Discontinuous Institutional Change: A Case Study of Water in California

Chapter 3

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Abstract

Institutions can change rapidly when there is a rational choice reason for the institutions to change. This paper looks at examples of rapid institutional change as they relate to water governance. We utilize the ideas of Douglas North and discontinuous institutional change and seek to explain why such changes while rare, are to be expected in the face of technological shocks that radically alter productivity.

1 Introduction

Douglas North argues in *Institutions, Institutional Change and Economic Performance* that institutional change occurs at the margin and occurs "incrementally rather than in discontinuous fashion (North 1990, page 6)." This paper will look at several examples of what we consider discontinuous institutional change. North offers the cases of war and conquest as examples of discontinuous change and these are obvious and strong examples. If an invading army creates their own system of courts, judges, and rules this will fundamentally alter the parameters of exchange within a society. For example, if a new ruler forbids the charging of interest on loans, a common historical prohibition, new financial arrangements will need to be created in order to deal with this new institutional environment. North is concerned with explaining the diversity of economic outcomes and focusing on such macro level questions makes sense given his research question.

North defines the functions of institutions as providing "the basic structure by which human beings throughout history have created order and attempted to reduce uncertainty in exchange (North 1990, page 118)." This functional explanation of institutions is not restricted to macro level phenomena like revolutions and conquest and can be applied to narrower markets, indeed: "Institutions reduce uncertainty by providing a structure to everyday life (North 1990 page 3)." By focusing on smaller markets and smaller institutions, we are provided with additional opportunities to look for discontinuous institutional change.

This paper focuses upon the historical evolution of water rights within the state of California as a case study of discontinuous institutional change. Water as subject deserves study because it is a common pool resource that exists quite far from ideal conditions. Observing groundwater is difficult and costly, one can look at a lake or reservoir and see the water levels

deplete with use. Groundwater basins can cover a large geographic area and before the advent of reliable survey technologies and techniques, their borders were poorly mapped. Groundwater is appropriated through drilling wells and while an individual may have knowledge of their own pumping activities, the same is not true about the activities of their neighbors. The lack of common knowledge about appropriation activities raises the cost, and the difficulty, of achieving successful governance. What we will argue in this paper is that as technology changed the marginal cost of obtaining information about the specifics subsurface water flows, institutions, as exemplified through the legal system, rapidly adopted these new findings and changed dramatically.

The paper is structured as follows. In section 2 we will provide a literature review of the institutional change and property rights. In section 3 we will discuss property rights in ground water and the end of the ad coleum doctrine. Section 4 will be about restrictions on pumping for sale and the ability to mine groundwater. Section 5 will address water quality and the use of surface water as a means of conveying pollutants. This section will focus on the historical regulation of water quality. Section 6 will conclude.

2 Why California?

California provides a unique legal and institutional framework for studying groundwater. The state has changed greatly since it was first founded in 1850. The state is not only the most populous in the nation, it is larger than the smallest 22 states combined. California has experienced a massive population increase over its history with more people competing for resources that were once abundant. With increased competition for these resources, new rules for governing appropriation were needed to coordinate individual activity and reduce uncertainty

about final distribution. In addition to its large populace, the state itself is geographically large. Large population and geographic size introduces heterogeneity as individuals have differing plans and beliefs about the appropriate, and best, use of the limited water resources. Size is important because California covers multiple climates and individuals in different climates will want to use different resources more intensely. For example, farmers in the drier southern parts of the state will be less willing to rely upon natural precipitation to water their crops and will be more than willing to pump groundwater if the weather and surface water supplies are not accommodating. The thesis of this paper is that as new technologies and developments in the hydrological sciences have expanded the potential uses, and value of water, new institutional rules were quickly adopted in response to conflicts that emerged from these new technologies.

Our analysis starts in the past, we do this to show how simple rules evolved to changing circumstances as new knowledge and technologies changed the costs and benefits of appropriating water resources. Currently, water regulations are complex and a lawyer could have a successful (and profitable) career solely litigating water law and guiding their clients through application and permitting processes. While we cannot rule out the possibility of rent-seeking within this system, we will instead focus our attention on the We will start with an economic explanation for the formation of property rights. We will then modify this theory and show how changes in both information and transaction redefine these existing rights. With this as our theoretical framework, we will show how changes in information and transaction costs have been reflected in an evolving body of law.

2.1 Theories of Rapid Institutional Change

Leeson (2012, 2014) provide some instructive examples of what I am calling rapid institutional change. In both cases, we see a religious institutional that was created to reduce violence amongst people by altering the perceived costs and benefits of violence. In the case of Leeson (2012) monastic maledictions increased the costs of engaging in violence, in Leeson (2014) this religious practice lowered the benefits of violence by lowering the amount of wealth that could be physically expropriated. What is important about both cases is that as property rights became more secure, these religious practices went away. The religious aspect is key because one would normally hold religious beliefs as mostly immutable over time and some of the hardest aspects of human behavior to change, we have stories of martyrs for a reason. It is for these reasons that institutions based in religious practice are important examples of discontinuous institutional change.

Leeson (2014) provides a historical analysis of the institution of human sacrifice where the Kond people of India preemptively sacrificed human victims as a way of lowering the risk and uncertainty that came from internecine conflict. The simple version of the explanation is that wealthy communities were more likely to be targeted by their neighbors for raiding so they preemptively destroyed their wealth in the form of human sacrifice. Victims were purchased from outside the community and murdered in a highly visible, verifiable, and spectacular fashion. What is interesting about the case of the Kond is that while the British hated this practice, they were unable to put an end to it through violence or education.[1]

What did end human sacrifice was the British promise of justice and arbitration between neighboring tribes. Human sacrifice, as an institution, despite its religious justification served a

[1] Even in cases where the British were able to rescue some of the intended victims, the Kond resumed the practice once the British left (Leeson 2014 page 161).

role in reducing uncertainty by reducing the payoffs to tribal violence. Previously, those injured by tribal violence had no recourse for justice. British arbitration and justice was a substitute for the institution of human sacrifice and because it was successful in limiting tribal violence, a religious rite that had been practiced "from time immemorial" (Leeson 2014 page 162) ended within years. Human sacrifice was costly, relying on British arbitration to serve the same end at a lower price was a powerful substitute. The end of human sacrifice within years qualifies as discontinuous institutional change, especially when we consider that the explicit purpose of the practice was to pacify a malevolent earth deity.

3 Evolution of Property Rights in Groundwater

The theoretical starting point for this paper is that property right in resources are endogenously created in response to changes in either the benefits of controlling a resource or the cost of enforcing that control. Demsetz (1967) provides a model where a resource that was previously held in common, animals, experienced a rapid increase in value due to developing markets in animal furs. The result of the increase in value was a change in the norms regarding who and under what circumstances may appropriate from the commons.

Creating and enforcing property rights costs real resources and in environments where the benefits of creating property rights are low relative to the costs one would not be surprised if rights were either weak or nonexistent (Anderson and Hill 1975). This paper conceives of property rights as a bundle of rights.[2] As the environment within which these rights exist changes, so too should we expect the bundle of rights to change. For example, changes in the

[2] For a discussion of the advantages and disadvantages of the "bundle of rights" approach see: Epstein 2011, Klein and Robinson 2011, and Merrill 2011.

cost of enforcement may change the composition of this bundle of rights. Using the earlier case provided by Demsetz, if more trappers are seeking to harvest fur in an area, rights regarding who may hunt what and when may change in response to increased externalities from appropriation. The history of ground water rights in the American West is one where rights have evolved in response to disputes arising from increased demand for water and changes in the scientific understanding of hydrology.

3.1 Absolute Rights – *ad coleum*

Water rights in the American West have Hispanic origins (Meyer 1989). The Treaty of Guadalupe-Hidalgo, which established peace between the United States and the Mexican Republic, bound the United States to respect the existing property rights of individuals in their newly conquered territory and this included groundwater rights. At the time, California was not yet a state. This treaty is the mechanism through which Spanish and therefore Roman legal traditions became a significant legal source governing initial groundwater rights. Groundwater rights were an appurtenance of land ownership. The individual owning the land could use the water for whatever purpose was desired and no limits were placed on quantity. This is best exemplified in contrast to surface water wherein some uses, particularly irrigation and industrial uses, were prohibited without an explicit right that was obtained through purchase, grant, or judicial award (Meyer 1989, page 292).

When California became a state in 1850, the English Common Law was adopted formally as the governing legal doctrine (see Young 1960). This, coupled with the earlier Spanish influences, determined the treatment of groundwater as a function of land ownership. In English common law, land ownership consisted of rights both above and below the land. This is known

as the *ad coleum* doctrine and its origins are traced to Acton v. Blundell.[3] A quick summary of the details of this case is that in excavating a coal mine the defendant interrupted subsurface water flows to the plaintiff's well. The court ruled that the defendant's ownership of the land came with the right to dig into the land and "apply all that is there found to his own purposes at his free will and pleasure." The application of the ad coleum doctrine to groundwater meant that a landowner could not be held liable for interrupting subsurface water flows to their neighbors. This is important because of how it contrasts with the treatment of surface water where impacting one's neighbors was grounds for liability. Kanazawa (2003) quoting Acton explains as follows:

> "The difference in legal treatment, argued Acton, was based on the fact that surface-water flows were obvious and observable to claimants, while groundwater movements were not. Consequently, surface-water rights could be based on the "implied assent and agreement" of various claimants to the same surface source, whereas "[i]n the case . . . of [groundwater], there can be no ground for implying any mutual consent or agreement... between the owners of the several lands beneath which the underground springs may exist, which is one of the foundations on which the law as to running streams is supposed to be built; nor, for the same reason, can any trace of a positive law be inferred from long-continued acquiesence [sic] and submission, whilst the very existence of the underground springs or of the well may be unknown to the proprietors of the soil" (Acton, p. 350)."

An individual knowing the results of their actions is important in establishing liability. If one dams a stream, they know it will impact all downstream users. The same is not true for one digging a mine because subsurface water flows are unknown. This is an important standard

[3] The doctrine's name derives from the Latin phrase: "*Cuius est solum, eius est usque ad coelum et ad inferos*." Translated: "whoever's is the soil, it is theirs all the way to Heaven and all the way to Hell."

because as technology and the science of hydrology advanced, it became possible to have knowledge about subsurface flows and how others would be impacted.

Artesian wells do not require pumping to access water, instead rely upon pressure differentials, oftentimes originating at great distances, to push percolating water to the surface. While the owner of one plot of land may have an artesian well, the functioning of that well is dependent upon water flows that occur across multiple land owners. Activities of other land owners could potentially lower the pressure within the system and reduce the efficacy of these wells. Artesian wells provide access to groundwater without the need for expensive pumps and this makes them desirable. This desirability lead to an interest in learning how to maximize water yields. In 1885, the US Geological Survey published a report on strata conditions that were ideal for underground water movement and how multiple wells could be arranged spatially to limit interference.[4] The importance of this growing hydrological knowledge was that it came to be increasingly referenced as pertinent facts in court cases. Plaintiffs now had the ability to provide a mechanism through which the actions of the Defendant lead to specific harms. In addition to describing the mechanism of harm, it was also possible to argue that such harms were a foreseeable consequence of specific actions.

4 The End of Absolute Rights – Reasonable Use

In the preceding discussion of the *ad coleum* principle, the right to pump ground water was absolute. This changed in 1903 with the case of Katz v. Walkinshaw (141 Cal. 116 [1903]) which established relative rights through the implementation of a reasonable use principle. A

[4] Kanazawa (2003) provides an explanation of this and other government reports: U.S. Census Office (1902), U.S. Department of Agriculture (1893a, 1893b), U.S. Department of the Interior (1896, 1902), and U.S. Department of the Interior: Geological Survey (1885, 1893, 1921)

quick summary of the case is as follows: Walkinshaw owned a handful of artesian wells and uncapped the wells so that the water would flow into a stream for sale. The sudden outflow of water caused the subsurface water pressure to drop and Katz's well ran dry and they sued for damages. The result was that in certain cases, subsurface flows were treated as riparian (surface) flows. For a discussion of the details of this case, see Dunbar (1977 p. 665-667). A common way this principle was applied was in prohibiting the pumping of groundwater for export outside the basin. For example, if one farmer was pumping water for overland irrigation use, this would be a reasonable use. If a differing individual was pumping groundwater to sell to another outside the basin, the aforementioned farmer could sue this individual on the grounds that their use of water was being hurt and that pumping water for sale was an unreasonable use.

Prohibiting pumping for sale transforms what was the market demand for water into a collection of the individual landowners' demand for water, which was a subset of total demand and limited to the basin within which the water was being pumped. For the individual, the cost of pumping is the energy needed operate the pumps. Individuals will allocate the first unit of water pumped to its, subjectively, highest valued use and all succeeding units will be put to less valued uses (Menger 1871). When the cost of electricity exceeds the benefit of the marginal unit of water, an individual will stop pumping. There is a limit to how much water a farmer can use on their fields, too much water will, in fact, kill their crops. Maintaining proper drainage and soil gradation on fields is important to keep water from pooling and drowning the crops. This is important because one can intuitively see that if water use was restricted to an individual's land, the marginal benefit of pumping would rapidly decline while the cost of pumping, electricity, stayed the same.

Pumping for sale allows marginal water that would not originally be worth the cost of pumping to be sold to someone with a differing and greater volume of water. It takes little to imagine a scenario where the option for sale leads to a massive increase in the quantity of water pumped from underground aquifers. The problem is twofold. First, while our example assumed only electric pumps, artesian wells that depend upon pressure differentials to function could run dry from industrial pumping. Secondly, a well is inherently limited by its depth. If an individual drills 100 feet into the earth and the water table is 150 feet underground, the well will is dry. The economic concern in this was that since drilling a well and installing a pump is a capital intensive process, individuals need a way to protect their investment.

Groundwater is a common pool resource and water that is not appropriated today may not be available tomorrow. Pumping for sale puts individuals within a single basin in a literal race to the bottom as the only way to ensure that one recovers their investment is to drill deep and pump as heavily and as quickly as possible. In addition to the costs that one's neighbors may be incurring, aggressive pumping can also destroy the water storage capacity of the basin through a process known as subsidence where the ground becomes compacted and stores less water in the future. In such a hydrological environment, it takes little imagination to understand why one would wish to sue their neighbors over their pumping activity.

Kanazawa (2003) puts forward the argument that part of the reason we see the law change in Katz v. Walkinshaw is that courts were seeing more of these cases being brought using the specific hydrological characteristics of the land as a fundamental argument. Through this process of repeatedly litigating similar cases, we see an evolution in the common law similar to what we would expect from Posner's (2014) model of efficient common law. As Kanazawa noted (pages 170 - 174) in the preceding decades we see a rapid shift in the types of wells being

used: simple pumps that were powered either by animals or the wind were replaced with steam and electric engines. Those who upgraded to new technology were at a pumping advantage relative to their neighbors as they could exert more pressure at deeper depths. For the first time, these new pumps made it cost effective to use groundwater for irrigation. This technology introduced a source of conflict as neighbors now had differing costs structures and ideas about the appropriate use of groundwater. These cost differences coupled with new information about underground flows allowed those with dry wells the credibility to state that they knew, for a fact, that their neighbors were responsible for their current predicament.

What we see in the changes to groundwater institutions is that what was once a previously absolute right to groundwater and the benefits of landownership became abrogated and replaced with a system of relative rights and doctrines of reasonable use. The reasoning behind the change is as technology lowered the costs of accessing subsurface water, economic activities that were previously contained to the land of a single owner started to generate externalities. Institutional rules were changed to deal with this externalities problem and this was ultimately driven by technological change and the lowered marginal costs of pumping water.

4.1 Novel Exceptions to Pumping for Sale – Water Banks

The Water Banks was a legislative innovation during the California drought of 1991 that attempted to ameliorate the drought by allowing the sale of water (Israel and Lund 1995). During a drought, the quantity of water demanded is greater than the supply. The problem was twofold. First, individual water rights are only for the use of a quantity of water and not the water itself. For example, one could use their water right to irrigate their fields but could not directly sell the water to their neighbors. Secondly, water rights are established and maintained through use. If

they are not used, this can become the legal basis for reducing the quantity of one's water right. Combined, this creates a situation where there is no incentive for forbearance. No one wants to voluntarily use less water.

The goal of the Water Bank was to improve allocative efficiency by enabling transfers between individuals with differing values of water. In practice, what this meant was paying farmers in the northern part of the state to voluntarily fallow their fields and allow the associated water to be transferred to higher valued users in the urban part of Southern California. The Metropolitan Water District, the provider for the city Los Angeles and the largest water district in the world, purchased 55% of the total water available through the bank (Israel and Lund 1995, page 11). The Water Bank was successful because the California legislature explicitly passed legislation that not only exempted farmers from reasonable use restrictions, but also guaranteed that participation in the program could not be used as a future justification for reducing water allocations.

The rules of the Water Bank were updated in 1992, of importance for my analysis was that it prohibited farmers from letting their fields lay fallow. This was a political consideration as supporting industries complained about decreased business. If a famer lets their field of tomatoes lay fallow, then they are not sending their product to the canary and fewer seasonal workers will be employed. What this requirement did was ensure that farmers who transferred their surface water rights compensated by pumping groundwater. Even though groundwater was not literally being pumped for sale, the effect was the same as if it were allowed. The Water Bank was a successful short term solution for dealing with the drought by allowing individuals to voluntarily transfer resources within the framework provided by the Water Bank.

5 Water Quality

The California Gold Rush plays an important role in the development of water institutions because it spurred the creation of appropriative water rights and as a result of these appropriative rights being used for hydraulic mining, created some of the very first water quality laws in the nation. Appropriative rights pertain to utilizing diversions from surface flows where the water has to be moved some distance before it can be utilized for economic purposes. Riparian rights are the rights of land ownership neighboring water. Appropriative rights are for taking this water and moving it some distance before it can be used.

In the case of the California Gold Rush, these appropriative rights were used for mining gold. The appropriative rights established a first in time, first in line doctrine of use which limited uncertainty over future use. For example, if one diverted 100 units of water, then that person was entitled to the use of those 100 units. Others could divert additional water provided that their diversion did not disturb the ability of the prior appropriators to utilize their water rights. Practically speaking, if there was a dry season and there was less water available than usual, the oldest appropriators would get their full allotment while the newer claims would go without.

The technological advance that we will focus on is the development of hydraulic mining. Hydraulic mining was a process where pressurized streams of water were used to blast apart mountainsides and the run off was then put through a series of sluices where gold particles would be separated from other, lighter, bits of particulate matter. The resulting slurry had to be disposed of and it was deposited back into the river from which the original diversion was made. The problem came from the large scale at which the hydraulic miners operated as they deposited

millions of tons of silt and sediment into mountain streams. This consequence of all this sediment was that when the rivers reached relatively flat and shallow areas, the sediment would accumulate and the rivers would flood over their banks and devastate resulting farmland. These sediments were also contaminated with mercury, a byproduct of the mercury amalgamation used during the gold extraction process. Mercury is toxic to humans and wildlife and some California lakes carry advisories against eating the fish because of this mining practice.

In response to the destruction of their farmland and the poisoning of the waters, farmers sued to stop the mining. The pivotal legal decisions was Edwards Woodruff v. North Bloomfield Mining and Gravel Company when in January 7, 1884 Judge Sawyer banned hydraulic mining in the state. Hydraulic mining was only reinstated with the Camminetti Act, passed by the United States Congress in 1893, which permitted the mining as long as sediment abatement and detention structures were used. In other words, mining was permitted as long as miners were internalizing the costs of mining and not shifting it onto farmers and other downstream landowners.

The economic logic of this piece of history is that hydraulic mining shifted the supply curve to the right. This new technology lowered the cost of mining and as a result we see an increase in the quantity and intensity of gold mining. The rivers had a carrying capacity for some amount of silt and detritus. The problem was that hydraulic mining was literally moving millions of tons of material by blasting away mountainsides and the carrying capacity of the rivers was overwhelmed. What was a low cost was disposal mechanism for the miners instead shifted part of the cost of their economic activities onto farmers and other landowners. In some cases, towns and cities were wiped away by floodwaters.

What started as a part of the reasonable use doctrine, it being unreasonable to dump that much silt into the river, eventually became part of the public trust doctrine. Apart from the flooding, the silt and heavy metals from mining poisoned the water and devastated the riparian ecosystem. What started as flood prevention eventually morphed into a more generalized environmental protection. Using rivers and waterways as means of garbage disposal are becoming less and less tolerated as it becomes to describe the effects with greater accuracy.

These institutions regarding water quality are a removal of some of the rights in the property rights bundle. Previously, if one had access to a flowing stream, one was permitted to dump whatever garbage or debris they wanted. In small amounts, this was not a problem, all poisons are defined by their dosage. The issue is that as more and more people inhabited the state and engaged in differeing degrees of economic activity, the anything goes environment of the past was no longer tenable. The water quality institutions seek to reduce uncertainty not only through flood protection, but through helping to guarantee access to clean water and healthy environements.

6 Conclusion

Rapid and discontinuous institutional change is to be expected when the benefits of changing institutional rules exceed the costs of change. In the multiple examples provided in this paper we have shown how changes in technology have altered perceived costs and benefits, thereby altering behavior. Changes in behavior led to natural resources being used with different intensities and purposes and to protect the long term value of the resource, institutional rules were altered to maximize the value of these resources. Successful institutional change may itself

suffer from a tragedy of the commons, but as Ostrom has repeatedly shown, such commons problems are routinely solved and such successful resolutions should not be a surprise.

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