish itself as a world economic player.

A series of monitoring systems commissioned by the Environmental Agency in Doha.
Photos: Hassan Al Salem

Smart and Sustainable

The Lusail City development project, which intends to be a new "smart" city of over 450,000 residents, is requiring massive coastal changes, the norm in the Gulf region's new super cities and commercial developments. The coastal modifications will entail marine and earthworks changes in the realm of dredging and excavation of nearly one billion cubic feet of gulf bottom, reclamation and land filling of over 700 million cubic feet, and creation of 6.2 miles of block walls, 13 miles of rock revetments, and 2.5 miles of 19 new beaches. It's a feat that is enormous and stunning from any perspective.

The Qatari government and its construction partners, to minimize environmental impact of the Lusail project as much as possible, took it upon themselves to adopt the Global Sustainability Assessment System (GSAS) and the internationally recognized LEED (Leadership in Energy and Environmental Design) standards for green and sustainable building development for Lusail City – a positive step on the world stage of supersized projects.

To adhere to the oversight requirements, and as part of the coastal dredging for new waterways, marinas, and island development, 50 monitoring stations including 8 anchored buoys are monitoring and reporting dredging impacts in real-time. These stations and buoys constantly monitor water conditions, as high sediment concentrations can lead to reduction in DO, negatively affecting marine life.

Additional water quality data such as pH, temperature, and turbidity is collected and uploaded to the Environmental Agency in Doha. Dredging contractor Al Jaber Engineering and agency personnel review and assess the data, and feed back to dredging equipment operators to adjust progress and direction as needed. It is a feedback loop that ensures the sustainable viability of the project, and a critical step to minimize the impact on the fragile marine ecosystems in the QMZ.

The Gold Standard

As civilization marches on, the practice of utilizing once-marginal land and locations to support ever-burgeoning populations will continue at the same pace. Given this trend, establishing and following progressive and sustainable development procedures – to monitor the impact as it's taking place and making corrective adjustments accordingly before proceeding – should be the new paradigm for contractors and developers. Lusail City is being billed as the high-tech smart city of the future. It seems to be very appropriate, then, that Qatar is taking steps to make the construction and development of Lusail equally smart and sustainable. Qatar should be proud of their progressive monitoring and development practices for Lusail, as they exemplify a significant step in the right direction for this type of development on the world stage – perhaps even the gold standard by which all future construction and development projects should hope to emulate.

DRILLING INTO THE ABYSS

INGER GRAVES

A rapid increase in sea level is a real threat if the larger ice shelves in the Antarctic disintegrate due to heat transportation from ocean currents.

Following a disintegration of the ice shelves, the inland ice could move freely into the ocean causing an accelerated rise in sea level. Are the ice shelves heading for a quick disintegration? Or, are they actually growing, gaining and becoming more stable? The answers lie below the 700 meter thick ice cover of the Filchner-Ronne Ice Shelf.

Digging into the Science

In 2006, a series of icebergs struck New Zealand's coast for the first time in almost a century. The icebergs, stemming from the Filchner-Ronne Ice Shelf, calved off in March 2000 and had an initial size of 167 kilometers by 32 kilometers. In order to study this calving and ice-ocean interaction, scientists from around the world have taken several missions to focus on what is happening hundreds of meters below the ice shelves.

To get through the ice, scientists have spent decades refining a technique of water drilling, enabling them to make real-time observations from under the ice.

One of the scientists who ventured to the Antarctic most frequently is researcher Svein Østerhus at Uni Research Climate. Østerhus, who holds the world record for measuring the lowest ocean temperature in the world at -2.6°C, has been going to the Antarctic since 1985. Having taken 12 trips there, his colleagues in Bergen joke he's the only researcher with his own dedicated camp site in the Antarctic. During the winter months of 2016, he'll once again camp out to collect more data on the integrity of the ice shelf.

Østerhus' focus has been to document the development of the ice shelves and predict the coming changes via modeling. Due to the cost associated with scientific missions to the Antarctic, there is less data from these areas, which could lead to missing important trends predicting sea level rise. In order to conduct his research he must venture deep into the Antarctic region, which requires research vessels, airplanes on skis, and hot water drilling for extended periods of time.

Not an easy task for the faint of heart.

Antarctica base camp.
Photo: Mr. Keith Makinson

Photos:
Mr. Svein Østerhus

Hot Water Drilling

The hot water drilling is energy demanding and challenging, requiring many barrels of fuel to be transported onto the ice shelf. First, Østerhus' team must heat up massive amounts of water. To do this, snow is melted in massive tubs and then a special hose is used to slowly melt through the ice. The drilling operation requires a steady supply of hot water and it is critical to perform at the correct pace, or one can easily start drilling sideways. Typically the drilling speed of 1.5 meters per minute can be achieved during the drilling operations, and no more. The end result is a 30 centimeter diameter hole, 700 meters deep into the ice shelf.

Once the hole has been drilled, Østerhus and his team need to move fast. Scientific instrumentation measuring water quality is lowered quickly through the ice shelf and the hole is left to freeze. At this point, it's critical that the system deployed into the water below is working as expected. The team kisses each instrument goodbye before it goes into the deep, cold, dark waters. This is the last time this monitoring equipment sees the light of day. After deployment, the hot drilling water is used for other important purposes, such as giving the team a rare Antarctic hot bath on the ice. When data starts trickling in from the under-ice observatory and the scientists are relaxing in the tub, the project is officially a go.

A Kiss Goodbye

So what sort of equipment is used in these extreme conditions? Since the foundation of Aanderaa Instruments in the mid-sixties, there has been a close working relationship between the company and the internationally renowned academic institutions in the Bergen, Norway area says Østerhus.

Over the years Aanderaa has been engaged in instrumentation development, drawing on the experience from numerous projects in deep and challenging waters. The cooperation with academia has led to a company that has established itself internationally as an instrumentation provider and designer of complete, rugged water monitoring systems.

During the International Polar Year (IPY), Aanderaa and Østerhus developed a platform for long-term studies in polar areas. The result was the SmartSub, a product that can be used for observatories on the sea bottom both in shallow and deeper waters. "This is the only commercially available product that came out of the IPY program," Østerhus jokingly stated.

The system used in the ice shelf project is a small under-ice observatory based on the SeaGuard instrument from Aanderaa. This instrument features a 500 meter long sensor bus, where sensors can be connected to various nodes at varying distances from the SeaGuard hub. In the setup utilized in the Antarctic, nodes contain a current sensor, with conductivity, temperature, and oxygen sensors attached.

From the under-ice observatory, there is a real-time communication cable frozen into the ice. Up top, a data logger stores the data relayed from the under-ice instruments and is housed in a protective cage. The team then buries the enclosure under a pile of snow to keep it out of the most brutal storms, which are common in the area. When Østerhus and his colleagues leave the arctic site, only a small flag and a set of antennas remain as evidence of their adventure.

Data transmitted across the globe via Iridium satellite, and Østerhus is able to tap into the observatory under the ice in real-time from the comfort of his office in Bergen. “This is a huge benefit over previous installations,” says Østerhus. In the past, the data were a mystery as real-time access to the arctic was unavailable. Yearly missions were required to manually recover and replace the equipment and only then could scientists discover what was changing in the ocean underneath the ice. Today, Østerhus can view and download live data in an instant and look at processes under the ice as they happen.

Observations, so far, demonstrate that the melting of the Ronne Ice Shelf is currently decreasing; however modeling shows that we can expect an increase of warmer water to be transported under the ice shelves in the coming decades. If this is the case, the melting rates can again increase and, at the extreme, could cause ice shelves to disintegrate.

Looking to the Future

So what is next for this scientist from Bergen? Being able to watch climate changes real-time is one thing, but the next step is to develop an alarm system for the processes occurring under the ice. The worst case scenario is the ice shelves are shrinking to the point they can no longer hold the in-land ice. Better safe than sorry, Østerhus is eyeing a system that accurately predicts sea level rise as it happens. But it may be some time before this technology is ready, so he and his team are in the process of planning another trip to the Antarctic during the winter of 2016 to deploy additional monitoring instruments. And according to tradition, the event will be celebrated with a hot bath.

Photo: Mr. Keith Makinson

The challenging task of ice drilling to make way for these SeaGuard instruments.

Photo: Mr. Svein Østerhus

Reward for a job well done.
Photo: Mr. Svein Østerhus

EARTH FORCE

Developing skills, knowledge, and motivation to solve environmental issues.

KRISTEN MUELLER-SIMS

For over twenty years, **Earth Force** has worked to engage young people as active citizens who improve the environment and their communities, now and in the future. We want youth to develop the skills, knowledge, and motivation to become lifelong environmental citizens and ensure a healthy planet.

At the core of Earth Force's programming is our Community Action and Problem-Solving Process, a six-step instructional model that guides young people to investigate their local environments and work with their communities to solve problems.

Educators use the Process to support young people in environmental problem-solving, while also building positive youth development. Through our programming, youth engage authentically with their communities by working to solve real problems.

Water serves as a large focus of our work. Earth Force operates in many low-income communities that are disproportionately affected by environmental challenges. This means that it's even more important that we equip youth to make environmental change. Oftentimes, young people think problems like polluted streams and rivers are beyond their control. Our goal is to help them see that not only can they be part of the solution; they have the ability to lead the solution. We run three water-based programs throughout the U.S. and Canada: **GM Global Rivers Environmental Education Network** (GREEN), **Keep It Clean - Neighborhood Environmental Trios** (KIC-NET) and **Caring for Our Watersheds**.

Keeping it Clean with KIC-NIT. Photo: Earth Force

Let's dive into exactly how Earth Force develops skills, knowledge, and motivation in young people and why it matters for the future of our environment.

We believe in supporting youth in real-world learning so they develop and use civic skills like problem-solving, critical-thinking, teamwork, and communication. Students take the content they learn inside the classroom and put it into practice to investigate real issues in their community. The most important part being, youth address issues that matter to them, versus working on a project selected by their teacher. This approach is successful: 90% of students who participate in Earth Force improve their problem-solving, decision-making, and civic action skills.

Our programming also focuses on building students' STEM knowledge by creating opportunities to use science, technology, engineering, and mathematics to solve environmental issues. In each of our three programs, students use chemical and biological concepts as they utilize monitoring kits to collect and analyze water quality data. Students often draw on engineering when designing solutions like a rain garden, retention pond, or rain barrels. Through this multidisciplinary approach, we've seen an increase in students' understanding around how science plays a role in environmental action.

One example of this approach takes us to Reagan Middle School in Grand Prairie, Texas. Students were concerned about a beaver dam on school property that caused dangerous and costly flooding in their Outdoor Learning Center. Trapping and removing the beavers was not a guaranteed solution, as they might return. Rather than choosing a stopgap solution, the students partnered with several local organizations to build and install a more sustainable solution, the "beaver deceiver." This contraption allows water to safely escape while keeping the dam intact, preventing flooding over the long term while leaving beaver habitat relatively undisturbed.

Earth Force youth create change like this all over the country. And our hope is that they are invested in understanding their environment, developing the skills and motivations to take action, and helping those around them to understand how we all play a role in protecting our planet.

We know that if youth are given real-world opportunities to practice civic skills and acquire a practical understanding of STEM, they will utilize those abilities and motivation throughout their lifetime. Our programs result in a 78% increase in students' desire to actively work on environmental issues in the future. The unknown challenges that will confront us in the future will require the commitment and ingenuity of all of us, and it is critical that we are preparing youth to take on this role.

EARTHFORCE *on the Web*

earthforce.org

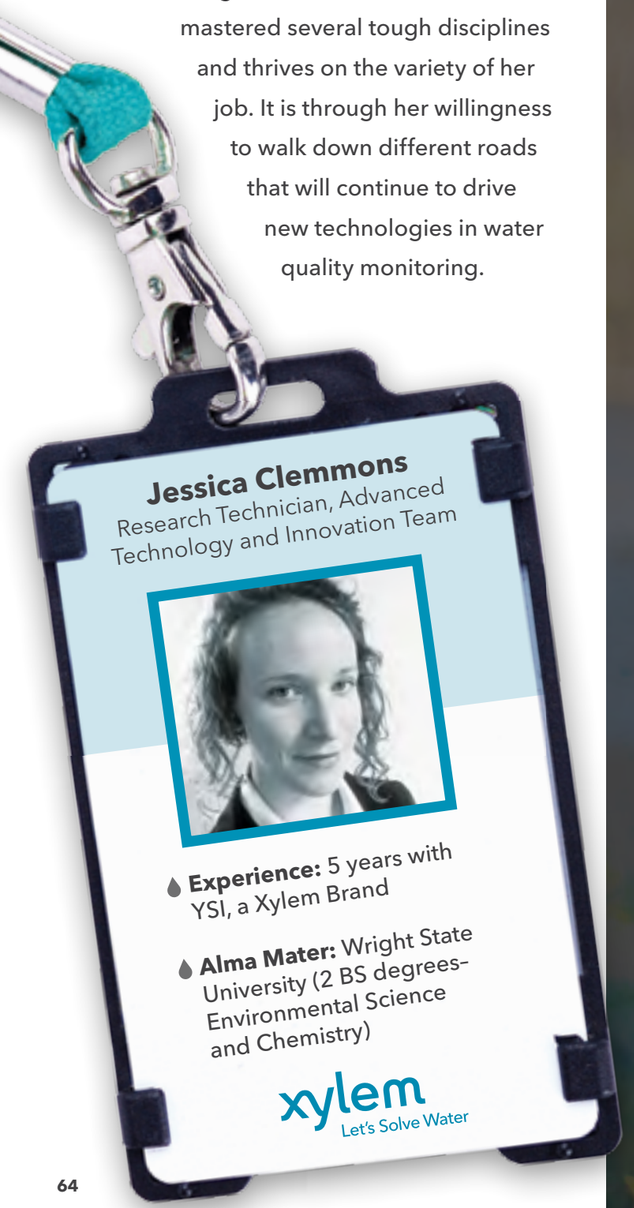
facebook.com/EarthForceGREEN

@earthforce

Young Environmental Stewards Photos: Earth Force

RENAISSANCE WOMAN

Jessica Clemmons is a modern-day renaissance woman who aspires for bigger things – interesting things – things that excite her. She has mastered several tough disciplines and thrives on the variety of her job. It is through her willingness to walk down different roads that will continue to drive new technologies in water quality monitoring.



Q: Tell us a little bit about your day-to-day job at Xylem Analytics.

A: I'm fortunate to have a career where every day is a different adventure. Last week I was at one of the biggest wastewater treatment plants I've ever seen, installing a network of sensors. This week I'll be out in the field taking grab samples for nutrient analysis, and next week I'm excited to be working side-by-side with scientists at one of my dream universities to push the limit of sensor technology. There's no routine, and I love it! My job changes from day to day, but the common thread is that I'm working with a team of brilliant researchers to shake up the status quo in water quality monitoring.

Q: What got you into this field?

A: When I think back, I always had an aptitude for math and science, so I naturally gravitated towards engineering as a focus in college. It didn't take long for me to realize that this wasn't a good fit. I have an insatiable curiosity, and I didn't want to confine myself behind a single subject.

People assumed I just couldn't settle on what I wanted to do with my life, but my gut told me that branching out into a wider number of subjects was right. All of my classes were starting to overlap and build on each other so beautifully; the environmental science puzzle became clear with chemistry, chemistry was expanded by the physics, and advanced mathematics was the foundation of it all. Without thinking all that much about it – I ended up building an interdisciplinary background perfectly aligned for developing sensors.

Q: Do you feel this is what you were meant to do?

A: Definitely! I recently met a professor at MIT who had created a "Renaissance Lab" where students are required to have mastery of at least 3 of 5 scientific fields (chemistry, biology, physics, etc.). When I heard this concept, I realized, "Wow! THAT is what I am doing! I'm a Renaissance woman!" *(laughter)* And that is exactly what I've been doing in my current role, and it keeps me motivated.

Q: What do you find most rewarding about your work?

A: There's a lot – mostly, this feeling when we hear about environmental issues on the news or in daily life and knowing that I'm playing an active role in solving these problems.

It feels good when our family and friends tell stories to their peers about our efforts here at Xylem. They can say, "My daughter, my friend is working on these issues," and that is really energizing to hear. And they can feel empowered to be a part of the solution too.

Q: Tell me a little bit about your involvement with Xylem's Watermark.

A: When I was studying environmental science, I wanted to spend more time in the field and I wanted to be more involved with community efforts. I knew that there was an incredible need for citizen scientists, but I had trouble finding volunteer opportunities. Sometimes grassroots organizations don't have the resources to get the word out about their events and it can be difficult to figure out how to get involved.

When I first heard about the new local focus of the Xylem Watermark Make Your Mark program, I knew I wanted to be a part of it. It was something outside of my daily work where I could be holistically dedicated to environmental issues. Having learned how difficult it can be to get involved on your own, I wanted to help connect people to these volunteer organizations and to help spread the word about their good work. I took the role of Watermark Ambassador for Analytics and now I help 'Champions' from Xylem offices get their colleagues involved in their local communities.

Q: What are some of your favorite things to come out of watermark?

A: Watermark volunteers all around the world have this renewed ownership of their company. It brings a lot more meaning and depth to the work they do for Xylem. Employees are proudly wearing volunteering t-shirts because they are proud of their own individual efforts and how they contribute to the bigger causes that help address water issues globally.

Q: What do you think the future holds for water quality around the globe?

A: It's hard to say what the future of water quality will be, we're just learning today about emerging contaminants and infrastructure problems we didn't know about yesterday. But what I can say is that I see an exciting trend towards growing environmental awareness.

People want to understand and want to protect their natural resources, and we're perfectly situated in the modern era to empower people with the tools and information to make better decisions; technology for scientists, students, and citizens who are passionate about water. I am so excited play an integral role in this momentum.

> **"...I'm working with a team of brilliant researchers to shake up the status quo in water quality monitoring."**

To speak with Jessica Clemmons about Xylem sensor development opportunities, email her at:
Jessica.Clemmons@Xyleminc.com

Great Miami River in New Baltimore, Ohio
Photo: Craig Moyer

Technical Tips

Thoughts from the front line of customer support.

TOM MOEGGENBERG
Technical Support Manager

Sapelo Island, Georgia.
Photo: Scott Kindleberger

Limitations with Measuring ORP

About ORP

ORP is measured to determine the oxidizing or reducing potential of a water sample. ORP can be a valuable measurement if the user knows a particular component within the sample that is primarily responsible for the observed reading. For example, excess chlorine in wastewater effluent will result in a large positive ORP value and the presence of hydrogen sulfide will result in a large negative ORP value.

Inconsistency with ORP Sensors

Although based on relatively simple theory, ORP is a measurement which can show more problems than other water quality sensors with regard to consistency between instruments and overall accuracy. These issues are dependent on both the condition of the sensor and the makeup of the water being tested.

The most common problem reported with regard to ORP determination in environmental water is the readings from various instruments differ by a significant margin even though the sensors are measuring the same sample.

In addition, all of the sensors may show identical readings in an ORP standard such as Zobell solution.

The exact explanation for this paradox is sometimes elusive, but there are a few possible reasons for its occurrence:

- ORP sensors can show a slow response in environmental water if the platinum button of the probe has been contaminated with extraneous material.

- There may be very few redox-active species present and those that are present may be in very low concentration.

The occurrence of multiple ORP sensors reading differently in environmental water yet the same in Zobell solution is due to the concentration of redox-active species being much greater in the standards.

In the absence of these species, ORP can be a significantly less exact measurement than many other sensors.

The inexactness is typically due to contamination of the electrode surface (either physically or chemically). Periodic maintenance of your YSI ORP sensors will increase your field consistency and accuracy, but may not overcome all problems.

The value of ORP in determining the content of environmental water is greatly enhanced if the user has some knowledge or history of the site. Historic data can be used to help determine the validity of the data or a proper functioning probe. But inconsistent data does not always indicate a bad or dirty probe. There could be environmental factors contributing to the unexpected data.

To learn more about ORP measurements, check out **bit.ly/ORPtips**

Xylem |'zīləm|

1) The tissue in plants that brings water upward from the roots;
2) a leading global water technology company.

We're a global team unified in a common purpose: creating advanced technology solutions to the world's water challenges. Developing new technologies that will improve the way water is used, conserved, and re-used in the future is central to our work. Our products and services move, treat, analyze, monitor and return water to the environment, in public utility, industrial, residential and commercial building services, and agricultural settings. With its October 2016 acquisition of Sensus, Xylem added smart metering, network technologies and advanced data analytics for water, gas and electric utilities to its portfolio of solutions. In more than 150 countries, we have strong, long-standing relationships with customers who know us for our powerful combination of leading product brands and applications expertise with a strong focus on developing comprehensive, sustainable solutions.

For more information on how Xylem can help you, go to www.xyleminc.com.

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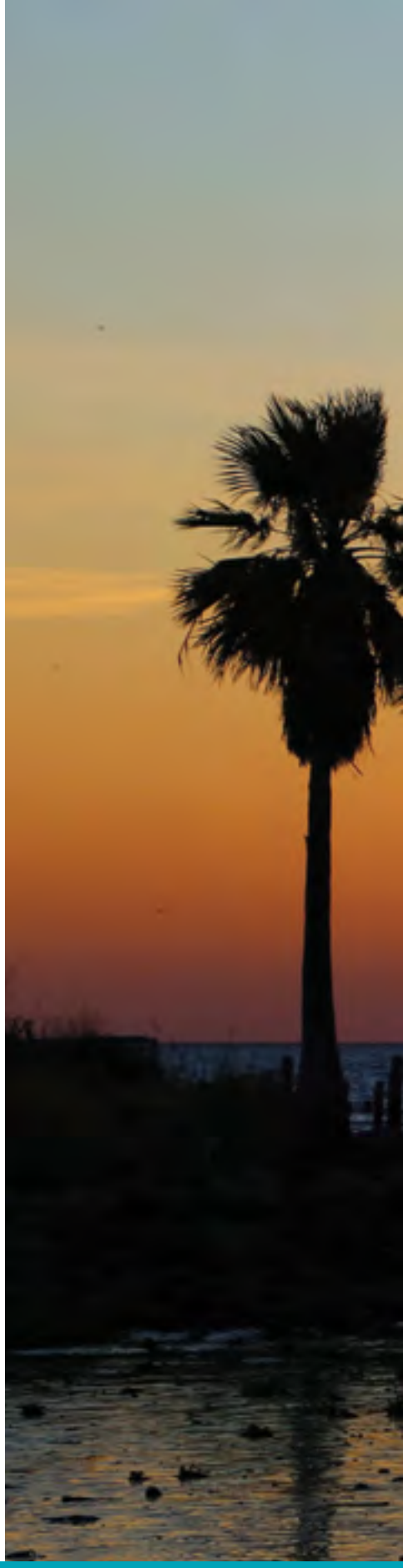

Who's Minding the Planet?®