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Water Scarcity

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Water scarcity is seen as the No. 1 global risk based on the potentially devastating impact it will have on society. Even with greater investment in supply projects, water shortages promise to handicap the very industries that are the backbone of the global economy, especially agriculture. Author Meghna Tare argues that the problem is made worse because water is undervalued and says a better pricing structure and conservation practices can provide rational incentives to invest in water-saving measures.

BNA Insights: Future of Water Rides on Efficiency, Social Innovation, Data Analytics

By Meghna Tare

In physics, the law of conservation of energy states that the total energy of an isolated system remains constant—it is said to be conserved over time. Energy can neither be created nor destroyed, but it can change from one form to another. Laws of physics dictate that water cannot simply vanish from the earth. But the water scarcity problem is global and serious. Without introducing the impact of climate change on water resources, the water scarcity problem influenced by the increasing population and fears of food security is dominating the policy- and decision-maker's agenda. The water crisis is the No. 1 global risk based on impact to society as a measure of devastation, and the No. 8 global risk based on the likelihood it could occur within 10 years, the World Economic Forum said in January 2015. Even after investing some $400 billion in water supply projects over the past century, the U.S., with so much innovation and technology at its feet, faces a shortage that has no easy remedy.

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The problem persists because water is so undervalued. According to Fortune magazine, New York City charges residential consumers $3.37 per cubic meter, while the rate in Chicago is $1.46 and in Miami, $1.15. Regions with the most serious water scarcity challenges have the lowest rates for water and sewage services in the country. For example, residents of Dallas pay $9.53 for 3,750 gallons in billable water usage compared to $19.81 for Atlanta, which receives more rainfall. The average home in the U.S. paid $3.24 for 1,000 gallons of water in 2011, and in 2015, that increased by only 6 percent, according to Circle of Blue. But the residential im-

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pact on water supply is minimal, with only 8 percent usage, meaning water scarcity cannot be linked to the usage in kitchen or bathroom.

According to the United Nations, 70 percent of the global water supply is consumed in agricultural production. Agriculture is responsible for about twice as much of total U.S. water withdrawals as all industry, building and mining operations combined. Water for agricultural use is still priced more cheaply than it should be, which encourages over-consumption. When farmers have to buy water on the spot market, it is sold in acre-feet and a lot cheaper than the municipal water. There has been very little incentive to conserve water on farms, because the public often subsidizes the use of water to grow taxpayer-subsidized crops. The price for water is simply the cost to deliver it, and nothing more! A second factor that encourages waste is the ''use it or lose it'' system of water rights, which means that if farmers do not use all the water to which they are legally entitled, they relinquish their future rights to the unused water, which may then get allocated to the next farmer in line. Thus, they have very little motivation to conserve.

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One could argue that the answer to water scarcity is the introduction of market economics and water pricing. The idea of treating water as a commodity, like oil or gold, might seem disturbing on its face, but access to clean water ought to be a human right, a position supported by the UN in a 2010 resolution. Environmental economists suggest applying free market forces—Adam Smith's ''The Invisible Hand'' speaks to this issue—in which a certain amount of water is allocated to everyone for free (or almost no cost) outside the market system. The rest would be handled through a free market, which helps distribute and manage it more efficiently. If, for example, the price of water for farming is set at $10 per acre foot and for urban use at $100 per acre foot, it leads to inefficient use of the water for irrigation purposes because farmers have no incentive to conserve. According to economists, water efficiency can be boosted by combining the two markets into one, thus generating a single price of around $70 per acre foot. Such an effort would clearly be efficient since the water not bought by farmers would be freed up for urban use. If a farmer paying about $200 per acre foot per year invests $50 per acre foot to save water, say, by using drip irrigation, and sells the excess for $200, he can actually make some profit while conserving natural capital. For a state such as California, the $46.4 billion agriculture industry accounts for 80 percent of water consumption but only 2 percent of the state GDP. If agriculture used 12.5 percent less water, it could increase the amount available for every residential and industrial use by 50 percent.

A better pricing structure and conservation practices can provide rational incentives to invest in water-saving measures. For example, properly installed drip irrigation uses 80 percent less water than conventional irrigation. From a resource management perspective, farmers will have a greater incentive to irrigate efficiently and choose higher-valued cropping patterns if water charges reflect the full cost of development and the opportunity costs of using water in other sectors. For example, in California's San Joaquin Valley, the Broadview Water District set a 1989 water intensity target at 10 percent below its 1986-1988 average for each crop, and it enforced a stiff surcharge on excess water use. Water use per acre fell by 17 percent and total drain water by nearly 25 percent.

Charles Fishman said in his book *The Big Thirst*, ''There is nothing unethical about managing water demand with price, and there's nothing immoral about allowing the market to help allocate water—just so long as we solve what might be called the first-glass problem, so long as everyone has access to water for their basic needs at the lowest possible cost. Beyond that, a little application of the market might help us use water more wisely, more equitably, and leave some for nature!''

Public choice theory dictates that although people acting in the political marketplace have some concern for others, their main motive is self-interest. Changing the incentive structure is an important policy lever for promoting better management of scarce water resources. Policies, innovation and technology that work with markets, not against them, should be implemented and adopted.

Social Innovation.

A new tech startup, Sustainable Water and Innovative Irrigation Management (SWIIM), developed in partnership with the U.S. Department of Agriculture and Colorado State University, has come up with a way to provide incentives for farmers to lease their extra water, much in the same way Airbnb enables homeowners to rent out their spare bedrooms or homes. Some farmers already sell their water during droughts. SWIIM offers farmers an option to keep farming with conservation techniques such as drip irrigation and then lease out the water they save. However, calculating the amount conserved from, say, switching from flood irrigation to a drip system is difficult. The SWIIM software calculates in real time how much of a farm's water is consumed and how much returns to underground flows, ensuring accuracy and accountability if they choose to sell their conserved water. The software also crunches data on water prices and a farm's soil and crop types to recommend crop rotation. In dry years it may even recommend growing different crops, reducing the water allocation for certain crops. A farmer enters how much water he or she wants to unload and that information becomes available to water managers, who can then offer the water to other farmers, companies or urban water districts facing water shortage providing them an incentive to conserve for profit.

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Technology and Analytics.

The last Green Revolution was driven by science by increasing yields through advances in biotechnology. Information technology, including advanced analytics and ''big data'' solutions, will drive the efficiencies and insight for improved decision making in this new era of ''Smarter and Sustainable Agribusiness.'' Farmers have traditionally relied on intuition and experience. Yet agriculture is ultimately driven by mathematics and science such as input of water for crop production. Predictive data analytics can give farmers greater visibility and minimize risk of crop damage. Farmers can use an analytics system to analyze water usage, as well as crop yields, modify operations to take advantage of natural weather patterns, mitigate the impact of climate change and gain a better understanding of the exact amount of water each type of crop needs. For example:

- Soil tension sensors—combined with data about temperature, weather and humidity—can be used to manage smarter irrigation systems for farmers. These irrigation systems use data to find more efficient times and better ways to use water.
- Refuting the idea that drones are primarily useful for surveillance or warfare, agriculture drones are helping shape the agriculture industry in terms of efficiency. They provide higher-resolution field images, infrared photography and instant integration with other farm data technologies, which help farmers detect water stresses and over irrigation and improve water usage efficiency.
- Using electricity data from basic smart meters that are installed on water pumps and networks can detect pump leaks. The farmer receives a text message in the event of an abnormal spike in water use (which corresponds with the spike in energy from the meter).
- Farm data management software, which includes tools for water management, helps farmers manage data such as real-time soil moisture, water balance information, irrigation scheduling, water reporting and more.
- IBM's Deep Thunder precision weather forecasting is helping farmers make more informed irrigation scheduling decisions. The forecasts are available on mobile devices, giving farmers 24-hour access to critical weather information in conjunction with other relevant field data, thus helping farmers conserve water and reduce the impact from future droughts. IBM SoftLayer also manages data flows and automates irrigation recommendations, allowing farmers to determine how much water a specific crop needs at various stages of its life cycle.

The aim of the emerging approach to water governance—rooted in social innovation and technological advances—is to adopt a stronger sustainability approach, one guided by principles of stewardship, equity and accountability. When faced with two different paths, each with certainties and unknowns, one could always take the path less travelled, but the cardinal rule in strategic planning is to take a path that allows you to shift to the other path if your initial decision should prove wrong. The solution to water scarcity requires policies such as better regulations, access to water for agriculture, innovation, use of technology and efficiency. We have to apply a systems-thinking approach to this problem—everything is part of the puzzle. Increasing population, food security and water scarcity are all interrelated and interdependent. As futurist, Peter Schwartz advises in his book *The Art of the Long View*, ''We should choose the option that gives us the most options in the future.''