The Wealth of Thirsty Nations:

Adam Smith's Modern Butcher, Baker & Brewer Will Secure 'Revenue Streams' From Water-Stressed Supply Chains If Firms and Families Can Exchange Equitable Shares of Our Ultimate Liquid Asset

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Abstract

The universal currency of the 21st Century is drying up into a 40% global deficit. Every continent depletes aquifers; over-allocates rivers; endangers aquatic biodiversity; borrows against future rains; and ignites increasingly fatal water resource conflicts. A thirsty supply chain impacts brand names and bottom lines. And therein lies hope. Adam Smith's logic about our 'propensity to truck, barter and exchange' can turn conflict into collaboration and scarcity into abundance if society begins to own and exchange equitable shares of the ultimate liquid asset. Business leaders who measure their water footprint can help embattled officials unlock virtual green 'click' markets within natural 'brick and mortar' water monopolies to unleash the true potential of the blue economy.

Introduction: A Silent, Invisible Threat

In the autumn of 2007 a new force quietly constricted the Southeast's economy. Panic set in as "animal spirits" of individual self-interest curdled into collective malaise. Faith in markets faltered, alarm spread, investment dried up, and governments rationed the source of life, cracking down on pleasure and urging families to inform on the 'anti-civic' habits of their neighbors (Bluestein, 2007).

It was just the beginning. Within a few weeks, Atlanta laid off 14,000 landscapers and shuttered hundreds of businesses. Multinational corporations also wilted. Delta Airlines adjusted its operations; UPS began an austerity program; Stone Mountain Park cancelled expansion of its theme park. Georgia Aquarium - the planet's largest - killed projects; and, Coca-Cola shut off corporate fountains (Credeur, 2007).

Unable to lobby for political action, the Chamber of Commerce and civic leaders began to pray: in public, and in vain (Walley, 2008). This contraction had nothing to do with real estate bubbles or toxic assets – all that would come the following year – but rather a volatile combination of natural forces: prolonged drought, rising temperatures, unchecked growth, reduced supply, and escalating demand. It all added up to acute water scarcity.

Draining into the Abyss

Corporate managers used to count on water as a business certainty. Open the taps and water flowed: cheap, abundant, and reliable, with more than enough for everyone. In agriculture, industry or energy and ecotourism, companies turned these ample currents into currency, governments secured infrastructure, and few felt exposed to risk.

No longer. That sense of immunity has literally evaporated from our "flat, hot, and crowded" world, leaving casualties – and opportunities – in its wake (Marsh Center, 2007).

Some of this is due to our warming world. Rising temperatures melt snowpack and glaciers, while heat waves, droughts, famines, and floods are expected to increase in frequency and severity. By 2025 some 1.8 billion people will be living in conditions of "absolute water scarcity" where per capita freshwater availability falls below 1,000 cubic meters a year; two-thirds will merely feel "water-stress" (UNDP, 2006).

By definition, change creates both winners and losers. But the UN reports that by 2050 climate impacts will harm twice as many as they will help. What's more, even climate skeptics concede that, due to population growth, prosperity and pollution, global demands for water is growing while supply remains finite (Brabeck-Letmathe, 2008, 2009). Water scarcity risk is not coming to America; in ten big cities – Orlando, Atlanta, Tucson, Las

Vegas, Ft.Worth, San Francisco, San Antonio, Phoenix, Houston and L.A. – it has already arrived. (24/7 Wall Street, 2010.) At least 36 states are facing shortages in the next five years as less rain, warm winters, and higher evaporation stress those pockets of the country with the fastest growth (O'Driscoll, 2007).

Having once dismissed environmental activists as alarmists, the prospect of water scarcity has caught many business and political leaders off guard; the lack of control scares them. Goldman Sachs warned investors that global water consumption had attained an "unsustainable" rate of growth (Economist, 2008). A World Economic Forum panel in Davos, Switzerland, predicted that civilization faced "limits to growth" due to fresh water shortages. The Chairman of Nestle, Peter Brabeck-Letmathe, argued that water scarcity poses a bigger threat than climate change. And, with 900 bottling plants in 200 countries, Coca-Cola CEO Muhtar Kent fears for the future of his company's main ingredient: "We can't sit back and watch the water of the world continue to drain into a non-returnable abyss." (Schwaub, 2009)

An Emerging Material Risk

Water, like carbon emissions, is now recognized as a material risk that corporate boards must address. Some of this comes through the potential for regulatory enforcement. In response to three years of petitions from investors representing $1.5 trillion in assets, [1] last February, the U.S. Securities and Exchange Commission (SEC) outlined risks that should increase corporate scrutiny and disclosure of climate and water risks in overseas supply chains (Coburn 2010).

But much remains voluntary. Norges Bank Investment Management in Oslo has identified 1,100 companies in its $441 billion portfolio that are facing escalating water risks. Anne Kvam, global head of ownership strategies explained how, “As investors, we need to know if companies are in industry sectors or regions where water supplies are scarce and how they are managing those supplies” (Coburn).

In April 2010, the investor-backed Carbon Disclosure Project broadened the scope of its non-profit operations to prod 302 global companies to report their water use. The group put business’ “water footprint” on par with their “carbon footprint” as a concern to shareholders because scientists predict that exposure to risk will rise due to climate change, and that global warming impacts are felt through water. This is a material issue, said the project’s leader, Marcus Norton: “It matters because long-term investors in particular see that water scarcity is going to impact companies’ operations and supply chains.” (Woodey, 2010)

All this feels rather sobering. Yet in an extensive survey of business managers, the Marsh Center for Global Risk found that only one in five executives recognize that water shortage would be “severe” or “catastrophic” for their global industries and, of those, less than 17% are prepared for such a calamity (Marsh Center, 2007). Such concern quickly escalates further when a seasoned water manager of the Colorado River looks ahead, sees no way out, and predicts that our common future will resemble “an Armageddon” (Gertner, 2007).

Brilliant Minds, Clouded Thinking

There is a way out. Businesses can escape Armageddon. But they must first recognize that water is no ordinary resource; it is a complex and subtle force of nature, our liquid matrix of life. Today, water isn’t the government’s resource problem to manage; it’s everyone’s asset, and everyone’s liability.

If you're among the many unaware of the extent of bottom-line vulnerability, or haven't fully appreciated the investment risks – and opportunities – posed by water scarcity, take comfort. You're in the company of the world's elite. Benjamin Franklin wrote, "When the well's dry, they know the worth of water," but in truth he was baffled by what water should cost and how to economize the wet stuff. Thomas Malthus, who predicted limits imposed by natural resources,[2] missed the decisive tipping point of food constraints: not land and population growth, but water.

It seems the Enlightenment was handicapped by geography. Great Thinkers did all their great thinking during a wet climatic era, in soggy lands, in cold damp studies while it rained outside. It is plausible that the overabundance of water 'clouded' their outlook. Today business decisions rely on analysis that is painfully dry. For example, a recent extensive study by McKinsey & Company for the International Finance Corporation confirms that the world economy has more to fear than inflation or. By 2030, global water requirements are projected to grow from today's 4,500 billion cubic meters to 6,900 billion cubic meters. That is 40 percent above current accessible, reliable, and environmentally sustainable supply. Local cases appear even worse. For one-third of the world's population the water deficit is 50 percent recession (McKinsey, 2009).

The global crunch means no country can entirely 'trade its way' out of water dependency, importing cheap goods grown in wet countries, and embedded with the 'virtual water' required to produce them (Allan, 2002; Hoekstra, 2008). In two decades humans will need two-fifths more water than our planet can supply, a reality that will escalate food prices, disrupt energy, constrict trade and destabilize society. In short, water scarcity is no longer an obscure, isolated and local economic issue. Thirst has gone global.

We face clear and present risks that arise every day because water lacks clear value, and because political leaders and business executives treat water as a substitute for what, in reality, it has become: the universal currency of the 21st Century, a liquid asset which underlies all business, economies, and the rising or falling…*wealth of nations*.

The Paradox, Revisited

While composing his towering masterpiece by that iconic title, Adam Smith got stumped. Like his colleagues, the godfather of economics grew confused by the worth of water. Smith explained how self-interest drove civilized growth because humanity's innate "propensity to truck, barter and exchange one thing for another" brought incentives, competition, division of labor, efficiencies of the market, and all material goods and services known to mankind. *The Wealth of Nations* remains Holy Scripture for the dismal science. Yet Smith's logic was undermined by what he called 'the paradox of value' (Smith, 1776).

This was no minor flaw. By definition, economists measure household goods; rational decisions must be based on relative value. And yet "value," as Smith noted, has two meanings: one from utility; the other from purchasing power or exchange. What tormented Smith was the blinding contrast when it came to humankind's most vital household good. "Nothing is more useful than water," he wrote, and yet it was worthless at the market because "scarce anything can be had in exchange for it. A diamond, on the contrary, has scarce any value in use, but a very great quantity of other goods may frequently be had in exchange for it."

Therein lies the essence of our chapter: humans, businesses, and nations thrive without diamonds, but they must have water. U.S. Energy Secretary Stephen Chu warns that even energy security depends on reliable access to water. Some observers now worry about neo-colonialism, as arid nations and multinationals buy up vast swaths of poor foreign lands just to get at the reliable rains falling upon them (WEF, 2010).

A Liquid Asset Behind All Commerce

To bring economic theory into practice, look around. Is there any aspect of any private enterprise anywhere that does not depend absolutely for its existence on fresh water? Beverage brand names seem most vulnerable. Coca-Cola, Pepsi, Evian and Perrier all compete for market share in the $22 billion market for bottled drinking water alone (Glennon, 2009). Farmers and agribusinesses use 70 per cent of all water withdrawals, while the world's extractive industries annually suck out 200 trillion gallons of water from aquifers and streams (Workman, 2009).

On Wall Street, index and hedge funds track performance in the water industry. Multinational companies – RWE, Veolia, Suez, and Bechtel – manage vast private water services worth $800 billion. Brokers tout companies that produce pipes, pumps, desalination technologies, filtration devices, etc., which are necessary to deliver, sanitize, and manage water (Merrill Lynch, 2007). Pension funds embrace water stocks because they involve secure, 30 to 50-year contracts (SAMS, 2007); while some portfolio managers view water as a "socially conscious investment, an opportunity to help the world solve a major and critical problem while making realizing a financial return (Calvert, 2008)." This market is vast, diverse, and booming – estimated by Goldman Sachs at US$ 400 billion and growing 15% each year (Goldman, 2008).

But vulnerability isn't necessarily about scale; it's about dependency. Look closer at local hair salon, bike repair, real estate, florist, restaurant, laundry, and tourism shops with a few employees. Without water, all such ventures cease to exist. Dehydrated labor would collapse, along with the manufacturing processes if they were deprived of reliable, clean water. FedEx/Kinko's would falter without the water embedded in paper. Even so-called post-industrial or virtual Web 2.0 -based IT firms require 3,400 gallons to manufacture a single microchip, plus even more water to produce the necessary energy required to operate and cool the remote Internet server farms that store much of our online data (Workman, 2010).

And, while speaking of Megawatts, it is reported that 19 percent of all energy in some U.S. states goes to treat, heat, lift, move, and clean a ton of water per household each day (NRDC, 2004). Conversely, the oft-discussed panacea of desalination is itself so energy-intensive that it relies on power plants that already require 40 percent of existing freshwater supplies. This **watergy** nexus – the connection between our thirst for water and our hunger for power – confounds the situation even further (Simus b, 2010).

Humanity vs. Self Interest

Businesses can adapt to economic scarcity, but not to political volatility. Yet, typically, in every country and from federal to local levels, the state owns and allocates all water supplies. Government agencies control access to rent-controlled water in a vertically integrated monopoly. With finite supplies, any policy decision to deny water here in order to allocate it elsewhere results in an "I win/You lose" zero-sum game.

As witnessed from California to the Southeastern U.S. and even the Great Lakes, efforts imposed by officials to economize from the top down – through rationing, restrictions, regulations, special rights and/or permits for a favored few – unleash destructive animal spirits that fragment society, curtail liberty, and erode trust. "Other hazards tend to pull people together," said Michael Hayes, director of the National Drought Mitigation Center, speaking of water's unique potency. "With a drought, because it's a limited resource, it tends to drive people apart." (Waddell, 2007)

Because water infuses every good and service – from food, industry and energy to health, ecosystems and national security – the lack of a real price signal for water can distort, devalue and destabilize entire commodities, industries, businesses or even nations.

Which brings us back to Adam Smith.

Under classical economic theory, resource conflict wouldn't happen because scarcity unites us under a voluntary, cohesive and benevolent social contract. In the widely and frequently quoted passage from *The Wealth of Nations*, Smith pointed out that

> "It is not from the benevolence of the butcher, the brewer, or the baker, that we expect our dinner, but from their regard to their own self-interest. We address ourselves, not to their humanity but to their self-love, and never talk to them of our own necessities but of their advantages."

In principle, his case is flawless. But, in real world practice, that lingering 'paradox of value' haunts Smith's reasoning. For like any enterprise large or small, Smith's proverbial butcher, his brewer and his baker (not to mention his iconic pin factory owner) base decisions on a foundation of secure access to abundant, stable, certain and often free supplies of clean water. Yet, despite our appeals to humanity, access is increasingly insecure, inaccessible, scarce, unstable, uncertain, and unclean. Indeed, World Bank analysts remain perplexed by how - contrary to their basic economic assumptions - water use has grown less efficient even as water has grown scarcer (Saleth, 2004).

Back in the rainy Scottish landscape of Smith's 1776 economy, the local livestock, beer and grain merchants could happily truck, barter and exchange in a relaxed local market. But today those same three industries find themselves competing fiercely with each other, with their bankers, with their environment, and with us, to secure a greater market share of the finite liquid asset that makes all our revenue streams, and existence, possible (Economist, 2008).

To appreciate our predicament, and seek a way out, consider the thinking behind business decisions of Smith's three iconic livelihoods.

The Butcher.

You like beef? So do we. But the reason we now eat meat with a more troubled conscience goes well beyond the *Food, Inc* ethics of animal rights, feedlots or lax health safety inspectors.

Each bovine in our 1.5 billion-strong global herds is a mobile greenhouse gas factory (UNFAO, 2006). More immediate than his carbon footprint, [3] however, is how today's butcher carves up a veritable swimming pool of water. Figures vary by location, but prodigious amounts of water are required at every stage in rearing cattle: in feed (2,800 pounds of grain and 15,000 pounds grass/roughage), providing drinking water (6,000 gallons) and processing (2,000 gallons). Working back down your butcher's supply chain, it takes 1.5 million gallons to liters to "produce" the average dryland cow, which yields 440 pounds of beef (Hoekstra, 2008). So when I devour my juicy quarter-pound ground beef hamburger, I am essentially swallowing 1,300 gallons of embedded or virtual water.[4]

The Baker.

From the patisseries of Paris to the tortes of Tijuana, bakers require three key ingredients: milled grain, sugar and water. All three affect public health, social stability, economic growth, and political security; they are besieged by global water scarcity pressures that no baker can control but to which he must adapt.

Adaptation doesn't come easy to one of the world's largest "bakers," Nestle, and in particular the company's outspoken Chairman, Peter Brabeck-Letmathe. Nestle scrutinizes its supply chain to reduce inefficient use of water – not to be 'Green' but rather because waste is expensive and water insecurity poses a material risk that investors would punish. Yet while Nestle can manage it's operations and reward efficiency along its supply chain, Nestle's agricultural suppliers are themselves relatively helpless in the face of climate change, competition from other water users, or $5 billion annual political subsidies in the U.S. that encourage us to burn up good food as 'clean' fuel.

True, ethanol amounts to 0.0002% of global energy consumption, but the grain calories it converted to fuel could have fed a quarter of a million people for a year. It takes half a liter to grow a calorie of grain; as Brabeck calculated, "a thousand liters could grow enough calories to feed a person for a day, or provide the fuel to drive to your local bakery for croissants."

The contrast seems ridiculous. But governments seek in earnest to divert food crops to boost biofuels; efforts that double agricultural water withdrawals without feeding a single extra hungry mouth. Biofuels have bipartisan backing. So unless today's baker can somehow secure his water, flour and sugar supply, his livelihood and profit margin (and customer) lies vulnerable, increasingly exposed to the risk of being priced out of the market or transferring his muffins into his gas tank.

The Brewer.

Don't cry into your beer, but that liter of lager requires up to 155 liters of water. That's why brewers Anheuser-Busch InBev, Heineken International, Kiring Holdings, SABMiller and Molson Coors are all competing to make the smallest, and thus least vulnerable, water footprint. (Greenbang, 2010)

SAB Miller CEO Graham MacKay acutely senses the growing risks of scarcity, and made his company a founding signatory of the United Nations CEO Water Mandate, promoting responsible water use throughout its operations. For 2008 – 2015, SABMiller announced it would cut the amount of water used per hectoliter of beer produced by 25% To do so, the brewer conducted an internal examination of water use as a tool to understand future risks, and a transparent analysis showed how agricultural water use accounts for more than 95% of the total footprint. Now SABMiller has begun pursuing water-efficient farming of barley; seeking to understand climate change impacts on water availability; and studying the impact of variables – rainfall patterns, legislation, groundwater, nitrates – on crop growth in the future. "The complex challenges surrounding water will only grow," warns MacKay. (WEF, 2010)

Yet responding to looming water constraints isn't just environmentally responsible; its potentially lucrative, offering new business opportunities for the brewers that act soonest.

“Now is the time to seize these opportunities, address water challenges and build resilience — not once the well has run dry,” says Gregory Wade, global chief supply chain officer for Molson Coors. (Greenbang, 2010)

Suicidal Public-Private Partnerships

Still, the way businesses can seize opportunities can be precarious. Some call for public-private partnerships, but these are often fraught with controversy, and stir deep emotions. Access to and control of water is a ferociously political issue. (Snitow, 2007; Barlow, 2004)

Piling onto existing scarcities after years spent railing against any “commodification” or “privatization” of water, social activists provoke dramatic confrontations with businesses. In 2000, they chased Bechtel out of Cochabamba, Bolivia (Finnegan, 2002). In 2002, they made water executives flee a suburb of Johannesburg, South Africa (Savulescu, 2002). In 2004, they stopped Coca-Cola from extracting water from Kerala, India (Flecker, 2004). Even in Stockton, California, citizens rose up to overturn a $600 million municipal water utility privatization contract with the multinational, OMI-Thames (Snitow, 2007)

If private interests can breed distrust, government management can breed waste, and a crumbling public infrastructure is hardly unique to the Third World. In America’s big cities 40 to 60 percent of water bleeds through cracks, corrosion, and poor maintenance. In Washington DC, water bursts are a daily event. Old dams are silted up from below and evaporating fast from above. America’s civil engineers give our nation’s water infrastructure a “D.” Each day 650 water mains break – one every two minutes – which with chronic leaks result in the annual loss of 1.7 trillion gallons of water— enough to supply abundant water to 68 million Americans (ITT, 2010). No wonder municipal bonds of U.S. cities are be riskier than investors realized; credit ratings don't reflect water shortages, failing assets, insecure supplies, and vulnerability to competition and climate change (Barringer, 2010).

It is all too tempting to blame 'incompetent bureaucrats' or 'greedy executives' for water troubles, but officials and managers are striving to boost cheap, abundant water supplies. Only recently have we begun to talk about reducing demand, which has its own risks. McKinsey & Company helpfully explained how elected officials could close that 40 percent global "water gap" or deficit by eliminating subsidies here and imposing tariffs there and jacking up rates across the board to then reinvest revenues in aging infrastructure, concluding, with unanimous support: "We need to put a price tag on water." (WEF, 2010)

Their data is sound, their conclusion impeccable, and any officials who follow such advice in a recession commit political suicide. Unemployed voters rarely elect those who promise to raise water rates, grocery prices, and utility bills. That's a third dead end.

Truck, barter, exchange…of water credits?

A more plausible approach asks: Who owns clean water?

Right now the answer is everyone and, thus, no one. More elaborately, in the United States, 53,000 public utilities and government-regulated districts control every drop as an absolute mini-monopoly. Each 'waterlord' then dictates who deserves to rent how much water, for what uses, at which rates. Rent-controlled water monopolies struggled to make ends meet even for small, sleepy populations. Today, as dynamic big city supplies crack under multiple stresses and demand grows more acute, water monopolies prohibit all choice, competition, or incentives to conserve (ITT, 2010).

Instead they resort, even in libertine Las Vegas, to policing our thirst. Florida cities impose Soviet-style water rationing. Los Angeles fines 'inappropriate uses.' San Francisco suburbs restrict lawn size. In Atlanta, recall those creepy hotlines encouraging snitches to inform on our neighbors' pool or garden habits (Waddell, 2007). Short-lived water campaigns exploit civic virtue or shame. Yet all these backfire when, perversely, abuse, waste and neglect increase a water monopoly's revenues while frugal efficiency results in debt.

Worse, while most disasters unite strangers in a common cause, water scarcity splits apart cities in an 'us-vs.-them' Malthusian panic. As tensions grow, political ideology divides left vs. right in a stale yet fierce debate over whether government should classify water as either "a free human right" (Barlow, 2002) or "a free market commodity (Bate, 2008)." Our years of international research and experience with human behavior lead us to believe that this is a false dichotomy; both views are symbiotic. A durable right to water works only if it is clearly defined, freely exchanged and securely owned – by you and me.

Timeless H2Ownership

Water ownership exchanges may seem radical, but have deep roots in thirsty landscapes. In Chile, Australia, and the Western U.S., governments endowed farmers with ownership rights to private shares of public currents; competing interests trade these rights to secure fresh water for urban and river health (Anderson, 2001). In Asia, informal traders compete to truck and sell water to families, who further barter the gallons they own. More equitably, South Africa distributes water shares among poor nonwhites as leverage to negotiate co-ownership of farms where they work (Workman, 2002). Under *Aflaj*, a 4,500-year-old water rights exchange system, Oman communities secure enough free water to drink or bathe; beyond that, water's value fluctuates by owner, season or irrigated crop (Workman, 2010). Oldest of all is a timeless reciprocity network, *xaro*, where Bushmen bands self-regulate their Kalahari economy by informal bartering of water resource goods, services or information (Workman, 2009).

These politically robust mechanisms are the antithesis to central monopolies. Adapting and replicating them could transform our 53,000 rent-controlled waterworks.

How? Infrastructure wouldn't change. Turn the tap; pipes rattle; meter dials spin like always. Only now, instead of just renting wet stuff, we'd own equal shares of our coveted liquid asset. If officials enshrined a free tradable eco – share of 100 gallons per day, our animal spirits would maximize value from our new possession, seeking ways to save and exploit every drop from source to tap and back again (Simus, 2010).

Priorities change because suddenly water has worth to us all as our endowment, or asset (De Soto, 2000). And as virtual 'shareholders,' ownership of water efficiency incentivizes those long-term innovation to invest in our system. Efforts to plug leaks, repair mains, harvest rain, trap runoff, reuse greywater or install compost toilets reduce exposure to water security risks – whether from climate change, from terrorist attacks or from systemic ruptures occurring from L.A. and Dallas to Boston or Washington, DC. Above all, today's butcher, baker and brewer – and any other business that depends on water (read: every private venture) would all have a vast and diverse new source of water security: their neighbors. If Al Gore, Peter Brabeck-Letmathe, or Graham MacKay need to increase supplies of water to fuel their Black Angus beef, Nestle baked goods, or

SABMiller lager, they could contract with you, me, or 6 billion other individuals to pay for whatever water we had conserved, at whatever price we voluntarily negotiate. This turns the zero-sum game into a win-win opportunity (Bate, 2004). Best of all, the poorest sectors of society benefit most, both in terms of potential income and opportunities that they didn't previously have (Zetland, 2010).

Adam Smith was wrong in his analysis of the water-diamond paradox, but right to explore it in depth, and correct in his understanding that "nothing is more useful than water." His principle of value holds true to this day. Water shortages will undermine economies as long as butchers, bakers and brewers can't make cheap water precious and politicians remain properly afraid to so. As Smith has reasoned, and as traditional exchanges have demonstrated, we humans have the unique capacity of all species to exchange one thing for another.

We measure what we value and we value what we own. Rather than fear the end of water, let our rational self-interest replenish the wrinkled and sunburned Invisible Hand, and calmly start to price what has been, up to now, so priceless.

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[1] The petitioners included 11 U.S. state and city treasurers and comptrollers, as well as the nation's two largest public pension funds, CalPERS and CalSTRS. The requests for guidance also received letters of support from 50 additional European and U.S. investors representing $6.5 trillion in assets. In its 2009 10-K filing, the Coca-Cola Company disclosed that "water scarcity and poor quality could negatively impact the Coca-Cola system's production costs and capacity," and stated that "climate change may also

exacerbate water scarcity and cause a further deterioration of water quality in affected regions, which could limit water availability for our system's bottling operations."

[2] Humans reproduced geometrically; our means of subsistence increased arithmetically; at some point hunger would outstrip food, leading to a future plagued by famine, hunger, and violence.

[3] As billions of microbes respire in the gut of each one, the anaerobic process generates methane gas and nitrous oxide, respectively 23 and 296 times more potent than carbon dioxide. Each day, cattle collectively generate 18% of Earth's greenhouse-gas emissions, more than all the exhaust-pipes protruding from all the vehicles of all the planet, combined. Ruminating on the peer-reviewed UN Food and Agriculture Organization report, *Livestock's Long Shadow*, one writer quipped, "a 16-oz. T-bone is like a Hummer on a plate."

[4] Our quest for meat will hardly taper off. In the past three decades, the earth's omnivores have tripled the average per capita meat consumption; in the next four decades global meat production will double to 465 million tons. As it does, pressure to convert water into protein will grow. To adapt to scarcity pressures and reduce vulnerability, modern butchers will increasingly put a premium on more expensive but less water-intensive meats, whether poultry and fish, grass-fed beef, or arid-adapted venison like deer, bison and gazelle.