WATER: A WEBSITE ABOUT OUR PRECIOUS RESOURCE

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WATER: A Website

Introduction

Water issues are complex. They involve physical, environmental, sociological, political, historical and geographic interactions among competing constituencies, resource limitations, weather and climate variations and social mores and traditions. To help the public understand the interactions among these complexities, *WATER: A Website*, serves as a single, continuously updated, scientific resource written in non-technical, accessible language by a science journalism student who is both a scientist and a teacher.

Water is a necessary component in the formation and existence of all known life and is the most versatile substance on our planet. It is the foundation of agriculture, supports much of the world's recreational needs and is used in industry as a universal solvent, dissolving a wide array of chemical compounds in food, medicine and building materials. Its molecular bonds are strong, enabling it to easily conduct electricity. Used by hydroelectric plants, it rotates turbines to produce clean energy for millions. It covers about 70% of Earth's surface and we take for granted that when we turn on the faucet clean, clear, drinkable water is instantly available.

In many places on the planet, this is simply not the case. Factors that explain both too little and too much water are complicated, meaning that science journalists have a special obligation to educate the public about increased competition for current and future water sources and uses, global warming and climate change threats leading to water instability and to present water resource management solutions.

According to the United Nations Department of Economic and Social Affairs (2015), the media has an important role to "shock and inspire, educate and inform." As observers and

communicators of the human condition, the media has a unique responsibility to notify the public about water management and safety, and politicians and water planners about water-related challenges faced by individuals and groups at local, state, national and international levels. *WATER: A Website*, proposes to do all of these.

Purpose of the proposal

This proposal aims to answer the following questions:

1. Why is water an important subject for science journalism?
2. What is the role of a science journalist?
3. What are the relationships between science journalists and scientists?
4. What are the relationships between science journalists as teachers and science literacy?
5. How and why should science journalists educate the public about water-related issues?
6. Why is a website an appropriate medium for educating the public about water?
7. What education and experience do I have that qualify me to educate the public about water?

Water is a human right

Access to clean water is essential to human dignity and foundational to virtually every other human right (Tahana, et al., 2021). Clean water promotes socio-economic development, human productivity, healthy ecosystems and epidemic and famine management (United Nations, 2020). Water regulates body temperature, assists in nutrient absorption, fights illness and maintains wellness of living creatures (Mayo Clinic, 2020; Silver, 2020). But an absence of clean water places severe burdens on those least responsible for water shortages.

Drought, for example, inflicts severe burdens on women and girls in emerging and developing countries, affecting their education levels, nutrition, health, sanitation and safety. In water-scarce societies, they take on the time-consuming and dangerous task of gathering water from distant sources. Almost 160 million children are exposed to severe and prolonged

droughts, and by 2040, one in four children will likely be living in areas with extreme water shortages (Algur, et al., 2021). Consequently, children in drought-stricken environments have little time to obtain an education or maintain personal health.

In 2021, an absence of clean water prevented Tribal members in western states from practicing adequate handwashing and bathing to prevent the spread of COVID-19. While the mainstream news media broadcast images of refrigerated trailers storing the bodies of New York City pandemic victims, the infection rate of the Navajo Nation was 21% higher, and that of the White Mountain Apache Tribe on the New Mexico-Arizona border was about twice as much as the national average (Fahys, 2021). According to some estimates, 48% of Native American reservations do not have clean water or adequate sanitation and are 19 times more likely than white households to lack indoor plumbing (Tahana, et al., 2021). On the Ute Mountain Tribe reservation, visitors bring bottled water as a greeting gift because reservation water is contaminated (Tahana et al., 2021). On eastern Arizona's Hopi Reservation, 75% of the residents depend on water that is contaminated with excessive levels of arsenic (Fahys, 2021).

Clean water

Around 500 BC, Greek cities grew and expanded, requiring clean water supplies. Later, Romans built aqueducts to transport water from its source to distant cities, while Medieval societies depended on local sources. By the 19th century, sanitation systems equipped to curtail biological hazards arose in Great Britain, spread across Europe and arrived in the U.S. These systems reduced the spread of water-borne diseases, including cholera, dysentery and typhoid fever that scientists discovered in water supplies. In the 19th century, water filtering and

chlorination were introduced into municipal water supplies (International Water Association, 2022).

By the mid-20th century, the health effects of new, non-biological hazards seeping into water systems, including chemical and radioactive waste, were discovered, but also not eliminated. In areas where insufficient financial resources and a lack of political will still exist, mitigating these hazards often fails. According to the United Nations (n. d.), as of 2019, 12% of the world population got its drinking water from unsafe sources, more than 2 billion people live in countries experiencing high water stress and more than 30% of the world population (2.4 billion people) live without any form of sanitation.

About 10,000 people die every day from dysentery, cholera, and other diseases caused by unsafe water and inadequate sanitation. Most are members of marginalized groups, refugees and the poor (International Water Association, 2022).

Climate change

Climate change, global warming and water are intimately related and affect all of us. White sea ice reflects 50% to 70% of solar radiation, preventing Earth from getting warmer (Climate Reality Project, n. d.). But due to increased carbon emissions and global warming, the Arctic and Antarctic ice caps and Greenland ice sheets are now melting six times faster than in the 1990s, the worst-case climate warming scenario set out by the Intergovernmental Panel on Climate Change (IPCC). In the near future, melting ice could produce a sea level rise that could subject 400 million people living near coasts to major flooding (Carrington, 2020).

And what happens in the Arctic, for example, affects the frequency and severity of western U.S. wildfires. Warmer land and sea surfaces create hotter and dryer summers,

resulting in more intense fires (Berwyn, 2022). Climate change has also made monsoons unpredictable for about 1.8 billion people, a quarter of Earth's population (Fountain, 2022).

Limitations

Before proceeding, it is important to address the limitations of *WATER*. The site is not intended to teach journalists how to think, communicate or write like science journalists; it is also not intended to be a replacement for thorough science research, understanding of the scientific method or study results. The website does not tell extensive stories, but gives insight into water topics that science journalists, and the public, desire to learn. Purposes of the site will be addressed in more detail below, in the *WATER* section.

The internet is a critical information source. According to a 2020 Pew Research survey, 86% U.S. adults indicated that they frequently got news from a smartphone, computer or tablet. Only 68% got news from TV sometimes, half said they tuned into radio news, and about a third read their news in printed publications (Shearer, 2021). Given that online media is the primary means of obtaining news information, this proposal does not address the availability or efficacy of water-related sources by television, radio, traditional printed or other resources that are not available online.

Unlike television and printed news stories, websites can be easily modified and updated. Some, like *WATER*, are constant work-in-progress that are never really finished. Over the last two-and-a-half years, I've continued to update and improve this site to make sure that it reflects the current state of water-related issues, especially those governing the Colorado River and catastrophic weather events. While sections of the site specifically cover the Arizona and Tucson environments, the Introduction, Hydrology, Earth's Water and Terminology sections are

more general, but do not cover international water-related issues in great depth. Links to sites related to international water issues are included in Resources sections if they are timely, relevant and supported by other known, reliable sources.

Literature Review

Science journalists have a unique role in society as interpreters and educators. They are expected to communicate complicated concepts to a public which may have an extremely limited science background and no context for understanding scientific methodology, results and conclusions.

To succeed, a science journalist needs sufficient specialized subject knowledge to decide what and how to present scientific information to a non-expert audience, as "an opportunity for them to learn something new" (Shehab, 2022). Investigating water issues requires a fundamental grasp of engineering, economics, meteorology and agriculture (Leavenworth, 2005) to determine how to clearly represent their interrelationships in water-related stories.

The normative roles of science journalists

The normative roles of journalists address how they are expected to meet the negotiated "aspirations and ideals of the general public" (Hanitzsch, 2017). Science journalists fulfill two roles that establish them as contributors to democratic participation: monitors and facilitators. The monitorial role involves the collection, publication, and distribution of scientific information of interest to the public and providing commentary, advice and warning (Christians, et al., 2009; Hanitzsch, 2017).

The facilitative role encourages dialog between stakeholders and encourages public participation in political life, where "the news media do not merely report on civil society's

associations and activities but support and strengthen them" (Christians, et. al., 2009). They provide relevant context, contribute to shared consciousness, and act as critics or government watchdogs (Hanitzsch, 2017) while promoting social justice, redistributing social power and revealing abuses in public service (Christians, et al., 2009).

Science editor Rehab Abd Almohsen summarized the role of a science journalist:

> When confronted by apparently impenetrable specialist terminology and concepts, it is a science journalist's job to act as the point of contact between researchers and the public. Like a pearl diver, you have to be able to pick out phrases that will resonate with the audience – phrases that contain a lot of scientific detail and meaning, that will have a real effect on the public's awareness and behaviour. For a science journalist to play this role, they need enough specialist knowledge to understand and discuss the research (Shehab, 2022).

Science journalism includes researching, investigating, and analyzing numerous scientific sources, linking expertise of scientists from various disciplines, presenting conflicting opinions within historical context, translating technical language in ways that can be accurately understood by the public and utilizing appropriate media to present scientific ideas.

Subscribing to journals and websites related to the fields they plan to write about facilitates understanding of the multifaceted nature of water-related issues, some of which have already been discussed. Science journalists need to question what they read, examine underlying social, political and economic motivations of government institutions, lobbying groups and laboratories, identify scientific explanations, develop a network of scientific experts and participate in conferences and seminars (Shehab, 2022).

Science journalists and scientists

Science journalists face unique opportunities and challenges. Hayden & Hayden (2018) stated:

> We live in a golden age of science and environmental journalism. In the face of the widespread decline of traditional publications, such as regional newspapers and national newsmagazines, and a broader media ecosystem awash with low-quality, sensationalized, sometimes intentionally misleading material, science and environmental journalists and their allies have stood up to assert the value of rigorous, factual, independent coverage and scrutiny.

A prime example requiring journalistic scientific scrutiny concerns water fluoridation. In 1945, Grand Rapids, Michigan, began adding fluoride to its water system (Center for Disease Control and Prevention, 2021). In 1950, school children in that city had far fewer cavities than those in surrounding communities. Other Michigan cities began adding fluoride to their water, and their children also demonstrated a significant reduction in cavities. Within a few years, many cities in the U.S. began adding fluoride to their water, achieving similar results (Center for Disease Control and Prevention, 2021).

Despite endorsements by the American Dental Association and the American Academy of Pediatrics, scientific articles are still available on the internet leading the public to believe that fluoridated water is dangerous. One, which includes 50 reasons not to allow fluoridation, was written by a scientist (Connell, 2012) and quotes sources and studies that are more than 25 years old. These sources are no longer relevant, given that the Environmental Protection Agency sets a maximum level of fluoride allowed in drinking water of 4.0 parts per million (ppm), recommending that fluoride levels be maintained at a minimum of 0.7 ppm to protect dental health. In this range, fluoride's benefits outweigh any potential harm (Gorman, et al., 2020).

This example exposes common challenges faced by science journalists working with scientists. First, science journalists need to not only evaluate the results of older scientific studies, but weigh them against new scientific information, federal, state and local regulations

and the credibility of scientific sources, especially when the scientific community does not agree. Connell's reliance on out-of-date information demonstrates that science journalists cannot simply assume that all published science is credible.

Second, science journalists need to decide how to present and refute misinformation, especially when that information can create fear and anxiety. Humans tend to overestimate small risks, while others tolerate no risk (Gorman, et al., 2020). Given that water is necessary to sustain life, any threats to its safety can cause significant emotional public responses, rather than careful, measured evaluation of scientific evidence. Thus, science journalists need to convey scientific information to those who may have no understanding of scientific language, methods and publications.

Third, science journalists "are charged with monitoring scientists and scientific institutions and keeping them accountable" (Bottesini et al., 2022). They serve as gate keepers in both widely promoting good science and discouraging publication of bad science. When the findings of a scientific paper with a limited academic audience are reinterpreted and rewritten by a science journalist, they may reach thousands or millions, rather than a small group of scientists within the field (Water Resources Research Center, 2010). The rise of scientific misinformation has encouraged cooperation between science researchers and science journalists to stem the tide of false information publication and distribution (Hayden & Hayden, 2018).

But challenges remain. Predatory journals, unchecked research results, studies sponsored by corporations with economic interests and unpublicized paper retractions pose an additional problem, requiring journalistic diligence and time to separate credible science from

disinformation (Bucci, 2019). Failure to do so threatens a science journalist's reputation and credibility as well as leading to widespread and potentially harmful and dangerous public disinformation.

Simply understanding scientific terminology is not sufficient. Scientific jargon has varied meanings depending on its discipline, which may be vastly different than its use in daily conversation (Davies, 2013). The term "deposition," for example, has several meanings. When the members of the public hear the term "deposition," they may interpret it in its familiar legal sense, where a lawyer obtains testimony from a witness under oath before a trial. In chemistry the term "deposition" refers to the transition of a gas directly into a solid; in geology, it refers to the process in which sediments, soil and rocks are added to existing sediments. These two scientific uses refer to vastly different phenomena. Appropriate interpretation by a science journalist significantly curtails the possibility of misinterpretation of scientific jargon.

Both science and journalism are "practices of inquiry that take the pursuit of verifiable truth as their highest calling…built on the individual curiosity and dedication of practitioners pursuing the public good, and both have well-developed traditions and professional structures that support this calling" (Hayden & Hayden, 2018). Science journalism seeks to broaden its audience by publishing quickly, while science works on its own independent timeline, usually unconcerned with distributing its results to the public (Hayden & Hayden, 2018).

To close this gap, science journalists can develop a network of scientific experts who value clear and timely public communication. They can work together to ensure that stories written by science journalists accurately portray the methodologies and conclusions of science

research by maintaining an open dialog and review process. The website *WATER* seeks to be a part this function.

Science journalists as teachers and science literacy

Water is boring. Water is only an environmental issue. Water is someone else's problem. While none of these is true (Leavenworth, 2005), science journalists must overcome these public perceptions and make water stories interesting and accessible. There is a limit to what can be presented in "any field without a whole lot of back-story to get an audience who can't remember their high school science to appreciate why it matters" (Davies, 2013) so science journalists must explain complicated ideas in ways that will keep the public's attention.

Science has everyday uses. Science-related problems involve practical, daily health, work and family-related decisions (Feinstein, 2010), ranging, for example, from best farming practices, reasons to protest (Roth & Lee, 2002), childhood vaccination decisions, food consumption choices, and water safety evaluation, which can only be determined through scientific analysis. As science literacy researcher Noah Feinstein (2010, p. 169) stated: "science education can help people solve personally meaningful problems in their lives, directly affect their material and social circumstances, shape their behavior, and inform their most significant practical and political decisions."

Educators rarely investigate how those in non-school environments make meaning of scientific information, nor do they attempt to provide intervention strategies to help non-students understand science (Feinstein, 2010). This leaves a large gap to be filled by science journalists.

Roth and Lee (2002) proposed that science literacy is a collective effort that allows for rational decision-making to benefit society. They studied the Henderson Creek watershed in Oceanside in the Pacific Northwest, where inadequate summer water supplies forced the community to limit water consumption. Urbanization, asphalt paving, creek straightening, forest and wetlands loss and industrial pollution exacerbated the water shortage. Residents with wells discovered that their water was biologically and chemically contaminated, requiring them to get clean water from a gas station five miles from their homes.

Public meetings demonstrated that well-versed citizens, who had been reading about the amounts of chromium in their water, were able to refute the findings of so-called experts. Residents' collective scientific literacy revealed ulterior political motives of those who had been hired by a water advisory task force (Roth & Lee, 2002).

Davies (2013) summarized the importance of science journalists as teachers:

> Effective science journalism matters because government decisions affect scientific work. If the democratic machinery is working, government decisions should follow public opinion – which, in turn, should follow good fourth estate journalism. The public then can understand why science matters, and track whether research is reasonably funded and/or conducted ethically.

Science journalism facilitates public conversations, builds consensus, exposes health and safety issues and inspires individuals to work together to solve problems. As "competent outsiders," (Polman, et al., 2014) science journalists identify valid and reliable information for public consumption. They refute unsubstantiated rumors, bad science and dubious technology (Polman, et al., 2014), and explain why some sources, findings, and studies lack credibility. They teach the public to be informed critical thinkers rather than passive news consumers.

Science journalists representing science in the media

Although researchers have investigated how mass media can influence public awareness and behavior about climate change and energy usage, only in the last five years have they started to study the influence of media coverage about water-related issues (Caycedo, 2018). Science journalists can critically explain water research results, as well as the social, political, economic and geographic aspects and attitudes of and about water use.

Local, state, national and global news have different approaches to covering water: ”the geographical categories of journalism (local, national, and international) are neatly separated, while the causes and effects of climate change transcend borders and are local and global at the same time” (Become a Writer Today, 2022). Local coverage tends to address concerns of individual citizens and community groups; stories intended for state-wide distribution characterize issues related to larger geographic areas, such as rivers and lakes; national stories are often the result of state and local science journalists exposing issues that the national media has previously ignored. Global stories often address international monsoons, floods, droughts, oceans and sea level rise and ice sheet melting.

According to Rita Schmidt Sudman, Water Education Foundation, media outlets only focus on water when there is too much or too little, creating a crisis involving money and growth (Leavenworth, 2005). Two decades ago, only local reporters covered impending water shortages in Las Vegas and declining Lake Mead. Now that both the Upper and Lower Colorado water basin states are facing long-term drought, state and national news media have jumped on the water crisis houseboat to report these stories (Leavenworth, 2005).

The situation in Flint, Michigan provides a case-in-point. Funes (2017) interpreted the results of a Harvard University Shorenstein Center on Media, Politics and Public Policy report that criticized media coverage of that city's water crisis. The report asked if the situation would have resolved differently if the national media had intervened sooner. In June 2017, as an outcome of the Flint water crisis, five Michigan officials were charged with involuntary manslaughter, more than three years after residents began reporting health issues with their water (Jackson, 2017).

While local news media covered the issues, citizens' complaints were ignored, residents were portrayed as helpless and complacent and African American activists were excluded from news coverage (Jackson, 2017). This story exposed broader issues of water-related social injustice. Funes explained that Jackson blamed a "lack of newsroom diversity, a history of national media paying little attention to environmental justice in communities of color, and the tendency to act only after harm has been verified by doctors and scientists—rather than in response to widespread citizen concern" (Funes, 2017; Jackson, 2017).

A 2017 Stanford University study, available online in *Science Advances* (Quesnel & Ajami, 2017), analyzed the connection between drought-related news coverage between 2005 and 2015 and urban water use in California's San Francisco Bay area. This was the first study to investigate the relationship between news coverage and water use behavior (Caycedo, 2018).

While the study was performed by two scientists, its results were interpreted and reported by a science journalist, who explained that the researchers analyzed drought news coverage by nine highly circulated national and California-based daily newspapers, including *The New York Times* and the *Sacramento Bee*. The study demonstrated a strong link between

increased drought news coverage and reduction in urban water use (Caycedo, 2018). The work of science journalists encouraged millions of Californians to conserve their water supply at a state level.

In an international journalistic effort, a 2019 *GlobalWaters* story reported that the U.S. Department of State and the U.S. Agency for Global Media trained about 30 journalists from Uganda, Jordan, Sweden and across the Middle East about water issues. The project impacted millions of people who would otherwise not have reliable news and information about water. Journalists partnered with the Nile Basin Initiative, private media sources, and water experts to address Nile-related hydrology, energy, environment, ecology and water conflict issues. They wrote 75 stories, including some on the Egyptian-Ethiopian conflict over dam construction and provided an online annotated site map describing water safety and access improvement projects (USAID, 2019).

Science journalists using the media to teach science

Jonathan Watts (quoted in Become a Writer Today, 2005) of *The Guardian* said "The media is part of a social nervous system, alerting the public to remote danger in the same way neurotransmitters tell the brain the tips of the fingers are being burned. We serve as amplifiers… to reach a wide audience and centers of decision making."

To be accepted as educators, science journalists need to maintain their public credibility by countering misinformation (Polman et al., 2014), making it clear that not all scientific claims have equal standing and explain how and why scientific knowledge evolves. For example, "if coffee cures cancer one week but causes it the next" (Bottesini et al., 2022, p. 4), science journalists need to explain why new scientific discoveries replace old research conclusions.

In a local 2016 story, News-Press Editorial Board reported that Fort Myers Beach Mayor Anita Cereceda and Lee County Commission Chairman Frank Mann blamed the media for reporting that "pollutants flowing down the Caloosahatchee from Lake Okeechobee releases are discoloring our water, killing the sea grass, killing marine life, causing algae blooms and red tide and generally making life miserable for those who want to enjoy our pristine beaches and use the water" (News-Press Editorial Board, 2016). The officials told the news outlet that it should "write more about the positive things occurring in our area" (News-Press Editorial Board, 2016).

News-Press (2016) responded, referring to the city's Tourist Development Council (TDC):

> It is the responsibility of the media to report the news, not keep people in the dark about what is happening around them. Most of it is positive, but issues that impact our community in a negative way are also very much a part of life. It is the responsibility of the TDC to help promote and protect our valuable resources.

While refuting politicians' attempt to cover up negative, but environmentally accurate news, News-Press instructed the public:

> The reality: the bad water and the damage that it is causing currently and what is still being done upstream. The spigot is mostly wide open, and water is pouring into the river at a rate of about 70,000 gallons a second. This week has been one of declarations and renewed promises to solve this growing environmental disaster (News-Press, 2016).

In this paragraph, News-Press educated the public with the what, where, why, when and how of Fort Meyers' polluted water.

Journalistic Methodology

To act as a scientifically literate person, individuals need to "find, evaluate, and make sense of new scientific and technical information" (Polman, et al., 2014). *WATER* encourages to individuals to do so.

Editorial limitations

Local, state, national and global water stories focus on different geographic, meteorological, technological, environmental, sociological and political aspects of water. They sometimes leave out critical connections among weather events, environmental damage, community impacts and laws and regulations affecting water use and safety.

Editorial and timing considerations may prevent news media from adequately making connections that would place water issues in the best context for public understanding: "This leaves media that produces short articles for broad target audiences stuck in terms of what it can say about scientific progress. Its current format doesn't give it much room to move, and as a result, the fragments of its audience who are interested in science" (Davies, 2013).

Russell (2008) said that science journalists, who lack the time or experience to research their own stories, sometimes use press releases created by university news offices, government research agencies, and corporations. These stories may be slanted to support scientific data, political and economic situations. *WATER* attempts to reduce these limitations and problems by evaluating many sources.

Limited connections

In August 2021, the U.S. Bureau of Reclamation (BoR) declared a 2022 Tier 1 Colorado River shortage and on August 16, announced a Tier 2 shortage as of January 2023 (Nilsen &

Ramirez, 2022). After the first BoR shortage statement, KGUN-TV reported that Arizona's Colorado River supply cut would affect agriculture but ignored the effects on water supplies of cities or Tribes (Simmons, 2022), while KVOA-TV declared online and at 5 p.m. that "Tucson could be an oasis in the desert" (Jackson, 2021). These stories failed to connect the declared shortages with the 20-year drought in the western U.S., water conservation efforts and Colorado River shortages as a symptom of potential global shortages.

The second shortage declaration produced additional inconsistent media messages. *60 Minutes* responded with a video demonstrating how Lakes Powell and Mead have declined nearly to deadpool levels, which would halt Hoover Dam power generation. The story included images of beached boats, cracked landscapes, parched canyons and dead trees, all of which were once in the flowing river (Czachor, 2022). At the same time, *The Washington Post* mentioned in passing that Lake Mead provides electricity to 350,000 homes and drinking water to 25 million but concentrated its story on oddities and distractions appearing in the draining lake: dead bodies, baby strollers, Prada sunglasses and fake skeletons. *azcentral.com* called for drastic water conservation efforts, while claiming that Arizonans faced no threat to our 2023 water supplies (Buschatzke & Cooke, 2022).

When the media fails to make these connections, the public makes connections on their own, sometimes based on incomplete information, misinformation and disinformation. Science journalists have a responsibility to correct erroneous information, while providing the public with clear and comprehensible science.

The history of WATER

I started *WATER* during the Fall 2020 semester as a multimedia project for JOUR 565: Issues in Covering Science and the Environment, taught by Dr. Susan Swanberg, who suggested that I use the site as my graduate project. By the end of that semester the site included Introduction, Hydrology, Earth's Water, Arizona's Water, Tucson's Water, Terminology and Site Notes sections. Subsections emphasized the physical aspects of water, including water properties, rivers, lakes, ground and surface water, water quality and a glossary of several hundred words.

I continued updating the site during 2021. It was expanded during the Spring 2022 semester while I was enrolled in EWRS 596B: Water Policy in Arizona and Semi-arid Regions, taught by Dr. Sharon Megdal. More than 300 annotated and linked acronyms were added.

This semester, subsections on Earth's water history, climate change, global warming, hydropower, droughts, floods and water challenges were added as part of a project for GLO 505: Media and Climate Change, taught by Professor Carol Schwalbe.

More than 500 academic journal articles, media and government reports, laws and regulations, archival documents, newsletters, videos, static and interactive maps, charts, graphs, images and websites (see *Sample of Existing WATER Website Resources*, below) were reviewed, analyzed, and evaluated using personal experience (see Qualifications, below). Sources that were not relevant, overly complicated, factually inconsistent, politically biased or known by me to not be credible, were not included.

Background information from interviews and written responses from Tucson, Pima County and Scottsdale water managers and consultants were also used to confirm data and

information when appropriate. For example, an interview with Tucson Water director John Kmiec, a leader of the Arizona Pure Water Brew Challenge team, supported Water Now Alliance, Arizona Community Foundation, WateReuse and Water Technology descriptions of the Pure Water Brew Challenge. Kmiec's personal knowledge of the project's history and outcome provided an expert and human interest angle for *WATER*'s Innovation subsection in the Tucson's Water section.

Why a website

Webmasters can and do manipulate websites so that search engines place them at the top of search results. Some sites are also funded by special interest groups, publicizing research results for economic or political gain (Polman, et al., 2014). Others have social, corporate and religious affiliations. The presence of science journalists on the web, who can teach the public to distinguish between fact and fiction encouraged by those with ulterior motives is critical to the public's development of scientific literacy.

Individuals can and do post false information based on rumor and speculation. In 2019, for example, thousands of Ecuadorians protested against a government decision to eliminate a fuel subsidy. Hundreds of misleading and manipulated videos were posted on Facebook, Twitter and WhatsApp. One false message, claiming that the country would run out of water, provided Quito's fact-checking journalists with an opportunity to verify that the rumor was wrong, and publicly correct misinformation (Tardáguila, 2019).

Because the internet exposes dubious motives and false information, it provides an opportunity for critical evaluation, feedback and correction. Websites, including *WATER*, can be updated and republished with revised information far more quickly than other written,

televised or online media forms. With more than five billion users as of April 2022, 63.1% of the global population (Statista, 2022), the internet enables website accessibility for more than half of the planet's population.

Multimedia and learning styles

There are four basic learning styles: visual, auditory, kinesthetic and tactile. *WATER* has been designed to appeal to each. The site incorporates more than 150 images, videos, maps, charts and graphs. Created with the recording assistance of my niece, Emily, there are a dozen sounds that site visitors can play and attempt to identify. For example, they include a running hose, water going down a kitchen sink, and a flushing toilet. Highlighting "Water sound" reveals the sound source. Kinesthetic and tactile learners, as well as the visually impaired, can use the magnifying glass attached to many of the images to expand parts of maps and graphics and examine grains in rocks and minerals.

Educational websites should be fun. Trivia questions are located throughout the site, challenging users' knowledge of water-related issues. I photographed the background image looking down into my sister Laura's pool because it represents one of the reasons that Arizona residents value water and it is visually appealing.

Copyright and source information

Written permission for proprietary and copyrighted images was obtained from Arizona Department of Water Resources (ADWR), Arizona Historical Society, Central Arizona Project (CAP), City of Tucson, Pima County and Tucson Water. These are listed in the Permissions

subsection of the Site Notes section. Creative Commons (CC) license links are included with non-copyrighted, non-public domain images (Meeks, 2022).

I have subscriptions to and regularly review several water-related periodicals (see *Water Periodicals as WATER Background Research*, below), which provide up-to-date information and links to new water information and resources. Many are included as endnotes, references, and clickable data table items on the website (Meeks, 2022).

Other features

Located in my personal web domain, at denisemeeks.com/water/, *WATER* is publicly accessible and includes my email address, inviting public comment and suggestions (see *Author Websites and Works*, below). The site is also linked from the Education and Outreach section of Pima County's Wastewater Reclamation page (https://webcms.pima.gov/government/wastewaterreclamation/) as "Water's Role on Earth." In October 20, 2022, *WATER* was added to the Science section of the Journalist's Toolbox website, https://www.journaliststoolbox.org/2022/10/20/science_resources_1/ .

WATER was created using educational web design principles, including high contrast, readability spacing, font and image placement consistency, avoidance of green and red colors, simplicity and useability principles (Sabo, 2016), and my 30 years of experience as an educational website designer. HTML ALT tags are included for all images, meaning that screen readers used by the visually impaired can provide oral captions. Images with small print or details include a magnifying glass feature (public domain code provided by Dynamic Drive, http://www.dynamicdrive.com/).

WATER

WATER describes, simplifies and summarizes. It connects geographic, historical, social, political and legal aspects of water to environments and events and places them in context. Unlike individual articles, or websites serving as article depositories, *WATER* includes local, state, national, and international water-related topics.

The menu structure enables users to navigation from one subsection to another with a single click. *WATER* is a tool, aggregating a wide variety of water-related topics: Earth's origins, water history, water properties, hydro power, ice sheets, oceans, rivers, lakes, groundwater, surface water, water quality, floods, drought, conservation and several others.

The following examples describe some specific website features facilitating use. Each is explained in the Navigation subsection of the Site Notes section. (Information taken from *WATER* is included in blue, below; sources are as they appear on the website.)

When users click on an in-text footnote number, the cursor moves to that clickable note, which opens a website or source document with additional information (the reader is encourage to access the website and try this for themselves). Clickable websites are indicated in bold on the website. For example, the Arctic Region subsection (under Earth's Water), which includes a map of the Arctic, along with other information, states

> Greenhouse gases from fossil fuel burning is causing temperatures in the Arctic to warm at twice the rate of the rest of the world.[2] Methane and carbon are found in Arctic permafrost, frozen peat bogs and under sea floor sediment. As they thaw, methane and carbon are released into the atmosphere, adding more global greenhouse gases and global warming. More warming results in more permafrost loss and more atmospheric greenhouse gases.[3]

[2] National Geographic Society. (2022). The Arctic. https://www.nationalgeographic.org/encyclopedia/arctic/

[3] The Climate Reality Project. (n. d.). How feedback loops are making the climate crisis worse. https://www.climaterealityproject.org/blog/how-feedback-loops-are-making-climate-crisis-worse

The Tribal Water Rights subsection under Arizona's Water explains

> When water quality degradation would undermine reservation water use, federal courts have recognized water quality as another element of Indian reserved water rights. Reserved water rights holders can seek legal protection from water quality degradation by other water users. In *U.S. v. Gila Valley Irrigation District, 454 F.2d 219 (1972)*, the Ninth Circuit approved a district court's finding that a reserved water right was impaired when other users' actions increased salinity of Tribal irrigation water.[3]

[3] EveryCRSReport.com. (Jun. 8, 2011). Indian reserved water rights under the Winters Doctrine: An overview. https://www.everycrsreport.com/reports/RL32198.html

Users can click on the link to the court case, which opens a new window to the United States Court of Appeals, Ninth Circuit decision, to learn more about the case.

The Oceans and Currents subsection under Earth's Water displays a table (this table is one of more than a dozen on the website). When the user highlights a table row, a map of that ocean appears to the right of the table, as indicated by the arrow to the right of the Earth's Oceans table title. Comparisons can be easily made about ocean area and volume.

Earth's Oceans➔				
Ocean	surface area in km^2	volume in km^3	Description	Percent
Pacific	162,250,000	669,880,000	largest and deepest ocean	48.3
Atlantic	106,460,000	310,410,900	extends between Europe and Asia	22.4
Indian	70,560,000	264,000,000	world's warmest ocean, bounded by Asia on the north, Africa to the west, Australia to the east	19.0
Southern	71,800,000	20,330,000	composed of water from the South Pole to 60°S latitude	5.18
Arctic	18,750,000	14,060,000	the smallest and shallowest ocean	1.35

WATER uses many scientific terms. Scientific jargon disrupts reader comprehension and processing fluency (Riggs, et al., 2022), but in-text definitions selected by the reader display definitions written in non-technical language. In the Importance subsection in the Introduction section, for example, users can highlight an italicized and underlined term and its definition will appear below the term:

> Water resources require short-term and long-term management to meet the needs of Earth's growing population. Increased competition for water, pollution, changes in technology demands *global warming*, and *climate change* lead to stresses on, threats to, and the balances among the *hydrosphere*, *biosphere*, *atmosphere*, *cryosphere*, and *lithosphere*.

When the user removes the cursor from one of these terms, the definition is hidden. Historical and modern photographs, annotated graphics, embedded videos and Google maps located to the right of the text provide additional explanation of technical terms.

Qualifications

I earned a bachelor's degree in astronomy and physics in 1981, master's degrees in systems engineering in 1989, geosciences in 2006 and space studies in 2014 and a doctorate in math curriculum and instruction in 1997. I have 27 years of experience teaching Earth science and comparative planetology to and creating curriculum for non-STEM college students, a background in statistics and research methods and ten years of experience organizing and participating in public STEM events.

I was the Science Department chair at the Pima College Northwest Campus for 11 years and organized, and ran 14 April Earth Day and October Earth Science Week events. More than 50 city and county environmental and educational organizations and 500 students participated in each event.

In April 2007 and April 2010, I invited world-renowned primatologist, Dr. Jane Goodall to speak at two public events, which I organized, at the Pima Community College Northwest Campus. Dr. Goodall spoke to more than 800 Tucsonans of all ages about climate issues. In 2014, I received commendations from the City of Tucson and the Pima County Board of Supervisors with a day in my honor for my community STEM-related outreach work with elementary, middle, high school and college students.

As a member of the University of Arizona Water Whys team (see University of Arizona, Water Whys, https://uavip.arizona.edu/teams/standalone-teams/water-whys), I contribute to development of scientific and easy-to-understand graphics to facilitate public understanding of water-related events. I was also a student at the first CAP University session, "Introduction to CAP," on Nov. 18, 2020, and attended a second session on December 6, 2022, "Deeper Dive on Power."

Results

WATER currently includes seven main sections: Introduction, Hydrology, Earth's Water, Arizona's Water, Tucson's Water, Terminology and Site Notes. Each is divided into subsections listed on the site menu, describing historical, geologic, geographic, meteorological, climatic, energy and regulatory aspects of water-related environments. The last section includes Research, Navigation, Credits, Permissions and Author Works subsections to inform the public about the methods used to create the site.

WATER includes a 700-word glossary annotated with videos, maps and historical images. It is constructed from more than 10,000 lines of HTML, CSS and JavaScript code. Subsections are easily added. The code is written using Notepad, a generic plain-text editor.

The end product will reflect the dynamic state of Tucson and Arizona's water environments, and the effects of climate change on Earth's water resources and populations. *WATER* seeks to create public awareness for the need to protect this vital resource by providing easily accessible, comprehensive and up-to-date information

Schedule

As of the end of the Fall 2022 semester I completed 33 units for a master's degree in Journalism with a specialization in Science, but for personal reasons, will continue to enroll in journalism classes for at least the next three semesters. Like some of my other sites (i.e., Science, http://denisemeeks.com/science/index.php, created in 1992) I intend to update *WATER* for many years to maintain it as a public educational resource, as noted in *WATER*, above.

Water-related information and updates are completed at least weekly. For example, as stated above, on August 16, the BoR declared a Tier 2 Colorado River shortage as of January 2023 (Water Resources Research Center, 2022). Arizona will need to cut CAP allocations by another 21% (Krol, 2022). This information has already been included in *WATER*, as have several new sources.

Conclusion

WATER is a multimedia project intended to partially fulfill this science journalist's responsibility to educate the public about water's role in social justice and public service inequities, water competition and instability and global warming and climate change threats, while providing scientific information about local, state, national and global water resources.

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