Water International

ISSN: 0250-8060 (Print) 1941-1707 (Online) Journal homepage: https://www.tandfonline.com/loi/rwin20

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To cite this article: Karsten Paerregaard, Susann Baez Ullberg & Malene Brandshaug (2020) Smooth flows? Hydrosocial communities, water governance and infrastructural discord in Peru's southern highlands, Water International, 45:3, 169-188, DOI: 10.1080/02508060.2020.1755538

To link to this article: https://doi.org/10.1080/02508060.2020.1755538

Published online: 13 May 2020.

WATER INTERNATIONAL
2020, VOL. 45, NO. 3, 169–188
https://doi.org/10.1080/02508060.2020.1755538

Routledge
Taylor & Francis Group

RESEARCH ARTICLE

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Smooth flows? Hydrosocial communities, water governance and infrastructural discord in Peru's southern highlands

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ABSTRACT

The article examines how the design and governance of Peru's water infrastructure shape the social practices and cultural values stakeholders engage in and draw on when negotiating water rights in a year of drought. Reviewing ethnographic data on a large irrigation project in south-western Peru, we discuss how the project both perpetuates power relations between water experts, authorities and users and creates room to challenge its hierarchical organization. The project's infrastructural assemblage of state and community canals offers an interesting case to explore how the stakeholder cooperation encouraged by Peru's water law produces hydrosocial communities.

ARTICLE HISTORY
Received 21 December 2018
Accepted 10 April 2020

KEYWORDS
Water infrastructure; water values; water governance; conflict; cooperation; Peru

Introduction

Propelled by the export of natural resources, Peru's recent economic boom has aggravated the country's water crisis and urged the state to take measures to calm social tensions and meet the growing water demand of the thriving mining and agricultural industries. In 2009, the country passed a water law to create a new institutional framework that encourages cooperation between stakeholders at local, regional and national levels (Roa-García et al., 2015). At the same time, it has invested in large water infrastructure to irrigate Peru's coastal desert (Lynch, 2012). One example of such hydraulic megaprojects is the Majes Siguas Special Project in Peru's south-western highlands (Stensrud, 2016a; Ullberg, 2019; Vera Delgado & Vincent, 2013).

This article examines how the design and governance of Peru's water infrastructure shape the social practices and cultural values stakeholders engage in and draw on when they negotiate water rights in a year of drought. Its point of departure is Peru's current water crisis, which has not only exacerbated existing social frictions in the country's water governance but also prompted the country to introduce a new water law which encourages water stakeholders to cooperate in a new institutional setting. We use the Majes Siguas Special Project, whose stakeholders include engineers, administrators and four user groups (three of small farmers on the coast and one of rural communities in the highlands), as a case to explore how this cooperation evolves in a situation of water shortage. We also suggest that the project's design, which connects large-scale infrastructure built and

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managed by the state's water experts to several small-scale irrigation systems operated autonomously by their users, offers an interesting case to examine how water infrastructure generates hydrosocial territories, networks and communities (Boelens et al., 2016; Rocha-Lopez et al., 2019).

The article contributes to the current debate on hydrosocial cycles, hydrosocial territories and hydrosocial networks by linking these concepts to theoretical work in anthropology on communities and infrastructure. While the notions of cycles, territories and networks open a broader understanding of the social and political structures that shape water management, they are informed by conceptual ideas of geographical boundaries, environmental change and institutional settings from such disciplines as geography, political ecology and environmental social science. By proposing the notion of hydrosocial community and highlighting the techno-social aspects of water infrastructure, we want to highlight the pivotal role of social practices and cultural values in water management and in this way expand on the conceptualization of hydrosocial constructs (Hommes & Boelens, 2017; Perramond, 2016; Rodriguéz-de-Francisco & Boelens, 2016).

Our argument is that the Peruvian state's attempt to make the management of Peru's water resources more inclusive is an important step in alleviating the water crisis but that the cooperation this inclusion implies is hampered by the relations of power and the cultural divides embedded in the incongruent design and hierarchical governance of its water infrastructure. To uncover these relations and divides, we examine the Majes Siguas Special Project's social history and infrastructural assemblage and scrutinize the knowledge claims and water values its administrators, experts and users draw on to negotiate water rights. On its way downhill, the project's infrastructure supplies a number of highland communities in the Colca Valley with water before it reaches its end station, the arid plains of Majes and Siguas, where farmers take the lion's share of its water to irrigate their fields. How much water should pass and how much can be drawn out, and when and where this should take place, are issues of dispute and practical action between public and private actors.

Scope and structure

The study is based on collaborative ethnography from multilocal fieldwork in 2016, an El Niño year with serious drought affecting the region (Figure 1). Data were gathered through extensive fieldwork within and outside institutional settings, by which the authors gained knowledge about everyday activities concerning water practices and interactions between stakeholders. The ethnographic methods included 12 formal interviews with selected representatives from state institutions, water experts and community leaders; more than 50 semiformal and informal interviews with organizational workers, water users and community members; and participatory observation at institutional meetings, community gatherings, expert excursions and a variety of social events, which provided insights into the water values and the different forms of knowledge and justice that inform the Majes Siguas Special Project's water management. Supplementary data collection included study of formal and legal documents and mapping of irrigation infrastructure. We conducted simultaneous field research in three settings along the project's infrastructural supply chain to investigate how its material and political infrastructure enables or curbs stakeholders' cooperation over a scarce yet

Figure 1. Map of Peru with site of fieldwork. Source: This map was downloaded from Vidiana.com (maps of the world). http://www.vidiani.com/large-detailed-relief-and-political-map-of-peru/ The arrows and place names have been added by the present authors.

vital resource in a year of drought. On several occasions, we also made joint participatory observation and informal interviewing in selected points of encounter between project stakeholders. To acknowledge the importance of the interviewees' collaboration and contribution to the data collection, we use their real names.

The analysis reviews data from our individual fieldwork and is organized into three case studies. Based on the anthropological research tradition that works with 'experience-near' field data (Geertz, 1973) and the case-study approach, which examines first-hand

field observations in shifting socio-political contexts (Evens & Handelman, 2006), the cases draw on our personal participation in the three field sites and take the form of ethnographic descriptions of how the project's water management is shaped by the social practices and cultural values of its stakeholders. Strategically located at three hotspots of encounters between the project's experts, authorities and users, the case studies shed analytical light on the interpersonal dynamics and contextual settings that in some situations perpetuate the project's power structures and hegemonic practices, and in others, challenge them.

The first case, 'Water Works', focuses on so-called multisector committee meetings, which are stakeholder meetings held once a month and attended by representatives from the water authorities and the user organizations involved in the project's water supply system. During these encounters, the experts mobilize their professional authority as water managers to determine the project's water availability and establish the water volume its user groups are entitled to. The second case, 'Water Engagements', deals with the processes of negotiation and contestation the water leaders of Yanque Anansaya, in the upper Colca Valley, engage in when they make claims for water from the project and later allocate it among the community's water users. The third case, 'Water Bargains', describes how the water leaders of Cabanaconde, in the lower Colca Valley, use their personal contacts with the project's experts to legitimize the demands of competing water user groups in the community. The project constitutes the analytical link between the case studies, which offer three distinct but related examples of how conflicting perspectives on Peruvian water management interlock in different institutional constellations and social contexts, reproducing and transforming existing relations of power and ideas of water at one and the same time.

The article has four main sections (following this introduction). Drawing on recent anthropological work on the intersection between infrastructure, sociality and politics, the first section introduces the concept of hydrosocial communities and discusses how it helps us understand the ways large state-managed water infrastructure projects produce hydrosocial territories and networks. The second section discusses how social inequality frames water conflicts and water governance in Peru and how the institutional framework of Peru's 2009 water law moulds the state's effort to create new forms of cooperation between the country's water actors to alleviate its water crisis. The third section describes the history and current development of the Majes Siguas Special Project in the Arequipa Region and presents the three case studies. The fourth section compares the insights from the three case studies; a concluding paragraph links these to the scholarly debate on water, infrastructure, and hydrosocial cycles, territories and networks.

Hydrosocial communities: water infrastructure, water practices and water values

A growing body of literature has investigated how the complex structure of irrigation systems creates vertical relations between the state, water experts and different user groups. In many parts of the world a hierarchical division emerges in large water management projects between the main infrastructure system and a number of secondary or tertiary canals, but although the dynamics at these different scales are often different, the users' water values pursue a common goal: to produce crops (Boelens &

Hoogendam, 2002; Vos, 2005). Notwithstanding this observation, however, some studies point to the frictions, in the form of competition for water, water theft and other irregularities, that sometimes result from the state's attempts to control autonomous water management systems or to connect different irrigation infrastructure (Perramond, 2016; Vandermeer, 1971; Van der Zaag & Rap, 2012).

To understand the social and political structures underpinning such conflicts and the hierarchical relations arising from large-scale irrigation projects, a group of scholars propose that we study modern water management as a *hydrosocial cycle*, which is 'a socio-natural process by which water and society make and remake each other over space and time' (Linton & Budds, 2014, p. 170), and which is made at the interface of political power, social agency, expert knowledge and cultural identity (Boelens, 2014). Such a view of water and society requires that we examine these as mutually constituting rather than pre-given phenomena. It also implies that we understand water and society as materialized functions of their internal relationship and as socio-natural hybrids that emerge from historical, political and geographical processes rather than independent entities that may coexist and impact each other but still belong to different realms (Linton & Budds, 2014; Swyngedouw, 2009).

Building on the notion of hydrosocial cycles and its understanding of water as an assemblage of historical, hydrological, political and technological circumstances, we inquire into the practices and values that produce water for irrigation. Irrigation implies taming water, which requires physical infrastructure to transport water from its natural settings to specific production sites. The hydraulic grids this infrastructure forms in the landscape generate what Boelens and others call *hydrosocial territories*, which are framed by configurations of people, institutions, water flows, technologies and biophysical environments and that constitute an important battleground between social and political actors, not only to control water and other natural resources but also to negotiate and contest values, norms, knowledge and identity (Boelens et al., 2016; Usón et al., 2017). Hydrosocial territories are therefore shaped by both natural-ecological and socio-political forces, and their boundaries are demarcated by the hydrosocial networks humans' interaction with water generates (Rocha-Lopez et al., 2019). However, as Boelens and others point out, hydrosocial territories need to be examined at different political, economic, social, cultural and ecological scales. To capture the scalar multiplicity of the Majes Siguas Special Project's infrastructure design, we use the term *hydrosocial community*, which enables us to scrutinize water management from not only a political ecology perspective, as the concepts of hydrosocial territories and networks do, but also from an anthropological and socio-cultural perspective (Perramond, 2016; Rodriguéz-de-Francisco & Boelens, 2016).

Unlike the terms *cycle*, *territory* and *network*, which direct our focus to the water–society nexus and the socio-political and institutional context framing humans' relation with the environment, the term *community* foregrounds the social practices and cultural values in which water management is embedded. Community is a crucial reference point for people's everyday interaction and their sense of belonging and creation of identity. Yet, as anthropological theory points out, community is an organization that serves to both include and exclude, and to which its members ascribe shifting meanings over time (Cohen, 1985). Similarly, relations across communities are often as important as relations within communities for their members' self-identification (Barth, 1969), just as

community membership may stretch across geographical borders and refer to real as well as imagined collectivities (Amit & Rapport, 2002). In other words, community is a malleable construct that its members can use both to adapt to the external world and to mark internal divisions. By proposing to study the Majes Siguas Special Project as a hydrosocial community, we borrow from this understanding of community to examine how its experts, managers and users interact across epistemic, geographical and social boundaries, how its stakeholders negotiate and contest water knowledge and water values, and how they create strategies and engage in new relations to acquire what everybody seeks: more water.

In a region where precipitation is limited to a few months a year, water and the infrastructure that transports it from the mountains to the fields are critical for the formation of communities. Moreover, in a situation where strife often occurs between villages that share water sources, water canals and reservoirs also serve as important symbols of community membership. To explore how water is fabricated as irrigation water and how irrigation infrastructure engenders hydrosocial communities, we draw on the anthropological scholarship on infrastructure, which defines it as 'matter that enables the movement of other matter' (Larkin, 2013, p. 329) and that views it as a vehicle to create political and moral spaces (Harvey, 2012), implement economic politics (Von Schnitzler, 2013) and forge social and political networks (Anand, 2012). Infrastructure is not merely things, or the relation between things. It discloses the political rationalities underlying technological projects (Larkin, 2013), and techno-political devices such as prepaid metres that evoke ideas of modernity and create new socialities and subjectivities by holding people accountable for their own agency (Von Schnitzler, 2013). In this regard, water infrastructure is peculiar because it not only alters social systems (Star, 1999) and creates its own relational and mobility spaces (Harvey, 2012), as other infrastructure does, but also challenges the natural order of a substance of existential importance for human life. Water infrastructure therefore both consolidates and disturbs the social and political order (Anand, 2012; Andersen, 2016; Strang, 2016; Swyngedouw, 2009), affirming the social and political leverage of empowered agents such as water administrators and experts while offering new room to manoeuvre for disempowered water users to question relations of inequality and contest the ethics and moral values of modern water infrastructure.

At the core of our analysis, then, is the intersection between infrastructure projects and community formation. In particular, we are interested in how water experts, managers and users interact socially and mobilize personal contacts and how they draw on expertise and values to negotiate and contest water claims and water rights in shifting institutional and social settings. In the following, we introduce the socio-political and cultural contexts in which these interactions and encounters unfold.

Contextualizing water in the Peruvian highlands

In 2009, to alleviate Peru's water crisis and prevent future water conflicts, the Peruvian government passed a new water law that invites the country's water stakeholders to manage its water resources within a new institutional framework (Roa-García et al., 2015). The law conceived a new National System of Water Resource Management governing on three levels: ANA (Autoridad Nacional del Agua – National Water

Authority), governed centrally from Lima; 14 AAAs (Autoridades Administrativas del Agua – Administrative Water Authorities) to direct and implement water politics and legal norms regionally; and ALAs (Autoridades Locales del Agua – Local Water Administrations) administering the rights to and use of water. This system of governance is based on stakeholder participation and collaboration to encourage water users to organize into water user committees (comisiones de usuarios) at the community level and water user organizations (juntas de usuarios) at the regional level. Guided by the World Bank's concept of Integrated Water Resources Management (Orlove & Caton, 2010), the Peruvian state has also created water basin councils in several regions to bring all the water basin's stakeholders together to discuss how water will be managed (Paerregaard et al., 2016). In some regions, such as the Camaná-Majes-Colca basin, where the Majes Siguas Special Project is situated, such water basin councils are still in the process of forming. Meanwhile, the water authorities meet with stakeholders in smaller multisector coordination committees, such as Colca-Siguas's which we present here.

When negotiating water rights within the institutional framework of the 2009 law, the stakeholders confront each other as agents of not only different economic interests but also conflicting political visions and cultural notions of water management, water rights and water ethics (Groenfeldt, 2013; Paerregaard, 2018a; Wade, 2018). Such encounters are particularly contentious in Peru's south-western highlands, where rain is both scarce and unpredictable and where almost all crops rely on irrigation fed with water from glaciers and snow-covered mountains, transported through canals to reservoirs, and then to the fields (Gelles, 2000; Paerregaard, 2013a; Rasmussen, 2015; Trawick, 2003). In many of Peru's highland communities, irrigation follows a century-long communal tradition of constructing and maintaining water infrastructure with local labour and materials and allocating water to support small-scale production. In these practices, water rights are tied to community membership and contingent on users' participation in communal work. Moreover, in some places the communities' water values and ethics include water as a living substance which humans access by paying tribute to the deities manifested as snow-covered mountains (Stensrud, 2016a; Brandshaug, 2019; Paerregaard, 2013b, 2013c, 2019a). On the other hand, the Peruvian state and the institutions and experts it has authorized to manage the country's water resources use a modern, scientific notion of water to design water laws and policies, establish rules for and practices of water governance, and devise, construct and maintain water infrastructure (Linton & Budds, 2014; Paerregaard et al., 2016). Within the state institutions and policies, water is treated as a physical object that can be captured, domesticated and transported to meet human demand, whether for private, public or industrial consumption. And water knowledge is synonymous with the numeric units the state's experts use to measure the exact water volume available at a specific time and specific place (Stensrud, 2019a).

The design and construction of Peru's water infrastructure embody this tension between the country's community-based production and relationship to water as a living substance, versus capital-driven production and the scientific notion of water as a chemical object. While the Peruvian state is increasingly funding small-scale irrigation projects in the highlands, most of its irrigation infrastructure aims at supporting large-scale, commercial production in Peru's coastal desert, production increasingly directed towards export and owned by transnational companies. Unlike the community infrastructure, which users maintain and

manage autonomously, the latter requires professional maintenance and management expertise and is therefore subject to legal regulation and formal supervision. Thus, even though the water users participating in the state's new water institutions share a common interest in improving the management of Peru's water supply, their cooperation is curbed by the design and governance of the country's water infrastructure, which favours cash-crop production and centralized decision making over subsistence production and decentralized decision making.

Considering the range of crops that need water from the Majes Siguas Special Project and the multiple economic and social demands it is expected to meet, water allocation is both a complex and a contested issue, as will be shown in this article. In Peru, irrigation allowances are often granted as water discharge per hectare per irrigation season for different crops, which represents an officially sanctioned cropping pattern and can vary for different valleys and irrigation systems (Vera Delgado & Vincent, 2013). These figures are then converted into L/s per hectare, given the variations in irrigation season length (Vos, 2005). According to Vera Delgado and Vincent (2013, p. 204), the irrigation supply registered for the Colca Valley communities 'may be related to the design discharge of local canals or offtakes (the discharge capable to supply the area to be irrigated in a given time period, including allowances for water losses)'. However, as the basis of these figures is unclear to local water users, the communities often question them, demanding more water to irrigate more frequently and to irrigate as much land as possible. Thus, even though the project has significantly improved the water discharge of the communities on the west bank of the Colca Valley, as we shall see, many water users contend they receive less than they should.

The conflicting notions of water rights and water ethics that hamper Peru's water governance are not incommensurable. Many highland communities are resilient to seasonal water shortage, which they manage by rationalizing water on a communal basis. However, excessive and irregular precipitation caused by climate change, and damage to canals and reservoirs and water pollution created by recurrent flooding, are compelling them to adopt and develop new technologies and change management practices to minimize water loss and maximize irrigation efficiency. On the other hand, the 2009 law recognizes water not only as a commodity that can be taxed, sold and otherwise commercialized but also as a common good that all citizens are entitled to (Autoridad Nacional del Agua, 2010). And even though the notion of water as a physical substance dominates in the state's institutional settings, its experts sometimes participate in ceremonial offerings to the communities' mountain deities (Stensrud, 2019b). By focusing on the relations of negotiation and contestation between three key players in the management of the Majes Siguas Special Project – the state's experts, the communities' water leaders and the communities' water users – the three case studies highlight both the power structures that shape its infrastructural design and the strategies its stakeholders pursue to challenge them.

The Majes Siguas Special Project

The project is a water supply system in the region of Arequipa declared to be of national interest. Envisioned already in the early twentieth century as a development project to support small-scale farming, the military government of Juan Velasco Alvarado (1968–1975) created what at the time was one of the world's most expensive irrigation projects

through public (35%) and international (65%) funding (Stensrud, 2016b). From its origin, the project was conceived to have two stages. The first stage was built between 1974 and 1982. It include the Condoroma dam, located in the highlands and fed by the nearby Colca River, and several intakes and 101 km of tunnels and canals that carry the water through the Colca Valley, where it supplies the communities on the west bank, to the Majes and Siguas plains on the coast, where it irrigates 15,000 hectares of fields for a variety of crops, including alfalfa (used as fodder for cattle and dairy cows in the region – Stensrud, 2016b), potatoes, corn and legumes for the regional market, and aji pepper and artichoke for export (Figure 2).

Due to Peru's economic and political problems in the 1980s and 1990s, the second stage of the project was not initiated until 2006 and has yet to be completed. It was intended to double the infrastructure's water supply, but the project's premises have changed. Still considered a regional development investment project in the interest of the Peruvian nation, the Majes Siguas Special Project II is organized as a public–private partnership between the Regional Government of Arequipa and the international private consortium Angostura-Siguas and thus funded through both public funding and private investments. It is now framed as an agro-energy project, oriented towards high-tech agribusiness and hydroelectric production. To meet this demand, this stage includes the building of a new dam (called Angostura) that takes water from the Apurimac River and

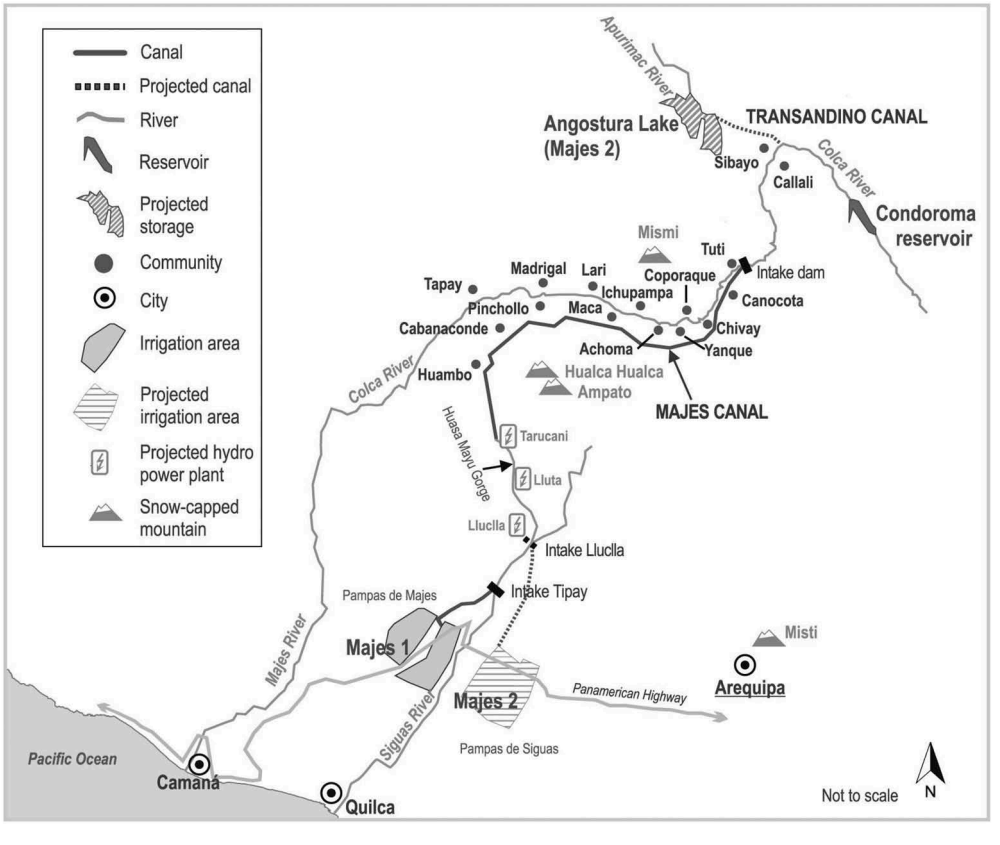

Figure 2. Map of the Majes Siguas Special Project. Source: Reproduced from Figure 1: The Colca-Majes-Camaná catchment and the Majes Irrigation Project, in Vera Delgado & Vincent (2013). Map by Juana Vera Delgado.

links this to the existing infrastructure through a 16 km diversion tunnel. At the other end of the hydraulic system a new irrigation grid is planned that will develop another 45,000 hectares of productive land in the Majes and Siguas plains. However, due to legal problems, conflicts over the contract and accusations of corruption, the construction of the project was still only in preparations as of March 2020.

Since 1983, the Majes Siguas Special Project has been administered by AUTODEMA (Autoridad Autónoma de Majes – Majes Autonomous Authority), which was an autonomous public agency under the Ministry of Agriculture and the central government until 2003 when it passed to the Regional Government of Arequipa. AUTODEMA's public experts will continue to manage the project until the second stage is finished and the private consortium that builds it takes over and runs the infrastructure for the 16 years of concession.

Three case studies

The three cases examine, first, how knowledge positions and water values frame the relations of power and contestation between the project's administrators, experts and users; second, how the project's infrastructural hierarchy of main, secondary and tertiary canals creates friction among its four water user groups (marginalizing some while privileging others); and third, how the project's water users and water experts mitigate this infrastructural discord and bridge the gap between their opposed water values by creating alliances and forging personal bonds of mutual interest. The cases are geographically and institutionally intertwined through the project's infrastructural assemblage and the social interactions and relations of negotiation its stakeholders engage in. Apart from the project's water experts and managers, the stakeholders include four water user groups (Pampa de Majes, Santa Rita de Siguas, Ampato-Siguas-Quilca and Valle del Colca), the first three of farmers on the coast and the last one of communities on the west bank of the Colca Valley.

At the lower end of the infrastructure, and the final destination of its water, are the Majes and Siguas plains, where the bulk of the project's users have their fields (Figure 2). Here is also the town of Pedregal, where ALA/Colca-Siguas-Chivay convenes most of the meetings with its stakeholders to discuss and negotiate all relevant matters of water supply. The aim of the first case study is to document the power relations that shape these meetings and show how the stakeholders' presence (or absence) influences decision making. The community of Yanque Anansaya, on the other hand, is close to the project's upper end, at the off-take from the Colca River. The water users of Yanque Anansaya and the others in the Colca Valley water user group are therefore among the first to take water, but due to lack of political leverage and geographical distance, they have few means to influence AUTODEMA's or ALA/Colca-Siguas-Chivay's decision making, which takes place in Pedregal (and Arequipa). The second case exemplifies the cat-and-mouse game the state's water managers and Yanque Anansaya's leaders engage in to control the community's water discharge and documents the expertise and values its water controllers employ to allocate water. Lastly, positioned halfway between the project's off-take in the highlands and the Majes and Siguas plains, Cabanaconde has a long history of water struggles that give it weight in regional politics and link it to AUTODEMA's and ALA/Colca-Siguas-Chivay's water experts but that also create

tension within the community. The third case provides an ethnographic account of the personal relation between an ALA/Colca-Siguas-Chivay engineer and a community leader and describes how the latter uses the former's expertise to pursue his own agenda in community affairs.

Water works: negotiating water rights and disputing infrastructural assemblages in Pedregal

The Colca-Siguas Multisector Coordination Committee is an institutionalized network that ALA/Colca-Siguas-Chivay uses to convene representatives from the Majes Siguas Special Project's stakeholders, which include AAA/Caplina-Ocoña, ALA/Colca-Siguas-Chivay, AUTODEMA, SEDAPAR (Servicio de Agua Potable y Alcantarillado de Arequipa – the regional public sanitation company of Arequipa) and the four water user groups that the project supplies. These actors meet monthly to determine the water volume that is available in the infrastructure and negotiate its distribution among the user groups. Other questions discussed at the committee's meetings are acute needs for repair of tunnels and gates and the quality of the project's water, which from time to time is exposed to contamination (Ullberg, 2019). This case study analyzes the dynamics of water works, that is, how the provision of water is organized and negotiated at these meetings.

On 29 January 2016, Isaac Martinez, then president of the AAA, led the committee meeting, in the offices of the ALA in Pedregal. Besides the AAA and ALA, AUTODEMA was also represented in the meeting as the water supplier, and among the water user organizations, the representatives of Majes and Santa Rita de Siguas were present, as well as SEDAPAR. The meeting venue had been announced as being in the neighbouring town of San Juan de Siguas but had been moved to Pedregal at the last minute after its conveners learned that a group of farmers were planning to enter the meeting in protest against their regional water user organization and that the local mass media had been invited to cover the event. On this occasion, Martinez started the meeting by saying that El Niño was hitting hard. Because of the lack of rain in 2016, water levels in the Condoroma dam were very low. He gave the floor to an agronomist from AUTODEMA, who, with the help of PowerPoint slides, gave an account of the past month's *movimiento hídrico*, that is, the data on the existing volume of water and the projected availability for the forthcoming months. 'Numbers talk', Martinez commented, urging the water users to stick to their respective water management plans, which they had designed in the preceding months and submitted to the authorities for approval. He recommended that they start considering their emergency plans, as they might have less water than they had applied for and been granted in their management plans. If the drought continued, he warned, since drinking water was an absolute priority, there would not be much left for irrigation. An hour of heated discussion followed, in which the water user representatives argued for their right to and absolute need for irrigation water (or their crops would be ruined), while the AAA and ALA representatives tried to convince them to adjust to the water shortage. Finally, the AUTODEMA agronomist presented a proposal for water distribution for the rest of the year in the various areas along the infrastructure, assuming that the much-needed rain would begin in February or March. At the same time, she assured the water users that, as in previous years, they

would continue to receive the lion's share of the water. Eventually, the water users accepted the agronomist's proposal.

When the next committee meeting came around, on 15 February 2016, still no rain had fallen. However, even though the predictions of no rain were coming true, only the two regional water user organizations from the Majes and Siguas plains were represented. They again questioned the shares of water, but on this occasion the representative of San Juan de Siguas' water user organization made a new point. To cast doubt on the water management of the Colca communities, the representative showed a photo of an illegal irrigation dam built on top of one of the project's tunnels near the community of Achoma, in the valley's upper part. He said that the added pressure could collapse the tunnel, which was already damaged. He also claimed that this could affect every water user below that point in the system and called on AUTODEMA to sanction the act and repair the damage. A hydraulic engineer representing AUTODEMA described the agency's plan for repairs, estimating they would require five days of work, during which the water would have to be cut off. The representative of the water users objected, saying that that they would lose all their crops if they were without irrigation for more than 72 hours. Eventually, the participants asked AUTODEMA to come up with a new proposal for the next meeting.

As one of Peru's largest water infrastructure projects, the Majes Siguas Special Project supplies both the farmers of the Majes and Siguas plains and the highland communities of the Colca Valley. Yet even though the infrastructure's stakeholders use the same water, their ideas of water justice and water management differ which limits the cooperation encouraged by the 2009 water law and hampers the formation of a hydrosocial community. These differences in values among the stakeholders are highlighted when they negotiate water rights and water accessibility at the committee meetings, where the state's experts use their professional knowledge and scientific logic to legitimize the committee's decisions. As the demands for water rights and water justice and the allegations of upstream sabotage show, the meetings are illustrative of the water values that shape such decisions. That they are justified with not only technical claims but also moral arguments suggests that the professional authority and political power the state's experts bring to bear in the management of Peru's water infrastructure draw as much on their particular water values as on their general water knowledge and expertise. It also indicates that mutual distrust between the project's four user groups and their different leverage in its decision making constitute an important obstacle to the attempt to integrate these in a hydrosocial community.

Water engagements: transgressing water infrastructure and practicing water values in Yanque Anansaya

The Majes Siguas Special Project has 27 valves that control the supply of water to the various communities. The community of Yanque Anansaya uses water from Valve 7 to irrigate a total of 790 hectares of cultivated land (Autoridad Local del Agua, 2014). As the connection between the project's infrastructure and Yanque Anansaya's local infrastructure, Valve 7 is critical for the community's water management and an issue of recurrent conflict. By law all water in Peru is the property of the state, but once it leaves the Majes Siguas Special Project and enters Yanque Anansaya's infrastructure, the community's

water user committee (comisión de usuarios Yanque Anansaya) controls it. The committee's main task is to distribute the water among Yanque Anansaya's 488 users, whose average land size is 1.62 hectares. Moreover, Yanque Anansaya and its water users can adjust the water flow from the project by using the valve, whose key is kept by the regional water user organization. Although Yanque Anansaya is bounded by its water licence and the 150 L/s the community is entitled to draw from the Majes Siguas Special Project, access to Valve 7 is critical to control the water volume especially when the Colca-Siguas Multisector Coordination Committee reduces it in times of drought. Even though the regional water user organization has a seat on the Coordination Committee, its leaders rarely attend these due to lack of funding to pay for their trip to Pedregal, as described in the first case study, and their marginal position in comparison to the water user organizations on the coast, which have more leverage in the project's decision making process. Rather than making their voices heard at the Coordination Committee's meetings, where they feel they have little to say, the water users of the Colca communities use more informal and practical strategies to get more water from the project.

Early one morning in February 2016, three engineers from the ALA and AUTODEMA visited Yanque Anansaya to inspect Valve 7, on the request of the farmers of the Majes and Siguas plains, who had complained that the Colca communities were taking more water from the project than they were entitled to (Brandshaug, 2019). During the bumpy car ride, one of the engineers recalled that Valve 7 had been wide open when he inspected it the previous week. In response, the two other engineers said that the keys to the project's valves in the Colca communities, which their regional water organization keeps and which their water committees sometimes use to regulate the water volume they receive from the project, give them too much control over the water.

On their arrival at Valve 7, the engineers used a stick, a meter and a table to estimate the valve's water flow. Although the measurement showed that the water flow and the valve's setting complied with the limits prescribed by Yanque Anansaya's licence, a more detailed investigation of the terrain and the otherwise dry Andean landscape, which had received no rain for nine months, suggested that water had been spilled on the ground and that a considerably larger volume had been exiting the valve before the three engineers arrived. For documentation, they took pictures of the damp soil, which they agreed supported the Majes and Siguas farmers' allegation and confirmed their suspicion that the Colca community had used the key to the valve.

After Valve 7, the project's water runs into Yanque Anansaya's main canal and then into a labyrinth of smaller canals and irrigation ditches divided into three irrigation sectors, before it enters the fields of the community's farmers. Three *regidores* (water allocators) appointed by the community are responsible for allocating water within the three sectors. Every morning before dawn they meet with the users who need water to plan the day's irrigation scheme. One such morning in January 2016, 11 men and one woman had surrounded one of the regidores to request water. 'I have beans', one man said. 'I haven't watered for days', another added. A third claimed he needed more water than the man with the beans, who had thick soil; his soil was thin and could not hold the water as long. The regidor looked in his notebook, where he had recorded the irrigation schedule, and asked the 12 water users whether some of them could share the water flow and irrigate their fields at the same time. Based on their reported types of crops, quality of

soil, area of land, the time since they last had received water, and their participation in community work, the regidor then decided how to allocate the water. Thus, rather than basing the water allocation on a quantitative calculation of the volume of water available, for example by using a stick to measure the water flow, as the engineer did, the regidor relied on the information the water users gave him about their crops, soil and community engagement.

Even though the project's and Yanque Anansaya's water infrastructure are physically connected, and even though they both are fed by water from the Condoroma dam, they are ordered in a hierarchy of organizational bodies (first the ALA, second the water user committee) that draw their legitimacy from distinct social histories and that command different forms of political leverage. Moreover, the state's engineers and the community's water leaders use different water values to manage and allocate the water flowing in the two sets of infrastructure. While passing through the project's infrastructure the water is measured in numbers and represented in tables and graphs; similarly, at the Coordination Committee's meetings in Pedregal water rights are granted in litres per second or cubic metres. By contrast, in Yanque Anansaya evaluations are based on personal relationships, soil quality, type of crops and communal contributions. At the Coordination Committee's meetings, water is regarded as a quantifiable resource; but during allocation in Yanque Anansaya it is valued as a relational, life-giving substance. Not surprisingly, a recent attempt by AUTODEMA to change the keys to the valves was met with fierce resistance by the Colca water users and their regional water user organization, which organized a demonstration in the regional capital of Chivay demanding the right to control the valves. The clash between Pedregal's quantitative measuring and Yanque Anansaya's qualitative estimation shows not only how the project's infrastructural hybrid shapes the way its stakeholders negotiate water rights but also how their distinct water values impact its water management and how the water users use these values to put forward their claims to water and contest the legitimacy and authority of the experts and managers. Thus, even though the inspection of Valve 7 concluded that someone had indeed adjusted the valve, nobody was ever sanctioned. And AUTODEMA eventually dropped the attempt to change the keys to the valves.

Water bargains: bridging infrastructural discords and engaging water expertise in Cabanaconde

Situated at the bottom of the Colca Valley, Cabanaconde is the last of its communities to take water from the project. But it was the first community to gain access to that water. On the project's opening in 1983, Cabanaconde made a hole in the channel's concrete to protest the original plan of directing all the water to the nearby coast. The action, which lent an image of resistance to the community, prompted AUTODEMA to grant water rights not only to Cabanaconde but also to the other communities of the Colca River's west bank. Today, Cabanaconde is almost entirely dependent on the project's water supply, which has doubled the community's irrigated land area, enhanced its productive capacity and enticed it to replace its traditional irrigation model, based on community service, with a state-designed model based on paid work (Paerregaard, 2013a, 2013b, 2018a). The project's enlargement of Cabanaconde's water supply has changed the community's perception of the state and improved its relation to the ALA,

AUTODEMA and other state institutions (Paerregaard, 2013b). However, it has also stirred up internal water right disputes. Up to 1983, snow-covered Mount Hualca Hualca (6025 m) was Cabanaconde's main water source, and the villagers saw it as a powerful mountain deity. Once a year they walked to the summit to present offerings in return for the meltwater it provided them. The elderly recount that water was always scarce and caused ongoing strife in the community, particularly during periods of drought, when they would give tribute to Hualca Hualca twice a year (Gelles, 2000). Since the project enlarged its water supply, Cabanaconde has stopped organizing collective offerings at the summit, but water is still contested. And the villagers continue to make offerings to the sources of their water as a means to authenticate water claims, sometimes with the support of the water experts from the ALA and AUTODEMA.

In 2016, Juan, the president of the comisión de usuarios of La Campiña, Cabanaconde's largest agricultural area, asked Lardi, an engineer working for the ALA in Pedregal, to visit the community and measure Hualca Hualca's water supply. Juan, who had met Lardi before and established a relationship of personal trust with him, wanted to use his measurements as proof of Hualca Hualca's continued importance for Cabanaconde's water supply and as support for his plans to reopen the waterway that directs the mountain's meltwater into the infrastructure of La Campiña. As an employee of the ALA, Lardi represents the state, and as an engineer, he embodies Western science and the modern concept of water, which was critical for Juan and his attempt to reform La Campiña's irrigation management and change its crop rotation to adapt to rising temperatures and other effects of climate change. Juan hoped that Lardi's scientific data would foster community approval of his plan and calm the concern of other water users, who feared it would reignite Cabanaconde's former water conflicts. It was also Juan's plan to use Lardi's numbers to support a complaint he had made against the comisión de usuarios of Joyas, a neighbouring agricultural area, and its unauthorized use of Hualca Hualca's meltwater.

Lardi arrived in Cabanaconde at 11 AM and took off, on an empty stomach, in Juan's car, together with two other members of the comisión de usuarios. After an hour's drive and two hours' walk they stopped at 4200 m in a gorge Lardi found suitable to measure the volume of Hualca Hualca's meltwater flow. To ask Hualca Hualca's permission, Juan arranged an offering ceremony that involved the participation of Lardi and the two other travellers and that included burning of gifts, saying prayers to the mountain, and drinking alcohol. After the ceremony, Lardi conducted the measurement, which he repeated twice further down the mountain, first at 3900 m, right above Joyas's off-take, and later at 3700 m, just below it. Lardi's data showed that while Hualca Hualca still produces a considerable amount of meltwater, Joyas captures most of it, leaving almost none for La Campiña. During the trip back to Cabanaconde, Juan affirmed his gratitude to Lardi, inviting him to his grandchild's birthday party in the evening. Lardi accepted Juan's invitation, pointing out that his visit was driven by a personal interest in Cabanaconde's affairs rather than work obligations.

By replacing Hualca Hualca as Cabanaconde's principal water supplier, the Majes Siguas Special Project has alleviated internal community disputes between La Campiña's water users and their competition with Joyas's water users. However, Juan's allegation against Joyas and his plans to reclaim La Campiña's rights to Hualca Hualca's water has brought new weight to old strife in Cabanaconde by stirring up water users' conflicting

interests and the different social histories that fuel them. Similarly, his use of Lardi's science-based estimates of Hualca Hualca's water flow to support his attempt to modernize La Campiña's water management has pitted two sets of water values against each other: the state's modern concept and Cabanaconde's relational notion. To overcome this divide, Juan invited Lardi to participate in the offering ceremony. Lardi, on the other hand, supported Juan's effort to mediate the two concepts of water and the power relations they embody by highlighting his personal engagement in Cabanaconde's water management. The collaboration between the two men illustrates not only the challenges the project's experts face in trying to create a hydrosocial community by attuning their own ideas of water management with the water values of the water users but also the tension the project's infrastructural design generates within the water users' own communities.

Discussion

The Majes Siguas Special Project encompasses an assemblage of channels, canals, reservoirs, technologies and devices that link the Peruvian state and its water administrators and experts to a range of water users. Created to promote coastal agriculture and economic development, the state and its water experts regard this infrastructure as a unique opportunity to modernize Peru's agricultural production. However, on its opening, the project's administrators extended its users to include not only the farmers in the Majes and Siguas plains but also the communities on the Colca Valley's west bank, connecting its hydraulic systems to a labyrinth of smaller irrigation infrastructure in Peru's highlands. In this way, they tried to create a hydrosocial community that includes four water user groups, which not only negotiate their water rights to the project through their own user organizations but also are divided into a myriad of water user committees that maintain their own water infrastructure and manage the water they take from the project's hydraulic system according to their own traditions. Hence, even though the water users are part of the same water supply chain and they all tap water from the same source, the project's multi-layered division into autonomous water organizations perpetuates the users' view of their local infrastructure as discrete units and their notion of the valves that connect them to the hydraulic system as devices they have the moral right to operate when needed. The users' image of the project's infrastructure as a conglomerate of self-contained irrigation systems and the valves as self-regulating gateways is reinforced by their water values, which attribute importance to water as not only a material and economic asset but also a moral, social and cultural good. Thus, as a hydrosocial construction, the project is an infrastructural hybrid of conflicting interests and identities that create friction between its water stakeholders, rather than the cooperation stipulated by the 2009 water law.

The three cases illuminate this paradox by examining how the project's experts and the users negotiated water rights and infrastructural discrepancies in a year of drought. The first case demonstrated how the water authorities try to mediate strife between competing water user groups over the shrinking water supply, while these employ shifting tactics to claim water. The second showed how sometimes community water users defy the water experts' authority as water governors by creative use of loopholes in the state management system to even out inequities in regional water distribution and manage water

according to community customs. The third described how at other times water engineers and local water leaders overcome the project's infrastructural discord by sharing their knowledge and values, and the latter mobilize their personal contacts with the former to gain support for local water claims.

The ethnographic details of the three cases suggest that when the project's water quotas, which are a continuous issue of contestation among its water users, are reduced in years of drought, the power structures inscribed in its infrastructural design are brought to the forefront. Because the production schemes and water needs of the project's four user groups differ, conflicts over water rights are implicit in its water management. However, they are particularly frequent between the project's original water user groups on the coastal plains, which are in the infrastructure's lower part and therefore take water last, and the highland communities, which were later included as a user group but are in the infrastructure's upper part and therefore get water first. Reconciling the social histories and opposing water claims of the coastal and highland user groups and creating a common understanding of water as a shared resource is therefore pivotal for the project's managers and experts and crucial to create a hydrosocial community.

The cases also reveal that even though Peru's 2009 water law states that the country's water supply and water infrastructure are the property of the state, and even though it authorizes the state's institutions to manage them, their administrators and experts only control the water flowing in the country's larger hydraulic systems, which are built by the state, such as the Majes Siguas Special Project. Once the water enters the smaller infrastructure that local users have constructed and maintained at their own cost, the state cedes its authority as water manager to the water committees and water user organizations. The boundary between the large, state-built infrastructure and the small, local infrastructure is marked not only by the valves that send water from the former to the latter but also by the different water values their managers employ to grant rights to and allocate water, which the water experts in most instances conceive as a modern, utilitarian substance and the water users as a relational, common good.

However, the cases also show that the state's and the water users' values are not antipodal. Even though to the latter water is a good provided by the mountain deities in return for offerings, they are aware of the impact climate change is having on Peru' water resources (Paerregaard, 2013c, 2018b, 2019b). As their communities' local water supplies dry up, the water users are increasingly asking the state for assistance to alleviate the growing water shortage, not only by investing in new infrastructure and connecting it to their water supply but also by mediating their internal water disputes. By engaging in the communities' affairs and forging personal bonds with their water leaders, the state's experts may therefore help mitigate the project's infrastructural discord and bridge the gap between the water values underpinning it.

The project was designed and is managed on the premise that its user groups identify as a hydrosocial community, with a common interest in managing the water supply in an efficient and sustainable way. Its stakeholders, however, are divided by conflicting water interests and water values, which are amplified by the project's infrastructural hierarchy and the different community identities and histories. In times of drought, as during the El Niño of 2016, the project's lack of organizational unity and social coherence comes to the

forefront, but, as the data presented in this article suggest, acute water shortage also creates possibilities of forging new alliances and collaborating in alternative ways.

Conclusion

To understand the socio-cultural complexity of the Majes Siguas Special Project's water management and the social and political tensions that framed it in a year of drought, we have used a conceptual framework that explores how state-orchestrated water infrastructure projects intersect with local water user communities and generate hydrosocial communities. Furthermore, by inquiring into the project's water infrastructure as an assemblage of not only material objects but also social relations and knowledge traditions, we have focused on the conflicting collective practices its stakeholders engage in and the water values they bring forward when contesting water rights. Our conclusion is that a close ethnographic look at the encounters between experts, managers and users of large-scale irrigation systems, where they negotiate water claims, and at the specific sites of the systems' infrastructural assemblages, where the stakeholders contest their organizational hierarchy, is a productive approach to understand the inherent power structures of hydrosocial communities.

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

This work was supported by the Vetenskapsrådet [242101101].

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