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Illinois as a World Provider of Virtual Water and Advocate for Clean Water: How Does Illinois Fit into the Global Water Crisis/Solution?

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THE SIMON REVIEW

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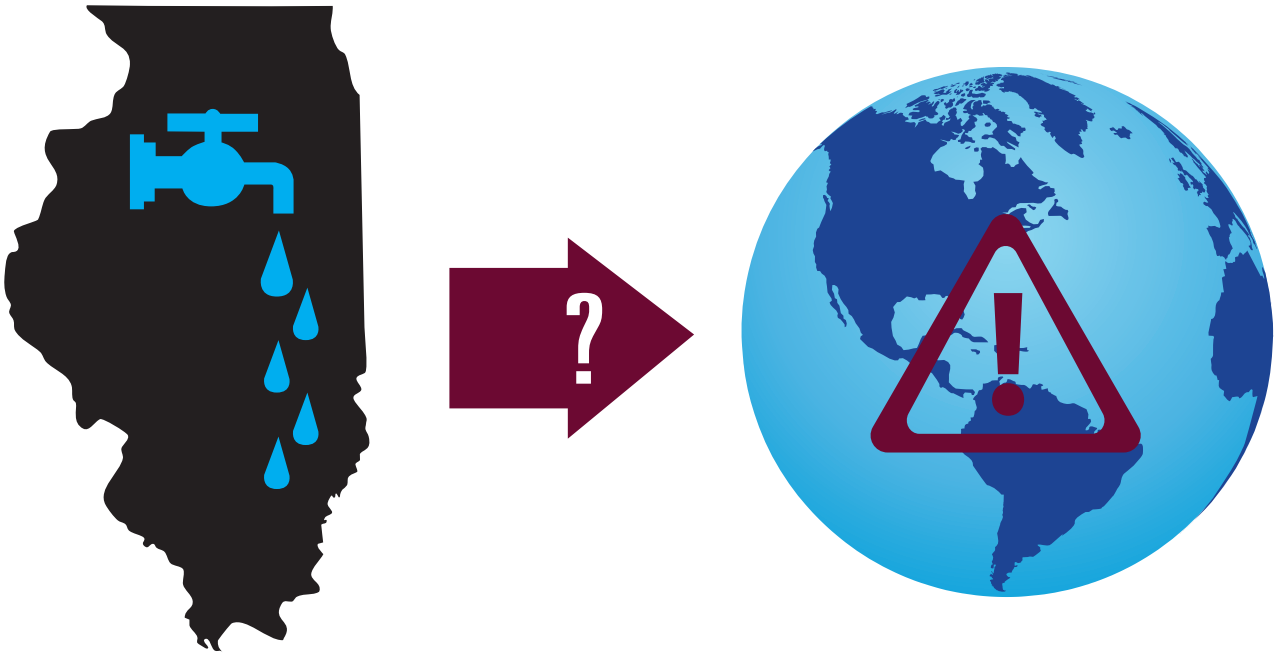

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THE SIMON REVIEW

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INTRODUCTION

Although politically Illinois has recently been plagued with an extensive budget crisis and stalemate on how to overcome its large deficits, Illinois as a state is fortunate in its exceptional natural geography which provides both abundant fresh water resources and fertile agricultural soils (Lant, 2005). As such, Illinois plays an important role in the global water crisis as a water supplier through its exports of crops which consume vast quantities of water. The state is a leading exporter of corn, soybeans, and swine, and through these commodities is supplying what many experts call "virtual water" to the world. Virtual water is "the amount of embedded water or hidden water used to produce agricultural and industrial goods" (Kehl, 2011, 83). Illinois alone provides more virtual water through its exports than most countries and constitutes 11% of the U.S virtual water exports (Lant, 2005). With such a unique location that allows for easily navigable water based transportation through our access to lakes and rivers and resources that include inherently fertile soils that receive plentiful precipitation, it is imperative that Illinois remains a powerful supplier of water and foods through its exports. Additionally, it calls for an added responsibility and determination to practice sustainable agricultural water practices so that Illinois' future abilities as a virtual water provider/supplier will not be diminished in years to come.

Furthermore, Illinois has played a large role in global water policies through the legacy of Paul Simon as it has provided an impetus for making clean water for all a significant foreign policy issue. Over twenty years ago, former veteran Illinois Congressman and United States Senator Paul Simon realized the impending crisis that a lack of water would play on the national and international stage. In his book, *Tapped Out* he discussed the importance of recognizing

conflicts that could occur in the future as water resources become scarce and proposed solutions to avert these coming crises (Simon, 1998). Through Simon's advocacy, work, and legacy of promoting water as an important global issue, the Water for the Poor Act was signed into law in 2005, placing water, sanitation, and hygiene on the foreign policy forefront (USAID, n.d.). In 2014, the Water Act for the World was adopted to build upon the 2005 Water for the Poor Act by specifying that water and sanitation are important resources necessary for human life and that the U.S. needs to be a global leader in providing sustainable access to clean water and sanitation to vulnerable populations (Congress.gov, 2015). It set forth provisions to designate USAID funds to be allocated towards water and sanitation, to appoint a USAID Global Water coordinator and designates their role as leading, revising, and implementing the Global Water Strategy once every five years and report to Congress, and to prioritize ten countries in severe need of improved access and to continue to make new designations each year. In addition, it requires that the President under the guidance of the Secretary of State, the USAID administrator, and other federal officials, submit a government-wide Global Water Strategy to Congress that includes how to increase access to safe water, sanitation, and hygiene in the designated high priority countries, how to improve management of water resources and watersheds, and development of a plan to prevent future conflicts over water resources (Congress.gov, 2015). These measures ensure greater efficiency, effectiveness, and transparency for the goals of both acts.

The challenges of global water security today are even more salient than when Senator Simon first drew attention to them. Population increases are estimated to make the total world population reach 9.5 billion by 2050 which will require different ways of managing water so energy, food, and water needs are met efficiently (van der Bliek, McCormick, & Clarke, 2014).

Currently, the world's population that resides in cities is about half of the total population, and by 2050, it will likely be close to two-thirds (Paterson, et al., 2015). As urbanization increases, problems arise with water resources as cities require more virtual water inflow than possible virtual outflow due to a high population with a great demand for commodities and little land space for food production (Paterson, et al., 2015). This puts great stress on resources and compounding this factor is the lagging water infrastructure in many cities (Paterson et al., 2015). Unequal access to clean water based on gender, social, or minority status is a real problem in the developing and industrialized world, which not only leads to dire health consequences but affects economic growth as well (van der Bliek, McCormick, & Clarke, 2014).

Climate change and environmental degradation are further obstacles in providing access to clean water for the 748 million people who live without it (Cassirer & Stoll, 2017). Climate change particularly affects water variability. Water variability can result in extreme flooding in wet, tropical regions and extensive droughts in arid and semi-arid regions (van der Bliek, McCormick, & Clarke, 2014). Moreover, environmental degradation negatively impacts natural ecosystems, which provide a wealth of benefits and services that are in many cases irreplaceable. Finally, water governance defined as, "the range of political, social, economic, and administrative systems that are in place to develop and manage water resources, and the delivery of water services, at different levels of society" is challenging due to a number of reasons (van der Bliek, McCormick, & Clarke, 2014, 15). There is great competition between agricultural, industrial, urban, and environmental needs. This competition is played out in the political and policy making process. This is also exacerbated by the reality that water as a resource is not confined to political boundaries but identified by river basins which further separate into watersheds, which are "geographic units of natural capital and of the production of ecosystem

services from this natural capital" (Lant, 2005, 4). Land use of these watersheds is dependent on the individual owners and laws regarding use at the local, state, and federal level. Undoubtedly, as the late Senator Simon noted, the political will to coordinate national and global water policies is lacking (Simon, 1998). As water resources and water scarcity are factors of temporal and spatial variability, coupled with complex global economic forces, it is difficult to find and engage policy drivers of the need for a comprehensive understanding of future water scarcity, conservation, and sustainable solutions (Paterson, et. al, 2015). Therefore, effective and comprehensive water governance is crucial in the days ahead.

This paper will examine Illinois' vital function in its role as provider and supplier of water on a global scale via its virtual water exports as well as its role as an advocate for access to clean water for the world through U.S. leadership. To accomplish these objectives, the paper has been divided into two sections, Part I will examine Illinois's role in providing virtual water through its crops. It will be accomplished through conducting an empirical literature review of the concept of virtual water and specifically the virtual water trade for its implications for Illinois and its impact on the global stage, examining Illinois' own water issues of quantity, quality, usage, and preparedness, viewing current legislation and water policies in the state, and discussing implications and solutions for the continuance of global virtual water provision in Illinois. Part II will explore the role Illinois, through Senator Simon and other state leaders, has had in advocating for increased access to clean water globally. This will be achieved by investigating Illinois' position as a proponent for the Water for the World Act of 2014 and its outcomes, looking at the current state of global water scarcity and poverty, discussing current legislative effects on water access, and finally recommending solutions that incorporate a

framework involving both global virtual water policy prescriptions and an integrative approach to address the multi-dimensional aspects of water governance.

1 ILLINOIS AS A PROVIDER

1.1 ILLINOIS AS A PROVIDER OF VIRTUAL WATER

Virtual water is a conceptual framework introduced by Tony Allan in the mid-1990s that is used to quantify the physical amount of water needed to produce goods, such as rice or corn, in one region (Paterson, et.al, 2015). It is measured in terms of volume of water and expressed using cubic meters (m^3) or gallons. Due to variability of climatic conditions such as rainfall, temperature, availability of fertile soil, evapotranspiration rates, and other measurements of environmental conditions, it requires a different amount of water to produce the same crop in different regions. This is one reason Illinois stands out as a virtual water provider, as its climate, soils, and topography allow it to be an effective user of water resources in rain fed agriculture. For instance, Utah would require 1,558 m^3 of virtual water to produce corn grain that takes Illinois only 278 m^3 to produce (Mubako & Lant, 2013). Additionally, as Illinois has an abundance of fertile soil set aside for agricultural uses, plentiful rainfall, and navigable rivers, a relatively low population density which limits its own food consumption, many food manufacturing companies, and efficient transportation systems; it has an excellent advantage as an exporter in the virtual water trade.

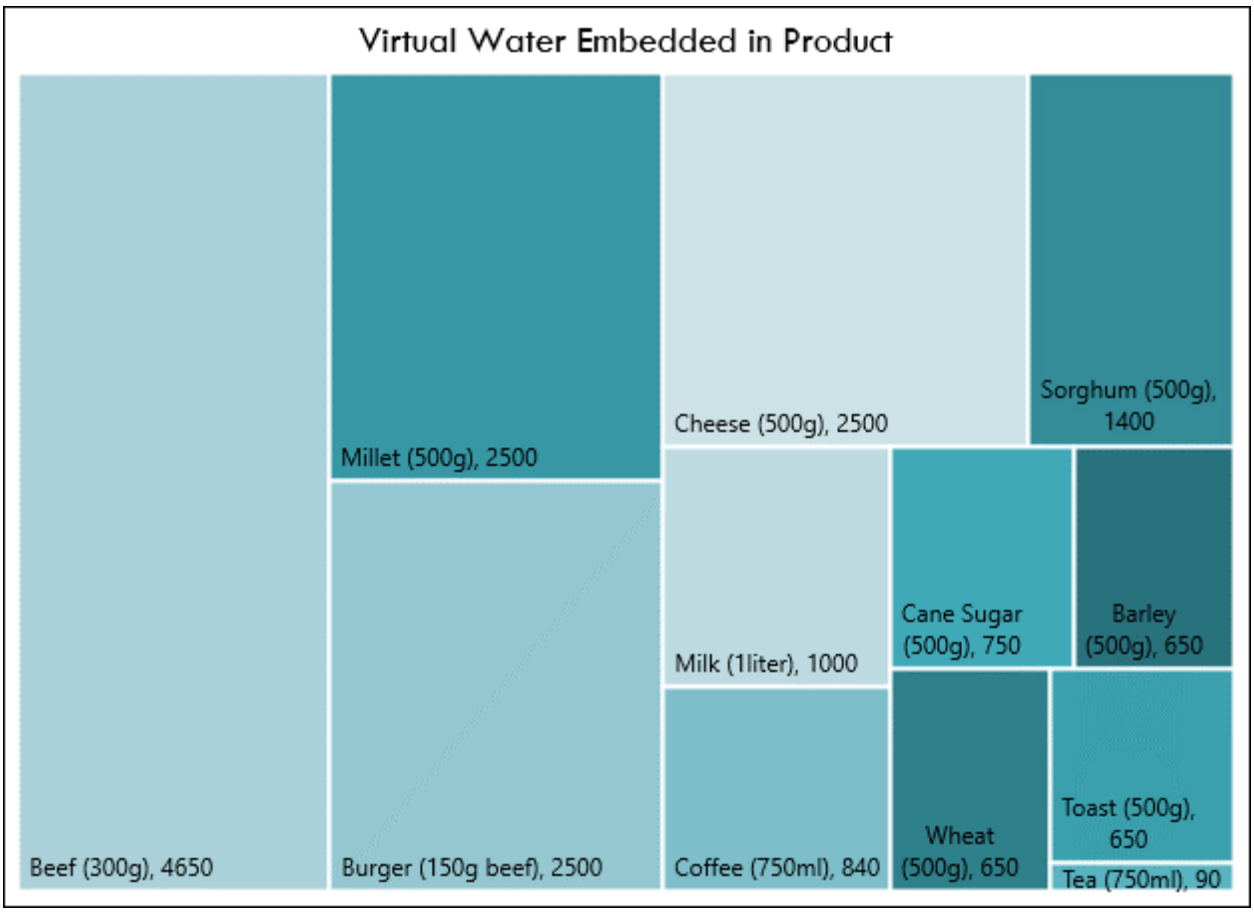

Figure 1. Virtual Water Embedded in Product [Product (quantity), liters of water] (Data: Hoekstra, A.Y. & Chapagain, A.K. (2008). *Globalization of water: Sharing the planet's freshwater resources*. Blackwell Publishing, Oxford, UK. www.waterfootprint.org) (Design Idea: Timm Kekeritz, www.virtualwater.eu)

Specifically, Illinois has 27 million acres of farmland which make up 75 percent of the total land area for the state (Illinois Department of Agriculture, 2017). Of that farmland, 89 percent is designated as prime farmland which according to the USDA, is defined as,

"…Land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and is also available for these uses. It has the soil quality, growing season, and moisture supply needed to produce economically sustained high yields of crops when treated and managed according to acceptable farming methods, including water management. In general, prime farmlands have an adequate and dependable water supply from precipitation or irrigation, a favorable temperature and growing season, acceptable acidity or alkalinity, acceptable salt and sodium content, and few or no rocks. They are permeable to water and air. Prime farmlands are not excessively erodible or saturated with water for a long period of time, and they either do not flood frequently or are protected from flooding."[SSM, USDA Handbook No. 18, October 1993](as cited in USDA National Resources Conservation Service).

As noted in the definition to be considered prime farmland, Illinois also has dependable precipitation averaging 39.04 inches a year (USclimatedata.com, 2017). The population density of Illinois does rank 12th in state rankings at 231.4 people per square mile (1keydata.com, 2017), but almost half of 12.8 million people live in Cook and DuPage County (worldpopulationreview.com, 2017). This allows for a low water footprint per capita at 1141-1220 m^3 range (Mubako & Lant, 2013) and with a large metropolitan area, it is home to more than 2,600 food manufacturing companies which makes it the largest revenue producer of processed food in the country and one of the world's largest concentration of food-related businesses (Illinois Department of Agriculture, 2017). Illinois is centrally located in the U.S. possessing superior highway, rail, and airport transportation (Illinois Department of Agriculture, 2017). The Illinois, Mississippi, and other rivers of Illinois provide over 1,000 miles of navigable waterways which allows for easy shipment of grain to the Gulf of Mexico (Illinois Department of Agriculture, 2017). Therefore, Illinois intrinsically possesses both geographical and economic features that give it strength as a virtual water provider and trader.

The virtual water trade has been researched heavily since the concept of virtual water was developed. Virtual water has many ramifications that are important from both a local and global standpoint. Since it is a comprehensive way to understand water uses, it can ultimately enable water conservation. Water scarcity or at least an acceptance of increasing strain on global freshwater resources is a reality widely accepted by scientists and government leaders. Therefore, much work has been invested into researching the water footprint defined as "the total volume of freshwater needed for the production of the goods and services consumed by the inhabitants of the country" (Chapagain & Hoekstra, 2004, 11) and the virtual water trade as "trade of agricultural and industrial commodities …associated with a virtual transfer of the water

resources used for the production of these goods" (Carr, D'Odorico, Laio, & Ridolfi, 2013) because both of these measures from an ecological perspective can help inform international policy and governance on freshwater uses as agricultural uses consume up 70-80% of the total use of freshwater worldwide (Dalin, Konar, Hanasaki, Rinaldo, & Rodriguez-Iturbe, 2012). Global food security also comes into play as the international food trade and its embedded virtual water overcome many national and geographical limitations a country has in regard to supplying food to its inhabitants. The flow of this virtual water trade has been studied extensively with some interesting implications for Illinois.

Since the virtual water concept came about, there have been numerous studies to examine the virtual water network retrospectively in order to examine the flow over years. Succinctly, what is found is a "globalization of water" (Hoekstra & Chapagain, 2008), that is the trade of water-intensive products on the global market from resource rich countries to countries with fewer resources or high consumption areas (Carr, D'Odorico, Laio, & Ridolfi, 2013). It does not necessarily follow clean lines of water rich to water poor countries, although many attribute the lack of materialization of the previously forecast water wars of the 1990's on the shift of those countries to rely on imported goods for virtual water (Allan, 1997). The virtual water trade network seems to follow more complex patterns dependent on many political, economic, and geographic factors (Carr, D'Odorico, Laio, & Ridolfi, 2013).

Dalin's et. al (2012) study which followed the virtual water trade network for over twenty years from 1986-2007 found that trade policies, socioeconomic circumstances, and agricultural efficiency all affected the network. It is not surprising to find out during this time period of the rise of globalization, that there was a rise in the number of trade connections and the volume of water embedded in the global food trade (Dalin et. al, 2012). In fact, the trade connections more

than doubled with some parts of the network remaining the same and other regional areas drastically changing. The United States as a large exporter of staple crops remained the largest virtual water exporter during the time period of the study, with a small gap of 2004-2006 when Brazil edged out the U.S. (Dalin et.al, 2012). However, changing trends included the shift of Asia relying more on South America for imports rather than North America, although trade to Asia for all has increased. Internal trade within North America increased after NAFTA, which showed Mexico's reliance on U.S. grains. European trade of exports from the U.S. has shrunk while European internal trade and trade with South America have increased. Country specific changes that were reflected heavily in the network show that as China's GDP rose, there were dietary changes to greater meat consumption and allowance and increase of soy imports (Dalin, et al., 2012). Soy imports to China are mostly coming from Brazil, the U.S., and Argentina and as such, these countries, have been able to decrease water usage while still increasing yield. In sum, the results of the study discuss that as trade has increased, global water savings have increased because of water-efficient trade relationships and the volume of foods traded internationally has increased.

Carr, D'Odorico, Laio, and Ridolfi (2013) also examined international trade data to follow global food trade patterns with respect to virtual water from 1986-2010 from the Food and Agricultural Organization of the United Nations. They found that the number of connections and the total flux of virtual water had increased over the time period studied. Participation in the global market increased for most countries and regions, showing in general that countries are more inter-connected. However, the African continent has not experienced this increased participation to the same degree, while the southern Asian countries of China, India, and Indonesia have increased their participation levels dramatically (Carr, et al., 2013). Another

important finding is that by 2010 most of the global population were net importers of virtual water as compared to 1986 when the export-import balance per capita was close to zero (Carr, et al., 2013). An interesting feature of examining the virtual water trade by net importing/exporting balance of countries and scaling for global population allows a picture of what percentage of the population is providing most of the global virtual water. They found, "32 percent of the global population is providing 90 percent of the virtual water" (Carr, et al., 2013, 7). With this insight, the study concluded that a small percentage of the global population is responsible for the global water resources to provide virtual water exports and that changes in these individual countries determine much of the pattern and changes that occur in the network (Carr, et al., 2013). Illinois is of course a vital contributor to the U.S. share of virtual water exports.

Mubako and Lant (2013) have conducted a similar study to analyze agricultural virtual water trade and footprint in the U.S. and found that the trade patterns are not necessarily humid to arid regions but rather follow trade patterns of comparative advantage. The Eastern urban states relied heavily on imports from the North Central region, while the Southwest only imports 18 percent to 19 percent of their water footprint which results in a loss of 92 billion m^3 in net water savings (Mubako & Lant, 2013). This study as well as the others shows that while international trade in virtual water is an important trend and rapidly growing, mesoscale trade which refers to the scale of trade among cities, counties, states is even larger. The biggest consumers of Illinois' virtual water exports are U.S. cities, including the east coast cities. From these studies observing virtual water and the virtual trade network, it is evident how Illinois and its exports of crops are clearly involved in the larger global water crisis and solution as well as having a major impact internally in the United States.

The U.S. leads as the world's largest gross and net virtual water exporter with most Midwestern states exporting more virtual water than they consume or withdraw (Mubako & Lant, 2013). Illinois is a part of this trade, as it dominates the exports of corn grain, soybeans, and wheat, which account for much of the international trade market of staple crops (Lant, 2005). Corn grain has the largest total water footprint per agricultural product in the U.S. by its sheer volume of 20.28 percent sold on the market, excluding processed meats or milks (Mubako & Lant, 2013). Illinois is a leader and efficient producer of corn grain making it an important exporter and conduit of virtual water, as 44 percent of Illinois grain is sold for export. Nationally, Illinois' exports of agricultural commodities exceed eight billion ranking it third overall, and 6 percent of the total for all U.S. agricultural exports (Illinois Department of Agriculture, 2017).

1.2 ILLINOIS' CURRENT WATER ISSUES

As evident through the discussion of Illinois' resources and advantages as a state, Illinois is on one end of the spectrum in regard to the availability of freshwater resources and reliable annual precipitation. However, the quantity and quality of water resources is always a vitally important issue in any state as "provision of adequate and reliable supplies of clean water at a reasonable cost is a basic necessity for public health, the economy, recreation, and navigation" (Winstanley et al., 2006, iii). The future demands for water in Illinois will be complicated by worldwide population growth and climate change. The frequency and severity of natural disasters will impact our water resources as well as increase in demand for highly populated areas (Illinois State Water Survey, 2017). The following paragraphs will examine the withdrawal usages of Illinois water and the water quality concerns in Illinois. All of these concerns are significant points of interest for the state and must be addressed in the days to come

to ensure our viability as a provider and advocate of clean water for the state, the rest of the nation and the world.

As a primarily rain fed agricultural state, thermoelectric power generation is the state's greatest water withdrawal driver, with public water supplies as second, self-supported industry as third, and livestock and irrigation as the last major user of our freshwater resources (Illinois State Water Survey, 2017). Nationally, Illinois is fifth in state rankings of freshwater withdrawals according to 2010 estimates from the United States Geological Service and second in rankings of thermoelectric power withdrawals (2016). As a country, water withdrawal usage is on a downward trend from 2005-2010, similar to withdrawal levels from 1970 (United States Geological Services, 2016). Previously, water withdrawals had been climbing steadily; decline is attributed to more efficient methods in thermoelectric cooling, such as increase in the use of natural gas and the development of new power plants with more water efficient cooling technology and more efficient irrigation systems, such as sprinkling or micro irrigation (United States Geological Services, 2016).

Even though withdrawal for thermoelectric power is the highest user in Illinois and the Midwest, it is not a large concern to global water issues, as very little water is consumed or lost in the process. Yet due to the magnitude of water being used for cooling in power plants, which is nearly 16,500 million gallons per day (mgd), any evaporation is significant. The Illinois Water Withdrawal and Use in Illinois 2010 report shows evaporation loss totals exceeds what was withdrawn from Lake Michigan for public supply (Bryant & Meyer, 2010).

Regarding public water supplies which withdraws 1,500 mgd (Bryant & Meyer, 2010), the more densely populated Northeastern section of the state is responsible for much of the state's domestic usage of water from Lake Michigan and groundwater (Illinois State Water

Survey, 2017). The northeastern part of the state has access to Lake Michigan, which is the source of 60 percent of the water used by Illinois public water systems, most serving over 200 public water systems in the Chicago metropolitan area. The northern half of the state also has access to water from deep bedrock aquifers (Bryant & Meyer, 2010). Downstate, southern Illinois relies heavily on the development of surface water sources such as reservoirs, lakes, and rivers as they lack the aquifers found in the northern part of the state (Illinois State Water Survey, 2017).

Next, self-supported industry is responsible for 4 percent of the total withdrawals for the country, and in Illinois, around 3 percent with a 520 mgd total (Bryant & Meyer, 2013). The water is used for the production of commodities, mostly for non-contact cooling (Bryant & Meyer, 2013). The last major user of water in Illinois is irrigation. Irrigation remains a high priority especially in national figures when excluding water withdrawal from thermoelectric power generation, as it uses up 61 percent of total freshwater withdrawals. California alone represents 10 percent of national freshwater withdrawals, mostly for irrigation purposes (United States Geological Services, 2016). In Illinois, mandatory reporting of row-crop irrigation did not start until 2015 after the Illinois Water Use Act of 1983 was amended in 2010 to include high capacity wells or intakes for agricultural purposes (Illinois State Water Survey, 2017). More recent data, reflecting the trends since 2015, will likely not be published for public use until after the spring of 2018. Anecdotally, since the drought of 2012, more farmers have installed irrigation systems as a safety net (S. Wilson, personal communication, August 29, 2017).

Another significant issue relating to water in Illinois is water quality. In Illinois, the quality of water varies regionally due to different geological features from where the water is drawn and also due to different sources of pollution (Illinois State Water Survey, 2017). The

composition of Illinois water varies chemically based on source and region, and whether drawn from aquifers, groundwater, or surface water (Illinois State Water Survey, 2017). There is also variation in waste pollution, ranging from organic waste from municipalities, to toxic waste from industry, to agricultural waste of fertilizers, pesticides, and animal waste from farms (Illinois State Water Survey, 2017). Water usage is tied to water quality as suitability is dependent on the amount and kind of minerals and organic substances in the water (Illinois State Water Survey, 2017). Different levels and types of treatment are therefore required.

The main issues that are in play here as far as water quality and the public are the elevated levels of concentration of arsenic, nitrate-nitrogen, and lead observed in the state that are above the standard for drinking water (Kelly et. al, 2016). Arsenic is a naturally occurring contaminant present in the sediments in aquifers, and the concentrations of it vary throughout the state dependent on geographic area and geological properties. In a study conducted by the Illinois State Water Survey of the Middle Illinois River region, elevated levels of arsenic were found up to > 75 (µg/L) exceeding the allowed 10(µg/L) (Kelly, et. al, 2016). The negative health effects of arsenic as a "Group 1 Carcinogen" have been observed by many epidemiological studies, linking it to skin, urinary bladders, and lung cancers (Smith et al., 1992, as cited in Bulka, Jones, Turyk, Stayner, & Argos, 2016). Interestingly, an ecological study that was conducted in Illinois counties that traced levels of arsenic in drinking water from 2000-2006 and prostate cancer incidence data from 2007-2011 showed "counties with higher mean arsenic levels in community water systems had significantly higher prostate cancer incidence" (Bulka, Jones, Turyk, Stayner, & Argos, 2016, 450). As a whole, they found that most Illinois counties were within the acceptable standard below 10 (µg/L) in the data set from the Safe Drinking Water Information System, but a correlation between higher levels of concentration and the

incidence of prostate cancers still occurred (Bulka, Jones, Turyk, Stayner, & Argos, 2016). In 2002, an inquiry into arsenic found in Illinois groundwater that included all of the community water supply data from the ISWS Water Quality Database prior to treatment showed 11 percent of the samples had arsenic levels above 10 (µg/L). Since the national standard of 10 (µg/L) went into effect in 2001 from the USEPA, all communities with elevated arsenic levels must treat their water so the finished water is below the standard (Illinois State Water Survey, 2002).

Another water quality issue of great concern and sizeable impact elsewhere is nitrogen and phosphorus contaminants that occur as a result of agricultural runoff at the watershed level into the streams and rivers of the Midwest and ultimately into the Gulf of Mexico. The presence of these contaminants is from sources such as synthetic fertilizer, livestock manure, soil disruption or septic discharge (Kelly, et al., 2016). As a state with a huge agricultural base, this has been a big problem for Illinois farmers and the source of political conflict between agricultural interest groups and the Environmental Protection Agency. As far as its effect on Illinois drinking water, the study conducted by the Illinois State Water Survey of the Middle Illinois River region found elevated levels of nitrate-N near the Illinois River, ranging up to >15 mg/L with 10 mg/L as the national drinking water standard (Kelly, et. al, 2016). An additional concern about water containing nitrogen is that it can lead to algae overgrowth making water unsafe for drinking or recreation if elevated levels of algal toxins are found (Illinois Environmental Protection Agency, 2015).

Besides affecting drinking water supply, the concern of agricultural runoff from excessive use of fertilizers for those in agricultural and environmental science has to do with the disturbance to the nitrogen cycle. Human modifications to the N cycle have been documented and remain a high priority in environmental issues as they are associated with global climate

change and eutrophication which occurs when a body of water is overly enriched with mineral and nutrients (Illinois State Water Survey, n.d.). Human activities such as application of nitrogen-based fertilizers can cause an increased amount of availability of nitrogen resulting in unused nitrate which seeps into the soil to then enter streams and rivers affecting the sources of our drinking water (Bernhard, 2010). The excess N concentrations and loads from Illinois agricultural runoff as well as other states in the Mississippi River basin that flow down through the Mississippi River to the Gulf of Mexico have considerable negative downstream effects of the depletion of dissolved oxygen from eutrophication. Subsequently, the water can no longer support living aquatic organisms resulting in a large dead zone (Illinois State Water Survey, n.d.; Louisiana Universities Marine Consortium, 2016). As nitrogen is a critical nutrient to regulate primary productivity and species diversity, alterations to the N cycle by humans "threatens our resources and have already significantly altered the global nitrogen cycle" (Bernhard, 2010, 25).

Water testing across the state has also revealed the presence of lead as a contaminant in Illinois water systems. This quality issue is not from a source contaminant in the drinking water but contamination of water as it passes through lead service lines from homes or from lead plumbing inside homes (Hawthorne & Smith Richards, 2016). Unfortunately, the prevalence of lead service lines in older homes occurs throughout the state and the city of Chicago has more lead services lines than any other U.S. City (Hawthorne & Smith Richards, 2016). Most contaminants have maximum contaminant levels (MCL) set by the EPA since the 1974 Safe Drinking Water Act. Lead has no MCL as there is no safe exposure to lead, which can cause a range of adverse health effects in children, adults, and pregnant women affecting the brain, nervous system, cardiovascular system, reproductive systems, and growth of fetuses (Environmental Protection Agency, 2017).

Most lead contamination in water occurs from the corrosion of plumbing materials (Environmental Protection Agency, 2017). As such the treatment from the water systems is to control the corrosivity of the water by adding anti-corrosion fighting chemicals. Regular monitoring of customer taps for lead is also required and to take further steps if more than 10 percent of the tap water samples exceed lead action level of 15 parts per billion (Environmental Protection Agency, 2017). The further steps include optimizing corrosion control treatment, educating the public about lead in drinking water, and replacing portions of lead service lines (Environmental Protection Agency, 2017).

Recently lead in the water has been a topic of interest in the news in Illinois as the Flint, Michigan story progressed and there has been evidence of laboratory test results showing lead levels above the 15 parts per billion in Chicago public schools (Ihejirika, 2016). This has become a significant political issue in Chicago which resulted in legislation to protect children in schools and daycare centers from lead. The other public health hazard stems from the problem that cities are not required to replace the lateral service lines, or the pipes connecting the water mains to the older homes. They must replace only the section of service lines on city property (Tiboris, 2016). While the city is replacing the water mains through a $412 million federal-state loan fund on water-related projects, the cost of the lateral lines are placed on the individual water consumer (Hawthorne & Matuzak, 2016). Furthermore, the water main replacement has actually increased the risk of lead to residents in Chicago as disturbing the lead service line increases chances of corrosion and shaking of lead (Environmental Protection Agency, 2017).

1.3 Legislation and Policies Regarding Water in Illinois

The primary laws that affect Illinois in regard to access to water are the federal 1972 Clean Water Act and 1974 Safe Drinking Water Act. The Clean Water Act of 1972 was an

update and expansion to the Federal Water Pollution Control Act of 1948 (33 U.S.C. § 1251 et seq.). This law stated "the objective of this Act is to restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (Federal Water Pollution Control Act, 33 U.S.C. § 1251et seq.). The Clean Water Act of 1972 helped to establish a basic structure for regulation of pollutants into water and quality standards for surface waters (United States Environmental Protection Agency, 2017). After the Act was passed, the EPA has implemented pollution control programs. The National Pollutant Discharge Elimination System (NPDES) is the federal program and it further specifies limits, monitoring and reporting requirements, and other provisions to ensure that pollutants from a point source do not endanger people's health or affect water quality (United States Environmental Protection Agency, 2017).

This program is further delegated to the states and ILEPA through USEPA has the ability to grant permits and to enforce compliance. As the U.S. allows states to craft legislation and state-wide programs to carry out federal objectives to be at least as strict and the ability to be stricter, Illinois roots its authority in the Environmental Protection Act (415 ILCS 5/1). It is described as a unified state-wide program for environmental protection to incorporate the objectives of federal programs and it protects water quality from multiple angles, including pollution from industrial and municipal sources under Section 12 which states, "Actions prohibited. No person shall: Cause or threaten or allow the discharge of any contaminants into the environment in any State so as to cause or tend to cause water pollution in Illinois, either alone or in combination with matter from other sources, or so as to violate regulations or standards adopted by the Pollution Control Board under this Act" (415 ILCS 5/12) (from Ch. 111 1/2, par. 1012; Sec. 12). The Illinois Pollution Control Board has been given regulatory authority to enforce the requirements, standards, and procedures established under the Clean

Water Act and NPDES and the Illinois Attorney's General's Office and State's Attorney have been given authority to sue if violations occur (Illinois Pollution Control Board, 2013; 415 ILCS 5/42).

Illinois water is additionally regulated by the 1974 Safe Drinking Water Act, in which the U.S. EPA sets national limits of contaminants in drinking water and requires public water supplies to comply with the standards to protect public health (Illinois EPA, 2015). If a public water supply exceeds the Maximum Contaminant Level (MCL) for a contaminant, the 1996 Amendment to the Safe Drinking Water Act (PL 104-182, August 6, 1996, Title XIV, Section 1420) requires the public water supply to inform the consumers of a violation. The Division of Public Water Supplies within the Bureau of Water is the agency in Illinois that oversees the surveillance, inspection, design, construction, and operation of public water supplies (Illinois EPA, 2015).

Recent legislation that has been a response to water quality issues in Illinois is SB0550 which was enacted into law on January 17, 2017 as Public Act 099-0922 which adds further regulations to the 1991 Lead and Copper Rule (56 FR 26460-2564, June 7, 1991). The U.S. EPA rule requires public water supplies to monitor for lead concentrations in drinking water at customer taps and if an action level is exceeded in more than 10 percent of the customer sample base, the public water system must take steps to control the contamination and inform the public of the steps they should take to protect their health (U.S. EPA, 2017). SB0550 adopts specific rules and provisions to check and identify for lead service lines and plumbing in public schools and day-care centers (65 ILCS/11). This helps to mitigate the concern by identifying lead service lines in schools with a plan of action to replace the lines if regulations are violated. It also requires samples from the representative sources of potable water in each school. The law

further contains provisions about notification requirements for owners and operators of community water supplies (65 ILCS/11). This law was put into effect immediately and hopefully will result in additional protection for the citizens of Illinois and particularly, children, who are a very vulnerable population to lead's detrimental effects.

1.4 IMPLICATIONS FOR ILLINOIS AS A PROVIDER AND ADVOCATE

Illinois faced a historic budget crisis from July 1, 2015 until July 6, 2017. The budget impasse had many adverse effects on the economy of Illinois. However, for the most part, effects on agriculture and the ability to export were able to remain separate from the crisis due to redirecting of resources at the state level (W. Goetsch, personal communication, November 7, 2017). In 2015, Illinois exported nearly $8 billion in agricultural goods compared to $9.3 billion in 2014 with soybeans, animal feed, and corn as the top exports (Farm & Food Facts, 2017). Yet operating agribusiness in a somewhat broken state could possibly have a long-term drag on our ability to be a world exporter of agricultural commodities and drain and strain the various industries involved (W. Goetsch, personal communication, November 7, 2017). Negative effects from the budget crisis primarily consisted of reduction in staff and funding for various departments. In relation to water, the Soil and Water Conservation Districts, which are local units of government under state law that help advise landowners to carry out natural resource management, have drastically been reduced in funds and in staffing (S. Chard, personal communication, November 7, 2017). With fewer administrative coordinators in the field, there is a loss of expertise as well as a loss of promotion of best practices in resource management, which for an agricultural state is vitally important.

Additionally, the Illinois State Water Survey, which is the "primary agency in Illinois responsible for producing and disseminating scientific and technological information, services,

and products related to the environment, economic development, and quality of life" has also had a reduction in funding leading to delays in reports (S. Wilson, personal communication, August 29, 2017). Moreover, the goals for long-term resource planning for regions in development at the local level so local units of government can develop water supply plans had been at a stalemate since the budget crisis hit (D. Injerd, personal communication, November 7, 2017). Fortunately, funding for additional staff for ISWS and the funding for several regional water supply planning areas have been provided for this year (S. Wilson & D. Injerd, personal communication, February 6, 2018). Overall, the various bureau chiefs in the Department of Agriculture and the Department of Natural Resources have strived to maintain the missions of their agencies despite the fiscal limitations. Furthermore, Illinois has definite advantages through its abundant resources, long-term planning implemented for Lake Michigan, and significant reductions to domestic use throughout the service area and in Chicago in particular, which allows Illinois foreseeably to easily provide its citizens with clean water (D. Injerd, personal communication, November 7, 2017).

Yet, these budgetary effects and political fiascos have hurt the state and as evident through various considerations, Illinois is a large piece in figuring out the puzzle regarding the provision of virtual water through agricultural goods. How can these resource concerns which have an immense effect on the quality of life through availability of food and water for so many be addressed in the future?

1.5 Solutions for Continuation of Illinois as a Virtual Water Provider

For Illinois to remain a provider and advocate for clean water worldwide, the current issues discussed above about our state will require attention. Additionally, in the face of a

current administration in Washington that favors loosening EPA regulations to provide advantages to the business sector and is unsure about beliefs and evidence regarding climate change, political courage and perseverance are indispensable at this time. Some of these qualities can be found in Illinois state government as well and will require the same persistence and leadership to ensure our agricultural advantages and water resources are managed properly.

For Illinois to maintain its ability as an effective exporter of agricultural goods, the state must continue to support sustainable agricultural practices and continue to expand its work in water resource management. Although regulatory restrictions are more difficult to pass in a state with strong agricultural interest groups, Illinois through Illinois Nutrient Loss Reduction Strategy (NLRS) has been making progress in reducing nutrient loads into Illinois streams and rivers through a voluntary system of education and outreach to farmers about best management practices and technologies (Illinois Environmental Protection Agency & Illinois Department of Agriculture, 2017). Over 70 percent of Illinois farmers are now knowledgeable about NLRS conservation practices according to a survey implemented by the USDA-NASS in 2016.

These gains were achieved in part due to the use of a logic model developed from Iowa Nutrient Reduction Strategy that takes into account the necessary changes that have to occur in people's knowledge, attitudes, and behavior. Logic models are designed to help facilitate change by providing a "systematic and visual way to present and share your understanding of the relationships among the resources you have to operate your program, the activities you plan, and the changes or results you hope to achieve" (The Pell Institute and Pathways to College Network, 2018). Each step of the logic model that includes resources, outreach, land, facilities, and water can be tracked and includes measurable indicators of quantifiable change (Illinois Environmental Protection Agency & Illinois Department of Agriculture, 2017). They are able to track how the

scope of the resources and funding they have from the state helps to implement change, examine the scope of their outreach and educational events and the number of people they reached, track the number of farmers implementing best management practices (BMPs) on their land, and track how those efforts resulted in reduction of nutrient loads (2017). There is substantial evidence of the adaptation to these BMPs from 2011-2015, such as a 1,340 percent growth in the use of cover crops, 92 percent growth in the use of buffers, 55 percent growth in allowing land set aside for pasture or left standing (2017). This has resulted in BMP-associated load reduction to water ways in Illinois in significant amounts since 2011, amounting to a yearly reduction of 444,000 pounds of nitrogen loads, and reduction in phosphorus at 225,000 pounds (2017). If this strategy continues and more farmers are educated and adopt these practices, Illinois' agriculture will be more sustainable and will contribute less to the pollutant load in the Gulf of Mexico. However, to put this percentage growth into context, the increase in cover crops from 768 acres in 2011 to 11,064 acres in 2015 is impressive, but considering the 27 million acres of farmland in Illinois, more farmers will have to take part in BMPs. Additionally, a recent reduction in wetland restoration will need to be addressed (2017).

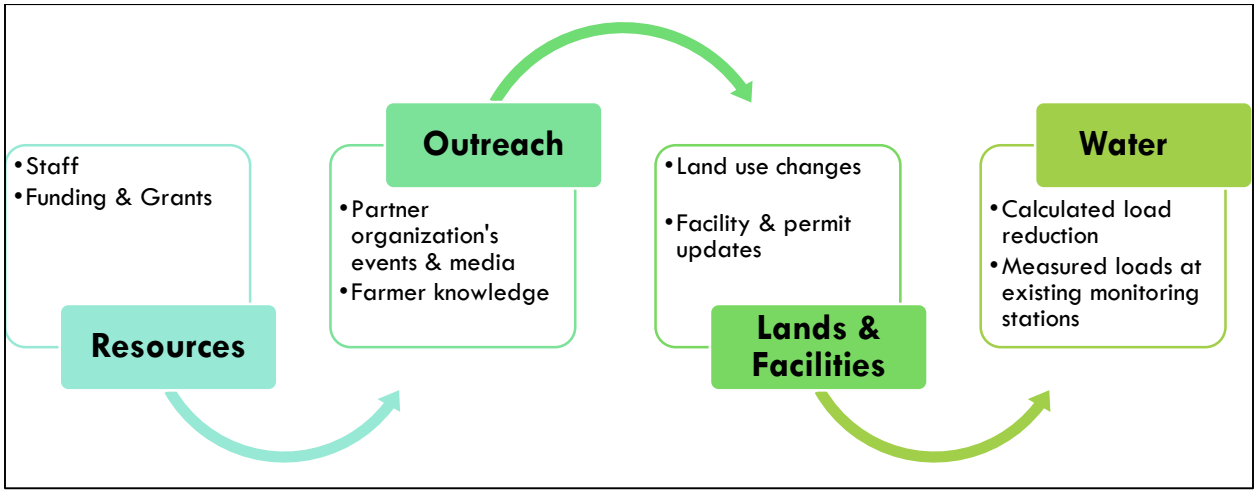

Figure 2. Measurable Indicators of Desirable Change (Source: Illinois NLRS Biennial Report)

In regard to watershed management and pollutants, the Illinois Environmental Protection Agency as part of the National Pollutant Discharge Elimination System requires a permit for point source discharge and a submission of a feasibility plan to reduce phosphorus levels (Illinois Environmental Protection Agency & Illinois Department of Agriculture, 2017). This requirement mostly affects wastewater treatment plants. The same logic model was applied to this aspect of the water sector as mentioned earlier. There are fewer stakeholders in this area of water management, mostly consisting of facility operators, governmental regulatory agencies, and environmental interest groups. For this group, compliance is required so many permits were issued and feasibility studies were enacted and are being reviewed. However, participation to help measure and track progress toward the goals was low, only 11 operators, but they represent facilities that cover 59.4 percent of Illinois' flow indicating that they are some of the biggest operations in the state. In the future, governmental agencies will need to do more to engage the key players for measuring progress towards reduction and continue awareness of funding through Illinois EPA State Revolving Fund to help treatment plants take advantage of loans for infrastructure updates.

In municipalities, aspects of drinking water and storm water are necessary to examine. With regard to drinking water, there is much legislation as mentioned earlier protecting citizens and their health and even recently Illinois has shown commitment to further protect children from lead through Public Act 099-0922. As a result of the Flint crisis in Michigan, the public problem of lead within public drinking water received a lot of media attention and became a point where agreement and action were successfully achieved. Yet, even though lead in water is a preventable problem, time will tell if politicians will concentrate the same effort on removing lead service lines on a large-scale basis, considering that Chicago has more lead service lines

than any other municipality (Hawthorne & Richards, 2016). It has been a difficult problem to remedy as there are legal questions as to whether the pipes are considered private property or shared jointly with the water systems (Hawthorne & Richards, 2016). In any case, this infrastructure issue is not going away and will need the support and concern of local, state, and national politicians.

U.S. Senator Dick Durbin has been calling for an upgrade in the aging water infrastructure for the state. He said, "Though we are a long way from Flint, there is a cause for concern. Federal, state, and local agencies need to be on the same page when it comes to testing and we need to do it more frequently" (Hawthorne & Richards, 2016, 4). His previous support, sponsorship, and leadership in regard to access to clean water will be necessary for Illinois. Some positive solutions that have been implemented are a first loan from the ILEPA to the city of Galesburg totaling $4 million dollars to target problems with lead through replacing 2,000 privately owned lead service lines, anti-corrosive additives in the city water, and providing free testing and filters (Phaneuf, 2016). Moreover, the ILEPA is considering a requirement for immediate intervention for homes with increased levels of lead in tap water called a "household action level" (Hawthorne & Richards, 2016).

Urban storm water is a problem also under the directive of the NLRS and with grant programs funded under the Clean Water Act (33 U.S.C. 1329). These areas of non-point source pollution are controlled through Municipal Separate Storm Sewer Systems known as MS4 permits which also obligate permit holders to perform an informative and educational role for residents (Illinois Environmental Protection Agency & Illinois Department of Agriculture, 2017). Additionally, since 2011, the Illinois Green Infrastructure Grant has funded different projects to implement various BMPs in urban areas including rain gardens, urban storm water wetlands, tree

planting, grass-lined channels, porous pavement, and many others. These efforts have led to an average annual reduction of 37, 206 pounds of phosphorus between 2012 and 2015 (Illinois Environmental Protection Agency & Illinois Department of Agriculture, 2017). This area in the water sector will need to continue to adapt and track the BMPs. There are 40 ongoing projects but more are needed as the number of cities engaged in the practices is very low (2017). More municipalities need to be informed and have the institutional capacity to apply for these funding opportunities and to implement the changes.

The good news in Illinois despite the budget crisis and political struggles is that agriculture is a priority and will continue to be. Furthermore, the Illinois Department of Agriculture is making progress toward sustainable best management practices. Nevertheless, further connections and partnerships in the water sector need to be made. Key political players often support agriculture or the environment within the deeply divided two-party system and rarely are both examined for mutual benefit except in academia in the agricultural sciences. The dissemination of knowledge through best management practices will need to continue to advance to the political sector. This is a necessary step for creating policies that achieve buy-in for the farmer's interests but also maintain our waters' quality and quantity.

Table 1. Agriculture Land and Facilities Measures BMP Tracking Template (Source: Illinois NLRS Biennial Report)

BMPs	Data Source				
	FSA	**Illinois DNR**	**USDA-NRCS**	**Illinois EPA**	**NASS**
Reduced N rate from background to MRTN on 10 percent of acres					✓
Nitrification inhibitor with all fall-applied fertilizer on tile-drained corn acres					✓
Split application of 50 percent fall and 50 percent spring on tile-drained corn acres					✓
Spring-only application on tile-drained acres					✓
Split application of 40 percent fall, 10 percent pre-plant, and 50 percent side dress					✓
Cover crops on all corn/soybean tile-drained acres	✓			✓	✓
Cover crops on all corn/soybean non-tiled acres	✓			✓	✓
Bioreactors on 50 percent of the tile-drained land			✓	✓	
Wetlands on 25 percent of tile-drained land	✓	✓		✓	
Buffers on all applicable crop land	✓	✓		✓	✓
Perennial/energy crops equal to pasture/hay acreage from 1987	✓				✓
Perennial/energy crops on 10 percent of tile-drained land	✓				

Illinois as an Advocate

1.6 Illinois' Role in Promoting Clean Water Globally

This study which examines the former Senator Paul Simon's legacy in water, and legislation bearing his name, provides one of the key links between Illinois and the world with respect to water policy. Before the Paul Simon Water for the Poor Act in 2005 according to the Summary of U.S. Agency Missions and Capabilities in Water, the majority of the United States Government resources were spent on water supply and sanitation infrastructure mainly in the Middle East and the U.S. border areas (U.S. State Department, n.d.). The Department of State and USAID did show engagement in water-related issues on a global scale through intervention efforts. This was done in the areas of data collection, management, analysis, application, and dissemination of information on water issues, integrated water resource management planning and execution at the watershed/basin scale, use of sustainable processes and technologies, capacity building for water resource management, securing financing to meet resource management needs, institution building for water-related issues, development of democratic governance structures, and through humanitarian assistance (U.S. State Department, n.d.). However, it was not a U.S. foreign policy priority.

The Simon Act helped to promote funding for WASH (acronym standing for water, sanitation, and hygiene) projects by providing services for water, sanitation, and hygiene, repairing and improving services, and working to provide awareness on human rights to water (WaterAidAmerica, 2017). Although it was useful in providing millions with service they previously had gone without, there was a need for greater effectiveness. Specifically, precision was desirable in how and where the money was being invested and how the projects were evaluated and reviewed (2017). The first version of the bill asked for assistance to be increased

in high-priority countries and had a subsection on how to determine countries for designation of high priority, but the guidelines were not concrete or measurable. Secondly, the bill required a yearly report given to congressional committees on the status of water strategy, the progress made, and if any changes were made in the strategy (H.R. 1973, 2005). But, there were no long-term requirements for planning the water strategy or long-term processes in place for evaluation and review. Therefore, the second bill was necessary to make the bill more impactful and efficient.

The Water for the World Act addressed these shortcomings through specifying prioritization of countries by the measurable assessments of "the population using unimproved drinking water and sanitation sources, the number of children younger than five years of age who died from diarrheal disease, and the government's capacity and commitment to work with the United States to improve access to safe water, sanitation, and hygiene" (H.R. 2901, 2014). Additionally, it directed the USAID Global Water Coordinator to develop and implement long term planning for the Global Water Strategy once every five years and submit a report to Congress. Both bills were inspired by the legacy and work of Paul Simon. Senator Dick Durbin sponsored S. 2946 which was later changed to a more condensed form of H.R. 2901. Since Simon's death Senator Durbin has played a leading role in getting the water resource policies enacted into legislation.

The impact of the bill has been significant in transforming the lives of many around the globe without access to clean water and sanitation. At the time of the first Senator Paul Simon Water for the Poor Act 2005 First Report to Congress, over one billion people lacked access to improved water sources and over two billion lacked access to improved sanitation (2006). As of 2015, now 633 million people lack improved drinking water sources, which shows a great

decrease due to increased focus and coordination of U.S. foreign policies coinciding with the United Nations' Millennium Development Goals (United Nations, n.d). Sanitation is less clear on the progress gained during this time since behavioral and cultural practices as well as lack of education hinders this growth, evident in the fact that 1 in 3 people still don't use improved sanitation (United Nations, n.d.). Throughout all the years of the report given to Congress, the U.S. averages anywhere from 750 million to 1 billion dollars invested in all water-sector and sanitation-related activities and around $400 to $500 million through USAID's investment in WASH programs (Bureau of Oceans and International Environmental and Scientific Affairs, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014). It involves the work of over 20 U.S. Government agencies and departments influencing water-related activities in around fifty to seventy-five countries yearly, with a specific focus on ten to fifteen high-priority countries.

The Global Water Strategy required every five years by the Paul Simon Water for the World Act in 2014 has just recently been released. Its four strategic objectives are "increasing sustainable access to safe drinking water and sanitation services, and the adoption of key hygiene behaviors; encouraging the sound management and protection of freshwater resources; promoting cooperation of shared waters; and, strengthening water-sector governance, financing, and institutions" (U.S Global Water Strategy, 2017). These objectives are comprehensive and integrative in nature, recognizing the political, social, behavioral, institutional, and economical factors that must be addressed to overcome complex water governance issues. The strategy also concentrates on sustainable principles both in access and management. The two-fold approach to determining the focus on the U.S. efforts is one, focusing where needs and opportunities are the greatest, and two, focusing where engagement overlaps to protect our national security interests (2017). Furthermore, coordination, direction, and guidance from the State Department and

USAID as well as agency-specific goals and involvement help to increase the effectiveness of the overall strategy and allow for technical expertise to be utilized.

The thirteen countries designated as high-priority for the following year come from the following regional areas of MENA, sub-Saharan Africa, Southern and Southeast Asia, and the Caribbean. Various factors influence each country's ability to supply their citizens with clean water and sanitation. Political variables include instability, conflict, limited civil society, weak governance, low government capacity and infrastructure. Economic factors involve lack of financing or accessible finances, weak growth rates, limited private sector engagement, and poverty. Demographic influences are increased population, rapid urbanization, and refugee influx. Environmental areas of concern are droughts, harsh conditions, rough terrain, arid regions, and water-stressed and water-scarce zones (U.S Global Water Strategy, 2017). These are challenges that must be tackled and a commitment and urgency is needed as Senator Simon had advocated. The political will, commitment, and leadership to follow through with these goals must not be short-sighted for this kind of global impact to continue. Elected and unelected officials in government will need to espouse the important virtues and legacy of the U.S. as a global leader in water and sanitation.

1.7 Current State of Global Water Access

Despite great gains in water and sanitation through the Water for the World Act and despite the potential role virtual water could play in providing water to the world, there still remains a large part of the global population where water is a luxury. For this reason, the virtual water concept and its application to the global network of trade and as a policy prescription have not been without its critics. Many environmentalists and economists have pushed back on the idea that virtual water has led to environmental benefits or 'real' water savings (Biro, 2012). The

virtual water concept views water from a global management perspective, not from the more obvious multiple local scarcities of water happening around the world. By framing it so, it somewhat avoids the political nature of the lack of infrastructure, ineffective water resource management, and underdevelopment in many countries (Biro, 2012). Therefore, a balanced approach to viewing the global water crisis/solution is to not only look for the value of virtual water as a policy consideration and prescription, but also to see water scarcity and water poverty as problems stemming from a lack of natural resources and underdevelopment due to lack of state capacity (Biro, 2012). Water scarcity generally refers to a lack of available water resources to fulfill the necessary human and environmental requirements (Jemmali & Sullivan, 2012). Water poverty is the idea of scarcity that is a result of political and/or socioeconomic factors, specifically as "a situation where a nation or a region cannot afford the cost of sustainable clean water to all people at all times" (Jemmali & Sullivan, 2012). To examine this side to global water policy, I will examine the current state of inaccessibility to sources of clean water, the factors that influence a state's capacity to ensure water delivery, and the responsibility of Illinois and the U.S. to "be a global leader in helping provide sustainable access to clean water and sanitation for the world's most vulnerable populations" (Congress.gov, 2015).

"Water scarcity affects more than 40 percent of the global population and is projected to rise" according to the World Health Organization (WHO) and the UN Children's Fund (UNICEF) joint report about the progress made on water and sanitation goals around the world (2017, 3). 2.1 billion people still lack access to safe water (World Health Organization, 2017). Of those, 844 million are without even a basic drinking water service, which forces 263 million of them to spend over thirty minutes per trip to collect water, and leaves 159 million who still drink from surface water sources (2017). Even more people, 2.4 billion, lack access to basic

sanitation (2017). This combined failure of lack of safe drinking water and sanitation is estimated to account for 3.5 million waterborne diseased deaths (Zawahri, Sowers, & Weinthal, 2011). This significantly affects children as the third leading cause of death of children under the age of five is diarrheal disease. The estimated total is over 361,000 a year, or about 1,000 children per day who die from a preventable disease (World Health Organization, 2017).

Many regions around the world are particularly in critical need of improved access to clean water and sanitation. The following sections will discuss the present need for water and the factors hindering water and sanitation progress in sub-Saharan Africa, the Middle East and North Africa region, and Southern and Southeast Asia as they are the most crucially in need of improved access. These critical areas were highlighted by the Millennium Development Goals, which was a global mobilization movement headed by the United Nations from 2000-2015 to "spare no effort to free our fellow men, women, and children from the abject and dehumanizing conditions of extreme poverty" (The Millennium Development Goals Report 2015, 2015, 3). These eight goals were set forth with practical steps in a variety of areas, one of which concerns access to clean water. Goal 7, which is to ensure environmental sustainability included increasing the population using an improved drinking water source and improved sanitation (The Millennium Development Goals Report 2015, 2015).

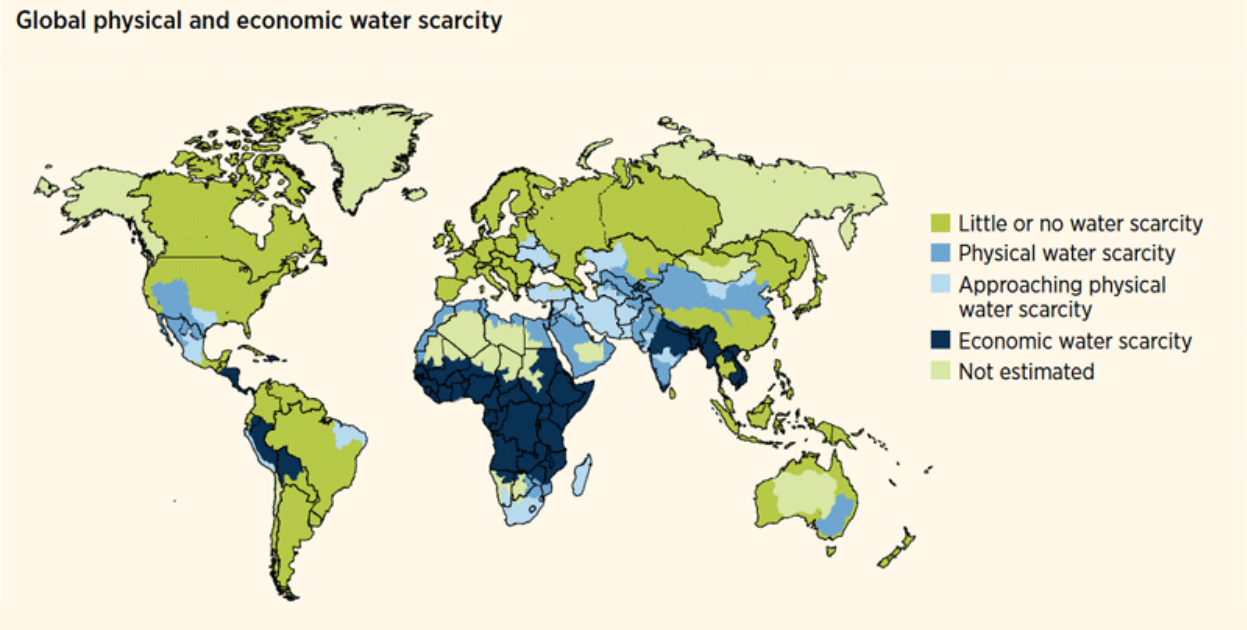

Figure 3.Global physical and economic scarcity. (Source: World Water Development Report 4. World Water Assessment Programme (WWAP), March 2012.)

1.8 Sub-Saharan Africa Status

Sub-Saharan Africa is the archetypal example of dire need in regards to lack of access to clean water. Of the 700 million people that do not have improved access to water, nearly half live in Sub-Saharan Africa (WHO, 2014 as cited in Adams, Boateng, & Amoyaw, 2016). Specifically, 42 percent of households in this area lack safe drinking water, which varies dependent on region (2016). The effect is dismal as millions of children under the age of five die each year from preventable diseases, "with about 90 percent of these deaths occurring in just 42 countries, 36 of which are in SSA." (Adams, Boateng, & Amoyaw, 2016, 219). There are many reasons that intersect to cause this lack of access to water and sanitation. The interplay between the factors of fledging economies, poor governance and resource management, rapid urbanization, poverty, lack of infrastructure, lack of safe sources in rural areas, and lack of education cause a disruptive cycle. This makes it difficult to remedy the problems that hinder provision of water and sanitation. Most of these countries experience water poverty rather than water scarcity as most have sufficient freshwater resources.

Sub-Saharan Africa experienced a rather extended economic recession through the 1980s which resulted in the involvement of international lending institutions requiring structural adjustment programs to be implemented in hopes it would stabilize their economies (Fotso, Ezeh, Madise, & Ciera, 2007). Public social services increased and former public support directed towards agriculture and rural development decreased. This led to increased unemployment and migration to urban areas, while decreasing wages and agricultural food production (Fotso, Ezeh, Madise, & Ciera, 2007). This liberalization and openness to the market has had mixed results and many findings suggest that "the relation between trade openness and economic growth is not linear for SSA" (Zahonogo, 2016, 41). The reflection of this has been noted in the divergent trend in sub-Saharan Africa where since 1995, this area has seen faster economic growth but larger populations of people living in poverty (Chandy, 2015).

The GDP for these countries is projected for a growth forecast of 4 percent, but with a population growth rate of 2.6 percent, the per capita income is 1.4 percent, compared to the world average per capita growth after population growth at 1.8 percent (The World Bank, 2015). In fact, this migration into the cities and high population growth has led to the doubling of the urban population between the years of 2000 to 2015 (Satterwaite, 2015). Despite the fact that more income has been generated, more of it has to be shared and more children are being born to the poorest sector, which is increasing the inequality between the rich and the poor that already is unusually high (Chandy, 2015).

This rapid urbanization exposes the population to many risks due to poor or non-existent infrastructure, including regular water supplies and sanitation facilities (Satterwaite, 2015). Although there have been great gains in improving access to safe water in urban areas, over 20 percentage points from 1990-2015, much of that data groups together regional reports of the

urban areas which masks the problem area of informal settlements or slums outside of cities (The Millennium Development Goals Report, 2015). Out of all regions in the world, sub-Saharan Africa has the highest prevalence of slum conditions and due to demands from an increased population, the number of people without piped water has actually increased since 1990, from 57 percent to now 66 percent (Satterwaite, 2015). Moreover, these unplanned urban slums are often in areas prone to natural disasters of flooding and landslides (A Snapshot of Drinking Water and Sanitation in Africa-2012 Update, 2012). This has come at a high economic and health related cost to these countries, as low GDPs and poor health are linked to lack of access to safe drinking water (Hunter, 2009 as cited in Adams, Boateng, & Amoyaw, 2016). Poverty and lack of accountability are overwhelming contributors to the lack of resources and capacity of local urban governments to build the infrastructure necessary for safe, regular, and good provision of water and sanitation (Satterwaite, 2015). Public debt present in these countries along with competition within public sectors impedes progress in these areas, as does a lack of state capacity to coordinate these efforts for water progress (A Snapshot of Drinking Water and Sanitation in Africa-2012 Update, 2012).

In rural areas there are also gaps in progress. According to the United Nations' Water for Life analysis from 35 countries in sub-Saharan Africa, there are significant differences in improved water services between the poorest and the richest and between rural and urban areas. For instance, 62 percent of the richest use piped water in urban areas, while only 9 percent of the richest in rural areas use piped water (Millennium Development Goals Report 2012, 2012). While 36 percent of the poorest use unimproved sources in the urban areas, 66 percent of the poorest in rural areas use unimproved sources (Millennium Development Goals Report 2012, 2012). Access to sanitation across sub-Saharan Africa is even more alarming, at a 30 percent

coverage overall and only small gains since the 1990s (A Snapshot of Drinking Water and Sanitation in Africa-201 Update, 2012). Rural areas are most challenged by the lack of reliable sources of safe water near communities which can be reasonably supplied by wells, water tanks, and tapped pipes near communities; however the ability to provide this infrastructure in these difficult, local contexts can be challenging (Arvai & Post, 2011).

Again, poverty and poor resource management for water storage come into play, as well as lack of education in water safety. One in five African adults in sub-Saharan Africa work on farms (Gallup World Poll, 2014) and less than 4 percent of their annual renewable water flows are stored which is crucial for reliable sources of irrigation and water supply (Mkondiwa, Jumbe, Wiyo, 2013). Farming households are found to be poorer and less educated in this region (Gallup World Poll, 2017). These variables work against access to clean water as those with better education are more likely to have knowledge about the potential health risks associated with unsafe water, they may be more likely to make investments for household water and sanitation, and have been found to have reduced time of access to an improved water source (Adams, Boateng, & Amoyaw, 2015). Furthermore, without accessible water, these groups are subjected to the time-consuming activity of fetching water, which disproportionately affects women and girls. Potential effects are lost education, physical strain, and danger of harassment and sexual assault, and other hazards (UNICEF, 2016).

Sub-Saharan Africa has a host of underlying problems regarding provision of clean water and sanitation for its population. In the days ahead, local, national, and global efforts will be necessitated to bring this area of the world up to WASH levels that can ensure the health and productivity of its population. Economic growth that is distributed equally, attention to

infrastructure in slums, and improvement in education and access for rural areas will be vital in the days ahead.

1.9 MIDDLE EAST AND NORTH AFRICA STATUS

The Middle East and North Africa (MENA) are dually plagued with physical water scarcity with no appreciable flow and multiple infrastructure issues due to internal conflict, unequal distribution between urban and rural areas, and a high population of displaced people. Furthermore, exclusionary political regimes have failed to accurately report coverage, adopt more accurate assessments or adaptive policies, and focus on quality of service (Zawahri, Sowers, & Weinthal, 2011). Overexploitation of surface and ground water and population growth aggravated by climate change does not bode well for the future water scenarios in this region.

First, countries in this area are some of the most water-stressed in the world. Water stress estimates are provided by comparing the annual renewable water resources with the ratio of domestic, industrial and agricultural water consumption, and dividing that by the population to determine the water availability per person (Verisk MapleCroft, 2011). The global average annual water per capita share is 7,500 cubic meters, with most MENA states around 1,250 cubic meters (Al-Kamali, 2016). Therefore, most countries in the MENA area and specifically the Persian Gulf countries are considered the most "water-stressed" (Sowers, 2014), with Bahrain, Qatar, Kuwait, Saudi Arabia, and Libya topping the chart. What makes MENA's situation so striking is that while possessing 6.3 percent of the world's population, it only possesses 1.4 percent of the world's available freshwater (Jemmali & Sullivan, 2012). Water use in these countries exceeds the theoretical renewable amount and 80 percent of the groundwater resources are constantly depleted (Jemmali & Sullivan, 2012).

Secondly, there are multiple infrastructure issues relating to water in this area of the world. Many countries in the region share water resources such as rivers and aquifers and any disruption in appropriation or change in rainfall, can lead to possible water risk and vulnerability (Sowers, 2014). It is estimated that over 80 percent of renewable water resources in some of these countries have their origins outside their own borders (Jemmali & Sullivan, 2012). The notorious example where this conflict over shared water resources plays out is in the West Bank. Palestine and Israel have the shared water resources of the Jordan River and the Mountain Aquifer. These resources are transboundary; however the usage of these resources is discriminatory and the cause of many conflicts in a region rife with conflict (Corradin, 2016). Another infrastructure issue deals with the disparity in infrastructure, services, and access between the urban and rural areas in these countries. While the Sustainable Development Goals of 2015 report 96 percent of the global urban population uses improved drinking water sources, only 84 percent of the rural population uses improved sources ((WHO) and the United Nations Children's Fund (UNICEF), 2017). This gap in MENA countries is even larger. For example, in Morocco only 65.3 percent of the rural population had access to improved water sources, while 98.7 percent of urban inhabitants had access to improved water sources (World Bank, 2017). Additionally, the water that is procured generally is used by privileged consumers in the cities and larger agricultural operations, while poor and marginalized communities and farmers pay much higher rates from private providers (Sowers, Vengosh, & Weinthal, 2011).

Next, the ongoing reality of wars, civil conflict, and military occupation is displacing millions of people from the countries of Sudan, Iraq, Palestine, Syria, and Yemen (Sowers, 2014). There are over 60 million refugees worldwide, and 17 million of them reside in Jordan, Iraq, Lebanon, Syria and Turkey (Khaminis, 2015). Syria's long-lasting conflict has displaced

millions internally and millions have been pushed out to the surrounding regions making the Middle East the center and host of displaced persons (Dakkik, 2017). Most of the camps especially in water-scarce countries themselves like Jordan cannot provide refugees with the minimum recommended amount of 20 liters per person per day (Dakkik, 2017). Sometimes water is brought by trucks and at other places from a singular source in the camp (Scherr, 2017). This makes the water expensive and a burden to the host countries, while also being intermittent service at best.

Although water at most camps is treated, due to the conditions of the camps, storage facilities, and use, a lot of the water is unsafe or becomes unsafe as it is used and waterborne disease outbreaks have occurred (Dakkik, 2017). Sanitation is also in a dire situation, as up to 70 people may share a single toilet in a refugee camp (Scherr, 2017). The sewage networks are being overloaded causing unsafe leakages and contamination (Dakkik, 2017). Yemen is a prime example of an area already burdened by water shortage and now as conflict rages the need is exacerbated by instability, absence of effective government, and the spread of armed conflict (Al-Kamali, 2016). Its annual per capita share of water is a staggeringly low 120 cubic meters, and that is a burden and health risk in the lives of many Yemenis who haven't had piped water since March 2015 (Al-Kamali, 2016). Furthermore, Yemen's collapse of health, water, and sanitation systems has resulted in the world's largest cholera outbreak potentially affecting up to 500,000 people in 268 districts in 20 provinces across the country (Bruwer, 2017).

Multiple barriers to water security exist within the political boundaries of the states of the MENA region. Authoritarian regimes with centralized systems of planning, exclusionary politics that leave out vulnerable populations, conflicts that weaken governance and infrastructure, and unemployment and lack of opportunity that hinder the scientific capacity are

all adverse features at work in the water delivery systems in MENA countries (Sowers, Vengosh, Weinthal, 2011). The limited space for social and political mobilization in these countries hampers movements that focus on rights or accountability and this is seen in issues of water equity and climate change initiatives (Sowers, Vengosh, Weinthal, 2011). Many states have yet to adopt acceptable standards for drinking water or vary them to accommodate local irregularities (Zawahri, Sowers, & Weinthal, 2011). Formally, change in the water sector is difficult in the MENA region as governments tend to focus on large-scale technological solutions, such as desalinization, water storage schemes such as dams and reservoirs, securing arable land in other countries for farming, or extraction from fossil water aquifers (Sowers, Vengosh, Weinthal, 2011).

Although, compared to some regions it appears as though MENA is providing improved access to water and sanitation in a range from 83 percent to 95 percent according to the most recent update of SDGs, or sustainable development goals ((WHO) and the United Nations Children's Fund (UNICEF), 2017), it is also evident that some data is lacking and that there is a gap between national and local reports with what has been reported by the JMP (Joint Monitor Programme). The JMP allows piped water to be considered as an improved source but in these countries it is often intermittent distribution, which allows for the pipes to be unpressurized for long periods of time. This can cause contamination from growth and re-growth of bacteria during the unused periods and intermittent supply forces households to store water in tanks for periods of time which can also cause microbial re-growth and pathogens (Zawahri, Sowers, & Weinthal, 2011). Thus, what is considered an improved source actually lacks acceptable water quality. Pollution and overextension of surface water have also led to contamination of surface waters in some of these countries (Jemmali & Sullivan, 2012). Illegal drilling of wells for

agricultural and household uses also occurs in this region, notably in Gaza, Yemen, and Libya which results in increased salinization and declining aquifers (Sowers, Vengosh, & Weinthal, 2011).

Finally, population growth of the MENA region exploded from 1950-2000, rising from 92 million to 349 million which was a 2.9 percent increase a year (Clawson, 2009). The projected population annual growth rate from 2010-2050 is 1.4 percent which will be a significant decrease mostly attributed to an expected drop in total fertility rate or the number of children born to the average woman over her lifespan (Pew Research Center, 2015). Yet, the population growth will fall more slowly than the TFR rate will as the large number of women in childbearing years will still increase the population significantly (Clawson, 2009). This will undoubtedly lower the per capita water availability by 30-70 percent over the next few years even if the renewable water resources stay as is (Sowers, 2014). This is very unlikely according to climate change studies in the area that agree to a major reduction in precipitation, projecting anywhere from 10-30 percent reduction in this next century (Conway and Hulme, 1996; Arnell, 1999; Sanchez et al., 2004; Milly et al., 2005; Suppan et al., 2008; Alpert et al., 2008; Evans 2008a, b, 2009 as cited in Sowers, Vengosh, & Weinthal, 2011). Additionally, surface temperatures are projected to rise by 4.5 degrees Celsius by the end of this century (Suppan, et al., 2008 as cited in Sowers, Vengosh, & Weinthal, 2011), which will result in decreased water availability due to higher rates of evaporation. Droughts and variable rainfall events are occurring now and will continue to rise which increases the probability of desertification and flooding (Sowers, Vengosh, & Weinthal, 2011).

Overall, although the MENA region has made some strides in improving access to sources of clean water, the overwhelming factors working against MENA's ability to achieve

water security are considerable. The most obvious factor of being largely an arid region and possessing limited renewable water resources, to infrastructure issues brought on by shared water resources, rural and urban disparity, conflicts and refugees, to limitations in social or political movements enforced by authoritarian regimes, to expected population growth compounded by climate change, the MENA region has many obstacles to overcome in relation to water in the upcoming years. MENA and other world leadership must work to incorporate efficient and equitable watershed resource management plans with the limited resources they possess adapting for population growth and climate change, to promote peace and security to enable rebuilding of infrastructure and allow for public service delivery, and the allowance of political and social movements that keep their government accountable to the basic needs of its citizens. Ultimately, in the face of the ongoing refugee crisis and the additional burden it places on an already water-scarce region, global leadership must do more to provide displaced persons with their basic human needs.

1.10 Southern and Southeast Asia Status

In this area of the world, the particular goals in regard to access to water are difficult to express in certain terms, as measurement in these areas often divide the groupings of countries differently. What is easily recognizable, however, is the lack of sanitation overall and rural access to basic water services is limited. According to the 2017 Progress on Drinking Water, Sanitation, and Hygiene Development Goals Update, in 2000, only 29 percent of the population for Central and Southern Asia had access to basic sanitation, while 82 percent had access to at least basic water service ((WHO) and the United Nations Children's Fund (UNICEF), 2017). They have made progress on their goals. In 2015, the percentage of population with access to sanitation increased to 50 percent, and access to basic water services to 88 percent (2017).

Eastern and Southeast Asia began with 64 percent coverage for basic sanitation in 2000 and have increased to 77 percent by 2015 (2017). Their access to basic water services began at 80 percent and increased to 94 percent coverage (2017). The region with the lowest coverage for both water and sanitation is Oceania, excluding New Zealand and Australia. In this report, the basic sanitation coverage was at 38 percent and remained the same over the fifteen years and the access to basic water services has actually decreased during this time frame, from 55 percent to 52 percent (2017).

When comparing urban and rural coverage for access to basic water services, Central and Southern Asia have improved from 78 percent to 86 percent by 2015, compared to the 94 percent consistent coverage experienced by urban areas. Eastern Asia and Southeast Asia have made great strides in meeting water and sanitation goals from 2000-2015, and moved from 68 percent coverage to an impressive 92 percent of coverage in basic water services. Urban areas have maintained 96 percent coverage (2017). Oceania has just 40 percent coverage for basic water services in rural areas and has actually decreased from 44 percent coverage in 2000. The urban population has maintained 92 percent coverage to basic water services. Rural sanitation is especially problematic with open defecation still occurring. In Central Asia and Southern Asia, rural sanitation is at 40 percent and 43 percent still practice open defecation. In the other areas, open defecation is not common, but basic sanitation services are still limited at 64 percent in Eastern and South-eastern Asia and 24 percent in Oceania. These areas of the world are particularly crucial for improving global progress in water and sanitation as they hold 32 percent of the world's population underserved in water and 46.8 of the population underserved in sanitation (World Health Organization, 2013).

Most of these areas have experienced a growth in gross domestic product (GDP) over the last twenty years which is usually correlated with an improvement in the basic requirements for life, including progress in the water and sanitation sector (Kamal, Goyer, Koottatep, Amin, 2008). These countries have made essential political and financial commitments to achieve many Millennium Development Goals (World Health Organization, 2013). However, the challenge that remains is to encourage proportional growth that recognizes the disparity between access in urban and rural areas, formalized urban areas and slums, and wealthy populations and poor populations (Samra, Crowley, & Smith, 2011).

In several studies examining access to water and sanitation services in rural and peri-urban areas in India and South-east Asia have found significant differences in access dependent on socioeconomic status revealing severe equity deficiencies (Subbaraman, et al., 2013; Kamal, Goyer, Koottatep, Amin, 2008; Samra, Crowley, & Smith, 2011; and Aguayo & Menon, 2016). As the GLAAS 2013 report noted, expenditures are largely used in urban areas even if the population with coverage is well served (World Health Organization, 2013). There is a need for funneling public investment and aid funds into strategic investment for vulnerable populations found in slums and rural villages (Aguayo & Menon, 2016).

A second challenge is the need for effective coordination between responsible ministries and departments of the central and local governments in these countries for wastewater management and municipal water supply (Subbaraman, et al., 2013) (Kamal, Goyer, Koottatep, Amin, 2008). "Over two thirds of the countries surveyed in South Asia and South-east Asia report insufficient staff to operate and maintain urban and rural drinking-water systems" (World Health Organization, 2013, n.p.). Additionally, there is insufficient domestic funding for the operation and maintenance of existing services (World Health Organization, 2013). A specific

look into this feature is evident in Kamal's et al. 2008 study which showed the central government of Bangladesh which was responsible for policymaking did not successfully coordinate with local governments which were responsible for constructing and operating the sanitation services of wastewater management.

A third challenge is addressing the behavioral practice of open defecation. South Asia accounts for nearly "two thirds of the global population practicing open defecation" (Aguayo & Menon, 2016). Untreated waste and wastewater flow into larger water bodies which become a great threat to public health and the environment as they lead to pollution and contamination (Kamal, Goyer, Koottatep, Amin, 2008). Water-borne diseases come at a high economic and social burden cost. Poor sanitation practices and the unimproved consumption of water that often prevail in these areas raises potential for exposure to pathogens, not only for the individual, but also for the household (Vedachalam et al., 2017). Childhood stunting has been linked to unhygienic environments through poor sanitation practiced in the household, which is a major problem in South Asia as it represents 40 percent of the global burden of stunting, where 38 percent of children under the age five are stunted (Aguayo & Menon, 2016).

Although this area of the world has made considerable strides in providing their populations with access to water and sanitation, there are still shortcomings. To improve the access to water and sanitation in this highly populated area of the world, governments, international aid providers, and private sector investors need to work on equity in provision of service between rural and urban areas, coordinate and finance municipal and wastewater management, and educate certain populations on the harmfulness of open defecation.

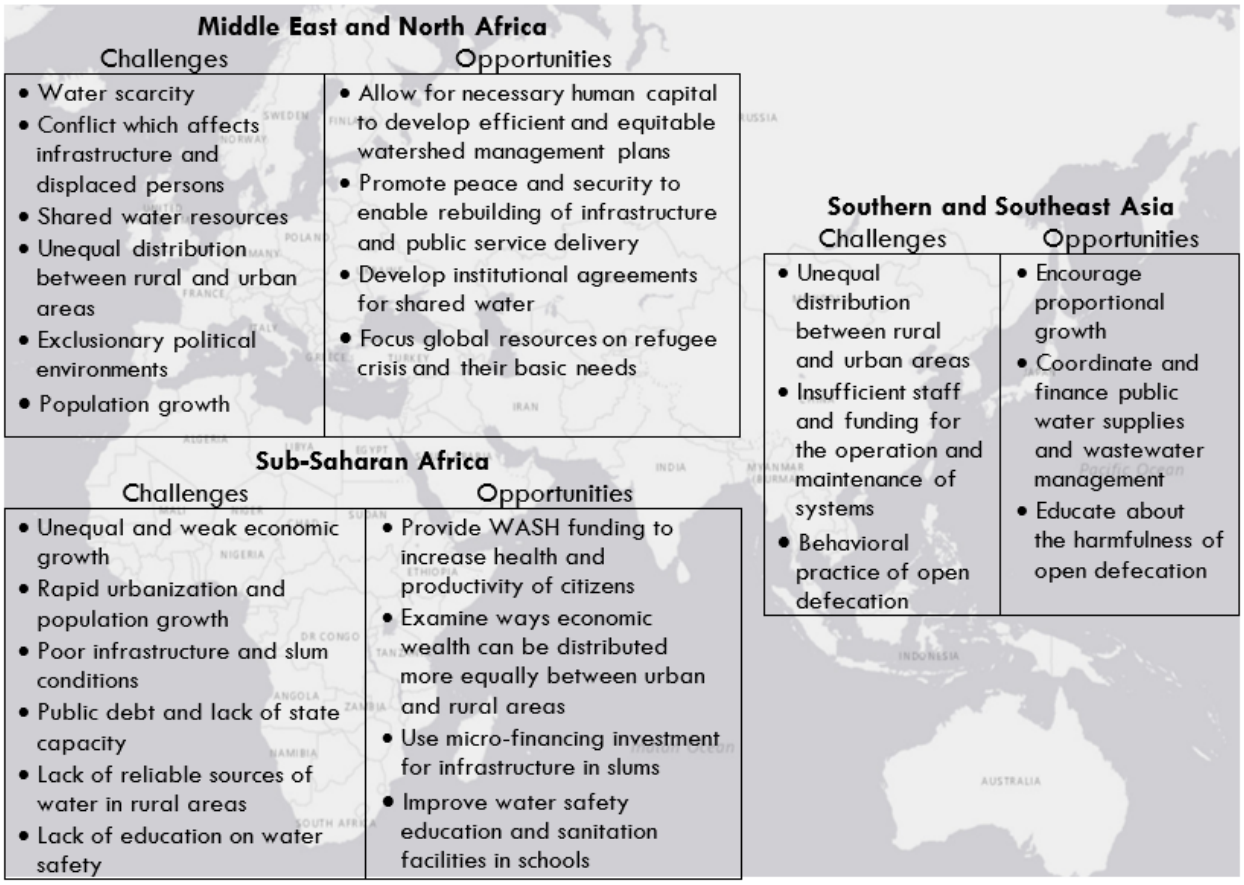

Figure 3. Global Water Challenges and Opportunities

1.11 CURRENT LEGISLATION AND WATER POLICIES EFFECTS

The current state of global access to clean water cannot be fully examined or solutions given without the understanding of the laws and the policies that affect it. Therefore, an examination of the laws and policies in place will be examined at the international and national level briefly. Within international human rights law is the agreement that there is a basic human right to water. It stems from the International Convention on Economic, Social, and Cultural Rights in 2002, which stated in General Comment 15 that "the right to water is also inextricably related to the right to the highest attainable standard of health (art.12, para.1) and the rights to adequate housing and adequate food (art. 11, para.1). The right should also be seen in conjunction with other rights enshrined in the International Bill of Human rights, foremost

amongst them the right to life and human dignity" (Committee of Economic, Social and Cultural Rights, General Comment 15: The Right to Water (Articles 11 and 12 of the International Covenant on Economic, Social, and Cultural Rights) as cited in Collins, 2010, 354). This correctly and legally linked the right to water to the right to an adequate standard of living (Collins, 2010). Yet, aspects of enforcement are problematic as not all countries have recognized this right by ratifying this treaty (Kornfeld, 2010). The limits of enforcement revolve around the inability of courts to hold a state actor accountable for not providing potable water for its citizens and the issue that many water utilities are privatized so rights scholars do not know how to address the shortcoming of the law which doesn't induce obligation (Kornfeld, 2010). The law remains authoritative on the issue but not binding (Collins, 2010).

The other resolution of significance globally and nationally was the U.N. General Assembly in Resolution 64/292. This resolution that was later affirmed by the Human Rights Council Resolution 15/9 stated, "the right to safe and clean drinking water and sanitation as a human right that is essential for the full enjoyment of life and all human rights" (G.A. Res. 64/292, U.N. Doc. A/Res/64/292 [July 28, 2010] as cited in Thor, 2013, 319). The U.S. government abstained from the Resolution 64/292 because of reservations about the wording not being reflective of international law and that all legal implications of a right to water had not been carefully considered (Thor, 2013). However, the U.S. has shown a commitment to water and sanitation access through joining the consensus for Human Rights Council Resolution 15/9 and financially through donations to the World Bank, the African Development Bank, the Inter-American Development Bank, and to intergovernmental organizations (Thor, 2013).

In the fiscal year 2016, the USAID invested over $433 million in water supply and sanitation (Congressional Budget Justification, 2018). Furthermore, the signing of the Senator

Paul Simon Water for the Poor Act in 2005 which was followed by the Water for the World Act in 2014 helped to make water and sanitation a specific policy objective for our foreign assistance programs (Thor, 2013). Overall, the U.S. has been reticent to formally declare a human right to water although it recognizes it, works to implement it, and finances it (Thor, 2013). This is due to the U.S. reliance on the U.S. Constitution which contains civil and political rights, but not economic, social, and cultural rights. Therefore the right to water is not protected by the U.S. Constitution or justiciable in U.S. Courts (Thor, 2013).

States have been involved in this right to water movement as well. Only Massachusetts and Pennsylvania have wording in their constitutions that mention water as a right (Thor, 2013). Legislative movement has occurred in California where water is a prominent issue because of the effects of a growing population, effects of groundwater pollution, and effects of climate change (Thor, 2013). Multiple attempts at legislation declaring a human right to water occurred within California's state government. AB 685 was signed into law after various amendatory rounds by Governor Brown in August 2012. The Act states, "It is hereby declared to be the established policy of the state that every human being has the right to safe, clean, affordable, and accessible water adequate for human consumption, cooking, and sanitary purposes" (AB 685, 2012). California is now the first state in the nation that has legally declared a human right to water and used international standards to define it. The important aspect of the law is that it "places the human right to water at the center of state policy and underscores the role state of agencies in addressing the human impact of unsafe water" (de Albuquerque, 2013, 2).

1.12 GLOBAL SOLUTIONS

Solutions for water-related issues have never been an easy fix. Rather, the solutions have often been contentious and long-debated, often with the status quo prevailing in order to not

upset the various stakeholders. In the coming days, the human factor will need to be integrated into policy prescriptions. Recent water resource management has realized the necessity of considering the human dimension and the uncertainty element in their water policy frameworks. Adaptive water governance that allows for integration of the human element and the capacity for systems to learn and adapt will be crucial in the days ahead in the face of the anticipated effects of climate change and population growth (Akamani, 2016). The best technological advances and water metrics analyzing real and virtual water availability can be extremely useful, but without acknowledging human action in the process, progress will be obstructed. Therefore, to best propose solutions for these water issues, the various political, economic, social, environmental interests must be considered.

Nationally, the political dimension to water solutions will require framing water-related issues creatively to address the values held by this administration. At the outset of the Trump Administration there was much talk about investing in infrastructure to create jobs and repair aging infrastructure in the U.S. If these plans materialize it will be to water sector stakeholders' advantage to capitalize on that initiative by the President to provide well-informed plans and policies for infrastructure improvements that also incorporate best management practices for water resource management for urban and rural areas.

Globally, the ability to provide access to clean sources of water has taken a severe federal budget cut. Most years examined since the 2005 Water Act for the Poor was initiated, around $400-500 million was designated for USAID for WASH activities. The FY 2018 request by the administration is drastically lower at $235, 742, 000 compared to last year's $433, 670,000 (USAID, 2017). Again, making the case for water as an opportunity for the U.S. to advance its security and economic interests will be useful. Strategic Objective 3 as announced by the Global

Water Strategy deals specifically with reducing global conflict by promoting cooperation on shared waters (U.S. Global Water Strategy, 2017). Water is a national asset and a security priority and for that reason, disputes around shared water can incite tension and conflict, for instance, in the U.S. between states in the Southwest and between nations such as Israel and its neighbors. If the USAID and others work to develop institutional agreements and management systems for shared water, regional peace and stability are more likely. Strategic Objective 4 focuses on developing sound water governance, financing, and institutions (Ibid). When sufficiently implemented it allows for increased capacity for recipient countries and less of a reliance on donor assistance (Ibid).

Economically, the U.S. stands to gain from investment in the international water sector. It is currently a market of over $700 billion dollars (U.S. Global Water Strategy, 2017). The U.S. has ample experience and multiple private sector companies which make water a great opportunity for new jobs and investment. Conversely, the loss of productivity and drain on health-related costs due to water-borne diseases is something to consider. The United Nation states "for every dollar invested in water and sanitation, there is a $4.3 return in the form of reduced health-care costs for individuals and society around the world" (UN News Centre, 2014). A helpful and profitable solution has been communitarian models that involve the private and public sector in developing countries. It has shown success through partnerships that are able to cross the state-market community divide (Gerlak, 2012). Another area that is of importance economically is the necessity of providing ways for assistance and economic growth to be funneled equitably between the rich and poor areas and the urban and rural areas. In regard to virtual water, trade relations that allow for open trading of agricultural goods and other water-intensive products would be beneficial for allocating our limited global water resources.

Unfortunately, age, gender, minority status, and socio-economic status influence the provision of potable water. The cost of not having access to water is unfairly weighted towards children and women. Over 1,000 children under five die daily from diarrheal diseases (World Health Organization, 2017). Women and girls bear the domestic burden of collecting water and performing household tasks without the easy access to water. As a result of that practice and not all schools having adequate sanitation facilities for girls their educational attainment is often restricted (World Health Organization, 2017). Marginalized populations, which are often ethnic minorities, do not always receive the same qualities in water service or do not always receive water service from municipalities. Many times this is because this impoverished population lives in slums or informal settlements, which forces them to spend a large part of their income to pay for water in an informal system (Subbaraman et. al., 2013). A major part of the solution will be for the human right for water to be recognized globally and in national and local contexts. When the human right to water is recognized through national legislation and constitutions, it effectively obligates the government to the judicial enforcement of equal rights to clean water (Gerlak, 2012). In essence, the right to water guarantees clean water and holds the government accountable to offering that right to all citizens, which can resolve some of the gaps in coverage and allocation of funds to only wealthier, urban areas.

Additionally, many international organizations and NGOS have pursued the route to empower women following the realization of the investment returns when women in developing countries are given the resources they need. Women are a doorway to the nutritional care, health care, and educational opportunities for their children (WHO, 2017). Various studies and successful implementation models of NGOs have shown that when women are involved and provided decision-making opportunities in the water sector, they make wise choices. Their

choices are often more risk-averse which can minimize health-risks for their family and community and when women are involved in the management of water the effect is more sustainable and comprehensive (Adams, Boateng, & Amoyaw, 2015). Furthermore, implementation models and technologies of water supply matter. Extensive community surveying and assessment of need and values are central to determining which systems would be sustainable and appreciated in a given context (Gerlak, 2012). In short, the local stakeholders must be involved in the decision-making process about water treatment and water management for efforts to be equitable, useful, and sustainable (Arvai & Post, 2012).

Finally, environmentally, water use and solutions can be categorized into effective watershed management, efficient use of global water resources through considerations of virtual water, and through social ecological concerns of our uses of water as a society. Scientifically, the knowledge and expertise to provide responsible and sustainable watershed management is available, but it must be dispersed to these local regions with problems of water scarcity and water poverty. Adaptive governance, which takes into account the need for water resource management systems to learn and adapt to changes and to be able to factor the human element is important as climate change progresses and political tides wax and wane. Furthermore, viewing water as part of the food-energy-water nexus and making the long-term management of these a priority is necessary, not only in the scientific, agricultural, energy sector, and environmental groups, but also in the broader parts of society. In the future, all sectors will need to work towards collective goals of sustainability.

Globally, virtual water is a thought-provoking concept, but mostly comprehended by agricultural engineers, climatologists, and hydrologists. A necessary step in the days ahead will be to make this "scientific research accessible, clear, coherent, and informative for politicians

and decision-makers" (Kehl, 2011). This could lead governments to move away from agricultural and irrigation subsidies that encourage producing water-intensive crops in semi-arid and water poor regions (2011). Many proponents of virtual water argue for countries to produce goods with a comparative water advantage in mind and freely export (2011). Current trade policies do not adequately consider this dynamic of water use and trade which hinders water savings. However, if this concept can be effectively spread to key players in the political and economic realm, the considerations of virtual water can possibly help overcome some of future water scarcities in regional contexts.

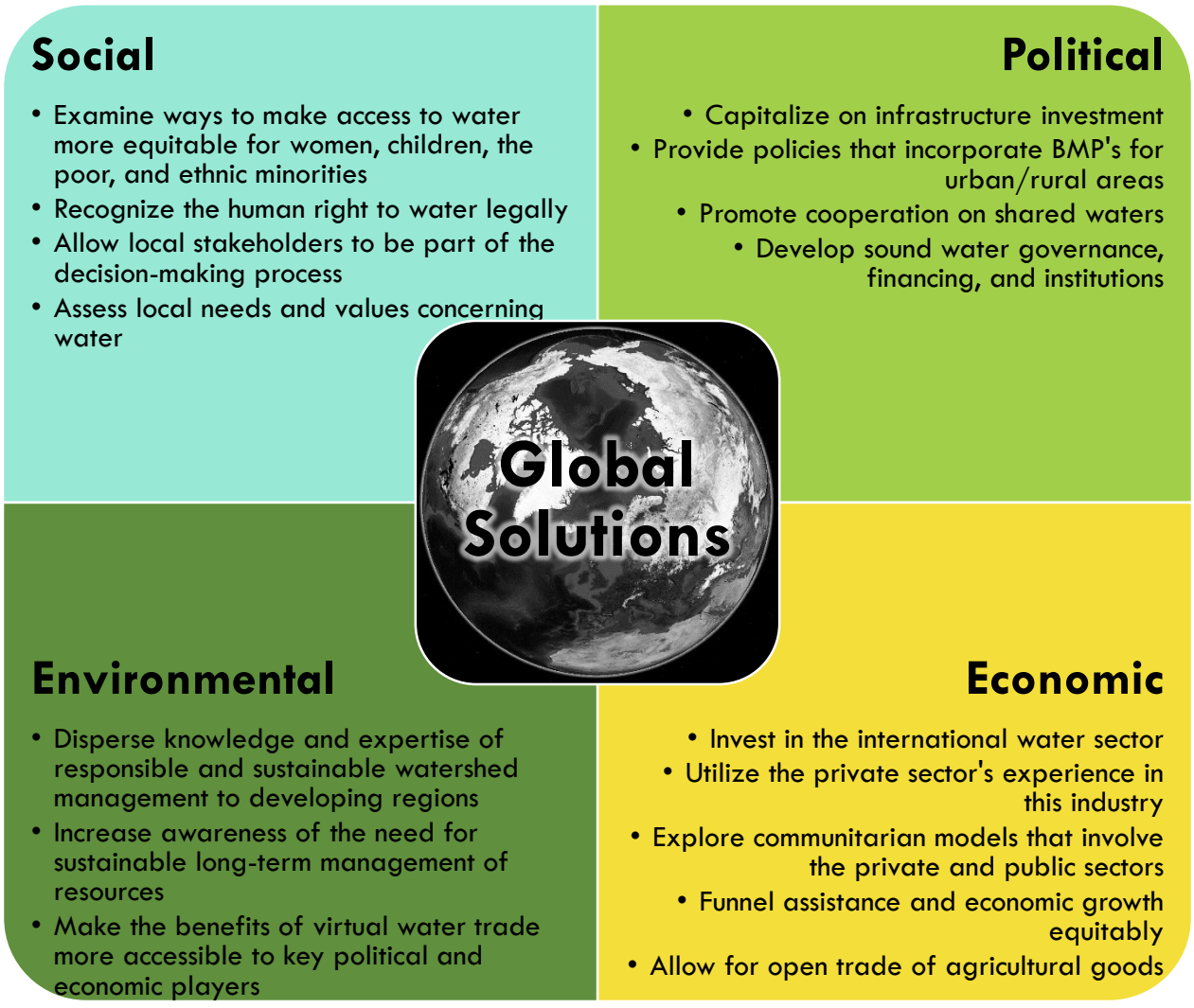

Figure 4. Global Water Solutions

CONCLUSION

In closing, both Illinois and the United States would benefit from a much more widespread understanding of just how crucial virtual water is in feeding the nation and the world. Thus policies adapted in Illinois to maintain our level of agricultural exports through careful management of soil and water resources have a world-wide impact in the amount of staple crops available. Although, the trade flows of staple crops are determined by the global market and then later distributed to regional and local markets which may or may not result in reaching the hungry who need it, there is still a responsibility to maintain good stewardship of important natural resources to ensure agricultural viability for the future. World Development Indicators from the World Bank estimate that by 2050, "feeding a planet of 9 billion people will require an estimated 50 percent increase in agricultural production and a 15 percent increase in water withdrawals" (Khokhar, 2017). Through an understanding of water as a global resource in the context of virtual water, hopefully, key players in the water-energy-food nexus will work to influence important political and economic players. However, a word of caution is necessary as increasing staple crops on the world market and/or delivering food aid does not always have the intended effects desired or ensure the objective of providing food to those who need it is accomplished. These efforts, although well intentioned, often make local farmers uncompetitive and recipient countries dependent on aid rather than encouraging domestic agriculture and stimulating forms of sustainable economic growth (Lockhart, 2014). Virtual water advocates cannot only look at the scientific calculations of trade and savings on the world market but must also examine the political, economic, societal, and environmental realities in which the world food trade exists.

Likewise, the political realities and widespread lack of state capacity that work against the provision of safe drinking water and sufficient food will not only require knowledge of the current lack of access to clean water, but also the political will and drive to do something about it as Senator Simon did. As Senator Simon recognized, and Congress confirmed with the Water for the Poor Act and Water for the World Act, local interests are inextricably national and international policy interests. The challenge now is to contribute to those policies that encourage equitable and sustainable international development in the water sector and to observe their impact.

Finally, there remains the ethical question of society's uses of water that are neither equal nor sustainable. Social ecology according to the Social Ecology Institute of British Columbia is defined "as the science of the relationships between human populations and communities and their environments" (n.d). Many humans in the developed world use 400-500 liters a day while those in the developing world use around 20 liters (Gerlak, 2012). Moreover, our high consumption of red meat in developed countries uses vast amounts of water to produce (Lant, 2005; Hoekstra, 2014). Specifically in regard to Illinois which is one of the most fertile areas in the world is the question of whether most of its agricultural energy should be spent on producing corn for ethanol and animal feed rather than more staple crops for humans. According to Hoekstra, one of the leading experts in virtual water, "40% of the cereals produced in the world are used for animal feed" (2014, 2). Lastly, climate change will likely impact poor populations as they are more dependent on their natural environment for basic needs (A Snapshot of Drinking Water and Sanitation in Africa-2012 Update, 2012).

All of these concerns will only continue to grow more pertinent in the face of population growth and climate change. Around 9 billion people will need to be fed by 2050 and even now

we simultaneously have hunger and famine coinciding with overconsumption (Vanham, Mekonnen, Hoekstra, 2013). In the midst of U.S. leadership with a weakening commitment to external engagement and obligations, Senator Simon's words ring no less true today, "The massive numbers dying for lack of both food and water will be seen by all of us over and over and over again if the world does not act; and action requires U.S. leadership. No other nation has our capability and resources to lead. The question is whether we will" (Simon, 1998, 16). This is even a greater challenge now.

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