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Social learning as an adaptive measure to prepare for climate change impacts on water provision in Peru

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Abstract
This article examines the conditions under which social learning occurs and leads to adaptive measures through two empirical examples of Peruvian cities that invested in watershed protection for their urban water supplies. Social learning is an increasingly popular approach aimed at achieving socio-ecological resiliency through multi-stakeholder collaborative governance processes. Social learning is a convergence in knowledge that occurs through dialog and deliberation. Yet, assumptions that social learning will necessarily lead to more environmentally sustainable and resilient practices may be overly optimistic, especially as they rarely consider the political and organizational dimensions of decision making. This study analyzes two seemingly similar case studies of multi-stakeholder water management in Peru that resulted in watershed protection programs—a novelty in Peru that will help ensure future water supplies. Despite similar programs adopted, though, the social interactions were markedly different. Social learning occurred in Moyobamba, where the multi-stakeholder platform was characterized by trust, flexibility, and sustainability. In Cusco, however, stakeholders reached an agreement on projects for watershed protection, but the process exhibited little evidence of social learning, trust, or flexibility. In this article, I use process tracing to analyze if and how social learning occurred in each case. Then, I identify factors that contributed to social learning, including diverse participation, open communication, multiple sources of knowledge, extended engagement, unbiased facilitation, and an opportunity to influence outcomes.

Keywords Water · Social learning · Adaptive capacity · Peru · Multi-stakeholder platform · Ecosystem services

Introduction

Extreme weather events, precipitation fluctuations, and other climate change impacts call for the need to increase communities' abilities to adapt, particularly with respect to water management (Noble et al. 2014; Armitage et al. 2009). Yet, local adaptation is challenged by the complexity of the ways natural and social systems interact and the nonlinearity of ecological responses (Folke et al. 2005; Holling 1973). Despite uncertainty associated with site-specific impacts, societies can prepare through strengthening their adaptive capacity, e.g., their ability to adjust to damage, take advantage of opportunities, or respond to consequences (IPCC 2014, 1758). While many scholars focus on the resiliency of physical systems, adaptive capacity includes two key social elements—socio-economic capabilities and the ability to make decisions that increase the resilience of the surrounding natural environment and infrastructure (Walker et al. 2004; Pahl-Wostl 2015).

In efforts to increase adaptive governance, natural resource management responsibilities are often transferred to local government-civil society collaborations. This research focuses on such collaborative efforts, particularly those by decision-making bodies composed of stakeholders who "perceive the same resource management problem, realize their interdependence for solving it, and come together to agree on action strategies for solving the problem," called multi-stakeholder platforms (MSPs) (Warner 2007). MSPs are not physical platforms, but identified groups for deliberation and decision making, such as councils, civil society bodies, and working groups. They are critical for adaptive capacity, as they can provide identified spaces for discussing and responding to climate-related events.

Scholars and practitioners have become increasingly interested in social learning processes as means to increase local adaptive capacity in multi-stakeholder processes. Social

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learning is defined as a convergence in knowledge that occurs through dialog and deliberation. Through sharing perspectives and knowledge, social learning can help actors reach mutual agreement, build collaborative relationships and trust, and make decisions that are perceived as fair (Schusler et al. 2003; Lebel et al. 2010). Further, as stakeholders gain trust in each other and in the process itself, it can increase the sustainability and flexibility of the decision-making process (Pahl-Wostl and Hare 2004; Fazey et al. 2007). This is key for strengthening adaptive capacity and addressing new, unforeseen issues that may arise, such as those anticipated with climate change (Engle and Lemos 2010; Pahl-Wostl 2007). Additionally, as stakeholders gain greater knowledge about the interaction between human and natural systems, they are more likely to adopt infrastructure that better deals with stresses (Armitage et al. 2008; Pahl-Wostl 2015).

Yet, collaborative or deliberative processes do not always yield social learning (Brummel et al. 2010). Social learning can help build consensus, but deliberation is also shaped by interests and power relations, particularly those from unequal resources and capabilities, which can inhibit social learning (Borowski 2010). However, in their review of the social learning literature, Cundill and Rodela (2012) found a dearth of consideration of power relations. Further, Muro and Jeffrey (2008) highlight how scholarship has contributed examples of successful social learning but needs to further analyze the context and process features under which it occurs. For example, there can also be "mistake" learning that is scientifically incorrect (Schusler et al. 2003), either introduced inadvertently or to sway decisions, or incorrect assumptions that more scientific knowledge will influence people's decisions (the "deficit model" of scientific communication, see Nisbet and Scheufele 2009). Water management is situated between deeply embedded interests in water, be it for economic or socio-cultural value. While farmers depend on water for irrigation in the dry season, hydropower companies want it throughout the year to produce electricity. Thus, since collaboration does not always lead to social learning, we need a better understanding of when and how it occurs.

Given the potential for social learning to strengthen adaptive capacity and the challenges of multi-stakeholder water management, this study asks: how and when does social learning occur within MSPs? I analyze this through comparison of two water management cases in Peru: Moyobamba and Cusco. They provide exemplary empirical fodder for analyzing social learning because they both established MSPs that resulted in watershed protection for urban water supplies, but they varied in terms of the social relations between stakeholders and process outcomes. In Moyobamba, there was extensive evidence of social learning, trust, flexibility, and sustainability of the platform. In Cusco, the stakeholders also reached an agreement, but there was little evidence of social learning, trust, or flexibility. In this study, I trace the process of what occurred in each case, analyzing contextual factors, characteristics of the MSPs, and social interactions to gain a greater understanding of how the process unfolded in each case. In addition to contributing to social learning theory, this research also provides insight for the design of MSPs, as well as for how national policies can create enabling conditions that promote social learning.

Social learning

Social learning has garnered greater attention due to its potential to strengthen adaptive capacity, particularly for complex natural resource issues. Water resources management is integral for adaptive capacity given that numerous climate impacts are water-related. Over the past 30 years, water governance has devolved to more local or basin scales. In addition to allowing for incorporation of site-specific ecological and climatic conditions, it also enables variation according to differing stakeholder uses and interests. Participation in management should, in theory, help increase the quality and durability of decisions through deliberation (Fischer 2000; Forester 1999; Elstub 2010; Dryzek 1997, 2000). Yet, reconciliation of different interests and ecological objectives is often more difficult in practice (Biswas 2004; Blomquist and Schlager 2005).

One way decentralized, integrated management has been operationalized is through the development of MSPs, such as river basin councils, which provide a site for developing consensus between stakeholders with varying uses, goals, and perspectives. The underlying philosophy is that management can be improved through involving relevant stakeholders, as people solve problems through communication and negotiation (Habermas 1985; Connick and Innes 2003; Forester 1999; Innes and Booher 1999; Wondolleck and Yaffee 2000); however, the design and implementation of such MSPs varies greatly. Figure 1 provides a conceptualization of social learning within MSPs. The platforms are shaped by a combination of contextual factors plus interactions within them, which in turn affect outcomes (Pahl-Wostl et al. 2007; Lebel et al. 2010; Mostert et al. 2007).[1] Of note, the governance structure, actors, and institutions that are part of the context include political and organizational dimensions. A MSP can be described in terms of its attributes and the social relations between participants. Attributes are descriptive characteristics, which can be predetermined by national regulations (such as participation), shaped by local implementation (such as openness of communication), or a combination thereof. Social relations refer to the relational practices between actors, which are shaped by their interactions and the power

[1] While this builds off of Pahl-Wostl's process model of social learning, it departs from her (and others') three-level model where social learning occurs at the micro, meso, and macro levels. In line with Reed et al. (2010) critique of the difficulty of discerning learning, this research focuses only on the micro-level, although recognizes that other levels of learning can occur.

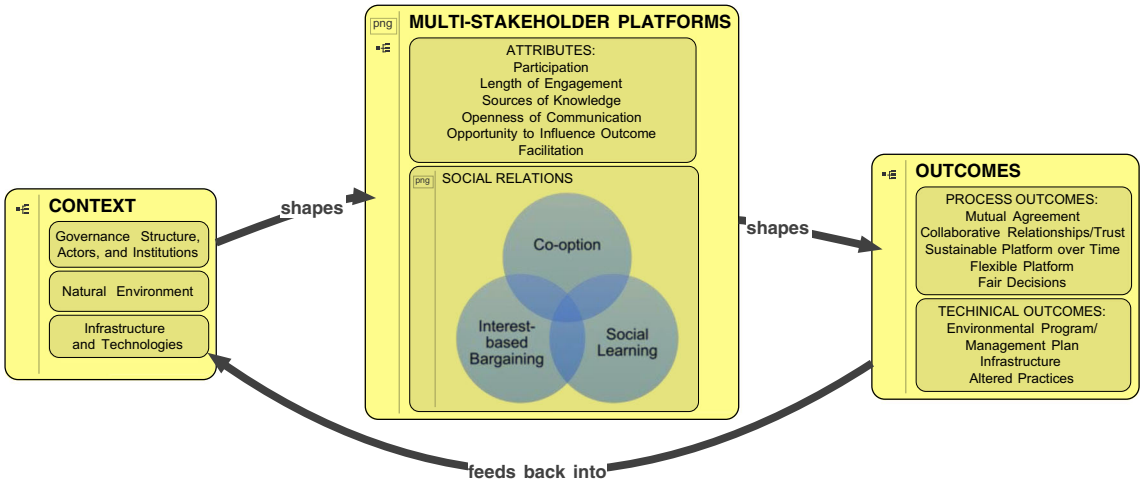

Fig. 1 Social learning diagram (developed using Vue)

relations between them. For example, it takes into account how actors' financial or political resources and capabilities enable them to influence the actions of other actors. Together, the specific context and MSP process yield process and technical outcomes, from which there is feedback that forms part of the context for future deliberations. Therefore, the social relations within the MSP are key for determining outcomes, yet are embedded within a broader context.

Building off of Reed et al. (2010), but highlighting the *convergence* to shared knowledge, here, social learning is defined as a convergence in knowledge that occurs through dialog and deliberation. Thus, social learning is both an outcome in itself and a process that leads to other outcomes. By sharing perspectives and values, stakeholders can better understand differing viewpoints, develop common understandings, and identify agreeable solutions (Pinkerton 1994; Woodhill 2004). Scholars draw from different theoretical origins, including deliberative democracy (Dryzek 2000; Habermas 1996), learning theories (Bandura 1977; Kolb 2014; Wenger 1998), and complex systems (Ison et al. 2007; Folke 2006). While not incompatible, differing underlying assumptions can lead to social learning's lack of conceptual clarity, particularly when social learning is not defined in a measurable way, not distinguished from social interactions where there is no learning, or conflated with outcomes (Reed et al. 2010; Cundill and Rodela 2012; Rodela 2013). As such, I look for three main criteria: there must have been social interaction around a topic, there must have been a change in cognition that brought actors to a shared understanding (i.e., beyond the individual level), and that change must be in part attributable to the social interaction. The shared understanding can be in terms of knowledge, be it instrumental or about stakeholders' priorities and values (Brummel et al. 2010), and it can either be reaching an initial consensus or changing from one shared consensus to another. Social learning can occur within a specific group or on a specific issue, so it is important to specify the actors and topic (Vinke-de et al. 2014). Social learning is only one of three ideal-types of social relations, contrasted with co-option by dominant actors (where outcomes are determined independent of social interaction) and interest-based negotiation (where there is no shared learning, but can be mutual gains).

The literature lays out numerous attributes that have empirically or theoretically been found to be associated with social learning. These include the diversity of participation, repeated meetings, openness of communication, unrestrained thinking, sources of knowledge, facilitation, opportunities to influence outcome, and small group work (Pahl-Wostl et al. 2007; Pahl-Wostl 2015; Reed et al. 2010; Muro and Jeffrey 2008; Schusler et al. 2003; Cash et al. 2003; Buck et al. 2001; Mostert et al. 2007; Webler et al. 1995).[2] For example, diverse participation actors can become aware of different points of views and values with respect to water management. This can both help improve the design of programs and identify solutions that meet the needs of the majority of stakeholders. It is important to note that these attributes may not be necessary nor sufficient for social learning to occur. Further, studies have identified when these are present when there is social learning, but few have examined the political dimensions of decision making or alternative explanations for the outcome. For example, unequal power relations can inhibit collaboration by generating distrust or a feeling of unfairness. Nevertheless, the attributes are a starting point to understand when and how

[2] To elaborate in greater depth on the other attributes: Sustained engagement over time can affect whether participants have time to form relationships and build trust. Open communication can help affect whether actors actually do open up and share their perspectives. Multiple sources of knowledge can contribute new types of information or new interpretations when combined, and notably also depends on the credibility, legitimacy, and salience of information. Facilitation can affect the tone and conduct of meetings, such as whether voices get heard or different types of knowledge discussed. Scholars also noted that opportunities to influence the outcome can help foster and sustain social learning, as it justifies time and effort to engage.

social learning occurs and affects outcomes and adaptive capacity.

Design and methods

This research focuses on the social relations within MSPs, recognizing that social interactions are embedded in specific historical, cultural, social, and environmental contexts. With the understanding that differences and conditions matter, the goal of this research is to identify and explain patterns in social phenomena—social learning in this case. As such, I use comparative case study analysis (both within- and between-case) of water MSPs in Peru. Case studies are well suited to identify, test for, and refine causal mechanisms amidst multi-causality, as well as compare qualitative characteristics. I focus on water management due to its complexity resulting from involvement of multiple sectors, relation to land use, and uncertainties associated with climate impacts. As part of a larger study on multi-scalar water governance, this paper focuses on two MSPs established for urban water utilities to invest in upstream watershed protection: Moyobamba and Cusco. While located in different geographical contexts—the upper Amazon and Andes, respectively—the cases share many similarities: they were two of the first Peruvian cities to invest in conservation upstream of their water supplies, they are both regional capitals, and they have histories of environmental initiatives (more so than other cities in Peru). Despite similarities, the cases differ in terms of the social relations between stakeholders and the process outcomes.[3]

To answer the main research question—*when and how social learning occurred*—the data analysis of this paper was broken down into two sets of research questions:

1) *Social relations within MSP*: Was the outcome subject to the social interaction within the MSP? Was there a convergence on shared knowledge (about what? for whom?)? Was it attributable to the social interaction?
2) *MSP attributes*: What MSP attributes characterized the MSP? Why did the MSPs have those attributes?

For there to have been social learning, the answers for all three questions regarding social relations must be affirmative. Without a change to a shared knowledge that is attributable to the social interaction, the social relations would be more accurately characterized as "interest-based bargaining," and without an outcome subject to the social interaction, it would be "co-option."

[3] Due to their many similarities with regard to adopting a watershed protection program, they were selected as "most similar" case studies, yet they differ in terms of social relations (Gerring 2006). Case study boundaries are the geographic context of each MSP's jurisdiction and from 1995 to 2016, which encompasses the period within which each was developed.

Data for this analysis included document data and semi-structured interviews with stakeholders involved directly or indirectly in the MSP, including local and national government, civil society, landholders, water utilities, and international development agencies. I completed 70 interviews that involved Moyobamba or Cusco, carried out between 2014 and 2017. I anonymized interviews to protect identities. When conducting the interviews, I framed questions within three groups: broader questions about water governance to glean the interviewees' perspectives and preferences, the MSP attributes and processes, and shifts in power relations.[4] From the interviews, I extracted MSP attributes, changes in knowledge, outcomes, and other factors that could affect social learning. To complete process tracing of the causal factors, I looked for observable points and evidence of alternative explanations (Bennett and Checkel 2012). Therefore, I more specifically took note of prior knowledge/understanding, activities or factors contributed to changes (particularly social interaction), new knowledge or improved understanding, and evidence of shared knowledge or understanding.[5] This data was used in conjunction with water utility data, MSP documents, international development organization project documents, and secondary literature to triangulate and verify interview statements. After analyzing each case, the findings of each were compared in terms of what attributes were indicative of social learning and how presence, lack, or certain combinations of attributes affected whether and how social learning occurred.

Case studies

Water governance in Peru

Before elaborating the two case studies, it is important to understand the broader context of Peruvian water management, where MSPs were becoming increasingly common. Water has historically been governed primarily for agriculture and concentrated mainly along Peru's arid coast, which houses the majority of the population, industry, and irrigated agriculture. Agriculture continues to consume the majority of fresh water—by some estimates up to 88% of fresh water used (ANA 2013); however, Peru's urban population has been growing steadily over the last half century, as has mining and industrial production (ANA 2013). Due in part to water demand outstripping supply along the coast, during the twentieth century, Peru undertook numerous large water

[4] Recognizing there are different types of power relations (see Barnett and Duvall 2005), here, I focus on unequal capabilities and resources.

[5] Following Brummel (2010), "shared" was identified when multiple participants had similar knowledge, exhibited a similar perspective, or noted shared knowledge/perspectives across actors, and when these findings were verified across multiple interviewees.

infrastructure projects, including dams and aqueducts that brought water from the Amazonian basins to the Pacific coast.

Since the mid-1990s, Peru has been transitioning from government management to a multi-sectoral, participatory approach, within which some regions have incorporated ecosystem-based management. After the devastation and violence of the 1980s, in the 1990s, President Fujimori made efforts to liberalize the economy. While the water sector was not privatized, despite his efforts, discussions began regarding integrating water management between sectors. Water supply planning was becoming critical, especially for cities, which house the majority of the population. In 2009, they passed the Water Resources Law that provided for the creation of river basin councils. These would involve stakeholders in the upper basins, who had previously been marginalized from water governance. This paralleled a growing understanding of the importance of watersheds, ecosystems, and climate change by those who work on water in Peru. The Cusco cases that follow were two of the first efforts to address this, and they paved the way for two additional laws—one obligating all water utilities to add a 1% tariff to fund watershed protection, and the other establishing a Contribution Mechanism for Ecosystem Services that provided a framework for such programs.

Moyobamba

The first Peruvian water utility to invest in conservation and reforestation in the upstream watershed was Moyobamba. The city of 83,000 people is nestled on the Amazonian side of the Andes Mountains, along the Alto Mayo River (INEI 2017). Although Moyobamba is not water-poor, receiving an average annual precipitation of 1408 mm, rainfall is seasonal (Quintero et al. 2009). The city's water comes from three micro-basins—Rumiyacu, Mishquiyacu, and Almendra—that cover 924 ha nearby the city where Andean migrants had settled in the 1980s to farm and raise livestock (León and Renner 2010; SUNASS 2014). In the 1990s, the water utility frequently shut off service, which the utility attributed to precipitation (either too little or too much, in which there was more sediment than the water treatment could handle), but city residents viewed the problem as poor management and lack of technology.

Since the water utility had not previously looked upstream of their intake point, in the late 1990s they began studies to better understand the problem, in part with the assistance of GTZ, the German development agency. In addition to studies on hydrological flows, they also analyzed soil and water use upstream (León and Renner 2010). These studies showed that both problems were being exacerbated by deforestation that had been occurring since migrants came and started converting forests to farmland. Building on the studies, starting in 2003, there were a series of discussions around the studies between the water utility, municipal government, GIZ, and upstream communities, among others. This group also began a few pilot projects through which there could be more informal "chats" with upstream landholders, most who had small, untitled plots, where they grew coffee and subsistence crops.

As studies and pilot projects were underway, the water utility and municipality began to bring in other stakeholders and identify all interests in water and the micro-basins. In 2005, they formally established the Management Committee, which consisted of 25 organizations/agencies, from Project Mono Tocón to the Chamber of Commerce, and the Alto Mayo Special Project (technical arm of the regional government) took over the lead. It met most frequently in the conceptualization and design stages of the process but has continued to meet and be seen by its participants as an open forum to discuss water-related issues. In the meetings, stakeholders shared their varying perspectives, made decisions on how to proceed, and partnered on awareness-building activities. Through Committee meetings and related activities, the stakeholders came to see the cause of the problem as deforestation due to lack of alternative economic activities, which would have to be addressed to protect the watershed. Additionally, as one technical expert poignantly noted:

> It is the exchange through which we really have learned the most, mutually learned. It is a little bit that [the upstream landholders] gained awareness of conservation and the role they can play in forest conservation, that is as much for them as it is for us [the city]. The Management Committee is a space – a platform – state and civil society. In it, we look to align [interests of] those that live above with those that are below.[6]

While there were discussions and decisions made within the Management Committee, the members voted on a smaller Technical Team to carry out the bulk of the work. It consisted primarily of stakeholders with directly related responsibilities and necessary competencies: municipal government, water utility, Alto Mayo Special Project, and upstream representative.[7] They met frequently to undertake technical studies, formulate ideas, and design the project. In particular, their discussions with upstream landholders helped the group gain a better understanding of what would change land-use practices.

A number of program ideas were considered within the Management Committee and Technical Team, such as payment for ecosystem services, but these were new to Peru.

[6] Translated from Spanish transcript.

[7] Among interviewees, there was wide respect for this tiered structure: making decisions with a large group of stakeholders is difficult and people do not have time to go to too many meetings, so many appreciate when a smaller group rolled up their sleeves, developed recommendations, and then presented them to the larger group for discussion and approval.

While upstream communities initially were in agreement of payment for watershed protection, the amount urban residents were willing to pay was far below payments necessary to incentivize change in land use. Along with being involved in the Management Committee and Technical Team through representatives, upstream landholders themselves were engaged in discussions, workshops, and trainings, such as on water management, reforestation, and alternative livelihoods. One interviewee involved highlighted that these interactions and the community organization that occurred to support the activities were, in her view, critical in designing the program and for its acceptance. Through these activities emerged a new approach: collected funds would support programs such as reforestation and beekeeping that would increase the incomes and well-being of the upper basin communities while protecting the watershed. Further, one upstream representative added that it was key that the Technical Team designed actions that people in the microbasins wanted and would dedicate themselves to, and that there was a constant flow of information throughout implementation.

On the side of the city, residents were initially resistant to paying substantially more on water bills, but with awareness-building activities; by 2006, there was greater acceptance. For example, they developed a water mascot that they used in parades, on murals, and activities in schools. In 2007, a survey showed that residents were willing to pay about three Peruvian Nuevo Sol (PEN) additional per month (equivalent to US$1), which was lowered to 1 PEN per month to foster greater acceptance (Tipacti Milachay et al. 2010). In 2007, Moyobambans voted to pay the additional PEN—a substantial amount considering the average bill was 10 PEN. At the time, there was unclear legal basis for the water utility investing above its point of intake, but SUNASS, the water utility regulator, helped make it legally possible, and Moyobamba became the first Peruvian water utility to implement a compensation program for watershed services.

To reduce deforestation, the Moyobamba program went beyond planting nurseries for reforestation and undertook alternative livelihood activities, notably beekeeping and handicrafts. In total, Moyobamba has over 12,000 households contributing monthly, amounting to approximately US$48,000/year (Stern and Echavarría 2013). Further, given the trust developed in the Management Committee, the regional government and others have used it to address new issues, such as riparian buffer delineation and protection, even after the national government started to develop a multi-sectoral basin council. Throughout my interviews, stakeholders from both the upper basin and the city overwhelmingly expressed satisfaction with the platform and noted the relationships developed there.

Cusco

Shortly after Moyobamba initiated its watershed protection program, Cusco began to discuss protecting its primary water source, Laguna (lake) Piuray, yet the process and outcome were remarkably different. Cusco, the regional capital and major economic node, is located on the Amazonian side of the Andes in southern Peru. Cusco's population increased steadily since the 1950s, landing at 450,000 in 2015 (INEI 2017). Furthermore, tourism for Machu Picchu has drawn increasing numbers of tourists, who go in and out of Cusco. The city has two main water sources that make up about 88% of its supply: Laguna Piuray and the aquifer Piñipampa, the former which supplies the majority of tourism establishments. Laguna Piuray's watershed, located 30 km from Cusco, is inhabited by 16 campesino (peasant) communities that live based on farming and livestock. Unlike the landholders in the Moyobamba watershed, however, they have extensive ancestral knowledge about water management. Additionally, the government PRONAMACHCS program worked with them to do soil conservation in the 1980–1990s.

Like Moyobamba, the origin of this case study dates back to the 1990s, when there were changes in Laguna Piuray's level. After drawing water by gravity-fed means for 50 years, in the 1990s, Cusco's water utility, SEDACUSCO, added a pump to increase water consumption. Exacerbated by several years of low precipitation, the lake level dropped and over 100 ha of surrounding land subsided. Attributing the subsistence to overpumping, in 1996, the campesinos began to organize, and in 2000, they formed a committee (Sallo Huallpayunca n.d.). They tried repetitively to open up a dialog with SEDACUSCO, to no avail, and both parties characterized 1998–2000 as a "conflict." Meanwhile, SEDACUSCO was experiencing rising costs of filtration, which they attributed to algae growth and a decline in the lake's water quality (Navarro et al. 2016).

The conflict continued into the 2000s, and then in 2011, the campesino communities and the nonprofit Centro Bartolomé de las Casas (CBC) completed an ecosystem services valuation and strategic plan. In 2012, SEDACUSCO finally agreed to talk with the campesino communities, which one interviewee attributed to the utility's new manager who was more open to dialog, although another noted the campesinos were threatening to physically disrupt the pipe drawing water from the lake. The two parties invited the local government around Laguna Piuray, the Municipality of Chinchero, to join. Shortly thereafter, the three parties signed an agreement whereby SEDACUSCO would provide compensation, mostly water and sanitation projects, that the municipality would implement (Zamalloa Jordán 2016).

At the start of the meetings, the causes of the contamination and land subsistence were viewed as well-known by the three parties. Aside from the campesinos' ecosystem valuation, the main technical study was a diagnostic/management plan for which SEDACUSCO contracted a local nonprofit. The plan was done through a participatory method, but one local water expert scoffed that it was done solely to justify previously

formed opinions and get national government approval, not to develop new knowledge or decide which projects to do. The outcome was not pre-determined by any party, but they each stuck to their positions. Both SUNASS and the Environment Ministry had high-level interest in formulating another compensation program for watershed services, especially as they were working on new national legislation, but few stakeholders interviewed attributed the outcome to that.

An agreement was reached; however, not all parties were satisfied. The bulk of the projects was sanitation, which addressed SEDACUSCO's quality concern. Even for that, one campesino leader said SEDACUSCO resisted and did it "with pain." The campesinos were split in their views—sanitation projects would improve living conditions, but the municipality was responsible for providing them, so some campesinos argued compensation funds should primarily be for projects like reforestation and infiltration ditches to recharge the lake. According to two stakeholders involved in the decision, the communities gave a list of projects, but it was the municipality that prioritized the projects, who was responsible for providing sanitation. Actors focused primarily on striking a deal and having some compensation, not in setting up an ongoing program or dialog. This contributed to the lack of flexibility to address other water topics, as evidenced in 2016 when SEDACUSCO started to put in new, larger pipes and the campesinos protested, with neither using the platform to discuss. Thus, while SEDACUSCO, the campesino communities, and Chinchero Municipality agreed to compensation projects, their MSP has not been flexible enough to discuss other topics nor has it generated trust.

Discussion

Both Moyobamba and Cusco's water utilities adopted watershed protection programs; however, the way in which they got there and process outcomes varied greatly. Opening up the black box of the MSP process, the Moyobamba case reveals several MSP attributes that promoted social learning and which resulted in a decision-making process characterized by flexibility, sustainability, trust, and fairness. Cusco's experience, on the other hand, shows that collaboration is insufficient to produce social learning and that social learning is not the only route to technical outcomes such as compensation programs for watershed protection.

Social learning

Comparing the two case studies, there was extensive evidence of social learning in Moyobamba, but not Cusco. In Moyobamba, after initial disparate views of the "problem," the process led to a convergence in understanding of the problem, its cause, and preferred solutions. The "problem" of water shortages went from being viewed as either the water utility's poor management, lack of adequate technology, or variable precipitation, to upstream deforestation. The appropriate solution then became supporting alternative livelihoods to reduce deforestation; although notably, it was not the only option—they could have strictly enforced no deforestation regulations or focused on the water utility's technology and sources. The agreed-to programs went beyond the water utility's previous geographic scope and functions. Importantly, actors gained shared knowledge, and even though the water utility held the purse strings, stakeholders all agreed with the approach, even if it was not their first choice.

Upon closer look, there were four distinct social groups within the process, and social learning occurred as a result of interaction within and between them. The Management Committee was the main space for discussion and sharing perspectives. Upstream communities were a distinct second group. They had representatives on the Management Committee and also engaged in discussions, workshops, and trainings. Third, the urban residents did not regularly attend meetings but interacted through awareness-building activities, surveys, and consultations. These not only changed their view of the problem, but also became important for the design of the program and for voting to pay the additional tariff. Finally, the Technical Team worked most closely together, as they were responsible for doing technical studies, identifying possible solutions, and designing the program for discussion in the Management Committee.

In Cusco, however, there was no social learning and political variables featured prominently. If one equated social learning with collaboration, it would appear there was social learning, especially as it resulted in the compensation projects. But whereas Moyobamba met all three criteria necessary for social learning, the social relations in Cusco are better described as interest-based bargaining—the outcome was subject to the social interaction, but there was little, if any, evidence of change or convergence in knowledge. Without a change in cognition, whose interests were met was determined largely by their political and financial resources. The agreement focused on SEDACUSCO's concern about water quality, which enabled the municipality to meet their responsibility to provide sanitation. While the campesinos wanted sanitation, many felt the municipality was responsible to provide it anyways, so the compensation from SEDACUSCO should not be used for it (Estrada Zúñiga et al. 2016). Instead, campesinos argued the majority of the funding should be put towards ecosystem-based projects like soil conservation and reforestation. In terms of power dynamics, SEDACUSCO and the Chinchero Municipality had greater ability to influence the decision making due to financial and political means. The campesino communities received some projects that they wanted, which was better than no projects, but the majority of

funds were spent on sanitation, not ensuring adequate recharge of the lake. Thus, in this case without social learning, unequal resources was a key determinant in the outcome; however, it is unclear whether political variables inhibited social learning or whether they were prominent only due to the absence of social learning.

These cases also show how scientific information can spark social learning, but does not necessarily, as aligns with science communication scholars' critiques of the "deficit model" (Nisbet and Scheufele 2009). Here, we see this in Moyobamba where studies were key in changing people's understanding of cause/effect relationships and potential solutions, but this was not just due to the studies themselves, but also the way they were used. Some gained legitimacy because they were developed by international experts that Moyobambans viewed as impartial experts, and others were trusted because they had been screened and interpreted by the Technical Team. The studies were salient to the problem at hand, including hydrological benefits, economic cost/benefit analysis, and other factors that mattered to stakeholders (income, biodiversity, etc.). Additionally, the process through which studies were undertaken, assessed, and used for awareness-building was done in conjunction with other types of knowledge, such as the experiences of the upstream communities and utility's technical expertise. By contrast, in Cusco, there were no joint studies, but rather, the campesino communities and SEDACUSCO each had their own.

Multi-stakeholder platform attributes

The social relations in Moyobamba were tightly linked to several MSP attributes (Table 1). Expansion of participation in the Management Committee enabled exchange of knowledge, perspectives, and interests. Initially, there were few organizations discussing Moyobamba's water supply, but they quickly brought in additional actors. Participation was diverse, extending to tourism operators and organizations concerned with biodiversity. Interviewees consistently characterized the Committee as open and democratic, providing a space for new ideas and the development of solutions that either met interests or changed views of what interests were. Critically, the Management Committee not only involved upstream landholders, but took into account their preferences and experiences working the land. Notably, while decisions were made in the Committee, the Technical Team carried out the bulk of the work, and they had legitimacy because they were the entities with directly related competencies or stakes, and they were democratically selected. Final decisions were made within the Management Committee, which was able to influence the programs adopted, since the water utility looked to it for ideas with widespread acceptance. Participants noted that even when decisions were not the ones they ranked first, this was an endeavor to develop solutions acceptable to all parties.

Table 1 MSP attributes

Attribute	Moyobamba	Cusco
Participation	Diverse	Limited
Length of engagement	Long	Too early to tell
Sources of knowledge/-perspectives	Multiple, including experience of upstream landholders and various types of studies	Mostly technical, with little clout given to ancestral knowledge
Openness of communication	Very open	Open
Facilitation	Widely/praised, unbiased facilitator	No facilitator
Ability to influence outcome	Yes, as water utility was in control of funding and took direction from MSP	Yes, but stakeholders had unequal ability to influence decision

Discussions gave people space to understand not just what other perspectives were, but why actors held them, which helped legitimize them even when they differed. Unbiased facilitation was also key. The individual in charge of this effort was universally praised—in part because she represented the process, not the interests of the government, and in part because of the way she included all stakeholders and the knowledge and perspectives they brought. Thus, Moyobamba's MSP was characterized by diverse participation, continuous engagement, multiple perspectives/sources of knowledge, open communication, unbiased facilitation, and ability to influence the outcome.

The attributes of Cusco's MSP stand in stark contrast with those in Moyobamba. The process consisted of three entities participating, and despite numerous other actors with a stake in water management, the platform remained closed to all others. There was no independent facilitator or leader, and all parties came with their own interests and goals. While participants noted that there was open communication, there was still contention between the parties. Interviewees did not note endeavors to understand the perspectives of others nor even define a common goal, but rather, each party focused on their own objectives. All three entities hoped to continue their meetings, but by the end of data collection, it was still too early to tell whether they would be sustainable. The meetings did provide some basis for the projects selected; however, multiple interviewees noted they had differing ability to influence that. Finally, a campesino leader lamented that the government gave little weight to ancestral knowledge and practices, such as the customary practice of digging infiltration ditches, which were practices the campesinos argued needed to be supported.

To confirm this interpretation, I also assessed alternative explanations and contributing factors to see if they could account for the social learning in Moyobamba. Stakeholders

consistently cited meetings and exchanges, including discussions about technical studies, as the primary way in which they arrived at a new understanding of the problem and potential solutions. None cited individual learning, even when asked. Another plausible explanation could have been international development. Stakeholders warmly acknowledged that the technical assistance enabled them to complete studies and pilot projects; however, none attributed the results to GIZ, but rather saw it as one factor aiding the process. In terms of legal requirements, far from being a motivating factor, laws prevented the water utility from intervening above their intake point and SUNASS had to help make it legal. Finally, other cities in the same region, such as Rioja, did not undertake similar actions until years afterwards when Moyobamba had already set the precedent. Therefore, I ruled out the alternative explanations of individual learning, international development, legal requirements, and a regional explanation.

Conclusion

This empirical analysis provides evidence that social learning can support strengthening adaptive capacity. Scientists anticipate increased variability in temperature and precipitation with climate change, which will affect ecosystems, watersheds, and the sustainability of future water supplies. Further, receding glaciers and increased frequency and severity of extreme weather events will challenge water management to an even greater extent. Along with adapting physical systems to be able to withstand fluctuations and shocks, social systems must also adapt. Governance and community-based systems will need to be able to respond to new situations that arise and do so in a timely manner. Social learning can help build this adaptive capacity by strengthening relationships and trust within management platforms that are sustainable over time and yet flexible. As the Moyobamba case showed, exchanging perspectives helped stakeholders better understand each other and build trust between each other and in the platform. The Management Committee has already been flexible enough to address new issues and stakeholders anticipate continuing to use it.

However, as Cusco showed, social learning is not a foregone conclusion in MSPs, nor will it necessarily result in process or technical outcomes. Agreement to meet does not mean there will be willingness or the ability to move towards shared knowledge, as was the case in Cusco. There can still be interest-based bargaining or co-option, particularly when actors have unequal political clout or financial resources. As such, it is important to analyze the political dimensions of decision making.

As these case studies show, MSPs may or may not generate social learning, but social learning is closely linked to certain MSP attributes. There are several ways that MSP design and implementation can be strengthened to put in place practices that help facilitate social learning in other contexts. Conveners can invite and facilitate the participation of diverse stakeholder groups, encouraging them to share multiple sources of knowledge and differing perspectives. The selection of a facilitator can also support dialog, particularly one that is unbiased and can create a space for open communication, where people will feel comfortable sharing. Finally, MSP dialogs and decisions should be able to influence outcomes, which not only justifies people's time and effort to participate, but can also be empowering to continue working together. Some attributes, such as who participates and the use (and funding) of a facilitator, can be encouraged through national regulations, and others, such as open communication, depend on site specifics of the people involved.

This study provides insight into how and when social learning occurs, but there is significant research that still needs to be done to determine the extent to which the experiences of these cases are generalizable and whether there may be trade-offs between them. Future studies could focus on whether different combinations of attributes affect social learning or whether certain attributes are sufficient. Additionally, with respect to the intersection between social learning and political variables, further studies could look at whether politics affect if social learning occurs or whether politics are just more influential in the absence of social learning.

In the face of climate change and increasing variability of water supplies, social learning can provide a powerful tool to increase resiliency of socio-ecological systems and adaptive capacity to deal with new challenges. Thus, it provides important insight for nonprofit/development organizations, national governments, and others as they try to foster local implementation of policies and programs. Social learning is not just for experts and managers, but an important resource for all actors that engage in natural resource management, as it can help develop shared knowledge of the problems/solutions and understand the perspectives of other stakeholders.

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