International Journal of the Commons
Vol. 12, no 1 2018, pp. 202–224
Publisher: Uopen Journals
URL:http://www.thecommonsjournal.org
DOI: 10.18352/ijc.806

ISSN: 1875-0281

Differentiated reactions to Payment for Ecosystem Service Programs in the Columbia River Basin: a qualitative study exploring irrigation district characteristics as local common-pool resource management institutions in Oregon, USA

Spencer Thomas Plumb
University of Idaho, USA
splumb@uidaho.edu

Travis Paveglio
University of Idaho, USA
tpaveglio@uidaho.edu

Kelly West Jones
Colorado State University, USA
kelly.jones@colostate.edu

Brett Alan Miller
Utah State University, USA
brett.alan.miller@aggiemail.usu.edu

Dennis R Becker
University of Idaho, USA
drbecker@uidaho.edu

Abstract: Payment for Ecosystem Services (PES) programs are increasingly employed to encourage individual actors to preserve and/or restore environmentally beneficial instream flows in freshwater ecosystems. However, the success of these PES programs has been mixed across geographic locations and the influence of local resource management institutions remains unclear. In the western U.S.A. little is known about the role of irrigation districts regarding these water transactions. This study addresses that deficit by using existing knowledge about common-pool resource management characteristics to explore the role of

irrigation districts in PES programs that incentivize water transactions in the state of Oregon. We conducted 20 semi-structured interviews with irrigation district managers and water transaction experts across the state in order to identify characteristics that influenced differential adoption of market-based PES programs for water. Our results reveal three groups of districts based on: rule formation, physical infrastructure, and user homogeneity. These groupings provide a means of categorizing institutional interactions and outcomes that correspond with district adaptability to water transactions. Specifically, we identify congruence between local conditions and rules as well as investment in infrastructure as design principles that shape how irrigation district managers responded to market-based PES.

Keywords: Common-pool resource management, instream flows, irrigation districts, PES, qualitative methods, water transactions

Acknowledgement: The authors would like to thank the Clearwater Fly Casters for their support of this work. Special thanks to Barbara Cosens, Alex Fremier, Dustin Garrick, Bruce Aylward, the Oregon Water Resources Congress, the Columbia Basin Water Transaction Program, the Freshwater Trust, and the Deschutes River Conservancy for their insights and advice. We are grateful for the time and thoughtful input we received from all of the irrigation district managers that participated in this research.

1. Introduction

Water scarcity threatens the sustainability of coupled human and natural systems throughout the world. While climate change and population growth will exacerbate water scarcity, proper water governance can help address scarcity by encouraging more efficient uses of water (Meinzen-Dick et al. 2004; Bruns et al. 2005). Improved water governance can help balance trade-offs between direct benefits from economic uses of water (e.g. irrigation, stock watering) and indirect benefits from maintaining ecosystems services (e.g. wild fish habitat) (Garrick et al. 2011).

Allocating water out of stream for agriculture can degrade or dewater streams that serve habitat needs of native salmon, including spawning grounds and fish passage. Market-based mechanisms known as Payments for Ecosystem Services (PES) are an increasingly popular approach for addressing the negative ecological impacts of overdrawing water for agriculture (Banerjee and Bark 2013). However, PES programs are often designed without consideration of, or input from, local resource management institutions or resource users. In this paper we explicitly focus on how irrigation districts, acting as local common-pool resource institutions, contend with the implementation of these PES programs.

PES programs provide beneficiaries of ecosystem services the opportunity to pay property rights holders to protect or improve the ecosystem services provided by their property (Farley and Costanza 2010). Thus, we characterize transactions

for instream flows (here forward 'water transactions') offered through voluntary programs as a form of PES (Kolinjivadi et al. 2014). Agricultural users may sell or lease their water rights and forego watering crops in order to keep water 'instream' and continue the provisioning of ecological benefits (Baron et al. 2002; Millenium Ecosystem Assessment 2005).

Effective incorporation and cooperation with local institutions is crucial to the success of PES programs broadly (Adhikari and Agrawal 2013). Yet, despite growing interest in and use of water-related PES programs in the western U.S.A., few assessments directly examine how local institutions, such as irrigation districts, respond to these PES programs. Local institutions have been shown to hinder implementation and discourage participation in water transactions among water rights holders (Garrick et al. 2009; Ranjan 2010; Grafton et al. 2011) but the institutional necessity of these actions remains under examined.

Existing studies of water transactions indicate that participation varies widely within watersheds. However, the influence of local institutions, such as irrigation districts, on variation in participation is understudied (Brewer et al. 2007; Garrick and Aylward 2012; Cook and Rabotyagov 2014). In the western U.S.A., irrigation districts have helped manage water for agricultural users for more than a century. Irrigation districts enforce state and local rules by marshaling collective action to deliver surface water (Heinmiller 2009). While individuals hold water rights that entitle them to a fixed amount of water at specific locations and times, many water rights holders rely on a centralized irrigation district to deliver water and manage water rights until the water is delivered. Thus, irrigation districts are local level common-pool resource management (CPRM) institutions that adapt formal rules (e.g. prior appropriation) and effectively manage common-pool resources by formulating operational rules that meet the conditions of the resource. Examples of irrigation districts' management actions include adapting rules to the needs of users, detecting and sanctioning rule violations, holding officials accountable to users, and distributing resources equitably (Ostrom 1990; Agrawal 2003).

For this research we use qualitative interviews with irrigation district managers across the state of Oregon, U.S.A., to identify how local contextual variables (both physical attributes and attributes of the population) and institutional arrangements within irrigation districts might facilitate differential participation in water transactions program. Oregon was chosen as a state that relies on irrigation but is attempting to maintain instream flows to protect salmon fisheries through water transactions, which inevitably affect operations of irrigation districts. We solidify qualitative observations into a typology of districts.

Exploring differences among local water institutions and their potential influence on the feasibility of PES programs can serve a number of practical purposes, including: (1) a means to better explain variations in water transaction participation across districts; (2) the basis for adapting water transaction programs to the local context of diverse areas; (3) the development of strategies that allow PES programs to serve complimentary roles for local institutions and; (4) the identification of other potential barriers for PES programs (Paveglio et al. 2017).

2. Background

2.1. Water management institutions in the western U.S.A.

Water resource management in the western U.S.A. is a complex and multi-layered system that involves local, state and federal institutional entities. The federal government has played a role in developing water for irrigation by funding the construction of dams and infrastructure for water conveyance (for a review see Hansen et al. 2009). However, irrigation districts, (here forward 'districts') manage more than half of the water used for irrigation in the western U.S.A. (Thompson 1993).

Districts throughout the western U.S.A. use both formal and informal rules in order to distribute and allocate water according to state systems of privatized usufruct rights (North 1990; Heinmiller 2009). In these respects, districts adhere broadly to the "design principles" of CPRM institutions (Ostrom 1990, 1993; Cox et al. 2010). CPRM institutions help manage and distribute benefits and responsibilities equitably among interdependent users to ensure the sustained provision of a resource over the long-term (Ostrom 1990; Agrawal 2001).

"Design principles" represent governance characteristics that facilitate the successful governance of a common-pool resource system (Ostrom 1993). Although Ostrom's institutional design principles can increase the likelihood of successful common pool resources (CPR) systems (Ostrom 1993; Baggio et al. 2016), ultimately, success depends on contextual variables such as physical attributes of the natural infrastructure, local context of rules and norms, and the hard infrastructure needed (i.e. type of canals, investment needed in hard infrastructure etc.) (Tang 1992; Baggio et al. 2016; Barnett et al. 2016).

One of the primary functions of districts is enforcing the state's system of water property rights known as prior appropriation (Thompson 1993; Ruml 2005). Prior appropriation provides access to water for private individuals as a private, usufruct right, according to the order in which water uses were first established (Getches 2009). Retaining ownership of a water right is contingent upon the 'beneficial use' (Getches 2009). Districts often use their own rules and norms to help facilitate cooperation among individuals and help prevent conflicts over water (Vermillion 1996; German and Keeler 2010; Lafreniere et al. 2013).

2.2. Water management institutions and transactions in Oregon

Water rights in Oregon fall into three classifications: (1) state, where water is publically owned, held in trust by the state that issues water rights for private use; (2) communal, where water rights can be owned jointly by individuals and the district that deliver their water; and (3) private, usufruct rights, where an individual is given the right to use water for private benefit and provided conditional access based on the rules of prior appropriation (Oregon Supreme Court 2008; Getches 2009; Aylward 2013). These multiple layers of property rights, ownership, and

local management pose challenges to developing tradable water rights for water transactions (Rosegrant and Binswanger 1994).

Three important institutional changes were made in Oregon during the mid-1990s to facilitate water transactions. Those changes included: (1) allowing instream flows to be considered a 'beneficial use' under prior appropriation; (2) creating a state-run program through which water transactions could be legally performed; and (3) allowing individuals to retain up to 75% of the water saved from water efficiency upgrades, which can be applied to new lands, but requiring they put at least 25% of the water saved back instream (Aylward 2013).

These state-level changes in Oregon were important for federal agencies such as the Bonneville Power Administration (BPA), which created the Columbia Basin Water Transaction Program that funds local non-profits to buy or lease water from local users for improvement of salmon spawning habitat. These non-profits are now the primary buyers of water for instream flows across the Columbia Basin (Garrick and Aylward 2012).

Water transactions evolved from water markets that allow the transfer of water rights for a negotiated exchange. These water transactions fit Wunder's (2015) definition of a PES in that they are, "a voluntary transaction between service users (buyers) and service providers (sellers) that are conditional upon agreed rules of natural resource management for generating offsite services" (Wunder 2015, 241). PES programs potentially reduce market failures, which results in the lower provision of ecosystem services as a public good (Farley and Costanza 2010). The theoretical premise of PES suggests that individuals are economically rational actors who will use their resources in order to maximize profits (Ferraro and Kiss 2002). Research on participation in water transactions has largely focused on the individual characteristics that influence participation such as education, age, wealth, and farm size (Pannell et al. 2006; Wheeler et al. 2009). However, these studies largely ignore the social and institutional contexts of these decisions and results have been largely inconclusive, suggesting that economic motivations are inconsistent or that other external factors may be influencing participation (Garrick and Aylward 2012; Cook and Rabotyagov 2014). The lack of participation in PES schemes may be the result of a social dilemma, where the interest of the group is at odds with the individual (Ostrom et al. 1999).

Observations of the program reveal that adequate stream flow and water quality conditions have not yet been fully realized in many critical salmon streams, and suggest that institutional differences across and within states may contribute to the heterogeneity in outcomes (Neuman 2004; Garrick and Aylward 2012). One way districts can influence water transactions is by lending credibility to the transaction and process, essentially encouraging members to trust water transactions as an acceptable use of water (Uzzi 1996; Lafreniere et al. 2013). Meanwhile, several authors argue that districts impede transactions by adding constraints to individuals' ability to perform transactions (Bretsen and Hill 2009; Libecap 2009).

This research uses qualitative data to explore the confluence of localized contextual variables and localized institutional arrangements in order to help

determine the response by local districts to water transactions. We propose the following research questions: (1) What formal rules or informal norms do district managers report regarding members' participation in water transactions? (2) How do contextual factors (social, physical and institutional) influence the rules and norms district managers use to adapt state rules that allow water transactions?

3. Methods

3.1. Study site

This research focuses on districts where instream flows are critical for salmon habitat. That includes districts in central and eastern Oregon – arid and semi-arid parts of the state where irrigated agriculture accounts for upwards 80% of surface water use (Brewer et al. 2007; Oregon Department of Agriculture 2012). All districts draw water from rivers systems supporting native salmon and therefore subject to the Endangered Species Act. Surface water in these regions is expected to diminish due to climatic changes (Franczyk and Chang 2009). Coastal areas and districts surrounding the greater Portland metropolitan area were excluded from this study because they have not faced surface water scarcity issues and thus have not been targeted for water transactions for increasing instream flows.

3.2. A framework for understanding district context

The approach used in this paper segments districts into similar groupings based on attributes identified in past research on CPRM institutions. Segmentation of districts by key attributes can help identify common challenges or opportunities that influence the strategies those districts take when adapting to external institutional changes (Agrawal 2001). More specifically, qualitative approaches can help uncover the complex relationship between CPRM institution characteristics and the design principles that guide those CPRM institutions (Barnett et al. 2016). Other authors have used similar approaches and typologies to better understand how group characteristics influence institutional and social responses to natural resource management of water and wildfire (Huber-Stearns et al. 2015; Paveglio et al. 2015).

The segmentation used here is based on five enabling conditions/characteristics commonly mentioned in existing CPRM literature: (1) resource characteristics; (2) group or user characteristics; (3) relationships between resource systems and group characteristics; (4) institutional arrangements; and (5) external environment (Ostrom 1994; Merrey 1996; Agrawal 2001). We combined conditions two and three as the two are closely related in the context of irrigation. Agrawal (2001) notes that each condition includes numerous attributes, and for each attribute a spectrum of variation may exist. See Table 1 for a description of the CPRM characteristics and their grounding in existing literature.

Table 1: Analysis framework.

CPRM enabling characteristics	District attributes	Attribute descriptions	Supporting literature for attributes
Resource characteristics	Water availability Water source Water right priority	Water availability – level of scarcity or uncertainty Water source – physical location and surface water type Water right priority is the order in which the district receives water relative to other districts in the basin	(Tang 1992; Meinzen-Dick 2007)
User characteristics	Water dependence Homogeneity Group size	Water dependence – district member reliance on water for livelihood Homogeneity – similarity of water use within a district Group size – the number of patrons served by a district	(Ostrom 1990, 1994; Agrawal 2001)
Existing institutions	Water sharing/Transfers Infrastructure Delivery efficiency	Water sharing – Ability to lease or transfer water to other patrons within the district Infrastructure – Physical capacity to physical move water Delivery efficiency – the ability to move water with minimal waste	(Tang 1992; Ostrom 1994; Garrick and Aylward 2012)
External environment	Relationships with other entities Federal and state laws	Quality of relationships that districts have with other organizations Enforcement of Endangered Species Act or other environmental regulations	(Ostrom 1994; Merrey 1996; Agrawal 2001)

3.3. Data collection

We conducted key informant interviews in order to understand if and how districts have adapted to institutional reforms that support water transactions. Researchers selected district managers as key informants because they could provide insight on the biophysical, social and institutional contexts that influence how each district operates within a coupled human and natural system (Postel 2000). Key informants are individuals with in-depth knowledge that can provide unique insights about a phenomenon under investigation (Huberman 1994). Two criteria related to Oregon districts were used in the approach for selecting the districts studied during this research: (1) a primary purpose of delivering water to water rights holders; and (2) membership in the Oregon Water Resources Congress (OWRC). The OWRC represents the interests of districts in the state legislature and provides publicly available contact information for irrigation district managers. OWRC staff noted that districts not belonging to OWRC are typically much smaller, but operate in similar way to member districts. A total of 25 districts (out of 41 OWRC districts) fit the criteria outlined above. Sixteen districts (64%) responded to requests for interviews. If a district did not respond after the first request they were contacted at least two additional times.

Researchers conducted sixteen interviews with district managers, and four additional interviews with state and regional managers of district associations and water transactions programs. District managers indicated that state and regional informants could provide an overarching perspective of water transactions and the role of districts in water leasing programs, and these interviews were used to contextualize interviews with district managers. We conducted all twenty interviews in the winter of 2014. Interviews lasted between 20 minutes and 1.5 hours. They were recorded for subsequent transcription and analysis. After sixteen interviews (four with water transaction program managers and twelve with irrigation district managers) we determined we had reached theoretical saturation, the point at which no new or novel information was being obtained from new interviews (Bryman 2015). The final four interviews with district managers verified that theoretical saturation was achieved.

Interviews followed a semi-structured interview guide developed by the researchers (Appendix A). Given the relative lack of research regarding how districts interact with PES-type programs, semi-structured interviews were determined to be the most appropriate exploratory approach (Huberman 1994). The protocol for this research focused on institutional changes regarding water transactions, water transaction activity, infrastructure, water uses, district history, and local user demographics. Interviewees were asked follow-up questions to obtain more information about topics discussed in their response. Interviewers also prompted managers to discuss formal rules about water management as well as their perceptions of informal rules regarding water transactions within the district.

3.4. Data analysis

A first round of thematic coding identified preliminary themes about district attributes or local context using the four characteristics of CPRM described above. Researchers also coded for examples of formal and informal rule changes within a district (Table 1) (Greene 2007). A second round employed "pattern coding" (Saldaña 2015, 236) to identify additional emergent but unexpected themes related to district characteristics and rule changes.

Two of the authors performed three independent rounds of coding on two interview transcripts and compared codes for consistency of theme content. Agreements occurred when both coders assigned a passage or paragraph to the same theme. Disagreements occurred when researchers coded the same statement differently or when researchers did not include the same interview segment into a theme. Cohen's Kappa was calculated to evaluate the level of agreement between coders about the themes found across interviews; the final three rounds of coding produced a Cohen's Kappa of 0.75. A Kappa of 0.7 or higher suggests a substantial amount of agreement between coders (Campbell et al. 2013). After coding reliability was established, the first author coded the remaining interviews.

Researchers employed a final round of axial coding to group districts into three categories based on similar expressions of thematic codes and emergent characteristics from previous coding phases, following the approach of Paveglio et al. (2015). We looked at differences across each of the CPRM characteristics and then began sorting districts into groups based on shared expression of those characteristics. For example, in the CPRM condition 'resource characteristics,' there were three groupings that emerged from the coding process: senior water rights, mixed, and junior water rights holders. These three groupings were related to formal and informal rule changes that occurred within the districts, and we used them to explain why districts have taken different approaches to dealing with changes to state water laws regarding instream flows (Wheeldon and Ahlberg 2011). This final combination of codes created conceptual categories for how and why districts chose their water management strategies (Saldaña 2015, 245).

4. Results

Based on the analysis described above, we found a clear distinction between three different groupings of districts: (1) water rights protectors: districts that were hesitant to adopt new rules related to water transactions; (2) cautious converters: districts that made incremental changes to water use rules and infrastructure; and (3) new pioneers: districts characterized by strong formalized institutional rules and piped water delivery systems that reduce water loss. Descriptions of their CPRM characteristics are summarized in Table 2 and described in the following sections.

Table 2: District groupings.

CPRM characteristics	Water rights protectors	Cautious converters	New pioneers
Resource characteristic	Low costs for water delivery Low efficiency water delivery	High cost for water delivery Seeking opportunities for replacing aging infrastructure	Low cost for water delivery High efficiency water delivery
User characteristics	Homogenous, High agricultural dependency	Increasingly heterogeneous suburban uses	Heterogeneous, high profit crops
Existing institutions	Static formal rules, accompanied by social norms Mix of junior and senior water rights	Dynamic formal rules Junior water rights	Dynamic formal rules Senior water rights
External environment	Few connections to other entities, typically contractual agreements with Bureau of Reclamation	Increasingly integrated, collaborating to improve water security or address environmental concerns	Highly integrated with other districts, state and federal agencies, and local watershed institutions
Integration with transactions	Instream leasing informally discouraged	Instream leasing allowed lack formal mechanism for instream leasing	Provide mechanisms for allowing instream leasing

4.1. Water rights protectors

Districts that fall within the water rights protectors group tend to serve agriculture-dependent communities. Managers in this group described their patrons as having large farms and therefore substantial water rights for that land. Patrons were generally more homogeneous in their water use for agricultural production. Managers emphasized that land values in these districts are tied strongly to availability of water rights for land. For instance, one district manager described how irrigating crops made a large difference in profits:

> "You get up there on the dry farms and you are talking about $100, $200 bucks an acre, and down on the irrigated ground, you are talking [$5000 to $6000] an acre… If you miss a watering on your potato field your production drops 20%."

Managers conveyed a sense that their patrons knew the existing districts rules about water use and typically followed them without threat of enforcement. Managers reported that rules about water use changed infrequently and turnover among board members was also infrequent, with some board members serving 20–30 years. District managers and district board members were often agricultural producers.

Managers of these districts emphasized that it is important to keep water with the land. Allocating water rights to other uses, like instream flows, elicited sentiments of trepidation and mistrust toward the state or other entities interested in utilizing the water for other purposes. As one eastern Oregon district manager articulated:

> "I think a lot of our patrons are pretty scared to do anything different, thinking that somebody from somewhere else might take that and run with it. And they don't want to get in a situation like that."

While most of the districts reported some piping and in-district efficiency projects, on-going efforts to continue piping and improve efficiency were not priorities due to the high upfront costs and long payback periods for infrastructure investments. Several managers in the water rights protectors group said they would not seek funding from the state to help pipe their canals because doing so would require allocating a minimum of 25% of the water savings to instream flows. District managers in the water rights protectors group indicated they did not have particularly strong working relationships with other organizations, agencies or districts and they rarely work with outside groups to fund water efficiency projects, due in part to the requirement of putting some of the saved water back instream.

4.2. Cautious converters

Districts in the cautious converters group focused on maintaining compliance with state and federal rules. Many of the managers described a need for clearly

defined rules so they can adapt their infrastructure and rules to be in-line with regulations. These district managers described the increasing scarcity of water, due to increasing demand and/or managing junior water rights. Water diversion and delivery infrastructure in these districts created significant costs and managers often discussed the need to replace or update this infrastructure.

Managers from this group described their patrons as increasingly heterogeneous. Several managers noted that the mix of users is driven by the conversion of agricultural land to suburban development, therefore shifting water from irrigation to domestic uses. Agriculture as a livelihood was still a major part of the patron base, but these districts also reported serving an increasing number of "hobby farmers" and suburban populations.

Nearly all of the managers in the cautious converter group discussed improving water delivery efficiency projects as a way to meet demand. They considered state programs requiring that a portion of conserved water be dedicated to instream flows as an acceptable compromise for better efficiency. Many of the managers in the cautious converters group sought funding to address aging infrastructure. However, the financial resources remained a limiting factor in completing these projects. While funding from partners was necessary, managers noted that it often came with conditions and more stringent regulatory requirements. As one manager noted:

> "We just have to spend the money that the district can in cost-share with the bureau, or grants, and play the game that way and that's all we can do."

Patron-to-patron water leasing as a means to meet new and growing water demands was prevalent in cautious converters districts. Individual leases for water instream had been allowed through board approvals, but often no formal rules existed to guide the transactions process. Managers often described instream flows programs as a less preferable option to leasing between patrons, because the latter could respond to internal agricultural demands. While most district representatives reported that instream leasing was infrequent, a few reported that it could be a beneficial tool to "park" water – and thus avoid claims that water was not being put to beneficial use.

4.3. New pioneers

New pioneer districts are best characterized as promoting innovations and actively seeking ways to improve water management through technological and/or institutional rule changes. Managers from these districts described the completion of many large-scale efficiency projects, collaborating with funding partners for large projects, adding in-pipe turbines for hydro-electricity production to reduce costs or generate revenue, and contributing to instream flow restoration efforts. Managers in this group describe themselves and their efforts as aligned with the cultural history of the West that requires innovation to adapt

to a harsh and variable climate. Thus, efforts to improve irrigation efficiency were described as culturally appropriate rather than a necessary concession or an outright threat.

The majority of managers in these districts reported that their patrons held senior water rights on their water supply. Often this coincided with being positioned to draw water from tributary streams in the upper reaches of a watershed, which is of particular importance for salmon habitat. Interviewees described these situations through the refrain, "Not all water is created equal." Thus, the positioning of the new pioneer districts often makes them attractive partners for environmental groups.

District managers suggested that the composition of water users in their districts was heterogeneous, with a mixture of high-value crop farmers (e.g. cherries, pears, and apples), hobby farmers, and growing suburban communities. Agricultural-intensive patrons in this group had installed high-efficiency irrigation technology such as micro-sprinklers and drip irrigation. These irrigation techniques were possible because districts had piped irrigation systems, which were able to supply pressurized water. Patrons using more efficient systems reduced their demand for water, leaving more water to be put to instream or transferred to other users.

Many new pioneer district managers came from outside of the district, bringing with them new ideas and perspectives on water use and water management. One manager even compared running the district to running a small utility company, where the objective was to provide a reliable service at the lowest cost possible while also being good stewards and neighbors. Managers from the new pioneers described districts as having a role to play in improving environmental conditions, but noted the need for collaboration within the district and with outside partners to achieve those goals. As one respondent articulated:

> "The river was dry for 100 years. And it wasn't one guy that did it. It was everybody, and we're not going to bring those fish back over night…we've done it incrementally. And DEQ, EPA guys, those are some of our biggest allies."

New pioneer districts sought out multiple partners to work on large infrastructure projects. They frequently described utilizing external funding from state or federal programs for improving infrastructure, which contribute some percent of water back to instream flows. Large infrastructure projects were described as long-term investments. District managers indicated that piping projects served to substantially reduce operation and management costs through reduced pumping costs or through electricity-generating projects. Most of the new pioneer districts had fully piped systems. As one manager described:

> "We are looking for ways to do projects that put water instream to improve the water quality… We might only be able to add three to five [cubic feet per second], but that water is ten degrees colder."

Districts managers were willing to allow their patrons to perform water transactions between users and for instream flows. Two of the districts noted that they had made rules to prohibit permanent transactions that put water instream because it would diminish the amount of water the district manages. Temporary instream leases, however, were seen as an important tool. They were a common, albeit low percentage, proportion of the district's' water use.

5. Discussion

The results provided above reiterate the importance of understanding local contextual variables, rules, and norms in order to understand how water transactions, as a new intuitional arrangement, are integrated with existing local CPRM management. Tailoring PES programs to meet local conditions and concerns is a key component of improving adoption and performance (Kerr et al. 2012; Hayes et al. 2015). Districts as CPRM institutions have the potential to directly and indirectly influence participation in environmental water transactions through formal rules and informal norms.

These results highlight the fact that districts are the most immediate and meaningful level of resource governance between end-users and larger institutional arrangements (Tang 1992; Ostrom 1993, 1999; Baggio et al. 2016; Barnett et al. 2016). Obviously, soliciting end-users will be necessary to confirm these observations, but focusing on the results of these qualitative interviews with managers allows for a typological assessment of the self-perception of managers. Characteristics of the hard, human-made infrastructures (e.g. piped water system) emerged from this typology as an important influence to institutional arrangements. These interviews reveal that infrastructure upgrades have the potential to enable instream flow transactions.

5.1. Existing institutions

District processes and the frequency of rule changes emerged as an important institutional context that structured how and when districts integrated with state-level institutional changes. New pioneer districts reported regularly updating local rules (annually or bi-annually) to better align themselves with changes in state laws. This helped districts provide guidance to their members about leases as an allowable water use. The ability to adapt rules to changing resource conditions has been identified as a factor contributing to the robustness of CPRM institutions (Baggio et al. 2016). Most cautious converters dealt with leases on a case-by-case basis. The pressure to change rules had not outweighed the potential risks and specific costs of making those changes. In general, new pioneer and cautious converter districts reported more heterogeneity among water users and clearer formal rules, which is one of the primary contextual variables pertinent to collective action (Ostrom et al. 1999).

Water rights protector districts suggested that their rules change very little from year-to-year. In settings where users are more homogeneous and few

changes to rules occurred, social norms were adequate to coordinate collective action among members. These findings support Roland's (2004) work suggesting that reliance on norms may slow institutional responses to external changes. Demographic changes in these districts may have weakened informal norms surrounding water use and created a need for clear rules since new members would be unfamiliar with social norms that inform water use decisions (Agrawal 2001; Kingston and Caballero 2006).

5.2. Infrastructure

The need to replace, repair, or upgrade water delivery infrastructure emerged as an important characteristic with implications for districts' physical capacity to allow leasing. Upgrading delivery infrastructure eliminates an important collective action constraint posed by some instream leasing arrangements (Rosegrant and Binswanger 1994). Piping projects can reduce third party effects (e.g. diminished delivery due to reduced upstream diversion). Physical infrastructure is an important variable affecting the successful governance of surface water as a common-pool resource (Baggio et al. 2016). The importance of infrastructure upgrades to facilitate water transactions warrants further investigation.

Paying for upgrades to improve water infrastructure poses significant challenges for district managers. Clear differences emerged regarding how districts prioritized and paid for water efficiency projects. New pioneer and some cautious converter districts formed collaborative partnerships to help finance piping projects. While managers acknowledged that the state, tribal and local partners who helped finance their projects often had different end goals, they were capable of negotiating arrangements resulting in mutual benefits that could otherwise not be achieved. This suggests that trust between partners is important for implementing programs that produce win-win outcomes (Kingston and Caballero 2006).

In contrast, water rights protectors took more incremental approaches to piping their systems. Several managers explained that upgrading "piece by piece" could avoid the need for external funding assistance, allowing the district to retain all of their water savings from efficiency improvements. This may suggest that water rights protectors are loss averse, foregoing benefits like cost-savings by incrementally upgrading their systems (Elmqvist et al. 2010). Water rights protectors often described potential funding partners, like the state, environmental groups, and Native American tribes, as competitors for water. This sense of competition may exacerbate loss aversion. Due to this loss aversion, funding efficiency upgrades for the district via temporary water leases rather than targeting individuals may help develop relationships, improve trust, increase resource security for the districts and eventually reduce transaction costs of future instream flows.

5.3. Resource characteristics

We found that the characteristics of water rights, including seniority, location, and allocation, help determine where incentives are offered and the value of

those incentives. This variation in value may shape how districts respond – or pressure from patrons to better integrate water transactions in their functioning (Baland and Platteau 1997). New pioneer districts held more senior water rights, which gave them more leverage and exposed them to less risk when allowing transactions.

On the other hand, water rights protector districts generally held more junior water rights, posing some risk that water rights may not be completely filled. Individual decisions to lease water rights could negatively impact other users in these districts. During water shortages, managers may pool all water rights and share water to lessen impacts on the most junior water-rights holders. Instream leasing could reduce water availability, thus exposing districts with more junior water rights to more risk, creating a social dilemma (Ostrom et al. 1999).

5.4. Lessons for PES

Our results suggest that the response of local institutions to PES programs is likely to vary with the potential to affect individual property owners' participation. Put another way, water transaction programs designed for individuals may be mediated through irrigation districts operating as local level CPRM institutions. CPRM institutions have largely been characterized as inhibiting transactions (Bretsen and Hill 2009; Libecap 2009).

Our findings suggest that districts inhibiting participation in water transactions do so in order to protect collective benefits for their members. Districts may oppose water transactions for a number of reasons, some of which include: (1) fear of losing control over water rights due to mistrust of government and environmental non-profits, (2) negative externalities (or third party effects) such as a decrease in the volume of water a district can divert, which decreases the hydraulic pressure necessary for delivering water to patrons at the end of a canal, and (3) increased monitoring and administrative costs associated with changing water uses (Rosegrant and Binswanger 1994; Neuman 2004; Libecap 2009; Cook and Rabotyagov 2014). In short, based on differing local contextual variables, water transactions could threaten local CPRM design principles (Baggio et al. 2016).

Alternatively, some districts facilitate water transactions by creating formal rules that minimize risks and reduce costs if some of the benefits of leasing can be captured by the district or the group as a whole. While some districts create friction surrounding water transactions, others are providing conditions that provide opportunities to participate in transactions (Saleth and Dinar 2004). CPRM research often recognizes that local institutions capable of protecting group interests over individual gains are more resilient institutions (Ostrom 1990; Heinmiller 2009). In either case, districts are attempting to maximize benefits at the group level as CPRM institutions while minimizing their costs and exposure to risk. Leasing water can present risks to some districts; in others, those risks are

lower and leasing represents a new opportunity for members to realize private benefits. When water transactions reduce the amount of water managed in the system, it represents an existential threat to the main objective of the irrigation district. Thus, this study suggests that low levels of participation by sellers in PES schemes may be the outcome of a social dilemma resulting in a market failure. That is, incomplete or inaccurate information provided to potential sellers by their irrigation districts and/or other entities could be distorting the 'market' for water leases. Research aimed at understanding the knowledge of these sellers is needed to explore this possibility.

Districts that had performed physical infrastructure upgrades were less affected by the physical constraints. Our results suggest that investments in technology (hard, human-made infrastructure, e.g. water piping systems) and institutional capacity (soft, human-made infrastructure, e.g. rules for transactions) are necessary steps for enabling other institutional changes (Baggio et al. 2016). For example, helping districts invest in piped systems is an initial step toward building a leasing program that could reduce risks and build trust between buyers and sellers. Designing transaction programs that provide complementary services such as adjudicating water rights in exchange for development of local water leasing rules may help reduce perceived risks. These kinds of integrative strategies help build upon existing institutions rather than replacing them (Meinzen-Dick 2007).

6. Conclusion

The objective of this study was to increase our understanding of PES-type program integration across different CPRM institutions in a developed country. Specifically, we wanted to better understand the diversity and potential influence of irrigation districts on water transactions for instream flows in Oregon. Our finding that districts have different responses to external institutional changes, and that those differentiated responses have (re)shaped the intended outcomes of water transactions, aligns with both theory and empirical findings on institutional change (North 1990; Ostrom 2008). Differential responses to transactions across districts in this study represent a range of different priorities, existing resource and user conditions, and perspectives on the future. As such, there may often be a need to better adapt incentive-based PES programs in ways that match local institutions and conditions.

Understanding districts as CPRM institutions is operationally important to PES program designs because it demonstrates that intermediary institutions shape incentives and add to the rules framing participation in PES programs (Heinmiller 2009; German and Keeler 2010; Hayes et al. 2015). This raises questions about how much influence local institutions have on individuals' resource management decisions, a topic on which more research would be welcome. We would expect to find variation in the amount, type, effectiveness and direction of influence exerted by districts on water users.

Literature cited

Adhikari, B. and A. Agrawal. 2013. Understanding the Social and Ecological Outcomes of PES Projects: A Review and an Analysis. *Conservation and Society* 11(4):359–374.

Agrawal, A. 2001. Common Property Institutions and Sustainable Governance of Resources. *World Development* 29(10):1649–1672.

Agrawal, A. 2003. Sustainable Governance of Common-Pool Resources: Context, Methods, and Politics. *Annual Review of Anthropology* 32:243–262.

Aylward, B. 2013. *Environmental Water Transactions: A Practioner's Handbook*. OSU Course. Bend, OR: Ecosystem Economics LLC.

Baggio, J. A., A. J. Barnett, I. Perez-Ibarra, U. Brady, E. Ratajczyk, N. Rollins, C. Rubiños, H. C. Shin, D. J. Yu, R. Aggarwal, J. M. Anderies, and M. A. Janssen. 2016. Explaining Success and Failure in the Commons: The Configural Nature of Ostrom's Institutional Design Principles. *International Journal of the Commons* 10(2):417–439.

Baland, J.-M. and J.-P. Platteau. 1997. Coordination Problems in Local-Level Resource Management. *Journal of Development Economics* 53(1):197–210.

Banerjee, O. and R. Bark. 2013. Incentives for Ecosystem Service Supply in Australia's Murray–Darling Basin. *International Journal of Water Resources Development* 29(4):544–556.

Barnett, A. J., J. A. Baggio, H. C. Shin, D. J. Yu, I. Perez-Ibarra, C. Rubinos, U. Brady, E. Ratajczyk, N. Rollins, R. Aggarwal, J. M. Anderies, M. A. Janssen. 2016. An Iterative Approach to Case Study Analysis: Insights from Qualitative Analysis of Quantitative Inconsistencies. *International Journal of the Commons* 10(2):467–494.

Baron, J. S., N. LeRoy Poff, P. L. Angermeier, C. N. Dahm, P. H. Gleick, N. G. Hairston, R. B. Jackson, C. A. Johnston, B. D. Richter, and A. D. Steinman. 2002. Meeting Ecological and Societal Needs for Freshwater. *Ecological Applications* 12(5):1247–1260.

Bretsen, S. N. and P. J. Hill. 2009. Water Markets as a Tragedy of the Anticommons. *William & Mary Environmental Law Review* 33(3).

Brewer, J., R. Glennon, A. Kerr, and G. Libecap. 2007. Water Markets in the West: Prices, Trading, and Contractual Forms. 13002. Cambridge, MA: National Bureau of Economic Research.

Bruns, B. R., C. Ringler, and R. Meinzen-Dick. 2005. *Water Rights Reform: Lessons for Institutional Design*. Washington, DC: International Food Policy Research Institute.

Bryman, A. 2015. *Social Research Methods*. 4th ed. New York, NY: Oxford University Press.

Campbell, J. L., C. Quincy, J. Osserman, and O. K. Pedersen. 2013. Coding In-Depth Semistructured Interviews. *Sociological Methods & Research* 42(3):294–320.

Cook, J. and S. S. Rabotyagov. 2014. Assessing Irrigators' Preferences for Water Market Lease Attributes with a Stated Preferences Approach. *Water Resources and Economics* 7:19–38.

Cox, M., G. Arnold, and S. Tomás. 2010. A Review of Design Principles for Community-Based Natural Resource Management. *Ecology and Society* 15(4):38. http://www.ecologyandsociety.org/vol15/iss4/art38/.

Elmqvist, T., E. Maltby, T. Barker, M. Mortimer, C. Perrings, J. Aronson, R. De Groot, A. Fitter, G. Mace, J. Norberg, and I. S. Pinto. 2010. *Biodiversity, Ecosystems and Ecosystem Services*. *TEEB Ecological and Economic Foundations*. London, UK: Earthscan.

Farley, J. and R. Costanza. 2010. Payments for Ecosystem Services: From Local to Global. *Ecological Economics* 69(11):2060–2068.

Ferraro, P. J. and A. Kiss. 2002. Policy Forum. *Science* 298(November): 1718–1719.

Franczyk, J. and H. Chang. 2009. The Effects of Climate Change and Urbanization on the Runoff of the Rock Creek Basin in the Portland Metropolitan Area, Oregon, USA. *Hydrological Processes* 23(6):805–815.

Garrick, D. and B. Aylward. 2012. Transaction Costs and Institutional Performance in Market-Based Environmental Water Allocation. *Land Economics* 88(1960):536–560.

Garrick, D., M. Siebentritt, B. Aylward, C. J. Bauer, and A. Purkey. 2009. Water Markets and Freshwater Ecosystem Services: Policy Reform and Implementation in the Columbia and Murray-Darling Basins. *Ecological Economics* 69(2):366–379.

Garrick, D., C. Lane-Miller, and A. L. McCoy. 2011. Institutional Innovations to Govern Environmental Water in the Western United States: Lessons for Australia's Murray-Darling Basin. *Economic Papers: A Journal of Applied Economics and Policy* 30(2):167–184.

German, L. A. and A. Keeler. 2010. 'Hybrid Institutions': Applications of Common Property Theory Beyond Discreet Property Regimes. *International Journal of the Commons* 4(1):571–596.

Getches, D. 2009. *Water Law in a Nutshell*. 4th ed. St. Paul, MN: Thomson West.

Grafton, Q., G. Libecap, S. McGlennon, C. Landry, and B. O'Brien. 2011. An Integrated Assessment of Water Markets: A Cross-Country Comparison. *Review of Environmental Economics and Policy* 5(2):219–239.

Greene, J. C. 2007. *Mixed Methods in Social Inquiry*. (Vol. 9). Hoboken, NJ: John Wiley & Sons.

Hansen, Z., G. Libecap, and S. Lowe. 2009. Climate Variability and Water Infrastructure: Historical Experiences in the Western United States. 15558. Cambridge, MA. http://www.nber.org/papers/w15558.

Hayes, T., F. Murtinho, and H. Wolff. 2015. An Institutional Analysis of Payment for Environmental Services on Collectively Managed Lands in Ecuador. *Ecological Economics* 118:81–89.

Heinmiller, B. T. 2009. Path Dependency and Collective Action in Common Pool Governance. *International Journal of the Commons* 3(1):131–147.

Huber-Stearns, H. R., J. H. Goldstein, A. S. Cheng, and T. P. Toombs. 2015. Institutional Analysis of Payments for Watershed Services in the Western United States. *Ecosystem Services* 16(October):83–93.

Huberman, M. 1994. *Qualitative Data Analysis*. 2nd ed. Sage Publications.

Kerr, J., M. Vardhan, and R. Jindal. 2012. Prosocial Behavior and Incentives: Evidence from Field Experiments in Rural Mexico and Tanzania. *Ecological Economics* 73(January):220–227.

Kingston, C. and G. Caballero. 2006. Comparing Theories of Institutional Change August 11, 2006. *Journal of Institutional Economics* 5(2):151–180.

Kolinjivadi, V., J. Adamowski, and N. Kosoy. 2014. Recasting Payments for Ecosystem Services (PES) in Water Resource Management: A Novel Institutional Approach. *Ecosystem Services* 10:144–154.

Lafreniere, K. C., S. Deshpande, H. Bjornlund, and M. G. Hunter. 2013. Extending Stakeholder Theory to Promote Resource Management Initiatives to Key Stakeholders: A Case Study of Water Transfers in Alberta, Canada. *Journal of Environmental Management* 129(November):81–91.

Libecap, G. D. 2009. The Tragedy of the Commons: Property Rights and Markets as Solutions to Resource and Environmental Problems. *Australian Journal of Agricultural and Resource Economics* 53(1):129–144.

Meinzen-Dick, R. 2007. Beyond Panaceas in Water Institutions. *Proceedings of the National Academy of Sciences of the United States of America* 104(39):15200–15205.

Meinzen-Dick, R., M. DiGregorio, and N. McCarthy. 2004. Methods for Studying Collective Action in Rural Development. *Agricultural Systems* 82(3):197–214. doi:10.1016/j.agsy.2004.07.006.

Merrey, D. J. 1996. *Institutional Design Principles for Accountability in Large Irrigation Systems*. Research Report 8. Colombo, Sri Lanka: International Irrigation Management Institute.

Millenium Ecosystem Assessment. 2005. *Millennium Ecosystem Assessment*. Washington, DC: World Resources Institute. http://www.bionet-intl.org/opencms/opencms/resourceCentre/onlinePublications/3GTW/pretoria/endorsements_all.doc.

Neuman, J. 2004. The Good, The Bad, The Ugly. *Nebraska Law Review* 83(432):432–485.

North, D. 1990. *Institutions, Institutional Change and Economic Performance*. Cambridge, MA: Cambridge University Press.

Oregon Department of Agriculture. 2012. *Oregon Agriculture Facts and Figures*. Washington, DC: United States Department of Agriculture. https://www.nass.usda.gov/Statistics_by_State/Oregon/Publications/facts_and_figures/facts_and_figures.pdf.

Oregon Supreme Court. 2008. *Fort Vannoy Irrigation District v. Oregon Water Resources Commission*. Enterprise, OR. https://www.ojd.state.or.us/records/sccalendar.nsf/0/32c0fea410c76f9188257392005b205e?OpenDocument.

Ostrom, E. 1990. *Governing the Commons: The Evolution of Institutions for Collective Action*. Cambridge, MA: Cambridge University Press. http://books.google.com/books?hl=en&lr=&id=4xg6oUobMz4C&oi=fnd&pg=PR11&dq=Ostrom+1990&ots=aMavCFiI-f&sig=bd3p_O_dV4W4Gi_p94jpfvDYB_I.

Ostrom, E. 1993. Design Principles in Long-Enduring Irrigation Institutions. *Water Resources Research* 29(7):1907–1912.

Ostrom, E. 1994. 6. Constituting Social Capital and Collective Action. *Journal of Theoretical Politics* 6(4):527–562.

Ostrom, E. 2008. The Challenge of Common-Pool Resources. *Science and Policy for Sustainable Development* 50(4):8–21. http://www.researchgate.net/publication/228909047_Sustainable_Development_of_Common-Pool_Resources/file/60b7d5277d80753b98.pdf.

Ostrom, E., J. Burger, C. B. Field, R. B. Norgaard, and D. Policansky. 1999. Revisiting the Commons: Local Lessons, Global Challenges. *Science (New York, N.Y.)* 284(5412):278–282.

Pannell, D. J., G. R. Marshall, N. Barr, A. Curtis, F. Vanclay, and R. Wilkinson. 2006. Understanding and Promoting Adoption of Conservation Practices by Rural Landholders. *Australian Journal of Experimental Agriculture* 46(11):1407–1424.

Paveglio, T. B., C. Moseley, M. S. Carroll, D. R. Williams, E. J. Davis, and A. P. Fischer. 2015. Urban Interface: Adaptive Capacity for Wildfire. *Forest Science* 61(April):298–310.

Paveglio, T. B., M. S. Carroll, and A. D. Boyd. 2017. Re-Conceptualizing Community in Risk Research. *Journal of Risk Research* 20:931–951.

Postel, S. L. 2000. Entering an Era of Water Scarcity: The Challenges Ahead. *Ecological Applications* 10(4):941–948.

Ranjan, R. 2010. Factors Affecting Participation in Spot and Options Markets for Water. *Journal of Water Resources Planning and Management* 136(4):454–462.

Roland, G. 2004. Understanding Institutional Change: Fast-Moving and Slow-Moving Institutions. *Studies in Comparative International Development* 38(4):109–131.

Rosegrant, M. W. and H. Binswanger. 1994. Markets in Tradable Water Rights: Potential for Efficiency Gains in Developing Country Water Resource Allocation. *World Development* 22(11):1613–1625.

Ruml, C. C. 2005. Coase Theorem and Western US Appropriative Water Rights, The. *Natural Resources Journal* 169:1–33.

Saldaña, J. 2015. *The Coding Manual for Qualitative Researchers*. 2nd ed. Thousand Oaks, CA: Sage Publications. https://books.google.com/books?hl=en&lr=&id=ZhxiCgAAQBAJ&oi=fnd&pg=PP1&dq=saldana+emergent+themes+thematic+coding&ots=yHZa3AMUgR&sig=0cPJVdQxFMV-V2-ZbN9_uvHaxms.

Saleth, R. M. and A. Dinar. 2004. *The Institutional Economics of Water: A Cross-Country Analysis of Institutions and Performance*. Northampton, MA: Edward Elgar Publishing.

Tang, S. Y. 1992. *Institutions and Collective Action: Self-Governance in Irrigation*. Food and Agriculture. San Francisco, CA: Institute for Contemporary Studies. https://www.researchgate.net/profile/Shui_Yan_Tang/publication/239062534_Institutions_and_Collective_Action_SelfGovernance_in_Irrigation/links/5410e4bd0cf2df04e75d68e1/Institutions-and-Collective-Action-Self-Governance-in-Irrigation.pdf.

Thompson, B. H. 1993. Institutional Perspectives on Water Policy and Markets. *California Law Review* 81(3):671–764.

Uzzi, B. 1996. The Sources and Consequences of Embeddedness for the Economic Performance of Organizations: The Network Effect. *American Sociological Review* 61(4):674–698.

Vermillion, D. L. 1996. *Impacts of Irrigation Management Transfer: A Review of the Evidence*. Colombo, Sri Lanka: International Irrigation Management Institute.

Wheeldon, J. and M. K. Ahlberg. 2011. *Visualizing Social Science Research: Maps, Methods, & Meaning*. Thousand Oaks, CA: Sage Publications. http://books.google.com/books?hl=en&lr=&id=ibh9xXwKJTcC&oi=fnd&pg=PR1&ots=aP3ApKwipS&sig=wz5ktIxijtbobckersg1mv5IrEA.

Wheeler, S., H. Bjornlund, M. Shanahan, and A. Zuo. 2009. Who Trades Water Allocations? Evidence of the Characteristics of Early Adopters in the Goulburn-Murray Irrigation District, Australia 1998–1999. *Agricultural Economics* 40(6):631–643.

Wunder, S. 2015. Revisiting the Concept of Payments for Environmental Services. *Ecological Economics* 117:234–243.

Appendix A: Interview Guide

- Can you please describe your role in the irrigation district (ID)?
  - How long you have been working in this position?
  - Tell me how you initially got involved with the ID.

- Can you give me a physical description of the district?
  - What type of irrigation infrastructure is present in your district?
  - What are the primary sources of water for the district?

- In your time here, have there been any major changes in infrastructure?
  - What were the reasons for those upgrades?
  - How was the project developed?
  - What other entities were involved?

- Can you tell me about the community that this water district serves?
  - What are the range of water uses?
  - How important is agriculture to the community?

- During your time with the district how have ecological or biophysical conditions influenced district operations?
  - For example, how are floods or droughts managed by the district?
  - What other external events have impacted the management of the irrigation district?

- In your time here have there been any major changes to the rules or bylaws of the district?
  - Can you describe that process of how rules are changed?
  - How are water rights held in the district?

- How does the district maintain contact with its water rights holders?
  - In your time here, has the district been involved in water transactions?
  - If yes, what kinds of transaction?

- Are individual members of this district involved in water transactions?
  - What kinds of transactions are common?
  - What role does the district play in those transactions?
  - What role has the state of Oregon or the Federal government played in transactions?

- When did the first transactions start happening?
  - What is the general opinion about water transactions?
  - Have water transactions been discussed during district meetings or in district mailings?
  - Has your district changed any rules or management practices due to water transactions?
  - What other organizations does the district work directly with?
  - What kinds of projects do you collaborate on?