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Analysis of the environmental conflict and community alternatives in the Pisba *Páramo*, Andes Mountain Range (Boyacá, Colombia)

Análisis del conflicto ambiental y las alternativas comunitarias en el páramo de Pisba, Cordillera de los Andes (Boyacá, Colombia)

Análise de conflitos ambientais e alternativas comunitárias no Páramo *de Pisba, Cordilheira dos Andes (Boyacá, Colômbia)*

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ABSTRACT The *páramos* are unique areas in the high mountains of the neotropics. They overlap with the Andean hotspot and form ecoregions of high regional biodiversity and endemic fauna and flora. They are important for water regulation, and their degree of threat classifies them as local hotspots. The use and control of their resources had set the interests of several actors for their conservation, which in Colombia implies specific management of the territory under different categories of protected areas. This research aimed to analyze the environmental conflict of the Pisba *páramo*, according to the perspective of the community of the municipality of Socotá (Boyacá, Colombia). For this purpose, we applied social mapping and participatory rural appraisal tools, analyzing the ecosystemic and cultural characteristics of the area, the conflict scenarios, and the perspectives of the community about alternatives previously proposed by other authors. As a main result, we identified an environmental conflict framed in the following components: 1. Presence of environmental authorities and protected areas, 2. Impact of agricultural activities in the *páramo*, 3. Impact of coal mining in the area, 4. The presence of the Andean bear, and 5. Difficulty of access to the *Ruta Libertadora* horse path. Alternatives, such as 1. Community management plans, 2. Application of agroecology and biocultural memory recovery,

and 3. Changes in the agrarian structure. These are reported to be a favorable response to consolidate a space for dialogue that allows the inclusion of *campesino* initiatives, with potential discussions on resource management, economic activities, protection of the *páramo*, and other challenges such as strengthening associativity. It also highlights the need for transition and training in agroecology in such a way that it is practical and operational in the territory. Finally, regarding changes in the agrarian structure, the community proposes to dignify their lives by recognizing the land ownership rights of the farmers and providing access to solutions such as land tenure regularization. They also propose access to essential services and strengthening the scope of territorial planning.

Keywords: conservation; protected areas; *high mountain ecosystems*; socio-environmental conflict; farmers

RESUMEN

Los páramos son espacios únicos de la alta montaña del neotrópico. Traslapan con el *hotspot* de los Andes y conforman ecorregiones de alta biodiversidad regional y endemismos de fauna y flora. Son importantes en la regulación hídrica y su grado de amenaza los cataloga como *hotspots* locales. El uso y control de sus recursos ha fijado intereses de varios actores para su conservación, lo que en Colombia implica la gestión especial del territorio bajo diferentes categorías de áreas protegidas. El objetivo de la presente investigación fue analizar el conflicto ambiental del páramo de Pisba, desde la perspectiva de la comunidad del municipio de Socotá (Boyacá, Colombia). Para esto se aplicaron herramientas de cartografía social y diagnóstico rural participativo, analizando las características ecosistémicas y culturales de la zona, los escenarios del conflicto y las perspectivas de la comunidad frente a alternativas previamente propuestas por otros autores. Se encontraron como principales resultados un conflicto ambiental enmarcado en los siguientes componentes: 1. Presencia de autoridades ambientales y áreas protegidas, 2. Impacto de las actividades agropecuarias en el páramo, 3. Impacto de minería de carbón en la zona, 4. Presencia del oso andino y 5. Dificultades del paso en el camino "ruta libertadora". Las alternativas tales como: 1. Planes de manejo comunitario, 2. Aplicación de la agroecología y rescate de la memoria biocultural y 3. Cambios en estructura agraria, reportaron una respuesta favorable para consolidar un espacio de diálogo que permita la inclusión de las iniciativas campesinas, con potenciales discusiones sobre el manejo de recursos, las actividades económicas, el cuidado del páramo y otros retos como lo es el fortalecimiento de la asociatividad. Así mismo se destaca la necesidad de la transición y capacitaciones en agroecología de tal manera que sea efectivas y operativas en el territorio. Finalmente, en los cambios en estructura agraria, la comunidad plantea el reconocimiento de los derechos de propiedad sobre la tierra de los campesinos y el acceso a soluciones como el saneamiento predial, para dignificar sus vidas, acceder a servicios básicos y fortalecer el alcance de la planeación del territorio.

Palabras-clave: conservación; áreas protegidas; ecosistemas de alta montaña; conflicto socioambiental; campesinos.

RESUMO

Os *páramos* são espaços únicos das altas montanhas do neotrópico. Eles se sobrepõem ao hotspot andino e formam ecorregiões de alta biodiversidade regional e flora e fauna endêmicas. São importantes na regulação hídrica e seu grau de ameaça os cataloga como hotspots locais. O uso e o controle de seus recursos estabeleceram os interesses de vários atores para sua conservação, o que na Colômbia implica a gestão especial do território sob diferentes categorias de áreas protegidas. O objetivo da presente pesquisa foi analisar o conflito ambiental do *páramo* de Pisba, a partir da perspectiva da comunidade do município de Socotá (Boyacá, Colômbia). Para isso, foram aplicadas ferramentas de cartografia social e diagnóstico rural participativo, analisando as características ecossistêmicas e culturais da área, os cenários de conflito e as perspectivas da comunidade em relação a alternativas previamente propostas por outros autores. Os principais resultados encontrados foram um conflito ambiental enquadrado nos seguintes componentes: 1. Presença de autoridades ambientais e áreas protegidas, 2. Impacto das atividades agropecuárias no *páramo*, 3. Impacto da mineração de carvão

na região, 4. Presença do urso andino e 5. Dificuldades de passagem na rota libertadora. Alternativas como: 1. Planos de manejo comunitário, 2. Aplicação da agroecologia e resgate da memória biocultural, e 3. Mudanças na estrutura agrária, relataram uma resposta favorável à consolidação de um espaço de diálogo que permita a inclusão de iniciativas camponesas, com possíveis discussões sobre gestão de recursos, atividades econômicas, cuidados com o *páramo* e outros desafios, como o fortalecimento do associativismo. Também destaca a necessidade de transição e treinamento em agroecologia, de modo que seja eficaz e operacional no território. Por fim, em termos de mudanças na estrutura agrária, a comunidade propõe o reconhecimento dos direitos de propriedade da terra dos camponeses e o acesso a soluções como a titulação da terra, a fim de dignificar suas vidas, acessar serviços básicos e fortalecer o escopo do planejamento territorial.

Palavras-chave: conservação; áreas protegidas; ecossistemas de alta montanha; conflito socioambiental; agricultores.

1. Introduction

The Andes Mountain Range in western South America has the greatest abundance of vertebrates and endemic plants on Earth. In addition, its mountainous relief offers unique habitats due to the broad altitudinal gradients and climatic variation. The Andean landscape is heterogeneous and holds a rich cultural legacy shaped by the communities that have inhabited it (Brush, 1982; Arroyo & Cavieres, 2013; Young, 2015). In the northern Andes, above the tree line and below the snow line, *páramos* are found. They are relatively continuous in their distribution across Colombia, Venezuela, and Ecuador while occurring discontinuously in isolated areas of Costa Rica and Panama (Luteyn, 1999; Hofstede, 2003). The definition of *páramo* is complex and encompasses various approaches and scales that classify it as a region, ecosystem, biome, landscape, living space, symbol, or socio-ecosystem (Hofstede, 2003; Baptiste, 2013). The *páramo* is emblematic of its vegetation and water resources. It plays a key role in water retention within the landscape and its provision for societal use and consumption in nearby areas. Additionally, it provides ecosystem services, including water and climate regulation, soil carbon storage, biodiversity support, provisioning of food, and cultural services such as recreation and spiritual values (Buytaert *et al*., 2006; Anderson *et al*., 2011; Armijos & De Bièvre, 2014)

The presence of humans in the *páramo* dates back to pre-Columbian times, with Indigenous communities temporarily occupying these areas for ceremonies and to obtain resources. From the 16th century, European arrival introduced new economic and property use incentives with permanent settlements in the high-altitude regions (Castaño-Uribe *et al*., 2003; Varela, 2008). However, the *páramo* is predominantly described as uninhabited, yet human influence through sociocultural dynamics is integral to the *páramo* itself, its ecological balance, and its conservation state. (Hofstede, 2013).

Using and managing *páramo* resources leads to conflicts driven by diverse interests, ranging from those advocating conservation approaches to those economically dependent on the area through agricultural activities and infrastructure development. Likewise, conflicts arise from local organizational dynamics, their goals, and other cultural representations of societies within these territories. The main actors in these conflicts are typically *campesinos* and state control institutions represented by en-

vironmental authorities (Avellaneda-Torres *et al*., 2015; Prieto, 2017).

Given the conflicts between communities and environmental authorities, Avellaneda-Torres et al. (2015) have identified three approaches, two of which are currently applied, while the third is a proposal that the researchers suggest for future implementation. The first approach is the efficiency achieved by the management of nature. It focuses on the valuation and economic appropriation, with the concession of ecotourism services in protected areas and land acquisition by mixed-economy companies. The second focuses on protecting nature, characterized by limited direct human intervention and enforcing regulations within protected areas. It is applied with restrictive and punitive measures to prevent transformation and exploitation. Finally, the third, proposed for implementation, seeks to consolidate community management plans, promote agroecology and the recovery of biocultural memory, and advocate changes in the agrarian structure.

To the northeast of Colombia, on the eastern ranges, lies the Pisba *páramo*. Researchers have biogeographically categorized it as a *páramo* complex. It covers 106,243 ha within the jurisdiction of 12 municipalities, most of which are in the department of Boyacá (Morales et al., 2007; MADS, 2023b). Its area overlaps with the 35,242.2-ha protected area of the Pisba National Natural Park (PNNP), which includes 25% of *páramo* and 38% of *sub-páramo*, totaling nearly 26,744 ha of *páramo* as estimated by the Ministry of Environment (Tellez et al., 2020; MADS, 2023a) (Figure 1). The PNNP is occupied by surrounding communities, which have been measured in agricultural production units (UPA), which are areas where goods are produced and where there is some degree of land tenure and management. An estimated 1,401 UPAs are in the park, representing 7.9% of the units in Colombia's protected areas (DANE, 2016). At the same time, the *páramo* complex is located in a region of significant coal mining importance (IGAC, 2005a), where local communities have a strong influence and Presence (Ardila et al., 2016).

Socotá is the municipality with the largest area within the Pisba *páramo*, covering 64.6% (38,319.7 ha) and 79% (3,555 ha) of the PNNP. The precedent of conflicts with environmental authorities in Socotá dates back to the park's creation in 1977, as it borders a buffer zone where multiple processes occur, such as the predominant primary production in the area, agricultural frontier expansion, improper land use, limited availability of suitable land for agriculture, the ongoing importance of mining activities in the region, scarce road infrastructure, and the ongoing disputes over restrictions on key activities such as livestock farming (Meneses *et al*., 2006). The delimitation of the *páramo* complex has recently added to the situation (MADS, 2023b).

This research aimed to understand the environmental conflict in the Pisba *páramo* from the perspective and ideas of Socotá's residents. The first objective was to diagnose the ecosystemic and cultural characteristics of the rural areas of Socotá near the *páramo*. The second objective focused on analyzing the population's viewpoints regarding the various components of the conflict. The third objective was to identify potential actions and perspectives on conflict resolution alternatives to the conflict, particularly concerning the proposal for community management plans, agroecology, the recovery of biocultural memory, and changes in agrarian structure (Avellaneda-Torres *et al.*, 2015).

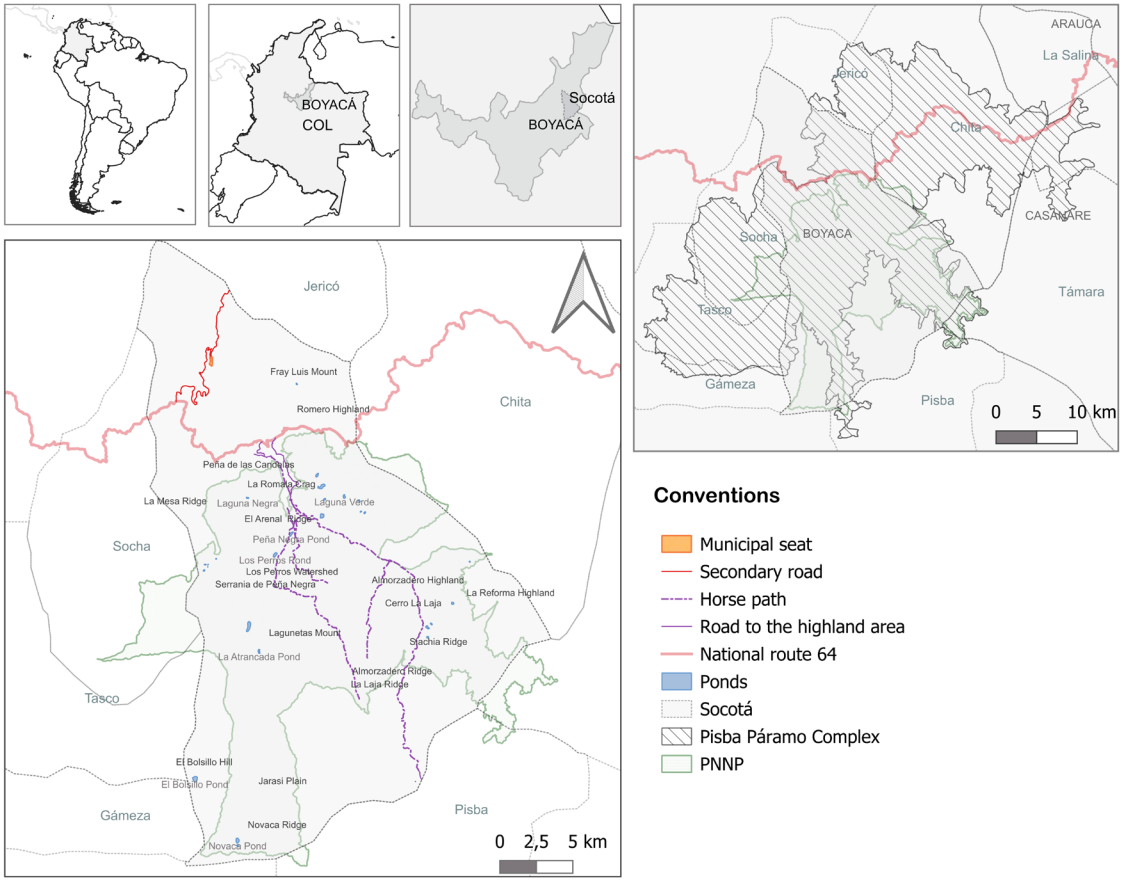

FIGURE 1 – Study area.
SOURCE: own elaboration

2. Methodology

Participatory rural appraisal (PRA) tools were applied: 23 semi-structured interviews, a community map, and participant observation (Geilfus, 2002; Expósito, 2003). We gathered additional data through 5 in-depth interviews (Johnson & Rowlands, 2012). In parallel, we contacted the local community with area leaders and referrals, engaging men and women from the rural areas of the *veredas* of Comeza Hoyada and La Romaza in Socotá. We coded the collected material using MAXQDA Standard 2018.2.0 from Verbi Software (Silver & Lewins, 2014) and cross-referenced the findings with a bibliographic review.

The conflict analysis was structured around three aspects. The first was focused on an environmental diagnosis according to Angel-Maya's (2013) perspective, which describes the ecosystem and culture. The second addressed the specific compo-

nents of the conflict identified by the community: 1. Presence of environmental authorities and protected areas, 2. Impact of agricultural activities in the *páramo*, 3. Impact of coal mining in the area, 4. Presence of the Andean bear, and 5. Difficulties in the *Ruta Libertadora* horse path. The third explored the community's perspectives on potential solutions, particularly the implementation of community management plans, agroecology, the recovery of biocultural memory, and agrarian structure, as Avellaneda-Torres et al. (2015) reported.

3. Results and discussion

3.1. Environmental diagnosis: ecosystem and culture

Socotá is a municipality in the northeastern region of Boyacá, within the Valderrama province. Its landscape features a rural and mountainous topography, with forests interspersed with agricultural land, residential properties, mining areas, and numerous streams (Correa, 1987). It has a total area of 60,011 ha, organized into 39 rural districts known as *veredas* (Alcaldía de Socotá, 2005). Socotá is located approximately 260 km north of Bogotá, the capital of Colombia. It is accessible by road, and the travel time from the capital typically takes around six hours by inter-municipal transportation.

Movement across the municipality is influenced by long distances and pronounced altitudinal gradients ranging from 3,000 to 3,780 masl. In each *vereda*, travel time typically takes an hour or more. Residents report even longer journeys between locations, lasting six to eight hours on horseback or foot. Rural travel relies on several trails, and the community has manually constructed some tertiary roads using pickaxes and shovels.

The diagnosis conducted by the community describes the highland area as a space characterized by a "dominance of the winter season," with a climate ranging from cold to very cold (6 to 12°C) and a bimodal rainfall regime, with precipitation between 2,800 to 3,700 mm. The air humidity is high, and the soil is shallow and well-drained (IGAC, 2005b Corpoboyacá, 2015; Agudelo-Calderón *et al*., 2016). From a hydrological perspective, the importance of the *páramo* was highlighted as a "water buffer, " contributing to two major river basins. To the west, it feeds the Magdalena basin through the flow of the Arzobispo and Comeza rivers. At the same time, to the east, it supplies the Orinoco basin via the Payero and Pisba rivers (Alcaldía de Socotá, 2005). The lotic system consists of multiple ponds such as *Laguna Verde*, *Pozo del Soldado*, *Chorro Blanco*, and *Laguna Negra*. These are in the middle of important peaks such as *Peña Negra* (3,600 masl) and *Peña Candelas* (3,620 masl) (Ojeda, 2003; Ardila *et al*., 2016).

The community describes the vegetation in the area as "abundant, " Among the species they mention, the most notable are encenillo (*Weinmannia tomentosa*), aliso (*Alnus acuminata*), chilca (*Baccharis latifolia*), and tilo (*Sambucus* spp., commonly known as 'elder'). Higher up the mountain, they identify additional plants, including frailejones (*Espeletia jaramilloi, Espeletia mirabilis*), cardón (*Puya* spp.), chusque (*Chusquea* spp.) also known as pantanero, and paja (*Calamagrostis effusa*) (IGAC, 2005a; Meneses *et al*., 2006; Díaz-Piedrahita & Rodríguez-Cabeza, 2010; Tellez *et al*., 2020). Moreover, the community associates the *páramo* and forest species with water regulation due to their ability to

retain water and its presence near rivers and 'espejos de agua' (water bodies). Other identified species include grasses used for livestock grazing and plantations of eucalyptus and pine. Regarding the fauna found in the *páramo*, notable species include the white-tailed deer (*Odocoileus virginianus*), the Andean bear (*Tremarctos ornatus*), the cougar (*Puma concolor*), and various bird species such as the Andean condor (*Vultur gryphus*), the pale-breasted spinetail (*Synallaxis subpudica*), Apolinar's wren (*Cistothorus apolinari*), the yellow-backed oriole (*Icterus chrysater*), and the rufous-collared sparrow (*Zonotrichia capensis*) (Meneses *et al*., 2006; IAvH, 2013; Tellez *et al*., 2020).

According to the community, the *veredas* primarily rely on animal husbandry, either done exclusively or in parallel with coal mining activities. These mining activities include coal extraction in underground mines and its processing in coke plants in Socha and the northwestern part of the municipality. The most prominent form of livestock production is cattle farming, primarily for beef sales. Followed by the breeding of horses and mules, which are vital for transportation. Ultimately, people raise sheep and goats to a lesser extent. In the highland areas, agriculture is for self-consumption, focusing on cultivating potatoes, fava beans, and wheat. The people cultivate these crops for up to 3,200 masl, and their residences are also situated there, some of which have vegetable gardens. The production pattern of Socotá is characteristic of the department, where, despite the presence of industrial sectors, the agricultural vocation remains strong (Vega, 2015). The community mainly organizes itself into local action boards, community water boards, and the representation of the municipality's councilors. Regarding beliefs, the population is predominantly Catholic; there are scattered chapels in some *veredas*, such as Comeza Hoyada, El Oso, or Los Pinos.

Access to education is facilitated by the rural technical educational institution based in Comeza Hoyada, where education up to the secondary level is provided. This access is further supported by rural schools run by a single teacher who teaches all subjects to a few students. Some *veredas* do not have active schools due to the lack of enrolled students. Regarding access to health services, the region only has first-level health centers, the only available medical care facilities providing basic and minimally specialized care. Socotá's only health center is in the municipal seat and conducts scheduled health outreach in rural areas. Because distance complicates access to healthcare, people often resort to self-diagnosis and self-treatment. In some cases, it is necessary to travel to medium-level medical institutions in Duitama or Tunja (Ardila *et al*., 2016). Concerning infrastructure and basic services conditions, local community water systems provide access to water, but in some cases, they lack legalization and maintenance. The electricity service covers 70% of the area but is absent in some remote *veredas*. The community generally handles waste management by burning waste in coal stoves. Only the urban area has a sewage system, while in the rural areas, septic tanks are used (Alcaldía de Socotá, 2005). The unsatisfied basic needs index for the municipality is 27.31%, which is higher in rural areas (31.40%) (DANE, 2022).

During dialogues with the community, the *campesinos* emphasized the importance of the *páramo*, particularly regarding the so-called *Comunidad de Benítez*. This territory encompasses

the Socotá *páramo* and its surroundings, where natural resources support communal livestock farming and conservation efforts. Conservation activities, strongly tied to the presence of the PNNP, are regulated collectively by the community. The inhabitants regard the *Comunidad de Benítez* as a legacy from their ancestors, a place of origin, and a familiar space that the *campesinos* know well. It is the land where traditional farming lifestyles are practiced, making it both a subsistence asset and an integral part of their identity (Pérez *et al*., 2011). Additionally, the region's history of land tenure in the *páramo* areas of Socotá, Pisba, Paya, Labranzagrande, Gámeza, Tasco, and Socha is notable. Local presence has been continuous for approximately 300 years, dating back to the colonial period and the chaplaincy established through the will of Sebastián Urdos de Arce, who allocated his inherited lands in the Nuevo Reino de Granada for the benefit of the region's people (García, 2009).

3.2. Environmental conflict from the community's perspective

The community identified an environmental conflict, which developed in the following components: 3.2.1. Presence of environmental authorities and protected areas, 3.2.2. Impact of agricultural activities on the *páramo*, 3.2.3. Impact of coal mining in the area, 3.2.4. Presence of the Andean bear, and 3.2.5. Difficulties of the *Ruta Libertadora horse trail.*

3.2.1. Presence of environmental authorities and protected areas

For the community, the ongoing discrepancies with environmental authorities are evident in two state-led conservation processes: the PNNP (1977), currently managed by the National Parks Authority, and the delimitation of the Pisba *Páramo* Complex (2017), overseen by the Boyacá Autonomous Corporation (Corpoboyacá). Conflicts regarding land occupation, tenure, participation, and decision-making over the territory are identified throughout these processes.

The community describes the conflict with the national parks in three key moments. The first occurred with the arrival of INDERENA[1], the state agency that declared the area as protected, imposing restrictions on land ownership and productive activities. Although the agency withdrew in the early 1980s, its actions left a lingering rejection of exclusionary mandates and ongoing concerns over land tenure regulation. With the establishment of the PNNP, one of the challenges of creating protected areas became evident: the declaration was made without public negotiation and primarily reflected the motivations of particular political and scientific sectors (Leal, 2017).

The second moment began with the arrival of the National Parks administration around the year 2000. Their efforts resumed through initiatives such as community-oriented sustainable agricultural projects, educational talks, and the implementation of measures to regulate potato cultivation in the *páramo* and control the widespread burning practi-

[1] The Spanish acronym for the National Institute of Renewable Natural Resources and Environment

ces of that period. Additionally, they undertook the maintenance of the park's horse path (Meneses *et al*., 2006). The third phase began in 2005 with a shift in management focus toward intermittent area monitoring. This shift included stricter enforcement of restrictions on permits for the legalization of aqueducts, infrastructure repairs, and the imposition of sanctions. Despite these measures, dialogues have since been established through consultation tables to move beyond the predominantly biological approach to conservation. These efforts have initiated land characterization to address ongoing discussions about land use and unclaimed properties.

Simultaneously, the community describes the "*páramo* complex" delimitation as expanding conservation efforts within the territory. This initiative is part of a national project mainly unfamiliar to them due to its limited outreach and partial consultation, leading to widespread disapproval: *They come to us with laws, and more laws, and more laws, but no solutions* (Interview 7, 2018). The technical and scientific definition of the *páramo*'*s* boundaries is a component of legislative efforts to protect these ecosystems, primarily by prohibiting mining and high-impact agricultural activities (Sarmiento *et al*., 2013). The process raises concerns about the very presence of people, specifically regarding the possibility of continuing to live at altitudes near 3,200 masl in high Andean Forest areas while maintaining their economic activities. This situation has resulted in pressures for displacement from these territories, fueled by fears of losing traditions and the anxiety of facing future economic difficulties, given the limited opportunities in other contexts (Piedrahita & Peña, 2016; Prieto, 2017).

The aforementioned situation elicits a response from the community, emphasizing their strong ties to the land through their knowledge of and care for their territories. They broadly state: *It is the campesino who conserves*! (Interview 15, 2018), and *We, the ones who are here, are the ones who are caring, the ones who are preserving, the ones who are attentive every day* (Interview 17, 2018). In this way, the community's perception of the authorities' management is described as absent, and its effectiveness is questioned partly due to a lack of assertive communication. These factors have distanced the community from staying informed through informational spaces led by the authorities. As participation declines, it is accompanied by waning interest, the corroboration of existing disagreements, and the conviction that crucial issues are not being addressed or solutions are not being sought. Additional criticism of the environmental authorities cites the biases when they have concessions to other actors due to their political or economic influence, such as mining companies. The limitations of the authorities' management are due to their adoption of a predominantly coercive approach, the challenges in exercising their regulatory role, and the lack of information, funding, and proper legal frameworks (Morales-Betancourt & Estévez-Varón, 2006; Nolte, 2016; Piedrahita & Peña, 2016).

3.2.2. Impact of agricultural and livestock activities on the páramo

The oversight of environmental authorities has driven efforts to limit agricultural activities in the *páramo* due to their impact on soil, water, and vegetation. The community acknowledges these concerns and has contributed to declining sheep

farming and potato cultivation above 3,200 masl, which were once predominant. However, the use of *páramo* resources continues through cattle and horse farming, along with crops grown in the adjacent forest. These activities raise concerns within the community about their long-term effects on the water system and the challenge of a possible shift in management. Nonetheless, the community emphasizes the importance of these economic and livelihood activities, advocating for their continuity with appropriate adjustments.

According to the *campesinos*, cattle raising in the highlands is due to the availability of open spaces in the *páramo*, which are not present on their smaller properties. Animals are left outdoors and scattered based on the availability of vegetation. The *páramo* supports low-cost livestock farming, requiring only investments in medication and salt, with cattle typically checked every 15 days. This modality requires relocating lactating cows and those to be sold to low-altitude areas while calves are brought to the highlands to be tamed. This practice reflects smallholding limitations and land use optimization according to altitudinal zones (Stadel, 2009; Arias & Antosová, 2018).

The population explains that the decision on livestock management comes from the legacy of the *Comunidad de Benítez,* which explains the communal use of the area. In the past, the control of land use was overseen by the leaders of the local action boards, who managed the collection of a tax. However, this practice was discontinued, and no transaction records remain (García, 2009). Currently, the use of the area continues and relies mainly on mutual assistance among users and their decision-making, as has been reported for the communal *páramo* management practices for grazing (Molinillo & Monasterio, 2002).

The community also highlighted the environmental impacts of livestock farming: *Regarding the cattle, it is evident that when the sun gets hot, the animals get thirsty, so they look for water in the ponds or streams they find. That is when you realize it causes damage because they trample the ground or contaminate the water* (Interview 15, 2018). The community mentioned the impact of cattle trampling and water source pollution, which is linked to the unrestricted movement of livestock, the pressure on vegetation consumed, the absence of water troughs, and the effect of excrement and other waste during the movement of cows between the *páramo* and adjacent forest areas.

In the same way, the community mentioned the pressures of cultivation exerted on the high Andean Forest by "clearing vegetation" or brush removal. This technique amplifies the strain on the vertical relationship of water regulation in the high mountains. Therefore, this impact induces a global response reflected in the change in the physical and chemical composition of the soil, its water retention capacity, and regulation. These effects are reinforced by the removal of vegetation, which leaves the soil exposed and vulnerable to the establishment of invasive species, the disturbance of ecological succession, and the reduction of aerial biomass, ultimately leading to vegetation fragmentation (Guhl-Nanneti 2002; Llambí & Cuesta 2014).

3.2.3. Impact of coal mining on the area

Mining activity generates conflict in the area by the contrast between its economic and employ-

ment benefits for residents and its socioeconomic impacts versus the effects on the ecosystem at the regional level, even though no direct extraction occurs in the high-altitude sector of Socotá.

As described by the community, the conflict traces the history of mining in the region, which was established in the territory almost 45 years ago, with the first coal tunnels in the *vereda* Guatatamo. An increase in extraction occurred approximately 35 years ago, driven by market trends and the influence of the Paz del Río Steel Mill. Since its establishment in 1950, this steel company has progressively industrialized the region through coal and iron mining (Avellaneda, 2013). Extraction continues today through a mosaic of national and multinational mining companies. Socotá, along with Socha, Sativa Sur, and Sogamoso, are the sites where most coal is extracted in Boyacá, within the northeastern region (BRC, 2019).

Regarding social impacts, the community describes tensions arising from introducing new traditions brought by people from other regions. These tensions were further compounded by concerns over decisions made without their involvement, particularly about coal exploration and exploitation licensing in the area. Such decisions led the community to respond with demonstrations and protests, as happened around 2008 in the sector of La Chorrera (*Laguna Negra*, Comeza Hoyada) when a multinational company attempted to establish operations high in the mountains. The protest prevented the project from moving forward, indicating potential territorial conflicts tied to the importance of the water resource (Vargas, 2019). The region also has a history of resistance, as evidenced by actions taken by communities in the neighboring municipality of Tasco (Moreno, 2012; Amaya & Duran, 2017).

The community also identifies asymmetries in how authorities enforce compliance with regulations. The *campesinos* face disadvantages in navigating the bureaucracy imposed by environmental authorities regarding resource use and management, such as difficulties in obtaining permits for forest utilization or watercourse use. The most frequently mentioned challenges include high financial costs related to travel, administrative procedures, and penalties that are often imposed before sufficient information is available to avoid them. Furthermore, these disadvantages, which discourage rural livelihoods and sustainable coexistence in high-altitude areas, stand in contrast to the benefits granted to multinational corporations. Backed by decisions from the Department authorities of Boyacá, these corporations receive incentives to promote large-scale mining despite the environmental authority's limited capacity to execute and regulate licenses effectively (Salamanca, 2016).

In terms of ecological aspects, the community emphasizes the importance of water. It describes the impact of coal mining on the hydrological system: "Where there is coal, there is water," they explain that removing coal leads to leaching and water acidification, which the community believes should be treated and stored. However, leachates are left to flow freely in some extraction sites, contaminating rivers and affecting water flows. Removal activities also impact the soil, compromising stability by changing its structural composition, which results in increased erosion, sedimentation, and changes in groundwater storage. In parallel, vegetation removal and subsequent fragmentation increase the risk of landslides and slope failure (Vargas, 2013). These processes are exacerbated by eucalyptus plantations, which alter soil cover. Such plantations

are encouraged by the mining industry to supply wood for fencing, firewood, and tunnel construction (Avellaneda, 2013). Finally, regarding air pollution, residents highlighted emissions from coke ovens, which in the area are not monitored for particulate matter levels, harmful emissions, and their effects on the community's well-being (Robledo-Martínez *et al*., 2017).

3.2.4. Presence of the Andean bear

The population identified the conflict between human communities and the Andean Bear (*T. ornatus*) primarily due to attacks on livestock in the municipality's highland area. These attacks led affected individuals to consider implementing control measures to reduce the bear's abundance in the territory. This situation leads to question the actions of the environmental authority, which is tasked with conserving the Andean Bear, whose mandate is opposed to the community's efforts to protect their livelihoods (mainly livestock) because of the direct and latent threat from the bear.

Bear attacks on livestock in open areas and on fenced properties have a socioeconomic impact, particularly affecting peoples' personal finances and planning. The community describes the economic consequences of losing cattle due to bear attacks as difficulties in repaying loans taken to purchase breeding stock and challenges in managing programmed spending for property maintenance. The situation reflects the high financial vulnerability inherent in the social reality of rural Colombia (Jorgenson & Sandoval-A, 2005). In Boyacá's populated centers and dispersed rural areas, the Multidimensional Poverty Index, in the aspects of work that accompany lack of income, measured a long-term unemployment deprivation rate of 14.4% and a formal employment deprivation rate of 90.1% in 2022 (DANE, 2023). Consequently, rural communities are confronted with poverty, informality, social inequality, concentration of land ownership, and inefficiencies in productive systems (Parra-Peña *et al*., 2013). Additionally, the community faces a sense of insecurity in the *páramo*, which leads to considering the area hostile, further complicating the management of these spaces (Jampel, 2016).

The community is aware of the efforts to conserve the bear. However, doubts persist regarding the information provided by the environmental authorities and their education initiatives. This uncertainty has prevented the development of actions or alternatives to address the conflict within the framework of sustainable territorial management. As approached by the community: *then, that is another problem —they say the bear is vegetarian, but sometimes it kills livestock anyway, and many people lose their goats, and they are poor people. They had to bury their goats, which were their means of survival, barely enough to get by* (Interview 15, 2018). The conflict diagnosis in PNNP remains limited due to the lack of information on the bear's population status despite ongoing community monitoring (Tellez *et al*., 2020). Besides, studying the bear's diet and predatory behavior is challenging because of difficulties documenting cases, identifying traces, and analyzing the nature and patterns of attacks (Goldstein *et al*., 2006; García-Rangel, 2012; Figueroa, 2015). Along with this, underlying causes must be addressed, such as the progressive expansion of the agricultural frontier—driven by the prevalence of smallholdings and limited access to land suited to its practical use and vocation—as

well as the fragmentation and loss of bear habitat (Jorgenson & Sandoval-A, 2005). Thus, it is key to view landscape transformation and integrate Andean bear conservation into managing high-mountain ecosystems to tackle this issue. Environmental authorities must develop viable strategies, considering the limited land access faced by impoverished *campesinos* and the conservation objectives.

3.2.5. Difficulties in the Ruta Libertadora horse path

This conflict scenario revolves around the community's need to improve the primary access to the *páramo*: the *Ruta Libertadora*, which is a horse path located in the *páramo* area, east of Socotá, starting from Pueblo Viejo *vereda.* It extends for 17 to 18 km, with an additional 8 kilometers of rural tertiary road in the Quebradas sector in Comeza Hoyada (Ministerio de Cultura, 2009). Crossing the PNNP, this historic path marks Simón Bolívar's 1819 Andean passage in the events of his liberation Campaign (Tellez *et al.*, 2020). Currently, it is one of the conservation objectives of the protected area (Parques Nacionales, 2011).

The path represents the community's primary infrastructure for traversing the *páramo* and the remote eastern *veredas*. The *Ruta libertadora* is the sole route in those sectors for accessing healthcare services and engaging in economic exchanges. Harsh climatic conditions, extreme distances, and lack of maintenance critically limit this function. This neglect has transformed the path into a constantly eroding landscape, with waterlogged areas and extensively fragmented terrain. Therefore, the community expresses:

> *Then, we demand the improvement of the trail, of the path. For what purpose? To work the lands outside the park (...) and stop causing less impact than what we are currently doing but with opportunities to cultivate our lands beyond the protection zone.*
>
> (Interview 21, 2018)

The paths' improvement seeks to obtain a 'passable road' or a 'humanitarian corridor,' with the necessary state assistance in defining construction parameters for vehicle passage, particularly for ambulances providing medical care. These elements demonstrate the subjection to distance and isolation experienced by Andean communities, with the department of Boyacá serving as an example, where even primary roads maintain a marginal condition (Guerrero et al., 2011; Rodríguez & Granados, 2017).

However, the environmental authority prevents any arrangements for the path from being made, hindering potential relief actions by other entities, such as municipal authorities. The community analyzes this response as contrary to the goal of protecting the *páramo* from a negative impact as it rules out active management, particularly for uses that have not stopped in years and even date back to the park's creation. In this scenario, park protection predominates over the needs of the populations, such as enabling transportation and communication. This tendency prevents cultural exchanges and development, thus continuing the historical hardships caused by isolation and remoteness (Stadel, 2009; Arias & Antosová, 2018). There is also a growing distance between the parties involved, with the continued violation of people's rights, that highlights one of the defining aspects of the region's environmental challenges: the re-

percussions of conservation efforts are reflected in the worsening of poverty due to the inequity of economic underdevelopment (Castro, 2000; Turner et al., 2012).

3.3. Community perspectives on the proposed alternatives to the conflict

In response to the aforementioned conflicts, Avellaneda-Torres *et al*. (2015) propose three alternatives based on the importance of the realities of *páramo* communities and their territories: 3.3.1. Community management plans, 3.3.2. Agroecology and the recovery of biocultural memory, and 3.3.3. Changes to the agrarian structure.

The following are the local community's perspectives about the alternatives the authors proposed.

3.3.1. Community management plans

They are a territorial management strategy in diagnosis, planning, implementation, and monitoring. Its construction includes the communities' ideas, interests, capacities, and decisions. The strategy also emphasizes relevant funding with systematic and continuous participation, allowing communication among all stakeholders (Alexander, 2008; Avellaneda-Torres *et al*., 2015). The community offers the following perspective:

> *I believe an agreement could be reached if another organization came along and spoke as if they understood the community and allowed us to work with them. I mean, an organization that lets the community do what they want, without excluding us, without saying, 'No, you cannot do this or have that.' If such an organization said: Yes, we agree. We support your idea, and we will help make it happen. Then, the community will agree that it is possible to achieve this.*
>
> (Interview 11, 2018)

The community's proposal in this alternative is to establish a space for dialogue through an "initiative for the *campesinos*" that includes potential discussions on resource management, economic activities, *páramo* conservation, and other challenges such as strengthening community associations (Figure 2). However, these discussions should maintain minimum standards according to the community capacities, which make them possible in terms of mode, format, and timeframe (Figure 3).

Community organization and participation have played a key role in claiming revisions of decisions involving the *páramo* made without their involvement. A background of this is the creation of the *Comunidad de Benítez* Management Board and the current actions led by the municipality's councilors. In the same way, the delimitation of the *páramo* complex was a scenario in which the community demanded the authorities to include the *campesino* point of view. This demand led to legal actions, whose ruling favored a new delimitation process and the declaration of the Pisba *Páramo* as a subject of rights (Cifuentes, 2018). It is therefore important to acknowledge the participation of social actors as part of the solutions towards the integral recognition of the ecosystem for its conservation

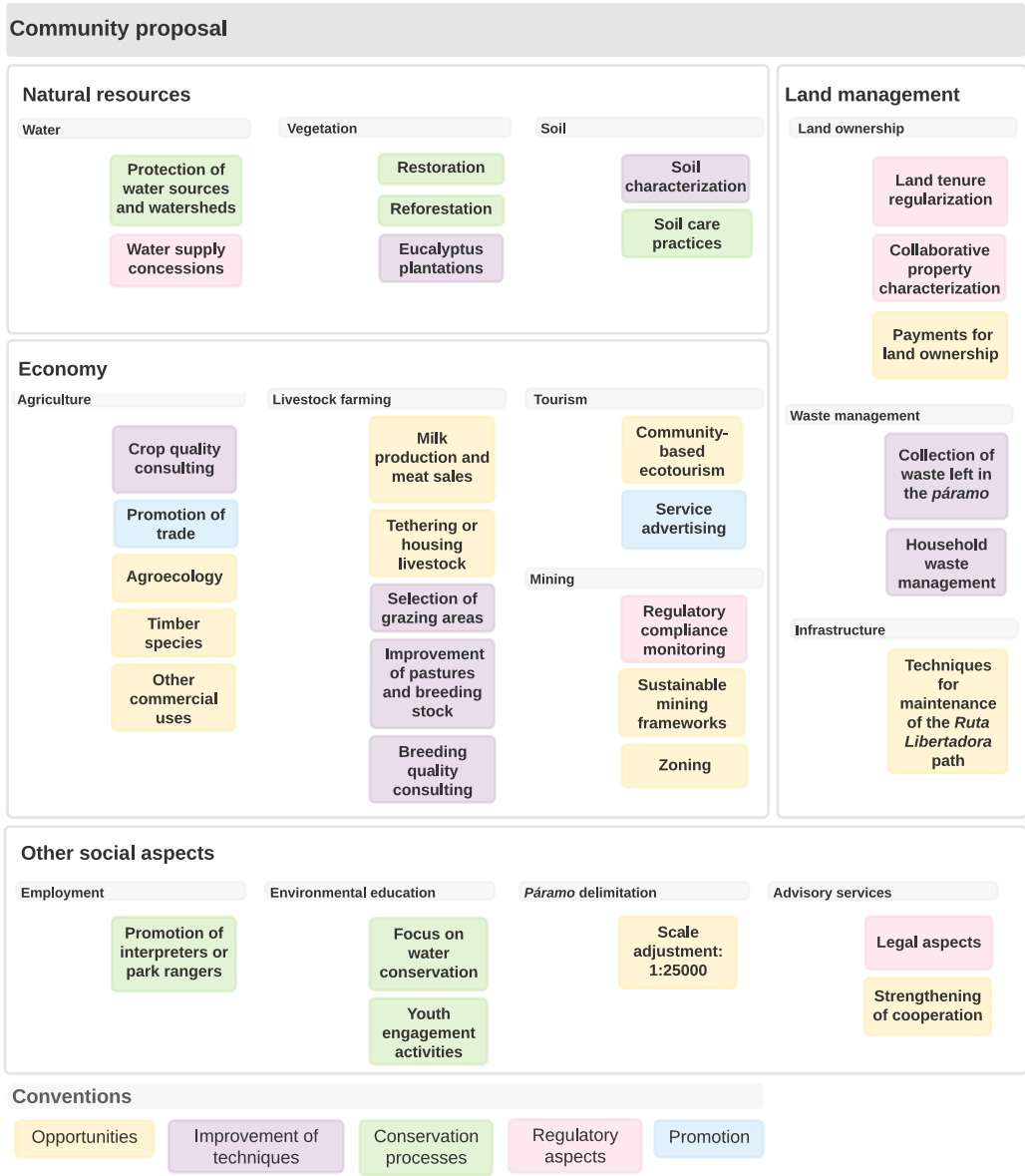

FIGURE 2 - Proposed themes and processes for discussion in community management plans. The community highlighted processes in the following categories: *Opportunities*: Scenarios that require feasibility analysis, addressing profitability, spaces for action, or calls for participation. *Improvement of techniques*: corresponding to the optimization of management and contingency evaluation of their impacts. *Conservation Processes*: These are related to maintaining ecological balance and include social aspects. *Regulatory Aspects*: issues that require advice and actions aligned with current legislation. *Promotion*: focuses on evaluating conditions for marketing and income generation.

SOURCE: own elaboration

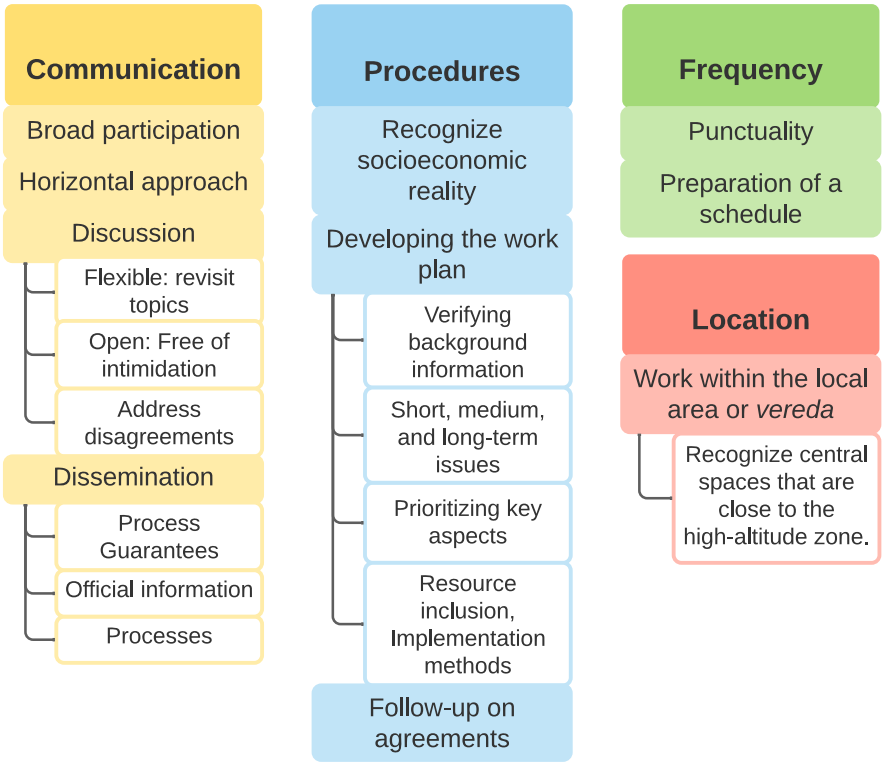

FIGURE 3 – Community proposal for facilitating participation in the community management plan.
SOURCE: own elaboration

and management (Morales-Betancourt & Estévez-Varón, 2006; Redpath *et al*., 2012).

The community's proposal is a call to view the territory and address multiple objectives. In the same way, it involves several actors, not only the environmental authority but also economic stakeholders, organizations, and other interested parties. As a result, this alternative starts from the community and involves the intersection between conservation and development (Berkes, 2007).

3.3.2. Agroecology and Biocultural Memory

This alternative focuses on transforming the management of productive systems towards the principles of the agroecological model, which prioritizes biodiversity functionality and the community's knowledge of their territories and ecosystems. Agroecology is an opportunity to strengthen communities in management tools and shield themselves from the socioeconomic effects of globalization while ensuring ecological balance and food security (Avellaneda-Torres *et al*., 2015; Santacoloma-Varón, 2015).

The community highlights the need for training to make agroecological practices effective and practical in the territory:

> *In that case, you would need someone, an expert, to teach you things and explain how such things are prepared. Because, honestly, well, here, sometimes if we got something organic for the fava bean crop — at least sheep manure, rabbit manure, chicken manure, the ash from the stove — we mix it all and sow with it. Well, I wish I had learned how to cultivate more thoroughly, and of course, we would like to eat more natural products instead of chemical ones*.
>
> (Interview 10, 2018)

However, the community does recognize some agroecological practices, like organic fertilizers. People debate their effectiveness in potato crops, particularly their implications for management, financial investment, and their opportunity to reduce soil and human health impacts. There is also interest in other practices such as organic farming pilots, mixed-species cultivation, the management of living hedges, the establishment of vegetable gardens, and the application of practices specifically aimed at improving soil use. The community broadly sees agroecology and its practices as valuable tools for conserving and using resources.

Community participation in agroecology empowers them and helps strengthen their knowledge and autonomy (Stadel, 2009). In addition, it creates opportunities in the economic dimension based on dialogue, action, and encouragement around sustainability through Family Farming. In that order, this scenario serves as a bridge between public policies such as Resolution 464 of the Ministry of Agriculture and Rural Development, which includes topics of interest to the community, such as encouraging associativity (MADR, 2017).

Finally, the second aspect of this alternative, the recovery of biocultural memory, seeks to vindicate the cultural meanings of biodiversity and its relationship as a whole, which explains the adaptability of societies to their environments (Reyes-Garcia, 2009; Avellaneda-Torres *et al*., 2015). People highlight this approach to improve resource management by recognizing the gradual loss of traditional knowledge. In this order, the community identifies a decline in some knowledge, such as in agriculture concerning the "agricultural techniques of the grandparents," like sowing according to the phases of the moon or practices that emphasize the care of water and soil.

3.3.3. Changes in the agrarian structure

This alternative recognizes the structural aspects of the context faced by *páramo campesinos,* who have been subjected to the historical inequity of land and resource distribution in Colombia. The country's reality places them at a disadvantage, making them vulnerable to pressures of use and occupant of land such as the one in *páramo* areas that are primarily designated for conservation, which results in conflicts or restrictions of use. Therefore, changes in the agrarian structure include enabling access to productive land, aligning current land use with its vocation of use, and other actions that promote the well-being of populations in a transformation within the ecological balance (Avellaneda-Torres *et al*., 2015).

In this sense, the community proposes addressing key processes such as land tenure regulariza-

tion to recognize land ownership rights and improve access to health services, economic associations, and connectivity, given the incomplete coverage of these aspects at the departmental level. This proposal is based on the ineffective state response to these matters, as it is prone to be dictated by market forces, political hegemony, and advantages granted to transnational capital, leaving smallholdings at a disadvantage. In Boyacá, there is also a historical precedent of unimplemented agrarian reforms that could have at least contributed to poverty reduction (Montaña, 2012; Tejedor & Tejedor, 2013). Consequently, it is necessary for the state to make social and economic investments in these territories and to acknowledge the realities faced by its rural communities:

> *I do not know where along the way, but they fail to notice that we should have rights. However, what a huge problem there is in Colombia— there is so much inequality in terms of rights, such as the right to a dignified life, the right to life, or the right to decent housing. Many of those people do not have decent housing. Most rural areas in the remote veredas I mentioned before lack electricity and do not have access to education as we do here. So, several rights are being violated.*
>
> (Interview 17, 2018)

From their perspective, the *campesinos* emphasize the opportunity to feel included, an opportunity to highlight their achievements, and the cultural and historical characteristics of their lives in the *páramo* within the rurality of their territories adapted to high mountain ecosystems. The *páramo*, as their land, enables the definition, integration, and provision of work, which are important aspects for rural communities (Stadel, 2009). Therefore, enabling broader well-being and improved use of land and resources within processes of agrarian structural change is a critical step toward resolving conflicts and dignifying the lives of these communities:

> *I agree that we must take care of and protect it (the páramo). However, this effort should be intertwined between environmental entities and the páramo inhabitants or campesinos because while we are population, we are also campesinos, and proudly so. However, I consider that in this part... because the authorities make decisions without understanding the reality of the páramos, the territories. They do not know the reality of these territories*.
>
> (Interview 17, 2018)

4. Conclusions

The development of agricultural, livestock, and mining activities characterizes the highlands of the municipality of Socotá. Its population is primarily rural and faces limited infrastructure for public utilities. The Pisba *páramo* is important for the community in the area as it represents a source of water resources wealth, and access to resources that sustain economic activities. Additionally, the area has a historical legacy of settlement dating back to colonial times, reflected in the heritage of the *Comunidad de Benítez*.

The community described the environmental conflict in the area across five aspects. First, it centers on the environmental authority and the protected areas, which affect land tenure dynamics and the level of community participation in formal conservation discussions. Second, the impacts of agricultural and livestock activities on the *páramo.* Third, the social and ecological impact of coal mining in the region. Fourth, there is a conflict between

the Presence of Andean bears and livestock farming. Finally, the fifth aspect describes the challenges of improving the *Ruta Libertadora* horse path.

The local population has responded favorably to the alternative community management plans, given that it is a dialogue space incorporating *campesino* initiatives, allowing for discussions on resource management, economic activities, *páramo* conservation, and challenges like strengthening associativity. Concerning the transformation of agroecosystems to agroecology, the community highlights the need for transition processes and training for these practices to become practical and functional within the territory. Finally, regarding changes to the agrarian structure, the community calls for recognizing land ownership rights and providing solutions such as land tenure regularization to dignify their lives, access to essential public services, and enhancing territorial planning.

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