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Strains in Sustainability Debates: Traditional Ecological Knowledge and Western Science through the Lens of Extension Agents in a Pastoral Region*

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Abstract Those involved in sustainability debates on developmental pathways concur in the synergistic potential of integrating traditional ecological knowledge (TEK) and Western scientific approaches. Transhumant pastoralism is a livelihood strategy adapted to spatiotemporal environmental variability in many mountainous and arid regions worldwide. This form of livelihood is based on a mobile logic that is increasingly threatened by novel lifestyles promoted from a Western mind-set and by climate change. The aim of this article is to identify and characterize the different perspectives of environmental and social issues in a pastoral region and their association with labor collaboration among extension agents, framed in an institutional action. We tackled the inquiry about viewpoints with Q methodology and related it to regional problems, alternative solutions, and future development pathways for transhumant pastoralism and landscape management in northwest Patagonia. We identified six perspectives and characterized them with their topological position in the social network. Mediating positions registered the highest network centrality of labor collaborations among agents, whereas more dominant perspectives emphasizing TEK or scientific knowledge registered intermediate centrality. There was consensus on the need for sustainable developmental options, but the emphasis on combining knowledge still needs convergent solutions.

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Introduction

Those involved in recent sustainability debates on developmental pathways concur in the synergistic potential of integrating traditional ecological knowledge (TEK) and Western scientific approaches (Becker and Ghimire 2003). However, even though there are theoretical and methodological proposals aimed at combining these sources of knowledge (e.g., Berkes, Folke, and Gadgil 1995; Huntington 2000; Moller et al. 2004), challenges remain in recognizing whether this convergence offers operative solutions regarding territorial governance in regions where there is a current tension between these worldviews.

Mountainous regions where transhumant pastoralism is the dominant land use are increasingly threatened by the development of other economic activities such as mining, tourism, real-estate business, forestry, and sedentary intensive livestock production. Urbanization processes and the development of regional infrastructure such as roads and communications are growing in these remote regions, introducing novelties in terms of resource allocation logics (toward fixing them in place rather than catering to mobility; cost-benefit rationales), social perceptions about environmental services, changes in land use, land tenure, and even new lifestyles. Climate change may also modify ecosystem functioning, challenging livestock production and overall ecosystem services supply. In this context of social and environmental change, a major concern is territorial socioecological sustainable development and the tension between TEK involved in mobile pastoralism and Western scientific approaches and lifestyle (Easdale and Domptail 2014; Raymond et al. 2010). One major difference between native people and Western culture has been described as thinking spatially in native worldviews, in contrast to the temporal orientation of Western political and historical thought (Deloria 1992). On the one hand, native people focus on local places to get a sense of their history, because their history has coevolved with local nature and it cannot be separated from the entire geography, biology, and environment to which they belong. On the other hand, people in Western culture (e.g., European immigrants to America) look back and forth in time to get a sense of their place in history, whereas the natural world is viewed as segregated and under anthropogenic control, merely consisting of resources that can be exploited for economic or aesthetic purposes (Smith 1996). The idea of convergence between these two worldviews suggests that TEK can contribute insights, new concepts, and even other unrecognized forms of life to Western science (Berkes, Colding, and Folke 2000; Pierotti and Wildcat 2000). However, both the prevalence gained and the role played by TEK as societies modernize are contested (Gómez-Baggethun et al. 2010).

Mobility in human societies is an ancient livelihood strategy of adaptation to environmental spatial and temporal variability (Dyson-Hudson and Dyson-Hudson 1980; Janssen, Anderies, and Ostrom 2007). The first signs of hunters and gatherers in the northwest Patagonia region date back 10,000 years (Llano and Barberena 2013). Transhumant pastoralism has a coevolutionary relationship with regional ecology. This process is less than 300 years old but represents the acquisition and application of TEK for at least 15 human generations. Prevalent circumstances over decades in this region have been the relative isolation from capitalist development and self-management (Sapag 2011). These conditions are reflected for example in the transhumant network that still exists today in relation to the use of the landscape heterogeneity (Bendini, Tsakoumagkos, and Destéfano 1985; Easdale, Aguiar, and Paz 2016). Thus, the perceptions of shepherds and their lifestyle are strongly rooted in the historical evolution of their own experience in the territory, which has largely been part of their social strategies of persistence (Bendini, Nogues, and Pescio 1993; González Coll 2008). In general, TEK has been studied by scientists and compared with scientific ecological knowledge (e.g., Ladio and Lozada 2009). However, there is less evaluation of how TEK is perceived and utilized by extension agents concerned with development and sustainability, but mostly educated in Western thinking. Since extension agents are the social interface between pastoralists and policymakers, their perceptions are enriched by both viewpoints.

Definitions of sustainability and sustainable development are based on multiple perspectives, moral values, and beliefs, which influence how a given society constructs reality at a particular moment (Pearson 2003; Röling 2003). The social group defined here as extension agents is composed of extension workers (e.g., professionals and technicians) linked to agricultural production processes and environmental management, who operate with an institutional agenda. They are relevant actors in the regional social network due to their capacity for action since they influence the direct dynamics of particular sectors such as farming systems, as well as other territorial dynamics through policy design or implementation (Borras and Franco 2010; Zheng 2010). Hence, one of the main objectives of this social group is to promote processes of change, innovation, or sociotechnological transitions (Smith and Stirling 2010). However, prioritization and intervention tools are not only guided by the institutional perspective from which each agent operates. Their individual viewpoints based on their own values and perceptions, which affect their personal construction of reality, are also involved (Cuppen et al. 2010). For instance, their place of birth, age, gender, values traditionally learned or reinforced within a family, professional expertise, labor

seniority, technical or vocational training, learning capacity, motivations, interests, and the social network in which they are involved are factors influencing and forging their dynamic standpoint and perceptions. In addition, these agents of territorial intervention are part of the local society in which they develop their lives, beyond their purely professional activities, and thus include other facets of life (e.g., religious, recreational, cultural, sports).

The construction of reality involves the way in which problems and alternative solutions are ranked and prioritized. This ranking process strongly influences the intervention activities and innovation processes that each individual agent promotes in the territory, in particular those which the agents find as more akin to their perceptions and perspectives of that reality. In contrast, in the same process, other proposals or alternatives that are further away from their standpoints may be discouraged, at least at a given time. In the context of a local network of labor relationships and collaboration among extension agents, a perspective represented by agents with a high central position in that network may be more powerful in influencing others' viewpoints than perspectives represented by agents topologically located at the periphery. The aim of this article is to study the perceptions of extension agents framed in an institutional action in northwest Patagonia (Argentina), with regard to transhumant pastoralism and landscape management, regional problems, and alternative solutions. This study was complemented with a network analysis of the labor collaboration among agents, to depict the topological position of different identified perspectives, as a measure of their dominance and influence. The questions that guided this research were: Which are the main viewpoints or perspectives of extension agents about the topic? Which of the perspectives are represented by agents located in a more central position in the network of labor collaboration?

Methods

Study Area

The study area was the northern region of Neuquén Province, Patagonia (Argentina). Transhumance is the main socioproductive system and source of livelihood for approximately 1,200 households (Easdale et al. 2016; Pérez Centeno 2007). A recent typology has described livestock keepers as the most vulnerable households. They are peasants and smallholder pastoralists with mixed herds dominated by goats, with low resource levels and long distances from urban areas. Their main forms of livelihood are based on livestock pastoralism and environmental services. A second group consists of transition farmers with higher resource

levels who are highly linked to urban dynamics, obtaining off-farm income, while still engaging in transhumance. Finally, a minor proportion includes ranchers, owning higher proportions of cattle and economic resources and typically residing in urban areas (Pérez Centeno 2007). On a regional scale, the main livestock is a local goat (i.e., *criollo* goat), which is highly adapted to the harsh environmental circumstances (Lanari, Pérez Centeno, and Domingo 2007), generally in mixed herds with cattle and sheep. During almost eight months (from April to November) herders use the lowlands for grazing (i.e., winter lands), moving in the summer (from December to March) to the pasturelands located in the mountains and highlands (i.e., summer lands). The winter lands are characterized by vast plains, hills, and plateaus dominated by shrub and shrub-grass steppes (i.e., arid and semiarid rangelands) (Easdale et al. 2016). Summer lands are fragmented landscapes due to the orography, dominated by meadows, grass-shrub steppes, and native forests (*Nothofagus* spp.), which are covered in snow in the winter, thus offering limited access. Most summer lands are state-owned, with grazing permission granted to families every year, without many changes in their allocation due to historical usage of lands. Winter lands show mixed ownership (i.e., state-owned with permission, private properties, and communal properties in indigenous communities). Finally, key components of the transhumance system are the herding roads, which are common lands that connect the different landscapes (Bendini et al. 1993).

Tackling Agent Perceptions with Q Methodology

To explore the perceptions and opinions of the agents involved in the study area, we used the Q methodology (Stephenson 1953), which allows a systematic approach to studying human subjectivity (Goldman 1999). In particular, the design seeks to unveil the views and opinions of participants about a specific subject, by establishing a dialogue among participants and involving the ideas of their colleagues (Robbins and Krueger 2000). These ideas are sorted and ordered according to their own assessments of the different possible aspects of a particular topic, reducing the influence of the observer or researcher on the study object.

The Q methodology involves five major steps: (1) identification of particular discourses under investigation (i.e., the set of possible statements that best reflect the judgments that can be made about a particular subject), (2) Q sample (subset of the statements that will be presented to participants), (3) selection of the P-set (participants), (4) Q sort (ranking procedure for statements based on a scoring template, provided to each participant), and (5) analysis and interpretation (Previte, Pini, and Haslam-Mckenzie 2007).

In order to identify the different discourses in relation to the focal topic under study, we designed an interview based on open questions. The main issues referred to different social, agronomic, and ecological aspects of transhumant pastoralism, regional socioeconomic and environmental processes and problems, possible alternative solutions, and current and future challenges. We interviewed a total of 20 agents (i.e., 36 percent of total extension workers) between April and October 2011. The interviews lasted for approximately two hours and were conducted in the offices of the agents themselves or in places they designated for that purpose. Different institutions and organizations were selected to include diversity in the agents' approaches and the focus of their interventions (e.g., livestock, forestry, social, environmental). Agents bearing dissimilarities in terms of labor seniority in the region, place of birth, gender, and contrasting profile opinion were also considered. The identification of contrasting profiles obtained during interviews helped to identify future participants for the following Q methodology steps.

The next step was to move from the general discourse obtained in the interviews toward identifying the concourse, which refers to the set of issues that exist in reference to a particular discourse or topic, usually embodied in a judgment (Previte et al. 2007). During the development of the set of statements, it is relevant to recognize a variety of viewpoints about a process under study, which should be sufficiently representative of the domain of opinion in question (Watts and Stenner 2005). We elaborated the statements from the responses and discourses obtained in interviews and they were later cross-checked with information from scientific bibliography. The processing of the interviews focused on identifying concepts that were developed from phrases or opinions which accurately identified different issues developed by the interviewees in relation to the proposed topic. This processing generated approximately 300 opinions-sentences that were synthesized in 70 statements. Synthesis was based on the similarity of concepts or complementary issues addressed in original opinions.

Whenever possible, the narrative of the statements was built with the language used in the original opinions (i.e., in Spanish, translated for this article). Finally, we contrasted the concepts of the final judgments with relevant issues identified in international and local scientific articles concerning mobile pastoralism, which served as sources to include some additional concepts that did not emerge from the interviews. Such review included a total of 30 articles focused on traditional pastoral issues, environmental and social challenges, opportunities, and changes. Most of them referred to analogous regions and pastoral systems. It should be noted that this last procedure did not provide new

concepts, but allowed improving or supplementing the central idea of some statements. This suggests that the diversity of opinions reflected in the discourses obtained during the interviews was in line with the main issues of discussion in academic fields, as measured in this case by the content of scientific articles.

During the interview stage, we identified all institutional agents in the region, considering both technical and professional decision makers and direct activities in the territory. The main identified institutions and organizations were linked to the pastoral sector, teaching, media, and environmental management in the study area. Based on information about each institution and its main mission associated with intervention processes, we grouped them according to four main axes, which qualified their management focus as follows: (1) agricultural production, (2) forest management, (3) environmental management, and 4) teaching and media.

The selection of the P-set was the next step. Since Q methodology emphasizes individual subjectivity, traditional statistical sampling techniques are not quite relevant (Brown 1996). The sampling process rather depends on strategic measures based on qualitative sampling or other features used in qualitative studies (Stenner and Marshall 1995). In this study, sampling targeted a mix of qualitative and quantitative features. In a first step, we defined the inclusion of all those profiles that were identified as contrasting during interviews (step 1), aiming at maximizing diversity in individual subjectivity. In turn, we also included a high diversity in relation to other factors that could be influencing perceptions, such as labor seniority in the region (i.e., as a measure of the level of experience and contact with the social and environmental regional circumstances), gender, and birthplace. Another significant criterion was the inclusion of at least three agents from each of the four identified institutional dimensions, and inasmuch as possible at least one representative of each of the institutions and organizations. We selected a total of 32 agents (P-set), who represented almost 60 percent of the total agents working in the study region.

The next step corresponded to the rating process (q-rating). Following standardized methods (McKeown and Thomas 1988), we instructed all participants to classify statements (on 13 x 7 centimeter printed cards) along a gradient from high agreement levels to strong disagreement with the core message of the statement. First, they were asked to read all cards with the offered statements, and then to classify them into three sets: (1) statements with which you agree, (2) statements with which you disagree, and (3) statements on which you would have a neutral or indefinite position. Then they were asked to rank the statements based on a preset quasi-normal distribution, with 13 categories ranging from

"strongly agree" on the one end (+6) to "strongly disagree" on the other end (–6). The number of allowable sentences (cards) in each category ranged from 3 to 10 at the midpoint and then back to 3 (see Figure 1 for all numbers). After the classification exercise and scoring, participants were asked to express, in general terms, the reasons for the classification, with some emphasis on statements placed at the end, as well as other statements located in intermediate positions, which may require any particular comment or explanation. These subsequent explanations allowed setting meaningful notes representing the conceptual reasoning and logics behind the perceptions and opinions, which were previously hierarchically organized. These notes and explanations in combination with the results of previous interviews (stage 1) were key for the interpretation of groups of opinions obtained as outcomes. This q-rating stage was carried out between May and July 2012.

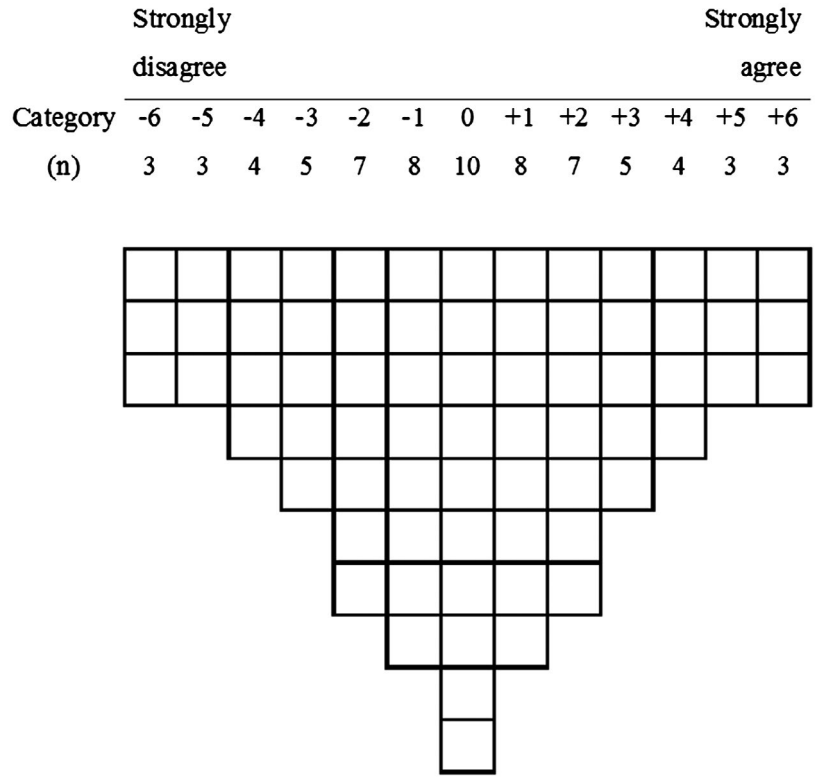

Figure 1. Distribution Scheme for the Classification of Statements.
References: Number of cards with a statement associated with each category (*n*).

The last stage was the analysis and interpretation of outcomes. The score of the participants, reflected in their individual judgments, offered a set of opinions regarding the main issues, strengths, and opportunities of transhumant pastoralism and the environmental and socioeconomic challenges in the study region. We performed principal component analysis to identify groups of people with similar scores and high loads on the obtained factors. It is relevant to notice that a given factor would not be representing the current perspectives of people who were part of the study, but instead depicts the main features which are generalized in the views and perceptions on the particular topic. These features emerge from individual standpoints associated with a factor (q-score of judgments). Factors did not represent groups of people but ideal types that symbolize common ideas in a community or society.

The selected factors were based on the following criteria: (1) eigenvalues>1.0, (2) at least two social agents with significant loading on a factor, and (3) the result of multiplying the loadings of the two agents with more loads on each factor should be twofold over the standard error of the score (z-score) (Van Exel and de Graaf 2005). Consequently, six factors were rotated using the Varimax procedure, using PQMethod (2012) software. Then, we estimated weighted averages to calculate the rating of each statement in each factor, from the q-score of participants with significant loads in each factor, respectively. Scores (z) for each factor had the same mean (0) and standard deviation (1), in order to be comparable among factors (Brown 1980).

The interpretation of the factors was based on the selection of judgments called distinctive and characterizing for each factor. The selected statements were defined first by z-scores with values between 1.5 and −1.5, and q-values in categories 5 and 6 (Figure 1), both positive and negative. The distinctive statements were defined as those that showed statistically significant differences ($\alpha = 0.05$), which implies that statements were significantly associated with a particular factor. The characterizing statements showed no statistical significant differences ($\alpha = 0.05$), which means that they may be associated with more than one factor, but recorded high q-scores, which may contribute a supplementary interpretation of the general logic around views and perceptions in relation to each of the factors, respectively.

Labour Relationships among Extension Agents with a Social Network Approach

We used a social network analysis to complement the identified viewpoints of extension agents with their labor collaboration. This study was proposed to better understand the position of different perspectives in the

local network as measured by their topological position. At the end of the Q methodology interview, we presented a complete list of the extension agents from different institutions to each person interviewed ($n = 56$), and asked the person to complete the type of labor relationship performed with each agent. The type of relationship was defined as: (1) null or without interaction, and (2) with interaction, whether it was occasional or frequent. We developed an oriented and nonsymmetric matrix based on the answers, in which nodes were the extension agents and relations were the type of interactions among them. Each node was classified by its belonging to a perception perspective. The agents with high loadings in the factors, obtained from Q methodology, were assigned to their respective perspective, whereas agents with nonsignificant loadings to a factor were considered as a different class named "others," which represented intermediate positions among different factors. We estimated centrality measures for the whole network and for each class (i.e., perspectives or viewpoints as the nodes of the network) following Freeman (1978). The indicators used were the following: (1) degree (number of relations of a given node with other nodes in the network), (2) out-degree (as a source of relations that a given node promotes to connect with other nodes in the network, as a measure of the generation of labor relationships with others), (3) in-degree (as a sink of relations that a given node receives from other nodes in the network, as a consultant or searched node), (4) closeness (sum of the lengths of the shortest paths between the node and all other nodes in the network), and (5) betweenness (number of shortest paths that pass through a node, which represents the level at which nodes stand between each other). We standardized all estimations (using as a reference a completely connected network). Finally, we defined a reference level (average + 1 standard deviation) to identify the highest values.

Results

We interpreted the six identified factors as six different perspectives on the topic, which accounted for 56 percent of the variability. The first two factors had the highest relative weight and the highest number of participants who loaded significantly on these perspectives. The q-scores assigned to the statements for each factor are presented in Table 1.

Discourses of Identified Perspectives

The different perspectives were named according to the dominant position in relation to the views and perceptions that characterized them, respectively. In addition, we developed a narrative based on the distinctive and characterizing statements that we obtained in each case, according to the established criteria.

Table 1. Statements Related to Problems, Strengths, and Opportunities with Regard to Transhumant Pastoralism in North Neuquén, Patagonia, Argentina.

Factors	F1	F2	F3	F4	F5	F6
Explained variability (%)	24	10	7	5	5	5
1. The stocking rate is regulated by the environment. It fluctuates among years, decreasing due to mortality in times of drought or storms, and increasing in wetter cycles.	1	−6	0	2	4	0
2. The stocking rate is determined by cultural and historical components (i.e., inheritance), and in some cases by social status.	−4	−2	2	−2	−1	2
3. Livestock is determined by the needs of the family for their well-being, income requirements, and occupation according to the members of the family.	−2	0	−3	3	−5	−4
4. Smallholders aim at having as many animals as possible to have a higher lambing rate and income; they do not assess the natural resources and therefore do not link livestock to forage availability.	−2	−1	0	−6	−2	3
5. In general, winter lands are the bottlenecks and impose restrictions to the stocking rate. They have less forage productivity, less water, and recurrent droughts.	1	4	−3	1	0	5
6. In general, summer lands are overgrazed, pastoralists are not aware of degradation, and there is no proper management.	−5	−1	2	−5	−2	2
7. Animals lose weight in the winter, and there are places with significant mortality, which shows that winter lands are overstocked. Whereas in the summer lands livestock gain weight and grow fat. This shows that the summer lands are in good condition.	−1	−1	2	−1	3	0
8. Natural resources are more affected by oil and mining activities (roads, exploration, oil wells) than by overgrazing, especially in many winter lands.	3	−5	−6	1	1	0
9. Many winter lands and summer lands have easy access for vehicles, or native forests are in worse condition due to the extraction of firewood.	−2	2	−1	−2	4	−2
10. There are more animals than the carrying capacity of rangelands because they are open, there are no defined limits, and there are many land-use overlaps. In general it is necessary to reduce stocking rates.	−3	2	5	−1	−3	2
11. Goat production is a matter of tradition and culture, and the one that best adapts to the conditions of the region, mainly to the winter lands, the conditions of transhumant roads, and climate. Policies for regional development should consider this issue.	4	0	−5	6	−1	1

(Continues)

Table 1. Continued

Factors	F1	F2	F3	F4	F5	F6
Explained variability (%)	24	10	7	5	5	5
12. Over the past 10 to 15 years, sheep production fell sharply in the area because of lower wool prices, whereas goats and cattle increased because meat offered better market opportunities.	–1	0	5	–3	1	–2
13. In many areas there is an increase in the number of cattle in land with higher productivity (e.g., wetlands or summer pastures), also due to the incorporation of infrastructure and farming technology.	–1	0	1	–1	–1	–1
14. Livestock production in the region is influenced by greater pressure for the displacement of cattle from the Argentine Pampas, which has led to an increase in cattle numbers in the region.	–2	–4	–2	–3	4	–3
15. Some policy measures such as the public livestock incentive helped smallholders to improve their incomes, mainly favoring those who owned cattle.	–3	–2	0	3	–4	–1
16. The main problem in both winter and summer lands is the lack of land infrastructure, which does not allow the implementation of adequate livestock management.	–1	2	2	5	6	4
17. The main problems in recent years have had to do with the climate: drought, lack of snow in the summer lands, storms during herd movements.	0	–3	3	–1	2	1
18. One of the main problems is related to land tenure. In general, tenure is precarious (farmers have no proof of property ownership), and owners or new private buyers of fields evict centenarian land users and erect wire fences.	6	–1	4	0	–3	1
19. Production could be enhanced with infrastructure that improves the status of rangelands: irrigation, pasture implementation and hay making, electric wiring in wetlands, enclosures in some areas, and rotational management.	2	6	1	2	0	4
20. Production could be improved through higher animal efficiency. Reduce the death of goats and improve lambing rates, for example by incorporating sheds for birth, strategic supplementation during prebirth periods, handling of older animals, and, in certain cases, fattening.	2	3	2	3	6	4
21. There are many problems with regional infrastructure, poor access to vehicles in many winter and summer lands, and communication problems. Rural families are very isolated in many areas.	3	0	2	1	4	–1
22. In summer lands, theft of animals in international border areas is a fairly widespread problem.	–1	–2	0	0	0	–5
23. One of the main productive problems is predation by fox and puma, which varies among areas.	0	–4	–2	–4	5	–3
24. There is a lack of public policies directed at peasants. For this sector, the presence of the state is insufficient, and the policy tools have been developed for more capitalized farmers. Therefore, they are not adequate to the conditions of smallholders.	4	6	–1	5	–1	–1

(Continues)

Table 1. Continued

Factors	F1	F2	F3	F4	F5	F6
Explained variability (%)	24	10	7	5	5	5
25. A serious rural extension program is missing. There is not enough technical assistance to reach all farmers or adequate financing and mobility for extension workers.	2	2	0	4	0	–4
26. Production is a consequence of the poor living conditions of the rural families. Education, health, and decent housing improve production.	5	2	–4	–5	1	2
27. There are relevant animal health and disease problems.	–4	1	–2	–1	1	–6
28. In transhumant roads, the conditions for people and animals are very bad. They are exposed to weather (wind and sandstorms), and there are no shelters, food, or water for animals.	3	–1	4	1	–1	6
29. The conditions of transhumant roads are increasingly poor due to the fencing of roads and paths, generating less space for rest and access to water. The historical transhumant routes are not respected.	5	–1	4	2	0	–1
30. The development of the region does not include transhumant activity. The transhumant roads have been modified where the towns have grown (urbanization), and many traditional roads have been used for the development of roads for vehicles.	6	–1	–2	2	2	–1
31. There is a lack of regulation about land and transhumant roads. There is an enacted law, but it is not regulated, so there is a legal gap that does not help.	5	2	2	0	1	1
32. In areas where there are no herding paths, there are no water and food problems for animals and the conditions are slightly more favorable.	1	–2	4	–2	–4	5
33. It is very difficult to solve the problem of transhumant roads. There is no other way but to wire the paths, since we must preserve private property and favor the most direct route. Paths also prevent the degradation of many areas.	–6	0	3	–1	–3	0
34. The main problem in transhumant roads is that the animals are underweight when they leave winter lands and find it difficult to endure the journey.	–1	–4	1	–3	2	0
35. A solution to the problems associated with transhumant roads is for pastoralists to move the animals by truck. If they had aid in this regard, they would do it.	–4	1	3	0	–4	2
36. In the last 10 years, the family is increasingly divided. In general, the men and some older son or relative may go up to the summer land. The women stay in the winter land. In some areas, women and minor children settle in villages for access to schools. This causes children to lose contact with the activity and the transmission of traditional knowledge.	2	–3	0	4	–2	0

(Continues)

Table 1. Continued

Factors	F1	F2	F3	F4	F5	F6
Explained variability (%)	24	10	7	5	5	5
37. Many pastoralists hire a laborer during calving and for herd movements, since there is less dedication of the whole family than there was before.	1	0	0	1	5	–1
38. Pastoralists know about breeding and how to manage their animals, and they are adapted to the conditions of the region. There is not much to teach them on this subject.	–1	–5	0	–5	–6	–2
39. Pastoralists know very well about the natural resources they have and their status. The problem of natural resources has to do with the problem of land tenure.	0	–3	–3	–6	–5	–4
40. Pastoralists need training and support in reproductive management and genetic improvement, but training should consider local genetic resources (*criollo* goats), and their own knowledge and needs.	–2	5	1	–3	–1	2
41. It is important to support the marketing channels and value added to livestock products such as meat (e.g., designation of origin), in order to promote sales at convenient prices.	–2	5	0	4	3	2
42. Whereas transhumance should be maintained, improvement of rangelands is achieved by enclosures with wire fences and rotating animal management.	–2	1	–1	0	–3	–2
43. It is important to work with the implementation of goat hair combing of fleece to obtain good quality cashmere, as a way to generate another complementary activity and additional income for pastoralists.	0	1	–1	0	2	0
44. It is important to promote diversification through complementary activities such as poultry raising, egg production, beekeeping, and with by-products such as cheese and leatherwork and the promotion of handicrafts in general.	3	4	1	–2	3	4
45. It is important to promote social organization, since pastoralists should become aware of their social role and role in the regional economy. The organization strengthens identity and makes their socio-political demands more genuine.	6	3	–1	0	2	6
46. A major problem with transhumant activity is that young people move from rural areas to urban areas in search of better conditions or income, leaving the old people alone in rural areas.	1	3	6	–1	2	3
47. Farming does not offer opportunities for everyone to stay, and the more children families have the worse the situation. The children leave because there are restrictions on the farm, but there is always one who takes over and stays.	0	–2	0	2	–6	–2
48. Education in rural schools is not oriented to the rural areas where children live, and this situation does not help. At the same time, in many schools, class periods overlap with important transhumance activities (e.g., herd movements, summer-land stays).	1	–1	–5	4	–1	5

(Continues)

Table 1. Continued

Factors	F1	F2	F3	F4	F5	F6
Explained variability (%)	24	10	7	5	5	5
49. Pastoralists generally seek to capitalize, to improve the profitability of their fields, to maintain their vehicle, and when it is possible, to invest in other activities different from livestock.	–3	–4	–3	–1	–2	–4
50. Pastoralists look for other income alternatives, such as having a state-dependent work relationship (civil servants) or working at oil companies, especially young people.	0	0	1	1	–4	0
51. Whereas families have different livelihood strategies in terms of their activities and income composition, livestock production remains as their main activity.	4	0	5	6	1	3
52. In rural areas, national pensions and the Universal Child Allowance (national law) have been good policies and should be maintained as they have improved the economy of many peasant families.	1	–2	–1	2	6	–2
53. Peasants do not have a good future, they just subsist. In the future, they will disappear since there is nothing attractive for them to stay in rural areas doing this type of transhumant activity.	–5	1	6	0	–6	–6
54. Private tourism is a threat to peasants and transhumant activity. There is a potential for real-estate business speculation associated with water, landscape, and tourism, and land is state owned and in a precarious situation.	3	–3	–4	–4	–4	–3
55. Tourism is a good alternative for peasants but in their own hands and as a complement to livestock activity. For example horseback riding, barbecue, escorting tourists when herds are moved, etc.	0	2	2	–3	0	0
56. The lack of private land tenure is a threat to the incorporation of infrastructure, and goes against the possibility of investing because pastoralists do not feel they are owners of the farm. Land property rights should be granted for pastoralists.	–5	–3	–5	0	5	–3
57. Desertification is a major problem and a threat to the transhumant pastoralism, since it depends on the natural resources.	0	5	–2	3	1	1
58. One of the main threats to livestock farming is climate change, since it can lead to further resource degradation, and the greatest risk is in the summer lands.	–1	–5	1	–5	3	1
59. Goat production is very harmful to natural resources and has to be replaced by other alternatives in the future.	–6	–6	–2	–6	–2	–5
60. Young people do not want to work in the farming system. Only older people remain and young people prefer to go to study and to look for other jobs, and therefore the next generations will not proceed with transhumant activity.	–3	0	6	3	1	0

(Continues)

Table 1. Continued

Factors	F1	F2	F3	F4	F5	F6
Explained variability (%)	24	10	7	5	5	5
61. The promotion of silvopastoral systems is a good alternative to complement livestock farming with forestry.	–3	4	–6	6	0	–3
62. The problem of land should be solved through common land tenure.	4	–6	–4	–2	–1	–6
63. A priority intervention measure should be the promotion of woodland plots on pastoralists' farms, as they would contribute to alleviate various needs (firewood for heating and cooking, poles, rods, others) and reduce pressure for firewood extraction and clearing in the rangelands.	2	1	–1	5	–2	3
64. Livestock farming has an excellent opportunity for improvement, since there is good market demand for livestock products (meat, hair, milk and cheese) and good prices, which could improve pastoralists' incomes.	0	1	–4	–4	–1	6
65. Pastoralists are predisposed and willing to improve, but usually the tools that are offered are not appropriate for them or they cannot reach them.	2	3	–1	0	0	–2
66. The state-based aids have created social needs and a strong dependence, which eroded people's desire to work.	2	1	–2	–2	–5	3
67. The region has great aesthetic and tourism potential, and its development should be encouraged.	0	4	1	1	2	1
68. Environmental conservation should be a priority in the design of policies for the region.	1	6	3	2	0	1
69. Forestry is a good productive and economic alternative for the region, which would generate greater economic development for the area, and work for the people.	–4	3	–3	0	–2	–5
70. Pastoralists do not know how to properly care for rangelands because they ignore which forage species are key and therefore which species need to be monitored. In other words, the fields may be maintaining a vegetation cover, but based on species that are not pasture ones and they do not see that there is degradation.	–6	–2	–6	–3	3	–1

Note: The score assigned for each factor (q-values) by the participants was estimated based on the 13 proposed categories, which ranged from –6 (strong disagreement) to +6 (strong agreement) (see Figure 1).

Perspective 1: Transhumant cultural advocates. This factor can be characterized as the advocates or defenders of the culture associated with the transhumant pastoralism. Their arguments were focused on the need to seek solutions to socioproductive structural problems based on the sociopolitical mobilization and organization of smallholders, and on a modification of policies aimed at the pastoral sector, especially land tenure issues. They considered the promotion of social organization as highly important in order to strengthen the identity of pastoral families and thus to better orient their demands (#45; hereafter the reference is to the number of the statement in Table 1). They believe that the development of the region has not included transhumant pastoralism (#30), and they pointed out that the problems are mainly related to land tenure (#6), and especially to the lack of regulations about common land associated to herding roads (#31), whereas they do not agree with the measures to fence herding paths (#33). They also disagree with granting individual property rights to farmers (#56), since there is a threat that private buyers will acquire such fields and this procedure may be a method of exclusion and progression of privatization (#18). In turn, they disagree with the idea that smallholders do not know how to manage their fields and that there is overgrazing because they ignore this problem or because they do not follow adequate management practices to avoid degradation processes (#70, #6). They consider that goat production is not harmful to rangelands, so pastoralism should not be replaced by another economic activity, and it is not in the process of disappearing (#59, #53).

Perspective 2: Environmental conservationists. This factor is characterized by emphasizing awareness about the importance of the environment as a relevant argument in relation to transhumant pastoralism. They consider that other productive alternatives have to be found to reduce the pressure on natural resources, and that the problems are mainly due to the lack of a state policy aimed at the smallholder pastoral sector. They consider that desertification is a major problem and a threat to transhumant pastoralism (#57) and that environmental conservation must be a priority in the design of regional policies (#68). However, they believe that there is no state policy for the transhumant sector, and that the available tools are designed for other productive sectors (#24). They do not believe that the land problem is solved by common ownership (#62). Although they do not consider that goat production is harmful for natural resources, they believe that the problem lies in livestock management. In this sense, they disagree that there is nothing to teach smallholders about animal husbandry and management (#38), and neither do they consider that the stocking rate is mainly regulated by environmental cycles (#1). In fact, they believe that improved production should be associated with improved pasture status, with adequate infrastructure and management (#19), and they support

efforts for marketing and adding value to obtain better livestock products (#41).

Perspective 3: Apocalyptic pessimists. The relevant feature of this factor is considering transhumance as an activity that has no viability over time (#53). They do not consider that goat production is the best-suited activity for the conditions of the region and is a matter of tradition and culture (#11), since young people are gradually choosing other lifestyles. They consider that the main cause for the decline of pastoral activity is the migration of young people to urban areas in search of better conditions and income, because they do not want to work in the countryside, where only the elderly remain (#45, #60). They do not consider the type of education in rural schools as the cause associated with this process. They disagree that smallholders do not know how to properly manage their farming systems, nor do they consider that oil exploitation and mining are the main cause for degradation of natural resources. Finally, they do not believe that silvopastoral systems are a good alternative for the region.

Perspective 4: Bridge builders. This perspective represents those mediating profiles, since they seek to reconcile relevant aspects of the postures described in perspectives 1 and 2. They recognize transhumant pastoralism as a matter of tradition and culture, highly adapted to the characteristics of the region (#11), but they also consider complementary alternatives such as silvopastoral systems (#61) and multipurpose forests (#63). They recognize that livestock farming remains as the main source of income for smallholders (#51), and that one of the main problems is the lack of land infrastructure to implement adequate management (#16), and a lack of state policy aimed at the transhumant sector (#24). They disagree that goat production is harmful and needs to be replaced (#59). They do not believe either that the problem of natural resources has to do with land tenure (#39) or that there is a threat of climate change promoting degradation processes (#58).

Perspective 5: Active state and productivity supporters. This factor is characterized by the inclusion of profiles that consider both the active role of the state and the improvement in production efficiency as means to strengthen transhumant activity. In particular, they consider that national pensions (i.e., National Law 26.425, which created the Integrated Social Security System of Argentina, enacted in December 2008) and the Universal Child Allowance (i.e., Executive Order 1602/2009, enacted in October 2009) were social measures with high positive impact on the peasant families that should be given financial support (#52). They disagree with the fact that the state has created needs and has eroded people's desire to work (#66). They consider that there are changes in the dedication of the family to productive activities that have led to the hiring of temporary labor (#37). They emphasize issues

that affect production efficiency, such as losses due to predation by fox and puma (#23), and the lack of land infrastructure to allow incorporating management raising animal efficiency by reducing goat mortality and increasing the lambing rates (#16, #20). Therefore, they disagree that there is nothing to teach to smallholders about animal husbandry and management (#38), and believe that the incorporation of land infrastructure is associated with a regularization of land property rights (#56).

Perspective 6: Market-based optimists with social organization. This factor is characterized by supporting the idea that transhumant pastoralism has opportunities for improvement given favorable market conditions for livestock products, which may raise peasant families' income (#64). They consider social organization to be highly relevant in this regard (#45) and improvement of general conditions of herding roads (#28), but they do not agree about common land tenure of grazing areas. They do not consider goat activity as harmful and needing to be replaced (#59), nor do they consider herd sanitary issues (#27) or animal theft to be relevant problems (#22).

Perspectives from a Network Approach

The highest network centrality values as measured by closeness and degree were registered for factor 4 (bridge builders), which had one of the lowest number of participants significantly loaded (Table 2). In addition, this factor registered the highest in-degree and out-degree, which means an active promotion of labor relationships, with the highest reciprocity. This result corroborates these agents' function as mediators, from the perspective of their topological position in the network. On the other hand, factor 3 (apocalyptic pessimists) registered the lowest centrality values and the lowest out-degree. Whereas the dominant perspectives as measured by participants significantly loaded and explained variability in Q methodology (represented by factors 1 and 2; see Table 2), both registered intermediate centrality values. This intermediate topological location in network centrality was also registered for factors 5 and 6, but these factors had the lowest number of participants significantly loaded (Table 2), meaning that number of agents loaded in a factor was not positively related to their centrality in the network. The highest levels of betweenness were registered for agents representing factors 1, 2, 4, and *others* (Figure 2). However, mediating positions accounted for the highest frequency of agents with high betweenness (i.e., factor 4 and *others*). Figure 3 indicates details of the labor collaboration among extension agents.

Table 2. Node Centrality Indicators for the Different Categories, Defined by Six Identified Perspectives with the Number of Social Agents with Significant Loadings on a Factor (*n*).

Factor	*n*	Identified Perspectives	Closeness	Degree	In-degree	Out-degree
1	9	Transhumant cultural advocates	0.65	0.65	0.26	0.40
2	6	Environmental conservationists	0.63	0.58	0.24	0.34
3	2	Apocalyptic pessimists	0.61	0.48	0.24	0.25
4	2	Bridge builders	**0.71**	**0.87**	**0.38**	**0.49**
5	2	Active state and productivity supporters	0.67	0.63	0.22	0.41
6	3	Market-based optimists with social organization	0.62	0.52	0.23	0.28
	8	Others	0.65	0.62	0.20	0.42
	24	Not interviewed	0.54	0.18	0.18	0.00
		Average	0.60	0.43	0.22	0.22
		Standard deviation	0.08	0.28	0.09	0.22
		Average + 1 standard deviation	0.68	0.72	0.31	0.44

Note: Two more classes are included so as to identify *others* (agents not significantly loaded in a factor) and no interviewed agents. A reference level (average + 1 standard deviation) was defined to identify the highest values.

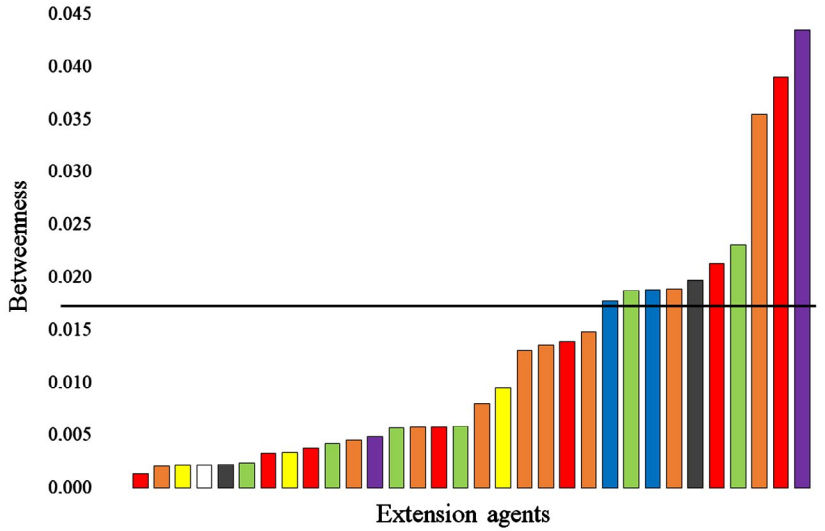

Figure 2. Node Betweenness of Extension Agents with Values above 0.
Note: Colors of bars refer to agents' perspectives (Table 2): transhumant cultural advocates (factor 1, orange), environmental conservationists (factor 2, green), apocalyptic pessimists (factor 3, dark gray), bridge builders (factor 4, blue), active state and productivity supporters (factor 5, violet), market-based optimists and social organization (factor 6, yellow), others (red), and not interviewed (white). The black line identifies a reference level defined by the average + 1 standard deviation. [Color figure can be viewed at wileyonlinelibrary.com]

Discussion

The studied perceptions of extension agents provided evidence of the high level of diversity with respect to the tensions between traditional ecological knowledge and Western scientific approaches. Their judgments about problems and regional development opportunities of transhumant pastoralism in the context of a mountainous socioecological environmental change represented perceptions from very different viewpoints. On the one hand, the transhumant cultural advocates valued the cultural aspects and livelihood adaptability as a main regional strength. On the other hand, environmental conservationists highlighted problems regarding the lack of policies for the sector and the threat of environmental degradation, whereas apocalyptic pessimists had a gloomier view and predicted a downward trend of transhumant pastoralism mainly due to a change in young people's expectations. There were bridge builders with mediating perspectives, which may help in the articulation of traditional and scientific knowledge. Finally, others focused on the opportunities associated with livestock production

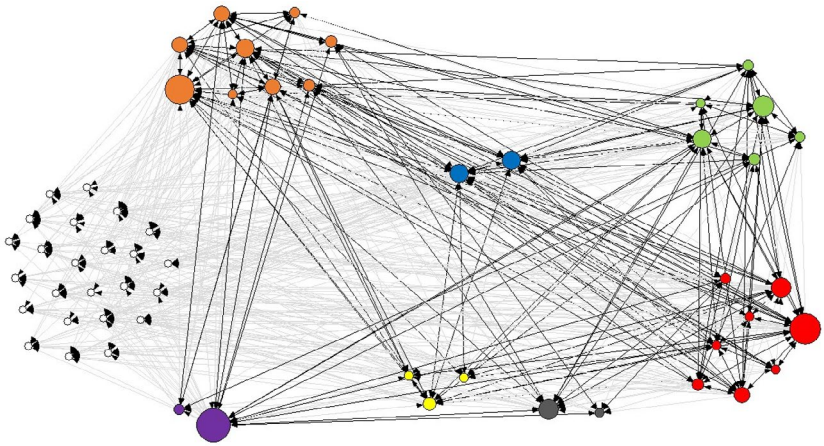

Figure 3. Network of the Labor Collaboration among Extension Agents.
Note: Nodes (circles) indicate different perspectives with their respective colors (see Table 2): transhumant cultural advocates (factor 1, orange), environmental conservationists (factor 2, green), apocalyptic pessimists (factor 3, dark gray), bridge builders (factor 4, blue), active state and productivity supporters (factor 5, violet), market-based optimists and social organizations (factor 6, yellow), others (red), and not interviewed (white). Black arrows identify reciprocal relationships and gray arrows identify nonreciprocal relationships. The bigger sizes of the nodes refer to higher levels of betweenness. [Color figure can be viewed at wileyonlinelibrary.com]

in particular, but differed on the active roles of the state or markets, respectively. Our study indicates that extension agents should not be considered as a homogeneous group in their perceptions. Furthermore, this diversity challenges the articulation between TEK and Western scientific approaches in this kind of region.

The diversity among opinion groups was also associated with differences in the hierarchy of recommendations that emerged as priority pathways for intervention at a territorial level. Antagonistic positions were recorded by the two groups with more loadings (perspectives from factors 1 and 2), such as their viewpoints with respect to forestry and silvopastoral systems, tourism development, and solutions to land tenure problems (Table 1). With dissimilarities in their discourses, the agents in their different perspectives were seeking to advance the modification of certain structural aspects of the regional dominant livelihood system or regime (i.e., transhumant pastoralism). From the perception of each specific group, these changes may be viewed as highly abrupt transformation processes, and possibly too conflicting with the values defended by each perspective, respectively. Both dominant positions can be

associated with different theoretical developments in the academic and political arenas regarding agrarian and rural development at national and international levels.

In the case of transhumant cultural advocates, their viewpoint was strongly based on the support of TEK. For instance, forestry activity would be conceived as a threatening transformation for transhumant pastoralism, because it would directly impact on key features of the system such as land use and tenure in summer lands. This logic could be framed in the discourse defending peasant economy (Chayanov [1925] 1974), and the analysis of peasants' resistance to the advance of capitalism and concentration processes. Their rejection is based on power differences of certain social actors linked to capital (see, e.g., Murmis 1994; Scott 1986), whose actions would be masked in these cases in the need for environmental conservation (Bendini, Tsakoumagkos, and Nogues 2004; Bryant 1997). Perhaps for this reason, the processes of degradation of natural resources were not part of their central position and they even discarded their relative importance, emphasizing that pastoralists have enough knowledge of their environment and correct management (e.g., statements #70, #6, Table 1). On the other hand, forestry and even tourism would promote a process of proletarianization of peasant families (i.e., they would cease to be pastoralists and would be hired as employees) by removing a key resource such as land from their direct access (Clapp 1998). This would lead to a growing reliance on capital to provide them with forms of livelihood. In this argument, the promotion of community land tenure would allow local actors to decide their land use more organically, and to defend their lifestyle and production, based on the concept of food sovereignity (Altieri and Toledo 2011; Borras 2008). One of the distinctive measures targeting this position was promoting social organization and strengthening the identity of transhumant culture, reflecting the idea that the way to enhance territorial governance is social mobilization and participation (i.e., a bottom-up process).

In the case of environmental conservationists, there was an association between their position and Western scientific approaches. This group was concerned with the provision of ecological services and represents an ecological perspective or "green" variation of the market economy (Pretty 2013), even with some logics rooted in the discourse on the tragedy of the commons (Hardin 1968). It postulates that in a system based on the common use of a resource, the maximization of the individual benefit would play against the community benefit, generating an overutilization of the resource (e.g., overgrazing) causing degradation and therefore a generalized collapse. The solution to this problem is postulated through the privatization of the land with the assumption

that the individual owner of the resource will implement more efficient management, avoiding its degradation and therefore ensuring a benefit to society by preserving natural resources. This perspective also had practical implications in promoting the sedentarization of production, wire delimitation of rangelands, and rotational management in arid and semiarid regions, which were originally based on mobile livestock (Homewood 2004; Rohde et al. 2006). Hence, the path of afforestation, in particular the promotion of silvopastoral systems, could be offering the twofold advantage of generating greater productivity and labor options in the region, while avoiding further degradation of natural resources, mainly attributed to overgrazing. Disagreement with community land tenure was due to its inefficiency to reverse the process of environmental degradation. However, one relevant distinction was that the agents also disagree with land privatization as a solution (#56, Table 1), but they did emphasize the incorporation of infrastructure for rangeland management, which involves wire fencing and rotational management at an individual farming level (#19, Table 1). Finally, they assigned a greater responsibility to public policy (a top-down approach), noting that the main problem is the lack of policies oriented to the transhumant pastoral sector.

When a sociotechnological regime is dynamically stable, the incorporation of innovations confronts some barriers that depend on the pressure of change and the capacity for adaptation or response to that pressure by the dominant regime (Smith, Stirling, and Berkout 2005). For example, afforestation with exotic species (i.e., *Pinus ponderosa*) was promoted as an alternative economic activity for the region in the 1980s, as in other regions of South America (e.g., Clapp 1998), aimed at replacing transhumant pastoralism as the main land use in the most productive areas such as summer lands (Bendini et al. 2004). This productive model did not take into account some key characteristics of these areas for the transhumant regional system such as connectivity and productive stability (Easdale et al. 2016), provoking social resistance that has persisted until the present. The results of our research suggest that there is a wide consensus among extension agents in disagreeing with the idea that goat production is very harmful to natural resources and has to be replaced (#59, Table 1). Based on this argument, the transhumant cultural advocates would seek to strengthen the current sociotechnological regime defined by transhumant pastoralism, supporting pastoralists' knowledge and lifestyle, and promoting social empowerment (Csurgó, Kovách, and Kučerová 2008). On the other hand, they downplayed the impact of climate change, such as the increased dryness of winter lands, rise in winter temperatures, and summer stress in highlands. Since livestock

is a critical resource for peasant livelihood, climate change challenges self-consumption due to the intensification of environmental stress, which was undervalued.

A sociotechnological transition process at a landscape scale involves the existence of technological niches under development as well as opportunities for incorporating these innovations in an established sociotechnological regime (e.g., a disturbance or a disruptive change). In addition, key social actors are relevant to promote a shift (Geels and Schot 2007; Van de Poel 2003). In this study, the role of social actors with mediating positions could favor processes for bringing contrasting visions closer toward an agreement with common axes for interinstitutional intervention. For example, bridge builders supported transhumant pastoralism as a socioproductive culture adapted to local conditions, but also considered silvopastoral systems to be viable alternatives, which can be developed as an alternative to incorporate afforestation into the current pastoral system but as a complementary option. This viewpoint suggests the existence of a niche of innovation in progress, still based on a small number of agents but with a high network centrality (Table 2), which could potentially promote transition processes in a sociotechnological regime, currently dominated by transhumant pastoralism (Geels and Schot 2007). A future change or stressful circumstance in the configuration of this regime may create windows of opportunity to promote a sociotechnological transition toward another regime (e.g., a transition to a new regime of silvopastoral systems). However, this new niche requires the society to concur with the allocation of economic resources aimed at developing a diversified pastoral region (Easdale and Domptail 2014).

Conclusions

Transhumance is a social-ecological system in which coevolution resulted in TEK embodying the regional spatiotemporal natural heterogeneity. The results suggest that the social group defined here as extension agents is not a homogeneous network, and does not have a unified message about the main regional problems and solutions that should be supported. Since the extension agents are at the interface between pastoralists and policymakers, resolving the identified strain between TEK and Western scientific approaches is critical for the future development of these regions. Further research is needed to better understand the manner in which different perspectives or visions imprint the field work of each extension agent, as well as the agents' influence on public policy. While there is consensus on the need to seek convergence of scientific and traditional knowledge of local communities to achieve better future pathways, the sustainability debate does not lead to convergent

and easy-to-implement solutions because of the dominance of antagonist perspectives. Whereas such discussion should empower mediating positions, sustainability pathways still require great efforts to seek societal consensus.

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