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Community Irrigation Supplies and Regional Water Transfers in the Colca Valley, Peru

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Water governance of Andean river valleys that are the site of large-scale water transfers and the home to highland communities with their own irrigation practices has been the subject of research and debate since the large water transfers began. In Peru, local and regional water governance has been shaped by changing national water laws that remain controversial regarding their effects on highland water users. This article presents findings from the Colca Valley, where water has been transferred to the Majes Irrigation Project since 1983, while many highland communities still struggle to access sufficient irrigation water. It summarizes the attempts by Colca Valley communities to protect their water rights and water management institutions under a system oriented to regional and national rather than local water resources management, with a detailed discussion of the community of Coporaque. It also presents data on the area's highly variable water allowances and water use patterns, which demonstrate the need for more transparency and agro-ecological understanding of local irrigation needs and efforts to support them. Processes of representation, participation, and water redistribution are discussed as critical issues in improved regional water governance in the Colca Valley.

Keywords: *Community irrigation; hill irrigation; regional water transfers; local customs and water rights; irrigation allowances; Majes Canal; Colca Valley; water governance.*

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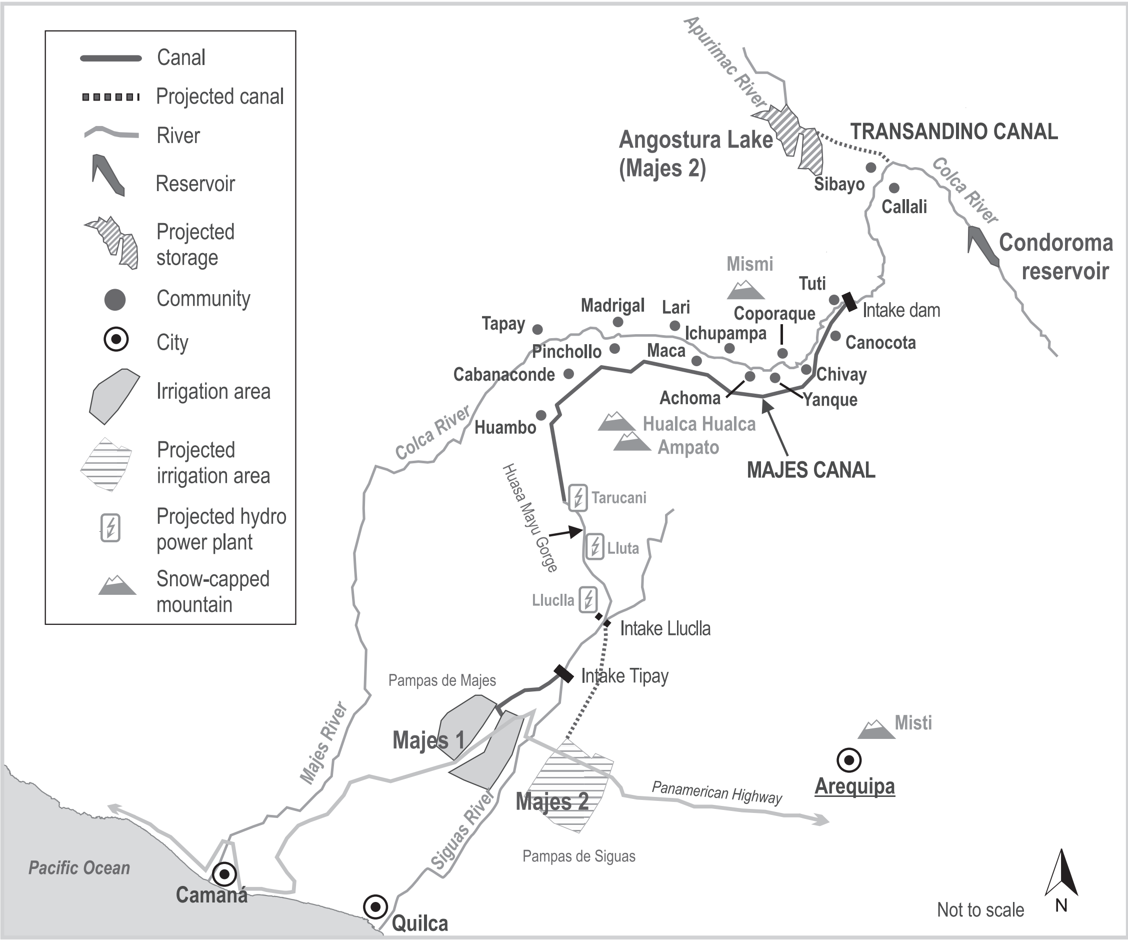
Introduction

Mountain catchments in Peru have supported local irrigation systems for millennia, but they are now increasingly targeted as water sources that can be transferred regionally to support increasing domestic demand and intensive lowland irrigated agriculture. These regional transfers put new pressure on highland water sources and livelihood opportunities, and their design raises important questions about equitable governance, water allocation, and irrigation distribution. This article presents the results of field research undertaken from 2005 to 2007 into the water rights and irrigation management of Andean communities in the Colca Valley (15.6°S; 71.88°W) affected by the construction and flow diversions of the Majes Canal. Since 1983, that canal transfers water across the valley from the high headwaters (4100 m) of the catchment to the large-scale Majes Irrigation Project in the arid *pampas* (plains) region (Figure 1; see also Paerregaard 2013, in this issue). Continued contact with key informants indicates no significant changes to these findings on community irrigation supplies. However, in February–March 2011, heavy rains triggered earth movements that damaged 40 m of the Majes Canal (between Yanque and Achoma) and flooded 10 ha of terraces and damaged local irrigation infrastructure. The canal was repaired immediately, but the affected irrigators received only partial compensation.

Developments such as the Majes Irrigation Project have been part of a larger nation-state development, seen as marking the start of a scientific and technocratic regime of water governance, which has largely ignored the local water needs and practices of communities at the altitudes where water is diverted (Vera and Zwarteveen 2008; Boelens 2009). The Colca Valley has long received attention from irrigation researchers for unique historical continuities found in its irrigation systems, which date back to pre-Inca times (Wernke 2007; Vera 2011), and specialized water allocation and distribution practices for its steep terraced slopes (Guillet 1987, 1992; Treacy 1994). Also documented have been the transformations of irrigation management and community collaboration consequent to both the construction of the Majes Canal and increased interaction with the state to transform community and water governance (Guillet 1981; Bolin 1990; Paerregaard 1994; Gelles 1994, 2000). This state intervention has introduced new institutions, including community organizations, irrigation districts, and water user associations, which have changed the power balance in water management between groups labeled by ethnicity (white, Indian, or mestizo) and older pre-Columbian lineages (political and

FIGURE 1 The Colca-Majes-Camaná catchment and the Majes Irrigation Project. (Map by Juana Vera Delgado)



social divisions such as moieties) in irrigation management.

This article shows how the regional and state agencies now empowered to control water rights and transfer water enforce an interaction, the co-construction of a water governance reality, and an image of participation, while insufficiently addressing critical issues of local recognition and redistribution of water rights to redress unequal access to water. It focuses on the experiences of the community of Coporaque in the Colca Valley. Coporaque was selected for study because, in contrast to most communities of the Colca Valley, it successfully claimed and diverted water directly from the Colca River to augment its irrigation system. Most other Colca Valley communities now either access their irrigation water indirectly through the Majes canal or remain dependent on local springs and streams. The article offers up-to-date information on water management and irrigation allowances for this mountain valley. It debates regional water governance questions that arise from the state's transfer of water from the valley to lowland areas.

Methods

The first author lived in Coporaque during the field research period (2005–2007), having also worked in the valley earlier for several years. The research used ethnographic methods, complemented by semistructured interviews with key actors, focus group discussions, action research, ethnohistorical literature review, official statistical information, and secondary data on other Colca Valley communities from older studies of the area. Water distribution and negotiation practices were studied at and across household, community, and extra-community levels, including agency workers and neighboring communities, and were cross-verified accordingly. Water availability in Coporaque was studied through local flow measurements and secondary data collection.

The concept of rural community (*comunidad rural*) is defined in Peruvian law. The term *Andean community* is used in this article, based on Albo (1999) and Pajuelo (2005), to describe communities whose members have a strong communal identity and collective management of

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natural resources (such as land and water) rooted in customary practices. The community articulates individual, family, and collective interests, and its members are heavily involved in smallholder production, which can be found across the Andes mountains and foothill zones. Research findings were presented and discussed in the community, at the 18th annual meeting (September 2006) of the *junta de usuarios* (JU, Water User Board) of the Colca Valley Irrigation District, and in international congresses (Vera 2006). The JU represents the 36 *comisiones de regantes* (local irrigator organizations; since 2009 these have been renamed *comisiones de usuarios*, water user organizations). Irrigator and community representatives expressed their thanks at being made more aware of the historical processes that shaped water rights and of existing disparities in water allowances and irrigation investments.

Historical background

From the Spanish Conquest until the Agrarian Reform of 1969, water governance in Peru was strongly influenced by Spanish water regulations. The first Water Code (1902) expressed the private-property ideology predominant in Europe, which favored private white landlords. The water law enacted during the Agrarian Reform was diametrically opposed to this code, because it considered water a state property and aimed to redistribute land and water. Yet it still undermined the water governance practices of Andean communities by failing to recognize local water management capacities. It gave authority to the State Technical Administration for Irrigation Districts (ATDR, Administración Técnica de Distritos de Riego), which focuses on procedures for allocating rights based on scientific standardized methods and coastal irrigation needs, as visible not only in specific organizational forms required of irrigators but also in estimation procedures for irrigation water allowances. The establishment of this regulatory authority, together with the priority given to coastal irrigation, not only facilitated the transfer of Andean water sources but also initiated a struggle to maintain customs and entitlements in local Andean water management, and to maintain and increase access to irrigation in Andean communities where water was scarce.

Since 1979, water users must form a *comité de regantes* (irrigators committee) at the secondary canal level. These committees are grouped under an irrigators commission or *comisión de regantes* (CR) at the primary canal level of an irrigation system. (This may also serve a particular land division of a community, such as a traditional moiety.) The CRs are grouped under a water users board or *junta de usuarios* at the irrigation district level. The *junta de usuarios* authorities, made up of an irrigators' representative from each CR and a water engineer, are trained by ATDR technicians to implement the water law, which takes precedence over traditional community water governance arrangements. Despite this, traditional authorities have remained visible, and communities have adapted new rules to the local system of water management, such that authorities of the CR work together with traditional water authorities.

Further neoliberal reforms since the 1990s have moved struggles for rights for indigenous communities into new ethnopolitical arenas, where issues of both cultural recognition and rights to territorial resources are contested to maintain local access to water. In 1991, President Alberto Fujimori decided to revise General Water Law 17752 and proposed a new water law, largely a copy of Chile's 1981 Water Code, which allowed the privatization of water. However, it failed to be approved in Congress because it was incompatible with the 1979 Constitution, which declared that water, as a natural resource, was a national heritage and thus could not be privatized. In 1993, this Congressional opposition was overruled by Fujimori's de facto government (that dissolved Congress in 1992), which established a new Constitution. Although this established a legal basis for privatization of water, the proposed law was still not approved because of strong opposition from water users and agrarian organizations (CONACAMI 2005; JNUDRP 2008). Discussions on the nature and scope of privatization, recognition of legal pluralism (coexistence of diverse legal systems in an area, including older local institutions and not only state laws), and revisions of draft laws took place over 19 years in the period 1991–2009, when the new Water Law (*Ley de Recursos Hídricos*) was issued.

Although the new water law reaffirmed public ownership of water and recognized, in theory, local customs and the autonomy of communities to manage water, its approach has been criticized, either as "managed multiculturalism," the celebration and recognition of cultural difference without questioning the existing structures and distribution of resources and power (Assies 2006) or as "mainstream multiculturalism," which allows uncritical acceptance of existing identities but does not promote the transformation of social relations and recognizes culture only when people obey the law so that indigenous people are still required to accept external definitions of their rights (Fraser 1996).

The new water law did not overturn the power of the ATDR (since 2009, this has been renamed Autoridad Local del Agua, the Local Water Authority: we continue to use the acronym ATDR because this was the organization present at the time of study), but it limited the effective participation of water users and communities in decision-making. The legal arguments to enable water privatization are now in place, since the new law opened the door to private-sector management of water (Urteaga 2009). It also legitimated legal procedures that encouraged privatization, which began in 2004 with programs such as

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FIGURE 2 The Colca Valley is famed for its terraces and its aridity. This photo shows the steep terraced landscape and local irrigation practices under which land is carefully maintained and irrigated with available water. (Photo by Juana Vera Delgado)

PROFODUA (Programa de Formalización de Derechos de Uso de Agua [Program to Formalize Rights to Use Water]). PROFODUA granted and formalized the use of water rights individually and in blocks, thus avoiding use of the term "collective rights." Such rights could be traded or exchanged by their holders, which meant that conditions were in place for a market in water rights to emerge. Some Andean communities, including the Colca Valley, resisted the implementation of PROFODUA. They demanded the recognition of their communal right to water and rejected individual entitlements. Because of this contentious issue, PROFODUA only formalized the individual water rights of users in blocks of the coastal irrigation systems (Vera 2011).

When Andean communities elsewhere have requested the formalization of their collective rights, they have faced cumbersome bureaucratic procedures and been told to pay for their own registration (because the government funding previously available under PROFODUA has now ceased). Without this registration, communities can no longer legally defend their rights to local water sources from external attempts to acquire them. Thus, such new laws allow recognition of customs but only in ways consistent with wider privatizing trends, without questioning the structures of power controlling resource distribution, such that indigenous people (including Andean communities) remain marginalized.

The Colca Valley and the Majes Irrigation Project

Colca Valley is the name given to the highland agricultural terraces (Figure 2) alongside the Colca River in Caylloma Province, some 150 km northeast of Arequipa, Peru's second city (see Figure 1), now increasingly visited by tourists. It is a semiarid region located in the middle zone of the Colca-Majes-Camaná catchment in the western Andes; annual rainfall was 275–560 mm in 1996–2006. The high variability and unpredictability of precipitation across and between years and decades, and the high range of evaporation are shown in Table 1. It should not be anticipated that potential evapotranspiration is low because of cooler average day temperatures (Henning and Henning 1981).

The Colca Valley farming systems show the local effort to build on the potential for diversity and niche adaptation, and not only the fragility and marginality that characterize mountain agriculture (Jodha 2000). They are seasonally adapted to conditions of rainfall, temperature,

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and frost risk, unlike those of the subtropical lowlands, which can cultivate crops year round if water is available. The traditional local crops (maize, beans, barley, and quinoa) are well adapted for these climate conditions. The main agricultural season is September–April, when rainfall is low in some months but temperatures enable crop growth; most lands lie uncultivated in May–August, a period not only of low rainfall but also too cold and frost-prone for cultivation. Irrigation is essential to support crops of maize, barley, quinoa, beans, alfalfa, and potatoes in the growing season. Tourism and urban markets have stimulated production of potatoes and fresh vegetables (onions, garlic, lettuce, and artichokes), crops that require more frequent irrigation, which also disrupts traditional irrigation patterns. Some fruits are also grown, such as prickly pear in mid slopes and peaches, apples, avocadoes, and *lukuma* (a native subtropical fruit, species *Pouteria Oborata*), in the lowest areas.

The Colca River originates at 4850 m in the wetlands of Qollqa Huallata. The 16 communities of the Colca Valley lie at altitudes of 2800–4000 m along both banks of the Colca River, with crops cultivated on steep terraces irrigated by complex systems of canals and reservoirs tapping upland water sources that consist of snow, wetlands, and springs. Direct use of the Colca River is difficult because it incises the valley profoundly, almost from the first agricultural community (Sibayo, 3847 m). After dropping to the *pampas*, the river is renamed the Majes River and finally the Camaná River at the coast, where year-round cultivation is possible. Thus, the catchment shows the local and regional vertical zoning of agriculture for which Andean river valleys are famous (Mayer 1979, 2001; Guillet 1981; Vincent 1995).

Water has been central not only in ensuring agricultural production in the Colca Valley but also in sociocultural and political dynamics that date to pre-Inca times, as can be found in most Andean communities not only in Peru but also in Bolivia, Chile, and Ecuador (Gerbrandy and Hoogendam 1998; Boelens and Doornbos 2001; Trawick 2003, 2008). The Spanish Conquest found approximately 60,000–70,000 people living in the Colca Valley, whose food supply was based on irrigated agriculture (Malaga 1977). Some 45 years later, only 23,689 inhabitants remained, the population decimated by death and capture for labor in the mines. This also reduced irrigation system maintenance, which caused shortfalls of irrigation water and abandonment of cultivated land. By 1586, the Colca Valley was described as unproductive and dry (Orihuela 1994), and this situation remained unchanged in subsequent centuries. Denevan (1986) calculated that 61% of the famous Colca Valley terraces had been abandoned because of a lack of water due both to deteriorating irrigation infrastructure and to scarcity of precipitation for rainfed agriculture. Although tourism has generated new employment opportunities since approximately 2000, irrigated terraces remain highly valued, and community members look for more irrigation water to cultivate more terraces where possible.

Water scarcity has obliged local people to develop rules for sharing and managing water fairly but strictly, rules that have been present at least since colonial times. Local irrigators experienced restrictions on cultivable areas due to limited water and practiced strong discipline in terms of assigning duties and electing authorities, maintaining infrastructure, choosing crops, and setting planting times. In Coporaque, there was a collective agreement that each registered user could only irrigate 1 ha of land, and discipline was intense to prevent larger landowners from irrigating more. People in this region also experimented with different irrigation rotation options to save water.

The water potential of the upper highlands of the Colca Valley attracted attention as early as the 1890s from investors in Arequipa seeking to irrigate lowland (800–1200 m) desert areas for market-oriented agriculture. These ambitions were realized through the Majes Irrigation Project, whose construction began in 1967 at exorbitant public cost. The multinational Majes consortium (MACON) was in charge of constructing the system, and, in 1983, the Majes Canal started to transfer Colca River water to irrigate up to a planned 22,000 ha (15,000 ha to date) in the Majes Irrigation Project, at first leaving the 16 communities of the Colca Valley without access to the diverted water. The government then created AUTODEMA (the Autoridad Autónoma de Majes, Majes Autonomous Authority) to maintain and operate the major infrastructure of the Majes Irrigation Project, including water diversions, allocate and regulate water distribution from the Majes Canal, promote market-oriented agriculture, and control irrigation according to set irrigation allowances in the *pampas* areas served by it. In the Majes Irrigation Project, year-round cultivation has focused predominantly on alfalfa for the livestock and the dairy industries, although potatoes and horticultural crops for local markets are now increasing.

The transfer system of the Majes Irrigation Project (see Figure 1) combines dams with a canal and tunnel (the Majes Canal) of approximately 100 km to convey up to 35,000 L/s of water. The Condoroma dam captures the Colca headwaters, then releases flows into the Colca River channel; this, together with local inflows, is then captured by the Bocatoma de Tuti Dam, just above Tuti, the second agricultural village of the Colca Valley. There, the river flow is transferred by the Majes Canal to the neighboring Siguas catchment, which leaves the downstream river virtually dry for 7 or more months of the year. The Majes Canal cuts across the "left bank" of the Colca Valley (a descriptive term used in water systems for land and irrigation canal zones as related to the side from which an observer is looking downstream and in the direction of the water flow). More dams and water transfers into the

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TABLE 1 Average monthly climatological data for the Colca Valley (Chivay station). (Table extended below.)

	Jan	Feb	Mar	Apr	May	Jun	Jul
Average temperature 1996–2006 (°C)[a)]	10.8	10.8	10.7	10.3	9.0	8.1	8.1
Average precipitation 1996–2006 (mm)[a)]	105.3	129	104.8	33.1	2.9	0.1	4.0
Average precipitation 1973–1982 (mm)[b)]	96.7	83.0	70.1	28.0	2.4	1.2	1.9
Precipitation 2003 (dry year) (mm)[a)]	40.3	91.0	66.0	19.7	6.5	0.0	0.0
Pan evaporation 1993–1998 (mm)[c)]	83.7	75.6	96.1	90	96.1	114	124

TABLE 1 Extended.

	Aug	Sep	Oct	Nov	Dec	Total
Average temperature 1996–2006 (°C)[a)]	9.1	10.2	11.8	12.1	11.8	
Average precipitation 1996–2006 (mm)[a)]	4.5	13.8	9.9	12.0	63.3	482.7
Average precipitation 1973–1982 (mm)[b)]	11.3	16.8	16.8	16.8	42.7	387.7
Precipitation 2003 (dry year) (mm)[a)]	4.5	1.0	0.0	0.4	46.6	276.0
Pan evaporation 1993–1998 (mm)[c)]	99.2	132	161.2	129	127.1	1328.0

[a)]SENAMHI (Servicio Nacional de Meteorología e Hidrología del Perú) Arequipa, reported in Valdivia (2007).
[b)]SENAMHI reported in Treacy (1994).
[c)]Càceres (2003).

existing infrastructure are planned from the upper Apurimac catchment to irrigate 34,000 ha of the Pampas de Siguas (called the Majes 2 project). Publicly available records up to 2000 show average annual diversions at Bocatoma de Tuti into the Majes Canal of approximately 8000–12,000 L/s (252.5–378.7 million m^3/y). Since 2000, these diversion data are only available internally, and there are concerns that transfers are higher than suggested by the official data, so local residents believe that there is little certainty about the water quantities transferred out from the Bocatoma de Tuti.

This pattern of large-scale water transfer has existed in Peru since 1950, after a formula proposed by the North American engineer Charles Sutton (Apaclla et al 1993; Oré 2005). Sutton envisaged many large-scale irrigation schemes in the coastal zone, which entailed transferring water from the Andean mountains through large-scale hydraulic works that often also had the potential to generate hydropower. These proposals failed to consider the water needs of irrigated Andean farming systems and, therefore, seriously threatened their water rights and security. The World Bank (1994) listed the potential irrigated area of 9 large irrigation systems constructed and now being developed further in this zone, supplied by regional water transfers: Chira-Piura (96,115 ha), Jequetepeque-Zaña (63,000 ha), Olmos (127,000 ha), Chavimochic (124,000 ha), Chinecas (51,000 ha), Majes-Sihuas (62,000 ha), Pasto Grande (9500 ha), Tacna (18,000 ha), and the now binational project of Puyango-Tumbes, with 20,000 ha in Tumbes, Peru, and 50,000 ha in Ecuador (see Plan Binacional 2013). The implementation and the social, environmental, and economic impacts of these projects still need study, including their effects on access to water by highland communities. Thus, we hope that the focus on water availability and the comparative regional appraisal of water allowances presented in this study will be followed elsewhere.

Struggles for irrigation access in the Colca Valley

Construction of the Majes Canal affected springs and water sources along the left bank of the Colca Valley, which triggered protests by communities that were also

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angry about their exclusion from access to this water being transferred. Reactions took different forms for the right and left bank villages, which involved actions by single or multiple communities that were based on older cultural associations as well as the hydraulic possibilities to build linking canals given the terrain. Communities had to act in a complex governance environment with major challenges to travel and cooperate politically. Because decision-making is centralized in Arequipa and Lima, communal leaders often had to travel to these cities to talk with the staff of ATDR, AUTODEMA, and funding organizations. They also had to confront complicated administrative procedures.

Left bank villages

Water struggles emerged at the very start of the Majes Canal. Cabanaconde was the first village to organize around water issues, in 1980, followed by the remaining communities of the left bank. As has been well documented by Gelles (2000), Cabanaconde's people held demonstrations to demand water, and, faced with the apathy of state politicians, used dynamite to blow a hole in the canal before meaningful negotiations and new agreements over water were established in 1983. When Majes Canal engineers started construction on 2 valves that deliver 150 L/s, not only villagers but a priest, governor, and judge were present to recognize the event. In 1991, the community managed to get more valves constructed, which deliver 350 L/s in total.

These actions inspired the other left bank villages to act together, and they formed the Frente de Defensa de los Derechos e Intereses del Valle del Colca (Coalition to Defend the Rights and Interests of the Colca Valley) to negotiate with AUTODEMA, and they got an agreement signed in 1989 to allocate water to different villages. After continued lack of action, and a problematic meeting in 1991, AUTODEMA agreed to open valves to the other 7 left bank communities. The reports of AUTODEMA note that the Majes Irrigation Project has benefitted the Colca Valley communities, with 23 intake valves that deliver 1500 L/s to 8 communities (see Table 2); but this only happened after strong local protests. More research is needed to see if and how these deliveries increase water availability and production above pre–Majes Canal levels. Community leaders insist that more water is needed to irrigate agricultural lands. Communities, for example, Pinchollo, have struggled to claim more water from the Majes Canal. They got 2 valves opened (which yield 60 L/s in total) after joining the negotiations and subsequently tried to negotiate with AUTODEMA for more water to no avail. Finally, they appealed to the president of the regional government when he was on a political campaign. He ordered another valve opened in 2005; but Pinchollo was fined by the ATDR and AUTODEMA because of the "illegal" procedure.

Right bank villages

The right bank villages of the Colca Valley irrigate their lands by using local streams and springs, and had no easy way to access the Majes Canal. However, after seeing the potential of this high-tech infrastructure, the communities of Coporaque, Lari, and Madrigal joined forces to develop a multicommunity irrigation project to take water from the river. They planned an intake 5 km downstream from the Bocatoma de Tuti, with a canal to run some 40 km across the 3 communities. Community leaders negotiated with AUTODEMA and ATDR for a flow of 1000 L/s, which they considered necessary to meet their needs, to be released from the dam, because, otherwise, the river was dry during the critical irrigation months. Finally, AUTODEMA agreed to release 680 L/s in an agreement signed by both parties. However, this suboptimal flow allocation, plus difficulties in raising state funds for the project, killed the enthusiasm and cooperation among the communities, and there were disagreements on how best to mobilize communal labor for this work. Ultimately, only Coporaque persisted. Their canal plan included an intake on the right bank, 10 km of open canals, 3 tunnels, and several control structures. The canal would feed the 2 ancient reservoirs of Coporaque, the Mallku Qocha in the Hunansaya moiety, and the Santa Rosa in the Urinsaya. These 2 reservoirs provide approximately 70% of the area's irrigation and supply at least some water to all water users, and they continue to be managed under traditional norms and authorities. They represent special cultural symbols within the customary irrigation management practices of the community.

This project faced serious technical challenges as well as a lack of external financial support and internal struggles over technology; it took 25 years (1980–2005) to complete. One major delay followed a dispute when one mayor launched an alternative design for a siphon connection to the Majes Canal to reduce costs and construction time. Community members rejected this for reasons that included keeping a right to use water from the Colca River, independence of flows in the Majes Canal controlled by AUTODEMA, and avoiding charges for this water. Then, after the canal was ready to convey 300 L/s, there was no water in the river because of transfers into the Majes Canal. Coporaqueños tried to claim the allowance of 680 L/s from AUTODEMA, which refused, because this had been established as an allowance for 3 communities.

No allowance is now recognized by AUTODEMA, and no regular release is given. Water for the Coporaque canal comes from seepage flows or ad hoc releases from the Bocatoma de Tuti. The canal design can convey up to 200 L/s, but actual flows in the canal range only from 55 to a maximum of 125 L/s during the high irrigation season (Valdivia 2007). Nevertheless, with this additional flow, the community was able to bring 80 ha of abandoned

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TABLE 2 Irrigation data for Colca Valley communities.

Banks of the Colca River	Community	Total cultivable area (ha)[a]	Irrigated area (ha)[a]	Irrigated land % of cultivable land (ha)	Water supply (L/s)[a]	Irrigation allowance (module) (L/s/ha)
Upstream of diversion: left bank	Callalli	66	60	91	30	0.50
Upstream of diversion: right bank	Sibayo[b]	30	8	27	7	0.88
Downstream of diversion: left bank	Canacota[c]	204	185	91	59	0.32
	Chivay[c]	601	546	91	398	0.73
	Yanque[c]	1043	948	91	353	0.37
	Achoma[c]	1363	1239	91	600	0.48
	Maca[c]	1041	946	91	535	0.56
	Pinchollo[c]	649	580	89	200	0.34
	Cabanaconde[c]	1766	1605	91	617	0.38
	Huambo[c]	1016	638	62	250	0.39
Downstream of diversion: right bank	Tuti	396	360	91	60	0.17
	Coporaque (field study)[d]	487 (689)	443 (490)	91 (72)	386 (210–280)	0.87 (0.43–0.57)
	Lari	583	530	91	220	0.42
	Ichupampa	488	444	91	[e]	[e]
	Madrigal	407	370	91	250	0.68
	Tapay	88	80	91	20	0.25

[a] ATDR 2005.

[b] Irrigation developments started after data collection in 2005–2006.

[c] Community gained water from the Majes Irrigation Project after protests.

[d] Vera (2006) data in parentheses are field measurements undertaken in 2005–2006.

[e] Data not available.

terraces under irrigation and improve the irrigation of an existing 300 ha of terraces by shortening the time between irrigations from 70–80 days to 25–30 days. Irrigation management, organization, and maintenance are subject to customary traditions, which are fulfilled by traditional water authorities (water mayors) in collaboration with the CR set up under ATDR norms. Both systems of authorities also perform the ritualized management of water, such as the annual festival Yarqa Haspiy (Figure 3). These cultural performances have taken on great significance as both strengthening the community's identity and emphasizing its claims on water (see Vera 2011).

These strategies of struggle for water, maintenance of cultural performance, and coproduction of irrigation management with the state-designed irrigation organizations show that communities have learned to maintain their commitment to their water claims. For Coporaque, these efforts have included claims of authority and autonomy, and they create a local space to contest new institutions and water allowances, without directly confronting national authorities.

Paerregaard (2013, in this issue) notes that in 2011, people interviewed from the Cabanaconde community affirmed that irrigation water was plentiful throughout the year, and that lands of once abandoned terraces have been returned to irrigated production. However, they also say they will make new claims for additional water if more water is brought through the Majes canal. Thus, increased water supply and system improvements may have lessened the scarcity of irrigation in critical periods for lands listed as irrigated, but the statements indicate there is still land that the community would like brought back under irrigation.

This interest for more water and for financial assistance and technical advice, which is also consistent

FIGURE 3 Water management in Coporaque includes many customary practices that play a key role in reproducing local water rights, alongside the standardized rules of the Water User Association. (Photo by Juana Vera Delgado)

with local preferences in irrigation management, still runs across the communities of the Colca Valley. As shown here, the nature of struggles to claim water and take-up of new water governance rules and recommended irrigation practices do vary across the Colca Valley, and these differences demonstrate the ethno-politics of water governance emerging alongside the state Water Law (Vera 2011). Ethno-politics show us the processes by which communities, while still maintaining their collective identity, increase their security of water supply not only through conflictive processes of cultural politics or frontal resistance, but also through alternative and creative processes; whereby people appropriate, adapt and reposition the state laws, predominant knowledge, and technology within their own local practices.

Water allowances across the Majes Irrigation Project and Colca communities

Where have these diverse struggles and water transfers left the different irrigators in the Colca-Majes-Siguas catchment? We look first at data on flows transferred from the Bocatoma de Tuti into the Majes Canal for the Majes Irrigation Project. These releases in relation to the irrigated area also compared with the initial designed irrigation allowance (also called *módulo de riego* or

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TABLE 3 Water flows diverted to the Majes Canal at the intake of Tuti, 1990–2000.[a)]

	Regulated water releases to Majes Irrigation Project (L/s)	Irrigated area, Majes Irrigation Project (ha)	Irrigation delivery rate (L/s/ha)
Design irrigation module	—	—	0.54
1990	9500	7500	0.78
1994	9771	10,604	0.92
1996	9587	11,971	0.80
1998	9770	12,450	0.78
2000	11,477	15,012	0.82
Planned total	—	22,000	—

[a)]AUTODEMA 2002.

irrigation module, see the next paragraph) for the Project of 0.54 L/s/ha, are summarized in Table 3. (This design module represents a calculation of irrigation water requirements used to design canals and system water supply, in this case, based on the demands of alfalfa). It shows that water use in the early years was much higher than this designed allowance. The first Majes farmers were highly diverse. A significant amount of land was owned by professionals who hired irrigators known as *kamayoq* who worked around Arequipa and were unused to the arid *pampa* conditions. In 1994, they used much more water (0.9 L/s/ha), on which originally there was little restriction. Eventually technical advisers improved these irrigation applications, as indicated in lower figures of 0.82 L/s/ha of diverted highland water, but they never fell to the original design allowance given above. Data collected for the communities of the Colca Valley on the water allowances registered by ATDR, also expressed as L/s/ha, are shown in Table 2. The variation among communities is striking, as is their low overall level. Table 2 indicates that 8 of the 14 communities downstream of the intake of Bocatoma de Tuti have an irrigation allowance of less than 0.4 L/s/ha. As a design flow and as a delivery rate, this level is indicative of risks of losses in canal distribution and of long durations to apply irrigation in the field (although low application rates with careful water spreading would also be practiced on terraces, see Figure 2); also of inadequate frequency of irrigation for optimum yields, this being very dependent on the area across which irrigation turns are organized. This is why communities not only seek rights for additional irrigation supplies and to maintain control over existing rights, but also seek funding and technical advice to maintain and improve canals and local storage reservoirs and experiment with new rotations. These dimensions of increased water supply, storage, and rotation can be designed to interact together to enable easier, more adequate but still equitable irrigation deliveries to farmers, allowing frequencies and durations of irrigation turns that enable improved yields and new crop options, as the data from Coporaque shows. The Coporaque community still wants more water for both its existing irrigated area and to return abandoned terraces to use—even though its registered supplies indicate an allowance of over 0.8 L/s/ha. In practice, the real water allowance is between 0.43 and 0.57 L/s/ha (see Table 3). Field measurements in Coporaque showed that flows received were smaller than the level registered by ATDR. Also, ATDR land registration appears to underrecord potentially cultivable area.

In Peru, irrigation allowances are often given as a volume of water per hectare per irrigation season for different crops, called *módulo de riego* (irrigation module). These can vary for different valleys and irrigation systems; they also represent an officially sanctioned cropping pattern. They were established by the ATDR. When the irrigation season length is known, such figures can be converted into L/s/ha. Vos (2002) notes that it is unclear on what basis these irrigation modules (also referred to as allowances) were established but that they were probably introduced in 1970 by the first irrigation plan. The irrigation supply registered for Colca communities is also compiled under the term *módulo*. Vera (2011) suggests that the *módulo de riego* data recorded 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). The basis of these figures is unclear to local water users, who also see that they get less than these recorded, already low, allowances. They still want more water to be able to irrigate more frequently and irrigate all available land. Although ATDR figures suggest approximately 90% of cultivable land is irrigated in most Colca Valley communities, fieldwork in Coporaque showed that irrigated land was still only 72% of what the community saw as cultivable.

It is too simplistic to directly compare the figures on the flows going to the Majes Irrigation Project with those of the Colca Valley communities, given their different and uncertain estimation procedures. We present them here to

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show the low level of registered irrigation allowances for Colca Valley communities. These irrigation levels are insufficient for crops other than fodder and maize, for example, emerging horticultural crop interests, and thus irrigation still demands careful sharing. The low allowances support community claims that the water they can access is too limited for current and potential needs. The Colca Valley communities get less than they need, whereas it appears that the Majes system is allowed to have more than called for by the design. The prioritization of the water supply to the Majes Irrigation Project has been based on images of high economic potential and profitability for larger investors, but the necessities and potentials of the Colca Valley systems also need greater recognition.

In addition to more transparency regarding existing data, additional irrigation studies are needed that relate to the specificities of mountain agro-climatology, topography, and hydrology, together with designs relevant to the highland environment and not only modern irrigation practices. Unlike the coastal irrigated areas that require flows to be transferred year round, the needs of Colca Valley systems are seasonal. In Coporaque, for example, runoff can fill the local reservoirs and supply irrigation needs in all months except September–December, when major deficits exist and careful management of water is needed (Vera 2011).

Conclusions

Water governance in the Colca Valley is still an arena of struggle between powerful state and regional agencies and local community and water user organizations. New laws that appear to allow local irrigation management practices still control and sanction water rights and allowances in ways that do not fully represent or recognize community water practices and needs. Andean communities have registered water allowances that are based on uncertain data sources and are insufficient to cultivate the available agricultural area; competition for scarce water and conflicts within and among communities are an everyday reality. There is a need for better distribution of water across the catchment, and the establishment of real vertical control over water resources that enhances social interaction to share benefits from water.

The formalization and normalization of water rights and institutions that have accompanied regional water transfer have partially incorporated some mountain communities in new legal frameworks, but there are different experiences of change across the Colca Valley, and, overall, there is still limited improvement in community access to irrigation water. The struggles of Colca Valley communities show that they operate under a mainstream or managed multiculturalism in which their norms must still fit with more standardized norms for organizing irrigation and claiming water rights.

However, these community struggles also show how real recognition of local capacities and knowledge can evolve. There is potential for new options for representation, participation, and redistribution of resources that support more equitable control of land and water use. These have followed the creation of spaces for autonomy and recognition of community institutions and irrigation designs, with acceptance of local projects of a collective agency such as the Coporaque canal. Villagers' ability to learn from earlier experiences of conflict and negotiation in Cabanaconde and Pinchollo, and to enable access to some of the water transferred across their territories, shows that it is possible to change social relations in water governance and water access. The communities' greater awareness of historical processes of water governance and the differences in irrigation allowances and investments across the basin can bring about new interactions with the state irrigation and water transfer agencies. Policy-makers and irrigation programs need to understand, recognize, and support these new interactions and opportunities for hill irrigation in rural communities. It is this commitment, along with the planning of regional water transfers, that can build an accountable water governance system in Peru.

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