

From traditional knowledge to novel adaptations of transhumant pastoralists the in face of new challenges in North Patagonia

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ABSTRACT

Transhumant pastoralism is a mobile livelihood strategy in many mountainous, arid and semi-arid regions worldwide. The knowledge of pastoral communities and their lifestyle are strongly rooted in the historical evolution of their own experience in the region, which has largely been part of their social adaptation strategies to environmental variability. However, other recent processes such as urbanization, land-use change, land grabbing and agricultural intensification have promoted the fragmentation of the landscape in this type of regions, thus threatening many mobile farming systems. Our aim was to study the predominant resources and perceptions in the discourse of transhumant pastoralists who are spatially distant from urban areas, with less relative contact with modern lifestyle and consequently, facing certain restrictions on resources availability. The study was oriented to explore the perceptions and adaptations of pastoral families with respect to the problems, challenges, and opportunities that transhumant lifestyle is currently confronting in North-West Patagonia, Argentina. We developed a collective cognitive mapping based on individual semi-structured interviews and network analysis techniques aimed at identifying their predominant perceptions. Traditional cultural issues associated with forms of livelihood and transhumant lifestyle were dominantly manifested, but there were references to some key resources, problems, and opportunities rooted in modern or urban lifestyle system. This mixture of resources and strategies suggests an increasing urban-rural articulation, which is an adaptation to strengthen the current socio-ecological system regime. However, younger generations of transhumant pastoralists are growing in an urban-rural network, which challenges their lifestyles and future developmental pathways.

1. Introduction

Transhumant pastoralism is a socio-productive strategy adapted to spatial and temporal environmental variability in many mountainous, arid and semi-arid regions worldwide. Despite its long-time development, this mobile logics is based on traditional knowledge, which remains a resilient form of coping with spatiotemporal heterogeneity in these regions (Janssen et al., 2007). However, transhumant pastoralism is being increasingly threatened by novel lifestyles and scientific approaches promoted from a Western mind-set (Rohde et al., 2006). For example, urbanization process, land grabbing, the development of different economic activities with implications on land-use change and State-based sedentary logics are increasingly straining human development pathways in such regions (Easdale and Domptail, 2014). However, definitions about sustainability and sustainable development

are based on multiple perspectives, including moral values and beliefs of different social actors in a particular moment (Röling, 1999). These issues are often mentioned rather than truly quantified. The construction of worldviews also involves the way in which problems and alternative solutions are ranked and prioritized. Understanding many of the current complex problems regarding human-environmental interactions requires novel strategies of integrating scientific and traditional knowledge (Whitfield and Reed, 2012). Inquiring into the knowledge and thoughts of social agents involves addressing complex social and individual cognitive processes as the basis of reasoning and decision making (Beratan, 2007), and recognizing social-based structures underlying such processes.

Human actions are developed within structures of rules or virtual schemes (i.e. cultural), as different kinds of procedures applied to the reproduction of social life in a given moment and place (Sewell, 1992).

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Pastoralists and rural households develop their identity and lifestyle as well as their ideas and knowledge in a complex and historical process which is permanently under negotiation between internal and external factors (Vanclay et al., 2006). In a local community, a repertoire of life strategies can be identified, which are derived from parables whose construction occurred at a social and historical level. This repertoire of strategies builds up many of the cultural elements shared in a rural community. Cultural schemes that are not empowered or regenerated by resources will be abandoned and forgotten by a society. Likewise, resources without cultural schemes that orient their usage would dissipate and decay with time. A set of schemes and resources are built into structures only when they manage to sustain each other over time (Sewell, 1992).

Traditional Ecological Knowledge (TKE), which is strongly tied to a spatial thinking, refers to the worldviews of native people. They search in local places to get a sense of their history, because their history has co-evolved with local nature and it cannot be separated from the entire geography, biology and the environment where they belong (Pierotti and Wildcat, 2000). Collective memory is not stored in a static representation of past experiences, but evolving in an active process (Ingold, 2000). For example, transhumant pastoralism involving a mobile way of living agglomerates a set of livelihood strategies that identify their lifestyle in many mountainous regions worldwide. Pastoralist decision-making processes and the resulting practical evidence emerge from a negotiation between the set of culturally fixed strategies (e.g. transhumant practice, production logics, land management, social networks), external local factors (e.g. intervention agents, media, market signs, environmental events), and internal factors (e.g. mediated by values and personal experiences, access to different livelihoods, configuration of household strategies) (Vanclay et al., 2006).

From an individual agent's perspective, schemes can also refer to cognitively accessible representations of past experiences, which remain stored in memory (Beratan, 2007), contributing to the development of mental models. Mental models are internal representations of the world associated with the relative significance given to things and processes, which are the basis of reasoning and logics, decision making and in some cases individual behaviour (Jones et al., 2011). Changes in individual schemes (and potentially in mental models) occur through non-conscious processes as a response to experimental learning, during exposure to new situations, ideas, and social relationships (Beratan, 2007).

Theories of discourse argue that the formation of meaning is a social process and that certain meanings tend to be fixed in collective uses (colloquial or media uses) and are institutionalized in time and space. These sets of meanings are available in discourses through which humans experience life (Evans, 2000). Discourse is, therefore, an important mechanism for the modification of individual schemes and mental models, and consequently a promoter of changes in human behaviour (Beratan, 2007). Some approaches to the study of mental models include the analysis of texts or interviews, graphical representations of relations among human agents, resources, and processes (Lynam et al., 2012). Another perspective proposes that cognitive mapping is a tool that makes qualitative mental models explicit and reflects the way in which a system operates, based on the definition of variables and causal relationships among them (Özesmi and Özesmi, 2004). In particular, causal mapping was used to explore common or predominant representations of a given discourse, using interviews with social agents of interest (e.g. Fairweather, 2010; Fairweather and Hunt, 2011).

Mobility in human societies is an ancient livelihood strategy of adaptation to the environmental spatial and temporal variability (Dyson-Hudson and Dyson-Hudson, 1980; Janssen et al., 2007). Transhumant pastoralism from North-West Patagonia has a co-evolutionary relationship with the regional environment. Relative isolation from the capitalist development that prevailed in this region and self-management have been prevalent over decades (Sapag, 2011). This

emerges for example in the socio-productive transhumant network that still exists today in relation to the use of the landscape (Bendini et al., 1985; Easdale et al., 2016). Thus, the perceptions of pastoralists 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 resistance (Bendini et al., 1993; González Coll, 2008). However, ongoing processes, such as urbanization, land-use change, land grabbing, appropriation of common land (pastoral herd ways that connect winter- and summer-lands for the construction of car roads), and agricultural intensification (promoted by federal agencies and governments), promote the fragmentation of the landscape in this type of region and threaten many mobile farming systems (Galvin et al., 2008). But more importantly, these processes challenge a culture and a way of living and perceiving the natural heterogeneity (at a regional scale). Our aim was to study the predominant factors and perceptions in the discourse of transhumant pastoralists who are spatially distant (> 100 km) from urban areas, with less relative contact with modern lifestyle, and in general with certain restrictions on resources availability. The study was oriented to explore the perceptions and adaptations with respect to the problems, challenges, and opportunities that transhumant lifestyle faces in North-West Patagonia, Argentina. It was expected that in the predominant collective discourse, the traditional cultural assets associated to livelihoods and lifestyle would be manifested, but also including references to current novel resources provided by the modern or urban lifestyle system and Western scientific approaches. This strain between the traditional and the modern lifestyle was used as a methodological strategy to measure the magnitude and current direction of the interrelationship between rural and urban dynamics.

2. Materials and methods

2.1. Study area

The study area was located in North-West Patagonia (Argentina), where transhumant pastoralism is a prevalent activity and the dominant land-use type. Transhumant pastoralists are very heterogeneous in terms of household composition, land tenure, biophysical features. Likewise, distances between winter- and summer-lands, distance to urban areas influencing the access to subsidies, off-farm income and education, and livestock production systems also offer a wide range of variety (Bendini et al., 1993; Easdale et al., 2016). The main livestock is a local goat breed (i.e. *criollo* goat), which is highly adapted to the harsh environmental circumstances of this region (Lanari et al., 2007). The main livestock product is meat for self-consumption and selling off surplus to local markets, whereas fibre extraction (cashmere) is an incipient innovation. Goats generally form mixed herds with cattle (crossbreed of Hereford and *criollo* cattle) and sheep (Merino and crossbreed of Merino, Hampshire Down and *criollo* sheep). A recent classification has described the socio-economic heterogeneity of transhumant pastoralists in three types: i) *livestock keepers* or *fragile peasants*, ii) *transition farmers* and iii) *ranchers* (Pérez Centeno, 2007). *Fragile peasants* are smallholders with mixed herds, dominated by goats, with the lowest resource levels and longest distance to urban areas. These are the most frequent and vulnerable households in the region. *Transition farmers* count with higher resource levels and are highly linked to urban dynamics, while still practising transhumance. Finally, a minor proportion of households are characterized as *ranchers*, who have higher proportions of cattle, economic resources, more productive lands and urban residence (Pérez Centeno, 2007). During almost 8 months (from April to November), herders use the lowlands (winter-lands) for grazing, moving, in the summer (from December to March), to the pasturelands located in the mountains, named as summer-lands. The winter-lands are arid and semi-arid rangelands characterized by vast plains, hills, and plateaus dominated by shrub and shrub-grass steppes. Ownership in these large areas is mixed, finding State-owned land with

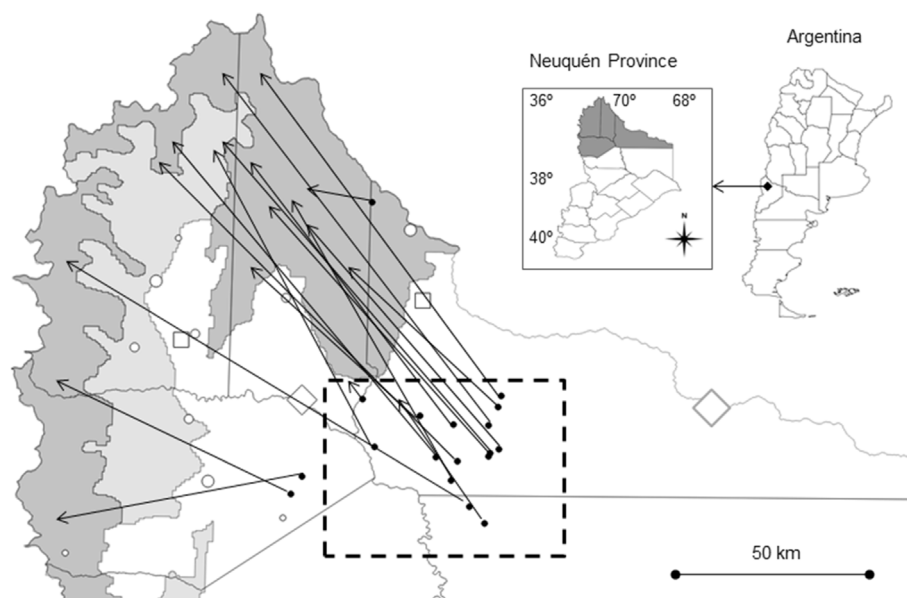


Fig. 1. Study area in Northern Neuquén, Patagonia, Argentina. The box with black cut line indicates the boundaries of the selected study area. The black spots indicate the location of winter-lands where the interviews were conducted, and the arrows indicate the location of the respective summer-land. Areas of dark gray identify the *Andes* and *Cordillera del Viento* mountains, whereas sub-Andean grazing areas are in light gray, and areas of steppes, plateaus, and plains in white. Urban areas are identified with the following figures: diamonds (> 3000 inhabitants), squares (2000–3000 inhabitants), circles (< 2000 inhabitants). Larger figures indicate larger population. The lines in the province of Neuquén identify the boundaries of counties.

grazing permissions, individual properties and communal properties in indigenous communities. On the other hand, summer-lands are dominated by meadows, grass-shrub steppes, and native forest of *Nothofagus* spp. in some areas, covered in snow in the winter, which limits access. Most summer-lands are State-owned, granting grazing permissions to families every year. Finally, key components of the transhumance system are the herding roads, which are common lands that connect winter- and summer-lands (Bendini et al., 1993).

An area from Northern Neuquén province was selected for this study, based on the following criteria: i) winter-lands (i.e. the areas where the pastoral families reside for longer periods along the year) with the lowest levels of regional infrastructure and further away from urban areas, ii) area which maximizes the biophysical contrast between the winter- and summer-lands, and iii) summer-lands distributed in different mountainous areas (Fig. 1). This study area considers approximately 100 pastoral households, whose winter-lands are located in the Monte phytogeographic province (León et al., 1998), whereas the summer-lands are situated both in the *Andean Mountains* and in *Cordillera del Viento* range. Due to geographical distances, these are transhumant pastoralists who spend the longest migration time of the region, reaching in general to almost 25 or 30 days from winter-lands to summer-lands.

2.2. Sampling and information gathering tool

The interviewees were randomly sampled, within the previously defined study area. Sampling was performed among the transhumant pastoralists defined as *fragile peasants*, which means those located further away from urban areas and with certain restrictions on the availability of socio-economic resources (Pérez Centeno, 2007). The total number of interviews was defined by two complementary criteria: i) a representativeness of at least 15% of pastoralists in the study area and ii) the saturation of emerging concepts in discourses during interviews. To define this saturation, the relationship between the accumulated frequency of emerging concepts in the discourses and the new elements incorporated in each additional interview was tracked. The repetitiveness of factors and concepts over 90% of the elements accumulated in previous interviews was considered as a saturation threshold. Finally, with the intention of testing the saturation criterion through the incorporation of potentially more heterogeneous cases, some interviews were carried out at sites far beyond the boundaries of the study area, but with similar situations in terms of the criteria used to define this area. Taking the mentioned criteria, a total of 18 interviews were

carried out between June and November 2011 (Fig. 1).

The selection of winter-lands to visit was determined on the field, randomly taking primary and secondary roads in the area, and without previous contact with pastoralists. The interviews were carried out within the house following the suggestion of the family (i.e. usually in the kitchen or the dining room), and with all the members of the family who were present at that moment, whenever possible. The interviews lasted approximately 2 h, and in many cases the talk was extended to expand some issues or even to incorporate a brief tour of the field, depending on the gained confidence, the concerns, and available time of pastoralists.

The interviews were semi-structured, including a section with a set of indicators and selected variables and another section with open-ended questions acting as guides to keep a common thread during the talk. In the structured section, information related to their access to different livelihoods was reported: i) natural capital, ii) human capital, iii) social capital, iv) manufactured capital and v) financial capital (Scoones, 1998; Davies et al., 2008; Easdale and López, 2016), considering the period from July 2010 until June 2011 as a reference. In the open section of the interviews, the questions were oriented to their perceptions and opinions about the general features of transhumant pastoralism in the context of their livelihood strategies, management decisions, problems and opportunities related to production, their lifestyle and the role of household members (see Appendix A2). During this stage of the interview, it was prioritized that the members of the family led and managed the times of the conversation, with the intention of detecting the most relevant emerging concepts in their discourses. For instance, threats to their lifestyle were not directly asked about, in order to let them emerge from their own perceptions. The relevance of the topics was generally inferred from the emphasis with which they were treated or presented, or from the frequency of appearance in the discourses during the interview.

2.3. Analysis: collective cognitive mapping

The objective of the interview was to collect information about factors which were proposed in the structured section, but at the same time, the non-structured section allowed the emergence of other factors or concepts not previously considered in the discourse of the pastoralists under study (Fig. 2). The set of factors was defined by their concurrence in that discourse, and the relationship among them was non-directed and non-weighted. The main advantage of this procedure is that a greater freedom is given to the interviewee to express their

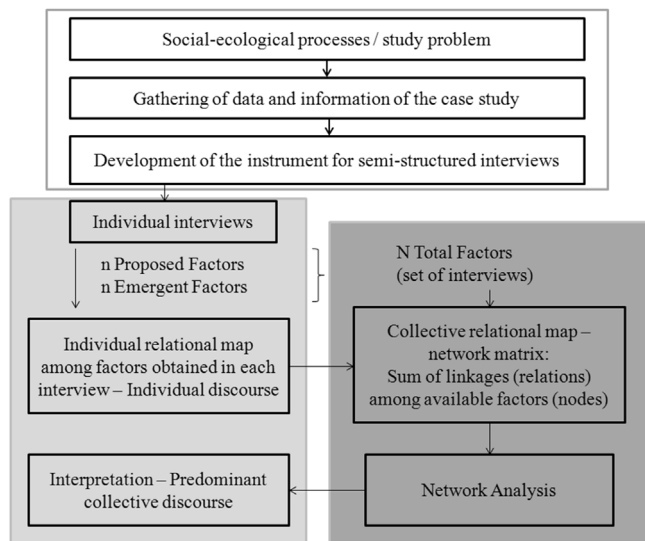


Fig. 2. Scheme with the sequence of the performed methodological steps. White box identifies early steps of the study, light gray box identifies steps based on qualitative procedures and dark gray box identifies steps based on quantitative procedures.

opinions and perceptions about a proposed theme or topic, and thus to be a participant in the generation of the matrix of factors, both in their particular case and in the collective discourse. The collective relational map was obtained from the set of individual maps (e.g. *sensu Fairweather, 2010*).

The interviews were processed obtaining factors, opinions, and perceptions associated with the different themes proposed and emerging from the discourses of the pastoralists and their families. The factors were represented by the selected variables in the structured section of the interview, which were associated with different livelihoods. On the other hand, from the open section of the interview, opinions and perceptions were obtained and synthesized in concepts. These concepts were expressed in the form of statements. Those opinions arising from different interviews, which referred to similar themes, were integrated into a single concept (hereinafter also referred to as a factor). A total of 150 factors (i.e., nodes of the relational map) were obtained, later used to construct a symmetric matrix (150 × 150). The body of the matrix represented the relationships between each pair of factors, whose link was binary (1-related, 0-unrelated). These linkages were generated from the concurrence of factors in the discourse of each individual interview. The relationships among the obtained factors in each interview were aggregated into a general matrix in order to obtain the factors with higher levels of relations (i.e. network degree), which would be associated with the predominant collective discourse (i.e. collective map). This general matrix was used to perform the analyses. In particular, the following indicators of network centrality were calculated for each factor: degree and intermediation (Freeman, 1978).

The identification of the central factors of the collective discourse was associated with the accumulated frequency of linkages between each pair of factors, as a variable which identified common elements in the discourse. The total average of factors that emerged in each interview was used as a threshold for the analysis of the core factors in the collective discourse (i.e. 47 average factors per interview). In turn, the general matrix was used to calculate the following indicators of centrality: standardized degree and intermediation (Freeman, 1978).

The collective relational map (i.e. the general matrix), was graphed. The spatial ordering of factors (nodes of the network) was iteratively optimised based on lines or orbits of degree similarity, placing the nodes with higher loads in the nearest orbits and those of smaller diameter. Progressively and in a centripetal sense, the nodes with the

lowest loads were located in farther positions within a given orbit, or in distant orbits. This graphical procedure identified nodes (i.e. factors in peasant discourses) that occupied a central space of the network and with greater energy. In this case, the nodes with the highest degree, which occupied that central network space, were the related factors that comprised the predominant discourse on the subject under analysis. The Kamada-Kawai method of separation of components (Batagelj and Mrvar, 1998) was applied, using Pajek 2.0 software.

3. Results

The number of factors, obtained in the interviews, which conforms peasant livelihoods and perceptions, reached a total of 150 (Appendix Table A.1., original statements in Spanish). They included structural aspects (natural, human, social, manufactured and financial capitals), and perceptions in reference to problems, strategies, and opportunities related to the transhumant activity and the role of household members. The discourses in the interviews averaged 47 factors, ranging between 31 and 57 factors between the interviews with lower and higher development, respectively.

The frequency with which the interviewed pastoralists linked different factors in their discourses presented a non-linear curve. This represents the saturation curve of factors and concepts associated with the topic proposed in the interview. In other words, high frequencies were recorded in the relationship between certain factors, which occurred in a small number of pairs of factors, suggesting the emergence of common elements in the discourse during the interviews, associated with some features or opinions with greater predominance (Fig. 3).

The collective relational map considers the 150 ordered factors in orbits with a similarity of degree (Fig. 4). This map allows graphically identifying those factors that are located in a closer relational space (central axis of the discourse to concentrate more energy), with respect to others which are in more distant orbits. These outside orbits refer to more specific factors and show a greater diversity of opinions. In other words, they are less associated with the collective discourse that appears as dominant. The limits on the relationships among factors are not clear, highlighting the complexity associated with opinions on a particular theme. However, based on all the information collected in the interviews (i.e. interview level or hierarchy), 44 factors were accumulated in 11 frequency groups (threshold = 47), related by at least 44% of the interviews (Table 1).

The collective discourse of transhumant pastoralists predominantly linked diversification with farm activities (order # 2, Table 1), and the use of a radio in the house (#1). The radio is mainly used to listen to information about local and social issues from the National

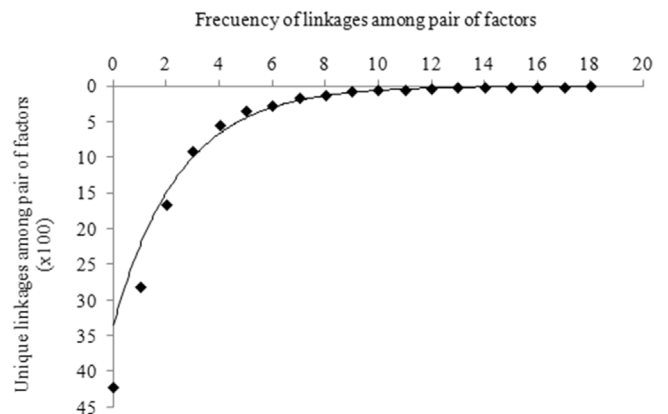


Fig. 3. Collective discourse saturation curve, represented by the frequency with which single pairs of factors were linked (n = 150 factors, with 11,175 total unique links), considering all the performed interviews ($y = 3359.8 e^{-0.404x}$; $R^2 = 0.97$).

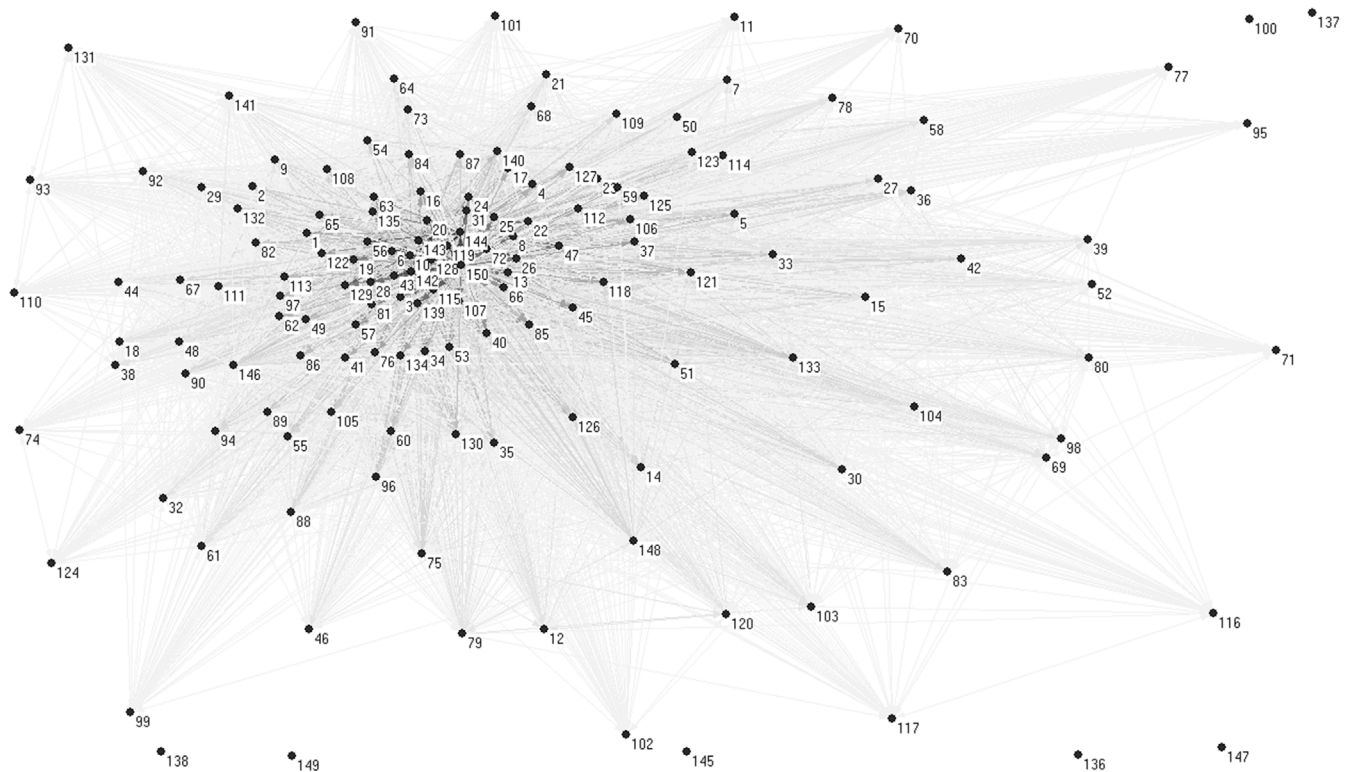


Fig. 4. Graphical representation of the relational collective map obtained from the collective discourse, based on a spatial ordering of factors in degree similarity orbits. Factors in the center of the network refer to the predominant collective discourse (see Table 1).

Broadcasting Station (Radio Nacional).

Regarding living conditions, the source of water was predominantly surface (#5), while the sources of energy for heating were firewood obtained directly from the field and bottled gas (#13), and solar panels as sources of electricity (#10). Bottled gas and solar panels were most frequently acquired through public assistance plans, and in few cases through purchase with their own funds. Most frequently houses presented poor or inadequate conditions because some building materials were of insufficient quality to provide complete insulation (e.g. dirt floors, or non-insulated cardboard roofs, #41).

In general, cases with permanent off-farm income (#18) were always associated with State benefits (e.g. pensions, Argentine Universal Child Allowance). This aspect was also related to a predominant configuration of the households with two generations living in the rural area, either a young couple with infants or school-age children or elderly people (> 65 years) with an adult son (#25). Another cultural aspect related to the households was handicraft activities (with wool, leather, wood), generally for own use and to a lesser extent for sale (#24). Predominant collaboration and support from family members in both rural activities and adverse situations (#30) were also corroborated, and many households showed spatial fragmentation associated with winter- and summer-lands (#40). Hiring a labourer could be the result of certain critical field tasks such as calving and/or herding (#14).

The household was enriched with elements and tools of modern/urban lifestyle such as pick-up trucks mostly older than 20 years (#26) and cellular phones (#29), as means of transport and communication, respectively. The presence of vehicles was linked in the discourse with the accompaniment and assistance during the harness (#19) and with periodical and more frequent purchases of supplies and food in the urban areas (#8). However, the horse is still the major means of personal and load transport during herd movements (#6). Horses have the priority to be fed with hay or corn, bought from urban areas or exchanged for goat kids or older animals such as female goats. Transport

of animals by truck was perceived as very expensive (#32) and was not a productive strategy.

Among the most relevant perceptions emerged that winter-lands are less productive than before (#3), and the main cause was attributed to the fact that the last three or four years were dry or bad in terms of lack of rainfall and snowfall (#7), and due to freezing and very cold conditions (#35). This discourse was also associated with a reduction in the number of animals in that period due to self-consumption and/or mortality (#11), as a consequence of lack of water or poor water quality in winter-lands (#22), and due to reduced rangeland forage production (#34). By contrast, opinions generally stated that summer-lands were in good or in similar conditions in recent years (#12).

The main strategies against the unfavourable productive situation were associated with a reduction in the demands and consumption of the family (#9), and the consumption of adult animals due to the lack of lambing (#39). There was a general opinion favouring rural over village life because it is quieter and they never lacked food (#17). On the other hand, the general opinion was also that young people prefer moving to the village (#28), but also making reference to the fact that people need to have work and money, and that there is a need to know how to do something (#23). The main perceived threat was associated with storms occurring during the movement of animals in herding roads or lambing periods due to death risk of animals and breeding (#21), and predation problems by fox and/or puma (#25). Although with less predominance in the collective discourse, it was mentioned that production would improve if better years came, which were associated with the occurrence of rainy years (#43). References to other problems were related to the closures of herding roads (#16), and to a lesser extent to the presence of alleys promoting harsh conditions for the animals, mainly due to lack of water and grass (#38).

The main commercial strategy was associated with direct sales of animals to customers or end-consumers (#20), in general in herding roads and strengthened by family collaboration and increased communication with urban areas. To a lesser extent, the sale of leather to

Table 1

Ordering of factors obtained in the collective discourse from the interviews, by frequency of links with the pool of available factors (Freq). The limit on the number of selected factors was defined by the average number of factors per interview ($n = 47$), which generated 11 groups of factors that were related to the main collective discourse. For each factor, other network indicators are presented: i) Standardized Betweenness (Bet) and ii) Standardized Degree (Dg). The factors are identified with a code comprised by a number of each factor in the original matrix (see Fig. 4), and letters that indicate: Social Capital (SC), Manufactured Capital (MC), Natural Capital (NC), Financial Capital (FC), Human Capital (HC), Perceptions or opinions (P), and Strategies (E). Statements in italics refer to phrases from pastoralists, with their wording in Spanish.

# Order	# Code	Factors and concepts	Freq	Bet (N)	Dg (N)
1	SC119	Radio as an information resource	1.00	0.63	30.6
2	MC128	Develop activities such as orchard, fruit trees, fowls (chicken, eggs)	1.00	0.63	30.6
3	E142	Buy and/or exchange animals for hay and or corn for horses	0.94	0.59	29.5
4	P6	Winter-lands are worse than before	0.94	0.59	27.6
5	NC144	Surface, slope or stream as sources of water	0.94	0.58	28.7
6	E10	Use of horses to move the herd, for work and transportation	0.89	0.59	29.5
7	P43	Last 3 or 4 years were bad, lacking rain and snow, it is very dry	0.89	0.55	28.1
8	E143	Purchase of food and supplies in the city	0.83	0.58	25.8
9	E72	During bad times, we resist and reduce consumption [<i>Pasarla nomás, nos vamos achicando</i>]	0.78	0.51	23.0
10	MC3	Fewer animals than before (the last 3 or 4 years)	0.78	0.49	22.3
11	MC150	Electricity with solar panel functioning	0.78	0.47	24.6
12	NC-MC115	Firewood and gas bottles as energy source for cooking and heating	0.72	0.44	24.2
13	P8	Summer-lands are well, similar to past years	0.72	0.38	19.6
14	E139	Direct sales to customers	0.67	0.53	22.3
15	E28	Hire labourer for lambing or herd movements	0.67	0.51	21.9
16	P20	On the farm, life is better, calm and there is food to eat	0.67	0.49	21.3
17	P56	A problem is the closing or lack of access to herd movement roads (alleys)	0.67	0.47	21.2
18	P107	Show interest in small forest plots in winter-lands for posts, firewood	0.67	0.46	20.4
19	E13	Pick-up truck support during herd movements	0.67	0.44	20.1
20	FC26	Permanent off-farm income	0.67	0.41	20.4
21	P81	Main threat: Storms that kill animals during herd movements or births. The Problem of not having goat kids	0.61	0.43	19.9
22	P66	Lack of water for consumption or poor quality in winter-lands	0.61	0.43	18.7
23	P19	In the town we need to have a job and cash [<i>en el pueblo hay que saber hacer algo</i>]	0.61	0.41	18.6
24	HC129	Develop activities like handicrafts (with leather, yarn, loom, other)	0.61	0.38	19.1
25	MC25	Own a pick-up truck	0.61	0.37	18.5
26	HC31	Two generations living on the farm (Young couple (< 65 years old), with children or parents)	0.61	0.37	17.9
27	P47	Problems with foxes and/or pumas	0.56	0.43	17.1
28	P22	A problem is that young people leave for town	0.56	0.40	17.2
29	E135	Sell leather to local buyer	0.50	0.39	16.4
30	P57	Truck transport of animals is too expensive	0.50	0.35	16.1
31	SC24	Cellular phone, as a resource for communication	0.50	0.35	15.2
32	SC40	Social capital based on family for collaboration and support	0.50	0.34	15.7
33	E134	Sell to a buyer on the farm	0.44	0.37	14.1
34	P53	Worse conditions, there is less forage than before	0.44	0.34	14.8
35	P45	A problem is too much frost and cold conditions	0.44	0.33	13.8
36	P16	Conditions during herd movements are hard for the animals	0.44	0.32	14.2
37	E118	Interested in animals' nutritional supplementation (some experience or did it before)	0.44	0.31	13.5
38	P63	Lack of water and forage during herd movements. Salty water.	0.44	0.31	13.4
39	E76	They resisted with older animals for a living (as a source of food), with kid goats obtained in the years before	0.44	0.29	14.8
40	HC34	Fragmented family during summer time (Winter- and summer-land fragmentation)	0.44	0.29	14.5
41	MC122	Regular housing, some substandard or poor quality of materials and insufficient insulation	0.44	0.25	14.2
42	P1	It is difficult to increase the herd because of rangeland limitations [<i>El piño no aumenta más, no da para más animales el campo, es montoso</i>]	0.44	0.25	12.2
43	P85	Production would improve if it rained [... <i>necesitamos que vengan años mejores</i>]	0.44	0.24	14.2
44	P112	Interested in tourism activity	0.44	0.22	13.0
Total matrix of factors ($n = 150$)					
Average				0.185	9.702
Standard Deviation				0.176	7.639
Centrality index (%)				0.45	21.05

the local gatherer (# 31) and direct sale to buyers/collectors on the farm (# 33) were recorded. Some perceptions were associated with more permeable viewpoints to incorporate new activities or strategies. In particular, a favourable opinion regarding small forest plots in winter-lands to supply heating (firewood) and provision of farm inputs (poles, sticks) (# 15) was relevant. To a lesser extent, some references

were made to goat and/or cattle fodder supplementation (# 37), whereas some were interested in tourism as a new activity (# 44).

4. Discussion

The perceptions and novel adaptations with respect to the problems,

challenges, and opportunities that transhumant lifestyle faces in North Patagonia, Argentina, was explored by means of a relational collective mapping which identified predominant factors in the general discourse of transhumant pastoralists. The main focus of discourse was influenced by the strong dependence on natural and manufactured assets as their main livelihoods, which are key features of TEK of rural communities in mountainous, arid and semi-arid regions worldwide (e.g. Reynolds et al., 2007; Davies et al., 2008; Easdale and Rosso, 2010). Besides features of their houses that increase vulnerability to weather vagaries, the access to vital environmental services such as potable water, firewood for heating, and fiber and food supplies obtained from their low-input farming activities (e.g. meat, orchard) depend predominantly on the direct provision of the local ecosystem. This situation was also recorded in the dominant perceptions regarding the problems and threats, whose origins were also environmental (essentially climatic) and productive, almost always associated to factors affecting livestock productivity (i.e. the number of animals obtained in each productive cycle). For example, there was a generalized reference to the unfavourable climatic cycle due to drought and its relation with the decrease in water supply and forage, as well as the consequent reduction in livestock productivity. The threat of storms at critical moments and predation by puma and fox were the main emerging menaces (Table 1). These results suggest that the interaction between the environment and the pastoral system in the near past defined the main problems in a homogeneous and dominant manner, irrespective of socio-productive heterogeneity (e.g. production system, land tenure, social networks) or the threat imposed by other social-driven sources of change.

Drought is one of the factors that most negatively affects the welfare of pastoral communities in arid and semi-arid regions, causing productivity reduction and losses due to animal mortality (e.g. Oba, 2001; Easdale and Rosso, 2010; Mogotsi et al., 2013). However, in other regions of the world, the social perception of the drought process can be heterogeneous according to the relative vulnerability of families (Keshavarz et al., 2013), and can be perceived differently at varying spatial and temporal scales (Slegers, 2008). In this study, the impact of drought was limited to winter-lands and to the recent three or four years previous to the interviews, whereas summer-lands were not included in the drought-related discourse and were perceived in good conditions. These results suggest that transhumant pastoralists have a differentiated perspective of drought and its impact on pastoral areas at a regional scale. This may be associated with the pastoral management at a landscape scale which involves the use of different pasture areas (Easdale et al., 2016), and therefore a perception that exceeds a particular site. On the other hand, this differential perception may also be conditioned by the level of exposure to drought (Turner et al., 2003). In this sense, winter-lands are the most arid and warmer places where the families live most part of the year (8 months), and in some cases part of the family stays all year round at these sites, which increases their exposure and vulnerability to droughts (e.g. lack of availability of water for human consumption). In contrast, the time spent in the summer-lands is shorter (four months), and in general, these areas are wetlands or high mountain grasslands which are sites with greater provision of ecological services at the moment of use (e.g. Viglizzo and Frank, 2006). These aspects may also have emotional implications (Keshavarz et al., 2013), which may be reflected in the more favourable opinion towards the summer-lands.

There was a decoupling between TEK of pastoralists and Western scientific knowledge developed in the region with regards to the causes and severity of key processes such as land degradation. Desertification is a complex problem in arid and semi-arid regions, which has gained consensus as an increasing priority theme during the last 30 years in global discourses both from scientific perspectives (e.g. Mabbutt, 1984; Kassas, 1995; Verón et al., 2006) and policy initiatives (e.g. United Nations Convention to Combat Desertification, created in 1994; Stringer, 2008). Regional environmental concern also refers to desertification in Patagonia as a serious problem (e.g. Del Valle et al.,

1998; Verón and Paruelo, 2010) and overgrazing as one of the relevant causes (Mazzonia and Vazquez, 2009). In the study area, the environmental discourses have been associated with overgrazing and particularly transhumance as a system that pressures over the environment, constituting an argument of support for the incorporation of other productive alternatives such as forestry (Bendini et al., 1993; Bendini and Steimbregger, 2011). However, from the perception of pastoralists, it is the climatic factor that always appears as the major influence in triggering livestock and social crises as in various arid and semi-arid regions worldwide (e.g. Andrade, 2005; Slegers, 2008; Keshavarz et al., 2013). In some studies, desertification or overgrazing appear in the discourse of farmers also as causes of problems, but in any case in interaction with climate (Andrade, 2005). Previous studies in Northern Neuquén indicate that pastoralists recognized the existence of the problem related to the impoverishment of the rangelands or lower availability of forage. However, they did not refer to a process of desertification or overgrazing but identified the climatic variable as the dominant cause, associated with a concept of recurrent cycles of drought and fatalistic representations of nature (Bendini et al., 1993). In this study, references from pastoralists were not related to as climate change but to natural cycles with recurrent periods of drought or stochastic events such as storms. After almost two decades of this study, our results corroborate that the perception of pastoralists in relation to the environment remains very similar. This evidence suggests that at least in this study area, the institutional discourses of the last 20 years emphasizing desertification, overgrazing or even climate change as central problems in arid and semi-arid regions of Patagonia have not permeated into the dominant perception of, at least, the most isolated pastoralists. Efforts to avoid the decoupling between the discourses of the scientific and political spheres with respect to the rural communities' perceptions remain as one of the main challenges in reference to desertification, its monitoring, and control (Stringer, 2008). One of the main restrictions is that desertification is still emphasized as a bio-physical problem (Torres et al., 2015), whereas there is still a lack of a more comprehensive interpretation of the process as multidimensional. Indeed, social drivers at a global level affect local ecosystems and livelihoods, while other worldviews are not fully tackled either in scientific studies or political proposals (Easdale and Domptail, 2014; Easdale, 2016). This circumstance denotes the low integration and dialogue that still exists in many regions between scientific and traditional knowledge (Whitfield and Reed, 2012), or between different social actors linked to the management of natural resources. For example, reducing the numbers of animals is not perceived by pastoralists as a sound management. As it was mentioned, this mobile way of living includes opportunistic sales of lambs, kids and fiber. This production strategy relies on a number of animals rather than biomass per animal (kg animal^{-1}). We suggest that any intervention in this system should be based on the local worldview, which is intrinsically opportunistic in terms of dealing with environmental constraints and coping with their fluctuations.

Income diversification is another frequent livelihood strategy of peasant families (Ilbery, 1991; Reardon, 1997; Escobal, 2001). Previous research in the study area recorded for the presence of off-farm income in transhumance pastoral families, mainly State-based (Pérez Centeno, 2007), and this issue was also corroborated in this study. Given the unfavourable farming context due to drought, off-farm income is a relevant strategy to partially dissociate family incomes from productivity losses (Easdale and Rosso, 2010). Although the internalization of this income in their economies needs further research, it would constitute a strategy to strengthen the resilience to sudden perturbations involving productively stressful circumstances. However, a partial decoupling of the household economy due to off-farm income and degradation processes may be occurring, which may influence relative perceptions of the causes of productivity losses (i.e. drought-based losses rather than degraded rangeland' carrying capacity).

Regional structural changes with consequences on the lifestyle or

pastoral system could be promoting modifications or novel functional adaptations in the transhumant system. For instance, changes in land tenure and landscape fragmentation associated with urbanization are increasing in this region (Easdale et al., 2018), as in many regions with mobile pastoralism (Galvin et al., 2008). The use of the radio to get information, the use of pick-up trucks and cellular phones are relatively new resources, which are currently included by most transhumant pastoralist lifestyles (Table 1), as in many other cultures (Fardon and Furniss, 2000). These results evidence some novel changes related to communication and logistics, which would be related to a growing urban-rural integration that needs further research. These new resources would allow them to overcome some difficulties during the herd movements from winter-lands to summer-lands (and vice versa), through assistance with food and material transportation. Their negotiation skills with respect to the marketing of their products with more information may have improved, due to a direct contact with customers and dispensing with commercial intermediaries. Finally, the supply of goods in urban areas at different times of the year, and not only associated with pastoral movements, would also be benefited by pick-up trucks.

Modifications associated with the adoption of new resources may imply a current functional adaptation to new circumstances, but with long-term changes that may influence a restructuring of some features of the transhumant culture. For instance, increased communication would be associated with improved technological availability, but also as a solution for bringing families which are spatially fragmented closer (i.e. winter/summer-lands, urban-rural fragmentation). For instance, the hiring of a temporary labourer would be a functional adaptation that denotes the restrictions of labour in the farming system, due to a partial presence of the family in the field for farm activities (Pérez Centeno, 2004). This situation may be restricting opportunities for knowledge transfer from older to younger generations and eroding local social capital. On the other hand, off-farm income and increased urban-rural communication would also be contributing to a growing mercantilisation of the peasant economy, as in other Andean regions (e.g. Paz et al., 2012). This trend may have consequences associated with a greater relative dependence of prices and availability of products in the market (Wood, 2002), to the detriment of self-sufficiency, and even a lifestyle increasingly related to urban dynamics and demands. However, the persistence of fowls and handicraft activities in the study area suggests that the integration with the market would still be partially occurring.

Urban-rural articulation does not necessarily occur in an integral and complementary way. The reference to the need of a job, money and special skills in urban areas, as opposed to a better life in the rural areas, shows that there is a perception that the qualification of many of the pastoralists is not consistent with the jobs offered in urban areas, and therefore it does not constitute a real alternative for them (Román, 2011). This circumstance still promotes the strong dependence of transhumant families on livestock products, both in terms of income and food security. However, the general concern about the movement of young people towards urban areas also shows an ongoing transition towards a lifestyle which is different from the viewpoint of the new generations. Meanwhile, there is a selective assimilation of some urban resources, without the necessary loss of distinctive cultural traits.

5. Conclusions

Transhumant pastoralism still maintains a traditional culture in relation to its mobile pastoral living, which is based on a strong dependence on the local environment as their main livelihoods, referred also as the sources of their main perceived problems and threats. The tension between this pastoral way of living and modern lifestyle was partially evidenced. In pastoral families who were far from urban areas, there was evidence of changes associated with the usage of certain new resources in relation to communication and logistics, which were

intrinsically part of their current livelihoods and strategies, suggesting a growing urban-rural integration. However, there was a decoupling between TEK of pastoralists and Western scientific knowledge developed in the region with regards to the causes and severity of key processes such as land degradation. This highlights a need for increased efforts to avoid the decoupling between the discourses of the scientific and political spheres with respect to the rural communities' perceptions, which remains as one of the main challenges in reference to complex problems such as desertification.

Finally, new generations of pastoralists are developing in a cultural space of growing urban-rural integration, which is accompanied by novelties. In particular, the mixture of new resources and strategies suggest adaptation capacity but challenges their lifestyles and future developmental pathways that need further research.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at doi:10.1016/j.jrurstud.2018.09.001

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