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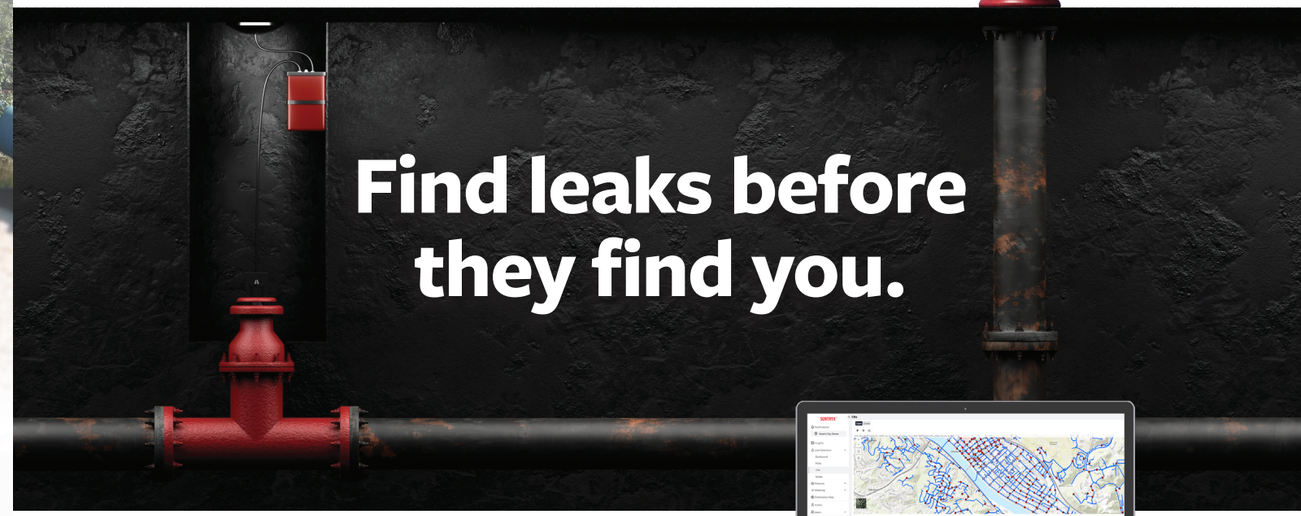

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FROM THE EDITOR
By Kevin Westerling
Chief Editor, editor@wateronline.com

Water Utilities vs. Climate Change:

A Q&A with Dr. Stephanie A. Smith

The U.N.'s Intergovernmental Panel on Climate Change (IPCC) is widely considered to be the world's foremost authority on what may be humankind's most existential threat, and this year The Working Group II of the IPCC released its Sixth Assessment Report on the state of the crisis. It reviewed not only the impacts of climate change throughout ecosystems and communities, but also the "capacities and limits of the natural world and human societies to adapt."

It is that ability to adapt — to understand what we in the water industry can do to effect change and protect our future — that drew me to a conversation with Dr. Stephanie A. Smith, an experienced manager, scientist, and entrepreneur whose professional training in microbiology and biochemistry has been the foundation for a career that has spanned academia, contract research, and industry. With the IPCC's report serving as the backdrop, Dr. Smith, who earned her doctorate in microbiology from The Ohio State University and currently serves as product segment manager for Laboratory Sciences at Xylem, speaks to the urgency of the situation, the points of impact to consider, the role of utilities, and why investing in sustainable infrastructure now is the key to ensuring a resilient and equitable supply of clean water for every household moving forward.

The IPCC recently came out with a summary for policymakers, *Climate Change 2022: Impacts, Adaptation and Vulnerability*.[1] What is the significance of the report?

There's a sense of urgency that makes this report so significant — a report, I would argue, that is the most inclusive and unbiased assessment of climate change that is obtainable today. Over 230 scientists from 65 countries reviewed over 14,000 scientific publications for this sixth assessment report (AR6, as it is called). They have concluded that not only have we run out of time to restore the climate to its pre-industrial-revolution state, but also the effects will be felt for centuries or millennia, even if all carbon emissions stopped today. The IPCC had actually concluded that in the prior report (AR5) in 2013, but the AR6 report shows some trends happening faster than predicted in 2013. This pace, if not slowed, will have catastrophic effects for a child you probably know today.

Yet, just as significant is the conclusion that if we take decisive action now, there is still time to prevent the existential threats that models predict.

Are utilities proactively addressing climate change in ways that the report endorses? Do you think the threat is being treated with adequate urgency?

First, what does the report endorse? The IPCC identifies "adaptation options" that include water use efficiency, water resource management, and sustainable management of urban water (which includes, for instance, stormwater management).

Utilities quite naturally strive for operational efficiencies that align with these adaptation options. For instance, some have rate structures that incentivize consumers to use less water at certain times of the day or year. This makes it easier for the utility to predict usage and manage the source with less waste and less energy expenditure. Less energy expenditure will further translate to a reduced carbon footprint.

However, you will rarely hear "climate change" cited directly as a motivation. Rather, these programs are a practical, financial, and political necessity. The targets set by utilities thus fall short of the targets required to reach sustainable development goals outlined in the IPCC report.

Utilities are directly or indirectly an extension of governments, and the climate threat is not met with sufficient urgency by the world's governments. Governments simply don't move fast enough. Thus, most utilities are not proactive on climate change adaptation — yet.

What steps need to be taken to understand risk and begin down the path to resiliency?

As illuminating as the IPCC report is, it can be difficult to distill its findings down to a program for an individual utility, because any such program must be rooted in local risks. So where does one begin?

Start with a trade organization and/or regional consortium where you can engage with industry professionals, citizen scientists, and consumers who have the collective power to gather data, assess risk, and educate. Every water professional should belong to one or more of these groups. This is the invaluable layer between policymakers and individual operators — it's where work gets done at the intersection of operations and policy.

Ask organizational leaders to provide more climate change programs. Better yet, become one of those leaders! Participate in generating data-based risk assessments that the entire community can use — most of our trade groups already have risk assessments you can start with.

The credibility of reports from a trade organization can give utilities the backing to approach both government sponsors and customers with recommendations that will conserve water resources and contribute to infrastructure resilience.

Funding is always a key component to infrastructure improvements. How would you counsel the utility or municipality that claims future proofing is too expensive?

First, it's a mistake to view climate change preparation as future proofing. Climate change impacts are already here — weather events, stormwater management, combined sewer overflows (CSOs), dangerously depleted reservoirs, and increased risks of contamination. It's a lot easier to seek funding to solve a problem you have now, rather than a problem in the future, even if that future is highly certain.

Thus, frame climate-related proposals by looking backward, instead of trying to convince sponsors that a problem is looming but not quite here yet. Clarify that these are no longer isolated events, but likely the "new normal." How much are CSOs costing not just your utility but your city, in the most recent events? What would be the return on investment on an upgrade in some component of the system, when weighed against those costs? Look not only at financial, but also human — and therefore political — impacts.

Is it only certain areas at risk — e.g., water scarcity in the U.S. West — or do climate impacts run broader and deeper? Please explain.

One of the challenges of the climate impact message is that most people associate it with big events, like wildfires in the West, hurricanes in the Southeastern U.S., and "superstorms" in the Northeast.

But we are *all* experiencing climate-related effects, and there is a direct link between climate change and some of the most insidious problems faced by water resource and utility managers, such as:

- Harmful algal blooms.
- Erosion and sedimentation.
- Stormwater (and all the problems it brings, like CSOs).

This short list of interrelated issues brings with it a whole host of additional issues. Erosion and sedimentation, for example, facilitate the introduction and transport of contaminants like coliform bacteria and heavy metals from industrial pollution.

Such impacts disproportionately affect the most vulnerable and underrepresented populations. One needs to look no further than the dangerous lead and bacterial exposures of Black families in Flint, MI, from 2014-15 as evidence of what is sometimes termed "environmental injustice."

Thus, in addition to engaging with trade organizations, water resource managers need to understand their communities at home and make sure that the entire population they serve will be considered when decisions are made.

How can cities and utilities plan for climate change without knowing exactly how their region will be affected?

One doesn't need to be very exact. A manager likely already has clues as to how their service will be affected. That's because, as mentioned above, climate change is a now problem, not a future problem.

I would advise utilities look at their top three challenges today, and simply evaluate if those problems are likely to get bigger, smaller, or stay the same as climate change marches on. Did you have a threatening storm event in the last 10 years? Do you think that is more likely or less likely to happen, based on climate models? How will that affect your operation and stakeholders if it happens every five years?

How does climate change impact "upstream" facilities and services you depend upon? This is an often-overlooked part of planning. COVID-19 has given us a bit of primer on this. I don't think any of us foresaw the effects of a compromised supply chain, for instance. Those logistical networks are an example of something

that likely will be affected by climate change, too. How will this affect you and your customers?

What is needed to get to the root of the problem?

It cannot be said enough: we must reduce carbon emissions. Please identify every opportunity your utility has to do so. The good news is that virtually every municipality has built-in financial incentives to reduce energy consumption and fix leaks, which are one of the biggest contributors to waste. Less waste will translate into less energy use, which reduces emissions.

A lot of the technology we need is already available. Wind, solar, and other alternative energies are becoming more affordable, and many utilities are using hybrid or electric vehicles. But there is always more that can be done on the technology front, and utility and academic collaborators must not only drive the next generation of solutions, but also figure out how to make solutions affordable and widely accessible.

Regarding regulations, we of course need climate-aware policies and incentives, and it's likely we'll see more unpopular actions like increased rates for water usage. However, I part ways a bit with many other professionals who are promoting new regulations to address climate change.

That's because a lot of the regulations we need are already in place. The real challenge is threefold: lack of enforcement, carte blanche exemptions for powerful companies and industries, and the ever-increasing demand for resources due to massive population growth. Why have more regulations if you can't put any teeth behind them, or even assure that they are consistently applied?

Are there any examples you can point to of who is getting it right?

There is collective action being taken by water professionals in some regions, and I think the entire world will benefit from what is learned and invented in those cases. My favorite example is the "Net Zero Routemap"[2] produced by Water UK. They have laid out a comprehensive, aggressive plan for reaching net-zero carbon emissions by 2030, 20 years ahead of the commitment of the governments of the U.K. The published report is a primer for the types of actions that can be taken. I encourage all water professionals to take a look at it.

The One Water initiative of the US Water Alliance has a Net Zero Plus[3] report that sets targets for 2050, so it is not as aggressive as Water UK's approach. In spite of this, something the US Water Alliance is doing very well is promotion of equitable policies and practices, which is a cornerstone of their approach. Their Imagination Challenge is a great program to get the generation that will deal with the consequences involved in finding technology solutions for climate change. The Imagination Challenge is also an opportunity for water utilities to collaborate and participate!

Finally, I commend some specific regions like Southern California, where water restrictions are being enforced in the face of water scarcity. While such programs and their implementation surely have room for improvement, what I admire is the boldness of the action itself, in the face of enormous political backlash. How these programs play out in cities like San Diego is something that all utilities need to pay attention to. ■

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WHAT ROLE CAN DECENTRALIZED WATER REUSE PLAY IN TACKLING WATER SCARCITY?

Onsite and localized reuse expand the practice overall, which will be essential for long-term security.

By Christian Bonawandt

On June 1, the White House released two reports addressing water scarcity in the U.S. and abroad. The first of these, the Drought Resilience Interagency Working Group's (IWG) Summary Report,[1] outlined a working plan and budget for various federal agencies to allocate resources to drought-stricken areas of the country and reduce both the health and economic impacts of water scarcity. The second, the White House Action Plan on Global Water Security,[2] takes a more high-level approach, identifying policy direction and methods that support the development of relevant government and non-governmental organization (NGO) strategies.

> **Decentralized water reuse can play a key role in reducing communities' dependence on source water.**

Both reports mention water reuse and recycling as core tools for tackling scarcity. In support of the effort, the U.S. Department of the Interior, which is part of the IWG, has earmarked $1 billion in grants specifically for water reuse projects for Fiscal Year 2022.[3]

Some cities have already built reuse into their water infrastructure, with more slated to vastly expand reuse over the next decade. The City of San Diego, for example, recently broke ground on the $950-million East County Advanced Water Purification Program — just one of three planned reuse facilities[4] to support local water security. However, such large-scale reuse projects, and the accompanying price tags, can be out of reach for many municipalities.

Given this, decentralized water reuse can play a key role in reducing communities' dependence on source water. The value of decentralized wastewater treatment has been well established and includes:

- ***Lower upfront investment.*** As the site needs only to serve key parts of the community, not the full population, decentralized projects are smaller and more affordable to build than a full reuse facility.
- ***Reduced strain on older/existing infrastructure.*** Some decentralized facilities can redirect flows away from existing pipelines, particularly those that are older and more prone to fail under duress.
- ***Access to different technologies.*** Depending on the gallons per day (GPD), the site may be able to utilize technologies, such as reverse osmosis (RO), that are more effective at lower flow rates than those commonly experienced in larger facilities.

Private Sector Inspiration

Several successful decentralized water reuse projects have been executed in the U.S. over the past few years. Many of these projects are ideal case studies in environmental leadership and innovation.

Salesforce Tower. Completed just last year, after numerous COVID-induced delays, Salesforce Tower is not only the tallest skyscraper in San Francisco, but it is also home to an ambitious private water reuse project. Salesforce Tower is a blackwater system, meaning it reuses all of the building's wastewater, including from the toilets. The treatment process involves aerobic screening, biological treatment, UV and chlorine disinfection, and total dissolved solids (TDS) and nutrient removal. The recycled water is used throughout the building, including in toilets, sinks, and cooling towers. Only fresh potable water is pumped in. Overall, 75% of its total water is reused, saving 30,000 GPD, or 7.8 million gallons per year.

Salesforce Tower's blackwater system is part of a nationwide recycling trend.

Emory University. Just outside Atlanta, Emory University has offset 40% of its water consumption (146 million gallons annually) with a reuse system it calls the WaterHub, which relies heavily on natural biological processes. Wastewater flows through a series of flora-based bioreactors. This artificial wetland allows specially selected plant life to consume and break down biological waste and other contaminants. Water is then pumped to small greenhouse-like housing units where it is treated with a combination of UV sterilization and chlorine disinfectant. The recycled water is used in steam and chiller plants, which heat and cool more than 70 buildings, as well as for flushing toilets in residence halls.

Smithsonian Environmental Research Center (SERC). Research facilities like SERC are large consumers of both energy and water. SERC reuses 20,000 GPD of graywater (wastewater sans toilet flushes), employing a sequencing batch reactor (SBR) and microfilter (MF) followed by UV and chlorine disinfection. Water that is used in laboratory experiments is further filtered through an RO system for ultrapure water. The rest is used for firefighting, toilet-flushing, and filling stormwater ponds.

The clear pattern is that many of the biggest innovations in water reuse are occurring in the private sector. Municipalities will need to tap into this trend by finding ways to mandate or encourage commercial industry and NGOs to invest in onsite, decentralized water reclamation.

Water treatment plants (WTPs) and wastewater treatment plants (WWTPs) can aid in this process by making their own expertise available whenever possible to help private entities learn more about the technologies and best practices in water treatment, as well as how best to construct facilities that reduce the strain on existing infrastructure. After all, we are all part of the same water cycle in one way or another, so it's in everyone's best interest to ensure that decentralized water reuse projects continue to expand and succeed. ■

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Christian Bonawandt is an industrial content writer for Water Online. He has been writing about B2B technology and industrial processes for 22 years.

Using **Biotechnology** To Restore Productivity Of Anaerobic Digesters

When the production line of anaerobic digestion is slowed, efficiency is lost, and the reverse is true when holdups are cleared.

By Dave Shackleton

The Problem

In wastewater treatment, it is anaerobic digestion that treats the majority of the organic load in the form of sludge that is removed in primary settlement tanks or as waste activated sludge from aerobic treatment tanks.

Anaerobic digestion breaks down long-chain biochemical polymers (proteins, lipids, carbohydrates, etc.). This is done by enzymes (produced by bacteria) that break specific chemical bonds in a sequential "production line" manner.

The first step in the production line is hydrolysis, and this breaks up:

- Carbohydrates into sugars
- Proteins into amino acids
- Lipids into fatty acids

(Note that acids are produced, which will lower pH below neutral 7.)

The next step in the process is acidogenesis (the generation of more acids), as the sugars, amino acids, and fatty acids are broken down to produce substances such as acetic acid.

The final step is methanogenesis, or methane (biogas) production. The problem is that the microbes responsible for methanogenesis are very sensitive to pH and require a pH between 6.5 and 8.0 to function.

So when acidogenesis causes pH to drop below 6.5, this inhibits the methanogenesis process. This means that the process can become self-limiting over time if the pH of the digester remains low. The production line is blocked, and we say that the digester has "gone sour."

When undigested sludge accumulates near the surface and gas bubbles are generated from below, they are trapped in this surface sludge. The effect is much like the rising of bread, where gas produced by yeast creates cavities in the dough. The sludge expands and dries out as these bubbles become entrapped. Over time, digesters can become blocked with solid sludge "crusts" that are several feet thick.

The net effect is that the volume of solids that must be treated and disposed of increases along with the costs of doing so.

The Solution

If we study the biochemical processes at play a little more closely, each step along the production line is driven by enzymes that are produced by bacteria. When pH rises and the bacteria responsible for producing the enzymes for the next step of the process are inhibited and die off, a backup is created and the whole of the rest of the production line is affected.

Adding more bacteria or microbes into such an environment is ineffective because they soon succumb to the hostile environment. However, adding the enzymes that the bacteria produce allows the process to be driven forward, and efficient digestion to be restored.

Key Parameters

The key parameters that illustrate this problem are:

- pH, which should be above 6.5
- Total fats, oils, and grease
- Volatile fatty acids
- Total alkalinity
- Volatile fatty acids to alkalinity ratio, which should be maintained between 0.5 and 0.15.

Proof Of Performance

Two anaerobic digesters had become completely dysfunctional. The digesters themselves had a solid layer of sludge 5 feet thick, and sludge management processes were unable to cope with the volume of solids, while the costs of trying to do so were unaffordable.

Laboratory analysis of samples taken from the digesters showed how bad the situation was.

	BEFORE	TARGET
pH	5.96	6.5 – 8.0
Total Fats, Oils & Grease	226 ppm	
Volatile Fatty Acids (VFA)	1,100 mg/L	
Total Alkalinity	1,700 mg/L	
VFA / Alkalinity Ratio	0.62	0.05 - 0.15

Biotechnology allows us to tackle the problem at the biochemical level directly by dosing the enzymes that are in short supply due to the inhibition of the microbes responsible for producing them, a result of low pH causing an acidic environment. These enzymes clear the holdup in the "production line" and restore functionality.

Enzymes were dosed into the digesters and circulation pumps were run for a few hours daily. The improvements achieved within seven days are shown below.

	BEFORE	TARGET	AFTER 7 DAYS	% IMPROVEMENT
pH	5.96	6.5 – 8.0	6.86	
Total Fats, Oils & Grease	226 ppm		9 ppm	96%
Volatile Fatty Acids (VFA)	1,100 mg/L		64 mg/L	94%
Total Alkalinity	1,700 mg/L		1,400 mg/L	18%
VFA / Alkalinity Ratio	0.62	0.05 – 0.15	0.05	92%

With full functionality and performance restored to the anaerobic digesters, the amount of residual sludge and solids was reduced by over 80%, making management of this easier and cheaper.

Applications

Dysfunctional anaerobic digestion is not only a problem in municipal wastewater treatment. Livestock operations make extensive use of lagoon systems for manure treatment, and these suffer from the same problems.

An anaerobic lagoon at a pig farm that has an extensive solid sludge layer on the top.

Enzyme treatment cleared this.

In one case, a bottom-based system to intermittently stir and mix the lagoon, together with enzyme treatment, ensured that not only was the performance of the lagoon optimized, but also that the accumulated sludge sediment that had reduced the effective volume of the lagoon by about 50% was digested and full volume restored. ■

About The Author

Dave Shackleton (daves@sis.bio) is the cofounder and CEO of SIS.BIO (www.sis.bio), a provider of biotechnology solutions to support the renewal of our world's water systems. For the last 10 years, Dave has worked with water resource managers and wastewater systems operators across four continents to help restore compromised waterways and wastewater systems. SIS.BIO's multidisciplinary approach prioritizes nature and eliminates the need for chemicals.

Mitigating Water Risk In A Passive Investment Strategy

Investors who consider water risk and how companies manage it can do well for themselves while promoting environmentally responsible business operations.

By Markus Barth

Climate has by far been the most prominent theme in environmental, social, and governance (ESG) investing over the past five years, with numerous exchange-traded funds (ETFs) tracking rules-based, low-carbon indices totaling hundreds of billions in assets. However, virtually 100% of these are focused on low carbon emissions. While no one will argue about the fact that CO2 emissions are bad for the planet, little information has been put forth about the impact of high carbon emissions on the future earnings of the worst emitters. And low carbon emissions investment strategies typically exclude entire sectors such as energy and utilities, while being heavily weighted in technology and healthcare. This has proven to be a good bet over the past five years because tech and healthcare have massively outperformed energy and utilities. This has also led many to conclude that low carbon has generated alpha, but this author believes that the sector bets were the source of return.

Over the past few months, as tech has corrected and energy prices soared, we've observed significant low carbon strategy underperformance. We question whether adding low carbon to a balanced portfolio has been more of a box-ticking exercise and a bet on technology than an environmentally based return-enhancing strategy. Investors seeking out environmentally friendly investments may be questioning their decisions now. Instead of targeting climate investing by making large bets entailing significant risks, we believe there is an alternative that still provides material environmental impact without bearing most of the inherent risk.

The Other Side Of Climate Is Water

According to the World Economic Forum, water is linked to nine out of the 10 worst global risks. However, it is not widely known that nearly all sectors rely on water to varying degrees. Beverages, industrials, textiles, mining, and semiconductors (to name a few) all require vast amounts of water as a critical input to their production processes. For example, it takes over 7,000 liters of water to manufacture a single pair of blue jeans. Consider the stark contrast between carbon and water usage today. A company that spews carbon into the atmosphere can still manufacture products, produce revenue, and grow earnings, which implies that high carbon emissions do not directly or materially impact corporate profitability. While planned European Union emissions trading scheme (ETS) reforms may have an impact on costs incurred by companies in the future, their materiality is unknown at this point — and there is still the U.S. and the rest of the world to contend with. If a Coca-Cola plant can't get water, the firm must close the plant or, at the very least, pay a much higher price to transport the water to the plant from another location. Either way, Coke's earnings would be negatively impacted.

The 2030 water targets outlined by the U.N. requiring US$670 billion of annual outlay will most likely not be met without stronger new actions. Why aren't investor portfolios focused more on water risk when considering climate investments?

Existing Water Indices

There have been water indices in the market since 2007, and investment in these indices is nearly US$40 billion as of year-end 2021. But these indices do not address water risk. They typically contain a concentrated basket of 30 to 50 companies that are either water utilities or manufacturers of water purification equipment. These indices are a pure play on water remediation and have no bearing on mitigating water risk across the broader markets. In addition, these indices have mostly underperformed their equity market benchmarks over recent years, and investors may be averse to further investment in the water theme as a result.

Global water scarcity is well documented and creates significant financial risk to investors who fail to account for water risk in their portfolio. According to the collateralized debt position (CDP), the potential financial impact of water risk to corporate earnings is more than US$301 billion, while mitigating those risks is estimated to cost one-fifth of that amount. Clearly, water risk has a meaningful and direct impact on future corporate earnings and investors who fail to incorporate water risk reduction into their portfolios may experience significant underperformance in the future.

According to a DWS report published in November 2020, equities provide the greatest progress in managing water risk, but most investors look to engagement to mitigate future risk. The report concluded that targeting risk control by reducing exposure to stocks with higher water risk was the best of both worlds, facilitating engagement while reducing portfolio "water footprint" and offering sustainable returns.

Defining Water Risk

Changing climate, which is substantially manifested through water scarcity, portends unprecedented disruption in supply chains, which poses threats to production and distribution channels. Water risk is environmental. It impacts future earnings, it is ubiquitous across all sectors, and it is wholly unaccounted for in market benchmarks. The drivers of water risk include climate change/climatic events, failing infrastructure, pollution, weak regulations, and poor company water stewardship. These risks lead to financial risks that are operational, reputational, and regulatory in nature, which can lead to earnings shortfalls, litigation, and penalties. The scarcity of water will directly impact the earnings of companies, which will translate into lower share prices for those companies that fail to manage water properly.

Clearly, water risk has a meaningful and direct impact on future corporate earnings, and investors who fail to incorporate water risk reduction into their portfolios may experience significant underperformance in the future.

There Are Two Key Aspects Of Water Risk

Water Utilization. *How well has a company utilized water?*
These metrics can be measured by total water withdrawal, freshwater withdrawal, water discharged, water pollution, and water recycled. These measure a company's water footprint and reflect where they are in terms of water utilization.

Water Stewardship. *Is the company doing anything to mitigate future water risk?*
Stewardship is a more forward-looking measure of water risk, and it focuses on the existence (or lack) of corporate water policies. For example:

1. Is there a water policy?
2. Does the company target water conservation?
3. Does the company use technology to mitigate water risk?

A likely reason for the lack of passive investment strategies focused on water security may be the difficulty in measuring water risk. Water data are not as readily available as CO2 emissions and the distribution of water usage across different industries is massive. As we know at Anatase, considerable research and analysis are required to develop a means to systematically stratify water risk at the company level. By applying certain statistical techniques, water risk can now be quantified, which enables a company-level ranking system across the broader capital markets.

Mitigating Water Risk In A Passive Strategy

Stratifying water risk results in a ranking system that enables portfolio constituent weights to be adjusted to reflect the degree of water risk. This effectively reduces portfolio water risk as companies with low risk are overweighted while companies with higher risk are underweighted.

Much the same way that CO2 emissions can measure the carbon footprint of a company and, by extension, the weighted carbon footprint of a portfolio, so too can the water footprint be calculated using a similar approach. As we explained, water utilization informs the water footprint, which enables such a footprint to be calculated at the company and portfolio level.

By using the water risk metrics described above, it is a relatively simple and transparent operation to reweight a broad universe of companies across all sectors, resulting in an average 50% lower water footprint than traditional market benchmarks (S&P 500, MSCI World, EuroSTOXX 50). This approach can significantly mitigate water risk without sacrificing diversification across sectors, countries, and regions. Investors can now hedge the future negative earnings impact from high water risk without making large bets and accepting unintended and undesirable risks.

While our water risk methodology does not specifically target a lower carbon footprint, we were not surprised to see that a water security index has an average 35% lower carbon footprint than the traditional benchmarks. It makes sense that a company that is mindful of its water risk also pays attention to its carbon emissions. While it may not be theoretically proven that low water risk results in lower carbon emissions, the evidence suggests that the two are at least somewhat correlated.

Reasons For Optimism: Water Security Indexes

Reweighting a free float market capitalization universe by adjusting for the degree of water risk results in a portfolio that has a 99.5% correlation to traditional benchmarks. While there are some modest over/under weights relative to sectors and countries, all of these are well within acceptable boundaries. This relatively close tracking to market exposures greatly reduces the risk of deviating too far from market performance while still resulting in a significantly lower water footprint and carbon footprint.

There is no doubt in my mind that the market has not been pricing water risk in securities to date. Benchmark indices have completely ignored water risk, and without a benchmark that hedges against water risk, there has been little interest in passive investment products linked to such a strategy. This is beginning to change, with the launch of the Thomas Schumann Water Security Indices, which the author helped to design, and which have outperformed their market benchmarks by approximately 2% per annum between October 2015 and December 2021 while having a much lower water footprint, similar volatility and dividend yield, and very high correlation to market benchmarks. At the financial indexing level, we would like to see greater interest in incorporating water risk in benchmarks and look to the future with optimism.

As sure as we are that water risk has not been priced in the market up until now, we are equally certain that water risk will materialize in security prices in the future. Each day, more information is reported on the impact of water shortages on manufacturing and production, and it is only a matter of time before corporate earnings more widely reflect the impact of those shortages. (We know that earnings disappointments lead to downward pressure on stock prices.) Therefore, in the future, it seems intuitive that those companies with lower water risk should significantly outperform those with higher risk. ■

About The Author

Markus Barth, CFA, is a seasoned investment professional and an index pioneer. Barth has designed, developed, and launched hundreds of highly successful proprietary indices throughout his 35-plus-year career in the financial services industry. In June 2019, he founded Anatase Ltd as an independent consulting firm in order to provide his extensive expertise in index development, ESG, structured products, and investment solutions globally. Prior to founding Anatase, Barth was global head of systematic indices at Deutsche Bank and DWS from 2002-2019 and global head of international quantitative research at Merrill Lynch.

ENERGY SAVING IN WATER SYSTEMS:

The Key To Cutting Costs And Achieving Net Zero

When seeking energy reduction and efficiency, start with your power-hungry pumps and the motors that drive them.

By Surendra Muppana

Many of us are lucky enough to be able to turn on a tap and have clean water start flowing. Behind this, and all sorts of other domestic, business, and industrial applications that enable our modern world, utilities must move and process incredible volumes of water.

Moving this much water is extremely energy-intensive. Experts estimate that around 4% of total global energy production goes toward water and wastewater processing. That's approximately equivalent to the total energy use of Australia.[1]

As the global population grows and the trend toward urbanization continues, demands on water and wastewater systems will also grow. This includes subsegments, such as water and wastewater treatment, desalination, and irrigation, all of which require significant amounts of energy.

Fortunately, even seemingly small-percentage efficiency improvements in these vital industries can add up to huge energy savings on a global scale.

Why Are Utilities Seeking Greater Efficiency?

The current approach is not scalable or sustainable in the long term. Meeting demand relies on making water and wastewater infrastructure more energy-efficient. This is in line with the society-wide push for sustainability. Legislation such as the EU's Green Deal, for example, sets minimum efficiency standards for multiple industries, including the water industry. Achieving net zero will require a combined effort from all industries, and efforts to increase efficiency are a valuable contribution.

Industrywide adoption of modern, high-efficiency technologies will enable the industry to meet its sustainability commitments and equip it to serve a growing population. Energy accounts for an average of 45% of the total cost of providing water, so utilities that adopt more efficient technologies will be able to maintain profitability.[2]

Here are some actionable steps that utilities can take to make operations more efficient.

Switch To High-Efficiency Motors

Centrifugal pumps, the heart of most operations in the water segment, are driven by electric motors. These motors are responsible for over 90% of electricity use in water facilities.

Often, utilities run motors to the end of their working life. This means that older, less efficient units, such as IE1 and IE2 efficiency class motors, can be kept in place for decades.[3] In the time since they were installed, technology has advanced and motors have become more efficient. Each new IE class motor reduces losses significantly over its predecessor — an IE4 motor, for example, has 20% lower losses than an IE3 motor.

Many utilities are already using ultra-premium IE5 synchronous reluctance motors (SynRMs), wherever feasible, in order to enhance their operations efficiency. Further, the return on investment on such advanced solutions is typically achieved within two years.

Adopt Variable Speed Drives

In many cases, the motors that drive centrifugal pumps and other key equipment do not need to run continually at maximum speed as the demand for water varies during a 24-hour period. Peak use occurs during daytime hours, while demand is lower at night.

To reduce the flow of water, mechanical methods such as valves and throttles are often used. This is similar to a driver applying the brakes in a vehicle to regulate speed while keeping the other foot on the accelerator.

An efficient and well-proven alternative is to use a variable speed drive (VSD) that regulates the speed and torque of the motor — and thus, the pump output — that equals the flow of water. This flow control with VSDs would reduce considerable energy consumption, as the power consumed by the centrifugal pumps is proportional to the cube of its speed. Moreover, improved flow control with VSDs would ensure the pump operates at its best efficiency point (BEP).

Water pumps at the Saneago site.

Modern VSDs also include flow-measurement and energy-monitoring functions, enabling facilities to develop a clearer understanding of energy use. Reduced energy use can be calculated in terms of kilowatt-hours, as well as in CO2 emissions eliminated and money saved.

These energy savings are so substantial that the return on investment on VSDs is typically paid off within one to two years. In addition, by ensuring the soft starting and stopping of the system, VSDs help minimize mechanical and electrical stresses and, in turn, extend the life of motors and pumps and improve the plant's overall productivity.

Increasing Efficiency The World Over

These energy-efficiency benefits have been demonstrated worldwide. In the Brazilian state of Goiás, the utility Saneago provides drinking water to over 5.7 million people. The company hired a consultant and identified that electricity was consistently one of the company's top expenditures, and that most of it was going toward powering pumps. To save costs, Saneago set out to replace these motors.

Saneago worked with ABB to install high-efficiency motors and drives throughout its facilities. The changes reduced the utility's electricity consumption by 25%.

The new water and wastewater drives have intelligent multi-pump functionality. This means that they can control multiple pumps simultaneously to meet flow and pressure requirements based on real-time data from sensors. They also installed remote condition monitoring tools at four inlet water pumping stations.

Osmar Qualhato Júnior, Saneago's energy management supervisor, said that by "being a pioneer in utilizing this type of technology in Latin America, we have moved Saneago into the era of digitalization … this has saved us much time, money, and trouble."

Across the Atlantic in North Rhine-Westphalia, Germany, the Bocholt sewage treatment plant was also looking to cut energy use. It used six pumps at a pumping station, but analysis determined that they could be made more efficient.

The wastewater facility made significant changes to the impeller geometry, which improved both the electrical and mechanical efficiency. As a result, the demand could be met with just four out of six pumps. In addition to reducing the number of motors, the Bocholt facility decided to use high-efficiency SynRMs, which must be paired with VSDs, to further reduce energy usage.

The system can now automatically adjust return sludge flow based on hydraulic load. Any time that the pumps are not operating at full capacity, the facility is using less electricity and saving money. Thanks to this modernization, the Bocholt sewage treatment plant has cut energy consumption by 40%.

Efficiency Makes Business And Environmental Sense

Energy-intensive processes are required throughout water and wastewater facilities. Optimizing these systems for improved energy efficiency saves money and reduces emissions.

An impactful change that facilities can make is adopting modern high-efficiency motors with VSDs. This alone cuts energy use up to 25% or more, taking a major chunk out of a facility's operating expenditures. The resulting energy savings quickly exceed the cost of the improvements, leaving the facility with lower energy costs and bringing the industry closer to net zero. ■

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3. In Europe, China, and several other countries, motor efficiency is measured by European IE (International Efficiency) class. A higher IE rating means that a motor is more efficient, and each increase in number (such as from IE3 to IE4) represents a 20% decrease in losses.

About The Author

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Top 5 Reasons To Consider An Active Water Tank Mixer

Active tank mixing increases tank longevity and improves water quality.

By Lucy Allen

Municipal water tanks and reservoirs are valuable assets for healthy, thriving communities. They represent a sizable capital investment and are a critical component to the quality of your potable water supply. Ensuring clean drinking water is important to the overall health and safety of your community. Here are the top five reasons to consider an active water tank mixer.

1. Safe Drinking Water Maintained

In order to maintain water quality, water in a storage tank must be moving. Static water conditions in a water tank can cause issues in all seasons. In winter, static water freezes, damaging the tank and its coating. During summer, temperature and chemical stratification can impact both the tank and water quality. These issues can lead to increased water age and reduced chlorine residuals, which can cause an increased risk of biofilm and increased production of disinfection byproducts.

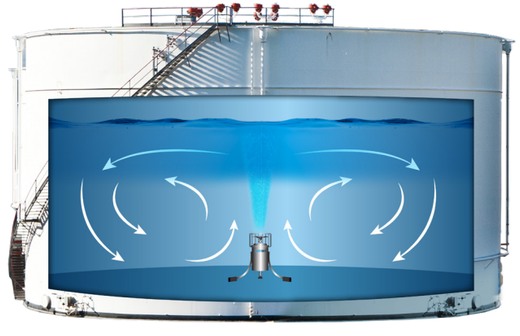
A mixing system is an operator's best tool to help maintain water quality. By adding a mixing system to your water tank, you can help ensure your water tank's integrity by reducing interior headspace temperature and reducing steel corrosion, as well as maintain overall water quality.

2. Avert Water Tank Quality Issues

There are many tank mixing systems, but the two most common are active and passive. Determining the appropriate mixing system for your water tank is the first step, and an active tank mixing system should be your primary consideration.

Active mixing systems keep water circulating inside the tank continuously 24 hours a day, 365 days of the year, regardless of water volume in the tank. They're smaller and more sustainable than passive mixers, as they provide operators with more mixing power, independent of drain and fill cycles. They're also less expensive, easier, and faster to install and can be easily removed for tank inspections and ongoing maintenance.

Seasonally, active tank mixers deter some of the most critical water tank issues, including ice formation and stratification. Through continuous mixing, ice is unable to form, and stratification can never develop. This significantly reduces physical damage from ice formation and minimizes the potential for biofilm growth and disinfection byproducts. The result is homogeneous water quality throughout the tank, reducing water age and increasing water quality.



It's critical to ensure you have the proper tank mixing system in place to meet the unique needs of the distribution system you are managing while keeping ease of installation and serviceability in mind.

3. Ease Of Installation

Tanks and reservoirs come in many styles, shapes, and sizes. It's critical to ensure you have the proper tank mixing system in place to meet the unique needs of the distribution system you are managing while keeping ease of installation and serviceability in mind.

Active mixing system selection should offer various mounting options to meet the unique tank or reservoir application. Regardless of the size and placement, active mixing systems should be easy to install in new or existing tanks, without using cranes or draining the tanks. Additionally, they should be easily removable for tank inspection and maintenance.

When determining the size and placement of your active tank mixer, you'll also want to carefully review the warranty and the NSF rating.[1] Both are critical components to ensure your mixing system provides years of service and the electrical and material quality to maintain the system integrity.

4. Effective Water Blend Cycle

Once your active tank mixing system has been installed and is continuously mixing your water supply, it's a best practice to ensure that your tank is mixing effectively, because consistency equals quality.

One method of ensuring effectiveness of your active mixing system is to look at the blend cycle. The blend cycle is the time it takes to mix the water to a homogeneous temperature during tank cycling. For instance, during daily operations, if it takes two hours to refill the tank, then the active mixer needs to be able to reblend the new water with that already in the tank in two hours.

You can also visibly see whether your tank is actively being mixed by looking at the exterior of your tank. In the summer months, examine at your water tank. Do you see a sweat line? Is there mold growing on the tank in that area? If so, it's indicating that the water below is colder than the water above the thermocline (sweat line). Other ways to test whether your tank is being mixed is to use a temperature data string inside the tank, or an aerial drone that can capture thermal imagery to determine if there is thermal stratification.

5. Cost-Effective Problem Prevention

While active tank mixing is critical for water quality, regular inspection and maintenance of your water tanks and mixing system are critical. Inspections help assess safety and security issues, structural and coating conditions, and obvious sanitary concerns, and notifies the operator of any needed tank service.

The American Water Works Association has determined a standard schedule of inspection. Visual inspection of your tanks should happen regularly, at a minimum on a monthly basis. Your tanks should be drained, washed, and professionally inspected at least every three years, if not more often. Your mixing system and ground fault breakers should be checked to make sure they are within manufacture recommendations. ■

Before and after images showing the thermocline layer eliminated by effective mixing.

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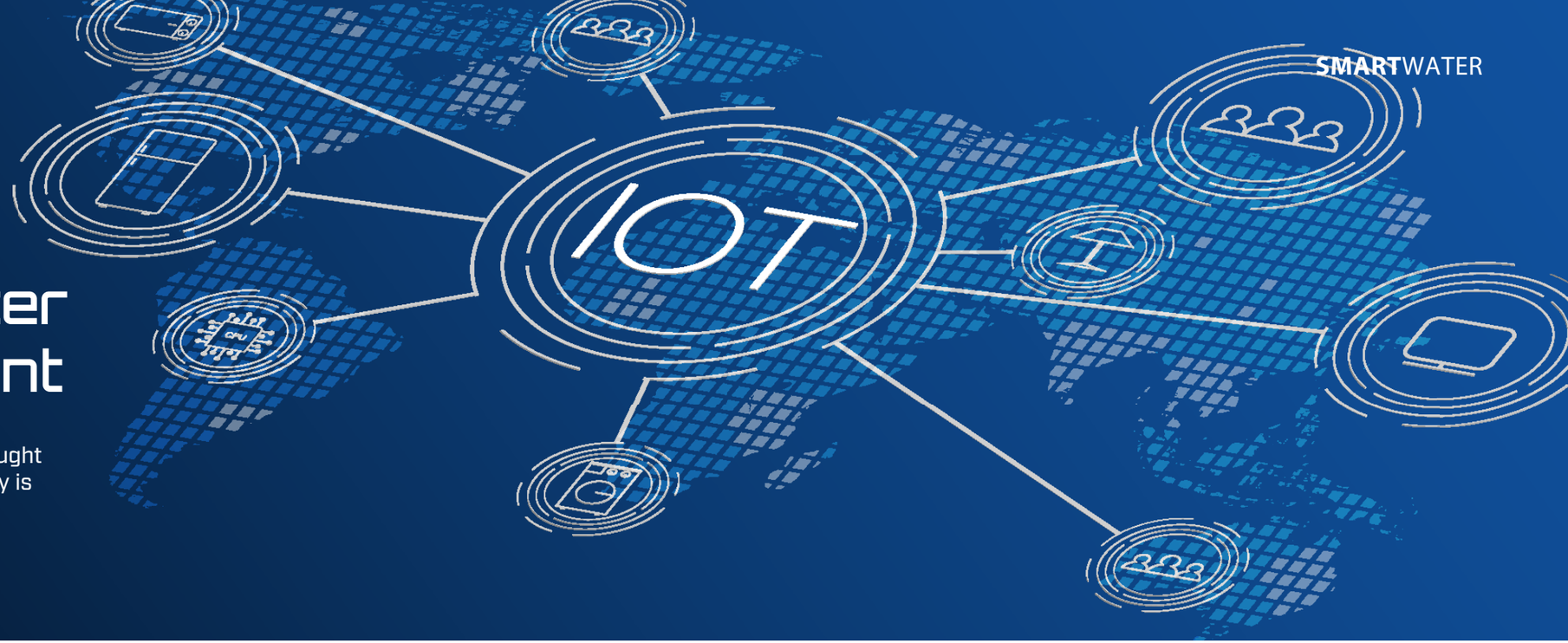
About The Author

Lucy Allen is the municipal business development manager for Kasco Marine. She has more than 15 years of experience in the water and wastewater industry and is an expert on water tank mixing. Learn more at kascomarine.com/certisafe.

IoT Cellular Connectivity For Optimizing Water Utilities Management



Digital transformation allows utilities to go from data drought (and actual drought) to a deluge of efficiency, but security is paramount.

By Adam Weinberg

Cellular Internet of Things (IoT) devices are an integral part of helping water utilities optimize their operations and lower costs. Using connected technology, companies can monitor water meters from a distance, remotely manage water supply facilities, and get a clearer picture of wastewater treatment processes. This reduces the amount of labor required and allows for better crisis preparation.

Currently, the cost of wasted water amounts to $39 billion a year,[1] financially burdening countless businesses and systems. Through the use of connected cellular IoT devices, fresh water and wastewater will be better managed at a lower cost while gathering more useful data than ever.

IoT Cellular Security Risks

It's a double-edged sword when implementing IoT cellular connectivity in water utilities. The benefits are enormous, but the risk remains high — a threat actor may gain access to the IoT cellular devices for a range of nefarious purposes. For example, once a hacker gains control, data on that IoT cellular device can be compromised, as well as the entire network itself.

Vulnerable IoT cellular devices may also enable an attack where homes, businesses, schools, and farms may be left without clean running water — or untreated waste can be released directly into the living water system. Therefore, taking security measures is a necessity when it comes to connected devices.

Maintaining Continuous Service Availability

The main challenge for any critical infrastructure organization is to ensure continuous service, with the goal of mitigating the threat of disruption as much as possible. Network attacks come in all shapes and sizes, and IoT cellular security systems need to be prepared to fight off these strikes.

Threat actors are seeking to exploit unsecured networks. They may drain batteries on the IoT cellular devices in a malicious act, override passwords and security, or use the IoT cellular devices as a gateway to steal sensitive information.

Here are a few examples of IoT cellular network-based attacks:

- *Denial of service (DoS) and distributed denial of service (DDoS) attacks.* These attacks aim to disrupt the service of a host connected to a network by making a machine or resource unavailable. They come in two "flavors" — targeted and nontargeted. Targeted attacks focus on disrupting the service of one device within the network, whereas nontargeted attacks aim to attack the entire network. The goal of the attack is to shut down a network and make it inaccessible.

- *Service DoS attacks.* These attacks are similar to the other DoS attacks but focus on disabling service — such as access to clean water. A service DoS attack may disable the logging service of the IoT cellular device while making no change to functionality, allowing the same device to be used later as part of a multilayered attack.

- *Location tracking.* While these attacks may not pose a direct threat, they can lead to the leak of vital geographical information and can be used to execute wide-scale and devastating attacks on physical pieces of machinery.

- *Functionality attacks.* Threat actors gain access to control functions by exploiting loopholes in the networks or IoT cellular devices directly. Once they are "in," they can interfere with operations, implement DoS or DDoS attacks, or use the IoT cellular devices to spread botnets.

- *Data channel rerouting.* In these attacks, hackers modify the data path coming to and from the device, allowing them to interfere with the data. They often alter the access point name (APN) registered on the device; the APN defines the gateway from the IoT cellular network to the internet. They may also change the domain name server (DNS) to control the IP address for the APN.

The protection of IoT cellular devices must focus on strategic planning at the foundation level. Connectivity has to be implemented in a way that allows the IoT cellular device to be resilient to a network-based attack or breach.

Water utilities can protect themselves from attacks by using a connectivity management platform that can automatically monitor, alert, and detect suspicious activity within the IoT cellular network or using on-device SIM applets, which have a security program directly on the SIM cards.

Attack preparation needs to occur on the company management level, as well. Clearly defined roles and responsibilities must be assigned before anything ever occurs, so the organization is prepared to handle these challenges. Most notably, security personnel must ensure all risks are addressed and prepared for. The top management teams within the water organization must verify that each security risk is analyzed, and that each person is assigned a specific role and knows exactly what must be done in the case of an attack.

Conclusion

When choosing their IoT cellular connectivity and security management platform, water utilities need to make sure it meets all the required standards and enables them to gain full control over their IoT cellular devices. The right technology ensures function and protection simultaneously.

A unified platform lets companies manage their devices as a group. This provides simultaneous control of millions of devices, saving costs, time, personnel, and other resources, allowing the facility management team to focus on all their other critical duties.

With the right solution, water utilities can continue to leverage smart devices to improve the efficiency and operation of water services while ensuring security protection against all types of IoT cellular attacks.

The best of both worlds? Combine a connectivity management system that gives full control over its IoT cellular connected devices with a built-in, comprehensive security solution to ensure ongoing operation. ■

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About The Author

Adam Weinberg, cofounder and CTO of FirstPoint Mobile Guard (www.firstpoint-mg.com), applies his extensive executive R&D experience in communications intelligence and cyber technologies in shaping FirstPoint solutions, which streamline management and security of any IoT cellular device.

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