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CULTURAL IMPORTANCE OF TREES AMONG SIX RURAL COMMUNITIES IN GUERRERO, MEXICO

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ABSTRACT

Traditional knowledge about the use of tree species is a relevant component of the relationship of the lives of peasant communities and the natural resources owned by them. This can facilitate the planning and execution of forest management and ecological restoration activities. The study was conducted in six indigenous and non-indigenous rural communities from three regions of Guerrero, to assess the importance of trees in the life of the participating communities. The cultural importance index was calculated, which is based on the intensity of use, the frequency of mention and the value of use for each species. Semi-structured interviews, participatory workshops and field walk transects were conducted. Lists of useful trees present in the participating territories were generated. *Pinus oocarpa* obtained the highest index in five of the six communities (10.6% among 65 recognized tree species, with six different uses, the greatest number of mentions and intensity of use), followed by *Quercus magnoliifolia* and *Enterolobium cyclocarpum* in four communities, both species with values that, added together, give a cultural importance index of 15.2% with six and five uses, respectively. The most frequent uses were firewood and construction (311 and 232 mentions, respectively). The information acquired provides useful elements to document the local knowledge about trees and their importance in the life of the communities, to record the uses given to the trees and the relevance of good forest resource management practices and the environmental services they provide.

KEYWORDS: forest communities, traditional knowledge, uses of trees.

IMPORTANCIA CULTURAL DE LOS ÁRBOLES EN SEIS COMUNIDADES RURALES DE GUERRERO, MÉXICO

RESUMEN

El conocimiento tradicional sobre el uso de las especies arbóreas es un componente relevante de la relación entre la vida de las comunidades campesinas y los recursos naturales que ellas poseen. Ello les puede facilitar la planeación y ejecución de obras de manejo forestal y restauración ecológica. El estudio se realizó en seis comunidades rurales indígenas y no indígenas de tres regiones de Guerrero, para evaluar la importancia de los árboles en la vida de las comunidades participantes. Se calculó el índice de importancia cultural, que se basa en la intensidad

de uso, la frecuencia de mención y el valor de uso para cada especie. Se realizaron entrevistas semiestructuradas, talleres participativos y recorridos de campo. Se elaboraron listas de los árboles útiles presentes en los territorios participantes. *Pinus oocarpa* obtuvo el mayor valor del índice de importancia cultual en cinco de las seis comunidades (10.6% entre 65 reconocidas, con seis usos distintos, el mayor número de menciones y mayor intensidad de uso), seguida por *Quercus magnoliifolia* y *Enterolobium cyclocarpum* en cuatro comunidades, ambas especies con valores que, sumados, dan un total de 15.2% con seis y cinco usos, respectivamente. Los usos más frecuentes fueron leña y construcción (311 y 232 menciones, respectivamente). La información obtenida provee elementos útiles para documentar el conocimiento local sobre los árboles y su importancia en la vida de las comunidades, para registrar los usos de los árboles y la relevancia de un buen manejo de los recursos forestales y de los servicios ambientales que estos brindan.

PALABRAS CLAVE: comunidades forestales, conocimiento tradicional, usos de los árboles.

INTRODUCTION

Traditional knowledge is the set of actions and innovations of local communities that form the basis for livelihoods that favor cultural and economic practices that are inherited intra- and intergenerationally, especially in an oral manner (Beckford and Barker, 2007; Warren *et al*., 1995). They are also relevant to local trade, forest management practices and product development from the use of natural resources available in the environment (Berkes, 2018; FAO and UNEP, 2020). Knowledge and skills in many local societies underpin and explain the daily use of plant species and their *in situ* conservation. According to Sánchez (1993), the diversity of uses of available resources shows a deep knowledge, because of an adaptive and evolutionary process of cultural groups to their natural environment, and whose interactions are the product of traditional knowledge generated through time (Sánchez, 1993 in Navarro-Garza *et al.*, 2012).

Research on traditional knowledge for the management of natural resources is common today, under the premise that local knowledge improves the lives of its holders (Stringer *et al*., 2006). Human communities meet many of their needs for food, clothing, fuel, medicines, and other goods, taking advantage of the plants in their environment. However, species vary according to geographic location and time of year (Garibaldi and Turner, 2004; Toledo, 2004). In Mexico, the existing great biocultural richness is reflected in the abundance of studies carried out on the importance of natural resources, as well as in the different methodological approaches applied and in the results that are obtained. Some studies integrate several parameters appropriate to the population and region of research to achieve a quantification index (Pagaza-Calderón *et al.*, 2006; Camou-Guerrero *et al.*, 2007; Garibay-Orijel *et al.*, 2007). However, some scales can be too simplistic to account for all the variables involved and not rigorous enough to be used with minimal bias (Turner, 1988).

The importance that human communities allocate to the plant or animal species existing in their environment varies between different generations and cultures, although there are certain resources that are equally important for the entire population (Phillips and Gentry, 1994; Gadgil *et al.,* 2000). Gender differences are also determining factors in the cultural valuation that a resource can have; thus, women might consider more important those plant species that are closest to the dwellings, while for men the species in the forest are probably more important (da Costa *et al*., 2021; Gutiérrez-Zamora, 2021; Pascual-Mendoza *et al*., 2022).

In Mexico, the main cause of deforestation in tropical areas has been the expansion of agriculture (Armenteras and Rodríguez Eraso, 2014; Bonilla-Moheno and Mitchell Aide, 2020; Cortés-Calderón *et al*., 2021). Some of the natural resources are seriously threatened by habitat loss and selective overexploitation of species; this entails the

loss of knowledge about its use and value (Boom, 1989). The recognition of this problem is essential to initiate any activity of ecological preservation or restoration (Román *et al.,* 2011). Research experiences have been documented regarding the traditional knowledge and use of forest plants (Beltrán-Rodríguez *et al*., 2017), participatory forest conservation practices, and the productive restoration of dry tropical forests in the state of Guerrero (Ceccon, 2020).

In the present study we sought to answer the following questions: What are the most important trees for the non-indigenous and for the indigenous Mixtec and Nahuatl communities in the study area? What are the mostly used species and what uses are they given? This research sought to assess the different uses of the tree flora given by peasant communities and to determine the importance of the trees within their environment in their daily lives.

MATERIAL AND METHODS

Characteristics of the participant communities and the study area. The research was carried out in six rural communities in three regions of the state of Guerrero: San Vicente de Benítez (SVB) and Agua Fría (AF), both in the municipality of Atoyac de Álvarez, Costa Grande region; these two communities identify themselves as non-indigenous; Yoloxóchitl (Yolo) and Cuanacaxtitlán (Cuana), municipality of San Luis Acatlán, in the Costa Chica region, self-identified as indigenous Mixtec in both cases; and Copanatoyac (Copa) and Ocotequila (Oco), municipality of Copanatoyac, both being Nahuatl-speaking indigenous peoples (Figure 1).

The main economic activity in both, SVB, and AF, is the production of coffee (*Coffea arabica* L.). Most of their plantations outside the inhabited areas, are over 900 m above sea level (masl) and under a canopy of trees that provide them with shade and moisture; these are important factors for the yield of high-quality coffee beans. The floristic richness and the high degree of conservation of these coffee-forest agroecosystems (Álvarez-Álvarez *et al*., 2020) are common features of high-altitude coffee stands, as it occurs in both communities, especially SVB, which received financial support (2012-2016) from the National Forestry Commission to take part in its Payment for Ecosystem Services program (Serafin-Castro *et al*., 2021). They have been classified as having medium and high grades of marginalization, respectively; this, in accordance with the Mexican government agency National Population Council (CONAPO, 2020), which for several decades has ranked all the Mexican localities by using indicators like literacy of the population, the existence of electric power, tap water and refrigerator inside the dwellings, but also the existence of dirt floor and other characteristics that are included in an algorithm that calculates a numeric value or index which eases its placement within one of five categories-or grades- of marginalization (very low, low, medium, high, and very high), three of which were recorded in this research.

In San Vicente de Benítez, areas of cloud forest and sub deciduous tropical forest, exist in addition to the lands that have been deforested for the establishment of fruit tree plantations (avocado, citrus) and pastures for cattle breeding. In Agua Fría, tropical deciduous forest prevails in combination with secondary vegetation and seasonal agriculture. The climate in these communities is warm subhumid with rains in summer, the temperature of the coldest month being higher than 18°C. The total annual rainfall is 1,236 millimeters (INEGI, 2010a).

In Yoloxóchitl and Cuanacaxtitlán, deciduous and sub deciduous types of tropical forest prevail, with mixtures of secondary vegetation and seasonal agriculture. The climate in both locations is warm intermediate subhumid with rains in summer, average annual temperature higher than 22°C and temperature of the coldest month higher than 18°C. The annual rainfall is 1,400 millimeters (INEGI, 2010b).

In Copanatoyac (the capital town of the municipality that also holds this name) and Ocotequila, for many years there have been large areas that were deforested to open new lands for the cultivation of staple grains. The slopes have very little tree cover. This has led to soil erosion and the upwelling of bedrock, as well as

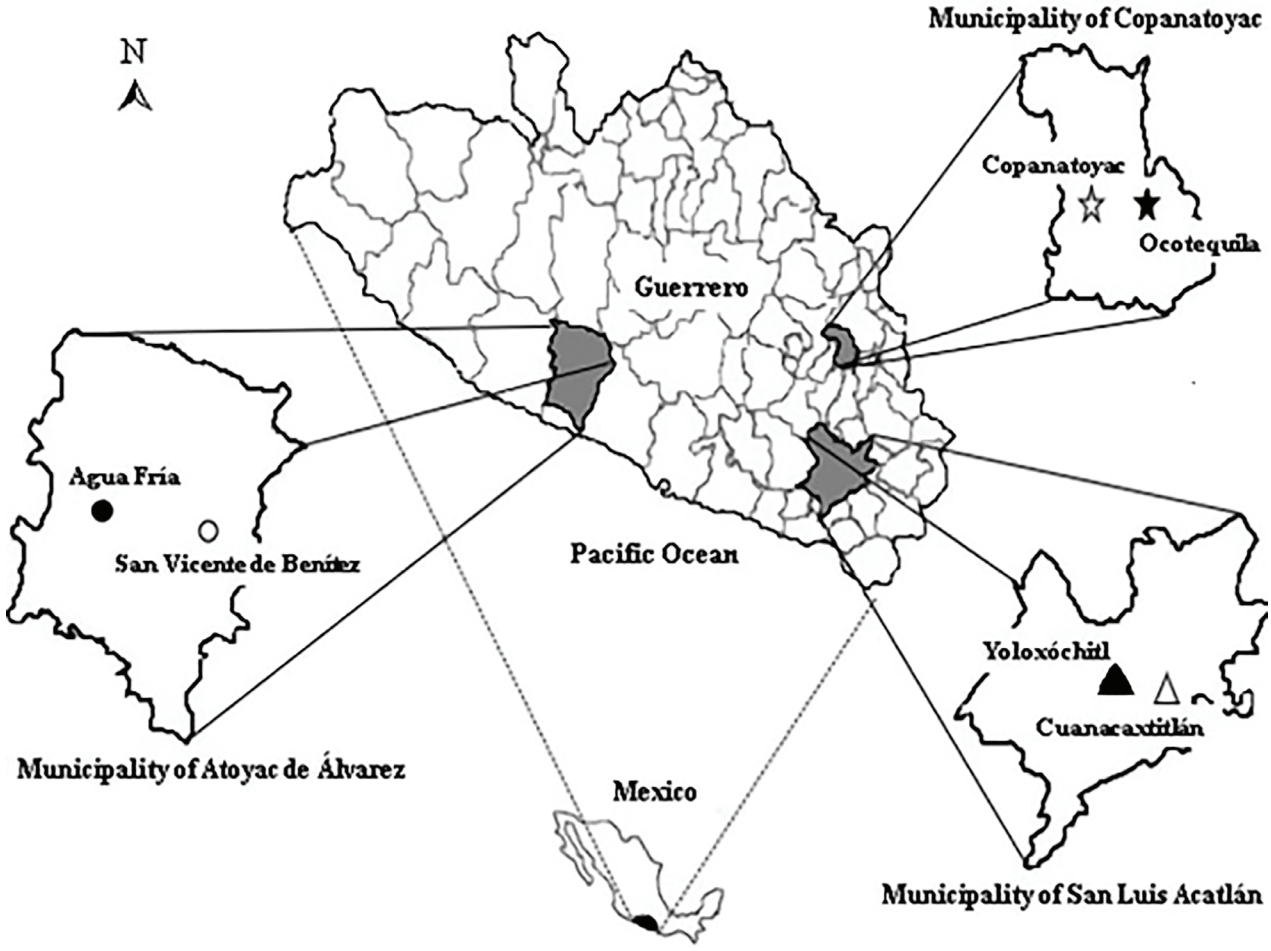

Figure 1. Location of the six participating communities.

the abandonment of land areas that eventually ceased to be productive. Secondary succession has occurred; however, the regrowth of trees and shrubs is cut intensively for use as firewood due to the need of the population for that resource. The climate in these two rural communities is semi-warm subhumid with rains in summer, an average annual temperature higher than 18°C and the lowest of the coldest month being lower than 18°C. The annual rainfall is 1,845 millimeters (INEGI, 2010c). Table 1 shows some other characteristics of the six participant communities.

Research techniques. The information obtained with this study was generated prior to the arrival into Mexico of the Covid-19 pandemic. Quantitative ethnobotany techniques were used and complemented by participatory research and a qualitative approach, which uses tools such as observational research, the application of interviews to community members, transect walks, participatory workshops, and action research (Bermúdez *et al.,* 2005; Hurtado *et al.,* 2006).

One hundred and nineteen adult participants (53 females and 66 males: SVB, 19 participants; AF, 17; Yolo, 21; Cuana, 20; Copa, 20; Oco, 22) were interviewed individually, selected by means of a random sampling procedure. Further, a participatory workshop was held in the premises of the local government of each community with adult inhabitants, who were summoned by the local authority based on their publicly recognized knowledge of the existing local tree species. A total of 18 women and 34 men took part, both genders being represented (female, men) from each community as follows: SVB 3, 4; AF 2, 3; Yolo 4, 7; Cuana 3, 7; Copa 3, 8; Oco 3, 5. The

Table 1. General characteristics of the participating communities.

VILLAGE	GEOGRAPHIC LOCATION		ALTITUDE (MASL)	EXTENSION (HECTARES)	ADULT POPULATION	GRADE OF MARGINALIZATION*
	NORTH	WEST				
San Vicente de Benítez	17°17'50"	100°17'00"	936	6,202	116	Medium
Agua Fría	17°17'33"	100°24'02"	409	2,935	74	High
Yoloxóchitl	16°48'57"	98°41'12"	618	5,347	584	High
Cuanacaxtitlán	16°47'58"	98°38'22"	474	1,953	255	High
Copanatoyac	17°27'51"	98°42'45"	1,382	3,220	256	Medium
Ocotequila	17°26'58"	98°40'38"	1,716	2,198	845	Very high

*According to CONAPO (2020).

following questions were asked at the workshops: What trees are the most important for you? What uses do you give to each of these trees? Each participant pointed out the names of the trees and the uses given to each one. The researchers always avoided to influence the information by not proposing names of trees or uses. During these meetings, key informants were identified (Suárez *et al*., 2011), being those participants who showed a broader knowledge about the topics under discussion.

Transect walks were carried out with the voluntary accompaniment of at least two of the experts or key informants who had been previously identified during the workshops in each community. A total of 7 women and 13 men participated in these field activities, both genders being represented (female, men) from each community as follows: SVB 1, 2; AF 2, 2; Yolo 1, 1; Cuana 0, 2; Copa 2, 3; Oco 1, 3. A semi-structured interview script was used, always ensuring that the questions to be asked during the field walk in each locality were essentially the same. Thus, the local names (in Spanish and indigenous language, when it was the case) of the different tree species that were encountered in the field, as well as their uses, were recorded *in situ*. Samples of plant parts were collected, press-processed (Lot and Chiang, 1986) and later deposited in the UAGC Herbarium of the Institute of Scientific Research-Area of Natural Sciences, Autonomous University of Guerrero (UAGro), where specialist staff helped to resolve the doubts that emerged in the taxonomic determination of the botanical material. The database Tropicos maintained by the Missouri Botanical Garden was used as a standard for nomenclature (Missouri Botanical Garden, 2022).

With the information obtained from the workshops, transects and individual interviews, a database was developed in an electronic spreadsheet that contained the common and scientific name of the tree, its name in indigenous language if any, the uses that were mentioned for each tree, as well as the number of mentions to each use and for each species. The parameters for the estimation of the Modified Cultural Importance Index (IICm) were calculated, based on López Toledo and Valdez Hernández (2011). These parameters were: Intensity of use (Iu, the percentage of uses in which a species appears); the Frequency of mention (Fm, the sum of mentions for a species, all uses and all informants); the Value of use x (Vu_x, the percentage of uses in which a species appears for a given use); the IICm was estimated for each of the species and reflects, as a percentage, their relative contribution, in the following variables: Iu rel = relative intensity of use; Fm rel = relative frequency of mention; Vut_z = relative total use value.

RESULTS AND DISCUSSION

A total number of 65 tree species belonging to 36 families and 53 genera were mentioned. The Fabaceae family obtained the highest IIC (15.6%), with 5 genera and 8 species, followed by the Fagaceae family (IIC=15.3%, with 1 genus and 5 species). These two plant families were the most important for the six communities, resulting this from the number of uses they are given. The genera with the highest cultural importance were *Quercus* (Fagaceae,

15.3%) and *Pinus* (Pinaceae, 10.6%), the latter reported by interviewees from five of the participant communities. The three species with the highest cultural importance index in the six communities were *P. oocarpa* Shiede, *Quercus magnoliifolia* Née and *Enterolobium cyclocarpum* (Jacq.) Griseb., which totaled 25.8% (Table 2).

The total number of different uses mentioned by the participants of the six communities was 13, distributed among the 65 tree species. Two species were reported with the greatest number of uses: *P. oocarpa* and *Q. magnolifolia*, followed by *Q. crispifolia* Trel., *E. cyclocarpum*, *Talauma mexicana* (DC.) G. Don, and *Lonchocarpus* sp.; the latter four coincided in the number and intensity of uses, but *P. oocarpa* and *E. cyclocarpum* were the most prominent, with a greater number of mentions (Table 3). The data confirm the high economic and social relevance of these tree species for the participant communities.

The use for firewood was the most mentioned and widely distributed among the six communities. Secondly, the production of lumber for house construction. These two uses accounted for 65.9% of the mentions reported by the interviewees. Thirdly, medicinal use concentrated 10.9% of the mentions (Table 4). These three most important uses of trees in the study region show how

Table 2. Tree species with higher cultural importance.

SPECIES / COMMON NAME (SPANISH)	INDIGENOUS NAME		VILLAGES	IU REL	FM REL	VU_x REL	IIC
	MIXTEC	NAHUATL					
Pinus oocarpa Shiede (ocote-pino)	Tun tuxa	Okolt	SVB, AF, Yolo, Cuana, Copa	4.2	13.1	14.5	10.6
Quercus magnoliifolia Née (encino amarillo)	Tuiki	Auakostle	Copa, Oco	3.6	4.9	14.4	7.6
Enterolobium cyclocarpum (Jacq.) Griseb. (parota)	Tun xinda	Cuaunacaztli	Yolo, Cuana	3	13.6	6.1	7.6
Quercus crispifolia Trel (encino)			SVB, AF	3	7.4	2.5	4.3
Lonchocarpus sp. (zopilote)	Tun pilo		Cuana, Yolo	3	5.2	3.4	3.9
Gliricidia sepium Kunt ex Walp. (cacahuananche)	Tun takui	Cacahuatlnantzin	SVB, AF, Cuana	3	4.4	1.9	3.1
Cupania dentata DC (amolador)			SVB	2.4	2.4	1.5	2.1
Swietenia humilis Zucc. (caobilla)	Tui tuya	Tzopilo-cuáhuitl	AF, Cuana	2.4	2.2	1.8	2.1
Quercus urbanii Trel. (agua cucharo)	Itun tiata kuan	Auakuchora	Copa	2.4	1.3	0.7	1.5
other 56 species				69.9	41.9	50.3	
Total				**100**	**100**	**100**	**100**

SVB, San Vicente de Benítez; AF, Agua Fría; Yolo, Yoloxóchitl; Cuana, Cuanacaxtitlán; Copa, Copanatoyac; Oco, Ocotequila; IIC, Index of Cultural Importance; Iu rel, Relative intensity of use; Fmrel, Relative frequency of mention; Vu_xrel, Relative value of use x.

Table 3. Species with a higher intensity of use, frequency of mention and value of use.

SPECIES	USE	N° OF USES	IU (%)	FM	VUTZ
Pinus oocarpa Shiede	Co, Fi, Me, Or, Po, Re	6	53.8	108	188.9
Quercus magnoliifolia Née	Ch, Co, Fi, Me, Po, To	6	46.2	40	186.6
Quercus crispifolia Trel.	Co, Fi, Fu, Or, Po	5	38.5	61	33.1
Enterolobium cyclocarpum (Jacq.) Griseb.	Co, Fi, Fu, Me, Po	5	38.5	112	79.5
Talauma mexicana (DC.) G. Don	Co, Fi, Fu, Me, Po	5	38.5	30	37.3
Lonchocarpus sp.	Co, Fi, Fu, Me, Po	5	38.5	43	43.6
Gliricidia sepium (Jacq.) Kunth ex Walp.	Co, Me, Or, Po	4	38.5	36	25.3
Quercus urbanii Trel.	Co, Fi, Me, Or	4	30.8	11	9.7
Cupania dentata DC.	Co, Fi, Po, Sh	4	30.8	20	19.2
Swietenia humilis Zucc.	Co, Me, Po	3	30.8	18	23.6
Other 55 species	Be, Ch, Co, Fi, Fo, Fu, Me, Or, Po, Re, Ri, Sh, To	13	892.3	345	653.3
Total		**13**		**824**	

Be, source of food for bees; Ch, charcoal; Co, lumber for construction; Fi, firewood; Fo, food (humans); Fu, wood for furniture; Me, medicinal; Or, ornamental; Po, wood for poles; Re, resin; Ri, ritual; Sh, shade for coffee shrubs; To, wood for work tools; Iu, Intensity of use; Fm, frequency; Vutz, Value of use of the mentioned species.

the impoverished rural people of these communities base a major part of their livelihoods on the tree flora surrounding them. By adding the other mentioned uses, a clear picture of the close interrelationship between people and trees is shown.

In relation to the knowledge and uses of trees in terms of the self-identification of the participants with indigenous peoples, the Nahuatl interviewees reported a greater number of different uses (n=12) given to the trees in their environment, although the species reported were 19 in each of the two localities belonging to that native culture; that number of species was smaller than the ones reported by non-indigenous interviewees (n=22), however, the number of uses they make of trees was slightly lower (n=9) than with the Nahuatl. On the other hand, the interviewees from the two Mixtec indigenous communities reported 15 and 16 tree species and a smaller number of uses each (n=7) than in the two previous cases. In Mexico, information on research about cultural importance is still insufficient (Lara-Vázquez *et al*., 2013), especially that related to its evaluation with a quantitative approach determined by the number of mentions that in different social contexts are made of the organisms under study.

The greatest cultural importance of the Fabaceae was reflected in the calculation of the cultural importance index (IIC), due to the great abundance and diversity of this plant family, and the fact that many of its tree species are used for consumption and sale of firewood by the inhabitants of the participating communities, mainly those settled in areas where the deciduous and sub deciduous forests predominate. The Fagaceae, with a single genus (*Quercus*) and five species of oaks, has its main uses for firewood, lumber for house construction, ornamentation, charcoal production, and medicine. This family, despite having a smaller number of mentions in the localities, is comparable to Fabaceae – which covers more genera and recognized species –due to a greater number of uses given by the communities involved.

The high IIC value reached by the genus *Quercus* was due to the use mainly by the inhabitants of Copanatoyac and Ocotequila (Montaña region), and was obtained by the various uses that trees of this genus have as a source of firewood, material for house construction, medicinal, the production of charcoal and for ornamentation, being the latter associated with the use of acorns from the oak trees, used in their traditions, expressed in various religious, civic and family holidays at different times of

Table 4. Uses of the most frequently mentioned trees by the six communities.

CODE	USE	MENTIONS		MOST-USED SPECIES
		NUMBER	%	
Fi	Firewood	311	37.7	*Q. crispifolia*, *Q. magnoliifolia, G. sepium*, *T. rosea*, *C. dentata*
Co	Construction	232	28.2	*Q. crispifolia*, *P. oocarpa*, *E. cyclocarpum*, *T. rosea*
Me	Medicinal	90	10.9	*Lonchocarpus* sp., *T. mexicana*, *B. crassifolia*
Po	Poles	70	8.5	*P. oocarpa*, *T. rosea*, *E. cyclocarpum*
Fu	Furniture	34	4.1	*E. cyclocarpum*, *T. mexicana*, *S. humilis.*
Fo	Food (human)	31	3.8	*Mangifera indica*, *Leucaena esculenta*, *Annona muricata*
Sh	Shade for coffee shrubs	24	2.9	*Swartzia simplex*, *Inga vera*, *C. dentata*
Or	Ornamental	18	2.2	*P. oocarpa*, *Q. magnoliifolia*
Re	Resin	4	0.5	*P. oocarpa*
To	Work tools	3	0.4	*Fraxinus uhdei*, *Q. conspersa*
Be	Bee food	3	0.4	*Vismia mexicana*
Ri	Ritual	3	0.4	*Bursera excelsa*, *Salix humboldtiana*
Ch	Charcoal	1	0.1	*Q. magnoliifolia*
Total		**824**	**100.0**	

the year, according to the informants. Several species of *Quercus* trees for firewood use, especially *Q. magnoliifolia*, were the preferred ones in a Montaña community, according to Mozo Ocegueda and Silva Aparicio (2022), which coincides with this report.

The prevailing poverty of most participating communities forces them to use various tree species in an intensive manner as a source of firewood and for the construction of their homes, furniture, poles, work tools and other useful objects. Standing out among the most widely used for these purposes, are *Q. crispifolia*, *Q. magnoliifolia*, *Gliricidia sepium* (Jacq.) Kunth ex Walp., *Tabebuia rosea* (Bertol.) DC., *Cupania dentata* DC., *P. oocarpa* and *E. cyclocarpum*. In coffee stands at Jocotepec, Oaxaca, Mexico, the oak *Q. crispifolia* was reported with the second highest importance value index, which measures the degree of dominance of species (Moreno-Guerrero *et al*., 2020). *Q. magnoliifolia* has shown to be a more fire-resistant species than others in that genus (López Moctezuma *et al*., 2015), being mostly used for firewood and construction purposes.

It is noteworthy the relevance of the ocote pine *P. oocarpa*, as it was the single species with the highest index of cultural importance due to the different uses mentioned in the research, being widely recognized in five of the six localities, the exception being Ocotequila. It should also be noted that in the case of this town (in the Nahuatl language, Ocotequila means "place of the ocote logging": ócotl, ocote; ***tequi***, cut; ***la***, place-related) (Mayo, 2008); despite the name of this locality, no person mentioned the ocote trees in any way. This is because, according to the interviewees, "*...since many years ago, there are no more ocote trees here*". This species was important in the past, but in the absence of preservation and restoration strategies, it became extinct locally, leaving a record of it only in the name of the town.

The use of trees to obtain firewood was recognized as the most common. In the three regions under study, the number of households where liquefied gas for cooking, heating water or other purposes is negligible; hence, the dependence on forest-tree firewood is very high, which represents a strong pressure on this natural resource. This situation has been internalized mainly in San Vicente de

Benítez where, during the last decade, the construction of wood-saving stoves has been adopted in many homes taking advantage of the technical and financial support that several government agencies have provided them for that purpose. This initiative allows a decrease in the use of firewood and in the rate of deforestation and environmental impact (Masera *et al.,* 2015). In addition, it has positive effects on the health of people, mainly housewives, who for many years have spent a large portion of each day in front of the still prevailing traditional open cooking fires, an important source of harmful smoke to which they and their families are exposed (Bailis *et al.,* 2009; Bonjour *et al*., 2013).

Also, in the Costa Chica and Montaña regions, the excessive cutting of trees and sale of firewood is very intense, and no control is exercised over these activities, although in the workshops and interviews it was generally recognized that these practices represent a mismanagement of the communities' natural resources, and that there is a high risk of an irreplaceable loss of their forested lands. Concerns about growing water scarcity due to uncontrolled logging were also expressed, particularly in Cuanacaxtitlan and Copanatoyac, associated with an increase in the awareness about the importance of protecting timber resources through the promotion of the consciousness and actions necessary to preserve and enhance the forest biomass. These communities have begun reforestation projects with *Pinus* spp., *Cedrela odorata* and other tree species, with the financial and technical assistance from the National Forestry Commission.

G. sepium had a higher index of cultural importance as compared to the study by Jiménez-Escobar and Rangel-Churio (2012); its use for firewood in Guerrero is like that in the Caribbean. *T. rosea* was reported in this same study with its main use as firewood and a cultural importance index of 4.16%.

There is a high diversity of species producing edible fruits within the territories of the participating communities, such as *Annona muricata* L., *Spondias purpurea* L., *Byrsonima crassifolia* (L.) Kunth, various citrus trees, *Musa* spp., *Syzygium jambos* (L.) Alston, *Psidium guajava* L. and *Persea americana* Mill, among others. These species are present in the house backyards and widely dispersed, being an important component of the family diet and a source of income derived from their local sale or in nearby towns.

An indirect use, recognized by some interviewees, was related to the nectar from *Vismia mexicana* Schltdl., which is "*...taken by honeybees, and it promotes the production of honey by beekeepers on the Costa Grande region*". The fruits from this tree species were also recognized as human food and medicine; they contain metabolites that contribute to the preservation of the health of the inhabitants of tropical regions (Hussain *et al*., 2012).

As for the medicinal use of various parts of trees, the fruits of *A. muricata* were mentioned by interviewees in all six participant communities as anticancer. Extracts from several parts of this tree have been shown to cause apoptosis of cancer cells (Na *et al*., 2016; Yahid *et al*., 2018). Fruits from mango trees were also mentioned as having anticancer properties. This has been documented for the mesocarp (Corrales-Bernal *et al.,* 2014), as well as pericarp extract (Lauricella *et al.,* 2019) of *Mangifera indica*, with antioxidant capacity and presence of bioactive and nutritional compounds, for preventing the appearance of various types of cancer. Some interviewees reported that the leaves of *B. crassifolia* produce an infusion that they use for "*cleansing and treating inflammation of the eyes*". It has been shown that the leaf extract of this species has components with anti-inflammatory properties (Pérez Gutiérrez, 2016). The seeds of trees known locally as ***vulture*** (*Lonchocarpus* spp.) and ***yoloxóchitl*** or heart flower (*T. mexicana*), are used in the participating communities to control hypertension. The bark of *Hymenaea courbaril* L. is used to treat kidney ailments, while the infusions of *Cecropia obtusifolia* Bertol. leaves are consumed by some diabetic people as a substitute of tap water; guava leaves and fruits were reported as having antidiarrheal properties.

Swietenia humilis Zucc. was reported as a source of lumber for construction; in addition, its seeds are used for the treatment of metabolic disorders such

as diabetes and dyslipidemia (Ovalle-Magallanes *et al.,* 2015). Timber from the stems of *E. cyclocarpum* is used for house construction and to manufacture poles and furniture; some interviewees indicated that they also use bark infusions to treat bronchitis. A person in San Vicente de Benítez pointed out that, in the past, in times of corn shortage, flour obtained from the seeds of this tree was used to make tortillas.

The area of the state of Guerrero in which coffee was produced in 2018, with 45,348 hectares, distributed in the Costa Grande, Montaña, Costa Chica and Centro regions, of which the former is the most important for its cultivated area, its yield (SIAP, 2019) and the number of farmers involved. There, Atoyac de Álvarez is the main coffee-producing municipality, with 23,980 hectares planted. In general, the coffee plantations of Guerrero are practically transformed forests (Moguel and Toledo, 2004) in which since the late 19th century, coffee shrubs have been added to the prevailing wild mountain vegetation to create productive forests. Most of the shade-providing trees are native species.

During the existence of the now extinct Mexican Coffee Institute (INMECAFE), the planting of specimens from several species of the genus *Inga* and other leguminous trees was encouraged in the producing areas of Mexico, to provide shade for the coffee plants; at the same time, the elimination of others was promoted, to achieve more homogeneous plantations, with very little diversified shade that would facilitate their management in accordance with the technical guideline that had been designed by that government institution (INMECAFE, 1990) to be applied at all coffee stands. With the passage of time, this recommendation was not heeded by most coffee growers in Guerrero, who kept the original tree diversity in their plantations. This decision also allowed them to maintain a high diversification not limiting their areas to produce only coffee and shade for this crop, but also firewood, lumber, various foods, uses in traditional herbal medicine and flowers among others, in addition to being an important source of environmental services (Segura-Pacheco *et al*., 2014; Richards *et al*., 2021). On the other hand, a greater biodiversity within the coffee stands gives them a higher resilience against natural phenomena that are frequent, such as hurricanes, or fungal diseases that have had devastating effects, such as the fungal coffee rust *Hemileia vastatrix* Berkeley &. Broome (Renard-Hubert and Larroa-Torres, 2017; Amico *et al*., 2019), insect pests like the coffee berry borer (*Hypothenemus hampei* Ferrari), as well as larger-scale problems such as global warming. Cooperativism and social organization for production under agroecological schemes are elements that also facilitate rural communities to achieve greater strength for the conservation of their natural resources (Galicia-Gallardo *et al*., 2020).

The four communities from Costa Grande and Montaña regions have conducted land management planning activities, in which the first two authors of this article took part. As for the Costa Chica Mixtec communities of Yoloxóchitl and Cuanacaxtitlán, although they have not worked on that land-use tool, their community assemblies have established rules regarding the prohibition of the felling and sale of wood. That is, in all cases there is a consensus to protect forest resources. Their main constraint, according to the interviewees, is the laxity in the enforcement of these guidelines and the monitoring of compliance with these rules by the local authorities. Due to the poverty of most population, the search to satisfy the basic needs by resorting to natural resources, forces it to extract from the environment many of the required goods such as firewood, edible plants and fungi, wild fauna, and others without adopting preservation measures. This can place the natural ecosystems at a critical point, from where it would be much more difficult to apply strategies for their restoration.

The self-identification of rural communities with an indigenous culture of the state of Guerrero; the traditional knowledge they possess and the use they make of the flora in their environment, showed differences that can be associated with the degree of conservation of forest resources. The existence of a territorial planning instrument denotes that a process of community land use regulation has occurred there, so a better health of the natural resources would be expected (Anta Fonseca *et al*., 2006). During the field walk trips, we registered that

the preservation of the natural environment was greater in the coffee ecosystems owned by the non indigenous communities of Costa Grande region. On the other hand, in the Montaña region a greater deforestation was evident, as well as the outcrop of bedrock or signs of forest fires that occurred in the recent past in the Nahuatl territories of Copanatoyac and Ocotequila, but mainly the latter, where the most acute poverty was detected as prevalent among its population. Dozens of male adult inhabitants of Ocotequila have emigrated to cities as far as Acapulco or New York in search of employment in urban activities, detached from agriculture or forestry (Segura-Pacheco *et al*., 2016).

The uses of trees are more intense and diversified (12 different uses were identified in the two Montaña communities), even though the interviewees indicated a slightly smaller number of tree species than those of the two communities of the Costa Grande region.

The study of the relationships established by rural communities with their natural environment is important due to the beneficial effects that the recording of traditional knowledge will have on its preservation, since it has the risk of being lost in the face of emigration, the erosion of cultural identity and the non-incorporation into productive activities by young people.

CONCLUSIONS

The species with the greatest importance for the six participating communities were *Pinus oocarpa, Quercus magnoliifolia, Enterolobium cyclocarpum*, *Q. crispifolia*, *Lonchocarpus* spp., and *Gliricidia sepium,* for the value of use that these trees have for them.

The most important uses of trees were firewood, wood for house and furniture construction, wood for poles, medicinal, human food, ornaments and handicrafts, shade for coffee, as a source of nectar for bees, charcoal production, resin extraction, as well as ritual use.

Both, indigenous and non-indigenous communities, make intensive and diversified uses of the tree flora to obtain goods and services provided by their natural environment, exacerbated by the conditions of poverty and marginalization in which they are forced to live.

Having carried out and approved the management of land use in four of the participating peasant communities, prior to this research, was evidenced in a better management of their forest resources, mainly by the coffee-producing communities in the Costa Grande region.

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