

All Dried Up: Averting the Day Zero Water Crisis through Tax Reform

Day Zero. Tomorrow, you wake up and turn on your sink. Nothing comes out. Instead, you trudge miles to line up with four million other people to get your small, daily ration of water. You boil some to save for drinking water—the rest you save for hygiene and sanitation. You are forced to stand in a small plastic tub and manually scoop up cold water and pour it over yourself to bathe, but then take that same water and use it to wash dishes, water your plants, or any of the thousands of other small tasks we take for granted every day.¹

For millions of the world's poorest individuals, this is life, but not for the people of Cape Town, South Africa²--at least not until 2015, when a drought forced the metropolis to face the reality of Day Zero, the day when the city's water supply would simply run out.³ After three years of living under extreme water rationing to avoid Day Zero, an intense rainy season saved the city and postponed the crisis, allowing the population to return to some semblance of normalcy.⁴

¹ The description provided above draws on the experiences of many Cape Town citizens living under drought conditions between 2016 and 2018. Aryn Baker, *What It's Like to Live Through Cape Town's Massive Water Crisis*, TIME, <http://time.com/cape-town-south-africa-water-crisis/> (last visited Apr. 28, 2019).

² *Aqueduct Water Risk Atlas*, WORLD RESOURCE INST., <https://www.wri.org/applications/maps/aqueduct-atlas/#x=40.87&y=9.00&s=ws!20!28!c&t=waterrisk&w=def&g=0&i=BWS-16!WSV-4!SV-2!HFO-4!DRO-4!STOR-8!GW-8!WRI-4!ECOS-2!MC-4!WCG-8!ECOV-2!&tr=ind-1!prj-1&l=3&b=terrain&m=group> (last visited Apr. 28, 2019). Aqueduct World Resource Institute measures the world's current water resources by grouping twelve indicators into a "framework identifying spatial variation in water risks." Francis Gassert et al., *Aqueduct Global Maps 2.1 Indicators: Constructing Decision-Relevant Global Water Risk Indicators*, WORLD RESOURCES INST. (Apr. 2015), <https://www.wri.org/publication/aqueduct-global-maps-21-indicators>. Six of the indicators are an ensemble of "time series estimators, spatial regression, and a sparse hydrological model to generate novel data sets of water supply and use." *Id.* The remaining six indicators draw on information from other existing publications. *Id.* The institute then aggregates the methods to "maximize transparency and communicability, and to allow for dynamic weighting to reflect different users' sensitivities to water-related risks." *Id.*

³ Trevor Bohatch, *What's Causing Cape Town's Water Crisis?*, GROUNDUP (May 16, 2017), <https://www.groundup.org.za/article/whats-causing-cape-towns-water-crisis/>; *Frequently Asked Questions About South Africa's Drought*, AFR. CHECK (Feb. 3, 2016, 7:36 AM) <https://africacheck.org/2016/02/03/frequently-asked-questions-about-south-africas-drought/>; Margaret Koopman & Abri de Buys, *What Do Long-Term Data Reveal About Cape Town's Water Shortage?*, S. AFR. ENVTL. OBSERVATIONAL NETWORK (Oct. 2017), <http://www.saeon.ac.za/enewsletter/archives/2017/october2017/doc01>.

⁴ Joe McCarthy, *Heavy Rains Save Cape Town from Running out of Water – For Now*, GLOBAL CITIZEN (June 13, 2018), <https://www.globalcitizen.org/en/content/cape-town-water-crisis-heavy-rains/>; *Explained: The World's Water Crisis* (Netflix episode aired Sept. 12, 2018); *Western Cape Edges Closer to an End to the Drought As Dam Levels*

Although Cape Town has been saved for the moment, the problems that caused Day Zero have not been resolved, and it is only a matter of time before the next major water crisis occurs. This crisis may not be limited to Cape Town, either. By 2040, 70% of the world will not be able to meet its water demands.⁵ Even before then, at least eleven other major cities are one bad dry season away from running out of water in the next year.⁶ This list includes modern meccas, like London and Miami, sitting in the heart of global empires with higher-than-average annual rain falls.⁷

The impending water crisis outweighs any other problem that humanity will face in the next century. Unlike the global energy crisis caused by our depletion of fossil fuels, there is simply no substitute for water; if we run out, we will die. Fortunately, distinct from gas or coal, there is enough water on earth to sustain humanity forever.⁸ The problem has never been one of

Continue to Rise, NEWS24 (July 12, 2018, 12:05 PM), <https://www.news24.com/SouthAfrica/News/western-cape-edges-closer-to-an-end-to-the-drought-as-dam-levels-continue-to-rise-20180712>.

⁵ *Aqueduct Water Risk Atlas: Projected Change in Water Stress*, WORLD RESOURCES INST., <https://www.wri.org/applications/maps/aqueduct-atlas/#x=64.60&y=17.79&s=ws!40!28!c&t=waterrisk&w=def&g=0&i=BWS-16!WSV-4!SV-2!HFO-4!DRO-4!STOR-8!GW-8!WRI-4!ECOS-2!MC-4!WCG-8!ECOV-2!&tr=ind-1!prj-1&l=3&b=terrain&m=projected> (last visited Apr. 28, 2019). Aqueduct World Resources Institute is able to estimate future water stresses using the following indicators: (1) water demand, (2) water supply, (3) water stress, and (4) intra-annual variability. The Institute derives estimates “from general circulation models (GCMs) from the Coupled Model Inter-comparison Project Phase 5 (CMIP5) and mixed-effects regression models based on projected socioeconomic variables from the International Institute for Applied Systems Analysis (IIASA)’s Shared Socioeconomic Pathways (SSP) database.” Frances Gassert et al., *Aqueduct Water Stress Projections: Decadal Projections of Water Supply and Demand Using CMIP5 GCMs*, WORLD RESOURCES INST. (June 2015), <https://www.wri.org/publication/aqueduct-water-stress-projections-decadal-projections-water-supply-and-demand-using>; Andrew Maddocks et al., *Ranking the World’s Most Water-Stressed Countries in 2040*, WORLD RESOURCES INST. (Aug. 26, 2015), <https://www.wri.org/blog/2015/08/ranking-world-s-most-water-stressed-countries-2040>. Two other studies have also forecast a global water crisis by 2040. Rajit Sengupta, *World Headed for Water Crises by 2040*, DOWNTOEARTH (July 4, 2015), <https://www.downtoearth.org.in/news/world-headed-for-water-crises-by-2040-45603>.

⁶ *The 11 Cities Most Likely to Run out of Drinking Water – Like Cape Town*, BBC (Feb. 11, 2018), <https://www.bbc.com/news/world-42982959>.

⁷ *Id.* Despite London’s reputation as a rainy city, it actually gets less rain fall per year than both New York and Paris. *Id.* Roughly 80% of its water comes from the city’s rivers. *Id.* Miami, on the other hand, receives enormous annual rainfall, but most of the water collected by the Biscayne Aquifer (Miami’s main source of water) has been contaminated by ocean water due to unforeseen consequences from draining the surrounding swampland. *Id.*

⁸ B.W. Eakins & G.F. Sharman, *Volumes of the World’s Oceans from ETOPO1*, NOAA NAT’L GEOPHYSICAL DATA CTR., https://ngdc.noaa.gov/mgg/global/etop1_ocean_volumes.html (last visited Apr. 28, 2019). There are over 1,338,000,000 cubic kilometers of water in the world’s oceans, which is enough to sustain the world’s population many times over. U.S. Geological Survey Water Science School, *The World’s Water*, U.S. GEOLOGICAL SURV.,

supply, but rather of how we perceive the cost of water usage.⁹ However, changing the perception regarding use of water may be more difficult than changing the perception concerning the depletion of fossil fuels. Moreover, none of today's widely-used methods of addressing water sustainability take into account cost as a vital aspect.¹⁰

To truly achieve water sustainability in the future, three things are necessary: (1) defining a set of measurable goals for what water sustainability should look like; (2) understanding how our current perceptions of water as a free public resource contribute to the problem; and (3) creating a policy that achieves these goals by focusing on changing our perception of the cost of water. This paper addresses all three of these concerns by presenting a demand-side, tax-based solution that strikes at the heart of the issue surrounding water sustainability—the perception water is free.

Demand-side solutions seek to control consumption by increasing the price of the resource. This type of solution is distinct from previous methods of water sustainability because it targets individuals' perceptions regarding the true cost of water. Over time, this will permanently change our attitudes toward how we use water, thus achieving long-term sustainability. The problem with the demand-side method as applied to water is that the marketplace, which acts as the enforcement mechanism, does not take into account “good” and “bad” uses of water or the fact that individuals with few economic resources still require water to survive and earn a livelihood.¹¹ Thus, a progressive-based consumption tax model is necessary to adequately account for the negative externalities of a demand-side solution, which the

<https://web.archive.org/web/20131214091601/http://ga.water.usgs.gov/edu/earthwherewater.html> (last visited Apr. 28, 2019). Moreover, the natural water cycle replenishes this water supply after it has been used. *Id.* The problem is that, in most cases, salt water cannot be used for human consumption. *Id.*

⁹ *Explained: The World's Water Crisis*, *supra* note 4.

¹⁰ See discussion *infra* Part II.

¹¹ See discussion *infra* Part III.

marketplace does not. To be successful, such a model must account for (1) what the policy goals should be; (2) why other water policies have failed; (3) what is included in the price of water; and (4) what has driven the success of similar tax-based solutions in other areas.

Accordingly, Part I of this paper will define good water policy. This section will argue that any successful water policy must be built around four pillars of water sustainability: consumption, efficiency, equity, and longevity. Part II will examine how the current methods of controlling water crises measure up to the definition of good water policy in Part I, and why they will ultimately fail as long-term solutions. Part III will explain how the current perception of water as an essentially-free resource creates problems for water management and how a water tax could serve as a solution. Part IV will look at the effectiveness of carbon taxes at curbing fossil fuel usage around the world as a model for a potential water tax. Finally, Part V proposes a generic model for what a potential progressive-based consumption tax would look like and how it would work.

PART I: The Four Pillars of Good Water Policy

In periods of drought, the focus on water conservation is usually short-sighted. The goals are to reduce water usage to a sustainable point until water levels can return to pre-drought levels. These types of policies are reactionary in nature and assume that, over time, the water levels will return to normal levels. The combination of climate change and our growing population, however, means that these assumptions no longer are realistic.¹²

¹² ARIS GEORGAKAKOS ET AL., CLIMATE CHANGE IMPACTS IN THE UNITED STATES: THE THIRD NATIONAL CLIMATE ASSESSMENT 69–112 (U.S. Global Change Research Program 2014), *available at* <https://nca2014.globalchange.gov/report/sectors/water>.

Mexico City, which resided near an enormous lake only a few hundred years ago, is now a permanently arid metropolis and must rely upon its reservoirs of diminishing groundwater.¹³ Other regions around the world could face similar threats in the near future, especially since rising global temperatures are reducing the annual snow melt.¹⁴ Our current systems of managing water crises do nothing to address the future permanent shortages that could exist by 2040.¹⁵ World leaders and global organizations are keenly aware of this situation and have begun to focus their conservation efforts on forward-looking programs.¹⁶ Despite world leaders' general shift in attitude, little has been done to delineate what the tangible goals of water sustainability should be or how they should be measured.

Defining goals and measurements to determine whether these goals have been met is vital to any policy's success. Goals regarding water conservation are often hard to define and policy-makers focus only on reducing consumption or increasing water production and recycling. The obsession over consumption as the sole goal of conservation policies is simply because it is easy

¹³ THE JOINT ACADEMIES COMMITTEE ON THE MEXICO CITY WATER SUPPLY ET AL., MEXICO CITY'S WATER SUPPLY: IMPROVING THE OUTLOOK FOR SUSTAINABILITY 8–18 (National Academy Press 1995), *available at* <https://www.nap.edu/read/4937/chapter/4>. Mexico City's use of ground water has also impacted the integrity of the ground. *Id.* at 12–16. Removing ground water creates empty air pockets under the earth's surfaces. *Id.* The weight of surface structures causes these pockets to collapse and compress. *Id.* The end result is that Mexico City is sinking into the ground by an average of 5 centimeters per year. *Id.* For more on the history of how Mexico's water system developed and its effect on the surrounding environment, see *The Lake's Specter: Water and the History of Mexico City*, METROPOLE: BLOG (May 24, 2017), <https://themetropole.blog/2017/05/24/the-lakes-specter-water-and-the-history-of-mexico-city/>; see also *Explained: The World's Water Crisis*, *supra* note 4.

¹⁴ Brian C. Howard, *6 Places Where Melting Snow Means Less Drinking Water*, NAT'L GEOGRAPHIC (Nov. 12, 2015), <https://news.nationalgeographic.com/2015/11/151112-river-basins-water-drought-snowpack-snowfall-climate-change-science/>. These regions include the California central valley, the Colorado river, the Rio Grande basin, and the Indus and Ganges basin. *Id.* Snow melt is important to the water supply because, unlike normal precipitation, snow remains on the ground longer and melts slowly. *Id.* This longer period creates a steady water supply over time and makes it easier to collect. *Id.*

¹⁵ See discussion *infra* Part II; see also *Aqueduct Water Risk Atlas: Projected Change in Water Stress*, *supra* note 5.

¹⁶ In 2010, the United Nations recognized water as a human right. G.A. Res. 64/292, ¶ 1, U.N. Doc. A/Res/64/292 (Aug. 3, 2010); see also *Human Rights to Water and Sanitation*, U.N. WATER, <http://www.unwater.org/water-facts/human-rights/> (last visited Apr. 28, 2019). In addition to recognizing water as a human right, in 2015, water was a key feature in the United Nation's 2015 sustainable development goals. The goals include providing universal access to clean drinking water by 2030, developing transnational water management protocols, and reducing pollution in the water supply. *Goal 6: Ensure Access to Water and Sanitation for All*, U.N., <https://www.un.org/sustainabledevelopment/water-and-sanitation/> (last visited Apr. 28, 2019).

to measure. A program that seeks only to decrease consumption can measure the effectiveness of the policy immediately, producing instant political gratification. Although consumption is important to any conservation program, focusing solely on consumption ignores how we use water and fails to measure whether the consumption is being distributed equitably.

Until now, scholarship has mostly ignored aspects of sustainability beyond consumption. This paper seeks to eliminate that gap in the literature by creating a systematic way of holistically measuring water policies. To that end, this Section advocates that a successful water program take into account not only consumption but also efficiency, equity, and longevity. Each of these pillars is discussed in detail below.

a. The First Pillar: Consumption

Consumption is usually the primary focus of most conservation efforts. The logic is fairly straightforward: if you have a scarce resource and use less of it, you will have more of it for the future. Measurement is also fairly straightforward, and many countries and international organizations do a good job of keeping track of water consumption.¹⁷ The problem is that not all water is the same, and, therefore, not all types of water consumption should be treated equally. 97.5% of the earth's water is salt-water located in various oceans and seas in no danger of depletion.¹⁸ Thus, consumption of this water source is not really of concern. Desalination

¹⁷ For example, in the United States, the U.S. Geological Survey and the EPA keep track of both how much water is being used and how it is being used. *Total Water Use in the United States*, U.S. GEOLOGICAL SURV., https://www.usgs.gov/special-topic/water-science-school/science/total-water-use-united-states?qt-science_center_objects=0#qt-science_center_objects (last visited Apr. 28, 2019); *How We Use Water*, ENVTL. PROTECTION AGENCY, <https://www.epa.gov/watersense/how-we-use-water> (last visited Apr. 28, 2019). Internationally, organizations like the World Bank keep tabs on global water use. *Water Productivity, Total (Constant 2010 US\$ GDP Per Cubic Meter of Total Freshwater Withdrawal)*, WORLD BANK, <https://data.worldbank.org/indicator/ER.GDP.FWTL.M3.KD> (last visited Apr. 28, 2019); *see also Water Consumed This Year*, WOLRDOMETERS, <http://www.worldometers.info/water/> (last visited Apr. 28, 2019).

¹⁸ U.S. Geological Survey Water Science School, *supra* note 8.

technology may, over time, make this a viable source of water, but currently it is only an economically viable option in extreme situations.¹⁹

Of the remaining 2.5% of earth's water, 1.7% is trapped in ice at the poles and cannot be accessed without apocalyptic ramifications to ocean sea-life.²⁰ The remaining 0.8% falls into two categories: surface water and groundwater.²¹ Surface water is the much smaller of the two and represents all the fresh water lakes and rivers that accumulate due to rain and snow melt.²² Think of surface water as a checking account; it may be drawn upon regularly and is periodically replenished, but problems ensue when usage surpasses replenishment. Unfortunately, that problem has now manifested. In the last decade, we have used so much of the surface water that it is not replenishing at all.²³ Thus, we turn to the last category: groundwater. Groundwater is a water source that exists deep within the earth, having accumulated there over centuries.²⁴ Until

¹⁹ As of 2012, it costs between \$2 and \$12 to produce 1,000 gallons worth of desalinated water. *Seawater Desalination Costs*, WATER USE 1, 13 (2012), available at https://watereuse.org/wp-content/uploads/2015/10/WateReuse_Desal_Cost_White_Paper.pdf. The major factors impacting the costs are: desalination technology, raw and product water quality, type of intake and outfall, the location of the plant or project, the type of energy recovery used, the price of electricity, post-treatment needs, storage, distribution, local infrastructure costs, and environmental regulations. *Id.* These cost and vary widely depending on the area. *Id.* In California, where there is a large water supply, these costs are relatively low and access to salt water is abundant, the cost to produce 1,000 gallons of water ranged between \$2.91 and \$3.70. *Id.* at 16. Comparatively, in California, it costs between \$0.50 and \$2.45 to retrieve water from other sources, such as tapping into groundwater or the Colorado River. *Id.* These estimates do not include the infrastructure costs of building and maintaining the desalination plant itself. *Id.* The Camp Pendleton desalination plant cost roughly \$1.9 billion to achieve a mere developmental level of production. *Id.* at 7. The large amount of capital needed to get a plant up and running, coupled with their higher comparative costs and dependency on numerous cost variables, make desalination economically impractical.

²⁰ U.S. Geological Survey Water Science School, *supra* note 8. For details on how melting Arctic ice affects the Arctic wildlife, see *Arctic Climate Change*, ARCTIC WORLD WILDLIFE FOUND., <https://arcticwwf.org/work/climate/> (last visited Apr. 28, 2019).

²¹ U.S. Geological Survey Water Science School, *supra* note 8. Of the remaining 0.8%, roughly 30% of that is made up of groundwater. *Id.*

²² *Id.*

²³ Water Availability & Use Science Program, *Estimated Use of Water in the United States in 2015*, U.S. GEOLOGICAL SURV. 50–54 (2015), available at <https://pubs.usgs.gov/circ/1441/circ1441.pdf>.

²⁴ *How Ground Water Occurs*, U.S. GEOLOGICAL SURV., https://pubs.usgs.gov/gip/gw/how_a.html (last visited Apr. 28, 2019).

recently, most groundwater has been inaccessible, and extremely costly to use.²⁵ Groundwater is like a savings account reserved for emergencies as replenishment occurs slowly over an extended period of time. As with surface water, ground water is currently being used at a greater rate than it is replenishing.²⁶

It is important to keep these different sources in mind when discussing consumption in creating water policy. Industries that use water to create energy or for cooling purposes can rely on salt water and therefore are not at issue.²⁷ Rather, the consumption that is important is the use of surface and groundwater. Therefore, good water policy should differentiate between, and account for, all three sources. Reducing the use of groundwater should be the primary goal, because it does not replenish as quickly, followed by surface water, which does replenish. At the same time, the policy should encourage the use of salt water when possible and help make desalination efforts economically viable.

b. The Second Pillar: Efficiency

Efficiency is as heavily discussed as consumption in literature regarding water conservation but can become a secondary issue in practice because it requires more oversight to implement.²⁸ The basic idea behind efficiency is that water policies should maximize the return

²⁵ See *Explained: The World's Water Crisis*, *supra* note 4. For a detailed discussion regarding the total economic cost of accessing groundwater, see John Strand, *The Full Economic Cost of Groundwater Extraction*, WORLD BANK (Dec. 2010), available at <http://documents.worldbank.org/curated/en/592401468314702740/pdf/WPS5494.pdf>.

²⁶ Water Science School, *Groundwater Decline and Depletion*, U.S. GEOLOGICAL SURV., https://www.usgs.gov/special-topic/water-science-school/science/groundwater-decline-and-depletion?qt-science_center_objects=0#qt-science_center_objects (last visited Apr. 28, 2019).

²⁷ See discussion, *supra* note 8. The amount of ocean water is enormous and is not in danger of running out compared to the infinitesimally smaller amount of fresh water, however, it is not fit for human consumption. Yet, humans do not consume water used for industrial purposes. Therefore, if users are encouraged to use salt water rather than fresh water for industrial purposes, the amount of water those consumers use no longer becomes an issue.

²⁸ See, e.g., G. Tracy Mehan III & Ian Kline, *Pricing As a Demand-Side Management Tool: Implications for Water Policy and Governance*, 104 AM. WATER WORKS ASS'N 61, 61–66 (2012), available at <https://www.jstor.org/stable/pdf/jamewatworass.104.2.61.pdf?refreqid=excelsior%3Afc6132e1e77e573498481bed8f8fd5f3>; T. Chesnutt & J. Beecher, *Revenue Effects of Conservation Programs: The Case of Lost Revenue*, A&N TECH. SERVS. (2004); D.B. BROOKS, M.B. OLIVER, & S. GURMAN, *MAKING THE MOST OF THE WATER WE HAVE: THE SOFT PATH APPROACH TO WATER MANAGEMENT* (1st ed. 2009).

product per unit of water.²⁹ Efficiency is most pertinent to water use in the production of other goods, particularly agricultural goods. Maximizing efficiency comes in two different forms: *absolute* efficiency and *comparative* efficiency.³⁰

Absolute efficiency refers to reducing the amount of water that is wasted in a given project. Water waste can occur, for example, when pipes leak, run off water is not collected, or water becomes unusable because of pollution. Municipalities and individuals can enhance their absolute efficiency by investing in infrastructure, such as fixing canals and sewage systems, or through better technology, like low-flow toilets. We can measure this type of efficiency by first quantifying the amount of waste in the system and then looking at how that waste is reduced in response to a given policy. Many different systems already have varying methods of estimating waste.³¹ For example, Cape Town estimates it's by measuring the difference between the source of the water and the metered units that actually arrive at a domestic residence.³² A good water policy would be one that reduces the amount of waste by encouraging investment in infrastructure and technology.

Alternatively, comparative efficiency looks at the activity the water is being used for compared to other activities. For example, if it takes less water to grow a pound of soy beans

²⁹ See T. Chesnutt & J. Beecher, *supra* note 28.

³⁰ This paper conceptualize water efficiency in the same way international trade conceptualizes absolute and comparative advantage. Troy Segal, *Absolute vs. Comparative Advantage: What's the Difference?*, INVESTOPEDIA (Apr. 20, 2019), <https://www.investopedia.com/ask/answers/033115/what-difference-between-comparative-advantage-and-absolute-advantage.asp>. In international trade, absolute advantages looks at the most efficient way to manufacture a single product. Countries that can manufacture that product in the most cost effective way are considered to have an absolute advantage over other countries. Other countries should not try and compete with a country with an absolute advantage. Conversely, comparative advantage looks at international trade holistically, looking at multiple products. A country has a comparative advantage if it has a lower opportunity cost, or the cost of producing an alternative good, than another country. Countries with a comparative advantage in one product should produce that product and then trade with other countries for products where they do not have a comparative advantage. Doing so increases the overall efficiency in the system and reduces prices.

³¹ See, e.g., *City of Cape Town Open Data Portal – Data Set Description*, CITY CAPE TOWN, <http://web1.capetown.gov.za/web1/opendataportal/DatasetDetail?DatasetName=Water%20consumption> (last visited Apr. 28, 2019), which provides metadata for suburban water consumption.

³² See *id.*

compared to a pound of rice, soy is a comparatively more efficient product than rice, assuming that a pound of each is equally beneficial. A good water policy would include a mechanism to encourage the use of water in comparatively efficient ways. In the agricultural sector, efficiency is easy to measure because farmers can determine with relative accuracy how much water certain crops need to grow compared to other crops. Comparative efficiency can become trickier in the industrial sector. For example, if product X uses 1500 liters of water per unit, but the water can be recycled if treated, is it more efficient than product Y that uses 10 liters of water but pollutes the water in such a way that it cannot be recycled?³³ It becomes even more complicated in situations where the activities are not easily comparable. For example, it is more difficult to determine if it is more efficient to water a lawn or wash a car. For the purposes of this paper, the focus will be on encouraging comparable efficiency between substitutes in the marketplace, while encouraging practices where water can be recycled after being used.

c. The Third Pillar: Equity

Equity is the most ambiguous and elusive of the four pillars because it means a lot of different things to different people. Nevertheless, in the case of water management, equity should be a crucial consideration because of the consequences that result from inequity of water access. Studies have shown that violent conflict is much more likely to occur when access to water is inequitably distributed.³⁴ For example, several studies have linked the genocide in Darfur, as

³³ In this example, there are many variables that impact efficiency: how long it takes to recycle the water, the cost to treat the water, and whether it is possible to recycle 100% of the water used, to name a few. Ultimately, it would be preferable to recycle the water in the long run but these considerations might affect the ability of a firm to recycle in the short term. Therefore, a good water policy would help cut down on the negative externalities that make recycling cost prohibitive.

³⁴ CNA, THE ROLE OF WATER STRESS IN INSTABILITY AND CONFLICT (2017), *available at* https://www.cna.org/CNA_files/PDF/CRM-2017-U-016532-Final.pdf; Christiane Fröhlich & Ulrich Ratsch, *Water Scarcity and Violent Conflict*, in GLOBAL CHANGE: ENOUGH WATER FOR ALL 240–43 (J. L. Lozán et al. eds., 2007), *available at* http://www.klima-warnsignale.uni-hamburg.de/wp-content/uploads/2016/01/froehlich_ratsch.pdf; *Editor's Pick: 10 Violent Water Conflicts*, RELIEFWEB (Sept. 4, 2017), <https://reliefweb.int/report/world/editor-s-pick-10-violent-water-conflicts>.

well as the greater conflict between North and South Sudan, to unequal access to water between different ethnic groups.³⁵ Another study demonstrated that tensions between Pakistan and India rise during dry periods, when access to water by both sides is more restricted.³⁶ Even the start of the Syrian civil war coincided with a severe drought in the region.³⁷ Conversely, efforts between the Turks and Kurds to establish equal access to water in eastern Turkey have helped foster cooperation between the two groups over water management despite the animosity between them.³⁸ These illustrations highlight the importance of water equality as a stabilizing or destabilizing force.

Consequently, a good water policy must take into account equitable concerns, particularly as to who has access to water and who incurs the cost associated with managing the resource. This paper defines an equitable water policy as one that allocates the cost of water management based on ability to bear those costs. Under this definition of equity, there are two types of equitable considerations: horizontal equity and vertical equity.³⁹ Generally, horizontal equity means that two individuals with identical economic capabilities should bear the same

³⁵ Lydia Polgreen, *A Godsend for Darfur, or a Curse?*, N.Y. TIMES (July 22, 2007), <https://www.nytimes.com/2007/07/22/weekinreview/22polgreen.html>; Lisa Schlein, *Water Scarcity Root of Darfur Conflict*, VOA NEWS (June 10, 2011, 8:00 PM), <https://www.voanews.com/a/water-scarcity-root-of-darfur-conflict-123688459/158292.html>.

³⁶ *India-Pakistan Water Dispute Explained*, TRT WORLD (Jan. 8, 2019), <https://www.youtube.com/watch?v=dTEp5FqgBwo>. The World Bank was able to broker a water treaty between the two countries in 1960, however, this treaty has not stopped India and Pakistan from fighting over the resources. As recently as 2019, there have been signs of military escalation along the border over access to water. The Indus Waters Treaty, India-Pak.-Int'l Bank Reconstruction & Dev., Sept. 19, 1960, 419 U.N. TREATIES 6032, *available at* <https://treaties.un.org/doc/Publication/UNTs/Volume%20419/volume-419-I-6032-English.pdf>; Keith Johnson, *Are India and Pakistan on the Verge of a Water War?*, FOREIGN POL'Y (Feb. 26, 2019, 3:00 PM), <https://foreignpolicy.com/2019/02/25/are-india-and-pakistan-on-the-verge-of-a-water-war-pulwama-kashmir-ravi-indus/>.

³⁷ Henry Fountain, *Researchers Link Syrian Conflict to a Drought Made Worse by Climate Change*, N.Y. TIMES (Mar. 2, 2015), <https://www.nytimes.com/2015/03/03/science/earth/study-links-syria-conflict-to-drought-caused-by-climate-change.html>.

³⁸ *Turkey-Armenia: Water Cooperation Despite Tensions*, FACTBOOK, <https://factbook.ecc-platform.org/conflicts/turkey-armenia-water-cooperation-despite-tensions> (last visited Apr. 27, 2019).

³⁹ MICHAEL J. GRAETZ & DEBORAH H. SCHENK, *FEDERAL INCOME TAXATION: PRINCIPLES AND POLICIES* 28–29 (8th ed. 2018).

cost.⁴⁰ In a basic income tax model, this means that if A makes \$1,000 per month working in an office and B nets \$1,000 per month selling magazines, they should both pay the same percentage of taxes on their income.⁴¹ Vertical equity, on the other hand, means that those with greater economic capacity should pay a greater percentage of the cost.⁴² Thus, if X made \$1,000 per month, and paid 10% of that amount in taxes, then Y, who makes \$10,000 per month, should pay 15% of her monthly income in taxes. This is the basic concept behind a progressive tax system.⁴³

Applying these concepts to water management requires nuance because one must also account for each individual's consumption. If A and B both have similar economic capacities, but A consumes twice as much water as B, then A should pay twice as much as B.⁴⁴ Here, horizontal equity is achieved when the *price per unit* is the same for individuals in identical economic situations. Meanwhile, if X uses 1000 liters of water at \$5 per liter and Y uses 500

⁴⁰ *Id.*

⁴¹ It is significant that B nets \$1,000 per month rather than grosses \$1,000. If the tax were applied to the gross earnings, B would not be in an identical economic position to A because B would have expenses associated with the way he earns income that A does not. Under U.S. tax law, B is allowed to deduct the expenses associated with his magazine sales. 26 U.S.C. § 162.

⁴² This view of vertical equity is not undisputed. Richard A. Musgrave, *Horizontal Equity, Once More*, 43 NAT'L TAX J. 113, 113 (1990), available at <https://www.ntanet.org/NTJ/43/2/ntj-v43n02p113-22-horizontal-equity-once-more.pdf>; James R. Repetti & Paul R. McDaniel, *Horizontal and Vertical Equity: The Musgrave/Kaplow Exchange*, 1 FLA. TAX REV. 607, 610–11 (1993), available at <https://lawdigitalcommons.bc.edu/cgi/viewcontent.cgi?referer=https://www.google.com/&httpsredir=1&article=1706&context=lsfp>. It could be argued that vertical equity does not require those with more income to pay a higher percentage. *See id.* These scholars assert that if the percentage is kept the same for every individual, those with higher income still contribute more total dollars than those with lower income. *See id.* The problem with this view of vertical equity is that it does not take into account that individuals with higher income spend proportionately less of their income on basic needs than those with lower incomes. The increased burden on high-income earners accounts for the fact that a greater portion of the income is disposable.

⁴³ GRAETZ & SCHENK, *supra* note 39, at 32–36. Those who justify progressive taxes often argue that: (1) larger income tax payers are better able to pay taxes than smaller incomes, (2) progressive rates are a mechanism for reducing inequality, (3) the tax rates offset other regressive taxes, like sales taxes, producing an overall proportionate tax, and (4) individuals with greater income often benefit more from government expenditures. *See id.* Critics of progressive taxes argue that it creates market inefficiencies and undermines individual's economic liberties. *See id.*

⁴⁴ For example, imagine A and B both earn \$1,000 per month, but A consumes 20 liters of water per month, whereas B consumes only 10 liters of water per month. If the government enacted a 1% tax to pay for water treatment facilities, A and B would both pay \$10 per month. While each individual is equally responsible for paying the tax, A derives more benefit than B because he uses more water. Therefore, A is getting more value per tax dollar he contributes. If the goal is to ensure that every person in identical economic situations derives the same benefit per tax dollar spent, the tax would have to account for how much each individual uses the resource.

liters of water at \$10, they both end up paying the same total amount for their water usage, but Y pays more per unit because Y has a greater economic capacity to do so.⁴⁵ In this way, vertical equity can be achieved even if two individuals in different economic situations end up paying the same amount.⁴⁶

When allocating the cost according to these concepts, there are a variety of political and economic factors to consider. This debate is beyond the scope of this paper and should be addressed by policy makers who are more familiar with their communities. For purposes of this paper and development of a tax-based solution, it is only necessary that the policy take into consideration both horizontal and vertical equity.

d. The Fourth Pillar: Longevity

Longevity is the last of the pillars and is often difficult to address when forming water policy because of the uncertainty of the future. Ideally, a successful water policy is sustainable over long periods of time. In the past, most water policies focused on the short term to deal with the crises at-hand, so consideration of longevity was not prioritized.⁴⁷ Consumption would decrease or efficiency increase during the crisis only to return to normal afterwards.⁴⁸ As the goal of a sustainable water program is to create permanent rather than momentary change, longevity is achieved if all three of the other measures are successfully sustained over the course of decades. This requires annual measurements and adjustments to the policy to accommodate changes to the factors that drive the policy. There need not be continuous improvements on

⁴⁵ In this context the goal of vertical equity is to ensure that individuals contribute an amount based on their ability to pay and the amount of benefit they derive from the tax. Here, Y is in a better position to contribute a higher percentage of his income to pay for the resource provided because he makes 10 times the amount of money as X. *Supra* page 12. Therefore the price per unit for Y should be higher than the price per unit for X. Y, however, also uses less overall water so his overall contribution should also reflect that reality.

⁴⁶ X pays \$5,000 in taxes (1,000 liters x \$5 per liter). Y pays \$5,000 in taxes (500 liters x \$10 per liter).

⁴⁷ *See infra* Part II(a)(i)(4).

⁴⁸ *Id.*

annual basis to achieve longevity, but the improvements that are made during the initiation of the policy should not erode over time. During times of drought, longevity is often not a priority because drastic measures are needed to reduce water consumption immediately. Thus, it is crucial that policymakers implement conservation efforts before crises occur so that the measures they take are not too heavy-handed, and therefore unsustainable, over the decades to come.⁴⁹

These four pillars—consumption, efficiency, equity, and longevity—are the critical elements of a proactive and sustainable water policy. Because most modern water policies only incorporate one or two of these elements, they typically do not enjoy life beyond the lives of the policymakers who created them. Next, the successes and shortcomings of these policies are examined and, ultimately, discarded.

PART II: The Current Strategies for Water Conservation: How They Measure Up

Strategies for water conservation can be divided into two general categories: “direct administrative oversight” (DAO) and “demand side.”⁵⁰ In addition to these two categories there is also “infrastructural Management,” which is not a stand-alone policy but a popular strategy that can be implemented within the two larger general policies.⁵¹ Of these three broad categories, demand side strategies have been overlooked in favor of the other two categories of water management. Policymakers justify the favoritism of DAO and Infrastructural Management

⁴⁹ The Colorado River Compact is an example of a successful forward-looking water management program. The compact dictates how water from the Colorado River has been divided between seven U.S. states and Mexico since 1922. The treaty is periodically revisited and updated to account for changes in water levels and usage. *E.g.*, Interim International Cooperative Measures in the Colorado River Basin Through 2017 and Extension of Minute 318 Cooperative Measures to Address the Continued Effects of the April 2010 Earthquake in the Mexicali Valley, Baja California, Int’l Boundary and Water Comm’n, Nov. 20, 2012, *available at* https://www.ibwc.gov/Files/Minutes/Minute_319.pdf. In addition to these periodic revisions, the U.S. Department of the Interior regularly provides reports on how best to manage the supply and demand of water from the Colorado River. *Colorado River Basin Water Supply and Demand Study*, in RECLAMATION: MANAGING WATER IN THE WEST, U.S. Dep’t of the Interior Bureau of Reclamation (2012), *available at* https://www.usbr.gov/watersmart/bsp/docs/finalreport/ColoradoRiver/CRBS_Executive_Summary_FINAL.pdf.

⁵⁰ These are terms created for this paper and do not appear in the existing literature. The terms are used to condense a wide variety of different water management plans into two broad categories.

⁵¹ Infrastructure management is also a term created for this paper and does not appear in the existing literature.

policies by arguing that water is an inelastic good, and therefore consumers will not alter their behaviors dramatically when prices fluctuate.⁵² This logic is dispelled in Part III. Using the Cape Town case study, this section examines the viability of the DAO as a solution to water conservation using the four pillars mentioned in the previous section. Additionally, this Section addresses the short-comings of over emphasizing infrastructural management within either of the two general policies.

a. Direct Administrative Oversight

DAO is a strategy whereby the government, at any level, places a direct restriction over the use of water. The prototypical version of this is water rationing, whereby the government restricts how much water each individual can use per diem.⁵³ Variations of this manifest in the form of restrictions on when water can be used—restricting usage during the hottest parts of the day—or restrictions on how water can be used—prohibitions on watering lawns.⁵⁴ These types of restrictions can be simple or highly sophisticated. For example, all golf courses in Arizona must use recycled waste water for their greens.⁵⁵ The general idea behind DAO is that the government has the power to force individuals to use less water and use water more efficiently by enacting laws that directly restrict how water is used.

⁵² Mehan III & Kline, *supra* note 28.

⁵³ See, e.g., *Water Outlook 2018 Report*, DEP'T WATER & SANITATION CITY CAPE TOWN (May 20, 2018), <https://resource.capetown.gov.za/documentcentre/Documents/City%20research%20reports%20and%20review/Water%20Outlook%202018%20-%20Summary.pdf>.

⁵⁴ For example, the California water service restricts the use of irrigation during specific times of the day, typically between 8:00 AM and 6:00 PM. Violators of this restriction would face a \$50 fine and could have their water service discontinued. *Time-of-Day Watering Restrictions*, CAL. WATER, <https://www.calwater.com/conservation/drought/watering-times/> (last visited Apr. 27, 2019). Similarly, in 2016, Long Beach County prohibited the use of water to wash vehicles in order to cope with a prolonged drought. *Water Use Prohibitions*, LONG BEACH WATER DEP'T, <http://www.lbwater.org/water-use-prohibitions> (last visited Apr. 27, 2019).

⁵⁵ *Arizona Golf Courses to Use Recycled Wastewater for Irrigation*, WATER QUALITY PROD. MAG. (June 4, 2010), <https://www.wqpmag.com/water-reuse/arizona-golf-courses-use-recycled-wastewater-irrigation>.

In theory, DAO should be an effective method of dealing with water conservation. First, the strategy eliminates the need for any causal mechanisms by controlling the use of water directly. Second, any DAO program can be modified to account for negative externalities that result as a byproduct of the government's interference in the marketplace. In practice, however, DAOs have mixed results, as is demonstrated by the Cape Town, South Africa case study.

i. Cape Town, South Africa – DAO Case Study

Cape Town, South Africa experienced a prolonged drought starting in 2015.⁵⁶ The city responded by enacting a DAO program that limited each individual's water use to 50 liters per day.⁵⁷ In some areas, meters were placed on houses that automatically cut off water when the 50 liter threshold was met, while in other areas individuals were forced to wait in lines to collect their daily allowance of water from distribution centers.⁵⁸ Individuals caught violating the restrictions on water use faced heavy fines.⁵⁹ Overall, the program was lauded as successful at cutting Cape Town's water usage in half and preventing Day Zero from occurring.⁶⁰ Upon closer

⁵⁶ See discussion *supra* note 3.

⁵⁷ See *Water Outlook 2018 Report*, *supra* note 53. The limitations was done in a series of phases. The first phase was to reduce what consumption through a series of levels. The city had been on a level 1 restriction since 2005, but in January 2016 the city moved to level 2 and then to level 3 in November 2016. The per diem restrictions for individuals kicked in at level 4 at 100 liters a day, which was implemented in June 2017. This was eventually decreased to 50 liters per day when the city moved to level 6B in February 2018. Phase 2 of the plan would come after Day Zero and involved shutting off all public access to water. This would be followed by phase 3 which would involve the complete termination of Cape Town's water supply. Fortunately, Day Zero never occurred. *Id.* The city also put out guidelines regarding how best to manage the use of an individual's 50 liter allowance. See *Your Guide to Use 50 Litres of Water Per Day*, W. CAPE GOV'T, <https://www.westerncape.gov.za/general-publication/your-guide-use-50-litres-water-day> (last visited Apr. 27, 2019).

⁵⁸ Baker, *supra* note 1; Krista Mahr, *How Cape Town Was Saved from Running out of Water*, GUARDIAN (May 4, 2018), <https://www.theguardian.com/world/2018/may/04/back-from-the-brink-how-cape-town-cracked-its-water-crisis>. Whether individuals continued to get water directly to their houses likely depended on the wealth of the individual. Bram Janssen, *Cape Town's Water Crisis Highlights City's Rich-Poor Divide*, AP NEWS (Feb. 3, 2018), <https://apnews.com/82b03361b51843268c569d8a6d5ecf08>.

⁵⁹ Mahr, *supra* note 58.

⁶⁰ *Id.*

examination, the DAO program used in Cape Town has serious flaws that prevent it from being a long-term solution.

1. Consumption

Looking solely at consumption, the DAO program appeared to be an enormous success. Between 2015 and 2016, overall annual water consumption in the city dropped from 146 kiloliters per person to 33 kiloliters per person, a decline of roughly 78%.⁶¹ Ideally, this overall reduction would be coupled with an increase in use of desalinated water and a greater proportionate decrease in the use of ground water compared to surface water. Until recently, Cape Town relied almost exclusively on the water from several dams.⁶² Only in 2018 did the city's three desalination plants become operational, and data is not yet available regarding their production levels.⁶³ Likewise, Cape Town has never relied heavily on ground water for the city's water supply.⁶⁴ The move towards desalination, coupled with an impressive reduction in overall consumptions, shows that Cape Town's DAO program is moving the city in the right direction. Although these numbers are laudable, they do not explain the whole story.

2. Efficiency

⁶¹ See Appendix 1: Figure 1. The data used in this Section is compiled from the City of Cape Town Open Data Portal and the Cape Town census and population statistics. *City of Cape Town Open Data Portal – Data Set Description*, *supra* note 31; *City Cape Town Census and Population Statistics*, CITY CAPE TOWN, <https://www.capetown.gov.za/Family%20and%20home/education-and-research-materials/data-statistics-and-research/cape-town-census> (last visited Apr. 27, 2019). Using these two sources of data, this paper was able to produce several graphics found in the Appendix.

⁶² *Reconciliation Strategy for the Western Cape Water Supply System*, DEP'T WATER & SANITATION REPUBLIC S. AFR., http://www.dwa.gov.za/Projects/RS_WC_WSS/sa.aspx (last visited Apr. 27, 2019).

⁶³ Nora Shelly, *Cape Town's First Desalination Plant Comes Online*, TIMES LIVE (May 21, 2018), <https://www.timeslive.co.za/news/south-africa/2018-05-21-cape-towns-first-desalination-plant-comes-online/>.

⁶⁴ See *Reconciliation Strategy for the Western Cape Water Supply System*, *supra* note 62. An exception to this might be in the City's townships but data is hard to gather because the water is unbilled. Townships is the term used to describe Cape Town's informal settlements. Data is difficult to get because there are no formal records of each settlement and access to electricity and water comes from unofficial means. The townships are a legacy of the apartheid era of South Africa's history where the black community was relegated to these informal settlements and denied full citizenship.

One of the major flaws in DAO programs is their efficiency. Prior to the implementation of the program, the top three categories of water use in Cape Town were: domestic use (45%), waste (32%), and commercial/industrial use (17%).⁶⁵ The 32% lost to waste is caused by leaks in the infrastructure that allow water to be lost while traveling from the dams to wherever it is being used.⁶⁶ The Cape Town program could have achieved high absolute efficiency if this number had been significantly reduced after the DAO program was implemented. A year later, however, waste actually increased compared to the other categories, representing 62% of all water use.⁶⁷ Because Cape Town's DAO only addressed consumption by the end user, all of the other categories of usage declined while waste went unaddressed.

Whether Cape Town's program achieved relative efficiency is a more nuanced issue. Looking only at consumption within Cape Town itself, it appears that all categories other than waste were reduced—commercial/industrial use reduced the most, to 4% of all consumption.⁶⁸ Unfortunately, Cape Town does not provide data on how the water in a given category is used specifically.⁶⁹ It is therefore impossible to know within the industrial sector whether there was a shift in manufacturing towards more water-efficient goods.

Expanding the scope of the Cape Town case study to the wine regions outside of the city provides a different story. According to one report, if the total annual water usage by wineries outside of Cape Town were diverted to the city, it could have prevented the crisis altogether.⁷⁰ Whether doing so would have achieved relative efficiency is not clear because, as explained in

⁶⁵ See Appendix 1: Figure 2.

⁶⁶ See *id.* See also the metadata for suburban Cape Town's water consumption: *City of Cape Town Open Data Portal – Data Set Description*, *supra* note 31.

⁶⁷ See Appendix 1: Figure 3.

⁶⁸ See *id.*

⁶⁹ *City of Cape Town Open Data Portal – Data Set Description*, *supra* note 31.

⁷⁰ *Explained: The World's Water Crisis*, *supra* note 4.

Part I, it is not a comparison between substitute goods. Nevertheless, this information is alarming, considering that wine is a luxury good that requires a disproportionate amount of water to produce.⁷¹ Ideally, if the DAO program was comparatively efficient, it likely would have resulted in some of the wine region water use being diverted towards general domestic use. The city's DAO program was limited in scope and focused primarily on domestic use within the city, not accounting for agricultural water usage by the vineyards outside of the city.

3. *Equity*

Equity also became a significant issue after Cape Town implemented the DAO program. With a Gini index of 62.5, South Africa has the highest level of income inequality out of those countries measured in 2013.⁷² This type of inequality has a deep-rooted history that is keenly felt by the population.⁷³ It is, therefore, extremely important for South Africa that their DAO be equitable in nature. On its face, the program appears to exhibit horizontal equity. Every individual, regardless of income, is limited to 50 liters per day. Thus, two individuals regardless of their economic situations have the same restrictions on their water usage.

The situation becomes more concerning when examining the vertical equity aspect of the program. Although the program limited how much water individuals could draw from the public

⁷¹ *Id.*

⁷² *The World Factbook*, CENT. INTELLIGENCE AGENCY, <https://www.cia.gov/library/publications/the-world-factbook/rankorder/2172rank.html> (last visited Apr. 27, 2019). The Gini Index is a summary measure of income inequality. The Gini coefficient incorporates the detailed shares data into a single statistic, which summarizes the dispersion of income across the entire income distribution. The Gini coefficient ranges from 0, indicating perfect equality (where everyone receives an equal share), to 100, perfect inequality (where only one recipient or group of recipients receives all the income).

⁷³ For a greater discussion of the history of apartheid and income inequality, see JEREMY SEEKINGS & NICOLI NATTRASS, *CLASS, RACE, AND INEQUALITY IN SOUTH AFRICA* (2005), available at https://www.sahistory.org.za/sites/default/files/file%20uploads%20/professor_jeremy_seekings_nicoli_nattrass_classbookos.org_.pdf.

water supply, it did not prevent private solutions to the water shortage.⁷⁴ During the drought, many wealthy individuals began drilling “bore holes” to tap into ground water under their property, buying machines that turn moisture in the air into drinking water, or staying at five-star hotels with their own private water silos.⁷⁵ In this way, the richest of the country were able to avoid the negative effects of the program and potentially create more harm in the future by drawing on their private supplies of ground water.

The ability of the country’s wealthiest individuals to buy their way out of the water crisis affronts the basic idea of vertical equity addressed in this paper.⁷⁶ How to achieve vertical equity in a DAO-type system is more uncertain. Theoretically, those with higher incomes should pay more because they are better able to bear the cost, but it is difficult to imagine how that would work in a system that restricts the water usage directly. It seems unrealistic to design a program that limits high-income individuals to 30 liters of water per day instead of 50 liters without enormous public outcry. Likewise, closing the loopholes by simply forbidding bore holes probably would only produce more sophisticated workarounds by the wealthy. The disparity in treatment between how the DAO program in Cape Town affects the rich and the poor highlights one of the major limitations in DAO programs generally.

4. Longevity

It is difficult to assess the longevity of Cape Town’s DAO program, the final pillar of a good water policy. Not enough time has passed to determine whether consumption will increase

⁷⁴ Kevin Sieff, *Divided by Drought*, WASH. POST (Feb. 23, 2018), <https://www.washingtonpost.com/news/world/wp/2018/02/23/feature/as-cape-towns-water-runs-out-the-rich-drill-wells-the-poor-worry-about-eating/>.

⁷⁵ *Id.*

⁷⁶ Moreover, the Townships only account for 4% of Cape Town’s water usage, whereas the richest communities consume disproportionately more water. Janssen, *supra* note 58; Maxwell Roeland, *Water Curbs: A Tale of Rich and Poor*, GROUNDUP (Mar. 7, 2018), <https://www.groundup.org.za/article/water-curbs-tale-rich-and-poor/>; *Water Outlook 2018 Report*, *supra* note 53.

again or whether other negative externalities may occur, and the program has since been relaxed after a heavy rainy season.⁷⁷ This is a common occurrence among DAO programs because they are often implemented to address a specific threat and are disregarded afterwards. Even if the drought had continued and the city had not lifted the restrictions, it is unlikely that this type of program could be sustainable in the long term. The city would eventually experience difficulties enforcing the policies as more individuals are incentivized to find ways of cheating. This would result in the poorest in the community bearing even greater hardships, which could lead to civil unrest.

ii. Lessons from Cape Town: Why DAO Programs Do Not Work

Although Cape Town's successful avoidance of Day Zero is often touted as a triumph, it is important to realize that luck played an important role in staving off disaster. The city's DAO program successfully reduced consumption, but was otherwise completely unsustainable and reckless. The Cape Town case study offers an ideal example of the challenges facing all DAO programs.

First, DAO programs often resemble sledge hammers in their approach. They usually contain blanket restrictions on water use to reduce consumption quickly in response to a crisis. To be effective in the long run, a DAO program must be meticulous in its design to account for numerous contingencies. This includes both closing loopholes that allow for inequity and finding ways to force industries to act with comparative efficiency. Not only is such a program difficult to legislate, but also it is more difficult to enforce.

⁷⁷ *City of Cape Town Relaxes Water Restrictions to Level 3*, EYEWITNESS NEWS (Nov. 29, 2018), <https://ewn.co.za/2018/11/29/cape-town-water-restrictions-relaxed-to-level-3>.

For the Cape Town program to work long term, the city would need to address all of the loopholes created by private solutions. It also would require spending enormous amounts of man power and resources enforcing those measures. Moreover, Cape Town likely cannot legally divert water away from the surrounding vineyards, which means that federal action would be required with immense oversight and coordination between local and federal agencies.⁷⁸

DAO programs also fail to account for waste.⁷⁹ Waste resulting from poor infrastructure accounted for over half of all water consumed during the Cape Town crisis.⁸⁰ Curbing this type of inefficiency would have helped prevent the water crisis. This could have been accomplished by encouraging individual businesses to fix their own leaks and by spending money on improving the public water and sewage systems. DAO programs neither incentivize individuals to fix these problems themselves, nor do they raise the capital needed for the government to fix the infrastructure. Thus, DAO can only serve as a temporary solution to address short term concerns.

b. Infrastructural Management

Infrastructure management is a strategy for water conservation that emphasizes the use of technology and structural improvements to our water system to reduce consumption.⁸¹ The idea behind this strategy is that if we can improve the mechanism that facilitates water use to be more water conscientious, water consumption will drop and efficiency will increase. Common

⁷⁸ *Explained: The World's Water Crisis*, *supra* note 4.

⁷⁹ See Appendix 1: Figure 3.

⁸⁰ *Id.*

⁸¹ S.M. Olmstead & R.N. Stavins, *Managing Water Demand: Price vs. NonPrice Conservation Programs*, PIONEER INST. 39 (2007).

examples of this type of strategy are the installation of low-flow toilets or drip irrigation systems, both of which use less water to accomplish the same goal as their predecessors.⁸²

Infrastructural management is unique in that, unlike DAO or Demand side, it is not a comprehensive stand-alone water policy but, rather, a series of technological innovations that improve water use. Because these improvements occur sporadically and unevenly across the sector, the strategy cannot be relied upon as a permanent fix to the larger issue of water management.⁸³ A DAO or Demand side policy would still need to be introduced to facilitate the widespread and standardized use of these improvements.⁸⁴ Infrastructural management, therefore, serves more as a complement to either DAO or Demand-side based policies rather than an alternative to them. Consequently, it is not necessary to include a complete analysis of its feasibility as was done with DAO in the prior section.

⁸² Low-flow toilets work by using 1.6 gallons of water to flush waste compared to the typical 4 gallons used on older traditional models. Jeff Harrison, *UA Study Shows Leaks in Conservation Theory Behind Low-Flow Toilets*, U. ARIZ. NEWS (Oct. 31, 2000), <https://uanews.arizona.edu/story/ua-study-shows-leaks-conservation-theory-behind-low-flow-toilets>. Drip irrigation is often compared to flood or furrow irrigation. Drip irrigation distributes small drops of water directly over the crop continuously over the course of several hours. This method has been shown to be more water-efficient than the furrow method, where large amounts of water essentially flood the field. Studies show that plants are better able to absorb the water using a drip method and there is less overall water runoff. *Drip Irrigation on Sugarcane in the Burdekin Region*, QUEENSLAND GOV'T, <https://www.reefplan.qld.gov.au/land-use/cane/case-studies/drip-irrigation> (last visited Jan. 31, 2019).

⁸³ These improvements occur sporadically because they require individuals to actively install the new infrastructure in their private residences and businesses. Capital limitations, cultural differences, education, and access to technology might inhibit the adoption of these types of technological improvements. For example, a poorer rural community with access to a nearby river might not find it advantageous to install a low-flow toilet.

⁸⁴ Congresswoman Alexandria Ocasio-Cortez attempted to get around these issues by introducing H. Res. 109, which calls for a “Green New Deal.” H.R. 109, 116th Cong. (2019), available at <https://www.congress.gov/116/bills/hres/109/BILLS-116hres109ih.pdf>; Aylin Woodward, *Alexandria Ocasio-Cortez Calls the Green New Deal the ‘Moonshot’ of Our Generation. Here’s What to Know About the Plan and the Opposition it Faces*, BUS. INSIDER (Feb. 27, 2019, 2:02 PM), <https://www.businessinsider.com/alexandria-ocasio-cortez-green-new-deal-2019-1>. Under this resolution, these types of improvements would be mandatory. *Id.* The Congresswoman’s resolution was voted down in the Senate 0-57 on March 27, 2019. Bob Fredericks, *Senate Rejects Ocasio-Cortez’s Green New Deal in 57-0 Vote Blasted As a ‘Sham’ by Dems*, N.Y. POST (Mar. 26, 2019, 5:24 PM), <https://nypost.com/2019/03/26/senate-rejects-ocasio-cortezs-green-new-deal-in-57-0-vote-blasted-as-a-sham-by-dems/>.

Nevertheless, because of the scholarship devoted to the subject, it is still worthwhile to discuss infrastructural management independent of DAO and Demand-side policies. This scholarship advocates that conservation can be achieved by simply promoting the use of these technological improvements with minimal additional oversight or regulation.⁸⁵ This argument rests on the assumption that technological advancements will eventually be able to increase efficiency to the point where the water crisis is resolved.⁸⁶ The role of policy makers, therefore, is to simply promote the use of these improvements and encourage innovation.⁸⁷ This argument is not without merit. For example, if desalination technology can improve to the point where it is both economically viable and able to be mass-produced on a global scale, the global water crisis will be resolved. The problem with overemphasizing the role of technology in water policies is that there are limitations on the types of results that can be achieved by simply improving the infrastructure.

The problem with overreliance on improvements to infrastructure can be divided into two smaller issues: economic issues and behavioral issues. The first issue is that installing low-flow toilets, improving pipes, and promoting new technology all require an initial capital investment. A study from UC Davis demonstrated that a recently built house, fitted with the latest water-saving devices, saved nearly twice as much water per year as a house built just four years earlier.⁸⁸ Despite this finding, the study was unable to conclude that installing these new appliances actually resulted in the house being more economically efficient.⁸⁹ The most shocking

⁸⁵ Olmstead & Stavins, *supra* note 81.

⁸⁶ *Id.*

⁸⁷ See discussion *supra* note 84.

⁸⁸ Tal Link et al., *Water Consumption Efficiency of Toilets & Shower Heads in Davis: Old Davis (Cambridge House) vs. New Davis (Sycamore Lane Apartments)*, U. CAL. DAVIS http://watermanagement.ucdavis.edu/files/6613/8255/4524/02_Group_Purewal_Purewal_Phung_Salmon_Link.pdf (last visited Apr. 27, 2019).

⁸⁹ *Id.*

finding from the study was that, despite reducing water use by half, the net savings from this significant reduction was a measly \$1 per week.⁹⁰ That savings is not enough to cover the cost of the new appliances.⁹¹ In this case, the inexpensive water price structures make it nearly impossible to achieve meaningful savings no matter how much consumption is reduced.⁹² What is more, although the new appliances function perfectly, the cost of installing these new appliances would be astronomical compared to the savings they produced.⁹³

The UC Davis study demonstrates a fundamental constraint on overreliance on infrastructure management. So long as water prices remain artificially low, there is little to no economic incentive to adopt costly improvements to the existing infrastructure. It is possible for the government to create a DAO program that mandates these types of improvements.⁹⁴ Such a program, however, requires the same compliance and monitoring issues exhibited in the Cape Town case study.⁹⁵ Additionally, any mandate to install these new appliances would be borne disproportionately by low-income individuals, who would struggle to afford the improvements. Even the option of only improving the efficiency of public works requires raising the necessary funds to make these improvements through increased taxes which is difficult to justify given the minimal economic gain involved. Again, in large part due to the artificially low water price.

Besides the economic issue, a key limitation to non-price approaches to water management is that, even when the technology works, the reduction in water consumption is often smaller than expected because of behavioral responses.⁹⁶ Individuals react to the water

⁹⁰ *Id.*

⁹¹ *Id.*

⁹² *Id.*

⁹³ *Id.*

⁹⁴ See discussion *supra* note 84.

⁹⁵ See discussion *supra* Part II(a)(ii).

⁹⁶ Mehan III & Kline, *supra* note 28.

savings by taking longer showers with low-flow showerheads, flushing twice with low-flow toilets, or watering lawns longer under day-of-the week or time-of-day restrictions.⁹⁷ This is not to suggest that these improvements have no effect: studies show that low-flow toilets do, in fact, reduce water use over time.⁹⁸ The purpose of this section is merely to identify the problems with scholarship that overly relies on technology as a means of managing the water crisis.

Infrastructure management is an important part of any water policy, but it will only be effective if paired with a policy that addresses both the economical and behavioral issues of water consumption. This starts with changing individuals' perception that water is a free and an unlimited public resources. The next section addresses this issue by demonstrating how a demand-side, tax-based solution can alter individuals' behavior

PART III: Perceptions of the Cost of Water: The Theoretical Argument for a Water Tax

Throughout human history, water has been treated as a public resource, one that has always been essentially free for anyone to use.⁹⁹ Apart from times of intense drought, regulations concerning water usage have been focused on comparative usage by individuals.¹⁰⁰ For example, there are numerous international treaties and domestic laws regulating what duties an individual or country upstream of a water source owes to individuals downstream.¹⁰¹ But rarely do countries have strong laws focused on how much water can be used by these

⁹⁷ *Id.* A study by the University of Arizona found that even though low-flow toilets use only 1.6 gallons per flush, the actual average water use is closer to 2 gallons because people will often flush twice. Harrison, *supra* note 82.

⁹⁸ The 2 gallons per flush used by low-flow toilets are still lower than the 4 gallons used by traditional toilets. Harrison, *supra* note 82. However, conservation groups recommend that individuals change their behavior in addition to installing low flow toilets. This includes not flushing the toilet when disposing of only liquid waste and disposing of non-human waste by other means. *How to Save Water*, WATER CALCULATOR (Aug. 2, 2017), <https://www.watercalculator.org/save-water/toilet/>.

⁹⁹ See *Explained: The World's Water Crisis*, *supra* note 4.

¹⁰⁰ See, e.g., ARIZ. REV. STAT. ANN. § 45-1311 (1987); COLO. REV. STAT. § 37-61-101 (1990); N.M. STAT. ANN. § 72-15-5 (1985); UTAH CODE ANN. § 73-12A-1 (1989); WYO. STAT. § 41-12-301 (1977) (all codifying the Colorado River Compact), available at <https://www.usbr.gov/lc/region/g1000/pdfiles/crcompct.pdf> [hereinafter Colorado River Compact].

¹⁰¹ ARIZ. REV. STAT. ANN. § 45-1311 (1987).

individuals or what the water can be used for.¹⁰² The lack of such laws is indicative of the nearly universally-held belief that everyone should have access to as much water as they need or want.¹⁰³

It is not difficult to understand the origin of this attitude. Historically, humanity always has had enough water, and there has never been a need for a global constriction on water usage.¹⁰⁴ Moreover, for most of the last several millennia, humans have lived in an agricultural society where individuals' livelihoods depended on access to free or cheap water.¹⁰⁵ These deep-rooted attitudes continue to persist into the twenty-first century and have been exacerbated by the ease of access to water that modern infrastructure provides. When one can turn on a faucet and obtain a seemingly endless supply of clean, usable water, it is easy to forget that the water must come from a supply. Thus, where the government or public utilities control access to water, it is extremely difficult to convince the populace to pay more than a marginal amount for water.¹⁰⁶

The problem with this continued perception of free water is that it is increasingly false. In the last two decades, global water usage has increased by six to seven times the amount that was consumed at the turn of the twenty-first century.¹⁰⁷ As the demand for water increases dramatically, access to usable water becomes increasingly costly. As previously mentioned, only

¹⁰² See generally *Explained: The World's Water Crisis*, *supra* note 4.

¹⁰³ See, e.g., G.A. Res. 64/292, ¶ 1, U.N. Doc. A/Res/64/292 (Aug. 3, 2010); see also *Explained: The World's Water Crisis*, *supra* note 4.

¹⁰⁴ See *Explained: The World's Water Crisis*, *supra* note 4.

¹⁰⁵ For more information about the role water access had in the development of agriculture around the world, see generally MARCEL MAZOYER & LAURENCE ROUDART, *A HISTORY OF WORLD AGRICULTURE* (transl. James H. Membrez, 2006), available at <http://base.dnsgb.com.ua/files/book/Agriculture/History-of-Agriculture/A-History-of-World-Agriculture.pdf>.

¹⁰⁶ See, e.g., Scott Zamost & Kyra Phillips, *Skyrocketing Water Bills Mystify, Anger Residents*, CNN (Mar. 2, 2011, 9:42 AM), <http://www.cnn.com/2011/US/03/01/water.bills.war/index.html>.

¹⁰⁷ William J. Cosgrove & Frank R. Rijsberman, *The Use of Water Today*, in *WORLD WATER VISION: MAKING WATER EVERYBODY'S BUSINESS* 1, 3 (2000), available at <http://www.worldwatercouncil.org/fileadmin/wwc/Library/WWVision/Chapter2.pdf>; *Explained: The World's Water Crisis*, *supra* note 4.

roughly 1% of the world's water supply is potable.¹⁰⁸ Of that 1%, a significant amount of it has been inaccessible groundwater.¹⁰⁹ That leaves only usable surface water, which represents a very small fraction of a percent of the water on earth.¹¹⁰

In the past century, this source of water has been depleted by a combination of overuse and pollution, forcing many countries to start tapping into the previously-inaccessible groundwater.¹¹¹ This creates major challenges for three reasons. First, as discussed in Part I, these aquifers do not replenish over time the way that surface water does.¹¹² Second, it is incredibly expensive and inefficient to access these sources.¹¹³ Third, the additional costs of accessing these sources are not passed on to the consumer because it is politically harmful to do so. Even more problematic is that most consumers do not realize the true cost of water in the products they consume on a daily basis.

a. The Hidden Cost of Water

When the public thinks about water conservation during times of drought or water crises, it is often in terms of domestic usage—cutting back on things like washing cars, watering the lawn, or taking long showers. These types of activities are often targeted because they are associated with waste or luxury. Further, it is easy for the public to connect water conservation with restrictions on these types of domestic uses because the use of water is immediate and visible to the consumer. Unfortunately, this type of domestic use represents a very small portion of water consumption and, therefore, does not address the larger issue.

¹⁰⁸ U.S. Geological Survey Water Science School, *supra* note 8. Of the remaining 0.8%, roughly 30% of that is composed of groundwater. *Id.*

¹⁰⁹ *Id.*

¹¹⁰ *Id.*

¹¹¹ For example, over 50% of Mexico City's water supply comes from groundwater. *Explained: The World's Water Crisis*, *supra* note 4.

¹¹² See discussion *supra* pp. 7–8.

¹¹³ *Explained: The World's Water Crisis*, *supra* note 4.

According to the Food and Agriculture Organization of the UN, only 11% of global water consumption is used for domestic purposes.¹¹⁴ Meanwhile, 19% of consumption is used for industrial purposes and the remaining 70% for agricultural purposes.¹¹⁵ There is, therefore, a major disconnect between how people think about water consumption and actual water consumption. Take, for example, a half-liter bottle of soda sold at a grocery store. An individual might assume that it takes approximately half a liter worth of water to produce the bottle of soda because it contains that much liquid. In actuality, it takes 28 liters of water to produce the ingredients used for soda and 7 liters to produce the packaging, for a grand total of 35.5 liters of water.¹¹⁶ The 35.5 liters that the consumer does not see represents the hidden cost of water that conservation efforts frequently fail to target. This hidden cost can become enormous in certain food products. A single half pound hamburger requires roughly 3,850 liters of water to produce, but because we cannot see it, we do not think about it.¹¹⁷ To put that into perspective, the United Nations estimates that the average human needs only 50 liters per day for hydration and sanitation purposes.¹¹⁸

In addition to being difficult to see, the reason that this type of water consumption often goes unnoticed is because it is not reflected in the price of the product. Currently, hamburgers can sell for as low as \$1 in the United States.¹¹⁹ If you wanted to use the same amount of water

¹¹⁴ *Water Uses*, FOOD & AGRIC. ORG. U. NATIONS, http://www.fao.org/nr/water/aquastat/water_use/index.stm (last visited Apr. 27, 2019).

¹¹⁵ *Id.* To put this in perspective, the vineyards outside of Cape Town, South Africa would theoretically use 6 to 7 times more water than the population of Cape Town ($70\%/11\% = 6.3$).

¹¹⁶ The Coca-Cola Co. & the Nature Conservancy, *Product Water Footprint Assessments: Practical Application in Corporate Water Stewardship*, WATER FOOTPRINT 1, 13 (2010), available at https://waterfootprint.org/media/downloads/CocaCola-TNC-2010-ProductWaterFootprintAssessments_1.pdf.

¹¹⁷ M.M. Mekonnen & A.Y. Hoekstra, *The Green, Blue and Grey Water Footprint of Farm Animals and Animal Products*, 1 UNESCO-IHE MAIN REPORT 1, 29 (2010), available at https://waterfootprint.org/media/downloads/Report-48-WaterFootprint-AnimalProducts-Vol1_1.pdf.

¹¹⁸ Ban ki-Moon, *The Human Right to Water and Sanitation*, U. NATIONS 1, 2 (2015), available at https://www.un.org/waterforlifedecade/pdf/human_right_to_water_and_sanitation_media_brief.pdf.

¹¹⁹ See, e.g., *Burger King Prices*, FAST FOOD MENU PRICES, <https://www.fastfoodmenuprices.com/burger-king-prices/> (last visited Apr. 27, 2019).

to take a really long shower it would cost you at least \$6.75 in San Diego and potentially more.¹²⁰ As discussed earlier in Part II, one of the main critiques regarding a demand-side solution to water conservation is that water is an inelastic good within a relative price range: consumers will not respond in a meaningful way to changes in price unless it is significant.¹²¹ Such notions, however, contemplate water only in terms of domestic consumption. It is hard to believe that consumption of Burger King's hamburgers would not drop significantly if the price per burger rose from \$1 to \$7.75. Thus, if water were priced in such a way that the consumer bore the *real* cost of the water in the final consumer product, it would change the way that individuals think about water consumption and conservation.

This concept of making consumers and manufactures alike realize and ultimately bear the real cost of water is the key to making a demand-side solution to water conservation work. First, it shifts the focus of conservation discussions away from domestic uses towards agricultural and industrial uses. Second, it raises awareness about how much water is used to make certain products. Third, it facilitates more efficient water usage by giving products that require lower amounts of water to produce a competitive advantage in the marketplace. The problem with simply adjusting prices is the devastating effects it can have if done haphazardly and without regard to the human element.

b. Privatization and Water as a Human Right

¹²⁰ *Water Billing Rates*, CITY SAN DIEGO (Aug. 1, 2018), <https://www.sandiego.gov/public-utilities/customer-service/water-and-sewer-rates/water>. It costs \$5 for 750 gallons of water for domestic use in the city of San Diego. *Id.* Given that there are 3.8 liters in a gallon and that it takes 3,850 liters to make a hamburger, it takes 1,013 gallons of water to make a hamburger. *See* M.M. Mekonnen & A.Y. Hoekstra, *supra* note 117. The cost of 1,013 gallons of water would be roughly \$6.75 in San Diego at the lowest price tier. *Water Billing Rates*, *supra*. The average shower uses 2.1 gallons per minute. *Showers*, HOME WATER WORKS, <https://www.home-water-works.org/indoor-use/showers> (last visited Apr. 27, 2019). Thus, an individual would need to take an 8-hour shower to use the same amount of water necessary to make a hamburger. *See id.*

¹²¹ Mehan III & Kline, *supra* note 28, at 63.

i. Pros of Privatization

Such an elegant solution to our water consumption has not gone unnoticed, and many in the private sector have sought to take advantage of future water shortages. In recent years, numerous private companies have begun acquiring formerly public water supplies.¹²² Goldman Sachs even produced a report where it explained how investors could take advantage of the impending water shortages worldwide.¹²³ It encouraged investors to invest in “take-out” candidates—businesses that would take over the water production of larger regions.¹²⁴ The report also predicted that investors could expect the emergence of water oligopolies in both services and equipment.¹²⁵

Privatization is not necessarily without its benefits for water conservation. It depoliticizes the issue of water pricing, allowing prices to rise to a reasonable level rather than be artificially suppressed. Likewise, privatization could lead to better infrastructure and more efficient consumption practices. In Mexico City, nearly one half of all water used is lost due to poor infrastructure that allows water to leak out of pipes.¹²⁶ Currently, the municipal government

¹²² This was even the plot of the James Bond film *Quantum of Solace*. QUANTUM OF SOLACE (Metro-Goldwyn-Mayer et al. 2008). The plot has been summarized as follows: “Following the death of Vesper Lynd, James Bond (Daniel Craig) makes his next mission personal. The hunt for those who blackmailed his lover leads him to ruthless businessman Dominic Greene (Mathieu Amalric), a key player in the organization which coerced Vesper. Bond learns that Greene is plotting to gain total control of a vital natural resource, and he must navigate a minefield of danger and treachery to foil the plan.” *Film Collection Agent James Bond 22/23/24 Casino Royale 007 Quantum of Solace + Skyfall DVD Daniel Craig Three Films Action Secret Spy Movie Set*, AMAZON, <https://www.amazon.com/Collection-Casino-Royale-Quantum-Skyfall/dp/B07QXGRQ4P> (last visited Apr. 27, 2019).

¹²³ Deane M. Dray et al., *The Essentials of Investing in the Water Sector*, GOLDMAN SACHS GROUP, INC. 1, 1 (2008), available at <http://www.venturecenter.co.in/water/pdf/2008-goldman-sachs-water-primer.pdf>. Goldman Sachs estimates that the global sector is worth at least \$425 billion annually and should be expected to grow at least 4-6% a year. *Id.* The report predicted that water would have a bigger market cap than petroleum in the next century. *Id.*

¹²⁴ *Id.* at 5.

¹²⁵ *Id.* at 5.

¹²⁶ *Megacity Mexico: A Tale of Leaks and Shortages*, WATER & WASTEWATER INT’L (July 18, 2013), <https://www.waterworld.com/articles/wwi/print/volume-28/issue-3/regional-spotlight-latin-america/megacity-mexico-a-tale-of-leaks.html>.

has neither the funds nor the expertise to fix the situation.¹²⁷ Moreover, because water prices are so low, the communities lack incentive to advocate infrastructure repairs. If a private company took over Mexico City's water services, many believe that the company would have the resources and incentives to fix the issue.¹²⁸

ii. Cons of Privatization and Why Privatization is Ultimately Unworkable

Privatization, however, is not the answer. Treating water like any other commodity and subjecting it to traditional market forces is impractical due to the unique complexities surrounding the resource. The first issue is the level of oversight needed to make a water marketplace practical.¹²⁹ Population density, climate, terrain, and geography all factor into the price of water for a given community.¹³⁰ The harder or more expensive it is to deliver water to a given area, the more expensive water is for the consumer.¹³¹ Left to an unregulated market, *i.e.*, privatization, the result is an increase in prices in areas that are already poor and underdeveloped, where access to water is likely more urgent. In an effort to address this issue, economists who support privatization have attempted to suggest that pricing be determined by “equi-marginal value in use.”¹³² Under this system, the price is equal for all customers in a class of consumers with identical cost conditions.¹³³ Accordingly, it is possible for the government to subsidize individuals in a class based on economic needs.

¹²⁷ *Id.*

¹²⁸ *Id.*

¹²⁹ See Enrique Catsañón Ballivián, *The Value of Water in Bolivia: An Economic Resource Or a Human Right?*, INST. ESTUDIOS AVANZADOS DESARROLLO 1, 5–6 (2010), available at <https://www.jstor.org/stable/pdf/resrep00658.pdf?refreqid=excelsior%3A86a67b7c9bfd0692126f366cd5541703>.

¹³⁰ *Id.* at 5.

¹³¹ See *id.*

¹³² *Id.*

¹³³ *Id.*

In practice, this model becomes unworkable and more closely resembles the health care marketplaces in the United States under the Affordable Care Act. As seen within the U.S. health care industry, the question becomes what to do when service providers start exiting the marketplace, reducing the number of service providers to the point where there are not enough to cover a single geographic area.¹³⁴ If a regulatory scheme comparable to that under the Affordable Care Act is implemented to address water regulation, prices may rise, but the regulatory system would become so complex that individuals would not react to water in the same way that they would react to a rise in gas prices in the free market. In other words, the regulatory machine destroys all benefits gained from privatization or from increasing the cost of water in a geographical area.

A slightly nuanced issue with a privatized solution is that it may not change people's perceptions of the cost of water or create a sense of shared responsibilities. Private control of water resources may cause prices to rise eventually, but this may not be as impactful if individuals do not recognize why the prices are rising. If a bottle of coke goes from \$1 to \$1.05, the average consumer is not cognizant of why the price increased. A company may raise prices for a number of reasons, and it is impossible for the consumer to know the true reason. A successful demand-side solution both raises prices and raises awareness of why prices are being raised. People respond differently when they are forced to pay for things like plastic bags at grocery stores or the deposits on aluminum cans.¹³⁵ Thus, a successful demand-side solution is one where the cost of water usage is itemized or somehow communicated to the consumer.

¹³⁴ See Rachel Fehr et al., *Insurer Participation on ACA Marketplaces, 2014-2019*, KFF (Nov. 14, 2018), <https://www.kff.org/health-reform/issue-brief/insurer-participation-on-aca-marketplaces-2014-2019/>; see also Olga Khazan, *Why So Many Insurers Are Leaving Obamacare*, ATLANTIC (May 11, 2017), <https://www.theatlantic.com/health/archive/2017/05/why-so-many-insurers-are-leaving-obamacare/526137/>.

¹³⁵ A report by Scientific America shows that bottle deposit laws cause people to react differently to plastic bottles. *Recycling Report Card*, SCI. AM. (Dec. 11, 2013), <https://www.scientificamerican.com/article/recycling-report->

iii. Water is a Basic Human Right and Privatization Jeopardizes that Right.

The more significant issue with commodifying water is that the marketplace is a system where there are necessarily winners and losers.¹³⁶ Unlike other resources, humans cannot survive without water. It is also a necessary component to all industrial and agricultural products. A water system where some in the marketplace lose out to others is unacceptable. In 2010, the United Nations recognized access to water as a fundamental human right.¹³⁷ Similarly, countries like Bolivia and South Africa have constitutional clauses protecting individuals' access to clean water.¹³⁸ Putting this resource at the mercy of the marketplace defies the understanding of water as a human right and may destroy communities.

card/. The report showed that states with these laws recycle 70% of bottles compared to only 33% in states without the additional costs. *Id.* Furthermore, states with these laws have less litter on their highways. *Id.* Likewise, several studies on plastic bag taxes show that it radically reduces the use of plastic bags at grocery stores. *See, e.g.,* Frank Convery et al., *The Most Popular Tax in Europe? Lessons from the Irish Plastic Bags Levy*, 38 ENVTL. & RESOURCE ECON. 1 (2007), available at https://econrsa.org/papers/p_papers/pp18.pdf; Haoran He, *The Effects of an Environmental Policy on Consumers: Lessons from the Chinese Plastic Bag Regulation*, U. GOTHENBURG 1 (2010), available at https://gupea.ub.gu.se/bitstream/2077/22459/1/gupea_2077_22459_1.pdf; *Single-Use Plastic Carrier Bags Charge: Data in England for 2016 to 2017*, DEP'T ENV'T FOOD & RURAL AFF. (Sept. 27, 2018), <https://www.gov.uk/government/publications/carrier-bag-charge-summary-of-data-in-england/single-use-plastic-carrier-bags-charge-data-in-england-for-2016-to-2017>. One study in Ireland found that a €0.15 tax on bags decreased plastic bag use by 90%. Convery et al., *supra*. Additionally, arguments have been made that a tax on plastic bags is actually more effective than an outright ban. Jennie Romer, *Why Carryout Bag Fees Are More Effective Than Plastic Bag Bans*, HUFFINGTON POST (Jan. 20, 2017, 12:13 AM), https://www.huffpost.com/entry/why-carryout-bag-fees-are-better-than-plastic-bag-bans_b_588187ace4b08f5134b61f79. This is due to the fact that grocers and plastic manufactures often react more negatively to outright bans than taxes and, in retaliation, drive up resistance to legislative action. *Id.* When Berkley enacted a tax on soda, sales actually declined before the tax even went into effect. Kara Manke, *Berkeley's Soda Tax Election Changed Drinking Habits Months Before Prices Went Up*, BERKELEY NEWS (Apr. 2, 2019), <https://news.berkeley.edu/2019/04/02/berkeley-soda-tax-election-changed-drinking-habits-months-before-prices-went-up/>.

¹³⁶ If water price is determined entirely by the free market, prices will fluctuate based on supply and demand. Those without the ability to pay will be unable to gain access to water. In a super competitive market where the water supply is limited, prices could rise astronomically. In this situation, businesses and individuals with limited access to capital would be priced out of the market and unable to compete.

¹³⁷ G.A. Res. 64/292, ¶ 1, U.N. Doc. A/Res/64/292 (Aug. 3, 2010); *see also Human Rights to Water and Sanitation*, *supra* note 16.

¹³⁸ S. AFR. CONST. art. 27, 1996, available at <http://www.justice.gov.za/legislation/constitution/SACConstitution-web-eng.pdf>; BOL. CONST. tit. II ch. 5, 2009, available at https://www.constituteproject.org/constitution/Bolivia_2009.pdf. Although the inclusion of these provisions is often more aspirational than practical, due to the limited resources at the states' disposal to enforce positive rights, they are nevertheless significant. What these provisions represent is the undying commitment of the state to provide access to water to all its people. In an entirely privatized system, money would become the determining factor for

In Mexicali, Mexico, these types of problems already exist. In 2018, Constellation Brands announced plans to open a production plant in Mexicali, creating hundreds of jobs.¹³⁹ Allegations have arisen that in closing a backroom deal with the local authorities, Constellation Brands promised to invest millions in developing infrastructure in the area in return for access to fresh water to manufacture its product.¹⁴⁰ Regardless of the validity of these allegations, the new production plant will have tremendous adverse effects on the Mexicali region. Mexicali has limited water resources, and the amount of water needed to operate the plant and manufacture the product will essentially destroy the local farming communities that survive on the small supply of water from the tail end of the Colorado River.¹⁴¹ Although the deal spawns hundreds of jobs, the net impact to the community is likely to be extremely detrimental.¹⁴² Moreover, Constellation Brands, which makes products like Corona beer, is using the water in an overall less efficient way than the farming community does.¹⁴³ The Mexicali situation represents the detrimental effects of a totally privatized water system where certain players have more resources than others.¹⁴⁴ Despite using the water in a more efficient manner, the farmers are losing to Constellation Brands, which can use its money and influence to seize control of water access. Any individual wishing to compete for access to water must therefore have enough resources to wrench control away from bigger players like Constellation Brands. Even in a

whether an individual would have access to water. Such a system undermines the very notion of human rights adopted by these countries and the United Nations.

¹³⁹ See Alex Zaragoza, *As Big Beer Moves in, Activists in Mexicali Fight to Keep Their Water*, NPR (Mar. 16, 2018), <https://www.npr.org/sections/thesalt/2018/03/26/596448290/as-big-beer-moves-in-activists-in-mexicali-fight-to-keep-their-water>; *Explained: The World's Water Crisis*, *supra* note 4.

¹⁴⁰ See Zaragoza, *supra* note 139; *Explained: The World's Water Crisis*, *supra* note 4.

¹⁴¹ See Zaragoza, *supra* note 139; *Explained: The World's Water Crisis*, *supra* note 4.

¹⁴² See Zaragoza, *supra* note 139; *Explained: The World's Water Crisis*, *supra* note 4.

¹⁴³ See Zaragoza, *supra* note 139; *Explained: The World's Water Crisis*, *supra* note 4.

¹⁴⁴ Although the Mexicali water supply is not actually privatized, the corruption that exists within the local government functions essentially like a privatized system. In both cases, an individual's access to water in the marketplace is determined by money and influence, and those without the necessary resources will lose out to those with the ability to pay.

heavily competitive market for water access, the cost of water will become a barrier to entry for actors with less starting capital to devote to water costs.

c. Tax-Based Model is the Best Solution

The issue with a demand-side solution is developing a way to create value in an invaluable resource while ensuring that everyone still has access to it. A tax-based model makes consumers realize the hidden cost of water without the cost being disproportionately born by the poor. This is accomplished through the combination of a value-added-tax (VAT) on the water used in manufacturing and agriculture, coupled with rebates to small businesses and low-income individuals. This system ensures that the overall prices of goods that use large amounts of water rise to the point where consumers change their behavior, without deteriorating the purchasing power of low-income individuals or the ability for small businesses to operate. The details of this proposal are discussed in Part V. The purpose of this Section is to demonstrate the superiority of a tax-based solution compared to the other available alternatives discussed above.

i. Behavioral Economics

One alternative not yet discussed is to simply raise the current water rates set by the public utilities companies. In most circumstance, resources like electricity and water are provided by public utility companies.¹⁴⁵ These companies are non-profits owned by a local government body and run by locally elected officials or public employees.¹⁴⁶ The entity is often funded by tax free bonds and rates are set by the utility's governing body or the city council to recover the cost of operations and maintain the interest on the bonds.¹⁴⁷ It is therefore, possible

¹⁴⁵ *Differences Between Publicly and Investor-Owned Utilities*, CAL. ENERGY COMMISSION, https://www.energy.ca.gov/pou_reporting/background/difference_pou_iou.html (last visited May 5, 2019).

¹⁴⁶ *Id.*

¹⁴⁷ *Id.*

for the officials governing these public utility companies to raise the rates in order to reduce demand for water.

Although this is a viable possibility, it may not be the most effective. Behavioral economists suggest that individuals react differently to taxes than they do to normal price increases.¹⁴⁸ One study found that the way the price of goods is presented affects individual's purchasing behavior.¹⁴⁹ For example, individuals will be less incline to buy a product if it starts with a low base and incurs a penalty than they would if it starts with a high base and receives a discount, even though the end price is the same.¹⁵⁰ This is because consumers associate discounts with savings and penalties with losses.¹⁵¹ Another study, looking specifically at tax aversion, found that individual's desire to avoid taxes exceed their economic motivation to avoid costs.¹⁵² In some cases, the consumer was willing to incur additional overall costs in order to avoid paying the tax.¹⁵³ According to the logic of these studies, keeping the base water price the same and taxing water consumption creates a form of penalty that should reduce water consumption more than just raising the price.

ii. Tax-Based Solution vs. DAO

There are several key issues that limit the success of a DAO program. One of the most significant is the inability to enforce the program and sustain it over time. The DAO program in

¹⁴⁸ See, e.g., Aradhna Krishna & Joel Slemrod, *Behavioral Public Finance: Tax Design As Price Presentation*, 10 INT'L TAX & PUB. FIN. 189 (2003), available at <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.587.1516&rep=rep1&type=pdf>; Abigail B. Sussman & Christopher Y. Olivola, *Axe the Tax: Taxes Are Disliked More Than Equivalent Costs*, 48 J. MARKETING RES. 91 (2011), available at <https://www.russellsage.org/sites/all/files/u137/jmr-I-s091-s101-online.pdf>.

¹⁴⁹ Krishna & Slemrod, *supra* note 148, at 189–90.

¹⁵⁰ *Id.* at 191.

¹⁵¹ *Id.* at 192.

¹⁵² *Id.* at 91, 99–100.

¹⁵³ Sussman & Olivola, *supra* note 148, at 93–94.

Cape Town was heavy-handed and many individuals found methods of cheating.¹⁵⁴ The city government did not have the resources to close these loopholes, and the scope of the DAO was limited, allowing major water consumers to continue to operate outside of the city's jurisdiction.¹⁵⁵

A Value Added Tax (VAT) does not have these same limitations. All countries already have a method of collecting revenues, so the administrative infrastructure to enforce the law is already in place at a national level. Because these administrations exist at both a local and national level, there is less concern that consumers outside a local jurisdiction will not be covered by the tax. Additionally, the manufacturers who actually pay the tax will pass their cost along to the consumers so there is less of an incentive to find loopholes.¹⁵⁶ Meanwhile, there is no need to enforce the tax at the consumer level because the tax is already built into the cost of the goods.¹⁵⁷ Even if there are violators, there are fewer taxpayers higher in the supply chain and, therefore, fewer resources are needed to audit would-be cheaters.¹⁵⁸

Attacking the problem higher in the supply chain also allows easier auditing of abuse areas and ensures that the specific types of consumption are targeted. DAO programs like the one

¹⁵⁴ See Sieff, *supra* note 74.

¹⁵⁵ See discussion *supra* pp. 18–19.

¹⁵⁶ A VAT is levied on the gross marginal value added at each point in the manufacturing-distribution-sales process of an item. *What is VAT?*, EUR. COMMISSION, https://ec.europa.eu/taxation_customs/business/vat/what-is-vat_en (last visited Apr. 27, 2019). The manufacturers, and not the consumers, pay the tax because they are the ones adding the value to the product. *Id.* In order to recoup the cost of the tax, the manufacturers raise the sales price of the product, thus passing on the cost of the product to the consumer. *Id.* Therefore, even though the manufacturers have to pay the tax, they have no reason to try to avoid the tax because it does bear the true economic burden of the additional cost. *Id.*

¹⁵⁷ Since the tax is collected from the manufacturer and not the consumer, the revenue service does not have to worry about whether the consumer is attempting to avoid the tax. The manufacturer acts as the enforcement mechanism by being economically incentivized to build the tax into the price of the goods sold to the consumer.

¹⁵⁸ Manufacturers might still be incentivized to avoid the tax if they think raising their prices will reduce their profit margins. This means that it might still be necessary to monitor taxpayers to make sure they are in compliance with the law. There are, however, far fewer manufacturers than there are consumers, so there are fewer taxpayers to audit when one assesses taxes further up the supply chain.

implemented in Cape Town control mostly domestic water use.¹⁵⁹ As explained above, this type of consumption accounts for very little of the total water consumption compared to consumption in manufacturing and agriculture. A VAT, however, taxes consumption at every stage of the production process rather than just the finished product.¹⁶⁰ Therefore, the total price of the finished product accounts for every time water is used, rather than just the limited amount used at the domestic level.

Another issue with DAO is sustainability over time. DAO programs are designed during crises and it is difficult to justify continuous restrictions during rainy seasons. Once the crisis in Cape Town was over, the rationing ended and consumption rose again.¹⁶¹ A demand side solution does not yield this problem because the level of consumption is not fixed. Consumption rises and falls depending on the price of the water, which can easily change by adjusting the tax rates. For example, the rate can be determined based on dry and wet seasons or even tied to an index that accounts for various water sources within a country. During times of drought, the rate increases, prices rise, and demand is reduced. Once the drought is over, rates are lowered and consumption rises again to a sustainable level. In this way, a tax-based model allows for more flexibility to account for unforeseen circumstances.

The final major critique of DAO programs is that they do not account for waste or efficiency. The DAO programs are only designed to account for how much water is used by the end consumer and ignores the water lost along the way.¹⁶² These programs also do not consider

¹⁵⁹ See discussion *supra* p. 16; see also Appendix 1: figures 2–3.

¹⁶⁰ *What is VAT?*, *supra* note 156.

¹⁶¹ *City of Cape Town Relaxes Water Restrictions to Level 3*, *supra* note 77. The problem with trying to adjust rates during times of crisis is that the reaction to the price change might not be immediate. During times of prolonged drought, this lag time might not be problematic, but changing the prices during shorter more acute crisis might not be sufficient. In these cases a DOA coupled with a price change might be the best solution.

¹⁶² See discussion *supra* p. 22.

how the water is actually being used once it is distributed. Increasing the cost of the water indirectly accounts for both of these concerns. If water prices rise to a level where manufacturers view it as a serious cost of production, there are incentives to address both absolute and comparative efficiency. More money will be invested in repairing leaks to reduce waste and manufacturers will shift resources to products that require less water to produce. In the agricultural sector, farmers are incentivized to shift from flood irrigation to drip method irrigation as well as growing crops that require less water.

iii. Complimenting Infrastructure Management

Combining infrastructure management with a water tax addresses some of the shortcomings of overreliance on infrastructure management alone. The overall success of infrastructure management is limited by the lack of economic incentive to invest in water-saving technology.¹⁶³ The payoff of installing these improvements is simply non-existent.¹⁶⁴ The incentive for investing in new technology increases by raising the price of water through the tax. If the per week water savings of installing a low-flow toilet increases from \$1 per week to even \$5 per week, the toilet pays for itself in one year.¹⁶⁵ This type of incentive to invest in new technology is even more evident in the manufacturing and agricultural sectors where consumption is much greater. Further, the revenue collected by the tax can be earmarked for improvements to public water works in addition to subsidizing low-income consumers, increasing the absolute efficiency that otherwise is not addressed by a generic price hike.

¹⁶³ See Tal Link et al., *supra* note 88, at 7-8.

¹⁶⁴ See *id.*

¹⁶⁵ See *id.* at 3. The cheapest low-flow toilet in the study costs roughly \$246. *Id.* Increasing the savings from low-flow appliances to \$5 per week would net a total of \$260 per year, enough to cover the cost of the toilet. See *id.* This does not necessarily fix the problem of up-front costs. If individuals do not have \$246 to spend on toilets then it does not matter how long it takes to recover the cost. One way around this might be rebates, whereby individuals could be reimbursed for a portion of the upfront cost of the toilet and then pay that portion back in taxes at a later point.

iv. Curbing the Private Sector Externalities

A water tax accomplishes many of the same outcomes as a private sector based solution, but without the negative externalities. Specifically, private sector solutions place a disproportionate burden on low-income individuals and small business. Rising prices make it difficult for low income-earners to afford both water and the goods produced by water. Rather than leaving these individuals at the mercy of the free market, the tax tightly controls how much the prices rise. The government issues yearly rebates or tax credits to offset the additional cost to individuals who fall below a certain income and are unable to afford the increased prices.

A similar concern associated with private sector-based solutions is that larger companies absorb the increased price of water in the short term to drive out smaller competitors in the long term.¹⁶⁶ Like the rebates for individuals, a corresponding deduction for small business offsets any additional costs if the price increase is the result of a tax hike. The deduction could be designed to phase out based on the size of the business. This gives smaller businesses a slight advantage in the marketplace initially to account for the fact that they have less flexibility to absorb costs.¹⁶⁷

Finally, even though a private sector solution might result in an increased price for water, there is no mechanism for the public to associate this price increase with water usage. This is significant because changing the population's perspective that water is a relatively free resource

¹⁶⁶ This is undesirable for the same reason that monopolies are undesirable. If we allow larger companies to control the market, it leads to a lack of competition. Less competition generally results in higher prices and a stagnation in innovation. Most countries have anti-trust laws to ensure that superior, smaller firms can enter the market and compete with larger firms. A successful tax policy should ensure that taxation does not impact the competitiveness of the market.

¹⁶⁷ Although tax breaks for small businesses are often encouraged for political gain, there are valid economic reasons for taxing these businesses less than bigger firms. As discussed, *supra* in note 166, promoting small businesses ensures that markets remain competitive. Additionally, small businesses represent 89% of all employers in the United States. *Facts & Data on Small Business and Entrepreneurship*, SBE COUNCIL, <https://sbecouncil.org/about-us/facts-and-data/> (last visited Apr. 27, 2019). If small businesses go under due to rising water costs, unemployment in the United States would skyrocket.

is essential to creating sustainable practices. On the other hand, a tax-based solution explicitly identifies which portion of the price is attributable to water consumption. This is communicated to the public by requiring that the water tax is itemized on all receipts and water bills. To make the point more prominent, law makers also may require products to label the amount of water used in manufacturing. These steps raise the public consciousness to the hidden cost of water while also rewarding water conscious manufacturing.

In these ways a demand side solution, using a tax model, takes advantage of the benefits of both DAO and private sector solutions without the negative side effects.

PART IV: Predicting the Effectiveness of a Water Tax: The Carbon Tax Model

Thus far, this paper has explored the various alternatives to water management that have been utilized using statistical, anecdotal, and inductive reasoning to highlight their insufficiencies. This paper also addresses why a demand-side solution, using a tax-based model, theoretically addresses most of the concerns left unresolved by the other various alternatives. This section provides statistical analysis demonstrating that a tax on water achieves the policy goals identified in Part I of this paper.

Unfortunately, because demand-side solutions within the water sector have been largely ignored, there is only one limited empirical study on demand-side water management.¹⁶⁸ Conducted in rural China, the study's conclusions are promising, but ultimately lack the reliability necessary to determine whether water taxes would be successful in a broader

¹⁶⁸ See generally Qiuqiong Huang et al., *Irrigation Water Demand and Implications for Water Pricing in Rural China*, 15 ENVTL. & DEV. ECON. 293 (2010), available at https://www.jstor.org/stable/44379015?seq=1#metadata_info_tab_contents.

context.¹⁶⁹ Consequently, this paper uses the data generated from various carbon taxes around the world to demonstrate the potential success and limitations of a water tax.

a. The Methodological Justification for Relying on Carbon Taxes as a Proxy

The justification for using carbon taxes as a proxy stems from the similarity between carbon emissions and water consumption. Both clean air and clean water are vital to human survival and are often viewed as a public, rather than private, resource. Consequently, both access to water and carbon emissions are viewed as essentially free goods. The goal of the carbon tax, therefore, is principally the same as this paper's proposed water tax: to force the public to realize the true cost of consumption.

Although there are numerous variations, true carbon taxes work by increasing the cost of fuels that produce carbon based on their carbon intensity.¹⁷⁰ A fee is paid to the government based on how much CO₂ is emitted, measured in metric tons.¹⁷¹ For example, if the government sets the tax at \$30 per ton, and a gallon of gasoline produces roughly 19.6 pounds (.0098 tons) of

¹⁶⁹ See *id.* The policy was implemented in rural China and tested whether raising the price of water would affect crop production. *Id.* The study found that crop production was significantly affected. *Id.* Overall production decreased among the three water-heavy crops studied. *Id.* Likewise, there was a general shift towards growing maize over wheat, which is a less water-intensive crop. *Id.* Crop production strategies also became more efficient as a result of the increased price as farms switched over to non-irrigated lands, which require less water. *Id.* Equity, however, remained an enormous problem. *Id.* The average farmer saw his income shrink significantly because of the price hike. *Id.*

Despite these findings, the study might not be reliable as proof of concept on a larger scale. First, the data was gathered from China Water Institute and Management. *Id.* Chinese government ministries are notorious for publishing inaccurate or misleading data, so the data might not be as precise as one would hope. Second, rural China is not representative of the economic realities of the larger global population. These areas are often underdeveloped and have less access to technology and infrastructure. Moreover, it is uncertain how comparable the impact of rising prices in a communist economic system is to the impact of rising prices in a capitalist system.

¹⁷⁰ *Pricing Carbon*, WORLD BANK, <http://www.worldbank.org/en/programs/pricing-carbon> (last visited Apr. 27, 2019). A true carbon tax is often compared to emission trading systems (ETS). *Id.* ETS cap the total level emissions and then allow low emitters to sell their extra allowances to larger emitters. *Id.* This establishes a market price for emissions and creates an economic incentive to reduce carbon output. *Id.* The cap helps ensure that the required emission reductions will take place in the aggregate. *Id.*

¹⁷¹ See Steven Nadel, *Learning from 19 Carbon Taxes: What Does the Evidence Show?*, ACEEE 1, 2 (2016), available at https://aceee.org/files/proceedings/2016/data/papers/9_49.pdf.

CO2 emissions, the tax on one gallon of gas is \$0.29.¹⁷² On the other hand, propane, which only produces 13 pounds (.0065 tons) of CO2 per gallon, incurs only \$0.19 tax per gallon.¹⁷³ This tax encourages individuals and companies to rely on cleaner fuels and find other ways of reducing emissions.

The success of carbon taxes is measured by a reduction in CO2 emissions (consumption), and increased efficiency in the energy and transportation sectors. Some carbon taxes even include rebates to offset the regressive effects of the tax on the lowest-income earners.¹⁷⁴ Importantly, many countries enacted carbon taxes in the 1990s, so there is enough data available to demonstrate that the long-term effect of the tax on emissions and consumption.¹⁷⁵ Accordingly, carbon taxes can exemplify of how a water tax can achieve long term sustainability.

b. The Carbon Tax Data

As of 2016, there are nineteen jurisdictions around the world with true carbon taxes.¹⁷⁶ Of these nineteen jurisdictions, sixteen are imposed at a national level, two at a providential level, and one at a municipal level.¹⁷⁷ The tax rate ranges from \$1 to \$168 per metric ton with the

¹⁷² *Frequently Asked Questions*, U.S. ENERGY INFO. ADMIN. (May 21, 2014), <http://www.patagoniaalliance.org/wp-content/uploads/2014/08/How-much-carbon-dioxide-is-produced-by-burning-gasoline-and-diesel-fuel-FAQ-U.S.-Energy-Information-Administration-EIA.pdf>. There are 2000 pounds in a ton. $\$30 \times 0.0098 = \0.29 .

¹⁷³ Dave Green, *The Easiest Way to Calculate the Carbon Footprint of Your Home*, GREEN ZERO CARBON HOME (July 16, 2018), <https://greenzerocarbonhome.com/2018/07/what-is-the-carbon-footprint-of-natural-gas-heating-oil-propane-and-coal/>. $\$30 \times 0.0065 = \0.195

¹⁷⁴ See, e.g., *Climate Action Tax Credit*, B.C., <https://www2.gov.bc.ca/gov/content/taxes/income-taxes/personal/credits/climate-action> (last visited Apr. 27, 2019).

¹⁷⁵ Nadel, *supra* note 171, at 2.

¹⁷⁶ *Id.* at 1.

¹⁷⁷ *Id.* at 2. Australia, Chile, Costa Rica, Denmark, Finland, France, Iceland, Ireland, Mexico, Netherlands, Norway, South Africa, Sweden, Switzerland, and the United Kingdom all have carbon taxes at the national level. *Id.* British Columbia and Quebec are two Canadian providences that also have carbon taxes. *Id.* Finally, the city of Boulder, Colorado enacted a carbon tax in 2007. *Id.* It is interesting to point out that South Africa enacted a carbon tax in 2016 in the midst of the water crisis in Cape Town. *Id.* This is encouraging because it demonstrates that the country has the political willingness to pass the type of legislation necessary to effectively manage its resources. *Id.*

median tax set at \$18.¹⁷⁸ Most of these taxes do not cover every source of CO₂ emission. For example, some taxes only cover emissions from the production of electricity.¹⁷⁹ The amount of carbon emissions covered by these taxes, range from 15% to 80% of all sources of emissions with a median of 45%.¹⁸⁰ On average, carbon taxes increase the cost of natural gas by 14%, gasoline by 6%, and coal by 75%.¹⁸¹

Of the nineteen jurisdictions with true carbon taxes, British Columbia's carbon tax provides the most comprehensive data available and therefore is the primary focus of this section, supplemented with evidence from other tax programs.¹⁸² Adopted in 2008, the British Columbia tax imposes a \$25 tax per ton of CO₂ on emissions from gasoline sales, which represents 70% of British Columbia's total CO₂ emissions.¹⁸³ The general trends exhibited by British Columbia are indicative of the larger trends shared among all similar tax programs. The advantage of using the British Columbia data, apart from its greater availability, is that it can be compared to emissions across the rest of Canada, which serve as a control group. In this way, it is easier to see what effect the tax policy has on emissions without concern about other variables.

i. Effect on CO₂ Emissions

¹⁷⁸ *Id.* at 3.

¹⁷⁹ *Id.* at 2–3.

¹⁸⁰ *Id.*

¹⁸¹ *Id.*

¹⁸² *Where Carbon Is Taxed?*, CARBON TAX CTR., <https://www.carbontax.org/where-carbon-is-taxed/> (last visited Apr. 27, 2019). In addition to the nineteen jurisdictions that were enacted prior to 2016, several other jurisdictions have enacted carbon taxes to meet their goals under the Paris Climate Agreement. *Id.* Although the impact of these more recent tax policies is not fully known, it does not affect this analysis as the goal of this section is to illustrate how the principles of the carbon tax can be applied to water taxes. *Carbon Pricing Dashboard*, WORLD BANK, https://carbonpricingdashboard.worldbank.org/map_data (last visited Apr. 27, 2019); *see, e.g., Canada Will Tax Carbon Emissions to Meet Paris Climate Agreement Targets*, GUARDIAN (Oct. 3, 2016, 5:54 PM), <https://www.theguardian.com/world/2016/oct/03/canada-carbon-emissions-tax-paris-climate-agreement>.

¹⁸³ Nadel, *supra* note 171, at 2.

Since the enactment of its tax in 2008, fossil fuel consumption has dropped significantly in British Columbia. A five-year report in 2013 shows that fossil fuel consumption in the province dropped 17.4% per capita while sustaining the same economic growth rate as the rest of the country.¹⁸⁴ More meaningfully, this drop was 18.8% lower than the consumption per capita outside of British Columbia; the rest of Canada's fuel use actually grew by 1.5% during the same period.¹⁸⁵ However, more recent studies show that this impact of the tax on carbon emissions has deteriorated a little over time. As of 2015, when the most recent study was conducted, the decline evened out to an overall reduction of 6.1% since 2008.¹⁸⁶ Although this suggests that it may take time to evaluate how individuals adjust to the price increase, the results are still encouraging considering that, during the same period, gasoline consumption across all of Canada rose by 3.5%.¹⁸⁷ The fact that British Columbia accomplished these feats without sacrificing economic growth over the same period demonstrates that it is possible to achieve long-term reductions through a carbon tax.¹⁸⁸

The 2013 study also observed that reduction in fossil fuel consumption in British Columbia was much larger than the reductions that normally occur from market-based price increases of the same amount, suggesting that consumers respond more acutely to the carbon tax

¹⁸⁴ Stewart Elgie & Jessica McClay, *BC's Carbon Tax Shift After Five Years: Results*, SUSTAINABLE PROP. 1, 2 (2013), available at https://www.energyindependentvt.org/wp-content/uploads/2014/11/BC_Carbon-Tax-success-story.pdf.

¹⁸⁵ *Id.*

¹⁸⁶ Nadel, *supra* note 171, at 6.

¹⁸⁷ *Id.*

¹⁸⁸ The fact that British Columbia did not experience any substantial alterations in economic growth during this time is crucial. *Id.* First, economic growth usually means more business enterprises and higher wages. More business in the area means that there will be additional emissions. Likewise, higher wages means that individuals will have more disposable income and are more capable of paying the additional cost to pollute. The fact that emissions dropped despite economic growth suggests that the tax impacted individual's perception regarding pollution. Additionally, one of the main complaints about carbon taxes (and taxes generally) is that they stifle economic growth. The fact that the economy grew in spite of the tax proves that these concerns are unfounded.

than price fluctuations pursuant to supply and demand.¹⁸⁹ In other words, the tax itself, and not just the rise in price, impacted consumer behavior. This observation is extremely encouraging for a potential water tax, where changing attitudes about water is as important as reducing consumption itself. Australia provides further evidence of the efficacy of taxes in shifting public attitudes

In 2012, Australia became the first country to implement a nationwide carbon tax of \$19.60 per ton exclusively on fuels used to generate electricity.¹⁹⁰ Total electricity consumption decreased in 2013 by 3.8%, of which 28%-50% is estimated to be directly attributable to the tax.¹⁹¹ Overall, carbon emissions also decreased by 8.2% between 2012 and 2013.¹⁹² Under intense political pressure, the Australian parliament repealed the carbon tax in 2014.¹⁹³ After the repeal of the tax carbon emissions rose by 2% within a matter of months, but not to the level that existed before the tax.¹⁹⁴ This particular result suggests two things: first, that individuals react quickly to changes in the price of carbon fuels and that the tax's effect on the price altered behavior; and second, that even though the price of electricity decreased after removing the tax, behavior did not return to higher pre-tax levels.

An optimistic interpretation of the second point is that, although removed, the tax nevertheless successfully shifted individuals' perspectives concerning use of electricity, leading to lower overall power usage in Australia. It is possible that while the tax was in place,

¹⁸⁹ Nadel, *supra* note 171, at 5–6. This supports the research of behavior economists that argue that individuals react differently to taxes than they do to normal price increases. Sussman, *supra* note 148 at 91.

¹⁹⁰ *Id.* at 2, 7–8; *see also Where Carbon Is Taxed?*, *supra* note 182.

¹⁹¹ Nadel, *supra* note 171, at 7.

¹⁹² *Id.*

¹⁹³ *Australia Votes to Repeal Carbon Tax*, BBC (July 17, 2014), <https://www.bbc.com/news/world-asia-28339663>. Interestingly, the justification for repealing the tax was that it harmed economic growth, which was not the case in British Columbia.

¹⁹⁴ *See* Nadel, *supra* note 171, at 7; *Where Carbon Is Taxed*, *supra* note 190.

individuals and businesses made permanent adjustments to their consumption practices like installing low-energy appliances or switching to renewable energy. If this is true, then even a tax that does nothing more than raise awareness about water conservation has lasting effects on individual behavior.

ii. Energy Efficiency

The British Columbia carbon tax covers emissions from fuels and primarily impacts the transportation industry.¹⁹⁵ Thus, evidence of an increase in absolute efficiency is validated by an increase in cars that have greater overall fuel efficiency. By comparing vehicle purchase decisions in British Columbia to other Canadian provinces', the 2016 data demonstrates that the carbon tax produced increases in absolute efficiency.¹⁹⁶ The preference model used "suggests that without BC's carbon tax, fuel demand per capita would be 7% higher, and the average vehicle's fuel efficiency would be 4% lower."¹⁹⁷ Thus, the tax successfully incentivizes people to invest in technology that increases overall carbon efficiency.

Comparative efficiency is a more difficult to track in the transportation sector. Although there are alternatives to gasoline vehicles, such as electric and hydrogen fuel cells, there may be factors other than cost that influence purchasing patterns. These include, among others, the availability of charging stations and the range that the vehicle can travel.¹⁹⁸ Diesel, however, is widely available and, because of its increased fuel efficiency, represents a comparatively more

¹⁹⁵ See Nadel, *supra* note 171, at 5; see generally Nicholas Rivers & Brandon Schaufele, *Carbon Tax Salience and Gasoline Demand*, U. OTTAWA 1 (2012), available at <https://sciencessociales.uottawa.ca/economics/sites/socialsciences.uottawa.ca/economics/files/1211e.pdf>.

¹⁹⁶ See generally, Werner Antewiler & Sumeet Gulati, *Frugal Cars or Frugal Drivers? How Carbon and Fuel Taxes Influence the Choice and Use of Cars*, U. B.C. 1 (2016); see also Nadel, *supra* note 171, at 6.

¹⁹⁷ Nadel, *supra* note 171, at 6. The level of fuel savings estimates are lower than other estimates due to the effect of the tax on cross-border trips to the United States, where there is no tax. *Id.*

¹⁹⁸ See Michael Koretzky, *5 Reasons Not to Buy an Electric Car*, MONEYTALKSNEWS (Feb. 28, 2011), <https://www.moneytalksnews.com/5-reasons-not-to-buy-an-electric-car/>.

efficient alternative to gasoline. Neither the 2013 nor the 2015 studies, however, demonstrated any kind of statistically significant shift from gasoline to diesel vehicles.¹⁹⁹ The lack of impact, while discouraging, does not necessarily mean that the carbon tax—and a potential water tax—could not achieve comparable efficiency. First, diesel engines are not available in all classes of vehicles, reducing the pool of consumers who could realistically pick diesel over gasoline. Second, the cost savings resulting from the tax increase may not be enough to warrant the increased cost and maintenance of buying a diesel vehicle. As such, it is possible that more people would choose diesel with a higher tax.

In other circumstances, however, carbon taxes have exhibited comparative efficiency. In 2013, the United Kingdom imposed a \$24 per ton tax on all carbon emissions, including emissions used to produce electricity.²⁰⁰ A report in 2017 showed a 74% decrease since 2006 in the use of coal, the most carbon-intensive fuel, as a means to produce electricity.²⁰¹ In addition, wind energy, which is not subject to the tax, produced a greater percentage of the United Kingdom's electricity than coal, which is taxed the most.²⁰² Additionally, low carbon substitutes, mainly renewables, accounted for 68% of the decrease in fossil fuels used for electricity in the United Kingdom.²⁰³ Australia also experienced a similar impact to the sources of its electrical production. During its brief tenure, the Australia carbon tax demonstrated a significant shift away from coal as a source of energy combined with small, but significant, increases in renewables.²⁰⁴

¹⁹⁹ See generally Elgie & McClay, *supra* note 184; see also Nadel, *supra* note 171.

²⁰⁰ *Where Carbon Is Taxed?*, *supra* note 182.

²⁰¹ *Id.* This study includes years before the carbon tax was enacted, suggesting that there are other variables beside the tax that accounts for the reduction in fuel.

²⁰² *Where Carbon Is Taxed?*, *supra* note 182.

²⁰³ *Where Carbon Is Taxed?*, *supra* note 182.

²⁰⁴ *Id.*; Nadel, *supra* note 171, at 7.

There is nothing to suggest that a tax on water would not increase absolute efficiency in the same way as carbon taxes. Farmers and manufacturers alike would gravitate toward more absolute efficient practices. For farmers, such a measure could be using drip irrigation instead of flood irrigation. Manufacturers, on the other hand, would make better efforts to recycle water or invest in low-flow appliances.

The impact of the tax becomes more limited when addressing comparable efficiency because it does not take into consideration individual preference and choice. The United Kingdom and Australia achieved comparable efficiency in electricity production because electricity is a fungible good. Electricity produced by renewables is exactly the same as electricity produced by coal. Under these circumstances, the producers' only consideration is their profit per watt. Thus, an increase in cost of one source of electricity results in an increase in the production of a comparably cheaper alternative product. The same type of efficiency relations did not manifest between gas vehicles and their alternatives because price and fuel efficiency are not the only considerations consumers have when buying a car. As mentioned above, diesel engines are not available in all vehicle classes, and electric cars have other limitations that might dissuade buyers.

Ultimately, the same efficiency limitations that apply to carbon taxes apply to water. Although water appears to be a fungible good in most instances, preference limits comparable efficiency. For example, a study about water use in rural China supports the assertion that farmers will switch to comparably more efficient crops if the price of water increases.²⁰⁵ The study examined only staple crops and treated each crop as a perfect substitute for another.²⁰⁶ This

²⁰⁵ Huang et al., *supra* note 168, at 311-13.

²⁰⁶ *Id.*

type of comparable efficiency works in the confines of rural China where food choices are scarce and caloric intake is the primary concern.²⁰⁷ In most developed countries, however, taste plays an enormous role in food selection. Thus, while the indifferent consumer might decide to buy more corn at a cheaper price instead of wheat, preferences prevent high levels of comparable efficiency. This is not to say that the water tax is unable to encourage comparative efficiency. If corn or wheat is used primarily for animal feed, we should expect to see some farmers switch towards producing more corn. In all other instances, however, preference limits the ability of a water tax to spur comparative efficiency outcomes.

iii. Equity Through Tax Credits

A successful water policy must have a method of addressing both horizontal and vertical equity. This analysis focuses only on whether the policy has some mechanism to achieve these goals. The degree of vertical equity, the extent to which higher-income earners pay more than lower-income earners, is a decision for individual policymakers. In the Cape Town case study, no mechanism existed to achieve some form of vertical equity.²⁰⁸ All individuals were limited to the same amount of water allowing higher-income individuals to use their wealth to obtain a larger portion through a variety of methods.²⁰⁹ In contrast, British Columbia's carbon tax uses tax credits as the mechanism to achieve both horizontal and vertical equity.²¹⁰ The program exhibits horizontal equity because everyone pays the same flat fee for the amount of carbon purchased. For example, if person A and person B both make \$100,000 and buy 100 liters of gasoline, they both pay \$7.78.

²⁰⁷ *Id.*

²⁰⁸ See discussion *supra* pp. 19–20.

²⁰⁹ *Id.*

²¹⁰ *Climate Action Tax Credit, supra* note 174.

A Climate Action Tax Credit, achieves vertical equity by offsetting the impact of the carbon tax paid by low-income individuals.²¹¹ The credit works by issuing a non-taxable, quarterly rebate to those who qualify for the credit. Only one person can receive the credit on behalf of the family.²¹² The amount of the rebate depends upon family size and adjusted net income.²¹³ As of 2019, an individual receives \$154.50 per adult and \$45.50 per child (\$154.50 per child for single parent families).²¹⁴ The credit is then reduced by 2% of the family's net income over the income threshold.²¹⁵ In 2018, the net income threshold for an individual was \$34,876 (\$40,689 for couples).²¹⁶ Both the size of the credit and the threshold are adjusted every year by policymakers.²¹⁷

This is an example of how this credit works: X is single and has a net annual income of \$30,000, and Y is single and has a net annual income of \$40,000. X is below the threshold, so X receives the full \$154.50 paid out in 4 quarterly installments. Y, on the other hand, is above the threshold and therefore Y's credit is reduced by 2% of the net income over the threshold. Y's income above the threshold is \$5,124. This amount is then multiplied by 2% to total \$102.48. This means that Y receives a credit of only \$52.02. For individuals, the credit phases out completely at \$42,600.

Whether the size of the credit and the threshold are sufficient to adequately achieve vertical equity is beyond the scope of this paper, the specifics of the credit to be decided by policymakers. The important requirement is that a mechanism exists to ensure that those with a

²¹¹ *Id.*

²¹² *Id.*

²¹³ *Id.*

²¹⁴ *Id.*

²¹⁵ *Id.*

²¹⁶ *Id.*

²¹⁷ *Id.*

greater ability to pay, contribute more than those without that same ability. As applied to water, a similarly structured tax credit should also be able to achieve the same goal of establishing a mechanism to ensure vertical equity.

iv. Longevity

The British Columbia carbon tax has continued to exhibit a positive impact on emissions for 10 years. Even if the initial success of the program is declining, there has still been a significant reduction in carbon emissions compared with the rest of Canada. Recently, however, the British Columbia carbon tax received scrutiny with the announcement that British Colombia will not meet its emission goals for 2020.²¹⁸ The biggest critique is that emissions in British Colombia have recently started to increase.²¹⁹ Although this is a valid concern, it may mask the true reality.

First, even though emissions have increased in recent years, emissions in British Colombia are still less than the rest of Canada.²²⁰ Second, both the population and GDP per capita of British Columbia have increased in the same period.²²¹ This means that there are more individuals with higher disposable income in British Columbia with the ability to pay to continue to pollute. It is unrealistic to expect the carbon tax to reduce emissions every year when the number and size of the emitters continues to increase. Finally, Canada enacted a nationwide

²¹⁸ Brier Dudley, *Look to B.C. for Evidence Carbon Tax Doesn't Work*, SEATTLE TIMES (Jan. 25, 2018, 1:58 PM), <https://www.seattletimes.com/opinion/look-to-b-c-for-evidence-carbon-tax-doesnt-work/>; Gordon Hoekstra, *Latest Figures Show B.C.'s Carbon Emissions Continue to Increase*, VANCOUVER SUN (Jan. 12, 2018), <https://vancouversun.com/business/energy/latest-figures-show-b-c-s-carbon-emissions-continue-to-increase>.

²¹⁹ Hoekstra, *supra* note 219.

²²⁰ Bora Plumptre, *Three Takeaways from Canada's Latest Greenhouse Gas Emissions Data*, PEMBINA INST. (July 12, 2018), <https://www.pembina.org/blog/three-takeaways-canadas-latest-greenhouse-gas-emissions-data>.

²²¹ *Trends in Greenhouse Gas Emissions in B.C. (1990-2016)*, B.C., <http://www.env.gov.bc.ca/soe/indicators/sustainability/ghg-emissions.html> (last visited Apr. 27, 2019).

carbon tax in 2018 to meet its requirements under the Paris Climate Change Agreement.²²² This second tax creates redundancies that are making both taxes less effective.

Looking outside of British Columbia, there is additional support of the long-term success of carbon taxes, with the most impressive occurring in the four Nordic countries that enacted carbon taxes in 1991 in response to the Kyoto Protocol.²²³ Sweden, for example, reduced its emissions by a staggering 25% between 1991 and 2018 despite enjoying economic growth of 60% during that same period.²²⁴

Norway, on the other hand, experienced an increase in emissions during that same period.²²⁵ But further investigation reveals that the increase is a result of its exportation of gas and oil that is excluded from the tax.²²⁶ Emissions in Norway from domestic consumption have actually decreased by 40% during that period.²²⁷ Canada, also an oil exporter, is similar to Norway.²²⁸ Because of the way the carbon taxes are structured, the tax is only assessed on the finished product and does not account for emissions in the production of oil itself.²²⁹ When oil is exported, it is never taxed and the market forces that encourage greener practices do not apply.²³⁰ To make the tax fully effective, certain larger polluters, such as oil producers, must be assessed

²²² Bethany Lindsay, *Research Suggests B.C.'s 2008 Tax Has Helped Reduce Emissions Without Hurting the Economy*, CBC NEWS (Apr. 4, 2019, 1:00 AM), <https://www.cbc.ca/news/canada/british-columbia/carbon-tax-bc-1.5083734>; *British Columbia's Carbon Tax*, B.C., <https://www2.gov.bc.ca/gov/content/environment/climate-change/planning-and-action/carbon-tax> (last visited Apr. 27, 2019).

²²³ Franziska Funke & Linus Mattauch, *Why Is Carbon Pricing in Some Countries More Successful Than in Others?*, OUR WORLD DATA (Aug. 10, 2018), <https://ourworldindata.org/carbon-pricing-popular>; Nadel, *supra* note 171, at 8. Denmark and Sweden both average a 1.3% decline in carbon emissions per year, whereas Norway and Finland average 1.8% and 2.1%, respectively. Nadel, *supra* note 171, at 4, 13.

²²⁴ Funke & Mattauch, *supra* note 223; Nadel, *supra* note 171, at 9.

²²⁵ Denis Hoffman, *Carbon Tax in Norway Has Been a Success Since 1991*, MED. HAT NEWS (Jan. 23, 2019), <https://medicinehatnews.com/commentary/letters-to-the-editor/2019/01/23/carbon-tax-in-norway-has-been-a-success-since-1991/>.

²²⁶ *Id.*

²²⁷ *Id.*

²²⁸ *Id.*

²²⁹ *Id.*

²³⁰ *Id.*

based on annual CO₂ emissions to account for emissions resulting from activities that otherwise are not accounted for by examining only fuel consumption. Regulations must require these polluters to document their annual emissions. This lesson is particularly relevant when discussing a potential water tax. If the tax only applies to water consumed by the end user, it ignores 89% of the water that is actually consumed.²³¹ This issue is solved by structuring the tax as a VAT, which is discussed in the following section.

The Nordic countries' tremendous success illustrates that long-term emission reduction is obtained through taxation. This is reassuring for taxing water because the bar for long-term success is actually lower. To reverse the effects of global warming, CO₂ emissions must be continually reduced year after year. Continuous reduction is not necessary for water.

Sustainable water practices only require that the population decrease its water consumption to the point where the natural water cycle can reliably replenish the supply of fresh water. Once that level is achieved, the consumption-replenishment equilibrium stabilizes. Moreover, water use reduction is only required until desalination technology becomes widely available and relatively inexpensive. These lower standards support a water tax to achieve the long-term success that the Nordic countries have enjoyed with their carbon taxes.

The details of how to implement an effective water tax based on the success of carbon tax model while considering the limitations of DAO and Infrastructure Management options is addressed in Part V.

PART V: The Water Tax

²³¹ Only 11% of water consumption is domestic, therefore if water is only taxed at the consumer level, the tax ignores 89% of water use. *Water Uses*, *supra* note 114.

A water tax is the proper solution to a potential Day Zero scenario both theoretically and practically. Water is a unique commodity far closer to a right than a good, thus rendering market-based solutions insufficient in regard to ensuring its universal availability in perpetuity. Likewise, the quantitatively verifiable success of carbon taxes in both abroad suggest that consumption taxes on “public” goods curb excessive use and, even more importantly, shift the public attitude. As such, this section outlines the components of an ideal water tax.

a. Value Added Tax Structure

The proposed water tax is structured as a value added tax (VAT). A VAT is levied on the gross margin value added at each point in the manufacturing-distribution-sales process of an item.²³² The tax is assessed and collected at each stage, in contrast to a sales tax, which is only assessed and paid by the consumer at the very end of the supply chain.²³³ In a normal VAT, the tax is assessed whenever value is added to the product.²³⁴

The water tax works like a traditional VAT, except that the tax is assessed based on how much water is used in each stage of the supply chain. For example, instead of a 10% VAT, there is a \$0.10 tax on every liter of water used. The ingredients for the soda cost \$2.00 and take 5 liters of water to produce. The tax on the ingredients would be \$0.50, paid to the government

²³² *What is VAT?*, *supra* note 156.

²³³ *Id.*

²³⁴ For example, imagine soda is manufactured and sold in a country with a 10% value-added tax. The soda’s manufacturer buys the raw materials for \$2.00, plus a VAT of \$0.20—payable to the government by the supplier—for a total price of \$2.20. The manufacturer then sells the soda to a retailer for \$5.00 plus a VAT of \$0.50 for a total of \$5.50. However, the manufacturer renders only \$0.30 to the government, which is the total VAT at this point, minus the prior VAT charged by the raw material supplier. The manufacturer does not need to pay the government the full \$0.50 because the supplier has already paid \$0.20 of the tax when the raw materials were sold to the manufacturer. Note that the \$0.30 equals 10% of the manufacturer’s gross margin of \$3.00. Finally, the retailer sells the soda to consumers for \$10 plus a VAT of \$1 for a total of \$11. The retailer renders \$0.50 to the government, which is the total VAT at this point (\$1), minus the prior 50-cent VAT charged by the manufacturer. The \$0.50 also represents 10% of the retailer’s gross margin on the soda. Note that even though the tax is assessed and paid at every stage, the consumer ultimately bears the full cost of the tax.

by the supplier, for a total of \$2.50. The manufacturer then sells it to a retailer for \$5.00. The manufacturer uses 10 liters to make and package the soda, resulting in a \$1 tax paid by the manufacturer. The retailer pays \$6.50 for the soda, which encompasses both the \$0.50 tax paid by the supplier and \$1 tax paid by the manufacturer. The retailer sells the soda to consumers for \$10 plus the water tax of \$1.50 for a total of \$11.50. No additional tax is assessed at the final transaction because no additional water is used at that stage. Further, the retailer does not pay any additional money to the government because the tax is already paid by providers further up the supply chain when the water was used. Note, however, that even though the consumer does not pay the tax directly, the price of the final product incorporates the tax amount.

There are several benefits for structuring the water tax this way. First, it places the tax at the point where water consumption is easiest to measure. The farmer who grows the ingredients for soda—or the utility company that supplies the water to the farmer—knows both how much water he uses to grow the ingredients and the source of the water. Because the water use is under the farmer’s control, the farmer is assessed the tax. Second, taxing water at the various point avoids the potential for tax evasion that British Columbia and Norway experience when oil is exported.²³⁵ If the tax is assessed only at the point of sale, manufacturers can avoid the tax altogether by exporting it to a jurisdiction without the tax. As the examples above demonstrate, the consumer ultimately bears the cost of the tax, but putting the tax within the supply chain increases the chance that water consumption is accounted for.

b. Rate Structure

²³⁵ See Hoffman, *supra* note 225.

The example in the previous subsection uses a fixed rate for the water tax. Research suggests, however, that water pricing is most effective when bracket pricing is used.²³⁶ Under a bracket pricing model, the price per hundred cubic feet (HCF) of water consumed progressively increases at higher brackets.²³⁷ For example, the first 4 HCF of water might be priced at \$5 per HCF, but HCF 5-10 would be priced at \$7 per HCF, and any HCF over 10 would be priced at \$10 per HCF. With the marginal cost of water increasing as more water is consumed, the tax punishes high water consumers and encourages them to find ways to decrease their marginal water use.

In addition to basing the rates on the amount of water use, the tax must also consider the water source. As discussed in Part III, not all water should be treated equally. Ground water is scarcer than surface water and does not replenish over time.²³⁸ To account for this, the brackets for using ground water should be higher than surface water. Likewise, ocean water is plentiful and its use should actually be encouraged. Therefore, consumers who use either ocean water or desalinated ocean water should be exempt from the tax altogether. Exempting this source of water essentially acts as a de-facto tax expenditure to encourage investment into desalination technology, something that is vital to long-term global water sustainability. Differentiating based on source ultimately results in three parallel tax brackets for ocean water, surface water, and ground water.

Although the idea of differentiating between the sources of water appears daunting at first, structuring the tax as a VAT aids in the process. Because the tax is assessed each time water is used, a single soda can be separately taxed in proportion to the various sources of water used.

²³⁶ Mehan III & Kline, *supra* note 28, at 63–64.

²³⁷ See, e.g., *Water Billing Rates*, *supra* note 120.

²³⁸ U.S. Geological Survey Water Science School, *supra* note 8.

For example, the farmer who grows the ingredients for soda and pays the tax may not know exactly where the water he uses comes from, but the public utility company that provides the farmer with the water does. The utility company can therefore accurately provide the farmer with the information necessary to calculate the correct amount of tax based on the source of the water. The same process occurs again at the manufacturer level. Thus, it is possible to tax the same end product proportionately to the various sources of water used in its manufacturing.

c. Rebates and Deduction

Like the British Columbia carbon tax, the water tax includes an automatic rebate for families that fall below a certain income threshold based on their income tax returns.²³⁹ The level of the rebate should be set so that it roughly offsets what the average individual pays in water taxes for the year. This can be accomplished in a variety of ways, but mostly likely involves estimating the amount of revenue collected per capita under the tax.²⁴⁰ Those individuals under the income threshold receive the entire rebate and the rebates of those above the threshold are reduced until it is ultimately phased out.

In addition to the rebate, small businesses should also be allowed to take a deduction equal to the amount of tax paid. This deduction recognizes that the tax disproportionately affects small businesses with much slimmer profit margins than bigger companies. Raising the cost of doing business for these small companies creates disparate hardships. Although the tax is designed to raise the cost of water to a level where individuals are more conscientious about their

²³⁹ Although this might be the simplest means of determining qualification for the rebate, it might not be the best method. Many individuals do not file taxes because they fall below the standard deduction and are not required to file. These individuals likely represent those most impacted by the water tax. This will be a critical issue in making the credit viable. However, solving this problem is beyond the scope of this paper.

²⁴⁰ There are a couple of issues that will need to be addressed when setting the amount of the rebate. A methodology would have to be developed for estimating the average water consumption per person. It might be more complicated than just looking at total consumption and dividing it by the total population. To this end, it might be necessary to vary the rebate by locality to account for variations in the average use.

behaviors, the goal is not to make affordability another barrier to entry for small businesses. The amount of the deduction would be based on the amount the business paid in water taxes and the size of the business. For example, any business with under five employees would be able to take a deduction equal to the total amount paid in water taxes, whereas businesses with six to fifteen employees would only be able to deduct 80% of their total tax bill.²⁴¹

d. Revenue Allocation

The purpose of the water tax is not actually to raise revenues, but rather to change individuals' behaviors towards water. If the program is successful, there should only be a modest amount of revenue collected because people should be reducing their consumption of water. Additionally, a large portion of the revenue is used for the rebates and to offset the small business deduction. And of course as with any tax, there is an administrative cost to the calculation and collection of the tax by the government. This also does not include the administrative cost to the businesses that pay the tax which becomes part of the product cost. Ideally, the tax is revenue neutral. Nevertheless, the revenue that is collected should be used to help improve overall water efficiency.

As discussed in the Cape Town case study, significant water is wasted when it is delivered to the consumer through poor infrastructure. To prevent this waste, cities must invest in updating and repairing their public water works. The money raised by the water tax can be used to make these repairs and improve absolute efficiency in the system. If the tax is imposed at the federal level, individual cities could be allowed to apply for grants to make these repairs.

²⁴¹ The number of employees is only one way of determining size and may not represent the best means of determining who should be eligible for the deduction. A combination of income and the number of employees might represent a better measure of whether the business needs the protection of the tax deduction. Moreover, depending on whether this tax is implemented at a state or federal level, the deduction might be subject to limitations under the state and local tax deduction (SALT). 26 U.S.C. § 164 (2017).

Requiring cities to apply for the money ensures that the funds are not diverted to other unrelated issues. If, however, the tax is imposed at a local level, the government must consider including a “lockbox” provision that prevents the government from diverting the revenue to the general fund.²⁴²

e. Labels

The final element of the tax proposal is to require the inclusion of labels on all products that require water in their production. The label would be affixed to the outside packing of all products and includes the average number of liters of water used in the manufacturing process. This allows consumers to easily compare the water efficiency of various products and raises awareness of the hidden water cost that otherwise goes unnoticed. Companies with poor water practices are shamed into improving. Additionally, the tax should also be itemized on all receipts so that consumers are aware how much money is spent on the water to produce the products they buy.

As previously stated, this paper neither formulates nor asserts a specific tax ready for legislative endorsement. Rather, the objective here is to demonstrate why a consumption tax on water is the proper solution both theoretically and practically and subsequently identify overall principles pursuant to which a legislative body better-equipped to flesh out policy details should ultimately structure a tax. The five aforementioned elements of a water tax preserve the theoretical and practical advantages of a consumption tax while acknowledging and curbing its potential disparate impacts and externalities.

²⁴² In British Columbia, the revenues from the carbon tax are also used to pay for research into green technology. Recently, this use of funds is under intense scrutiny because the organizations funded have produced inconclusive findings. There are also allegations that the organizations selected to receive funding are politically motivated.

CONCLUSION

The water tax is not likely to be a popular initiative. It will increase the cost of almost every product and affect the entire population of the countries that adopt it. There will likely be a rough transition period where businesses and individuals alike must recognize and accept the fact that water is not free. It requires strong leaders to make people understand the importance of the program for the long-term survival of humanity. Although Cape Town survived and staved off Day Zero, it is only a matter of time until the next crisis. The next one may occur in an even larger city, such as London or Miami, where the effect on human life could be catastrophic.

Now is the time for action. By the year 2040, the crisis will have spread across the world, leading to massive political unrest. When that happens, it likely is too late to do anything about our water supply. The methods employed in the past are no longer sufficient. A new, bold path forward in water management is necessary to save humanity, and a demand-side solution using taxation is the answer. Water is not free, and ultimately, humanity must pay the price for its past mistakes.

Appendix 1

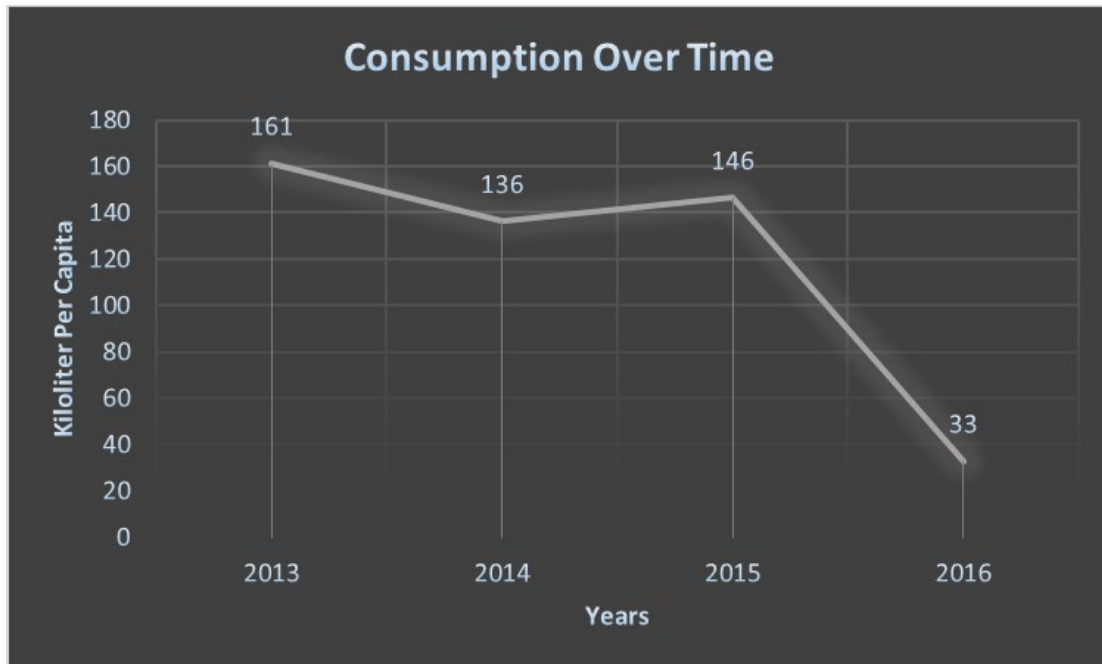


Figure 1

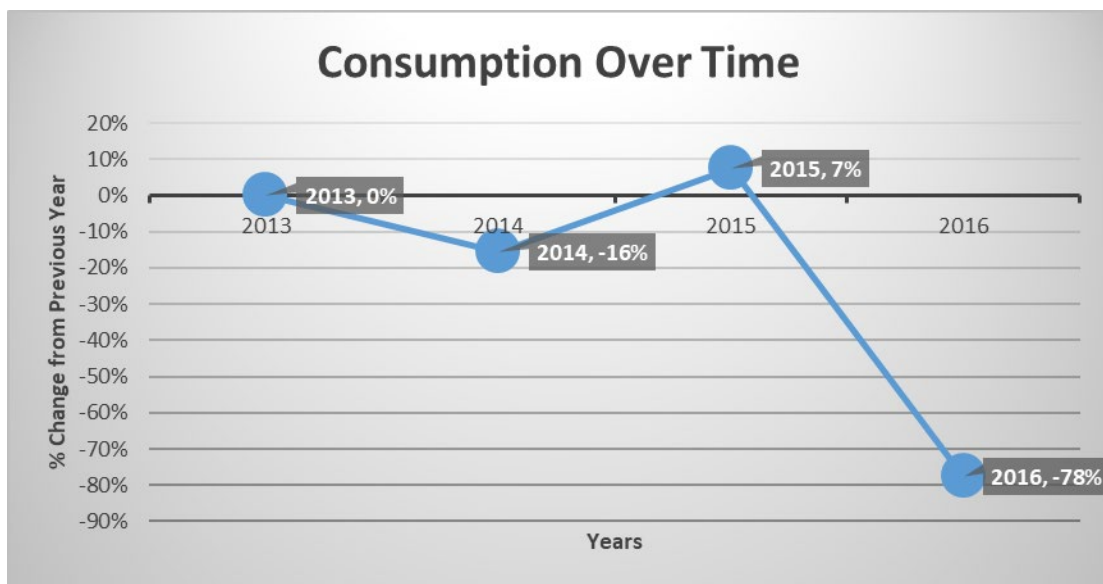


Figure 2

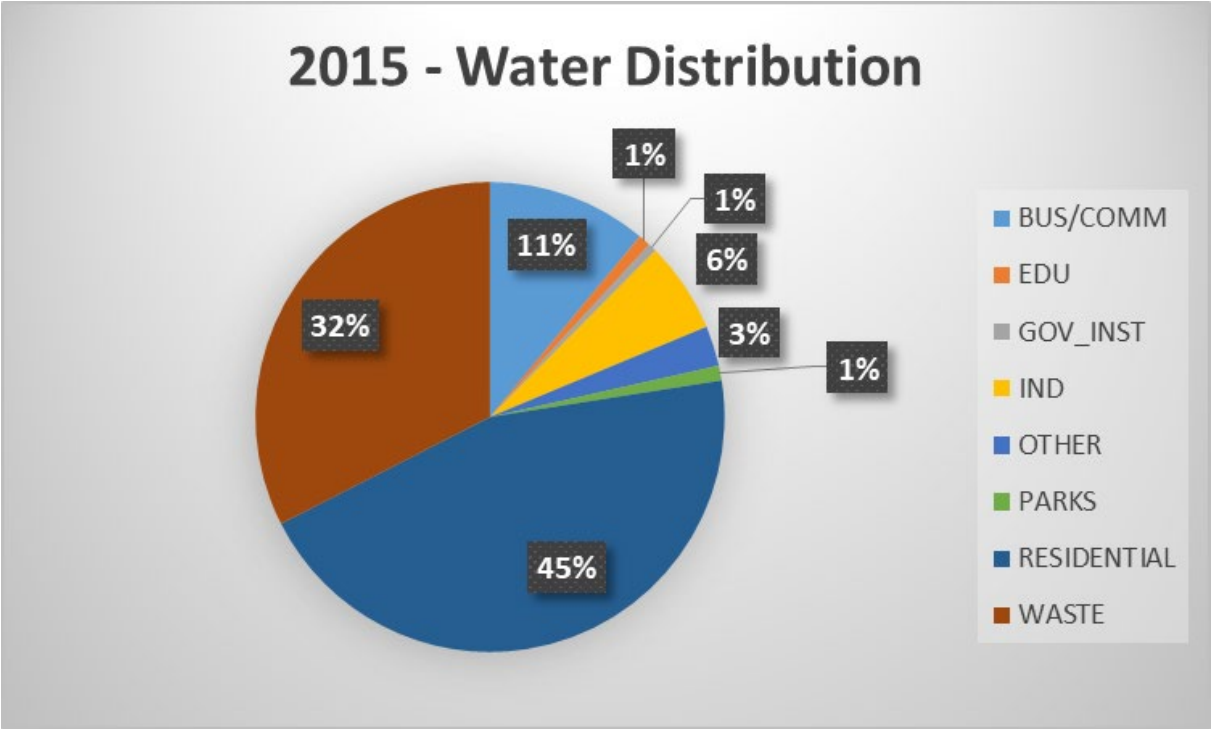


Figure 3

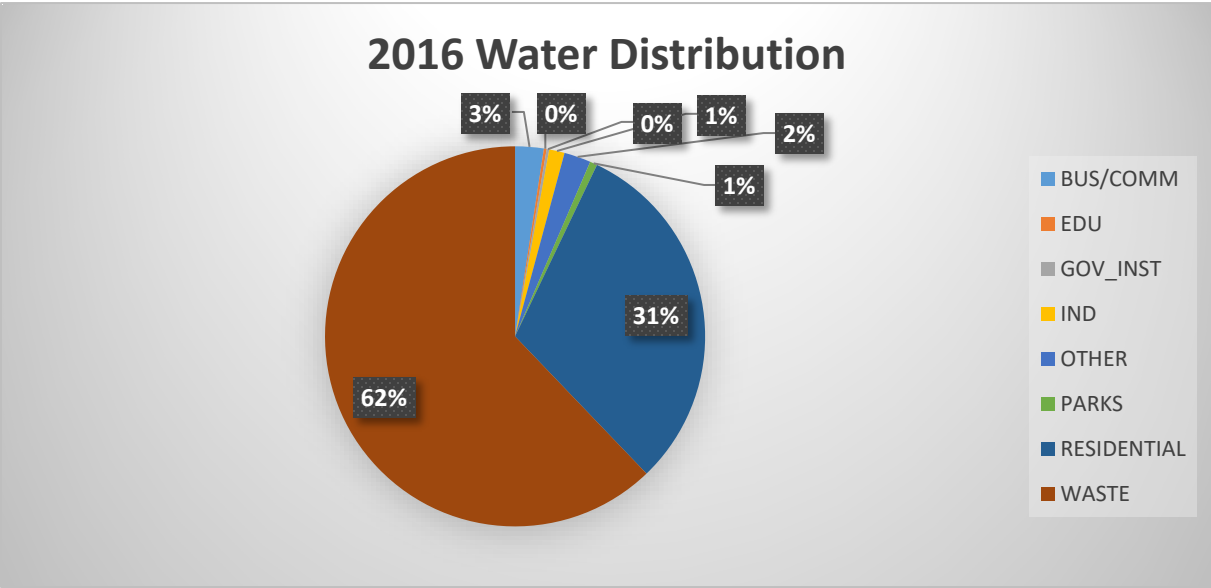


Figure 4