Synopses

2021-2025

PLASTIC SEA ISLANDS

There is a new twist to the ocean's giant regions of plastic waste, such as the Great Pacific Garbage Patch, that has apparently surprised marine biologists. Coastal marine organisms such as anemones and rock-dwelling polyps that inhabit nearshore or even intertidal environments are now being found attached to plastic trash in the middle of oceans. Although scientists surmise that nearshore species may have hitched temporary rides on degradable oceanic "vehicles" (e.g., logs or flotsam) in the past, their permanent residence in the open ocean is novel. This observation raises questions about whether the immigrants are competing with resident pelagic species for food, space and other resources and whether they may eventually evolve adaptations for better exploiting their plastic environment. In any case, it appears their new anthropogenic habitat is continuing to expand.

LITHIUM FROM WATER

A growing concern about global climate change has accelerated the replacement of gasoline-powered vehicles with electric ones that require large quantities of lithium for the batteries. Large-scale terrestrial mining of lithium is damaging to the environment; hence, researchers are looking to water as a more benign source. Highly concentrated salt solutions, known as brines, are available from geothermal and lacustrine sources that can be further concentrated in evaporation ponds or supplied with an energy-efficient heat source (e.g., solar) that expedites evaporation. Because lithium represents such a small percentage of seawater's ions, its use as a source is generally not practical. However, an electrochemical method that enhances lithium's separation from the more abundant ions is now available. Perhaps the brines produced by desalination can one day serve as a reliable lithium source.

OPTIMAL DRINKING WATER (part 1)

Whereas the emphasis on water quality has traditionally been removing contaminants to reduce health related issues, the topic of beneficial attributes for water (either naturally-occurring or additions following treatment) has received considerably less scientific attention. Potentially healthful benefits of drinking water have focused on minerals such as calcium, magnesium and potassium; however, their bioavailability from water is variable and dependent on an ion's valence state, as well as a person's gut flora and concurrent intake of food. Water provides less than 5% of our requirement for most essential minerals, although calcium and magnesium can reach 20%. As such, communities characterized by harder waters have been associated with lower rates of cardiovascular disease, hypertension and other diseases, perhaps because magnesium is a common mineral deficiency. Still, food remains our major source of minerals.

OPTIMAL DRINKING WATER (part 2)

Besides the dissolved minerals in drinking water, there are several other physical/chemical attributes (e.g., molecular structure, pH, ORP, deuterium content) that have been postulated to affect human health. Molecular structure is the most controversial of these attributes because it is difficult to measure and the persistence of clusters following ingestion has not been demonstrated, particularly in light of the processes by which water enters living cells. So-called alkaline (high pH/low ORP) water has been portrayed as an anti-oxidant and acid neutralizer; however, its ability to retain these physical properties long after ingestion is also frequently disputed. Similar to alkaline water, the benefits of deuterium-depleted water are based mainly on treating medical problems, rather than maintaining health; however, the mechanisms by which normal biological processes favor hydrogen over deuterium are scientifically recognized.

SAVING A GLACIER

The recent discovery of massive cracks in the ice shelf of Antarctica's Thwaites Glacier has concerned scientists because if the tongue of the glacier breaks off, it could precede its entire loss and subsequently raise sea levels by as much as 10 feet worldwide. Hence, there are a number of proposals to buttress the glacier using artificial braces, berms or islands that would buy time (probably a few hundred years) to cut greenhouse gas emissions and maybe stabilize the climate. Another proposal is to install anchored curtains around the ice that would redirect the warm dense waters that are melting the ice from below. Logistical, legal, and engineering challenges (not to mention the costs) associated with these alternatives are huge, and their probability of success is unknown—as are their unanticipated effects on the local environment. It usually comes down to a question of what's the riskiest path in the near term.

RED SNOW

Whereas algal blooms most often occur within the warm liquid waters of oceans, lakes and ponds, there are algae species that prefer the colder media of snow. They are red in color and darken the surface of the snow that, in turn, absorbs more heat (as sunlight) and melts it more rapidly. As melting snow is linked to warmer temperatures associated with climate change, scientists are interested in whether the increased snow melt and organic carbon production (due to algal photosynthesis) is offset to any extent by the CO_2 captured by the same process. It seems that the extent and duration of red snow is enhanced by the time interval between snowfall events because newly fallen snow blocks the sunlight required by algae species inhabiting previously fallen snow. As snowfall events become more infrequent during the winter in some locations, the effects of red snow could prove to be important.

WATER AND LOANS

Water conservation and sustainability has become such a hot topic that a major bank (BBVA) is now using water footprint analyses to determine whether they will loan money to a company. Essentially, these water footprint loans are applicable to companies that use water intensively in their production of energy, foods and textiles, which are also the industries most cited for polluting waters. This represents BBVA's solution to the sustainable financing market and permits the loans to be structured as either bilateral or syndicated, thus serving as an incentive for companies to transition to more water-conscious operations in generating their products. The water footprints are focused on current water consumption and wastewater discharge, while also encouraging a reduction of 50% by 2030. The companies with smaller water footprints become preferred loan recipients and pay lower interest rates.

WASTEWATER EPIDEMIOLOGY

As a consequence of modern wastewater infrastructure that uses water as a transport medium to carry human wastes, researchers have been able to use wastewater analyses to paint a surprisingly detailed picture of local populations. Data as diverse as the rise and fall of viral epidemics (e.g., Covid-19), the use of new cosmetics or recreational drugs, and the kinds of foods preferred by people in the service area are collected. Whereas sampling at the wastewater treatment plant generally includes a very large and diverse cross-section of the local population, sampling sewer laterals from specific neighborhoods or even streets can provide more focused data. Given the specific information that wastewater analyses provide about people's personal activities, there have been concerns that these investigation techniques could violate privacy rights. If such rights are not violated, what goes down the drain becomes public knowledge.

SYSTEMS AND A.I.

The management of water resources and their associated anthropogenic technologies are increasingly addressed by systems theory and artificial intelligence (A.I.). The advantage of a systems approach is that it describes interactions among water resource or watershed components as spatiotemporal relationships through which matter and energy are cycled. The emphasis is on a water system's organization and connected components for identifying the controls and feedback dynamics that govern its properties and behaviors. A.I. functions in a similar manner by identifying patterns and then making decisions based on what is learned from them. Computer algorithms use data inputs to perform a number of functions that include locating water losses (leaks), predicting water consumption, suggesting energy-related water savings, and designing water monitoring networks.

A THIRSTY A.I.

However valuable A.I. may be saving water and energy with its data, the massive centers that generate these data require enormous amounts of water. Specifically, the process of A.I. learning creates heat that must be cooled by water. This results in a burgeoning demand by data centers to obtain and treat the water. Augmenting water with air and even supercritical CO_2 for cooling purposes is currently being investigated; however, water will remain indispensable. In addition to the direct use of water, generative A.I. also exerts an indirect water demand related to its increased energy use. This energy demand is prompting major tech firms to consider reopening coal and nuclear power plants. The previously closed plants will require additional water sources for their own cooling purposes, as well as for the extraction and refining of fuels used to generate the electricity.

ELECTRICITY FROM WATER PIPES

Surprisingly, one source of electricity for dealing with A.I.'s huge energy demand is actually provided by the flow of potable water in the pipes that deliver it to homes and businesses. Water leaving treatment plants must be pressurized to transport it through the network of conduits (predominantly underground) that are ubiquitous in today's world. The pressurized water is used to spin miniature hydroelectric turbines and generate electricity that can backup intermittent electricity sources such as wind and solar. An advantage of in-pipe power generation is that it requires neither construction of new infrastructure nor substantial changes to existing pipe networks, as do most other forms of alternative or renewable energy. Although this technology has been installed in only a limited number of locations, it could potentially provide more than a gigawatt of power for the USA alone.

A LIVING BEING

In early 2023, more than 190 countries agreed on a United Nations treaty protecting the ocean's health and biodiversity within the so-called *high seas* that lie beyond the 200-mile territorial limits of individual nations. While this treaty has been debated and anticipated for decades, some marine scientists are calling for a more profound recognition of the oceans as a "living being" with rights similar to those of humans. They note that oceans are still not represented by international laws that would recognize their possessing value as intrinsic worth, rather than as just a resource or repository. Humans' footprint on the oceans has been enormous in terms of species extinctions, decimated fisheries and coral reefs, chemical pollution, plastic wastes, and the absorption of carbon and heat associated with climate change. The oceans' role in climate stabilization alone has been invaluable in minimizing the potentially catastrophic consequences of rapidly changing global temperature and precipitation regimes.

REFREEZING POLAR SEAWATER

Arctic ice sheets extending long distances into the sea have shrunk by 40% due to climate change; hence, solar radiation that was historically radiated back to space is now absorbed by the polar seawater. Because sea ice freezes from the bottom-up, it is insulated from the frigid air temperatures that could enhance the processes of freezing and thickening. A proposed fix to this situation is drilling through the existing ice to reach the underlying seawater, which is then pumped onto the surface ice and snow. Exposed to the cold air, seawater then freezes and thickens the ice sheet, increasing its so-called thermal conductivity. As with many geoengineering schemes, this one has potential issues such as accumulated salt on the ice surface (a result of freezing seawater), impacts to marine algae that comprise the base of the marine food chain, and a reduction in surface snow cover that reflects more solar radiation than does ice.

UNCONVENTIONAL SOURCES

Previous synopses have presented unconventional ways to obtain usable water from recognized sources, but water challenges have progressed to the point that previously dismissed or ignored sources are now considered. Towing icebergs from polar to temperate regions is an alternative that expands the practice of towing them short distances to avoid collisions with marine oil rigs; however, the energy requirement, the loss of melting water during transport, and the risk marine ecological effects could be substantial. Another alternative is wastewater recycling to generate potable water, which requires the costliest treatments available and also comes with the risk of currently unidentified wastewater contaminants. Finally, there are deep sea desalination pods that use the ocean's hydrostatic pressure to remove the salts, but require energy to pump freshwater to the shoreline and are at risk for damage to the ocean floor. How do we perceive the risks associated with water's availability and quality?

ASSESSING WATER RISKS

There are mathematical models that estimate the relative risks of health and ecological impacts associated with implementing a range of water technologies, but they are limited to what is known or anticipated. In addition, human decision-making is usually more aligned with beliefs, ideologies, fears, and conditioned responses than with rational assessments. Neuroscience has revealed that people can hold completely inconsistent and even contradictory ideas with equanimity, as the brain has no automatic mechanism for evaluating their compatibility. As such, the perception of water-related risks often produces decisions that appear paradoxical and irrational, which is at least partly due to how water is generally perceived in the postmodern world and how the brain utilizes heuristics to oversimplify complexity. These final synopses delve further into human perceptions and the challenges they pose to addressing water issues.

IS WATER REAL? (part 1)

This may sound like a nonsensical question, but it relates to a much broader inquiry into any form of matter. The dominant scientific axiom is that the physical world represents the fundamental level of reality and that all phenomena, including consciousness (as a personal awareness) and fields (both classical and quantum), are the result of physical processes occurring in space and time. Considering its inability to reconcile classical and quantum physics, as well as to explain consciousness, some scientists theorize that matter and spacetime owe their existence to a more fundamental level of reality. Among the alternative theories, one posits that consciousness or experience (as a type of universal "mind") gives rise to matter and spacetime in the form of a useful interface for navigating our perceived reality. If so, water represents an aspect of the universal 'mind' that we do not otherwise perceive. This kind of representation would then apply to our body and personal (subjective) awareness as well.

IS WATER REAL? (part 2)

The theory that a universal consciousness represents the fundamental level of reality is known as *formal idealism*, as opposed to *physicalism* that assumes matter and spacetime are fundamental. As for perceived physical substances, formal idealism (different than ethical idealism) maintains that the act of observation is what permits matter to serve as a subjective representation of the transpersonal mental states ("mind") characterizing a universally shared consciousness. This form of idealism does not diminish the importance or ubiquity of water, which is essential for living practically within our perceived physical world. Instead, water would represent an aspect of a fundamental reality that we do not directly observe. As noted in earlier synopses, some ancient and/or indigenous cultures linked water to an unobservable realm that ultimately gives rise to the observed physical world. As such, water was often identified metaphorically as a kind of mediator between their intuited and perceived realities.

PERCEPTUAL INSIGHT

Insight is considered to be as a sudden realization or comprehension that can result in the solution to a problem or situation as a result of its reinterpretation. Neuroscience research suggests that the right cerebral hemisphere is primarily involved and that insight is often accompanied or immediately preceded by gamma brain-wave activity. Perceptual insight combines sensory inputs with a deeper interpretation of that which is observed (often via the recognition of patterns), thus compensating for internal distortions and achieving a more accurate understanding of the observation. Perceptual insight is related to how effectively a person questions their sensory observations (using introspective knowledge) when inferring actual states of the world. This can apply to easily recognized illusions such as the relative motion of multiple objects, as well as to potentially subtler appearances such as the ultimate reality of a physical world perceived through the senses.

WHY WATER INSIGHT?

So, why discuss perceptual insight and consider metaphysical questions about the nature of reality as it pertains to water, which is only one of countless physical substances in our observable world? Because water seems to be unique in its ubiquity and myriad roles in sustaining earthly life and regulating planetary conditions, our considering what water may or may not represent on a more fundamental level could be worthwhile. As humans ponder, ignore or deny the planet's changing environmental conditions, decisions we make regarding water will be of utmost importance. If water does represent something more than a seemingly ordinary substance, might this realization influence our actions and decisions? Will anything other than intuiting or realizing that water is something more fundamental or quintessential than we are able to discern with our senses and logic be capable of prompting such a shift?

A FUNDAMENTAL MYSTERY

Water's mysteries have long been revered by humans, and science has developed theories that have provided testable and logically consistent frameworks for predicting natural phenomena and developing technologies. Nonetheless, some scientists and philosophers are increasingly skeptical that these theories, however practical, can ever unveil the ultimate reality of physical existence. Specifically, the fundamental status of matter and spacetime (as physicalism) is being questioned in light of basic research conducted over the last 125 years. Is our observable world derived from something more fundamental that we do not access? While the answer to this mystery is unknown, the prospect of such a perceptual insight is intriguing—although contrary to our sensory observations and conditioned beliefs. The reality of all matter notwithstanding, water ranks among the most mysterious even in terms of conventional theories.