ETHNOECOLOGY, ECOSEMIOSIS AND INTEGRAL ECOLOGY IN SALINAS GRANDES (ARGENTINA)

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RESUMEN

El manejo de los recursos naturales en Salinas Grandes está basado en el conocimiento popular, entendiendo e interpretando la naturaleza a través de signos y actuando sobre ella. Las nuevas condiciones socio-políticas forzaron a los campesinos a modificar sus prácticas tradicionales, reestructurando sus estrategias de vida a fin de lograr la reproducción social. El objetivo de este trabajo es el de describir, medir y analizar la percepción sobre la naturaleza de los habitantes de las Salinas Grandes a través de un enfoque etnoecológico y ecosemiótico, y el de establecer la relación entre esta percepción y el uso de los recursos naturales. Se relevaron las percepciones locales sobre el clima, suelos, geomorfología, agua, ambientes, vegetación, fauna, tecnología y prácticas de manejo. El conocimiento popular y la iniciativa individual promueven una mayor resiliencia social frente a disturbios. La resiliencia de la semiosfera local puede ser medida por medio del conjunto de conocimientos de la comunidad medido como entropía de la información sobre el comportamiento del ecosistema. Los protocolos de construcción de programas de desarrollo debieran ser revisados, adecuando las tecnologías tradicionales en lugar de aplicar tecnologías nuevas, aprendiendo y aprehendiendo las claves en la percepción de las comunidades locales, integrando estas conjuntamente con el conocimiento científico, dentro de una Ecología Integral, cubriendo las cuatro dimensiones: Experiencia-Cultura-Comportamiento-Sistema.

PALABRAS CLAVE: Ecología Integral, percepción, conocimiento popular, resiliencia, semiósfera.

ABSTRACT:

The natural resources' management in Salinas Grandes is based on popular knowledge, understanding and interpreting nature through signs, and acting over it. New sociopolitical conditions forced peasants to modify their traditional practices, restructuring their life strategies in order to achieve social reproduction. The objective of this paper is to describe, measure and analyze the perception on nature of the inhabitants of Salinas Grandes through an ethnoecological and ecosemiotical approach, and to establish the relationship between this perception and the use of natural resources. Local perceptions on climate, soil, geomorphology, water, environments, vegetation, fauna, technology and management practices of natural resources were surveyed. Popular knowledge and individual initiative boost a higher social resilience of the group to stresses. The resilience of the local semiosphere can be measured by the set of knowledge of the community measured as the entropy of the information about the

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behavior of the ecosystem. Protocols for construction of development programs should be reviewed, to adequate traditional technologies instead of applying new ones, learning and apprehending the keys in the perception of local communities, incorporating these together with scientific knowledge, into an Integral Ecology covering the four dimensions: Experience-Culture-Behavior-System.

KEY WORDS: Integral Ecology, perception, popular knowledge, resilience, semiosphere

INTRODUCTION

Space and time adopt different dimensions according to the interpreter. Space is understood as the context in which we develop our everyday life while time relates with the dynamics of the context and its influence over individuals and communities.

Space gets treated as a fact of nature, perceived through the assignment of common-sense everyday meanings; although it is dynamic and its perception is never complete because new meanings are permanently being integrated through practice, modifying the whole. Subjective experience can take us into realms of perception, imagination, fiction, and fantasy, which produce mental spaces and maps as so many mirages of the supposedly 'real' thing (Harvey, 2004).

The natural resources' management is based on popular knowledge of native species properties (ethnobotany), soil characteristics (ethnopedology), climate and environmental dynamics (ethnoecology). Popular knowledge is achieved by the understanding of nature through signs, interpreting the meaning of nature, and acting over it.

The Ethnoecology discipline studies the relations between kosmos (K) (beliefs and symbolic representations), corpus (C) (set of knowledge) and praxis (P) (set of cultural practices) (Toledo, 2002), synthesized in 'myths', abstract structures acting as mirrors of the perceived reality.

The K-C-P triad is the synthesis of several factors and dimensions of the multicultural world, opposed to modernity that tends for a reduction of the different aspects of 'reality', through a positivist perspective, only recognized by its empirical form.

On the other hand, Ecosemiotics can be defined as the semiotics of relationships between nature and culture. This includes research on the semiotic aspects of the place (and time) and the role of nature for humans. Ecosemiotics deals with the semiotic interpretation of human over its ecosystem. It covers nature's structure as it appears, its classification (syntactics), it describes the meanings of nature by people (semantics), and defines the personal or social relation over the components of nature, and participation in nature (pragmatics) (Kull, 1998). Ecosemiotics studies the Semiosphere. Semiosphere is the semiotic space; outside space interpretation of signs cannot exist (Lotman, 2005).

Ethnoecology and ecosemiotics are intimately related. Analyzing the relations kosmos-corpus-praxis of the first, with the relations syntactics-semantics-pragmatics of the second, both disciplines apply the same basic principles.

Data produced by the 'objective' (scientist vision) and 'interobjective' (science community vision) perspective about ecology are valuable, however, these do not cover an exhaustive comprehension of the ecological problem *per se*, neither encourage action. Motivation is achieved when a specific environmental problem is experienced through two additional perspectives: 'subjective' (the vision of those who experience the problem) and 'intersubjective' (the vision of the local community, or ethnoecology). These four aspects build the tetrad Experience-Culture-Behavior-System. These dimensions are irreducible because they are different and contribute different degrees of knowledge over the problem and/or solution (Esbjörn-Hargens and Zimmerman, 2009). The combination of these four dimensions defines the Integral Ecology discipline.

Aboriginal and rural communities have usually different conceptions of space and time compared with urbanites, valuing natural resources differently; therefore conflicts between these social groups are always latent.

Natural resources in Salinas Grandes (Argentina) are managed by rural local inhabitants based on their productive tradition, sociocultural conditions, and the environmental carrying capacity. The latter is based on the diversity of environments and in its potential (Karlin *et al.*, 2014). Many of the management practices have been entrenched by trials of proof and error developed along centuries.

Several local aboriginal practices were combined and hybridized into the rural culture, which in turn were influenced by alien aboriginal cultures, and by Iberian technologies.

The local aborigine influence is shown until our days in Creole communities, and can be seen in hunting and gathering practices, in the use of aromatic, medicine, dye and edible plant species, and in the use of environments.

Cattle and intensive agriculture management practiced by European settlers have also been adopted by local inhabitants, taking advantage of centuries of experience in plant and animal domestication in Europe.

Respect to the present socio-political conditions, peasants are forced to modify their traditional cultural practices, restructuring their life strategies in order to achieve social reproduction. Most of these changes are a consequence of the arrival of technological packages developed in the Pampas, which cannot always be adapted to local conditions.

The objective of this paper is to describe, measure, and analyze the perception over nature of the inhabitants of Salinas Grandes through an ethnoecological and ecosemiotical approach, and to establish the relationship between this perception and the use of natural resources, synthesized as an integral ecology vision.

MATERIALS AND METHODS

The study area is located in the Salinas Grandes region and its vicinities, at the southernmost portion of the Province of Catamarca and the southwestern portion of Santiago del Estero, covering rural communities within a polygon defined between 29°30' S - 65º36' W on the northwest, 29º03'S - 64º44'W on the northeast, 29º 57'S - 65º 30'W on the southwest and 29º53'S - 65º 17'W on the southeast. The location map can be seen in Figure 1.

The area is characterized by continental, mesothermal, semi-arid climate with dry winters, high thermal ranges, important rainfall oscillations, and high evapotranspiration rates. Average annual precipitations oscillate between 300 and 500 mm, occurring mainly from November to March while the driest months are June, July, and August (Ruiz Posse *et al.*, 2007). Annual potential evapotranspiration is 950 mm, resulting in water deficit throughout the year

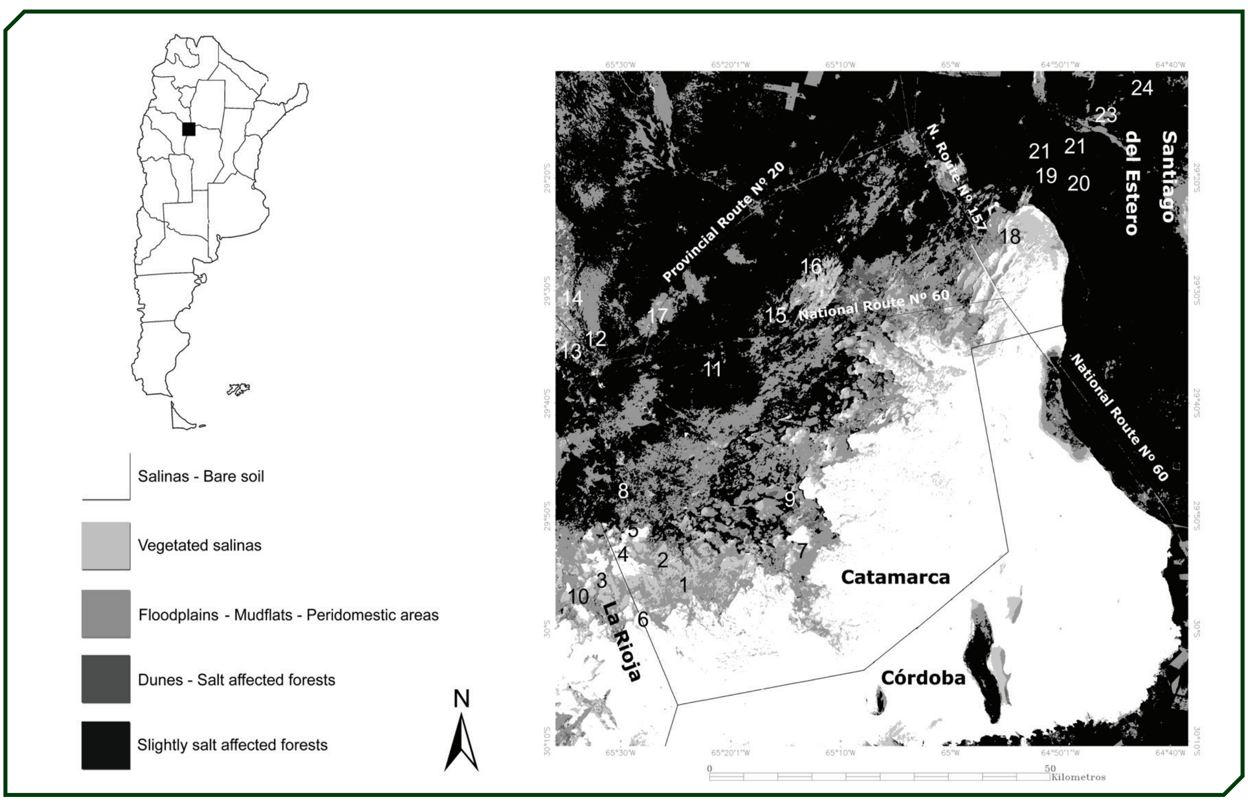

Figure 1 Environmental map of Salinas Grandes and location of all surveyed communities. 1) San Isidro, 2) El Quimilo, 3) El Chaguaral, 4) San Vicente, 5) San Agustín, 6) La Florida, 7) Palo Santo, 8) El Silo, 9) Pozo de la Orilla, 10) La Lata, 11) El Clérigo, 12) El Puente, 13) El Quemado, 14) Puesto Nuevo, 15) La Zanja, 16) El Garay, 17) La Guardia, 18) Km 969, 19) La Suerte, 20) La Cruzada, 21) El Puesto, 22) El Colorado, 23) La Vuelta, 24) San Delfín.

(Zamora, 1990). Average annual temperature is 20.5ºC (Dargám 1995), with absolute maximum and minimum temperatures of 42 and -6ºC respectively. Frosts occur between April and September, although at low frequency (Ruiz Posse *et al.*, 2007). Winds are relatively frequent and run generally from northeast to southwest and from east to west during the driest months (Ragonese, 1951).

Local population makes use of different environments and their natural resources. In this region, three great environments can be distinguished, corresponding to highlands, lowlands, and peridomestic areas, and within them seven zones are identified (modified from Ruiz Posse *et al.*, 2007), differing in topography, soil characteristics, vegetation, and use. The identified zones are (Figure 1):

- Lowlands: Salinas, Vegetated Salinas, Floodplains, Salt Affected Forests, Mudflats.
- Highlands: Dunes, Slightly Salt Affected Forests.
- Peridomestic areas

Soils differ between zones by soluble salt content. Soils in low areas present higher soluble salts content manifested by the presence of saline crusts and halophyte plants, differing from those of high areas. Low areas present silty clay topsoil horizons while in high areas sandy loam soils predominate (Ruiz Posse *et al.*, 2007; Karlin *et al.*, 2011).

Vegetation presents changes in its composition between the saline coast and the central plains, related to a positive salt content gradient in the soil (Ragonese, 1951; Karlin *et al.*, 2011).

Plant and soil surveys were made with local population from the communities of San Isidro, El Quimilo, El Chaguaral, San Vicente, San Agustín, La Florida, Palo Santo, El Silo, Pozo de la Orilla, La Lata, El Clérigo (at south of the study area), El Puente, El Quemado, Puesto Nuevo (at west), La Zanja, El Garay, La Guardia (at north), Km 969, La Suerte, La Cruzada, El Puesto, El Colorado, La Vuelta and San Delfín (at east), over the identified zones (Figure 1), based on previous non-structured interviews (Yuni and

Table 1. Total population and declared used area of the communities under study. NDA: No data available. ND: Not declared.

	COMMUNITY	TOTAL SURVEYED FAMILIES	TOTAL POPULATION (HAB)	DECLARED USED AREA (HA)
1-2	San Isidro – El Quimilo	5 - 9	27 - 68	52.490
3	El Chaguaral	4	19	23.450
4-5	San Vicente – San Agustín	2 - 5	7 - 22	17.100
6	La Florida	1	5	WL
7	Palo Santo	7	20	22.100
8	El Silo	5	44	3.470
9	Pozo de la Orilla	1	2	2.500
10	La Lata	2	7	2.500
11	El Clérigo	4	30	26.230
12	El Puente	1	10	570
13	El Quemado	2	NDA	6.300
14	Puesto Nuevo	4	NDA	ND
15-16	La Zanja - El Garay	7 - 6	17 - 35	60.000
17	La Guardia	1	NDA	ND
18	Km 969	19	85	13.200
19	La Suerte	6	24	1.375
20	La Cruzada	1	4	ND
21	El Puesto	3	12	1.065
22	El Colorado	1	4	ND
23	La Vuelta	2	NDA	ND
24	San Delfín	1	6	ND

Urbano, 2000) over 99 local families (Table 1), classified and supported by cartography (). Three participatory workshops were made, in which abundance and local uses of plant and animal species (Cavanna *et al.*, 2010; Karlin *et al.*, 2010b; Reati *et al.*, 2010), cattle management (Cavanna *et al.*, 2010), and ecology of natural resources (Karlin *et al.*, 2011) data was collected. Data from interviews and workshops were triangulated among most members of communities to validate them. All interviewed families live within the study area. A 100% of the interviewed are livestock breeders. The age and sex of the interviewed is heterogeneous. Data of total population and declared used area for some of the communities surveyed is shown in Table 1. From all surveyed people, only 10 families do not own the land; the rest declare landownership. Ecological and social aspects can be seen in detail in Cavanna *et al.*, 2010; Karlin *et al.*, 2010a; Karlin *et al.*, 2010b; Karlin *et al.*, 2011; Karlin *et al.*, 2014; Ragonese, 1951; Reati *et al.*, 2010; Ruiz Posse *et al.*, 2007

Field data was contrasted with people's perception over natural resources and environmental dynamics; 250 plant species and 54 wild animal species were identified and valued according to people's perception. Plant and animal uses of only 45 plant species and 31 animal species were recognized and tabulated.

In order to quantify data, the knowledge about the uses of the species by the local communities served to calculate an information index for each species (ec.1):

$$I = \log_2 \frac{1}{P_s} \quad \text{(ec.1).}$$

The amount of information (*I*) in bits is equal to the binary logarithm of the inverse of the probability (P_s) to find the symbol (plant or animal species) within the system. If P_s equals the 50%, then the amount of information is equal to one bit (binary unit).

However, not all the sources of information have equiprobable results; the probabilities of the symbols (species) can be different and, therefore, the amount of information can be dissimilar between symbols.

Information is, therefore, related to the entropy of the system (ec.2):

$$H = \sum_{i=1}^{n} P_s I_s \quad \text{(ec.2)}$$

where $P_s = N_i \Big/ \sum_{i=1}^{n} N_i$, N_i is the number of potential uses people make the i^{th} species and I_s is the information index of the symbol (Shannon, 1949; García Mayoraz, 1989). *H* is the entropy of the system in bits/symbol. Results of the entropy of local knowledge were compared to the entropy calculated with all known uses (global knowledge) of the same plant and animal species, compiled by Karlin *et al.* (2010b) and Reati *et al.* (2010). Scientific names were updated according to The Plant List (Royal Botanic Gardens; Kew; Missouri Botanical Garden, 2015), the IUCN Red List of Threatened Species (2015) and the Catalogue of Life (Species 2000-ITIS, 2010) databases.

RESULTS

Local inhabitants have achieved along generations a complex ecological knowledge system through the individual and collective cognitive construction of their own space. They have built their own perception of the environment through trials of proof and error, assimilating scientific knowledge offered by intervening technicians and media.

The following is a synthesis of the data collected in interviews, surveys, workshops and interinstitutional meetings, about local perceptions over climate, soil, geomorphology, water, environments, vegetation, fauna, technology and management practices of natural resources.

Climate

For local inhabitants, production is the main indicator of environmental quality. "Over time, rains become scarcer", says a local producer from the south of the region, in the clear allusion that there is lesser grass offer for the animals as a consequence of slower soil water infiltration (despite that the registered rainfall was superior to average, according to Contreras *et al.*, 2010). The inhabitants 'measure' the effective rainfall, responsible of resprouting and dams filling. "Years ago rains were good, the animals were fine". "Maybe deforestation produces less rain". [Forests] "destruction affects the climate and affects us". "Fifty of my animals died" as a consequence of the 'drought' suffered between 2008 and 2010 (phenomena called 'outbreak' because of the lack of forage). "There are good and bad years, and within each year, good and bad seasons", referred to seasonability of rain.

High animal loads, the reduction of the foraging surface by perimeter wiring, and a reduction in water catchment by the dams (due to mud accumulation, slope collapse, contamination, percolation losses and high evaporation), produced a natural regulation of the animals by the rise of mortality.

Drought makes grasses dry earlier in high areas, so these are more susceptible to fires; however animals go to saline areas where grasses are greener.

The winter morning dew is quite important; it provides water to grasses and shrubs. Thanks to this, in the year 2005 "animals were not that bad because of the weeds".

Hail is also important in the region, not as a negative factor, but as a soil conditioner because it breaks the superficial saline crust and allows germination of some plants.

The wind is responsible for the dunes' formation, which are formed by the accumulation of sand particles at the foot slopes of some shrubs from saline playas (Karlin *et al.*, 2011). They evolve to dunes where fewer halophyte species may develop. Dunes are quite important as a reserve of woody species for fuel and wood. The wind can also "fill the forest with dust and animals do not graze". "Dust covers up the grass". Dams also fill with dust, reducing their water capacity.

Respect to temperature, "when frosts arrive, there is no grass", reducing grass reserves for the animals.

Plantations of prickly pear (*Opuntia ficus-indica* (L.) Mill.) and saltbush (*Atriplex nummularia* Lindl.) depend on climate conditions and soil water. "Cubans (alluding to the arrival of foreign technicians) said that pads should be planted with east-west orientation (so that rain water, coming from the south, could be caught by pads), but I said [to them] that pads should be planted with north-south orientation", because radiation is better captured and southern winds do not pull down the plants. Saltbush plants are planted inside closures near the dams in order to pump water from the phreatic, with the lesser content of salts.

The moon effect is also very important. Old men say that trees should be logged with waning moon, so resprouting is assured (because tree sap drops down towards the roots). The same occurs with plant sowing. If the plants produce subterranean reserve organs, these should be sowed with waning moon; if the plants produce fruits these should be sowed with the new moon or waxing moon. The latter is quite common with cucurbit species.

The flowering of some plants is related to climatic conditions: "The cross stick tree (*Tabebuia nodosa* (Griseb.) Griseb.) is in bloom; there will be rain". This species and some cacti species like *Stetsonia coryne* (Salm-Dyck) Britton & Rose are considered as 'forest barometers', indicating rainfall, however "sometimes they lie…, but hope still remains" (Contreras *et al.*, 2010).

There exist other factors (not well understood) such as the influence of airplanes or bombs (ballistic tests are made by the military in this region) affecting rain. Peasants are convinced that the lack of rain relates somehow with these factors.

Soil, geomorphology, and water

Local inhabitants have learned to 'read' the ecosystem in a particular way, having classified grazing areas, valued according to topography and soil characteristics (salinity, soil texture, permeability), and identifying different zones used for special purposes (Table 2).

These zones are not static, they change over time. Respect the environmental dynamics people affirm that "there are many dunes that fly", "they fly because the weather is too dry". "The smaller dunes are at most twenty years old" and these are formed thanks to bushes acting as barriers for the wind (Karlin *et al.*, 2011). Mudflats were formed by the deposition of materials from different sources: "These present three meters of clay on the surface, and then sand" as they could see by the construction of dams and wells, indicating that these soils were formed with different parental materials, depending on historical climate conditions.

Some plant species act as 'soil builders': "The horse hobbler (*Lippia salsa* Griseb.) has a guide that hobbles the horses, this is why they call it like that. It forms a web over the salinas", which apparently stabilize soil over erosion processes, and even enables evolution towards other zones.

Some species do not develop over some soils: "In La Zanja (a community at the north of the region) there is no root grass (*Trichloris crinita* (Lag.) Parodi) because the soil is too hard". "*Mistol* tree (*Ziziphus mistol* Griseb.) does not grow in lowlands", "this is scarce in the dunes".

Peasants agree that the lack of water is the main problem they have to face. "With no water, there can be no life".

Communities at the northeast of the region affirm that water quality depends on the location of saline areas: "There is good water near the playas". "The water from the wells dug near the dams is better than others", and they can see this in the general condition of the animals.

"Water is lost in short times. Dams are covered with mud". The reduction of water volumes in the dams and wells makes the salt concentrate: if goats are freed in

Table 2. Environmental characterization over edaphic characteristics and their potentiality, according to local perception.

ZONE	*TOPOGRAPHY*	*SOIL TEXTURE*	*SALINITY*	*PERMEABILITY*	*OTHER CHARACTERISTICS*	*POTENTIALITY*
FORESTS	"Highlands"			Good	"Fat soils" (high contents of organic matter)	Forest use
DUNES		"Sandy"		High		Forest y forage use
"SLIGHTLY SALT AFFECTED FOREST"						Forest y forage use
"HIGH PLANES"			"Moderately salty"		"Chalky" (high contents of calcium carbonate)	
"GOOD LOW LANDS"				Waterlogged		Forage use
"BAD LOW LANDS"	"Lowlands"	"Heavy" "Clayey"				
"VEGETATED SALINAS"			"Very salty"			Forage use (low animal receptivity, but large areas)
"MUDFLATS"				Impermeable		Occasional animal water supply
PERIDOMESTIC AREAS						Water and deferred forage supply

the forest "the flock does not come back because water is too salty".

Environments and plants

The patches of vegetation in Salinas Grandes offer different resources through time and space.

The forage mass change in time and space, concentrating in the summer time and extending its offer until May or June, depending on the amount of water stored in the soils. The forage scarcity occurs from July to October, until de occurrence of new precipitations.

Communities recognize three great grazing sub-systems: 'highlands', 'lowlands' and peridomestic areas (Ruiz Posse *et al*., 2007; Table 2).

The 'highlands' are mostly important during summer because of the presence of grasses, such as root grass (*T. crinita*) and swirl grass (*Sporobolus pyramidatus* (Lam.) C. L. Hitchc.), by woody species such as mesquite (*Prosopis aff. nigra*), *mistol* tree (*Z. mistol*), fox's mistol (*Castela coccinea* Griseb.) and *lata* (*Mimozyganthus carinatus* (Griseb.) Burkart), important as a source of forage, wood and as host for epiphytes (*Tillandsia spp*.) of good quality as forage. Regarding the latter, "goats die hanging looking for these, so we have to harvest them with hooks".

The 'lowlands' are important areas because of their forage offer during winter and spring time when forage resources are scarce in 'highlands'. "There is no grass during September, October and November". "The animals that forage in the forest die, not those that go to the playa". These zones present higher moisture conditions during winter time, enabling the development of some species such as palta (*Maytenus vitis-idaea* Griseb.), which "when it resprouts, exudes a sort of honey that produces indigestion to goat kids", however "it raises milk production in goats". According to peasants, this species ‘seeks’ humid conditions in saline areas. Other important species are the native saltbush (*Atriplex argentina* Speg.), blue stick (*Cyclolepis genistoides* D.Don), ostrich’s maize (*Ehretia cortesia* Gottschling) among other, being greener and more palatable for a long time. The ostrich’s maize produces a “very sweet fruit that is eaten by ostriches and goats; cows also eat it but when it is new”. These species are the responsible for maintaining a good balance of minerals and proteins in the animals. Cacti are important because of their water supply, maintaining the animals in a good health.

The *chañar* (*Geoffroea decorticans* (Hook. & Arn.) Burkart), provides several products used by cattle and native fauna, and hosts epiphytes. It produces sweet fruits used for human and animal consumption, although “sometimes it gives fruits, but sometimes it does not”. “When the climate is dry, fruit grows”, “when it rains, the base of the flowers rot”. It also happens with mesquite fruits. “When forage is scarce, cows eat chañar cortex” called *yuchán*.

In the vegetated salinas and ‘bad lowlands’, *guanaco* grass (*Distichlis acerosa* (Griseb.) H.L.Bell & Columbus) is quite important for cattle systems, especially during winter time when forage is scarce in the other zones. For sustainable grazing systems, large areas of saline zones are necessary; local producers have managed to take advantage of this species, extending the grazing area towards the center of the basin. Hare saltbush (*Suaeda divaricata* Moq.) is also important in these zones when it “gets greener with night dew”, being “quite fattening”.

The *cardón* (*Stetsonia coryne*) is essential for the maintenance of goats during winter time because it produces fruits along the year.

During autumn, “leaves fall” from trees and shrubs, and they are eaten by the animals.

The peridomestic areas have evident signs of overgrazing. In these areas animals are fed in a controlled way with species such as palta, epiphytes, prickly pear pads and saltbush stems (*A. nummularia*).

The importance of counting with several zones lies in the constitution of a particular grazing cycle along the year and even dialy. The peasants, who have access to large extensions of communal lands, without wiring delimitation between zones, make use of a wide variety of species that adapt to each environmental situation, offering forage in adequate quantity and quality (Cavanna *et al*., 2010). Wiring reduces the forage offer for the animals: “Animals cannot circulate”. In those cases where land is delimitated, goats can cross wires and graze neighboring lands: “They eat our neighbor’s grass”.

Remote areas from the peridomestic areas are undergrazed. These areas are better exploited when grazing is overlapped (with word agreements between neighbors) with animals from other communities. This way, undergrazing is avoided as could happen in wired areas, where overlapping cannot be made.

Such forage availability is detailed in Figure 2, identifying the most important species, related with each area and season.

Traditional knowledge about plants can be quantified by the ec.1 and 2, and can be compared with the global knowledge, understanding it as the sum of the products obtained or the uses made in this and other regions (Table 3).

Table 3 shows the probability of each plant to be used by local settlers related to the totality of uses made over all species. The information offered by each species reduces with the increase of recognized uses of such plant. If a species is related to a single use, the interpreter immediately relates this with its unique application; if a species is related to several uses, information drops due that the interpreter relates this species with different uses and needs more information in order to decide the application of this species; in other words, the message will turn more redundant (Shannon, 1949). The more frequent the code appears the less information it leads (García Mayoraz, 1989).

The entropy (*H*) of local semiosphere regarding the knowledge about plants is similar to the global semiosphere. However, the amount of local knowledge of potential uses of plants is quite inferior to the global knowledge. There are several reasons for this, e.g. only specific uses are recognized regarding local needs, there are other means to cover their needs compared to other regions, cultural preferences, lack of experience about plant properties, etc.

Hunting and gathering

Some expressions about the present condition and management of wild fauna were captured. The hunters and gatherers show a ‘green’ discourse regarding the use of fauna and the relation with the different zones. This knowledge can be valued and serves as a base for the implementation of the sustainable use of this resource with the active participation of the local population (Reati *et al*., 2010):

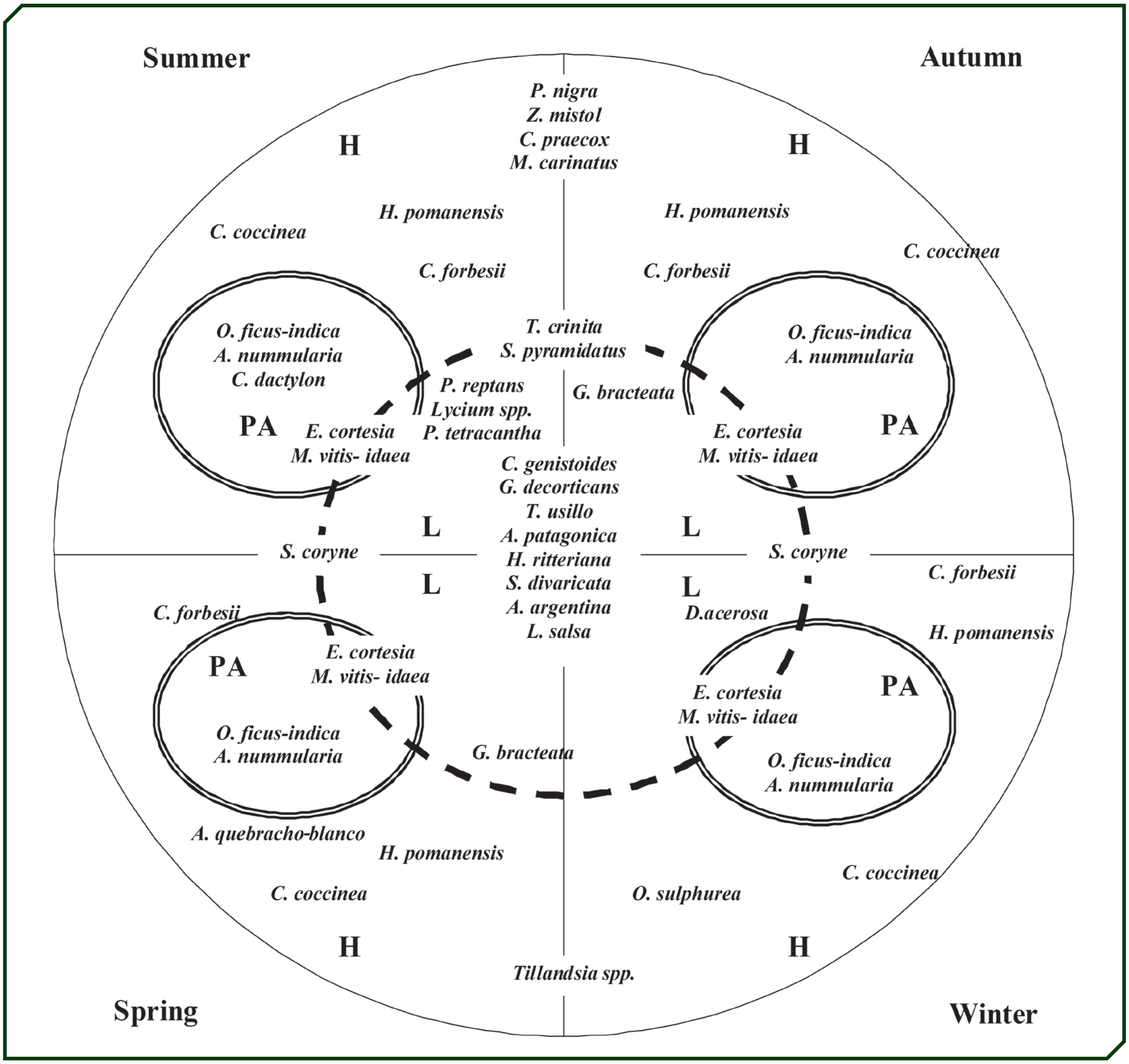

Figure 2 Scheme of the spatial and temporal distribution of the most important species from salinas grandes. H: Highlands; L: Lowlands; PA: Peridomestic Area (extracted from Cavanna et al., 2010).

- "The *vizcachas* (*Lagostomus maximus* Desmarest, 1817) disappeared". "There are still some ostriches (*Rhea Americana* Linnaeus, 1758) in the saline coast, but there are no more *guanacos* (*Lama guanicoe* P.L.S. Müller, 1776)". *"The guanaco has been liquidated by the militia in military exercises". "In El Garay forest there are lots of ostriches. Workers are logging there and the lion* (*Puma concolor* Linnaeus, 1771) comes over here [peridomestic areas]". "There are a lot of lions that come from the hills". "They come because of the clearance of forests and fires".

- Ostrich eggs: "You don't have to collect the first ones, but the last ones. This way, in winter time there will be bigger animals and there can be more eggs". "We have to teach our children that, by collecting the eggs, there will be no more ostriches".

- Native bees: "You have to respect the time of the year to collect honey".

- "Local people usually hunt for fun, but it always goes to the pot". "I never kill a breeding *lampalagua* (*Boa constrictor occidentalis* Philippi, 1873)". "You must know when the hunting season begins". "I have always hunted to feed my children".

Table 3. Probabilities, information, and entropy of the local and global knowledge about plant uses.

PLANT SPECIES	LOCAL KNOWLEDGE			GLOBAL KNOWLEDGE		
	KNOWN USES	P_s	I_s	KNOWN USES	P_s	I_s
Stetsonia coryne (Salm-Dyck) Britton & Rose	8	0,0808	3,63	15	0,0575	4,12
Cereus forbesii C.F.Först.	2	0,0202	5,63	5	0,0192	5,71
Harrisia pomanensis (F.A.C. Weber ex K. Schum.) Britton & Rose	2	0,0202	5,63	5	0,0192	5,71
Opuntia quimilo K. Schum.	1	0,0101	6,63	7	0,0268	5,22
Opuntia sulphurea G. Don	5	0,0505	4,31	8	0,0307	5,03
Cleistocactus baumannii (Lem.) Lem.	3	0,0303	5,04	3	0,0115	6,44
Tillandsia spp.	1	0,0101	6,63	1	0,0038	8,03
Trichloris crinite (Lag.) Parodi	1	0,0101	6,63	1	0,0038	8,03
Sporobolus pyramidatus (Lam.) C.L.Hitchc.	1	0,0101	6,63	1	0,0038	8,03
Distichlis acerosa (Griseb.) H.L.Bell & Columbus	1	0,0101	6,63	1	0,0038	8,03
Prosopis spp.	7	0,0707	3,82	9	0,0345	4,86
Prosopis torquata (Lag.) DC.	3	0,0303	5,04	7	0,0268	5,22
Cercidium praecox subsp. *praecox* (Ruiz & Pav.) Harms	2	0,0202	5,63	9	0,0345	4,86
Geoffroea decorticans (Hook. & Arn.) Burkart	9	0,0909	3,46	14	0,0536	4,22
Mimozyganthus carinatus (Griseb.) Burkart	1	0,0101	6,63	5	0,0192	5,71
Acacia aroma Hook. & Arn.	2	0,0202	5,63	6	0,0230	5,44
Bulnesia retama (Gillies ex Hook. & Arn.) Griseb.	2	0,0202	5,63	8	0,0307	5,03
Ziziphus mistol Griseb.	4	0,0404	4,63	15	0,0575	4,12
Castela coccinea Griseb.	1	0,0101	6,63	4	0,0153	6,03
Aspidosperma quebracho-blanco Schltdl.	3	0,0303	5,04	10	0,0383	4,71
Tamarix ramosissima Ledeb.	3	0,0303	5,04	8	0,0307	5,03
Atriplex argentina Speg.	2	0,0202	5,63	4	0,0153	6,03
Suaeda divaricata Moq.	1	0,0101	6,63	6	0,0230	5,44
Allenrolfea patagonica (Moq.) Kuntze *Heterostachys ritteriana* (Moq.) Ung.-Sternb.	1	0,0101	6,63	6	0,0230	5,44
Jatropha macrocarpa Griseb.	1	0,0101	6,63	2	0,0077	7,03
Vallesia glabra (Cav.) Link	2	0,0202	5,63	7	0,0268	5,22
Ximenia Americana L.	2	0,0202	5,63	15	0,0575	4,12
Senna aphylla (Cav.) H.S.Irwin & Barneby	5	0,0505	4,31	8	0,0307	5,03
Maytenus vitis-idaea Griseb.	4	0,0404	4,63	7	0,0268	5,22
Cyclolepis genistoides D.Don	2	0,0202	5,63	7	0,0268	5,22
Larrea divaricata Cav. *L. cuneifolia* Cav.	3	0,0303	5,04	5	0,0192	5,71
Plectrocarpa tetracantha Gillies ex Hook. & Arn.	1	0,0101	6,63	2	0,0077	7,03
Capparis atamisquea Kuntze	1	0,0101	6,63	11	0,0421	4,57
Grabowskia duplicata Arn.	1	0,0101	6,63	3	0,0115	6,44
Lycium spp.	2	0,0202	5,63	4	0,0153	6,03

Table 3. Cont.

PLANT SPECIES	LOCAL KNOWLEDGE			GLOBAL KNOWLEDGE		
	KNOWN USES	P_s	I_s	KNOWN USES	P_s	I_s
Tricomaria usillo Hook. & Arn.	1	0,0101	6,63	7	0,0268	5,22
Ehretia cortesia Gottschling	2	0,0202	5,63	2	0,0077	7,03
Prosopis reptans Benth.	2	0,0202	5,63	8	0,0307	5,03
Grahamia bracteata Gillies ex Hook. & Arn.	1	0,0101	6,63	5	0,0192	5,71
Lippia salsa Griseb.	1	0,0101	6,63	4	0,0153	6,03
Justicia gilliesii (Nees) Benth.	1	0,0101	6,63	3	0,0115	6,44
Morrenia odorata (Hook. & Arn.) Lindl. *M. brachystephana* Griseb.	1	0,0101	6,63	3	0,0115	6,44
Sum	**99**			**261**		
H (bits/symbol)			**5,02**			**5,13**

The identification of niches of some animals enables hunters to find the *hunting areas. "The guanaco goes to the playa at night to eat guanaco grass, and then by day to the forest to seek for shadow".*

Within the communities, there are mixed opinions about the sustainable management of fauna, recognizing that the resource is something limited that must be conserved (Reati *et al*., 2010).

Traditional knowledge about fauna has also been quantified and compared with the global knowledge (Table 4).

Table 4 shows the probability of use and the information offered for each wild animal.

The entropy (*H*) of local semiosphere concerning the knowledge about fauna is similar to the global semiosphere, and the known potential knowledge of fauna is also similar to the global knowledge.

Applied technologies

People build closures in order to deal with the dry season, using branches of *M. carinatus* or stems of *S. coryne* as raw materials. Grasses are reserved in these sites to be used during winter time when forage is scarce. "With closures, we don't need to buy maize or lucerne [for animal supplementation]".

They recognize different potentials in each zone: "In the summertime, grass grows well in the dunes; in winter time, it grows well in lowlands".

Referring to forestry production, the application of forestry laws restricting wood exploitation, forced local producers to apply other strategies of extraction. To obtain poles, trees are pruned during winter time (with waning moon) to assure resprouting. They do this with several species such as *retamo* (*Bulnesia retama* (Gillies ex Hook. & Arn.) Griseb.), mesquite (*P. aff. nigra*) and *quebracho* (break-ax, *Aspidosperma quebracho-blanco* Schltdl.). Despite forestry restriction do not apply over the use of *cardones*, people apply the same practice to this species, offering the branches to animals as a source of emergency forage and water, but enabling the plant to produce flowers and fruits that will be consumed during the winter and spring time.

Prickly pear production has been of great value for past generations, but the advent of a plague (*Cactoblastis cactorum* Berg, 1885) made most of the plantations disappear. Old men mention that this production was very important, using the fruits and its derivatives. The production of prickly pear has been replaced by other forages that need to be purchased in the cities. Young men affirm that the plantation of prickly pear plants make the animals *quimileros* (they eat another native *Opuntia* plant called *quimilo* which is harmful to cattle), and animals usually eat these cacti, that is used to build closures. Old men disagree with this perception.

Perception changes

In the last decades, the new sociopolitical context such as the agriculture advance over marginal lands, economic interests and the intervention of several formal and informal institutions occurred in this region, changed certain aspects

Table 4. Probabilities, information, and entropy of the local and global knowledge about wild animal uses.

ANIMAL SPECIES	LOCAL KNOWLEDGE			GLOBAL KNOWLEDGE		
	KNOWN USES	P_S	I_S	KNOWN USES	P_S	I_S
Pecari tajacu Linnaeus, 1758	3	0,0588	4,09	3	0,0556	4,17
Didelphis albiventris Lund, 1840	1	0,0196	5,67	1	0,0185	5,75
Marmosa spp.	1	0,0196	5,67	1	0,0185	5,75
Dolichotis salinicola Burmeister, 1876	2	0,0392	4,67	2	0,0370	4,75
Mazama gouazoupira G. Fischer, 1814	2	0,0392	4,67	2	0,0370	4,75
Puma yagouaroundi É. Geoffroy Saint-Hilaire, 1803	1	0,0196	5,67	1	0,0185	5,75
Leopardus geoffroyi d'Orbigny & Gervais, 1844	1	0,0196	5,67	1	0,0185	5,75
Leopardus pajeros Desmarest, 1816	1	0,0196	5,67	1	0,0185	5,75
Puma concolor Linnaeus, 1771	3	0,0588	4,09	3	0,0556	4,17
Dolichotis patagonum Zimmermann, 1780	2	0,0392	4,67	2	0,0370	4,75
Tolypeutes matacus Desmarest, 1804	2	0,0392	4,67	2	0,0370	4,75
Cabassous chacoensis Wetzel, 1980	2	0,0392	4,67	2	0,0370	4,75
Chlamyphorus truncates Harlan, 1825	2	0,0392	4,67	2	0,0370	4,75
Lagostomus maximus Desmarest, 1817	2	0,0392	4,67	2	0,0370	4,75
Conepatus chinga Molina, 1782	1	0,0196	5,67	1	0,0185	5,75
Pseudalopex gymnocercus G. Fischer, 1814	2	0,0392	4,67	2	0,0370	4,75
Aratinga acuticaudata Vieillot, 1818	1	0,0196	5,67	1	0,0185	5,75
Gubernatrix cristata Vieillot, 1817	1	0,0196	5,67	1	0,0185	5,75
Chunga burmeisteri Hartlaub, 1860	2	0,0392	4,67	2	0,0370	4,75
Phoenicopterus chilensis Molina, 1782	1	0,0196	5,67	1	0,0185	5,75
Sicalis flaveola Linnaeus, 1766	1	0,0196	5,67	1	0,0185	5,75
Amazona aestiva Linnaeus, 1758	1	0,0196	5,67	1	0,0185	5,75
Nothoprocta cinerascens Burmeister, 1860	2	0,0392	4,67	2	0,0370	4,75
Nothura spp.						
Cyanocompsa brissonii Lichtenstein, 1823	1	0,0196	5,67	1	0,0185	5,75
Rhea Americana Linnaeus, 1758	5	0,0980	3,35	5	0,0926	3,43
Tupinambis merianae Duméril & Bibron, 1839	2	0,0392	4,67	2	0,0370	4,75
Boa constrictor occidentalis Philippi, 1873	2	0,0392	4,67	3	0,0556	4,17
Epicrates cenchria Linnaeus, 1758	1	0,0196	5,67	1	0,0185	5,75
Chelonoidis chilensis Gray, 1870	1	0,0196	5,67	1	0,0185	5,75
Melipona spp.	1	0,0196	5,67	4	0,0741	3,75
Sum	**50**			**54**		
H (bits/symbol)			**4,68**			**4,72**

in the perception of rural people.

According to Sanchez-Criado (2009), living in a society is subject to continuous (re)tuning-participation-training processes in the course of activity, frictional with other living rhythms, exceeding the figure of culture or ecology as something static and holistic.

The region's political importance gained over the last few years has caused a wave of interventions on the communities by different institutions, some of them well-intentioned, but some others not.

The (mis)use of subsidies by the members of these communities, has changed the culture of work not only here, but all over the country.

It is proven that in those communities that are over-intervened, conflicts between their members are produced, breaking their structure and producing the collapse of 'development' projects.

The lack of coordination between intervening organizations overloads people with reunions, interviews, workshops, who finally lose interest in the process. The loss of visualization over the importance of labor (individual or communitarian) and the autonomy in the quest for resources is clear. It is very common to hear that "the government is responsible" for their current situation, seeking permanently for the government to take care of their necessities. They do not see self-management alternatives. "For the government, we don't care". "They send people who do whatever they want". "They stole the money (of subsidies); it is a mess that thing of the dams" [construction]. "We don't dare to demand more things (to the government)".

DISCUSSION

Relations between Ethnoecology and Ecosemiotics

The kosmos/syntactics in Salinas Grandes is represented by people's beliefs, the structure of nature, and its classification, as seen in Table 2 and Figure 2. All perceived signs, such as the occurrence of climatic events, soil characteristics, water quality, plants and animals or environments have a meaning in people's life, and these are set in the corpus/semantics.

For example, grass scarcity and the animals' sanity, act as signs of weather conditions such as the occurrence of rainfall or drought, and these are directly related to future economic conditions of the community. The physiognomy of the different zones, also act like signs of productive potentiality and are related with the offer of natural resources. Vegetated salinas are known as areas where resources are limited, but they are also conceived as buffer areas for animals during winter. Each plant has a meaning for people and is related with its potential use as forage, food, wood, medicine, etc. The presence of wild animals or their footprints in the identified zones are the sign of their distribution or even their abundance. It is possible to establish a signic relation with each element of the natural environment in the study area and its meaning.

Kosmos/syntactics and corpus/semantics have defined the set of practices along generations clustered in the praxis/pragmatics dimension. An example is the link between drought, signified as grass scarcity and the corporal condition of the domestic animals. To overcome these conditions, local inhabitants have managed to develop several techniques such as the setting up of closures or the development of the grazing cycle, seen in Figure 2.

Empiricism and Cultural Metabolism

Occidental science applies a quantitative or positivist goal (Senkowski, 2006) which is unilineal and dogmatic, following the way traced by Bacon and Descartes through empiricism. The dynamic response of natural systems has been historically simplified, analyzing these in a deterministic way, consistent with the physical theory. The ecosystem is culturally conceived as a productive machine at men's service (Berkes *et al.*, 1998).

Ecological knowledge (seen as a natural scientific knowledge) is not sufficient to solve several ecological problems, it is unable of meeting the environmental issues of contemporary culture (Kull, 1998).

Popular knowledge and individual initiative promote the resilience of the group to stresses, but sometimes resilience limits are exceeded due to structural factors, such as the application of productive paradigms that cannot adapt to local conditions, therefore, the habitus collapse (Karlin *et al.*, 2010a) and makes actors to change their positions in the social field.

The practices and perceptions of local inhabitants, that define the temporal and spatial rhythms of the communities, are set into mythical structures and can clearly be disorganized by changes in the sociopolitical and cultural context, producing new senses for the space and time in a world of the ephemeral (consumption, subsidies), and the fragmentation of those communities.

Science, empowered as the dominant form of knowledge in the occidental civilization, is seen as a specific cultural phenomenon, subjected to a historical, social and economical context, substituting traditional knowledge (e.g. moon importance). Considering the importance of traditional knowledge into peasant communities (e.g. prickly pear plantation method), it becomes harder to sustain that an absolute truth exists (Durand, 2000).

Opposite to empiricism, the Cultural Metabolism (Senkowski, 2006) implies a wider and profound review of reality and implies the integration of the natural, environmental and cultural diversity of the different morphological, philosophical and spiritual classes. This cultural integration does not neglect the knowledge produced by occidental science, but implements it in its 'corpus/semantics', processes it through the 'kosmos/syntactics' and applies it in the 'praxis/pragmatics'. I.e., the confrontation of traditional knowledge, obtained by trials of proof and error, with scientific knowledge, obtained by modern occidental society (antagonism spiritual man-rational man), are processed through his perception and synthesized through practice.

Resilience of Semiospheres

Most of the recommendations made by technicians and politicians, result being unsuccessful due to the lack of serious diagnostics. Without understanding the semiotic mechanisms which define the place of nature in different cultures, there is little hope of solving local environmental problems, and to find the stable place of culture in nature (Kull, 1998). Perimeter wiring, as a proof of land possession, has always been the recommended solution for communities; however, this action modifies absolutely the ancestral practices of cattle management, by cutting their circulation in the grazing cycle. This also brings a total dependence over subsidies, and the lack of creativity and joint work for acquiring the necessary materials. Consequently, the unity of the communities can crack and local organizations may be destroyed.

Local semiosphere relates with the alien semiospheres (outside reality) only through the process of semiotic transformation. According to Kotov (2002) this transformation occurs only on borders of semiospheres, receiving outside messages and new information by, in this case, involved technicians, disturbing the local semiosphere.

Depending on the magnitude of the disturb lying below or above some critical threshold, the fluctuation may be repressed or may spread through the whole system. The fluctuation can break the system's resilience, taking it to a bifurcation point: the system can either dissolve or reach a new organization of a higher order (Kotov, 2002). It means that the exchange of information and interpretations over nature among semiospheres (especially local semiosphere), can either threaten people's perception and break the community, or drive the community into a new and more resilient sphere of knowledge, into the sphere of Integral Ecology (Esbjörn-Hargens and Zimmerman, 2009), such as happens with the recently discussed Multiple Evidence Base approach (Tengö *et al*., 2014) or the Biocultural approach (Gavin *et al*., 2015). The real challenge for all these approaches is to find the way to imbalance power over all forms of knowledge across the objective/interobjective/subjective/intersubjective perspectives.

In order to quantify semiospheres, proved methods are needed for legitimate ways of aggregating, evaluating and synthesizing knowledge (Tengö *et al*., 2014). Information theory provides some interesting indicators as the information index to do so. Table 3 shows that known uses for plants by the local communities are quite inferior to those applied in other regions. Therefore, the information offered by each species is superior compared with global knowledge. However, the close values of entropy between local and global semiospheres mean the local appraisement about some species is similar to the appraisement to the same species by communities in different regions. The lower number of potential uses respect global knowledge, means that possibly local acquis can grow with the exchange of information between different semiospheres.

Table 4 shows that known uses for wild animals by the local communities are close to the potential knowledge about this resource. Information offered by each species is similar compared with global knowledge. As happens with plants, the close values of entropy between local and global semiospheres mean that the proportion of uses for each animal species is alike. The close number of potential uses with respect to the global knowledge, means that local acquis cannot grow with the exchange of information between different semiospheres.

Differences within plant and animal use knowledge may be due to the different potential offered by each resource; plants can offer lots of products compared to animals which can barely offer meat, skins, feathers, eggs as products for local communities.

CONCLUSIONS

The application of technologies without its adequacy based on serious diagnostics and without considering local perception has managed to deconstruct traditional management practices, which have been adjusted along generations through trials of proof and error. The disciplines of Ethnoecology and Ecosemiotics become better approaches for the adoption of adequate diagnostics.

Wiring delimitation, as a paradigm of progress in the rural ambit and as an icon of individual possession, is just an example of the changes in perception suffered by local inhabitants. It reduces the possibility for biodiversity use in space and time, limiting social reproduction, intensifying production and overexploiting local resources. This over-exploiting reduces biodiversity, and with it, the community acquis. The resilience of the local semiosphere can be measured by the set of knowledge of the community measured as the entropy of the information about the behavior of the ecosystem. In Salinas Grandes, information exchange potential between semiospheres is higher for plant uses than for animal uses. Protocols should be reviewed for the construction of development programs, to adequate better traditional technologies instead of applying new ones, and basically to learn and apprehend the keys in the perception of local communities, incorporating these together with scientific knowledge, into an Integral Ecology covering the four dimensions: Experience-Culture-Behavior-System.

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