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Local Management of Andean Wetlands in Sajama National Park, Bolivia

Persistence of the Collective System in Increasingly Family-oriented Arrangements

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Andean wetlands or bofedales *are commonly used by indigenous communities for livestock production. Decisions regarding management of* bofedales *involve the active participation of local people and their social institutions. Consequently, any action addressing emerging challenges must be implemented in coordination and agreement with local actors. This decision process requires an understanding of the local socioeconomic and cultural dynamics, especially those related to land and natural resource management. In many Andean communities, the* ayllu *is the institution that governs decisions on regional land use. However, in the face of increasing challenges such as climate change and population growth, use of the* ayllu *has declined in favor of individual decision-making. Here we discuss how the Andean camelid herders of Sajama National Park in highland Bolivia rely on both the* ayllu *and family-level decision-making to manage their pastoralist landscapes, including their* bofedales*. Using a rights mapping methodology, we describe how water and wetlands are managed, and determine which decisions are taken at the community level and which are made at the family level. We conclude that indigenous collective organization networks are still significant for managing the system at a regional scale and possibly determinant for mitigating risks associated with climate change on sensitive ecosystems such as* bofedales.

Keywords: Ayllu*; collective and individual rights; camelid herders;* bofedales*; Altiplano; Bolivia.*

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Introduction

Since the Spanish conquest in the 16th century, the world view of native Andean indigenous communities has had to interact with the dominant sociopolitical systems of the colonial and later republican period (Schiffers 1992; Regalsky 1994; Platt et al 2006). One important element of confrontation between these 2 visions is the form of land and natural resource management: collective versus individual. Indigenous communities have adapted and developed a number of cultural and productive organizational strategies to cope with the new forms of domination, trying to maintain the logic and vision of the Andean territorial management strategies (Orlove 1977; Platt 1982; Spalding 1984).

One of the main strategies in the Andean world was access to the greatest possible number of ecological zones, which was a strategy to achieving food self-sufficiency and also an important risk management tool, mainly for climatic risks (Murra 1972; Browman 1983; Regalsky 1994). This was accomplished through diverse forms of collective access to land. However, during the colonial and republican period, dominant groups gradually dismantled these collective practices. This resulted in mixed regimes that combined communal control and individual use in a flexible and constantly evolving way, based on informal agreements (Bottazzi and Rist 2012).

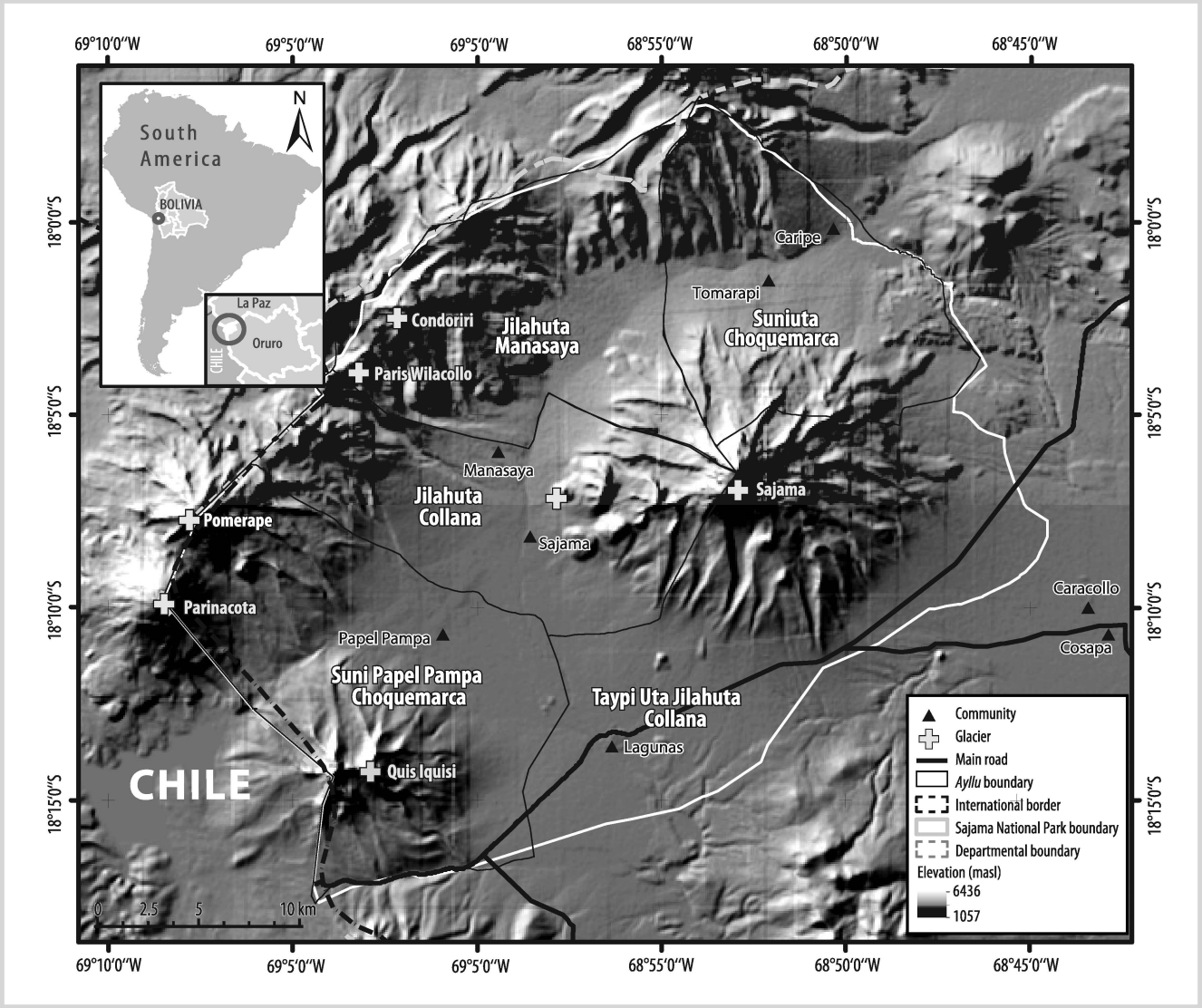
A large number of communities in the Bolivian puna have maintained traditional forms of organization. One example is the *ayllu*, which governs decisions on local land use. However, there are indications that smallholder-based decision-making is gradually replacing traditional community-based land management. Various studies have addressed the transformations and adaptations of *marca* and *ayllu* organization—see in particular Hirt and Lerch's (2013) recent analysis of mappings of *ayllus* and *marcas* in Bolivia—but few have focused on land use and access rights within the *ayllus*.

Because of the social and economic importance of wetlands, especially for camelid (llama and alpaca) herders, communities in these areas periodically revise and adapt institutional arrangements for sustainable management. High Andean wetlands, known locally as *bofedales,* represent one of the most productive native vegetation types of the puna. However, they are seriously threatened by climate change as they depend on constant

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FIGURE 1 Map of Sajama National Park, Bolivia, showing communities and *ayllus* interviewed during this study. (Map by Ana Paola Castel)



water flow, which is mostly assured by annual glacier melt and precipitation (Squeo et al 2006; Yager et al 2008; Ruthsatz 2012). In view of these threats, it is particularly important to document how local wetland management strategies are being adapted to cope with emerging challenges (Pinto-Romero 2011; Verzijl and Guerrero Quispe 2013).

In this study, we analyze traditional forms of pastoralist landscape management in Sajama National Park, Bolivia. We describe the relation between traditional organizational structures and local territorial management, understood as the system of collective control and regulation of individual and collective access and use of natural resources (Metais 2011). Finally, we explore the extent to which traditional forms of community-based land management are gradually giving way to smallholder-based decision-making processes as a strategy to reduce risk factors such as overgrazing of *bofedales*, increasing population growth, and climate change.

Study location and background

Sajama National Park is located in the Andean puna of western Bolivia (68°38′–69°08′W, 17°56′–18°17′S) and extends over an area of 1002 km^2 (SERNAP 1997). The park is situated within the Municipality of Curahuara de Carangas in Bolivia (Figure 1). The region is characterized by a semiarid climate with an annual average temperature of 5.3°C and precipitation of 320 mm (García 2012). Most of the precipitation is concentrated during the rainy season (November–March), with less than 10% falling

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TABLE 1 Number of families and inhabitants in Sajama National Park.

Locality	Number of families	Number of inhabitants
Sajama Jilahuta Collana	125	542
Taypihuta Jilahuta Collana	121	517
Suniuta Choquemarca	34	171
Jilahuta Manasaya	13	83
Suni Papel Pampa Choquemarca	26	133
Total	**319**	**1446**

during the dry season (May–August) (Beck et al 2010). The park surrounds Mount Sajama (6542 masl) extending outwards and downwards, forming a series of valleys and plains. Varying degrees of slope and altitude result in a heterogeneous landscape of grassland, shrubland, *queñua* forests (*Polylepis tomentella* Wedd), *bofedales*, and open plains dominated by scattered tussock grasslands; the area is inhabited by wild vicuña (*Vicugna vicugna*), vizcacha (*Lagidium viscacia*) and other mid- and small-sized rodents, lesser rhea (*Rhea pennata*), tinamou (*Crypturellus soui*), and other puna species (Beck et al 2010).

The *bofedales* in Sajama National Park occupy an area of 82.56 km^2 and receive water from streams, groundwater, and glacier discharge (Buitrón Aliaga and Fernández Callisaya 2012). They are mostly found in valley bottoms (3950–4300 masl) and occasionally on mountain slopes (4500–4800 masl). *Bofedales* are rich in plant species compared to the surrounding vegetation. Small herbs, sedges, and grasses dominate the vegetation cover, which forms thick cushions crosscut with streams (Alzérreca et al 2007; Molinillo and Monasterios 2007).

The predominant economic activity in the area is camelid pastoralism. Of all the families who live in the Curahuara de Carangas municipality, approximately 72% rely predominantly on camelid herding, 19% provide services such as tourism, 3% sell products to nearby cities, and 6% work in the informal sector of border towns (Vargas 2012). Very few families practice agriculture, as high elevation and severe climatic conditions constrain crop production. Approximately 1440 people live in Sajama National Park (Table 1), distributed in 5 *ayllus*—which Platt et al (2006) define as "social units with endogamic tendencies that share a combination of territorial circumscription and ritual symbolic integration through common ancestry"—with the group of *ayllus* forming a *marca*. When the park was created in 1939, local organizations and territorial management were not taken into consideration. At that time, indigenous people were excluded from political and decision-making structures. The park delimitation contributed to dismantling the local territorial management by including, within park boundaries, part of the *ayllus* of 2 traditional territorial management units that have 2 different ancestral authorities (Mallcu de Aransaya and Mallcu de Urinsaya).

Later, historical processes gave way to a gradual empowerment of indigenous people (Bottazzi and Rist 2012). Historically, Andean communities were organized in nested hierarchies (Albarracin-Jordan 2007); since 1997, they have been reconstituted into 1 indigenous organization known as the Council of Ayllus and Marcas of Qollasuyu (CONAMAQ) at the national level (Choque 2000). Figure 2 illustrates how the Sajama local communities are embedded in this broader organizational system, and particularly the Suyu Jacha Carangas (Cottyn 2012). The 5 *ayllus* in Sajama are Jilahuta Collana, Taypihuta Jilahuta Collana, Jilahuta Manasaya, Suni Papel Pampa Choquemarca, and Suniuta Choquemarca.

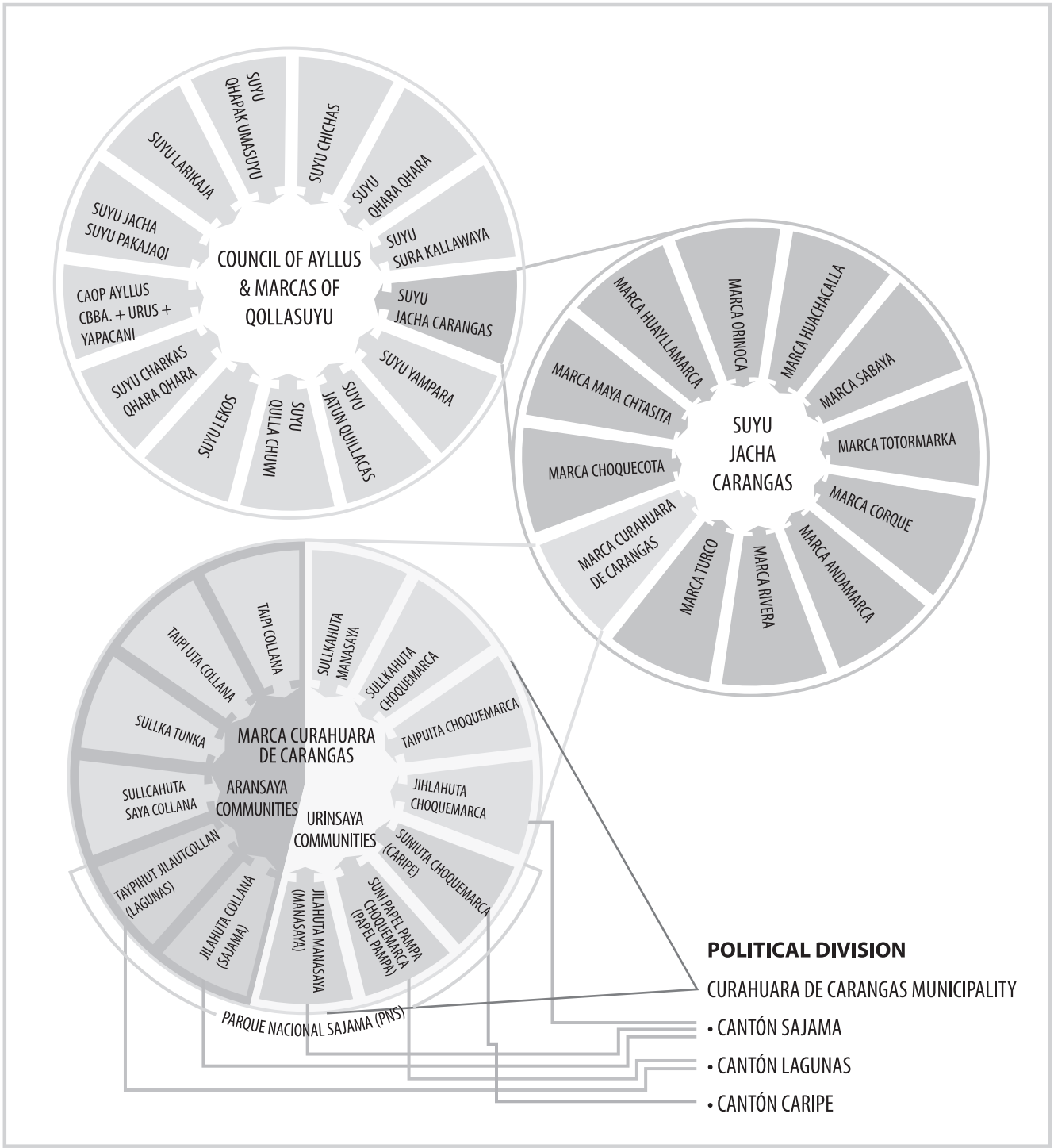
Since 1996 Bolivia has implemented important legislative reform including the new State Constitution, leading to a gradual recognition of traditional forms of organization and the possibility of accessing forms of autonomy for territories. This includes acquiring the legal status of Original Community Lands (Tierras Comunitarias de Origen [TCO]) or Original Indigenous Peasant Lands (Territorios Indígenas Originarias Campesinas [TIOC]) (Republic of Bolivia 1996, 2009). However, in the case of the Marca Curahuara, neither the *ayllus* nor the *marca* have succeeded in obtaining this type of legal instrument. There is currently a mixture of documents, some dating from colonial times and others from the Agrarian Reform of 1953, on which *ayllus* rely for legal aspects.

The empowerment of indigenous organizations at national level is reflected locally in the strong influence of the indigenous authorities of Marca Curahuara at decision-making levels in the Curahuara Municipality (see Municipio de Curahuara de Carangas 2005). This level of influence has made it possible to address local demands through municipal investment projects that communities consider necessary to strengthen their productive systems.

Another consequence of the empowerment of indigenous organizations is the inclusion of local authorities in protected areas by means of a management committee. The creation of a management committee in

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FIGURE 2 Indigenous organization including studied communities in Sajama National Park, Bolivia.



Sajama Park in 1995 gave way to a more inclusive and participative scenario for managing the park's resources (see Hoffman 2007). Although it has only limited economic and human resources, the management committee has influenced and implemented concrete actions in wildlife management, tourism, and some livestock improvement projects. Decision-making and management regarding wetlands and pastures are implemented according to local rules established by the *ayllus*; these decisions are later communicated by *ayllu*

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authorities to the park committee and most of them are incorporated in the park management strategies. At the same time, the park director participates in each *ayllu* meeting and also in the general meeting of the 5 *ayllus*.

Rights mapping methodology

The rights mapping methodology was developed by Villarroel and Perez (2004) during the implementation of water research projects aimed at improving understanding of the complexity and diversity of local water management and customary rights to irrigation and drinking water sources. The methodology was continuously adapted and consolidated, a process that can be followed on the website of the nongovernmental organization Agua Sustentable and in research reports by Villarroel and Perez (2004, 2007, 2008, 2010, 2012, 2014). The methodology was initially designed to assess water rights. It was later modified to study land use access rights, to make it applicable for *bofedal* assessment. This was possible because of the similarities between water and land management organization structures in Andean communities. Both systems are based on a combination of collective and individual rights, with similar decision-making procedures.

For water rights mapping, a typology and characterization was established and adapted to the case studies, based on the theoretical framework proposed by Schlager and Ostrom (1992) and revised by Beccar et al (2001). One important input of these approaches was the characterization and typology of rights to common property resources, which Schlager and Ostrom (1992) describe as a *bundle of rights* where individual and collective forms of access are situated. Based on this insight, water rights mapping distinguishes between 3 components applicable to the different case studies:

1. Type of right (individual, collective, intermediate);
2. Subject of the right (user organization or family);
3. Expression of the right (water quantity).

These components proved to be applicable to the study of land access rights, although a fourth component was added to better illustrate the relation with the bundle of rights scheme proposed by Schlager and Ostrom (1992):

4. Assigned bundle of rights.

The different scales, objectives, and variation in customary practices, as well as the frequent lack of data in rural areas, make this methodology an interesting tool because of its flexibility in the use of resources, technology, and participatory emphasis. It takes into account 2 important elements related to access rights issues for the Andean context.

- First, given that access rights are a historical and cultural construction (Beccar et al 2001), it not only includes the present situation of rules and assignment of rights, but inquires about their origins and past changes, to enable a better understanding of possible inequities and power relations.
- Second, and one of the main contributions of this methodology, the combination of information (qualitative and quantitative) on customary access rights and geographical information helps visualize the often overlooked local management systems—referred to as the "system nobody sees" by Verzijl and Guerrero Quispe (2013)—in a practical and comprehensive way.

Data for this study were collected in 2012. Fieldwork consisted of organizing a workshop in each of the 5 *ayllus*, attended by most community members. During the workshops, participants discussed customary land use rights and created maps using Google Earth. They mapped the boundaries of their communities and the spatial structure of plots or *sayañas* (see below) and provided information on land management practices and grazing areas. Areas with an uncertain location were visited and geo-referenced using a global positioning system (GPS). In addition, 8 community leaders were exhaustively interviewed, complementing and providing a synthesis of the results of the workshops and visits.

Following the fieldwork, the information was systematized for each ayllu, each with maps and descriptive information. This approach was chosen because of limitations in time and resources. Though it was not the best method for exhaustive research or for capturing the nuances of the process observed in the *ayllus*, it was sufficient for the objectives for which it was intended: providing inputs for the drafting of the climate change adaptation plan. These limitations were compensated by the support and interest of the *ayllu* leaders, who either confirmed that data had been adequately interpreted or provided additional evidence. The information thus obtained provides an interesting overview of local wetland management that could be deepened by more specific research in the future.

Indigenous organization and territorial management within the Marca Curahuara de Carangas

As mentioned above, herders of Sajama National Park are part of a broader organizational system: the Marca Curahuara de Carangas, the organizational unit most closely related to territorial management of the *ayllus* in the park. Understanding this relationship helps to understand the local management of wetlands and pasture vegetation types (Albó 1972; Mayer 2002). For instance, an analysis and interpretation of *ayllu* names in the Marca Curahuara de Carangas illustrates this interaction. The names of *ayllus* are composed of Aymara

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BOX 1: Aymara prefixes and family surnames with meanings that convey location of and territorial hierarchy in *ayllus*

The most frequently used prefixes have the following meanings:

jila = major; *uta* = home; *taypi* = center; *sullka* = minor; *suni* = low.

Thus, using the Bolivian surnames Collana and Choque, the meanings of the following names are:

Jilahuta Collana = greater Collana House; Sullkahuta Choquemarca = lower house of Choque's Village; Taypihuta Choquemarca = center house of Choque's Village.

prefixes with meanings that convey location and territorial hierarchy of family surnames (Box 1).

The construction of *ayllu* names is related to one of the main land use management strategies in the Andean world: vertical control. Murra's (1972) model of vertical control proposes that Andean pre-Hispanic societies tended to occupy the highest number of ecological regions to ensure access to a variety of complementary resources with 2 main objectives: food self-sufficiency and climate risk management (Huarachi 1992; Regalsky 1994). The *ayllus* of Curahuara de Carangas used to have access to territories not only in different microenvironments in the Sajama area but as far away as the coastal valleys of northern Chile (Durston and Hidalgo 1997). Today, links no longer exist with most of these remote territories, weakening the food self-sufficiency objective. Nonetheless, a discontinuous occupation of the territory can still be observed inside the limits of the Marca Curahuara and serves as an effective tool for risk management (see below).

The Municipality of Curahuara de Carangas consists of 2 neighboring districts, District A and District B. Sajama National Park (Figure 1) corresponds to District B. The original *ayllus* are located in District A (not shown in Figure 1) but they have territories in District B, which they refer to as "islands". The *ayllus* in Sajama National Park are therefore considered as "islands" of the original *ayllus* in District A.

The origin of the *ayllus* is still very important and respected by the people. According to one of the interviewees, the park management committee displeased local people because it did not take into account the *ayllus*' hierarchy in the meetings. The interviewee said that in the meetings of traditional authorities of Marca Curahuara, everybody had to sit in the "correct place": the 2 main original authorities, *mallcu* of Aransaya and *mallcu* of Urinsaya in the middle; the authorities of the Aransaya *ayllus* (tamanis) to the right; and the authorities of the Urinsaya *ayllus* to the left. At the same time, these authorities had a defined order, starting from the center with the oldest *ayllu* authorities near the mallcus, and the other *ayllu* authorities—consecutively in order of creation—toward the sides. The interviewee said that, in the meetings of the park committee, "authorities are sitting anywhere."

Although this relation between "original" *ayllus* and "island" *ayllus* is fully present in the local institutional organization, in practice it has evolved in different ways because of internal dynamics and external influences. Some small *ayllu* islands merged and share a leader (Suniuta Choquemarca), others acquired the category of zones within another *ayllu* (Manasaya), and others still maintain an organic relationship with the authority of the original *ayllu* (Jilahuta Manasaya). To illustrate this, we describe the example of Suniuta Choquemarca, one of the cases reported in the interviews.

The *ayllu* Suniuta Choquemarca originates from 2 ancient *ayllu* islands, Jilahuta Choquemarca and Sullkahuta Choquemarca. These 2 *ayllu* islands occupied neighboring territories and decided it would be best to share one territory and the same authorities, merging to form a new, united *ayllu*. To symbolize a real union, they considered it very important to find a new neutral name, calling the new *ayllu* "Suniuta Choquemarca." The people of the ancient Jilahuta Choquemarca still maintain the access rights to lands located in the original *ayllu* in District A, where they are permitted to raise crops. However, the people from the ancient Sullkahuta Choquemarca have not retained any rights in their original *ayllu*. The reasons for the decision to merge both *ayllus* were unclear to the interviewee, but it seems that because the *bofedales* used by these 2 *ayllus* are part of the same vegetation patch, it was difficult to control herds trespassing *ayllu* boundaries. Also, both *ayllus* were using the same water source for irrigating the *bofedales*, which may have been another reason for the merger. The interviewee mentioned that before the *ayllus* were merged, only Sullkahuta Choquemarca used to irrigate their lands. Under a later agreement, Jilahuta Choquemarca was permitted to use 30% of the water volume. Once they became a united *ayllu*, water volume was distributed equally, with 50% for each.

Collective strategies and actions within the *ayllus*

Until the 1990s, most of the *ayllu* territory and natural resources were managed collectively. A Jilahuta Collana interviewee recalled that their grandparents chose this mode of organization because "they were few and there was no problem for people to move the herds from one place to another." According to interviewees, decisions regarding grassing and fallow periods were taken collectively, sometimes by a group of families living nearby or sometimes in general assemblies. Families were living in *estancias* (see Huarachi 1992) or farmsteads that

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TABLE 2 Types of access rights to territory of *ayllus* and corresponding surface area in Sajama National Park, Bolivia. (Table extended on next page)

Type of right	Subtype of right	Subject of right (type)[a)]	Expression of rights	Assigned bundle of rights
Collective rights	***Ayllu* territory**	*Ayllu* assembly (proprietor)	Territory of the *ayllu* defined by its limits	Exclusion, management, access, withdrawal
	***Ayllu* sector**	*Ayllu* assembly (proprietor)	Sector of an *ayllu* with diffuse limits, generally located at upper elevations	Exclusion, management, access, withdrawal
	Island	Members of an *ayllu* that acquire the right in a sector of another *ayllu* (claimant)	Well delimited sector inside the territory of another *ayllu*	Management, access, withdrawal
Interfamily rights	**Semidefined**	Group of families from neighboring *estancias* (claimant)	Sectors of *sayañas* inside an *ayllu* with diffuse limits	Management, access, withdrawal
	Defined	Group of families from neighboring *estancias* (claimant)	Sectors of *sayañas* inside of a community defined by fences	Management, access, withdrawal
Family rights	**Semidefined**	A family (claimant)	*Sayañas* inside an *ayllu* with diffuse limits	Management, access, withdrawal
	Defined	A family (proprietor)	*Sayañas* inside an *ayllu* defined by fences	Exclusion, management, access, withdrawal

[a)]Classes of property rights holders according to Schlager and Ostrom (1992): *owner* (has access, withdrawal, management, exclusion, and alienation rights), *proprietor* (has access, withdrawal, management, and exclusion rights), *claimant* (has access, withdrawal, and management rights), *user* (has access and withdrawal rights).

had no fixed limits but only certain basic arrangements among families living nearby.

Since 1990, increasing pressure on the territory augmented the need for agreements on new forms of territorial access. There was more overlap on pasture areas among herds of increasingly larger families. A study by Espinoza (2001) concludes that Sajama *ayllus* are facing a sustainability crisis, based on the following indicators:

- The population has doubled in the last 2 generations, tripling the family farming units in the same shared territories.
- Livestock population has doubled in the last 40 years, with an estimated fodder deficit in the park of 45,000 UAL (alpaca units) for the dry period (8 months) and corresponding stress on the park's carrying capacity (Espinoza 2001).
- Traditional grazing practices that include periods of rest and rotation have been increasingly abandoned.

These changes have resulted in a decrease in livestock yields that has led families to search for new sources of income such as tourism, periodic labor migration, commercial activities in nearby towns, and other off-farm activities. In turn, this has necessitated development of a productive system requiring less family labor. To achieve this, families have (1) proceeded towards a clear delimitation among territories already used traditionally by *ayllu* families and (2) fenced in prioritized grazing areas (*bofedales*).

Thus, collective management of wetlands and grasslands is gradually replaced by family-based management, a tendency observed in each of the 5 *ayllus*. Each *ayllu*, at its own pace, is moving towards clearly delimited land plots for family usufruct locally known as *sayañas*. In the Sajama area, families usually remain as 1 unit for a maximum of 2 generations. They usually subdivide the sayañas when sons get married and are considered a new family. Daughters in most cases receive no inheritance; when they marry, they go to live in their husband's *sayaña*.

Delimiting and allocating *sayañas* is a task of the *ayllu* assembly. This does not occur as the result of a single decision, but as a sequence of agreements that include stages with areas with diffused limits and interfamily access rights. All these different stages are simultaneously present in the 5 *ayllus*.

Table 2 shows a typology of rights considering the characteristics mentioned above (diffuse and defined limits; family, interfamily, and collective access areas) combined with the *bundle of rights* typology proposed by Schlager and Ostrom (1992) and divided into 2 levels of

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TABLE 2 Extended from previous page.

Type of right	Subtype of right	Surface area within *ayllus* (ha)				
		Suniuta Choquemarca	Jilahuta Manasaya	Jilahuta Collana	Suni Papel Pampa Choquemarca	Taypihuta Jilahuta Collana
Collective rights	***Ayllu* territory**	15,312	16,869	16,053	22,113	31,955
	***Ayllu* sector**	0	14,554	8922	0	15,677
	Island	0	16,869	136	0	136
Interfamily rights	**Semidefined**	0	807	0	0	0
	Defined	0	0	6995	0	15,813
Family rights	**Semidefined**	8205	1508	0	0	0
	Defined	7107	0	0	7881	0

actions: collective-choice levels of actions (alienation, exclusion, and management rights) and operational levels of actions (access and withdrawal rights). It also shows the extent of area with each type of right to illustrate the differences among *ayllus*. Land-right modifications have mostly affected rights corresponding to the operational level of actions (access and withdrawal rights), which have moved from collective towards family-level decision-making. Rights corresponding to collective-choice level of actions (alienation, exclusion, and management rights) have remained unchanged and are still the domain of the *ayllu* assembly. Eventually, the assembly has the right to decide on the redistribution of land or changing land rights regulations. Figure 3 shows the spatial distribution of types of rights within each *ayllu*. Family rights are represented by *sayaña* delimitations, and collective rights are represented by the areas of the *ayllu* where no limits have been established that all families can access with their herds; these areas usually correspond to the higher ecological zones.

Progressive delimitation starts in areas of prioritized resources, in this case the *bofedales*, and moves towards other grassland according to the degree of demographic pressure. The size of *sayañas* is defined by internal agreements that take into account historically established "uses and customs." This means respecting areas that family groups occupied in the past. Because each family has a different number of descendants that the areas are shared among, it results in a different number of internal subdivisions and, consequently, smaller or bigger *sayañas*.

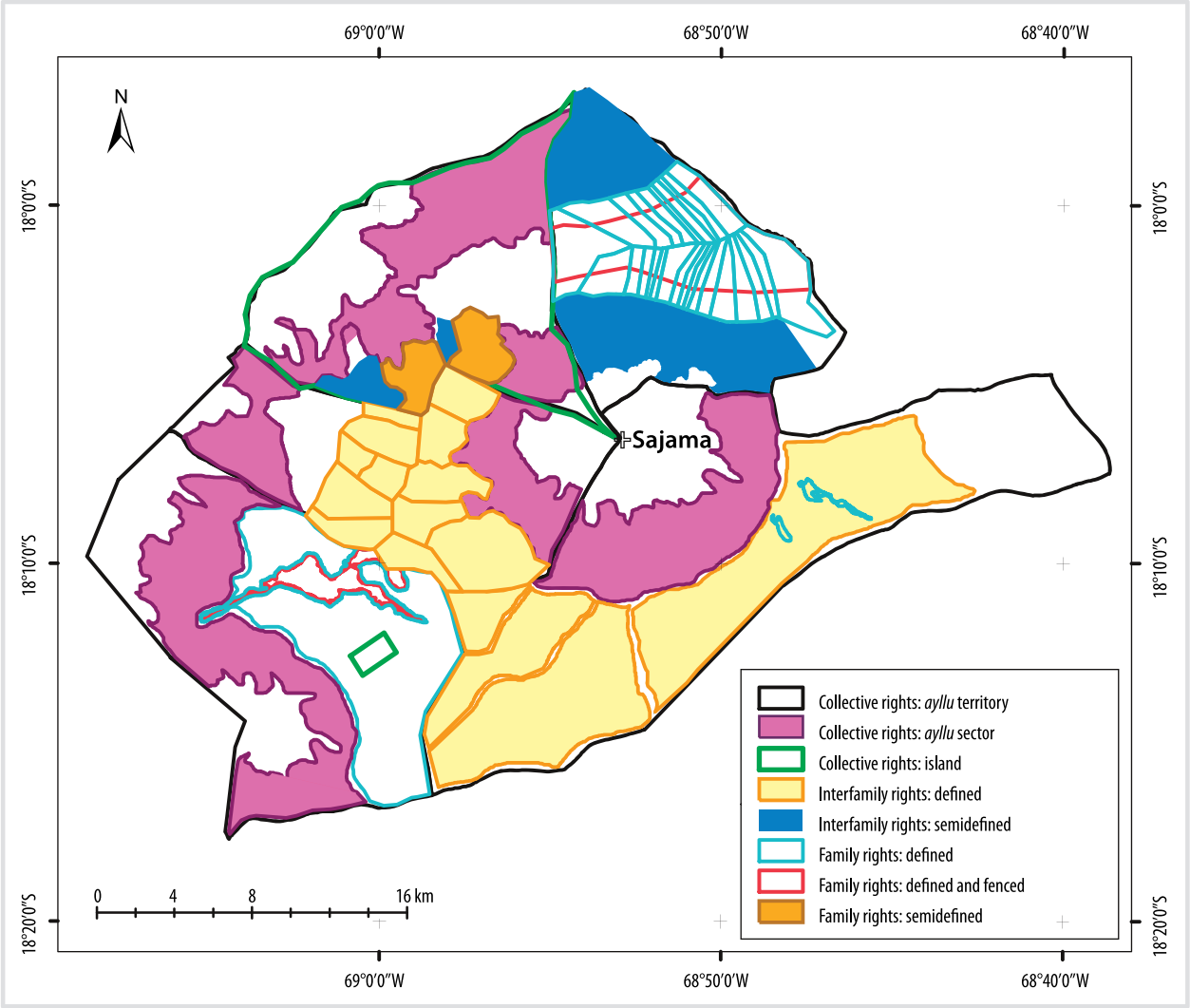
In the case of water resources, no major complexities were observed regarding access rights. In the studied *ayllus*, irrigation practices are rarely implemented, and considering that water scarcity is not a problem, no major agreements are required for water use. The general vision is that anyone has the right to use water sources such as springs that flow within the territories of their *ayllus*. River flows are also considered a common resource, but some agreements between *ayllus* may be required.

In practice, only 1 traditional irrigation system for more than 1 family was observed, located in Suniuta Choquemarca. In the other *ayllus*, several families apply small irrigation techniques with sources that flow from their own *sayañas* or from neighboring ones. These irrigation practices are not intended to increase the area of the *bofedal* but to prevent degradation in the dry season.

A case related to the drinking water source of Jilahuta Collana is illustrative for understanding the local vision regarding water access rights. The water source of this *ayllu* is located inside a *sayaña*. The owner complained about water distribution problems caused by infrastructure, but not about preferential access right. This shows that there is an implicit agreement about collective rights to water resources among *ayllu* members. The assembly decided to compensate the owner by letting part of the water flow for irrigating his *bofedal*. This compensation was not aimed at preferential rights but to

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FIGURE 3 Map of types of access rights to land use within each *ayllu* in Sajama National Park, Bolivia. (Map by Jhonny Perez and Ana Paola Castel)



alleviate the discomforts of water capture and conveyance infrastructure.

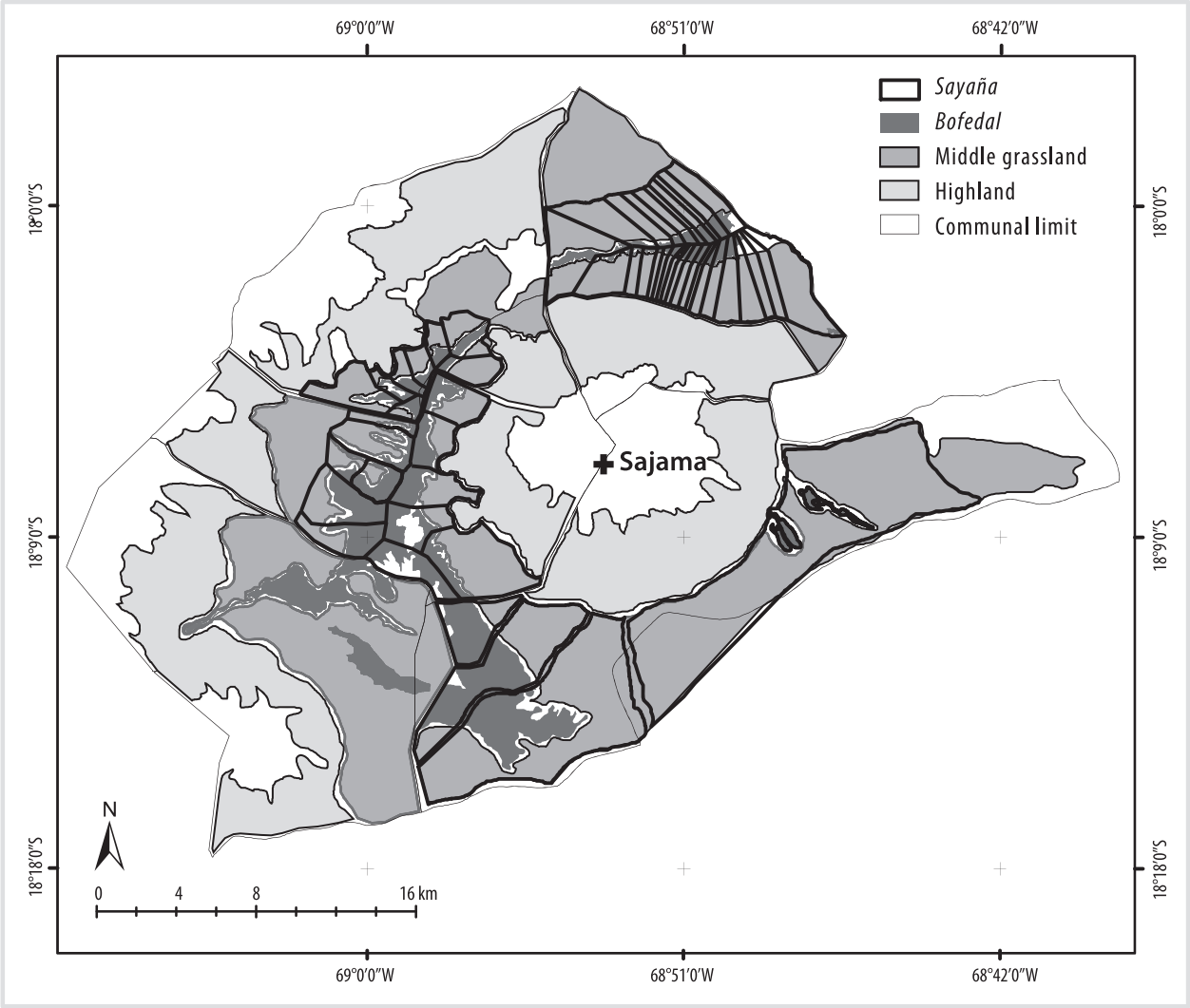
Family organization, land use, and individual rights

In Sajama National Park, the logic of access to a greater diversity of resources is replicated at the family level within each *ayllu*. In other words, every family has the right to access the diversity of resources (different ecological zones) by means of either collective access or exclusive family access. Access to heterogeneous areas is very important for climate risk management in high-mountain ecosystems. A wet year and subsequent excessive moisture in lower pastures may lead to livestock diseases; this can be avoided by accessing the highest grazing areas. In contrast, a dry year causes vegetation loss at higher elevations and in drier areas. In this case camelids depend solely on *bofedales* for foraging plants.

Figure 4 shows the main ecological zones identified by local inhabitants in Sajama National Park and the distribution of *sayañas*. The zones identified include *bofedales* found at the valley bottoms, grasslands intermixed with shrubs located at middle elevations, and *queñua* forests intermixed with grasslands at the highest elevations. Family or interfamily *sayañas* intersect most of these altitudinal gradients. Each *sayaña* is designed to provide access to *bofedales* and grasslands, and *queñua* forests can be accessed collectively. Although the size, shape, and locations of *sayañas* are more or less fixed by local tradition, these can change and be renegotiated. This process involves agreements between families with the guidance and support of the indigenous authorities of each *ayllu*. Details of the process were not addressed in this study but involve solving conflicts in collective assemblies and

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FIGURE 4 Map of *sayañas* and ecological zones in Sajama National Park, Bolivia. (Map by Jhonny Perez and Ana Paola Castel)



smaller gatherings between affected parties. In the interviews, community members said they did not experience major conflicts over *sayañas*. Although some inequalities were observed regarding access to *sayañas*, it appears that they respond to internal rules, such as the degree of family involvement in communal activities and traditional use of certain areas by a few families.

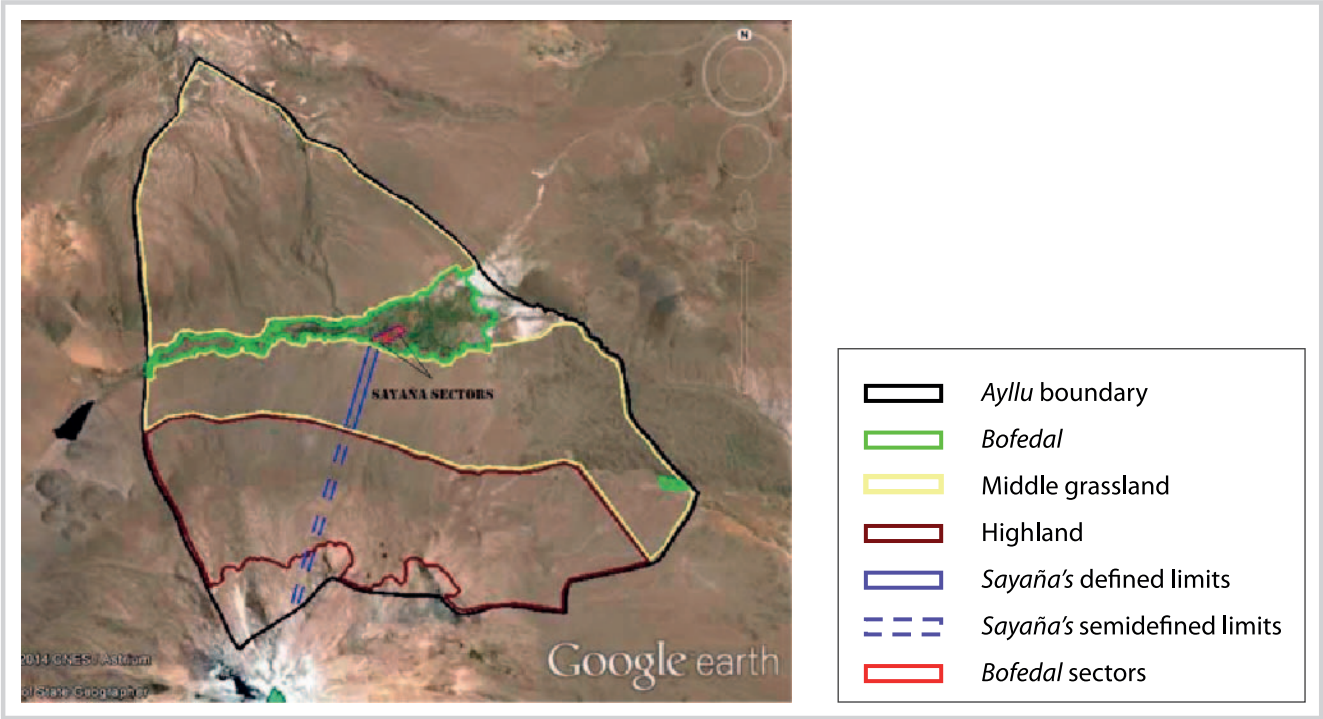
During workshops and interviews, people expressed their agreement with the results of *sayaña* delimitations. As one interviewee from Suniuta Choquemarca explained, the ancient collective system worked very well when there were fewer people and livestock in the *ayllus*. He also explained that many of the ancient collective wetland management measures could no longer be applied because of the actual migration strategies that reduced time and dedication of herders and family members. In this new scenario of increased pressure on *bofedales* and grasslands, he said that reaching agreement to reduce the size of family herds sharing the same area was a conflictual and complicated issue. The interviewee said he felt the best solution would be to clarify the limits of family territories, allowing each family to decide the best size of its herd according to the capacity of its pastures and *bofedales*.

Family strategies and actions

The families in Sajama National Park use several strategies and actions for *bofedales* and grassland management in attempts to find a balance between conservation and productive aspects. Family access to most of the ecological diversity is an important strategy for dealing with climatic risk. As explained above, in each case families benefit from certain ecosystem advantages

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FIGURE 5 Family *sayaña* of case study in the *ayllu* Suniuta Choquemarca. (Map by Jhonny Perez and Ana Paola Castel)



adequate for different climate threats. In the workshops, participants explained the importance of *bofedales* in dry years, as they become the main pasture area. But because a dry year also affects these areas, they combine with tussock pasture areas, which are also resistant to droughts, compared with other types of grassland vegetation to which they also have access rights.

The delimitation of *sayañas* has led to substantial changes in the family management of *bofedales*. One of the main contributions of family-fenced *bofedales* was the reduction of labor necessary to take care of herds in open areas. This is beneficial in an area that experiences reduced labor availability for half of the year, as it is common for men to migrate to Chile for 6 months to take part in complementary economic activities. The interviewee from Suniuta Choquemarca explained that the fencing of the *sayañas* helped improve livestock and *bofedal* management. He said that once the *sayañas* were fenced he started controlling his animal stock, establishing fallow periods and carrying out genetic selection and deparasitation of his herd, the combination of which resulted in a significant mortality rate reduction. The interviewee said that an animal stock of 100 is the optimum for his *sayaña,* considering the balance between conservation and economic aspects. Each year he has to sell as many animals as are born—approximately 35—selecting nonreproducing females, old males, and weak animals.

As an example of family management of the *sayañas* we use the case of the Suniuta Choquemarca interviewee. In his *ayllu*, there are 34 *sayañas*, all completely fenced in the *bofedal* area. He manages his *bofedal* area by dividing it into 2 parts so he can implement a resting period, alternating between these 2 sectors. The resting period is only 3 to 4 months (January–March), after which they use the entire *bofedal* again. The *sayañas* start in the middle of the *bofedal* towards the highlands, reaching the *ayllu's* boundary. But the limits between *sayañas* vary from well-defined fenced limits in the *bofedal* area, to defined but not fenced limits in the middle grasslands, up to diffuse limits in the highlands. Figure 5 illustrates the geographical dimensions of this case study.

In the mornings, at 10 AM, the families take their herds to the middle grasslands. At noon they bring them back to the *bofedal*. During the dry season they buy supplementary forage (alfalfa, barley). Until the 1980s, they also used the highland grasslands, where they left the herds to graze without a herder. Today, families no longer use these grazing areas; wildlife protection measures in the park have enabled pumas and foxes to multiply, making it impossible to leave herds unprotected.

This example demonstrates that families constantly change and adapt their management strategies and actions according to factors that may be climatic, ecological, and economic. It also shows how family

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strategies are linked to collective decisions and strongly rely on communal support.

Conclusions

The study shows the ability of Andean communities to face up to social and environmental challenges in Sajama National Park. The 5 *ayllus* that are part of the park have managed their natural resources, which include Andean wetlands, since precolonial times. In doing so, they have maintained a balance between permanence (the principles and world vision of the Andean culture) and flexibility (changing strategies for adapting to constant environmental, sociopolitical, and economic change).

During the last decades, an increase in demographic pressure and numbers of livestock necessitated modifications to productive systems. In turn, this has meant changes to the land rights regime. A clear process from collective to family management of wetlands and grasslands is observed in the study area, mostly because fenced management requires less family labor (eg herders) and reduces conflicts among neighboring families. We observe that although traditional forms of community-based control are slowly giving way to smallholder-based decision-making processes, Andean herders still strongly rely on communal institutional arrangements to cope with social and environmental risks. The changes in land access only refer to usufruct rights, keeping the property rights at the communal level.

Because the need for regulating livestock and pasture management has increased, *ayllu* members believe the best way of governing land is to modify land rights with a clear definition or limits along family-run areas. That way, many of the decisions needed to change access and withdrawal rights are taken at family level, relieving the traditional authorities from the burden of managing these details. Access to the diversity of microenvironments in Sajama is one of the permanent elements that have been maintained through management and rights access modifications. This is an important risk management tool for families that helps to deal mainly with climatic risks.

It is important to mention that the *ayllus* of this study are embedded in broader indigenous organizations through nested hierarchies that are a main support for achievements at national policy levels. These achievements are the framework that allowed the Sajama *ayllus* to have a strong influence in decision-making spaces in the Curahuara Municipality and in the park. As a result, the different *ayllus* synergistically articulate 2 spheres (traditional organizations and state).

More broadly, decisions regarding the management of Andean wetlands involve the active participation of local people and their social institutions. For better results and according to the latest legislative changes (Republic of Bolivia 2009, 2010), any action to address emerging challenges must be implemented in coordination and agreement with local actors and their collective institutions. This is one of the reasons why, since the establishment of the management committee, Sajama National Park is widely accepted among local people and is known to be one of the best examples of participatory park management in Bolivia.

Finally, we raise the question of how the process of collective versus family-based decision-making will develop in the future. Adapting to change appears to have accelerated in the last decades, and market influence is becoming more intrusive in the *ayllus*' daily operations. It is worth asking if this process will lead to a gradual dismantling of the *ayllu* and the loss of one of the main strengths of Andean communities: collective organization networks.

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