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Reevaluating Colorado's Groundwater Policy Framework

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Abstract

Water rights in semi-arid Eastern Colorado is a battleground topic. Between stressed surface water supplies and strict regulation of alluvial aquifers, farmers may face water shortages and impacts associated with high water table levels. Disruptions in farming on a large enough scale can have dire consequences for the local and state economy. Utilizing the framework of Livingston and Garrido's 2004 paper, this study reevaluates the physical, economic, and institutional indicators of the efficacy of groundwater policy in Weld County, Colorado. We find that the most significant changes stem from costs associated with damages and mitigation related to a high water table. Findings may influence state and local government to adjust groundwater policy.

Contents

Introduction

Intensive farming requires substantial water. While some areas of the world may be able to make do with water provided by precipitation, dryer regions must exploit rivers and aquifers to irrigate their fields. Colorado – the agriculturally driven northeastern plains in particular – requires such irrigation. Platteville, Colorado in Weld County receives only 14 inches of rain per year compared to the national average of roughly 30 inches per year (NOAA national centers for environmental information, climate at a glance: National time series.2018).

Considering the dry climate and extensive agriculture of Colorado, exploitation of rivers and groundwater to water crops is necessary. Much of Weld County relies on the South Platte River and associated alluvial aquifers to supply irrigation water. Securing such water is not a simple or cheap process in Colorado. Lawyers and engineers may be necessary to acquire sufficient water to operate a farm (Colorado. Division of Water Resources, 2012). Groundwater, although abundant in parts of Weld County, can be even more difficult and expensive to utilize due to stringent regulations on well operation (Jones & Cech, 2009). Perhaps unsurprisingly, these myriad factors have been associated with reported water shortages for farmers in the South Platte region of Weld County (Silvy, 2018).

In addition to water shortages, local newspaper articles describe negative impacts stemming from an abnormally high water table. Described impacts include flooding of home basements, destruction of crops such as potatoes, and mineral deposits rendering fields unusable for growing. One article on the subject attributes the high water table to the lack of wells in the area. Silvy cites an unpublished study from the Weld County Farm Bureau that states groundwater issues have caused approximately $4 million in damages to local farmers (Silvy, 2018).

This study aims to assess the efficacy of groundwater regulations in the South Platte River valley in Weld County. This study could provide insight into potential complications of strict groundwater regulations in areas with similar alluvial aquifers. In the long run, this study may contribute to the literature on groundwater regulation and inform potential policies.

Review of Literature

Background

Weld County – situated along Colorado's Wyoming border – is the most agriculturally productive county in the state (Colorado. Department of Agriculture Markets Division, 2014). With particular emphasis on grain, corn, and livestock, Weld County produced nearly $1.9 billion worth of agricultural products in 2012 (USDA census of agriculture, 2012). This success comes even though the Front Range and Eastern Plains of Colorado face significant water challenges. While the state's mountains are the source of major rivers like the Colorado and Rio Grande, Weld County is a considerable distance from either (However, Weld County does utilize Colorado River water that is brought to the East Slope via the Colorado-Big Thompson Project. (Nothern Colorado Water Conservancy District, 2018).

the South Platte River runs through the county near Greeley and smaller towns like Platteville, Gilcrest, and LaSalle. Surface flows of the South Platte and the associated alluvial aquifers in the area provide irrigation water for farms in the area (Young, Daubert, & Morel-Seytoux, 1986)

Groundwater Issues in Weld County

Farmers are not the sole beneficiaries of the South Platte's flows. Alongside municipal use and agriculture, hydraulic fracturing accounts for a considerable amount the county's water

usage. One 2017 study found that hydraulic fracturing in Weld County used enough water in 2014 to supply 35% of the population of Weld County for one year (Walker, Anderson, Read, & Hogue, 2017). While this is a small portion of the overall demand for water in the county, competition for water on the South Platte is significant. Between unmet agricultural needs and municipal projects in the Denver Metropolitan area, little water is available downstream (Burr, 2012). Compounded by restrictions to groundwater pumping, this competition has led to critical water shortages for at least some farmers (Silvy, 2018)

In addition to water shortages for farmers, groundwater usage restrictions may be responsible for an increase in the water table in the Platteville-Gilcrest-LaSalle area. According to several local newspaper articles, high groundwater levels have caused damage to houses and affected Gilcrest's water treatment system (Bowman, 2015). One farmer near Gilcrest relocated a significant portion of his potato crop to New Mexico after high groundwater had caused part of the crop to rot in the field. Little discussion focuses on the scope of these groundwater issues. Based on the literature, a conclusion on the number of farmers and acreage affected by groundwater issues cannot be reached (Silvy, 2018).

Gaps exist in discussion of the geographic area affected and the severity of these issues in comparison to previous years. This literature review will inform the research area and methodology of this project. To ensure that the boundaries of the water issues in question are found, research should be conducted in the broad South Platte area of Weld County and beyond to establish a control. Severity of these issues can be gauged by questions involving dollar amounts of damage done to crops and fields. While surveying farmers on the impact of groundwater was not found in the literature, one study using a Likert scale to qualitatively asses the perceived impact of a drought was found (Udmale, Ichikawa, Manandhar, Ishidaira, & Kiem,

2014). A Likert scale could be used to deduce the qualitative severity of Weld County groundwater issues as perceived by the farmers experiencing them and find the frequency of such issues.

Colorado's Groundwater Policy Framework

Much has been written on the intricacies of Colorado's water laws. Certainly, books spanning many hundreds of pages have been published by water lawyers and the conservancy districts. Many water-related lawsuits involving farmers, towns, the state engineer and other entities may be found. For the purposes of this literature review, the primary focus will be the overarching principles of Colorado water law and the primary statutes on groundwater.

Colorado water law is based on the prior appropriation doctrine. This system originates from the California Gold Rush of the mid-1800s. As opposed to older systems of water law common in Europe and the eastern United States, prior appropriation was intended to allocate the smaller and less constant flows of the rivers in the western US. Prior appropriation dictates that those with the most senior rights to the water get priority access to the stream given they divert flows and continually put them to beneficial use. A right holder who ceases to use their flows loses their right. Importantly, prior appropriation doctrine allows for exclusionary use. In times of shortage, a senior rights holder may use as much as they need even if that prevents junior rights holders from using the stream (Jones & Cech, 2009).

Between 1860 and the 1890s, gold was discovered at several locations in present day Colorado. Miners flocked to the area including some with experience in California's prior appropriation system. Like the California Gold Rush, most early concerns over water rights were about mining operations. As irrigation-reliant farming expanded along Colorado's streams and rivers, conflicts led to the doctrine's expansion to cover these non-mining uses. In 1861, the

newly formed Colorado Territory government passed a bill allowing stream water to be used on land not immediately bordering the stream, effectively beginning the codification of Prior Appropriation and rejecting the old Riparian system. (Jones & Cech, 2009). 1872's *Yunker v. Nicholas* case furthered this transition. Importantly, this case gave irrigators not adjacent to streams the right to transport water across someone else's property (Hess, 1916). Colorado's Constitution, adopted in 1876, recognized this right-of-way to transport appropriated water across the land of riparian property owners. Furthermore, Article 16, section 5 explicitly declared stream water as public property subject to appropriation (The constitution of the state of colorado, 1876).

While the above discussion describes the foundation of Colorado's water law, groundwater was neither considered nor legislated during this period. Prior to 1957, groundwater was not considered in prior appropriation laws and was not subject to water rights. The Ground Water Law of 1957 changed this and gave the Colorado Groundwater Commission authority to regulate groundwater withdrawals. In contrast to later regulation, this act did not include consideration of surface water right holders. Further regulation of groundwater came in 1965 and 1969. The 1965 Groundwater Management Act provided the State Engineer with the authority to restrict pumping to protect surface water right holders since the 1957 act did not outline a comprehensive water management stream. 1969's Water Rights Determination and Administration Act required alluvial aquifers (like those located near the South Platte River in parts of Weld County) to be regulated as part of the surface water priority system. According to Jones and Cech, this law was primarily motivated by a 1968 study funded by the General Assembly to assess the condition of stream-linked alluvial aquifers in the Arkansas and South Platte River basins. Optimal use of the South Platte's water resources, the study argued, required

integrated management of surface and groundwater resources. Furthermore, the study concluded that regulation of alluvial aquifers in the South Platte basin was necessary to protect surface right holders' allotments. Regulations require well operators to demonstrate an ability to replenish 100% of their withdrawals. Also, well operators must present an augmentation plan to the courts (Jones & Cech, 2009)

An augmentation plan, according to the Colorado Department of Natural Resources Division of Water Resources, is a plan that allows the well operator (who is a junior rights holder) to use their well in a way that does not infringe upon senior rights. Such plans require a detailed application describing where the water comes from, its intended use, how it will be replaced, and how the augmentation water will be handled. The augmentation application requires analysis from an engineer, and the application is usually completed by a water lawyer (Colorado. Division of Water Resources, 2012). Applications can be very expensive. According to one report, the average irrigator can afford to spend $1,000 per acre-foot. Water acquisition on the South Platte can be greater than $10,000 per acre-foot (Great Western Institute & Colorado Water Conservation Board, 2010).

Groundwater Management

Significant literature exists on the efficacy and impacts associated with groundwater management from an economic perspective, though little focusses on the South Platte alluvial aquifers. Despite this, discussion of the general principles and potential impacts of groundwater policy at large may aid understanding of the issue in question.

Young, Daubert, and Morel-Seytoux discuss management of the alluvial aquifers along the South Platte in their 1986 article. The article argues that strict adherence to the prior appropriation doctrine with the South Platte's aquifers would negatively impact farmers.

Interestingly, this study finds that the previously mentioned augmentation plans requiring irrigators to replace all groundwater withdrawals is economically beneficial. The author's model shows that unrestricted access to the aquifers could hurt surface right holders in years in which surface flows are below average (Young et al., 1986).

In contrast to this study, much of the literature on groundwater management uses complex hydrologic and economic models involving many variables. However, these studies often come to conclusions relevant to this project. For instance, analysis of groundwater policy in Western Kansas using a hydroeconomic model found that localized groundwater policies provide greater net benefits than broad management policies. The study determined that simple policies based on price, quantity and water rights markets perform poorly compared to localized management (Guilfoos, Khanna, & Peterson, 2016). Another study also focused on Western Kansas found that benefits of groundwater management differ based on aquifer characteristics. By differentiating aquifers based on factors related to recharge rate, hydrologic conductivity, and water demand, this study determined that management benefits vary (Edwards, 2016). Other factors that may impact the impact of groundwater policies include well capacity, weather patterns, and soil composition (Hrozencik, Manning, Suter, Goemans, & Bailey, 2017). All of the aforementioned studies contrast with Colorado's current groundwater management scheme. Other than a few exempted areas considered non-tributary to surface water, groundwater and well permitting is uniform across the state (Jones & Cech, 2009). These articles argue that such a broad approach may be inefficient.

Although the most efficient possible management policy may not be possible, discussion of environmental economics principles like maximum sustainable yield (MSY) and optimal yield are useful for discussing the goals of groundwater management. Sustainable yield may be

defined as "…the rate of extraction or harvest that maintains a particular population or stock level…" (Roumasset & Wada, 2010). Considering the augmentation requirement that Colorado well operators be able to replace 100% of the groundwater they withdrawal, it appears that the state's groundwater policy considers the current level of the South Platte's alluvial aquifers to be the desired stock level. Roumasset and Wada argue, however, that MSY is not economically optimal aquifer management. When maximization of present benefits is considered along with the cost of substitutes, a level above or below MSY may be preferable. For the purposes of this project, it may be useful to ask farmers if they would benefit from increased access to groundwater sources.

Livingston and Garrido's Framework

While groundwater policy and management are complex and multifaceted, Livingston and Garrido (2004) identify physical, economics, and institutional factors as the primary indicators of the efficacy of groundwater management. Within each of these three broad categories are several specific aspects found in Appendix A along with a qualitative assessment of the efficacy of different policy tools on managing each aspect. Livingston and Garrido then use these physical indicators to compare case studies in Colorado, Texas, and Spain (Appendix B).

Although Colorado's groundwater policy framework has already been studied, it stands to reason that much has changed in the last 17 years. Utilizing Livingston and Garrido's indicators, this paper reevaluates Colorado's groundwater policy, institutions, and the physical conditions of alluvial aquifers associated with the South Platte River in Northern Colorado.

Changes in Physical Indicators

It is unclear the precise geographic are of Colorado that Livingston and Garrido included in their assessment of the state's groundwater policy. Data from the Colorado Department of Water Resources indicates that groundwater levels in the South Platte River Basin between Denver and Greeley indicates that groundwater levels have increased dramatically since the early 2000s. Typical groundwater depth measurements near Platteville in 2005 were between 0 and 5 and were between 10 and 20 in 2020 (CDWR, 2021).

No data was found on the level of pollution in Weld County's alluvial aquifers, their hydrological resilience, or their link with surface water. There is no evidence to suggest any of these aspects have dramatically changed between Livingston and Garrido's work in 2004. It is the author's opinion that the high level of groundwater noted in the area suggests a high degree of hydrological resilience.

Changes in Economic Indicators

Economic factors appear to be both the greatest change in policy indicators since Livingston and Garrido's study and the most difficult to measure. Jones and Cech (2009) suggests that the process for obtaining a well permit on the South Platte's alluvial aquifers has become more stringent since 2004. As previously mentioned, well operators must present an augmentation plan and demonstrate the ability to replenish withdrawals. While it is clear this process is costly, precise data on changes in well operating costs is not presently available.

An additional layer of costs comes from the mitigation of high groundwater affects noted in Southern Weld county since the late 2000's. While direct damages are discussed in the literature review, little data exists on these direct costs. The South Platte Basin Roundtable's Groundwater Technical Committee proposed several potential methods to mitigate groundwater

damages ranging from formalizing drainage districts to increasing groundwater pumping in areas with high water tables. One consistent con mentioned in almost every proposal are high initial costs (SPBR GTC, 2018). More data is needed to quantitively assess changes in relative and absolute pumping costs.

Livingston and Garrido suggest that the diversity and number of users on a groundwater system are important indicators of the difficulty of coordinating interests and incentives. Certainly, the users of the alluvial aquifers in Weld County and the associated waters of the South Platte River are many and include a blend of agricultural producers, municipal projects, and oil and gas drilling operations (Silvy, 2018). Agricultural producers have a significant financial incentive to sell senior water rights to the later two groundwater users, however the divergent interests of each group may cause conflict and test the relevant water institutions and authorities.

Changes in Institutional Indicators

Little has changed in the institutional powers overseeing the South Platte River Basin. Legitimate user associations such as the Central Colorado Water Conservancy District and the South Platte River Basin Roundtable can oversee negotiations and stakeholder issues, while the Colorado Department of Water Resources and the governor's appointed water czar oversee state groundwater policy. Demand management and allocation rules are present and even included in the state's constitution. One apparent difference in management rules since Livingston and Garrido's paper is the requirement that well operators demonstrate the ability to recuperate 100% of well withdrawals (Jones & Cech, 2009).

Conclusion

The level of complexity involved in the South Platte's groundwater management – not to mention the management of groundwater at large – is considerable. Reports of damage to deep rooted crops, salinization of fields, and critical water shortages warrant investigation into the scope and severity of these impacts. Analysis of laws and permitting requirements reveal that high groundwater levels may stem from the legal and financial issues associated with operating wells in Colorado.

Utilizing the framework outlined in Livingston and Garrido's 2004 paper on groundwater policy, we evaluated changes in Colorado's groundwater conditions and management. We found that physical indicators have remained largely consistent except for groundwater levels which have increased significantly. Data on economic indicators of policy efficacy was found to be lacking, but there is reason to believe that costs associated with well operation and mitigation of high groundwater levels have increased significantly since 2004. Additionally, an uptick in municipal purchases of water rights and increased oil and gas extraction have led to a more diverse pool of groundwater users with diverging interests and incentives. Institutional indicators of groundwater policy have remained largely unchanged since the original study.

Future research is needed to more precisely quantify the changes in well operation costs since 2004. Surveying well operators in the South Platte River basin would provide valuable data on relative and absolute pumping costs and the diversity of users of Weld County's groundwater.

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