Local Water Struggles

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Abstract

Before there were people, there was only water; Sierra Miwok creation story (Fagan, 2003, P. 4). The mention of water as a precursor to life agrees with the Biblical text; "…the Spirit of God moved upon the face of the waters" (Genesis 1:2). These two cultures, half a world away from each other, recognized the value and importance of water.

This essay will examine the ways in which local and regional communities deal with the tensions and challenges of shifting and limited natural resources and the demands and expectation of modern communities and economy. Disparate in culture, diversity and geography, these each will be viewed with an eye for any uniqueness as well as commonalities.

Introduction

According to Murtinho, et al (2013) water scarcity can be defined as a period when water requirements exceeds water availability and people find that their lives and livelihoods are constrained by water shortages (Murtinho, 2013, P. 668). An important point to note, in this definition, is that water scarcity, or a drought, is not necessarily a meteorological condition where there is little or no precipitation. Each discreet paradigm can present a set of issues which are wholly their own. Thus, each may require a different set of methods to ensure adequate water of a necessary quality to be useful to humanity.

Global

Climate change is complicit in bringing about food shortages. Specific events include extremes in weather; heatwaves, droughts and floods. This is particularly an issue in developing countries as well as impoverished regions of developed nations (Padgham, 2009, P. xvi). Combined with potential financial crises these climate driven events will have an elevated negative impact (Alwang & Norton, 2011, P. S140). These realities have a particular impact on the small-scale/smallholder farmers. With little or no governmental or collective supports the prospect of a cascading family catastrophe are very real (Alwang & Norton, 2011, P. S139).

These issues prevail in virtually every part of the globe. Efforts are underway in some nations to minimize these impacts by way of price controls. Nations of note include the Americas, Ethiopia, Egypt, Indonesia, Mexico and Morocco (Alwang & Norton, 2011, P. S141). In Mexico, the rural poor farmers are eligible for cash pay outs if their children will stay in school. In addition to the general support of the small-scale family farmers, there is the added benefit (and perhaps more important) that increasing school attendance, which enhances the possibility of the next generation rising out of poverty (Alwang & Norton, 2011, P. S144).

Since water scarcity plays a prominent role in agricultural production it therefore has a significant negative impact on any farming operation. (Roco, et al, 2015, P. 958). The global nature of this scarcity is expected to become worse in the coming years (Sheffield, Wood & Roderick, 2012, P. 435). Water consumption by agricultural efforts tend to utilize most of water supply of any locality (Roco, et al, 2015, P. 969). It stands to reason that continued pace of climate change driven weather anomalies will affect the small-scale farmer at an increasing rate.

Local

Sao Paulo, Brazil

Since 1934 the authorities in Sao Paulo, Brazil have been aware of the prospect of an issue with providing adequate water for their growing metropolis. There have been efforts to engage policies and processes which were intended to meet the needs of flourishing agriculture and industry. However, the results have been less than satisfactory as three drought events have each left the city with a temporary shortage of water (Johnsson and Kemper, 2005, P. 13).

Drummond and Barros-Platiau (2006) each collected and analyzed data from selected environmental laws and policies enacted by the federal government of Brazil from 1934 to 2002. The results of their work were originally published as a master thesis (1998) and doctoral dissertation (2000), respectively. The paper published by the Baldy Center for Law and Social Policy combined and refined the findings of Drummond and Barros-Platiau highlighting the significant efforts regarding water management.

The "Water and Mines Code" (a popular name for Presidential Decree 24.643) was enacted in July of 1934. In conjunction with this, the forest management code was also decreed. These decrees were a milestone in Brazilian environmental law, the main effect of which was to place all public lands under the control of federal agencies. Up to this time these resources had

been under the control of private interests. This system was not unlike the "law of the jungle" in that the most powerful entity exercised control over as much land and its resources as possible. Through a concession system, established under the Water and Mines Code, companies were licensed to use the land resources. Private, state-owned and hybrid entities developed hydroelectric systems and expanded agricultural use (Drummond & Barros-Platiau 2006, P. 87).

The "Forest Code", enacted in January of the same year, mainly dealt with control of logging. However, there was some provision for protecting some classes of forest land. Unfortunately, the sections that provided protection of the watershed were not included among those granted "permanent protection". The enforcement of this "protection" was only lightly implemented, and then only where there was easy access to the area and the inspection effort was less difficult. Though the initiative was groundbreaking, in practice the 1934 decrees lacked specific attention to the problem of providing a domestic water supply (Drummond & Barros-Platiau 2006, P. 89).

The next significant effort came because of the "Land Statute", enacted in November of 1964. The intervening years saw little additional movement toward management of natural resources due to a global depression and World War II. A 1964 military coup, that ousted the civilian government, enacted a progressive land reform law, which made it legal for the government to seize private land deemed to have "full social function". This revolutionary concept made wasteful land use illegal, while making protection of the environment public policy (Drummond & Barros-Platiau 2006, P. 89).

Despite all these efforts, a specific provision of adequate clean water for the general population was still not considered a point of necessity. In fact, these decrees appeared to primarily benefit wealthy individuals and corporate interests.

In June of 2005 Rosa Maria Formiga Johnsson and Karin Erika Kemper completed research, funded by the World Bank. The working title of their paper was "*Integrated River Basin Management and the Principle of Managing Water Resources at the Lowest Appropriate Level – When and Why Does It (Not) Work in Practice?*". The research findings were published as *a World Bank Policy Research Working Paper* entitled *Institutional and policy analysis of river basin management: The Alto-Tiete river basin, Sao Paulo, Brazil*.

Johnsson and Kemper (2005) state that Brazil had begun to define and implement water resource management systems earlier than other countries. The resource management system put into practice was based on the principles espoused by various prominent global charters. A major element of these principles embraced the concept of localized policies and decentralization of authority regarding the management of water resources.

In 1991 Sao Paulo was the first state to codify these principles (Johnsson and Kemper, 2005, P. 4). Johnsson and Kemper (2005, P. 4) opine that São Paulo state would be expected to achieve advances in decentralized water resources management. Being the richest and best-equipped as well as having the most-experienced water management institutions, the state of Sao Paulo was able to take the first steps towards implementation with no federal assistance. However, the process of increasing the scale of implementation was more difficult. Due to the excessive amount of industrial development and the increase in the urban population (in the focus area of the 2005 study) the execution of localized control was hampered (Johnsson and Kemper, 2005, P. 5). It was determined that the tactics employed must consider the hydrology, socio-economic, cultural and historical aspects of the indigenousness population of the local area (Johnsson, et al, 2005, P. 5).

Johnsson and Kemper (2005, P. 5) introduce the term “basin-level” to describe the context of the local area. This is a reference to the specific region that was the focus of their research, The Alto-Tietê River Basin, in São Paulo, Brazil. However, the term is appropriate for virtually any other locality since the supply of water to most regions will generally equate to a river basin.

Johnsson and Kemper (2005, P. 5-6) further define the specific attributes to consider when engaging the process of decentralization:

- Economic development of the nation;
- Economic development of the basin area;
- Initial distribution of resources among basin stakeholders; and
- Class, religious, or other social/cultural distinctions among basin stakeholders.

(Johnsson and Kemper, 2005, P. 5-6).

The case of the Alto-Tietê River Basin, and therefore that of the São Paulo metropolitan area, historically had positive marks for the first two elements. However, the third had only included industrial and large agricultural entities without consideration for small farms or the general population. In addition, there is no indication that the fourth marks were factors considered in the early efforts to implement water management processes. The exceptions would be that the upper class might have benefited from the industrial and major agricultural uses. By the time of the research of Johnsson and Kemper, the provision to the urban population had finally become a concern and was therefore an additional consideration in the process of water management (Johnsson and Kemper, 2005, P. 9).

An issue which arose was because of urban sprawl being unregulated (Johnsson and Kemper 2005, P. 8, 11-12). This lead to a condition where the use of ground water resources was out of control (Johnsson and Kemper, 2005, P. 11). This was exacerbated by the continued hegemony of the influential hydropower sector conflicting with the need of drinking water for the Sao Paulo metropolitan area.

An additional complicating factor was the lack of adequate sewage collection and treatment facilities and improper disposal of solid waste. This lack lead to contamination of the little water that was available (Johnsson and Kemper, 2005, P. 12).

Each of the issues had some form of legislative direction which was intended to deal with the issue. However, they each lacked complimentary regulation to make the laws operational (Johnsson and Kemper, 2005, P. 12).

The structure of the organization developed for the purpose of water management in the Alto-Tietê River Basin, consisted of as many as 14 separate federal, state and municipal agencies. The relationships between these entities is a complex arrangement and the processes engaged to affect water management entailed a series of dynamic bargaining protocols. The net result was (as of 2006) the establishment of what is essentially a symbolic organization which consisted of a small office with a three-person technical team (Johnsson and Kemper, 2005, P. 21).

A major drought was experienced in Brazil late in 2000 which carried into 2001. The drought eventually leads to a declaration of a national level energy crisis due to insufficient water supply for hydropower systems (Johnsson and Kemper, 2005, P. 13). This impact was also felt by the urban population. However, Johnsson and Kemper do not mention the issue of human

suffering. The meteorological mechanisms at work during this event were not unheard of in the region, though rarely experienced to this degree (Cavalcanti & Kousky, 2001, P. 2).

Since December 2013/January 2014 (the normal rainy season for the Southern Hemisphere) the region, which includes Sao Paulo has been experiencing the meteorological anomaly which has previously brought about the drought conditions (Escobar, 2015). This dearth, now in its fifth year, has led to a severe shortage of water throughout the Sao Paulo metropolitan area. The local governments are attempting to curtail excessive use and waste by financially rewarding those who conserve and punishing those who do not by levying a fine. In addition, the pressure of the water main has been reduced to minimize leakage rates and discourage waste. It is being contemplated by the several local governments to take drastic measures in the form of a complete shutdown of the water distribution system for hours or days at a time.

The Alto-Tiete river basin water system, as of Escobar's article, has only 15% of its volume remaining. Reservoirs in adjacent regions are also at low volumes. A new system that will bring in water from a distant watershed is not expected to be completed until 2016. The impending dry season of 2015 is already upon the region, leaving the expectation of a human tragedy of epic proportions.

Escobar (2015) cites unnamed Brazilian scientists (with expertise in water issues) as blaming a combination of the effects of the current climate anomaly and the ineffective government programs for the growing crisis. They further stated that there is a need to be prepared for increasingly extreme climate events.

The early effort of water management was oriented to industrial and major agricultural uses. The tendency to cater to the desires of the affluent had the potential of resulting in mismanagement (Johnsson and Kemper, 2005, P. 8, 11-12). Due to low-income residents being continually expelled from the urban centers the city's periphery became shanty-towns for the poor (Johnsson and Kemper, 2005, P. 8). Mismanagement of water resources combined with uncontrolled urban sprawl set the context for a potential disaster (Johnsson and Kemper 2005, P. 8, 11-12).

The ingredient which has completed this recipe for disaster is unfortunately mostly beyond the control of any human being. Climate variability, whether of anthropogenic origin or a completely natural cycle, is the element which is the catalyst for an unexpected event. Yet these events are not unknown.

Based upon historical documentation and the geological record, humanity is very much aware of many potential climatic events. With these we may plan for each as much as it is possible relative to the risk of the event and the potential lost.

Brazil has significant water resources available on a national level. The Amazon is responsible for about 20% of the Earth's fresh water entering the oceans. The river pushes a vast plume of fresh water into the ocean. The plume is about 250 miles long and between 62 and 124 miles wide (Penn, 2001, P. 8). The river basins, lakes and reservoirs which make up the Sao Paulo metropolitan area water supply system do not compare to the Amazon. But the water supply is adequate to the needs of the population.

The referenced data lead one to conclude that the issue which lead to the current crisis is mainly a lack of adequate management. This applies to the domestic housing, sewage collection

and disposal/processing, solid waste collection and disposal, as well as the equitable division of water resources. Each of these had some form of legislative effort to administer and control at various levels. However, the lack of operational regulations each law had little or no effect.

Despite the long history of water related policy development and implementation the efforts to date have created what appears to be a bureaucratic system that does not return on the investment of time and resources.

San Joaquin Valley, California

The first human inhabitants of the San Joaquin Valley are believed to have arrived around 11,200 BCE. It is assumed that these pioneers came from the south since at the time the glaciers and snow of the Cascade and Sierra Nevada mount ranges would have made it impossible to come into the valley from the north (Fagan, 2004, P. 3). Alternatively, these early inhabitants may have been members of the seafaring adventurers who first landed on the transverse coast of California; what is now Santa Barbara County. These were most likely of the Coastal Miwok tribe (Fagan, 2004, P. 134). Up until the arrival of the Europeans the inhabitants of the San Joaquin Valley engaged mainly in hunting, fishing and foraging for fruits, nuts and other fodder that could be found growing in the wild. Eventually the concept of agriculture was discovered and implemented on a small scale at various small sub-tribal locations.

The various tribal units initially had little cause for hostility toward one another due to the ample supply of natural resource. As the environment began to grow more arid and the resulting decrease in resources, inter-tribal hostilities arose (Fagan, 2004, P. 32). As the European invaders began to dominate the land, as well as the indigenous peoples, the strain on the natural resources began to engender strife; erupting into hostile disputes both between the various tribes and the European occupiers.

In the end the Europeans either forced the native population to migrate to less desirable climes or into slavery (Johnston-Dodds, 2009, P. 17). The eventual over utilization of the San Joaquin Valley in the most recent five hundred years has contributed to the extreme impact of the current drought.

Since the conquest by Europeans of the Americas the administration of natural resources has become an issue. With the influx of Europeans intent upon building new lives in what was assumed to be a frontier, the land and it many natural resources, were taxed at a level never seen before by the indigenous population. Consequently, efforts by the invaders were taken to control the natural bounty for themselves while limiting access to the local tribes.

The forced conversion by the indigenous tribes by the Spanish conquistadores associated priests subjected them to the rule of the Church. The royal land grants to wealthy or well-connected Spanish immigrants gave the grant holder carte blanche in the use of natural resources on their property without regard for the needs of the tribes. Essentially the tribes were conquered and then subjected to all but slave labor. As grand and storied as the California missions are it cannot be forgotten that they were built by the blood, sweat and tears of a subjugated people (Haas, 1995).

Today the efforts to control water usage have seen limited success. After almost seven years of drought a declared state of emergency has required the reduction of residential and business water use by at least twenty five percent. Failure to meet the standard incurs fines. In response the average decreased use has been over forty percent. Though this reduction is commendable it is questionable whether it will have any real effect on issues of water. Other than mandated usage reductions the political efforts have been focused on apportioning what little water is available (Thompson, 1993, P. 682).

As the human social units grow it becomes apparent that there must be defined standards of behavior. Such standards would eventually be developed in application to natural resources. This would at least come about when it became evident that availability of those resources was beginning to decrease.

As the population of California increased and the dependency of much of the nation upon the bounty of the San Joaquin valley, the formerly plentiful supply of water from the various immediate sources has been depleted while the root sources have not kept up with the increased flow. Political elements in the San Joaquin valley, as well as those of the state of California at large, have attempted to reconcile this continuing deficit mainly by limiting water use for various purposes; specifically, personal/residential and industrial/agricultural.

The earliest policies were directed at the indigenous tribal units. These prevented the tribes from living as they had for many generations. As with many other policies enacted at the federal level, these policies had the net effect of disenfranchising the tribes of their ancestral homelands; water being one of its many. The injustice brought upon the tribes essentially stole the land and its resources from them and gave it to the conquering European invaders (Johnston-Dodds, 2009).

Later policies began to address the occasional water supply issues brought on by droughts and over-use (Thompson, 1993, P. 674). Up to the 1960's the policy was essentially a "political-engineering" (Thompson's term) approach where, as a need for additional water supply was identified, the Federal government would build another water project (dam/reservoir, aqueduct, etc.). These methods unfortunately lead to a significant level of environmental damage in addition to being economically costly. Since the 1970's, however the paradigm employed has

been market based. This has been operated as if it were not but another capitalist venture. It was assumed that as demands grew that "the market" would grow and provide the need.

Market based water management has apparently lead to a circumstance that is not unlike that of the ancient system of the tribal groups during episodes of water scarcity; that is, an individual or group have taken on the role of the "big man" also known as the aggrandizer. This has resulted in poor to unfair resource allocation which works well for the "big man" and his fellows but not so much for the rest of the agricultural water users.

Syros Island, Greece

Syros Island is located in the Greek Cyclades complex, south of the Aegean Sea. With an archetypal Mediterranean climate, it has relatively low annual precipitation. In an attempt to mitigate the impact of the occasional water scarcity events, a system of drought-related risk estimation was defined. This risk analysis provided an approximation of the effects of various mitigation options (Giannikopoulou, et al 2017, P.655).

Domestic use takes a back seat because much of that comes from desalination. Since the main effect of droughts is on the agricultural efforts in Syros, the risk management framework focuses on that impact. Toward this end various drought mitigation options were identified:

- Rainwater harvesting for domestic use
- Rainwater harvesting for irrigation
- Wastewater recycling for irrigation,
- Increase of desalination capacity to meet peak demand
- Artificial aquifer recharge
- Crop substitution to more drought resilient ones

A process for the risk-based assessment of drought mitigation options is proposed, which involves three steps, starting from future hazard analysis and concluding with a comparative analysis of potential mitigation options:

- Risk identification. Drought conditions are analyzed in terms of magnitude (severity), duration and frequency (probability of occurrence and return period), on the basis of climate projections;
- Risk assessment regarding anticipated impacts. Impacts are quantified in monetary terms, for the different drought severity levels, and then aggregated to estimate the total risk of economic losses;
- Risk management, through measures for dealing with drought and minimizing risk to an acceptable level. Water balance modelling is used to assess the effect of measures on drought mitigation, whereas measures are compared and ranked on the basis of three criteria: risk, vulnerability and cost-benefit ratio (Giannikopoulou, et al 2017, P.663).

Risk based management efforts ensure that the higher priority uses are targeted with respect to their vulnerabilities and the mitigating actions. This management paradigm is ideal for focusing on the "return on investment" and generally minimizes wasted efforts and assets.

Sana'a Basin, Yemen

The Sana'a Basin is located at the eastern end of the western highland of Yemen, at the southern end of the Arabian Peninsula. The population of the basin, as of 2015, was 3,517,225. The anticipated increase, based upon a ten-year estimate, is expected to nearly reach six million by 2025. This growth is expected to cause water demand to exceed the supply provided by the local rain fall (Taher, 2016, P. 1595).

Overexploitation has caused a shortage of water of adequate quality. Abstraction has been five times higher than recharge resulting in water table levels to decrease by four to eight meters per year. The situation has been exacerbated by a lack of suitable water management methods (Taher, 2016, P. 1593).

Efforts to address the issue include reducing the number of wells drawing on the aquafer and/or decreasing the number of hours of well operation. In addition, since agricultural usage accounts for about ninety percent of the total water use, more efficient irrigation methods for that community were recommended (Taher, 2016, P. 1593).

This forward thinking is an absolute necessity for any reality which has an element of uncertainty. With climate change guaranteeing an unpredictable state of the major water sources supply could easily fall short of the burgeoning demand of a growing population.

Fúquene watershed, Eastern Andes of Colombia

The Fúquene watershed is in the northern part of the eastern mountain range of the Andes, about 60 miles north of Bogotá. Elevations range from 7875 feet, where the lake Laguna De Fúquene is located, to 12,300, in the surrounding mountains.

Global climate models indicate that the expected rainfall, local to the Andes, will be widely variable. Consequently, it is anticipated that there will be a greater frequency of water scarcity periods (Murtinho, et al, 2013, P. 667).

The projected water scarcity has mobilized various entities intent upon preparing the respective communities for the eventuality. Government at all levels are working with non-government organization (NGO) to enable the local water users to engage with the local management systems and public utilities to this end (Murtinho, et al, 2013, P. 667).

The issue appears to be one of a lack of education of the interested parties with respect to the realities of water scarcity. Perception of the causes and consequences, by the water users, is ill-defined. The desire of the NGO and government cooperative is to assess the level of knowledge and educate as necessary to improve efforts to reduce water use while innovating to increase crop yields.

Major water users being unaware of issues regarding water scarcity would threaten to bring about a cascading social casualty. Misuse and waste might lead to loss of a crop which in the worst-case scenario could lead to a local famine like condition. Thus, enhances understand on the part of the agricultural community regarding drought causes and consequences is imperative.

Goleta, California Central Coast

As with water scarcity issues from around the globe, the circumstance in the Central Coast of California has been (Fagan, 2003, P. 30-31) and is (Hundley, 1992, P. 400-401) essentially the same. The early inhabitants, mainly the Chumash tribe, contended with droughts regularly from the age of hunter-gatherers to the eventual farmers of the acorn (Gamble, 2005, P. 93).

Despite the droughts, the acorn was an ever-present asset, due to the variety of oak species and abundance of natural groves (Fagan, 2003, P. 30-31). In addition, the El Niño-Niña cycle only marginally impacted the supply of seafood, thus providing sufficient sustenance for the tribe (Fagan, 2003, P. 32-33). Still, the relative lean times required agricultural and fishing processes to be well organized to ensure equitable distribution of food. In times of abundance the tribe operated in an egalitarian mode with little need for direction from the elders. As supplies lessened stricter organization was implemented by those known as the “Big Men” (Fagan, 2003, P. 178).

Today, the subsistence of the agricultural community is subject to the potential of the same natural disasters experienced by their predecessors (Solomon, 2010, P. 12). And, not unlike those "Big Men" aggrandizers of old, there are those who attempt to, and occasionally successfully, corner the water market through affluent connections, thus short changing the current small-scale farmer, who's voice is too small to have any impact (Zenovich, 2017).

With public policy (regarding water scarcity) requiring the reduction in water use to all users, agriculture cannot continue to irrigate as they would during periods of normal water availability (Bachman, 2011). Without additional water from precipitation or private well, Goleta small-scale farmers are guaranteed to have lower crop yields (Steduto, et al, 2012, P. 1).

During the current drought conditions, the per capita water use in California, at large, fell from 178 gallons per day to 130 (Mount & Hanak, 2016). With agricultural water use constituting 80% of all water use in the state, crop yields for farmers who rely solely on public utilities for irrigation, will have suffered to some extent. Fortunately, for the farmers sake, crop yield has improved in the decades since the late 19th century, because of greater scientific knowledge and application as well as advances in technology (Hanak, 2011, P. 171).

Though forced usage reduction is a proper action in the case of a condition of a water shortage emergency, additional sources might minimize the necessity of such a requirement.

Amalgam

Each location has a unique perspective with respect to water issues. These range from the current condition of insufficient water supply, because of significant reduction in local precipitation, to the expectation of future issues which might arise. This is a picture of much of the world; on the one hand there are those dealing with water scarcity and on the other, those who are anticipating such an event.

The situational vectors which results in a state of water scarcity consist of more than just a lack of precipitation. In the case of Sao Paulo, there has been a situation where water was available but not of a level of quality that would be sufficient for human uses. Whereas, in Yemen, the condition of water scarcity is a future probability due to the estimated imminent increase in population.

Some of the causes of a condition of water scarcity can be anticipated while others happen only with a minimal level of regularity or forewarning. However, the consequences are well known and can be dire for those impacted.

No matter the location or exact circumstance a combination of the efforts in each instance would likely achieve satisfactory results. Thus, any entity tasked with ensuring adequate water for a user base could adhere to the following:

- the Major water users need to acquire a proper perspective regarding drought causes and consequences. To this end public information sessions could be regularly scheduled
- A thorough risk program could be implemented to identify specific vulnerabilities, risks for each and potential mitigating actions.
- Alternative water sources could be developed to supplement existing sources.
- Regulatory policy should allocate using a doctrine of fairness where available resources are shared according to a reasonable method of apportionment.
- Contingency plans should be developed to address shortage events.
- Legislation must have attendant regulations
- Management must be objective in discharge of legal obligations
- Water should be considered a public resource and not a marketable commodity.

In any event, it should never be assumed that a location or region will always have enough water. Many of the factors that contribute to the main issue of water scarcity are well known and constitute the sciences of meteorology and climatology. However, the myriad possible impacting elements of the planet, solar system, galaxy and the reality we know as the universe are currently quite beyond the full understanding of humanity. Therefore it is crucial that policy makers take this element of uncertainty seriously when defining the requirements that will ultimately generate expenditures of revenue.

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