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"Transcultural Impacts and Perspectives on the Future"

Perspectives from Finland, France, India, Italy, Japan, Sweden, the United States of America, and Venezuela.

From the Desk of Tim Mack, President, World Future Society

Life on planet earth, regardless of geographic setting or culture, has some very specific requirements, common to every living person. This article will look at those challenges relating to the health and well being of all humans, ranging across all cultures. One of the basic premises here is that while cultural forces can affect many aspects of life, the elements involved in sustaining that life can have just as profound an effect on culture, especially in a negative or disruptive fashion.

There are three fundamental resources associated with sustaining life anywhere on this planet: water, energy and food. As many people learned in recent years concerning corn-based ethanol, there is a wider relationship between energy and food than previously understood. We also know there is a long-term relationship between energy and water, in the form of hydropower and now tidal power. And the connection between water and the production of food is largely self-evident.

There is a clear convergence of all three of these basic fundamental needs and their many relationships. The world needs solutions that address these challenges on all axes simultaneously, as opposed to solving one problem while creating stresses elsewhere. Accordingly, I am addressing not just water futures but also how they interact with the futures of energy and food. And I am not just addressing maintaining the status quo, because that would not be possible, but am instead considering strategies for increasing self sufficiency in the future, in the face of myriad forces acting to reduce that self-sufficiency. Among these forces, I would include skyrocketing demands on existing resources, increasing infrastructure stresses, climate change, and the politics of global competition for water, energy and food. Positive counter-forces, which can be tactically enhanced, include new technologies, education on public health, and consumption practices and the politics of cooperation.

Water

Let me begin with water, as it remains one of most critical resources and the one most at risk. Global water use models from the Stockholm International Water Institute indicate that the driving forces of increasing population growth, aquifer depletion, natural catastrophic stresses, and runaway use and demand are ending our history of inexpensive and easily accessible water resources. Increasing rates of water use are driving increasing drought and decreasing water quality around the globe. In addition to the dramatic increase in global suffering from the effects of disasters related to climate change, there are also the impacts of poor water management, deteriorating infrastructure, and deep aquifer drilling. Catastrophic events, such as flood, drought, cyclone, hurricane, and earthquake, all loom heavy on the horizon, leading to the need to safeguard water infrastructure in every country.

Urbanization

The future of urban areas is increasingly becoming the future of the globe, where those areas not urbanized are likely to be supplying and supporting those that are. World urban population will double by 2030 and by 2020 there will be nine cities with populations over 20 million. By 2050, more than 70% of world's population will live in urban areas, with a 3 billion plus population. And by 2025, over 36 countries will have deficient freshwater and agricultural land resources (up from at least 20 countries today).

One problem is unplanned urbanization – development without consideration of environmental and health consequences. This means the growth of interactive but unstructured urban regions as opposed to development of coherent administrative groupings. As much as 70% of the energy used in an urban water system relates to pumping – which means that as these urban areas expand geographically, so do their costs.

Infrastructure

One of the biggest urban and rural infrastructure challenges is replacing aging water systems (100+ year old in some cases – made with decaying or even counterproductive materials). The counter forces include cost considerations and the short life spans of many pipe materials. By 2020, 100,000 miles of water mains in the US alone will need replacement annually ($100 billion US over next 20 years and climbing).

The U.S. Geological Survey estimates that water lost from water distribution systems in the US alone is 1.7 trillion gallons per year at a national cost of $2.6 billion per year. A 2005 British study correlated self-reported diarrhea with low water-pressure events (including water main breaks). And a growing number of pharmaceutical and personal care products can inhibit or interfere with the wastewater treatment process, especially in areas with growing populations and demands on the system.

However, options do exist to replace the status quo with new technologies, such as greenways and other vegetation filtration systems for recycling grey water outputs. Infrastructure failure prediction software and hardware such as robot pipe cameras can also provide support for improving water system function. The Regina pipe crawler, a pipe bot that can inspect water pipes down to six inches in diameter from the inside while flow is at full strength, is under development and the Darwin Calibrator software (Bentley Systems), which assesses the failure variables for water infrastructures, is already in use worldwide.

Climate Change

The global average temperature is generally expected to increase more in inland areas and at higher latitudes and higher temperatures, which will increase the loss of water through evaporation. Where water supplies decrease, there is also likely to be an increase in demand, which could be particularly significant for agriculture (the largest consumer of water) and also for municipal, industrial and other uses. Higher temperatures reduce dissolved oxygen levels, which can have an effect on aquatic life. Where stream flows and lake levels fall, there will be less dilution of pollutants; however, increased frequency and intensity of rainfall will produce more pollution and sedimentation in the water cycle due to runoff. Glaciers in the Andes are losing mass faster than predicted, and this leads first to flooding and then to drought plus less hydropower (half of electricity in Peru, Bolivia and Ecuador now comes from melt runoff). Himalayan glaciers have lost 21 % since the 1960s, and they are the source of five river systems in China, India and Pakistan.

Sea level rise may also affect freshwater quality by increasing the salinity of coastal rivers and bays and causing saltwater intrusion into fresh ground water resources in coastal regions. Climate change will also enhance vector-borne diseases such as malaria, dengue, Lyme disease, and water and food borne diseases, and it will result in water and food security challenges , parasite and insect population explosions , increased air pollution , and h eat stress.

We still do not have dependable climate models to support planning for coming shocks to the system. Natural systems no longer fluctuate within set ranges when 100-year storms appear every few years. For example, the Indian monsoon season was once four months of relatively gentle recharging rain but now has become 2.5 months of heavy flooding. All regions of the world show an overall net negative impact of climate change on water resources and freshwater ecosystems. The beneficial impacts of increased annual runoff in other areas are likely to be tempered in some areas by negative effects of increased precipitation variability and seasonal runoff shifts on water supply, water quality, and flood risks.

Drought

This is driven by the growing shrinkage of the globe's great water reserves such as the Himalayan Glaciers (the water towers of Asia), with a recently projected disappearance by 2035. The present Australian drought is the worst in over 100 years, with their whole agribusiness industry threatened by a 10% loss in rainfall. Australian local governments are undertaking new pipeline projects, drawing on higher mountain resources, but reservoirs continue to go down and the remaining water is often too salty to use. And growing economic and energy demands will increase the shortfall. It is difficult to predict future changes in regional precipitation patterns. A 14 % increase in water withdrawals for irrigation is expected for developing countries by 2030, with one in five will be suffering water scarcity. In large areas of India and China, groundwater levels are falling by 1 to 3 metres per year. In East Africa, the rainfall decline of 15 % beginning in the 1980s is likely to continue until 2050 – leading, according to US Geological Service, to a global doubling of undernourished people by 2030.

Technology

One of the leading water reclamation technologies is desalination – utilizing a range of technologies, including distillation, reverse osmosis, and energy recovery. These technologies are very energy intensive (especially reverse osmosis), producing a salt sludge which requires discharge management. Reverse osmosis under high pressure requires energy to force the water through salt filtering membranes. But energy recovery technology, along with prescreening and better membranes, has lowered the costs. Nanofiltration and bioremediation seem to offer some hope, as at present, most filters in use are fouled by organic build up. Nanotech filters lower energy costs over reverse osmosis, nanorust can remove arsenic magnetically, and nanosilver can absorb and degrade pesticides.

Major desalination plants are underway worldwide, but the US has not been a big supporter in past, with only one new plant north of San Diego ($300 million) and Texas and Massachusetts considering them. Melbourne has a $250 billion US project and London is building a $400 million US plant on the Thames River.

The question is how to power these new plants. Coal generated electricity raises other issues, especially when cheap coal is used. China is building high-sulfur coal plants and soon will release as much pollution as the rest of world combined. Solar power is a local solution, but the biggest plant at present is a 60 Megawatt solar desalination plant in Spain. A large desalination plant can consume the same energy as 35,000 homes in a year. A strong argument is often made that cities should exhaust water recycling options first before considering energy-intensive desalinization plants.

A new Perth, Australia plant that uses a nearby wind farm for electricity is a model for the renewable power sources approach. But one of the most promising power sources for desalination is tidal power. Ocean-based power is an almost inexhaustible source of kinetic electrical power – both wave and tidal driven. These provide predicable and weather independent patterns of power delivery though a medium over 800 times denser than air (thus allowing for more compact and durable turbines than wind power generation). With nearly 50 % of the world's population living within 60 miles of a coast, power transmission to desalination plants is cost effective.

Although desalination water still costs up to eight times as much as groundwater sources, declining water tables have raised the stakes on existing 'natural' water resources, as drilling down to 'fossil' water becomes necessary. But desalination opponents say the cost of water is still increasing, and new plants are built just so wealthy people can have gardens. Others say that enabling desalination technology takes the pressure off conservation and cultural value change so that socially obstructive behavior continues. But intelligent buildings that manage water use, recycling, and waste management are under development, and their utilization is another area for cautious optimism.

Sanitation and Disease

Global sanitation (human waste disposal) continues to be one of our greatest public health challenges, and 41% of the global population (2.6 billion) lacks adequate sanitation. As a result, 1.5 million children under age five die annually from diarrheal diseases. Europe and North America generously supply each person with 15,000 liters of water annually to flush away excretions, which only adds to the global water shortfall. What we need are culturally sensitive alternatives for waste removal that works with our growing water and resource shortages, which can be tragic. For example, a shortage of purification chemicals during the waste system overflow resulting from broken sewage pipes were significant contributors to the devastating Zimbabwean Cholera outbreak in 2008. For months that followed, there was no available safe public water at the urban or rural level.

There are up to 75,000 sanitary sewer overflows per year in the United States, resulting in the discharge of 3-10 billion gallons of untreated wastewater. Up to 3,700 US illnesses annually are due to exposure to recreational water contaminated by sanitary sewer overflows. Leaking mains, evolving microorganisms, and man-created hazards such as animal feedlot runoff, antibiotics and other pharmaceuticals, industrial waste, and defective filtration all add to the problem. The issue is further complicated by questions regarding the carcinogenic nature of chlorine in combination with other biochemicals of numerous sorts and its ineffectiveness against toxic chemicals and some pathogens.

Water and Food

Agriculture is responsible for about 70 % of all fresh water withdrawn for human use. But climate change has not been beneficial to agriculture, with the worst drought in seventy years now decimating the northern China wheat crop and reducing soybean harvests in Argentina, Brazil and Paraguay by 40%. Strategies that save water in agriculture will mean that more water is available for other sectors.

But, of course, there are counterfactors. For example, as economic development expands worldwide and cultures intermingle, consumer food preferences change. And this involves not only the consumption of more meat (which is highly water-intensive to produce) but also crops like alfalfa (for animal food), pecans, sugar cane, and dairy products. These high water users are increasingly popular food crops.

Irrigation also pulls off animal, pesticide and fertilizer runoff out of rivers and other surface water. As well, deep well groundwater sources require deeper drilling when reaching dropping aquifers. Better water management around the globe is one way to improve agricultural output, but biotechnology will also likely help, such as drought resistant strains of food plants.

The Dubai Food City projects is an example of how innovation in agriculture is possible, utilizing vertically stacked, hydroponics-based urban farms and renewable energy (off-grid, self-sufficient). But it is also an example of how innovation can be sidetracked by economic downturns, as has occurred in Dubai.

Hydroponics is more conservative of water resources (using 70% less water than irrigation), but is also high tech and high investment, especially in greenhouses. It represents a significant culture change in many countries, as does the shift to organic fruits and vegetables. The next level, aeroponics, uses 70% less water than hydroponics, and both control the weather inside a building farm. Aeroponics (misting) uses less energy as well, and it offers plants more access to oxygen and CO_2 than in conventional agriculture at much lower cost than hydroponics with greater control over pathogens – as well as reducing food travel miles and the associated energy use. Developing countries have shown a good deal of interest in aeroponics, and great strides have been made in the technology in recent years in countries like Vietnam.

Dickson Despommier of Columbia University asserts that one 30-story farm could feed 50,000 people for one year, including chicken and fish fed on plant byproducts, while producing a net output of clean water and energy using renewable energy to power lights, pumps and conveyer belts. Critics of vertical urban farms see the levels of artificial light as too high, but designing them for increased natural light (with more windows) and renewable power including methane digesters could address these problems. While a number of crops are not suited to vertical farming and the acreage is limited, it provides a year-round growing season at greater crop densities.

Water Futures

Over the next twenty years, climate models predict severe regional droughts that will affect sectors like agriculture and new development. Climate change could thereby lead to accelerated migration, lost livelihoods, and conflicts driven by resource competition. Prices for water will rise, but this can also stimulate investments in water research and development (conservation and desalination, water reuse systems, low friction technologies, etc.).

Agriculture in countries suffering prolonged drought (e.g. Australia, China, India, the Andes countries, and the United States) will be exploring genetically modified (GM) crops adapted for drought and saltwater farming, nanotech-altered soil to decrease water evaporation, anti-leakage technology, more effective desalination near coastal areas, slow drip watering powered by solar cells, and geographic barriers to decrease evaporation. But some multinational corporations will also move their operations to countries where water conservation regulations are more lenient, thus reinforcing the downward spiral of declining water resources.

Conclusion

In spite of the rather intimidating array of challenges to sustainable self-sufficiency in the future –climate change, runaway economic development, resource competition and conflict, and poor resource management – there are a number of hopeful developments underway as well. These include:

- New agricultural strategies
- Increased education in conservation and ecology policies
- Innovative renewable energy resources
- Creative infrastructure technologies
- Energetic public health initiatives
- Strong and cooperative urban, regional, national and global leadership models

Accordingly, there are encouraging signs that the future across all cultures may be an optimistic one, but not without some innovative technologies and creative new policies designed to alter the status quo.