Water: The Essence of Life

Water. The essence of life. Living in Western Pennsylvania, we are blessed with an incredible supply. Three major rivers flow through Pittsburgh and in years like 2018 we are overly blessed as record rains have caused major flooding and infrastructure damage. However, much of the world suffers from the opposite problem. Flying around the world, I am amazed at how often looking out the window the predominant color one sees across much of the globe is brown, often with only narrow strips of green following a river valley or irrigation trenches. Flying out west in the United States, I was initially perplexed at the geometric patterns I often saw, a perfect brown square with a green circle in the middle, until I learned that was how farmers irrigated. A central well and a giant rotating radius of a sprinkler system bringing life to near desert conditions.

Australia recently suffered a massive prolonged drought lasting 2003-2011 with some regions of the continent still suffering from water deficiencies. Regions of the continent began to suffer again from 2013-2015. Today in 2018, farmers in New South Wales and Queensland are being hit once again with crippling droughts. Cape Town, South Africa was on the brink of "Day 0" last year, the projected day when the city would be forced to shut off water to a population of 4 million people. Other major cities around the world have been faced with crippling shortages. In 2015, Sao Paulo, Brazil faced water intakes clogged with mud and projecting a mere 20 days of water supply in its reservoirs. Mexico City, which pumps massive amounts of water into the city from surrounding regions loses an estimated 40% of its water to leakage from dilapidated infrastructure. This results in shortages and little water service in poorer communities.

In the United States, we hear reports about how southwestern aquifers are being sucked dry and rivers in that region are flowing at a fraction of their historic levels as demand increases annually. Forecasts are for continued growing demand on hydraulic assets. Even still, the United States is blessed with an abundance of water compared to many regions of the world. This has raised several interesting analyses. One that I found fascinating is that the US is exporting incredible amounts of water. Not water in the form of pure H2O. Water in the form of agriculture that requires massive amounts of water.

When California was going through its 5-year drought from 2012-2017, I read many reports about just how water intense many crops are and how desperate farmers were drilling ever deeper to get access to the ever-dwindling water supplies in the underlying aquifers. The number that still fascinates me any time I get to enjoy one: every single almond requires a gallon of water to grow. I am consuming 10 gallons of water in a single handful! Many water intense agriculture products are popular exports. According to the US Geologic Survey, 1 egg requires 50 gallons of water to produce, 1 pound of corn requires 110 gallons of water, and amazingly 1 quarter pound beef hamburger requires 460 gallons! Another water intense feed crop, alfalfa hay, is a major export to China from our western states.

So what is one to do? Some arid countries like Israel and Chile have focused on technological solutions like drip irrigation. Agriculture scientists have been breeding and genetically engineering seed that is more drought tolerant. However, if one reads the forecasts for the coming decades, the planet faces increased desertification and more distress on fresh water systems not only from over exploitation of aquifers, but inundation from salt water as fresh water levels drop and sea levels rise and increase the backflow of brackish water. Many countries are building more and more desalinization

infrastructure. However, such facilities are expensive to build and maintain and are energy intensive, as is pumping water inland from coastal areas.

I have recently seen two very interesting technologies that might help. A Dutch inventor named Ap Verheggen has devised Sunglacier, a solar powered water gathering system that can convert the humidity in desert air using the same principle that makes a cold soft drink bottle sweat on a hot day. His current system can produce 1,000 grams of water per hour and a newer design is producing 4.5 liters overnight. The Dutch Ministry of Defense is funding the development of a portable unit capable of producing 40 liters of water per day. Such production would be valuable to residents of arid regions. While this is a promising technology, it is still expensive to construct.

For Verheggen's invention to make a difference on a mass scale, however, it would require a truly massive number of solar panels and infrastructure. Would this make sense?

In a 2016 Forbes magazine article, UC Berkeley Professor Mehran Moalem gave an interview discussing carbon free energy possibilities. With 2016 solar technology, Moalem calculates that covering 1.2% of the Sahara Desert (43,000 square miles) with solar panels, one could produce slightly more energy than is consumed globally on an annual basis. Is such a feat feasible? Moalem estimates that the cost would be $5 Trillion. That is a little more than I have in my savings account and when I checked with American Express, they were not willing to up my credit limit. Alas, they said it was a bit much for them, even given my 25 years as a member with a perfect payment history. To put $5 Trillion into perspective, that number is 25% of US National Debt and about 10% of Global GDP. Expensive? Yes. Providing a carbon free energy source that could more than power all global needs? Arguably a great deal.

Would this mean that we would have to consider moving to Africa? Given current technology (please pardon the pun) much of that electricity can be shipped to Europe and the Middle East with nominal loss. According to a 2015 BBC interview with Gerhard Knies, Co-Founder of TREC, a network of sustainable energy experts, power can be transferred via power cables and lose only about 2% of the energy over a 1,000 mile transmission. Solar energy is more expensive than fossil fuel generated electricity, but the technology continues to advance and with the massive economies of scale that such a project would create, one can see the price being quite competitive with conventional means. With such electrical output, other forms of energy also become viable. Hydrogen can be created via the electrolysis of water and easily shipped around the globe to power fuel cells. Desalination plants will have a massive source of energy to draw on. High energy storage advanced technology zirconium and titanium batteries could also move electric power. All this in a region where only about 30% of the sub Saharan population has access to electricity today.

Does this all sound too good to be true? How about I take it one step further. Another scientific study recently caught my eye. Massive solar and wind farms in the Sahara Desert have been proposed as a method of geoengineering, halting desertification in Africa. The heat generated from the sun baking solar cells and altered wind patterns due to windmills would change weather patterns and significantly bring rainfall according to climate models in a study published by Yan Li and a team of researchers in Science Magazine. Talk about having your cake and eating it too!

A project such as this would bring massive industry to one of the poorest regions of the world. Energy generation would theoretically far outstrip that which we produce via carbon intense extractive methods. Africa, perhaps the poorest region on the globe, would have to benefit. One would like to see more politically stable governance in the region and it would require massive global cooperation in an

era where we are witnessing intensifying xenophobic populism, but it is reassuring to know that such incredible potential exists and could reasonably be implemented in a few decades. The Intergovernmental Panel on Climate Change issued a report in October 2018 warning that we could face dire consequences due to global warming if carbon emissions are not drastically cut soon. In this report, the panel warns that the worst impacts can be avoided only by a "far-reaching and unprecedented" transformation of the global energy system, including virtually eliminating the use of coal as a source of electricity. In fact, it calls for a complete moratorium on coal fired electric plants by 2050. Such stark warnings regarding global warming might seem too intimidating to tackle, however forward-thinking projects like converting the Sahara to a solar farm could solve many of our water, energy, and carbon reduction concerns.

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