Agriculture and Human Values
https://doi.org/10.1007/s10460-020-10157-y

SYMPOSIUM/SPECIAL ISSUE

In vino veritas, in aqua lucrum: Farmland investment, environmental uncertainty, and groundwater access in California's Cuyama Valley

Madeleine Fairbairn[1] · Jim LaChance[2] · Kathryn Teigen De Master[2] · Loka Ashwood[3]

Accepted: 12 September 2020

Abstract
This paper explores the relationship between farmland investment and environmental uncertainty. It examines how farmland investors seek to "render land investible" (Li, Trans Inst Br Geographers 39:589–602, 2014) in spite of drought, groundwater depletion, and changing regulations. To do so, we analyze a single case study: the purchase of 8000 acres of dry rangeland in California's Cuyama Valley by the Harvard University endowment for use in creating an irrigated vineyard. Drawing from interviews with Cuyama Valley farmers and community members, participant observation at community meetings, and public document analysis, we make two primary contributions to understandings of uncertain resource materiality in farmland investment. First, this case reveals that investors can turn environmental uncertainty into an advantage, exploiting both the *temporal* uncertainties associated with resource management under climate change and the *spatial* uncertainties inherent to all subsurface resources. We argue that the material and legal uncertainties of groundwater access provide investors with a potentially lucrative opening to assert their preferred land imaginaries and improve their property values. In the Cuyama Valley they did so through both participation in groundwater governance and the establishment of water-related infrastructure on their property. Second, this case highlights that the asset-making processes involved in farmland investment may be as much vertical as they are horizontal. The need to map and measure the uncertain vertical dimension of land creates an outsized role for scientific expertise in farmland assetization.

Keywords Farmland · Financialization · Assetization · Groundwater · Climate change · Environmental uncertainty

Introduction

"Managing agricultural assets with climate change in mind can be better for the planet *and* for long-term investors," asserts a recent report by the asset management branch of pension fund TIAA, which controls a 2-million-acre portfolio of global farmland (Nuveen 2018, p. 6). The report depicts climate change as a major threat to agricultural investments, arguing that "aspects of this threat—severe storms and floods, droughts and wildfires, extensive erosion—severely impact farmland and diminish value for investors" (ibid.). Yet the report also describes a silver lining; a proactive investment approach can transform climate risks into a source of above-market "alpha" returns for savvy investors. While farmers across the globe struggle to cope with increasing environmental uncertainty, institutional investors in agriculture—including pension funds, hedge funds, and university endowments—are considering how to use this uncertainty to their advantage.

That some investors in agricultural land see potential for profit in the face of increasing environmental uncertainties is not surprising. Investment, by its very nature, involves imagining and wagering upon an uncertain future (Beckert 2016). Whereas most agricultural producers must take steps to avoid or mitigate risk (or face the loss of their

✉ Madeleine Fairbairn
mfairbai@ucsc.edu

Jim LaChance
james.lachance@berkeley.edu

Kathryn Teigen De Master
kathryn.demaster@berkeley.edu

Loka Ashwood
Loka.Ashwood@uky.edu

1 Environmental Studies, University of California, Santa Cruz, USA

2 Environmental Science, Policy, and Management, University of California, Berkeley, Berkeley, USA

3 Department of Sociology, University of Kentucky, Lexington, USA

Published online: 22 October 2020

livelihoods), for the financial sector, commodifying and trading risk can itself be a foundation for profit (Zaloom 2004; Christophers 2018). The environmental uncertainty surrounding climate change has already engendered an array of financial products, from novel forms of index-based crop insurance for small farmers facing climate risks (Isakson 2015) to "catastrophe bonds" that allow investors to hedge and speculate on the likelihood of catastrophic weather events (Johnson 2014). But while finance's lucrative relationship with environmental uncertainty clearly applies to agricultural commodity derivatives and other such mobile and fungible financial assets, what about cases in which the investment *is* the agricultural operation? In such instances, how might investors ensure that environmental uncertainty will not lead to a devaluation of their property investment?

We present here a case study that reveals how one institutional investor in agriculture—Harvard Management Company (HMC)—is contending with the environmental uncertainties surrounding one of its farmland investment properties. This property, an $11 million, 8700-acre ranch in California's Cuyama Valley, is situated in a region gripped by climatic and hydrological uncertainty. HMC, the firm charged with investing Harvard's $39 billion endowment, purchased the land in 2014 with the intention of developing an irrigated vineyard (McDonald 2018). This land acquisition was steeped in environmental uncertainty from the outset. First, it occurred at the height of a prolonged California drought that increasingly appeared to be the new normal under climate change. Second, the property could hardly be seen as a safe bet for such dry times: the Cuyama Valley receives little precipitation even in non-drought years, it has almost no surface water, and years of excessive pumping for irrigation have left the groundwater basin severely depleted. Third, the government response to environmental change adds layers of political uncertainty on top of environmental uncertainty. Just months after HMC purchased the property, California responded to the drought by passing the Sustainable Groundwater Management Act (SGMA), which placed regulatory limits on groundwater extraction for the first time in the state's history. Whether SGMA was simply an unpleasant surprise for HMC's representatives or constituted, as some suspicious commentators suggested at the time, "a well-timed water play" (Fritz 2014) designed to profit from impending groundwater use restrictions is unclear. Either way, the potential success of this investment was, from the outset, closely bound up with the interrelated uncertainties of climate, hydrology, and resource governance, making it an excellent case with which to examine the complex role that environmental uncertainty can play in the production of farmland as a profitable financial asset class.

Our analysis suggests that savvy, well-capitalized, and politically powerful farmland investors can, under the right conditions, turn environmental uncertainty to their advantage. The Cuyama Valley's climatic and hydrological uncertainty—mediated through government action in the form of changing groundwater regulation—has created opportunities for investors to lock in future profits and promote the valorization of their investment property. The profound uncertainties currently surrounding groundwater in this region, including the *temporal uncertainties* of resource management under climate change and the *spatial uncertainties* inherent to subsurface resources, constituted an opening for HMC's representatives to assert a "land imaginary" (Sippel and Visser, this issue) calculated to benefit their financial interests. This case also suggests that the "asset-making" processes surrounding farmland (Ducastel and Anseeuw 2017; Visser 2017; Ouma 2020) may be as much vertical (pertaining to the subsurface) as they are horizontal (pertaining to surface characteristics). In water-strapped agricultural areas such as Southern California, physical and legal access to groundwater are the *sine qua non* of land assetization. The effort to map and enclose this vertical, subsurface dimension of land creates an outsized (and contested) role for scientific and legal expertise in farmland investment.

We begin our analysis with a brief overview of three distinct but interrelated bodies of scholarly work with a bearing on this case: research on the production of farmland as an investible asset class, on the relationship between finance and environmental risk (which relates to temporal uncertainty), and on the political ecology of the subsurface (a realm of spatial uncertainty). Next, we detail our methods and then describe the Cuyama Valley's geography and history as well as HMC's land purchase there. We then present our findings, exploring two primary means by which HMC's representatives have sought to leverage groundwater uncertainty in an effort to lock in potential future profits on their investment: (1) participation in groundwater governance processes associated with SGMA, and (2) efforts to establish water-related infrastructure on their property. We note that community members have contested these efforts by similarly making use of the ambiguities of groundwater science to present competing scientific and legal visions. We conclude by discussing the implications of these kinds of transformative agricultural investments for communities, like the Cuyama Valley, where hydrological and climate-related environmental uncertainty is the new norm.

Literature review: Farmland investment in the face of environmental uncertainty

There is a growing scholarly literature on the "financialization" of agriculture generally and of agricultural land specifically (Clapp and Isakson 2018). A new wave of farmland investors has been flocking to farmland since the 2008 financial crisis, motivated largely by the potential for land price appreciation (Fairbairn 2014; Gunnoe 2014; Kuns et al. 2016). Some investors expect this appreciation to occur passively, the result of global population and income growth or of regional development initiatives, while many others actively transform their farm properties through land clearing, infrastructural improvements, or intensification of existing operations (Fairbairn 2020).

Yet the process of extracting investment returns from farmland is neither frictionless nor inevitably successful. Though much of the land currently targeted by the financial sector has already been through a process of commodification—i.e. it is already private property—its desirability and profitability in the eyes of finance-sector investors hinges on processes variously referred to as "rendering land investible" (Li 2014), "asset making" (Visser 2017), and "assetization" (Ducastel and Anseeuw 2017). Drawing on a growing body of scholarship on "resource materialities" (Bakker and Bridge 2006; Richardson and Weszkalnys 2014), this work sees land as "an assemblage of materialities, relations, technologies and discourses that have to be pulled together and made to align" (Li 2014, p. 589). For farmland to become a profitable financial asset requires many things to fall into place: fences for physical exclusion, property titles for legal exclusion, financial metrics that benchmark farmland returns, diagrams displaying land as scarce and rapidly appreciating, and moral narratives justifying investment (Li 2014; Ouma 2016; Ducastel and Anseeuw 2017; Visser 2017; Fairbairn 2020). These efforts at asset making are geographically uneven, varying greatly between political, social, and agro-ecological contexts (Magnan 2015; Sippel et al. 2016). They also are prone to setbacks, particularly when their moral legitimacy erodes (Kish and Fairbairn 2018; Sippel 2018; Ouma 2020). In short, farmland, as an investible and profitable financial asset class, is an undertaking, not a fact. Both its attractiveness to investors and its profitability once they do invest are, as Ouma (2016, p. 82) describes, "practical accomplishments."

The materiality of agriculture is central to both the successes and failures of the asset-making process. Visser (2017, p. 185) explores this point in detail, arguing that the material characteristics of land—including soil fertility, scarcity, and potential for yield increases—are all essential to investors' efforts at "land value creation" but that they also frequently feature in "its flipside: value erosion and stagnation." In Russia and the Ukraine, Visser finds, initial investor hopes were stymied when there turned out to be an "insufficient scarcity" of farmland to generate the desired land price appreciation. Likewise, Kuns et al. (2016), document the disappointing performance of Nordic agroholding companies in Russia and Ukraine after they failed to fully account for agroecological risk, particularly the highly variable weather in the region. These studies reveal that optimistic investor beliefs about the profit potential of a notional, standardized, and abstracted farmland asset class may falter when faced with the place-based biophysical limits of actual farms in actual locations.

While environmental uncertainty figures in these accounts primarily as an obstacle to investment success, there is reason to think that it could also be a source of profit. For the financial sector, risk is a primary source of profit (Beckert 2016; Christophers 2018), and even a source of pleasure and personal identity for traders of financial assets (Zaloom 2004).[1] In agriculture in particular, finance has a long history of profiting from the risks, delays, and seasonal credit-crunches experienced by farmers as a result of the inconvenient materiality of their nature-based production process (Henderson 1998). The agricultural risks that farmers wished to avoid, for instance, gave rise to the agricultural commodity derivatives traded by financial speculators for profit (Clapp and Isakson 2018). In recent years, climatic uncertainty has spawned a host of new financial products. As Leigh Johnson (2014, p. 155) explains in her discussion of catastrophe bonds, "the place-based physical vulnerabilities of fixed capital have been rendered into assets deemed increasingly desirable by growing blocks of financial capital." There is, however, a big difference between financial investments and direct capital investments—that is to say, between buying agricultural commodity derivatives and buying a farm. Farms are immobile and non-fungible, and farmland markets are relatively illiquid (Fairbairn 2020). These differences are likely to translate into very different relationships to the material uncertainties of agriculture. We ask, therefore: does the financial investor's ability to profit from environmental uncertainty still hold when they themselves become the owner of "place-based physical vulnerabilities" in the form of a farm?

While scholarship on the intersection of environment, finance, and uncertainty primarily emphasizes *temporal* uncertainty, there is also an important *spatial* component to the uncertain materiality of farmland investment. Land rents (and therefore values) reflect the resource endowments of a property—whether in the form of oil, timber stands, or basic soil fertility—but these endowments are fundamentally uncertain until stabilized through agreed-upon metrics. Statistical and spatial mapping play a central role in transforming such biotic and abiotic elements of the natural world into commodifiable "natural resources." By making them legible to states and private capital alike, scientific inventories enable value extraction (Scott 1998; Braun 2000; Demeritt 2001).

[1] Risk and uncertainty are related but not identical concepts. Frank Knight and John Maynard Keynes distinguished between *risk*, which refers to situations where it is possible to estimate probabilities of different future outcomes, and *uncertainty*, which refers to truly unpredictable future scenarios (Froud 2003).

Such expert interpretation is particularly necessary when it comes to subsurface resources, which are largely hidden from sight and therefore depend on scientific visualization if they are to become sites for private capital accumulation. Braun (2000), for instance, describes how the mapping of Canada's geology during the late nineteenth century—a process he describes as "producing vertical territory"—served to make mineral resources intelligible to the state as well as to mining companies and their investors. Such scientific mapping of subterranean resources frequently comes into conflict with local knowledge systems (Bebbington and Bury 2009). Work on the political ecology of groundwater reveals it as a site of political struggles, often premised on epistemic contests between local and state knowledges (Birkenholtz 2008; Budds 2009) or "dueling" scientific interpretations with vastly different implications for management (Holifield 2009). Adrienne Kroepsch (2018, p. 61) argues that, even with major advances in computer-based modeling of groundwater, the materiality of the subsurface— "its opaqueness; its vast, heterogeneous, and slow-moving nature; and the ontological politics involved in rendering its depths legible for governance"—results in "persistent inscrutability." For her and others working in the emerging subfield of "STS underground" (Kinchy et al. 2018, p. 23), "rather than existing a priori, the underground comes to be through interlinked political, economic, cultural, and technoscientific practices and processes."

Drawing insights from the political ecology of the underground, we can see that the process of rendering land investible has an essential vertical dimension—one which has so far remained unexplored in the context of the present farmland rush. Work of farmland asset making has tended to focus on horizontal factors, such as the statistical picturing devices used to imagine certain areas as "frontier" or "underutilized" (Li 2014). Yet the vertical dimension of land is also crucial to the land rush. Groundwater extraction serves as a vertical "spatial fix" (Harvey 2001) for various crises of capital: by transforming dry, uncultivable land into lush, high-value agricultural properties, it creates an outlet for over-accumulated capital. By providing additional water resources to farms in the face of the drier conditions resulting from environmental change, it offsets (partially and temporarily) the effects of a major ecological crisis of capitalism. This vertical spatial fix is accompanied by distinct land imaginaries that justify its downward (rather than outward) expansion. Such imaginaries may exploit the spatial uncertainty of the subsurface in order to performatively influence the temporal uncertainty of financial markets, as, for instance, when mining companies "conjure" the prospect of vast underground deposits in order to raise the speculative capital needed to make their discovery a genuine possibility (Tsing 2000). Here the inscrutability of the subsurface provides an opening for vertical imaginaries aimed at transforming financial risk into profit.

Mobilizing groundwater in pursuit of increasing farmland values is not a simple task. In the case study that follows, we examine how HMC's regional representatives are working within intersecting environmental uncertainties—the temporal uncertainty of climate change and related environmental regulations, and the spatial uncertainty of the invisible subsurface—in an attempt to lock in the potential future profitability of their real estate. Their vertical asset-making endeavor is taking place on two fronts simultaneously: through active participation in local groundwater governance processes the investors assert an imaginary of ample water resources conducive to their extraction plans, while their simultaneous construction of water-related infrastructure makes that extraction a material possibility. Together, these governance and infrastructural interventions seek to capitalize on environmental uncertainty, transforming it into a source of increased land rents.

Methods

Our research, which took place during 2018 and 2019, involved a qualitative extended case study (Burawoy 1998) based on interviews, participant observation, and document analysis. We conducted 24 in-depth, semi-structured interviews with growers, ranchers, land owners, and long-time Cuyama Valley community members. We recruited interview participants primarily via network sampling, with some additional interviews resulting from directly contacting knowledgeable individuals (e.g., a rural realtor active in the area). We transcribed all interviews and coded them for key themes. In addition to interviews, we attended local community meetings related to groundwater governance, taking careful notes of our observations. These included meetings of the Cuyama Basin Groundwater Sustainability Agency (GSA), the Standing Advisory Committee to the GSA, and the Cuyama Basin Water District, as well as public workshops on the Sustainable Groundwater Management Act (SGMA) process. Attending these public meetings allowed us to glean a diverse array of perspectives of community members, farmers and ranchers, investment managers, and scientists. We triangulated this data by collecting and systematically reviewing relevant public documents about Cuyama Valley land and water usage, including public meeting minutes and videos, hydrogeological reports, public comments, and permitting applications. These documents and recordings allowed us to confirm the details of governance processes that were often highly technical and therefore difficult to ascertain from interviews alone.

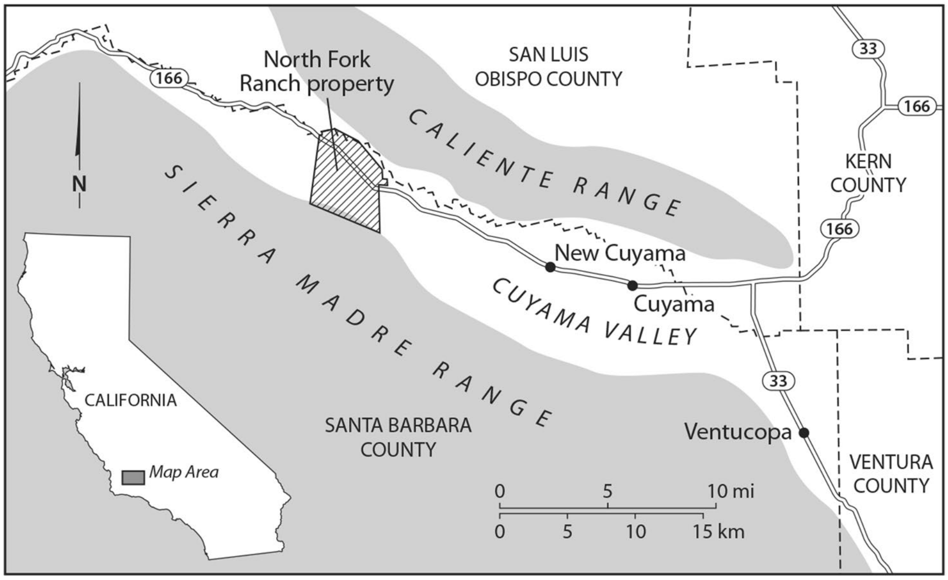

Fig. 1 The Cuyama Valley with approximate location of North Fork property. Map by Bill Nelson

Fig. 2 The Cuyama Valley satellite image with approximate location of North Fork property. Map by Bill Nelson

Background: Harvard comes to the Cuyama Valley

The sparsely populated Cuyama Valley runs northwest to southeast between two mountain ranges—the Sierra Madre to the south and the Caliente Range to the north (see Figs. 1, 2). It was originally inhabited by the Chumash people, from whom it gets its name, before they were violently dispossessed by Spanish colonizers. Today, scattered ranches dot the foothills, and three unincorporated communities—Cuyama, New Cuyama, and Ventucopa—are home to under a thousand people, mostly Anglo-American and Latinx (US Census 2018). Driving east on the single lane highway that cuts through the center of the valley, the landscape is initially dominated by rolling pastureland—parched golden yellow for much of the year—and native vegetation, with mountains on either side. As one gets close to the eastern end of the valley, however, pasture is replaced by bright green agricultural fields, frequently seen through the mist of sprinkler or center pivot irrigation. Agriculture on the eastern end of the valley is dominated by specialty crops, most notably large-scale organic carrot production by two of the country's largest carrot producers—Grimmway Farms and Bolthouse Farms.[2]

[2] Other crops grown on the valley's eastern end include barley, wheat, onions, garlic, potatoes, alfalfa, as well as an assortment of permanent crops: pistachios, olives, grapes, and apples. Other major growers in the area include Duncan Family Farms, Santa Barbara Pistachio Company, Cuyama Orchards and Sunridge Nurseries.

The growth of commercial agriculture in the eastern portion of the valley, particularly beginning in the 1980s and 1990s, created a massive demand for groundwater. The Cuyama Valley is arid; its scant average annual rainfall ranges from 7 to 15 inches (Hanson et al. 2015). Meanwhile, the only surface water, the Cuyama River, dries up during the summer. As a result, irrigated agriculture in the valley is almost entirely dependent on pumping, and the rate of groundwater extraction from the Cuyama Basin underlying the valley is roughly twice the long-term average rate of recharge, leading to steady groundwater level declines (Hanson and Sweetkind 2014). The California Department of Water Resources (DWR) considers the Cuyama Basin to be in a state of "critical overdraft" (DWR 2019).

The unsustainable extraction of the valley's groundwater resources, however, did not deter HMC from selecting this as the site for a new irrigated vineyard. In recent years, HMC has invested heavily in agricultural properties around the globe (McDonald 2018), including other parts of California (Gold 2018; Walsh 2019). In 2014, HMC purchased the North Fork Ranch, an 8700-acre expanse of rangeland on the Cuyama Valley's western end (McDonald 2018). Though HMC is the ultimate owner of the property, it is not directly involved in day-to-day operations. Instead, the property was purchased in the name of a Delaware-based subsidiary company named Brodiaea, Inc., and the management of both Brodiaea and the North Fork property are handled by San Luis Obispo-based agricultural investment advisory firm Grapevine Capital Partners, LLC. (In what follows, we will most frequently reference Grapevine Capital Partners, hereafter, "Grapevine" or "the investors," because its representatives are the most visible managers of this investment). Once the North Fork property had been purchased, Grapevine quickly set to work establishing a vineyard on 850 acres of the property (Gold 2018).

This land purchase had all the markings of a real estate play. HMC has a history of investing in California vineyards; just three years prior, in 2011, HMC had sold their stakes in two California vineyard investment funds (Silverado Premium Properties and Silverado Winegrowers Holdings) to the financial services company TIAA-CREF (Fritz 2014). This previous sale suggests that HMC's interest was not in the profits to be made from growing and selling wine grapes, but rather in the profits to be made from buying and selling vineyards. In the case of the Cuyama Valley, in particular, the establishment of an irrigated vineyard from scratch holds the potential for vast property value increases. In San Luis Obispo and Santa Barbara counties, where the vineyard is located, large parcels of dry pasture rangeland (those greater than 1500 acres) generally sell for between $300 and $1200 per acre, whereas vineyards in the same region sell for $25,000 to over $60,000 per acre (ASFMRA 2018). Though an initial report suggested that HMC had paid the slightly above-market rate of $1322 per acre for the North Fork ranch (Fritz 2014), the vineyard portion of the property could nonetheless eventually attain a valuation twenty to forty times its purchasing price.

The future success of this particular real estate venture, however, depends upon ample groundwater access, something which can no longer be taken for granted in California. The land purchase came at a moment of intertwined climatic, hydrological, and regulatory uncertainty in California. Between 2012 and 2016 the state suffered through a protracted drought, as a run of lower-than-average annual precipitation—not unusual in the state's history—was exacerbated by the higher-than-average temperatures linked to anthropogenic climate change (Diffenbaugh et al. 2015). The drought led to increased groundwater pumping by growers, which in turn led the state to pass SGMA in 2014, which mandates the creation of local-level plans limiting groundwater extraction to sustainable levels. Rather than being deterred by this environmental uncertainty, however, Grapevine has leveraged it as an asset-making opportunity. The political uncertainty of impending groundwater regulation, combined with the scientific uncertainty inherent to subsurface resources, have provided the investment firm with an opening for action aimed at ensuring future land value increases. Specifically, Grapevine has been active on two fronts: (1) working to influence the outcome of the SGMA planning process by promoting a land imaginary in which their property sits atop ample groundwater that is largely disconnected from other parts of the water basin, and (2) constructing groundwater infrastructure to ensure ongoing physical access to this purportedly plentiful water. We discuss each of these efforts in turn below.

Hydrology is not destiny: rendering land investible through groundwater governance

One major way in which Grapevine has worked to ensure the future value of its investment property, our research suggests, is through active participation in the local groundwater governance processes mandated by the brand-new SGMA legislation. Under SGMA, all groundwater basins designated by the state as either "high" or "medium priority" are required to create local-level plans for sustainable management.[3] Local public agencies in these basins must form a governing body known as a Groundwater Sustainability Agency (GSA). The GSA is charged with defining

[3] Groundwater basin boundaries used by SGMA are laid out in DWR Bulletin 118 (DWR 2019). Of the state's 515 water basins, 127 were designated high or medium priority. Of the high priority basins, 21 were deemed "critically overdrafted.".

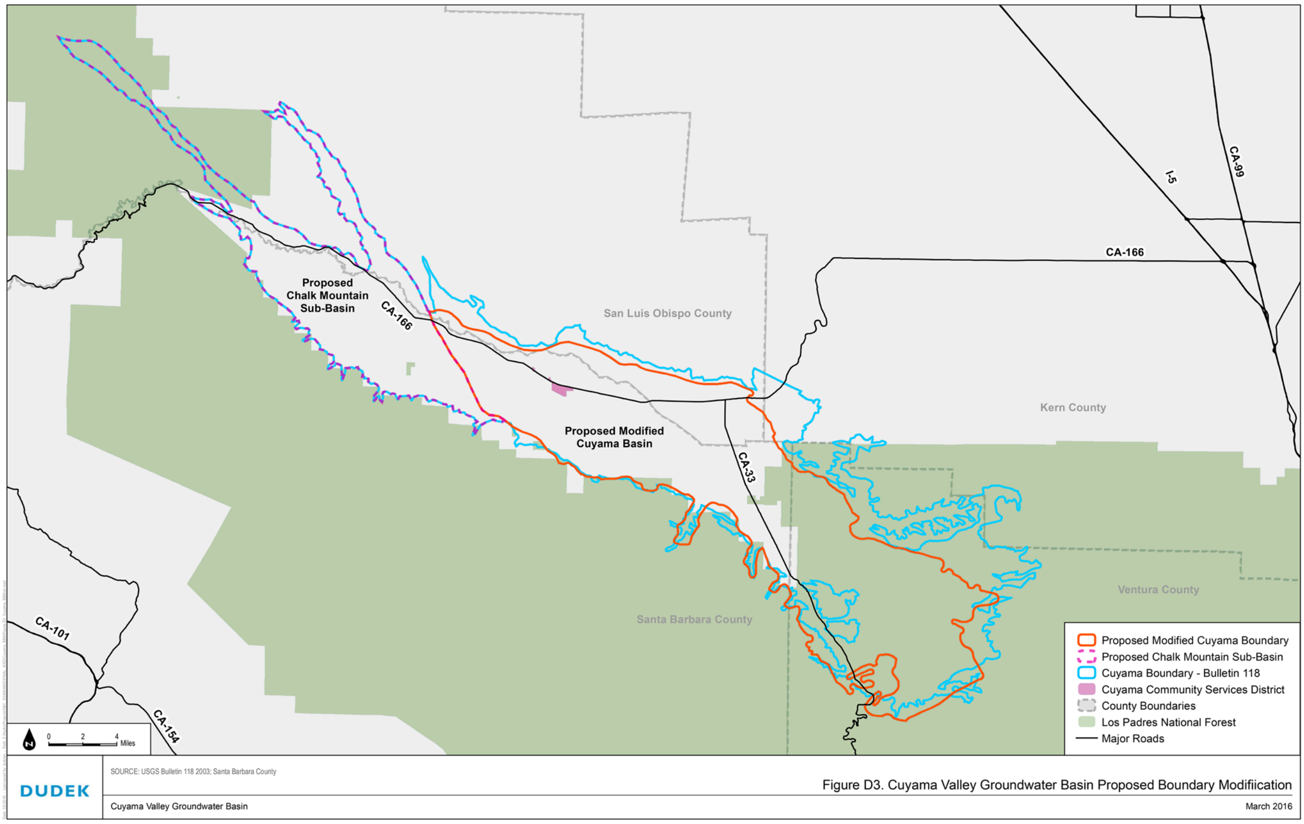

Fig. 3 Proposed boundary modification presented by Santa Barbara County in 2016 and still supported by Grapevine Capital Partners (Santa Barbara County Water Agency 2016)

how much water can sustainably be withdrawn from the basin and limiting extractions accordingly. The majority of GSAs are mandated with creating and implementing a Groundwater Sustainability Plan by 2022, while "critically overdrafted" water basins, such as the Cuyama Basin, must begin implementation by 2020. Grapevine therefore had a window of several years—from their land purchase in 2014 to the Groundwater Sustainability Plan implementation in 2020—in which to participate in the rules-crafting process that would govern their own future water access.

Land values in overdrafted water basins are generally expected to decline under SGMA, as new limits on pumping reduce agricultural productivity (ASFMRA 2018). But hydrology is not destiny. Our research suggests that the regulatory uncertainty of a newly established groundwater law, combined with the material uncertainty of subsurface structures and flows, provides an opening for well-endowed investors to actively enhance their farmland value by wading into governance debates based on contested hydrogeological science. In our study, the investors have sought to intervene in the SGMA process by advancing a land imaginary in which subsurface structures form strong barriers to water flow, leading to ample water reserves below their property. This vertical vision is central to their asset-making efforts.

Boundary politics

In its efforts to ensure the future value of its property, Grapevine promotes a subsurface imaginary in which the western end of the valley (where the vineyard is located) is hydrologically disconnected from the eastern end (where the majority of other agricultural operations are located). Grapevine's vertical vision of a separate sub-basin isolated by a largely impermeable barrier serves the political purpose of disconnecting the vineyard's extensive groundwater withdrawals from those of the carrot growers on the valley's eastern end, thereby reducing regulatory oversight.

Initially the company's hopes were pinned on a request, filed by Santa Barbara County, to exclude the western end of the valley—where the North Fork vineyard property is located—from the Cuyama Basin, renaming it the Chalk Mountain Sub-Basin (see Fig. 3). Had this proposal passed, the low population and low historical groundwater use in the western end of the valley would almost certainly have meant a "low priority" designation for the new basin, exempting it from the groundwater sustainability planning process entirely. The California DWR rejected this boundary modification request, however, leaving the original, larger basin boundaries intact as the basis for the SGMA planning process. For Grapevine, this decision constituted a major setback: the boundary modification would have meant essentially limitless groundwater access, greatly benefiting their vineyard operation and their future land values. Though Santa Barbara County accepted the DWR's decision, therefore, Grapevine did not give up so easily. Shortly after the modification request was rejected, Grapevine retained the services of a geological consulting firm to collect hydrogeological data with the eventual goal of submitting a new request to revise the basin boundary (CBGSA 2018a).

This effort to alter the basin boundaries benefited from the uncertain materiality of subsurface geological structures. The arguments for and against the boundary modification hinge on the nature of a particular geologic fault, the Russell Fault, whose permeability to water is subject to competing scientific interpretations. The scientific uncertainty surrounding the Russell Fault is reflected in the final Groundwater Sustainability Plan (CBGSA 2019, pp. 2–18) for the Cuyama Basin, which points out that even the *type* of fault it represents is up for debate: "The [Russell] fault is referred to as strike-slip by several authors, and normal fault by others, and is sometimes referred to as both strike-slip and normal within the same document."[4] The plan also chronicles a history of changing scientific interpretations of the fault's permeability to groundwater, most notably by the US Geological Survey, which concluded that "the Russell fault did not appear to be acting as a barrier to groundwater flow" in a 2013 report (Everett et al. 2013) before treating it as a "no flow boundary" and using it to delimit the western boundary of the basin in a 2015 study (Hanson et al. 2015). The Russell Fault, in short, is a perfect example of subterranean uncertainty. This uncertainty could be reduced (though not entirely abolished) through further research. A report commissioned by the Cuyama water district recommended "investigations of the conductivity and vertical extent of the Russell fault zone, as well as mapping of local groundwater gradients on both sides of the fault line" (EKI 2017, p. 12). In the continued absence of this research, the fault remains open to interpretation.

Grapevine seized upon the lack of scientific consensus about the Russell Fault to advance their preferred vision of the subsurface. In ruling against the boundary modification, the DWR had cited a lack of evidence for the impermeability of the Russell Fault, and so Grapevine hired geological consultants with the express intention of collecting that evidence. In 2018, a year and a half after the DWR's unfavorable ruling, the geologists submitted a report to the Cuyama Basin GSA. This report not only presented research to support the fault's limited permeability, it further asserted that the proposed Chalk Mountain Sub-Basin is highly compartmentalized, allowing Grapevine to argue that extensive groundwater withdrawals by the new vineyard would be unlikely to affect the smaller wells of their neighbors (Cleath-Harris Geologists 2018; Grapevine Capital Partners 2018).

Though this boundary modification effort has been unsuccessful thus far, it underscores that scientific data collection and modeling can be central to farmland asset making. Farmland's vertical attributes, because they are invisible to the naked eye, are generally imagined through scientific modeling. Yet hydrogeological models are not simply unbiased representations of an external reality (Budds 2009). Kroepsch (2018, p. 59) suggests that, "Rather than viewing groundwater models as simplified pictures of nature with which to make policy decisions, we are better off understanding them as 'world builders'—as tools that embed, enact, and circumscribe subsurface politics as they produce subsurface knowledge and shape socio-ecological outcomes." In our case, the scientific uncertainty surrounding the Russell Fault provided an opening for Grapevine's vertical asset-making enterprise. Their "world building" efforts, buttressed by a made-to-order geological study, were singularly focused on the valorization of their property and the production of investment returns.

Advocating for deeper drawdown

The success of the investors' asset-making endeavor depends on the water below their property being not only disconnected but also ample.[5] Grapevine Capital Partners has therefore assiduously promoted the view that—despite being located in one of the most critically overdrafted water basins in the state—their property sits atop plentiful groundwater which can easily support the enormous withdrawals required by a large vineyard. Though not officially represented on the Cuyama Basin GSA board—the primary decision-making body for SGMA implementation—Grapevine has promoted this interpretation to the board, influencing its decisions.

One of the primary tasks of the Cuyama Basin GSA is to determine the appropriate range for future groundwater levels in the basin. The GSA divided the valley into various "threshold regions" and assigned to each a "measurable objective" (MO)—basically a goal groundwater level—as well as a "minimum threshold" (MT)—a floor below which groundwater levels should not fall because it would cause negative environmental consequences known in SGMA

[4] Strike-slip faults occur when two pieces of the Earth's crust slide past each other horizontally, while normal faults occur when they pull apart.

[5] Alatout (2009) argues that, while scarcity narratives tend to receive more scholarly attention, resource abundance can play an equally pivotal role in environmental politics.

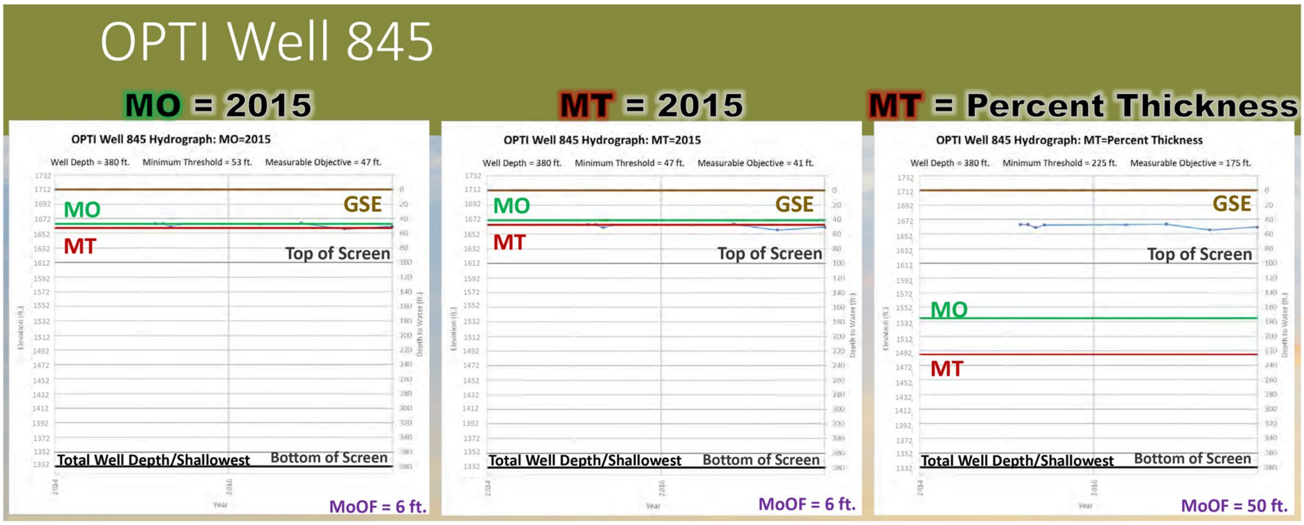

Fig. 4 The three proposals for establishing MOs and MTs in the Northwestern threshold region that were ultimately presented to the Cuyama Basin GSA as they would operate at one monitoring well. The option to the right was based on input from Grapevine Capital Partners (CBGSA 2018c)

parlance as "undesirable results." The environmental consulting firm hired by the GSA board to assist in developing the Cuyama Basin's groundwater sustainability plan originally intended to propose two options for setting thresholds in the "Northwestern" threshold region where the vineyard is located: (1) using the water level when SGMA went into effect in 2015, the height of the drought, as the MT, and five years of storage above that as the MO, (2) using the 2015 level as the MO and five years of storage below that as the MT. These "threshold rationales" translate into different depths for each of the monitoring wells in the region; under the first scenario, the MTs for the various wells would have ranged between 12 and 72 feet below the surface; in the second scenario the MTs would have ranged between 35 and 101 ft below the surface (CBGSA 2018c).

However, here again, Grapevine stepped in with their own bespoke hydrogeological studies and governance recommendations. The day before the public meeting at which the consultants hired by the GSA had prepared to propose these two alternatives, Grapevine's own hydrogeology consultants presented them with an argument that the water table could be drawn down much deeper before any undesirable results occurred. Although official GSA meetings are open to the public, this interchange happened at a closed-door meeting of the "Technical Forum," a committee of the various hydrogeological consultants hired by Cuyama Basin interest groups. At this private meeting, and based on their own hydrogeological data (which was not made available to the public), Grapevine's hydrogeological team proposed a third option for setting thresholds in their region: (3) basing the MT on a percentage of the aquifer's "saturated thickness" (the distance from the water table to the base of the aquifer) with an MO of five years storage above (CBGSA 2018b). Figure 4 shows what these three proposals looked like for a single monitoring well in this threshold region: the third scenario, proposed by Grapevine, allows for significantly deeper drawdown. The GSA's consultants took this suggestion under advisement and proposed all three scenarios to the GSA board.

Grapevine's proposal ultimately prevailed. At a December 2018 meeting, the Cuyama Basin GSA board voted to set the MT for all monitoring wells in the region at 15% of saturated thickness for the aquifer, or 203 feet below the surface, roughly twice the depth of the deepest MT under consideration before Grapevine weighed in. Grapevine representatives were present at this meeting and participated in reaching this outcome. At one point in the meeting a GSA board member simply asked the Grapevine representative what threshold levels he would feel comfortable working within (CBGSA 2018d).[6] Grapevine's success at influencing the GSA process is evidence of how environmental uncertainty can work to investor advantage. The unsettled state of California groundwater regulation,

[6] This was not a particularly unusual moment. At a GSA board meeting we attended on December 3, 2018, one of the presenting environmental consultants stated explicitly to the board: "My job as a technical person is to bring you choices that we can defend in front of the state. What you choose within that is entirely up to you and I'm very purposefully trying not to advocate very hard one way or the other. So, if you think it's important to lower this [proposed threshold] a certain amount, I think that is plausible and it's not my decision." For much of the GSA process, hydrogeological models simply set the outer bounds for what were essentially political decisions made by a board dominated by representatives of large growers and landowners from the local water district.

combined with the ongoing "inscrutability" of groundwater resources, made this a risky investment at the outset. However, those uncertainties also provided the opening for Grapevine to lock in far more ample groundwater with which to irrigate—and valorize—its property.

In places where agricultural productivity depends on sustained groundwater access, hydrogeological data and modeling are essential to efforts at rendering land investible. Two aspects make them particularly powerful asset-making tools. First, hydrogeological models are ostensibly neutral and framed as unbiased representations of the natural world even though they are deeply embedded in social relations (Budds 2009; Kroepsch 2018). The hydrogeological modeling of the Cuyama Basin took place within a SGMA planning process that was, from the beginning, dominated by representatives of large growers and landowners. The Cuyama Valley's largest agricultural operators were involved in *creating* those models, including contributing data from their operations and assisting with selection of the "representative wells" used for groundwater monitoring. They were also involved in *applying* those models because their representatives dominated the GSA board. Behind a patina of scientific objectivity, the most powerful and vocal actors, including but by no means limited to Grapevine Capital Partners, were able to sway the process to their benefit.

Second, hydrogeological models are effective at rendering land investible because they are incomprehensible to most non-experts, thereby creating a barrier to participation in groundwater politics (cf. Budds 2009). In the Cuyama Basin, the groundwater science used in the SGMA planning process was made even more impenetrable by the fact that the major growers, including Grapevine, all refused to make public the monitoring well data they had contributed to the modeling effort. As a result, Cuyama Valley residents were confronted with scientific claims about the subsurface but given no possible way to verify them. That the last-minute proposal to drastically lower water thresholds in the Northwestern region was first made in a closed-door, scientific forum underscores how hydrological expertise can serve to bolster the "powers of exclusion" that enable ongoing commodification of land (Hall et al. 2011).

This case suggests that the vertical processes involved in farmland asset-making may be particularly suited to enabling accumulation by dispossession (Harvey 2003). Vertical imaginaries are crucial to mobilizing the subsurface for the purposes of land valorization, but they may also be peculiarly difficult to contest.

Community contestation of investor proposals for groundwater governance

Yet despite these difficulties, Grapevine's asset-making efforts have met with considerable contestation. A diverse coalition of Cuyama Valley residents has formed to resist what they see as an unsustainable water grab. This community opposition stems from both general concern about the unsustainability of Grapevine's water-use plans and more specific fears about how the vineyard's water use might affect neighboring residents. While further declines in the water table will not affect the vineyard's extremely deep irrigation wells, they could devastate smaller neighbors who may not be able to afford the $25,000 or more required to deepen an existing well (Walsh 2019).

Like the investors, this community opposition leverages environmental uncertainty—both the regulatory uncertainty of the SGMA process and the material, hydrogeological uncertainty of the subsurface—but unlike the investors it does so in support of a precautionary approach to groundwater use. In response to the initial boundary modification request, fifty people, almost all Cuyama Valley residents, signed a letter requesting that the DWR reject this proposal. The letter made a case against the modification on grounds of subterranean uncertainty, arguing that there was insufficient baseline data about the western portion of the basin and that the impermeability of the Russell Fault had not been scientifically established in prior hydrological studies (Jaffe et al. 2016).

The opposition projects a very different vision of the subsurface. Where the investors conjure an imaginary of abundance, the community opposition deploys evidence of sub-surface scarcity. At public meetings, vineyard opponents frequently reaffirm the basin's drastic groundwater declines and state of critical overdraft. Additionally, during interviews, several community members questioned Grapevine's depictions of water abundance under the North Fork property. In a typical example, one local landowner and farmer explained,

> The wells that are down here… on the Harvard property, [a Grapevine representative] said those are refilled by the water flowing down the river. Well that's a little scary because there's no water that flows down the river. Once in a great while. Now, there's probably some underground water that's going through… but there's not a lot. When you look at rainfall and especially the further down in the valley you get, it is really a desert.

Other vineyard opponents voiced doubts about water abundance based on the lack of interest shown by corporate vegetable growers in the valley. As another local landowner and farmer put it,

> [Speaking about a local rancher with a long history in the valley.] I've talked to him a lot of times and he just shakes his head when he sees this thing going on. He says, "There's just not enough water there, period. If

> there was enough water there," and you hear this from other people, too, "if there was enough water down here to farm, folks like Grimmway and Bolthouse would have bought it a long time ago.

These community members use their own place-based expertise, or reference that of others, to question Grapevine's hydrological assessments of their property's groundwater resources. They exploit the inherent uncertainty of subsurface resources in order to render the North Fork property incrementally *less* investible. Though unlikely to affect property values directly, this counternarrative subtly challenges the vertical imaginary of water abundance upon which the vineyard's resale price depends.

The battle of the frost ponds: rendering land investible through groundwater infrastructure

At the same time as Grapevine representatives were engaged in the Cuyama Basin SGMA process, they were also moving forward with establishing water-related infrastructure on the North Fork property. The company rapidly drilled twelve wells for groundwater irrigation and made plans to construct above-ground reservoirs that would provide a readily available source of water for spraying on the vines to prevent frost damage. However, like the investor efforts at rendering land investible through groundwater governance, this process of establishing infrastructure has not been frictionless. In fact, the frost protection reservoirs ("frost ponds") have become a significant front in the struggle over the vineyard's water consumption.

The frost pond project

Water access can only be capitalized into property values if the right infrastructure is in place to secure its extraction and utilization. Water-related infrastructures, such as dams, wells, and irrigation canals, serve to stabilize resource access by engineering water claims into the built environment itself. In the case of groundwater, this infrastructure takes an uncertain subterranean resource and brings it to the surface where it becomes more visible and dependable. Once on the surface, the water becomes an incrementally less vertical and more horizontal resource. The shift from subsurface to surface, and from vertical to horizontal, brings material advantages to landowners. Once on the surface, groundwater sheds its uncertainty—teams of hydrologists and lawyers are no longer needed to assert its existence and claim ownership—and it can more easily and rapidly be used to protect permanent crops and the economic value they embody.

Storing groundwater on the surface, however, introduces new material complications with which investors must grapple. First, water on the surface suddenly has a large and visible footprint, which invites additional regulatory oversight and creates openings for contestation. As a large vineyard, North Fork requires a lot of water to protect against frost. But any reservoir containing over 50 acre-feet of water storage is considered a "dam" by the California DWR and is subject to strict, state-level permitting and ongoing regulation. Grapevine addressed this problem by proposing instead to construct three separate reservoirs of 49 ac-ft, each just a hair under the regulatory threshold. Thanks to this subdivision, they had only to go through the significantly less demanding county-level ministerial permitting process. Even with the reservoirs sized to ensure minimal regulation, however, Grapevine still had to comply with the California Environmental Quality Act (CEQA), which requires project planners to either complete an Environmental Impact Report (EIR) or submit a much briefer Mitigated Negative Declaration (MND) asserting that an EIR is unnecessary because the project will have no significant environmental impact once certain mitigating steps have been taken. Grapevine submitted an MND for the frost pond proposal (Brodiaea 2018), a move which, as we will see, was hotly contested by neighboring landowners.

A second material difficulty associated with the shift from subsurface to surface is that the water becomes vulnerable to evaporation. The extent of evaporation likely to occur from the surface of the three frost ponds became a major point of contention during the permitting process. In their MND, the investors asserted that the construction of the three reservoirs would not have a significant impact on water resources. They were aided in reaching this conclusion by the fact that regular agricultural activities are exempt from CEQA, and so they had only to consider the evaporative water loss from the surface of the reservoirs—not the pumping of groundwater to fill the ponds in the first place, nor its spraying onto the crops to protect from frost, nor its use for irrigation at the end of the winter, all of which will eventually be covered by SGMA. Grapevine calculated that evaporative water loss from the pond surfaces would amount to 26 ac-ft per year, just comfortably under the county threshold for a significant environmental impact of 31 ac-ft per year, which would have triggered the need for an EIR (Brodiaea 2018). While the materiality of water—its uncertain flows between different parts of the basin—posed challenges and opportunities for asset-making when it was below ground, its shift to the surface introduced new volatilities. As water became a horizontal resource with surface area exposed to sun and air, evaporation became a serious consideration, one which neighboring landowners seized upon in their opposition to the vineyard.

Community opposition to the vineyard's groundwater infrastructure plans

The investor efforts to establish groundwater-related infrastructure on their property were adroit, but they nonetheless encountered considerable resistance, the physicality of the frost ponds providing a rallying point for the local opposition. The frost ponds project was initially approved by the Santa Barbara zoning administrator in September of 2017, but neighboring farmer-landowners—along with a law firm they hired—appealed this decision to the Santa Barbara Planning Commission, arguing that the minimal environmental studies conducted by Grapevine Capital Partners were insufficient and that the company should be required to conduct an EIR for the project. In September of 2018, the Planning Commission sided with the neighbors, requesting a focused EIR from the company. Grapevine Capital Partners appealed this decision to the Santa Barbara Board of Supervisors where they lost once again in February of 2019, leaving them with no choice but to conduct the EIR. This was a major success for the community coalition opposing the vineyard's water use plans.

The opposition once again mobilized scientific and regulatory uncertainties to contest Grapevine's asset-making endeavor. Their case hinged largely on a rival hydrogeological interpretation. They hired a hydrologist, who presented an alternative calculation of evaporative water loss which came to 44 ac-ft per year, well over the 31 ac-ft significance threshold requiring an EIR (Chytilo 2019).[7] The opposition also emphasized the current moment of rapid regulatory and climatic change to make the case for a more stringent assessment of water impacts. In written and oral arguments, they repeatedly pointed to the impending SGMA implementation and the ever-increasing groundwater overdraft as reasons for the authorities to use their discretionary ability to require more than the lowest thresholds for environmental impact.

Community members also sought to discredit the vineyard investors by exposing their intention to use groundwater as a means to ensure increasing ground rents rather than as an agricultural input for agriculture's sake. It was striking, for instance, that throughout the frost pond hearings, those opposing the vineyard's water consumption plans insisted on calling the landowners "Harvard." They did not refer to the vineyard by the property name (North Fork vineyard) nor by the name of the landowning entity (Brodiaea) nor by the name of the agricultural investment management organization which calls the shots (Grapevine Capital Management). Instead they relentlessly connected the vineyard to the elite, east coast university-cum-institutional investor who will ultimately profit or lose from whatever water-related decisions are made regarding the property. This repeated emphasis on the institutional investor behind the vineyard served to problematize the beneficial treatment the vineyard received under CEQA by virtue of its status as an agricultural producer. At the Santa Barbara Planning Commission (2018, 3:31:18) meeting, where the case was heard, one local resident stated:

> I'm concerned that we don't have the groundwater to support this particular operation. That ten thousand (sic) acres purchased by the Harvard institution and the planting of almost a thousand of those acres is all a fairly obvious extractive endeavor. I support farmers' rights to farm. I don't believe that this is about farming. I believe it's about financial extraction.

Meanwhile, at the Santa Barbara Board of Supervisors (2019, 6:52:03) hearing where the frost pond case was finally decided, a neighboring landowner stated this argument very plainly:

> Our major concern with this whole project is this is a real estate deal masquerading as an agricultural project, and we're afraid that the next round of discussions we're going to have before the board is how they're going to split this property up and subdivide it off into little ranchettes so that none of us have any water… This thing is just a real estate deal and I think that the environment impact review on all of this should be handled in the way of what you would do with any other real estate project instead of trying to hide it as an agricultural venture.

This repeated reminder that the vineyard is a real estate investment backed by a financial institution has not succeeded in changing the vineyard's legal standing as an agricultural producer, but it may have chipped away at the project's perceived legitimacy in the eyes of this relatively conservative, rural community. The battle of the frost ponds is still being waged, and the outcome is undetermined.

Conclusion

A recent article on the website *Agri Investor* warns that "Water scarcity presents risk for investors," but adds that "…tackl[ing] water scarcity is a 'big opportunity' for investors, too, especially in agriculture" (Kemp 2020). Our case study analysis of HMC's farmland investment in the Cuyama Valley demonstrates some of the ways in which investors may use this "big opportunity" to increase the value of their

[7] The opposition made other arguments as well. They rejected the biological surveys conducted by Grapevine Capital Partners, which were done at the height of the drought and after the property had already been disked for cultivation. They also amplified concerns expressed by the California Department of Transportation that the reservoirs could pose a flood risk to Route 166 (Chytilo 2019, Santa Barbara Board of Supervisors 2019).

farmland investments. In the Cuyama Valley, Grapevine has worked assiduously to turn the uncertainties associated with climate change and groundwater depletion into a source of profit. Through active participation in the SGMA groundwater governance process, they have turned a declining water table into a source of scarcity rents that will be capitalized into the value of their property. Through their ongoing efforts to construct reservoirs and other groundwater-related infrastructure, they cement their water claims into the built environment.

This case suggests that agricultural investors are clearly attuned to climate change, groundwater depletion, and other long-term environmental threats. However, it does not follow that investors will seek to counter those threats (through divestment from fossil fuels, for instance, or by avoiding regions where water is being withdrawn at unsustainable levels). Instead, if HMC's investment in the Cuyama Valley is any indication, investors may see environmental threats as a lucrative source of first mover advantage, a chance to extract resource rents, even if it means compounding environmental problems in the process. HMC's efforts to render its property investible—through the planting of water-intensive permanent crops, the pursuit of deeper drawdown levels under SGMA, and the effort to store groundwater on the surface where it will be subject to constant evaporation—all tend towards exacerbating the already highly unsustainable groundwater situation in the Cuyama Valley. This is particularly noteworthy because HMC explicitly frames itself as a "long-term investor" that "focuses on environmental, social, and governance (ESG) factors that may impact the performance of our investments" (HMC 2019). Yet in the case of the North Fork vineyard, it seems clear that "sustainable investing" means ensuring that ESG factors are leveraged for profit, rather than working to foster sustainable practices on the land.

Though the investors' asset-making efforts remain contingent and contested, at present they appear likely to succeed. Through intensive engagement with groundwater regulatory processes and major capital investments in water-related infrastructure, HMC seems poised to profit from relatively unfettered groundwater access in a region where such access is increasingly restricted. Just a few months after the groundwater sustainability plan for the Cuyama Basin was finally submitted, Grapevine was issued construction permits to drill three additional irrigation wells on their property. At the same time, however, this aggressive strategy for pursuing land valorization through uncertainty also carries inherent risks. Expensive investments in the built environment—including wells, reservoirs, and even vines—are themselves at risk for devaluation in the event that this wager on environmental uncertainty goes south. The sunk costs of this physical and biological infrastructure may lock the investors out of more ecologically adaptive management practices in the future, potentially increasing their vulnerability to climate impacts. In general, the Cuyama Valley case reveals that, although uncertainty can lead to speculative profits, it also creates openings for political change. Even the largest, most deep-pocketed institutions are vulnerable to community opposition, something that in the Cuyama Valley shows no signs of waning.

Acknowledgements This project was supported by the Agricultural and Food Research Initiative Competitive Program of the USDA National Institute of Food and Agriculture (NIFA), grant number 2017-68006-26347. We are indebted to the many people who provided formative feedback on earlier drafts of this paper, including: Flora Lu and the rest of her brilliant lab group, Katharine Legun, Zenia Kish, Julie Keller, Lindsey Dillon, Amanda Smith, Renee Fox, and Alma Heckman. We also thank the special issue editors, Sarah Sippel and Oane Visser, for an incredibly helpful round of internal reviews and for being the most organized special issue editors we have ever encountered. Finally, we are deeply indebted to the Cuyama Valley residents who housed us, fed us, and generously shared their wealth of knowledge about the valley and its water politics.

References

Alatout, S. 2009. Bringing abundance into environmental politics: Constructing a Zionist network of water abundance, immigration, and colonization. *Social Studies of Science* 39 (3): 363–394.

ASFMRA (American Society of Farm Managers and Rural Appraisers). 2018. Trends in agricultural land and lease values: California and Nevada. https://www.calasfmra.com/db_trends/Trends2018_Ebook.pdf. Accessed June 24, 2020.

Bakker, K., and G. Bridge. 2006. Material worlds? Resource geographies and the 'matter of nature'. *Progress in Human Geography* 30 (1): 5–27.

Bebbington, A., and J. Bury. 2009. Institutional challenges for mining and sustainability in Peru. *PNAS* 106 (41): 17296–17301.

Beckert, J. 2016. *Imagined futures: Fictional expectations and capitalist dynamics*. Cambridge, MA: Harvard University Press.

Birkenholtz, T. 2008. Contesting expertise: The politics of environmental knowledge in northern Indian groundwater practices. *Geoforum* 39 (1): 466–482.

Braun, B. 2000. Producing vertical territory: Geology and governmentality in late Victorian Canada. *Ecumene* 7 (1): 7–46.

Brodiaea, Inc. 2018. Final mitigated negative declaration: North Fork Ranch frost ponds. August 1, 2018. https://cosantabarbara.app.box.com/s/q97rv82305oyfnbdjhcyxrrdhu3dgkqy/file/392545753182. Accessed 10 July 2019.

Budds, J. 2009. Contested H_20: Science, policy and politics in water resources management in Chile. *Geoforum* 40 (3): 418–430.

Burawoy, M. 1998. The extended case method. *Sociological Theory* 16 (1): 4–33.

CBGSA (Cuyama Basin Groundwater Sustainability Agency). 2018a. Cuyama Basin Groundwater Sustainability Agency Board of Directors meeting. May 2, 2018. Meeting minutes. https://cuyamabasin.org/assets/pdf/2018-05-02-CBGSA-Board-Minutes.pdf. Accessed 11 April 2020.

CBGSA (Cuyama Basin Groundwater Sustainability Agency). 2018b. Joint meeting of Cuyama Basin Groundwater Sustainability Agency Board of Directors and Standing Advisory Committee. December 3, 2018. Agenda and packet. https://cuyamabasin.org/assets/pdf/2018-12-03-CBGSA-Board-Packet-rev1.pdf. Accessed 5 July 2019.

CBGSA (Cuyama Basin Groundwater Sustainability Agency). 2018c. Special joint meeting of Cuyama Basin Groundwater Sustainability Agency Board of Directors and Standing Advisory Committee. December 18, 2018. Agenda and packet. https://cuyamabasin.org/assets/pdf/2018-12-18-Special-Joint-Board-Packet.pdf. Accessed 5 July 2019.

CBGSA (Cuyama Basin Groundwater Sustainability Agency). 2018d. Special joint meeting of Cuyama Basin Groundwater Sustainability Agency Board of Directors and Standing Advisory Committee. December 18, 2018. Meeting minutes. https://cuyamabasin.org/assets/pdf/2018-12-18-CBGSA-Special-Minutes-final.pdf. Accessed 23 Mar 2020.

CBGSA (Cuyama Basin Groundwater Sustainability Agency). 2019. Groundwater Sustainability Plan. December, 2019. Prepared by Woodard and Curran. https://cuyamabasin.org/resources#final-gsp. Accessed 23 June 2020.

Christophers, B. 2018. Risking value theory in the political economy of finance and nature. *Progress in Human Geography* 42 (3): 330–349.

Chytilo, M. 2019. Re: Harvard appeal of the planning commission's action requiring a focused environmental impact report for the North Fork Ranch frost ponds project. Letter and exhibits sent to the Santa Barbara County Board of Supervisors. February 1, 2019. https://santabarbara.legistar.com/View.ashx?M=F&ID=7063202&GUID=01060A39-E7AB-4FB8-9174-8F8FB14BF8E1. Accessed 12 July 2019.

Clapp, J., and R. Isakson. 2018. *Speculative harvests: Financialization, food, and agriculture*. Halifax, NS: Fernwood.

Cleath-Harris Geologists. 2018. Cuyama Valley Groundwater Basin (3–13) boundary modification request: Technical memorandum. Report prepared for Grapevine Capital Management. https://cuyamabasin.org/assets/pdf/Russell-Fault-BBMR-Report-Final.pdf. Accessed 26 June 2019.

Demeritt, D. 2001. Scientific forest conservation and the statistical picturing of nature's limits in the Progressive-era United States. *Environment and Planning D* 19: 431–459.

Diffenbaugh, N., D. Swain, and D. Touma. 2015. Anthropogenic warming has increased drought risk in California. *PNAS* 112 (13): 3931–3936.

Ducastel, A., and W. Anseeuw. 2017. Agriculture as an asset class: Reshaping the South African farming sector. *Agriculture and Human Values* 34 (2017): 199–209.

DWR (Department of Water Resources). 2019. Bulletin 118. https://water.ca.gov/Programs/Groundwater-Management/Bulletin-118. Accessed 25 March 2019.

EKI. 2017. Preliminary findings from review of the USGS study of the Cuyama Valley groundwater basin. EKI B70069.00. Prepared for Cuyama Basin Water District. https://cuyamabasin.org/assets/pdf/EKI-Review_of_USGS_Study_2017-10-27_final.pdf. Accessed 23 June 2020.

Everett, R., D. Gibbs, R. Hanson, D. Sweetkind, J. Brandt, S. Falk, and C. Harich. 2013. Geology, water-quality, hydrology, and geomechanics of the Cuyama Valley Groundwater Basin, California, 2008–12. U.S. Geological Survey Scientific Investigations Report 2013–5108. https://pubs.usgs.gov/sir/2013/5108/pdf/sir2013-5108.pdf. Accessed 26 June 2019.

Fairbairn, M. 2014. 'Like gold with yield': Evolving intersections between farmland and finance. *Journal of Peasant Studies* 41 (5): 777–795.

Fairbairn, M. 2020. *Fields of gold: Financing the global land rush*. Ithaca, NY: Cornell University Press.

Fritz, M. 2014. Harvard pushing further into farm sector with California Central Coast vineyard play. March 14, 2014. *Farmland Investor Center*. https://www.farmlandinvestorcenter.com/?p=722&option=com_wordpress&Itemid=171. Accessed 5 June 2019.

Froud, J. 2003. The private finance initiative: Risk, uncertainty and the state. *Accounting, Organizations and Society* 28: 567–589.

Gold, R. 2018. Harvard quietly amasses California vineyards—and the water underneath. *Wall Street Journal*. December 10. https://www.wsj.com/articles/harvard-quietly-amasses-california-vineyardsand-the-water-underneath-1544456396. Accessed 6 June 2019.

Grapevine Capital Partners. 2018. Cuyama Basin—North Fork Vineyard: Company background plus data insights to support GSP development for the Cuyama Basin. Presentation to the Cuyama Basin GSA, April 26, 2018. https://cuyamabasin.org/assets/pdf/2018-04-26-Cuyama_NorthForkVineyard.pdf. Accessed 27 June 2019.

Gunnoe, A. 2014. The political economy of institutional landownership: Neorentier society and the financialization of land. *Rural Sociology* 79 (4): 478–504.

Hall, D., P. Hirsch, and T. Li. 2011. *Powers of exclusion: Land dilemmas in Southeast Asia*. Honolulu: University of Hawai'i Press.

Hanson, R., and D. Sweetkind. 2014. Cuyama Valley, California hydrologic study: An assessment of water availability. *US Geological Survey Fact Sheet*. https://doi.org/10.3133/fs20143075.

Hanson, R., L. Flint, C. Faunt, D. Gibbs, and W. Schmid. 2015. Hydrologic models and analysis of water availability in Cuyama Valley, California. US Geological Survey Scientific Investigations Report 2014–5150. Version 1.1, May 2015. https://pubs.usgs.gov/sir/2014/5150/pdf/sir2014-5150.pdf. Accessed 26 June 2019.

Harvey, D. 2001. Globalization and the spatial fix. *Geographische Revue* 2: 23–30.

Harvey, D. 2003. *The new imperialism*. Oxford: Oxford University Press.

Henderson, G. 1998. *California and the fictions of capital*. Philadelphia: Temple University Press.

HMC (Harvard Management Company). 2019. Investing for the long-term. https://www.hmc.harvard.edu/sustainable-investing/. Accessed 16 March 2020.

Holifield, R. 2009. How to speak for aquifers and people at the same time: Environmental justice and counter-network formation at a hazardous waste site. *Geoforum* 40: 363–372.

Isakson, R. 2015. Derivatives for development? Small-farmer vulnerability and the financialization of climate risk management. *Journal of Agrarian Change* 15 (4): 569–580.

Jaffe, R. et al. 2016. Re: Opposition to 3–13 Cuyama Valley Groundwater Basin boundary change proposal. Letter dated April 28, 2016.

Johnson, L. 2014. Geographies of securitized catastrophe risk and the implications of climate change. *Economic Geography* 90 (2): 155–185.

Kemp, D. 2020. Water scarcity presents risk for investors, but opportunity too. *Agri Investor*. February 5, 2020. https://www.agriinvestor.com/water-scarcity-presents-risk-for-investors-but-opportunity-too/

Kinchy, A., R. Phadke, and J. Smith. 2018. Engaging the underground: An STS field in formation. *Engaging Science, Technology, and Society* 4: 22–42.

Kish, Z., and M. Fairbairn. 2018. Investing for profit, investing for impact: Moral performances in agricultural investment projects. *Environment and Planning A* 50 (3): 569–588.

Kroepsch, A. 2018. Groundwater modeling and governance: Contesting and building (sub)surface worlds in Colorado's Northern San Juan Basin. *Engaging Science, Technology, and Society* 4: 43–66.

Kuns, B., O. Visser, and A. Wastfelt. 2016. The stock market and the steppe: The challenges faced by stock-market financed, Nordic farming ventures in Russia and Ukraine. *Journal of Rural Studies* 45: 199–217.

Li, T. 2014. What is land? Assembling a resource for global investment. *Transactions of the Institute of British Geographers* 39 (4): 589–602.

Magnan, A. 2015. The financialization of agri-food in Canada and Australia: Corporate farmland and farm ownership in the grains and oilseed sector. *Journal of Rural Studies* 41: 1–12.

McDonald, M. 2018. Harvard spent $100 million on vineyards. Now it's fighting with the neighbors. *Bloomberg*. November 15, 2018. https://www.bloomberg.com/news/articles/2018-11-15/harvard-spent-100-million-on-vineyards-some-neighbors-complain. Accessed 16 March 2020.

Nuveen. 2018. Nuveen knows responsible investing. https://www.tiaa.org/public/pdf/addressing_the_climate_change.pdf. Accessed 8 Feb 2020.

Ouma, S. 2016. From financialization to operations of capital: Historicizing and disentangling the finance-farmland-nexus. *Geoforum* 72: 82–93.

Ouma, S. 2020. This can('t) be an asset class: The world of money management, 'society', and the contested morality of farmland investments. *Environment and Planning A* 52 (1): 66–87.

Richardson, T., and G. Weszkalnys. 2014. Introduction: Resource materialities. *Anthropological Quarterly* 87 (1): 5–30.

Santa Barbara Board of Supervisors. 2019. Santa Barbara Board of Supervisors meeting of February 5, 2019. https://sbcounty.granicus.com/MediaPlayer.php?view_id=3&clip_id=3475&meta_id=392601. Accessed 24 June 2020.

Santa Barbara County Water Agency. 2016. Santa Barbara County Water Agency - 3-013 CUYAMA VALLEY. California DWR SGMA Portal – Basin Boundary Modification Request System. https://sgma.water.ca.gov/basinmod/basinrequest/preview/31. Accessed 15 Oct 2020.

Santa Barbara Planning Commission. 2018. Santa Barbara Planning Commission meeting of September 12, 2018. https://sbcounty.granicus.com/MediaPlayer.php?view_id=11&clip_id=3369. Accessed 24 June 2020.

Scott, J. 1998. *Seeing like a state*. New Haven, CT: Yale University Press.

Sippel, S.R. 2018. Financialising farming as a moral imperative? Renegotiating the legitimacy of land investments in Australia. *Environment and Planning A* 50 (3): 549–568.

Sippel, S.R., N. Larder, and G. Lawrence. 2016. Grounding the financialization of farmland: Perspectives on financial actors as new land owners in rural Australia. *Agriculture and Human Values* 34: 251–265.

Tsing, A. 2000. Inside the economy of appearances. *Public Culture* 12 (1): 115–144.

U.S. Census. 2018. 2018 American Communities Survey 5-year estimates. https://www.census.gov/data.html. Accessed 22 June 2020.

Visser, O. 2017. Running out of farmland? Investment discourses, unstable land values and the sluggishness of asset making. *Agriculture and Human Values* 34: 185–198.

Walsh, C. 2019. Water to wine: Industrial agriculture and groundwater regulation in California. In *In defense of farmers: The future of agriculture in the shadow of corporate power*, ed. Jane W. Gibson and Sara E. Alexander, 175–204. Lincoln, NE: University of Nebraska Press.

Zaloom, C. 2004. The productive life of risk. *Cultural Anthropology* 19 (3): 365–391.

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Madeleine Fairbairn is a sociologist and assistant professor in the Environmental Studies Department at the University of California, Santa Cruz. She studies the political economy of agriculture, including the financial sector's growing interest in farmland and, more recently, the Silicon Valley agri-food tech sector. Her first book, *Fields of Gold*: *Financing the Global Land Rush* was published in 2020 by Cornell University Press.

Jim LaChance is a PhD Candidate at UC Berkeley in the Department of Environmental Science, Policy, and Management. His research focuses on social and ecological change in natural resource dependent communities, both on land and at sea.

Kathryn Teigen De Master is a rural sociologist and associate professor at the University of California, Berkeley. Her research focuses on agricultural transitions in the US and internationally, and she studies farmland access and financialization, the "agriculture of the middle," diversified farming systems, participatory mapping, and the agri-food tech sector. De Master's co-edited book *Bite Back: People Taking on Corporate Food and Winning*, was recently published with the University of California Press.

Loka Ashwood is an assistant professor in the Department of Sociology at the University of Kentucky. She studies corporate and regulatory structures that prompt injustices and animosity toward the state, with an mind toward action-based change in rural communities. She published the book, *For-Profit Democracy: Why the Government is Losing the Trust of Rural America* (Yale 2018), and is co-author of An *Invitation to Environmental Sociology* (6th edition, Sage, fall 2020).