

## 2013-2016

## CONFLICTS AND WATER

A substantial number of papers and books have been written about the role of water in global, regional, and local conflicts. On the local level, improved access to clean drinking water can keep children in school by preventing chronic disease and reducing the time required to collect and haul water. Thus, children realize greater economic and professional opportunities, reducing poverty and increasing so-called human or internal security. Examples of external security threatened by water conflicts are nothing new, but the added burden of climate change on water resources has heightened the probability of regional, international, and even tribal disputes. Disagreements over rights to transboundary waters of diminishing quantity and quality are particularly problematic. Perhaps this is why many ancient cultures considered water to be a gift, rather than a right.

## WATER JAZZ

The topic of underwater sound was discussed in a previous insight, but water as a subject for musicians and nature-oriented composers has produced some remarkable works and demonstrated that the sounds of water have a recognizable rhythm and pitch. Sounds of waterfalls and breaking waves have been relaxing muscles and soothing nerves for millennia. Recently, a British scientist suggested that water displays a quantum coherence that is similar to jazz because it permits both local freedom and global cohesion. Water has a vibrational range spanning more than 50 octaves that corresponds to everything from molecular interactions to planetary vibrations. The extent to which water orchestrates or underlies these phenomena is unknown; however, the analogy of different water structures or networks playing the role of various instruments or tracks within a jazz tune is a thought-provoking one.

## GEOENGINEERING WATER

Geoengineering remains a controversial “fix” for climate change due, in part, to its potential effects on planetary water. Ocean fertilization is a technology that adds soluble iron to the surface in an attempt to stimulate phytoplankton (microscopic algae) proliferation and consumption of CO<sub>2</sub>. Ecologists warn that massive blooms could reduce local biodiversity and question whether the carbon-rich algal biomass would actually reach the seafloor before being respired back to CO<sub>2</sub>. Similarly, geoengineering projects ranging from building berms and artificial reefs to importing clays and exotic plants have been proposed for Gulf Coast marshes devastated by oil spills, hurricanes, and altered hydrologic regimes. Critics note that past geoengineering schemes are largely responsible for the present damage. Is another round of geoengineering prudent or could nature restore the marshes before it's too late?

## GPS TRACKING OF WATER

Using the global positioning system (GPS) to assist us in finding a place where we have never been is now fairly commonplace for most of us. Geoscientists utilize GPS networks to measure the movements of the planet's surface and, more recently, to measure attributes of the terrestrial water cycle in the form of snow cover, soil moisture, and plant water content. This is possible because some of the GPS signal reflects off the land surface near the antenna before reaching the satellite. Water scientists and managers use this data to monitor the real-time progress of droughts, floods, precipitation, and the uptake of soil water by vegetation characteristic of different regions. The largest GPS network currently consists of 1100 sites (antenna) scattered throughout the Western USA; data from this network can be downloaded from the internet by researchers interested in the dynamics of local water cycles and watersheds.

## TAP VERSUS BOTTLED

The quality of drinking water available from various sources has become a major controversy among experts, advocates, and the public. The bottled water industry has flourished for the last two decades based on the assumption that tap water is often contaminated with pollutants (e.g., metals, solvents) and additives (e.g., fluoride) that are removed by the processes used to prepare most bottled waters. The current backlash against bottled water is fueled by the arguments that it wastes energy (in many ways), creates more plastics, and is less regulated (for quality) than is tap water. While the dispute continues, no clear choice is provided to people who are genuinely concerned. Several water advisory groups suggest the use of home water filters, ranging in scope from simple activated carbon to reverse osmosis units, to treat tap water—representing a hybrid choice that requires people's active participation.

## EATING WATER

The term “eating water” refers to the observation that the largest component of a person's water footprint (about 90%) is devoted to food in the form of crop and animal production. By comparison, domestic water supply and industrial product contributions are relatively small. Most of this eaten water is *green*, meaning that it is rainfall consumed directly by food crops or by grasses that feed animals. In arid regions where rainfall alone is insufficient for food crops, *blue* water present in surface or subsurface environments (e.g., lakes, aquifers) must supply the remainder. Finally, agricultural and livestock operations produce biological and chemical wastes that must be diluted by so-called *grey* water to concentrations that meet water quality standards. The combined volumes of these three waters compose the major portion of a human water footprint; hence, changes in diet and food waste may be the key to water conservation.

## EPIC DROUGHTS

Australians have endured drought conditions for decades and, recently, Californians (and many living in the Western USA) are facing a similar situation. Neither of these two epic droughts is unexpected, as both regions are subject to cyclic rainfall patterns. Moreover, neither situation has or will be addressed solely by imports or technologies, which have permitted Californians to engage in activities (e.g., irrigated agriculture, population growth) that exceed the carrying capacity of local water resources. The state's water agencies have placed restrictions on residential and industrial water use, but this represents a small fraction of the water consumed in the state. Most of the water is used by agriculture (now severely impacted), fueling arguments that less water-consumptive crops should be grown and more desert-compatible lifestyles should be adopted. In any case, the focus is slowly shifting from technological miracles to rational activities.

## CIVILIZATION COLLAPSES

Whereas short-term droughts can have a detrimental effect on the economy and ecology of regions, longer-term water shortages have collapsed entire civilizations. Researchers posit that the great Roman civilization thrived by importing grains that were grown in distant water-rich areas, which eventually experienced declines in production due to climate variations. As a result, insufficient water to produce food for the huge urban population of Rome may have initiated its collapse. Similarly, the highly advanced Mayan civilization probably succumbed to long-term drought, even though the frequency of hurricanes may not have decreased. At some point, the waters of the Yucatan's subsurface limestone system were insufficient to irrigate the crops required to feed a huge population. These collapses suggest that large populations dependent on consistent water supplies are vulnerable to even modest changes in climate.

## PLASMA FROM WATER

Plasma is the so-called fourth phase of matter that joins the more familiar solid, liquid and gaseous phases. Most of the matter in our universe is plasma, which consists of charged particles (e.g., positive ions and free electrons) that are present in stars, outer space and common electrical devices. Subjecting water to sufficient electrical or thermal energy breaks the chemical bonds that hold it together, producing a plasma stream that can be used to cut metals or to generate hydrogen gas as a fuel. Creating plasma from water can also serve as a means of treating potable water via producing the kinds of free radicals that are often used for disinfection and detoxification. Advantages of this plasma method include the relatively energy-efficient plasma reactors, the small volume of water required to generate sufficient plasma, and an absence of chemical byproducts resulting from the conventional treatment of drinking water.

## WATER FROM PLASMA

As the predominant form of matter in our universe, plasma and its associated electrical currents seem to be ubiquitous in the cosmos and may give rise to more recognizable forms of matter—including water. The interaction of solar wind (plasma) with oxygen-containing dust particles in the cosmos may have created much of the water on the earth and moon. Moreover, a planet in the constellation Ophiuchus appears to contain huge amounts of supercritical water that results from the planet's high pressures and temperatures. This "plasma water" possesses the properties of both a gas and a liquid. Plasma currents in interstellar space are known to contain dust particles, as well as hydrogen and oxygen ions, leading some scientists to posit that water is continuously created via plasma discharges. From the photospheres of red giant stars to the water jets of quasars, is most of the water in our universe created electrochemically?

## FOGGY RESOURCES

An under utilized water resource in coastal arid regions is the fog or low-lying marine clouds present in the evenings and early mornings. Condensation of the fog on native plants has permitted their growth despite precious little rain in regions such as California and Chile. Several groups around the world have developed simple catchment technologies to condense fog water and collect it to provide everything from garden irrigation water to a premium drinking water. Each square meter of collection surface (a fine mesh) can produce 2 to 7 gallons of water daily that varies in quality depending on air pollution overlying the sea and coastal hills. There are studies currently underway to pinpoint the most productive places to collect fog water, which is produced under a narrow range of topographic, oceanic, and atmospheric conditions. Unfortunately, the heat associated with urbanization has reduced the extent of fog near cities.

## ENSO AGAIN?

The press is buzzing with the prospect that a 2015-2016 ENSO event could be the most powerful in almost 20 years. ENSO (El Niño/Southern Oscillation) is the combined oceanic and atmospheric event resulting from unusually warm surface waters in the eastern equatorial Pacific Ocean. Drought-stricken Californians hope ENSO ushers in a wet winter; however, ENSO events don't always bring heavy rains and the global climate has changed in the last two decades. Even if heavy rains do arrive, they will not end the drought conditions in one winter but they may result in widespread urban flooding. Most urban runoff in California cities is diverted into concrete canals that empty into polluted coastal waters. Los Angeles is now building stormwater capture basins to utilize the runoff as a water resource to treat or to recharge aquifers. In either case, Californians are learning they cannot take any water for granted.

## ANTHROPOCENE H<sub>2</sub>O

The Anthropocene is the geologic epoch (or a proposed one) in which we now live and it's characterized by human activities shaping the global environment rather than vice-versa. There is no doubt that humans have altered the continents, oceans, atmosphere and biosphere, but perhaps the most substantial human impacts have been on the planet's freshwaters. Besides overexploiting the now scarce water resources, humans have relocated enough surface water (mostly from rivers to reservoirs) to slightly alter the spin of the Earth. Also, global inequalities in accessing sufficient clean water are now considered to be a major threat to international security. Climate change not only affects the volume and distribution of available freshwater, but the reverse is also true. Water is the primary agent of change on Earth and it cannot be separated from the other major planetary compartments that were previously mentioned.

## RIVERS IN THE AIR

A previous insight described global-scale ocean currents or rivers that transport seawater and temperature signals, and now atmospheric scientists have discovered rivers in the sky that transport water vapor from subtropical to temperate regions. These atmospheric conveyor belts of moisture play a role in creating and sustaining hurricanes, as well as determining where and when rainfall occurs over mountainous terrain. For people living in California, the most famous atmosphere river is the "Pineapple Express," which brings heavy rains (especially during El Niño events) northeastward from the tropical moisture overlying Hawaii. On the flip side, changes in the location of these airborne rivers or the amount of water vapor they carry can also result in drought conditions, as they are responsible for up to 90% of the precipitation in the mid-latitudes. As is true of all climate phenomena, the oceans appear to be the primary controller.

## UNDERWATER WAVES

Besides the familiar surface waves in the ocean that result from storms, winds or seismic events (e.g., earthquakes), there are much larger and deeper waves that form and break deeper in the ocean. These waves move along the planet's ocean floors and result from the sinking of dense, cold water at the poles (particularly Antarctica) that spread out until encountering a continental shelf, where they either break or rebound back and forth across ocean basins. In either case, a huge volume of seawater is mixed by this turbulence, thus maintaining the global balance between cold and warmer waters. Interestingly, the deep waves have a rhythmic or pulsating component to them thanks to the influence of daily tidal cycles. Not only do these deep waves contribute to the steady state of the oceans, they do so by exchanging as much energy as all of humanity consumes in a year.

## TOO MUCH SEAWEED

During the last five years, coastal waters and beaches of the Atlantic Ocean, Gulf of Mexico and Caribbean Sea have been inundated with *Sargassum*, which is a macroalgae or seaweed that vegetatively reproduces and floats on surface waters as it's transported by winds and currents. Although the seaweed provides a marine resource in terms of nutrients, food and habitat for marine organisms, something has caused it to overproduce and create a nuisance. Accumulating and decomposing on beaches and in shallow waters, the seaweed produces noxious H<sub>2</sub>S gas, attracts insects, and kills fishes and sea turtles. Whereas the cause of the *Sargassum* proliferation is still unknown, it appears as elongated slicks on the ocean surface that display distinct patterns—suggesting that temperature, pH or dissolved chemical (e.g., nitrogen, phosphorus, iron) anomalies associated with localized currents may be a factor.