California's Water Crisis- The Black Hole of Water

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Abstract

This paper discusses the structure and workings of the California water market. It will review the important literature on this topic and use it to examine whether California's water distribution system is efficient. It concludes that California's current water distribution system is inefficient because of the limitations of its managed economy characteristics, the lack of price transparency, and market discontinuance brought on by a complicated and confusing bureaucratic organizational structure.

Introduction

Water is one of the indispensable things in life. In California, this essential ingredient is currently threatened by one of the worst droughts in its history. Nearly 80 percent of California is in extreme or exceptional drought (Kim). It is estimated that 11 trillion gallons of water are needed to get California out of the drought. (Brumfield). The drought has brought a renewed focus on how Californian's get their water. This paper will discuss the fractured, complicated and convoluted way that water is distributed, allocated and bought and sold in California.

California is a state full of rich farmland, but also arid desert, making water a limited resource when the needs of the entire state are considered. Dating back to the Spanish settlers of 1769, Californians have always been concerned about securing and dividing up water. Particularly now with California deep into one of the worst droughts in its history, water allocation is an important topic. This year alone, experts estimate that the drought caused California to incur a 2.2 billion dollar loss in its agricultural sector alone (Carlton). This raises major questions such as, who gets water? Why should people get water? And most importantly to this paper, is water being priced and allocated efficiently?

Attempting to answer some of these questions will require studying current pricing schemes and examining the consequences that arise from the current system of overlapping rights and regulatory tiers. In particular, this paper will look at the efficiency of water allocation at district, county and regional levels. It will analyze whether the current system incentivizes the proper allocation of water or if the market needs to be reformed for this to be achieved. It is the goal of this paper to

describe the complexities of the water market and find areas in which market inefficiencies would suggest that marginal benefit does not equal real marginal cost. The paper will be broken down into three main sections: a description of the current California water market, the identification of market inefficiencies, and a discussion of policy implications.

The description of the current market will examine the mechanisms that divide California's water among its many users. It will explain the various distribution systems that have been adopted in California and discuss water rights. This section will detail the history of water distribution in California and highlight some of the historical challenges California has faced with water allocation. The paper will look at the users, or consumers of water, that constitute market demand. Water is essential to sustain life, and it is provided as a utility to citizens of the state. Additionally it is an important commercial input, the demand for which is a function of its price. After reviewing the current system of water distribution in California, the stage will then be set to analyze its efficiency.

In the analysis section, general market theories will be applied to the California water market to try to identify inefficiencies. Further, incentives in the current system will be examined in order to gauge their impact on water decision-making. For example, do the interests of the state match the interests of the water districts? This will help answer questions such as, why agriculture accounts for 80% of water consumption in California, but only 2% of economic activity (Economist). The paper will examine whether water distribution is optimized by reviewing

previous research and through original analysis, essentially trying to find out where marginal benefit does not equal marginal cost.

The last section will explore possible benefits of market reform, as well as potential pitfalls. This will require an overview of current water politics in regards to allocation and the state's power in regards to natural resources. Lastly, the paper will discuss whether policy reform is need in the water market.

Literature Review

Water studies are typically either small in scope to allow for measurable results, or have larger ambitions based in generalized theory analysis. This creates holes in the research that do not address the disconnect between small-scale water analysis in practice and large-scale water analysis in theory. This gap must be defined and addressed in order to properly evaluate the current market.

An example of a largely theory-based work on California water is Gaffney's paper, which argues that California needs to deregulate its water market. The paper states it is a common belief that if the water market were deregulated, water prices would rise, causing economic dislocations such as decreases in wages and property values. Gaffney argues, however, that this belief is unfounded, primarily supporting his analysis with labor and capital models, correlation studies and basic economic theory. He writes that lower water prices are not correlated with higher economic values for communities or with increased quality of life; in fact, he believes that low prices of water for agriculture actually create less value per acre, whereas high prices cause a more efficient allocation of labor to capital, which positively affects value per acre. "Water is such a potent substitute for labor and capital," Gaffney says, "that more water often means lower yields from each acre." Gaffney surveys much of the established research and data and draws these theoretical conclusions from it.

Some concerns he raises about the current system are the lack of limitations on water rights, the question of groundwater regulation, and the production of low value, but high water-content crops such as barely, rice, alfalfa, and irrigated

pasture. Gaffney's largest concern is in the lack of transactions in the water market, which he believes is primarily caused by a lack of motivated sellers of water. From his study of historical data of the private water market, Gaffney outlines two causes of this under-motivation: the ever rising value of water rights, and the market's ability to gather water from sources such as the unregulated drilling of groundwater. He concludes that the number of transactions should be increased through market reform, so that sellers have more ability and motivation to participate.

Unlike Gaffney, Lefebvre, Gangadharan, and Thoyer argue that the water market is already fairly functional. They believe, however, that by transitioning to a more freely trading market, primarily through security-differentiated water rights, the market could become even more efficient. Security-differentiated water rights describe rights that have various levels of water guarantees and costs associated with them. The difference with these new water rights, compared to rights traded in the past, would be the attached guarantees, which change their value and their cost. This, they argue, would enable more people to participate in the market at lower price points, improving market dynamics. It would also allow more people to treat their water as a long-term asset, instead of thinking of it as a use-it-or-lose-it asset. Currently no California market uses a trading system in which there are differentiated guarantees on the rights.

The authors hypothesized that this would also stabilize incomes for farmers as well as year-to-year water risk. However, only part of this theory proved true. After running regressions on their data which projected demand based on historical

numbers, profits did not stabilize, although risk did decrease in their empirical analysis. The authors theorized that this had a lot to do with one of the major issues in water: transaction costs. Many market types that work for other goods do not work for water, as water is unique in its difficulty to transport. This is a highly limiting factor in transactions, thus limiting profits. Transaction costs, Lefebvre, Gangadharan, and Thoyer conclude, will inform how effective the system is. Their discussion of the current market pricing strategies and pitfalls along with Gaffney's analysis displays the overarching theory view of the literature on the California water market.

At the other end of the spectrum are the more detailed small case studies on California water distribution. Zetland's dissertation is an example of this, as it outlines some of the problems California water distribution agencies have faced, using the Metropolitan Water District (MET) as an example. The biggest flaw of the current system, Zetland points out, is that although the water districts are run as public good agencies, the self-interest of their members causes the organizations to fail. He uses basic capitalistic principles of self-interest and game theory, among other methods, to highlight how MET fails to be efficient. He concludes that as soon as water becomes scarce, it must be managed differently than the traditional "club" style that allows members to have as much as they want. These problems of pricing and allocation exist in almost every county in California today. Zetland also highlights issues in the recordings of water data, such as groundwater, which is often reported in a misleading manner and encourages poor allocation decisions.

Another type of data driven analysis is seen in Bar-Sharia et al.'s paper. Unlike Zetland, they examine different forms of pricing on a specific type of user: the agricultural sector. Bar-Sharia, et al. looks at historical data of traditional pricing (pricing at cost) verses block pricing. Pricing at cost is the pricing strategy of pricing water at the cost of its collections, where as block pricing charges users more or less depending on their usage of water. The more water you use, the more expensive it becomes. This study was done in Israel, where both forms of pricing are employed. With this data Bar-Sharia, et al. uses multiple regression analysis to project demand, and project farm efficiency. Bar-Sharia, et al. shows that block pricing, in actuality, decreases total use by charging larger farms (and therefore larger water users) high prices while actually lowering costs to small farmers. However, Bar-Sharia, et al notes that because large farms are more efficient than small farms, block pricing actually reduces farming efficiency.

Another concern that is voiced in studies is the disconnect between the actual cost of water and the price at which it is sold. The price of water currently does not reflect the social and non-direct costs. Agnew writes about many of the social and non-direct costs of water management. In particular, Agnew focuses on the environmental side effects of improper water allocation that are caused by the current system. These external costs are not presently represented by the price and instead are covered through general taxes. This leads to confusion about water prices and its use as many agricultural and industrial users complain about higher taxes that go to support water related programs or water reservations (the practice of reserving a certain quantity of water not to be sold for environmental reasons).

Further this means the population as a whole pays for the actions of a few. This research shows that the cost is not truly reflected in the price of water—if it were, the taxes would theoretically be redundant and the reservations of water would be less necessary.

There are many theories about how to best allocate water and what the future holds for changes in water allocation. In their paper, Dole and Niemi examine the Willamette Valley water authority in an effort to study efficient water pricing and allocations. Their study conducts demand projections based on three different scenarios: conservation (a shift to promoting environmental policies), development (loosening water laws and allowing market forces free rein), and the status quo. They attempt to effectively price water for each scenario, based on the scenario's set of conditions and projected demand. Dole and Niemi conclude that water allocation should be tackled at county (the equivalent of a California district level), rather than a state level for each scenario. Due to the highly variable demand and supply of water in the Willamette Valley, central planning of water was doomed to be inefficient. Instead they favor a more locally responsive system. While this seems to add complexity, they argue that because scarcity of water cannot be generalized, counties (districts) must be considered individually. Dole and Niemi study also is interesting as one of the scenarios is a move to a more conservationist effort and is an attempt to answer how to effectively price in state-run environmental programs that are designed to protect water habitats. Their study is not a perfect match for California, since all water in their study essentially comes from the Willamette River and its subsidiaries, but the general idea holds.

The subject of water and pricing has been covered in the world of economics on a number of occasions. The point of this paper is to consolidate, build on and expand this research. The system of water rights and distribution authorities in California is confusing, seeming to combine to make a murky mess. Hanak, et al. attempts to clarify the subject with a historical explanation of water rights in California from the Spanish missions, through the gold rush of 1849, all the way to current day. With a discussion and explanation of every significant water related lawsuit and bill passed in California, this book is critical to understanding water history and politics in California. The book also provides an analysis of the current political climate for water distribution and its nuances, and also details potential reforms.

All of these authors address their given question in a very detailed manner. However, their analyses largely do not overlap, which leads to an opportunity to expand on their work. Gaffney's research is most similar to what this paper will address, although he proposes a new system without discussing why the current system is not working. Gaffney's research will provide a firm base to which my paper will refer; his methodology of broadly identifying inefficacies is similar to what this paper seeks to accomplish. This paper will also use districts as examples, as in Zetland's work, however it will look at the district's interactions with other levels of water bureaucracy as well. This will leverage Zetland's argument to show that the interests of the various parties involved invariably conflict. Dole and Niemi's argument will also be useful, as they also conclude that regions struggle to effectively price for counties because of the same conflict. This paper will

consolidate the previous research while also using original market analysis to show that water is not effectively priced by identifying inefficiencies.

Analysis

The California water market is a complicated morass. The analysis begins by defining the levels of bureaucracy that run the California water market, followed by a discussion of the problems of the market, as it is constituted. These problems include the managed economy characteristics of the water market, the lack of price transparency, and market discontinuance.

The water market has four main administrative levels: distributor, district, county, and region. Each level is discrete and intended to perform a different function. The chart (Figure 1) below demonstrates a basic layout of the four levels.

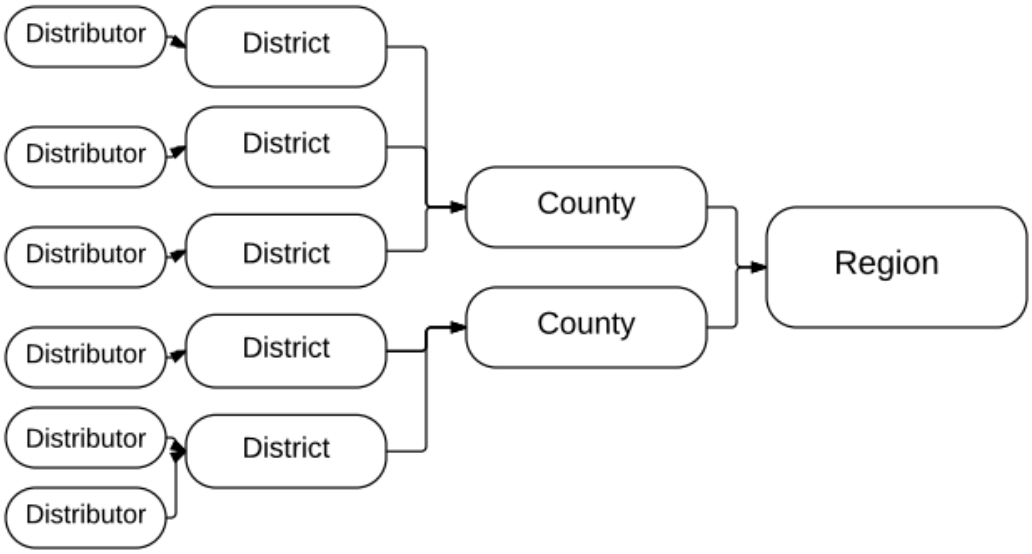

Figure 1

The lowest administrative level is the water distributor. This part of the market is where everyday consumers, businesses, and agricultural users get their water. Most people interact with the water market at this level; this interaction and their bill is all they know of the system. The next level up is the district level. The

district level is populated by distributors. Moving up one level takes us to the county level, which is made up of the districts. Finally the water region is the highest level in the state and the water region consists of the counties. The distributors, districts and counties are all regulated by the level above them, as well as by local and regional governments. The regions are regulated by the state. Unfortunately the system is even more complex than the hierarchy suggests.

The distributors make up the water districts. This relationship is often a one to one matching arrangement, and sometimes the district and distributor are a single integrated entity. There are over 250 water districts in California. The distributors act as the business end of the district. Districts will frequently band to together to better access water and to combine water rights. The Metropolitan Water District is an example of this (Figure 2). This alliance allows the districts more control over their land area, and in theory allows them to better allocate and price water. The district estimates the water needs of the area, and tries to reconcile and apply water regulations, as well as mandates from higher authorities. Further complicating their function is that these districts may be subject to the regulations of local governments such as cities and towns. The primary job of the district is to allocate, or preserve, the proper amount of water based on county mandate and local regulation. Where these mandates and regulations conflict, however, there is a grey area. Obviously, if local law runs counter to state or regional law, it's clear-cut and the higher authority wins out. However, the conflict is often between local laws and regional mandates. This leads to tricky decisions and negotiations by the water

districts such as balancing their commercial obligations with region mandated environmental restrictions.

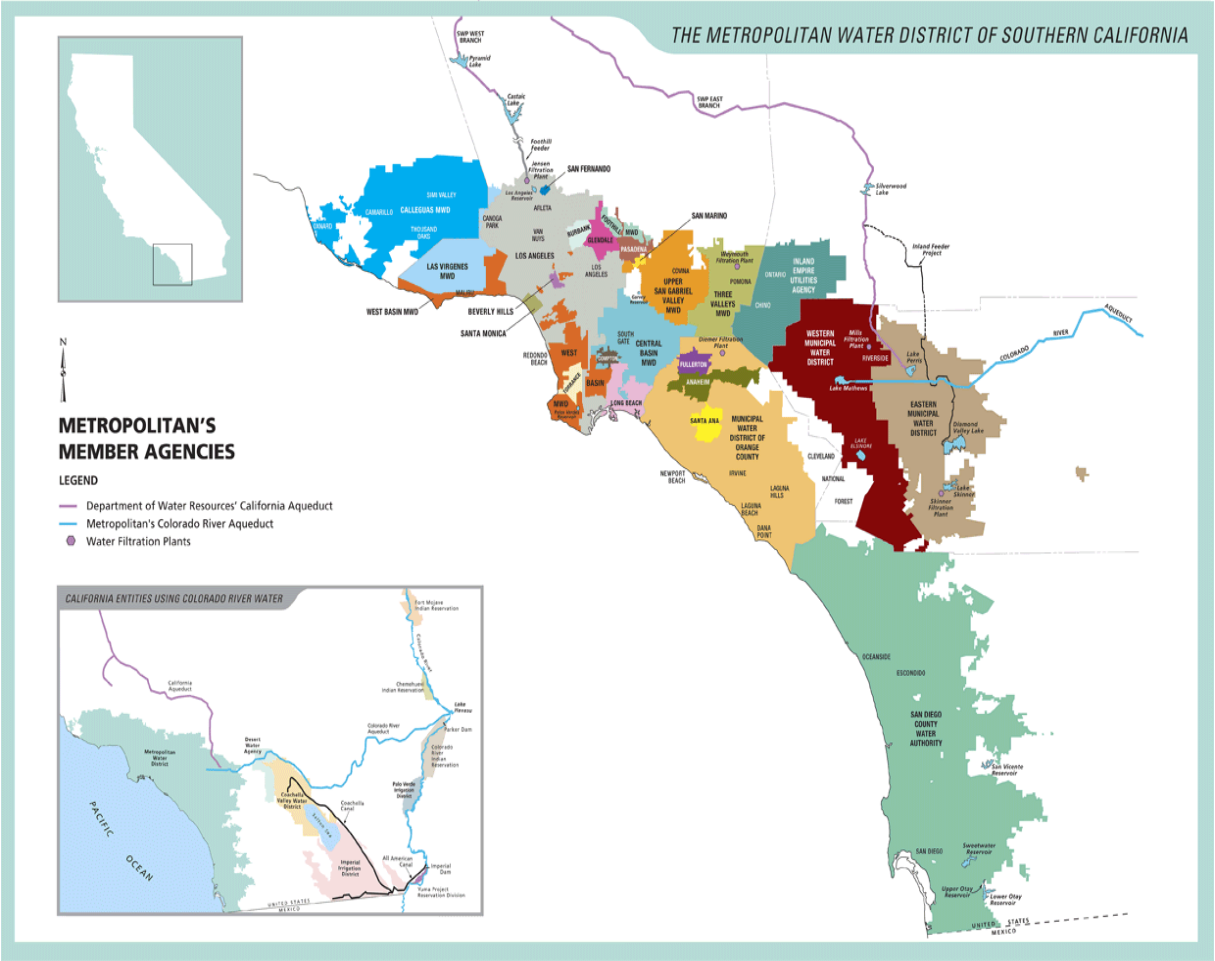

Figure 2

Districts get their water from water counties, which are organizations that encompass several water districts (Figure 3). Counties are defined by the state and regulated by the water regions. Counties manage water from a variety of sources: rivers, dam, aquifers, desalination plants, and others. The counties decide how water is divided among its member districts usually based on water rights, some of which go back to the Spanish colonial rule, and on other allocation factors such as population, general needs and other factors. Most of the water allocated by the

counties is done so based on a complicated water right system. The counties also apply mandates that have been passed down from the water regions. The county is where water conservation efforts, and other statewide goals, are calculated and measured. The point of origin of the water is not part of the information passed on, unless the district's water rights require water from a certain source. In the current system, water is priced by the county at cost of collection, and sold to the districts.

Figure 3

The water each county gets is regulated by water regions. The regions distribute water to their various counties and enforce California state water laws and regulations. The regions are defined by California agencies who only largely

agree on what the regions are (Figure 4). Regulatory confusion starts at the top where resource agencies of California are not 100 percent consistent on the regions borders (CA.Gov). The regions are in charge of executing water policies and collecting information on California's statewide plans. These plans and polices evolve frequently and are often times conflicting.

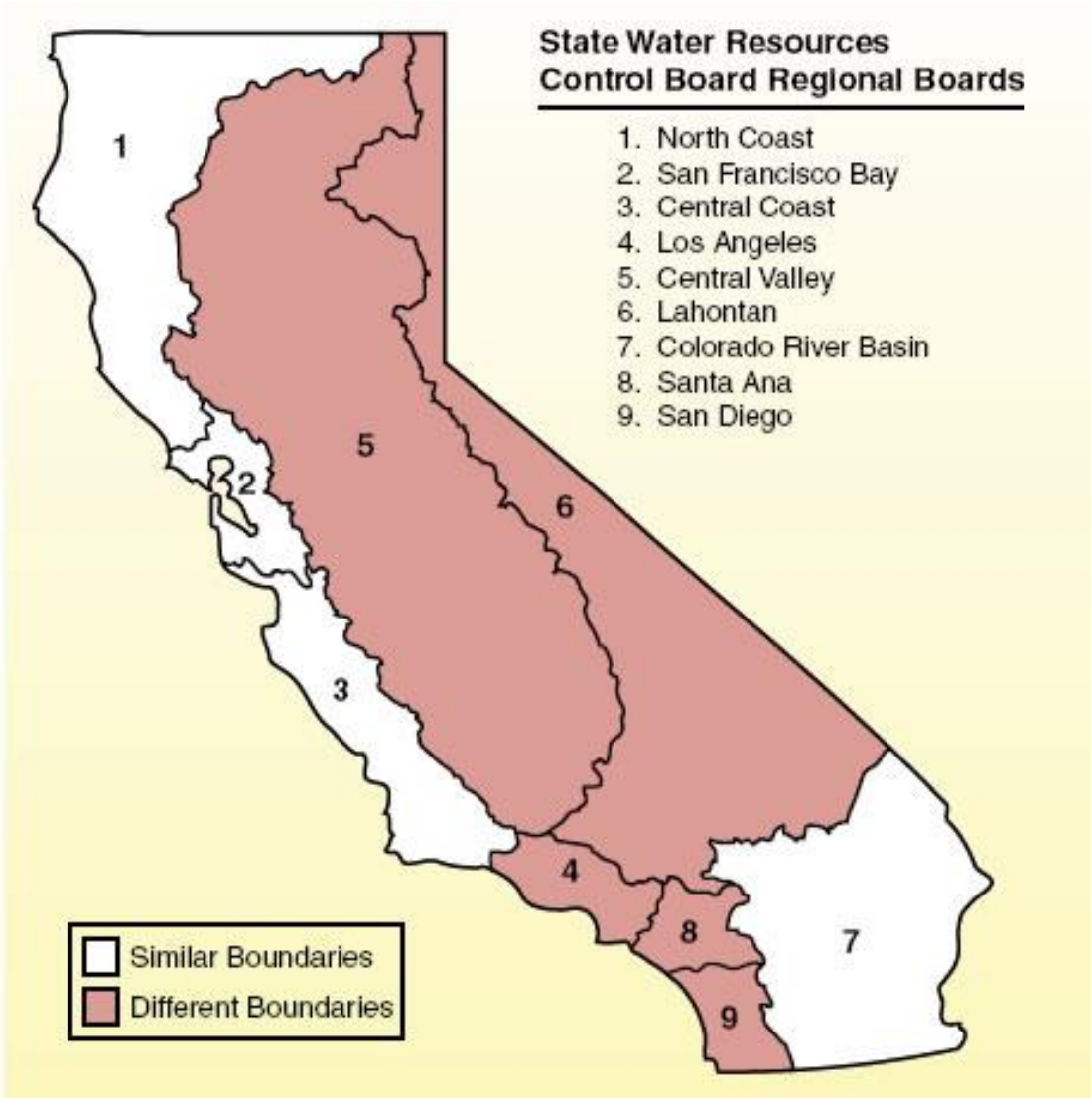

Figure 4

A lack of transparency is the first major issue that becomes apparent when examining this system. When trying to achieve efficient prices in an economic sense, perfect information is a key attribute. Realistically, no market has perfect information and even the existence of nearly perfect information depends on whom you ask. However, almost all economists agree that very good information exists and is very attainable in most markets. The water market does not provide key information to its participants. Most information about water usage and water prices is only available several years after the fact, making such information outdated and not relevant. Price analysis is nearly impossible if one wishes to price on a week to week basis, let alone on a day to day or up to the second basis.

This informational black hole makes water inputs and outputs extremely hard to track and value. However, blame for this lack of transparency cannot be placed completely on the districts—the counties deserve a healthy share of blame as well. This same problem is true at every level, with even water origin information not being made available at every level.

For private water markets information is also poor. While local information exists, water is a transported and statewide product so local information does not provide a complete picture. While some water trading exists, the market is very underutilized, and fails to accomplish a true water market. Obviously the lack of competitive water pricing information is a significant impediment to a viable market. Beyond the common knowledge that California is in a drought and that water prices are rising, private sellers do not have the data to make informed pricing determinations. Further, since water transportation is expensive, and not

easy to execute, water is usually not traded over distance, though it could be and perhaps should be in certain market environments. Unfortunately, the lack of availability of information makes a study of prices a task that is beyond the scope of this paper.

Another issue within the water distribution system is the dissonance between each level of the system. Currently the market operates in a system in which every regulatory level has different economic, political and environmental incentives. This discord creates situations in which participants within the system are working against each other and hurting efficient allocation efforts.

At the district level, the only goal is to satisfy its constituents – the users. While districts are in charge of implementing water policy from above, ultimately they are responsive to the local needs and market demands of their district, as this is where the money comes from. Where the water comes from is largely irrelevant to the district; their only concern is the price of it, though from their standpoint the price and allocation are fixed. Some southern California districts, for example, are located in areas described as arid at best. Inexpensive water rights allocate these districts lots of water at an inexpensive price and they are happy to supply all of it to their customers at their cost. When conservation concerns arise, they are some the first districts to be scrutinized because of the vast amount of water they consume, but their sub-market (their district) is separate from the overall market. They might be harming the state as a whole, but these districts are just consuming based on the local incentives they have. They are given the water and they supply it to their customers at their cost.

Another example, of market dysfunction is in the Central Valley. Some pieces of land rely on natural irrigation from rivers, streams and underground aquifers. As the current drought takes hold and water is being taken, by a combination of landowners and county or state, to be distributed elsewhere, these rivers, streams and aquifers are drying up. The landowners in these formerly naturally irrigated areas are now forced to pay exorbitant prices to get water. The county or region takes water away from these districts to respond to the needs of the county or region as a whole regardless if it is fair at a local level in the minds of these landowners.

Water distribution in California is often further complicated when the state declares protected habitats (wetlands) or species. This can create situations in which water sources a district has relied upon become off-limits. This can diminish a district's water supply and drastically impact allocation decisions in the whole county.

These three examples show how the responsibilities and incentives of each level are often not well aligned. This misalignment creates friction among the levels and often prevents them from collaborating to effectively allocate water from top to bottom. This disconnect also shows how the system can be unresponsive to local markets and local markets unresponsive to needs elsewhere in the system.

Currently, the major decisions about water distribution in California are made at a statewide level. These decisions can include a variety of policy considerations, such as environmental policy, agricultural policy, urban development and others. The impact of these overlapping policies can cause major

issues at the local level. As discussed previously, well-meaning and positive initiatives, such as protecting ecosystems, can cause meaningful economic problems in small pockets of the state. While the governments harming one individual, with the intent to help another is nothing new in the world, water is unique in that it is essential to life. This makes being responsive to local issues regarding water crucial; it is the idea behind having the levels of government in the first place. However the lack of reporting relevant information and the failure of integration between levels of government in California's water distribution system creates more problems than local governance solves. Further, since water pricing and allocation are so influenced by rights and regulations, it is hard to change water distribution particularly when it matters, as it does in the current drought or any other circumstance that vastly changes the water landscape. The lack of flexibility makes the system very unresponsive to change.

Water rights are a major issue as well. While they have served useful purposes, they distinctly shape water supply and give some people inherent advantages. This means that water will never be a product with fair pricing as long as the market is tiered and constrained by long-term water rights. An equivalent of the situation would be if certain companies were legally entitled to as much electricity as they wanted at a low price, while other companies got only what was left and at a much higher price. This system would be considered an outrage and be considered vastly unfair. However little such outrage is currently being raised about the water system. This can be attributed to two factors. First that the water system in California is long entrenched (dating back to the founding of the State) and has

never been very different than it currently is. Second, that the market has never been under as much stress as it currently is. While there have been water shortages before, they tended to be regional shortages or manageable. This is no longer the case.

The California water distribution system will take time to reform, however, as forces standing in the way of any policy change are powerful. Changing water laws requires moving against rules that have been established since California was settled. Farmers and other big lobbies have major interests in keeping the laws as they stand. The social and economic cost to Californians, however, should be weighed against the cost of market reform and actions such as the taking of water rights through eminent domain need to be studied.

Conclusion

The recent California drought has been statewide and had severe consequences. Crops have died and commercial users are going bankrupt in some cases. For really the first time, the water market is getting truly scrutinized, not out of an academic exercise but out of necessity. If California's water market is to be changed, there is a huge opportunity in the current climate. Water must be priced more effectively in the future so that price can play an appropriate role in balancing supply and demand. It is too important of a resource to be wasted or misallocated. Currently the market does not provide the information so that consumers can make decisions that balance real marginal cost with marginal benefit. This creates a rigid market that is too segmented and fails to deliver efficient pricing and usage.

The various administrative levels cause inefficiencies at every step that affect pricing and supply. These levels should be collapsed from four to two: districts to supply water to customers and water regions that divide the state's water among the districts and implement the state's mandates regarding conservation and the environment, among others. The water regions would then have all public pricing information and would be able to make this information transparent to the public. This would also alleviate some of the friction currently between the various levels and more closely align the state and district goals. Public pricing information would inform the private market, making it more functional. The water regions should study the idea of intermediating private market trades so that a party in Northern California might be able to sell water to a party in Southern California with the State accepting delivery in one region and supplying in another region for a fee. The State

should pilot a program in security-differentiated water rights as described earlier in the paper. If the State water region piloted such a program and offered some such rights for sale, more participants would engage in water trading. Improved ease of trading would lead to more transactions and improve market function. If the state water region piloted such programs more participants would engage in water trading thus improving the water market as a whole.

These recommendations fall directly from the studies cited in this paper and close the gap between the theoretical studies and the empirical studies. The California market is crying out for reform and as structured is doing a disservice to Californians. Currently the market fails to address clearly who should get water and who doesn't. Further the system does not incentivize the most efficient use of the water, but rather allocates based on the bureaucracy, top down policy and entrenched rights. This inefficiency is part of the reason agriculture generates only 2% of economic output while using 80% of the water (Economist); a clear consequence of using high water low value crops. The market can only be fixed by addressing the key factors of market discontinuance, lack of price transparency, and the managed economy characteristics. Only when these problems are improved will water be more effectively priced and efficiently allocated. The recommendations above are initial steps that are not all which needs to be done, but a good beginning toward a reform that would employ economically sound principals to create a better water market.

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