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Environmental perceptions of cloud forest conservation in three mestizo communities of Sierra Madre Oriental, Mexico

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ABSTRACT

Cloud forests are highly biodiverse ecosystems currently at risk of disappearing due to agricultural and livestock expansion. Local communities have traditionally relied on them for firewood, timber, food, and water, and other resources. Conservation strategies have often focused on establishing protected areas, yet these initiatives frequently neglect the social component, leading to community rejection and limited success. In contrast the community-based conservation emphasizes the role of local people as the main promoters of biodiversity protection. As a first step toward implementing such strategies is to assess environmental perception within local populations. This study examined environmental perception in three mestizo communities located in a cloud forest area of the Sierra Madre Oriental, México, through semi-structured interviews. Respondents expressed affection for the forest but did not consider it an economically valuable resource. They acknowledged specific benefits, particularly the provision of firewood, but displayed aversion toward wildlife, especially snakes. Overall, participants showed little concern for forest conservation and demonstrated reluctance to engage in environmental programs, prioritizing productive projects that provide immediate economic returns. Currently, forest persistence in the region appears to be more strongly influenced by external factors, such as agricultural abandonment driven by migration, than by deliberate conservation actions. These findings highlight that before introducing new conservation initiatives, it is essential to inform and raise awareness among local communities about the broader social and economic benefits associated with maintaining cloud forest. Strengthening this understanding could encourage local participation and help ensure the long-term sustainability of these ecosystems.

Keywords: Community based conservation, Firewood, Human migration, Forest values, Pro-environmental attitude..

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SIGNIFICANCE STATEMENT

The cloud forests are a priority ecosystem for conservation, due to their very limited distribution and high biodiversity. Conservation initiatives tend to focus on protected areas, which are often criticized due to a lack of social consensus. Community-based conservation emphasizes the role of society in ensuring the success of nature conservation initiatives. This study provides an insights into how mestizo communities perceive cloud forest, underscoring the importance of incorporating social perceptions into conservation strategies to ensure their long-term effectiveness. Although all interviewees expressed affections for the forest, they did no regard it as an economically valuable resource, with firewood being the most frequently mentioned forest product. By revealing limited concern for conservation but strong reliance on forest resources, our findings highlight the urgent need to strengthen community awareness of the socio-economic benefits of cloud forest preservation. So, informing and engaging local perceptions will be essential before implementing conservation measures.

INTRODUCTION

Conservation strategies should be promoted from a comprehensive approach since social inclusion reduces the factors limiting long-term success (Estrada and Butler 2013; Guibrunet et al. 2021). A key component of successful forest conservation is fostering and strengthen positive opinions that generate proactive attitudes among local populations (Toledo-Aceves et al. 2011; Tengö et al. 2014; Tadesse and Teketay 2017). Proactive attitudes imply participating in actions aimed at preventing deforestation due to land use changes for agricultural or livestock activities (Tadesse and Teketay 2017; Störmer et al. 2019). However, conservation policies often restrict social participation, which could consequently lead to social conflicts and ecosystem degradation (De Pourcq et al. 2017; Rubio et al. 2020). The establishment of protected areas has been criticized for restricting the traditional ways of life that people have had on their land, both environmentally and economically. Therefore, in many cases, imposed conservation initiatives are rejected. Conservation is not only an environmental challenge but should also be considered a socio-political process. (Vucetich et al. 2018; Büscher and Fletcher 2019).

In general, forests have been preserved based on decisions made by the land rights holders. In many cases, this is because they are located in inaccessible areas and are not suitable for agriculture. However, forests are valuable to communities as sources of firewood, food, timber, game, and water, among other things. These values of the forest allow for their integration into conservation efforts, which requires a deeper understanding of traditional knowledge about the forest, its use, and its management. This situation is reflected in community-based conservation approaches that explicitly recognize humans as key actors in the conservation and sustainable management of ecosystems, where local communities are incorporated into forest conservation and restoration efforts (Fox et al. 2006; Calva-Soto et al. 2019; Christmann and Menor 2021; Soares and Ortega 2021). In this regard, environmental perceptions within communities are a fundamental basis for determining the values that conservation holds for different stakeholders. In this context, perception is part of the cognitive process that integrates, processes, and interprets stimuli from the environment to generate behavioral responses (Gärling and Golledge 1989). Then, assessing environmental perception is a crucial study that stakeholders should adopt to legitimize strategies and satisfy the opinions, interests, and attitudes of the communities (Lhoest et al. 2019; Pedraza et al. 2020; Escudero and Mendoza 2021; Jadin and Rousseau 2022). Furthermore, environmental perception is associated with various social factors such as age, gender, economic income, educational level, activity, and ethnicity, among others (Frick et al. 2018; Cuni-Sánchez et al. 2019).

Globally, Cloud Forests (CF) are considered a priority ecosystem for conservation, due to their very limited distribution and high biodiversity (Krasilnikov 2020). Agricultural and livestock expansion has been the leading cause of the degradation and loss of the CF, to which the impact of climate change is currently added (Ponce-Reyes et al. 2012; Ramírez-Soto et al. 2018). CF persist on the humid and frequently foggy slopes of tropical America and Southeast Asia (Doumenge et al. 1995). The extent of this mountain ecosystem has decreased alarmingly, from 50 million hectares in 1974 (Doumenge et al. 1995) to 21.5 million in 2000 (Bruijnzeel et al. 2010), underscoring the need for their conservation. In Mexico, CF is fragmented and has high deforestation rates. However, the remaining fragments still harbor high biodiversity and provide critical nature´s benefits, such as hydrological benefits (Toledo-Aceves et al. 2011; González-Espinosa et al. 2012). CF extends over 1.7 million hectares in Mexico, representing only 0.9% of the national territory (CONAFOR 2022). The loss rate of these Mexican forests was -0.14% between 2000 and 2015 (FAO 2015). Specifically, in the central area of the Sierra Madre Oriental (SMO), located in east-central Mexico, the deforestation rate is higher, ranging between -1.3 and - 1.5 % (Leija-Loredo et al. 2018).

Considering these challenges, the main objective of this work was to evaluate the environmental percep-

tion that local residents have about the forest, considering the benefits that obtain, in three mestizo communities in the south-central region of SMO, Mexico. Specifically, we analyzed the meaning they attribute to the forest, its role in their way of life, and its relationship to conservation.

MATERIAL AND METHODS

Study area

The fieldwork was conducted in the municipality of Tlahuiltepa, Hidalgo, located in the eastern part of Mexico within the SMO (Figure 1). The SMO is a mountain range that surrounds the Gulf of Mexico with an area of 7,879.9 km^2; it is highly heterogeneous with diverse types of soils, climates, and vegetation, which maintains high biodiversity and nature´s benefits (Luna et al. 2004; Bravo-Cadena and Pavón 2018; Suárez-Mota et al. 2017). In the landscape of the south-central region of the SMO, the CF represents mountain ecosystems that are maintained in fragments of various sizes and levels of conservation within a matrix of agricultural and livestock areas (Toledo-Aceves et al. 2011). A humid environment with continuous fog and flora that maintains a mix of boreal and tropical elements characterizes CF (González-Espinosa et al. 2012). Secondary forests grew on abandoned agricultural land.

Within the municipality of Tlahuiltepa, Hidalgo, an area was selected where three neighboring towns are located (Demañi, Palo Perdido, and El Duraznito). The linear distance between the communities is less than 3 km, but El Duraznito (1400 masl) is separated from Demañi and Palo Perdido (2000 masl) by 600 m of altitude (Figure 1). The three communities were considered as replicates, they were analyzed separately. The climate of zone is temperate with an average annual temperature of 18° C, minimum temperatures of -3° C and maximum temperatures of 22° C. The rainy season occurs in summer (June-October), but with the contribution of humidity from cold fronts during the winter and the frequent presence of fog (Pavón and Meza 2009).

The population in the area is mestizo, represented by 149 inhabitants in Demañi (78 men and 71 women), 210 in Palo Perdido (102 men and 108 women), and 284 in El Duraznito (148 men and 136 women). Indigenous Hña-Hñu people founded the communities in the study area. This people originally come from the semi-desert of central Mexico (Mezquital Valley). Due to the Mexican Revolutionary War at the beginning of the 20th century, many people had to migrate to the mountainous regions. However, there are also evidence of the previous presence of the Mexican people. The predominant religions practiced here are Evangelical Christianity and Catholicism. The area has a significant population of migrant workers, particularly in El Duraznito, where people travel to the United States seasonally. In Demañi and Palo Perdido, migration is primarily to Mexico City and Pachuca. Consequently, a majority of the population receives remittances from abroad. Fewer and fewer people are now working in agriculture. People say that it is cheaper to buy their food than to grow it themselves.

There is heterogeneity in the livelihoods of the study communities. On the one hand, local and traditional livelihoods are based on small-scale primary activities, which is reflected in the traditional styles of housing and diet (Figure 2). While traditional agriculture is still practiced, livestock raising has become increasingly uncommon. On the other hand, several individuals engage in migration as a livelihood strategy, which brings about cascading changes in religious beliefs. According to conversations with older members of these communities, forests have visibly recovered in the surrounding landscape, as they are currently used less for subsistence than they were a few decades ago (Figure 2).

Sampling design

A semi-structured interviewing was applied to the three selected communities' inhabitants during the summer of 2022 (16 in Demañí, 24 in Palo Perdido, and 23 in The Duraznito). These localities culturally characterize the mestizo communities of the Sierra Madre Oriental, so they were considered replicas. Convenience sampling was used due to the need to identify individuals with the greatest expertise in local conservation; the communities were visited from house to house, and the interviewees were selected based on their residence and the inhabitants' availability (Bernard 2017). The interviewing (Additional File 1) contained 42 questions covering the following aspects: identity, meaning, behavior, threats, conservation, organization, and belonging.

Identity considers social aspects, including values, experience, benefits, and interests related to the forest. Behavior considered the activities in the study area, such as the use and availability of forest resources. Threats to conservation included aspects related to human impact on the forest. Conservation considers people's knowledge about it, reasons for conserving the forest, and actions taken to protect it. Organization included participation in forest use, as well as benefits, impacts, and decision-making processes involved. Finally, membership considered migration and the perception of the forest´s future.

The initial structure of the interviewing was modified based on previous visits to the communities, where exploratory chats were conducted with some residents.

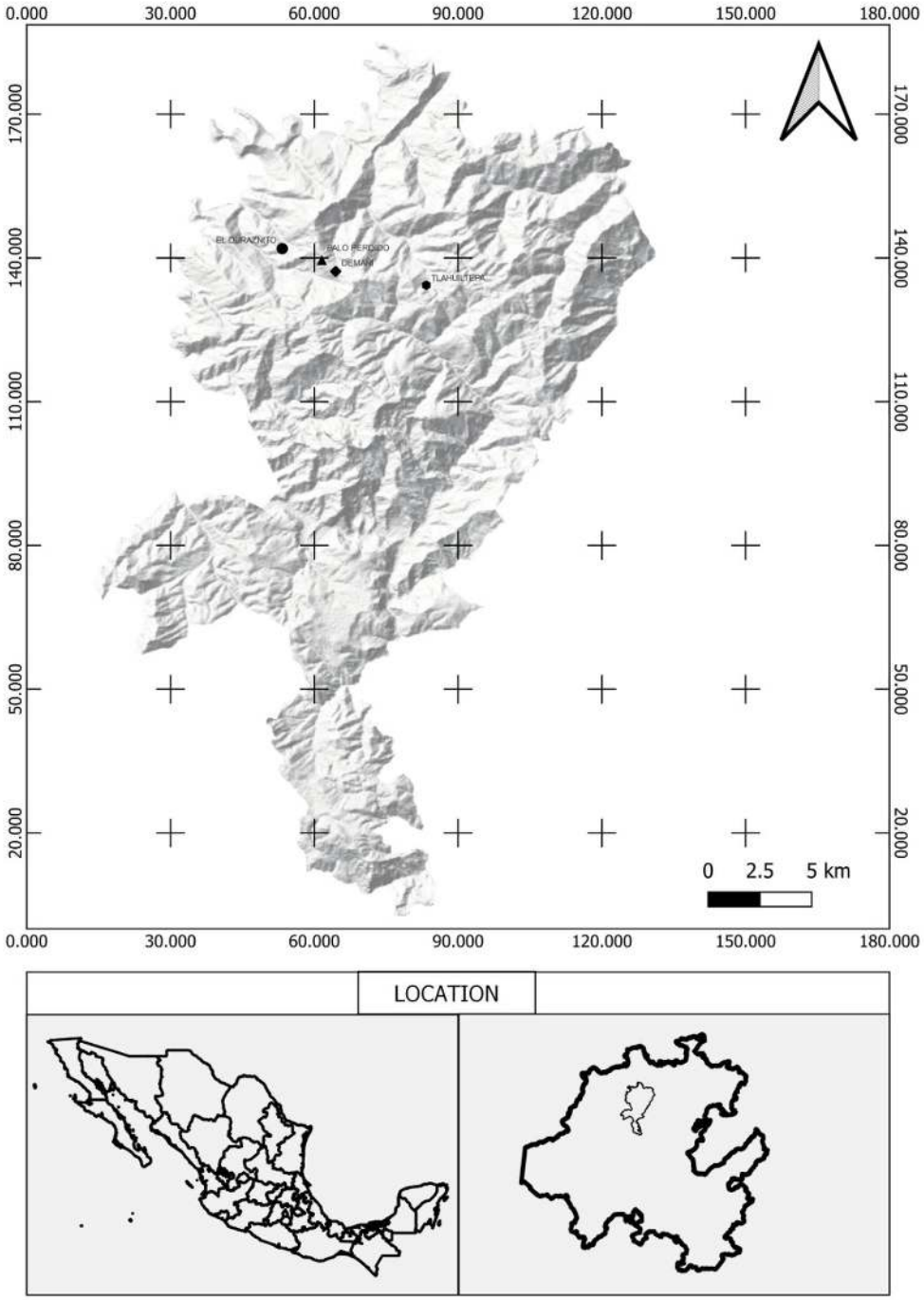

Figure 1. Location of the study area in the eastern part of Mexico in the municipality of Tlahuiltepa, state of Hidalgo.

Certain questions were changed by replacing technical terms with words commonly used in the area. In accordance with the Declaration of Helsinki (Mancini 2000), the interviewer introduced himself to the participants, explained the objectives of the study, and requested their cooperation for the interview and permission to use the information obtained. The interviews were conducted individually to avoid the pres-

Figure 2. Photographs of landscape and activities performed by inhabitants of the Municipality of Tlahuiltepa, Hidalgo, in the Sierra Madre Oriental, México, during this study.

ence of others, and all bystanders were kindly asked to allow privacy to prevent any external influence.

YCT and an assistant, who had previously standardized how they approached the interviewees and how the questions would be asked, conducted the interviews. During the interviews, it was necessary to provide some explanations. For example, it was necessary to explain the nature´s benefits of provision, regulation, support, and cultural. Alien invasive species were defined as plants and animals not native to the study area but have recently arrived. In addition, some interviewees had difficulties with the term "forest fragmentation," so the help of photographs of fragmented landscapes was explained. The data obtained were captured in a database for later analysis.

Data analysis

The respondents' priorities on behavior (questions A, B, E, F), forest's conservation (questions A-G), and belonging (question E) (see interviewing in Additional File 1) were analyzed using the free list technique (Bernard 2006) and the Smith relevance index (SRI) (Smith and Borgatti 1997). These analyses identified priority elements according to the order and frequency of mention. Smith's relevance index values range from 0 to 1, with the closer to 1, the more important the item. The analyses were performed using Visual Anthropac software v.1.0.1.36.

The Likert-type scale was used to calculate the intensity of an attribute based on each interviewee's response of meaning (question D), behavior (question C), and Forest´s conservation (question A), organization (questions A, C, D-F), and belonging (questions A-C) (see interviewing in Additional File 1) (Joshi et al. 2015). For this work, three categories were considered, based on the impact of each activity, at the following measurement levels: negative (nothing and minor), neutral (regular), and positive (a lot and too much). The above is based on the assumption that the experience in the intensity of the categories is linear (nothing, little, average, a lot, and too much). The average value of the Likert scale was calculated by multiplying the response frequency of each item by the

numerical value of its corresponding level. The total number of responses was then divided by the sum of the responses (Joshi et al. 2015). Likert-type questions had five response levels (not at all in agreement = 1, slightly = 2, moderately = 3, highly = 4, extremely = 5); therefore, the mean score ranged from 1 to 5 (values closer to 1 indicate that respondents were not at all in agreement with the statement, whereas values closer to 5 indicate that they were extremely in agreement). The Cronbach's Alpha value was used to determine the reliability of the Likert-type scale. This scale varies between 0 and 1, where values close to 1 indicate high reliability (Amirrudin et al. 2021).

On the other hand, the independence between the percentage values of the categories and the communities of behavior (questions A, E), forest´s conservation (question C), and belonging (questions A, D) (see interviewing in Additional File 1) were analyzed with Chi-square tests.

A No metric multidimensional scaling ordination was performed to explore respondent's perception about CF conservation in the study area. A database was previously created with the values assigned to the response options given in the interviewing to the questions related to meaning, behavior, threats, and conservation attitude. To analyze whether environmental perception differed among communities a permuted multivariate analysis of variance (PERMANOVA) was performed. Statistical analyses were performed using Past software ver. 4 (Hammer et al. 2019).

RESULTS

The 63 interviews were conducted in Demañi with 4 men and 12 women; in Palo Perdido with 7 men and 17 women; and in El Duraznito with 12 men and 11 women. The average age of the interviewees was 34 years old; the oldest people were 70 years old. Half of the interviewees mentioned being evangelical Christians (9 in Demañi, 9 in Duraznito and 14 in Palo Perdido). For the study area, 17 occupations were recorded such as laborer, farmer, bricklayer, receptionist, guard, homemaker and migrant, among others. Highest educational level was bachelor degree, and in most of the respondents was secondary level. In general, the interviewees considered themselves to belong to a middle socio-economic level.

Migration turned out to be a factor that was dependent on the community ($\chi^2 = 8.639$, d.f. $= 2$, $p = 0.013$). While in Demañi (75%) and Palo Perdido (70.8%), respondents do not intend to continue to migrate, in El Duraznito they do. In this community, 65% of the respondents mentioned their interest in migrating, mainly to the USA. The main reasons for migrating were economic (IS = 0.463) and having a job (IS = 0.339). In particular in El Duraznito, family is another important driver for migrating (IS = 0.206), as they already have relatives working in the USA.

All the interviewees in the three communities like the forest. In general, they considered that both people and the rest of nature are equally important ($\chi^2 = 3.651$, d.f. $= 4$, $p = 0.455$). A total of 46% of the respondents, across the three communities reported having positive experiences in the forest ($\chi^2 = 5.203$, d.f. $= 6$, $p = 0.517$).

Overall, perceptions of the importance of forests and their threats were similar among communities. The nonmetric multidimensional scaling ordination showed overlapping among respondent´s perception of three communities in Tlahuiltepa (Figure 3). The PERMANOVA indicated no significant differences amount communities (F = 1.01, p = 0.48).

For the interviewees, the forest has mainly emotional meanings, but they also mentioned sentimental, spiritual, and utilitarian meanings. In contrast, the perception of the economic value of the forest was low (Table 1; Cronbach's alpha = 0.506). In Palo Perdido, the spiritual meaning was lower than other communities (Table 1).

Good air quality (SRI=0.264) and a clean environment (SRI=0.122) stood out as the main advantages of the existence of the forest, among 18 advantages mentioned. Regarding the perception of the benefits of the forest, in the three communities firewood and air quality stood out above the rest with SRI = 0.414 and SRI = 0.262, respectively.

In all three communities, respondents considered recreation to be the main activity they carry out in the forest (SRI of 0.580). In general, firewood stood out as the main use of the forest (SRI of 0.799) among 10 different uses. In addition, they reported that they have always used the forest. However, their perception is that forest resources have decreased, this opinion was significantly adjusted between communities ($\chi^2 = 3.841$, $p = 0.698$).

The interviewees considered that the forest is threatened by various factors related to human activities (Table 2; Cronbach's alpha = 0.746). Of these factors, the introduction of species had the lowest value on the Likert scale. Palo Perdido was the community that stood out because they gave a high value to illegal logging and fires as threats to the forests.

Climate change, in terms of temperature increase, was a highly perceived phenomenon, with more than 60% of those interviewed agreeing that it did not exist before and now it does. In Demañi, up to 75% of those interviewed perceived this same condition.

Agriculture, cattle raising, and hunting are activities that have remained constant in the study area. However, in El Duraznito the dominant opinion with 52.2% was that agriculture has decreased in recent years. Threats to the forest that did not adjust be-

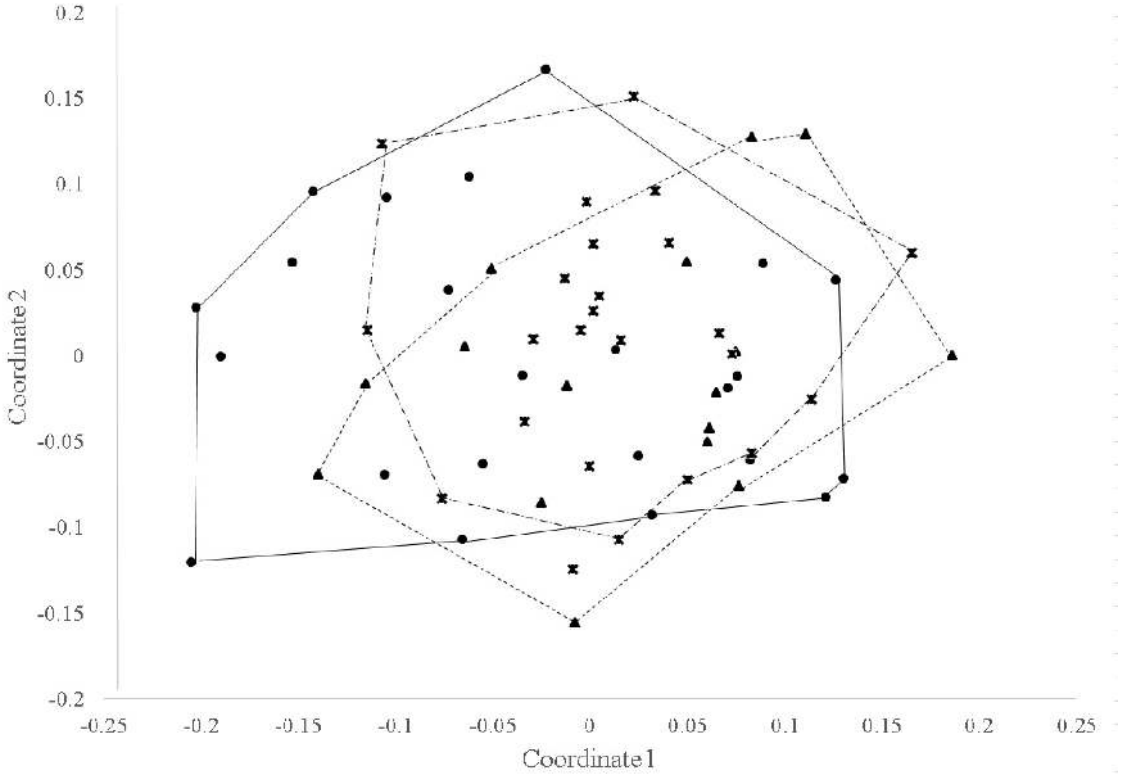

Figure 3. Ordination diagram of No-metric Multidimensional Scaling of the perception variables in three communities in the municipality of Tlahuiltepa, Hidalgo, Mexico. Circles represent respondents from Palo Perdido, triangles from Demañi, and X from El Duraznito. The lines frame the skull of each community.

Table 1. Highest values obtained from the Likert scale for the different meanings assigned to the forest in three communities of Tlahuiltepa, Hidalgo, Mexico.

Likert-type scale	Emotional	Sentimental	Spiritual	Utilitarian	Economic
Demañi	3.87	3.56	3.06	3.5	2.56
El Duraznito	3.78	3.73	3.56	3.78	2.86
Palo Perdido	3.58	3.29	2.62	3.66	3.08
Study area	3.73	3.52	3.07	3.66	2.87

tween communities were hunting ($\chi^2 = 18.72$, $p = 0.043$) and mining ($\chi^2 = 44.69$, $p < 0.000$).

According to Smith's relevance index, the response with the highest index value (0.365) was that no human activity generates a risk. Meanwhile, garbage dumps (0.245) and logging (0.212) were the activities most associated with being harmful to the forest.

The term conservation was associated with 11 actions within the study area. The consensus of the communities was that caring for the forest is the most important action (SRI = 0.651), followed by not cutting down trees (SRI = 0.190). In general, the interviewees associated flora as the most relevant component to conserve (SRI = 0.696), followed by the fauna (SRI = 0.189), followed by water (SRI = 0.151). The reasons for conserving were diverse but in general the most important was the quality of life (SRI = 0.254). In Demañi, a single relevant concept was highlighted which was the provision of water (SRI = 0.229). Although 15 actions were mentioned for conservation, reforestation was the most relevant (SRI = 0.401). It was interesting that the second most relevant action was none (SRI = 0.222). On the other hand, in general the interviewees showed regular or little willingness to participate in conservation activities. They were asked about their willingness to participate

Table 2. Likert scale values on the perception of threats to the Cloud Forests conservation in Tlahuiltepa, Hidalgo, Mexico.

	Climatic change	Invasive alien species	Fragmentation	Legal logging	Ilegal logging	Cattle raising	Hunting	Agriculture	Fires	Mining	Overharvesting	Recreational activities
Demañi	3.31	1.93	2.81	3.18	3.62	2.31	2.43	2.12	3.93	2.31	2.87	2.00
El Duraznito	3.69	1.95	3.13	3.13	3.91	1.82	2.91	2.08	3.59	2.00	2.26	2.21
Palo Perdido	3.45	1.70	2.62	3.12	4.25	1.79	3.08	1.87	4.20	2.00	2.62	2.37
Study area	3.50	1.85	2.85	3.14	3.96	1.93	2.85	2.01	3.91	2.08	2.55	2.22

in six workshops related to conservation actions and the general response was average. In El Duraznito we recorded the lowest willingness to participate in workshops. In general, the highest values of intention to participate in workshops related to forest conservation, according to the Likert scale (Cronbach's alpha = 0.895), were those of productive practices (3.28), and economic benefits (3.26).

For the study area, it was considered that all people are little or not at all affected by the use of the forest, the values according to the Likert scale fluctuated between 1 and 2.29 (Cronbach´s alpha = 0.215).

In general, all inhabitants are regularly taken into account regarding forest use (values between 2.7 and 3.27 on the Likert scale). Only in Demañi, the Government was considered an actor of regular importance in decision-making (3.06 on the Likert scale). However, in Duraznito and Palo Perdido, it was mentioned that the Government should be considered for decisions, 3.17 and 3.37 on the Likert scale, respectively. No other actors, including non-governmental organizations were mentioned as necessary to be involved in decision-making.

A key aspect of this work was the perception of the interviewees about the future of the forest in the study area. In this sense, the majority of the interviewees considered that there will be less forest in the next 50 years (Table 3). This opinion was significantly similar among communities in the study area ($\chi^2 = 9.089$, $p = 0.334$). Some people even considered that the forest would disappear.

DISCUSSION

The three communities studied had similar environmental perceptions because they shared the same forest and socio-economic characteristics. However, we recorded differences among communities in certain aspects. For instance, in Palo Perdido, there was a slightly greater interest in aspects related to the forest and its conservation.

In general, the interviewees showed little interest in the benefits of forest conservation, which partly explains the lack of a positive attitude towards initiatives involving community participation in forest preservation. The low intensity of emotional and affective ties could imply a lower environmental commitment (Hunn 2014; Tonge et al. 2014). Although all the interviewees expressed a liking for the forest, due to their positive experiences, they did not consider this valuable. The importance of CF was mainly associated with the benefits derived from it, which were not necessarily economic. Various social and economic factors could drive this perception, reflecting changes in traditional uses and customs.

Migration, the abandonment of agriculture, and processes of religious change constitute key factors that place forest conservation at risk by contributing to the erosion of socio-territorial identity. Rural-urban migration and migration to the Unites States have been widely documented as processes that weaken everyday ties to the territory, fragmented local ecological knowledge, and reduce community participation in natural resource management (Bebbington 1999; Jokisch 2002; Radel et al. 2010). In addition, the abandonment of agricultural activities has weakened the daily relationships of peasant households with the

Table 3. Perception about the future of the Cloud Forests in Tlahuiltepa, Hidalgo, Mexico. Data are showed as percentage of the total of respondents.

	Disappears	**Less**	**Same**	**More**	**Uncertain**
Demañi	06.25	68.75	06.25	12.50	06.25
El Duraznito	04.35	65.22	13.04	13.04	04.35
Palo Perdido	20.83	41.67	08.33	08.33	20.83
Study area	10.47 ± 9	58.61 ± 14.7	9.20 ± 3.5	11.29 ± 2.6	10.47 ± 9

landscape and traditional agroforestry systems, affecting both local ecological knowledge and the capacity for community organization (Robson et al. 2018; Castillo-Rivero et al. 2021). In parallel, the introduction and expansion of religions in regions traditionally dominated by Catholicism may reconfigure value systems and meaning associated with forest, displacing symbolic or spiritual conceptions previously linked to their protection and collective management (Byers et al. 2001; Sheridan and Nyamweru 2008; Mavhura and Mushure 2019).

In other studies on environmental perception, it was reported that people struggled to understand the concept of ecosystem services (Ramos et al. 2018; Gouwakinnou et al. 2019), and this was no exception within the study area. Recently, new terms have emerged replacing "ecosystem services," such as "nature's contributions to people" (Díaz et al. 2018) and "nature's benefits" (Kamjou et al. 2024). Although, some authors who consider them synonymous with "ecosystem services" have criticized these proposals, the new terms actually eliminate the commodification of nature and reduce the anthropocentric perspective. Therefore, in this work, we use the term "nature's benefits" (NB). For instance, in Demañi respondents referred to NB as "benefits from God," "benefits from the forest," or "natural resources." The latter could be a sign of cognitive effect that influence environmental protection decisions (Hunn 2014). In general, provisioning NB was the most relevant, which coincides with other researches (Ramos et al. 2018; Cuni-Sánchez et al. 2019; Gouwakinnou et al. 2019; Lhoes et al. 2019). For Gouwakinnou et al. (2019), provisioning NB is the most important for the poorest communities and those closest to the forest. While people with a higher economic and educational level primarily identify the regulating NB (Caballero-Serrano et al. 2017). In the study area, the communities are very close to the forest, and the population has a basic level of education. They mainly consider themselves to belong to the middle-income class. Supporting and regulating NB also were identified in the three communities, with air quality and a clean environment being the most prominent. These two NB have been the most mentioned in other studies (Frick et al. 2018; Pedraza et al. 2020).

On the other hand, the leading provision is firewood, which is consistent with other tropical regions of Latin America; in Mexico, it was estimated at 16 million firewood users (Pérez et al. 2023). In Demañi, some people were detected selling firewood, which the interviewees denied. In contrast, in El Duraznito, wood for construction was highlighted as a good provided by the forest. The communities have regulations requiring individuals to request from the communal assembly, specifying their logging needs.

Their lack of economic dependence on the forest could be a factor that prevents harmful actions (Tonge et al. 2014). However, conservation is not at odds with the sustainable management of resources. It is crucial to consider the social and economic benefits it can bring to the inhabitants, generating a positive local perception. This underscores the importance of each individual's role in forest conservation (Sena-Vittini et al. 2023).

To address these challenges and promote conservation approaches that integrate socioeconomic well-being with forest conservation, several strategies can be implemented. For example, in Mexico, The "Sembrando ida" program has been developed with the aim of generating income opportunities in rural areas through the establishment of agroforestry systems that combine agriculture production with forest restoration (Gómez-Rodriguez et al. 2023), thereby contributing to both rural employment and the nature conservation. Likewise, community-based forest management initiatives have been associated with migration dynamics in forest-dependent rural economies, suggesting that local forest management strategies may influence migration decisions and contribute to the sustainability of rural livelihoods (Smith et al., 2024). Adding, at the regional level, alliances that strengthen local governance, territorial rights, and regenerative forest economies have been promoted to enhance the resilience of Indigenous and rural communities in the face of population loss and environmental degradation

(Climate and Land Use Alliance 2025). Taken together, these experience suggest that integrated public policies that link sustainable economic opportunities, support for agriculture and reforestation, the strengthening of community organization, and the recognition of cultural values associated with forest can help reverse trends of rural abandonment and foster forest conservation from a comprehensive socio-ecological perspective.

In general, people were unaware that human activities negatively affect the forest. The perception of threats and environmental pressures on the forest was weak. It has been reported that local communities tend to recognize only those forest benefits directly linked to their livelihoods, a pattern shaped by socio-economic conditions, education level, and direct dependence on specific forest resources (Pour et al. 2023). This perceptual bias may explain why the impact of human activities often go unnoticed by local population. A study conducted in Colombia reported that when forest degradation occurs gradually, it may be underestimated due to sociocultural background and levels of participation in forest management processes (Armenteras et al. 2023). When degradation processes develop slowly, such as subtle changes in forest structure or the loss of less visible components of biodiversity, communities may fail to detect these changes or may attribute them to natural variability rather than to human impact.

In addition, forest-based subsistence activities, such fuelwood collection, can shape local belief systems by prioritizing direct and tangible benefits over other, intangible forest functions, such as carbon sequestration or climate regulation. As a result, the impacts of less frequent or less visible activities, such as selective logging or land-use conversion, tend to be underestimated (Armenteras et al. 2023; Hepner et al. 2025). From another perspective, local actors may also minimize the negative impacts of their own practices as a psychological mechanism to sustain their livelihoods and reduce the perceived conflict between subsistence needs and conservation (Pour et al. 2023).

The interviewing included twelve possible threats to the forest, of which only climate change and logging were highlighted. The respondents linked the increase in temperature and the drought to climate change. For them, the most important environmental problem they are facing is the scarcity of water, which they believe is due to climate change. Climate change is a complex phenomenon that has been widely disseminated by various media in recent years in the study area. Additionally, recent experiences with the impacts of drought and fires left an impression on the population, increasing the perception of this threat (Clayton 2019). Some authors mentioned that the population that perceives greater risk from extreme events are more willing to establish mitigation and adaptation measures to climate change (Maddison 2007; Semenza et al. 2008).

Hunting is an activity that persists in the area and perceived as harmful to the forest. However, wild animals were also considered harmful, particularly snakes; one interviewee even considered the forest harmful because it favors snakes. In this sense, it is recommended that environmental education activities be carried out to prevent and manage snakebite accidents (Fernández-Badillo et al. 2021). The interviewees did not identify exotic species within the CF, so they did not consider them a threat. On the other hand, there is a positive attitude towards domestic animals, which represent food and economic income and are not restricted in the forest. However, some domestic species, such as goats and sheep, consume tree seedlings, negatively affecting the forest (Veitch and Clout 2001).

The scant interest in participating in conservation workshops evidenced the poor pro-environmental attitude. Palo Perdido stood out for being more willing to participate in conservation strategies. The simplicity of the responses to questions about actions associated with the term "conservation" was apparent, with respondents pointing to the abstract idea of "taking care of the forest" without specifying concrete actions. However, this distance from the forest among some interviewees could be reversed with activities and workshops focused on self-discovery of its values.

Migration is an important factor to consider when explaining the obtained results. Migration can lead to a loss of a sense of belonging, decreasing the perception of the environmental component and, thus, less interest in forest conservation. As individuals become attached to a place, they are more likely to protect it since the dimension of place identity is also related to the level of commitment, attitude, behavioral intention, critical thinking regarding social or environmental conditions, and pro-environmental behavior. Thus, greater commitment facilitates the development of long-term conservation actions (Tonge et al. 2014). In Duraznito, people migrate to the United States to perform agricultural work. In Demañi and Palo Perdido, they migrate mainly to urban areas of Mexico. In 2007, remittances reached one billion dollars in the state of Hidalgo, which includes the municipality of Tlahuiltepa (Cortés-Rivera et al. 2020). Migration is associated with the abandonment of lands caused by agricultural decline and its negative impact on rural livelihoods (Soliva et al. 2010; Frei et al. 2020; Mantero et al. 2020). In several Latin American countries, the recovery of forest ecosystems after rural-urban migration has been reported (Aide and Grau 2004). Given the migration that occurs in the area and the abandonment of agricultural activities, forest

succession will occur in the medium term. Globally, forest recovery occurs more frequently on steep slopes in mountainous regions (Garbarino et al. 2020). Aide et al. (2012) estimated that approximately 360,000 km^2 of new secondary forests were developed on abandoned agricultural land. Forest recovery favors the conservation of tree species and improves landscape connectivity (Smallbone et al. 2014; Palmero-Iniesta et al. 2020).

In the area, the perception of the forest's future was negative, with many believing it would disappear. This perception contradicts the lack of recognition of threats to the forest. This pessimistic view is shared elsewhere. For example, children in a community in northeastern Brazil were pessimistic about the future of forests (De Sousa et al. 2021). This pessimism may reflect a bias in considering only economic importance, leaving aside other values necessary for human well-being (Tadesse and Teketay 2017).

Conservation initiatives that incorporate economic and social development are more likely to generate positive attitudes and behaviors towards forest conservation (Ihemezie et al. 2021). This does not undermine traditional knowledge as fundamental in conservation strategies (Ihemezie et al. 2021). However, it is important to note that cultural values can be vulnerable to social changes in rural communities, such as the spread of religions and the transculturation of young people (Mavhura and Mushure 2019). This vulnerability should be a cause for concern and a motivation to act, as it can affect the success of conservation efforts. For the study area, community-based sustainable development projects could be generated as a conservation strategy (Aide and Grau 2004). Activities such as beekeeping and ecotourism have been successfully promoted in other areas (Chanthayod et al. 2017). On the one hand, it is essential to understand local residents´ opinions regarding necessary planning and governance (Upadhaya et al. 2022). Nevertheless, local inhabitants must also be involved in awareness-raising processes that serve to strengthen the sense of belonging and biological-environmental knowledge in a simple but progressive way.

In general, we found that environmental perception regarding the importance of forests was limited among mestizo communities in the study area. This result highlights the need to better communicate how forest ecosystems provide benefits that translate into community well-being. Although this study could have explored in greater depth the factors underlying people's disengagement from the forest, it allowed us to formulate the hypothesis that migration processes in the region are reshaping local livehoods, contributing to the erosion of traditions historically linked to nature. Migration is a socio-ecological phenomenon with complex dynamic, and its implications for forest conservation warrant further investigation, not only from an economic perspective related to the satisfaction of basic needs, but also considering social identity and sense of place. Thus, this topic remains and important avenue to future research.

This research adopted a primarily diagnostic approach; however, it lays the groundwork for advancing toward a more applied conservation proposal based on interventions that respect, represent, and value the local context. In this regard, the study did not include participatory methodologies through which community members could propose conservation strategies aligned with their productive and economic interests. Currently, one of the authors (ROP) is working alongside local communities on sustainable forest management and the resolution of environmental challenges, such as water scarcity. A critical step toward the conservation of the cloud forest of the Sierra Madre Oriental, Mexico, will be to foster community-led proposals for forest management and conservation, recognizing that forest inhabitants themselves should be the primary stewards and decision-makers responsible for caring for the natural environments they inhabit. Ultimately, strengthening forest conservation in this region depends on sustaining the reciprocal relationship between people, knowledge, and forest landscapes that have historically shaped both cultural practices and ecological integrity.

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DATA AVAILABILITY

The data used to support the findings of this study are available from the corresponding author (NPP) upon reasonable request.

CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

CONTRIBUTION STATEMENT

Conceived of the presented idea: NPP.
Carried out the experiment: YCT
Carried out the data analysis: YCT, MTPS
Wrote the first draft of the manuscript: YCT, NPP, MTPS, ROP
Review and final write of the manuscript: YCT, NPP,

MTPS, ROP
Supervision: NPP, MTPS, ROP
Logistical support: NPP, ROP

DISCLOSURE OF AI USE

The authors used ChatGPT and Grammarly to assist in improving language clarity to the manuscript. The content was reviewed and edited by the authors to ensure accuracy and appropriateness.

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Additional Files

Add File 1. Semi-structured interviews based on the following questionnaire applied to the inhabitants of the communities of Demañi, Palo Perdido, and El Duraznito in the municipality of Tlahuiltepa, Hidalgo, Mexico, to assess their perception of the conservation of the Tropical Mountain Cloud Forest. The numbers assigned to each response were used to generate the data matrix for the analyses.

https://ethnobioconservation.com/ebc/article/view/1179/525