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Margaret V. du Bray
Augustana College

Morey Burnham
Idaho State University

Katrina Running
Idaho State University

Vicken Hillis
Boise State University, vickenhillis@boisestate.edu

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Adaptive Groundwater Governance and the Challenges of Policy Implementation in Idaho's Eastern Snake Plain Aquifer Region

Margaret V. du Bray

Augustana College, Rock Island, IL, USA; megdubray@augustana.edu

Morey Burnham

Idaho State University, Stop, ID, USA; burnmore@isu.edu

Katrina Running

Idaho State University, Stop, ID, USA; runnkatr@isu.edu

Vicken Hillis

Boise State University, Boise, ID, USA; vickenhillis@boisestate.edu

ABSTRACT: Globally, groundwater overdraft poses significant challenges to agricultural production. As a result, it is likely that new water management policies and governance arrangements will be needed to stop groundwater depletion and maintain agricultural viability. Drawing on interviews with state and non-state water managers and other water actors, this paper provides a study of a recent resource management agreement between surface water and groundwater irrigators in the Eastern Snake Plain Aquifer region of Idaho. Using adaptive governance as our descriptive framework, we examine how groundwater governance arrangements emerge and are applied to mitigate the impacts of groundwater overdraft. Our findings suggest that adaptive governance, while not a stated goal of the agreement, may enable flexible and sustainable social and ecological outcomes. Our findings also indicate that this new governance arrangement creates a vacuum in enforcement authority that may prove challenging as the management agreement is implemented. These findings extend our understanding of the conditions necessary for effective adaptive governance of groundwater resources, and highlight the challenge of creating capacity for local resource managers as governance shifts from more bureaucratic to adaptive and decentralised arrangements.

KEYWORDS: Groundwater governance, adaptive governance, irrigated agriculture, US West, Idaho

INTRODUCTION

Globally, groundwater overdraft poses significant challenges to agricultural production (Wada et al., 2010; Gleeson et al., 2012). As climate change alters existing patterns of precipitation and snowpack melt, and exacerbates the stresses already faced by groundwater-dependent agricultural economies, it is likely that new water management policies and governance arrangements will be needed to stop groundwater depletion and maintain agricultural viability (Melillo et al., 2014; Horangic et al., 2016; Hoogesteger and Wester, 2017). Building on the extensive literature examining how surface water is governed, a growing body of research has sought to define groundwater governance and to analyse the processes that shape groundwater governance arrangements and outcomes around the world (Megdal et al., 2017; Villholth et al., 2018). Within this literature, researchers have recently evaluated how

elements of groundwater governance, such as stakeholder engagement and regional collaboration (Hussein, 2018; Megdal et al., 2017), institutional design (Kiparsky et al., 2017; Varady et al., 2016), the availability of and access to information, economic and regulatory frameworks (Varady et al., 2016), and adaptive governance (Susskind, 2005) shape the ability of water system actors such as governments, managers, and users to solve groundwater problems through policy change. While this literature has provided important insights into how groundwater governance enables or inhibits the development and application of innovative policy solutions to mitigate the impacts of declining groundwater, few empirical case studies document how these processes play out in large-scale industrial groundwater-dependent agricultural systems. Further, little research has examined the application of adaptive governance principles in shaping policymaking processes and outcomes in these same groundwater-dependent agricultural systems. Within this research context, recent groundwater policy changes in the Eastern Snake Plain Aquifer (ESPA) region of Idaho, which were designed to recharge a depleting aquifer and ensure irrigation water access for farmers in the region, provide an important opportunity to analyse the relationship between groundwater governance and the development of policies designed to adapt to changing groundwater availability.

Agriculture in the ESPA region relies on declining aquifer resources for agricultural production. In 2015, after 20 years of extensive litigation between surface water and groundwater irrigators, these two parties negotiated an agreement that led to a new policy, which requires groundwater irrigators to reduce their groundwater withdrawals by an average of 13%. Known as the 2015 Settlement Agreement, this policy change was designed to ensure that surface water users downstream of the aquifer received their full water rights and to implement a managed aquifer recharge program to replenish the ESPA. In this paper, we draw on interviews with water managers and other actors involved in the 2015 Settlement Agreement to answer the following research questions: 1) how did the groundwater governance arrangements in the ESPA region shape the emergence and design of the 2015 Settlement Agreement, and 2) how did the new governance arrangements affect the implementation of the agreement.

Our analysis expands the growing literature on groundwater governance in two key ways. First, we use Susskind's (2005) prescriptive framework for achieving adaptive governance in groundwater systems, to provide a lens for analysing our interview results. We examine how groundwater governance arrangements emerge and are applied to mitigate the impact of groundwater overdraft, offering insights on where our own results diverged from Susskind's, and, when possible, why they diverged. Second, and in contrast to much of the literature on adaptive governance, we go beyond assuming that the application of adaptive governance arrangements will confer on its constituents the capacity to act, and briefly assess how the governance arrangements put in place by the 2015 Settlement Agreement influence the local implementation of the policy solution. In the next section, we provide a short review of the literature on groundwater and water governance, with particular attention to describing the adaptive governance framework that guides our analysis and discussion of our results. This is followed by an overview of our study site and a description of the 2015 Settlement Agreement. We then describe our methods, before moving on to our results and discussion. In particular, we demonstrate how the governance arrangements underlying the settlement agreement enabled flexible and potentially sustainable social and ecological outcomes. We also consider how the policy solution that emerged from the settlement agreement negotiations created a vacuum in enforcement authority. We finish with a brief conclusion that summarises the paper and explains how our findings extend our understanding of the conditions required for adaptive governance. We also identify decentralisation of authority and the attendant lack of capacity of local resource managers to implement policy, as potential mediating challenges in the shift to adaptive governance arrangements.

LITERATURE REVIEW AND ANALYTICAL FRAMEWORK

Groundwater governance is defined in our study as "the overarching framework of groundwater use laws, regulations, and customs, as well as the processes of engaging the public sector, the private sector, and civil society" (Megdal et al., 2015: 678). How groundwater governance systems are designed is critical to their effectiveness (Kiparsky et al., 2017), and how governance systems are implemented sets the parameters that determine how groundwater resources get managed (Megdal et al., 2017). In particular, governance arrangements affect the processes through which groundwater problems such as aquifer decline are addressed, and the capacity of groundwater managers and other actors to adaptively solve problems. The design of a groundwater governance system mediates both how adaptive decisions are made and how management actions are implemented and enforced to ensure compliance with new policies (Kiparsky et al., 2017). In particular, research has found that in order for adaptive problem-solving to occur, it is essential that groundwater management agencies have adequate jurisdictional authority and can implement new policies and management activities (Ostrom, 2005; Pahl-Wostl et al., 2012; Kiparsky et al., 2017).

In the broader literature on resource management, adaptive governance is frequently considered to be the ideal strategy for management of scarce resources such as groundwater. Adaptive governance is generally characterised as the development of "new governance institutions capable of generating long-term, sustainable policy solutions to wicked problems through coordinated efforts involving previously independent systems of users, knowledge, authorities, and organized interests" (Scholz and Stiftel, 2005, cited in Chaffin et al., 2014). The goals of adaptive governance include developing and strengthening relationships between government organisations at multiple scales, and allowing for decision-making power to be distributed between different governmental and non-governmental organisations. In order for adaptive governance to work, however, an overarching set of rules and norms must be agreed upon and established (Ostrom et al., 1961; Susskind, 2005; Ostrom, 2010; Pahl-Wostl and Knieper, 2014). If rules and norms are not established and recognised by all parties, the system is more likely to be fragmented and ineffectively coordinated, particularly if authority is not centralised to some degree (Pahl-Wostl et al., 2012; Pahl-Wostl and Knieper, 2014; Morris and de Loë, 2016). When well designed, adaptive governance may lead to increased knowledge and responsiveness in the face of risk, and allow for greater flexibility in addressing environmental problems that are being managed at different levels, including by individuals who are concerned with their own needs and resource use (Childs et al., 2013; Scott et al., 2013; Gillet et al., 2014; Risvoll et al., 2014; Kirchoff and Dilling, 2016). While research on adaptive governance has provided important insights into how particular forms of governance can enable flexibility and responsiveness in the face of environmental change or other forms of risk, it has largely been assumed that application of the principles of adaptive governance will themselves confer the capacity to implement and enforce policy solutions on non-state and other actors, rather than providing a mechanism for ensuring that capacity exists, or working to create it. This assumption has led to a disproportionate focus on the conditions that allow for state and non-state actors to engage in policymaking processes, at the expense of focusing on the outcomes of the subsequent policies.

Susskind (2005) identified four minimum conditions for effective adaptive governance of groundwater systems. First, he suggests that decision making about water use that affects competing parties must include stakeholders and elected and/or appointed representatives who are appropriately selected and adequately prepared. If this condition of *representation* is not met, these decision-makers may not be considered legitimate representatives of those who will be affected, and thus it is likely that a new policy developed under these conditions would be rejected. Second, for the process to be considered legitimate, stakeholders need to have access to the *scientific and technical information* informing decisions, and need to be able to interact directly with decision-makers. Third, *neutral facilitators* selected by the competing parties should run negotiation processes using a consensus-oriented approach. Finally, *areas of disagreement between the competing parties should be defined*,

and experimentation and collaborative monitoring should be used to resolve disagreements and deal with scientific uncertainty.

While there are other adaptive governance frameworks (e.g. Ostrom, 2005; Pahl-Wostl et al., 2007), here we use Susskind's framework as the organising and analytical architecture for our analysis. In particular, we assess whether each of Susskind's four conditions is present in our case, and to what extent they contribute to effective implementation of the settlement agreement. Susskind's framework is particularly relevant to our case because it was developed in the United States in response to groundwater issues in Florida. Thus, our analysis is an important opportunity to assess the relevance of this framework to another case of groundwater governance in the US, and to identify any potential extensions or improvements to it. While the settlement agreement's signatories did not explicitly set out to implement an adaptive governance system in the ESPA, the four elements of adaptive governance reviewed here were present to various degrees in the process that led to the agreement. Moreover, and keeping with our critique of the adaptive capacity literature above, using Susskind's framework (which is largely focused on the conditions that enable adaptive governance to be achieved) allows us to demonstrate the problematic consequences of ignoring the policy-implementation capacity created (or not created) by governance arrangements. Thus, using these elements as an organising framework to guide our analysis helps us understand the factors that shaped the emergence, design, and application of the 2015 Settlement Agreement.

STUDY SITE AND SETTLEMENT AGREEMENT BACKGROUND

Agriculture in the Eastern Snake Plain Aquifer Region

Idaho is a major contributor to the global agricultural market, with four million acres of irrigated land supporting a US\$15 billion agricultural industry (Watson and Ringwood, 2016). Within the United States, Idaho is the number one producer of potatoes and barley, and is the second-largest producer of sugar beets (ibid). These crops, along with alfalfa and wheat, form the mainstay of Idaho's agricultural production. Additionally, Idaho has a growing dairy industry, which is often supported by, and contributes to, the crop market in Idaho. In total, the agricultural industry contributes 16% of value added to Idaho's gross state product (ibid). Much of this production occurs within the ESPA, where 33% of the potatoes, 20% of the sugar beets, and 10% of the wheat in the United States is produced on 1.6 million acres (U.S. Department of Agriculture, 2014). Given the continental and global importance of Idaho's agricultural system, changes in water governance have potential ramifications for global commodity markets.

Irrigated agriculture in the ESPA region is accomplished through both groundwater and surface water withdrawals, with farmers south of Magic Valley and North Snake Ground Water Districts solely dependent on surface water from the Snake River, and farmers in the ten groundwater districts north and east of the Twin Falls area dependent on a combination of groundwater from the aquifer and surface water from the Snake River (see Figure 1). Importantly, these two water sources are hydrologically connected, and surface water availability from the Snake River south of Twin Falls is partly determined by the amount of water leaving the aquifer at Thousand Springs. While farmers in the region originally depended on surface water resources from the Snake River and its tributaries to irrigate their crops (Jones, 2016), rural electrification, the cheap price of electricity, and technological advances in well and irrigation technologies allowed farmers to begin pumping groundwater from the Eastern Snake Plain Aquifer starting in the 1950s. In addition to ensuring a reliable source of water, these advances allowed for 700,000 acres of agricultural land to be put into production in areas north and east of Twin Falls between about 1950 and the mid-2000s. While many farmers have maintained surface water rights in addition to their groundwater rights, reliance on groundwater in this area became the norm, and some farmers now rely solely on it for irrigation.

Figure 1. The boundaries of the Eastern Snake Plain Aquifer and the eight groundwater districts involved in the 2015 Settlement Agreement (Image courtesy of the Idaho Department of Water Resources).

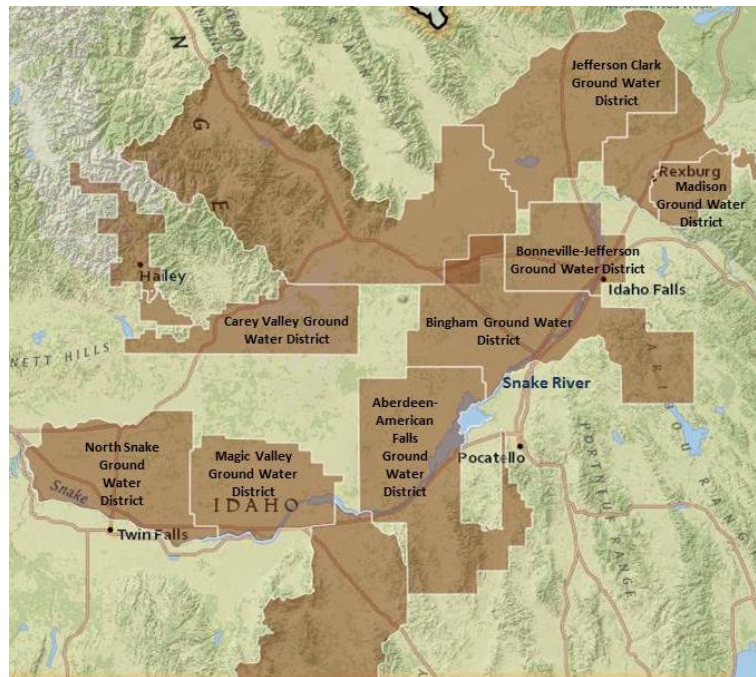
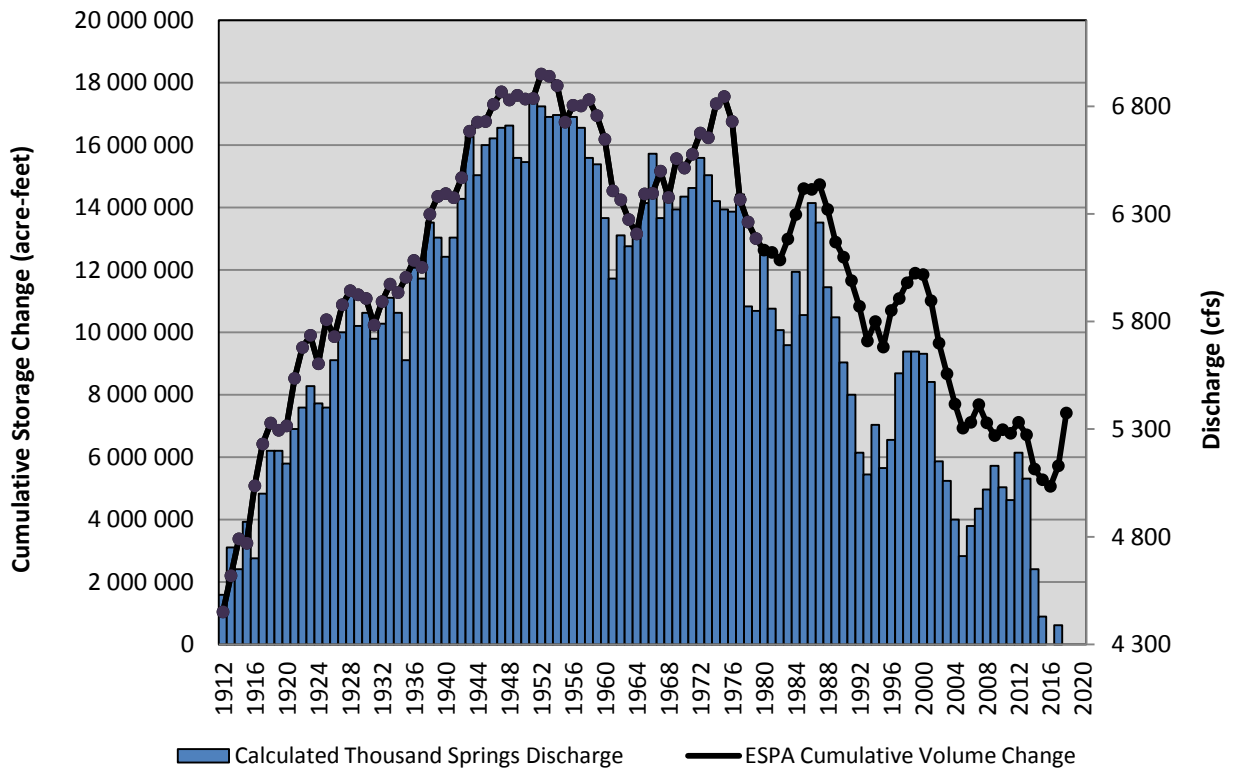


Figure 2. EPA Volume of Water and Thousand Springs Discharge. The artificial inflation and subsequent decline of the Eastern Snake Plain Aquifer as a result first of flood irrigation and second of increased irrigation efficiency (Image courtesy of Idaho Department of Water Resources).



As farmers increased the area in agricultural production and relied more heavily on groundwater, they also moved towards using more efficient irrigation technology to conserve water resources and lower their power bills (Huffaker et al., 2000). These changes decreased incidental recharge levels in the ESPA, which led to falling water levels (see Figure 2). As such, farmers and other users today have approximately 13 million acre-feet (MAF) (around 16 Bm³) less water available in the aquifer than in 1952. By the mid-1990s, the decline in the aquifer led to water delivery calls and subsequent litigation between surface water users and groundwater users, gradually over the subsequent 20 years changing how water was governed along the ESPA. By 2015, surface water and groundwater users recognised that litigation was no longer enough to ensure water access and security for both parties. By 2016, approximately 30% of agriculture in the ESPA region was being irrigated with groundwater, and, overall, the rate of groundwater use is typical of industrialised nations (Idaho Department of Water Resources, 2016; Idaho National Laboratory Oversight and Radiation Control Program: Idaho Department of Environmental Quality, 2005; National Groundwater Association, 2016).

Background and settlement agreement description

As in much of the American West, the doctrine of prior appropriation was chosen to regulate irrigation water when agriculture in Idaho started expanding rapidly in the early 1900s (Harrington, 2012; Jones, 2016; Leonard and Libecap, 2017). Prior appropriation allocates water to water rights holders using a priority system that dictates which users receive water first in times of scarcity. It is based on the principle of 'first in time, first in right'. In this regulatory system, irrigators are issued usufruct water rights by the state, each of which has a priority date and allows the withdrawal of a specified amount of water from a particular source over a certain time period. The priority date associated with each right establishes that right's position within the overall hierarchy of the region's water rights. In times when there is insufficient water for all water rights to be met, water access is curtailed starting with the most junior right so that senior rights are ensured to receive their allocated water. Both surface and groundwater rights in Idaho are allocated according to the doctrine of prior appropriation.

While many farmers perceive prior appropriation as a decentralised management strategy that grants a private property right to farmers, from a legal perspective, prior appropriation is a centralised approach that allows state water managers to issue water rights, address shortages, and manage delivery calls (Harrington, 2012). In Idaho, the Idaho Department of Water Resources (IDWR) is the governing body in charge of managing water throughout the state. Indeed, over the last two decades, IDWR implemented an extensive adjudication process to ensure that water rights are clearly issued, managed, and recognised across the state, ensuring that priority is always honoured (Fereday and Creamer, 2010; Idaho Department of Water Resources, 2014). In addition to delineating the water available for agricultural use, this water adjudication process also sought to guarantee sufficient water to keep the state's large hydropower generation plant operational.

Between 1994 and 1995, IDWR and the state legislature recognised that groundwater and surface water resources were hydrologically connected, leading to the implementation of conjunctive management to address potential shortfalls experienced by surface water users below the American Falls reservoir. Conjunctive management put in place a series of new rules that meant that water rights from hydrologically connected ground and surface water sources would be administered together, and that junior groundwater users would now be subject to delivery calls from senior surface water rights holders in cases where material injury could be shown under the rules of prior appropriation. Importantly, the application of conjunctive management accomplished two significant things that set the stage for later developments in water management in Idaho. First, it recognised the hydrological connectivity of these two formerly separately regulated water resources, meaning that any new policies would have to take into account both types of water. Second, it established a means for filing water delivery claims against upstream users (who are mostly junior), many of whom primarily rely on groundwater pumping. By establishing conjunctive management as the new framework for governing

water along the ESPA, IDWR encouraged the creation of four original groundwater districts (now a total of ten groundwater districts), each of which could work independently to recharge the aquifer to prevent delivery calls, and organise their constituents to use less water overall (Idaho Department of Water Resources, 1997).

While conjunctive management was the first formal change affecting the relationship between surface water and groundwater users, additional changes followed. In 2005, Rangen Inc., a fish hatchery near Twin Falls, made a water delivery call against groundwater users northeast of American Falls reservoir because the hatchery had not received its full allotment of water to operate the fish farm. This call and its aftermath established two important precedents that would later influence the 2015 Settlement Agreement. First, the judicial decision that was made in order to rectify the Rangen call set a precedent for the Idaho Groundwater Appropriators (IGWA) to buy and deliver water to surface water users downstream so as to ensure that senior water rights holders received their full share, even when their normal delivery system failed (Idaho Department of Water Resources, 2005). This decision became especially significant as the buying and delivery of water during times of scarcity became a particularly important tool over the next ten years. It also established the 'futile call doctrine', which dictates that, in order to require groundwater pumpers to shut off their pumps to satisfy a water call, this unused water must reach the surface water user in a "reasonable amount of time", which is usually considered to be within two weeks (Idaho Department of Water Resources, n.d.). If the curtailed water does not augment water sources available for use by the theoretically injured parties within that period of time, it is considered a futile call and the groundwater user is not further required to reduce their water usage.

Then, in 2015, after twenty years of gradual change to Idaho's water governance and repeated water calls made against junior groundwater rights holders, a crisis event occurred that catalysed major institutional change in Idaho's groundwater governance. After a dry winter, IDWR issued a report indicating that water levels in the ESPA were very low and that up to 300,000 acres of irrigated agriculture could face total curtailment by July. In order to avoid a devastating blow to farmers and to Idaho's economy, members of the state legislature met with IDWR hydrologists and consultants, along with lawyers and members of the Surface Water Coalition (SWC) and IGWA, to determine a solution. The goal of these meetings was to determine how to manage the aquifer for current and future use. Extensive negotiation and debate ensued, ultimately leading to the 2015 Settlement Agreement, which went into effect in 2016. The agreement stipulates that groundwater districts must reduce their groundwater pumping by 240,000 acre-feet (AF), or approximately 13%. While the SWC is not allowed to make delivery calls between the start of irrigation season in 2016 and the end of irrigation season in 2018, IGWA is responsible for leasing 50,000 AF of storage water to deliver to downstream surface water users during that time. The agreement also required all groundwater wells to be metered by the start of the 2018 irrigation season. Finally, to meet one of IGWA's primary demands, the agreement included managed recharge, meaning that groundwater districts were able to pay for and develop recharge sites to offset some of the necessary reductions. Recharge responsibilities were also allocated to the state, with the state legislature promising money to the Idaho Water Resource Board (IWRB) in order to recharge 250,000 AF of water each year.

The terms of the settlement agreement also affected groundwater governance at the local level by giving groundwater district managers some autonomy in how the agreement would be implemented in each district. Using the overall percentage reduction requirement as a guideline, each groundwater district was allowed to allocate specific reductions between different water rights holders and to monitor compliance however they chose. Most districts developed a tiered system that requires farmers to cut their groundwater withdrawals by certain percentages depending on the seniority of the water right. Some other districts required that farmers with the historically highest pattern of use reduce the most. The agreement went into effect in 2016, and will be re-examined and potentially renegotiated in 2020 depending on the ESPA levels.

DATA AND METHODS

The primary data we analyse in this paper comes from 27 interviews conducted during 2017 and 2018 with water managers, scientists, lawyers, legislators, and other authorities involved in water management in Idaho. Initial respondents were identified through snowball sampling from contacts in the community; subsequent water managers were identified from publicly available documents. Local groundwater managers, most of whom are also farmers or retired farmers, were interviewed in six of the eight signatory groundwater districts. Other water managers included those at the state level. We also interviewed lawyers from each side of the negotiations, along with other water authorities involved in the negotiations. Using a semi-structured protocol, we asked questions about the 2015 Settlement Agreement negotiation process. Respondents described key actors involved in the negotiations and implementation, the alternatives to the settlement agreement that were discussed, their opinion about the necessity of the settlement agreement, and who they considered its major beneficiaries. For respondents involved in implementation at the local groundwater district level, we also asked questions about the particular practices and systems they were using to implement the terms of the agreement, and the amount of latitude they had to make adjustments at the local level while still meeting the state's demands. Respondents were encouraged to introduce additional topics important to understanding the emergence, design, and application of the 2015 Settlement Agreement that were not covered in the interview guide. Follow-up questions were asked by the interviewer where appropriate.

Interviews were recorded and then transcribed. We managed and analysed transcripts in MAXQDA. We analysed interviews using thematic content analysis (Bernard et al., 2016) and coded them using both deductive and inductive techniques. Deductive codes were selected from the literature review; in particular, we focused on the extent to which the changes to policy brought by the agreement aligned with adaptive governance principles (Susskind, 2005). We also assessed the way water managers perceived the legitimacy of the negotiations (Scholz and Stiftel, 2005; Susskind, 2005), as well as changes to the centralisation of decision making and enforcement authority at the state and local levels. Inductive codes emerged throughout multiple iterations of coding (Charmaz, 2014). The inductively derived codes primarily included codes about prior appropriation, issues of beneficial use, the role of the state in water management, local perceptions of the centralisation and decentralisation of water management, and other locally-specific codes related to water use and water management. Each interview was coded at the sentence level. The themes and patterns derived are discussed in the results and conclusions presented below.

RESULTS AND DISCUSSION

In the following section, we present and discuss results from our study that demonstrate that, while the processes that led to the 2015 Settlement Agreement and its implementation were not designed around Susskind's four metrics of adaptive governance, the governance arrangements it incorporates mirror elements of adaptive governance. Thus, our presentation of the emergence, design, and implementation of the agreement is guided by considerations of its legitimacy of representation, redistribution of scientific and technical knowledge, subsequent negotiations by neutral parties, and the potential for natural experimentation to resolve previously defined disagreements. Finally, we consider how the governance arrangements put in place by the agreement affect its implementation, showing how the terms of the new agreement change the distribution of power and authority between state and local actors. We contend that this redistribution of authority has generated uncertainties in the system with respect to enforcement.

Legitimacy of representation

Water managers from most of the groundwater districts and canal companies, as well as state water managers, members of the state legislature, lawyers for each side, and technical consultants were present throughout the negotiation process. Groundwater district managers from seven of the eight signatory groundwater districts were present at all meetings, as were water managers from major canal companies. Because groundwater district members elect these water managers, their presence at the negotiations ensured the representation of each district, and also contributed to the legitimacy of the negotiations and of the agreement itself. From the state, one water manager and several technical consultants contributed advice and scientific information at the negotiation meetings. Additional individuals from the state included two state legislators, as well as an attorney for the state who has been involved in water rulings in the past.

Notably absent from the negotiations, however, were the groundwater district board members from one of the northern groundwater districts. According to these water managers, they were not invited to the negotiations until very late in the process, and their input was not solicited. As this groundwater district manager said,

There was one guy that was principally involved from our area and he's now not involved at all. He was a very good negotiator, very intelligent person. Anyway, he was just really good. But they wouldn't let him into the meetings either. They did that agreement on a closed-door agreement.

The lack of representation from all groundwater districts indicates that stakeholders were not properly prepared, both during the negotiations and as water managers began to implement the agreement in their districts. The lack of early representation in the negotiations of some districts produced discord. A groundwater district manager from one of those districts told us,

This upper valley, we weren't included very much. In the early negotiations, we weren't included at all. Then once they progressed, we were complaining that we weren't part of it and they invited to us to come but they wanted us to be very quiet and sit in the back and not voice our opinion.

Making a space for dissensus is a crucial element of adaptive governance and, without the opportunity to share and resolve alternative opinions, management changes resulting from the agreement will give rise to discord and frustration. This is often because there is a lack of institutional knowledge but also because incomplete representation undermines the legitimacy of agreements.

After the 2015 agreement was signed and information was being distributed to stakeholders within each of the eight signatory groundwater districts, groundwater district managers held meetings to communicate information about the agreement to the farmers in their respective districts. Members of IDWR and the state legislature often attended these meetings, not only to give legitimacy to the agreement itself, but also to serve as a scapegoat for the frustration of farmers in each district. This allowed groundwater district managers to maintain their own legitimacy and good standing within the eyes of their community.

Redistribution of scientific and technical knowledge

Susskind argues that scientific and technical knowledge is a key feature of adaptive governance, and that the redistribution of this knowledge must be done by experts selected by stakeholders. Water managers at the state and local level involved in Idaho's 2015 Settlement Agreement seemed to agree with this sentiment, arguing that the agreement could not have been negotiated without their having access to aquifer-level data and modelling that allowed them to explain to their constituents the level to which the aquifer had declined. In addition, throughout the process, representatives of the IDWR attended groundwater district meetings to help distribute knowledge of the aquifer model and the associated terms of the agreement. While irrigators knew that the aquifer had been declining, the

updated hydrological and technological information IDWR provided during the negotiations helped local water managers accept the implications of the aquifer decline. As a member of IDWR noted, "I think it was important to have the technical tools in place that we have now, such as very good groundwater and surface water monitoring data sets and a fairly refined groundwater model, so that you can tell people, you can scenario test". This sentiment was echoed by some local groundwater managers as well. As one groundwater district manager commented, communicating information about the aquifer decline was challenging at first, but as farmers learned more, they started to help others understand as well:

I think the more times that you talk to people about it then it starts to become clearer to them... I think those that understand it more are looking at the numbers for the first year. They've come a lot closer to where they are supposed to be, or outright made their obligation. Those people are helpful too, because then like he was saying before, it's really a grassroots system right now. They'll turn around, the more I understand it the more I talk to my neighbour, I help my neighbour understand it.

As this groundwater district manager demonstrates, the distribution of scientific and technical knowledge has helped groundwater district members recognise the problem. Even further, as individuals have learned more, they've started helping others by explaining the aquifer decline, which has legitimised the settlement agreement in the eyes of many.

In providing the technical tools that the above specialist discusses, scientific knowledge was distributed to farmers, rather than just to water managers. This is one way in which this agreement represents a move towards adaptive governance along the ESPA. Susskind advocates the distribution of scientific and technical knowledge by locally selected experts, and the distribution of this knowledge to all affected stakeholders. In the case of the agreement, however, the experts providing technical and scientific knowledge were representatives of IDWR, rather than locally selected experts, and the information was primarily distributed to groundwater district managers.

The involvement of IDWR and the redistribution of scientific and technical knowledge to local groundwater district managers also led to a recognition that it was no longer possible or sustainable to continue to purchase water for mitigation – a strategy that had been used to mitigate water shortages prior to the agreement. Given the possibility that 300,000 acres of irrigated agriculture could be curtailed without mitigation, the groundwater district managers recognised that the problem was much more severe than in the past and that there was no way to mitigate water shortfalls for so many acres. As one groundwater district manager said:

I think people realized that, you know what, we need to get to a point where we're actually, instead of just buying water out of the river every year to mitigate an issue, come up with some solutions that would actually change what's going on with the aquifer.

Given the challenges of mitigation and the data from the aquifer models, groundwater district managers and the IGWA president accepted the necessity of signing the 2015 Settlement Agreement and implementing governance changes.

Resolution by neutral parties

Susskind argues that, in order for governance to be adaptive, any resolution that is reached between parties must be negotiated and resolved by impartial parties. In this section, we explore the role of mediators in the agreement negotiation process. We argue that, while the mediators of the negotiations are not truly 'neutral', they are as close to impartial as possible given the circumstances and institutional knowledge needed to negotiate an agreement like this.

During interviews with local and state water managers, respondents regularly identified two key actors from the state legislature who helped successfully negotiate the terms of the 2015 agreement. Both had been involved in agriculture or ranching in the state, had knowledge of water law, and

believed strongly in the importance of agriculture to Idaho's economy and culture. Many groundwater managers who were present at the negotiations explained that the history of conflict between water users involved in the negotiations meant that the presence of outside parties was required at the negotiations to mitigate tensions between the two parties, and that these two legislators did a great deal of the legwork to ensure that an agreement was reached. As one member of IDWR said,

Between April of 2015 to when it got inked in September, I will say there was between 15 and 20 meetings between the parties. They were really ragged at the beginning. It had to be shuttle diplomacy. They were in their separate rooms and we would go back and forth. They could not be in the same room with each other.

During the negotiations, 'shuttle diplomacy' was conducted by the two members of the state legislature who were heavily involved. They would hear complaints and demands from either the SWC or IGWA, and then go to the other party and hear the same thing, until they were able to collectively work out an agreement that was acceptable to all parties, including the state.

Scholars of adaptive governance (Scholz and Stiffler, 2005; Susskind, 2005) argue that neutral facilitators ensure fair and reasonable governance outcomes. The two state legislators involved in the 2015 agreement negotiations were neutral in the sense that neither of them is currently affiliated with the SWC or IGWA. However, both have historically been involved in farming and ranching in Idaho, and, as state legislators, both also have a vested interest in ensuring the ongoing economic success of agriculture in Idaho. While this perhaps belies their neutrality, in this case, the institutional knowledge from their background in agriculture was necessary in order to understand the complexities of the state's water issues well enough to effectively facilitate and mediate the negotiations. Thus, even though these two state legislators do not exactly meet Susskind's definition of what constitutes a truly 'neutral' facilitator, in this context mediators with knowledge of the system were necessary, and despite their vested interests, their legitimacy was valued by stakeholders enough to ensure that an agreement was reached. Our results thus suggest that neutral facilitation is not necessarily a requirement of effective adaptive governance, inviting reassessment of Susskind's framework. We find instead that credibility, legitimacy, and a strong knowledge of the resource system may be equally (or even more) important attributes than neutrality. Future research should continue to examine the most important attributes facilitators should possess.

While allowing mediation from parties with institutional knowledge may have been necessary in this situation, some of the stakeholders did have objections to how these individuals influenced the outcome of the agreement. In particular, local groundwater managers noted that, because the state was involved in the negotiations, it was able to retain a substantial amount of centralised authority for itself. As Pahl-Wostl and Knieper (2014) have described, systems with multiple sites of authority can lead to a fragmented governance system, where some authority is recognised, but other authority is too diffuse to be exercised, or is made secondary to the central authority if there is conflict with implementation and enforcement policies. In this way, fragmentation may also lead to greater frustration, as some groundwater district managers expressed to us in their interviews.

The negotiation process itself offered an opportunity for the state to re-emphasise its own authority with regard to water management. While prior appropriation has traditionally been perceived by farmers and other water rights users as a decentralised management strategy that emphasises private property rights (Anderson et al., 2016), prior appropriation is actually a centralised strategy that ensures that a single governing body can administer and manage water rights in a state (Harrington, 2012). However, because prior appropriation has been perceived as a decentralised strategy, the negotiation process was read by many stakeholders as the state reasserting its authority to govern water, and in doing so, becoming more visible in the water management process. As one groundwater manager indicated, "We're worried about it, because if this agreement does not turn out, then we will be under a water management area, and having the state dictate that you all cut back (...) to 20%, we're

worried about that". While many local water managers acknowledged the role of the state (particularly state judges) in ruling on past litigation, they see the negotiation process and the subsequent agreement as a way for the state to reassert its authority over water management. As Scott (1998) and Birkenholtz (2012, 2014) have noted, institutional change involves the process of making various actors more visible either to, or as, leaders of policy processes, which is often rejected or contested by others involved in the process of change. While Scott (1998) originally argued that institutional change, particularly when it comes to changes to the centralisation of government, is a process of rendering individual subjects more visible or knowable to the government, and thus subject to being governed, Birkenholtz (2014) extrapolates this argument to indicate that institutional change is also the process of rendering the state more visible to its constituents via concentration of authority, thus establishing or reclaiming control.

Despite these questions about the relative pre-eminence of the state versus the groundwater districts' authority, however, the state's involvement in the agreement was generally viewed positively because the state demonstrated commitment to the agreement by taking on its own aquifer recharge obligations. Of the twelve groundwater district managers we interviewed, seven viewed the state's involvement positively. This suggests that, even though the state was not truly a neutral negotiator, and many water managers saw the negotiations and subsequent agreement as a way for the state to reassert its authority, they nevertheless grudgingly acknowledged the value of the state's involvement. Specifically, as part of the agreement, the state legislature allotted money to the Idaho Water Resource Board, a subset of IDWR, to recharge up to 250,000 AF per year, as available. One IWRB member told us they had allocated US\$5 million a year for that effort, which was widely seen as an acknowledgement by the state that it had over-distributed water rights in the past and was recognising its responsibility to help fix the current problem. This awareness of its own mistakes in not managing water more frugally in the past likely helped the state representatives build trust with the other stakeholders and generally soften any frustration they may have felt about the state's active involvement in the agreement.

Defining and resolving disagreement through natural experimentation and collaborative monitoring

Susskind's final metric of adaptive governance is the opportunity to define and resolve disagreement through natural experimentation and collaborative monitoring. Both during the negotiations and since implementation has commenced, areas of disagreement continue to be defined. Natural experimentation and collaborative monitoring, however, have only occurred since implementation of the agreement began, which has led to additional scepticism of the science and monitoring of the ESPA.

While some groundwater district managers argued that the agreement could only have been negotiated with the help of the aquifer models developed by IDWR, others expressed scepticism about the science that produced the models. Perhaps because the scientific and technical experts were not selected by stakeholders, or perhaps because of a general distrust of IDWR as a centralised government authority, five out of the twelve groundwater district managers indicated distrust towards the aquifer model data and the conclusion that groundwater users were at fault for the aquifer's decline. This creates a substantial problem for groundwater district managers attempting to address concerns and entice individual farmers to cooperate. As the following quote from a groundwater district manager – representative of many farmers' perspectives – illustrates, some farmers affected by the agreement do not believe there is sufficient data to warrant its terms:

Those guys are scrambling around saying that it's our – it's the groundwater users that are perpetrating their losses. And that may be true within five miles maybe of the river, but it's not in other places. All they have is the groundwater model. They really don't have any testing. They have years where they can say, well, the water table has dropped for the last 50 years. They can say that. But where did they measure that at? That's the problem. If they measured it right next to the river and there was gains in farming right next

to the river, it's probably accurate. But it's not accurate basin wide. That's the problem. And so they are trying to build a model off of insufficient data.

As the quote above also demonstrates, there is no consensus among stakeholders when it comes to the decline of the ESPA. Susskind argues that defining areas of disagreement is fundamental to ensuring adaptive governance. Thus, in the case of the 2015 agreement, the lack of locally selected technical and scientific experts may be an important problem, and demonstrates one of the ways in which the agreement fails to meet the necessary criteria for genuine adaptive governance. However, it is important to note that in cases where there is little to no local expertise because the issue at hand is highly technical, the absence of local knowledge may not be as important as the need to design governance arrangements in such a way that local managers become experts over time.

As part of the settlement agreement, all groundwater wells in the affected groundwater districts in the ESPA are required to be metered by the beginning of the 2018 irrigation season. By metering wells, local groundwater district managers will have better information about the water use of farmers in their districts, and can communicate this use to the state. From this data, IDWR will develop additional models that examine how the 13% reduction and additional recharge that the districts and IWRB have engaged in are affecting ESPA water levels. While the metering of groundwater wells is considered a better-late-than-never strategy, many groundwater district managers have argued that the metering should have preceded the agreement itself. By only requiring well meters after the agreement goes into effect, some groundwater district managers argued that there was no way to ensure that the groundwater pumping itself was what was causing the aquifer decline. Additionally, while IDWR argued for the 13% reduction in pumping as a way to return to aquifer levels similar to those of the 2000s, groundwater district managers argue that it is hard to know how well the 13% reduction will work. In combination with the natural recharge from the 2016/2017 winter, groundwater district managers have argued that it will be very difficult to determine how effective the reductions are compared to wet winters overall. Several groundwater district managers expressed concern that the aquifer will rise, and that if it does it will not be the result of changes to groundwater pumping but rather will be the result of wet winters:

Do I think that pumpers have an effect on the aquifer, yes. I don't think that we have near the effect that the surface water coalition has propagated. I think that when we get to 2020 and they measure those sentinel wells, I think that we will have a better argument as pumpers. Because if we have done everything that they called for, plus this last winter, holy crap, and if those wells still are reacting, I think we will have a standoff.

Given that no natural experiments were conducted prior to the implementation of the agreement, groundwater district managers are expressing frustration at the mandates, even while they do want to positively affect the aquifer. In the following section, we consider how the governance arrangements put in place by the settlement agreement affect its implementation.

IMPLEMENTATION CHALLENGES

Manager preparedness

While the final round of negotiations that led to the 2015 agreement was catalysed by a low snowpack and predictions of a dry year, farmers and water managers along the ESPA had been amending water management in the area for decades prior. As a result, from a broad perspective, one would expect that state and local water managers would be prepared to carry out new changes. As local groundwater managers argued, however, they and their constituents were not prepared for the changes to water management and the redistribution of authority that accompanied it, particularly the decentralisation of authority from the state that rendered the groundwater districts more powerful. The agreement

stipulated that groundwater district boards, which had started forming in Idaho after conjunctive management was mandated in 1994, were allowed to decide how the required reductions to groundwater irrigation should be distributed among the members of their district. Overall, this change was positively received, as local governance has long been valued in the American West among resource managers and users who generally support local decision-making authority (Anderson et al., 2017). While groundwater district managers have indicated that the delegation of decision-making authority to the local level is a key reason for the likely 2015 agreement, it has also created some new challenges for groundwater districts.

One major challenge expressed by groundwater district managers was that many of the districts did not have paid staff and a professionalised central office that could effectively communicate the new policy changes and the implementation options available to members. Relatedly, most districts did not have an established process to address and mediate members' objections. Further, because of the way the hydrology of the ESPA had been understood in the past, the three groundwater districts northeast of American Falls had never experienced curtailment orders. As a result, these groundwater district managers lacked institutional knowledge when it came to understanding the hydrological system, the complexities of water law, and the diversity of management options that were available to meet their required cuts. As this groundwater district manager noted,

The district boards were super overwhelmed and so they kind of did, they would throw this thing out, everybody's going to just take the 12.6% cut. Then everybody would go, no we're not. There's got to be a different way. And then this water in to it from the canals, that made a big difference. But the boards were just, I mean they were used to meeting once a month for an hour and then say, yeah let's do this, and go on their merry way. They had no idea of water delivery systems. They really had no idea of any kind of historic water law. They're just volunteers that have just gone, oh okay, I will sit on this board.

The decentralisation of implementation authority did not just create implementation problems. Indeed, in some cases, it facilitated implementation by allowing water managers to address fairness concerns held by farmers. Here, while all districts were required to reduce groundwater use by 13% overall, district managers could choose different ways to distribute these cuts. Most chose a tiered system in which farmers had to cut their groundwater use by a certain percentage depending on the seniority of their water right. Other districts' management choices were based on historical use patterns, and mandated that farmers with higher historic use must reduce more, while users who had already increased their efficiencies would be expected to reduce less. This type of flexibility helped address fairness concerns among farmers with strong beliefs in the inviolability of prior appropriation, while also maintaining the values of decentralisation that permeated the farming community in the state prior to the agreement (Wester et al., 2011; Birkenholtz, 2012, 2014).

Flexibility in management decision making was also necessary because of differences across the eight districts in terms of hydrogeology, climate, and soil. All of these differences at the district level meant that a 'one size fits all' solution would be likely to fail and/or be unfair to many farmers. Thus, the added flexibility at the local level demonstrates one of the ways in which the settlement agreement aligns more closely with adaptive governance principles than have previous governance strategies in Idaho. This built-in flexibility also suggests that Idaho's policymakers intuited that the implementation of new policies is more likely to succeed if affected communities are offered more local decision-making authority and opportunities to adapt management changes to local conditions (Childs et al., 2013; Scott et al., 2013; Risvoll et al., 2014). The lack of preparedness among some groundwater district managers also indicates how dissimilar the prior system had been, and how many changes are needed before successful adaptive governance in the ESPA can be realised, including the development of specialised knowledge in water management, identification of options for farming with less water, and building a cohesive district office to handle implementation.

Enforcement authority

One of the major challenges to implementation of the 2015 agreement that groundwater district managers highlight is that their authority only goes as far as telling farmers what they can and cannot do to meet the terms of the agreement – fundamentally, they have no enforcement power. If a given farmer chooses not to comply with the terms of the agreement, the district itself would not be able to force that farmer to comply. As one groundwater district manager describes below, the belief among many groundwater district managers is that the agreement neither centralises nor decentralises enforcement authority, and instead creates an absence of enforcement authority. He told us that if farmers do not comply:

They're going to figure it out with the state. But the state, I know what they're going to do. They're just going to throw them right back in our district and say 'you guys take care of it'. I know how that works. We've been down this road before. It's true, that's what happens.

Groundwater districts do have authority to exclude uncooperative farmers from their districts, which would make those farmers subject to curtailment in a dry year. However, as the groundwater manager quoted above indicated, the state would likely refuse that action as a solution and instead ask the groundwater district to find another consequence. This fuzziness in specific enforcement authority reveals one of the primary weaknesses of the agreement: under its current terms, farmers are expected to comply out of goodwill, with few fail-safes in place.

Susskind does not define how preparedness of stakeholders and the distribution of decision-making authority should intersect, and adaptive governance as a framework does not clearly define how enforcement authority should be distributed in order to ensure flexible and sustainable social and ecological resource governance. Our interviews with water managers at state and local levels in Idaho indicate that, while authority has been decentralised to the groundwater district managers as far as implementation is concerned, the preparedness of these managers to take management actions was frequently lacking, particularly given the disparity in institutional knowledge among the districts. While preparedness may come in many forms, the assumption of additional administrative and implementation responsibilities, along with the task of acquiring additional knowledge, demonstrates the difficulty of preparing stakeholders to achieve the goals of policy solutions developed through adaptive governance. In the case of Idaho, the state's active involvement and acceptance of institutional responsibility for facilitating the agreement's goals seems promising. Overall, however, the vacuum of enforcement authority is a potential problem with both Idaho's 2015 Settlement Agreement and with the adaptive governance framework.

CONCLUSION

The 2015 agreement offers a unique and ongoing opportunity to understand how novel governance arrangements and the policy solutions that arise from them unfold over time. The agreement was not written to adhere to adaptive governance principles, yet it includes elements of both adaptive governance and management. Based on our analysis, by adopting principles of adaptive governance, institutional change at the state and local level was enabled, building social and ecological flexibility into the governance system as it moves forward. This social and ecological flexibility, which is considered a main goal of adaptive governance, is generally considered a benefit because it allows for better outcomes, including sustainability. However, as our case shows, adaptive governance is not a panacea for resource management or governance. As others have shown in studies of decentralised governance (Andersson and Ostrom, 2008; Hoogesteger, 2012; Dunn et al., 2014; Boelens et al., 2015), changes to the distribution of authority can also create vacuums of authority. Along the ESPA, there is little enforcement authority in place that allows for groundwater districts to ensure farmers meet their required water cuts. Adaptive governance has little to say about the troubles of re-distributing

authority, largely arguing that movement away from bureaucracy and toward adaptive governance is a benefit (Susskind, 2005) without considering how this movement affects local resource managers' capacity to implement policy.

The 2015 Settlement Agreement is an ongoing process. Water managers will once again meet at the end of the 2018 irrigation season to assess how the levels of the ESPA are doing. While there are many groundwater district managers who argue that reducing pumping is not going to be the solution to aquifer decline, and that the wet winter of 2016/2017 will recharge the aquifer in a way that pumping reductions alone could not accomplish, the reassessment of the aquifer also provides an opportunity to renegotiate other parts of the agreement. Given that the goals of the agreement are assessed annually and that there is room for renegotiation starting in 2020, there are also opportunities for elements of adaptive governance to be strengthened, and to ensure that there is, among other changes, greater stakeholder preparation and participation. We suggest that, while adaptive governance cannot be considered the panacea of resource management solutions, the terms of the settlement agreement and the opportunities to reassess the agreement provide opportunities for social and ecological flexibility that are well-regarded by stakeholders. As a result, this case offers the opportunity to continue to evaluate adaptive governance and examine the degree to which it does contribute to better groundwater outcomes.

Finally, this case shows the range of actors, interests, and networks that are mobilised in changing governance. While these stakeholders had differing degrees of preparedness and knowledge, the knowledge that IDWR was able to provide, even if it was not always trusted, was an important part of the settlement negotiation and the changes to governance it produced. We show that, at least in Idaho, a range of actors must be mobilised in order to change and establish new state groundwater policies. Even with a process that is more participatory than most, this case shows that there are still limits to state power that prevail in areas where decentralisation is a value and centralisation of authority at the state level is seen as an imposition. In spite of these circumstances, water managers at various levels of governance were able to negotiate an agreement that has been implemented by a diverse group of stakeholders. While we do not wish to idealise this case, the establishment of the 2015 Settlement Agreement and the elements of adaptive governance that emerged organically in the process, nevertheless support a certain optimism for a collaborative approach to governing groundwater and preventing groundwater overexploitation in the future.

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