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CHANGES IN THE USE OF NATURAL RESOURCES IN A POPOLOCA COMMUNITY IN THE STATE OF PUEBLA

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ABSTRACT

This study interprets how the relationship of the inhabitants of the community of San Felipe Otlaltepec, Puebla, Mexico, with the natural resources of their territory has changed, using information taken from the local actors them and by comparing perceptions over a 30 year period. The interaction between man and nature, particularly the role of the latter as the main subsistence provider in rural communities, is subject to notable changes due to endogenous and exogenous factors. In the absence of local studies indicating local use of natural resources, the oral information obtained from the areas inhabitants enabled us to assess these dynamics of change. Through interviews with key informants and the application of questionnaires to 154 farmers, we developed a model for the use of local natural resources and evaluated perceived changes in their agricultural, livestock and forestry systems. The farmers interviewed perceived changes in their agricultural production system and in the use of local natural resources, particularly concerning livestock grazing, cultivated area, crop yield, number of goats in the family unit and use of firewood (extraction from the forest and its purchase). We concluded that the direct use of the natural resource and the crop of greatest importance to the interviewees (maize) relate to the interviewees' perception of the change in the use of natural resources and agricultural systems.

Keywords: crop, firewood, forest, land, livestock.

INTRODUCTION

The Popoloca language is spoken by 17,274 inhabitants in Mexico (National Institute of Statistics and Geography-INEGI, 2021). The community of San Felipe Otlaltepec is a rural community of Popoloca origin and is relevant ethnically because it is one of the communities that has been the basis for the reconstruction of the Popoloca language family (Swanton, 2001). Due to its indigenous roots, there is a vast wealth of local knowledge and traditional systems of agricultural production and use of natural resources. San Felipe Otlaltepec has not been exempt from the changes associated with the modernizing processes affecting most rural communities in Mexico.

Migration, innovative economic activities and projects promoted by government institutions have influenced the economic, social and ecological transformation of the community. There are no studies on these community transformations no information relating to how farmers perceive them. The perception of the local population is important in the formulation of public policies and programs because ultimately it is local residents, who coexist with ecosystems and directly use natural resources. Although the importance of local actors, in terms of being those immediately responsible for the care of their natural resources is increasingly recognized, the majority of environmental policies are formulated

by external agents, who are unaware of the reality facing local communities. Consequently, the programs established at different levels of public administration are not very successful and social participation is low.

The dynamic of this community of indigenous Popoloca origin (a culture little studied compared to other better-known cultures), currently transformed socially, economically and ecologically, is considered transcendent. Apparently, in this community, agricultural activities constitute the determining factor in the use of natural resources and their deterioration or conservation, as is the general tendency in peasant communities (Ruiz *et al*., 2015). An outstanding characteristic of these communities is that natural resources are managed entirely by local actors, with traditional production systems, models of collective appropriation and perceptions about resources conforming to their cultural context (Velázquez, 2006; Trillo *et al*., 2016).

The objective of the study was to conceptualize a model concerning use of natural resources and the perception of local producers on how their use has changed, in the community of San Felipe Otlaltepec, Puebla. The research hypothesis was that producers in the community of San Felipe Otlaltepec, Puebla, perceive and maintain in their historical memory, a series of transformations related to their connection with the natural resources of the community; associated with the transformation of their systems for life and survival.

THEORETICAL FRAMEWORK

The transformations of rural communities in Mexico, especially those considered indigenous, cannot be understood without taking into account both their cultural base and the role that ecosystems and natural resources play in people's livelihoods. Similarly, exogenous economic-social and environmental factors, both national and international, such as globalization, migration and climate change, must be recognized as contributing to these transformations in rural areas. The role played by natural resources in meeting the basic needs of rural residents, evolves as the community transforms ecologically and socioeconomically. Housing transformations, for example, associated with factors such as greater economic dynamics, generated by income derived from migration (Juárez-Sánchez *et al*., 2018; Rello and Saavedra, 2013), contribute to changing requirements for materials previously used to construct traditional homes.

Various theoretical viewpoints have attempted to explain the transformations of the rural environment in Mexico and other parts of the world. A recent theoretical perspective, proposed at a regional level, refers to land use transition, which postulates that the morphology of land use (amount of land used, spatial patterns of land use, land tenure, agricultural production, etc.), is determined by socioeconomic changes and innovations (Long and Qu, 2018). This has been applied at a local level to study the tendency to abandon marginally productive agricultural lands (Yan *et al*., 2016; Zhang *et a*l., 2016). This, at first glance seems to be a negative trend (because food production is affected); but in fact generally contributes to facilitating the recovery of vegetation, because it induces

the renewal of forest areas (Yan *et al*., 2016). This perspective has aspects that coincide with the "de-agrarianization" of the rural environment.

In one sense, in rural communities, natural resources still play an important role as factors affecting the life process of peasant families, with traditional systems of agricultural production and use of natural resources persisting. However, global and national trends indicate a progressive "de-agrarianization" in communities (Escalante *et al*., 2007), where the importance of primary sector activities in the economy constantly decreases, and there is increasing migration and aging of the rural population. It appears that rural pluriactivity, which implies a diversity of non-agricultural jobs, combined with factors such as the aging of rural producers and migration, contributes to the procedure of "de-agrarianization" (Jarquin *et al*., 2017). This process entails not only changes in the use of land and natural resources, but is also associated with the loss of knowledge, technology and traditional practices in rural communities; as well as changes concerning the connection of individuals and groups with their environment (Vergara-Buitrago, 2018).

The role of peasant families as a historical source of information in rural and semi-rural regions of Mexico has been reevaluated, especially in relation to knowledge about the environment and forms of organization and technological knowledge (Tovar and Rojas, 2012). The way in which farmers preserve this information is varied. It can be through documents and photographs kept by families and in the facilities of local institutions, as well as through the knowledge that each individual accumulates, which is partly socialized both intra- and inter-generationally (Ruiz, 2018; Solórzano-Ariza *et al*., 2017).

Local knowledge, traditional production practices and the perception of local residents about their environment and life systems are important, not only as the focus of study to increase the cultural and scientific heritage. They are also valuable factors for establishing national policies and programs that consider local realities and include alternative development projects (Mojica *et al*., 2016). The perception that residents have of their natural resources, their availability, types of uses, deterioration and dynamics of their use are central to the understanding of local ecological-productive systems.

Although we can interpret the concept of perception in many different ways, when studying the connection of the local population with their environment and natural resources, the idea of understanding this as the reflection of the phenomena and processes of consciousness of individuals is relevant, in relation to how these activities affect their feelings (Ramírez and Triana, 2015). To reverse the current trends affecting natural resources, such as degradation and unsustainable methods, the perceptions of farmers or inhabitants in a particular rural community must be considered, as they are the ones who make the decisions and develop strategies, both for conservation and adaptation to adverse environmental conditions. These perceptions are decisive in terms of the way they relate to their natural resources and for their own survival (Infante and Infante, 2013).

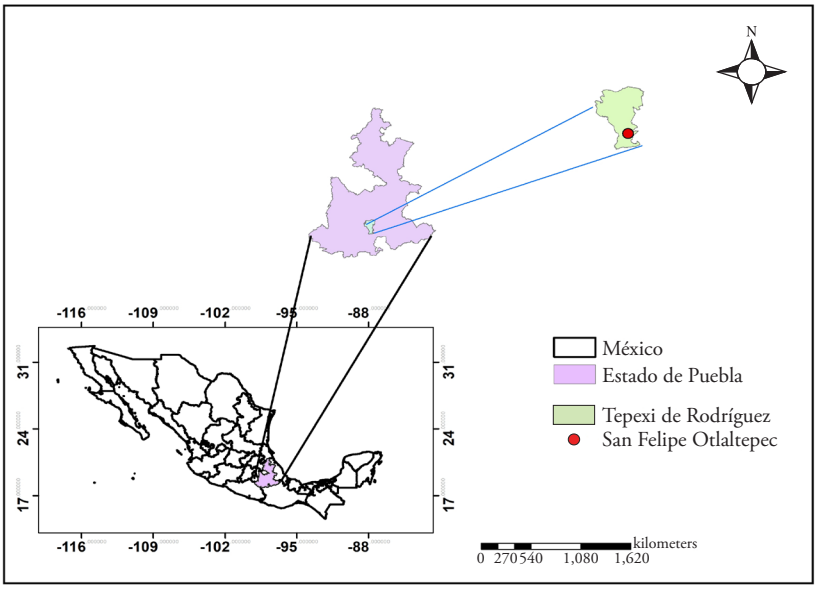
Although the importance of traditional knowledge is currently recognized as stemming from a cognitive process of reliable practices (Valladares and Olivé, 2015), a progressive tendency to lose traditional practices and knowledge in rural communities has been

documented (Cano *et al.*, 2016). The coexistence of people with the natural resources of their community allows them to generate and appropriate knowledge about the type of uses, management, exploitation and conservation of these. If agricultural activities or use of resources cease, the cognitive process of the environment and traditional practices will be lost or diminished. In addition to these, there are external legal, social and technological factors (Matos, 2014).

METHODOLOGY

This study was undertaken in the Popoloca indigenous community of San Felipe Otlaltepec, municipality of Tepexi de Rodríguez, state of Puebla. San Felipe Otlaltepec is located between 18° 24' 02.85" North Latitude and 97° 45' 28.70" West Longitude (Figure 1); highest altitude varies between 1,500 and 2,100 meters above sea level, with an average altitude of 1,850 meters above sea level. The community covers a total area of 7,120.06 ha and has a population of 1,980 people (INEGI, 2021).

San Felipe Otlaltepec has very rugged topography, and consists of steep slopes and extremely stony terrain. The geological substrate is mainly composed of limestone. The predominant climate is (A)C(wo) type; described as semi-warm, with an average annual temperature exceeding 22 °C and the temperature of the coldest month above 18 °C. Another type of climate found here is that of BS1(h´)w; semi-warm subhumid, average annual temperature above 18 °C, temperature of the coldest month under 18 °C and the temperature of the hottest month above 22 °C (National Commission for the Knowledge and Use of Biodiversity-CONABIO 2002).



Source: self elaborated.
Figure 1. Location of the study community.

An exploratory study was carried out by applying interviews to seven key informants to obtain the information required to conceptualize and develop a local model for land use and other natural resources in the community; the key informants selected were agricultural authorities and people over 40 years of age. Subsequently, based on the conceptual model, a questionnaire was applied to 154 residents in the community (100 men and 54 women). His was designed to study the perception of the interviewees concerning changes in agricultural activities and the use of natural resources from the forest from 1980 to 2009 (period identified by key informants, in which a notable transformation began in terms of productive activities of the community). The questionnaire included nine paired questions (1980-2009) on crops and land use, 13 on livestock activities and use of pastures, 26 on forest use and extraction of non-timber forest resources, four on extraction of materials from special sites and two on alternative energy use (Table 1).

The information obtained was analyzed as paired data, applying the non-parametric Wilcoxon signed-rank test and the sign test (Helsel *et al*., 2020), using the SPSS program,

Table 1. Variables used in the study.

Variable	Associated natural resource
Maize cultivated area (MSUP80, MSUP09)	Agrícultural land
Maize crop yield (MRTO80, MRTO09)	Agrícultural land
Amount of maize sold (MVEND80, MVEND09)	Agrícultural land
Price of maize sold (MPREC80, MPREC09)	Agrícultural land
Cost of maize production (MCOST80, MCOST09)	Agrícultural land
Bean cultivated area (FSUP80, FSUP09)	Agrícultural land
Bean crop yield (FRTO80, FRTO09	Agrícultural land
Amount of beans sold (FVENT80, FVENT09)	Agrícultural land
Cost of bean production (FCOST80, FCOST09)	Agrícultural land
General animal ownership (ANIM80, ANIM09)	Pasture - back-garden
Goat ownership (CAPRIN80, CAPRIN09)	Pasture
Donkey ownership (BURR80, BURR09)	Pasture - back-garden
Pig ownership (CERD80, CERD09)	Pasture
Poultry ownership (AVE80, AVE09)	Pasture
Goat consumption (CONCAPRIN80, CONCAPRIN09)	Pasture
Beef consumption (CONBOV80, CONBOV09)	Pasture - back-garden
Sale of goats per year (VENTCAPR80, VENTCAPR09)	Pasture
Price from goat sale (PCAPR80, PCAPR09)	Pasture
Goat grazing (PASTCAPR80, PASTCAPR09)	Pasture
Distance of goat grazing (DPASTCAPR80, DPASTCAPR09)	Pasture
Days of goat grazing (FPASTCAPR80, FPASTCAPR09)	Pasture
Days of goat stabling (FESTABCAPR80, FESTABCAPR09)	Back-gardem
Use of firewood (ULENA89, ULENA09)	Woodland
Bought firewood (LCOMP80, LCOMP09)	Woodland
Firewood extracted from forest (LMONT80, LMONT09)	Woodland
Loads of firewood cut (CLCS80, CLCS09)	Woodland
Time taken to go for firewood (HRIRCL80, HRIRCL09)	Woodland
Firewood for own consumption (LAUTOC80, LAUTOC09)	Woodland
Firewood sold (LVENT80, LVENT09)	Woodland
Price for a load of firewood (PLENA80, PLENA09)	Woodland

Table 1. Continuation.

Variable	Associated natural resource
Firewood for cooking (LCOMI80, LCOMI09)	Woodland
Firewood for water heating (LBANO80, LBANO09)	Woodland
Use of "cubata" species (CUBA80, CUBA09)	Woodland
Use of "palo blanco" species (PBLAN80, PBLAN09)	Woodland
Use of "Tehuixtle" species (TEHU80, TEHU09)	Woodland
Use of "tlahuitol" species (TLAHI80, TLAHUI09)	Woodland
Use of "palo de venado" species (PVENA80, PVENA09)	Woodland
Daily use of firewood (ULDIA80, ULDIA09)	Woodland
Weekly loads of firewood (UCLSEM80, UCLSEM09)	Woodland
Male role in firewood extraction (LVAPA80, LVAPA09)	Woodland
Distance of firewood extraction (LDIST80, LDIST09)	Woodland
Extraction of palm (PALEX80, PALEX09)	Woodland
Weaving of extracted palm (CANTPALM80, CANTPALM09)	Woodland
Responsible for palm extraction (RESPALM80, RESPALM09)	Woodland
Time taken to go for palm (TIEMPALM80, TIEMPALM09)	Woodland
Distance of palm extraction (DISPALM80, DISPALM09)	Woodland
Who extracts palm (RESPALM80, RESPALM09)	Woodland
Hunting of wild animals (CAZA80, CAZA09)	Woodland
Soil extraction (EXTRRA80, EXTRRA09)	Unique forest
Distance of soil extraction from woodland (DISTEXT80, DISEXT09)	Unique forest
Stone extraction from woodland (EXTRPI80, EXTRPI09)	Unique forest
Distance of stone extraction (DISTP80, DISTP09)	Unique forest
Domestic use of gas (UGAS80, UDAS09)	Alternative energy source
Price of a tank of gas (20kg) (GPRE80, GPRE09)	Alternative energy source

Source: self elaborated.

version 15. These tests are used in studies where people are closely related, as in this case, in which pairs of observations of the same individuals were obtained, of the before and after type (Nama-kforoosh, 2010).

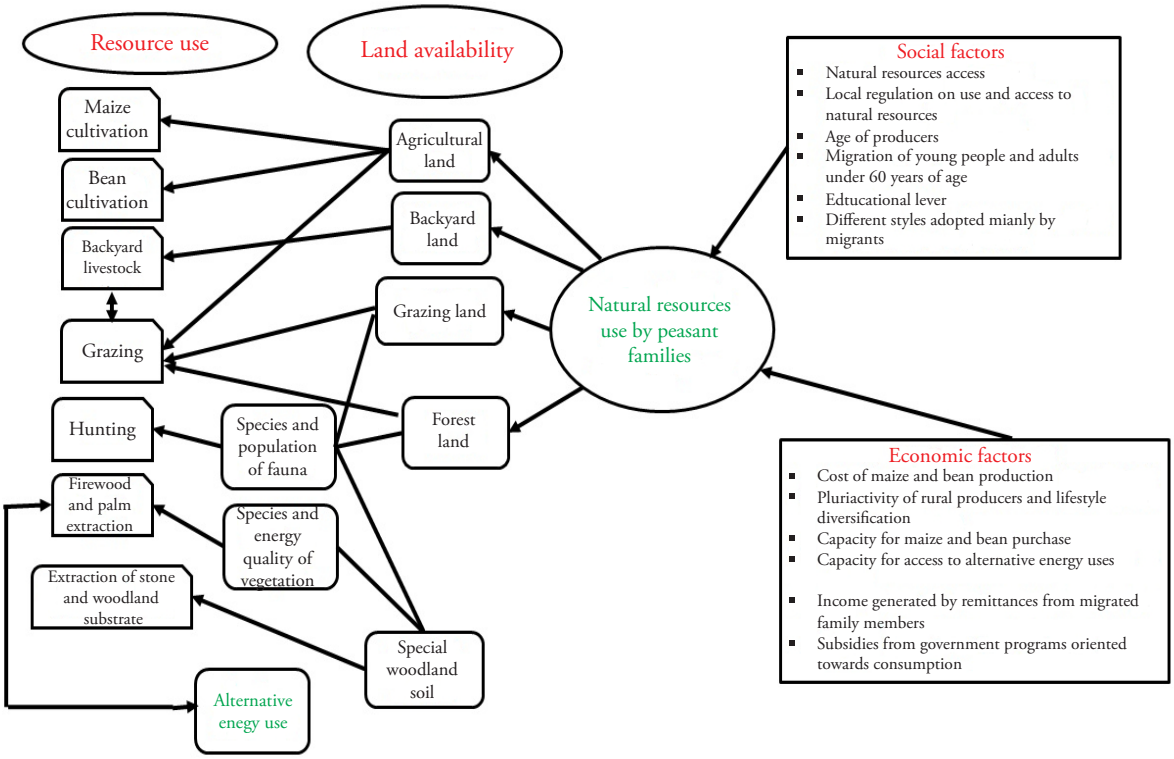
RESULTS

Socioeconomic characteristics of the interviewees

The average age of the interviewees was 54 years, ranging from 31 to 81 years. Their predominant activities were agriculture for men and housework for women; with an average monthly income of 969 pesos, ranging from 0 to 2400 pesos. The average number of family members was 4 people, ranging between 1 and 10 members; their average for years in school was 4.25 years, 21% have no years of formal education and 1.9%, the category with the highest education level (more than six years of formal education), are teachers.

The local model showing uses of natural resources

The use of resources in San Felipe Otlaltepec relates to ecological, economic and social contexts (Figure 2). In ecological terms, this determines the availability (quantity and



Source: self elaborated.
Figure 2. Conceptual model for the local use of natural resources in San Felipe Otlaltepec.

quality) of resources. The economic aspect concerns the rate of use of natural resources, both as inputs for productive activities and to fulfill the basic needs of the peasant family. Then, the social context relates to the population's access to natural resources, including how internal community organization regulates access and use of natural resources, as well as local mechanisms to regulate possible conflicts between users.

Factors having greatest effect on the use of natural resources in San Felipe Otlaltepec are economic and social. The local population employ natural resources as part of their subsistence (especially the poorest sector of the population). For them, natural resources are substitutes for external income that would otherwise represent an expense (firewood, as a substitute for fuels derived from petroleum; stones and sand for construction, instead of materials purchased externally). Likewise, they provide some products that are not commercially available or which can be easily accessed in the community (medicinal plants, edible vegetables and fauna). The predominance of an elderly population, with a long tradition of extractive use of natural resources, means that these still for an important part of their livelihoods. Previously, these resources were the main basis for family subsistence in the community. From the 1980s onwards, factors such as migration, especially of young people and adult men, resulted in the decline in the extractive use of natural resources.

The availability of natural resources and the proximity of their extraction sites determine the intensity and frequency of their use. The availability of firewood, for example, determines the intensity and use of this resource, especially among the lower-income population group. The population prefers to use certain species for firewood, such as cubata (*Acacia cochliacantha* Humb. & Bonpl. ex. Willd), palo blanco (*Mariosousa coulteri* (Benth.) Seigler & Ebinger), tehuixtle (*Acacia bilimekii* J. F. Macbr.), tlahuitol (*Lysiloma divaricata*) and palo de venado (*Ipomoea murucoides* Roem. & Schult.), as they assess both the quality of the firewood and the availability of the species.

Perception on the dynamics of the use of agricultural soils

The producers who were interviewed perceived statistically significant changes (Table 2) in the area planted with maize (the average cultivated area decreased, from 1.97 ha in 1980 to 1.5 ha in 2009), but not for the area cultivated with beans. The average production cost of maize cultivation increased from 1,830 pesos in 1980 to 2,676 pesos in 2009; the production cost of bean cultivation, which were not fertilized, did not manifest a statistically significant increase (Table 2). They consider that the average yield for the maize crop decreased from 1,000 kg in 1980 to 754 kg/ha in 2009; likewise, they think that the bean crop yield also decreased. No change was perceived in terms of the quantity of maize grain or beans sold, as both were intended for self-consumption. The lack of perceived changes in the production cost of bean cultivation is explained, because it is an associated crop; maize is the main crop and the majority of production costs are associated with it (land preparation, labor, weed control), and less attention is paid to beans, which represents an associated crop.

Perception of the dynamics of livestock activities

The producers interviewed only perceived statistically significant changes in the practice of goat grazing (Table 3). Statistically, no changes were perceived concerning the ownership

Table 2. Perception of changes in the maize-bean production system.

Variables	Wilconxon μ	Sign test μ
Maize cultivated area	0.024*	0.021
Maize crop yield	0.069	0.041
Amount of maize sold	0.285	
Price of maize sold	0.063	
Cost of maize production	0.000**	0.000**
Bean cultivated area	0.55	
Bean crop yield	0.031*	
Amount of beans sold	0.655	
Cost of bean production	0.590	

*p <0, **p <0.01 significance for the Wilcoxon test and the sign test.
Source: self elaborated.

Table 3. Perception of changes in their livestock production system.

Variables	Wilconxon	Sign tests
Animal ownership in general	0.285	0.350
Ownership of goats	0.345	0.688
Ownership of donkeys	0.900	
Ownership of pigs	0.932	
Ownership of poultry	0.910	
Consumption of goats per year	0.734	
Consumption of cattle per year	0.325	
Sale of goats per year	3.170	
Unit price for goat sale	0.180	
Goat grazing practice	0.000**	0.000**
Goat grazing distance	0.705	
Goat grazing days	1.000	1.000
Goat stabling days	1.000	1.000

Source: self elaborated.

of animals by the household, due to the fact that 97 interviewees had no change in animal ownership and only 24 experienced a change in this variable. Likewise, there was no change in the ownership of goats per family, characteristics of goat management (consumption of goats, sale of goats, distance in which they take their goats to graze, frequency in which they take goats to graze or feed goats at home). Neither did they perceive changes in family cattle ownership and management; or in the ownership of donkeys, pigs and poultry per family.

The perceived change in the grazing variable (goat grazing), despite the fact that there are considered no changes in its frequency (days of grazing), is important from the ranger's point of view. It is common that in regions similar to San Felipe, grazing is decreasing, due to lack of labor (shepherds), with a consequent reduction in livestock herds. Statistically, no significant differences were apparent, concerning the ownership of the various livestock species; a decrease is apparent in absolute terms, mainly in the number of goats; a slight decrease in poultry and cows per family, and a slight increase in the number of donkeys and pigs (Table 4).

Perception of the dynamics of forest use

Regarding use of the forest, the interviewees perceived statistically significant changes concerning the purchase of firewood, loads of firewood extracted weekly, the amount of firewood used weekly, the amount of firewood destined for self-consumption, frequency in the use of firewood, palm extraction (*Brahea dulcis*), the number of palm weavings produced weekly and animal hunting in the forest (Table 5). They perceived few changes regarding use of firewood, extraction of firewood from the forest, hours spent fetching firewood, firewood destined for sale, the price of a load of firewood, the use of firewood to make food, the use of firewood to heat water for bathing, the use of species for firewood,

Table 4. Average number of livestock per family.

Species	Average population 1980	Average population 2009	Change in average population
Goats	42.8	11.5	-31.3
Donkeys	2.1	2.2	0.1
Pigs	2.2	2.3	0.1
Cattle	5.7	4.8	-0.9
Poultry	8.9	5.7	-3.2

Fuente: self elaborated.

participation of family members in the collection of firewood, the distance of extraction of firewood, time allocated to the extraction of firewood or palm, distance of palm extraction, the family member who goes for the palm, the distance of extraction of soil from the forest or the distance of extraction of stone from the forest.

No statistically significant differences were observed concerning the change in firewood use from 1980 to 2009, as in 2009 a large number of people continued to use firewood

Table 5. Perception of changes in firewood and palm use.

Variables	Wilconxon	Sign tests
Use of firewood	0.289	0.377
Purchased firewood	0.008**	0.013*
Firewood extracted from woodland	0.217	0.280
Loads of firewood cut	0.000**	0.000**
Time to get a load of firewood	0.172	0.377
Firewood used for self-consumption	0.000**	0.000**
Firewood used for sale	0.317	
Price of a load of firewood	0.180	
Use of firewood to make food	0.384	0.486
Use of firewood to heat water	0.209	0.281
Use of the species “Cubata”	0.414	
Use of the species “Palo Blanco”	0.785	
Use of the species “Tehuixtle”	0.785	
Use of the species “Tlahuitol”	0.194	
Use of the species “Palo de Venado”	0.059	
Daily use of firewood	0.000**	0.000**
Loads of firewood used weekly	0.000**	0.000**
The father goes for the firewood	0.773	0.885
Distance covered to extract wood	0.760	1.000
Palm extraction	0.000**	0.000**
Weaving of extracted palm	0.000**	0.000**
Time spent on going for palm	0.169	
Distance of palm extraction	0.212	
Who extracts the palm?	0.445	
Hunting of wild animals	0.000**	0.000**

Source: self elaborated.

and a slight increase was observed, going from 130 people in 1980 to 136 in 2009. The number of people who buy firewood increased slightly (Table 5), eight firewood sellers were identified in the community and the number of loads of firewood purchased in 2009 was on average 0.5, at an average price of 70 pesos (in 1980 the average purchased loads was 1, at a price of 50 pesos). The number of people who collect firewood in the mountains decreased (Table 6). The amount of firewood used daily was 7.3 kg and 5.8 kg in 1980 and 2009, respectively. The clear perception they have concerning the change in the use of firewood as an energy source is because this is a natural resource frequently employed for domestic tasks.

Regarding the extraction of animals from the forest, they perceived changes in the activity of "hunting" forest animals in the forested area (Table 7). They considered that 20 years ago, this activity was more frequent in the area surrounding the community and has decreased because there are other employment options (day laborers, masonry, etc.) that generate greater family income, meaning there is less demand for wild animals as part of family subsistence.

In terms of use of other forest materials, they perceive a change in the extraction of soil and stone from woodland. However, concerning the distances at which soil and stones are extracted from woodland, they do not perceive any change, meaning that the same extraction sites have been maintained.

Perception of the dynamics of alternative energy sources to firewood

In the community, a statistically significant change is evident concerning the use of liquefied petroleum gas (LP) (Table 8). This change has been both in terms of frequency of use, as well as in the cost of fuel. In 1980, only 14 people used domestic gas, whereas

Table 6. Number of people who used, bought and collected firewood.

Activity	1980	2009
They used firewood	130	136
They bought firewood	9	20
They collected firewood	127	119
Collection time (hours)	5	8

Source: self elaborated.

Table 7. Perception of changes in the use of other woodland resources.

Variables	Wilconxon	Sign tests
Extraction of woodland soil	0.001*	0.001*
Distance of soil extraction	0.066	
Extraction of stone from the forest	0.000*	0.000*
Distance of stone extraction	1.000	

Source: self elaborated.

Table 8. Perception concerning changes in use of alternative energy sources.

Variables	Wilconxon	Sign tests
Use of gas for domestic consumption	0.000*	0.000*
Price of a tank of gas	0.002*	

Source: self elaborated.

for 2009 this increased to 113. Although a greater number of people mention that they currently use domestic gas, firewood continues to be an important source of energy in family units, as it plays a role as a complementary energy source, helping reduce family expenses.

DISCUSSION

The sociodemographic characteristics of those interviewed are similar to those of other indigenous rural communities, characterized by an aging rural population, with low levels of schooling and large families. The age, number of children and education of those interviewed is similar to those reported for the region of Soconusco, Chiapas. Here an average age of 53.8 years is reported (with a range of 25 to 78 years), an education spanning 7 years and an average number of children of 2.7 (ranging from one to eight), according to the study by Ramírez and Méndez (2007). Likewise, the family structure is similar to that of other regions in Puebla, where an average number of inhabitants per household of 4.4 to 5 has been reported (Castrejón *et al*., 2005) and an age range of 51 to 53.2 years (Santos *et al*., 2010).

The local model for the use of natural resources is similar to other communities in the state of Puebla and coincides with Ramírez's (2010) premise that farmers in these regions develop production and survival strategies depending on the environment. Peasants adapt according to their social, economic, human and physical assets. Natural resources constitute capital in a model of rural pluriactivity, in which agricultural and non-agricultural activities combine (Jarquín *et al*., 2017).

The relevance of the land and the cultivation of maize among the production and survival strategies of San Felipe Otlaltepec is similar to that documented for marginalized rural communities in other regions of Mexico, such as the Costa Chica De Guerrero (Navarro *et al*., 2010). Communities may exclude or assign less importance to other components of the agricultural system, but maintain maize cultivation as a central part of their subsistence.

The trend for decline concerning intensively grazed species in the study community is similar to that observed in indigenous communities experiencing population migration, especially of the younger population or due to their lack of affinity with family livestock farming (Elizalde *et al*., 2022). Herding may decline because young people have emigrated or because those who remain in the community do not wish to undertake this activity, and for older adults this represents a difficult activity.

Firewood continues to represent an important energy source in San Felipe Otlaltepec, a trend similar to that reported in other regions of Mexico, where most of the rural population continues to use firewood as a source of energy, with a tendency to combine its use with liquefied petroleum gas (Jiménez-Mendoza *et al*., 2022). However, in the community, although the use of firewood for domestic activities continues, people buy more firewood than before, which implies community specialization, as there are people dedicated to cutting and selling firewood internally; the internal marketing of firewood or with neighboring towns has been reported for other regions, such as Montaña de Guerrero (Mozo and Silva, 2022). Likewise, it is to be expected that the use of domestic gas would imply less use of firewood, as this use increased by 800%; however, this is not the case. In San Felipe Otlaltepec, the amount of firewood used daily is greater than that reported for other regions of Mexico (Quiroz-Carranza and Orellana, 2010) and similar to that reported for the rural area of Usme, Colombia (5.2 kg) (Sierra *et al*., 2011).

CONCLUSIONS

The model for the use of natural resources in the community of San Felipe Otlaltepec showed that the availability, quantity and quality of this land resource and the associated natural resources of vegetation, fauna, woodland soil and stone are determining factors in their relevance for subsistence of the local population. In the community, this use has been changing due to factors such as migration, crop production costs and aging of the rural population.

The residents of the community recognize changes in the use of natural resources and agricultural systems, both in terms of activities and use of agricultural lands, grassland forests and special woodland areas. However, these are gradual changes, particularly concerning the use of crop and grazing land. Some activities, such as wildlife hunting and palm extraction are now practiced less intensely; but the extraction of firewood from the forest has increased, despite the introduction of domestic gas as an alternative energy source. This firewood extraction mainly involves the use of five species considered to have energy quality, such as cubata (*Acacia cochliacantha* Humb. & Bonpl. ex. Willd), palo blanco (*Mariosousa coulteri* (Benth.) Seigler & Ebinger), tehuixtle (*Acacia bilimekii* J. F. Macbr.), tlahuitol (*Lysiloma divaricata*) and the more widely available, palo de venado (*Ipomoea murucoides* Roem. & Schult.). This means that the forest may be over-exploited, because firewood extraction is limited to few tree species.

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