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How Metrics Shape Water Politics in New Mexico: From Quantifying Governance to Active Monitoring

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ABSTRACT: The politics of quantifying water are nothing new to the state of New Mexico. Indigenous views of water as integral, holistic, and bound to the land were shaken by Spanish Colonial norms of water infrastructure, metrics, and institutions. A second abrupt shift into Anglo-American water metrics tied to western homesteading emerged at the start of the 20th century. The Anglo-American system of assigning private use rights to water has resulted in more bureaucratic metrics far removed from either indigenous or – understandings of water. Interestingly, Spanish and Anglo-American forms of settler-colonial water metrics were not completely incommensurate in their intent despite their qualitative and quantitative differences. *Surcos*, a qualitative metric of water for the Spanish, and American acre feet both measure the amount of water needed to cover an area of land and were employed for active land settlement. It was not in the award phase of settler-colonial water rights that water metrics became most problematic. Based on over a decade of ethnographic work in the state, I argue here that the current politics and contestation of water quantification in the state of New Mexico are driven by changes to water governance when new technologies and policy measures are used to govern and monitor water users less transparently.

KEYWORDS: Water metrics, politics, water governance, New Mexico, USA

INTRODUCTION

In New Mexico, two long-phase settler-colonial periods altered the experiences of existing Indigenous land, water, and cultural relationships. The first phase, Spanish Colonial and Mexican national officials measured water use and allocation in distinct ways from the second (current) U.S. nation-state. The distinctions in these approaches to land-water metrics are important to understand in contemporary New Mexico. Different colonial or national metrics are reflections of differing ideologies of what land and water mean. These differing societal ideologies produced distinct approaches to the software (policies, laws) and the hardware (infrastructure, dams, canals) of water governance and water allocation. Measuring water and metering users might seem straightforward, yet quantification is always fraught and political (Perramond, 2016).

Water-user stories of contested water measurement reflect every spatial and historical scale of political discord over water measurement or being measured as user of water. Individual water rights, or ditch-wide communal water rights, are used by the state to manage water users. Distinct cultural framings against the quantification of water are premised from alternate cultural norms of how water metrics are used and to what end. In both the Spanish and the later Anglo-American U.S. systems, new units and metrics for measuring water shifted water governance and redefined water itself (and water users).

Contemporary concerns with water metrics in New Mexico, however, are less about water rights and the measurement of water *per se*. Instead, political friction, protest, or accommodation arise from how *quantitative metrics* are perceived to be used by the state to monitor water users. Here, I argue two

points related to the quantification of water. First, settler-colonial water metrics shaped new norms of (water) property and approaches to water. These norms must be understood before addressing the politics of modern metrics. Second, as the state of New Mexico began to monitor and enforce more recent water rights and quantities, the contemporary politics of water quantification became more apparent because new forms of water measuring technology became less overtly visible to local water users.

In both Spanish and Anglo-American systems, the differing cultural metrics of quantification were about awarding and allocating water to new settlers. The more recent assignment of individual and quantitative water use-rights as a form of property has had important consequences (Rodriguez, 2022). These new settler 'rights' and access to resources, following Curley (2021b), were 'produced' by dispossessing prior peoples of these same lands, water, and landscapes.

Epistemologies of water and its purpose, imposed under two different regimes of settler-colonialism, created new water realities of use, duty, and politics in this region (see Lane, 2024 for more). Each system of new water metrics became, over time, the standard for quantifying a new form of water governance through water tenure, whether communal and more qualitative (Spanish) or individual and quantitative in nature (American). New Mexico's current politics of water quantification reflect the land and water metrics introduced under the two waves of settler-colonialism.

Since the mid-20th century, when the New Mexico Office of State Engineer began to actively monitor flows and water use, the politics of water quantification have become more contested. Below, I include ethnographic vignettes to demonstrate how these new metrics are received and contested and why they matter so much.¹ I first discuss past communal metrics, then the later individual water rights in acre-feet, and finally what shapes the contemporary politicization of water metrics when applied to monitoring water use and users in New Mexico.

NUEVOMEXICANO WATER METRICS

Floodwater irrigation has long been utilized in semi-arid New Mexico. Some Indigenous Pueblo communities relied on floodwater farming and off-river channels to irrigate their fields (Bryan, 1929; Vlasich, 2005). However, more permanent ditch (irrigation channel) agriculture was not as common until the arrival of the Spanish in 1598. What native peoples saw as integral, holistic, and bound to the land was shaken by Spanish Colonial norms of water infrastructure, metrics, and institutions (Arellano, 2014).

We need to acknowledge the logic of settler-colonial dispossession in this process. As Wolfe (2006: 388) put it, "the breaking-down of native title into alienable individual freeholds" was one of the principal policy technologies by which to sever Native and/or communal ownership and "free up territory" for later settler individual citizenship through private property (see also Veracini, 2010, 2015). The first settler-colonial shift to a new water metric happened under the Spanish regime of water governance. Spanish Colonial water and land policies reflected an agrarian, pre-industrial era, where water still bound people, ditches, and villages together. Nevertheless, lay Spanish settlement and colonial policies worked to dispossess Indigenous communities of previously planted, arable land, and 'forced accommodations' were imposed on Pueblo farmers especially. Forced labour, captivity practices, crop tributes to the Crown, and conversion to Catholicism all featured prominently in the colonial period of 1598-1821 (Ortiz, 1969; Gutiérrez, 1991; Brooks, 2002; Brown, 2013; Ebright et al., 2015).

Notably, the Spanish brought the *acequia* ditch and institution to New Mexico. An *acequia* is both a physical ditch and an institution, governed by a *mayordomo* (ditch boss) and three water commissioners. *Parciantes*, the members of an *acequia* ditch, share in the communal use of the water and pay dues for

¹ All ethnographic source citations, apart from Arellano, are pseudonyms. The long-term field work and interviews took place between 2007 and 2017 and research protocols followed Colorado College's Institutional Review Board.

ditch maintenance. In addition to regular dues, *parciantes* are also responsible for either directly cleaning the ditch during the spring season before irrigation or paying for someone to clean their share of the ditch. These ditches, offices, and institutional practices are still in use today, even as they struggle to clean out ditches with local labour and to sustain local interest in the ditch customs. The *acequias* also used distinct metrics to measure land and water according to customary use. These metrics were more qualitative, relative, and based on need instead of absolute quantitative empirical data.

For land, the Spanish did rely on fixed measurement metrics like the *vara*, a unit of measure roughly equivalent to a yard (roughly 0.835 m). However, colonial, and post-colonial (after 1821) authorities did not extend the logic of a fixed quantitative metric to water. Instead, the concept of the *surco* was more common. A *surco* was counted as either one share along a ditch, or however many shares (*surcos*) were needed to fully irrigate a pasture, a field, or an orchard. Interestingly, however, a *surco* was not a fixed unit with a standard volumetric metric, but instead enough water per share to satisfy household or field agricultural fields (Arellano, 2014). This matters in that Spanish and later Mexican governance practices understood that "water was different from land" (Arellano, 2009) at the level of use and allocation for small villages and farms.

The quantification of water during the Spanish and Mexican periods of New Mexican history reflects the 'rustic precision' of Spanish and *NuevoMexicano* water systems. Strong foundations from Moorish water law structured on-the-ground assumptions about the communal, shared nature of water, and shaped much of the language around water infrastructure. Precision was less necessary in this communal, agrarian, setting, as long as there was enough water in any given year. Water was shared. As Juan Estevan Arellano (2009) explained at length to me,

the *acequia* was a not-so-simple-gravity fed water ditch, dug on both sides of any valley, with a pretty rustic diversion... rocks, logs, whatever we could use, and *parciantes* would irrigate according to how much water was available. The *mayordomo* would enforce amounts, or timing of water use if we were in shortage or drought, and the commissioners would try and keep the peace, a budget, and follow state guidelines and rules on meetings and elections. The system still works if we choose to keep it.

Figure 1 shows the *vara*, the Spanish unit for measuring distance and land, wielded by an unnamed surveyor, alongside the alleged founder of Santa Fe (Pedro de Peralta), memorialized in bronze outside the main Santa Fe post office. While the *vara* may have shaped the metric or length of ditch (*acequia*) an individual was tasked with cleaning in the spring, the *vara* was not coupled to a water metric under Spanish or Mexican rule. A cleaning *tarea* (task) for each ditch user would be around two *varas* long. A more key water measure for irrigators was the *surco*, which, as mentioned above, was not a fixed quantitative measurement. The ditch- and land-specific nature of *surco* measures was key to the pragmatic function of this unit.

Today, most (but not all) New Mexicans generally think of their water rights in acre-feet, the standard metric set by the 1907 water code (as will be discussed more below). However, for most of the last century, irrigators along *NuevoMexicano* *acequias* thought in terms of *surcos*. *NuevoMexicano* elders along *acequias* today still often harken back to this unit, or even record the unit in their *mayordomo* journals and logs (on paper). *Surcos* refer to swells of water moving through a ditch.

During over a decade of ethnographic research, irrigators often described *surcos* to me in hand gestures, indicating how deep, wide, and strong water flow must be in a particular ditch to be considered a measure of flow to cover a field. Juan Estevan Arellano (2009) explained how the *surco* could be broken down into finer measures for calculating a *parciantes*' water 'share' along the ditch: "half a *surco*, a full share, two *surcos*, and so on. It was also sensitive to any urgent need or request by a *parciantes* for special help... we made exceptions, not strict rules". A *surco* varied by ditch, and irrigators only a few miles apart could have different understandings of the measure (Arellano, 2014). In root language origins, the term *surco* comes from the Latin word for 'furrow', showing its pragmatic links to land and flood irrigation.

Figure 1. Photo of a surveyor holding a vara, part of the Pedro de Peralta statue found north of the Santa Fe post office.



Source: Photo by the author, 2018.

Logically, mayordomos allotted surcos not by quantitative volume but more by time rotations, based on how much water was available and/or needed to fully cover an individual field and the irrigator's needs and priorities. The advantage of this system is that it inherently created enough hydraulic force to irrigate entire fields. Today's system of individual rights in acre-feet does not explicitly do so. Some mayordomos still view acre-feet as an imprecise or a false metric since it ignores the actual physical properties of a field. Different soils, slopes, and inter-cropping call for different water applications and proportions instead of a fixed acre-foot unit. The acre-foot system is a universal measure, blind to agroecological needs or uneven topography, offering a kind of abstract and false precision that no one used (or could measure) at the time the metric was introduced.

As Arellano reflected on the acre-foot, back in 2009,

the acre-foot... I mean, who irrigates with a full foot, and we didn't really use acres back then, since we used the long-lot system and varas for measuring land, it was completely foreign and abstract as a measure... it didn't embody any local sense of understanding about water here, how it behaves, how it varies on the soil, you know? We wanted on the field, spread out evenly, to get to the seeds we put in, not just flooding a field a foot deep...but the state wanted to award acre-feet when the water was under adjudication, so people understood they were still going to get water... just in some different unit. It wasn't too controversial once people understood it was just a different measure.

The use of water rights not only varies in quantity and nature, but also in cultural-scientific norms of measurement. This is important. While the stakes of this difference may not seem crucial, there is an important distinction between how much total water flows through a main or lateral canal and how much water irrigators are allocated to use from any particular portion of the ditch system. The mayordomo, or parciante, does not really care how many acre feet are moving through the canal, as the surco was a rough, qualitative flow rate meant for field coverage. What they care about is that water reaches all parts of their planted field, or their garden, or a livestock tank.

Mayordomos allocated water based on its availability, weekly and seasonally, rather than by some universal measure. The surco qualitative flow practice was inherently variable even from ditch to ditch, but need of a water user was one of the factors that underscored its use as a unit of allocation. The

concept of 'need' was also relative to the property size, the crop, the size of the family needing water, and was flexibly accommodated along these ditches. Since mayordomos and parciantes understood that there was no such thing as an 'average year' for water, allocations were based on what was available in snowpack and water, not a fixed inviolate amount that would come to be seen as inflexible under the American system of acre-feet of water. As one seasoned irrigator from the Mimbres River region put it, "we knew we didn't have absolute rights to some quantity of water, it was just.... What we needed to use for particular crops in some years" (Lopez, 2010). Water rested with the ditch, in the village, with communal labour and participation in the NuevoMexicano communities. Under the new system imposed gradually in the late 19th and early 20th centuries, however, water would be individually defined and privatized as a user right.

This shift led to instances of water rights disputes over the form of water tenure. Namely, there was friction between the *communal* acequia norms of water access and the state's later legal system of allocating *individual* water rights (Crawford, 1990; Rodriguez, 2006; Arellano, 2014). Acequias sometimes ignored the official dated and measured individual rights. However, the state turned these measures into a legible map for enforcing priority across the state, thereby creating a new form of politics over water's measures and metrics.

FROM COMMUNAL SURCOS TO INDIVIDUAL WATER RIGHTS

After the US-Mexican War of 1846-1848, the region became the Territory of New Mexico and included the current state of Arizona. During the territorial period, between 1848 and 1912, an increasingly common metric for water, one that a mayordomo in the Rio Embudo called a "false precision" (Arellano, 2009), was unfurled and deployed: the acre-foot.² Tying a water metric to a new unit of land was inherent in nascent U.S. land policies. The Homestead Act of 1862 was one of the primary means through which this new land metric of an acre was visible, as authorities in the territorial period tried to impose a new water metric tied to land (Collins, 1984; Anderson, 2011).

Bound to the new 'American' grid logics of public land survey system of private property and homesteading (Blomley, 2003), acre-feet as a metric began to work its power in asserting a new quantification of water 'rights', breaking from communal understandings of water. NuevoMexicano communal land grants were fraudulently parcelled out to individual ownership through various legal and court arrangements over decades (Montoya, 2002; Correia, 2013; Roybal, 2017). This loss of communal land resonates in cultural memory for NuevoMexicano and is one of the clear reasons that irrigators in New Mexico view individual water rights as problematic. This privatization of water allocations, especially under the prior appropriation legal framework described below, had far-reaching consequences at both local and state levels (Schorr, 2012).

The individuated, private, approaches and measures to land and water clearly benefited (new) settler-colonial pioneers. The hope in counting this water, and water users, on a map was that some water might be left to allocate to future settler or alternative uses. This new approach to individual water use rights was corrosive to existing indigenous communities because their water claims were ignored for decades (McCool, 2002). Even after the landmark 1908 Winters case heralded some recognition for federal reserve waters, states continued to ignore the implications, and the U.S. federal government did not formally engage Indigenous water settlements until decades later. As others have pointed out, the Winters case was more about protecting federal reserve waters and authorities for navigable rivers, national forests, infrastructure, and the like than it was about protecting Indigenous water rights (see Curley, 2019).

² One acre-foot is equivalent to 1234 m³.

The abrupt shift into Anglo-American water jurisprudence at the start of the 20th century brought bureaucratic metrics removed from both Indigenous and NuevoMexicano approaches to water. The 1907 water code implemented a private use rights approach to water known as prior appropriation. Under this 'software' for water governance, individual rights were assigned by date of first proven beneficial use of water. Older water rights were considered 'senior' and had priority over more 'junior' rights. This new metric of the acre foot and new system of privatized water allocation by individual dates were not immediately controversial because they were largely ignored by communal acequias and their irrigators.

These new water metrics would offer the illusion of precision, created by a new nation-state phalanx of experts. But existing ditch dynamics in New Mexico confounded Anglo-American understandings of land and water tenure. Territorial period courts struggled to understand, reconcile, and render decisions between existing ditch users as judges had little understanding of the prior legal norms of water use, allocation, and enforcement on a communal water basis (Lane, 2011). The formalization of use rights as transferrable 'property' assumed that water could be transferred away from the original parcel of irrigated land. Severing water from the land represented a drastic change from the aggregate village approach used along ditches (acequias) in New Mexico.

Water quantities in the 'modern metric' era of water, after the enactment of the 1907 water code, reflect the state logic of atomized and individualized access water rights. Anglo-American water norms, reflected by the Office of the State Engineer, started to quantify 'averages' of the *duty* of water: how much water was needed for what kind of crop, in what part of the state (Wescoat, 2013). Volumetric water arrangements for the duty of water for a single field did not include considerations for variations in slope, grade of field, the type of soils, or groundwater levels. Water 'duties' represented yet another universalizing 'expert' approach that tied field crop commodities to a new commoditized understanding of individual use rights water.

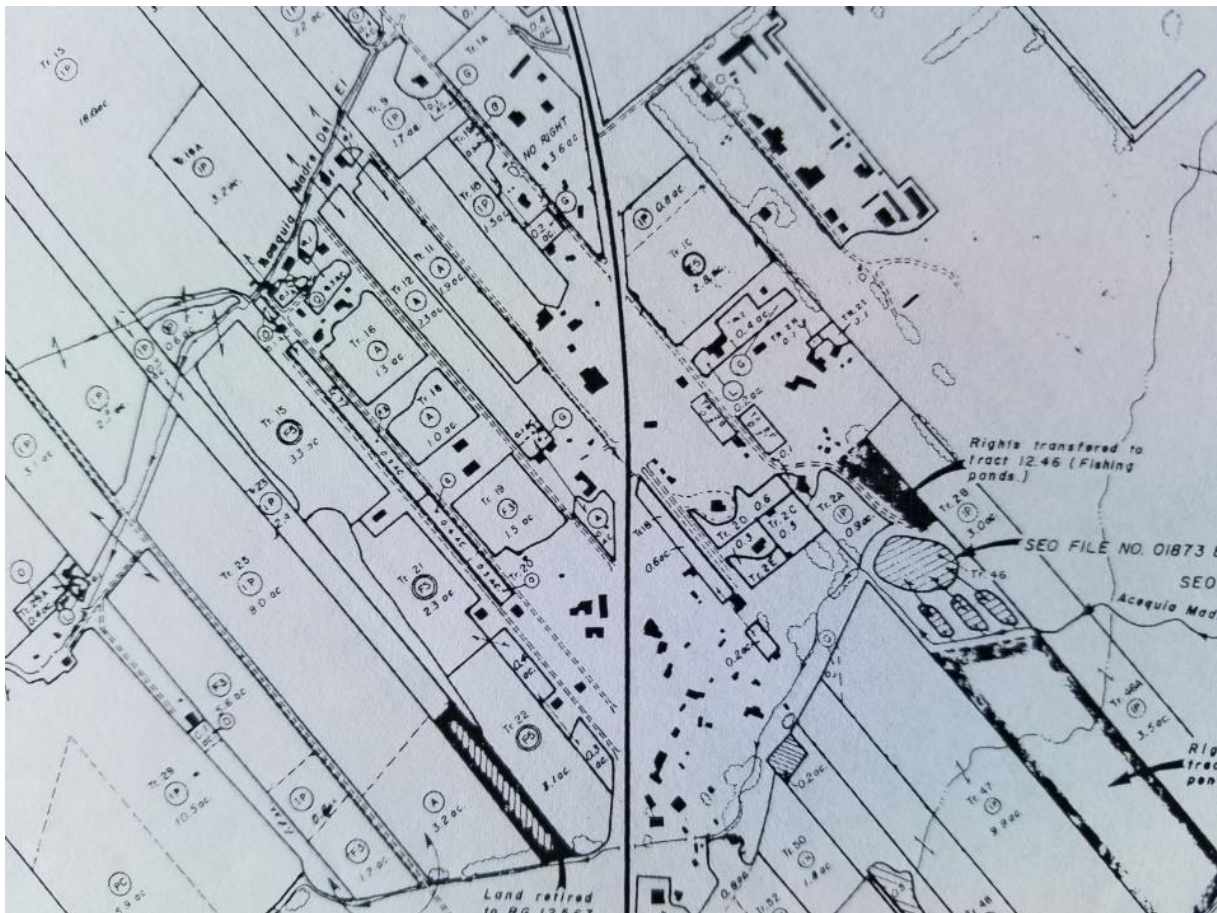
As one elderly *parciante*, Daniel Fernandez (2012), in his eighties at the time of the interview, from the Santa Barbara drainage shared with me:

We didn't really worry about prior appropriation and individual water rights and dates until the state [OSE] started adjudicating basins and trying to give out specific water dates to specific people. That is when we pulled together in acequias to argue for common, single date ditch dates, based on a village's founding. So, we all have the same date, we don't have our waters broken up, and we can continue to use the water that is here in this or any valley... but it's real water, it's what we have available in any given year, not just paper water rights. It's a more... natural approach to working with water. You can't irrigate if there's no water in the ditch, and you don't have to worry about cutting people off in a great year when there's plenty of water. We use what we have and share in the tough times when there's nothing or very little. Still works.

Figure 2 shows a sample adjudication map with all crops, duties, and field-bound measures from the Taos region of the late 1960s. The state-assigned duty varies not only by the crop being grown (at the time), but also by the location of the irrigated parcel, with hotter and drier areas typically receiving a higher duty (measure) of water for the assigned crop (see Wescoat, 2013 for more on duties of water). Such specific mapping was tedious, labour-intensive, and essentially outdated by the time it was completed. However, the approach of privatizing land and assigning water-use rights to individuals was never much in question by the emerging state. The state of New Mexico had to estimate how much water was being used by area, and by crop, to have an accurate 'count' of water use.

Most importantly in this shift from communal to individual metrics, once the water accounting was complete, through an adjudication or settlement process of these water rights, water rights could be sold and severed from this same land. Daniel Romero (2011), an irrigator from the Taos Valley, shared his thoughts on this transition between communal acequia and privatized individual water rights:

Figure 2. Close-up sample of an Office of the State Engineer map of the Taos adjudication survey performed in the late 1960s.



Note: Crops are specified and tied to amounts of 'acre-feet' of water as per the 1907 water code. The key point here is that these data and associated methods are static (see Lankford, 2004 for more). They are not (currently) updated in any live record-keeping system (unlike the states of Colorado and Idaho, for example). This 'water accounting' also shows how water use was seen by the state as individual, not communal. Photo of map detail by the author.

I think the main concern was that OSE was trying to break us up, into like... individuals, rather than a whole ditch as we currently operate. Once we kind of understood what they were mapping, looking for, asking about, we got a bit more comfortable, but we still had to fight like hell to keep a single date for the whole ditch so that we [irrigators] wouldn't fight each other for some earlier in time right... which didn't exist, since the whole town is from a single date and no one was really keeping records of what month or year we started irrigating, it's the village date, the ditch date overall, that matters.

Once NuevoMexicanos understood that the rather arbitrary metric of 'acre feet' would largely serve the same agrarian and settler-colonial irrigation purposes as surcos did, the superimposition of the new acre-foot measurement created little friction. Indigenous sovereign nations, however, viewed these new forms of land (and thus water) metrics as more 'settler-colonial déjà vu' and a further route to dispossess not only land, but the water itself (following Whyte, 2016; Curley, 2021a). Why would an occupying force, after all, quantify if not to ultimately dispossess resources? As a Diné farmer publicly stated to a panel of water experts during a water conference, "your [white] perspectives on water are just linear, they don't reflect any reciprocity with water or others who need and want water, it's just a one-way street to extraction...still" (Deetz, 2024).

ACTIVE MONITORING: WHEN QUANTIFICATION MATTERS

While land and water metrics were not immediately problematic or political at the local scale of ditches throughout New Mexico, they started to be as the Office of The State Engineer (OSE) began to assert greater powers of water governance over local ditches. One of the more potent tools that the OSE now has available is the Active Water Resource Management Act, passed in 2002.

Introduced after the 2002 drought which struck several southwestern states in the United States, the Active Water Resource Management provisions in the water code now allow for the OSE to actively enforce prior appropriation and enforce cut-offs and irrigation times even in areas that have not yet been fully adjudicated – in areas where the 'state's map' of water rights users and owners is incomplete, partial, and not yet certified. River, water, and special masters can all be appointed by the OSE or a state supervising court and the variation in terminology can be confusing, but the effects felt locally can be the same.

Several New Mexican basins are now subject to this new program called Active Water Resource Management (AWRM or 'a worm' as it is typically pronounced in New Mexico). To some irrigators, this 'solution' to 2002 drought has been more upsetting than the drought itself. Much of the continued resistance has to do with AWRM's main components: the new meters for monitoring and the 'special masters' with broad powers to control flows and settle water disputes.

New water flumes and water meters were installed throughout the basins with disputes (see Figure 3 below). These flumes were often poorly sized and dropped into larger, wider ditch banks. When too much flow moves through, the flumes can constrain flow and create flooding behind the flume, an ongoing frustration for mayordomos trying to allocate water or settle disputes. Even more frustratingly, the data provided by the flumes went only to the state. The special masters adjudicated water disputes based on numbers only they could see.

These new powers to monitor ditches and users rubbed irrigators the wrong way, even in basins that have been adjudicated. In the Mimbres River Valley of southwestern New Mexico, a basin that was adjudicated in the late 1980s for water rights, Fitzgerald (2010) expressed his frustrations about the redundancy of AWRM measures:

If we have quantified water rights, and we have mayordomos, then why is the state coming in during a drought to tell us what to do when we already know what to do... that's what acequias do, for God's sake, we have already shared in the shortages, it's pretty unnecessary and bureaucratic. Why do they have to meter us if we police ourselves already?

Thus, even in areas where state presence, adjudication, and individual water rights have been part and parcel of daily life for decades, these new powers of active management after changes to the state water code in 2002 produced volatile reactions to state management.

As Antonio Morales (2010), an irrigator from the Pecos River explained it to me,

a lot of us were in favour of trying to get some help from the state, but we had no idea that the OSE would just send some random person into our valley, who didn't know us or understand what the disputes were, to try and do water management. They were either special masters, or a river master, but it just became a kind of middle management that we [mayordomos] did not need or ask for... it was a hard adjustment period, and there are still flooding incidents and locked headgates we can't open because only the AWRM master has access to this technology and stuff.

Figure 3. A Las Vegas (New Mexico) irrigator inspects a water gauge placed on a too-narrow flume, itself imposed on an older earthen acequia.



Note: As a closed system, these water gauge data are seen by agency personnel at the OSE, an example of how certain technologies render state monitoring of water use less apparent to the public in New Mexico. Source: Photo by the author.

Flumes and gauges were one part of the AWRM toolbox. The second involved human intervention. Special masters and river masters were assigned by the OSE and given powers to administer water using prior appropriation rules, even in *basins where water rights were not adjudicated*. From the OSE's perspective, these special masters would serve as a neutral third party to help settle disputes or long-term water challenges. Typically, these individuals have some background in water resources, although their level of expertise is highly variable. They are also not necessarily from the basins they serve. As Steven Loreto (2012) from the Pecos Valley put it, "these guys think they're the mayordomo of mayordomos, it creates problems for us since they're not elected by our irrigators". This has added vertical complexity to water governance and water allocation in areas that have long held a place-based approach to hydrosocial relationships (Rodriguez, 2006). The state insertion of new governance agents made water management less flexible, timely, and transparent to local water users, *parciantes*, and *mayordomos* (Perramond, 2019).

The AWRM program highlights two important aspects: first, the role of new 'experts' and the new metered, less locally visible, vision of water. Second, AWRM was deemed necessary by the OSE for times of water scarcity (drought). Despite challenges to the AWRM rules by water users, a state court in 2012 supported the new measures and affirmed the State Engineer's broad administrative power to allocate water in basins that have not yet been adjudicated. "It's pretty frustrating that we haven't even had our acequia waters and rights quantified and yet the state is coming in presuming to know how to govern, direct us, cut us off, allow us to irrigate", said Antonio Morales in 2010. "Like that's our job as *mayordomos* to handle those day-to-day operations, not some guy from Santa Fe an hour away".

Older, prior understandings of water as communal, as sacred, and as local continue to adapt and respond to these metrics. Each new incremental power sought by, or afforded to, the Office of the State Engineer is questioned, excepted, or resisted by certain parties aligned with those currently still-existing water cultures. Irrigators and mayordomos mostly objected on two major points. First, the new quantifying *technologies* such as flumes and meters produce data illegible to local ditch institutions. Without data sharing, resentment can build regarding surveillance and the use of the data. Acequias have always had conflicts between users and ditches. However, those disputes could be addressed face to face, locally, rather than by a state bureaucrat. Now, seemingly, only the OSE-assigned special master has the 'data' to resolve disputes or understand what is being metered and measured. As irrigators often see it, they and their local metrics of governance are being ignored.

Second, by inserting special masters as part of AWRM policy, a new layer of 'middle managers' governed mayordomos. As a result, the OSE created a new level of abstracted *governance*, since out of basin special masters are less present and responsive to actual hydrological behaviours along streams and even ditches. The software of new metrics, then, must be rightfully coupled to physical infrastructure that does not create further problems along river systems. This was especially important and problematic in the Rio Pecos drainage between ditches trying to coordinate water allocation and amounts. As Steven Loreto (2012) put it,

A flume should measure the flow, sure, but not give us more flooding headaches because it wasn't sized properly. We then got blamed by another ditch downstream that were holding back water and not letting the water get to them... it was ridiculous!

Both the software (governance) and the hardware (metering) generate these frictional politics along ditches and irrigation districts in New Mexico.

THE POLITICS OF WATER GOVERNANCE, QUANTIFICATION, AND MONITORING

Nearly all water users in New Mexico are now subject to water governance through metrics. This is true whether one is walking along a highly diverted montane stream still operating under the acequia system or along one of the more recent federal irrigation projects in southern New Mexico in the Elephant Butte Irrigation District. State agencies and experts have an increasingly distant relationship to water itself; water 'managers' have reinvented the river as a post-modern circuit diagram. If water became 'modern' through the invention of H₂O (Linton, 2010), it became fully integrated into the circuits of capitalism through the distancing of water from humans. These new metrics 'flatten' the complexity of past cultural water metrics to simplify legibility for the state (Vogt, 2021).

Settler-colonialism continues to install, enforce, and manage structures of colonization. This is more visibly apparent in the form of infrastructure, the so-called "beach heads of settler-colonialism" (Curley, 2021a). Yet just as important, the software of legal norms – in the form of water rights, metrics, and new governance schemes – are fundamental to and often *precede* the physical infrastructures that dominate landscapes in the American West. Law was a form of conceptual technology that often led the way to material technologies like dams and diversions (Perramond, 2019).

Both legal software and concrete infrastructure (hardware) help 'theft' become property (Nichols, 2020) in ways that are seemingly legal but no less violent. Quantification is not seen by rural New Mexicans as any different: enumeration serves a purpose, and its purpose may be to move water away from their streams and ditches. The degrees of freedom between actual water in a stream or ditch, and what large infrastructure water operators now do, seem a world apart. This post-modern, capitalist, and highly 'scientized' water cannot be operationalized or used for governance of water users without quantification. It is also arguably why settler-colonial strategies of quantification cannot be ignored, elided, or absent from discussions of water governance. Quantification, expertise, and extraction were

and remain intertwined with settler-colonialism, in almost any setting, whether for land, water, or governance of new subjects (following Mitchell, 2002).

There is no escape from using a kind of measurement or metric, much less big data, in our current daily lives or politics (Nost and Goldstein, 2022). When pushback occurs on new monitoring efforts for water, these moments demand our attention as they reflect an enduring debate over the purpose of water metrics, governance interventions, and metering technologies that may create problems for water users. Quantification serves political-ecological purposes, interests, and parties, and it reflects water agency agendas and power. When new forms of water quantification occur via closed technologies, such as gauging stations or data-loggers, with little local transparency (see Figure 3 again), the resulting tension over state-produced and monitored water data remains no less problematic for water users who do not have access to these data.

CONCLUSION

Here, I have argued that the politics of water quantification in New Mexico directly reflect the dual phases of settler-colonial logics. New approaches to water governance required new metrics. Water metrics have been directly used to bind water to land, and then later to individuals, as part and parcel of (first) Spanish and then (second) American settler-colonial logics. Yet the current form of individual water rights as a severable use right from the same land means any acre-foot of water is one that can be traded, moved; expunged in one place and used in another (as if it was the same water source). These politics over metrics and metering are heightened now especially when users feel monitored or managed themselves.

As Miguel Romero (2014) from the Taos Valley observed,

we know our rights, for water, it's when the state comes in and tries to police us about the rights we have that things get... difficult. Our rights pre-exist that office [OSE] so who are they to try and govern us? And why are they counting and metering our water if not to move it to some different city?

Water users also made it abundantly clear, in interview after interview, that they do not have problems with big data, the duty of a particular crop, or the water metrics used to measure water *per se*. What matters to them is that these data should be shared, legible, available to them and not solely levers of power the state uses to govern water rights and rivers. If we are to take seriously the claims of Schorr (2012), and his compelling case that prior appropriation was born out of a concern to avoid monopolies and water hoarding from corporate entities, we can better understand how New Mexicans feel about who or what agency is monopolizing or hoarding data about water use, and why individual water users might have anxieties about getting access to the same public data.

These shared ethnographic vignettes strike at the heart of the politics of water quantification. As Fitzgerald (2010) from the Rio Mimbres shared with me, "It's not that we deny droughts or any kind of climate change...we understand that's happening, we feel those effects. It's just the AWRM [policy] measures that seem like an overreach... we feel like we are being managed, rather than the water itself". In fact, this might be the entire point of AWRM; to manage water users (and not the water). As Fligstein (1998: 325) argued about the politics of quantification, "science needs to have ways to control people in order that they do not fudge evidence either intentionally or unintentionally, and quantification is one way to do this".

In summary, it is not the act of measuring water rights, as 'held' by a water user in settler-colonial societies, which creates frictional politics through measurement. Instead, it is the monitored quantification of water governance that has visibly created political friction. The enforcement of new water policy measures when and where users are actively metered and governed for water use is contentious. Newly imposed surveillance devices that threaten long-standing, autonomous water governance become clearly seen, politicized, and contested. Any system of water governance with new

metrics can be understood as an engine of social change, not just a 'camera' for state legibility (following MacKenzie, 2006).

Newly imposed metrics are also a reflection of the new society's governance assumptions, ideologies, and goals. The perceived loss of water governance or decision-making capacity, and the lack of access to water data about governance, are of real concern to rural New Mexicans. Because the language of water rights sustains a politics of individual autonomy, of rights not responsibilities, it is local perceptions of state data collection, monitoring and enforcement that generate political reaction. Moreover, water users suspect that water management is now less about managing the water than it is about managing them as users.

Such concerns provoked state legislative action in 2019, and the state legislature and Governor approved the Water Data Act, to make public previous forms of agency water data from the state. The political concerns of water data, then, are not localized to a handful of irrigators. There is a new, genuine, effort to make these data accessible to a larger public, and not just state agency experts. Measuring and monitoring do not just produce data for the state, they produce socio-ecological tensions and reactions by water users on the ground.

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